COASTAL STORMWATER REMEDIATION PLAN FOR THE TOWN OF IPSWICH

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PREFACE AND ACKNOWLEDGEMENTS

In May of 1991, the Ipswich Shellfish Advisory Board produced a report which illustrated that high levels of coastal pollution seriously affected Ipswich's recreational and multimillion dollar commercial shellfishing industry and could endanger recreational activities such as swimming and boating (Ipswich Shellfish Advisory Board 1991). The report indicated that 30 % of the town's productive shellfish areas were closed at all times, and the remaining 70 % were closed about half of the available shellfishing days following rainfall, due to stormwater contamination. The Board of Selectmen responded by creating the Ipswich Coastal Pollution Control Committee (CPCC) to pursue the problem of coastal pollution in Ipswich. After studying the problem for three years, the CPCC issued a report to the town in 1995 with over 100 recommendations to address the problem. Many of these recommendations addressed storm water. In 1999, the Massachusetts Office of Coastal Zone Management (CZM) hired a resource technician to work with the committee to develop a stormwater management plan on behalf of the town. In cooperation with CZM, we created this plan as a tool for officials to use to prevent, and control stormwater pollution. It is important to note that due to the size and complexity of the stormwater problem in Ipswich, this report focuses entirely upon the impact of stormwater on the town’s unique and valuable coastal resources. It is recognized that stormwater has a significant deleterious affect on all aquatic systems however, the impact and remediation of stormwater on fresh water systems is beyond the scope of this report.

The report is organized into the following sections: introduction and background, methods, findings, and recommendations. The purpose of the introduction/background, and overview section is to introduce the reader to the subject of stormwater pollution in general, and specifically how it impacts the coastal resources of Ipswich. The methods section describes how we utilized the existing CPCC data in more detail, combined with our additional methods to develop our findings and justify our recommendations for stormwater remediation.

We would like to thank all staff members and department heads from the Town of Ipswich for their support and assistance. Chief among the officials was Armand Michaud, the Director of the Public Works Department. We thank the North Shore Coastal Zone Management office for their guidance and resources. Thanks also go to many local, regional, and government organizations for their support and guidance. And we especially thank George Howe, Town Manager, for his generosity in sharing his office space and resources, and the members of the CPCC who’s years of volunteer work provided the data and direction that made this plan possible.

We encourage town department heads and boards to use this report in all areas of planning, and permitting. It is our hope that this plan may be used as a tool for other towns to address stormwater management.

EXECUTIVE SUMMARY

Stormwater Pollution in the town of Ipswich is an overwhelming problem. Hundreds of individual sources were identified, most of which are transported to the coastal area via the town's 114-storm drain located in the eastern section of town. These sources contain bacteria, viruses and nutrients from human and animal fecal wastes as well as sediment, petroleum products and heavy metals from automobiles. These pollution sources are almost ubiquitous throughout the town, which makes finding a solution to the problem a complex issue. Furthermore, the age and pattern of development in old coastal communities such as Ipswich complicates the issue. Because it would be impossible to effectively control stormwater pollution from all of these sources due to these factors, our primary recommendation is that the town concentrate on the implementation of preventative measures whenever possible. Where significant levels of pollutants have been found emanating from storm drains, we have recommended that site-specific stormwater treatment systems be installed at these contaminated drains.

Thirty preventative recommendations are made within this report. The implementation of these recommendations is very cost-effective and totals less than $5,000. Beyond prevention, we recommend stormwater treatment systems be installed on 37 individual storm drain systems over a 20-year period. We recommend that these be repaired through a combination of an annual increase in the Department of Public Works budget of $30,000 and by grant funds. Overall, it is estimated that these installations will cost between $600,000 and $920,000, depending on who performs the work (DPW vs. private contractors).

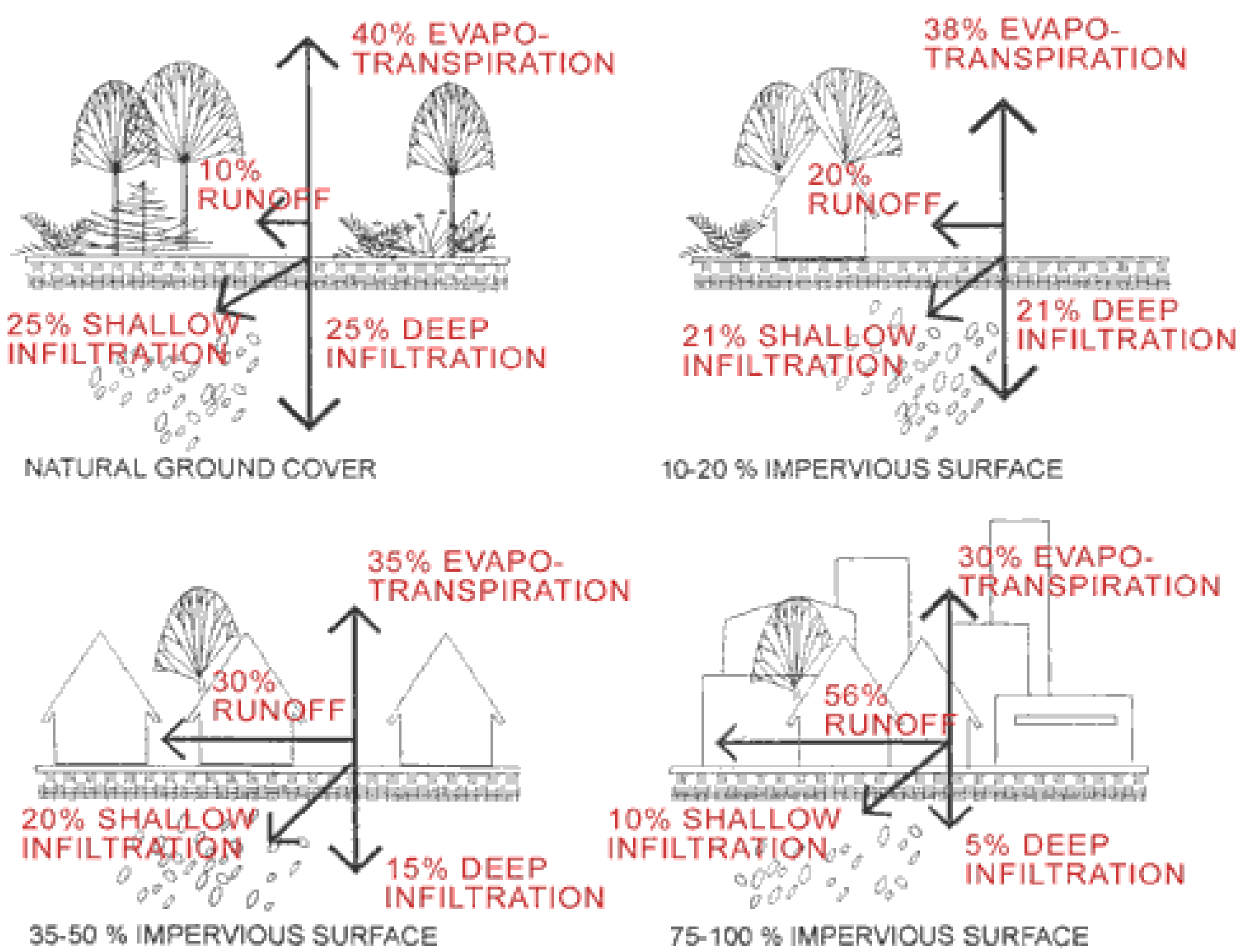
Although these measures will not eliminate all sources of pollution in stormwater, we estimate that we can effectively reduce the current negative impacts of stormwater and certainly prevent the problem from becoming worse over time. This effort should be cost effective and will undoubtedly reduce the level of current impact on shellfish beds and other resources while protecting the coastal environment for future generations.

INTRODUCTION, BACKGROUND AND OVERVIEW

Stormwater is defined as the water flowing directly or indirectly off developed areas during or immediately following rain. Pollutants are carried off developed land by rainwater into nearby rivers, streams, lakes, ponds, wetlands, marine waters and groundwater (Department of Environmental Protection, Vol. I, 1997). According to the Massachusetts Department of Environmental Protection (DEP), the largest source of water pollution in the state is stormwater. Contaminated runoff considerably degrades water quality and aquatic life. As assessed in the MA DEP 1995 Summary of Surface Water Quality, stormwater is responsible for 46 percent of assessed river segments not supporting their use, and 48 percent of assessed marine waters not supporting their designated use. In agreement with the DEP, the United States Environmental Protection Agency concludes that urban runoff is " the most influential nonpoint source of pollution in the country" (DEP, Vol. I, 1997).

The pollutants we speak of are generated by development and land-use activities. Loss of pervious surfaces, such as wetlands and meadows that once intercepted and stored precipitation can no longer do so. Land development increases the amount of impervious area in a watershed, which in turn increases the quantity of surface runoff in every storm event (Comprehensive Environmental, 1996). As stormwater flows over impervious surfaces, it washes off pollutants accumulated on these surfaces.

Water Cycle Changes Associated with Urbanization



Source: Environmental Protection Agency, *Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters*, #840-B-92-002, 1993.

Examples of pollution sources found in stormwater are animal wastes, pesticides, fertilizers, litter, sediments (from soil and debris), trace metals (from household wastes, commercial wastes and auto leakage), and petroleum hydrocarbons (from roads, parking lots and driveways). In addition, rainfall can also lead to problems with municipal sewage system and private septic systems. The following contaminants pose the greatest threat from polluted runoff into our waterways:

- **Fecal Coliform Bacteria**
  The main sources of fecal coliform bacteria contamination are from animal waste runoff (pets, wildlife, agricultural, commercial) and septic system/municipal sewage system leakage or overflow. This bacteria is the most common contaminant tested for in potable and nonpotable water due to its impact on human health. Fecal coliform data is used as an indicator of overall water quality. This type of data is used by environmental officials nationwide to indicate how polluted a water body may or may not be. Our data is based primarily on fecal coliform levels and, we have used these findings to represent the overall effect of nonpoint source pollution on our coastal water quality.
- **Metals**
  The most significant sources of metals in stormwater runoff come from commercial areas, household wastes, and most importantly automobile wastes from parking lots, roadways and driveways.
- **Nitrates**
  Runoff from lawns, roads, farms, and leachate from septic systems and landfills are among the most significant sources of nitrogen in stormwater pollution. Nearly all forms of animal wastes, especially from pets and farm animals, deposited on or adjacent to developed areas are significant sources of nitrogen.
- **Pesticides and Herbicides**
  Pesticides and herbicides washed off of lawns and farm fields during rainfall are often significant pollutants in stormwater.
- **Petroleum Products (Oil, Grease, Gas)**
  These types of contaminants most commonly enter the storm drain systems from accidental spills, automobile discharge to roadways, parking lots, driveways, and improper disposal practices. Petroleum products can be particularly dangerous because "they contain thousands of organic compounds with diverse physical, chemical and toxicological properties with equally diverse environmental impacts" (DEP, Vol. II, 1997).

Consequences of stormwater pollution are tremendous. The changes to watershed hydrology caused by stormwater contamination results in water quality impairment, increased sedimentation and erosion, habitat loss, increased flooding, and loss of aesthetic value in coastal resources. Increased nutrients in contaminated stormwater causes receiving waters to become eutrophic. This excess in nutrients such as nitrogen causes an elevated growth of algae and aquatic vegetation in marine waters. This can lead to development of red and brown tides that pose a threat to marine organisms and human health. Increased sedimentation to local waters eventually causes habitat destruction. Also, sedimentation has economic impacts as well. "These excess deposits of sediment clog harbors and other water transport routes and reduce the storage capacity of reservoirs, obliging governments to spend billions of dollars each year to dredge and maintain those channels and facilities" (National Resources Defense Council 1999). Flooding becomes a problem when increased impervious surfaces are created due to development. As stated by Federal Emergency Management Director James Lee Witt, " The runoff has to go somewhere, and places that never flooded before are now at risk." (NRCS 1999). The aesthetic losses to coastal waterways caused by stormwater contamination are also tremendous. Beach closings and shellfish bed closures are common results of stormwater contamination. This contamination poses a threat to tourism and recreation thereby causing an economic loss to the community.

WATERSHED HYDROLOGY

Ipswich is a relatively small community of approximately 13,000 people located on the northeast coastal plain of Massachusetts. Land use in the community is extremely diverse. Large sections of the town can be considered rural in nature with the predominant land uses being protected conservation land, agriculture, or large undeveloped privately held wooded parcels. However, many sections of the town, especially in the eastern coastal area, are heavily developed. Two state highways traverse the coastal section of town and the downtown area, which contains a dense commercial and residential district. In addition, much of the desirable coastal area consists of densely developed residential neighborhoods such as Great Neck, Little Neck, and Ocean Avenue. Ipswich, like many older coastal communities developed relatively early on and most of the development in the coastal section predates 1970. Therefore, all of the environmental controls have been implemented since that time. Approximately 50% of the town's residential and commercial property is serviced by a secondary level municipal sewage treatment system. The remainder, including much of the coastal area, is serviced by on-site subsurface disposal systems. The topography is highly variable, with many coastal drumlins interspersed among the large expanses of flat wetlands. The soils and topography generally exacerbates the stormwater pollution problem and limits remediation options.

The coastal area of Ipswich is located entirely within "The Great Marsh," the largest estuary system in New England. The majority of this marsh, and all of the coastal areas of Ipswich, are designated by the state Executive Office of Environmental Affairs (EOEA) as an Area of Critical Environmental Concern (ACEC). ACEC areas are those "…containing concentrations of highly significant environmental resources…" (EOEA, 1993). This designation directs state environmental agencies to take actions to preserve, restore and enhance its resources. (See Appendix J for Ipswich ACEC map). All of the developed area of the town drains into The Great Marsh by a myriad of small rivers, streams, ditches and stormdrains that eventually become tidal creeks before discharging into the ocean. Much of the surface soils throughout the coastal area of town are considered poor for development and consist of relatively impermeable marine clay.

Stormwater Pollution And Rainfall:

Unfortunately, there is no single large source of runoff responsible for coastal pollution in Ipswich. Shellfish bed closures, for example, appear to be due to the cumulative impact of several small and diffuse sources. This may help to explain why the shellfish bed closures tend to cover large, generalized areas as opposed to small individual flats. For example, the majority of the Ipswich River and upper portions of the Castle Neck and Rowley River estuaries are closed to shellfishing at all times reflecting the impact of several direct dry weather sources. On the other hand, all of the town's shellfishing areas are closed for extended periods following rainfall due to the many indirect and widespread sources of bacteria in stormwater runoff.

The most significant factor determining the degree to which a source impacts the coastal area is rainfall. During dry weather, sources of contamination must be discharged either directly into the coastal area or indirectly through a tributary or pipe. Dry weather sources tend to pollute on a regular or recurrent basis. Examples of these types of sources include direct discharges from failing septic systems, indirect discharges from septic systems through street drains and ditches, semi-domestic waterfowl, farm animals, and the Wastewater Treatment Plant effluent. Rainfall can influence the impact of the dry weather sources by delivering them to the coastal area more quickly over larger areas or by dilution. Rain also introduces tremendous amounts of contaminants in stormwater from developed areas that otherwise would not impact the coastal areas. Stormwater is by far the largest single contributor of fecal coliform bacteria in Ipswich (CPCC 1995). Sources of bacteria in stormwater include surface deposited animal wastes (pet, farm, wildlife), failing septic systems without a direct or indirect discharge to the coastal area, or the municipal sewage system due to problems associated with rainfall. Stormwater is also the single largest contributor of excessive nutrients, petroleum hydrocarbons, oils and grease, metals such as lead, copper and mercury, and many volatile organic compounds.

Precipitation and Climate:

The climate in Ipswich is typical of the coastal area of Southern New England. Overall, the basin's climate is fairly humid and moderate. From 1961 through 1995, the average annual air temperature was 49 degrees Fahrenheit. Monthly mean temperatures during this time period ranged from 25° F in February to 70° F in July and August. Precipitation averages 48 inches per year and is distributed fairly evenly throughout the year ranging from 3.2 inches in July to 4.8 inches in November. The majority of precipitation in the winter is also in the form of rain as only 37 inches of snow falls in an average winter (United States Geological Survey, 1999). Rainfall frequency and intensity are also highly variable. Over 40 runoff producing rain events (>0.1 inches) occur each year on average, and single rain events in excess of one inch occur frequently (Town of Ipswich 1999).

The following tables, provided by the Town of Ipswich Utilities Department, outlines precipitation in Ipswich from January 1978 to January 1999.

IPSWICH PRECIPITATION: 1978-1988 - In Inches (Recorded at Wastewater Treatment Plant)

	1978	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
JAN	8.53	10.40	0.68	1.12	6.95	4.25	2.56	1.20	4.80	5.60	2.50
FEB	2.50	1.92	1.05	8.36	2.65	5.70	9.25	2.10	2.50	0.35	2.67
MAR	2.98	2.51	5.57	1.49	2.83	12.30	5.52	3.65	4.50	4.60	3.55
APR	2.05	4.29	5.59	4.92	2.56	8.30	5.60	1.50	3.30	12.60	2.55
MAY	6.08	4.70	1.40	1.48	3.75	5.30	9.60	4.30	1.25	1.70	4.31
JUN	3.74	1.45	3.70	2.03	14.75	2.10	3.05	4.30	8.30	2.40	0.50
JUL	2.21	1.35	4.74	4.98	4.20	1.90	4.03	4.55	4.45	1.10	4.65
AUG	2.85	5.92	0.57	3.82	3.50	2.75	1.15	4.70	2.00	2.35	3.85
SEP	1.60	2.65	1.18	3.82	2.91	1.20	0.90	4.25	2.20	8.75	1.55
OCT	2.86	4.10	4.65	5.43	4.56	2.93	5.40	1.73	2.30	3.55	1.55
NOV	1.02	5.11	3.88	4.85	4.25	13.35	1.85	7.95	5.90	4.05	7.10
DEC	3.60	1.02	1.40	5.86	1.27	6.80	4.45	1.40	7.65	3.35	1.20
TOTAL	40.02	45.42	34.41	48.16	54.18	66.88	53.36	41.63	49.15	50.40	35.98
AVG	3.34	3.79	2.87	4.01	4.52	5.57	4.45	3.47	4.10	4.20	3.00
MIN	1.02	1.02	0.57	1.12	1.27	1.20	0.90	1.20	1.25	0.35	0.50
MAX	8.53	10.40	5.59	8.36	14.75	13.35	9.60	7.95	8.30	12.60	7.10

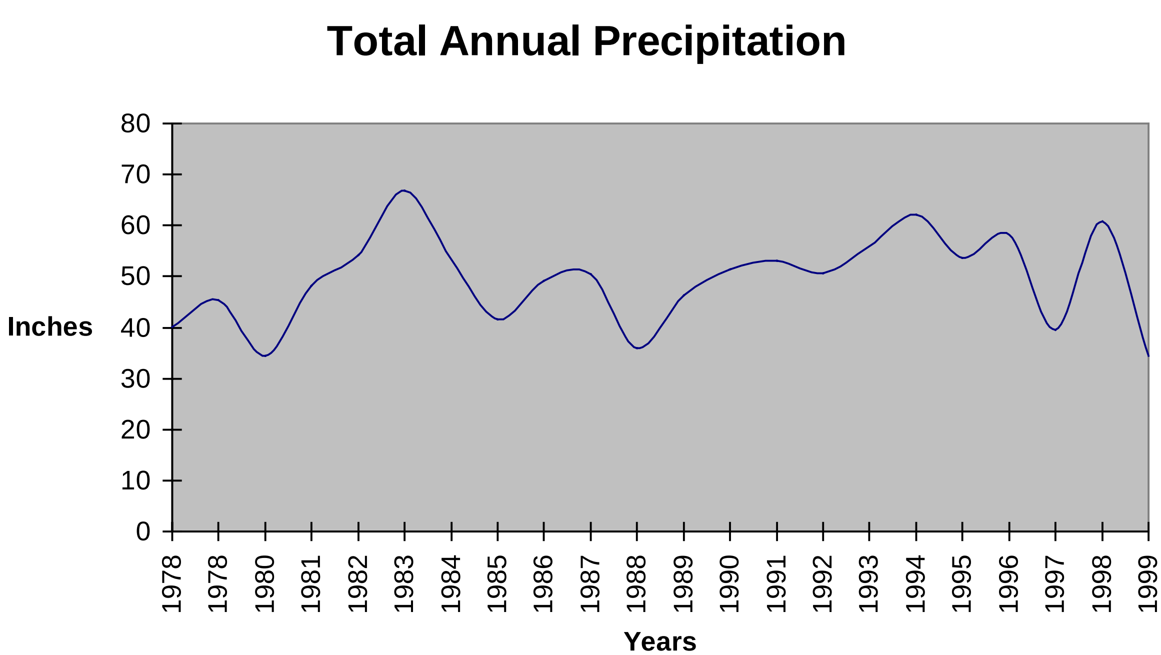
Table continued on page 8.

IPSWICH PRECIPITATION Continued: 1989-1999 - In Inches (Recorded at Wastewater Treatment Plant)

	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999***
JAN	0.65	3.50	4.20	4.65	2.85	6.30	6.20	7.15	3.20	10.28	7.79
FEB	2.90	4.35	1.80	3.20	5.70	2.40	3.25	3.60	2.15	6.74	5.14
MAR	3.25	1.95	3.85	4.55	8.50	9.55	2.40	3.15	5.80	4.71	3.30
APR	4.40	6.80	6.25	3.05	8.75	3.20	2.25	5.30	4.25	3.56	3.30
MAY	3.80	6.00	1.40	3.30	1.75	7.05	3.65	2.80	3.10	8.57	3.80
JUN	4.50	1.00	2.75	4.20	2.00	1.60	5.85	2.60	0.60	8.60	0.38
JUL	5.25	4.50	2.85	3.95	1.20	3.60	3.45	3.90	1.65	2.04	3.33
AUG	3.90	5.55	6.85	5.60	1.75	4.65	1.95	0.65	2.61	2.87	0.55
SEP	4.05	1.15	9.00	3.90	5.85	7.79	4.00	5.95	1.97	3.77	6.88
OCT	7.55	9.50	5.20	2.65	5.70	1.80	6.90	12.86	2.10	6.49	
NOV	4.70	2.50	4.40	5.80	4.20	5.40	9.42	2.90	8.33	1.56	
DEC	1.45	4.55	4.55	5.85	7.65	8.85	4.30	7.39	3.77	1.60	
TOTAL	46.40	51.35	53.10	50.70	55.90	62.19	53.62	58.25	39.53	60.79	34.47*
AVG	3.87	4.28	4.43	4.23	4.66	5.18	4.47	4.85	3.29	5.07	3.83*
MIN	0.65	1.00	1.40	2.65	1.20	1.60	1.95	0.65	0.60	1.56	.038*
MAX	7.55	9.50	9.00	5.85	8.75	9.55	9.42	12.86	8.33	10.28	7.79*

* Not including data from October, November and December.

The following represents the above total precipitation data (total precipitation in Ipswich from 1978 to 1999, in inches) graphically. Overall, there were no years of extremely low precipitation showing that the town maintained a moderate to high yearly average of approximately 45 inches.

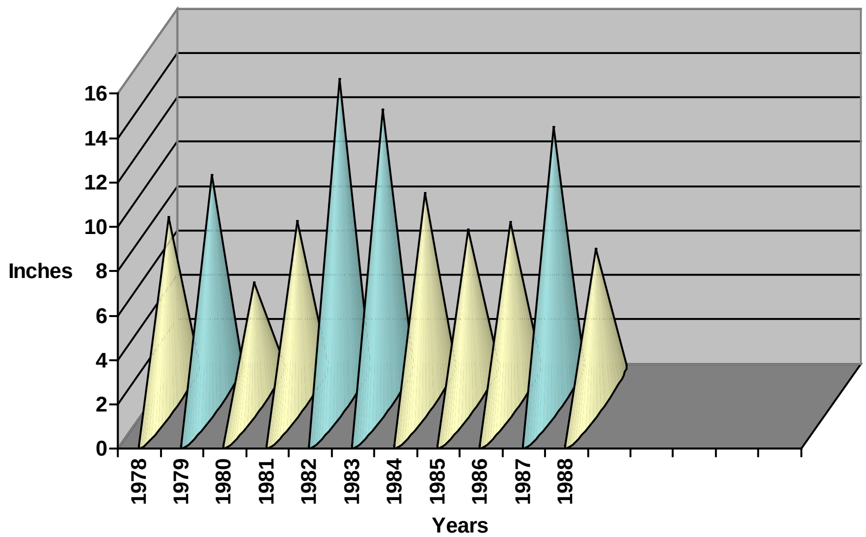


Beyond monthly and annual averages, it is important to evaluate the intensity of rainfall as well to help design appropriate stormwater management systems. The intensity of rainfall will determine whether or not preventative measures may be sufficient, or if a stormwater system repair or replacement at particular locations is best. The following table and graphs (graphs on page 9) indicate the distribution of "peak" rain events during the sample period.

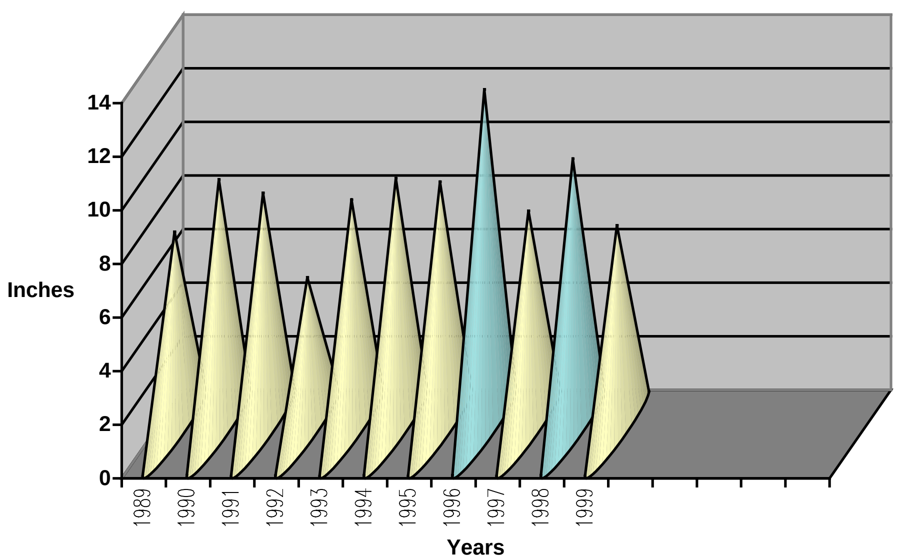
Maximum Monthly "Peak" Precipitation (1978-1999).		
Year	**Month**	**Precipitation In Inches**
1978	January	8.53
1979	January	10.40
1980	April	5.59
1981	February	8.36
1982	June	14.75
1983	November	13.35
1984	May	9.60
1985	November	7.95
1986	June	8.30
1987	April	12.60
1988	November	7.10
1989	October	7.55
1990	October	9.50
1991	September	9.00
1992	December	5.85
1993	April	8.75
1994	March	9.55
1995	November	9.42
1996	October	12.86
1997	November	8.33
1998	January	10.28
1999	January	7.79

Please refer to the graphs on the next page (p. 10).

Maximum Monthly Precipitation: 1978-1988



Maximum Monthly Precipitation: 1989-1999



<u>Watershed Areas And Stormwater Pollution:</u>

[Note: The following was adapted form the CPCC 1995 report. For a complete description of the watersheds and how each source of stormwater is related to water quality in the area, see Appendix C.]

There are six sub-watershed areas in the coastal section of Ipswich: Rowley River, Eagle Hill River, Northern Marsh Creeks, Plum island Sound, Ipswich River and Castle Neck River. Each of these in turn drains into the two main estuaries in Ipswich, Plum Island Sound and Essex Bay before discharging into the ocean. Please refer to the map provided on page 12 for visual.

Rowley River

The Rowley River begins at the confluence of the Egypt and Muddy Run Rivers in Ipswich, and flows along the Ipswich/Rowley town line for 5 miles to Plum Island Sound. Bull and Dow Brooks are the main tributaries to the Egypt River. The Egypt River watershed is located primarily within relatively undeveloped municipal watershed land and therefore receives very little stormwater runoff. Muddy Run, on the other hand drains much of the densely developed northern section of the downtown area, including a large section of the route 1-A/133 highway business district. Much of the area is heavily urbanized with dense residential areas, commercial buildings, and parking lots. Several storm drains discharge into Muddy Run. Two large farms and a zoo are also located within the watershed. Unlike the upper watershed, the lower watershed area of Muddy Run is relatively undeveloped and flows through a several hundred-acre freshwater wetland area prior to its convergence with the Rowley River within the saltmarsh. This wetland area appears to provide a significant amount of pollution attenuation prior to the brook's discharge point as indicated by the significant reduction in pollutant levels within this wetland documented by the CPCC. (See Appendix H.) Therefore, stormwater pollution remediation within this watershed could be a lower priority.

Northern Marsh Creeks

The "Northern Ipswich Marsh Creeks" (Niaway, Rogers Island, Lords, Metcalf's, Broad, Laws, Goose, Third and Stacy) are a series of creeks within the great marsh and together comprise the most significant shellfish beds in the town. Fortunately, there is no upstream development within the watersheds of these creeks and no sources of stormwater contamination were documented. These areas are, however, impacted by stormwater contamination from the adjacent Rowley River, Eagle Hill River, and Plum Island Sound, so stormwater remediation within these watersheds will have a positive impact on water quality in these creeks as well. Another important factor to note is the possible sewage leaking from systems located in several hunting camps located in this marsh area. (Please see findings section for more information on camps.)

Eagle Hill River

The Eagle Hill River is predominately a tidal river system with a small upland watershed area. However, much of the adjacent upland area is heavily developed and three storm drains discharge into the watershed. Stormwater runoff from the Eagle Hill and Ocean Avenue coastal residential communities has been documented to negatively impact water quality in the watershed.

Plum Island Sound (Lower Sound)

The portion of the lower Plum Island Sound within Ipswich receives the drainage from the Rowley River, Eagle Hill River and the Ipswich River. In addition, the Sound receives a tremendous amount of stormwater runoff directly from the densely developed coastal communities of Great and Little Neck. Water quality is also negatively impacted from sources in the northern Sound outside of Ipswich in the Towns of Rowley and Newbury. Due to hydrology and attenuation of pollutants from the distant sources in the northern Sound and the Ipswich River, the CPCC has determined that the runoff from the Rowley River, Eagle Hill River, and Great and Little Neck is of most concern and accounts for the bulk of the negative impact on water quality in the Lower Sound.

Ipswich River

The Ipswich River watershed drains the majority of the developed portions of Ipswich and receives drainage from several streams, creeks, stormdrains, the discharge from the town's sewer plant, and most of the stormwater from the downtown area. The CPCC has identified over 100 sources of stormwater within this watershed and has documented that the river is severely impacted by stormwater contamination. The Ipswich

River is a relatively large freshwater system nearly 40 miles in length and drains a very large watershed inland of Ipswich. Much of the upper watershed is heavily urbanized and all or parts of 22 municipalities are within the basin. Fortunately, except for the downtown area of Ipswich, the lower watershed is relatively undeveloped and consists of large expanses of pristine freshwater wetland areas that appear to attenuate pollutants from the upper watershed. The CPCC had documented that water quality in the Ipswich River as it enters the downtown area of Ipswich is excellent, even in wet weather and has concluded that all of the water quality problems within the Ipswich River estuary can be attributed to sources from within Ipswich.

The Ipswich River can be divided into two sections within Ipswich, the freshwater section upstream of the dam in downtown, and the estuarine section immediately below the dam. Because the dam is centrally located within the developed portions of the town, roughly 50% of the sources of stormwater are located on either side of it. Three relatively large tributaries, Farley Brook, Kimball Brook, and Saltonstall Brook drain the downtown area and receive the majority of the stormwater from the area via over 30 storm drain systems. Of these, Kimball and Saltonstall Brook join the river upstream of the dam and Farley Brook joins the river below the dam. In addition to these major tributaries, several stormdrains discharge directly into the estuary portion of the river below the dam. These drains are located both in the downtown area and coastal neighborhoods such as Great Neck, and Little Neck. Each of these drains has been documented to contribute high levels of stormwater pollution to the Ipswich River. Farm runoff is also a significant source of stormwater contamination to the river. Gould’s Creek, which joins the river within the estuary drains three livestock farms and has been reported to contribute a great deal of pollution to the river following wet weather.

In addition to non-point sources of pollution from stormwater runoff, the Ipswich River receives a great deal of domestic sewage contamination related to stormwater as well. Excessive inflow and infiltration of stormwater into the town’s municipal sewage collection system, overflows of untreated sewage directly into the river, and discharges of poorly treated sewage caused by disruptions at the plant itself, negatively impact the river following rain events, especially in the spring. In addition, several street drains in the non-sewered portions of the estuary have been documented to contain domestic sewage from failing septic systems due to direct illegal connections or poorly functioning systems improperly sited adjacent to street drains. While many of these drains impact the river during dry weather, they also affect the river following storm events due to flushing of sewage within the systems, or rainfall’s impact on marginal systems located adjacent to street drains.

In terms of relative impact, the CPCC determined that sources of stormwater contamination located below the dam have a much more significant contribution to the overall problem than drains located above the dam. Apparently, the large, deep pond area and wetlands created by the dam has a significant ability to attenuate pollutants before they impact water quality below the dam. On the other hand, pollutants discharged to the river below the dam have a direct and immediate impact on water quality within the estuary. Of these sources, Farley Brook, and the storm drains along the river in the downtown area between the dam and the Town Wharf and on Great and Little Neck, contribute the majority of the pollutants. Additionally, because the two overflow points in the town’s sewage collection system, as well as the outfall from the treatment plant, are located below the dam within the estuary, this source of contamination is significant as well.

Castle Neck River

The Castle Neck River begins in two wetland areas just above Choate/Chebacco Roads, one branch in Ipswich and One in the Town of Essex. The two branches meet just upstream of the saltmarsh east of the road and becomes a tidal river for several miles before joining Essex Bay. The watershed is largely rural in nature and is impacted by stormwater runoff from one farm. Although State Route 133 passes over the river, there isn’t a stormdrain collection system to concentrate the runoff. Because the runoff from the roadway is decentralized over a large upland/wetland area, pollutants appear to be attenuated to a large degree before impacting water quality in the Castle Neck River.

RESEARCH METHODS

Our research has included, and was not limited to, the following mechanisms: review of technical reports, manuals and literature regarding stormwater management, established contacts with town officials and organizations, assistance from state and federal regulatory and environmental agencies, review of other similar projects, collection of local ordinances for review, and participation in local committees.

The Coastal Pollution Control Committee took quite an active role in compiling the data necessary to establish a good sense of stormwater pollution. CPCC Members participated in seminars on Title V disposal system regulations and stormwater management and visited alternative treatment sites and wastewater treatment plants while preparing for their study. Members also met with neighborhood groups, hosted visits from Mass Bays groups and performed site surveys with vendors of pollution control equipment. They reviewed data with state and federal specialists from the Natural Resources Conservation Service, Environmental Protection Agency (EPA) and the United States Department of Agriculture. Lastly, the members met with town boards and officials and participated monthly in the Eight Towns and the Bay (8T&B) coalition of neighboring towns. In 1992, the Coastal Pollution Control Committee initiated a study that focused on identifying and quantifying sources of bacteria. The time frame was defined flexibly to encompass at least two annual weather cycles and to respond to the study's findings as it progressed. We found the data from their study to prove extremely useful in developing this Stormwater Management Plan. Their extensive sample data, conclusions on nonpoint pollution sources, and project technique regarding coastal pollution in the town of Ipswich were what we based our research methods and recommendations on. An important portion of their methods we must mention is their use of fecal coliform data as a pollution indicator.

<u>The Fecal Coliform Indicator:</u>

Public health officials monitor water to determine the degree to which it has been contaminated by fecal coliform bacteria because it serves as a great indicator of human and animal fecal contamination. In addition to being a good indicator of fecal wastes, it is also an excellent indicator of stormwater pollution because fecal coliforms are always present in stormwater and often is relative to concentrations of other contaminants. When certain concentrations of fecal coliforms (continually referred to in our Plan as pollution, pollution concentration, or contamination) are reached in a body of water, certain uses are prohibited. Swimming is banned above 200 fecal coliforms per 100 milliliters of water (about 4 ounces). Since shellfish concentrate pathogens, the limit for shellfishing is 14 fecal coliforms per 100 milliliters. Any measurable level of contamination in drinking water is considered unsafe (at a level greater than zero). The fecal coliform indicator has several merits: it is inexpensive and easy to test for, is well established, and has provided a measure of health protection for many years. This indicator does, however, have some recognized deficiencies such as: (1) Animal and human sources are not differentiated, and (2) fecal coliform do not necessarily relate consistently or in proportion to the threat to public health from pathogens.

Because rainfall has a significant impact on bacteria concentration since it tends to wash bacteria from land surfaces over large areas into waterways, CPCC sample results were analyzed according to the time, date, and amount of rain (as in Appendix A). Where flow data are available, the "bacterial loading" rate was calculated to provide the basis for a relative comparison between sources. Bacterial loading is commonly used in studies to evaluate and compare sources of bacteria because it takes into account the intensity of the source. It represents the actual number of bacteria produced from a source, whereas bacterial concentration is simply a measure of the number of bacteria in a 100 ml portion of the source. For example, a source with a low or moderate bacterial concentration but high flow would have a relatively high bacterial loading and would contribute much more contamination than a source with a high bacteria concentration but low flow.

Bacterial loading is expressed as the number of fecal coliform bacteria per day (fc/day) and is calculated according to the formula of Kittrel (CPCC 1995):

$$fc/day = fc \times Q \times 24.6 \times 10^{6}$$

where: fc = fecal coliform concentration per 100 ml of water and
Q = flow in cubic feet per second (when flow is in gallons per minute, bacterial loading = $fc \times Q \times 5.48 \times 10^{4}$)

Bacterial loading is sometimes expressed as human equivalents (H.E.). One H.E. is the amount of fecal coliform produced by an adult human in one day, or two billion (2×10^{9}) fecal coliforms per day. The expression (with Q in gpm) is:

$$H.E. = fc \times Q \times 2.75 \times 10^{-5}.$$

Our research included the following steps, similar to those that the CPCC took for their study:

1. Review of existing information, including CPCC's identification of pollution sources/source areas from their shoreline survey and their sampling of potential pollution sources.
2. Analyzing CPCC field data and prioritizing stormwater remediation recommendations based on this data. (Storm drain prioritizing can be reviewed on page 27 of our recommendations section.)
3. Identification and evaluation of alternatives for pollution source management.
4. Development of recommendations.

Importance of CPCC Data (Shoreline Survey and Sample Monitoring):

Because the data from the CPCC original shoreline survey and sampling program still stands true today, we were able to build a definitive evaluation on stormwater pollution in Ipswich. Before we discuss our findings and make recommendations, we feel that it is important to describe the methods of the CPCC shoreline survey and sampling program as the data it created fueled-the-fire for our management plan.

The purpose of the CPCC shoreline survey was to locate and evaluate potential sources of pollution impacting the coastal area. The shoreline of the coastal area and its tributaries was divided into four sections and surveyed according to methods of the National Shellfish Sanitation Program (CPCC 1995). The following areas of town were surveyed by the CPCC in 1991:

- Great Neck and Little Neck.
- Clark Pond shoreline.
- Eagle Hill and Ocean Avenue areas.
- Island Park.
- Upper Eagle Hill watershed.
- Ipswich River in town - north bank between Sixth Street and Cameron Road.
- Ipswich River in town - south bank between Masconomet Road and Labor In Vain Road.
- Lower Kimball Brook.
- Lower Castle Neck River along Argilla Road.
- Upper Castle Neck River - Old Essex Road to Choate Street.
- East Branch of Goulds Creek along Argilla Road.
- Base of Castle Hill along Fox Creek.

A four-member team was assigned to each area, trained in survey techniques, and provided with the background information relative to each area from the review of existing information. An inventory was made of the potential pollution sources that were found. Detailed information about each source was recorded, mapped, and an initial evaluation made. Where possible, the flow of pipes, ditches, streams, runoff, etc. was measured at the United States Geological Survey gauging station for Ipswich, using the methods depicted in the United States Department of Health and Human Services' National Shellfish Sanitation Program's Manual of Operations (CPCC, 1995). Observations relative to the pollution source such as animal life, land use, topography, hydrology, vegetation, odor, stains, other types of pollution, or follow up work needed, (etc.) were made. Each section of the survey was further evaluated to determine which potential pollution sources were suspect enough to require testing (CPCC 1995). Sample stations were established based on the results of the shoreline survey, the review of existing information, and representative locations along the main tributaries to the coastal area. Water samples were collected in disposable pre-sterilized containers and handled according to Standard Methods (CPCC 1995). Samples were collected to test for a pollution indicator: fecal coliform bacteria concentration [fc], (number of bacterial per 100 milliliters (ml) of water - about 4 ounces) within 6 hours of collection by the membrane filtration (MF) or Most Probable Number (MPN) techniques. The samples were then analyzed at one of three certified laboratories. When necessary, the samples were also analyzed for fluoride content or laundry detergent (optical brighteners) if the source was suspected to contain town water or domestic sewage. Other parameters such as temperature, flow, recent rainfall data (as measured at the Town's rain gauge at the sewage treatment plant), and other relative information were recorded at the time of sample collection.

RESEARCH FINDINGS

GENERAL FINDINGS:

There are four major sources of bacteria in stormwater affecting the coastal area of Ipswich:

1. Animal wastes flushed across impervious developed areas and through the Town's storm drain system by stormwater.
2. Runoff from failed septic systems facilitated by impervious developed areas and storm drains.
3. Urban runoff from development, through the existing street drain system, in both dry and wet weather.
4. Overflow of untreated wastewater from the municipal sewage system due to excessive infiltration of stormwater.

The above are further outlined in the table below:

Summary of Stormwater Pollution Sources	
Agriculture, Pets, Wildlife	During wet and dry weather. Animal feces deposited on land, pastures, lawns, rooftops, on or near paved areas is flushed, untreated, directly or indirectly via street drains.
Septic Systems	Main conduit for sewage from failing systems is storm drain systems. Extremely high levels of fecal coliform (as high as the limit of testing: 240,000 fecals/100 ml in some cases) were recorded, fluoride (indicates town wastewater), and laundry detergents were found in some drain systems.
Urban Runoff From Development, Through Existing Street Drain System	Urban runoff is the most contributing factor to stormwater pollution. Pollutants are flushed by rainfall from impervious surfaces (paved areas & lawns) and rapidly carried to storm drains & then waterways. This bypasses natural detention and filtering mechanisms. Private connections to street drains are a major problem.
Municipal Sewage Collection System	Overflows caused by the inflow & infiltration of stormwater into the system. Overflow goes directly into river at Town Wharf area.

During their sampling program, CPCC members established the following facts:

1. Every sample of stormwater runoff collected from a developed area or farm was very high in fecal coliforms. Some of the street runoff samples had bacteria levels comparable to sewage. The water bodies receiving this runoff were also documented to be highly impacted. The highest concentration of bacteria appeared to occur during the “first flush” or initial period of runoff. Please see Appendix M for example data.
2. Bacterial concentrations in storm drains in the sewered downtown area were of the same order of magnitude as those in the unsewered Neck area. Bacterial loadings were actually higher in the sewered downtown area than the unsewered Neck area indicating surface deposited pollutants are the primary source of stormwater contamination.

3. Longitudinal studies of the Ipswich River (i.e., simultaneous samplings along its length) after heavy rain show a sharp increase in bacterial concentration after passing through the downtown area and corresponding bacterial loadings which, if from human source, would be equivalent to waste from well over 100 persons. (See graph on page 12.)
4. The CPCC's animal/human differentiation and optical brightener sampling tests indicate that animals are the source of the fecal coliform found emanating from the downtown area.
5. The size and complexity of the stormwater problem is almost overwhelming due to the number of individual sources and the wide variety of sources.

The CPCC has identified well over 100 locations in Ipswich where these sources are contributing to coastal pollution which makes finding a solution to the problem more difficult. Sources of polluted stormwater in adjacent towns have some localized effects but do not appear significant, primarily because many of these pollutants are attenuated by the time they reach Ipswich waters. The most contributing sources of stormwater pollution are categorized by source and described below.

Animals/Agriculture, Wildlife & Pets:

Animals are a significant source of fecal pollution during both wet and dry weather. Wild and semi-domestic waterfowl as well as farm animals, are the principal sources of pollution during dry weather when feces is deposited directly into waterways, thus impacting the coastal area. During and after wet weather, animals become one of the major sources of fecal coliform affecting the coastal area. Several days or weeks worth of untreated animal feces deposited on land, pastures, lawns and rooftops, on or near the paved areas of the developed sections of town, is flushed directly or indirectly via street drains, streams and ditches into coastal areas. While there is a certain component of the wild animal problem that cannot be addressed, the majority of the problem is related to domestic animals, due to direct and indirect associated actions by humans.

The magnitude of the animal sources can best be comprehended by comparing the amount of fecal coliform produced per day by various animals and birds to that produced by an adult human. The following table shows, for example, that the average dog produces 2.7 times as many fecal coliform per day as an average adult human.

AVERAGE FECAL COLIFORM (FC) PRODUCTION ESTIMATES FOR SOME ANIMALS:

	WEIGHT/DAY(G)	#FC/G	#FC/DAY (MILL)	HUMAN EQUIVALENT
Human	150	13,300,000	1950	1.00
Horse	16100	130,000	2093	1.07
Dog	227	23,000,000	5221	2.70
Cat	40	800,000	320	0.16
Cow	26300	230,000	6049	3.10
Duck	336	33,000,000	11088	5.70
Goose	350	3,600,000	1260	0.65
Swan	317	2,500,000	1000	0.52
Chicken	182	1,300,000	237	0.12
Turkey	1820	290,000	528	0.27

Animals/Agriculture

Animal feces deposited by wild, domestic, and farm animals in open undeveloped land do not present a problem. There is little runoff and animal wastes are generally trapped on land. Farm animal feces does, however, become a problem when farm animals are permitted access to waterways that flow into the coastal areas or when manure is stored or spread in areas where it readily runs off into coastal areas or streams leading to coastal areas. A survey conducted by the Animal Control Department in 1992 found well over a thousand farm animals in Ipswich including domestic ducks, geese, goats, cows, sheep, and horses and it is believed the figure has actually increased since then. The farms with the potential to contribute pollution to the coastal area were identified from the town-wide farm survey. The CPCC has identified at least sixteen sites in Ipswich and one in Essex where these types of animals are believed to be contributing to coastal pollution. (See Appendix M for data.)

Wildlife

Wild and semi-wild waterfowl (mostly ducks, swans, and gulls in the Ipswich River) and other birds that live and/or feed along the river as it flows through the downtown area are a major source of pollution in dry weather when they deposit their feces directly into the river. The numbers of these birds are great and their individual production of fecal coliform is particularly high. Almost all birds in/along the river are found at five locations between the Sylvania Dam and Town Wharf. These are: between Sylvania Dam and Choate Bridge, at Choate bridge near Chipper's Restaurant, at the cove between the County and Green Street bridges, at the Ipswich Outboard Club boat ramp, and at Town Wharf. In addition, three large colonies of pigeons nest above the river under a building on South Main street and the Green Street and Labor In Vain Road bridges. The number and species of birds at these sites varies considerably from day to day. However, a survey conducted by the Coastal Pollution Control Committee on a regular basis in 1993-94 indicated an average of 48 birds, and a three-month average during the winter of over 190 at the five sites each day. On many days, over 120 gulls, ducks, and swans and other birds were counted at Town Wharf and observations of over 80 ducks congregating at the Choate Bridge site were not uncommon. Recent surveys show that although the average number of waterfowl went down to 25.2, the number of waterfowl during the late Summer/early Fall remained quite high (see table below).

Waterfowl Survey Results Along Ipswich River: Ipswich, MA

Date & Time	Sylvania to Choate Br.	Choate Br. to County St.	County St. to Green St.	Green St. to Outboard Club	Outboard Club to Town	Total	Comments
8/19/99 2pm	30	30	4	1	16	81	People feeding ducks @ Wharf.
8/30/99 3pm	3	35	0	2	10	50	Sediment along river. Many pigeons @ Green St.
9/13/99 3:30pm	0	30	10	5	4	49	
9/14/99 12:30pm	27	10	3	0	2	42	Rapid flow along river.
9/20/99 10:30pm	0	3	0	0	5	8	
9/29/99 2pm	0	0	0	0	4	4	Vandalized “No Waterfowl Feeding” sign @ Wharf.
Average 8/19/99 through 9/29/99	**10**	**18**	**2.8**	**1.3**	**6.8**	**39**	

Observations made during the CPCC surveys indicate that these unnaturally high congregations of waterfowl are attracted and maintained in these areas *due to feeding by people* or in the case of geese, by green lawns adjacent to waterways.

During wet weather, the amount of pollution attributable to the wild and semi-wild birds along the river is increased due to the runoff of the large deposits of feces that fouls adjacent land and roof tops. These deposits, documented during the bird surveys, are left primarily by gulls and flocks of pigeons that roost on rooftops adjacent to the river. The density of these birds is so great that many of these surfaces have been stained white with their droppings, especially in the Town Wharf area.

Pets

The wet weather runoff of bird feces is greatly augmented by the fecal contributions of the large number of domestic pets living in the heavily developed sections of town that have a high ratio of paved to unpaved land and where the surface water and street drains flow directly into the river or coastal areas. Over 600 dogs live in the drainage area covered by the bird survey: i.e., Sylvania Dam to Town Wharf. Over one hundred dogs live in the Eagle Hill, Great and Little Neck area year round, and the dog populations increase at these locations during the summer months when the several hundred seasonal homes in this area become occupied. These three locations are of critical concern because of their proximity to the coast and because of the other pollution problems experienced in these areas. The table (on page 17) shows that the average dog produces more than twice the amount of fecal coliform per day than a human. The roads, walkways, beaches and shorelines adjacent to the river and the coast are *the* most popular places for owners to walk their dogs. For example, more than 50 dogs are taken to Water Street and Sally's walk every day. For all intents and purposes, it has become impossible to walk on the grass between Water Street and the river because of the concentration of dog feces there. Similar conditions were documented to exist along some of Ipswich's smaller beaches, Eagle Hill, and other shoreline areas.

Additional Animal Findings

The CPCC was able to determine the difference between human and animal wastes by conducting a fecal differentiation test. Two “groups” of bacteria are used in these kinds of studies: “fecal streptococci” and fecal coliform.” By enumerating the number of each group of bacteria in a water sample and comparing their ratios, it is theoretically possible to determine the source of the bacteria in a water sample and comparing their ratios of each (as determined in a laboratory). A ratio of less than 0.7 is considered to be of animal origin. Between 0.7 and 4.0 indicates either a mixed source (human and animal) or some kinds of livestock. A fecal coliform to a fecal streptococci ratio (fc/fs) of 4 or greater indicates a human source. There are some problems with this ratio test that primarily have to do with the different survival rates of the groups of bacteria. Fecal streptococci bacteria tend to live for a very short time outside of the host whereas fecal coliform tend to survive much longer. There are other various problems with the test; therefore our conclusion regarding pollution caused by particular types of wastes is not based solely on this indicator. Trying to find an indication of human involvement in pollution, and from what location it stems from, can be a very difficult and arduous task. In order to assist in this process, an optical Brightener test was conducted in certain stream pipe locations. Searching for these brighteners provides us with a good indication of human wastewater because brighteners can only be found in manmade laundry detergents. The results of the initial brightener tests done indicate that the technique is very useful and accurate in verifying the presence of laundry and sewage discharges.

Preliminary results of studies performed to distinguish between animal and human sources of fecal coliform bacteria clearly indicate that animals are the primary source of the wet weather pollution problem in Ipswich. The amount of fecal coliform from animals during wet weather is so great that it appears to exceed the contribution from humans even in the street drains that were documented to contain sewage from illegal connections to septic systems during/following rain storms. Twenty-three longitudinal studies of the Ipswich River (see chart on page 21) show a marked increase in bacterial loading after the Sylvania Dam, which is the beginning of the downtown area. Expressed in human equivalents, this increase amounts to hundreds during light rain events and thousands during heavy rain, even though the entire area is sewered. It should be emphasized that although animals are the primary source of fecal coliform bacteria in stormwater, the problem is principally due to domestic or semi-domestic animals, and is therefore caused by humans.

Septic Systems:

The CPCC has identified approximately 800 septic systems in areas within 200 feet of the coast, saltmarsh, streams, and storm drains draining into the coastal area. Due to their location, these systems are considered to have the potential to pollute coastal waters in the event of failure. The committee's sampling program has identified several of the 23 storm drains that were examined in the unsewered areas with evidence of human fecal contamination. The majorities of these systems are old, and may not be adequate for their current use or location and may help explain their high rate of failure. According to Board of Health (BoH) records, septic system repairs have averaged approximately 20 per year among these systems.

It is important to specify that the main conduit for sewage from failing septic systems to the coastal area is through the municipal or private storm drain systems (see Appendix K for details). Unfortunately, the location of the actual failing septic systems polluting the drains is very difficult to determine, and calls for an inspection program for illegal connections. Overall, septic systems do not appear to be a significant source of stormwater contamination except when illegally connected to stormdrains. This point is clear when one contrasts sample results between the unsewered Great Neck neighborhood versus the sewered downtown area (please see table on p. 23). In this table, one can clearly see that the results for the unsewered neck area are lower in contamination than the heavily populated, sewered downtown areas.

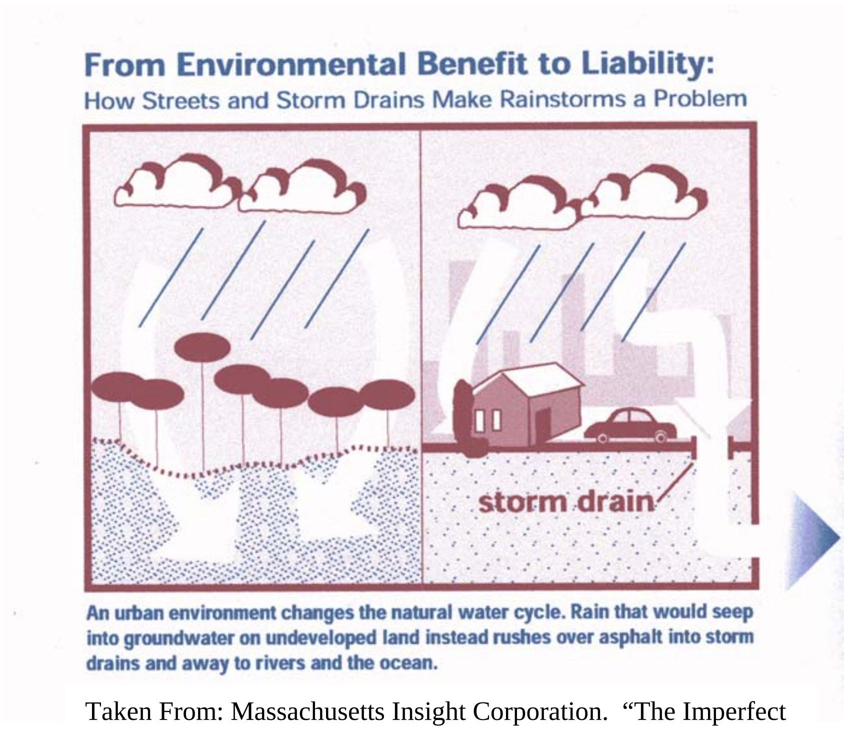
However, when compared to other sources of pollution, the overall contribution of septic systems to the stormwater contamination problem appears small. Bacterial loading calculations preformed by the CPCC clearly indicate that the majority of the wet weather problem is due to other sources (See Appendix O). Although septic systems were found to be contaminating street drains and ditches throughout the non-sewered sections of the coast, bacterial loading calculations done by the CPCC clearly indicate that there are a limited amount of systems contributing to the overall coastal pollution problem (CPCC 1995). As an example, the CPCC estimated that fewer than 18 systems were responsible for the entirety of septic system related fecal coliform pollution from the Great Neck and Little Neck area (CPCC 1995). If these specific systems were located and repaired, relatively little coastal pollution would emanate from septic systems in general. It should be noted however, that these figures merely represent systems in failure during the three-year sampling period. Over time, additional systems are likely to fail as they age unless a permanent solution to the problem is found.[1] Because the number of systems that are contributing to coastal pollution in any given point in time appears limited, site specific solutions to individual systems will likely control the problem.

Urban Runoff and Development:

The existence of the town's extensive storm drain system plays a major role in transporting pollutants from nearly all of the coastal sections of town following a rain event. In addition to the sources of stormwater contaminants previously discussed, the existence of the current drain system allows for other sources to readily impact the coastal waters as well. While large scale development appears to be well regulated in terms of

[1] [Note: Previous point notwithstanding, since 1995 many of the identified systems have been repaired. It is currently estimated that only three storm drains on Great Neck and Little Neck, one off Ocean Drive and a ditch off Lakemen's Lane are currently contaminated with domestic sewage from septic systems.]

stormwater contamination through the Planning Board via the Subdivision, Special Permit, and Site Plan Review processes, much development adjacent to the existing storm drain system is entirely unregulated. Examples include reconstruction, single-family home construction, large landscaping projects, road resurfacing projects, etc. We have determined that these types of projects, which are exempt form any local review process, when constructed adjacent to a street drain system contribute significant amounts of pollutants to the coastal area. Although some of these sites can be located miles from the coast, pollutants from the site will eventually enter coastal waters. The diagram below portrays the difference between rainfall on undeveloped land, and on developed land, where the transference of stormwater from streets to coastal waterways is unrestrained:



Taken From: Massachusetts Insight Corporation. "The Imperfect Storm" January 2000.

It is not uncommon to witness large sediment plumes several miles in length traveling down the Ipswich River emanating from one of these sites through the street drain system. It is estimated that the annual sediment loading to the coastal area from these "unregulated" sources exceeds those from all development projects that receive local development review.

It appears that the municipal street drain system has also become a de facto private drainage system because of the practice of allowing connections from homes to the street drains. It is possible to observe many of these connections throughout the town. While many appear to discharge relatively "clean" water from roof drains and sump pumps, these connections directly and indirectly contribute to coastal pollution. For example, roof drainage may contain significant amounts of bacteria from bird droppings. The cumulative effects of these inputs contribute a steady flow of water during both dry and wet weather. This eliminates the normal retention capacity of catch basins, reducing their ability to reduce pollution from small rain events. In addition, the existence of these connections have allowed homeowners the ready convenience of simply connecting laundry waste and even sewage when problems arise with their septic systems, which historically has been a significant problem in Ipswich.

Municipal Sewage Collection System:

The ICPCC had found that discharges from the Ipswich Wastewater Treatment Plant are a regular source of fecal coliform to Greenwood Creek and the Ipswich River during both dry and wet weather, even when the plant is operating normally. When such discharges are a result of a "wash-out" of the plant due to excessive inflow and infiltration of stormwater, the pollution may affect large areas of the Ipswich River, Lower Plum Island Sound, and Crane Beach (CPCC 1995). All effluent from the Plant discharges was via Greenwood Creek into the Ipswich River Estuary. The fecal laden discharges were primarily related to two operational shortcomings of the plant, (1) Inadequate disinfection of the effluent due to the lack of adequate disinfection facilities, resulting in regular fecal pollution; and (2) Inadequate sludge processing such that the plant is unable to process the solids generated in the treatment process. The stored backlog of solids consumes available storage capacity, resulting in a "wash out" in which sludge is discharged in Greenwood Creek. Rainfall exacerbates this problem by producing more flow into the Plant, straining inadequate facilities. Inflow and infiltration (leaks into the sewage collection system) also aggravate this problem by directing still more flows into the Plant, further exceeding its capacity. The Plant then released inadequately treated sewage or "washes it out" into Greenwood Creek.

The Town of Ipswich has since addressed each of these problems. The WWTP is now equipped with a newly installed ultraviolet disinfectant system in order to try to meet state water quality criteria standards downstream of its effluent. To increase sludge handling capacity, thereby reducing the potential for wash outs, the town also installed a new belt filter press. Based on these upgrades, the Plant should satisfy current effluent standards and avoid future incidence of washouts.

In addition to causing problems at the plant, excessive inflow and infiltration leads to direct overflows of raw sewage from the collection system to the Ipswich River. These overflows, which typically occur about six to eight times per year, result when the flow in the system exceeds the capacity of the forcemain system. The forcemain system pumps the sewage from the downtown collector at Town Wharf to the plant for treatment. The town has recently approved funding to replace the forcemain, which is purported to eliminate the occurrence of overflows into the river. While the plant is theoretically designed to handle this excess flow, the ability of the plant to process the additional inflows is yet undemonstrated, especially considering the sensitive nature of the new ultraviolet system.

SPECIFIC STORM DRAIN FINDINGS:

There are 114 drains impacting the coastal area, and there are some that are harming the environment more than others. The Coastal Pollution Control Committee had collected 779 samples from 151 locations across town. (Wet weather sampling results can be viewed in Appendix A.) The data indicated overwhelming impacts of stormwater pollution throughout the town. The majority of contaminants were detected in the downtown area, a section of town that is heavily developed.
The table below outlines a comparison of selected storm drain sampling results in the sewered neck area versus the downtown area, following rain events (see Appendix L for total data). We have determined that during wet weather, rain introduces extensive amounts of contaminants in stormwater from developed areas that otherwise would not impact coastal areas.

STORM DRAIN SAMPLE RESULTS ANALYSIS - WET WEATHER

Unsewered Neck Locations vs. Sewered Downtown Locations Feeding Ipswich River:

SAMPLE STATION NO.	LOCATION & STORM DRAIN NO. (SD #)	SAMPLE DATE	RAIN	BACTERIAL CONCENTRA-TION: "F" FECALS/100 ML	FLOW GPM "Q"	BACTERIAL LOADING: F x Q x 54800 FECALS/DAY
NECK LOCATIONS, UNSEWERED:						
51	Northridge Road, Pole #26 SD # 18	08-14-92	.3" Cum.	>24,000	10(2)	$131x10^8$
52	Northridge Road at Goldfinch SD # 20	06-11-92	.25" 06-08	3,100	5	$8.5x10^8$
54	Little Neck Road across from Pavilion - West. SD #7	07-16-92	.75" 24	950	13	$6.8x10^8$
55	Little Neck Rd. across from Pavilion - East SD # 8	07-16-93	.75" 24	350	1	$0.2x10^8$
60	Little Neck Rd. at Sutland Way SD #6	08-18-92	2" Cum. .8" 08-	2,900	8	$12.7x10^8$
62	Northridge Rd. at base of hill SD # 23	08-18-92	2" Cum. .8" 08-	>10,000	40	$219x10^8$
Notes: (1) Maximum loadings recorded after a rain event, not necessarily the maximum that could have occurred (2) Flow is estimated value typical of this storm drain.					Average	$63.03x10^8$
DOWNTOWN LOCATIONS, SEWERED:						
27	County Road by bridge S.D.# 60	07-28-93	.45" Cum.	14,000	40	$306x10^8$
58	Storm drain/ditch West side I.O.C. Lot SD #56	08-18-92	2" Cum. .8" 08-	6,000	20	$66x10^8$
80	Off Market Street behind Chipper's SD #107	08-14-92	.3" Cum. .8" 08-	9,200	20(2)	$100x10^8$
94	Main Street SD# 109	07-27-93	.4" Cum.	28,000	20	$306x10^8$
106	Off Green Street under Riverwalk SD # 111	07-27-93	.4" Cum.	92,000	25	$1260x10^8$
107	Town Wharf parking lot SD # 59	07-27-93	.4" Cum.	54,000	40	$1184x10^8$
Notes (continued) (3) Maximum loadings are often of short duration and cannot be compared with continuous loadings.						$537x10^8$

The following table portrays the differences (at representative sampling stations), between wet weather, and dry weather contamination in selected streams impacting the coastal area. On average, wet weather sample station results were higher than dry weather results in the coastal areas of Ipswich, indicating that urban runoff largely contributes to stormwater contamination.

Results by Waterway, Sampled Immediately Following Rain Event Vs. Dry Weather:

Location	No. Samples Taken	Sample Date(s)	Average Fecal Count During Rain Event (or 1 day after)	Average Fecal Count During Dry Weather
Saltonstall Brook @ County Road	15	5/5/92-10/28/93	3600	356.75
Ipswich River @ Green Street	12	10/30/92-11/18/93	1016.14	150.80
Farley Brook @ car buffs & Ipswich River	21	5/4/92-12/22/93	8050	1731
Kimball Brook @ Kimball Street	15	5/21/92-9/16/93	5903	854.40
Kimball Brook @ Haywood Street	2	11/3/92 (wet) 6/6/93 (dry)	16000	1587
Muddy Run @ School Street	5	10/27/92-10/28/93	2400	915
Ipswich River @ County Road	18	6/1/92-11/18/93	1267	176.14
Creek under Little Neck Road @ Mullholland Drive	10	5/7/92-12/1/93	1785.4	284.8
Miles River @ County Road	15	6/2/92-10/28/93	2115.4	196.2
Ipswich River @ Town Wharf	20	6/2/92-11/18/93	1935.58	396.62
Ipswich River @ Little Neck Dock	7	7/16/92-11/3/93	360	247.6

RECOMMENDATIONS

Because the nature of the stormwater problem is so widespread and complicated, we recognize that it is both financially and logistically impossible to control stormwater from every source. Therefore we are recommending a multifaceted approach that concentrates on reducing the impact of current sources and prevent the situation from becoming worse over time as the town inevitably continues to develop. Our recommendations fall into two categories:

1. Preventative measures.
2. Installation of site-specific best management practices on the most problematic storm drains.

Some of these recommendations are new to the town but a majority was recommended in the CPCC's 1995 Final Report, and in some instances has already been completely, or partially implemented. However, to ensure that the approved recommendations have been adequately implemented, we recommend that they be followed-up as part of this plan. Beyond that, we recommend that a mechanism is established in town to periodically follow up on these, and the new recommendations made in this report to ensure continued pollution control over time.

There are three recommendations that the National Resource Council made in their 1999 Stormwater Strategies report that we find, as a whole, integrate with our recommendations:

- Preventing pollution is highly effective and saves money.
- Preserving and utilizing natural features and processes have many benefits.
- Routine monitoring and constant enforcement establish accountability.

Preventative Measures:

Pollution prevention is more desired because it prevents pollution from ever impacting natural resources. Prevention can be very effective, and it is much less costly than pollution abatement. Stormwater pollution prevention measures are the key component of a successful pollution remediation plan. Therefore, prevention measures as summarized in the following table are our most important and highest priority recommendations.

Each of the preventative recommendations is outlined in the table on page 26. In the table, "Timeline" refers to the proposed amount of time we expect each recommendation or measure to take to implement. The "Cost" column reflects the cost incurred by the town to complete the recommendation. The "Approved by" column lists the party that is responsible for approval of the recommendation (an asterisk denotes if the recommendation has already been approved by the approving body). The "Responsible Party" indicates who is to oversee the task. The last column indicates whether or not the recommendation has been completed as of January 2000.

Preventative Measures	Timeline	Cost	Approval Required By	Responsible Party	Complete ?
The Conservation Agent should accompany the animal Control Officer during the existing farm animal survey to coastal farms identified in Appendix M to educate landowners and seek pollution remediation. Educational pamphlet should be distributed at this time.	Each Fall + winter	$0	Board of Selectmen*/ Conservation Commission*	Conservation Agent & Animal Control Officer	No
Implement public & school based educational pollution program on coastal pollution.	Ongoing	$0	Board of Selectmen*/ School Committee	Superintendent of Schools & Principals	No
Post and maintain signs advising against waterfowl feeding at popular feeding locations.	Done	$0	Board of Selectmen*	Animal Control Officer	Yes (follow –up needed)
The Conservation Commission should seek solutions to specific sources of pollution identified on farms in Appendix M.	2000	$0	Board of Selectmen*/ Conservation Commission	Conservation Agent & Commission:	No
Complete map of municipal street drain system for future reference.	2000	$0 (funds approved)	Board of Selectmen	Department of Public Works/Utilities Dept.	No
Expand existing no disturb/no build zones in wetlands buffer zones along ACEC and coastal tributaries.	2000	$0	Board of Selectmen*/ Conservation Commission	Conservation Commission	No
The Conservation should require an increased no disturbance zone, and seek to improve existing site conditions in exchange for granting permits for new projects on existing lots	2000	$0	Conservation Commission	Conservation Commission	No
Require catch basin cleaning contractor to report illegal connections and suspected pollution in catch basins on written form.	2000	$0	Board of Selectmen*	Dept. of Public Works:	No
Implement regulations prohibiting wild waterfowl feeding.	2000	$0	Board of Selectmen or Board of Health	Board of Health Animal Control	No
Adopt manure storage regulations to prevent the storage of manure in the wetlands buffer.	2000	$0	Conservation Commission* Board of Health	Conservation Commission and Board of Health	Partial (Concom only)
Adopt regulations to manage dog and horse waste on beaches.	2000	$0	Board of Selectmen* & Trustees*	Animal Control Officer, Trustees	Yes
Install wire &/or chink stones to inhibit pigeon nesting colonies over 3 specified water areas.	2000	$500	Board of Selectmen*	Dept. of Public Works	No
Conduct periodic waterfowl surveys to evaluate success of regulation and public education against wild waterfowl feeding.	Ongoing	$0	Board of Selectmen*	Animal Control Officer and/or Shellfish Constable	Partial (1999 survey complete)

* = Recommendation has already been approved by the approving body. Table Continued on page 27.

Preventative Measures (Continued)	**Timeline**	**Cost**	**Approval Required By**	**Responsible Party**	**Complete ?**
Improve the publication and enforcement of the leash law.	Ongoing	$0	Board of Selectmen*	Animal Control Officer	Partial
Develop ongoing fecal coliform monitoring program in major coastal streams & storm drains.	Ongoing	$1,000	Board of Selectmen	Shellfish Const., Utilities	No
Adopt a regulation requiring dog owners to clean-up after their dogs (pooper-scooper law)	Done	$0	Town Meeting*	Animal Control Officer	Yes
Install and maintain signs at popular dog walking areas informing public of pooper-scooper law	Ongoing	$0	Board of Selectmen	Animal Control Officer or DPW	Partial
Prohibit the discharge of pollutant-laden stormwater in all development currently exempt from review.	2000	$0	Planning Board, Building Inspector	Planning Board and Building Inspector	No
Establish mechanism to periodically evaluate the status of approved and new recommendations to ensure ongoing implementation	Ongoing	$0	Board of Selectmen	Planning Dept.	N
Establish mechanism to oversee, install and manage the specific BMP's recommended in this report	Ongoing	$0	Board of Selectmen	DPW	No
Require that any new connections to municipal stormwater system be required to meet state stormwater standards for the receiving waters	2000	$0	Planning Board Conservation Commission DPW	Planning Board Conservation Commission DPW	No
Establish a formal application and review process for requests to make private connections to the storm drain system that explores/exhausts other possibilities.	2000	$0	Board of Selectmen	DPW	Partial
Expand the jurisdictional review area of the Conservation Commission to cover projects that connect to or impact the existing street drain system.	2000	$0	Conservation Commission	Conservation Commission:	No
Adopt a Septic System Management Program in the coastal non-sewered areas of Ipswich.	2000	$75-150 annual homeowner fee	Town Meeting, Board of Selectmen	Board of Health. Utilities Dept.	No
Order the repair of failed septic systems identified in Appendix K	2000	$0	Board of Selectmen* and Town Manager*	Health Agent	No
Replace the sewage system forcemain	2000	$0 (already approved)	Board of Selectmen*	Utilities Dept.	No (construction expected 2000)
Develop/Implement comprehensive inflow & infiltration remediation/prevention program in sewage collection system.	2000	? (>$20k per yr.)	Board of Selectmen	Utilities Department	No

* = Recommendation has already been approved by the approving body. Table Continued on page 28.

Preventative Measures (Continued)	**Timeline**	**Cost**	**Approval Required By**	**Responsible Party**	**Complete ?**
Prohibit the expansion of the sewage collection system to service new development until: 1) the forcemain is replaced, 2) it is demonstrated that the plant performance is not upset by the additional flows once the forcemain is replaced, 3) a comprehensive Inflow and infiltration program is in place	2000	$0	Board of Selectmen	Utilities Dept.	No
Inventory and establish a database for all habitable camps on the marsh and Treadwell's Island. Contact owners and inform them of the need to go through the proper permitting process before working on their properties.	2000	$0-30	Board of Selectmen	Health Agent and/or Shellfish Constable	Partial
The town should stencil educational pollution messages next to each catch basin in the coastal area	2000	$0 (supplies in hand)	Board of Selectmen	DPW	No

Installation of Site Specific Best Management Practices on the Most Problematic Storm Drains:

All of the town's storm drains (listed in Appendix H) have been investigated by engineers, DPW staff and experienced CPCC members and environmental consultants over the past ten years to get a feel for the status of each drain. The same group of individuals reviewed plans of the latest technologies regarding best management practices (BMPs) for stormwater management, evaluated a wide range of BMPs, and then repaired some of the drains using these practices (repaired drains listed in Appendix G). From this standpoint, we were able to learn about current BMPs, and those used on prior drains in order to make recommendations for the remaining storm drains. We took into consideration that it is not economically feasible to repair all the storm drains, making it essential to prioritize. Therefore, the drains have been carefully analyzed and separated into three categories: lowest priority, low priority, and priority (see Appendices F, E, and D respectively), according to pollutant loading calculations and/or proximity to shellfish beds. The lowest priority drains (16 of 114 total) we found to have the least impact on the coastal areas of town, therefore we decided that these systems were not in need of repair. We have eliminated these drains from our list of systems we recommend be repaired. Low priority drains (52 of 114) we have found directly or indirectly impact the coastal area, however, the impacts are limited. Therefore, we recommend that they be repaired *after* priority drains. These drains are also omitted from our list of systems we recommend be repaired initially. Priority drains (42 of 114 total) are those that we find to have a high impact on the coastal area, and we recommend that they be repaired. Because of the sheer number of priority drains, we continued to breakdown this list into further prioritization: high, moderate and low priority according to pollutant loading calculations. Also, through our research and calculations, we have found that there are some priority drains that are impacting the coastal area more than others. We separated storm drains of the Farley Brook area into their own high priority group due to these drains' distinctive nature.

For each priority storm drain to be repaired, we have included cost estimates along with their recommended Best Management Practices. The estimates are based on the current costs of each type of BMP, and actual installation experience in Ipswich. We have provided estimates for repairs made by the local DPWs vs. private contractors. As noted, repairs made by private contractors employ higher costs than those made by the local DPW. Also, there are some projects that we find more suited for the DPW, in which there will not be an estimated cost for a contractor. It is important to note that the Ipswich DPW has a great deal of experience in installing stormwater BMPs and will likely play a major role in the future. The main reason that DPW costs are lower is that fixed costs such as labor and equipment are not included and typically only include the costs of materials. Obviously, the DPW, due to their other duties, has a limited capacity to take on additional projects. Therefore, the DPW's capability as a department will need to be enhanced if they are to play such a role in installing new BMPs. Please be sure to view the cost considerations/budget summary section following specific recommendations.

Priority Street Drains
The number of priority street drains is still quite vast. It would be very costly to try and repair every priority drain. Therefore we have broken-down the list of priority drains into three categories: high priority, moderate priority, and low priority. High priority drains are those in which we have determined an urgent need to repair. We will focus in on these first. Moderate priority drains are those that we feel should be repaired, after the high priority drains are under control. Lastly, low priority drains are those that are in less need of repair than the first 2 categories, therefore we will discuss these last. Please keep in mind, although the low priority drains in this section are of less need, we do feel that these drains indeed should be repaired when funds are available.

High priority Drains:

SD #

6. Little Neck Road across from Jutland Way: Replace existing last catch basin with new deep sump basin to trap sediment on this dirt road. Ideally, the road would be paved to eliminate a problem. Figure D6. Concom RDA required.
Estimated cost: DPW: $1,000, contractor: $3,000.

15. Foot of Bowdoin Road by fence: Cut off end of existing pipe and install a new pipe into wooded area adjacent to Clark Pond so water runs overland into pond. Figure D15. Recommend performed by DPW. Concom RDA required. *Private Road.*
Estimated cost: $<1,000. Potential problem: may be private road.

23. North Ridge Road across from pole #3: Construct detention basin or swale with forebay on edge of road immediately at discharge point. Figure D23. May need landowner permission on unbuildable lot.
Estimated cost: DPW: <$1,000, contractor: $3,000.

27. Agawam Avenue at no parking sign by Town Wharf: Install large unit under Agawam Avenue and connect to existing drainpipes. Concom RDA required. Figure D58.
Estimated cost: DPW: $27,000, contractor: $38,000.

47. Turkey Shore Road near pole #2: Install medium unit under roadway on edge of road in town right of way at the end of existing discharge pipe. Outlet water next to existing location through headwall. Concom RDA required. Figure D47.
Estimated cost: DPW: $16,000, contractor: $25,000.

57. Water Street across from Hovey Street: Install large unit on edge or roadway on inside corner of Hovey and Water Street and connect to existing drainpipes. Concom RDA required. Figure D57.
Estimated cost: DPW: $27,000, contractor: $38,000.

58. Foot of Water Street at Town Wharf by sewer overflow pipe: Install medium unit on edge of road in town right of way at end of end of existing discharge pipe. Connect drain # 59 to this system prior to treatment unit. Outlet water above existing location over bank. Concom RDA required. Figure D58.
Estimated cost: DPW: $18,000, contractor: $27,000.

107. Market Street behind Cooperative Bank: This drain should be connected to the Farley Brook system for treatment. See Farley Brook Plan for details; Figure F1.

108. Parking lot of Aspen leaf by Choate Bridge: Seek permission of landowner to install small unit just above existing discharge pipe. Catch basin across the street needs to be tied into basin on east side of street so new culvert across S. Main St. required. Figure D110. Concom RDA/NOI required.
Estimated cost: DPW: $15,000, contractor: $20,000.

109. South Main Street out of basin by pole #5: Install small unit on small town owned lot where existing drainpipe is located. Cut into existing pipe and install unit in-line using existing discharge pipe. Concom RDA required. Figure D110.
Estimated cost: DPW: $11,000, contractor: $18,000.

110. South Main Street out of manhole by Pole #7 in front of QLF: Install medium unit on edge of roadway under QLF driveway where existing drainpipe is located. Cut into existing pipe and install unit in-line using existing discharge pipe. Although in existing drainage easement, landowner permission required. Concom RDA required. Figure D110.
Estimated cost: DPW: $16,000, contractor: $25,000.

Farley Brook Plan (Also High Priority):

The watershed for Farley Brook is approximately 100 acres in size. Land use is medium-to-high-density residential and commercial, with gas stations, a state highway, parking lots and other impervious areas. Throughout most of the watershed, the brook is underground. Except near the Boston and Maine Railroad tracks, the only way water gets into the brook is through catch basins.

Farley Brook is a natural perennial stream that drains a majority of the downtown area north of the Ipswich River. As the area became urbanized, all of the individual stormwater drains were directed into the brook. The majority of the upper watershed has been filled over and is culverted. A small stretch of the brook in the mid-portion of the watershed is still open, but it has been heavily channeled for flood control purposes. The lower third of the brook is culverted through the downtown area until its discharge point in the Ipswich River above Choate Bridge. Farley Brook is by far the largest contributor of contaminated runoff to the coastal area of Ipswich.

A series of individual street drains discharge into the brook; the majority of these connections are underground: 76, 77, 78, 81, 82, 83, 83a. In addition to these, the Market Street drain system (two separate drains, missed during the initial survey, no SD#'s) discharges into the brook from each side and drains all of Market Street including the majority of Town Hill. The only exception is SD #107, which discharges directly to the river. This drain should be connected to the larger Market Street drain system and addressed as part of the overall Market Street treatment plan.

The plan involves three primary strategies: 1. The installation of two constructed wetlands/retention ponds in the middle watershed to treat the upper watershed above the main downtown culvert behind the Laundromat. 2. The installation of a series of large underground treatment units at the end of each street drain system prior to the discharge points into Farley Brook. 3. The installation of an oil boom and oil absorption system at the outlet of Farley Brook. Concom NOI required for all of this. Details:

1. Two constructed wetlands should be built adjacent to the brook. The purpose of the wetlands is to divert the brook and its associated stormwater into these wetlands areas for treatment purposes. Both areas are existing wetlands on private property so drainage easements would need to be purchased (cost likely to be reasonable since areas have no economic value and will also provide for beneficial flood control). The project would need

an extensive amount of design, engineering, and permitting work. Estimated costs: Engineering and permitting, $12,000, construction: $70,000. (Does not include costs of obtaining drainage easements from private landowners.)

2. Nine individual large package stormwater treatment systems would be installed within town roadways, parking lots, or easements in-line in the 9 existing street drain systems discharging into the brook in this section. Each would be located adjacent to the brook and discharge through existing storm drainpipes. In addition, the existing outlet of SD #107 would be blocked so all flow is directed to Farley Brook via the Market Street drain system. Estimated cost: DPW: $27,000, contractor, $38,000 each (multiply by 9).

3. A permanent oil boom will be installed attached to the headwall across the outlet of Farley Brook at its confluence with the Ipswich River, to trap floatables. One or two disposable oil absorbing pads will be floated just inside the boom to absorb hydrocarbons. The absorbent pads will be collected and replaced following each rain event in excess of one-quarter inch. Estimated cost: Boom $300, pads $30 each X 2 X 30 rain events per year. Pads will be managed by the DPW Dept. and disposed of properly.

Moderate Priority Drains:

<u>SD #</u>

4. Little Neck Road across from Plover Hill Road: Add riser to existing drain inlet at corner of roadway to create detention pond in existing swale. Connect all drainage to swale. Concom RDA required. See figure D4. Recommend performed by DPW only.
   Estimated cost: $1,000.

5. Little Neck Road - west side to Neck Creek: Install small unit on edge of road in town right of way at end of end of existing discharge pipe. Outlet water next to existing location over bank. Concom RDA required. Figure D6.
   Estimated cost: DPW: $11,000, contractor: $18,000.

18. North Ridge Road near pole #26: Install medium unit on edge of road in town right of way at end of end of existing discharge pipe. Outlet water next to existing location over bank. Concom RDA required. Figure D18.
   Estimated cost: DPW: $16,000, contractor: $25,000.

20. North Ridge Road across from Goldfinch Way: Install medium unit on edge of road in town right of way at end of existing discharge pipe. Outlet water next to existing location over bank. Concom RDA required. Figure D20.
   Estimated cost: DPW: $16,000, contractor: $25,000.

26. Foot of Seaview Road: Cut off existing discharge pipe about half way. Construct detention basin or swale with forebay between edge of road and salt marsh immediately at new discharge point. Concom RDA required. Figure D26. Recommend performed by DPW only.
   Estimated cost: DPW: <$1,000.

50. Riverside Drive out of basin at pole #8: Install medium unit on edge of road in town right of way at end of existing discharge pipe. Outlet water next to existing location over bank. Concom RDA required. Figure D50.
   Estimated cost: DPW: $16,000, contractor: $25,000.

54. Water Street across from Summer Street: Drain #54 should be intercepted at the intersection of Green/Water streets and a new pipe placed on the north side of Water Street to the last catch basin at the foot of Summer Street. Last catch basin on Summer Street should be replaced. New discharge pipe should be installed and medium unit placed on riverbank at edge of pavement. Discharge should be to existing location. Concom RDA or NOI required. Figure D54.
Estimated cost: DPW: $20,000, contractor: $29,000.

105. Union Street out of basin across from Vinwood Caterers: Install medium unit on edge of road in town right of way next to existing catch basin. Outlet water into existing discharge pipe. Figure D105.
Estimated cost: DPW: $16,000, contractor: $25,000.

111. Basin #1 drain on Little Neck:
112. Basin #2 drain on Little Neck:
113. Basin #3 drain on Little Neck:
These should be combined into one project and constructed together. Block existing outlets of all three catch basins. Construct new pipes so that each basin is part of single system draining down hill. At outlet of last basin, install new discharge pipe to newly constructed detention basin with sediment forebay in existing gravel parking area just outside entrance way to Little Neck. Construct new discharge pipe into existing discharge ditch from catch basin # 111. Private property. Concom NOI required. Plans may be required. Figure D111.
Estimated cost by contractor: $25,000.

Low Priority Drains:

We have determined the following low priority drains in need of repair, and have described best management practices that best remedy their polluted discharge.

<u>SD #</u>

3. Mullholland Drive near metal light pole by Little Neck Road: Cut off drain at top of hill at intersection with Pasture Way. Discharge into vegetated swale to be constructed in town right of way parallel to roadway on the upstream side of road. Construct small sump and discharge under road through existing catch basin. See figure D3. Concom RDA required.
Estimated costs: DPW in-house: $1,000, contractor: $4,000.

16. Foot of Nuthatch Road: Replace existing last catch basin. *Private Road*. Figure D16.
Estimated cost: DPW: $1,000, contractor: $3,000.

17. Foot of Kingfisher Road: Replace existing last catch basin. *Private Road*. Figure D17.
Estimated cost: DPW: $1,000, contractor: $3,000.

25. 132 Jeffrey's Neck Road-out of basin in cedar trees: Replace existing catch basin with new basin. Figure D23.
Estimated cost: DPW: $1,000, contractor: $3,000.

28. Damon Avenue out of basin in circle by house #20: Replace existing last catch basin with new basin. Figure D28.
Estimated cost: DPW: $1,000, contractor: $3,000.

53. Water Street at corner with Green Street: This drain should be connected to # 54 and treated there. See project description for drain 54. Figure D54.

59. Town Wharf out of basin at speed bump under landing to floats: Figure D58.

Although the following street drains directly impact the coast, we have determined that there is no immediate action necessary. In comparison to other drains, their flow is too small and their level of impact is too low to have repairs be cost effective.

<u>SD #</u>

1. Jeffrey's Neck Road near Island Park Road across from house #88
9. Little Neck Road on corner across from playground
19. North Ridge Road across from Herring Way
24. North Ridge Road out of basin at white house (Divine)
41. Argilla Road across from pole #5/154
48. Turkey Shore Road out of basin near Green Street bridge
49. Turkey Shore Road out of basin near pole #28
51. Tansey Lane across from pole #3
52. Green Street Bridge - 3 basins each going to river
55. Water Street near pole # 6
64. Fowlers Lane and Town Farm Road out by pond
114. Little Neck by dock near community center

For a full description of each Best Management Practice (BMP) that was recommended, please refer to Appendix I.

COST CONSIDERATIONS/ BUDGET SUMMARY

Cost of Drain Repairs by Priority: DPW Cost vs. Contractor Cost (Summary continued on page 35.)

STORM DRAIN #	LOCATION	DPW COST	CONTRACTOR COST
High Priority Drains			
6	Little Neck across from Jutland Way	$1,000	$3,000
23	N. Ridge Rd. across from Pole #3	$1,000	$3,000
15	Foot of Bowdoin Rd. by fence	$1,000	NA
27	Agawam Ave. @ No Parking sign	$27,000	$38,000
47	Turkey Shore Rd. near Pole #2	$16,000	$25,000
57	Water St. across from Hovey St.	$27,000	$38,000
58	Foot of Water St. @ Town Wharf	$18,000	$27,000
107	Market St. behind Co-Op Bank	$27,000	$38,000
108	Aspen Leaf parking lot by Choate Br.	$15,000	$20,000
109	S. Main St. by Pole #5	$11,000	$18,000
110	S. Main St. by Pole #7	$16,000	$25,000
	Total:	$160,000	$235,000
Farley Brook Drains (Also High Priority)			
76	Liberty St. out of basin by RR tracks	$27,000	$38,000
77	Behind Brooks off Liberty St.	$27,000	$38,000
78	Brown St. Behind Martells Garage	$27,000	$38,000
81	Mineral St. near house #12	$27,000	$38,000
82	Granite Ct. by underground to Farley	$27,000	$38,000
83	Town Parking by fish mkt.	$27,000	$38,000
83a	Unknown outlet by Tedfords	$27,000	$38,000
107	Market St. behind Co-Op Bank	$27,000	$38,000
	Overall Cost for Permanent Oil Boom (plus 2 pads replaced following 30 rain events/year):	$2,100	$2,100
	Overall Cost for Constructed Wetland:	$82,000	$82,000
	Total:	$300,100	$388,100
Moderate Priority Drains			
4	Little Neck Rd. across Plover Hill	$1,000	NA
5	Little Neck Rd. W. side to Neck Creek	$11,000	$18,000
18	N. Ridge Rd. near Pole #26	$16,000	$25,000
20	N. Ridge Rd. across Goldfinch Way	$16,000	$25,000
26	Foot of Seaview Rd.	$1,000	NA
50	Riverside Dr. out of basin @ Pole #8	$16,000	$25,000
54	Water St. across from Summer St.	$20,000	$29,000
105	Union across from Vinwood Caterers	$16,000	$25,000
111*	Basin #1 Drain on Little Neck	NA	$35,000
112*	Basin #2 Drain on Little Neck	* one-time cost for storm drains 111, 112 & 113	
113*	Basin #3 Drain on Little Neck		
	Total:	$97,000	$232,000

Cost of Drain Repairs continued:

STORM DRAIN #	LOCATION	DPW COST	CONTRACTOR COST
Low Priority Drains			
3	Mullholland Dr. by Little Neck Rd.	$1,000	$4,000
16	Water St. + Green St.	$20,000	$29,000
17	Town Wharf @ speed bump	$18,000	$27,000
25	Foot of Nuthatch Rd.	$1,000	$3,000
28	Foot of Kingfisher Rd.	$1,000	$3,000
53	132 Jeffery's Neck Rd.	$1,000	$3,000
59	Damon Ave. by house #20	$1,000	$3,000
	Total:	$44,000	$76,000
	Grand Total:	$601,100	$931,100

<u>Implementation:</u>

Because there are so many individual sources of stormwater pollution affecting the coastal area of Ipswich, and the installation of best management practices is often very costly, implementation of preventative measures should be the highest priority. Most of these measures require very little cost, (if any) to adopt, therefore the cost/benefit ratio is favorable. Implementation of site-specific recommendations is somewhat more problematic. We need to note that some of the recommended BMPs may not necessarily be the most ideal primarily due to site constraints (see Appendix I for planning considerations).

It is possible to prioritize each drain based on its overall contribution of pollution to the coastal area by reviewing pollution loading calculations and/or the proximity of the discharge point to sensitive coastal resources. However, we have determined that it would not be worthwhile at this point to prioritize the drains beyond the level we have done in this report due to our experience with storm drain remediation to date. The costs and degree of technical difficulty vary so greatly and the availability and sources of funding are unknown because each solution is so site specific. Therefore, we have determined that it is more advantageous to have a group of drains to choose from within prioritized groups. This is in order to maintain flexibility in the site selection process so that resources and other unique factors can be most efficiently matched to a given project.

In general, we recommend that the Department of Public Works commit to installing two stormwater best management practice projects per year based on the prioritized list. In order to accomplish this installation, an annual increase in the DPW budget of $20,000 should allow the construction of one low cost and one moderate cost BMP each year with existing staffing levels in the Department. Beyond that, we recommend that the DPW budget be increased by $10,000 to allow the town to have cash on hand to use as a match for various grant programs that are available for stormwater remediation. The state's Coastal Pollution Remediation Program administered by Coastal Zone Management (CZM) is an ideal source of funding for such projects. This would allow for the construction of 1-2 additional BMPs per year using private contractors. Finally, we recommend that the town pursue large grants to provide funds for the completion of a large-scale, area-wide remediation project such as Farley Brook. Because a project such as this can often be coupled with flood protection, public health and welfare goals, there are several possible funding sources for a "mega" project such as this one. Sources include the Massachusetts Department of Environmental Protection's (DEP) 319 grant program, state and federal transportation funds, state and federal disaster relief/prevention funds, and direct legislative appropriations. The Coastal Pollution Control Committee and several local groups and organizations are available to asset the town in administering this overall effort (Eight Towns and the Bay, CZM, DEP, Ipswich River Watershed Association, Ipswich River Basin Team, etc.). Under these scenario's, it is not unreasonable to expect that all 37 priority drains could be remediated within a 20-year time frame.

CONCLUSION: BENEFITS AND EXPECTATIONS

In order to justify the great deal of effort involved and expenditure of funds required to implement this plan, it is important to discuss anticipated benefits. Full implementation of the preventative measures should ensure that the pollution problem does not deteriorate significantly from the existing condition as time goes on. Implementation of all preventative measures requires a one-time cost between $2,600 and $4,600. For specific storm drain abatement (as noted in our cost summary table) we recommend a total budget of $538,640 for in-house costs, to $855,640 for hiring a private contractor, to use over several years (up to 20). To remediate existing specific sources of stormwater contamination using in-house capabilities, it would cost the town approximately $25,000 per year. The town's shellfish resource is worth an average in excess of $1million wholesale, and $6 million once processed to the local economy (Ipswich Shellfish Advisory Board, 1991). In addition, it is not unreasonable to state that the town's $100 million seafood processing industry is dependent on this local resource as well, since they are located here exclusively for the marketing value that the "Ipswich" name carries in the seafood industry. In excess of 400 Ipswich families are dependent on this industry in one-way or another (Ipswich Shellfish Advisory Board, unpublished data). It seems that weighed against this value alone the effort appears worthwhile.

However, it should be noted that the issue of stormwater and its impact to local shellfish resources is extremely complex. Although stormwater has a direct and demonstrable impact on the town's shellfish resources, it is difficult to accurately determine how stormwater remediation will directly impact shellfish harvesting. Certainly, it can be argued that doing nothing could result in the complete closure of the local shellfishing industry. Implementation of these recommendations will certainly prevent the situation from becoming worsened over time. In addition, it can be argued that the length and breadth of the current rain closure would be reduced to some degree, which would provide additional shellfishing opportunities and benefit the economy further. These factors alone seem to provide adequate justification for remediation. Beyond that, it is difficult to quantify the positive impact to the shellfishing industry, since there are so many watershed-wide sources of stormwater contamination outside of the sources we have identified.

It is also difficult to quantify the impacts of stormwater pollution on water quality and other coastal resources beyond impacts to shellfish. Although it is clear that all of these other pollutants (metals, nitrates, pesticides, herbicides, and petroleum products) have a significant impact; they cannot necessarily be easily quantified. It is safe to conclude that, due to the sheer volume of stormwater sources and the various land uses it emanates from, the negative impacts are substantial. It should also be noted that the majority of BMPs recommended here, despite their limited (10-40%) ability to remove bacteria and nutrients, are quite effective at removing sediments, metals, and hydrocarbons, which should not be discounted. This is important, especially in the highly urbanized downtown area, where most of the recommended site-specific solutions are located. With regard to sedimentation, it has been determined that a majority of the sediment currently responsible for the shoaling problem in the Ipswich River is from upland sources, much of which can be related to construction projects and winter applications of road sand (Shellfish Advisory Board, unpublished data). The implementation of the preventative measures and installation of BMPs as recommended will greatly reduce the sedimentation problems in the Ipswich River. Regardless of these easily quantifiable benefits, the intrinsic value of clean water and healthy coastal resources should also be considered added benefits.

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APPENDIX A

IPSWICH COASTAL POLLUTION COMMITTEE WET WEATHER SAMPLING RESULTS BY STATION, 1992-94

Results by Waterway, Sampled Immediately Following Rain Event.
Expressed: fecal count(date)days since last rain: 1=day after rain event, 0=rained day of sampling.

Site # Site Name

1. **Agawam Avenue Storm Drain**
   >10,000 (08/18/92) 0+1
   35000 (07/27/93) 0

2. **Farley Brook at Car Buffs on Central Street**
   16000 (08/05/93) 0
   1700 (10/30/92) 0
   1300(06/01/92) 0
   >24000 (09/16/93) 0
   70 (06/02/92) 1
   2200 (09/27/93) 1
   380 (06/09/92) 1+3
   9200 (07/20/93) 0
   4300 (12/22/93) 1
   >24000 (08/14/92) 0
   5400 (07/21/93) 1

3. **Ipswich River at Mill Road**
   140 (06/02/92) 1
   21 (08/14/92) 0
   490 (08/05/93) 0
   110 (08/17/92) 0+1+3
   87 (09/16/93) 0
   169 (07/20/93) 0
   57 (10/30/92) 0
   133 (07/21/93) 1
   223 (11/18/93) 0
   17 (11/03/92) 0

4. **Summer Street Storm Drain**
   13000(07/27/93) 0
   2500 (08/18/92) 0+1
   5400(08/14/92) 0

5. **Ditch/Storm Drain on Eastside of Ipswich Outboard Club Parking Lot**
   10000 (08/18/92) 0+1

6. **Hovey Street Storm Drain**
   330 (11/03/92) 0
   9200 (08/14/92) 0
   8500 (08/18/92) 0+1

7. **Saltonstall Brook at County Road**
   790 (10/13/93) 1
   220 (05/21/92) 0
   6200 (06/01/92) 0
   790 (08/14/92) 0
   2850 (08/18/92) 0+1
   1700 (07/20/93) 0
   330 (10/27/93) 0
   3500 (07/21/93) 1
   <20 (10/28/93) 1
   16,000 (11/03/92) 0

8. **Creek under Little Neck Road at Mullholland Drive**
   360 (05/21/92) 0
   5400 (11/18/93) 0
   1587 (08/14/92) 0
   790 (08/17/92) 0+1+3

9. **Ditch receiving both storm drains across from Pavillion**
   >24000 (08/14/92) 0
   2200 (11/18/93) 0
   6500 (08/18/92) 0+1

10. **Storm drain at Town Wharf next to sewer system overflow**
    1200 (08/18/92) 0+1

11. **36" RCMP culvert under Little Neck Road into Neck Cove**
    60 (07/16/92) 0

12. **Breakout site #7A great Neck shoreline survey**
<10 (05/09/92) 1

13. **Breakout #2 site 7A Great Neck Shoreline survey**
<10 (05/09/92) 1

14. **Breakout site 8A Great Neck Shoreline Survey**
<10 (05/09/92) 1

15. **Culvert from ditch under County Road by New Church near Lakemens Lane**
3200 (06/09/92) 1+3

16. **Farley Brook at Mineral Street**
>24000 (08/14/92) 0
3700 (12/22/93) 1

17. **Tributary to Muddy Run on Mitchell Road below Duck Pond**
90 (10/27/93) 0
1700 (10/13/93) 1

21. **Creek under Jeffreys Neck Road at Notre Dame**
1587 (11/03/92) 0
1390 (08/18/92) 0+1
3500 (11/18/93) 0

22. **Seaview Road storm drain**
54,000 (11/03/92) 0

24. **Plover Hill Road storm drain**
130 (11/18/93) 0
35000 (07/27/93) 0

27. **Storm drain on County Road by bridge at Ipswich River**
14000 (07/27/93) 0

28. **Groundwater outbreak under storm drain corner of Turkey Shore and Green Street**
<10 (05/19/92) 0

29. **Groundwater outbreak in wall at Cove Park**
<10 (05/19/92) 0

30. **Goulds Creek at Argilla Road**
245 (05/19/92) 0
2700 (06/01/92) 0
1700 (08/05/93) 0
2500 (06/02/92) 1
790 (09/16/93) 0
490 (07/16/92) 0
170 (08/17/92) 0+1+3

31. **Ditch/culvert under Argilla Road by Orchard**
4000 (05/19/92) 0
980 (06/09/92) 1+3
7300 (06/01/92) 0

32. **Kimball Brook at Kimball Street**
280 (05/21/92) 0
1300 (07/21/93) 1
12000 (06/01/92) 0
>2400 (10/30/92) 0
>2400 (11/03/92) 0
850 (06/09/92) 1+3
16000 (08/05/93) 0
5400 (08/14/92) 0
2400 (09/16/93) 0
16000 (07/20/93) 0

33. **Ipswich River at County Road**
2400 (06/01/92) 0
3500 (08/05/93) 0
980 (06/02/92) 1
170 (06/09/92) 1+3
3500 (09/16/93) 0
130 (07/16/92) 0
900 (07/20/93) 0
790 (11/18/93) 0
133 (10/30/92) 0
243 (07/21/93) 1
2400 (11/18/93) 0
940 (11/03/92) 0

34. **Road runoff on Ipswich Outboard Club Ramp**
3500 (06/01/92) 0
1300 (08/14/92) 0
500 (07/27/93) 0

35. **Road runoff on Town Wharf Ramp-Eastside**
400 (06/01/92) 0
4900 (07/27/93) 0

36. Road runoff on Town Wharf Ramp-Westside
500 (06/01/92) 0
1300 (08/14/92) 0

37. Miles River at County Road
3500 (06/02/92) 1
330 (08/17/92) 0+1+3
20 (10/27/93) 0
5400(08/05/93) 0
130 (10/28/93) 1
9075 (09/16/93) 0
900 (07/20/93) 0
1300 (10/13/93) 1
169 (07/21/93) 1

38. Ipswich River at Sylvania Dam
860 (06/02/92) 1
790 (08/05/93) 0
130 (07/16/92) 0
243 (08/14/92) 0
4 (09/16/93) 0
490 (08/17/92) 0+1+3
243 (09/27/93) 1
28 (07/20/93) 0
44 (07/21/93) 1
17 (10/30/92) 0
900 (11/18/93) 0
57 (11/03/92) 0

39. Goulds Creek at Labor In Vain Road
2000 (06/02/92) 1
130 (07/16/92) 0
2400 (08/05/93) 0
110 (08/14/92) 0
790 (08/17/92) 0+1+3

40. Ipswich River at Town Wharf
1600 (06/02/92) 1
347 (10/30/92) 0
490 (07/21/93) 1
230 (11/03/92) 0
460 (07/16/92) 0
900 (08/14/92) 0
9200 (08/05/93) 0
1100 (08/17/92) 0+1+3
1300 (09/16/93) 0
5400 (07/20/93) 0
1100 (11/18/93) 0

41. Muddy Run at Clamshell Road
1700 (09/27/93) 1
20 (10/27/93) 0
20 (10/28/93) 1

42. Muddy Run at 133
<20 (10/28/93) 1
700 (11/03/92) 0
230 (10/27/93) 0
5400 (09/27/93) 1

43. Egypt River at 133
14 (11/03/92) 0

44. Rowley River at Rowley Town Landing
16000 (08/17/92) 0+1+3

46. Farley Brook at Railroad Tracks behind Martel's
7600 (12/22/93) 1
>24000 (08/14/92) 0

47. Farley Brook behind Brooks off Liberty Street
1300 (08/14/92) 0
40 (12/22/93) 1

48. Kimball Brook at Topsfield Road
200 (06/09/92) 1+3
>24000 (11/03/92) 0

51. Storm Drain at Pole #26 on Northridge Road
2000 (07/16/92) 0
>24000 (08/14/92) 0

52. Storm Drain on Northridge Road across from Goldfinch Road
2100 (07/16/92) 0
2400 (08/14/92) 0

53. Stream draining Notre Dame Ponds under Sewage Plant Outfall Access Road
820 (07/16/92) 0
16000 (11/18/93) 0
2950 (08/14/92) 0

54. Storm Drain on Little Neck Road across from Pavillion-West
950 (07/16/92) 0

55. Storm Drain on Little Neck Road across from Pavillion-East
350 (07/16/92) 0

56. Storm Drain foot of Masconomet Road
5700 (08/18/92) 0+1
5400 (11/03/92) 0

57. Storm Drain foot of Upper River Road
7100 (08/18/92) 0+1
2800 (11/03/92) 0

58. Ditch/Storm Drain Westside of Ipswich Outboard Club Lot
6000 (08/18/92) 0+1

59. Road runoff from Water Street across from Westside of Outboard Club Lot
475 (08/18/92) 0+1

60. Storm Drain on Little Neck Road across from Jutland Way
2900 (08/18/92) 0+1

61. Outlet of Clark Pond
460 (08/14/92) 0
>10000 (08/18/92) 0+1
>24000 (11/18/93) 0

62. Storm Drain at base of hill on Northridge Road
>10,000 (08/18/92) 0+1

63. Eagle Hill River at landing
50 (07/16/92) 0
17 (08/17/92) 0+1+3
21 (08/19/92) 1+2

64. Mouth of Paine Creek
<20 (07/16/92) 0
243 (08/17/92) 0+1+3
133 (08/19/92) 1+2

65. Mouth of Greenspoint Creek
230 (07/16/92) 0
61 (08/19/92) 1+2
223 (08/19/92) 1+2
532 (08/17/92) 0+1+3

66. Mouth of creek north of Greenspoint Creek
20 (07/16/92) 0
347 (08/17/92) 0+1+3
61 (08/19/92) 1+2

67. Mouth of Notre Dame Creek
80 (07/16/92) 0
243 (08/17/92) 0+1+3
133 (08/19/92) 1+2

68. Castle Neck River at Choate Street - North Branch
490 (07/16/92) 0
170 (08/17/92) 0+1+3

69. Castle Neck River at Choate Street - South Branch
70 (07/16/92) 0
3500 (08/17/92) 0+1+3

70. Culvert under causeway behind Lewis' Restaurant
1300 (07/16/92) 0
1400 (08/17/92) 0+1+3

71. Castle Neck River at Old Essex Road
170 (07/16/92) 0
1400 (09/16/93) 0
1700 (08/17/92) 0+1+3
5400 (08/05/93) 0

72. Castle Neck River at Goodales Property
20 (07/16/92) 0

73. Creek draining marsh from Goodales Orchard
700 (07/16/92) 0
3500 (08/17/92) 0+1+3

74. Castle Neck River at Shurcliffs Dock
130 (07/16/92) 0
110 (08/17/92) 0+1+3

75. Ipswich River at Little Neck Dock
700 (07/16/92) 0
330 (08/17/92) 0+1+3
80 (07/27/93) 0

76. Creek draining Neck Cove
790 (07/16/92) 0

9200 (08/14/92) 0
279 (08/14/92) 0

77. Greenwoods Creek, 100 downstream from Sewage Plant Outfall
1300 (07/16/92) 0
490 (10/30/92) 0
16000 (11/13/92) 0

78. Mouth of Neck Creek
133 (08/14/92) 0
110(07/27/93) 0

79. Farley Brook at Ipswich River
16000 (08/14/92) 0
330 (07/21/93) 1
3500 (09/16/93) 0
490 (09/27/93) 1
3500 (08/05/93) 0
16000 (07/20/93) 0

80. Storm drain behind Chippers off Market Street
9200 (08/14/92) 0

81. Creek draining marsh off Ocean Avenue and Jeffrey's Neck Road
133 (08/17/92) 0+1+3
133 (08/18/92) 1+2

83. Rowley River at last house on Railroad Ave
230 (08/17/92) 0+1+3

84. Marsh drainage adjacent to east side of 133 into Castle Neck River at town line
330 (08/17/92) 0+1+3

85. Greenwood's Creek upstream from Sewage Plant Outfall
1700 (10/30/92) 0
16000 (11/13/92) 0

86. Sewage Plant Outfall
3500 (11/13/92) 0
>24000 (11/24/92) 1
330 (10/30/92) 0

87. Muddy Run at School Street
1300 (09/27/93) 1
2400 (10/27/93) 0
3500 (10/28/93) 1

89. Kimball Brook at Heard Street
5400 (09/16/93) 0
>24000 (11/03/92) 0

91. Ipswich River at Railroad Tracks
12 (10/30/92) 0
5400 (08/05/93) 0
4 (11/03/92) 0
347 (09/16/93) 0
133 (07/21/93) 1
1587 (11/18/93) 0

92. Ipswich River at Green Street
243 (10/30/92) 0
1300 (08/05/93) 0
260 (11/03/92) 0
3500 (07/20/93) 0
1300 (09/16/93) 0
220 (07/21/93) 1
490(11/18/93) 0

93. Kimball Brook at Haywood Street
16000 (11/03/92) 0

94. Storm Drain behind Cape Ann Sign on South Main Street
790 (11/03/92) 0
28000 (07/27/93) 0

95. Saltonstall Brook at Public Works Drive
>24000 (08/14/92) 0
490 (10/13/93) 1
460 (11/03/92) 0
<20 (10/28/93) 1

96. Road runoff from Little Neck at entrance to Little Neck
>24000 (08/14/92) 0

99. Ipswich River at Ipswich Outboard Club
133 (10/30/92) 0
1700 (07/20/93) 0
9200 (09/16/93) 0
1300 (08/05/93) 0
330 (11/18/93) 0

105. Miles River at Don Bosco Driveway
20 (10/27/93) 0
20 (10/28/93) 1
490 (10/13/93) 1
2400 (11/18/93) 0

106. SD# 111 off Green Street under Riverwalk
92000 (07/27/93) 0

107. SD#59 draining Town Wharf Parking Lot
54000 (07/27/93) 0

108. Road runoff on Kings Road at Bay Road Little Neck
92000 (07/27/93) 0

109. Road runoff on Plum Island Road at Bay Road Little Neck
>240000 (07/27/93) 0

111. Stream at Sewage Treatment Plant - below plant
7900 (07/27/93) 0
220 (11/18/93) 0
330(10/13/93) 1
<20(10/28/93) 1

112. SD#64 Town Farm Road
92000(07/27/93) 0
1500(10/27/93) 0
9200(11/18/93) 0
3500 (10/13/93) 1
490 (10/28/93) 1
2000 (10/27/93) 0

113. Mouth of Greenwoods Creek
700 (07/27/93) 0

114. Mouth of Spew Island Creek at Treadwells Island
20 (07/27/93) 0

115. Ipswich River at Robinsons Creek
90 (07/27/93) 0

116. Mouth of Goulds Creek
170 (07/27/93) 0

117. Ipswich River at Nabbys Point
2050 (07/27/93) 0

118. Ipswich River under Sylvania Parking Lot
9200 (08/05/93) 0
61 (09/27/93) 1
532 (09/16/93) 0

121. Seep on riverbank behind Woolworths
130 (09/27/93) 1

122. Muddy Run at Kimball Avenue
>24000 (09/27/93) 1
9200 (10/27/93) 0

123. Muddy Run outlet into salt marsh behind gravel pit
4500 ((09/27/93) 1
700 (10/27/93) 0

127. Stream at Sewer Treatment Plant - above plant
490 (10/13/93) 1

128. Muddy Run at Linebrook Road
>24000 (10/28/93) 1

130. Stream off Town Farm Road Tributary #1
80 (10/27/93) 0
700 (11/18/93) 0
130 (10/28/93) 1

131. Stream off Town Farm Road. Tributary #2
16100 (10/27/93) 1
330 (11/18/93) 0
1700 (10/28/93) 1

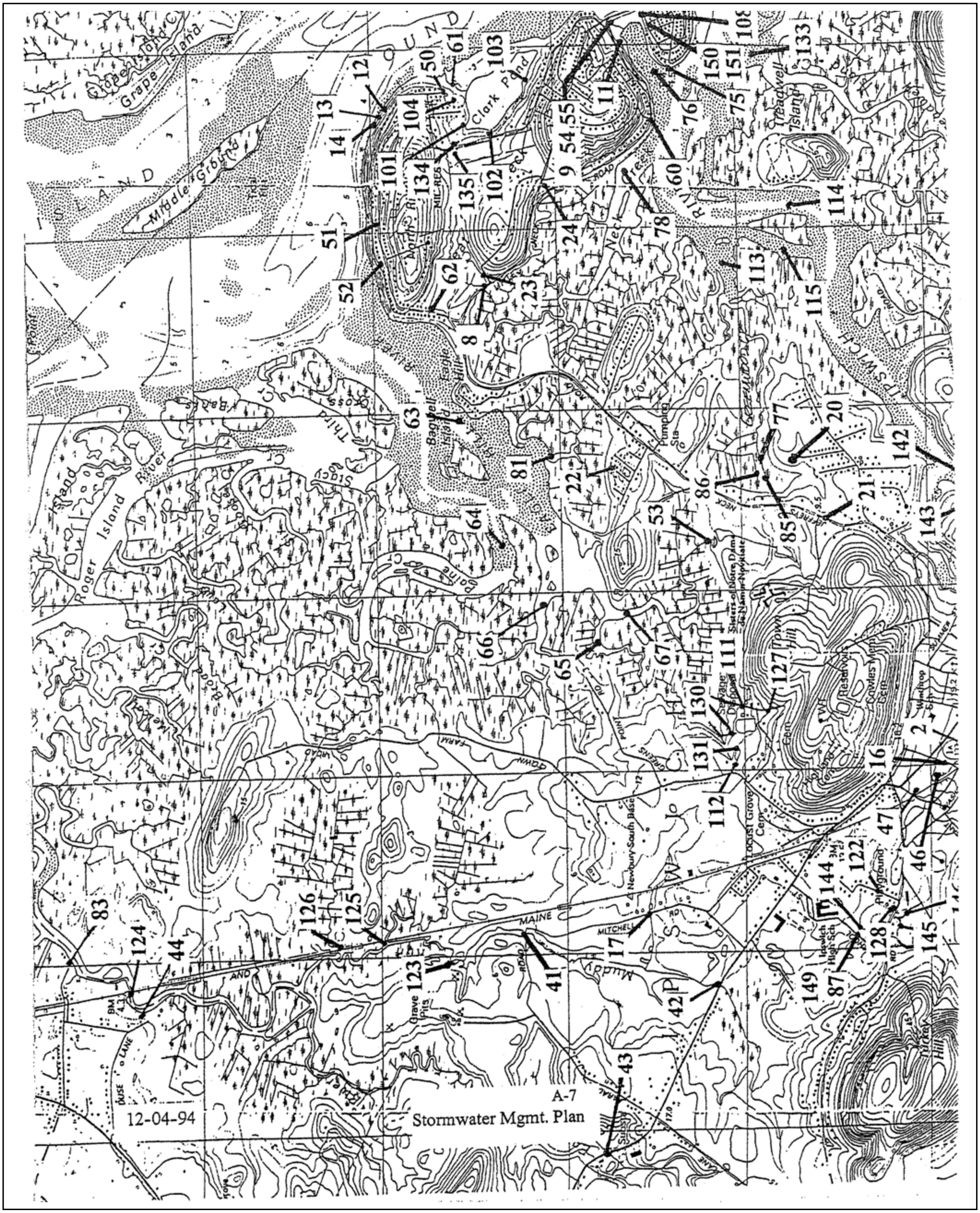
132. Road runoff off driveway to Public Works Garage
2400 (10/27/93) 0

134. Outlet of culvert under Clark Road at corner receiving SD#13
9200 (11/18/93) 0

142. Creek under Labor In Vain Road South Branch
970 (12/22/93) 1

143. Creek under Labor In Vain Road North Branch
239 (12/22/93) 1

WET WEATHER SAMPLING LOCATIONS:



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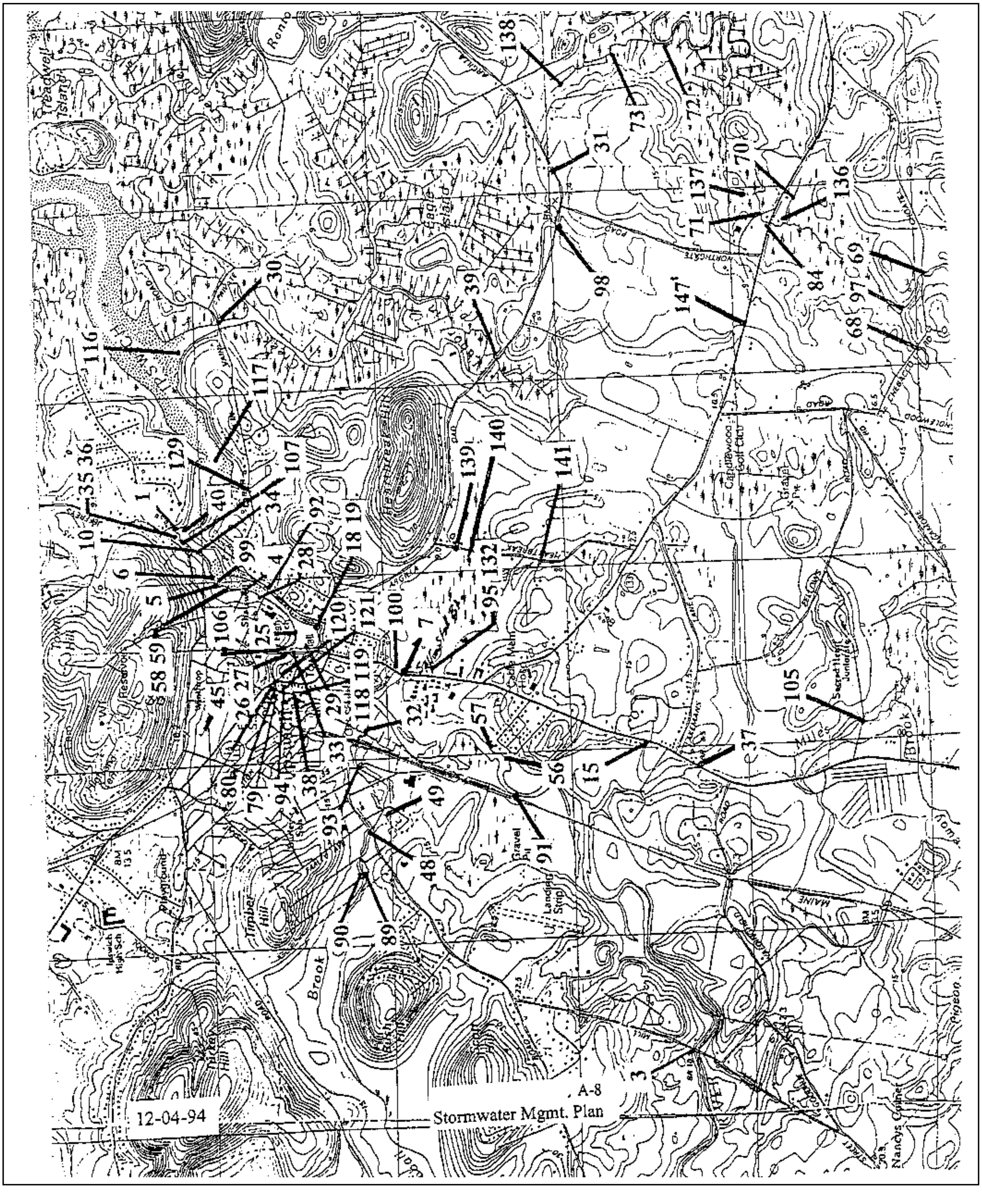

APPENDIX B

TOTAL LIST OF IDENTIFIED STREET DRAIN OUTLETS AND THEIR WATERSHEDS:

Notes: SD = Storm Drains

IPSWICH RIVER WATERSHED:

SD #	Location
1.	Jeffreys Neck Road near Island Park Road across from house #88
2.	Hodges Way near junction of Island Park Road-culvert under road
3.	Mullholland Drive near metal light pole by Little Neck Road
4.	Little Neck Road across from Plover Hill Road
5.	Little Neck Road - west side to Neck Creek
6.	Little Neck Road across from Jutland Way
7.	Little Neck Road near pole #76
8.	Little Neck Road near pole #78
9.	Little Neck Road on corner across from playground
27.	Agawam Avenue at no parking sign by Town Wharf
28.	Damon Avenue out of basin in circle by house #20
29.	Arrowhead Trail by pole #9
30.	Arrowhead Trail Ext. through yard at house #26
31.	Applewood Drive between houses #14 and 16
32.	Upper River Road out of basin on lower corner
33.	Foot of Masconomet Road by house #43 near pole #9
34.	Beginning of Lakemans Lane out to Miles River along County Road
35.	Heatherside Lane by pole #44/3
36.	Fellows Road between pole #'s 44 and 45
44.	Burridge Lane out of basin 1/2 way down road on right
37.	Candlewood Road out of basin at pole 19
45.	Burridge Lane out of basins on circle
46.	Heartbreak Road near guardrail at stream
47.	Turkey Shore Road near pole #2
48.	Turkey Shore Road out of basin near Green Street Bridge
49.	Turkey Shore Road out of basin near pole #28
50.	Riverside Drive out of basin at pole #8
51.	Tansey Lane across from pole #3
52.	Green Street Bridge - 3 basins each going to river
53.	Water Street at corner with Green Street
54.	Water Street across from Summer Street
55.	Water Street near pole # 6
56.	Water Street near IOC ramp about 50 feet west of flagpole
57.	Water Street across from Hovey Street
58.	Foot of Water Street at Town Wharf by sewer overflow pipe
59.	Town Wharf out of basin at speed bump under landing to floats
60.	County Street by bridge at corner of river walkway
61.	County Road across from Elm Street at small park
62.	County Road at stream by park and stop light near Town Garage
63.	High Street at High Street Ext. out of basin at Town Farm Road
65.	Town Farm Road out of basin across from #40
66.	Currier Park - ties into state basins on High Street

67. Dornell Road out of basin by pole 138/5 ties into state basins
70. Linebrook Road at manhole near pole #94
71. Linebrook Road out of basin at guardrail at house #156
72. School Street out of basin at pole #4
73. Linebrook Road out of basin at house #66
74. Kimball Avenue out of basin at house #41
75. Linebrook Road out of Basin at house #6
76. Liberty Street out of basin by RR tracks
77. Behind Brooks off Liberty Street
78. Brown Street behind Martells Garage
79. Appleton Park out of manhole in circle
80. Blaidsdell Terrace out of basin at end of street
81. Mineral Street near house #12
82. Granite Court by shed-underground connection to Farley Brook
83. Town parking lot by fish market- underground connection
83a Unknown outlet by Tedfords from Mt. Pleasant Street area
85. Warner Road out of basin at pole #9
86. Mill Road at Ipswich River
87. Topsfield Road out of basin across from pole #42
88. Bush Hill Road out of basin at pole #2
89. Bush Hill Road out of manhole at Abell Avenue
90. Bush Hill Road out of basin at circle
91. Colonial Drive - River Ridge and Bayside Condo's
92. Kennedy Drive out of basin across from house #1
93. Heard Drive out of manhole across from House #6
94. Topsfield Road out of basin at pole #20
95. Winter Street across from house #6
96. Peabody Street out of basin at Kimball Brook
97. Haywood Street across from Pole #2 at Kimball Brook
98. Topsfield Road across from Wayne Avenue
99. Topsfield Road at RR crossing
100. Estes Street out of basin between Sylvania and Riverview
101. Foot of River Court
102. Foot of Peatfield Street
103. Foot of First Street
104. Second Street and Kimball Street to Kimball Brook
105. Union Street out of basin across from Vinwood Caterers
106. Outlet of Farley Brook culvert behind Woolworths
107. Market Street behind Cooperative Bank
108. Parking lot of Aspen leaf by Choate Bridge
109. South Main Street out of basin by pole #5
110. South Main Street out of manhole by Pole #7 in front of QLF
111. Basin #1 drain on Little Neck
112. Basin #2 drain on Little Neck
113. Basin #3 drain on Little Neck
114. Little Neck by dock near community center

PLUM ISLAND SOUND:

10. Bayview Road between Pavillion and first house on Bayview
11. Clark Road near house #68 - to Clark Pond
12. Clark Road out of basin to Clark Pond
13. Clark Road near hydrant to Clark Pond
14. Clark Road across from Skytop Road
15. Foot of Bowdoin Road by fence
16. Foot of Nuthatch Road
17. Foot of Kingfisher Road
18. North Ridge Road near pole #26
19. North Ridge Road across from Herring Way
20. North Ridge Road across from Goldfinch Way
21. Skytop Road out of manhole at pole #32
23. North Ridge Road across from pole #3
24. North Ridge Road out of basin at white house (Divine)

EAGLE HILL RIVER:

22. Skytop Road out of basin at pole 137/3
25. 132 Jeffreys Neck Road-out of basin in cedar trees
26. Foot of Seaview Road
64. Fowlers Lane and Town Farm Road out by pond
84. Sewage Plant at base of parking lot

ROWLEY RIVER:

68. Mitchell Road out of basin at pole #3
69. Paradise Road diagonally across from fish and game club gate

CASTLE NECK RIVER:

38. Argilla Road out of basin across from Robinsons Stand
39. Argilla Road out of basin by pole #5/125
40. Argilla Road near pole #142
41. Argilla Road across from pole #5/154
42. Argilla Road across from pole #58
43. Argilla Road beyond pole #52

Please see Storm Drain/Watershed Map for locations.

APPENDIX C

SUMMARY OF WATERSHED AREAS:

Notes: The site numbers in ( ) refer to sample station # from sampling data (Appendix A).
SD # is storm drain # from master storm drain list (Appendix H).

ROWLEY RIVER

The Rowley River begins at the confluence of the Egypt River and Muddy Run in Ipswich and flows as the Rowley/Ipswich town line for 5 miles to Plum Island Sound. There are several tributaries in Ipswich and Rowley. Pollution sources in its watershed impact both the many productive shellfish areas within the river in Ipswich and contribute to the overall bacterial loading in Plum Island Sound.

The Massachusetts Division of Marine Fisheries (DMF) monitors the river near its mouth near Plum Island Sound. DMF has found the average fecal counts at this station to exceed the shellfishing standard immediately following .5" or more of rain. The counts then decrease by day 3 following the rain, then there is a secondary increase on day 4, which then subsides rapidly. They currently close the river to shellfishing for 5 to 8 days, depending on rain amount. Their data indicates sources are present within the river itself and upstream sources that require several days travel time before it impacts their sampling station (which may account for the secondary increase in counts). DMF has performed a shoreline survey around the developed area of the river in Rowley (Railroad Avenue, Ocean Avenue, Warehouse Lane, and the Marina, and found no obvious conduit (i.e., a storm drain or stream) to discharge contaminated water into the river. They currently have a poor understanding of the pollution sources impacting the river.

Muddy Run Brook

Muddy Run begins in two wetland areas, one above Kimball Avenue, and the other above Linebrook Road near St. Joseph's Church. The two branches meet just above School Street, flow into a large wetland area behind the high school, under Route 133 then through a second large wetland north of Mitchell Road, under Clamshell Road, through a third wetland area next to Vitale's Gravel Pit, and enters the salt marsh below Vitale's Gravel Pit [9]. There are several small tributaries. Six monitoring stations were sampled in Muddy Run: at its outlet into the salt marsh (site #123), at Clamshell Road (#41), Route 133 (#42), School Street (#87), and Linebrook Road (#128). A shoreline survey of this upper area of Muddy Run as shown on the map is needed to locate the exact location of these discharges and to identify other discharges rumored to be in the area. A storm drain survey of the Kimball Avenue SD is needed to locate the sewage discharge there. Sampling results indicate there are probably several septic systems discharging into the upper Muddy Run, which appears to be an open sewer at times. After School Street, the counts decrease considerably during dry weather due to detention/die-off in the large wetland area as indicated by the counts at the Route 133 site (#42). However, during wet weather, the counts are high at this station reflecting the impacts of these and other sources. There are likely to be other wet weather sources which may be of concern: septic system discharges from houses/businesses built on wetlands not connected to sewer in this area and agricultural runoff from an upstream cattle farm (see appendices T and V). A shoreline survey should be done as indicated on the map to determine if sources are present in this area. Another area of concern along Muddy Run just below 133 is the zoo since many animals and human visitors are located there. Unusual amounts of algae clog the wetlands just below this site, which may indicate a nutrient problem from manure and/or sewage. The manure and sewage disposal methods at this site should be investigated (there is a lack of records in Health Department files). Below Route 133, the counts decline again during dry weather due to detention/die-off in the second wetland area as indicated by counts at Clamshell Road (#41). The water quality is excellent at this station during dry weather. However, the counts are elevated at this station during wet weather due to the upstream sources mentioned above. The tributary (#17) also contributes bacteria during wet weather but does not seem to be a problem during dry weather. This is probably due to the small farms along this creek upstream of this sampling site. Below Clamshell Road, there was a significant increase in the counts by the time the brook reaches the monitoring station at the entrance to the marsh (#123) each time the site was sampled in 1993, but the problem was not evident in 1994 sampling. The increase in 1993 sampling is unexpected since the counts should decrease in the third wetland area just upstream of this site. The only explanations are: wildlife (doubtful), illegal dumping of septage at Clamshell Road (rumored to occur) or sewage being discharged into the ditch draining the adjacent businesses. The sewage disposal methods of the businesses should be investigated and Clamshell Road be blocked to prevent septage haulers from illegally dumping in this area.

Muddy Run brook discharges a significant amount of bacteria into the Rowley River during both wet and dry weather. However, the dry weather source documented mostly in 1993 seems to be below Clamshell Road. The identification of this (these) dry weather sources is a priority. The many other actual and potential sources located in this watershed appear to negatively impact the Rowley River primarily during wet weather only because of the dry weather detention and treatment functions performed by the large wetland areas, so their remediation should be a lower priority (although the direct sewage and animal discharges should located and removed).

Egypt River

The Egypt River flows out of Bull Brook and Dow Reservoirs under Route 133 and into the marsh where it meets Muddy Run to form the Rowley River. There is very little development in its watershed. One station at 133 has been established (#43). The dry and wet weather data is variable. The wet weather variability is likely due to road runoff. The source of the dry weather variability is unexplained, although waterfowl and other wildlife could be a source. Due to the sensitivity of the area, the several town buildings in this area should be investigated to determine the condition of their septic systems and to evaluate other potential impacts to the river. However, the counts are relatively low overall and the Egypt River contributes relatively little bacteria to the estuary.

In addition to the problems identified in Muddy Run Brook, there are likely to be sources of pollution impacting the Rowley River in Rowley as well because the counts from Muddy Run cannot fully account for the level of contamination in the Rowley River. The CPCC has established Rowley River stations in Rowley at Town Landing (#44), and end of Railroad Avenue (#83), and seems to have confirmed previous DMF data: that the Rowley River is highly contaminated in these areas, especially during rainfall. Possible sources in Rowley: septic systems on the Warehouse Lane, Ocean Avenue, Railroad Avenue area (the Rowley Board of Health has identified this neighborhood as being a concern because of the condition of the septic systems-although there are no obvious conduits for this contamination to reach the river), the 3 unnamed creeks that also drain developed areas which may be receiving sewage from failing septic systems and a school (just south of Warehouse Lane and the two creeks on either side of Hammond Street), buildings and boats at the marina, and houses and camps on marsh. The CPCC should seek the assistance of the Town of Rowley, DMF, and the minibays project to track down sources in this area. A shoreline survey should be conducted as shown on the map around the three creeks. In addition, because it also drains a developed area, the impact of Sand Creek should be evaluated. The several houses and camps along the Rowley River, most of which are in the marsh and on small hummocks adjacent to the marsh can't possibly have adequate sewage disposal systems and are a major concern due to their proximity to Ipswich waters.

NORTHERN MARSH CREEKS

The "northern Ipswich marsh creeks" (Niaway, Rogers Island, Lords, Metcalf, Broad, Laws, Goose, Third, Stacy) are the most important shellfishing areas in Ipswich. Fortunately, there is no upstream development on any of these creeks and no pollution survey work was required. These areas are currently being closed after rain because they are being contaminated by floodwater from Plum Island Sound. These areas will improve as pollution sources impacting the Ipswich portion of Plum Island Sound are eliminated. The only potential direct source of pollution to this area (besides wildlife) are the several hunting camps on the marsh. Some of these camps were observed to have bathrooms, but no way to properly dispose of sewage. The sewage disposal problems at these camps need to be addressed.

EAGLE HILL RIVER

The Eagle Hill River and its tributaries are very productive shellfishing areas. Pollution sources impacting this area also impact the shellfishing areas of Plum island Sound. This area receives drainage from several small freshwater creeks, a few storm drains, and has some development on the marsh edge. DMF monitors the river at a station off the Eagle Hill landing and has found significant contamination problems, especially after rainfall. Although the restrictions are the same as for Rowley River, and it is open during dry weather, the wet weather counts are higher and the dry weather counts are approaching the closure level. The main sources of contamination are poorly understood by DMF.

The CPCC has established boat sampling stations at the mouths of the main tributaries (#18), (#67), (#65), (#66), (#64) to attempt to identify the major source areas. The water quality in each tributary was similar so could not be used to identify problem areas. A shoreline survey has been conducted in a portion of the area as shown on the map. Three obvious dry weather sources have been found: the Seaview Road storm drain (# 22), the Town Farm Storm Drain (#64) and the creek draining from the Notre Dame ponds (#53). The sewage tie-in into the Seaview Road SD should be located, and the source of the problem in the creek identified. The source responsible for the high counts in SD#64 needs to be located but it is unclear if a septic system is responsible. The area served by this drain should be part of the overall septic system program. In addition, DMF has identified the road runoff on the Eagle Hill landing as a significant source of bacteria. The relative contribution of these sources on the dry weather problem is unclear at this time. Potential problems/sources identified during the shoreline survey are as follows: a popular dog walking area along Jeffreys Neck Road at Eagle Hill Cove and landing; homes on Eagle Hill: this area is a concern because most houses are older, on cesspools and lots are too small for septic systems, are too close to water. The continued conversion of seasonal homes to year round use is also of concern in this area. There are several nutrient rich groundwater outbreaks around the hill indicating septic systems could be a concern. The frequency of septic system pumpouts and repairs should be investigated. The Ocean Avenue neighborhood is a concern because of the poor soils, known frequency of septic system pumpouts/failures/repairs (frequency should be documented). The location of the sewer system force-main (along marsh) and known high frequency of rupture (should also document) is a concern and a slow, undetected leak could account for the unexplained high counts in the Notre Dame Creek (#53). The "Town Farm Creek" is a definite wet weather source since it receives storm drains #64 and 84, the runoff from the sewer plant, dog pound, and homes. A buffer zone should be provided between the farm fields off Town Farm Road and the marsh; frequency of manure spreading should be investigated. Shoreline survey needs to be completed between the farm and the Town dump as shown on the map in this area.

PLUM ISLAND SOUND (LOWER SOUND)

The area of lower Plum Island Sound in Ipswich is relatively clean due to its high flushing rate, but does have a wet weather contamination problem as well. DMF monitors this area at Middle Ground and at Pavilion Beach and closes the area following .5" of rain in spring-fall and 1" in winter. It is believed that the major sources impacting this area are: upper Plum Island Sound outside Ipswich, the Rowley River, Eagle Hill River, drainage from Great Neck, the Ipswich River, and boats in summer. If the sources impacting this area from Ipswich are reduced, the area could remain open (except during large rains) because the level of contamination that impacts Ipswich from the upper sound is not that great.

Outer Great Neck Sources

The CPCC has identified storm drains #11(site 103), SD #12 (#107), SD#13(site 134), SD#14 (site 101), #20(site 52) and #18(site #51), a failing septic system (#50), and the outlet of Clark Pond as dry weather pollution sources in need of remediation. The results indicate that direct sewage connections to these SD's are present, especially in SD#'s 11, 13, and 18.

Clark Pond

The CPCC data indicates that there has been a significant improvement in the quality of water exiting Clark Pond during dry weather as compared to historical data. This is probably due to the recent removal of direct septic system discharges to the pond. However, there is still a significant wet weather problem due to the many stormwater discharges to the pond. Four storm drains discharge into Clark Pond: SD's 11 and 13 contain sewage, SD12 and SD14 may have sewage, but additional evaluation is needed. Although these drains discharge sewage to Clark Pond during dry weather, their impact on Plum Island Sound is reduced due to dye-off and detention in the pond.

The shoreline survey of outer Great Neck found many groundwater outbreaks, but samples collected at the most suspect (#'s 12, 13, 14) indicate no problem. Street runoff on the Ipswich Yacht Club boat ramp is a problem and should be remediated. The remaining storm drains in this area (SD #'s 15-17, 19, 24) were not found and still need to be evaluated. Because of the steep bank and dense vegetation, the shoreline survey found it difficult to examine septic systems. Due to the many existing cesspools in this area and the frequency of pumping/repairs, other means should be employed to evaluate the septic systems in this area.

IPSWICH RIVER

The Ipswich River estuary contains about 30% of the productive shellfish area in Ipswich, but is currently prohibited to shellfishing due to long-term contamination problems. The river and its tributaries receive drainage from several streams, storm drains, the discharge from the town's sewer plant, and most of the stormwater runoff from the downtown area of Ipswich. Although the current condition of the river appears to be much improved, the CPCC has identified a tremendous amount of pollution sources still entering the river.

The last sanitary survey of the river was done by the state in 1979. They found certain portions of the lower river, Neck Creek, Treadwells, Greenwoods, and Goulds Creeks to be mildly contaminated and suitable for restricted harvest with depuration. Fox Creek was found to be overly variable, and the remainder of the river, especially as it entered the estuary was grossly contaminated. A shoreline survey (done by the state) found homes along Newmarch Street (now on sewer), Tansey Lane, The Sylvania Plant, Poplar Street, and Upper River Road to be discharging raw sewage. A few of the town storm drains were also problematic. Farley Brook was described to be in "nuisance condition". They found the river as it entered town at Mill Road to be relatively clean, but by the time it reached Town Wharf, it was grossly contaminated. Another state survey in 1989 found sewage in two storm drains discharging into Neck Cove, continued problems in Farley Brook, and high bacteria counts in Greenwoods Creek attributable to the sewer plant outfall.

Ipswich River Mainstream

The CPCC has spent the majority of its shoreline and sampling effort in areas in and tributary to the Ipswich River. The Committee currently has a good understanding of the sources of fecal contamination impacting the river. Sample stations have been established in the freshwater portion of the river (site #'s 3, 91, 38, 33, 92, 99, 40), most of the shoreline survey has been completed, and most of the direct inputs have been evaluated. The sanitary condition of the river currently appears to be improved when compared to the latest state survey. The river was found to be in good condition during dry weather as it enters the developed area of town (site 91). It picks up some contamination by the time it reaches the Sylvania Dam, more by the time it reaches County Road, remains about the same past Green Street and the Outboard Club, but is consistently moderately contaminated by the time it reaches Town Wharf. During wet weather, the trend is similar, but the fecal counts are considerably elevated due to the tremendous amount of storm water that enters the river as in flows through the downtown area. Because of the many pollution sources impacting the estuary (part of river below Town Wharf) directly, the relative impact of the freshwater portion of the river has on the shellfishing areas within the estuary is lessened. Sampling at the mouth of the river at Little Neck (site 75) and at the mouths of the major tributaries in the estuary (site #'s 76, 78, 113, 114, 115, 116, 117, 133) indicates that it is contaminated in the estuary, but it is unclear what portion is from the mainstream of the river or sources within the estuary. Until the sources documented within the estuary are removed, it will be difficult to evaluate the degree to which the sources entering the river upstream of the estuary affect the shellfishing areas. Dry and wet weather sampling within the estuary to determine the relative impact the sources identified in the river and its tributaries have on the shellfish areas within the estuary indicates that the river remains contaminated above shellfishing standards. Stations have been established at the following locations: Nabby's Point [38], Goulds Creek [39], Spew Island [40], the river at Robinsons Creek [41], Greenwood Creek [42], Neck Creek [43], Neck Cove [44], Treadwells/Fox Creek [45], and at the mouth [46]. These results indicate that significant pollution source remediation is needed before consideration should be given to evaluating the re-opening of the river to shellfishing.

IPSWICH RIVER TRIBUTARIES

Little Neck and Neck Cove

Sources of contamination have been identified at SD #6 (site 60), 8+9 (site 9) and from Little Neck storm drains in Bay Road (SD #'s 112-14). SD 6, 8, 9 are predominately wet weather problems, although SD#9 has elevated dry weather counts from septic system(s). The Little Neck Storm drains are discharging small amounts of sewage from septic systems(s) in the summer months. Sampling at the outlet of Neck Cove at low tide (site 76) confirms the impact on the cove by these sources. It is unclear to what degree these sources impact the Ipswich River estuary. In addition during wet weather, direct street runoff is a problem throughout the area as indicated by the results from sites 96, 108, 109. Nutrient rich groundwater outbreaks on Neck Cove along Little Neck indicate septic systems could be a problem, although no fecal pollution was detected. There is a concern over the age, condition, and density of the septic systems on Little Neck.

Neck Creek and Island Park

Mullholland Creek (site 8) was found to impact Neck Creek during wet and dry weather. Mullholland Creek receives drainage from the Neck and SD's 3, 21, 23. SD23 is only a wet weather problem, but SD21 needs to be evaluated and is suspect. A shoreline survey is needed in the Mullholland Creek watershed to identify other possible sources as shown on the map. In addition, SD #'s 4+5 discharge into Neck Creek and still need to be evaluated. Wet weather sampling at the mouth of Neck Creek (site 78) confirms the creek is being impacted by pollution to some degree. A shoreline survey along the 3 houses tributary to Neck Creek on Jeffreys Neck Road needs to be done. These septic systems should also be surveyed. The shoreline survey around Island Park (in blue) did not find any problems, but the crew could not adequately evaluate the situation due to dense vegetation and high water.

Greenwoods Creek

Greenwoods Creek receives the discharge from the town’s sewage plant. Sampling at the outfall (site 86), just downstream (site 77), and just upstream (site 85) of the outfall identify the outfall as a very significant source of bacteria (see discussion on town sewer plant). The unnamed creek (site 21) by Notre Dame was also confirmed as a source, but its impact on Greenwood Creek is unclear because of the pond just downstream of the sampling location, which should reduce the counts by dilution/die-off (see summary of site 21). The shoreline survey around Grasshopper/Harborview Lanes did not reveal any problems, but the shoreline survey around the upper marsh area of Greenwoods Creek is needed. The older septic systems, especially at the business, along Jeffrey's Neck Road should be investigated. These sources were documented to impact the shellfish areas at the mouth of Greenwoods Creek (site 42) but the relative impact of Greenwood Creek on the rest of the river is unclear.

Fox and Treadwells Island Creeks

The present sanitary quality of Fox and Treadwells Island Creeks is variable. A shoreline survey was done along the developed portion of Castle Hill (in blue). Some sources were identified, and have been repaired. A survey needs to be conducted along the few older homes in the upper reaches of Fox Creek and along the homes on the east side of Treadwells Island due to rumored problems there. Because Treadwells Island receives town water, the town should develop a plan to insure that the sanitary conditions on the Island are acceptable due to its proximity to shellfish beds.

Goulds Creek

Goulds Creek begins in wetlands west of Essex Road, flows through a kennel area, two farms, under Argilla Road, and through the marsh to Labor In Vain Road where it meets the Ipswich River. It has many tributaries. Stations have been established at Argilla Road and Labor In Vain Road The creek is contaminated at Labor In Vain station (site 39), especially after rainfall. Although it is unclear the relative contribution it has to the overall problem, some of the source appears to be entering the creek from the upland portion of its watershed above Argilla Road as indicated by the data at this station (site 30). The creek receives the runoff from the 3 properties with animals mentioned. These obvious sources should be addressed (see animal section). Other sources found include the culvert under Argilla Road (site 98) and the ditch draining from another farm (site 31). A shoreline survey has been conducted in the remaining developed portion of the Goulds Creek watershed as indicated on the map, which indicate that agricultural runoff another upstream farm is a likely source. In addition to impacting shellfish beds within the creek itself, pollution sources in Goulds Creek appear to be impacting the Ipswich River as well, especially during wet weather. When compared to historical data, Goulds Creek seems to have declined in water quality.   This could probably be explained by the relatively recent increase in the farm animal populations noted above.

Saltonstall Brook

Saltonstall Brook begins in wetlands between Argilla, Heartbreak, and County Roads and is variably contaminated. The sources impacting the brook appear to be downstream of Heartbreak Road. While counts are very high following rain (expected because brook receives SD62, other state highway drains, and road runoff), it is unexplainably high on occasion during dry weather. The brook enters the Ipswich River just above Sylvania Dam and is a moderately significant source of bacteria, especially during wet weather. A shoreline survey is needed up to the VFW as shown on the map. The unnamed tributary, which flows through the farm off Ward Street, may be contaminated by the recent large increase in farm animals there and should be included in the farm animal program. It should also be determined if Public Works, VFW, and the house on County Road are on town sewer.   Due to its low flow, the brook does not appear to be a significant source during dry weather.

Kimball Brook

Kimball Brook begins in wetlands along Pineswamp Road, flows through farmland into the more developed parts of town at Heard Street to the river just above Sylvania Dam. It receives a tremendous amount of stormwater from SD's (89, 90, 92-98, 104) and several areas of direct street runoff. Several actual and potential pollution sources have been identified. The results indicate that septic system(s) are tied into the Kimball Avenue storm drain, SD#74 (site#122) which discharges to the brook at Kimball Avenue and in the west branch above Linebrook Road (#145). Sample results from the School Street station document the impact of these sewage discharges on the main brook. SD #'s 90, 95 have been evaluated, and #'s 92, 94, 96, 97, 98, 104 have been examined for dry weather flow and do not require further examination. Several stations have been established along the brook (sites 32, 93, 48, 89), and there is a substantial difference between wet and dry weather counts. The brook, due to the tremendous amount of urban runoff (and possibly farm runoff in its upper reaches) is highly contaminated during/following rain, and probably contributes significantly to the wet weather problem in the Ipswich River. The water quality is relatively poor during dry weather as well. There is some elevation in dry weather counts after the brook flows through town (compare sites 93 and 32), but the sources are unclear. The shoreline survey (Ipswich River to Heard Street) identified a tremendous amount of potential wet weather sources, but did not find any obvious dry weather inputs. A tremendous amount of wildlife/cat feces were found along its banks, indicating the brook is a popular urban wildlife corridor (could this account for the dry weather counts?). But since the flow is relatively low during dry weather, which does not seem to significantly impact the Ipswich River (see results from Sylvania Dam sampling, site 38), the dry weather counts are less of a concern. A shoreline survey should also be done above Heard Street (in green) to identify upstream wet weather sources, although the farms in this area are probably a source of the wet weather counts. The portion of the brook between Heard Street and the Ipswich River has been drastically altered by flood and mosquito control projects. This once natural brook has been completely channeled and is little more than an open conduit for stormwater. The water quality (and ecology) of the brook would benefit if some of the original wetlands and meanders were restored if possible (see data summary #32).

Farley Brook

Farley Brook begins at the discharge point of SD#'s 76, 77 (off Liberty Street behind Brooks) and SD#78, flows under Mineral Street to a large 6' culvert at Car Buffs on Central Street, and flows underground to its discharge point in the Ipswich River behind Woolworths. The brook also receives SD#'s 81-83, and most of the Downtown area's storm water, most of which connect underground in the culvert. The Brook remains one of the major sources of bacteria to the Ipswich River. It was long suspected that sources of contamination entered the brook in the many underground connections within the culvert. However, due to the low water conditions in 1993, sampling was possible at the outlet of the culvert where it meets the Ipswich River. A comparison between this site (#79) and where the brook enters the culvert (site #2) indicates that very little, if any additional contamination, is entering the brook in the underground culvert. In fact, the counts were almost always about half where the brook enters the river due to dilution by additional water entering the system. The data collected from the station before the brook goes underground at Car Buffs (site #2) indicates significant wet and dry weather sources. The source of the dry weather inputs above this sampling station appears to be primarily from sewage in SD#78 (site 46), and to a lesser degree from SD#77 (site 47). SD#78 flows at all times, drains a large area, and should be investigated. In addition, because the brook receives a huge amount of urban runoff (mostly) through storm drains, it discharges a tremendous amount of bacteria to the river during wet weather. A shoreline survey should be conducted along the short section of the brook above ground as shown on the map to identify any other inputs. The above ground portion of the brook has been channeled much like Kimball Brook, and could benefit from similar remediation.

Miles River

The Miles River begins in Beverly, flows through Hamilton and Wenham and enters Ipswich at the Don Bosco property, under County Road and joins the Ipswich River near the railroad crossing off Waldingfield Road. It is second only to the Ipswich River in terms of flow of all streams in Ipswich. Two stations were monitored: at Don Bosco (site 105) and County Road (site 37). One tributary was monitored (site 15) and found to contain sewage. A subsequent shoreline survey found 2 septic systems discharging directly into the brook. The Health Agent was notified. It is unclear how this tributary affects the water quality of the Miles River since the County Road monitoring station is located above where this brook joins the river. The Miles River was found to be in good condition during dry weather. However, the Miles becomes contaminated during/following rain events. Much of this rain related contamination appears to be entering the river from sites within Ipswich as is indicated by the significant decline in water quality between the two monitoring stations (sites 37 and 105). This is likely due to agricultural runoff into the unnamed tributary that joins the river just above County Road and drains a large agricultural area off Lakemens Lane and Fellows Road. Runoff from these farms should be addressed. In addition, SD#36, which discharges into this tributary which has not been sampled should be investigated since it drains Lakemens Lane which is an area reported to have many failing septic systems. However, due to its good condition during dry weather, and its distance from shellfishing areas, pollution source remediation in the Miles River watershed should receive a low priority (except for any direct sewage discharges).

Ipswich River - North Bank, RR Tracks to Newmarch Street

Several sources of contamination have been found along this stretch of the river, all related more or less to rainfall (except for Farley Brook). No obvious dry weather sources/or source areas of (other than waterfowl) have been documented during the site walks or sampling program. SD#'s 27, 52-58, 60, 107 have been evaluated and contribute huge amounts of bacteria during/following rainfall. SD#'s 28, 100-103 still needs to be evaluated. The results from samples of road runoff, identified either during the site walks or sampling (site #'s 39, 5, 35, 36) were all highly contaminated, and are probably representative of the general bacteriological quality of runoff in this area during rain events. Neither of the two groundwater outbreaks considered to be the most likely sources collected from this area (site #'s 27, 25) were contaminated. Therefore, it is probably safe to conclude that the other groundwater outbreaks found in this area probably aren't sources and do not require further sampling. The section along the river between Melansons Boat Yard and the Town Wharf still needs to be surveyed by boat. Huge amounts of dog feces along the riverwalk, Water Street, and the Town Wharf area were documented as an obvious source. A high concentration of waterfowl was documented during the waterfowl survey was also documented in this area and is likely a very significant dry weather source. Many of these birds seem to be maintained in this area due to feeding by people and have become semi-domesticated. In addition, several manicured lawns to the edge of the river in the Pole Alley area were identified as a problem because they appear to attract and maintain a resident Canada geese population. A carpet of goose feces was observed on these lawns. These "people-related" animal sources should be addressed.

Ipswich River in town - South Bank, Masconomet Road to Labor In Vain Road

A large number of source/sources areas have been found in this area; mostly related to rainfall. SD#'s 32(site 56), 33(site 57), 109(site 94), 47(site 92) have been evaluated and contribute large numbers of bacteria to the river during wet weather. SD#'s 48, 49, 61, 108, 110, have been visually inspected and did not require sampling (only flow during rain and have typical urban runoff characteristics). SD#'s 51 and 50 still need to be evaluated. Sites identified during the site walks still that were of concern include the ditches adjacent to both Masconomet and Upper River Roads. All other potential sources identified during the site walks have been evaluated or do not require additional sampling. Several groundwater outbreaks were found in this area. The worse cases of these (site #'s 29, 19, 28) were samples and found to be clean. Therefore, the remaining groundwater outbreaks found in this area probably aren't sources and do not require additional sampling. The several lawns to the river's edge, popular dog walking areas around Cove Park and Turkey Shore Road, and runoff from a paddock on Turkey Shore Road should be addressed. A direct sewage discharge from two homes into the river on Tansey Lane was found and reported to the Health Agent. The small creek under Labor In Vain Road (site 129) does not appear to be a significant problem, but counts were variable. The north branch of this tributary (site 143) may contain farm runoff from upstream or intermittent contamination from one of the few older septic systems in the area. The remaining shoreline along Riverside Road, Browns Island, and Spew Island still need to be surveyed. The Riverside SD (SD# 50) needs to be investigated.

SUMMARY OF IPSWICH RIVER BETWEEN MASCONOMET ROAD AND TOWN WHARF

Dry Weather

The water quality of the Ipswich River where it enters the first developed areas of Ipswich at Masconomet Road is excellent. Once the river reaches the next sampling station at Sylvania Dam (site 38), it has picked up some additional bacteria, but overall water quality remains excellent. These additional bacteria probably come from Kimball and Saltonstall Brooks, SD#32 (site 57), and resident waterfowl or wildlife as indicated by the lack of other identified dry weather sources. By the point the river reached County Road, however, it becomes contaminated. Due to the lack of other sources identified in this section, Farley Brook is probably responsible for much of the increase in contamination. Because the bacteria levels and flow analysis, the discharge from Farley Brook alone does not appear high enough to account for the increase at the County Road station. The large flock of resident Waterfowl and a rumored direct sewage discharge off North Main Street (house not on sewer) could be responsible (although this source was not located during the shoreline survey). The river remains relatively unchanged past Green Street until the Outboard Club/Wharf area, where there is another significant decline in water quality. The reason for the large increase in bacteria levels in this stretch of river is unclear, but is probably a combination of the sewage discharge on Tansey Lane and the large resident waterfowl population in this area. It is unclear to what extent this level of bacterial contamination impacts the estuarine portion of the river below Town Wharf, but it would appear that the water quality of the river entering the estuary in dry weather is much improved when compared to data collected in prior studies. If the dry weather sources identified to date in this section of the river were eliminated, the river would contribute relatively few bacteria to the shellfish areas in the estuary.

Wet Weather

An examination of the wet weather data from the in town Ipswich River sites (91, 38, 33, 92, 99, 40) indicates a similar pattern of contamination seen in the dry weather data, but the counts are several orders of magnitude higher. Due to the tremendous amount of wet weather source identified by the CPCC to date in this section, the river receives a huge bacteria load during rainfall. This load is probably enough to negatively impact all the shellfish areas in the Ipswich River estuary. While remediation of all the wet weather sources would be impossible, some reduction in bacterial loading is probably achievable which would limit the overall impact of a rain event on the shellfish beds.

CASTLE NECK RIVER

The Castle Neck River (CNR) begins in two wetland areas just above Choate/Chebacco Streets, one branch in Ipswich and one in Essex. The two branches meet at the head of the salt marsh just east of the road, passes under Route 133 and Old Essex Road, and meanders through the salt marsh for a few miles parallel to Argilla Road to Essex Bay. Productive shellfish beds in Ipswich lay both within the river itself, and further downstream in the Ipswich portion of Essex Bay. All Ipswich shellfish beds in Essex Bay are impacted by the water quality of the Castle Neck River. DMF regularly monitors the river where it widens in the vicinity of Fox Creek, and has found it to be contaminated. The upper portion of CNR above Fox Creek is currently closed to shellfishing at all times, the lower portion (to Hog Island) is closed for extended periods following rain, and the rest of Essex Bay in Ipswich is closed following rain, all due to sources within the CNR. DMF has a moderately good understanding of the sources impacting the river. Bacteria counts have been very high at Route 133/Old Essex Road, indicating an upstream source. Counts decline some downstream from there, but increase again by the time the river reaches the Fox Creek area, indicating additional source(s), possibly along Argilla Road. DMF suspects a farm on Choate Street in Essex as a significant source, but feels there must be other upstream sources.

Sample stations have been established in the CNR at Choate/Chebacco Streets in Ipswich and Essex (sites 68, 69), below the farm pond (site 97), at Old Essex Road in Ipswich (site 71), at Goodales (site 72), and at Shurcliffs (site 74). Two tributaries have been monitored: the creek behind the Restaurant (site 70) and the creek draining a farm on Argilla Road (site 73) and 4 ditches identified during the shoreline survey were also sampled. The north branch of the CNR (site 68) above Chebacco Road has generally good water quality and does not appear to contribute to the problem. The south branch in Essex (site 69) at Choate Street has good water quality during dry weather, but is variable during wet weather indicating a possible upstream source (there is a horse farm upstream). A comparison between this station and just downstream of the farm pond (site 97) indicates the south branch may receive some contamination from the 20 domestic geese which inhabit the farm pond, or from another source entering the pond. A shoreline survey was conducted in this area. There is little question that the farm has a significant potential to contaminate the CNR during rainfall. Several thousand animals are raised annually in large outdoor pens. The pens on the north side of the farm are on the slope of the hill that causes obvious runoff problems. The pens on the south side of the farm border a small drainage ditch that is also tributary to the CNR. This tributary, not direct runoff from the slope pens is likely the major conduit for bacteria to reach the river. Outside assistance for the farmer should be sought as indicated in Appendix T to remedy this situation. Samples collected in the CNR (site 71) are highly variable. While generally elevated, the counts found during CPCC sampling are much below those found by DMF and others over the last few years. This may be due to improvements at the farms, the removal of another unidentified source, or lack of significant rainfall during the sample period. The creek draining the area behind the restaurant (site 70) was documented as a source. Although the shoreline survey did not find an actual problem, a sewage odor was found to be emanating from the septic tanks under the restaurant parking lot. The Essex Board of Health (or another method) should be contacted to investigate if this system is failing and contributing to the high counts found at site 70. The shoreline survey also found an overflowing cesspool behind a business on Old Essex Road in Ipswich flowing directly into the marsh. The Ipswich Health Agent was contacted to remedy this source. The shoreline survey also indicated a potential septic system failure at another Essex business. Because this building does not appear to have room for a septic system, the Essex Board of Health should be contacted to investigate. If each of these actual/potential sources is remedied, the water quality in the upper CNR should improve dramatically.

Because of the suspected additional sources areas in the lower CNR, shoreline surveys were conducted along the Argilla Road areas as shown on the map. Due to the many animals at one farm adjacent to the marsh, the creek draining the farm (site 73) was sampled. The results indicate a significant wet weather, and possible dry weather problem here. Outside assistance should be sought to manage the animals so their manure does not enter the creek to contaminate the river. A failing septic system on the edge of the marsh in the vicinity of Fox Creek was also found, and could contribute to the problem. The Health Agent was contacted. In addition, a survey to investigate the exchange characteristics between the Ipswich and Castle Neck Rivers via Fox Creek was initiated to examine the possibility of the Ipswich River contaminating the CNR.

Although the CNR is believed to be the major source of contamination affecting the Ipswich shellfish beds in Essex Bay, potential pollution from the large summer anchorage of boats at back beach should be addressed.

APPENDIX D

PRIORITY STREET DRAINS:

Notes: (1) These drains have been found to have high potential to impact coastal area. Because of the numerous drains that comprise this list, we have continued to categorize priority into low, moderate, and high according to pollution loading calculations and/or proximity to shellfish beds.
(2) Farley Brook Plan: these drains have been separated out from other priority drains because of the individualistic nature of Farley Brook.
(3) SD = Storm Drain

HIGH PRIORITY STORM DRAINS:

SD #	Location
6.	Little Neck Road across from Jutland Way
15.	Foot of Bowdoin Road by fence
23.	North Ridge Road across from pole #3
27.	Agawam Avenue at no parking sign by Town Wharf
47.	Turkey Shore Road near pole #2
57.	Water Street across from Hovey Street
58.	Foot of Water Street at Town Wharf by sewer overflow pipe
107.	Market Street behind Cooperative Bank
108.	Parking lot of Aspen leaf by Choate Bridge
109.	South Main Street out of basin by pole #5
110.	South Main Street out of manhole by Pole #7 in front of QLF

FARLEY BROOK PLAN - HIGH PRIORITY DRAINS:

SD #	Location
76.	Liberty Street out of basin by RR tracks
77.	Behind Brooks off Liberty Street
78.	Brown Street behind Martells Garage
81.	MINERAL STREET NEAR HOUSE #12
82.	Granite Court by shed-underground connection to Farley Brook
83.	Town parking lot by fish market- underground connection
83a	Unknown outlet by Tedfords from Mt. Pleasant Street area

MODERATE PRIORITY STORM DRAINS:

SD #	Location
4.	Little Neck Road across from Plover Hill Road
5.	Little Neck Road - west side to Neck Creek
18.	North Ridge Road near pole #26
20.	North Ridge Road across from Goldfinch Way
26.	Foot of Seaview Road
50.	Riverside Drive out of basin at pole #8
54.	Water Street across from Summer Street
105.	Union Street out of basin across from Vinwood Caterers
111.	Basin #1 drain on Little Neck

112.	Basin #2 drain on Little Neck
113.	Basin #3 drain on Little Neck

LOW PRIORITY STORM DRAINS:

With Recommendations For Repair:

SD #	Location
3.	Mullholland Drive near metal light pole by Little Neck Road
16.	Foot of Nuthatch Road
17.	Foot of Kingfisher Road
25.	132 Jeffreys Neck Road-out of basin in cedar trees
28.	Damon Avenue out of basin in circle by house #20
53.	Water Street at corner with Green Street
59.	Town Wharf out of basin at speed bump under landing to floats

Without Recommendation For Repair : No immediate action, do not impact the coast significantly, cost/benefit ratio unreasonable..

1.	Jeffreys Neck Road near Island Park Road across from house #88
9.	Little Neck Road on corner across from playground
19.	North Ridge Road across from Herring Way
24.	North Ridge Road out of basin at white house (Divine)
41.	Argilla Road across from pole #5/154
48.	Turkey Shore Road out of basin near Green Street Bridge
49.	Turkey Shore Road out of basin near pole #28
51.	Tansey Lane across from pole #3
52.	Green Street Bridge - 3 basins each going to river
55.	Water Street near pole # 6
64.	Fowlers Lane and Town Farm Road out by pond
106.	Outlet of Farley Brook culvert behind Woolworths
114.	Little Neck by dock near community center

49 Total Priority Drains

APPENDIX E

LOW PRIORITY STREET DRAINS:

Note: These are drains that directly or indirectly impact coastal area however, impacts are limited. These drains are recommended to be repaired only after priority drains have been repaired.
SD = Storm Drain

SD #	Location
2.	Hodges Way near junction of Island Park Road-culvert under road
11.	Clark Road near house #68 - to Clark Pond
12.	Clark Road out of basin to Clark Pond
13.	Clark Road near hydrant to Clark Pond
14.	Clark Road across from Skytop Road
21.	Skytop Road out of manhole at pole #32
22.	Skytop Road out of basin at pole 137/3
29.	Arrowhead Trail by pole #9
30.	Arrowhead Trail Ext. through yard at house #26
31.	Applewood Drive between houses #14 and 16
32.	Upper River Road out of basin on lower corner
33.	Foot of Masconomet Road by house #43 near pole #9
34.	Beginning of Lakemans Lane out to Miles River along County Road
40.	Argilla Road near pole #142
42.	Argilla Road across from pole #58
43.	Argilla Road beyond pole #52
44.	Burridge Lane out of basin 1/2 way down road on right
45.	Burridge Lane out of basins on circle
46.	Heartbreak Road near guardrail at stream
62.	County Road at stream by park and stop light near Town Garage
63.	High Street at High Street Ext. out of basin at Town Farm Road
65.	Town Farm Road out of basin across from #40
66.	Currier Park - ties into state basins on High Street
67.	Dornell Road out of basin by pole 138/5 ties into state basins
68.	Mitchell Road out of basin at pole #3
72.	School Street out of basin at pole #4
73.	Linebrook Road out of basin at house #66
74.	Kimball Avenue out of basin at house #41
75.	Linebrook Road out of Basin at house #6
86.	Mill Road at Ipswich River
89.	Bush Hill Road out of manhole at Abell Avenue
90.	Bush Hill Road out of basin at circle
91.	Colonial Drive - River Ridge and Bayside Condo's
92.	Kennedy Drive out of basin across from house #1
93.	Heard Drive out of manhole across from House #6
94.	Topsfield Road out of basin at pole #20
96.	Peabody Street out of basin at Kimball Brook
97.	Haywood Street across from Pole #2 at Kimball Brook
98.	Topsfield Road across from Wayne Avenue
99.	Topsfield Road at RR crossing
100.	Estes Street out of basin between Sylvania and Riverview

101. Foot of River Court
102. Foot of Peatfield Street
103. Foot of First Street
104. Second Street and Kimball Street to Kimball Brook

45 Total Low Priority Drains

APPENDIX F

LOWEST PRIORITY STREET DRAINS

Note: These are drains have the least impact on the coastal area. The cost/benefit ratio does not justify expending resources.

SD = Storm Drain

SD #	Location
10.	Bayview Road between Pavillion and first house on Bayview
35.	Heatherside Lane by pole #44/3
36.	Fellows Road between pole #'s 44 and 45
37.	Candlewood Road out of basin at pole 19
38.	Argilla Road out of basin across from Robinsons Stand
39.	Argilla Road out of basin by pole #5/125
69.	Paradise Road diagonally across from fish and game club gate
70.	Linebrook Road at manhole near pole #94
71.	Linebrook Road out of basin at guardrail at house #156
79.	Appleton Park out of manhole in circle
80.	Blaidsdell Terrace out of basin at end of street
85.	Warner Road out of basin at pole #9
87.	Topsfield Road out of basin across from pole #42
88.	Bush Hill Road out of basin at pole #2
95.	Winter Street across from house #6

15 Total Lowest Priority Drains

APPENDIX G

REPAIRED STREET DRAIN OUTLETS:

Note: The following street drain systems have already been repaired by the town's Department of Public Works, with technical and financial assistance. The repair mechanisms of these drains gave us the knowledge we required to make recommendations on several other drains in need of repair.

SD = Storm Drain

SD #	Location
7.	Little Neck Road near pole #76
8.	Little Neck Road near pole #78:
56	Water Street near IOC ramp about 50 feet west of flagpole
60.	County Street by bridge at corner of river walkway
61.	County Road across from Elm Street at small park
84.	Sewage Plant at base of parking lot

6 Total Repaired Drains

APPENDIX H

LIST OF IDENTIFIED STREET DRAIN OUTLETS IN THE COASTAL AREAS OF IPSWICH:

Note: SD = Storm Drain

SD #	Location
1.	Jeffreys Neck Road near Island Park Road across from house #88
2.	Hodges Way near junction of Island Park Road-culvert under road
3.	Mullholland Drive near metal light pole by Little Neck Road
4.	Little Neck Road across from Plover Hill Road
5.	Little Neck Road - west side to Neck Creek
6.	Little Neck Road across from Jutland Way
7.	Little Neck Road near pole #76
8.	Little Neck Road near pole #78
9.	Little Neck Road on corner across from playground
10.	Bayview Road between Pavillion and first house on Bayview
11.	Clark Road near house #68 - to Clark Pond
12.	Clark Road out of basin to Clark Pond
13.	Clark Road near hydrant to Clark Pond
14.	Clark Road across from Skytop Road
15.	Foot of Bowdoin Road by fence
16.	Foot of Nuthatch Road
17.	Foot of Kingfisher Road
18.	North Ridge Road near pole #26
19.	North Ridge Road across from Herring Way
20.	North Ridge Road across from Goldfinch Way
21.	Skytop Road out of manhole at pole #32
22.	Skytop Road out of basin at pole 137/3
23.	North Ridge Road across from pole #3
24.	North Ridge Road out of basin at white house (Divine)
25.	132 Jeffreys Neck Road-out of basin in cedar trees
26.	Foot of Seaview Road
27.	Agawam Avenue at no parking sign by Town Wharf
28.	Damon Avenue out of basin in circle by house #20
29.	Arrowhead Trail by pole #9
30.	Arrowhead Trail Ext. through yard at house #26
31.	Applewood Drive between houses #14 and 16
32.	Upper River Road out of basin on lower corner
33.	Foot of Masconomet Road by house #43 near pole #9
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41.	Argilla Road across from pole #5/154
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43.	Argilla Road beyond pole #52
44.	Burridge Lane out of basin 1/2 way down road on right
45.	Burridge Lane out of basins on circle

46. Heartbreak Road near guard rail at stream
47. Turkey Shore Road near pole #2
48. Turkey Shore Road out of basin near Green Street bridge
49. Turkey Shore Road out of basin near pole #28
50. Riverside Drive out of basin at pole #8
51. Tansey Lane across from pole #3
52. Green Street Bridge - 3 basins each going to river
53. Water Street at corner with Green Street
54. Water Street across from Summer Street
55. Water Street near pole # 6
56. Water Street near IOC ramp about 50 feet west of flagpole
57. Water Street across from Hovey Street
58. Foot of Water Street at Town Wharf by sewer overflow pipe
59. Town Wharf out of basin at speed bump under landing to floats
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61. County Road across from Elm Street at small park
62. County Road at stream by park and stop light near Town Garage
63. High Street at High Street Ext. out of basin at Town Farm Road
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66. Currier Park - ties into state basins on High Street
67. Dornell Road out of basin by pole 138/5 ties into state basins
68. Mitchell Road out of basin at pole #3
69. Paradise Road diagonally across from fish and game club gate
70. Linebrook Road at manhole near pole #94
71. Linebrook Road out of basin at guard rail at house #156
72. School Street out of basin at pole #4
73. Linebrook Road out of basin at house #66
74. Kimball Avenue out of basin at house #41
75. Linebrook Road out of Basin at house #6
76. Liberty Street out of basin by RR tracks
77. Behind Brooks off Liberty Street
78. Brown Street behind Martells Garage
79. Appleton Park out of manhole in circle
80. Blaidsdell Terrace out of basin at end of street
81. Mineral Street near house #12
82. Granite Court by shed-underground connection to Farley Brook
83. Town parking lot by fish market- underground connection
83a. Unknown outlet by Tedfords from Mt. Pleasant Street area
84. Sewage Plant at base of parking lot
85. Warner Road out of basin at pole #9
86. Mill Road at Ipswich River
87. Topsfield Road out of basin across from pole #42
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89. Bush Hill Road out of manhole at Abell Avenue
90. Bush Hill Road out of basin at circle
91. Colonial Drive - River Ridge and Bayside Condo's
92. Kennedy Drive out of basin across from house #1
93. Heard Drive out of manhole across from House #6
94. Topsfield Road out of basin at pole #20
95. Winter Street across from house #6
96. Peabody Street out of basin at Kimball Brook
97. Haywood Street across from Pole #2 at Kimball Brook

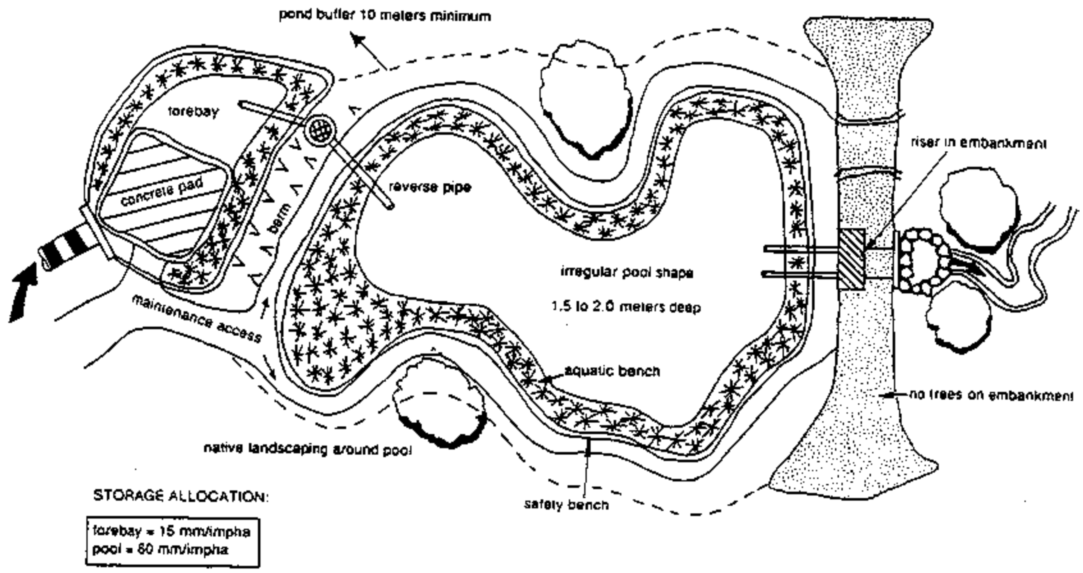
98. Topsfield Road across from Wayne Avenue
99. Topsfield Road at RR crossing
100. Estes Street out of basin between Sylvania and Riverview
101. Foot of River Court
102. Foot of Peatfield Street
103. Foot of First Street
104. Second Street and Kimball Street to Kimball Brook
105. Union Street out of basin across from Vinwood Caterers
106. Outlet of Farley Brook culvert behind Woolworths
107. Market Street behind Cooperative Bank
108. Parking lot of Aspen leaf by Choate Bridge
109. South Main Street out of basin by pole #5
110. South Main Street out of manhole by Pole #7 in front of QLF
111. Basin #1 drain on Little Neck
112. Basin #2 drain on Little Neck
113. Basin #3 drain on Little Neck
114. Little Neck by dock near community center

(List compiled with the help of the Public Works Department)

APPENDIX I

BEST MANAGEMENT PRACTICES FOR STORM DRAIN ABATEMENT:
(Diagrams, planning considerations, and design considerations were taken directly from the Massachusetts Department of Environmental Protection Stormwater Technical Handbook - Volume Two March 1997, Chapter 3 - Best Management Practices.)

VEGETATED SWALE:



This BMP will reduce runoff velocities and potential erosion from the discharge of runoff. It will also help to remove particulate pollutants from stormwater runoff and increase infiltration. It works to improve water quality and reduce peak runoff by limiting the velocity in the swale. Vegetated swales remove pollutants at a significantly higher rate than drainage channels. They are generally less expensive than curb & gutter systems, and work well to reduce driving hazards by keeping stormwater flows away from the street. A swale can be used at sites where a dense strand of vegetation can be established and where either a stable outlet exists, or can be constructed as a suitable conveyance system to safely dispose of runoff flowing from the swale (Franklin et. al. 1997). It can also be used in residential areas of low to moderate density where the percentage of impervious cover is relatively small, in a drainage easement, and adjacent to parking areas.

Planning Considerations:
When designing a vegetated swale, the primary considerations are soils, capacity, erosion and vegetation. Site considerations and design specifications may limit usage. Swale capacity should be based on the maximum expected reduction in velocity that occurs when vegetation is at maximum growth for the year. The minimum level should be used when checking velocity through the swale. This usually occurs during the early growing season and dormant periods. Other important planning considerations for swales are land availability and maintenance requirements. The topography of the site should allow for the swale's design to be sufficient in slope and to provide for a cross-sectional area. The cross-sectional area will maintain a nonerosive flow. The longitudinal slope of the swale should be as close to zero as possible and not greater than 5%. Grass or vegetation types used in swales should be suited to soil and water conditions. Wetland hydrophytes or obligate species are generally more water tolerant than facultative species and are good selections for wet swales.

Grassed swales should be planted with species that produce fine and dense cover and are adapted to varying moisture conditions.

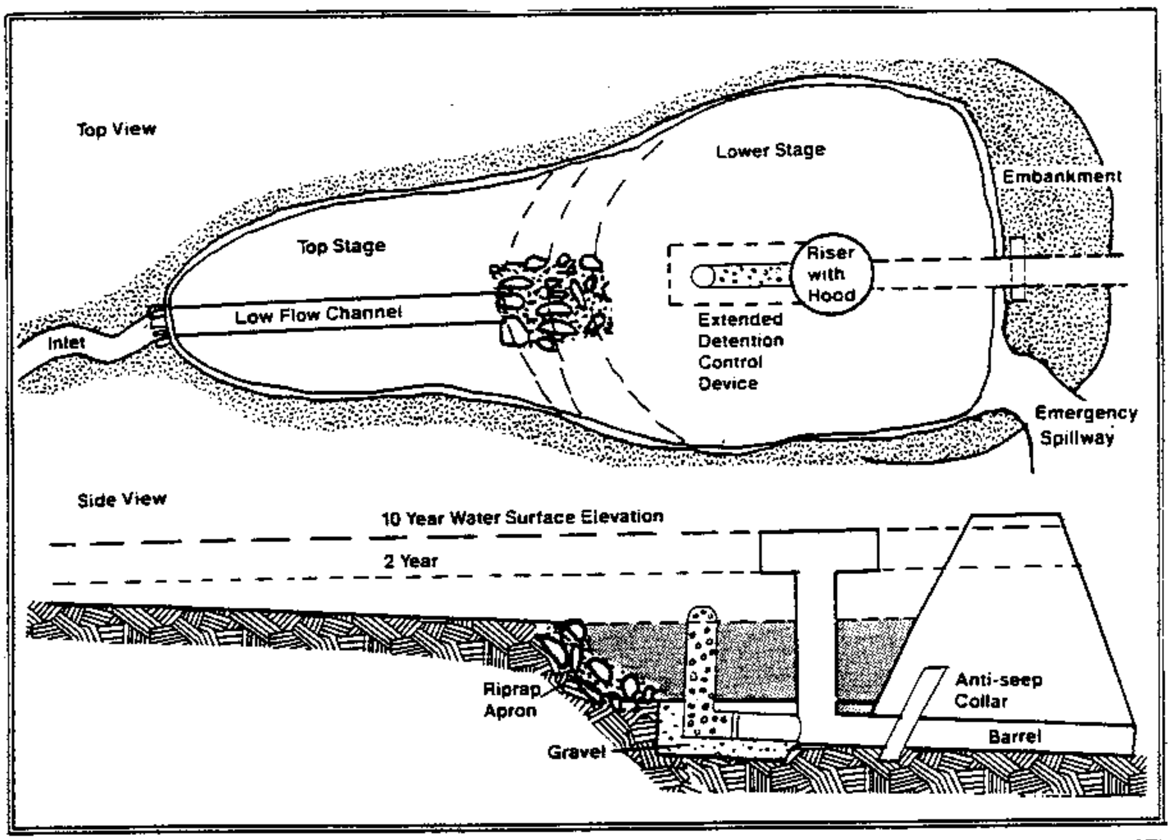
Design:
See the following references for complete design instructions:

Site Planning for Urban Stream Protection. 1995 Schueler. Center of Watershed Protection.

Watershed Protection Techniques, Volume 2, Number 2, 1996. Center for Watershed Protection.

Biofiltration Swale Performance, Recommendations, and Design Considerations. 1992. Metro Seattle: Water Pollution Control Department, Seattle, WA.

CONSTRUCTED WETLAND:



(Schueler, 1987)

This BMP is designed to maximize the removal of pollutants from stormwater runoff through wetland vegetation uptake, retention and settling (MA DEP 1997). They temporarily store runoff in shallow pools that support conditions suitable for the growth of wetland plants. It is important to note the difference between constructed stormwater wetlands and natural wetland areas. Constructed wetlands have been engineered for compensatory storage purposes, restoration, and are designed specifically for flood control and water quality purposes. They do not have the full range of ecological functions of natural wetlands.

Planning Considerations:
Sites must be carefully evaluated when planning constructed wetlands. Soils, depth to bedrock, and depth to water table must be investigated before designing and siting constructed wetlands. A "pondscaping plan"

should be developed for each constructed wetland. This plan should include hydrological calculations (or water budget), a wetland design and configuration, elevations and grades, a site/soil analysis, and estimated depth zones. The plan should also contain the location, quantity, and propagation methods for the constructed wetland plants. Site preparation requirements, maintenance requirements, and a maintenance schedule are also necessary components of the plan. The water budget should demonstrate that there will be a continuous supply of water to sustain the constructed wetland. The water budget should be developed during site selection and checked after preliminary site design. Drying periods of longer than two months have been shown to confirm that drying will not exceed two months. Establishment and maintenance of the wetland vegetation is an important consideration when planning a constructed wetland. (DEP, Vol. 2, 1997.)

Horner et al. (1994) complied the following list of recommendations for creating wetlands:

- In selecting plants, consider the prospects for success more than the specific pollutant capabilities. Plant uptake is an important removal mechanism for nutrients, but not for other pollutants. Information on vegetative pollutant removal has been compiled, however. The most versatile genera, with species throughout the country, for pollutant removal appear to be *Carex*, *Scirpus*, *Juncus*, *Lemna*, and *Typha*.
- Selection of native species should avoid those that invade vigorously.
- Since diversification will occur naturally, use a minimum of species adaptable to the various elevation zones within the constructed wetland.
- Give priority to perennial species that establish rapidly.
- Select species adaptable to the broadest ranges of depth, frequency, and duration of inundation (hydroperiod).
- Match site conditions to the environmental requirements of plant selections.
- Take into account hydroperiod and light conditions.
- Give priority to species that have already been used successfully in constructed wetlands and that are foraged by the wildlife expected on site.
- Establishment of woody species should follow herbaceous species.
- Add vegetation that will achieve other objectives, in addition to pollution control.

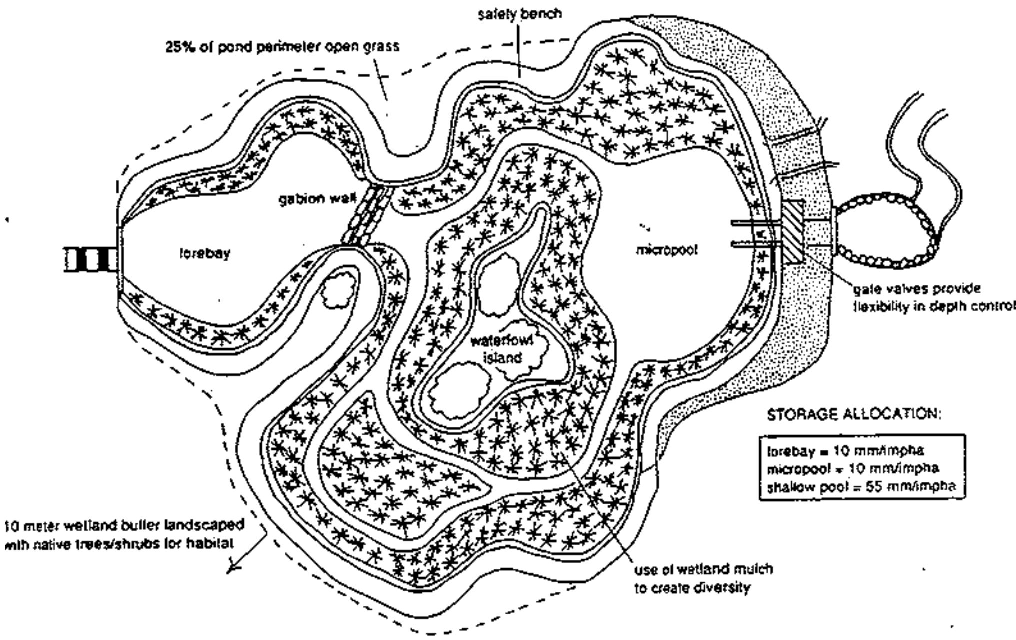
The plant community will develop best when the soils are enriched with plant roots, rhizomes, and seed banks. Use of " wetlands mulch" enhances the diversity of the plant community and speeds establishment. Wetland mulch is hydro soil that contains vegetative plant material. This mulch can be obtained where wetland soils are removed during dredging, maintenance of highway ditches, swales, sedimentation ponds, retention/detention ponds, or clogged infiltration basins. Wetland soils are also available commercially. The upper 5.9 inches of donor soil should be obtained at the end of the growing season, and kept moist until installation. (DEP, Vol. 2, 1997.)

Design:

See the following references for complete design instructions:

Design of Stormwater Wetland Systems. 1992. Schueler. MWCOG Information Center.

DETENTION BASIN:



This BMP is designed to hold stormwater for at least 24 hours to allow solids to settle and to reduce local and downstream flooding. The basin is also designed to remove particulate pollutants from runoff. Essentially, they are modified conventional dry ponds or basins. They should be constructed to have the capacity to regulate peak flow rates of large, infrequent storms (10, 25 or 100 years). It is necessary to construct a lower section of the basin that detains smaller storms for a sufficient period of time in order to remove pollutants from runoff. The advantages or this BMP are that it (1) is the least costly BMP to control stormwater quality and quantity, (2) can remove significant levels of sediment and sorted pollutants, (3) has less potential for hazards than deeper permanent pools and, (4) has potential for beneficial terrestrial and aquatic habitat.

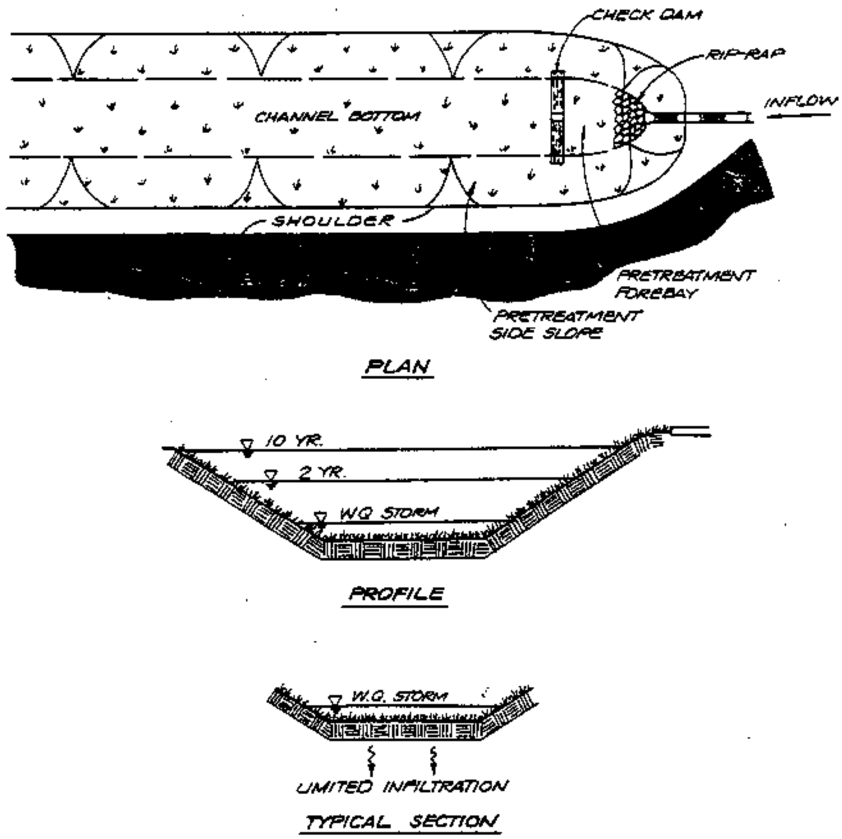
Planning Considerations:
Soils, depth to bedrock and depth to water table should be checked before designing a detention basin. It is possible to have problems with standing water if soils are relatively impermeable, or if the water table is within two feet of the bottom of the detention basin. Maximum depth of detention basins may range from 3 to 12 feet. Detention basins should be above normal groundwater elevation (i.e. should not intercept groundwater). The effects of seepage on the basin need to be investigated, if the basin is to intercept the groundwater table. (DEP, Vol. 2, 1997.)

To be effective in reducing peak runoff rates, the basin must be located where it can intercept most of the runoff from the site. Usually, this location is found at the lowest elevation of the site where wetlands are found. The effects of a detention basin on wetland resources must be examined. Altered wetland resources must be mitigated according to local, state, and federal regulations. Under the requirements of the state's 401 Water Quality Certification Regulations, not detention ponds or other stormwater controls may be located in natural wetlands (See Appendix O for MA Water Quality Certification Requirements summary.)
Embankments, or dams, created to store more than 15 acre-feet, or that is more than 6 feet in height, is under the jurisdiction of the state Office of Dam Safety and is subject to regulation. (DEP, Vol. 2, 1997.)

Design:
See the following document for complete design references:

Design of Stormwater Pond Systems. 1996. Schueler. Center for Watershed Protection.

RETENTION BASIN:



(Also called Wet Retention Pond.) This BMP utilizes a permanent pool of water as the primary mechanism to treat stormwater. The pond operates to treat stormwater by allowing incoming water to displace water that is already in the pool. The new stormwater will remain in the pool until it is displaced by runoff from another storm event. This feature warrants settling over a longer period of time, which in turn allows particulates, including fine sediments, to deposit. There is a permanent pool that serves to protect deposited sediments from resuspension during a large storm event. Biological activity of algae and fringed wetland vegetation reduces the concentration of soluble pollutants. The ponds have a moderate to high capacity for removing most pollutants, depending on how large the volume of the permanent pool is in relation to the runoff from the surrounding watershed (MA DEP 1997).

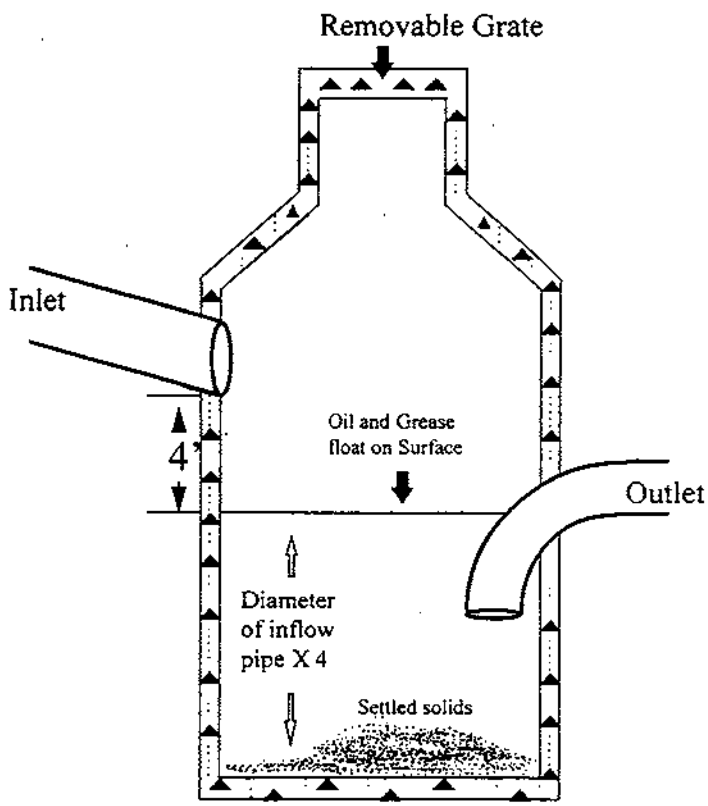
Planning Considerations:
Soils and depth to bedrock must be checked before designing a wet pond in a retention basin. If the soils are impermeable (A and B soils), heavy drawdown of the pond may occur during dry periods. In these situations, the potential for drawdown can be minimized by installing a liner at the bottom of the pond or by compacting the pond soils. To be effective in reducing peak runoff rates, the pond must be located where it can intercept most of the runoff from the site. Usually this location is found at the lowest elevation of the site where freshwater wetlands are most often located. The effects of the wet pond on wetland resources must be examined. Altered wetland resources must be mitigated according to local, state, and federal regulations. Embankments, or dams, created to store more than 15 acre-feet, or that is more than 6 feet in height, is under the jurisdiction of the state Office of Dam Safety and is subject to regulation. (DEP, Vol. 2, 1997.)

Design Criteria:
See the following document for complete design references:

Wet extended Detention Pond Design: Step by Step Design. 1995. Claytor. Center for Watershed Protection.

Design of Stormwater Pond Systems. 1996. Schueler. Center for Watershed Protection.

NEW DEEP SUMP CATCH BASIN WITH OIL TRAP:



This particular type of BMP is also known as an oil and grease or hooded catch basin. It is designed as an underground retention system to remove trash, debris and some sediment and oil/grease from stormwater runoff. It functions as a modified catch basin and has (by design) the stormwater inflow at the top of the basin. The discharge point is located at least 4 feet below the inflow point. Typically, the basin will have a permanent pool of water that oil and grease will float on. Stormwater flows through a screen into this chamber with the permanent pool, it then passes through the opening of an inverted pipe to the bottom where solids settle on the bottom. The benefits of this BMP are (1) it removes debris, sediment and hydrocarbons from stormwater runoff, (2) it provides treatment for other BMPs, and (3) it can be used for retrofitting small urban lots where larger BMPs are not feasible. Lastly, longevity of the systems is high, and standardized designs allow for relatively easy installation.

Planning Considerations:
Provisions need to be made for frequent cleaning and inspection. Catch basin materials often include various concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals. Catch basin cleanings are classified as solid waste by DEP and must be handled and disposed of in accordance with DEP regulations, policies, and guidelines (DEP, Vol. 2, 1997). Under written approval, cleanings may be disposed at

any DEP permitted landfill however, cleanings containing free draining liquids are prohibited. In the absence of DEP written approval, catch basin cleanings must be taken to a DEP facility to accept the solid waste and dispose of it properly.

Design Criteria:
The inflow pipe should be sized and constructed to pass the design storm volume into the water quality inlet or deep sump and excess flows should be directed to another BMP of sufficient capacity to meet the water quantity requirements or to a storm drain system. An off-line design should enhance pollutant removal. To achieve constant removal of pollutants, the volume of the permanent pools in the chambers of the inlets should be maximized. The combined volume of these pools should equal at least 400 cubic feet per acre of contributing impervious area. The pools should be at least four feet deep for settelability. Where feasible, the third chamber should also be used as a permanent pool (see p. I-10). Vertical baffles at the bottom of the permanent pools can help to minimize sediment resuspension. To keep out floatables, a trash rack or screen should cover the discharge outlets. To trap hydrocarbons in the water quality inlets, an inverted elbow pipe should be located between the second and third chambers and the bottom of the pipe should be at least three feet below the second chamber permanent pool. For deep sumps, the four times sizing rule (i.e. depth equals 4X pipe diameter) must be followed. Manholes should be included for each chamber to provide access for cleaning. (DEP, Vol. 2, 1997.)

VORTECHNICS BRAND UNIT

The Vortechs Stormwater Treatment System efficiently removes grit, contaminated sediments, heavy metals, and oily floating pollutants from surface runoff. This highly innovative oil and grit separator has high removal rates, minimal land consumption, low maintenance, and cost-effectiveness (Vortechnics 1999). Maintenance is made easy with its easy access manhole located directly on top of the large openings in the system's grit chamber. Removal of large objects and contaminants is much easier.

For more information on the Vortechs Stormwater Treatment System, contact:

Vortechnics, Inc.
41 Evergreen Drive
Portland, ME 04103
tel. 207-878-3662
fax 207-878-8507
e-mail vortechnics@vortechnics.com
www.vortechnics.com

DOWNSTREAM DEFENDER BRAND UNIT

The Downstream Defender treatment is a device designed to capture settleable solids, floatables, oils and grease from stormwater runoff. More versatile than conventional stormwater treatment systems, Downstream Defenders require a fraction of the land area of storage tanks and detention ponds. Standard sizes are available; each designed to treat a predetermined design flow to a predetermined solids removal efficiency based on particular solids grading curves (H.I.L. 1999).

For more information on the Downstream Defender treatment system, contact:

H.I.L. Technology, Inc.
94 Hutchins Drive
Portland, ME 04102
tel. (207) 756-6200
toll free (800) 848-2706

fax (207) 756-6212
hiltech@hil-tech.com
www.hil-tech.com

APPENDIX J


Parker River/Essex Bay
Area of Critical Environmental Concern
NORTHERN MAP KEY
ACEC Boundary
(Designated March 2, 1979)
Basemap: Georgetown (1966), Gloucester, Ipswich (1966), Newburyport East (1966), and Newburyport West (1968) 1:25,000-scale USGS topographic maps.
ACEC Program, Dept. of Environmental Management, 100 Cambridge Street, Boston, MA 02202 (617)-727-3160
PLUM ISLAND
PARKER RIVER NATIONAL WILDLIFE REFUGE
PLUM ISLAND SOUND
NEWBURY
ROWLEY
ATLANTIC OCEAN
Newbury Old Town
Tidal Flat

APPENDIX K

FAILED AND SUSPECT SEPTIC SYSTEM LIST:

Note: To protect the privacy of individual landowners, the recommendations and information in this appendix is confidential and is therefore not included in public copies of this report. For further information, please contact the Ipswich Board of Health.

APPENDIX L

STORM DRAIN SAMPLE RESULTS ANALYSIS
Neck Locations, Unsewered

STATION NO.	LOCATION	DATE	RAIN	BACTERIAL CONCENTRATION "F" fecals / 100ml	FLOW GPM "Q"	HUMAN EQUIVALENTS F x Q x 2.7 x 10-8 1 H.E. = 2 x 109 fecals / day	BACTERIAL LOADING F x Q x 54800 fecals / day
9	Two storm drains across from Pavillion	08/18/92	2.0" Cum. .8" 08/17	6,500	100	17.9	356 x 108
23	Mulholland Drive	05/14/92	None Recent	30	2	---	---
24	Plover hill Road	07/27/93	.45" Cum.	35,000	20(2)	19.3	383 x 108
51	Northridge Road, Pole #26	08/14/92	.3" Cum. .8" 08/09	>24,000	10(2)	6.6	131 x 108
52	Northridge Road at Goldfinch	06/11/92	.25" 06/08 2.3" 06/06	3,100	5	0.4	8.5 x 108
54	Little Neck Road across from Pavillion - West	07/16/92	.75" 24 hours	950	13	0.3	6.8 x 108
55	Little Neck Road across from Pavillion - East	07/16/92	.75" 24 hours	350	1	0.0	0.2 x 108
60	Little Neck Road at Sutland Way	08/18/92	2" Cum. .8" 08-17	2,900	8	0.6	12.7 x 108
62	Northridge Road at base of hill	08/18/92	2" Cum. .8" 08-17	>10,000	40	11.0	219 x 108
101	S.D. #14 at Skytop Road	02/12/93 11/17/93 03/02/93	None Recent	790 130 50	5 8 10	---	---
102	S.D. #12 at Clark Road	02/12/93 03/02/94	None Recent	50 490	3 10	---	---
103	S.D. #11 at Clark Road	02/12/93 03/02/94	None Recent	24,000 24,000	1 15	---	---
12/29/94	**Notes: (1) Maximum Loadings recorded after a rain event, not necessarily the maximum that could have occurred. (2) Flow is estimated value typical of this storm drain**				**Average**	**7.0**	**139.7 x 108**

STORM DRAIN SAMPLE RESULTS ANALYSIS
Sewered Downtown Locations Feeding Ipswich River

STATION NO.	LOCATION	DATE	RAIN	BACTERIAL CONCENTRATION "F" fecals / 100ml	FLOW GPM "Q"	HUMAN EQUIVALENTS F x Q x 2.7 x 10-8 1 H.E. = 2 x 109 fecals / day	BACTERIAL LOADING F x Q x 54800 fecals / day
1	Agawam Avenue S.D. #27	07/27/93	.45" Cum.	35,000	60	57.8	1151×10^8
4	Summer Street S.D. #54	07/27/93	.45" Cum.	13,000	25	8.9	178×10^8
5	Ditch/storm drain Eastside I.O.C. Lot	08/18/92	.2" Cum. .8" 08/17	10,000	60	16.5	328×10^8
6	Foot of Hovey Street	08/12/92	.2" Cum. .8" 08/17	8,500	60	14.0	279×10^8
10	Storm drain next to town sewer overflow	08/18/92	.2" Cum. .8" 08/17	1,200	8	0.3	5×10^8
18	Storm drain at Pole #2 Turkey Shore Road	05/14/92	None Recent	<10	1.5	---	---
27	County Road by bridge S.D. #60	07/28/93	.45" Cum.	14,000	40	15.4	306×10^8
58	Storm drain/ditch Westside I.O.C. Lot	08/18/92	.2" Cum. .8" 08/17	6,000	20	3.3	66×10^8
80	Off Market Street behind Chipper's	08/14/92	.3" Cum. .8" 08/09	9,200	20(2)	5.1	100×10^8
94	Main Street S.D. #109	07/27/93	.4" Cum.	28,000	20	15.4	306×10^8
106	Off Green Street under Roverwalk S.D. #111	07/27/93	.4" Cum.	92,000	25	63.3	1260×10^8
107	Town Wharf parking lot S.D. # 59	07/27/93	.4" Cum.	54,000	40	59.4	1184×10^8
12/29/94	**Notes (cont'd): (3) Maximum Loadings are often of short duration and cannot be compared with continuous loadings.**				**Average**	**21.6**	**430×10^8**

APPENDIX M

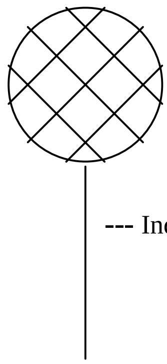
RECOMMENDATIONS FOR SPECIFIC AGRICULTURAL SOURCES:

Note: To protect the privacy of individual farm owners, the recommendations and information in this appendix is confidential and is therefore not included in public copies of this report. For further information, please contact the Ipswich Animal Control Officer or Conservation Agent.

APPENDIX N

DIAGRAMS/STREET LOCATIONS OF RECOMMENDED BEST MANAGEMENT PRACTICES:

Key: The following symbol indicates the location of below grade structural in-line BMPs such as Vortechnics or Downstream Defender brand units:

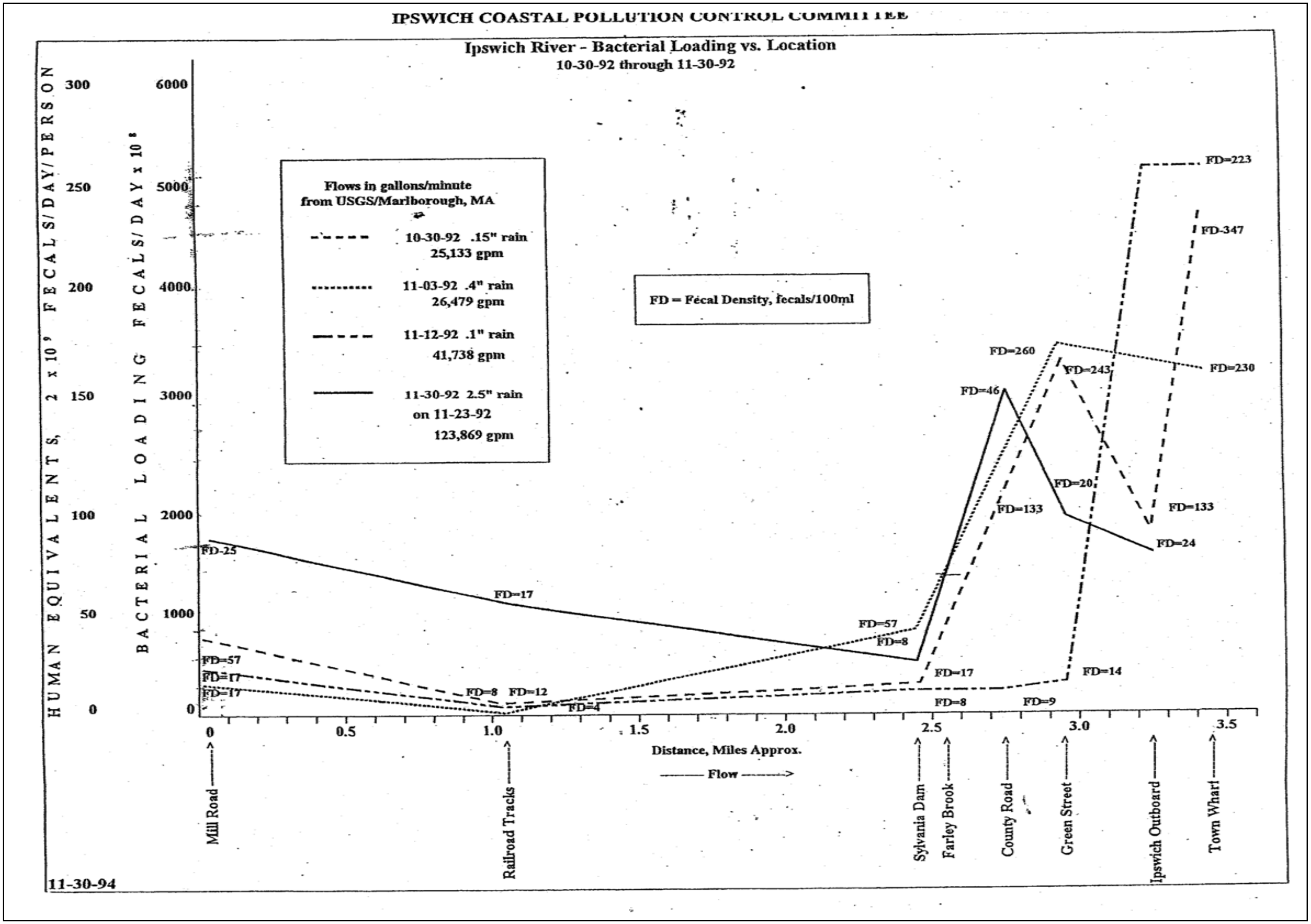


--- Indicates Outlet (Discharge) Pipe

(1) Other BMP's categories are labeled on each page.
(2) Diagrams have been drawn on town Assessor's Maps. Street names and lot numbers are provided.

NOTE: **Please contact the Massachusetts Office of Coastal Zone Management for copies of these diagrams at: 617-626-1200 or by e-mail at: czm@state.ma.us.**

APPENDIX O



IPSWICH COASTAL POLLUTION CONTROL COMMITTEE
Ipswich River - Bacterial Loading vs. Location
10-30-92 through 11-30-92
HUMAN EQUIVALENTS, 2 x 10⁹ FECALS/DAY/PERSON
BACTERIAL LOADING FECALS/DAY x 10⁸
300
250
200
150
100
50
0
6000
5000
4000
3000
2000
1000
0
Flows in gallons/minute
from USGS/Marlborough, MA
10-30-92 .15" rain
25,133 gpm
11-03-92 .4" rain
26,479 gpm
11-12-92 .1" rain
41,738 gpm
11-30-92 2.5" rain
on 11-23-92
123,869 gpm
FD = Fecal Density, fecals/100ml
FD=223
FD-347
FD=260
FD=243
FD=230
FD=46
FD=20
FD=133
FD=133
FD=24
FD-25
FD=17
FD=57
FD=8
FD=17
FD=14
FD=57
FD=17
FD=17
FD=8
FD=12
FD=4
FD=8
FD=9
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Distance, Miles Approx.
Flow
Mill Road
Railroad Tracks
Sylvania Dam
Farley Brook
County Road
Green Street
Ipswich Outboard
Town Wharf
11-30-94