

NORTH GREEN STORMWATER MANAGEMENT PROJECT

SECTION 319 NPS PROJECT 01-17/319

PREPARED BY:

TOWN OF IPSWICH
DEPARTMENT OF PLANNING AND DEVELOPMENT

PREPARED FOR:

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF RESOURCE PROTECTION

AND

US ENVIRONMENTAL PROTECTION AGENCY
REGION 1

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This project has been financed with Federal Funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (the Department) under an s.319 competitive grant. The contents do not necessarily reflect the views and policies of EPA or of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

May 19, 2005

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2002 -- 2004

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I. Executive Summary

The goal of the North Green Stormwater Management Project was to provide a means to treat stormwater from the North Green area before it enters the Ipswich River, thus mitigating the adverse impact of the stormwater runoff on the approximately 300 acres of shellfish bed that lie downstream of the discharge point. The project goal was accomplished by constructing a closed drainage system in the area, consisting of deep sump catch basins, catch basins with outer hoods, a CDS stormwater quality unit, and a sand filter. It was anticipated that 80% of TSS would be removed from the stormwater prior to discharge into the river. The purpose of the sand filter was to remove bacteria from the stormwater.

The stormwater improvements were undertaken in 2003. Over the course of the next year, the Town monitored the quality of the treated stormwater. The results indicate that the installed BMPs have significantly reduced the extent of fecal coliform and TSS that is flushing from the North Green area into the Farley Brook and the Ipswich River.

The North Green Stormwater Management Project is part of a comprehensive program to mitigate stormwater impacts. To enhance the pollutant remediation provided by the project, the Town has taken other non-structural initiatives, including outreach and education to encourage homeowner BMPs. This was achieved through the preparation and distribution of a brochure about nonpoint source pollution, which included discussion of lawn fertilizer use, pet waste, septic system maintenance, stormwater management, and pesticide/herbicide application. The brochures were distributed to all residents in the project area and are available to the general public at the Town Hall and the Public Library.

To ensure that the stormwater improvements remain effective over the long-term, the Town developed a comprehensive Operation and Maintenance Program for the North Green drainage system. The plan which was developed with input from project designers, equipment manufacturers, Ipswich DPW staff, and natural resource staff from the Department of Planning and Development, describes the system's operation, provides a program and record of cleaning and maintenance necessary to ensure the proper functioning of the system, and relevant regulations governing catch basin cleaning and disposal of street sweeping.

II. Project Summary

The North Green Stormwater Management Project included the design and construction of a closed stormwater management system and stormwater treatment device on North Main Street in Ipswich, Massachusetts. The project area lies in a portion of downtown Ipswich, located approximately at the intersection of Central Street (Route 133/1A)/Market Street and extends along North Main Street to the intersection of Green Street/Meeting House Green. The site slopes toward the Ipswich River.

Prior to this project, stormwater runoff from the project flowed directly into the river or into Farley Brook, a tributary, carrying sediment, bacteria, salt, petroleum products, and other non-point source pollutants with it. High levels of pollutants, including fecal coliform and other bacteria, have been documented in Farley Brook and in the Ipswich River downstream of the North Green.

The primary goal of the project was to capture and treat stormwater runoff from the project area before it entered the river. At the time of application, the project was projected to remove 80% of total suspended solids from the stormwater discharge, but did not necessarily remove significant amounts of bacteria. Upon receiving a Coastal Pollution Remediation Grant from CZM to supplement the 319-funds, the Town added a BMP (i.e., sand filter) to specifically remove bacteria. Improvements in water quality brought about by this project are expected to significantly benefit approximately 300 acres of shellfish bed that lie downstream of the discharge point.

Components of the new North Green drainage system included deep sump catch basins with hoods, which were predicted to remove approximately 25% of Total Suspended Solids (TSS), and one CDS stormwater quality unit, which were projected to remove approximately 55% of TSS.

Project Scope

The following tasks were undertaken as part of the overall project scope:

Task 1: Quality Assurance Project Plan (QAPP)

A Quality Assurance Project Plan was drafted, revised and approved by DEP/EPA. For a full discussion of the QAPP task, please refer to Section IV of this report, “Environmental Monitoring.” Deliverables under this task include:

- DEP and EPA-approved QAPP (A full copy of the QAPP is available from the Division of Watershed Management, DEP, 627 Main Street, Worcester, MA 01608); and
- Analytical report and data sheets for pre-and post-installation water quality monitoring at the outlet to the Ipswich River (Appendix A).

Task 2: Design, Permitting and Construction of Drainage System

- A. Under the Direction of the Ipswich Department of Public Works, a survey of the project area was conducted. A closed drainage system including 17 deep sump catch basins, 11 manholes, one CDS stormwater treatment device, a sand filter, and over 2000 linear feet of main pipe for stormwater conveyance were designed, permitted and installed. Final design was consistent with the conceptual plans that the Town submitted as part of its original 319 proposal. A consultant, VHB of Watertown, Mass, was hired to provide preliminary and final design services. Deliverables included: (a) Final design and construction plans for the closed drainage system and stormwater treatment device (submitted for review and comment to the DEP project officer prior to construction. The final plans were reviewed and stamped by VHB's professional engineer prior to review by the DEP project officer); (b) Construction permits and approvals were obtained; (c) final "as-built" drawings of the stormwater system were prepared and submitted to DEP; (d) a letter from the designer stating that the system was installed according to design specifications was provided (see Appendix B); and (e) Vendor Information Forms from all bidders who responded to the public bid for the project.

Task 3. Operation and Maintenance Plan

A long-term Operation and Maintenance Program, "North Green Neighborhood Drainage Improvements," prepared by VHB, was completed on December 29, 2003 (Appendix C). The plan was developed with input from project designers, equipment manufacturers, Ipswich DPW staff, and natural resource staff from the Department of Planning and Development. Deliverables included:

- Operation and Maintenance Program, "North Green Neighborhood Drainage Improvements: Ipswich, Mass.," prepared for Robert Gravino, Director, DPW, prepared by VHB, dated December 29, 2003. Contents: Description of System, O/M Program, and Attachments including plans, maintenance and inspection checklists, and relevant regulations governing catch basin cleaning and disposal of street sweeping.
- Best Management Practices: Maintenance/Evaluation Checklist and CDS Technologies "Annual Record of Operation and Maintenance;" together, these provide a program and record of cleaning and maintenance necessary to ensure the proper functioning of the system (This was incorporated into the Operation & Maintenance plan).

Task 4: Outreach and Education

A 2000 Coastal Pollution Remediation Plan for the Town identified four major sources of bacteria in stormwater affecting the coastal areas in Ipswich. These include animal waste and urban runoff from developed areas, as well as failed septic systems and overflow of untreated waste from the municipal sewer system. Originally, the Town's plan was to install a BMP that removed sediment, but did not necessarily remove significant amounts of bacteria. Upon receiving a Coastal Pollution Remediation Grant from CZM to supplement the 319-funds, the Town added a BMP (i.e., sand filter) to specifically remove bacteria. Still, the BMPs do not prevent 100% of all pollutants from entering the Ipswich River. Thus, the Town has developed materials about nonpoint source pollution, which recommend BMPs on the topics of lawn fertilizer, pet waste, septic system maintenance, stormwater management, and pesticide/herbicide application. Materials have been distributed to all residents in the project area and are available at the Town Hall, Public Library, and the Town's website (www.town.ipswich.ma.us). Deliverables for this task included the aforementioned materials and a report outlining how the information was (a) distributed directly to project area homeowners; and (b) how it was made available for wider distribution. Copies of the letter to residents, the web narrative, and the informational brochure are provided in Appendix D.

Task 5: Reporting

The following reports have been submitted to DEP in accordance with the Milestone Schedule (Attachment C, Section 319 NPS Project 01-17/319 Contract):

5a: Quarterly progress reports (1/1/03-3/31/03; 4/1/03-6/30/03; 7/1/03-9/30/03; 10/1/03-12/31/03) were submitted providing a summary of all work completed, by task and as a percentage of each task completed, during the reporting period. Quarterly 5700-52a M/WBE were submitted to the Department's Contract's Manager.

5b. A draft final report is being submitted herewith to the Department's project officer and 319 Program Coordinator.

5c. Once (1) camera ready copy and twenty-five (25) copies of the final report and a diskette with electronic versions of the final report which are compatible with the Department's internet website (.pdf format) and software system (MS Word 6.0) will be submitted to the Department by June 30, 2005.

5d. An Acknowledgement of Support will be made in connection with the publishing and internet posting of any material based on or developed under this Agreement, and will be in the form of a statement substantially as follows:

"This project has been financed with Federal Funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (the Department) under an s.319 competitive grant. The contents do not necessarily reflect the views and policies of EPA or of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use."

5e. Prior written approval from the Department will be secured before material derived from the deliverables received under this Agreement are presented for publication or posted on the internet.

5f: Acknowledgement will be given to the DEP and EPA as a part of any statements to the press regarding this project.

III. Project Budget

Project Expenses	Budget	Actual	DEP	CZM	Funds
Miles Rvr Sand & Gravel	\$314,869	\$359,730	\$207,324	\$67,875	\$84,531
CES, Inc. (engineering)	20,995	21,810	\$20,676		1,134
VHB (O/M Plan)	3,000	3,000			3,000
Police & Fire Details	34,000	50,403			50,403
QUAPP	3,600	3,600			3,600
SUBTOTAL:	\$376,464	\$438,543	\$228,000	\$67,875	\$142,668
In-Kind Services					
Personnel	13,875	16,822			16,822
TOTAL	\$390,339	\$455,365	\$228,000	\$67,875	\$159,490

The initial budget for the North Green Stormwater Management Project was just under \$400,000.* The expectation was that Town would contribute about \$120,000 toward the project cost, about 12% of which would be in the form of in-kind services. The identified funding sources for the project were DEP’s 319 program, CZM’s Coastal Pollution Remediation program, and the Town’s Chapter 90 funds. After the Town’s initial application for CPR funds was rejected, we added an additional BMP (sand filter) and resubmitted the project to CZM. This time the grant was awarded, but the project cost increased to accommodate the sand filter. Ultimately, the project cost exceeded all of the funds appropriated for the project, resulting in another \$40,000 of costs for the Town, nearly one-third higher than the projected amount.

The budgeting for this project was complicated by the fact that the DEP and CZM grants had their own matching and completion requirements. The CPR funds and its required local match needed to be expended on specific elements of the project that met, in the judgment of CZM, the objectives of the CPR program. The Town also needed to ensure that none of the local match came from the 319 funds. Further, because the CPR funds had to be expended by the end of the fiscal year, the Town needed to organize the construction sequencing to ensure that this requirement was met. The overall cost estimates were reasonably accurate, except in one respect. The costs for police and fire details exceeded the budgeted amount by more than 30%. This overage was due in part to the fact that police details needed to be supplemented by a fire detail whenever blasting occurred, which was frequently. Our office was unaware of this requirement when the project was estimated. The cost of the police and fire details represented nearly 12% of the total construction cost, an extraordinarily high percentage in our opinion.

* Exclusive of the cost of project design, which was approximately \$50,000 and was borne entirely by the Town.

IV. Environmental Monitoring

The Town of Ipswich coordinated the development of a DEP/EPA-approved QAPP, which governed protocols for all water quality sampling conducted pre- and post-construction to evaluate the project results.

In accordance with the QAPP, pre- and post-construction water quality monitoring was conducted to assess improvements in stormwater quality being discharged to the river and in the river itself. For the pre-construction monitoring, six events were sampled during wet and dry weather events at two sites. Sampling measured total suspended solids, *E. coli*, and fecal coliform. US EPA EMPACT grant funds were used for this task, which was undertaken by a consultant.

There were four sampling rounds conducted post-installation of the BMPs. They were conducted on October 27, 2003, November 20, 2003, July 19, 2004, and December 11, 2004 (see Appendix A for more information).

The acceptable error for fecal coliform and *E. coli* samples was less than 30% RPD for log 10 transformed data. A total of 13 fecal coliform samples were collected, and 6 of those 13 (46%) were duplicated. The average RPD of the log 10 transformed values was 7.8%, with a range from 0.4%-27.8%. All values thus met the quality control standard of less than 30% RPD. A total of 13 *E. coli* samples were collected, and 6 of those 13 (46%) were duplicated. The average RPD of the log 10 transformed values was 1.8%, with a range from 0.0%-5.0%. All values thus met quality control standard of less than 30% RPD.

The acceptable error for TSS samples was less than 20% relative error. A total of 11 TSS samples were analyzed, and 3 of those 11 (27%) were duplicated. The relative error of the duplicates was 0%, 10.5%, and 66.6%. The 66.6% value was due to the low actual value of 2 and 4 mg/L of one of the duplicate samples, which skews the results. By dropping the low value sample, the relative error maximum of 20% is met.

The acceptable error for turbidity samples was less than 10% relative error. A total of 9 turbidity samples were analyzed, and 3 of those 9 (33%) were duplicated. The relative error of the duplicates was 0.1%, 5.7%, 18.6%, with an average of 8.1%. Thus one sample exceeded the acceptable error range.

Before the installation of the BMPs, as shown in Section 1 of Appendix A, the values of the wet weather fecal coliform samples at the confluence of the Ipswich River and Farley Brook in 14 samples ranged from 51-60,000 colonies per 100 mL, with an average of 3,391 colonies per 100 mL, and a standard deviation of 5,465.

After the installation of the BMPs, as shown in Section 2 of Appendix A, the values of the wet weather fecal coliform samples at the confluence of the Ipswich River and Farley Brook in 4 samples were 320, 30, 5,600 (average of duplicates), and 85 (average of duplicates) col/100mL, with an average of 1,508 col/100 mL and a standard deviation of 2,370 col/100mL.

Although the sample size is small, there is improvement between the before intervention average (3,301 col/100 mL) and the after intervention average (1,508 col/100 mL) at the confluence of Farley Brook and the Ipswich River.

For comparison purposes only (as there is no before intervention *E. coli* data), the values of the wet weather *E. coli* samples at the confluence of the Ipswich River and Farley Brook in 4 samples were 120, 22, 1050 (average of duplicates), and 80 (average of duplicates), with an average of 318 colonies per 100 mL and a standard deviation of 490.

Before the intervention, as can be seen in Section 1 of Appendix A, the values of the wet weather TSS samples at the confluence of the Ipswich River and Farley Brook in 2 samples were 5.6 and 106 mg/L, with an average of 55.8 mg/L,

After the intervention, as can be seen in Section 2 of Appendix A, the values of the wet weather TSS samples at the confluence of the Ipswich River and Farley Brook in 4 samples were 1, 1, 5 (average of duplicates), and 3 (average of duplicates) mg/L, with an average of 2.5 mg/L.

Although the sample size is small, there is improvement between the before intervention average for TSS (55.8 mg/L) and the after intervention average for TSS (2.5 mg/L) at the confluence of Farley Brook and the Ipswich River.

V. Results and Conclusions

Based on the reduction of the average load of fecal coliform and TSS into the Ipswich River at the confluence of Farley Brook, it appears that the North Green Stormwater Management Project has been successful in reducing the load of fecal coliform (and by inference *E. coli* bacteria) into the Ipswich River. The majority of data quality objectives were met in this study, although the sampling methodology was modified to account for the time necessary to sample.

Although the sample size is small, the results indicate that the North Green Stormwater Management Project was successful in reducing pollutant loading to the mainstem of the Ipswich River. Thus, this project contributed, as one piece of a larger strategy, to improving the anadromous fish runs in the Ipswich River, and thus also complements the Commonwealth's initiatives to clean up shellfish beds. These were the stated goals of this project undertaken by the Town of Ipswich and funded by DEP and CZM.

Less quantifiable than the results achieved by the installed BMPs are those associated with the education and outreach conducted by the Town as part of this project. Given that the materials prepared by the Town: (a) contained straight-forward and simple steps to minimize nonpoint source pollution; (b) were distributed to a fairly sizeable segment of the community; and (c) were presented in an easy to read format, it is the Town's estimation that the brochures had some effect in altering behavior and thus have contributed in some small way to the pollution remediation effort.

VI. Lessons Learned

The North Main Street Improvement Project, although ultimately successful, was a challenging project to undertake and complete, for a variety of reasons. *For one*, we found the project requirements from the funding sources (i.e., 319 and CPR) placed a significant burden on a small and already over-taxed town planning staff. *Second*, as noted previously, it was challenging to mesh the matching and completion requirements of the two different funding sources. *Third*, we encountered significant cost overruns that forced the Town to expend considerably more than originally anticipated.

Fourth, the construction management was a much more significant responsibility than we realized at the outset. At first, our intention was to oversee construction using existing town personnel, primarily the DPW Director and the engineer in the Town's utilities department. The DPW Director insisted that the Town hire a construction engineer to oversee the project construction. This turned out to be an exceedingly wise decision. A number of problems were encountered during construction, and had we not hired a professional engineer to help troubleshoot them, the overall project outcome would have been less sanguine. We were fortunate to hire a competent professional who did a fine job in preparing our QAPP. *Fifth*, the process for undertaking the post-installation monitoring turned out to be much more involved and time-consuming than we expected. Because our test areas were in the middle of a busy street, we could not test without cooperation from the Police Department, which they were not always able to provide. We also found it difficult to complete the required sampling during the length of the storm events that occurred.

Based on our experience with this project and the 319 grant program, we offer the following advice to other grantees and other prospective program applicants:

- Understand that considerable resources need to be expended to satisfy the requirements of the 319 program
- Take advantage of the strong support provided the 319 staff
- Make sure you include a clerk of the works and make it a project cost

- Hire a professional to develop your QAPP and develop a workable strategy for undertaking pre- and post-construction monitoring.
- Recognize that police and fire detail costs can represent a significant part of overall construction costs

VII. References and Further Reading

In preparing the educational materials about nonpoint pollution for distribution to residents in the project area and the wider community, the Town made use of the following resources:

1. Massachusetts Non-point Source Management Manual: Mass. Dept. of Environmental Protection.
2. Stormwater Management: Vol I and II; Massachusetts Department of Environmental Protection (while this DEP policy does not apply to single-family households, it is useful information conceptually).
3. “The Chemical-Free Lawn,” by Warren Schultz.
4. Wetlands Protection Act and Regulations: MGL Chapter 131, Section 40 and 310 CMR 10.00, et seq.
5. “The Scoop on Dog Poop!”, Ipswich Coastal Pollution Control Committee (12/1996)
6. “Water Wise Gardening”, Ipswich River Watershed Association
7. “How Animal Wastes Pollute our Waters...”, Ipswich River Watershed Association
8. “Horses at Home in a Healthy Watershed”, Ipswich River Watershed Association
9. “Boaters Guide to the Great Marsh”, MA Office of Coastal Zone Management and Eight Towns & the Bay Committee
10. “About Lawns”, Ipswich River Watershed Association, Parker River Clean Water Association, Massachusetts Watershed Initiative, and the LARP Department, University of Massachusetts, Amherst (2/2001)

Appendices

APPENDIX A

Final Report

North Green Stormwater Management Project

Water Quality and Efficacy Report

CZM RFR: ENV-03-CZM-03-01 DEP 319: 01-17/319

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Background on the Project and Installation

The Ipswich River watershed in Northeastern Massachusetts is 155 square miles in area and includes part or all of 21 communities. The topography of this Atlantic coastal plain basin is characterized by low relief, with an average grade of 3.1 feet per mile. This small river system supplies water to people and businesses in 14 communities. In 1997 and 2003, the Ipswich River was listed as one of the nation's most threatened rivers because of its severe low-flow problems. A USGS model found that groundwater withdrawals in the upper reaches of the watershed reduce summer flows by up to 90 percent (Zarriello and Ries, 2000). A companion study conducted by USGS and the Massachusetts Division of Fisheries and Wildlife found that the Ipswich River's fisheries have been seriously degraded by low-flow problems, as the river's biodiversity has been diminished because of the loss of most "river-dependent" species (Armstrong, 2001).

The Town of Ipswich is situated on the coastal floodplain of the Ipswich River. Historically, shellfishing and fishing have been an important part of Ipswich's economy. The Food and Drug Administration (FDA) of the United States Government has set the maximum fecal coliform concentration in shellfish for interstate transport at 14 col/100 mL (NRC, 1993). Nationwide, approximately 37 percent of commercial shellfish beds in estuarine water are closed or under restriction. Sewage treatment plants, septic systems, and urban runoff are the most common causes of closure. In Massachusetts, shellfishing is prohibited when fecal coliform levels reach 14 col/100 mL and "thousands of acres of productive shellfish beds, representing millions of dollars, have been closed to harvesting in recent years because of potential pathogen contamination" (MCZM, 2002).

The "Ipswich Clam" is famous for both its taste and the economic and recreational benefits to the town of Ipswich. In May of 1991, the Ipswich Shellfish Advisory Board reported that high levels of fecal coliform seriously affected Ipswich's recreational and commercial shellfishing industry (ICPCC, 1995; ISAB, 1991). In 1991, thirty percent of the town's shellfish areas were permanently closed, and the remaining 70 percent were closed approximately half of the available shellfishing days after rainfall.

From 1999 through January 2001, the Ipswich shellfish beds began to be reopened on a conditional basis based on extensive sampling by the Division of Marine Fisheries (Roach, 2002). The mainstem of the Ipswich is currently under seasonal closure (closed October to April). Fox and Treadwell Creek are conditionally open, and closed for three days after a rainfall 0.25 inches or greater. Eagle Hill and Rowley Rivers are closed seasonally, while Parker River west of Cottage Road is prohibited. Plum Island Sound closes with 0.5 inches of rainfall for 5 days and with 1.0 inch of rainfall for 8 days. DMF is required to test Fecal Coliform at conditional areas monthly.

Farley Brook is a small brook that flows south from the north of Ipswich and is culverted through the Town Center. The furthest downstream surface water access to Farley Brook is on the CarBuffs property at 78 Central Street in Ipswich. The brook is then piped underground and flows into the Ipswich River just downstream of the Sylvania Dam. Stormwater flow from the area bounded by Central Street (Route 133/1A), Market/North Main Street and the intersection of Green Street and Meeting House Green is collected in the storm drain system and flows into the culverted Farley Brook and thus the Ipswich River via underground connections. The 319 grant was obtained in order to install a

treatment train that would remove pollutants from the stormwater that flows through the storm drain system before it connects with the culverted Farley Brook. The 319 grant was used to fund the construction costs of the project: materials, labor, and construction activity. A CZM CPR grant was also obtained for this project, and that money was spent on the 15 inch pipe, concrete, the sand filter, the storm quality unit, and the manholes, frames, and covers.

There are two main water quality parameters of issue in the stormwater flowing from Farley Brook into the Ipswich River: total suspended solids (TSS) and bacteria.

In 1992-1994 the Ipswich Coastal Pollution Control Committee (ICPCC) conducted fecal coliform sampling in dry and wet weather events throughout the Town of Ipswich (Table 4). Results indicated that Farley Brook “remains one of the major sources of bacteria to the Ipswich River” (ICPCC, 1995). Dry weather sources of fecal contamination were identified upstream of the area where Farley Brook is culverted at CarBuffs. However, the storm pipes entering Farley Brook while it is underground downstream of CarBuffs and upstream of the confluence with the Ipswich River drain a large area of urban runoff. Thus, the ICPCC concluded that “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” (1995).

ICPCC sampling was conducted using a SOP, using certified laboratories. All sampling holding times were met. Wet weather samples were conducted at first flush, and then for two subsequent days. Dry weather sampling conditions were defined as 72 hours without rain. It is unknown whether QC samples were collected.

Table 1: ICPCF Farley Brook Fecal Coliform Results

Date	Dry Weather Sampling Fecal Coliform (col/100 mL)		Wet Weather Sampling Fecal Coliform (col/100 mL)	
	CarBufs	Confluence	CarBufs	Confluence
5/4/92			1,070	
5/5/92			670	
5/12/92	4,600			
6/1/92			1,300	
6/2/92			70	
6/4/92			1,200	
6/8/92			90	
6/9/92			380	
8/14/92			>24,000	16,000
9/17/92	1,700	900		
9/29/92			3,500	2,400
10/27/92			1,300	
10/30/92			1,700	
11/12/92	>24,000	1,700		
11/30/92	330			
12/02/92	1,300			
12/15/92			2,400	
6/23/93				380
7/20/93			9,200	16,000
7/21/93			5,400	330
8/4/93	490	490		
8/5/93			16,000	3,500
8/20/93			1,300	1,700
9/16/93			>24,000	3,500
9/27/93			2,200	490
10/14/93			5,400	1,700
10/19/93	410	230		
12/22/93			4,300	
8/4/94	5,400	1,700		

In addition to the ICPCF sampling, fecal coliform levels have been more recently sampled by the DMF (Table 5) and by Alethia Environmental (Table 6).

In 2002, the Town of Ipswich and the Division of Marine Fisheries (DMF) conducted additional sampling at the outfall of Farley Brook into the Ipswich River (Table 5). Samples were analyzed at the Ipswich Wastewater Treatment Plant (IWWTP) using membrane filtration methodology.

Table 5: IWWTP and DMF Farley Brook Sampling Results, 2002

Date	CarBuffs	Confluence
May 3, 2002 (0.50 inches of rain)		51
May 13, 2002 (0.65 inches of rain)	1,000	680

IWWTP/DMF sampling was conducted using a SOP, using certified laboratories. All sampling holding times were met. Wet weather samples were conducted at first flush. Dry weather sampling conditions were defined as 72 hours without rain. It is unknown whether QC samples were collected and analyzed.

Lastly, additional sampling was conducted for the Town of Ipswich by contractor Alethia Environmental. Samples were collected in sterile containers and transported to the Ipswich Wastewater Treatment Plant for membrane filtration analysis. Two wet weather samples, one upstream and one downstream of the proposed treatment train, were collected during two separate storm events.

Table 6: Farley Brook Sampling Results, 2002: Fecal Coliform (col/100mL)

Date	CarBuffs	Confluence
June 5, 2002 (0.26 inches of rain)	1000	236
July 9, 2002 (0.4 inches rain)	700	500

Alethia Environmental sampling was conducted using a SOP, using certified laboratories. All sampling holding times were met. Wet weather samples were conducted at first flush. Dry weather sampling conditions were defined as 72 hours without rain. QC samples were not collected.

As can be seen from Tables 5 and 6, more recent sampling of fecal coliform confirms that fecal coliform levels still exceed standards for shellfishing (14 col/100 mL) and swimming (200 col/100 mL).

TSS levels in the outfall water were also measured by Alethia Environmental (Table 7). Samples collected by Daniele Lantagne of Alethia Environmental were analyzed at the Ipswich Wastewater Treatment Plant.

Table 7: Farley Brook Sampling Results, 2002: TSS (mg/L)

Date	CarBuffs	Confluence
June 5, 2002 (0.26 inches of rain)	4.6	5.6
July 9, 2002 (0.4 inches of rain)	52	106

Alethia Environmental TSS sampling was conducted using a SOP, using certified laboratories. All sampling holding times were met. Wet weather samples were conducted at first flush. Dry weather sampling conditions were defined as 72 hours without rain. QC samples were not collected.

The Division of Marine Fisheries (DMF) conducted a study in the spring of 2002 on anadromous fish habitat in a number of locations across Massachusetts (Chase, 2002). TSS and other habitat and water quality data were collected once a week for 16 weeks at each location. The middle of the Ipswich River downstream of the Sylvania Dam and upstream of the Choate Bridge (Route 1A) was one of the sites DMF collected data at. This is also the area where Farley Brook flows into the Ipswich River.

Brad Chase of DMF noted that the middle of the Ipswich River was consistently one of the cleanest sites in the study in dry weather, with low TSS values that were good for fish spawning (2002). The TSS values ranged from 0.8 mg/L to 10.2 mg/L with an average of 2.2 mg/L throughout the study. However, he noted while sampling during wet weather that there was very “foul” outfall from a tributary stream that flowed into the river. This outfall only occurred in wet weather, and Brad Chase actually sampled from the plume because it was so noticeably contaminated. The TSS value 10 meters downstream of the culvert in the discharge plume was 245.6 mg/L. He expected that this plume would negatively impact spawning habitat as it moved downstream.

I asked Brad Chase to describe this culvert, and he mentioned it was on the left side of the river looking downstream, and was a box culvert with a storm pipe in the cement of the culvert. This description matches the Farley Brook outfall culvert, and as such, Mr. Chase was noting the high TSS plume that flowed from Farley Brook into the Ipswich River during storm events as a negative impact on fish spawning in the area.

DMF sampling was conducted using a SOP, using certified laboratories. All sampling holding times were met. Wet weather samples were conducted at first flush. Dry weather sampling conditions were defined as 72 hours without rain. It is unknown whether QC samples were collected.

The recent sampling by DMF and Alethia Environmental indicate that TSS levels are also high in the outfall of Farley Brook.

This report details the results of the post-intervention (post installation of the storm quality unit) water quality in four storms sampled in 2003 and 2004 and assesses the impact of the intervention storm quality unit on Farley Brook and the Ipswich River Mainstem.

Dates of Post Intervention Sampling and Sampling Results

Sampling Round 1

Date: October 27, 2003

Rainfall: 0.42"

Tide: Low Tide

Sampler: Frances Doyle

Upstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time 0	6,200	2,600	41	--
Time +20	16,000	11,000	--	--

Downstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time 0	Not enough flow to sample			
Time +20	Not enough flow to sample			

Farley Brook and Ipswich River Confluence Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +50	320	120	1	--

The results of this sampling show:

- There is a high load of bacteria into the intervention.
- The intervention is well able to control that flow and mitigate it to a lower flow (as evidenced by the lack of flow in sampling).
- There is not a high load of bacteria to Farley Brook.

Sampling Round 2

Date: November 20, 2003

Rainfall: 0.35"

Tide: Medium Tide

Sampler: Frances Doyle

Upstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +0	180	59	64	112
Time +10	500	250	56	95.1
Time +30	--	--	--	95.9 96.0

Downstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +30	110	85	12	50.9
Time +50	--	--	--	49.7

Farley Brook and Ipswich River Confluence Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +60	30	22	1	16.9

The results of this sampling show:

- There is a relatively low loading of bacteria to the intervention.
- The intervention reduces that bacteria loading and the turbidity loading.
- There is low bacteria at Farley Brook.

Sampling Round 3

Date: July 19, 2004

Rainfall: 0.11"

Tide: Low Tide

Sampler: Frances Doyle, Ted & Kim of DPW

Upstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time 0	9,300	4,800	10	35.3
	9,000	5,400	9	29.3

Downstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +30	30	<10	--	17.0
	90	<10		

Farley Brook and Ipswich River Confluence Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +40	5,200	1,100	5	16.2
	6,000	1,000	5	15.3

The results of this sampling show:

- There is a high load of bacteria into the intervention.
- The intervention is well able to control that bacteria.
- There is a high loading of bacteria in Farley Brook – although the high levels indicate there is another source other than Farley Brook.

Sampling Round 4

Date: December 11, 2004

Rainfall: 0.95" Tide: Incoming-High

Sampler: Frances Doyle, Beth O'Conner

Upstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time 0	120 80	100 80	<1	--

Downstream of Intervention Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +30	480 340	390 320	<1	--

Farley Brook and Ipswich River Confluence Location

	Fecal Coliform (col/100 mL)	E. coli (col/100 mL)	TSS (mg/L)	Turbidity (NTU)
Time +70	90 80	80 80	4 2	--

The results of this sampling show:

- The time difference between the Upstream and Downstream of Intervention sample most likely accounts for the increase in bacteria.
- There is not a high load of bacteria to Farley Brook.

Data Quality Objectives

Quality Assurance / Quality Control

The acceptable error for fecal coliform and *E. coli* samples was less than 30% RPD for log 10 transformed data.

A total of 13 fecal coliform samples were collected, and 6 of those 13 (46%) were duplicated. The average RPD of the log 10 transformed values was 7.8%, with a range from 0.4%-27.8%. All values thus met the quality control standard of less than 30% RPD.

A total of 13 *E. coli* samples were collected, and 6 of those 13 (46%) were duplicated. The average RPD of the log 10 transformed values was 1.8%, with a range from 0.0%-5.0%. All values thus met quality control standard of less than 30% RPD.

The acceptable error for TSS samples was less than 20% relative error.

A total of 11 TSS samples were analyzed, and 3 of those 11 (27%) were duplicated. The relative error of the duplicates was 0%, 10.5%, and 66.6%. The 66.6% value was due to the low actual value of 2 and 4 mg/L of one of the duplicate samples, which skews the results. By dropping the low value sample, the relative error maximum of 20% is met.

The acceptable error for turbidity samples was less than 10% relative error.

A total of 9 turbidity samples were analyzed, and 3 of those 9 (33%) were duplicated. The relative error of the duplicates was 0.1%, 5.7%, 18.6%, with an average of 8.1%. Thus one sample exceeded the acceptable error range.

Storm objectives:

All storms met the objective for greater than 0.2 inches of rainfall, and 72 hours of dry weather. In addition, all samples were completed in low to medium tide.

Many lessons were learned in this sampling, including:

- The initial sampling regime of three samples at each site in 40 minute increments was too rigorous for the following reasons:
 - It was not possible for the samplers to collect the samples in that time frame.
 - The storms that were able to be sampled did not last 80 minutes long.

Therefore, the sampling regime was modified in storms three and four to only include one sample per storm per location.

Comparison of Sampling Results to Previous Collected Data as Outlined in the QAPP

Before the intervention, as can be seen in Section 1 of this document, the values of the wet weather fecal coliform samples at the confluence of the Ipswich River and Farley Brook in 14 samples ranged from 51-60,000 colonies per 100 mL, with an average of 3,391 colonies per 100 mL, and a standard deviation of 5,465.

After the intervention, as can be seen in Section 2 of this document, the values of the wet weather fecal coliform samples at the confluence of the Ipswich River and Farley Brook in 4 samples were 320, 30, 5,600 (average of duplicates), and 85 (average of duplicates) col/100mL, with an average of 1,508 col/100 mL and a standard deviation of 2,370 col/100mL.

Although the sample size is small, there is improvement between the before intervention average (3,301 col/100 mL) and the after intervention average (1,508 col/100 mL) at the confluence of Farley Brook and the Ipswich River.

For comparison purposes only (as there is no before intervention *E. coli* data), the values of the wet weather *E. coli* samples at the confluence of the Ipswich River and Farley Brook in 4 samples were 120, 22, 1050 (average of duplicates), and 80 (average of duplicates), with an average of 318 colonies per 100 mL and a standard deviation of 490.

Before the intervention, as can be seen in Section 1 of this document, the values of the wet weather TSS samples at the confluence of the Ipswich River and Farley Brook in 2 samples were 5.6 and 106 mg/L, with an average of 55.8 mg/L,

After the intervention, as can be seen in Section 2 of this document, the values of the wet weather TSS samples at the confluence of the Ipswich River and Farley Brook in 4 samples were 1, 1, 5 (average of duplicates), and 3 (average of duplicates) mg/L, with an average of 2.5 mg/L.

Although the sample size is small, there is improvement between the before intervention average for TSS (55.8 mg/L) and the after intervention average for TSS (2.5 mg/L) at the confluence of Farley Brook and the Ipswich River.

Results and Conclusions as to the Efficacy of the BMP

Based on the reduction of the average load of fecal coliform and TSS into the Ipswich River at the confluence of Farley Brook, it is hypothesized, although there are only four storms of data, that the North Green Stormwater Management Project has been successful in reducing the load of fecal coliform (and by inference *E. coli* bacteria) into the Ipswich River. The majority of data quality objectives were met in this study, although the sampling methodology was modified to account for the time necessary to sample.

Although the sample size is small, the results indicate that the North Green Stormwater Management Project was successful in reducing pollutant loading to the mainstem of the Ipswich River. Thus, this project contributed, as one piece of a larger strategy, to improving the anadromous fish runs in the Ipswich River, and thus also complements the Commonwealth's initiatives to clean up shellfish beds. These were the stated goals of this project undertaken by the Town of Ipswich and funded by CZM.

Thank you to Frances Doyle and assistants for sampling, and if you have any questions, please contact Daniele Lantagne at daniele@alethia.cc or 617.549.1586.

APPENDIX D

Homeowner Stormwater Management

1) Website narrative

Reduction Stormwater Pollution – How you can help

As a resident of Ipswich your contribution to the protection of our Ipswich River is important.

The Town of Ipswich recently completed a storm water management project in the North Main and Meeting house Green area. The goal was to reduce storm water runoff during storms and treatment before it entered the river. But more effort is needed to reduce pollution and protect our River from contamination.

By removing pollutants that are carried in runoff from nearby land uses before they reach surface water or ground water is important for protection of our drinking water, fisheries, shellfish beds, recreational uses and protection of food sources to support the aquatic food chain.

You can be part of the solution to storm water pollution, by using care when handling and disposing of pet waste, petroleum, fertilizers, pesticides and other household pollutants.

To learn more how you can help reduce toxins in our environment link to:

Homeowner Stormwater Management: what you can do to help.

2) Letter to Homeowners

September 23, 2003

Re: Reducing Stormwater Pollution -- How You Can Help

Dear Ipswich Resident:

As you know, the Town of Ipswich recently completed a stormwater management project in the North Main Street and Meetinghouse Green area. Runoff from this area has been a major contributor to stormwater pollution in the Ipswich River. The goal of the project is to treat stormwater before it enters the river by constructing a closed drainage system, which will remove 80% of the Total Suspended Solids (TSS), as well as a significant percentage of fecal coliform. As this and other municipal efforts will not remove all bacteria or petroleum products from stormwater runoff, we are asking for your help. All you need do is read and observe the recommendations in the enclosed brochure.

Nonpoint source (NPS) pollution occurs when contaminants are picked up by rain water and snow melt and carried over land, in groundwater, or through drainage systems to the nearest water body. NPS pollution is currently the number one pollution problem in U.S. coastal waters. Contaminants include soil sediments, nutrients from fertilizers and sewage, and chemicals from pesticide use and other sources. NPS pollution can prevent water bodies from meeting water quality standards, which means that people cannot use the water for certain purposes, such as drinking, shellfishing, or swimming. Over the past fifteen years, shellfish bed closings have increased dramatically and many of these closings appear to be the direct result of NPS pollution from septic systems and from domestic and farm animals.

By using care when handling and disposing of pet wastes, petroleum, fertilizers, pesticides, and other household pollutants, you can be part of the solution to stormwater pollution. If you have any questions about the brochure or this issue generally, please call the Conservation Office at 356-6661.

Sincerely,

Glenn C. Gibbs, Director
Department of Planning & Development

Enclosure

P.S. As you know, the drainage construction project lasted longer than expected, due in part to the unusually rainy summer. We regret the extended inconvenience this caused, and we greatly appreciate your patience in seeing it through.

APPENDIX E

Final Design and Construction Plans

APPENDIX F

As-Built Drawings

(Note: Due to document size, As-Built drawings were submitted electronically in both Autocad R14 and Adobe .pdf format and are not included here in paper format)