TOWN OF DARTMOUTH
BUTTONWOOD BROOK WATERSHED
MANAGEMENT PLAN

SES

SANFORD ECOLOGICAL SERVICES, Inc.

Environmental Consultants

TOWN OF DARTMOUTH
BUTTONWOOD BROOK WATERSHED
MANAGEMENT PLAN

Prepared for:

THE TOWN OF DARTMOUTH
TOWN HALL
SLOCUM ROAD
DARTMOUTH, MASSACHUSETTS
02749

Prepared by:

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December, 1991

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1.0 INTRODUCTION

Background

Historically, Buzzards Bay has been a productive source of shellfish such as quahogs, clams, scallops and oysters. The annual economic value of its landed catch is estimated at 6.6 million dollars.[1] Over the last twenty years, there has been a dramatic increase in the number of shellfish-harvesting areas closed due to pathogen contamination. In 1970, 4,358 acres were closed; by 1990, nearly 13,500 acres had been put off-limits to shellfishing.

The Town of Dartmouth Massachusetts, a coastal community on Buzzards Bay, has had over 1,700 acres of its shellfish beds closed during this period. Among those areas affected are 50 acres of shellfish beds located north of Mullins Wharf in upper Apponagansett Harbor (Figure 1). In 1989, The Town of Dartmouth received a Community Mini-Grant from the Buzzards Bay Project to develop a Water Quality Management Plan for the Buttonwood Brook Watershed, a drainage basin whose waters are popularly perceived as being substantially responsible for this shellfish bed closure. The goal of the watershed management plan is to develop management strategies that will:

- minimize bacteriologic pollution and,
- create conditions that might allow for the reopening of this shellfish area.

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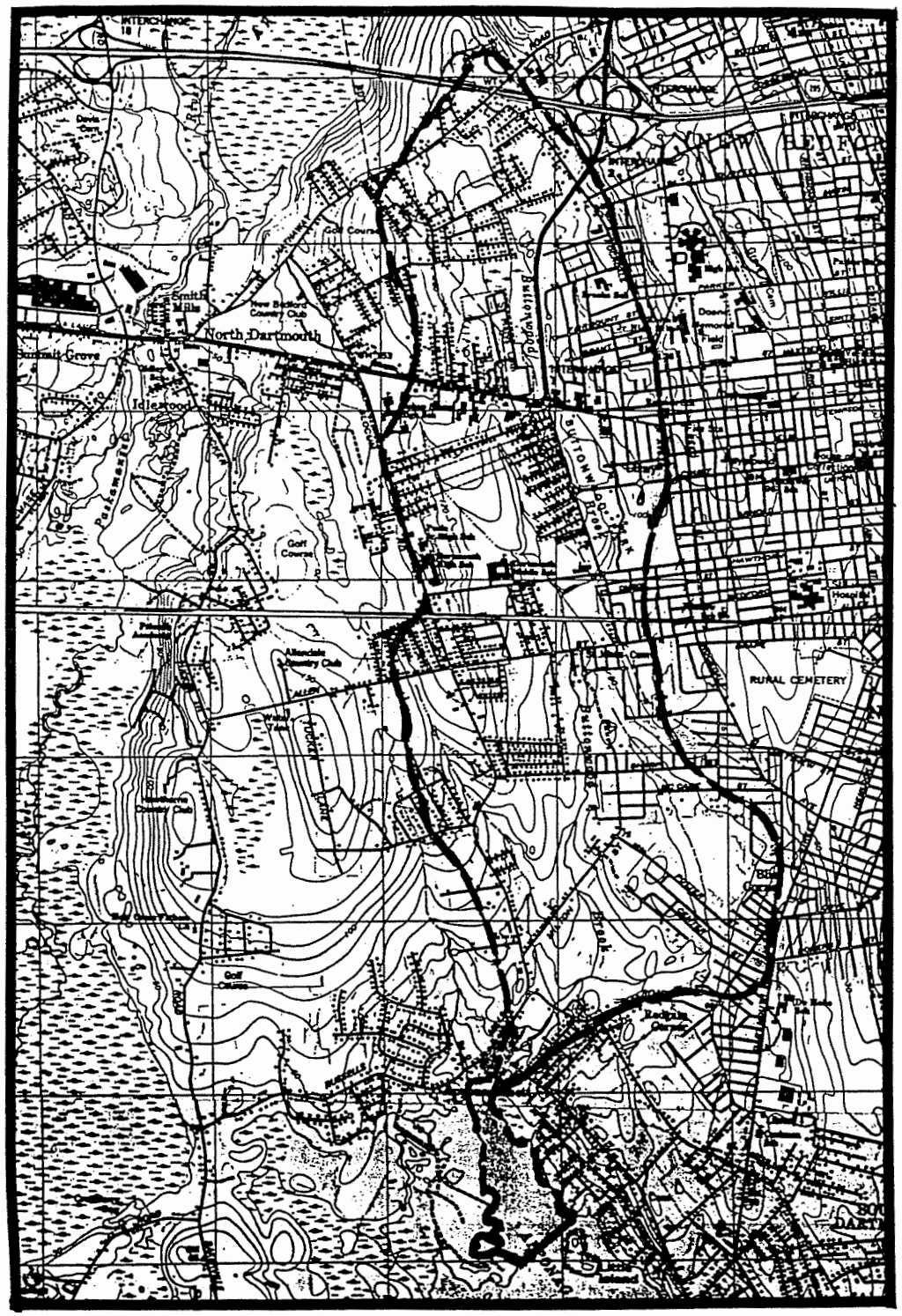
[1]Boston University Marine Program. Shellfish in Buzzards Bay: A Resource Assessment, Woods Hole, Massachusetts, June 1987.



SITE LOCUS
BUTTONWOOD BROOK WATERSHED AND
NORTH APPONAGANSETT HARBOR
TOWN OF DARTMOUTH MINI GRANT
NEW BEDFORD NORTH AND SOUTH, MA TOPOGRAPHIC QUADRANGLES
APPROXIMATE SCALE 1" = 3200'

FIGURE 1

Watershed Description

The Buttonwood Brook Watershed (Figure 2), located on the eastern boundary of the Town of Dartmouth, is comprised of approximately 2,300 acres, of which, about one third lie within the City of New Bedford. Generally, the watershed is bounded on the west by Slocum Road, on the south by Russells Mills Road and on the east by Rockdale Avenue. Buttonwood Brook (Branch A) originates in New Bedford near the water tower on Hathaway Road and flows into the northern end of Apponagansett Harbor. Two tributaries, branches B and C, flow into the Brook north of Russells Mills Road.

With the exception of some areas of moderate slope on its periphery, the watershed's topography is relatively flat.

According to the U.S. Soil Conservation Service [2], four soil series predominate in the watershed: the Paxton Series, the Ridgebury Series, the Whitman Series and the Woodbridge Series. These soil series have similar characteristics; they are fine to extremely stoney sandy loams of little (0%) to moderate (8%) slope with seasonally perched water tables that limit their suitability for community development and septic tank absorption fields.

Of the watershed's 1,700 acres located in Dartmouth, 58% of the land use is urban (single family residential, institutional, commercial and retail/office) and 42% is open space (regulated

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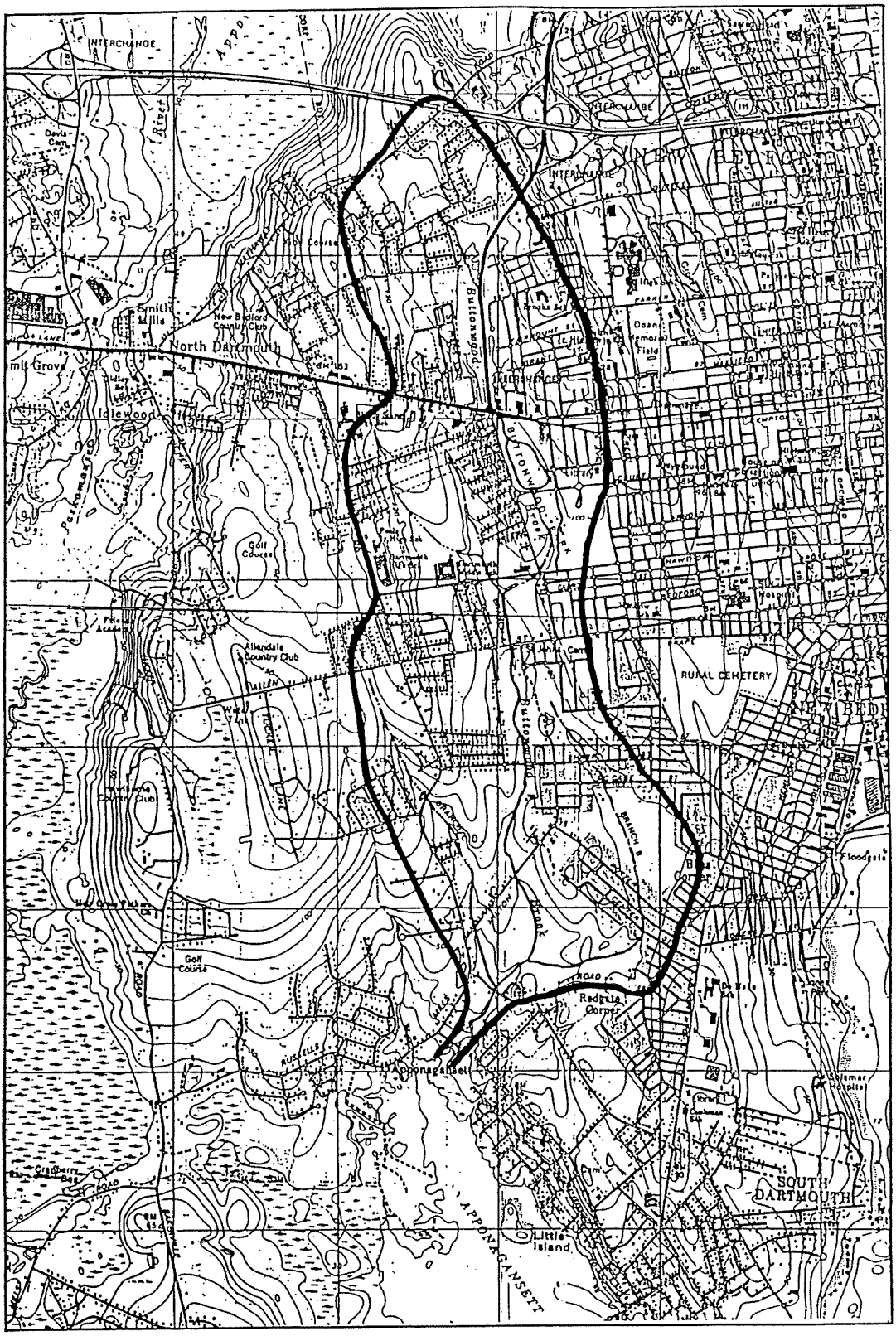
[2] Soil Survey of Bristol County Massachusetts, Southern Part



BUTTONWOOD BROOK WATERSHED

DARTMOUTH, MASSACHUSETTS

SANFORD ECOLOGICAL SERVICES, INC.
258 MAIN STREET
BOURNE, MASSACHUSETTS
JANUARY, 1990
SCALE 1 INCH = 800 FEET
SOURCE: USGS

N

FIGURE 2

wetlands, conservation lands, and agriculture) (Figure 3). Deciduous wooded swamps, deciduous shrub swamps and wet meadows, all protected by local, state and federal regulations, flank significant portions of the brook and its branches.

Much of the watershed is presently serviced by both sanitary and stormwater sewer systems. However, stormwater is routinely discharged directly into the Buttonwood Brook system at numerous locations.

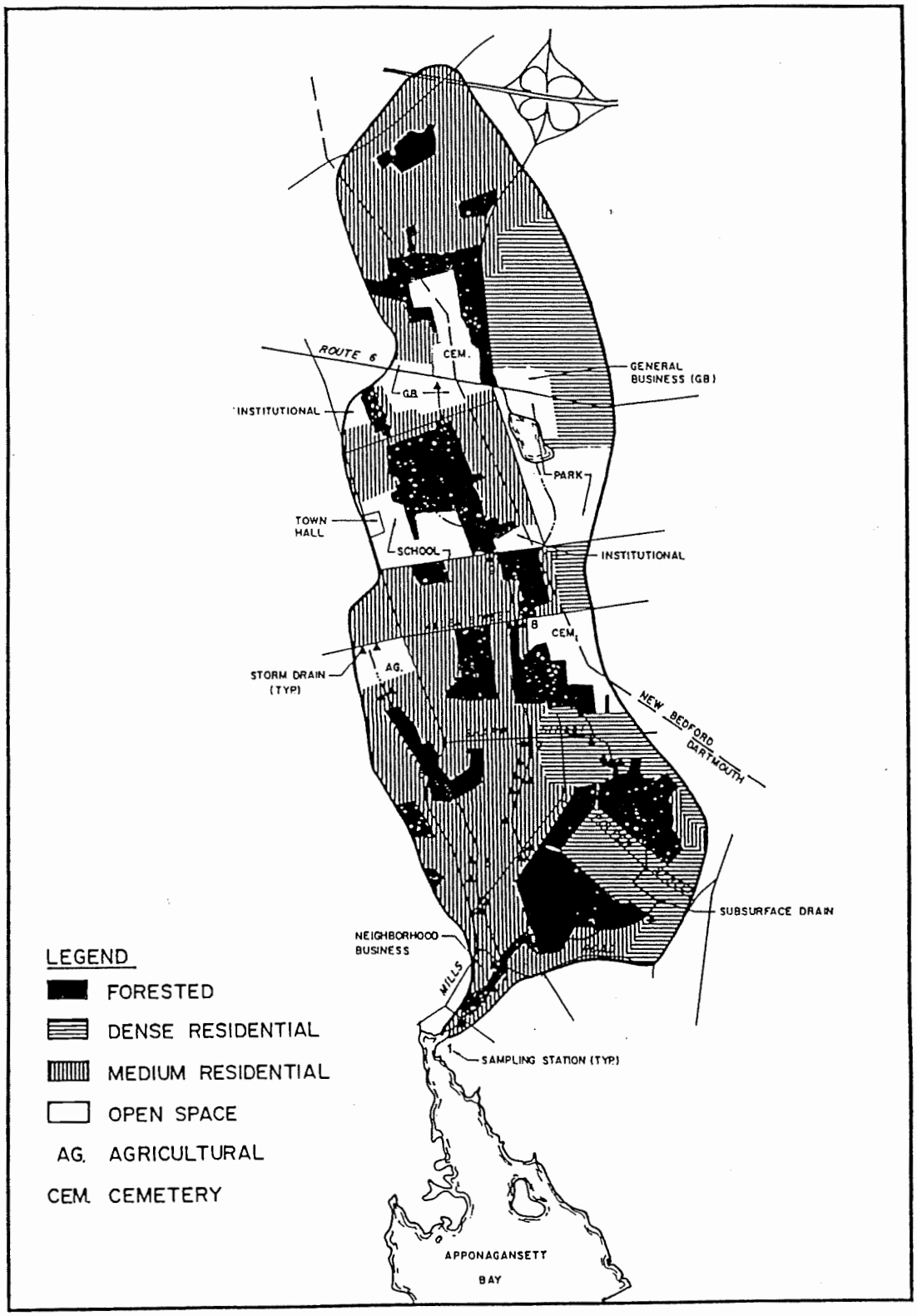
Project Scope

Preparatory to developing the Watershed Management Plan, the Town of Dartmouth, acting through its agent, Sanford Ecological Services, Inc. (SES) performed these tasks:

- Established a water quality monitoring program based on an assessment of the study area to target locations and general trends in seasonal nutrient and bacteriological pollution loads to the watershed (See Attachment 1),

- Inventoried shellfish populations in Apponagansett Harbor north of the line drawn from "Star of the Sea Villa" to "Mullin's Wharf", to determine the size, abundance, and species of shellfish present. The inventory provides a basis for the evaluation of the economic value of the Apponagansett Harbor resources. (See Attachment 2) and,

- Reviewed and evaluated all applicable existing land use and water quality regulations (See Attachment 3).



BUTTONWOOD BROOK WATERSHED LAND USE MAP

SANFORD ECOLOGICAL SERVICES, INC.
258 MAIN STREET
BOURNE, MASSACHUSETTS
MARCH, 1991
SCALE: 1" = 800'

FIGURE 3

2.0 STATEMENT OF FINDINGS

2.1 Water Quality Summary

A summary of the Water Quality Evaluation found in Attachment 1, as well as a more detailed examination of fecal coliform pollution in the watershed is presented in this section of the report. In general, the chemical and physical parameters measured - nitrate-nitrogen, ammonia-nitrogen, total kjeldahl nitrogen, ortho-phosphate, total suspended solids, and the metals cadmium, copper, lead, and zinc - occurred at levels below water quality standards and EPA toxicity thresholds for aquatic organisms. The biological parameter, fecal coliform, was found at levels which exceed standards used to regulate coastal shellfishing at many locations.

Fecal coliform is often used as an indicator for monitoring water quality for drinking and contact recreation and for managing coastal shellfishing; the latter being of greater importance in Buttonwood Brook due to the closure of shellfish beds in Upper Apponagansett Bay. For shellfish beds to remain open, the EPA recommends that the median fecal coliform bacteria concentration not exceed 14 MPN/100 ml and not more than 10% of the samples should exceed 43 MPN/100 ml. These levels are often surpassed in the Buttonwood Brook Watershed.

As further discussed in the Water Quality Evaluation (see Attachment 1), high levels of fecal coliform (110 to >2400 MPN/100 ml) were found at all ten sampling stations during the non-episodic summer sampling event. Specifically, in Buttonwood Brook (Branch A) for this non-episodic sampling event, coliform levels of 920, 1600, >2400, and 350 MPN/100 ml were measured at stations 10, 8, 7, and 2 (see Figure 4), which run from the headwaters to the mouth. These results indicate that high levels of fecal coliform enter the stream under normal flow

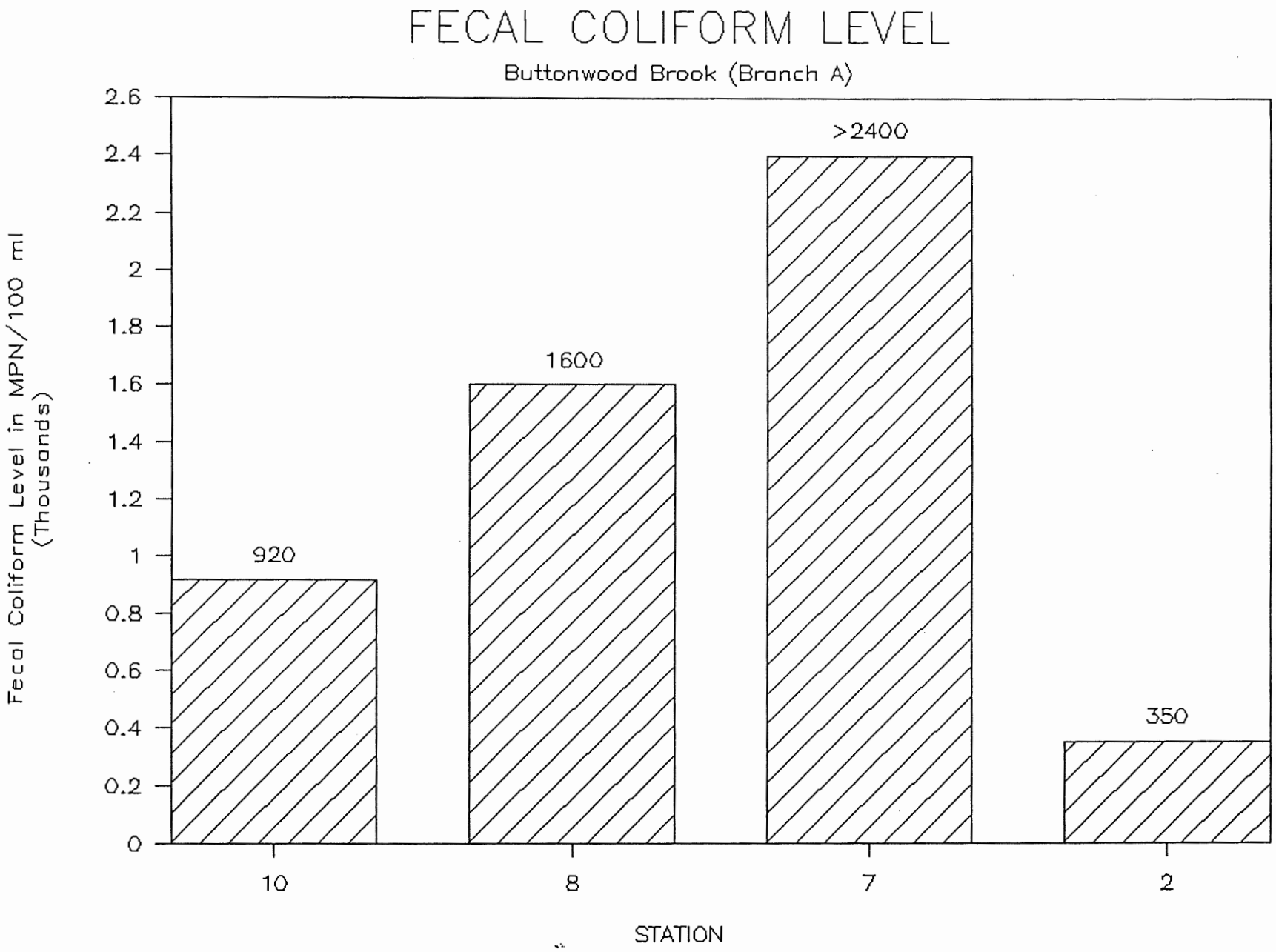

FECAL COLIFORM LEVEL
Buttonwood Brook (Branch A)
Fecal Coliform Level in MPN/100 ml
(Thousands)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
920
1600
>2400
350
10
8
7
2
STATION

FIGURE 4

conditions upstream of station 10, between stations 10 and 8 and between stations 8 and 7. Improvement in water quality occurs by station 2, due in part to dilution by water from Branches B and C which converge with Buttonwood Brook (A) upstream of station 2. This data shows that subdrainage areas 7 and 8 appear to contain significant sources of fecal coliform pollution, even in the absence of significant precipitation events.

High levels of fecal coliform (240 to >2400 MPN/100 ml) were also observed at all ten sampling stations during the spring episodic (i.e., heavy rain) sampling event. These data are noteworthy for two reasons: (1) values as high as two orders of magnitude greater than those found during the non-episodic spring sampling event collected 20 days earlier were observed and (2) extremely high levels (>2400 MPN/100 ml) were observed in all three branches of the brook.

These data suggest that the source of fecal coliform is related to the land's surface (such as animal scat, etc.) which is washed into the brook <u>via</u> runoff rather than due to leaks in the sewerage system. This view is supported by the water chemistry as changes in the water chemistry indicative of sewage inputs (e.g., elevated nitrate-nitrogen concentrations) are not observed.

In conclusion, subdrainage areas along all three branches of the brook contribute significant quantities of fecal coliform to the system under episodic conditions. Subdrainage areas 7 and 8 appear to be the primary "hot spots" for fecal coliform pollution as high levels of fecal coliform occur at these locations even under non-episodic conditions. It should be noted, however, that these conclusions are based upon limited water quality sampling during a one year period.

It is important to point out that while nearly every urban and suburban land use exports sufficient coliform bacteria to violate health standards, older and more intensely developed areas are responsible for the greatest level of export[1]. In addition, elevated levels of coliform exceeding public health standards for contact recreation are commonly observed during storms in most urban streams. Thus, the situation in Buttonwood Brook is typical of waterways flowing through urban areas.

2.2 Shellfish Resource Summary

A summary of the Shellfish Resource Evaluation found in Attachment 2 is presented in this section of the report. A 50 acre area located between Little Island and Lucy Street was sampled to evaluate the shellfish community structure and to allow an estimate of the gross market value of the shellfish resources of upper Apponagansett Harbor to be made.

A total of 336 shellfish were collected during the sampling effort, all of which consisted of a single species: quahogs. According to established market designations, 74.5% of the collected quahogs were classified as chowder, 8.3% as cherrystone, and 12.9% as littleneck. A general trend based upon individual size was observed during the analysis of the data; in general, a higher proportion of smaller individuals was found in samples collected from the more southerly portion of the sampling area. Factors underlying this distribution pattern and the significance of this trend are not known, but could be related to season, salinity, tide, or other environmental conditions, including pollution.

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[1]Schueler, Thomas R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington Metropolitan Water Resources Planning Board.

Based upon information provided by the Massachusetts Division of Marine Fisheries and the sampling results, the gross market value for the shellfish resources of the upper harbor was estimated to total approximately $166,000. As reopening of the shellfish beds of the upper harbor is an underlying factor in the development of a watershed management plan, the economic value of the shellfish resources should be considered in the design and implementation of the mitigation effort.

3.0 WATERSHED MANAGEMENT PLAN RECOMMENDATIONS

The recommended "Best Management Practices" for the mitigation of high levels of bacteria in urban runoff are infiltration systems (i.e., trenches and basins). These systems treat runoff prior to its discharge to ground water or to a receiving watercourse. The long-term pollutant removal rate for bacteria for these systems ranges from 75 to 90% for infiltration trenches and from 75 to 98% for infiltration basins depending upon the sizing methodology utilized. These systems are not practical for this watershed, however, because soil conditions found along Buttonwood Brook are characterized by seasonally perched water tables, a fatal design constraint for these infiltration devices. Besides soil, additional limiting factors include slope, depth to bedrock, and water table level.

As a result of these limitations, SES recommends that the following actions be taken to mitigate contaminant impacts to Buttonwood Brook and Apponagansett Harbor. Numbers indicate a suggested priority:

1. The Dartmouth Department of Public Works should initiate a program to regularly clean catch basins. Properly maintained catch basins are most effective at removing particulates, especially larger-sized sediments, and particulate-associated contaminants. To maximize contaminant removal efficiency from storm water runoff, catch basins should be cleaned four to six times per year.

2. The Dartmouth Board of Health should conduct a survey of animal populations within the watershed, with special emphasis on those areas of the watershed suspected of being coliform "hot spots". As indicated in the Water Quality Evaluation and the Water Quality

Summary, fecal coliform inputs under normal flow conditions were greatest in subdrainage areas 7 and 8.

3. The Dartmouth Department of Public Works should initiate a comprehensive street sweeping program in the watershed. The quantity of contaminants available to be picked up by storm water runoff will be reduced by frequent sweepings of roadways. A twice monthly sweeping program is expected to be effective in reducing levels of particulate and particulate-associated contaminants (including toxicants and trace metals) from storm water runoff.

4. The Dartmouth Board of Health, in conjunction with other local, state and federal agencies, should initiate public education/outreach programs in the Buttonwood Brook Watershed to increase public awareness of how day-to-day activities impact coastal resources. A successful program of this kind has been established in the Chesapeake Bay Area.

5. The Dartmouth Board of Health should sample the water quality in Buttonwood Brook on a regular basis to monitor the effectiveness of this program in reducing fecal coliform levels, as well as those of other contaminants sampled in this study.

6. Additional contaminant impacts on Apponagansett Harbor should be investigated. While Buttonwood Brook does contribute contaminants to the bay, other potential sources of contaminants, including coliform bacteria, exist and should be examined. These include: a) the approximately 1,700 boats moored in the harbor, b) the six storm water outfalls which originate outside of the Buttonwood Brook Watershed and discharge directly into

the eastern side of the harbor, c) the runoff from agricultural fields to the west of the harbor (a significant population of Canada geese forage here), and d) the three other streams (including Salt Creek) which discharge directly into the bay. Once these additional potential sources of contaminants to the northern portion of the bay are investigated, the Town of Dartmouth should develop a prioritized remediation program which addresses contaminant inputs based on their level of magnitude. Such a program might include the construction of infiltration devices (where suitable soils and sub-surface conditions exist), boat pump-out stations, catch basin maintenance, street sweeping, on-going water quality monitoring, etc.

7. The flushing characteristics of Apponagansett Harbor should be investigated. The causeway could restrict water flow and negatively impact normal flushing patterns resulting in stagnation of the water in the bay. If this occurs to any significant extent, cleaning up the discharges to the bay may not have the desired effect.

8. The Executive Secretary to the Board of Selectmen should organize an educational forum for Town officials, employees and other interested parties to familiarize them with the report's findings and recommendations.

9. The Executive Secretary to the Board of Selectmen should act as Project Coordinator to ensure the implementation of activities specified for each Town department.

ATTACHMENT 1

WATER QUALITY EVALUATION

WATER QUALITY EVALUATION

This section of the report presents the methodology and results of a year long water quality evaluation of the Buttonwood Brook Watershed which was conducted by Sanford Ecological Services, Inc. in conjuction with volunteers from the Dartmouth Fisherman's Association between 14 February and 10 November 1990.

Methodology

Samples for water quality analysis were collected seasonally from ten stations throughout the watershed (Figure 1) under both non-episodic and episodic conditions. Non-episodic sampling allowed evaluation of water quality under normal flow conditions; episodic sampling measures the contributions of road and land runoff during major precipitation events.

All water samples were analyzed in state certified laboratories for nitrate-nitrogen, ammonia-nitrogen, total kjendahl nitrogen, ortho-phosphate, total suspended solids, and fecal coliform. Sampling for the metals cadmium, copper, lead, and zinc occurred only during the summer episodic sampling event. The results of water quality analyses are presented in Appendix A.

Results

The discussion of the results is presented in two sections. In the first section, the water quality characteristics of the watershed are discussed for each parameter with emphasis placed on the levels observed, seasonal variation, non-episodic versus episodic results,

SAMPLING LOCATIONS

STATION 1 Apponagansett Harbor
STATION 2 Russells Mills Road
STATION 3 Arnold Street
STATION 4 McCabe Street
STATION 5 Holly Drive
STATION 6 Slocum Road
STATION 7 Sharp Street
STATION 8 Allen Street
STATION 9 Hawthorne Street
STATION 10 Corporate Boundary

FIGURE 1
SAMPLING STATION LOCATIONS
BUTTONWOOD BROOK WATERSHED
DARTMOUTH, MASSACHUSETTS
APPROPROXIMATE SCALE 1" = 2000'

and comparisions to available toxicity thresholds. The second section presents a more general discussion comparing the relative contaminant contributions with corresponding land use patterns for ten subdrainage basins within the watershed.

Water Quality Analysis Results

Nitrate-nitrogen, the first of the parameters evaluated to examine nitrogen loading, is indicative of wastewater releases and is generally accepted as the limiting nutrient in both estuarine and marine systems with regard to eutrophication. Under both non-episodic and episodic conditions, the mean nitrate-nitrogen levels remained fairly consistent throughout the seasons. The non-episodic and episodic values ranged from 0.07 to 7.01 mg/L and 0.34 to 6.1 mg/L, respectively. The highest levels were found for all seasons in samples collected under both conditions at sampling stations 5 and 6 (Holly Drive and Slocum Road). Concentrations at these stations ranged from 2.62 to 7.01 mg/L and averaged roughly 5 mg/L. The EPA surface water quality criteria for nitrate-nitrogen indicate that levels of 5 mg/L should be protective of most warmwater fisheries.[1] Thus, nitrate-nitrogen is not a significant contaminant in the Buttonwood Brook Watershed.

The two remaining nitrogen parameters examined in this study, ammonia-nitrogen and total kjeldahl nitrogen (TKN), are indicative of sanitary pollution and nutrient loading. Ammonia-nitrogen levels under non-episodic conditions ranged from <0.05 to 0.45 mg/L, with the highest values

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[1]U.S. EPA Quality Criteria for Water. Office of Water Regulations and Standards. May 1, 1986. EPA 44015-86-001, Washington, D.C.

typically observed during the summer. In contrast, under episodic conditions the ammonia-nitrogen levels were usually lowest in the summer with values for all seasons within the range of <0.05 to 0.25 mg/L. TKN concentrations for non-episodic and episodic conditions were similar, and both were seasonally dependent with the highest values found during the summer and autumn. The non-episodic and episodic values ranged from <0.05 to 1.17 mg/L and 0.07 to 1.83 mg/L, respectively. In general, these values are not of concern.

Phosphorus is generally accepted as the limiting nutrient controlling the eutrophication of freshwater systems. Under non-episodic and episodic conditions, concentrations of ortho-phosphate ranged from <0.05 to 0.08 mg/L and <0.05 to 0.38 mg/L, respectively. In the majority of the samples analyzed for this study, ortho-phosphate levels were below the detection limit of 0.05 mg/L. The elevated levels found in the summer episodic sample at station 8 (Allen Street; 0.38 mg/L) and during the autumn episodic event at station 6 (Slocum Street; 0.16 mg/L) are of some concern. These values probably result from runoff from nearby agricultural areas. A goal for the prevention of aquatic plant nuisances in streams or other flowing waters not directly discharging into lakes or impoundments is 0.10 mg/L total phosphorous.[2]

Under non-episodic conditions, total suspended solids ranged from <4.0 to 142 mg/L. These were seasonally dependent with the highest values at most stations observed in the summer. The levels found under episodic conditions

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[2]Ibid.

were also seasonally dependent with the highest values typically observed in the winter and spring. In this case, the levels ranged from <4.0 to 44 mg/L. While no specific numerical standard is provided in the literature, in general, the values reported are not of concern, with the exception of the summer non-episodic sample from station 1 (Apponagansett Bay; 142 mg/L) located at the mouth of Buttonwood Brook.

The trace metals examined in this study - cadmium, copper, lead, and zinc - are common roadway and parking lot runoff constituents. Concentrations of these metals were measured only once during the course of the study: during the summer episodic event. Cadmium and lead levels were below their respective detection limits of 0.010 and 0.070 mg/L at all ten stations. Copper concentrations ranged from <0.004 to 0.029 mg/L and zinc levels ranged from 0.05 to 0.131 mg/L. The elevated levels of copper at stations 7, 8, and 9 (Sharp Street, Allen Street, and Hawthorne Street), and the elevated zinc concentrations at stations 6, 8, and 9 (Slocum Road, Allen Street, and Hawthorne Street) are of concern from an aquatic toxicological viewpoint. The copper concentrations exceed both chronic and acute EPA toxicity levels for freshwater organisms of 0.018 mg/L and 0.012 mg/L, respectively.[3] Zinc levels at stations 6 and 9 exceed the chronic EPA toxicity threshold of 0.110 mg/L and the level at station 8 exceeds the acute EPA toxicity threshold of 0.120 mg/L.[4] These levels may be due to automobile emissions and deposition in the above mentioned areas.

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[3] Water Quality Criteria Summary, 1986. USEPA Quality Criteria for Water. Office of Water Regulations and Standards. May 1, 1986. EPA 440/5-86-001, Washington D.C.

[4] Ibid.

Fecal coliform is used as an indicator organism for monitoring water quality and for managing coastal shellfishing. Non-episodic fecal coliform levels ranged from <2 to >2400 MPN/100 mL and were seasonally dependent with the highest values typically found during the spring, summer, and autumn. Episodic values ranged from <1 to 6200 (>2400) MPN/100 mL. These were also seasonally dependent with the highest values occurring during the spring (summer levels were not measured). This seasonal dependence is not unusual because bacteria multiply more rapidly at higher temperatures. For Class B surface waters, fecal coliform levels shall not exceed a geometric mean of 200 organisms per 100 ml in any representative set of samples nor shall more than 10% of the samples exceed 400 organisms per 100 ml [310 CMR 4.05(b)(4)]. Excessively high levels were found at all ten stations for the spring episodic samples (240 to >2400 MPN/100 ml) and for the summer non-episodic event (110 to >2400 MPN/100 ml). Elevated levels were also observed at all ten stations for the non-episodic spring and autumn sampling events. Thus, fecal coliform pollution is a widespread problem in the Buttonwood Brook Watershed. Patterns of fecal coliform pollution in the watershed are discussed in greater detail in the Water Quality Summary section of this document.

Water Quality and Land Use Practices

The Buttonwood Brook Watershed was divided into ten subdrainage areas based on the location of the sampling stations (Figure 2). These subdrainage areas range from 80.95 to 1,783 acres in size. In six out of the ten subdrainage areas, over 50% of the land use is urban. Storm drains discharge road runoff to the brook in all but one of the subdrainage areas (area 10). A summary of land use practices for the various subdrainage areas of the Buttonwood Brook Watershed is presented in Appendix C.

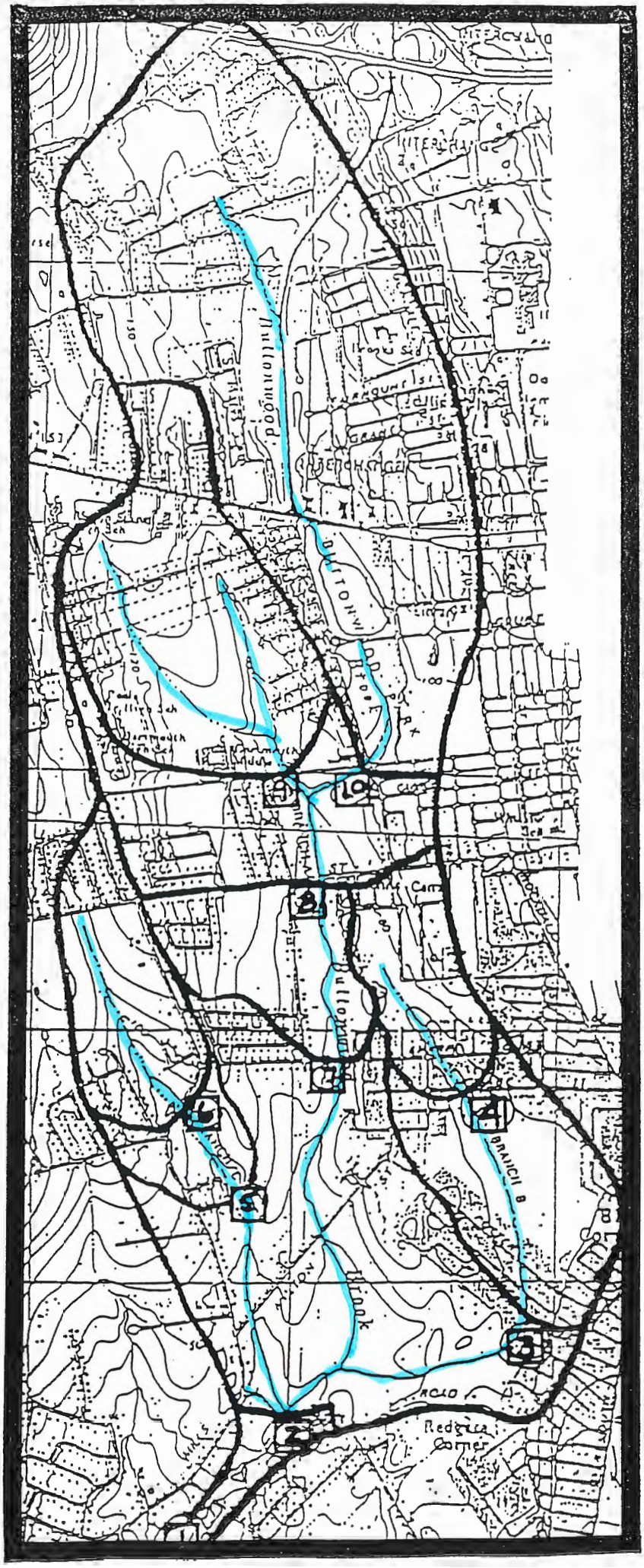

FIGURE 2 BUTTONWOOD BROOK SUBDRAINAGE AREAS

SCALE: 1" = 2,000'

Subdrainage area 10

The subdrainage area located at the headwaters of the basin is the main contributing area to sampling station 10 (Corporate Boundary). This subdrainage area consists of 553.83 acres and comprises 31.1% of the total watershed area. The land use is primarily urban consisting generally of residential neighborhoods and highways. Branch A of Buttonwood Brook flows through Buttonwood Park and Buttonwood Zoo approximately one-quarter mile upstream of sampling station 10. Concentrations of tested parameters for subdrainage area 10 were generally below the calculated mean values for the watershed except for ammonia-nitrogen, which was consistently elevated.

Subdrainage area 9

The subdrainage area contributing to sampling station 9 (Hawthorne Street) is 260.86 acres in size and comprises 14.6% of the total watershed. Land use is primarily urban consisting generally of residential areas and schools. This subdrainage area is located at the headwaters of Branch A of Buttonwood Brook. Episodic water quality analyses indicate that the drainage from this area contains elevated levels of copper and zinc. These metals are probably derived from road runoff.

Subdrainage area 8

The contributing subdrainage area to sample station 8 (Allen Street) is 964.26 acres in size and comprises 54.1% of the total watershed. This subdrainage area includes subdrainage areas 9 and 10 and is located on Branch A of the brook directly south of subdrainage area 9. The land use in this area is approximately 71% urban consisting of residential neighborhoods, schools, cemeteries, and other urban structures. Analyses indicate that the Buttonwood Brook discharge at this station is generally elevated in copper and zinc. The elevated copper and zinc levels are probably derived from road runoff.

Subdrainage area 7

The subdrainage area contributing to sample station 7 (Sharp Street) is 1,057.63 acres is size and comprises 59.3% of the total watershed area. It includes subdrainage areas 8, 9, and 10 and is located south of subdrainage area 8 along Branch A of Buttonwood Brook. The land use in this subdrainage area is approximately 64% urban. In general, metal concentrations are lower at station 7 than at upgradient station 8. This probably results from the large area of open space between these two sample collection stations.

Subdrainage area 6

Subdrainage area 6 is 100.94 acres in size and comprises 5.7% of the total watershed area. This subdrainage area is located at the headwaters of Branch C of Buttonwood Brook. Approximately 66% of this subdrainage area is open space with the remaining area covered by residential neighborhoods. Water quality analyses indicate elevated levels of nitrate-nitrogen from this drainage area. This is probably a consequence of the agricultural activity in this subdrainage area. In addition, the level of zinc, probably derived from road runoff, is higher than average.

Subdrainage area 5

The subdrainage area contributing to sample station 5 (Holly Drive) is 146.41 acres in size and comprises 8.2% of the total watershed area. This area includes subdrainage area 6 and is located on Branch C of Buttonwood Brook just downstream of that area. The land use in this subdrainage area is approximately 61% open space and 39% urban. Water quality analyses indicate that nitrate-nitrogen is elevated at the station, however, this elevated level probably originates from subdrainage area 6. The level of zinc is much lower than that measured at station 6.

Subdrainage area 4

Subdrainage area 4 measures 80.95 acres in size and comprises 4.5% of the total watershed area. This area is located at the headwaters of Branch B of Buttonwood Brook and is approximately 65% open space. The remaining 35% is primarily residential neighborhoods. Water quality analyses indicate that no significant levels of contaminants are derived from this portion of the watershed.

Subdrainage area 3

The subdrainage area contributing to sample station 3 is 212.37 acres in size and comprises 11.9% of the total watershed area. This area includes subdrainage area 4 and is located directly south of subdrainage area 4 along Branch B. Land use in the area is approximately 49% urban. Water quality analyses indicate that no significant levels of contaminants are derived from this portion of the watershed.

Subdrainage area 2

Subdrainage area 2 is 1,756.99 acres in size and comprises 98.5% of the total watershed area. Branch B, Branch C, and Branch A of Buttonwood Brook converge within this subdrainage area which includes subdrainage areas 3 through 10. Approximately 52% of the land use is urban. Water quality analyses indicate that contaminants present at this portion of the watershed are probably derived from upgradient areas.

Subdrainage area 1

Sample station 1 is located at the mouth of Buttonwood Brook where it empties into Apponagansett Bay. Subdrainage area 1 is 1,783 acres in size and represents 100% of the total watershed area that lies within the Town of Dartmouth. Approximately 58% of the watershed land use is

urban. No significant changes in water quality occur between sampling station 2 and sampling station 1.

Conclusion

Water quality analyses indicate that no specific location contributes significant quantities of chemical contaminants to Buttonwood Brook. In general, the contaminants that were observed (i.e., nitrate-nitrogen and metals such as copper and zinc) are derived primarily from road and agricultural runoff throughout the basin. One area, subdrainage area 6, which is located in the eastern portion of the watershed, does contribute elevated levels of nitrate-nitrogen. This probably results from agricultural runoff of fertilizers.

Levels of fecal coliform were, in general, elevated throughout the watershed with extremely high levels observed at stations 7 and 8 during non-episodic summer sampling and at virtually all of the stations during episodic spring sampling. It should be noted that nearly all suburban and urban land uses export coliform at levels that exceed health standards. Furthermore, older and more intensely developed areas generally export the highest levels, and coliform levels exceeding standards are common occurances during storms in most urban streams.[5] Thus, the situation in the Buttonwood Brook Watershed is not unusual, but is of particular concern because this parameter is utilized by the Massachusetts Division of Marine Fisheries to regulate shellfishing.

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[5]Schuler, Thomas R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington Metropolitan Water Resources Planning Board.

ATTACHMENT 2

SHELLFISH RESOURCE EVALUATION

SHELLFISH RESOURCE EVALUATION

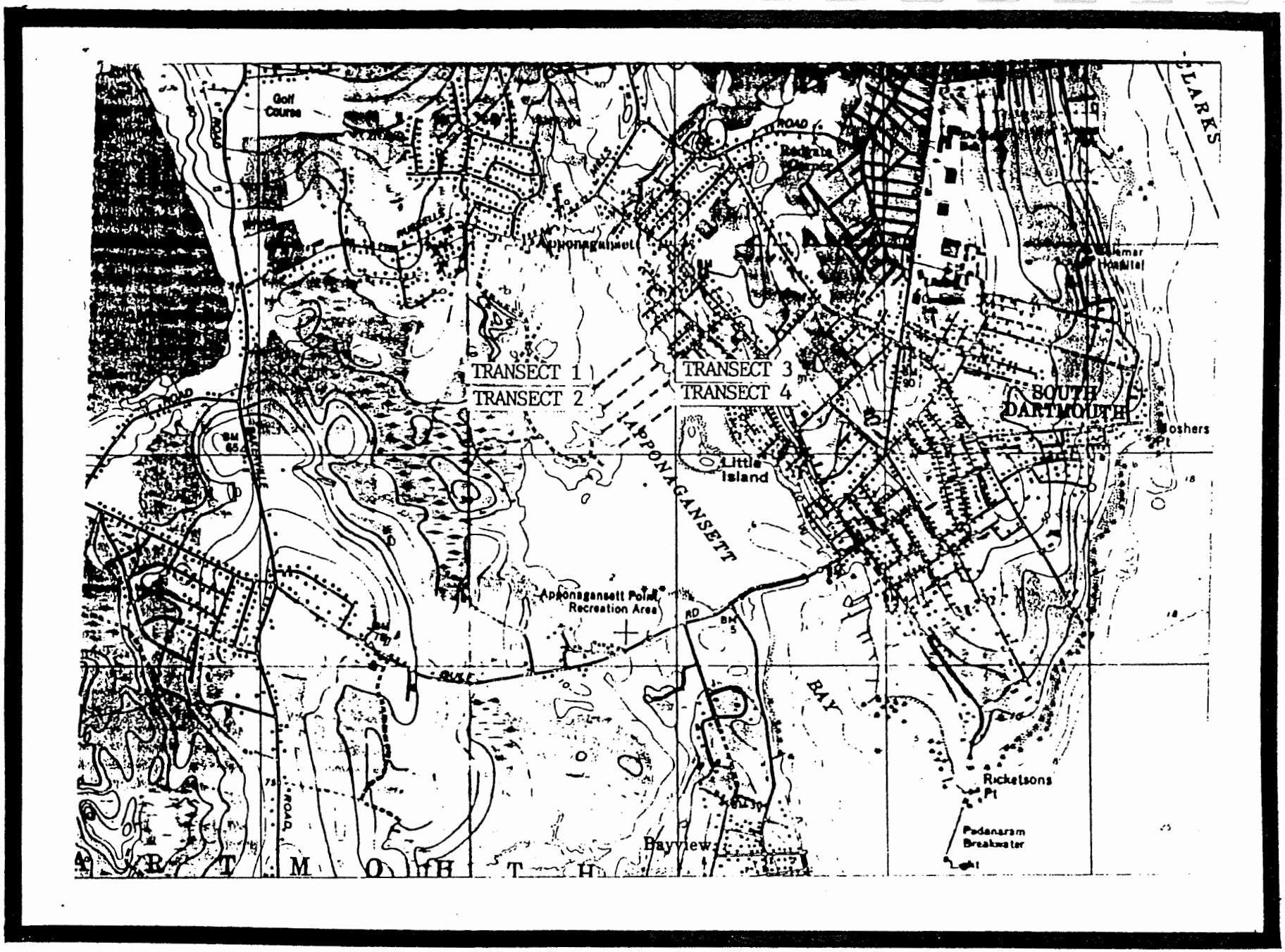
This section of the report presents the methodology and results of a shellfish resource evaluation conducted on 10 November 1990 in the subtidal and intertidal regions of upper Apponagansett Bay. This study was conducted by Sanford Ecological Services, Inc. (SES) in conjunction with Mr. Michael Hickey of the Massachusetts Division of Marine Fisheries and volunteers from the Dartmouth Fisherman's Association. The shellfish resource area examined in this study is fifty acres in size and is situated between Little Island to the south and Lucy Street to the north (Figure 1).

Methodology

Four transects were established across upper Apponagansett Bay at 275 foot intervals. Sampling stations were located at 50 foot intervals along each transect. At each sampling station, three grab samples (2 square feet each, 6 square feet total sampling area per station) were taken from a boat using a bullrake. The shellfish from the three grab samples at each station were combined into a single sample and were classified by species, individual size (shell length), and market designation. The harvested shellfish were turned over to John Sherman for disposition.

Results

All 396 of the shellfish collected in this survey were quahogs. Thus, the shellfish resources of upper Apponagansett Bay at the time of this sampling consisted of only a single species. The collected quahogs ranged in size from 1.6 to 4.6 inches. The sampling data collected during this survey is presented in Appendix B.



APPROXIMATE LOCATION OF SHELLFISH SAMPLING TRANSECTS

SCALE: 1" = 2,000'

FIGURE 1

The market designations for quahogs, which are based on shell length, are: littleneck, 2.0 to 2.25 inches; cherrystone, 2.25 to 2.5 inches; and chowder, 2.5 inches and larger (pers. comm., M. Hickey). According to these designations, 74.5% of the collected quahogs were classified as chowder, 8.3% as cherrystone, and 12.9% as littleneck. The remaining 4.3% of the collected quahogs had a shell length of less than 2 inches; consequently, these had no market designation and were not included in the economic analysis.

Based on the November sampling, the overall population density for quahogs of all sizes in the upper bay was approximately 0.76 individuals per square foot of substrate. The estimated densities for the various market designations in individuals per square foot were approximately: chowder, 0.57; cherrystone, 0.06; littleneck, 0.10; and no market designation, 0.03.

Some trends were noted regarding the distribution of the various market designations among the four transects (see Figure 1). At transect 1, the uppermost in the bay, 95.4% of the 65 quahogs collected were chowder and 4.6% were classified as littleneck. At transect 2, 87.4% of 119 organisms were classified as chowder, 5.9% each as cherrystone and littleneck, and 0.8% had no market designation. At transect 3, 56.1% of 57 quahogs were chowder, 21.1% were cherrystone, 17.5% were littleneck, and 5.3% had no market designation. At the most southerly transect, transect 4, 62.6% of 155 organisms were classified as chowder, 9.0% as cherrystone, 20.0% as littleneck, and 8.4% had no market designation. In general, the proportion of the collected quahogs consisting of smaller sized individuals tended to increase in samples collected at transects located lower (more southerly) in the bay. The significance of and factors underlying this distribution pattern are not known, but could possibly be related to season, salinity, tide, and/or other environmental conditions, including pollution.

The number of quahogs per market designation is based upon samples collected from 522 square feet of the upper bay. The shellfish resource area examined in this survey covers 50 acres (2,178,000 square feet); therefore, the total number of quahogs per market designation for the entire resource area can be estimated by multiplying those collected in the sampling effort by a factor of 4172. Based on the estimated number of quahogs present in the resource area, the number of quahogs per pound, and the price per pound for each market designation, the gross market value for the shellfish resources of upper Apponagansett Bay was estimated to total approximately $166,000. Due to the systematic sampling methodology employed in this study, no estimate of variability associated with this value can be determined. The complete economic analysis is presented in tabular form in Appendix C.

In conclusion, the shellfish resources of upper Apponagansett Bay, based on sampling on 10 November 1990, consist of a single species of shellfish (quahog). Using information provided by Mr. Hickey of the Division of Marine Fisheries, the gross market value for the shellfish resources was estimated to total approximately $166,000.

ATTACHMENT 3

REVIEW OF MUNICIPAL REGULATIONS

REVIEW OF DARTMOUTH MUNICIPAL REGULATIONS AFFECTING WATER QUALITY WITHIN THE BUTTONWOOD BROOK WATERSHED

Towns within the Commonwealth of Massachusetts may exercise significant authority over land use, development, and public health issues as a result of the Commonwealth's home rule tradition. This section of the report will review the Town of Dartmouth's regulations and bylaws as they affect water quality protection within the Buttonwood Brook Watershed. The following categories of regulations will be assessed: zoning, subdivision, wetland protection, agriculture, and earth removal.

Zoning

Zoning is the principal form of land use control authorized by M.G.L. Ch. 40A. Zoning ordinances allow local governments to control development according to land use suitability and compatibility of uses. Zoning regulations specify lot size, shape and dimensions, the density of structures, frontage, parking and height requirements and most significantly, the land usage. In addition to defining land usage, zoning regulations establish the allowable percentage of lot coverage by structures. The density of development affects water quality through its impact on aquifer recharge, flooding, contamination of stormwater runoff, and, in unsewered areas, through septic system discharges.

In the Buttonwood Brook Watershed, the following zoning districts have been established:(see Figure A)

DISTRICT	MINIMUM LOT SIZE	PERCENT COVER ALLOWED
SRA	40,000 sf	40%
GB	40,000 sf	65%
GR	15-20,000 sf	40%
NB	20,000 sf	65%

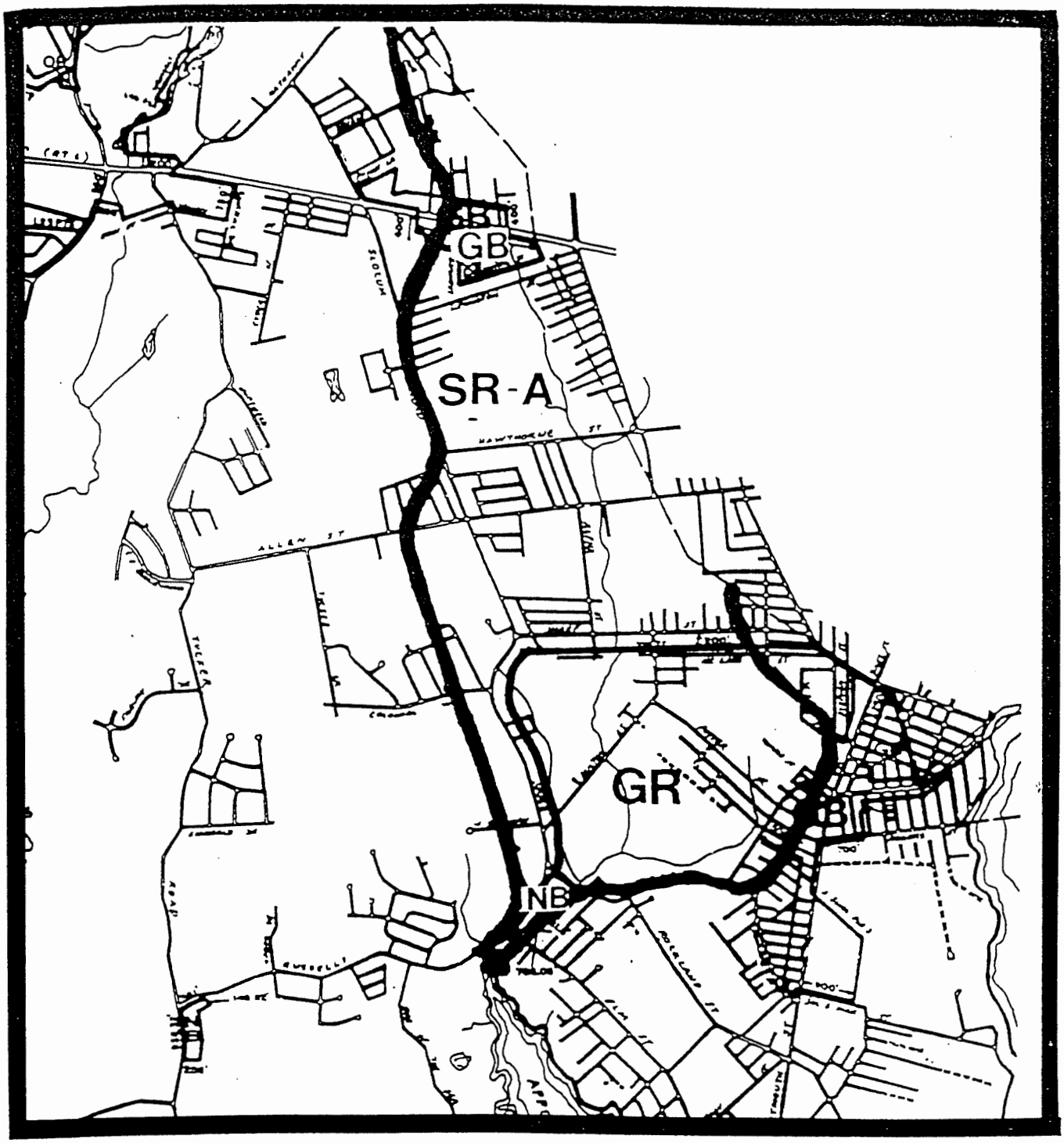


FIGURE A

ZONING DISTRICTS WITHIN THE BUTTONWOOD BROOK WATERSHED

Source: Dartmouth Planning Board
(Not to Scale)

By Special Permit, Cluster Development and Planned Residential Development are also allowed to promote more efficient use of land and to provide for open space and resource protection.

In addition to these districts, three overlay districts provide protection to inland and coastal wetlands:

- o Superimposed Inland Wetlands,
- o Flood Prone Land District, and
- o Coastal Wetlands District.

Subdivision Rules and Regulations

The initial stages of urbanization within a watershed are well documented.[1]

1) Site clearing leads to the loss of native vegetation.

2) Site grading leads to the loss of natural depressions that temporarily store water, and the loss of the original humus-rich soil through construction activity and erosion.

As a result, the land loses much of its natural water storage capacity and its ability to prevent rainfall from being rapidly converted to runoff.

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[1]Schueler, Thomas R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington Metropolitan Water Resources Planning Board.

Once construction is completed, rooftops, roads, parking lots, sidewalks, and driveways make most of the site impervious to rainfall. Runoff overloads the existing drainage system necessitating "improvements" to redirect runoff from the site. These drainage improvements dramatically affect stream hydrology:

- increased peak discharges rise 2 to 5 times higher than the pre-development levels,
- runoff increases by as much as 50% from forested conditions,
- the cumulative impacts of sedimentation, increased flooding, higher water temperatures, and pollution degrade the aquatic ecosystem, and,
- pollutants, which have accumulated on impervious surfaces, run off into adjacent and downstream receiving waters.

To regulate land on which such alterations occur, local planning boards are empowered by the Subdivision Control Law, M.G.L., Chapter 41, Section 81K - 81GG to promulgate rules and regulations governing the standards for the design and construction of proposed developments. These regulations stipulate criteria for managing drainage discharges from development to moderate its effect on flooding, subsurface hydrology, and water quality. Subdivision Rules and Regulations specify standards for roadway construction, utilities, curbs, sidewalks, and drainage.

Subdivision rules and regulations can influence, for better or worse, the impacts of urbanization on a watershed. Requirements for wide streets, piped drainage, double sidewalks, paved driveways and direct stormwater discharge to surface water channels can result in degradation of the quality of downstream water. On the other hand, good subdivision rules and regulations that require stormwater detention, on-site direct discharge, oil and gas traps, protection of existing vegetation, dry wells for roof drains, and reduced road size can offset the negative drainage impacts of development.

The Rules and Regulations Governing the Subdivision of Land in the Town of Dartmouth (June 1990) contain the following drainage requirements:

- Stormwater is to be recharged to the ground on site"to the maximum extent feasible".
- To encourage on-site groundwater recharge of surface stormwater, open leaching type catch basins are allowable.
- Peak runoff and stream flows at the boundaries of a development shall be no greater than 80% of the rate prior to development. In any case, the discharge shall not exceed one (1) cubic foot per second (CFS) per acre.
- Water collected by the drainage system shall be detained on-site and filtered through man-made detention and filtration systems before discharging into any water body, wetland area or the general environment. Drainage water, detained on-site, must flow a minimum of 100' from the drainage system outfall through detention/retention facilities before discharge.
- All detention and filtration systems should be designed to retain the "first flush" of drainage water entering such facilities.
- Stormwater drainage systems shall be designed to handle all water generated in the tributary watershed.
- All drainage calculations and designs are reviewed by a consultant employed by the Town.

Wetlands Protection By-Law and Regulations

Much like the Massachusetts Wetlands Protection Act (WPA), the Dartmouth Wetlands Bylaw (April 1990), identifies wetland interests or values that are likely to be affected by activities carried out in areas subject to protection under the Act. The purpose, areas of jurisdiction, and definition of key words and phrases of the Dartmouth Wetlands Bylaw and its Regulations, though similar to the WPA, go beyond the State statute to promote the protection of ground and surface water quality.

The Massachusetts Wetlands Protection Act lists eight wetland functions it is charged to protect: 1) public and private water supply, (2) ground water supply, (3) flood control, (4) storm damage prevention, (5) prevention of pollution, (6) protection of land containing shellfish, (7) protection of fisheries, and (8) protection of wildlife habitat. The Dartmouth Bylaw supplements these with three additional functions or values, one of which is water quality related: erosion and sedimentation control.

The Wetlands Protection Act lists four protectable freshwater wetland resources: (1) Bank, (2) Bordering Vegetated Wetlands, (3) Land Under Water Bodies and Waterways, and (4) Land Subject to Flooding. The Dartmouth Wetlands Protection Bylaw extends its jurisdiction to land in or within a 100' buffer zone of any freshwater wetland, marsh, wet meadow, bog, swamp, or vernal pool; any lake, river, pond, stream, estuary or any land under said waters. The definitions of activities allowed by the Act have been amplified to encompass issues of drainage and water quality. For example, the Dartmouth Bylaw extends the definition of "alter" to encompass:

- any activities, changes, or work which may cause or tend to contribute to pollution of any body of water or groundwater.

The Bylaw Regulations serve as a guide to enforce and implement the Bylaw. Of particular interest in the Regulations is the section on <u>Stormwater Management Guidelines and Requirements</u>. Realizing the likelihood of stormwater discharges causing permanent or cumulative damage to the functions of wetlands and the quality of receiving waters, the Regulations provide detailed requirements for roadways and parking places that:

- specify "zero increase" as the goal of stormwater attenuation,

- require that hydrologic analysis must include all parts of the project which may be modified by construction activity as well as any up-gradient areas on or off-site, and

- allow the Conservation Commission to require that the design of attenuation facilities take into account the potential development of the entire tributary watershed, including off-site areas.

Board of Health

In 1977, the Department of Environmental Protection (DEP) adopted the current regulations under Title V of the State Environmental Code. Title V regulations were designed as a minimum health standard to protect water supplies from bacterial contamination, and to ensure adequate siting and design of sewage disposal systems. Regulations specify requirements for the type and capacity of systems, location, installation, and maintenance. According to Title V, each sewage disposal system shall be located so that it "will not create a nuisance or discharge into any watercourse." Title V sets forth the minimum distance of sewage disposal facilities from wells, surface water supplies and watercourses. Septic tanks must be at least fifty (50') feet from wells or surface water supplies and twenty five (25') from watercourses. Leaching facilities are required to be at least one hundred (100') from wells or surface water supplies and fifty feet (50') from watercourses.

Local Boards of Health, under M.G.L. Chapter 111, Section 31, may adopt regulations to supplement Title V. The Dartmouth Board of Health has increased the setback distances for septic systems and leaching facilities. Its regulations stipulate a fifty (50') setback for septic systems from watercourses and a one hundred foot (100') setback for leaching fields from water courses.

Agriculture

MGL Chapter III, Section 31 authorizes Boards of Health to make reasonable health regulations and to publish and enforce these regulations. With regard to agriculturally induced water quality issues, the Board of Health can regulate the proximity of animal husbandry activities to waterbodies. The Dartmouth Board of Health requires a 100' setback of manure storage from any water body.

Earth Removal

The Town of Dartmouth Soil Conservation By-laws (1979) established a Soil Conservation Board to regulate earth removal activities. While the existing By-laws impose certain conditions for securing earth removal permits, they do not contain adequate provisions to protect water quality. For example, the Dartmouth By-law fails to specify:

- permissible depths of excavation to the water table,
- sedimentation and erosion control guidelines,
- grading and slope requirements following earth removal,
- replanting and revegetation requirements, and
- any additional requirements that will ensure that the site is left in such a condition that it will be suitable for the land use for which it is zoned.

Summary

The Town of Dartmouth's existing zoning by-laws, subdivision rules and regulations, and wetlands bylaws and regulations are demanding with regard to their design and drainage requirements. But, for the most part, the Buttonwood Brook watershed is an urbanized watershed. Regulatory controls for new development will not substantially mitigate existing water quality conditions in much of the watershed. What is needed are public policy initiatives to implement the "Best Management Practices" set forth in Section 3.0 of this report.

REFERENCES FOR THIS SECTION

Buzzards Bay Project. Buzzards Bay Comprehensive Conservation and Management Plan, 1990.

Moor, Susan R. and Wyatt R., 1987. Inventory of Local Regulations Pertaining to Water Quality in Buzzards Bay. Taunton, MA., Southeastern Regional Planning and Economic Development District.

Schueler, Thomas R., 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington Metropolitan Water Resources Planning Board.

Town of Dartmouth, MA., Dartmouth Conservation Commission. Wetlands Protection By-Law and Regulations. April, 1990.

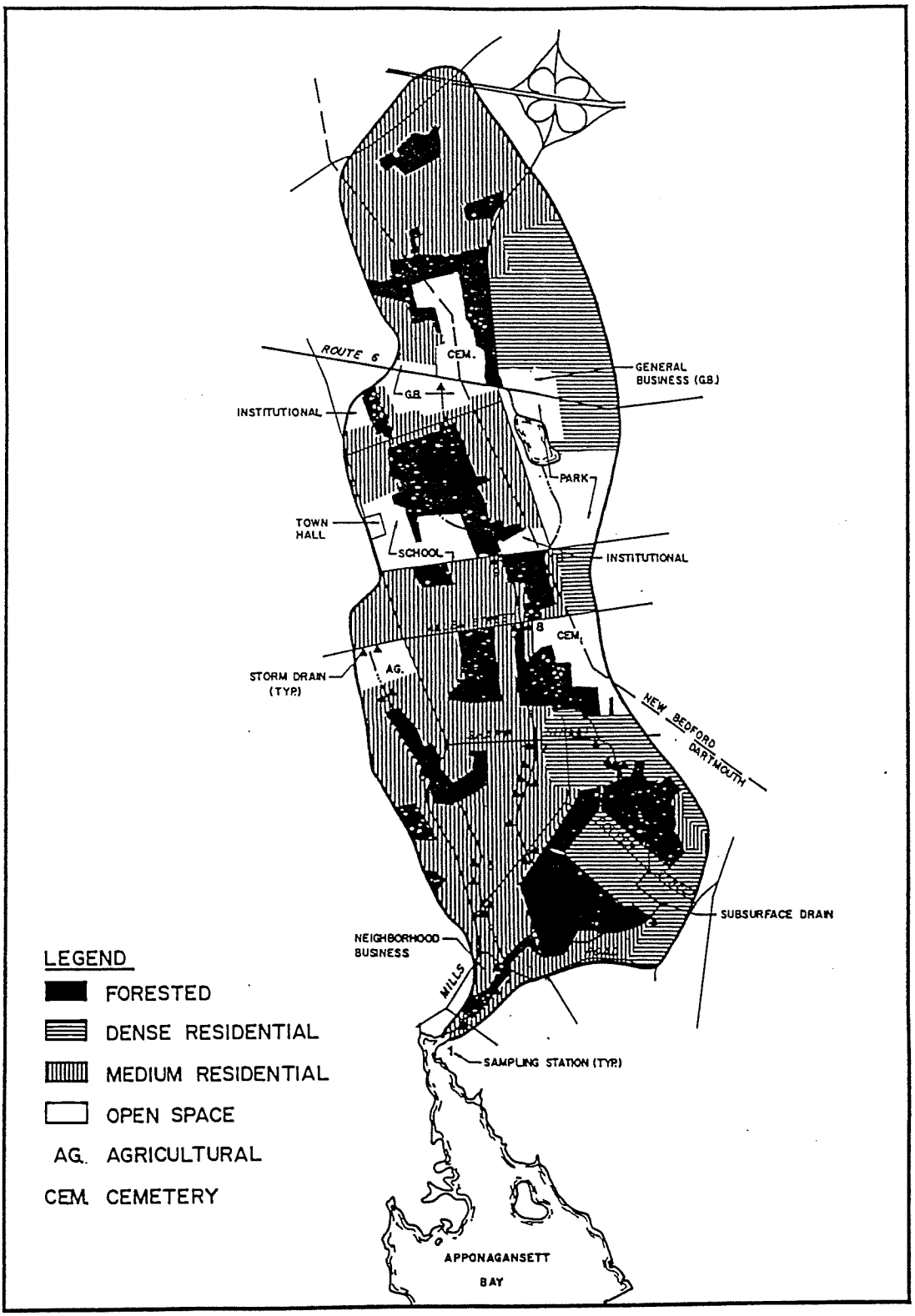
Town of Dartmouth, MA., Dartmouth Planning Board. Rules and Regulations Governing the Subdivision of Land. June, 1990

Town of Dartmouth, MA. Soil Conservation By-Laws. January 1, 1979.

Town of Dartmouth, MA. Zoning By-Laws. June 19, 1990.

ATTACHMENT 4

WATERSHED LAND USE MAP



BUTTONWOOD BROOK WATERSHED LAND USE MAP

SANFORD ECOLOGICAL SERVICES, INC.
258 MAIN STREET
BOURNE, MASSACHUSETTS
MARCH, 1991
SCALE: 1" = 800'

APPENDIX A

BUTTONWOOD BROOK WATER QUALITY DATA

TABLE 1 (CONTINUED)

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 2-14-90	SPRING 5-9-90	SUMMER 7-30-90	AUTUMN 10-10-90
ORTHO- PHOSPHATE (mg/L)	1	APPON.HRBR.	<0.05	<0.05	0.08	<0.05
	2	RUSS.MILLS	<0.05	<0.05	<0.05	0.06
	3	ARNOLD	<0.05	<0.05	<0.05	<0.05
	4	McCABE	<0.05	<0.05	<0.05	0.06
	5	HOLLY	<0.05	<0.05	<0.05	<0.05
	6	SLOCUM	0.06	<0.05	<0.05	<0.05
	7	SHARP	<0.05	<0.05	<0.05	<0.05
	8	ALLEN	<0.05	<0.05	<0.05	<0.05
	9	HAWTHORNE	<0.05	<0.05	<0.05	<0.05
	10	BOUNDARY	<0.05	<0.05	0.08	0.05
		MEAN	0.05	0.05	0.06	0.05
		SD	0.00	0.00	0.01	0.00
		HIGH	0.06	<0.05	0.08	0.06
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL SUSPENDED SOLIDS (mg/L)	1	APPON.HRBR.	7.0	24	142	4
	2	RUSS.MILLS	<4.0	<4.0	<4.0	36
	3	ARNOLD	<4.0	<4.0	4	<4.0
	4	McCABE	<4.0	<4.0	14	6
	5	HOLLY	<4.0	4.0	18	<4.0
	6	SLOCUM	<4.0	<4.0	12	14
	7	SHARP	<4.0	<4.0	14	<4.0
	8	ALLEN	<4.0	<4.0	14	4
	9	HAWTHORNE	5.0	<4.0	12	<4.0
	10	BOUNDARY	5.0	8.0	16	4
		MEAN	4.5	6.4	25	8.4
		SD	1.0	6.3	41	10.2
		HIGH	7.0	24	142	36
		LOW	<4.0	<4.0	<4.0	<4.0
FECAL COLIFORM (MPN/100mL)	1	APPON.HRBR.	63	>64	920	>246
	2	RUSS.MILLS	63	30	350	>246
	3	ARNOLD	46	41	920	71
	4	McCABE	23	>64	920	246
	5	HOLLY	5	64	350	>246
	6	SLOCUM	4	14	110	143
	7	SHARP	17	>64	>2400	>246
	8	ALLEN	<2	64	1600	>246
	9	HAWTHORNE	<2	>64	240	90
	10	BOUNDARY	17	>64	920	>246
		HIGH	63	>64	>2400	>246
		LOW	<2	14	110	71

TABLE 2. BUTTONWOOD BROOK WATER QUALITY DATA (EPISODIC)

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 3-18-90	SPRING 5-29-90	SUMMER 9-22-90	AUTUMN 11-10-90
NITRATE	1	APPON.HRBR.	2.00	1.45	2.03	1.71
NITROGEN	2	RUSS.MILLS	1.49	2.25	2.12	1.69
(mg/L)	3	ARNOLD	1.92	2.12	2.48	1.21
	4	McCABE	1.64	1.86	1.79	0.85
	5	HOLLY	4.59	2.62	2.96	5.3
	6	SLOCUM	6.1	3.95	4.84	3.5
	7	SHARP	1.94	1.67	2.48	1.58
	8	ALLEN	4.73	0.98	2.77	1.32
	9	HAWTHORNE	1.22	1.00	0.61	0.52
	10	BOUNDARY	0.63	0.35	1.29	0.34
		MEAN	2.63	1.83	2.34	1.80
		SD	1.82	1.01	1.13	1.51
		HIGH	6.1	3.95	4.84	5.3
		LOW	0.63	0.35	0.61	0.34
AMMONIA	1	APPON.HRBR.	0.08	0.11	<0.05	<0.05
NITROGEN	2	RUSS.MILLS	0.10	0.08	<0.05	0.06
(mg/L)	3	ARNOLD	0.15	0.21	<0.05	0.14
	4	McCABE	0.12	0.25	<0.05	0.11
	5	HOLLY	0.12	0.10	<0.05	0.06
	6	SLOCUM	<0.05	0.22	<0.05	0.13
	7	SHARP	0.13	0.16	<0.05	0.10
	8	ALLEN	0.17	0.07	0.18	0.19
	9	HAWTHORNE	0.08	<0.05	<0.05	0.12
	10	BOUNDARY	0.15	0.19	<0.05	0.20
		MEAN	0.12	0.14	0.06	0.12
		SD	0.04	0.07	0.04	0.05
		HIGH	0.17	0.25	0.18	0.19
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL	1	APPON.HRBR.	0.13	0.11	0.24	0.17
KJENDAHL	2	RUSS.MILLS	0.18	0.08	0.52	0.12
NITROGEN	3	ARNOLD	0.23	0.28	0.92	0.36
(mg/L)	4	McCABE	0.18	0.25	1.00	0.17
	5	HOLLY	0.76	0.10	0.82	0.15
	6	SLOCUM	0.29	0.22	0.34	0.34
	7	SHARP	0.22	0.16	0.24	1.83
	8	ALLEN	0.25	0.07	0.34	0.19
	9	HAWTHORNE	0.12	0.07	0.34	0.12
	10	BOUNDARY	0.19	0.19	0.14	0.29
		MEAN	0.26	0.15	0.49	0.37
		SD	0.18	0.08	0.31	0.52
		HIGH	0.76	0.28	1.00	1.83
		LOW	0.12	0.07	0.14	0.12

TABLE 2 (CONTINUED)

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 3-18-90	SPRING 5-29-90	SUMMER 9-22-90	AUTUMN 11-10-90
ORTHO- PHOSPHATE (mg/L)	1	APPON.HRBR.	<0.05	<0.05	<0.05	<0.05
	2	RUSS.MILLS	<0.05	<0.05	<0.05	<0.05
	3	ARNOLD	<0.05	<0.05	<0.05	<0.05
	4	McCABE	<0.05	<0.05	<0.05	<0.05
	5	HOLLY	<0.05	<0.05	<0.05	<0.05
	6	SLOCUM	<0.05	<0.05	<0.05	0.16
	7	SHARP	<0.05	<0.05	<0.05	<0.05
	8	ALLEN	<0.05	<0.05	0.38	0.09
	9	HAWTHORNE	<0.05	<0.05	<0.05	<0.05
	10	BOUNDARY	<0.05	0.05	<0.05	<0.05
		MEAN	0.05	0.05	0.08	0.06
		SD	0.00	0.00	0.10	0.04
		HIGH	<0.05	0.05	0.38	0.16
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL SUSPENDED SOLIDS (mg/L)	1	APPON.HRBR.	22	26	<4.0	4.0
	2	RUSS.MILLS	13	44	<4.0	<4.0
	3	ARNOLD	12	14	<4.0	<4.0
	4	McCABE	13	22	<4.0	6.0
	5	HOLLY	5.0	15	4.0	<4.0
	6	SLOCUM	8.0	22	<4.0	<4.0
	7	SHARP	8.0	30	<4.0	<4.0
	8	ALLEN	<4.0	28	<4.0	<4.0
	9	HAWTHORNE	5.0	24	<4.0	<4.0
	10	BOUNDARY	<4.0	20	<4.0	<4.0
		MEAN	9.4	24.5	4.0	4.2
		SD	5.7	8.6	0.0	0.6
		HIGH	22	44	4.0	6.0
		LOW	<4.0	14	<4.0	<4.0
FECAL COLIFORM (MPN/100mL)	1	APPON.HRBR.	23	920	*	<1**
	2	RUSS.MILLS	14	>2400		6200
	3	ARNOLD	130	1600		<1
	4	McCABE	170	>2400		<1
	5	HOLLY	49	>2400		<1
	6	SLOCUM	14	>2400		<1
	7	SHARP	30	>2400		<1
	8	ALLEN	14	1600		<1
	9	HAWTHORNE	41	920		<1
	10	BOUNDARY	350	240		<1
		HIGH	350	>2400		6200
		LOW	14	240		<1

* Samples for this date were not analysed within recommended holding period.
** Counts for this date in cfu/100ml as determined by membrane filtration method.

TABLE 3. BUTTONWOOD BROOK WATER QUALITY DATA (EPISODIC, 9-22-90)

STATION	LOCATION	CADMIUM	COPPER	LEAD	ZINC
1	APPON.HRBR.	<0.010	0.004	<0.070	0.051
2	RUSS.MILLS	<0.010	<0.004	<0.070	0.074
3	ARNOLD	<0.010	<0.004	<0.070	0.079
4	McCABE	<0.010	0.009	<0.070	0.101
5	HOLLY	<0.010	<0.004	<0.070	0.050
6	SLOCUM	<0.010	0.011	<0.070	0.113
7	SHARP	<0.010	0.026	<0.070	0.085
8	ALLEN	<0.010	0.029	<0.070	0.131
9	HAWTHORNE	<0.010	0.019	<0.070	0.111
10	BOUNDARY	<0.010	0.008	<0.070	0.059
	MEAN	0.010	0.012	0.070	0.085
	SD	0.000	0.010	0.000	0.028
	HIGH	<0.010	0.029	<0.070	0.131
	LOW	<0.010	<0.004	<0.070	0.050

Note: Total metal concentrations in mg/L

APPENDIX B

SHELLFISH SAMPLING DATA, 10 NOVEMBER 1990
APPONAGANSETT HARBOR, DARTMOUTH, MASSACHUSETTS

Transect 1

Station	Shell Length of Individual Quahogs in Inches
1	-
2	-
3	-
4	-
5	-
6	-
7	3.7 3.0 3.2 3.2
8	3.6 2.9 2.7
9	3.3 3.0 3.3 4.6 2.2
10	3.8 3.2 3.3 3.1 3.0 3.8 3.3
11	3.6 3.4 3.1 3.5 3.5 3.8 2.9
12	3.4 3.0 3.2 3.8 3.6 3.4 2.5 2.9 2.9 3.9
13	2.5 3.7 3.4 3.7 3.4 2.9 3.1
14	3.3 2.8
15	3.2 3.4
16	2.7 4.1 3.6 3.0 2.8 2.6 3.0 2.8 2.1 2.2 3.2
17	2.7 3.2 3.2 2.6 2.7 3.9 3.2
18	-
19	-
20	-

Transect 2

Station	Shell Length of Individual Quahogs in Inches
1	-
2	3.5 2.6 2.8 2.5 2.4 3.9 2.9 3.0
3	2.7 2.9 3.4 3.6 2.8 2.2 3.7 3.5 3.2
4	2.1 3.4 2.9 3.4 3.8 2.1
5	4.0 2.8 3.5 2.8 2.8
6	2.6 2.6 2.4 3.3 2.6
7	3.4 3.9 2.1 2.9 3.4
8	4.1 3.4 3.2 2.5 2.3
9	4.2 4.0 3.3 3.3 3.7 3.7 3.4 3.4
10	3.4 3.4 2.9 3.6 2.6 1.9 2.6 3.0 3.3 3.4 3.3 2.6
11	3.2 3.3 2.1 3.8 3.2 3.4 3.1 3.7 3.2 3.3
12	3.7 3.3 4.0 3.5 3.5 3.2 2.6
13	3.1 3.7 3.3 3.0 2.7
14	3.7 2.7 3.2 2.4 3.1 2.9 3.3
15	3.6 2.8 3.0 2.4 3.2 3.0
16	3.8 2.8 2.2 3.1 2.4 2.6
17	2.7 3.1 3.1 3.6 3.1
18	3.3 2.9 2.7 2.4 2.9
19	3.3 2.2 2.9 3.3 2.6
20	-

Transect 3

Station	Shell Length of Individual Quahogs in Inches
1	2.2 2.1
2	2.6 2.8
3	2.1 2.1 2.3
4	2.3 2.6
5	2.4 1.8 3.3
6	2.4 2.4
7	3.3
8	2.4
9	2.2 2.1
10	2.3
11	2.4
12	3.2 2.2
13	2.1 1.9
14	2.8 2.7 2.3 2.4
15	2.3 2.7 2.2
16	3.3 2.9
17	2.9 2.8 2.5
18	3.1 2.6 3.1 3.6 2.7
19	2.8 3.0 2.5 2.9
20	3.0 2.9 3.1 3.0 2.5 2.7 2.0 2.3 1.9 2.5 3.2 2.6

Transect 4

Station	Shell Length of Individual Quahogs in Inches
1	3.6 2.8 3.2 3.9 2.7 2.7 2.3 2.3 2.5
2	3.3 3.3 2.1
3	-
4	2.8 3.4 2.5 3.0 2.1
5	2.7
6	2.2 3.7
7	2.9 3.1 1.6 2.6
8	3.2 3.4 2.9 2.5 2.5 2.5 2.5 2.9 2.5 2.5 3.4 2.5 3.5 2.8 2.7 2.2 2.2 2.2 1.9
9	3.1 2.0 2.5 3.4 2.6 2.4 2.3 3.3 2.5 1.8 1.9
10	3.2 3.1 3.4 2.6 2.7 2.5 2.5 2.2 2.1 2.1 2.1 2.0 1.9
11	4.2 4.0 2.7 2.2 2.3 2.2 1.9 2.2 1.7 2.0
12	3.7 2.8 2.6 1.9 1.8 2.2
13	3.0 2.6 2.1 2.9 1.7
14	2.0 2.3 2.1 2.0
15	2.5 2.6
16	1.9 2.4 2.1 2.3 2.2
17	2.4 1.9 2.5 2.9 2.5 2.3 2.9 2.2
18	2.7 2.6 2.4 2.6 2.3 2.3 1.9
19	3.0 2.6 2.1
20	4.0 2.8 2.6 2.5
21	4.0 3.5 3.5 2.9 3.4 2.8 2.1
22	3.1 2.9 2.3
23	3.6 2.9 2.5 2.2 2.5
24	2.9 2.5
25	2.6 3.0 3.0 2.1
26	2.9 2.5 3.3 2.7 2.2
27	2.9 2.8 3.0 2.5 2.5 2.6 2.1 2.1

APPENDIX C

MARKET VALUE OF SHELLFISH RESOURCES
APPONAGANSETT BAY, DARTMOUTH, MASSACHUSETTS

Market Designation	Estimated Number in Resource Area	Number of Quahogs per Pound *	Price per Pound *	Estimated Market Value
littleneck	212,772	6	$0.925	$ 32,802
cherrystone	137,676	3.5	$0.25	$ 9,834
chowder	1,230,740	1	$0.10	$123,074
			TOTAL	$165,710

* pers. comm., Mr. Michael Hickey, Division of Marine Fisheries, 14 March 1991

TOWN OF DARTMOUTH
BUTTONWOOD BROOK WATERSHED
MANAGEMENT PLAN
Shellfish Sampling & Water
Quality Data, Municipal
Regulation Review
and Land Use Map

SES

SANFORD ECOLOGICAL SERVICES, Inc.

Environmental Consultants

TOWN OF DARTMOUTH
BUTTONWOOD BROOK WATERSHED
MANAGEMENT PLAN
Shellfish Sampling & Water Quality Data, Municipal Regulation Review and Land Use Map

Prepared for:

THE TOWN OF DARTMOUTH
TOWN HALL
SLOCUM ROAD
DARTMOUTH, MASSACHUSETTS
02749

Prepared by:

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258 Main Street
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Bourne, Massachusetts 02532

April 24, 1991

SUMMARY OF THE SHELLFISH INVENTORY PROGRAM

SHELLFISH RESOURCE EVALUATION

This section of the report presents the methodology and results of a shellfish resource evaluation conducted on 10 November 1990 in the subtidal and intertidal regions of upper Apponganset Bay. This study was conducted by Sanford Ecological Services, Inc. (SES) in conjunction with Mr. Michael Hickey of the Massachusetts Division of Marine Fisheries and volunteers from the Dartmouth Fisherman's Association. The shellfish resource area examined in this study is fifty acres in size and is situated between Little Island to the south and Lucy Street to the north (Figure A).

Methodology

Four transects were established across upper Apponganset Bay at 275 foot intervals. Sampling stations were located at 50 foot intervals along each transect. At each sampling station, three grab samples (2 square feet each, 6 square feet total sampling area per station) were taken from a boat using a bullrake. The shellfish from the three grab samples at each station were combined into a single sample and were classified by species, individual size (shell length), and market designation. The harvested shellfish were turned over to John Sherman for disposition.

Results

All 396 of the shellfish collected in this survey were quahogs. Thus, the shellfish resources of upper Apponganset Bay at the time of this sampling consisted of only a single species. The collected quahogs ranged in size from 1.6 to 4.6 inches. The sampling data collected during this survey is presented in Appendix A.

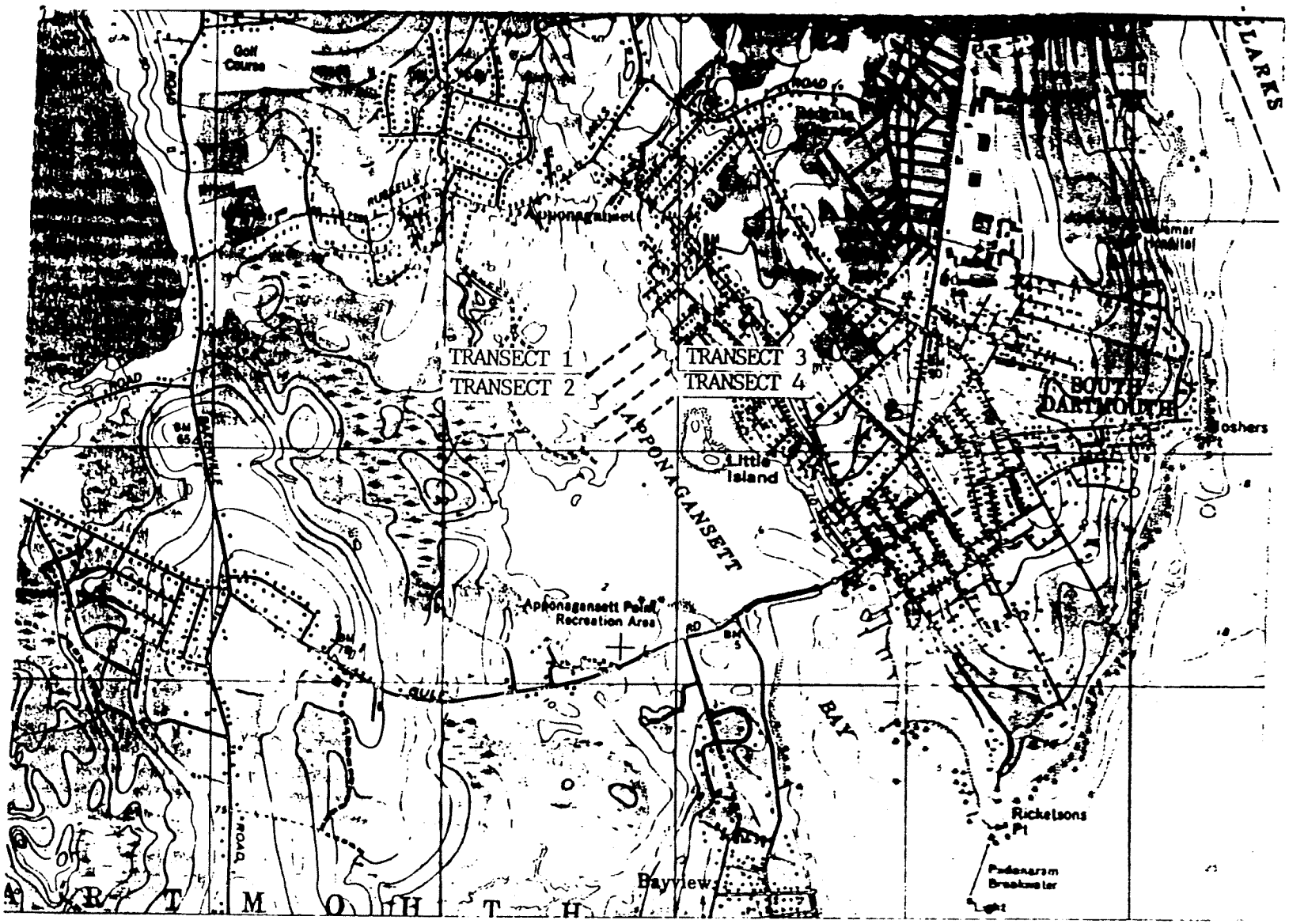

FIGURE A

APPROXIMATE LOCATION OF SHELLFISH SAMPLING TRANSECTS

SCALE: 1" = 2,000'

The market designations for quahogs, which are based on shell length, are: littleneck, 2.0 to 2.25 inches; cherrystone, 2.25 to 2.5 inches; and chowder, 2.5 inches and larger (pers. comm., M. Hickey). According to these designations, 74.5% of the collected quahogs were classified as chowder, 8.3% as cherrystone, and 12.9% as littleneck. The remaining 4.3% of the collected quahogs had a shell length of less than 2 inches; consequently, these had no market designation and were not included in the economic analysis.

Based on the November sampling, the overall population density for quahogs of all sizes in the upper bay was approximately 0.76 individuals per square foot of substrate. The estimated densities for the various market designations in individuals per square foot were approximately: chowder, 0.57; cherrystone, 0.06; littleneck, 0.10; and no market designation, 0.03.

Some trends were noted regarding the distribution of the various market designations among the four transects (see Figure A). At transect 1, the uppermost in the bay, 95.4% of the 65 quahogs collected were chowder and 4.6% were classified as littleneck. At transect 2, 87.4% of 119 organisms were classified as chowder, 5.9% each as cherrystone and littleneck, and 0.8% had no market designation. At transect 3, 56.1% of 57 quahogs were chowder, 21.1% were cherrystone, 17.5% were littleneck, and 5.3% had no market designation. At the most southerly transect, transect 4, 62.6% of 155 organisms were classified as chowder, 9.0% as cherrystone, 20.0% as littleneck, and 8.4% had no market designation. In general, the proportion of the collected quahogs consisting of smaller sized individuals tended to increase in samples collected at transects located lower (more southerly) in the bay. The significance of and factors underlying this distribution pattern are not known, but could possibly be related to season, salinity, tide, and/or other environmental conditions.

The number of quahogs per market designation is based upon samples collected from 522 square feet of the upper bay. The shellfish resource area examined in this survey covers 50 acres (2,178,000 square feet); therefore, the total number of quahogs per market designation for the entire resource area can be estimated by multiplying those collected in the sampling effort by a factor of 4172. Based on the estimated number of quahogs present in the resource area, the number of quahogs per pound, and the price per pound for each market designation, the empirical market value for the shellfish resources of upper Apponganset Bay was estimated to be approximately $166,000. Due to the systematic sampling methodology employed in this study, no estimate of variability associated with this value can be determined. The complete economic analysis is presented in tabular form in Appendix B.

In conclusion, the shellfish resources of upper Apponganset Bay, based on sampling on 10 November 1990, consist of a single species of shellfish (quahog). Using information provided by Mr. Hickey of the Division of Marine Fisheries, the empirical market value for the shellfish resources was estimated to be approximately $166,000.

APPENDIX A

SHELLFISH SAMPLING DATA, 10 NOVEMBER 1990
APPONGANSETT HARBOR, DARTMOUTH, MASSACHUSETTS

Transect 1

Station	Shell Length of Individual Quahogs in Inches
1	-
2	-
3	-
4	-
5	-
6	-
7	3.7 3.0 3.2 3.2
8	3.6 2.9 2.7
9	3.3 3.0 3.3 4.6 2.2
10	3.8 3.2 3.3 3.1 3.0 3.8 3.3
11	3.6 3.4 3.1 3.5 3.5 3.8 2.9
12	3.4 3.0 3.2 3.8 3.6 3.4 2.5 2.9 2.9 3.9
13	2.5 3.7 3.4 3.7 3.4 2.9 3.1
14	3.3 2.8
15	3.2 3.4
16	2.7 4.1 3.6 3.0 2.8 2.6 3.0 2.8 2.1 2.2 3.2
17	2.7 3.2 3.2 2.6 2.7 3.9 3.2
18	-
19	-
20	-

Transect 2

Station	Shell Length of Individual Quahogs in Inches
1	-
2	3.5 2.6 2.8 2.5 2.4 3.9 2.9 3.0
3	2.7 2.9 3.4 3.6 2.8 2.2 3.7 3.5 3.2
4	2.1 3.4 2.9 3.4 3.8 2.1
5	4.0 2.8 3.5 2.8 2.8
6	2.6 2.6 2.4 3.3 2.6
7	3.4 3.9 2.1 2.9 3.4
8	4.1 3.4 3.2 2.5 2.3
9	4.2 4.0 3.3 3.3 3.7 3.7 3.4 3.4
10	3.4 3.4 2.9 3.6 2.6 1.9 2.6 3.0 3.3 3.4 3.3 2.6
11	3.2 3.3 2.1 3.8 3.2 3.4 3.1 3.7 3.2 3.3
12	3.7 3.3 4.0 3.5 3.5 3.2 2.6
13	3.1 3.7 3.3 3.0 2.7
14	3.7 2.7 3.2 2.4 3.1 2.9 3.3
15	3.6 2.8 3.0 2.4 3.2 3.0
16	3.8 2.8 2.2 3.1 2.4 2.6
17	2.7 3.1 3.1 3.6 3.1
18	3.3 2.9 2.7 2.4 2.9
19	3.3 2.2 2.9 3.3 2.6
20	-

Transect 3

Station	Shell Length of Individual Quahogs in Inches
1	2.2 2.1
2	2.6 2.8
3	2.1 2.1 2.3
4	2.3 2.6
5	2.4 1.8 3.3
6	2.4 2.4
7	3.3
8	2.4
9	2.2 2.1
10	2.3
11	2.4
12	3.2 2.2
13	2.1 1.9
14	2.8 2.7 2.3 2.4
15	2.3 2.7 2.2
16	3.3 2.9
17	2.9 2.8 2.5
18	3.1 2.6 3.1 3.6 2.7
19	2.8 3.0 2.5 2.9
20	3.0 2.9 3.1 3.0 2.5 2.7 2.0 2.3 1.9 2.5 3.2 2.6

Transect 4

Station	Shell Length of Individual Quahogs in Inches
1	3.6 2.8 3.2 3.9 2.7 2.7 2.3 2.3 2.5
2	3.3 3.3 2.1
3	-
4	2.8 3.4 2.5 3.0 2.1
5	2.7
6	2.2 3.7
7	2.9 3.1 1.6 2.6
8	3.2 3.4 2.9 2.5 2.5 2.5 2.5 2.9 2.5 2.5 3.4 2.5 3.5 2.8 2.7 2.2 2.2 2.2 1.9
9	3.1 2.0 2.5 3.4 2.6 2.4 2.3 3.3 2.5 1.8 1.9
10	3.2 3.1 3.4 2.6 2.7 2.5 2.5 2.2 2.1 2.1 2.1 2.0 1.9
11	4.2 4.0 2.7 2.2 2.3 2.2 1.9 2.2 1.7 2.0
12	3.7 2.8 2.6 1.9 1.8 2.2
13	3.0 2.6 2.1 2.9 1.7
14	2.0 2.3 2.1 2.0
15	2.5 2.6
16	1.9 2.4 2.1 2.3 2.2
17	2.4 1.9 2.5 2.9 2.5 2.3 2.9 2.2
18	2.7 2.6 2.4 2.6 2.3 2.3 1.9
19	3.0 2.6 2.1
20	4.0 2.8 2.6 2.5
21	4.0 3.5 3.5 2.9 3.4 2.8 2.1
22	3.1 2.9 2.3
23	3.6 2.9 2.5 2.2 2.5
24	2.9 2.5
25	2.6 3.0 3.0 2.1
26	2.9 2.5 3.3 2.7 2.2
27	2.9 2.8 3.0 2.5 2.5 2.6 2.1 2.1

APPENDIX B

EMPIRICAL MARKET VALUE OF SHELLFISH RESOURCES
APPONGANSETT BAY, DARTMOUTH, MASSACHUSETTS

Market Designation	Estimated Number in Resource Area	Number of Quahogs per Pound *	Price per Pound *	Estimated Market Value
littleneck	212,772	6	$0.925	$ 32,802
cherrystone	137,676	3.5	$0.25	$ 9,834
chowder	1,230,740	1	$0.10	$123,074
			TOTAL	$165,710

* pers. comm., Mr. Michael Hickey, Division of Marine Fisheries, 14 March 1991

SUMMARY OF WATER QUALITY SAMPLING DATA

WATER QUALITY EVALUATION

This section of the report presents the methodology and results of a year long water quality evaluation of the Buttonwood Brook Watershed. This study was conducted by Sanford Ecological Services in conjuction with volunteers from the Dartmouth Fisherman's Association between 14 February and 10 November 1990.

Methodology

Samples for water quality analysis were collected seasonally from ten stations throughout the watershed (Figure 1) under both non-episodic and episodic conditions. Non-episodic sampling allowed evaluation of water quality under normal, dry condition flow; episodic sampling allowed the contributions of road and land runoff due to significant climatic episodes to be evaluated.

The water samples were analyzed in state certified laboratories for nitrate-nitrogen, ammonia-nitrogen, total kjendahl nitrogen, ortho-phosphate, total suspended solids, and fecal coliform. Sampling for the metals cadmium, copper, lead, and zinc occurred only during the summer episodic sampling event. The results of water quality analyses are presented in Appendix C.

Results

The discussion of the results is presented in two sections. In the first section, the water quality characteristics of the watershed are discussed for each parameter with emphasis placed on the levels observed, seasonal variation, non-episodic versus episodic results, and comparisions to available toxicity thresholds. The

SAMPLING LOCATIONS

STATION 1 Apponagansett Harbor
STATION 2 Russells Mills Road
STATION 3 Arnold Street
STATION 4 McCabe Street
STATION 5 Holly Drive
STATION 6 Slocum Road
STATION 7 Sharp Street
STATION 8 Allen Street
STATION 9 Hawthorne Street
STATION 10 Corporate Boundary

FIGURE 1
SAMPLING STATION LOCATIONS
BUTTONWOOD BROOK WATERSHED
DARTMOUTH, MASSACHUSETTS
APPROPROXIMATE SCALE 1" = 2000'

second section presents a more general discussion comparing the relative contaminant contributions with corresponding land use patterns for ten subdrainage basins within the watershed.

Water Quality Analysis Results

Nitrate-nitrogen, the first of the parameters evaluated to examine nitrogen loading, is indicative of wastewater releases and is generally accepted as the limiting nutrient in both estuarine and marine systems with regard to eutrophication. Under both non-episodic and episodic conditions, the mean nitrate-nitrogen levels remained fairly consistent throughout the seasons. The non-episodic and episodic values ranged from 0.07 to 7.01 mg/L and 0.34 to 6.1 mg/L, respectively. The highest levels were found for all seasons in samples collected under both conditions at sampling stations 5 and 6 (Holly Drive and Slocum Road). Concentrations at these stations ranged from 2.62 to 7.01 mg/L and averaged roughly 5 mg/L. The EPA water quality criterion for nitrate-nitrogen indicates that levels of 5 mg/L should be protective of most warmwater fisheries. In addition, the drinking water standard for nitrate-nitrogen is 10 mg/L. Thus, nitrate-nitrogen is not significant contaminant in Buttonwood Brook.

The two remaining nitrogen parameters examined in this study, ammonia-nitrogen and total kjendahl nitrogen (TKN), are indicative of sanitary pollution and nutrient loading. Ammonia-nitrogen levels under non-episodic conditions ranged from <0.05 to 0.45 mg/L, with the highest values typically observed during the summer. In contrast, under episodic conditions the ammonia-nitrogen levels were usually lowest in the summer with values for all seasons within the range of <0.05 to 0.25 mg/L. TKN concentrations

for non-episodic and episodic conditions were similar, and both were seasonally dependent with the highest values found during the summer and autumn. The non-episodic and episodic values ranged from < 0.05 to 1.17 mg/L and 0.07 to 1.83 mg/L, respectively.

Phosphorus is generally accepted as the limiting nutrient controlling the eutrophication of freshwater systems. Under non-episodic and episodic conditions, concentrations of ortho-phosphate ranged from <0.05 to 0.08 mg/L and <0.05 to 0.38 mg/L, respectively. In the majority of the samples analyzed for this study, ortho-phosphate levels were below the detection limit of 0.05 mg/L. The elevated levels found in the summer episodic sample at station 8 (Allen Street; 0.38 mg/L) and during the autumn episodic event at station 6 (Slocum Street; 0.16 mg/L) are of concern.

The level of total suspended solids contained in the water column is indicative of pollutant loading to aquatic systems. Under non-episodic conditions, total suspended solids ranged from <4.0 to 142 mg/L. These were seasonally dependent with the highest values at most stations observed in the summer. The levels found under episodic conditions were also seasonally dependent with the highest values typically observed in the winter and spring. In this case, the levels ranged from <4.0 to 44 mg/L. In general, the values reported are not of concern, with the exceptions of the spring episodic and autumn non-episodic samples from station 2 (Russells Mills Road; 44 and 36 mg/L) and the summer non-episodic sample from station 1 (Apponganset Bay; 142 mg/L). It is important to note that both of these stations are located near the base of the Buttonwood Brook Watershed. Why is this impt?

The trace metals examined in this study - cadmium, copper, lead, and zinc - are common roadway and parking lot runoff constituents. Concentrations of these metals were measured only once during this study: during the summer episodic event. Cadmium and lead levels were below their respective detection limits of 0.010 and 0.070 mg/L at all ten stations. Copper concentrations ranged from <0.004 to 0.029 mg/L and zinc levels ranged from 0.05 to 0.131 mg/L. The elevated levels of copper at stations 7, 8, and 9 (Sharp Street, Allen Street, and Hawthorne Street), and the elevated zinc concentrations at stations 4, 6, 8, and 9 (McCabe Street, Slocum Road, Allen Street, and Hawthorne Street) are of concern from a toxicological viewpoint. The copper concentration exceeds both chronic and acute EPA toxicity levels for freshwater organisms. Zinc levels at all ten stations are above the chronic EPA toxicity threshold of 0.047 mg/L for freshwater environments. Due to the extreme toxicity of cadmium and because the exact level of cadmium in the samples are not know (i.e., below detection limit of 0.010 mg/L), concern should be expressed here, as well.

based on what

what is it.

why did you sample if our detection limit was above our standard of concern?

Fecal coliform is used as an indicator organism for monitoring water quality and for managing coastal shellfishing. The geometric mean Most Probable Number (MPN) of the water sample cannot exceed 14 colony forming units (cfu) per 100 mL, and not more than 10% of the samples can exceed an MPN of 43 cfu/100 mL for a five tube decimal dilution test. Non-episodic fecal coliform levels ranged from <2 to >2400 cfu/100 mL and were seasonally dependent with the highest values typically found from the spring to autumn. Episodic values ranged from <1 to 6200 (>2400) cfu/100 mL. These were also seasonally dependent with the highest values occurring during the spring (summer levels were not measured). Particularly high levels (>2400 cfu/100 mL) were found in the spring episodic samples for

stations 2, 4, 5, 6, and 7 (Russells Mills Road, McCabe Street, Holly Drive, Slocum Road, and Sharp Street) and for the summer non-episodic event at station 7 (Sharp Street). In addition, during one or more sampling events through the year, all of the stations exceeded 14 cfu/100 mL, the aforementioned threshold established for shellfish bed closure.

Water Quality and Land Use Practices

which is the entire drainage basin ... #1 includes 2-10

The Buttonwood Brook Watershed was divided into ten subdrainage areas based on the location of the sampling stations (Figure 2). These subdrainage areas range from 80.95 to 1783 acres in size. In six out of the ten subdrainage areas, greater than 50% of the land use is urban. Storm drains discharge road runoff to all but one of the subdrainage areas (area 10). A summary of land use practices for the various subdrainage areas of the Buttonwood Brook Watershed are presented in Appendix D.

Subdrainage area 10

The subdrainage area located at the headwaters of the basin is the main contributing area to sampling station 10 (Corporate Boundary). This subdrainage area consists of 553.83 acres and comprises 31.1% of the total watershed area. The land use is primarily urban consisting generally of residential neighborhoods and highways. Concentrations of tested parameters for subdrainage area 10 were generally below the calculated mean values for the watershed except for ammonia-nitrogen, which was consistently elevated.

Subdrainage area 9

The subdrainage area contributing to sampling station 9 (Hawthorne Street) is 260.86 acres in size and comprises 14.6% of the total watershed. Land use is primarily urban consisting generally of residential areas and schools.

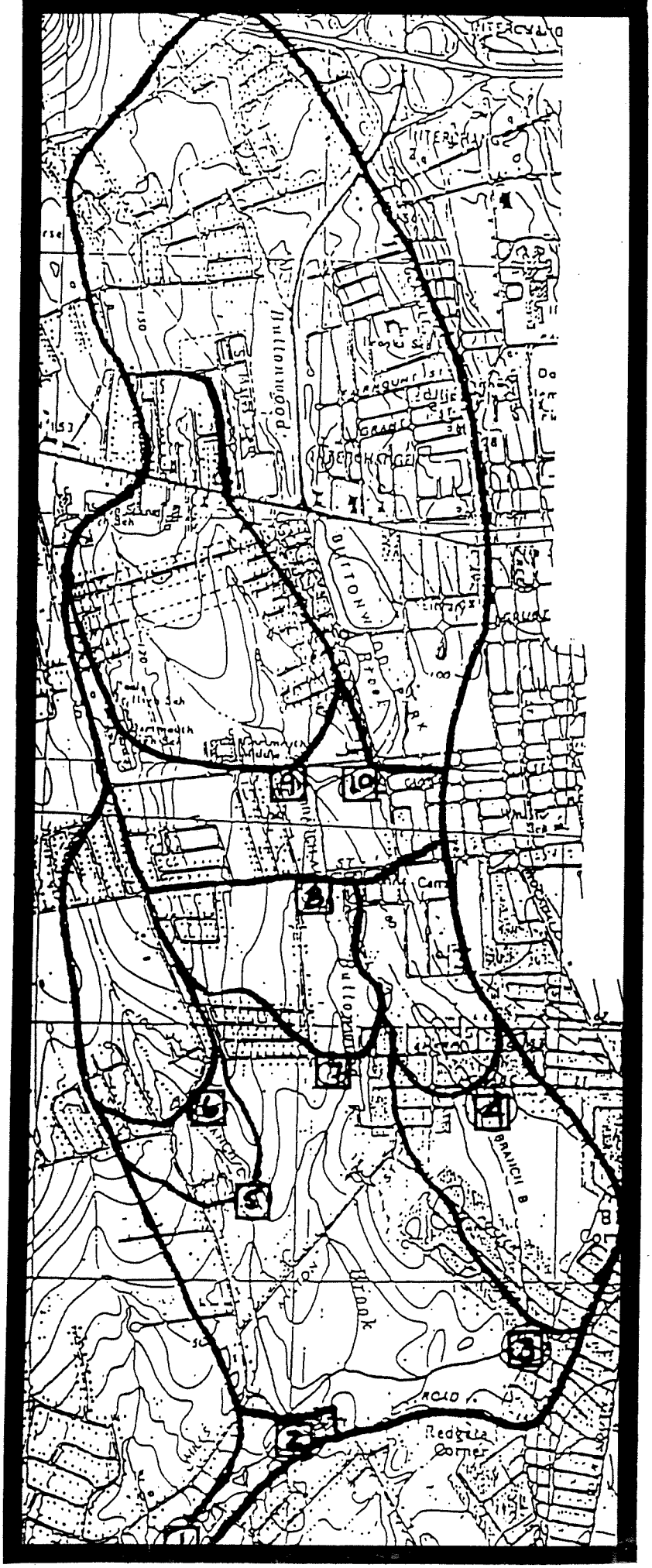

FIGURE 2 BUTTONWOOD BROOK SUBDRAINAGE AREAS

SCALE: 1" = 2,000'

This subdrainage area is located at the headwaters of Branch A of Buttonwood Brook. Episodic water quality analyses indicate that the drainage from this area contains elevated levels of copper and zinc. These metals are probably derived from road runoff.

Subdrainage area 8

The contributing subdrainage area to sample station 8 (Allen Street) is 964.26 acres in size and comprises 54.1% of the total watershed. This subdrainage area includes subdrainage areas 9 and 10 and is located on Branch A of the brook directly south of subdrainage area 9. The land use in this area is approximately 71% urban consisting of residential neighborhoods, schools, cemeteries, and other urban structures. Analyses indicate that the Buttonwood Brook discharge at this station is generally elevated in ammonia-nitrogen, copper, and zinc. The elevated ammonia-nitrogen levels probably result from inflows from subdrainage area 10. The elevated copper and zinc are probably derived from road runoff.

Subdrainage area 7

The subdrainage area contributing to sample station 7 (Sharp Street) is 1057.63 acres is size and comprises 59.3% of the total watershed area. It includes subdrainage areas 8, 9, and 10 and is located south of subdrainage area 8 along Branch A of Buttonwood Brook. The land use in this subdrainage area is approximately 64% urban. In general, ammonia-nitrogen and metal concentrations are lower at station 7 than at upgradient station 8. This probably results from the large area of open space between these two sample collection stations.

Subdrainage area 6

Subdrainage area 6 is 100.94 acres in size and comprises 5.7% of the total watershed area. This

subdrainage area is located at the headwaters of Branch C of Buttonwood Brook. Approximately 66% of this subdrainage area is open space with the remaining area covered by residential neighborhoods. Water quality analyses indicate elevated levels of nitrate-nitrogen from this drainage area. This is probably a consequence of the agricultural activity in this subdrainage area. In addition, the level of zinc, probably derived from road runoff, is higher than average.

Subdrainage area 5

The subdrainage area contributing to sample station 5 (Holly Drive) is 146.41 acres in size and comprises 8.2% of the total watershed area. This area includes subdrainage area 6 and is located on Branch C of Buttonwood Brook just downstream of that area. The land use in this subdrainage area is approximately 61% open space and 39% urban. Water quality analyses indicate that nitrate-nitrogen is elevated at the station, however, this elevated level probably originates from subdrainage area 6. However, the level of zinc is much lower than at station 6.

Subdrainage area 4

Subdrainage area 4 measures 80.95 acres in size and comprises 4.5% of the total watershed area. This area is located at the headwaters of Branch B of Buttonwood Brook and is approximately 65% open space. The remaining 35% is primarily residential neighborhoods. Water quality analyses indicate that no significant levels of contaminants are derived from this portion of the watershed, although road runoff probably contributes to an elevated zinc concentration.

Subdrainage area 3

The subdrainage area contributing to sample station 3 is 212.37 acres in size and comprises 11.9% of the total

watershed area. This area includes subdrainage area 4 and is located directly south of subdrainage area 4 along Branch B. Land use in the area is approximately 49% urban. Water quality analyses indicate that no significant levels of contaminants are derived from this portion of the watershed.

Subdrainage area 2

Subdrainage area 2 is 1756.99 acres in size and comprises 98.5% of the total watershed area. Branch B, Branch C, and Branch A of Buttonwood Brook converge within this subdrainage area which includes subdrainage areas 3 through 10. Approximately 52% of the land use is urban. Water quality analyses indicate that contaminants present at this portion of the watershed are probably derived from upgradient areas.

Subdrainage area 1

Sample station 1 is located at the mouth of Buttonwood Brook where it empties into Apponagansett Bay. Subdrainage area 1 is 1783 acres in size and represents 100% of the total watershed area. Approximately 58% of the watershed land use is urban. No significant changes in water quality occur between sample station 2 and sample station 1.

In conclusion, water quality analyses indicate that no specific location contributes significant quantities of chemical contaminants to Buttonwood Brook. In general, the contaminants that were observed (i.e.,nitrate-nitrogen, ammonia-nitrogen, and metals such as copper and zinc) are derived primarily from road and surface runoff throughout the basin. One area, subdrainage area 6, which is located in the eastern portion of the watershed, does contribute elevated levels of nitrate-nitrogen. This probably results from agricultural runoff of fertilizers. Levels of fecal coliform were, in general, greatly elevated at a number of

locations throughout the watershed. As this parameter is used by the Division of Marine Fisheries to regulate shellfishing, these levels are of particular concern.

APPENDIX C

WATER QUALITY DATA

BUTTONWOOD BROOK WATERSHED, DARTMOUTH, MASSACHUSETTS

TABLE 1. BUTTONWOOD BROOK WATER QUALITY DATA (NON-EPISODIC)

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 2-14-90	SPRING 5-9-90	SUMMER 7-30-90	AUTUMN 10-10-90
NITRATE NITROGEN (mg/L)	1	APPON.HRBR.	1.98	1.03	0.43	0.07
	2	RUSS.MILLS	2.49	1.45	1.91	2.1
	3	ARNOLD	1.93	1.34	1.8	2.16
	4	McCABE	2.09	1.14	1.83	0.94
	5	HOLLY	6.03	6.00	7.01	5.66
	6	SLOCUM	6.50	4.86	5.52	5.2
	7	SHARP	1.91	1.08	2.91	1.33
	8	ALLEN	1.09	0.79	1.57	1.27
	9	HAWTHORNE	1.35	0.93	1.4	0.99
	10	BOUNDARY	0.67	0.11	0.81	0.80
		MEAN	2.60	1.87	2.52	2.05
		SD	2.00	1.93	2.11	1.88
		HIGH	6.50	6.00	7.01	5.66
		LOW	0.67	0.11	0.43	0.07
AMMONIA NITROGEN (mg/L)	1	APPON.HRBR.	<0.05	0.07	0.38	0.11
	2	RUSS.MILLS	<0.05	<0.05	0.06	<0.05
	3	ARNOLD	<0.05	0.06	0.12	<0.05
	4	McCABE	<0.05	0.06	0.15	0.06
	5	HOLLY	<0.05	0.13	<0.05	<0.05
	6	SLOCUM	<0.05	<0.05	<0.05	<0.05
	7	SHARP	0.06	0.07	0.21	0.08
	8	ALLEN	<0.05	0.08	0.18	<0.05
	9	HAWTHORNE	<0.05	<0.05	0.14	<0.05
	10	BOUNDARY	0.07	0.14	0.45	<0.05
		MEAN	0.05	0.08	0.18	0.06
		SD	0.01	0.03	0.14	0.02
		HIGH	0.07	0.14	0.45	0.11
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL KJELDAHL NITROGEN (mg/L)	1	APPON.HRBR.	0.06	0.21	1.17	0.46
	2	RUSS.MILLS	<0.05	0.17	0.61	0.81
	3	ARNOLD	<0.05	0.12	0.52	0.36
	4	McCABE	<0.05	0.17	0.43	0.36
	5	HOLLY	<0.05	0.31	0.3	0.46
	6	SLOCUM	<0.05	<0.05	0.13	0.51
	7	SHARP	0.06	0.15	0.35	0.36
	8	ALLEN	<0.05	0.19	0.43	0.41
	9	HAWTHORNE	<0.05	0.08	0.48	0.36
	10	BOUNDARY	0.07	0.20	0.48	0.41
		MEAN	0.05	0.17	0.49	0.45
		SD	0.01	0.07	0.27	0.14
		HIGH	0.07	0.31	1.17	0.81
		LOW	<0.05	<0.05	0.13	0.36

NON-EPISODIC WATER QUALITY DATA

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 2-14-90	SPRING 5-9-90	SUMMER 7-30-90	AUTUMN 10-10-90
NITRATE	1	APPON.HRBR.	1.98	1.03	0.43	0.07
NITROGEN	2	RUSS.MILLS	2.49	1.45	1.91	2.1
(mg/L)	3	ARNOLD	1.93	1.34	1.8	2.16
	4	McCABE	2.09	1.14	1.83	0.94
	5	HOLLY	6.03	6.00	7.01	5.66
	6	SLOCUM	6.50	4.86	5.52	5.2
	7	SHARP	1.91	1.08	2.91	1.33
	8	ALLEN	1.09	0.79	1.57	1.27
	9	HAWTHORNE	1.35	0.93	1.4	0.99
	10	BOUNDARY	0.67	0.11	0.81	0.80
		MEAN	2.60	1.87	2.52	2.05
		SD	2.00	1.93	2.11	1.88
		HIGH	6.50	6.00	7.01	5.66
		LOW	0.67	0.11	0.43	0.07
AMMONIA	1	APPON.HRBR.	<0.05	0.07	0.38	0.11
NITROGEN	2	RUSS.MILLS	<0.05	<0.05	0.06	<0.05
(mg/L)	3	ARNOLD	<0.05	0.06	0.12	<0.05
	4	McCABE	<0.05	0.06	0.15	0.06
	5	HOLLY	<0.05	0.13	<0.05	<0.05
	6	SLOCUM	<0.05	<0.05	<0.05	<0.05
	7	SHARP	0.06	0.07	0.21	0.08
	8	ALLEN	<0.05	0.08	0.18	<0.05
	9	HAWTHORNE	<0.05	<0.05	0.14	<0.05
	10	BOUNDARY	0.07	0.14	0.45	<0.05
		MEAN	0.05	0.08	0.18	0.06
		SD	0.01	0.03	0.14	0.02
		HIGH	0.07	0.14	0.45	0.11
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL	1	APPON.HRBR.	0.06	0.21	1.17	0.46
KJELDAHL	2	RUSS.MILLS	<0.05	0.17	0.61	0.81
NITROGEN	3	ARNOLD	<0.05	0.12	0.52	0.36
(mg/L)	4	McCABE	<0.05	0.17	0.43	0.36
	5	HOLLY	<0.05	0.31	0.3	0.46
	6	SLOCUM	<0.05	<0.05	0.13	0.51
	7	SHARP	0.06	0.15	0.35	0.36
	8	ALLEN	<0.05	0.19	0.43	0.41
	9	HAWTHORNE	<0.05	0.08	0.48	0.36
	10	BOUNDARY	0.07	0.20	0.48	0.41
		MEAN	0.05	0.17	0.49	0.45
		SD	0.01	0.07	0.27	0.14
		HIGH	0.07	0.31	1.17	0.81
		LOW	<0.05	<0.05	0.13	0.36

NON-EPISODIC WATER QUALITY DATA (CONTINUED)

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 2-14-90	SPRING 5-9-90	SUMMER 7-30-90	AUTUMN 10-10-90
ORTHO-PHOSPHATE (mg/L)	1	APPON.HRBR.	<0.05	<0.05	0.08	<0.05
	2	RUSS.MILLS	<0.05	<0.05	<0.05	0.06
	3	ARNOLD	<0.05	<0.05	<0.05	<0.05
	4	McCABE	<0.05	<0.05	<0.05	0.06
	5	HOLLY	<0.05	<0.05	<0.05	<0.05
	6	SLOCUM	0.06	<0.05	<0.05	<0.05
	7	SHARP	<0.05	<0.05	<0.05	<0.05
	8	ALLEN	<0.05	<0.05	<0.05	<0.05
	9	HAWTHORNE	<0.05	<0.05	<0.05	<0.05
	10	BOUNDARY	<0.05	<0.05	0.08	0.05
		MEAN	0.05	0.05	0.06	0.05
		SD	0.00	0.00	0.01	0.00
		HIGH	0.06	<0.05	0.08	0.06
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL SUSPENDED SOLIDS (mg/L)	1	APPON.HRBR.	7.0	24	142	4
	2	RUSS.MILLS	<4.0	<4.0	<4.0	36
	3	ARNOLD	<4.0	<4.0	4	<4.0
	4	McCABE	<4.0	<4.0	14	6
	5	HOLLY	<4.0	4.0	18	<4.0
	6	SLOCUM	<4.0	<4.0	12	14
	7	SHARP	<4.0	<4.0	14	<4.0
	8	ALLEN	<4.0	<4.0	14	4
	9	HAWTHORNE	5.0	<4.0	12	<4.0
	10	BOUNDARY	5.0	8.0	16	4
		MEAN	4.5	6.4	25	8.4
		SD	1.0	6.3	41	10.2
		HIGH	7.0	24	142	36
		LOW	<4.0	<4.0	<4.0	<4.0
FECAL COLIFORM (cfu/100mL)	1	APPON.HRBR.	63	>64	920	>246
	2	RUSS.MILLS	63	30	350	>246
	3	ARNOLD	46	41	920	71
	4	McCABE	23	>64	920	246
	5	HOLLY	5	64	350	>246
	6	SLOCUM	4	14	110	143
	7	SHARP	17	>64	>2400	>246
	8	ALLEN	<2	64	1600	>246
	9	HAWTHORNE	<2	>64	240	90
	10	BOUNDARY	17	>64	920	>246
		HIGH	63	>64	>2400	>246
		LOW	<2	14	110	71

EPISODIC WATER QUALITY DATA

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 3-18-90	SPRING 5-29-90	SUMMER 9-22-90	AUTUMN 11-10-90
NITRATE	1	APPON.HRBR.	2.00	1.45	2.03	1.71
NITROGEN	2	RUSS.MILLS	1.49	2.25	2.12	1.69
(mg/L)	3	ARNOLD	1.92	2.12	2.48	1.21
	4	McCABE	1.64	1.86	1.79	0.85
	5	HOLLY	4.59	2.62	2.96	5.3
	6	SLOCUM	6.1	3.95	4.84	3.5
	7	SHARP	1.94	1.67	2.48	1.58
	8	ALLEN	4.73	0.98	2.77	1.32
	9	HAWTHORNE	1.22	1.00	0.61	0.52
	10	BOUNDARY	0.63	0.35	1.29	0.34
		MEAN	2.63	1.83	2.34	1.80
		SD	1.82	1.01	1.13	1.51
		HIGH	6.1	3.95	4.84	5.3
		LOW	0.63	0.35	0.61	0.34
AMMONIA	1	APPON.HRBR.	0.08	0.11	<0.05	<0.05
NITROGEN	2	RUSS.MILLS	0.10	0.08	<0.05	0.06
(mg/L)	3	ARNOLD	0.15	0.21	<0.05	0.14
	4	McCABE	0.12	0.25	<0.05	0.11
	5	HOLLY	0.12	0.10	<0.05	0.06
	6	SLOCUM	<0.05	0.22	<0.05	0.13
	7	SHARP	0.13	0.16	<0.05	0.10
	8	ALLEN	0.17	0.07	0.18	0.19
	9	HAWTHORNE	0.08	<0.05	<0.05	0.12
	10	BOUNDARY	0.15	0.19	<0.05	0.20
		MEAN	0.12	0.14	0.06	0.12
		SD	0.04	0.07	0.04	0.05
		HIGH	0.17	0.25	0.18	0.19
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL	1	APPON.HRBR.	0.13	0.11	0.24	0.17
KJENDAHL	2	RUSS.MILLS	0.18	0.08	0.52	0.12
NITROGEN	3	ARNOLD	0.23	0.28	0.92	0.36
(mg/L)	4	McCABE	0.18	0.25	1.00	0.17
	5	HOLLY	0.76	0.10	0.82	0.15
	6	SLOCUM	0.29	0.22	0.34	0.34
	7	SHARP	0.22	0.16	0.24	1.83
	8	ALLEN	0.25	0.07	0.34	0.19
	9	HAWTHORNE	0.12	0.07	0.34	0.12
	10	BOUNDARY	0.19	0.19	0.14	0.29
		MEAN	0.26	0.15	0.49	0.37
		SD	0.18	0.08	0.31	0.52
		HIGH	0.76	0.28	1.00	1.83
		LOW	0.12	0.07	0.14	0.12

EPISODIC WATER QUALITY DATA (CONTINUED)

SEASON DATE PARAMETER	STATION	LOCATION	WINTER 3-18-90	SPRING 5-29-90	SUMMER 9-22-90	AUTUMN 11-10-90
ORTHO-PHOSPHATE (mg/L)	1	APPON.HRBR.	<0.05	<0.05	<0.05	<0.05
	2	RUSS.MILLS	<0.05	<0.05	<0.05	<0.05
	3	ARNOLD	<0.05	<0.05	<0.05	<0.05
	4	McCABE	<0.05	<0.05	<0.05	<0.05
	5	HOLLY	<0.05	<0.05	<0.05	<0.05
	6	SLOCUM	<0.05	<0.05	<0.05	0.16
	7	SHARP	<0.05	<0.05	<0.05	<0.05
	8	ALLEN	<0.05	<0.05	0.38	0.09
	9	HAWTHORNE	<0.05	<0.05	<0.05	<0.05
	10	BOUNDARY	<0.05	0.05	<0.05	<0.05
		MEAN	0.05	0.05	0.08	0.06
		SD	0.00	0.00	0.10	0.04
		HIGH	<0.05	0.05	0.38	0.16
		LOW	<0.05	<0.05	<0.05	<0.05
TOTAL SUSPENDED SOLIDS (mg/L)	1	APPON.HRBR.	22	26	<4.0	4.0
	2	RUSS.MILLS	13	44	<4.0	<4.0
	3	ARNOLD	12	14	<4.0	<4.0
	4	McCABE	13	22	<4.0	6.0
	5	HOLLY	5.0	15	4.0	<4.0
	6	SLOCUM	8.0	22	<4.0	<4.0
	7	SHARP	8.0	30	<4.0	<4.0
	8	ALLEN	<4.0	28	<4.0	<4.0
	9	HAWTHORNE	5.0	24	<4.0	<4.0
	10	BOUNDARY	<4.0	20	<4.0	<4.0
		MEAN	9.4	24.5	4.0	4.2
		SD	5.7	8.6	0.0	0.6
		HIGH	22	44	4.0	6.0
		LOW	<4.0	14	<4.0	<4.0
FECAL COLIFORM (cfu/100mL)	1	APPON.HRBR.	23	920	*	<1
	2	RUSS.MILLS	14	>2400	only	6200
	3	ARNOLD	130	1600		<1
	4	McCABE	170	>2400		<1
	5	HOLLY	49	>2400		<1
	6	SLOCUM	14	>2400		<1
	7	SHARP	30	>2400		<1
	8	ALLEN	14	1600		<1
	9	HAWTHORNE	41	920		<1
	10	BOUNDARY	350	240		<1
		HIGH	350	>2400		6200
		LOW	14	240		<1

something seems wrong here!

* Counts were not determined for this date.

EPISODIC WATER QUALITY DATA (METALS, 9-22-90)

STATION	LOCATION	CADMIUM	COPPER	LEAD	ZINC
1	APPON.HRBR.	<0.010	0.004	<0.070	0.051
2	RUSS.MILLS	<0.010	<0.004	<0.070	0.074
3	ARNOLD	<0.010	<0.004	<0.070	0.079
4	McCABE	<0.010	0.009	<0.070	0.101
5	HOLLY	<0.010	<0.004	<0.070	0.050
6	SLOCUM	<0.010	0.011	<0.070	0.113
7	SHARP	<0.010	0.026	<0.070	0.085
8	ALLEN	<0.010	0.029	<0.070	0.131
9	HAWTHORNE	<0.010	0.019	<0.070	0.111
10	BOUNDARY	<0.010	0.008	<0.070	0.059
	MEAN	0.010	0.012	0.070	0.085
	SD	0.000	0.010	0.000	0.028
	HIGH	<0.010	0.029	<0.070	0.131
	LOW	<0.010	<0.004	<0.070	0.050

Note: Total metal concentrations in mg/L

APPENDIX D

SUBDRAINAGE AREA LAND USE SUMMARY
BUTTONWOOD BROOK WATERSHED, DARTMOUTH, MASSACHUSETTS

SUBDRAINAGE AREA	SIZE *	PERCENT TOTAL WATERSHED	PERCENT OPEN SPACE	PERCENT URBAN	STREET AREA *
10	553.83	31.1	31	69	0 — [illegible]
9	260.86	14.6	36	64	0.57 — [illegible]
8	964.26	54.1	29	71	9.51
7	1057.63	59.3	36	64	93.37
6	100.94	5.7	66	34	7.68
5	146.41	8.2	61	39	10.40
4	80.95	4.5	65	35	3.19
3	212.37	11.9	51	49	7.60
2	1756.99	98.5	48	52	55.44
1	1783.00	100.0	42	58	112.99

* area in acres

SUMMARY OF MUNICIPAL REGULATIONS AND BY-LAWS

A REVIEW OF DARTMOUTH MUNICIPAL REGULATIONS AFFECTING WATER QUALITY WITHIN THE BUTTONWOOD BROOK WATERSHED

Towns within the Commonwealth of Massachusetts may exercise significant authority over land use, development, and public health issues as a result of the Commonwealth's home rule tradition. This section of the report will review the Town of Dartmouth's regulations and bylaws as they affect water quality protection within the Buttonwood Brook Watershed. The following categories of regulations will be assessed: zoning, subdivision, wetland protection, agriculture, and earth removal. why not BofA says?

Zoning

Zoning is the principal form of land use control authorized by M.G.L. Ch. 40A. Zoning ordinances allow local governments to control development according to land use suitability and compatibility of uses. Zoning regulations specify lot size, shape and dimensions, the density of structures, frontage, parking and height requirements and most significantly, the land usage. In addition to defining land usage, zoning regulations allowable percentage of lot coverages by structures. The density of development affects water quality through its impact on aquifer recharge, flooding, contamination of stormwater runoff, and, in unsewered areas, through septic system discharges.

In the Buttonwood Brook Watershed, the following zoning districts have been established:(see Figure A)

DISTRICT	MINIMUM LOT SIZE	PERCENT COVER ALLOWED
SRA	40,000 sf	40%
GB	40,000 sf	65%
GR	15-20,000 sf	40%
NB	20,000 sf	65%

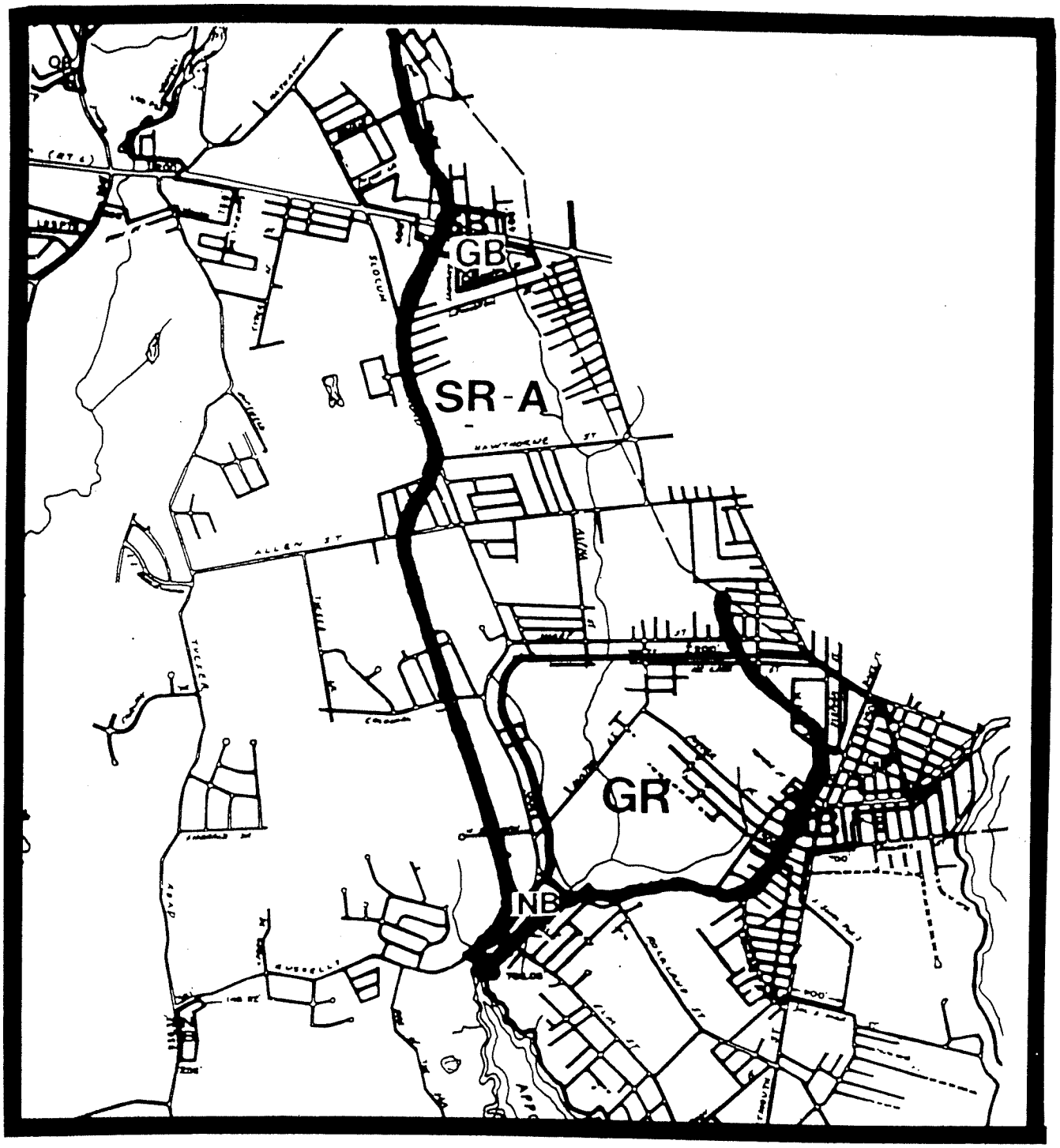

FIGURE A

ZONING DISTRICTS WITHIN THE BUTTONWOOD BROOK WATERSHED

Source: Dartmouth Planning Board
(Not to Scale)

By Special Permit, Cluster Development and Planned Residential Development are also allowed to promote more efficient use of land and to provide for open space and resource protection.

In addition to these districts, three overlay districts provide protection to inland and coastal wetlands:

- o Superimposed Inland Wetlands,
- o Flood Prone Land District, and
- o Coastal Wetlands District.

Subdivision Rules and Regulations

The initial stages of urbanization within a watershed are well documented.[1]

1) Site clearing leads to the loss of native vegetation.

2) Site grading leads to the loss of natural depressions that temporarily store water, and the loss of the original humus-rich soil through construction activity and erosion.

As a result, the land loses much of its natural water storage capacity and its ability to prevent rainfall from being rapidly converted to runoff.

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[1]Schueler, Thomas R.,. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington Metropolitan Water Resources Planning Board.

Once construction is completed, rooftops, roads, parking lots, sidewalks, and driveways make most of the site impervious to rainfall. Runoff overloads the existing drainage system necessitating "improvements" to redirect runoff from the site. These drainage improvements dramatically affect stream hydrology:

- increased peak discharges rise 2 to 5 times higher than the pre-development levels,
- runoff increases by as much as 50% from forested conditions,
- the cumulative impacts of sedimentation, increased flooding, higher water temperatures, and pollution degrade the aquatic ecosystem, and,
- pollutants, which have accumulated on impervious surfaces, run off into adjacent and downstream receiving waters.

To regulate land on which such alterations occur, local planning boards are empowered by the Subdivision Control Law, M.G.L., Chapter 41, Section 81K - 81GG to promulgate rules and regulations governing the standards for the design and construction of proposed developments. These regulations stipulate criteria for managing drainage discharges from development to moderate its effect on flooding, subsurface hydrology, and water quality. Subdivision Rules and Regulations specify standards for roadway construction, utilities, curbs, sidewalks, and drainage.

Subdivision rules and regulations can influence, for better or worse, the impacts of urbanization on a watershed. Requirements for wide streets, piped drainage, double sidewalks, paved driveways and direct stormwater discharge to surface water channels can result in degradation of the quality of downstream water. On the other hand, good subdivision rules and regulations that require stormwater detention, on-site direct discharge, oil and gas traps, protection of existing vegetation, dry wells for roof drains, and reduced road size can offset the negative drainage impacts of development.

The Rules and Regulations Governing the Subdivision of Land in the Town of Dartmouth (June 1990) contain the following drainage requirements:

- Stormwater is to be recharged to the ground on site,"to the maximum extent feasible".
- To encourage on-site groundwater recharge of surface stormwater, open leaching type catch basins are allowable.
- Peak runoff and stream flows at the boundaries of a development shall be no greater than 80% of the rate prior to development. In any case, the discharge shall not exceed one (1) cubic foot per second (CFS) per acre.
- Water collected by the drainage system shall be detained on-site and filtered through man-made detention and filtration systems before discharging into any waterbody, wetland area or the general environment. Drainage water, detained on-site, must flow a minimum of 100' from the drainage system outfall through detention/retention facilities before discharge.
- All detention and filtration systems should be designed to retain the "first flush" of drainage water entering such facilities.
- Stormwater drainage systems shall be designed to handle all water generated in the tributary watershed.
- All drainage calculations and designs are reviewed by a consultant employed by the Town.

Wetlands Protection By-Law and Regulations

Much like the Massachusetts Wetlands Protection Act, the Dartmouth Wetlands Bylaw (April 1990), identifies wetland interests or values that are likely to be affected by activities carried out in areas subject to protection under the Act. The purpose, areas of jurisdiction, and definition of key words and phrases of the Dartmouth Wetlands Bylaw and its Regulations, though similar to the WPA, go beyond the State statute to promote the protection of ground and surface water quality.

The Massachusetts Wetlands Protection Act lists eight wetland functions it is charged to protect: 1) public and private water supply, (2) ground water supply, (3) flood control, (4) storm damage prevention, (5) prevention of pollution, (6) protection of land containing shellfish, (7) protection of fisheries, and (8) protection of wildlife habitat. The Dartmouth Bylaw supplements these with three additional functions or values, one of which is water quality related: erosion and sedimentation control.

The Wetlands Protection Act lists four protectable freshwater wetland resources: (1) Bank, (2) Bordering Vegetated Wetlands, (3) Land Under Water Bodies and Waterways, and (4) Land Subject to Flooding. The Dartmouth Wetlands Protection Bylaw extends its jurisdiction to land in or within a 100' buffer zone of any freshwater wetland, marsh, wet meadow, bog, swamp, or vernal pool; any lake, river, pond, stream, estuary or any land under said waters. The definitions of activities allowed by the Act have been amplified to encompass issues of drainage and water quality. For example, the Dartmouth Bylaw extends the definition of "alter" to encompass:

- any activities, changes, or work which may cause or tend to contribute to pollution of any body of water or groundwater.

The Bylaw Regulations serve as a guide to enforce and implement the Bylaw. Of particular interest in the Regulations is the section on <u>Stormwater Management Guidelines and Requirements</u>. Realizing the likelihood of stormwater discharges causing permanent or cumulative damage to the functions of wetlands and the quality of receiving waters, the Regulations provide detailed requirements for roadways and parking places that:

- specify "zero increase" as the goal of stormwater attenuation,

- o require that hydrologic analysis must include all parts of the project which may be modified by construction activity as well as any up-gradient areas on or off-site, and

- o allow the Conservation Commission to require that the design of attenuation facilities take into account the potential development of the entire tributary watershed, including off-site areas

Agriculture

MGL Chapter III, Section 31 authorizes Boards of Health to make reasonable health regulations and to publish and enforce these regulations. With regard to agriculturally induced water quality issues, the Board of Health can regulate the proximity of animal husbandry activities to waterbodies. The Dartmouth Board of Health requires a 100' setback of manure storage from any waterbody.

Earth Removal

The Town of Dartmouth Soil Conservation By-laws (1979) established a Soil Conservation Board to regulate earth removal activities. While the existing By-laws impose certain conditions for securing earth removal permits, they do not contain adequate provisions to protect water quality. For example, the Dartmouth By-law fails to specify:

- o permissible depths of excavation to the water table,

- o sedimentation and erosion control guidelines,

- o grading and slope requirements following earth removal,

- o replanting and revegetation requirements, and

- any additional requirements that will ensure that the site is left in such a condition that it will be suitable for the land use for which it is zoned.

Summary

The Town of Dartmouth's existing zoning by-laws, subdivision rules and regulations, and wetlands bylaws and regulations are demanding with regard to their design and drainage requirements. But, for the most part, the Buttonwood Brook watershed is an urbanized watershed. Regulatory controls for new development will not substantially mitigate existing water quality conditions in much of the watershed. What is needed are public policy initiatives to implement suitable Best Management Practices, such as:

- diversion of street runoff to prevent direct discharges to streams,

- municipal cleaning practices to remove potential pollutants from public roadways and street and storm sewers, and

- installation of infiltration devices to increase percolation of stormwater into the soil.

REFERENCES

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Schueler, Thomas R., 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington Metropolitan Water Resources Planning Board.

Town of Dartmouth, MA., Dartmouth Conservation Commission. Wetlands Protection By-Law and Regulations. April, 1990.

Town of Dartmouth, MA., Dartmouth Planning Board. Rules and Regulations Governing the Subdivision of Land. June, 1990

Town of Dartmouth, MA. Soil Conservation By-Laws. January 1, 1979.

Town of Dartmouth, MA. Zoning By-Laws. June 19, 1990.

WATERSHED LAND USE MAP

QUALITY ASSURANCE PROJECT PLAN
for
BUTTONWOOD BROOK WATERSHED
MANAGEMENT PLAN

SES

SANFORD ECOLOGICAL SERVICES, Inc.

Environmental Consultants

QUALITY ASSURANCE PROJECT PLAN
for
BUTTONWOOD BROOK WATERSHED
MANAGEMENT PLAN

Prepared for:

U.S ENVIRONMENTAL PROTECTION AGENCY
REGION I
NATIONAL ESTUARINE PROGRAM
BUZZARDS BAY PROJECT

Prepared by:

SANFORD ECOLOGICAL SERVICES, INC.
258 Main Street
Bourne, Massachusetts
02532

February 23, ~~1989~~ 1990
Revision

Approved By:

Marc J. Garrett
Chief Scientist

SES Job No. C890223

QUALITY ASSURANCE PROJECT PLAN

for

BUTTONWOOD BROOK WATERSHED MANAGEMENT PLAN

Prepared by

SANFORD ECOLOGICAL SERVICES, INC.
258 MAIN STREET
BOURNE, MASSACHUSETTS 02532

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I
(NATIONAL ESTUARINE PROGRAM)
(BUZZARDS BAY PROJECT)

DECEMBER 29, 1989

APPROVALS:

_____

Michael Gagne, Town of Dartmouth

_____

Dr. Joseph Costa, Buzzards Bay Project Coordinator

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QUALITY ASSURANCE PROJECT PLAN

for

BUTTONWOOD BROOK WATERSHED MANAGEMENT PLAN

1.0 PROJECT NAME: Buttonwood Brook Watershed Management Plan

2.0 PROJECT REQUESTED BY: U.S. EPA REGION I

3.0 DATE OF REQUEST: ~~JULY 6~~ MARCH 26 1990, 1989

4.0 DATE OF PROJECT INITIATION: NOVEMBER 15, 1989

5.0 PROJECT OFFICER: ~~Dr. Joseph Costa~~ CAROL KILBRIDE
PROJECT DIRECTOR: Marc J. Garrett

6.0 QUALITY ASSURANCE OFFICER: ~~Dr. Joseph Costa~~ ~~SOMEONE EPA~~ CHARLES PORFERT

7. PROJECT DESCRIPTION

A. Objectives and Scope

The Town of Dartmouth, through its agent Sanford Ecological Services, Inc. (SES), in collaboration with the offices of the Board of Selectmen, Conservation Commission, Departments of Public Works and Natural Resources, Board of Health, and the Dartmouth Fishermans' Association seeks to develop a Watershed Management Plan for the Buttonwood Brook Watershed. The goal of this watershed management plan is to develop management strategies which will minimize bacteriologic pollution and nutrient loading, and create a condition to allow for the reopening of the shellfish resources for commercial and recreational shellfishing which are currently closed in the portion of Apponagansett Harbor north of a line drawn from the Star of the Sea Villa to Mullin's Wharf (see Attachment A, Site Locus).

At present, the shellfish resources within Apponagansett Harbor are closed to commercial and recreational digging. These closures are mandated under Massachusetts General Law, Chapter 130, Sections 17A, 74 and 74A. These regulations use fecal coliform bacteria as the indicator organism for monitoring water quality and managing the coastal shellfishery, and they incorporate standards established by the U.S. Food and Drug Administration as part of the National Shellfish Sanitation Program (NSSP). The closure threshold as established for fecal coliform is the median or geometric mean Most Probable Number (MPN) of the water sample that does not exceed 14 colony forming units per 100 ml., and not more than 10% of the samples may exceed an MPN of 43 for a five (5) tube decimal dilution test (or an MPN of 49 per 100 ml. for a three (3) tube decimal dilution test). Division of Marine Fisheries (DMF) uses the five (5) tube standard.

The project's objectives and scope are described below:

- Assess Buttonwood Brook Watershed for potential point and non-point pollution sources

- Inventory shellfish populations in Apponagansett Harbor north of the line drawn from Star of the Sea Villa to Mullin's Wharf, to determine kind, size, density and distribution of the sensitive receptor community. The inventory will also provide a basis for the evaluation of the economic and intrinsic value of the Apponagansett Harbor resources.

- Establish a water quality monitoring program based on assessment of study area.

- Review and evaluate all applicable existing land use and water quality regulations

- Prepare a model watershed management plan

B. Data Usage

The data obtained on shellfish populations, water quality, land use, and current regulations will be used to support the development of the watershed management plan. As active participants in the development and implementation of the watershed management plan, various town boards and departments can employ the data generated by this study. For example:

- The Board of Health can utilize the data to evaluate remediation options in both the sewered and the unsewered portions of the watershed.

- The Department of Public Works can utilize the data to assess the condition of its stormwater drainage infrastructure and the need to expand the extent of the service. Also consideration should be given to areas where both sanitary sewer and stormwater drainage systems are in close proximity to each other.

- The Planning Board can utilize the data to promote zoning changes and draft new performance standards that will protect water quality and coastal resources.

- The Conservation Commission can utilize the data in its enforcement of the Wetlands Protection Act and in the drafting of appropriate pending regulations for the Dartmouth Wetlands Protection By-law.

- The Department of Natural Resources can utilize the data to promote municipal policies and actions that protect Dartmouth's shellfish resources.

Finally, information generated in this study will be used to educate and inform Dartmouth's citizens regarding the water quality of one of Dartmouth's principal watersheds, the extent and value of its shellfish resources, the changes to natural resource systems resulting from the urbanization of Dartmouth's landscape, and the need to effectively manage land use within the watershed to protect its water quality.

C. Design and Rationale

Watershed Mapping

Prior to establishing the water quality monitoring program, the Buttonwood Brook Watershed will be assessed to determine potential sources of point and non-point source pollution. This assessment will be comprised of two components:

- a review of existing watershed information contained in USGS maps, Town of Dartmouth, Planning Department and Department of Public Works' maps, aerial photographs and pertinent town reports and documents; and

- a field assessment of the watershed in conjunction with the Dartmouth DPW, Conservation Commission and Board of Health to search out known and suspected sources of pollution.

Once assembled, this information will be compiled on the watershed base map. Strategic sampling locations will then be selected.

Upon completion of the watershed assessment, a base map showing natural features will be compiled from available sources, which include USGS topographic quadrangles and the Town of Dartmouth Planning Department's ARC-INFO system. At a 1"= 2,000' scale, the base map will show topography, waterbodies and waterways, wetlands, roadways, zoning, land use and municipal boundaries. The completed base map will allow SES to accurately delineate the Buttonwood Brook Watershed and to initiate the watershed assessment.

Land use overlay maps will then be prepared from existing data contained on the MacConnell Land Use Maps dated 1985, and Town of Dartmouth Planning and Engineering Department maps. The land use overlay maps will be prepared at the same scale as the watershed base map and will indicate specific vegetative cover types, land uses, and the location of town sewer and stormwater discharge outfalls. Once these watershed characteristics and breakdowns are determined, SES will be able to establish the exact number and locations of the water quality sampling points. These sampling points will be selected to bracket subwatersheds to be representative of any significant variables that exist within the watershed. The process of bracketing will allow for easy targeting of problem areas and areas for remedial activities.

Field Sampling Procedures

Shellfish Resource Inventory

The initial project sampling program will be the inventory of shellfish resources within the northern portion of Apponagansett Harbor. Closed to commercial and recreational shellfishing for over 20 years, this portion of Apponagansett Harbor is rich in shellfish (pers comm., November 1989, Mike Hickey, DMF). SES will utilize the services of Mr. Hickey, who will train volunteers from the Dartmouth Fisherman's Association in the standardized shellfish inventory procedures as approved for resource evaluation. Mr. Hickey, in conjunction with SES,

will supervise the field sampling efforts in the subtidal and intertidal portions of the upper bay. Data to be collected will include: species present, market designation, individual size, population density, distribution, and location. This data will be compiled for presentation purposes in the final management plan, and will be evaluated for both economic and intrinsic value to the community.

Water Quality Sampling

Water quality samples will be collected at the locations shown on Figure 2, during a single 12 month cycle. Seasonal sampling will occur under both episodic and non-episodic conditions. The purpose of episodic sampling is to determine the contributions of road and land runoff during significant climatic episodes. Non-episodic sampling will evaluate water quality during normal dry condition flow.

Winter testing will take place when the deicing of roads and thaw runoff occurs. Spring testing will take place during a season of normally heavy rainfall, elevated groundwater levels, and concentrated fertilizer usage. Summer testing will indicate the extent and effectiveness of seasonal land use practices (lawn fertilizer use and agricultural runoff), and watershed attenuation of chemical and biological loading. Fall testing will complete the annual hydrologic cycle by adding information on post leaf-drop nutrient levels.

A climatic episode will be defined as a regional precipitation event of 0.4" or more, and a duration of 3.5 hours. This criterion has been established after analysis of existing rainfall data from local weather stations, which included an evaluation of frequency, duration, and intensity of local rain events. Non-episodic samples will be collected a minimum of 48 hours after rain. A climatic episode will need to be identified at least 24 hours in advance to be able to mobilize the sampling effort.

Water samples will be tested for Fecal Coliform, total Kjeldahl nitrogen (TKN), nitrogen as ammonia ($N-NH_3$), nitrogen as nitrate ($N-NO_3$), ortho phosphorus, and suspended solids. Testing for cadmium, copper, lead, and zinc will be done once during the late summer episodic sampling effort. This strategy will provide a baseline metal concentration contained in the watershed's stormwater runoff, during a season of representative worst case traffic load scenario.

Water samples will be analyzed for fecal coliform bacteria using the A-1 modified MPN method. The New Bedford Health Department's laboratory will be the testing facility for fecal coliform as requested by the Buzzards Bay Project coordinator. The New Bedford laboratory has recently been inspected by the U.S.F.D.A. and certification from this agency is pending.

Toxicon Laboratories of Woburn, Massachusetts will analyze water samples for TKN, $N-NH_3$, $N-NO_3$, ortho phosphorus, suspended solids, lead, copper, zinc and cadmium. Toxicon Laboratory carries certification and registration from the state which certifies them with both the state and federal agencies (Attachment B).

D. Monitoring Parameters

During winter, spring, summer and fall, ten stations (Figure 2) in the Buttonwood Brook watershed will be sampled in episodic and non-episodic conditions for fecal coliform, TKN, $N-NH_3$, $N-NO_3$, ortho phosphorous, and suspended solids. Testing for metals will be done during the late summer episodic sampling event.

The parameters selected for analysis represent parameters commonly used for the assessment of urbanized stormwater runoff conditions. Nitrogen loading to the system be be evaluated using three parametric evaluations. The first is to conduct a total Kjeldahl nitrogen determination. The TKN analysis indicates the content of organic nitrogen. Nitrogen as ammonia ($N-NH_3$) provides a measure of the inorganic nitrogen content. Nitrogen as nitrate ($N-NO_3$) is indicative of wastewater releases, is an essential nutrient for photosynthetic autotrophs and has been identified as a growth limiting nutrient. Nitrogen is generally accepted as the limiting nutrient in both estuarine and marine systems in regard to eutrophication. Eutrophication of upper Apponagansett Harbor is a concern since the bridge crossing at Padanaram creates a significant alteration in the natural estuarine circulation.

Phosphorous is the limiting nutrient in freshwater systems. A measure of ortho phosphate will indicate the potential for eutrophication by another common and very significant nutrient source. Ortho phosphates are generated by land fertilizing and are indicative of urbanized watershed conditions.

The amount of suspended solids contained in a water column is indicative of pollution loading to any aquatic system. Schueler (1987) estimates that approximately 50% of all stormwater runoff pollution loading from an urbanized (developed) watershed can be attributed to the loading of suspended solids to that system. This is based on the electro-chemical properties of the solids, the ionic fractions of the pollution parameter, and fecal coliform bacteria. The determination of suspended solids loading to a system, coupled with an associated reduction of that loading, can significantly reduce pollution inputs to any receiving water.

The selected metals for analysis (cadmium, copper, lead, and zinc) are common pavement (roadway and parking lot) runoff constituents. Although metals are not directly related to the issue of shellfish bed closures, SES proposes a one time sampling and analytical event to provide an indicator of all pavement runoff constituents. Special care will be taken at Toxicon

Laboratories to analyze metals given the particular sample matrix. It is fully understood that saline waters contain constituents which will interfere certain metal analyses (chlorides, Total Dissolved Solids and alkalinity). All appropriate measures will taken and incorporated into the analytical procedures.

The last parameter to be analyzed for is fecal coliform. As stated previously, this is the parameter utilized by DMF for shellfish resource closure action. SES proposes to analyze for this parameter throughout the study, in as many varied conditions as possible, to determine the sources and locations of those sources of bacteriological loading. This, in conjunction with all of the monitoring parameters, will enable SES to propose strategies to minimize and/or alleviate the problems within the watershed.

E. Parameter Tables

The following tables summarize the sampling and analytical procedures which will take place during the study. These procedures are in full compliance with methods as provided by EPA (1982).

TABLE 7-1 SAMPLING REQUIREMENTS

Parameter	Sample Volume (liters)	Sample Container	Immediate Processing and Storage
TKN	.500	P/G	Cool, 4°C
$N\text{-}NH_3$/ $N\text{-}NO_3$	.100	P/G	Cool, 4°C
Ortho-Phosphorous	.050	P/G	Cool, 4°C
Suspended Solids	.500	P/G	Cool, 4°C
Cadmium	.100	P/G	metals preparation
Copper	.100	P/G	
Lead	.100	P/G	
Zinc	.100	P/G	

G=Glass P=Polyethylene

NOTE: Samples will be cooled down and stored in ice chests with ice packs

TABLE 7-2 MONITORING PARAMETERS

Parameter	Sampling Frequency	Test Replicate Sampled	Immediate Processing or Measurement
TKN	8	8	Collect, pack in ice, ship express mail to lab
$N\text{-}NH_3$/ $N\text{-}NO_3$	8	8	
Ortho-Phosphorous	8	8	
Suspended Solids	8	8	
Cadmium *	1	1	
Copper *	1	1	
Lead *	1	1	
Zinc *	1	1	
Fecal Coliform	8	8	

G=Glass P=Polyethylene

* metal preservation

TABLE 7-3 LABORATORY PARAMETERS

Parameter	Matrix	Units	Methodology	Ref.	Maximum Holding Time	Preservation
TKN	Water	500 ml	351.3	(1)	28 days	$4^{o}C$
Ortho-Phosphous	Water	50 ml	365.3	(1)	28 days	$4^{o}C$
$N-NH_3$/ $N-NO_3$	Water	100 ml	350.2	(1)	48 hrs.	$4^{o}C$
Suspended Solids	Water	500 ml	160.2	(1)	7 days	$4^{o}C$
Fecal Coliform	Water	Org./ 100 ml	A-1 MPN or MSC media	(2)	24 hrs.	$4^{o}C$
Cadmium	Water	100 ml	213.2	(1)	6 months	HNO_3, pH<2 (3)
Copper	Water	100 ml	200.7	(1)	6 months	HNO_3, pH<2 (3)
Lead	Water	100 ml	239.2	(1)	6 months	HNO_3, pH<2 (3)
Zinc	Water	100 ml	200.7	(1)	6 months	HNO_3, pH<2 (3)

Ref.=Reference Org.=Organisms

References:

(1) U.S. Environmental Protection Agency, 1979. Methods for chemical analysis of water and wastes, EPA 600/4-79-020 (Revised March 1983): Cincinnati, OH.

(2) American Public Health Association, 1985. Standard methods for the examination of water and wastewater, Sixteenth edition: Washington, DC.

(3) Matrix modifications methods for saline samples will be employed should they be required for the analyses for metals.

8. PROJECT FISCAL INFORMATION

This project has received a $13,200 minigrant from the EPA through the Buzzards Bay Project. In addition, the Town of Dartmouth, through its Water Quality Monitoring Fund, is contributing an additional $2.000.00 to be used to defer laboratory costs. As the client, the Town of Dartmouth will be invoiced for services on a monthly basis. Payment will be expected on a quarterly basis for the sum of $3,300.00 The scheduling of these payments is as follows:

QUARTERLY DESIGNATION	PAYMENT DUE
November - January 1990	January 31, 1990
February - April 1990	April 31, 1990
May - July 1990	July 31, 1990
August - End of Project	End of Project (December 1990)

9. SCHEDULE OF TASKS AND PRODUCTS

The following is a breakdown of the technical tasks to be performed during the project, the technical products to be produced for submission to the town and the Buzzards Bay Project, and the associated schedule for completion of said tasks and product submittals.

TASKS	SCHEDULE OF WORK
Prepare the QA Plan for the Project	November/December 1989
Prepare Watershed Base Map	November/December 1989
Conduct Shellfish Inventory	December 1989 *
Prepare Land Use Overlay Maps	December/January 1990
Conduct Water Quality Sampling	January/December 1990
Review of Land Use Regulations and By-laws	February/May 1990
Prepare Draft Watershed Management Plan	November/December 1990
Review of Draft Watershed Management Plan	December 1990
Prepare Final Watershed Management Plan	December 1990

* This scheduling may be modified, should ice conditions within the harbor not allow for shellfish inventorying. Should this occur, the inventory will be conducted as soon as conditions allow.

PRODUCTS	SCHEDULE OF WORK
Complete and Submit Draft QA Plan for Review	December 15, 1989
Submit Final QA Plan to the EPA	December 29, 1989
Complete Watershed Base Map	December 29, 1989
Complete Shellfish Inventory and	December 29, 1989 *
Complete Land Use Overlay Maps	January 31, 1990
Select Water Quality Sampling Locations	January 31, 1990
Summarize Existing Land Use Regulations and By-laws	May 31, 1990
Preliminary Data Analysis of Water Quality Program	May 31, 1990
Prepare an Interim Progress Report	May 31, 1990
Complete Data Analysis and Statement of Findings for the Water Quality Program	October 31, 1990
Prepare Draft Watershed Management Plan for Comment	November 30, 1990
Prepare and Submit Final Watershed Management Plan	December 31, 1990

*Dependent on ice conditions and ability to sample the shellfish flats.

10. PROJECT ORGANIZATION AND RESPONSIBILITY

PROJECT MONITOR AND
QUALITY ASSURANCE OFFICER
Dr. Joseph Costa

PROJECT MANAGER
Marc J. Garrett

FIELD COORDINATION	ANALYTICAL COORDINATION	DATA MANAGEMENT
William H. Waldron, Jr.	William H. Waldron, Jr.	Cynthia King

Mr. Marc J. Garrett, M.S., is the Project Manager for the Study. Mr. Garrett is a Chief Scientist with extensive experience over the past ten years in shellfish aquaculture, aquatic and non-point source pollution evaluation and remediation. He has also published and presented several technical papers on shellfish contamination, and non-point pollution evaluation, remediation and application. In 1987-88, he was involved in the development of a protocol for non-point source pollution evaluation in the South Shore's North River

Watershed. This protocol was approved by the Division of Water Pollution Control (DWPC) and is included in the Final Draft Non-point Source Management Plan (DWPC 1988). In addition to the overall project management, he will also oversee the technical project applications in the areas of watershed assessment, shellfish and water quality sampling, remediation design, regulatory review and report production. Mr. Garrett holds a B.A.(Biology) and M.S.(Biology) from the University of Bridgeport.

William H. Waldron, Jr. will collaborate with Mr. Garrett throughout the study. Mr. Waldron is an environmental planner/landscape designer with duties including land planning and landscape design, open space and recreation planning, land restoration, and wetland delineations. Mr. Waldron has extensive community land planning experience in Dartmouth. For seven years, he has been an officer and director of the Dartmouth Natural Resources' Trust, a community land conservation trust with open space landholdings in the study area. He served on the Natural Resources Sub-committee of Dartmouth's Growth Management Masterplan. In addition, he serves as a consultant to the Lloyd Center for Environmental Studies for its Scenic Rivers Management Plan. Mr. Waldron holds a Master's Degree from the Conway School of Landscape Design, a school of land planning and landscape architecture.

In addition to Messers. Garrett and Waldron, Ms. Kathryn Small will assist in the shellfish inventory, and Ms. Cynthia King will assist throughout the project, lending their own technical expertise in specific technical areas.

Ms. Small is an environmental scientist/marine biologist with SES. She is a graduate of Southeastern Massachusetts University with a B.S. in Biology/ Marine Ecology. Ms. Small has experience in marine fisheries studies and coastal wetland evaluations. Her work in marine fisheries includes fish sampling and aquaculture research.

Ms. King is also an environmental scientist with SES. Ms. King has experience in estuarine and marine pollution research. Particular project experience includes evaluating the relationship between estuarine degradation and waterbird breeding populations in Massachusetts; and analyzing for and assessing the significance of organochlorine contaminants in dolphins from southeastern Florida. Ms. King has a Master's Degree in Biological Oceanography from the Rosenstiel School of Marine and Atmospheric Science, Univeristy of Miami.

Resumes of each are included as Attachment C of this QA Plan document.

11. DATA QUALITY REQUIREMENTS AND ASSESSMENTS

A. Precision

Precision is the degree of mutual agreement among independent, repeated measurements. Precision can be monitored by using replicate samples or measurements, and is most commonly expressed as standard deviation or standard error.

Watershed Mapping

By using the USGS 7.5x15 minute adjoining quadrangles of New Bedford North and New Bedford South for the base map, minimal variation from the USGS standard error will result. The McConnell Land Use Maps are generated from aerial photographs which are analyzed, categorized and mapped onto USGS quadrangles. This information is then digitized for computer map production. The Town of Dartmouth Planning Department is producing the McConnell Land Use Maps for this project on its ARC-INFO system. The common USGS base map and the employment of the computer mapping system assures that land use mapping will be characterized by precise actions.

Shellfish Resource Inventory

The shellfish resource inventory will be characterized by precise action in the determination of testing locations, measuring of testing quadrants and inventorying the kind, number, and size of shellfish. All inventories of data will be conducted using standard statistical techniques for the evaluation of population data.

Water Quality Sampling

To monitor for intra-laboratory performance, an internal quality control program has been implemented at Toxicon Laboratory. Blind replicates will chosen during each sampling event and presented for analyses to the laboratory. There will be no indication as to the sampling location for said replicates. Spiked samples are to be submitted to their analysts as a standard laboratory procedure. The analytical procedures present guidelines for the number and frequency of quality control samples. A detailed list and description of quality control samples, their identity, and concentration of surrogate samples is maintained in the quality assurance files. The quality control samples are interspersed with the field samples and analyzed in the same manner as field samples. Analytical results of the quality control samples are used to document the validity of data and to control data quality within the predetermined acceptance limits. The quality control samples include blanks, spike duplicates and matrix spikes.

B. Accuracy

Accuracy is the degree of closeness between a measured value and its true value. It can be monitored by using blank samples or standard reference materials. For field quality control, samples are routinely spiked with a known reference material. Accuracy of an analytical method is most commonly expressed as percent recovery of a standard.

Watershed Mapping

By compiling the base map from the standard USGS 7.5x15 quadrangles, correctness is assured. The correctness of the mapped data is assured due to its reliance on the USGS quadrangle system, on McConnell's standardized land use classification, and on mapping capabilities of Dartmouth's ARC-INFO system.

Shellfish Resource Inventory

The correctness of the data is assured through the supervision of Mr. Michael Hickey of the DMF and SES personnel with experience and training in shellfish population biology and aquaculture.

Water Quality Sampling

Accuracy will be achieved by minimizing variables within the sampling process. All sampling locations will be clearly marked. The water volumes to be sampled for each parameter will be constant. A standardized documentation and chain of custody program will be strictly adhered to throughout the project. A SES staff member will be on-site or in communication with a predetermined volunteer coordinator and the Town of Dartmouth Board of Health.

C. Representativeness

Representativeness is the degree to which samples represent true systems.

Watershed Mapping

The USGS base map for the study area is typical for all USGS mapped areas. The utilization of the standardized McConnell Land Use Maps insures that the land use data is typical for the study area.

Shellfish Resource Inventory

The utilization of DMF standardized sampling techniques and professional supervision assures that the results will be typical for the study area.

Water Quality Sampling

All efforts will be made to insure representativeness, including: training and retraining of volunteers in water sampling techniques; observation of techniques by the Field Leader on a random basis; sampling the same sample site each time; and documenting prevailing conditions at sampling time.

D. Comparability

Comparability is the degree to which data from one study can be compared to other, similar studies.

Watershed Mapping

The USGS base map for the study area will be prepared using the standard USGS mapping database. The use of the McConnell Land Use data, digitized to the USGS mapping system, will insure that the study area land use information will be similar or equivalent to other land use areas.

Shellfish Resource Inventory

Adherence to the DMF agency shellfish inventory methodology allows for the data to be compared to similar or equivalent sampling programs statewide.

Water Quality Sampling

Samples will be taken at each sampling station during each sampling event. Should it not be possible to collect a sample (due to drought or lack of volunteer availability), or if a sample cannot be analyzed (due to sample contamination or loss), those missing stations will be noted in all reports.

E. Completeness

SES has proposed to conduct this study over a 12 month study period. This study period was designed to assess the watershed throughout a complete annual cycle. Seasonal variations are quite common in watershed evaluations based on several environmental variables. Therefore it has been proposed to conduct the study to address any seasonal variation which may effect the watershed.

12. SAMPLING AND LABORATORY PROCEDURES

Sanford Ecological Services staff personnel, trained in water quality sampling techniques, will perform the sampling during non-episodic periods. The episodic sampling events will be conducted with the assistance of volunteers from the Dartmouth Fisherman's Association who will be trained by SES personnel in

approved water quality testing techniques. The project manager has performed training of several volunteer corps with EPA-approved techniques and documentation. The Field Coordinator will be responsible for supervising timely sampling during the episodic events and for coordinating the delivery of samples to the Board of Health at Dartmouth Town Hall and to Toxicon Laboratories.

Surface water sampling procedures will follow those outlined in the EPA Handbook for Sampling and Sample Preservation of Water and Wastewater. Sampling bottles will be positioned towards the current flow and away from the hand of the collector and the shore. The sampling will occur between depths of 6-12" below the water surface. Once the filled bottle is removed from the brook, it will be tightly stoppered and labeled.
Samplers will use care to insure that they do not disturb and ultimately collect solids stirred up by their presence.

Episodic sampling for water quality chemistry and metals shall include two grab samples taken at one (1) interval during each seasonal storm event. These grabs will be made as follows: the first grab will be taken 2.0 hours after the storm event begins; and the second grab will be taken 3.0 hours after the storm event begins. The two grabs will be composited in the field and the laboratory analysis will be conducted on the composite sample. The fecal coliform sample shall be taken during the second grab, 3.0 hours into the storm event.

All samples will be refrigerated. The SES Field Coordinator will deliver all samples to be tested for fecal coliform to the Dartmouth Board of Health for delivery that day to the New Bedford laboratory. The SES Field Coordinator will send samples to be tested for TKN, $N\text{-}NH_3$, $N\text{-}NO_3$, ortho phosphorus, suspended solids, and metals (one-time sampling) to the Toxicon Laboratories in styrofoam coolers with ice packs via overnight express mail.

13. SAMPLE CUSTODY PROCEDURES

All specimens will be appropriately labeled in the field (see Attachment D). In addition, a chain of custody forms (see Attachment E) will be completed by the field sampling personnel during the sampling event. The Field Coordinator will sign over the samples to either Toxicon Laboratories or the Board of Health's Designated Representative, Board Member Katherine Stern, who will then sign over the samples to the receiver at the New Bedford Laboratory. SES personnel will ship the chain of custody sheets in the sealed shipping containers to Toxicon Laboratories. It will be possible to track any sample from collection through analysis. Each laboratory will return the copies of the chain of custody forms with the test results for project management and record.

14. CALIBRATION PROCEDURES AND PREVENTIVE MAINTENANCE

Toxicon Laboratory has presented SES with their complete Quality Assurance Plan. This document is included within this QA plan as Attachment F, and covers all applicable analytical descriptions including, but not limited to: analytical methodology, analytical equipment, calibration, maintenance, recording of calibration and maintenance events, contingency plans, back-up of equipment, and equipment inventory.

The only information available from the New Bedford Laboratory calibration procedures and preventative maintenance is contained herein:

The Elconap air incubators are maintained at a temperature of 35 degrees C plus or minus 0.5 degrees C. There are three thermometers inside each incubator, which are checked twice a day to ensure the temperature is at the prescribed level. The thermometers are checked against acceptable standards every 6 months. Records are kept of all temperature checks and thermometer checks. These records are stored in the laboratory in a book. State inspectors routinely inspect records and equipment to make sure standards are met. There is a back-up air incubator should the primary device fail. This is also an Elconap, subject to the same temperature monitoring as described above.

The Blue M water baths are maintained at 44.5 degrees C. A thermometer is kept immersed at all times in each. The temperature is checked and recorded twice a day. The thermometer is checked against acceptable standards every 6 months. In July 1989 the laboratory was inspected by the USFDA, which also checked the thermometers. There are three water baths, allowing an ample back-up supply.

An autoclave is used for sterilization. There is a chart that automatically records time and temperature as the autoclave runs. It is designed to hold 15 lbs. psi at 120°C. Kilit ampoules are used as a way of testing whether an item has been sterilized properly. In addition, autoclave tape is used, which displays a heat-activated color change after the correct amount of time at a certain temperature.

The laboratory uses positive and negative bacterial controls to check for media deficiencies, equipment failures, and operator error. For lactose-positive thermotolerant bacteria, a known amount of fecal coliform is inoculated into the media and checked. For negative, non-thermotolerant bacteria, a known amount of enterobacter is inoculated into the media and checked.

All media is made up from individual components on site as needed. Commercially prepared media is not used, because it is not accepted by the state.

All test tubes are washed above 180°F, using a high pH, phosphate-free detergent. They are rinsed in MS or distilled water. Glassware is sterilized in dry heat at 150 degrees C for a minimum of 1 hour. There are temperature controls in the oven for dry heat.

Pipettes and glassware are checked for chlorine residues from soap.

Sample bottles are made of nalgene, which can be autoclaved. These are washed using the same process as for glass, but are autoclaved instead of being subjected to dry heat.

15. DOCUMENTATION, DATA REDUCTION, AND REPORTING

A. Documentation

Upon collection, samples will be clearly labeled as prescribed by EPA protocol (EPA 1982). The labels will contain the following information:

- Company Name
- Company Phone Number
- Analyses Required
- Sample Media
- Sample Identification Number
- Time and Date Collected
- Collected By
- Sample Station Location

All sampling personnel will be required to complete sample labels fully prior to acceptance by the Field Coordinator.

Chain of Custody forms will be filled out and transmitted as described in section 13 of this QA plan.

All data will be generated in hard copy form by both Toxicon and the New Bedford Laboratories. SES shall compile all water quality data in our computer-based data management system. This system is coordinated by Ms. Cynthia King. Data will be stored on 5 1/4 floppy disks for easy access and reproduction.

Test results will be filed chronologically by sample collection date and sample station. All data shall be available to the Town of Dartmouth, the Buzzards Bay Project, and the EPA in hard copy form. Computer originals or photocopying will be the two means of generating statements of results. This will eliminate transcription errors.

16. DATA VALIDATION

At the receipt of properly documented and transmitted samples to the laboratories, SES will rely on both laboratorys' internal QA/QC systems to validate the analytical data which each presents. Toxicon Laboratories has provided a description of their in-house data validation process. This information is contained in Attachment F. SES was unable to obtain details of the New Bedford Laboratory's in-house data validation process.

Upon receipt of the analytical results from each laboratory, SES will conduct its own statistical review of each data set, to determine if it is representative or non-representative data. Consideration will be given to the type of sample collected (episodic or non-episodic) and location. SES will utilize accepted data bases of urbanized stormwater runoff constituents (ie: Schueler 1987) for comparison purposes.

17. PERFORMANCE AND SYSTEM AUDITS

The project will comply with any performance or system audits the EPA may choose to administer during the term of the project.

18. CORRECTIVE ACTION

In the field, water samplers will be trained by SES personnel and retrained when necessary to insure that their technique is correct. Samplers will be rotated periodically to help eliminate sample bias caused by faulty technique.

Test results will be provided in a timely manner so that SES can review and validate each data set properly. If a data set is determined to be invalid, SES will review the entire sampling and analytical process for that particular data set to identify the problem area. SES will be responsible for correcting said problem, and conducting another representative sampling and analytical event to replace the lost data.

19. PROJECT REPORTING

SES proposes four scheduled report submittals to the Town of Dartmouth. The first and second reports will consist of the completion and submittal of the Draft Quality Assurance Plan for review and comment and the Final Quality Assurance Plan to the Town of Dartmouth, the Buzzards Bay Project and the EPA.

The second report will be an interim progress report during the late spring. This report will describe and chronicle all project activities to date and will also summarize any preliminary conclusions should any be available at that time.

The third report submittal shall be the Draft Watershed Management Plan for review and comment by the Town of Dartmouth and the Buzzards Bay Project. The fourth and final report to be prepared by SES will be the Final Watershed Management Plan. With the submittal of that Final Watershed Management Plan, the project will be complete.

20. LITERATURE CITED

1) American Public Health Association, (1985) Standard Methods for the Examination of Water and Wastewater, 16th. edition: Washington, D.C.

2) Schueler, T.R. (1987) Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's, Washington Metropolitan Water Resource Planning Board.

3) U.S. Environmental Protection Agency (1982) Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, September 1982: Cincinnati, OH.

4) U.S. Environmental Protection Agency (1979) Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (Revised March 1983): Cincinnati, OH.

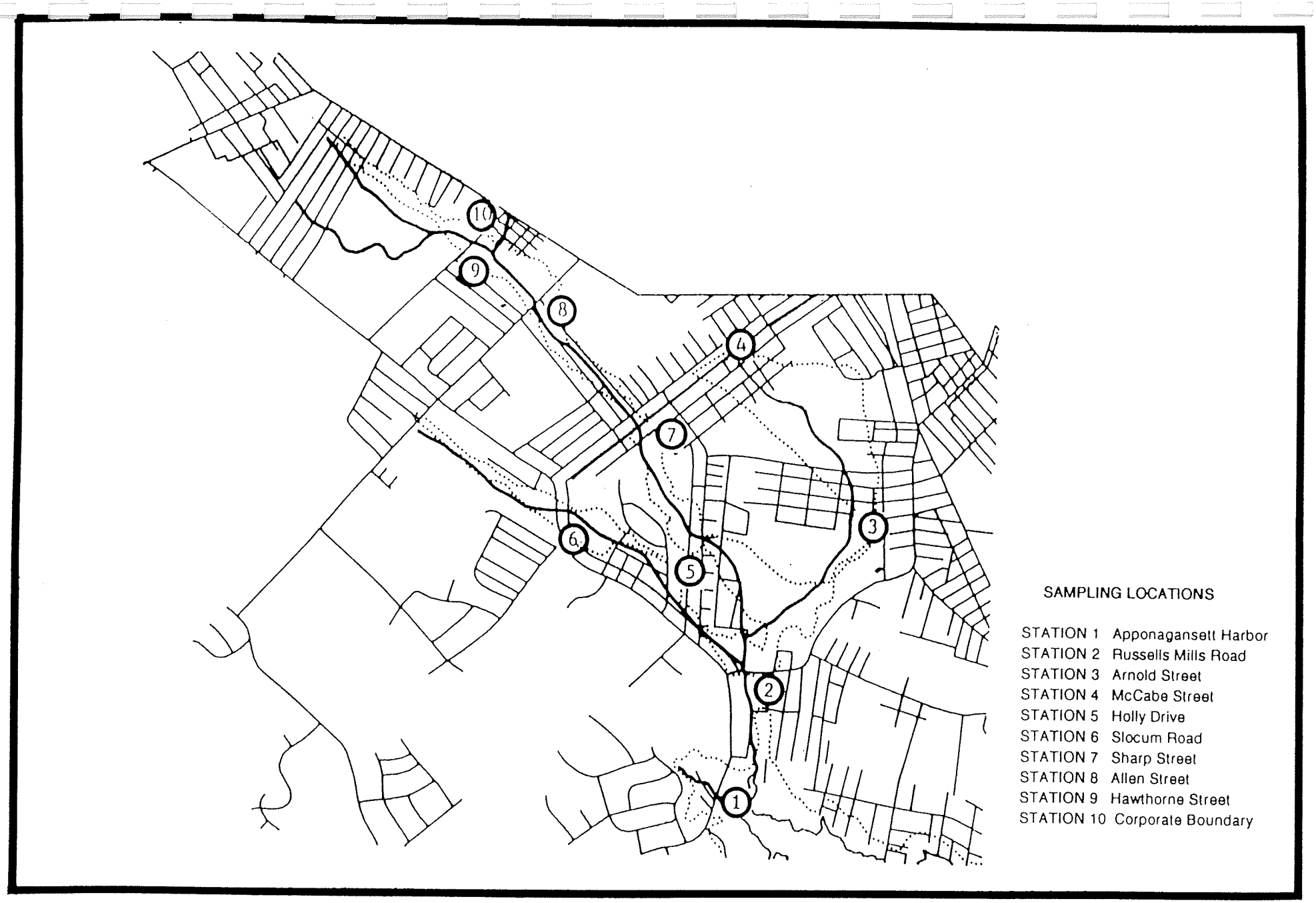

FIGURE 2
SAMPLING STATION LOCATIONS
BUTTONWOOD BROOK WATERSHED
DARTMOUTH, MASSACHUSETTS
APPROPROXIMATE SCALE 1" = 2000'