JOHN M. TOMASZ, P.E.
DIRECTOR OF PUBLIC WORKS

TEL: 978-546-3525
FAX: 978-546-3562

OFFICE OF THE DIRECTOR

TOWN OF ROCKPORT

TOWN OFFICE BUILDING
34 BROADWAY
MASSACHUSETTS 01966-1537

06/06/06 / 1017
P

May 24, 2006

U.S. Environmental Protection Agency
Water Technical Unit
PO Box 8127
Boston, MA 02114

RE: Town of Rockport
NPDES Phase II Annual Report

As required, I am forwarding you The Town of Rockport's NPDES Phase II Annual Report. If you have any questions or comments, I can be reached at 978-546-3525.

Sincerely,

John M. Tomasz, P.E.
Director of Public Works

Annual Report

National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Management Plan 2006 Annual Report – Year 3

Rockport, Massachusetts

Prepared for:

Town of Rockport
Town Office Building
Rockport, Massachusetts 01966

Prepared by:

Earth Tech, Inc.
196 Baker Avenue
Concord, Massachusetts 01742

Reports Submitted to:

United State Environmental Protection Agency
Water Technical Unit
P.O. Box 8127
Boston, Massachusetts 02114

Massachusetts Department of Environmental Protection
Division of Watershed Management
627 Main Street
Worcester, Massachusetts 017608

May 2006

EarthTech
A tyco International Ltd. Company

Municipality/Organization: Town of Rockport

EPA NPDES Permit Number:

MaDEP Transmittal Number: W036169

Annual Report Number
& Reporting Period: No. 3: March 05-March 06

NPDES PII Small MS4 General Permit Annual Report

Part I. General Information

Contact Person: John Tomasz, P.E. Title: DPW Director

Telephone #: (978) 546-3525 Email: jtomasz@townofrockport.com

Certification:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: John M Tomasz

Printed Name: JOHN M. TOMASZ

Title: DPW DIRECTOR

Date: 5/24/06

Part II. Self-Assessment

The Town of Rockport has successfully implemented or begun implementation of several Measurable Goals noted in Rockport's Notice of Intent. Prior to the development of Rockport's Comprehensive Stormwater Management Program, including Measurable Goals, the Town had an assessment performed of current activities, programs, and regulations that could support the NPDES Phase II Stormwater program. This assessment became the basis for modifying current activities, recommending new programs, and informing town boards and departments of their obligation toward successful implementation of Rockport's Comprehensive Stormwater Program.

Rockport is pleased to present the following summary describing Rockport's success at implementing the third year of the town's Comprehensive Stormwater Management Program.

Part III. Summary of Minimum Control Measures

1. Public Education and Outreach

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
PE-1	Stormwater Brochure	Department of Public Works	Y1-Y5: Develop and mail one (1) brochure per year in the Consumer Confidence Report to residents and industries in Rockport.	The Consumer Confidence Report was distributed and made available at public office and the website: www.town.rockport.ma.us	The Town will continue this program.
PE-2	Provide stormwater information at Town buildings	Department of Public Works Chamber of Commerce	Y1-Y5: Brochures will be available in the Chamber of Commerce and Town Hall	The Consumer Confidence Report was available at public offices for viewing. The Rockport Watershed Protection Committee and Rockport DPW developed and distributed a brochure to residents within the watershed highlighting the hazards of illegal dumping along roadways and into storm and sanitary sewer systems. The brochure also reviewed stormwater best management practices for common residential activities. This brochure is also available in the Town Hall.	The Town is in receipt of a disc containing EPA fact sheets and other stormwater education brochures. Relevant publications will be printed, copied, and distributed. The Town will continue to develop and make available educational material on protecting local water quality.
PE-3	Stormwater Editorial	Department of Public Works	Y1-Y5: Print one (1) editorial in the Gloucester Daily Times each year.		The Town will prepare an editorial or press release.
PE-4	Pet Waste	Department of Public Works	Y1-Y5: Post signs at public park lands and supply bags for pet owners to properly dispose of waste. Enforce leash law and exclusion of pets from resource areas during the summer.	Signs have been posted for properly disposing pet waste and leash laws. Plastic bags are available for public use. Town of Rockport regulations applicable to public beaches and parks are available for public viewing at the Town website.	This program is expected to continue.

2. Public Involvement and Participation

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
PP-1	Involve Public Schools	High School Science Dept./ Allyson Bachta and Eric Sabo	Y2: Stormwater presentation to high school science class and environmental sampling field trip to local water body. Conduct necessary planning for biology and environmental science projects incorporating stormwater issues. Y3-Y5: Implement stormwater projects in biology and environmental science classes.	Local teens assisted in installing metal plates at storm sewer catchbasins that read: "No Dumping, Drains to Ocean."	Contact will be made with high school science department.

PP-2	Incorporate Stormwater into Public Meetings	Department of Public Works	Y1: Discuss final Stormwater Management Plan (SWMP) at Spring Town Meeting. Y2-Y5: Present updates to the SWMP. Continue to invite stormwater discussion at one (1) meeting per year.	The Citizens Advisory Committee on Water & Wastewater is appointed by the Selectmen to work with professional consultants to plan for long-range solutions to Rockport's water and wastewater problems. The Committee's meetings are posted and held in accordance with the Massachusetts Open Meeting Law. The Ad Hoc Committee on Town Water Supply is the longest standing committee for the Town of Rockport, established at the 1980 Annual Town Meeting. Annually "...the Moderator appoints a Committee to be comprised of not less than seven registered voters including a designee or member of the Board of Health and a designee of the Board of Selectmen ... (Its charge is) to assist the Director in the investigation and make recommendations relating to the Town's water supply..." The Committee's meetings are posted and held in accordance with the Massachusetts Open Meeting Law. DPW Director Tomasz presented Rockport's Comprehensive Stormwater Management Program at a meeting of the Essex County Highway Association.	Rockport will continue to update the public on the Stormwater Management Plan.

PP-3	Stencil Storm Drains	Department of Public Works	Y2: Identify potential labor sources (scouts, etc.). DPW will facilitate storm drain stenciling effort in the downtown area. (50% complete) Y4: Continue effort in downtown area (100% complete)	Local teens assisted in installing metal plates at storm sewer catchbasins that read: "No Dumping, Drains to Ocean."	Contact will continue with youth groups and students to continue the catchbasin identification program (See PP-1.)

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 1	Planned Activities – Permit Year 2
PP-4	Involve Watershed Protection Committee	John Tomasz, Chairman (Members from several Town departments)	Y1-Y5: Discuss stormwater issues at quarterly meetings.	The Watershed Protection Committee is composed of Rockport residents who are professionals in the fields of hydrology, environmental science, fisheries, earth science, and resource management. Most recently, the Watershed Protection Committee has focused their efforts on completing a Wellhead Protection Plan (WHPP) for Rockport's Mill Brook Wellfield. This effort was funded by a grant obtained from the Massachusetts Department of Environmental Protection's Drinking Water Program. The WHPP focused on a variety of technical and regulatory issues including characterizing existing stormwater quality near the wellfield, identifying potential water quality threats, reviewing applicable town bylaws and making recommendations to strengthen them to protect water quality. The plan also includes a public outreach component. An electronic copy of the WHPP and the accompanying informational brochure can be found in the "REPORTS" section at www.town.rockport.ma.us	The committee will continue discussion of stormwater issues.

PP-5	Poster Contest	High School Science Dept./ Allyson Bachta and Eric Sabo	Y1-Y5: Discuss stormwater issues at quarterly meetings.		Discussion will be made with the high school science department regarding the poster contest.

3. Illicit Discharge Detection and Elimination

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
ID-1	Evaluate Eligibility Criteria	Department of Public Works	Y1: Create map of critical habitats and historic properties as described in the General Permit Part 1.B. Y2: Once outfalls are mapped in these areas (see ID-2), consult applicable services and departments (e.g. Fish and Wildlife Service, National Marine Fisheries Service, State Historic Preservation Officer.) Y3: Take appropriate measures if any discharges are not authorized by the General Permit.	An outfall map was created as part of the August 2000 Stormwater Management Plan.	The Town will finalize stormwater impacts, if any, on critical habitats or historic properties.

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
ID-3	Eliminate Illicit Discharges	Department of Public Works	Y1: Develop Illicit Discharge Detection and Elimination Plan as described in General Permit Part II.B.3. Y2-Y5: Implement plan.	The Rockport Mill Brook Wellhead Protection Plan included sampling of outfalls within the Mill Brook Watershed. Two sampling rounds revealed the occurrence of common stormwater pollutants, most of which are at relatively low concentrations. The Town of Rockport received grant assistance to evaluate conditions of storm sewer catchbasins and to install sumps and hoods. DPW monitors outfalls regularly at Old Garden Beach.	The DPW will continue to implement the IDDE program.
ID-4	Develop and Implement Illicit Discharge By-Law	Department of Public Works	Y1: Develop draft bylaw prohibiting non-stormwater discharges into the storm sewer and providing for appropriate enforcement procedures. Y2: Present bylaw at Town meeting and finalize. Y3-Y5: Implement and enforce bylaw.	Rockport has draft language for by-law prohibiting illicit discharges into storm sewer system.	Rockport will review draft bylaw prohibiting non-stormwater discharges into the storm sewer and providing enforcement. The Town will also seek to present the bylaw to the Town meeting.

ID-5	Educate Citizens	Department of Public Works	Y2: Notify public of Illicit Discharge Detection and Elimination Plan. Y3: Notify public of upcoming Illicit Discharge Bylaw. Y4: Notify public of new bylaw in place.	Brochure entitled "Protecting Rockport's Mill Brook Watershed" informs the public of the dangers of illegal dumping and discharging into storm and sanitary sewer systems. The brochure was mailed to all households within the watershed and is available at Town Hall.	Rockport will notify the public via local access, public meeting, and website of the IDDE plan.

4. Construction Site Stormwater Runoff Control

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
CS-1	Develop and Implement Construction Site Runoff Control Program	Department of Public Works	Y1: Develop Construction Site Runoff Control Program as described in General Permit Part II.B.4. Y2-Y5: Implement plan.	Rockport has draft language for Construction Site Runoff Control by-law.	Town will review Construction Site Runoff Control bylaw. The Town will also seek to present the bylaw to the Town meeting.
CS-2	Develop and Implement Erosion and Sediment Control Bylaw	Department of Public Works	Y1: Research bylaw requirements (General Permit Part II.B.4 and MA DEP Stormwater Management Standard 8) and compare to existing town regulations. Y2: Modify existing regulations and/or develop bylaw. Y3: Present bylaw at Town meeting and finalize. Y4-Y5: Implement bylaw.	Rockport has draft language for Erosion and Sediment Control by-law.	Town will review Erosion and Sediment Control bylaw. The Town will also seek to present the bylaw to the Town meeting.

5. Post-Construction Stormwater Management in New Development and Redevelopment

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
PC-1	Develop, Implement, and Enforce Post-Construction Runoff Control Program	Department of Public Works	Y1: Develop Post-Construction Site Runoff Control Program as described in General Permit Part II.B.5 and MA DEP Stormwater Management Standards 2, 3, 4, and 7. Y2 -Y5: Implement plan.	Rockport has draft language for Post-Construction Site Runoff Control by-law.	Town will review Post-Construction Site Runoff Control bylaw. The Town will also seek to present the bylaw to the Town meeting.
PC-1	Develop, Implement, and Enforce Post-Construction Runoff Control Program	Department of Public Works	Y1: Research Post Construction Runoff bylaw requirements (General Permit Part II.B.5 and MA DEP Stormwater Management Standard 2, 3, 4, and 7) as part of the Post-Construction Runoff Control Program. Y2: Modify existing regulations and/or develop bylaw. Y3: Present bylaw at Town meeting and finalize. Y4: Implement bylaw. Y5: Review effectiveness of bylaw and enhance if necessary.	Rockport has draft language for Post-Construction Site Runoff Control by-law.	Town will review Post-Construction Site Runoff Control bylaw. The Town will also seek to present the bylaw to the Town meeting.

6. Pollution Prevention and Good Housekeeping in Municipal Operations

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
GH-1	Employee Training Program	Department of Public Works	Y1-Y5: Hold one good housekeeping workshop per year at DPW.	DPW director attended University of New Hampshire workshop on stormwater BMPs and a Stormwater Management Financing Seminar. Other Rockport officials and employees also participated.	Town expects to continue training program.
GH-2	Storm Drain Stenciling	Department of Public Works	Y1: DPW will stencil storm drains in Town (excluding downtown area) while cleaning catch basins. Y3: Re-stencil drains. Y5: Re-stencil drains.	Local teens assisted in installing metal plates at storm sewer catchbasins that read: "No Dumping, Drains to Ocean."	Contact will continue with youth groups and students to continue the catchbasin identification program (See PP-1.)
GH-3	Beach Clean-up	Department of Public Works	Y1-Y5: DPW will clean seaweed and trash from beaches weekly in the summer.	DPW cleans seaweed and trash from the beaches throughout the summer.	This program is expected to continue.
GH-4	Catch Basin Cleaning	Department of Public Works	Y1-Y5: DPW will clean each catch basin in Town once per year.	The DPW cleans catch basins once a year.	This program is expected to continue.
GH-5	Street Sweeping	Department of Public Works	Y1-Y5: DPW will sweep every street in Town once per year. The downtown area will be swept daily in the summer.	The DPW sweeps streets in the downtown area daily in the summer. All of the streets in town are swept at least once per year.	This program is expected to continue.

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
GH-6	Recycling Program	Department of Public Works	Y1-Y5: Continue the Town's recycling and household hazardous waste collection programs.	The transfer station is available to town residents. Signs are posted at the facility indicating where to leave recycling and hazardous waste products. The Transfer Station provides several services to help reduce the amount of waste produced by the community: The Town held one hazardous waste collection day. Four times per year, oil is collected at the Waste Water Treatment Plant to prevent it from being released into drains or the ocean. Hazardous items such as mercury thermometers and fluorescent light bulbs are collected at the Transfer Station and disposed of properly. Transfer station regulations and collection schedules are posted in the Town Hall and at www.town.rockport.ma.us	This program is expected to continue.

GH-7	Operation and Maintenance	Department of Public Works	Y1: Inventory maintenance activities, identify potential pollutant runoff. Y3: Identify means of reducing potential pollutant runoff, implement reductions as budget allows. Y5: Reduce pollutant runoff potential.	The DPW has inventoried Rockport's storm sewer infrastructure. Individual identifications have been assigned to system appurtenances. Recorded are catchbasin inlets and outlets, depth of sumps, system condition, maintenance history, and evidence of potential illicit flows. The Town of Rockport received grant assistance to evaluate conditions of storm sewer catchbasins and to install sumps and hoods.	Town will continue to maintain storm sewer inventory and identify opportunities to increase system performance.

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
GH-8	Reporting	Department of Public Works	Y1: Create a method to record stormwater management activities (e.g. catch basins cleaned, streets swept, yearly training workshops held, bylaws implemented, etc.) Y1-Y5: Begin recording all stormwater management activities. Provide MADEP and EPA with yearly report as described in the General Permit, Part II.E.	The DPW has inventoried Rockport's storm sewer infrastructure. Individual identifications have been assigned to system appurtenances. Recorded are catchbasin inlets and outlets, depth of sumps, system condition, maintenance history, and evidence of potential illicit flows.	Town will continue to maintain storm sewer inventory and identify opportunities to increase system performance.

7. BMPs for Meeting Total Maximum Daily Load (TMDL) Waste Load Allocations (WLA)-

BMP ID #	BMP Description	Responsible Dept./Person Name	Measurable Goal(s)	Progress on Goal(s) – Permit Year 3	Planned Activities – Permit Year 4
TMDL-1	Check Current Impairment List	Department of Public Works	Y1: There are no completed TMDL studies for receiving waters in Rockport. Y2-Y5: Reference Part II of the current Massachusetts Integrated List of Waters for newly listed water bodies with completed TMDL studies in which Rockport SW outfalls directly or indirectly discharge.	There are no completed TMDLs for receiving waters in Rockport. Cape Pond has been identified in "The Proposed Massachusetts Year 2004 Integrated List of Waters" as needing a TMDL for turbidity.	Rockport will continue to monitor new TMDLs.

7a. Additions

7b. WLA Assessment

Part IV. Summary of Information Collected and Analyzed

Part V. Program Outputs & Accomplishments (OPTIONAL)

Programmatic

Stormwater management position created/staffed	(y/n)	
Annual program budget/expenditures	($)	

Education, Involvement, and Training

Estimated number of residents reached by education program(s)	(# or %)	
Stormwater management committee established	(y/n)	
Stream teams established or supported	(# or y/n)	
Shoreline clean-up participation or quantity of shoreline miles cleaned	(y/n or mi.)	
Household Hazardous Waste Collection Days		
▪ days sponsored	(#)	
▪ community participation	(%)	
▪ material collected	(tons or gal)	
School curricula implemented	(y/n)	

Legal/Regulatory

	In Place Prior to Phase II	Under Review	Drafted	Adopted
Regulatory Mechanism Status (indicate with "X")				
▪ Illicit Discharge Detection & Elimination				
▪ Erosion & Sediment Control				
▪ Post-Development Stormwater Management				
Accompanying Regulation Status (indicate with "X")				
▪ Illicit Discharge Detection & Elimination				
▪ Erosion & Sediment Control				
▪ Post-Development Stormwater Management				

Mapping and Illicit Discharges

Outfall mapping complete	(%)	
Estimated or actual number of outfalls	(#)	
System-Wide mapping complete	(%)	
Mapping method(s)		
▪ Paper/Mylar	(%)	
▪ CADD	(%)	
▪ GIS	(%)	
Outfalls inspected/screened	(# or %)	
Illicit discharges identified	(#)	
Illicit connections removed	(#) (est. gpd)	
% of population on sewer	(%)	
% of population on septic systems	(%)	

Construction

Number of construction starts (>1-acre)	(#)	
Estimated percentage of construction starts adequately regulated for erosion and sediment control	(%)	
Site inspections completed	(# or %)	
Tickets/Stop work orders issued	(# or %)	
Fines collected	(# and $)	
Complaints/concerns received from public	(#)	

Post-Development Stormwater Management

Estimated percentage of development/redevelopment projects adequately regulated for post-construction stormwater control	(%)	
Site inspections completed	(# or %)	
Estimated volume of stormwater recharged	(gpy)	

Operations and Maintenance

Average frequency of catch basin cleaning (non-commercial/non-arterial streets)	(times/yr)	
Average frequency of catch basin cleaning (commercial/arterial or other critical streets)	(times/yr)	
Total number of structures cleaned	(#)	
Storm drain cleaned	(LF or mi.)	
Qty. of screenings/debris removed from storm sewer infrastructure	(lbs. or tons)	
Disposal or use of sweepings (landfill, POTW, compost, recycle for sand, beneficial use, etc.)		
Cost of screenings disposal	($)	

1. Introduction

1.1 Purpose

The Town of Rockport received funding from the Massachusetts Office of Coastal Zone Management to conduct a Nonpoint Source Pollution Assessment of the lower section of Mill Brook. The purpose of this project was to conduct an assessment of the sediment and bacteria contamination of the lower portion (Poole's Lane north to Front Beach on Sandy Bay) of Mill Brook in Rockport, MA located in the North Coastal Watershed. The goals of the project are to better characterize and evaluate the nature and sources of the contamination, and to look for potential to implement or install best management practices (BMP's) to reduce the contamination reaching the stream and coastal waters. These goals are being met through water quality monitoring at locations throughout the study area, through physical assessment of the drainage areas of the outfalls, through education of town boards and officials, and through undertaking of pilot programs to maximize efficiency of catch basin cleaning and street sweeping practices within the lower Mill Brook watershed. The end products of the proposed project are a physical and wet-weather water quality assessment of the lower portion of Mill Brook and its outfalls; an evaluation of the potential for structural BMP's at specific outfalls including draft designs where applicable, an evaluation of the effectiveness of pilot programs for enhanced catch basin cleaning and street sweeping, and draft by-law language establishing local thresholds for infiltration of runoff from any new impervious surfaces; and for requiring BMP's for sediment control from construction sites within the lower Mill Brook watershed.

Periodic beach closures and a permanently posted warning to swimmers at the mouth of Mill Brook are indications that a pollution problem exists. Increasing visual evidence that the historic Mill Pond on Mill Brook is succumbing to sediment is evidence that a sedimentation problem exists. Rockport is a coastal community with a large portion of its economy being tourist-based, inns, bed and breakfasts, restaurants, shops, and other activities (kayaking tours, sailing tours). One of the focal points of summer tourists in Rockport is its sandy beaches and clear coastal waters. Mill Brook discharges at the western end of Front Beach in the heart of the downtown. Because it is accessible to the many inns and bed and breakfasts in the downtown area, Front Beach is one of the most conspicuous and popular of Rockport's beaches. The other industry, in addition to tourism, that still thrives in Rockport is a fleet of inshore lobster boats and small draggers that depend on the health and bounty of Rockport's coastal waters for their living. Mill Brook also supports an American eel (*Anguilla rostrata*) run up to Loop Pond and rainbow smelt (*Osmerus mordax*) spawning habitat at its mouth. These catadromous and anadromous fish species not only contribute to a healthy marine food web, they are important to recreational and professional rod and reel fishermen and are known to provide an important food source for other commercially important fish species such as striped bass, bluefish and cod.

Beach closings and a public perception of contaminated water at Rockport's beaches could have a negative impact to the tourist industry. Sedimentation and excess nutrients, often associated with elevated bacteria levels, can degrade freshwater and coastal resources to the point where they can no longer support healthy populations of American eels, rainbow smelt and shellfish and other commercially important species that depend on a healthy coastal food web.

1.2 Description of Study Area

Mill Brook is Rockport's largest perennial stream with its headwaters in the undeveloped interior of Cape Ann, actually starting in the neighboring City of Gloucester, and running approximately 1.5 miles to its outlet at Front Beach on Sandy Bay. From its undeveloped origins to the north and west of Loop Pond, Mill Brook runs through a moderately developed watershed between Loop Pond and Poole's Lane at which point it enters an area densely developed with both commercial and residential development. The focus of this project is the lower watershed portion of Mill Brook from Poole's Lane north to its mouth at Front Beach.

The study area is approximately 94 acres and comprises the watershed to the lower section of Mill Brook from Front Beach up to Poole's Lane and including the lower section of Squam Brook up to Squam Hill Court. (See Figure 1, Lower Mill Brook Nonpoint Source Pollution Assessment Study Area.) The Mill Brook watershed (above Poole's Lane) and Squam Brook watershed (above Squam Hill Court) both drain into the Lower Mill Brook study area. The Mill Brook and Squam Brook watersheds are part of the Town of Rockport Watershed Protection Overlay District (WPOD) and have both previously been delineated for watershed protection purposes. These watersheds are included in the Lower Mill Brook nonpoint source pollution assessment through water quality monitoring stations J and L which were included to characterize the inputs from these less-densely developed watersheds.

2. NPS Assessment

2.1 GIS Map

One of the tools used on this project to provide analysis and graphical display of the watershed was Geographic Information Systems (GIS). Basemap data collected from MassGIS, and from the Town of Rockport were used with several layers created for this report. Those layers include the Lower Mill Brook watershed study area, water quality monitoring sample collection locations, parcels with septic systems, identified outfalls on Mill Brook. municipal and private catch basins within the watershed, and sub-drainage areas delineated for each water quality monitoring sample collection location. These layers were used to create a comprehensive site map which is included in the insert in the back of this report. The GIS data layers have also been delivered to both CZM and to the Town of Rockport, and can be used for further analysis of the hydraulic features and nonpoint source pollution parameters in this area using GIS. Further analytical techniques could include network tracing, stormwater modeling, sediment loading to the brook, etc. in conjunction with other GIS layers which MassGIS, CZM, or other agencies may have in their data libraries.

2.2 Drainage Area Delineation

The sub-watershed drainage area was delineated for each of 10 of the sampling stations monitored during the study period. (The Mill Brook and Squam Brook watersheds, drainage areas for monitoring stations J and L were previously delineated as explained above.) This was undertaken to help better assess pollution and sediment sources that might be influencing water quality at the sampling stations. In part, because Rockport's historic downtown, which comprises much of the study area, was developed so long ago, few of the drainage systems are documented. This made delineating the drainage areas a challenge, particularly in the vicinity of Railroad Avenue and the commuter railroad station where there is a dense mix of commercial development with fairly expansive impervious surfaces and little documentation of the existing drainage systems.

2.2.1 Methodology

Delineation of the sub-drainage areas was conducted using the following methodology: The boundary of the lower Mill Brook watershed study area and of the sub-drainage areas within the study area were delineated using topographic maps, field observations during precipitation events, and identification of catch basins and outfalls including a limited amount of dye testing of drainage pipes. First, the lower Mill Brook watershed was delineated using topographic maps including USGS topographic maps and Town of Rockport topographic maps (5 foot contour intervals, 1 in.:100 foot scale), using standard watershed delineation techniques The watershed boundary for this section of lower Mill Brook was then further refined based on field reconnaissance. The project partners walked sections of the lower Mill Brook watershed including during precipitation events, observing direction of sheet flow down roads and over impervious surfaces and direction of flow in catch basins. During at least two heavy precipitation events, monitoring dye was introduced to catch basins to determine where along the stream the runoff was being directed.

Table 1: Description of Sampling Station Locations and Sub-Drainage Areas

	Sampling Station Location	Drainage Area Description	Size in Acres	WQ Trtmnt. Volume (gal.)*	No. of Catch Basins	No. of Outfalls	No of Septic Systems
A	Beach St--downstream	Part of Beach St.; most of King St.; some yards at corner of King and Beach and Maine and Beach	4.83	37,475	13	4	0
B	Beach St–upstream	Millbrook Meadow up to Mill Pond; Mill Lane up to Maine St.; associated yards	5.64	28,178	4	3	0
C	Mill Pond--downstream at dam	Mill Pond with adjacent land from King St. to Maine St.	5.39	18,074	3	0	0
D	Mill Pond—upstream behind Union Cemetary	Top of Mill Pond to Henderson Crt; west to King St.; east to Maine St.	9.45	34,255	5	1	0
E	Henderson Ct—Mill Brook above Squam Brook tributary	Parts of Railroad Ave. west and east of stream up to Maine St.: Henderson Crt.; commercial and railroad parking areas off Railroad Ave; part of Whistlestop Mall	8.32	68,450	6 (+3 Private)	10	0
F	Henderson Ct—Squam Brook	Northwest end of Railroad Ave. up to Summit Ave.; yards off Railroad Ave.	5.57	32,479	3 (1)	0	0
G	Railroad Ave—immediately upstream	Isinglass Place and other commercial buildings and parking; Anchorage town houses; residential southeast to Poole's Lane and Main St.	4.2	38,289	0 (8)	10	0
H	200m upstream of Railroad Ave	Railroad station; Whistlestop Mall; Mill Brook Park Housing; Evans Field; weat to Summit Ave; east to Poole's Ln. ?	13.78	92,511	0 (12)	4	5
I	Poole Ln—immediately downstream	Poole's Ln; part of Evans Field; west up to Hospital Hill; east just shy of Main St.	22.26	45,784	6 (2)	3	1
J	Poole Ln—immediately upstream	Mill Brook Watershed	448.64	Not Calculated	Not Counted	Not Counted	41
K	Squam Brook—immediately down stream of Summit Ave	Summit Ave. down to base of Lowest Ln	14.43	44,960	2 (1)	0	8
L	Squam Brook—end of Squam Hill Ct.	Squam Brook Watershed	112.07	Not Calculated	0	None Identified	35

* Water Quality Treatment Volume is based on a 0.5 inch rain event.

Upstream of the study area on Squam Brook, the Squam Brook watershed is completely unsewered and all residential development relies on onsite subsurface sanitary sewage (septic) systems. There were 35 septic systems identified in this watershed. Upstream of sampling station J is the Mill Brook watershed. The majority of the Mill Brook watershed is undeveloped. The municipal sewer system does extend to parts of the more densely developed sections of this watershed, primarily off of upper Main Street. The exception is the unsewered Hodgkins Road area which is a fairly densely developed residential neighborhood on fairly steep slopes just above Loop Pond on Mill Brook. The *Mill Brook Wellfield Wellhead Protection Plan (2004)* identified 36 parcels with septic systems within this watershed. A revised estimate after a closer inspection of the watershed is 41 parcels with septic systems.

2.4 Outfalls

The *Mill Brook Illicit Discharge Detection and Elimination Summary Report* prepared for the Rockport Dept. of Public Works by Woodard & Curran in 2003 identified seventeen direct outfalls on the section of Mill Brook from Front Beach up to Poole's Lane. Additional outfalls were identified in a walk of the stream with the project team and on subsequent walks of the stream by the study team during the study period. A total of 35 direct pipe discharge outfalls are identified in this report. The outfalls are identified and numbered on the GIS map (reference pocket insert). Table B-1 contains a description of the location and characteristics of each outfall pipe with notes of observations made during reconnaissance. Appendix B contains photos of most direct discharge outfall pipes identified on the GIS Map and in Table B-1.

2.4.1 Description

A number of the identified direct outfalls on the lower section of Mill Brook are of municipal origin. Four drains discharge to the brook under Beach Street, 3 under Railroad Avenue and 3 under Poole's Lane. Many of these are part of the municipal storm drainage system. However, it is likely that at least one of the discharges under Poole's Lane originates from the commuter rail station. At least one other discharge, Outfall #7, located approximately 200 feet upstream from Beach Street connected to a catch basin draining Millbrook Meadow, is part of the municipal storm drainage system.

Several of the other outfalls appear to be discharging stormwater from adjacent commercial and residential properties. The section of town between Poole's Lane down to and including the north side of Railroad Avenue is one of the most densely commercial areas of town. This is also the area of the highest concentration of outfalls. (See GIS map.) This includes a sizeable shopping center including an IGA grocery store, pharmacy, Laundromat, and variety store. The commuter rail station, another smaller shopping center, Isinglass Place, Dunkin' Donuts, a hardware store, an oil company, and an automotive repair garage are all located in this area as well. A public housing apartment complex and a privately-owned townhouse complex also abut the brook in this area.

A number of pipes appear to be discharging from sumps or basements inside adjacent commercial and/or residential buildings. Several of these pipes were observed to have dry-weather discharge. At least two of these appeared to be connected to automatic pumps because they were observed to discharge at irregular intervals. Other pipes are likely draining residential yards adjacent to the brook. There were no visual indications of direct sewage outfalls observed.

2.4.2 Permit History

A review of the Rockport Conservation Commission records was conducted to determine the permit history of the direct discharge outfalls. A summary of all permits and determinations under the MA Wetlands Protection Act and Rockport Wetlands By-law for property or activities adjacent to Mill Brook within the study area is located in Table B-2. A total of 23 permit actions were identified. Of the 23, only two appeared to have any reference to direct discharge outfalls on the brook. These included the installation of a 6-inch diameter "interceptor" drain to drain groundwater from a residential property just north of Railroad Avenue, and a permit for a substantial building and drainage renovation at Isinglass Place commercial center located just south of Railroad Avenue, which included two 12-inch PVC discharge pipes draining a series of catch basins, located in the Isinglass Place parking lot. These permits correspond with Outfall #13 or 14 and 25 and 28, respectively. In summary, 3 of the 35 identified direct discharge outfalls within the study area have any permit history on record with the Rockport Conservation Commission.

2.5 Monitoring Erosion at Outfall Locations

Monitoring erosion at outfall locations was a specific recommendation of the *Mill Brook Illicit Discharge Detection and Elimination Summary Report (2003)*. Monitoring was conducted by walking the entire section of stream in the study area at least once and most parts of the stream a number of times during the course of this study. Photos were taken and observations noted during these reconnaissance surveys. Photos are included where available in Appendix C. Areas of particular concern were:

1. A discharge to the bank above the stream approximately 100-feet upstream of Beach Street in Millbrook Meadow was noted by Woodard & Curran in the *Illicit Discharge Detection Summary Report*. This site was visited several times during the course of the study. No significant increase of erosion was observed. (Appendix C, Figure C-1).

2. One of the reasons for undertaking this nonpoint source pollution assessment is the town's concern over the noticeable accumulation of sediment at the head of Mill Pond. Sediments from upstream sources that are carried by the stream are deposited when the stream's velocity slows upon entering the pond. Physical removal of these sediments is likely an impracticable alternative for the town from a financial and logistical perspective. Reducing upstream sediment inputs to slow the rate of accumulation and extend the life of the pond may be the town's only practicable alternative.

3. A number of municipal catch basins were found to be located directly over and therefore discharge stormwater and sediments directly into stream culverts. These included Catch Basin # CB-4 on Beach Street, CB-24 and CB-25 on Poole's Lane,

and CB-33, and CB-34 on Railroad Avenue, and CB-45 at the base of Summit Avenue.

4. A cement retaining wall serving as the south side of an open culvert for the Squam Brook tributary just after it passes under the base of Summit Avenue (at sampling station K) is beginning to cave in toward the stream. This retaining wall is likely privately owned. If it were to collapse at some point in the future, it would cause a significant release of sediment into the stream. Since this location is upstream of Mill Pond, if it were to collapse it is likely that this would be another large dose of sediment added to the already sediment-choked pond. (Appendix C, Figure C-2).

5. One of the tenants at the Isinglass Place commercial plaza just upstream from Railroad Avenue is a day care facility for infants and young children. The facility's "play area" located behind the building abuts a cement retaining wall forming the west bank of the stream. Imported sand from the play area has created a significant sediment source to the stream. A deep sand pile has accumulated in the stream channel at the base of the retaining wall directly below the play area. Sand from this source has likely been transported downstream as well. (Appendix C, Figure C-3).

6. A section of the stream between the Rockport Housing Authority Millbrook Park and Isinglass Place properties (just upstream from sampling station H) across from the Whistlestop Mall parking lot is eroding. It appears that an attempt to impound the stream into a small pond by building a berm across the stream bed has created an erosional situation. Its path blocked by the berm, the force of the stream is in the process of blowing out the west bank of the stream in that location. As the bank is eroded, a large amount of sediment is being released into the stream, adding more sediment to the stream channel and ultimately to Mill Pond where it is retained. (Appendix C, Figure C-4).

7. A significant source of sediments includes the upstream watersheds flowing into the study area. In particular, the Squam Brook watershed has steep slopes and roads with no curbs or drainage systems. These conditions can lead to enhanced overland flow and elevated sediment transport in the runoff. The Squam Brook watershed in particular was identified in a letter from the Natural Resources Conservation Service (NRCS, Oct. 2003) as an area to focus erosion control and sedimentation BMP's.

2.6 Beach Testing Results v. Rainfall 1999 - 2004

Comparison of bacteria levels at the mouth of Mill Brook and Front Beach and rainfall was made by plotting bacteria levels collected for beach testing purposes with rainfall levels measured at a rain gage in Rockport for 1999-2004. These plots can be viewed in Appendix D. For 1999 and 2000, fecal coliform was tested for as the indicator of bacteria-borne pathogens for both the stream and different locations along the beach. In 2001, the target bacteria groups tested for changed to E. coli for the stream (freshwater) and Enterococci for the beach (marine water). Acceptable limits of bacteria for swimming waters are 200 colonies of fecal coliform per 100ml., 235 colonies E. coli per 100ml. and 104 colonies and 61 colonies of Enterococci for marine and fresh water respectively. In the summer of 1999, there were frequent exceedances of the acceptable bacteria limits acceptable for swimming at the mouth of Mill Brook and at least two (2) at Front Beach despite the fact that there were few rainfall events between June and

September. In the summer of 2000, there were again frequent exceedances at the mouth of Mill Brook and at least one exceedance (exceeding 7,500 colonies fecal coliform per 100ml.) measured at the middle of Front Beach. The summer of 2000 exhibited more frequent rain events, and the one beach exceedance appears to be associated with a 0.75 inch rain event. In 2001, no water quality monitoring samples were collected at the mouth of Mill Brook in coordination with the Front Beach monitoring. There was one exceedance (140 colonies of Enterococci per 100ml. on July 23) not apparently associated with a rain event. During 2002, one exceedance for the mouth of Mill Brook occurred on July 10 in association with a 0.5 inch rain event. The summers of 2003 and 2004 saw no exceedances in the marine waters of Front Beach. The summer of 2003 saw four (4) exceedances at the mouth of Mill Brook with the highest reaching a count of 2000 colonies E. coli per 100ml. on July 22 associated with a 0.8 inch rain event. In 2004, only one exceedance at the mouth of Mill Brook was detected prior to commencement of sampling for this study. Over the 1999-2004 periods, it appears that exceedances of acceptable bacteria limits have reduced in number and frequency at Front Beach and the mouth of Mill Brook. An initial comparison showed that elevated bacteria counts were found both during wet and dry periods, implying that there may be more than one vector for bacteria to the beach.

2.7 Water Quality Monitoring

Three (3) rounds of wet-weather water quality monitoring were conducted at twelve sampling locations on the lower Mill Brook during this study period. From each sampling location for each round, water samples were analyzed for four different types of bacteria (Total Coliform, Fecal Coliform, E.coli, Enterococci) and Total Suspended Solids (TSS). In addition, on one occasion, Optical Brightener monitoring was conducted at 5 locations within the study area.

2.7.1 Bacteria and TSS Analysis

After a preliminary investigation and evaluation of the study area, twelve initial sampling locations were identified along the lower section of Mill Brook in coordination with the project partners including the MA Office of Coastal Zone Management, Massachusetts Bays Program, Woodard & Curran, Rockport Dept. of Public Works and Rockport Board of Health. Sampling stations were chosen:

- to coordinate with previous monitoring studies of the stream;
- to divide the study area into logical sub-drainage units;
- to facilitate feasibility of sampling.

Sample collection stations are shown on the GIS Map (insert).

Wet-weather water quality monitoring, collecting water samples from the stream during precipitation events, was proposed because the results would best reflect effects of stormwater impact as pollutants from adjacent land is washed into the stream from runoff. No water quality monitoring specifically targeting wet-weather events had been done on Mill Brook. Wet-weather sampling was also proposed in order to compare the results with targeted dry-weather sampling that had been done the previous year for the *Mill Brook Illicit Discharge Detection and Elimination Summary Report (2003)*. To qualify as a wet-weather sample, water samples were collected during a precipitation event that occurred after a minimum of 72-hours of dry (no precipitation) weather, and the precipitation event had to be a minimum of a 0.25-inch rain event with rain falling at a minimum of 0.10 inches per hour. Samples were collected following standard bacteria sampling protocols. Collected samples were analyzed at Biomarine of Gloucester, MA, a state-certified laboratory, using *Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998 and EPA Method 1600, March 2000.* Laboratory data sheets are included in Appendix E.

Results 1st Wet-Weather Sampling Round - September 8, 2004. (Table F-1, Figures F-1 through F-5)

Water Quality monitoring results for the September 8th sampling event showed high counts of all four types of bacteria analyzed. Total Coliform ranged from 4,000 colonies per 100ml. to 180,000 colonies per 100ml. with the lowest counts found at sampling station C just below Mill Pond, and the highest counts found at sampling station D just above Mill Pond. Fecal Coliform counts ranged from 2,300 colonies per 100ml. to 47,000 colonies per 100ml. with the lowest counts again at sampling station C just below Mill Pond and the highest counts found at sampling station F on the Squam Brook tributary just before it entered Mill Brook off Henderson Court. E.coli counts ranged from 1,300 colonies per 100ml. to 16,000 colonies per 100ml. again with lowest and highest values found at sampling station C and F, respectively. Enterococci values ranged from 430 colonies per 100ml. to 16,000 colonies per 100ml. with the lowest counts found at sampling station B just upstream of Beach Street and the highest counts again found at sampling station F on Squam Brook off Henderson Court. Total Suspended Solids (TSS) counts ranged from 19 to 497 mg/L with the lowest counts found at sampling station G just upstream of Railroad Avenue and the highest at sampling station K on Squam Brook at the base of Summit Avenue.

2nd Wet-Weather Sampling Round - November 24, 2004. (Table F-1, Figures F-1 through F-5)

Bacteria counts from the November 24th monitoring events were considerably lower than the September 8th event except for Total Coliform. Total Coliform counts ranged from 2,400 colonies per 100ml. to 190,000 colonies per 100ml. with the lowest counts found at sampling station L on Squam Brook off of Squam Hill Court and the highest counts found at sampling stations D and E on Mill Brook upstream of Mill Pond and off Henderson Court. Fecal Coliform counts ranged from 50 colonies per 100ml. to 2,900 colonies per 100ml. with lowest counts found again at sampling station L on Squam Brook and highest counts found at sampling station A at the mouth of Mill Brook at Front Beach. (Here the duplicate sample measured 2,900 colonies per 100ml., almost 3 times higher than the 1,000 colonies per 100ml. of the original sample for this location.) E.coli counts ranged from 10 colonies per 100ml. to 1,900 colonies per 100ml. with lowest counts again found at sampling station L and highest counts found at sampling station D above Mill Pond. Enterococci counts ranged from 20 colonies per 100ml. to 3,400 colonies per 100ml. with lowest counts found at sampling station L and highest at sampling station A. (The duplicate sample measured 3,400 colonies per 100ml., compared to the 2,500 colonies per 100ml. of the original sample for this location.) TSS counts ranged from 9 to 312mg/L with the lowest counts found at sampling station L and the highest at sampling station D upstream from Mill Pond.

3rd Wet-Weather Sampling Round - May 7, 2005 (Table F-1, Figures F-1 through F-5).

Bacteria and TSS counts from the May 7th monitoring event were considerably lower than the two previous monitoring events. Total Coliform counts ranged from 1,500 colonies per 100ml. to 7,400 colonies per 100ml. with lowest counts found at sampling station A at the mouth of Mill Brook at Front Beach and the highest counts found at sampling station E on Mill Brook downstream of Railroad Avenue. (The duplicate sample for sampling station A measured 1,500 colonies per 100ml., less than half the 3,800 colonies per 100ml. of the original sample.) Fecal Coliform counts ranged from 70 colonies per 100ml. to 750 colonies per 100ml. with lowest counts found at sampling station F on the Squam Brook tributary before it enters Mill Brook and highest counts found at sampling station E on Mill Brook downstream from Railroad Avenue just upstream from where the Squam Brook enters Mill Brook. E.coli counts ranged from 40 colonies per 100ml. to 670 colonies per 100ml. with lowest counts found at sampling station L on Squam Brook off Squam Hill Court and the highest counts found at sampling station D upstream from Mill Pond. Enterococci counts ranged from 10 colonies per 100ml. to 160 colonies per 100ml. with lowest counts found at sampling station J just upstream of Poole's Lane and highest counts found at sampling station A at the mouth of Mill Brook. (The duplicate sample measured 60 colonies per 100ml., less than half the 160 colonies per 100ml. counted in the original sample.) TSS counts ranged from 4 to 30mg/L with the lowest values found at sampling stations A at the mouth of Mill Brook and C downstream of Mill Pond and the highest values found at sampling station G upstream of Railroad Avenue.

Comparison of Wet-Weather Monitoring Rounds - Bacteria

Water quality monitoring results from the Sept. 8, 2004 sampling event show elevated bacteria counts at almost every location. Sampling stations B and C downstream of Mill Pond for all bacteria measured and sampling station L off Squam Hill Court on Squam Brook for all but total coliform were less elevated than other stations, but still considered elevated based on levels considered safe for swimming. In comparison, monitoring results from the November 24, 2004 sampling event show a significant decline in all bacteria types except for total coliform which continue to be quite high, most notably at sampling stations D and E upstream of Mill Pond and below Railroad Avenue. Sampling station L off of Squam Hill Court had the lowest counts with sampling stations B and C downstream of Mill Pond and sampling station K at the base of Summit Avenue on Squam Brook having some of the lower counts. All bacteria counts dropped significantly between the November 24, 2004 and May 7, 2005 sampling events, although the majority of sampling locations still had bacteria counts in excess of the acceptable limit for swimming waters for all bacteria types. Acceptable levels for swimming are considered to be 1,000 colonies total coliform per 100ml., 200 colonies fecal coliform per 100ml., 235 colonies E. coli per 100ml. and 61 colonies Enterococci (for freshwater) per 100ml.

Factors that could be contributing to the variation in bacteria counts between wet-weather sampling events are: seasonal land use practices by humans and animals, water temperature in the stream, stream baseflow, water table depth, rainfall intensity, length of time since last significant precipitation event, timing of sampling within the rain event, and stormwater management BMP's. The September 8, 2004 sampling event took place the week immediately following Labor Day weekend. Land use of beaches, parks, roads, parking areas, seasonal residences, etc. would likely have been close to its peak of the summer season just prior to the sampling event. Elevated levels of human (and animal) activity without adequate stormwater management BMP's can result in elevated pollutant levels in the stream at this time of year. Water temperature affects the rate that bacteria reproduce and multiply. Streamwater temperatures in early September can be expected to be much higher than in late November or early May, and thus bacteria will be multiplying more quickly at this time of year. Rainfall intensity and duration, as well as the length of time since the last precipitation event, can impact pollutant levels in the stream. Higher intensity storms, and/or storms of a longer duration, are more likely to produce runoff over a greater proportion of the watershed which can result in greater pollutant delivery to a stream. Also, a longer period of time since the last significant rainfall will allow for more pollutants to build up within the watershed before being "washed" into the stream by a precipitation event. Rainfall intensity is related to both the volume and duration of precipitation. It can be highly localized and would require a dense network of more sophisticated equipment to take more precisely timed measurements of a rainfall event over time. For this study, the depth measurement taken at a single rain gage was used to estimate precipitation volume over the entire watershed area. Comparison of the three events shows total rainfall depths of 0.58 inches, 0.49 inches and 1.28 inches respectively. In the case of duration since last significant rainfall, defined as a rainfall event equally or exceeding 0.25 inches, a duration of 18 days had passed since a significant rainfall event before the 9/8/2004 event, a duration of 11 days since a significant event prior to the 11/24/2004 event, and 8 days prior to the 5/7/2005 event. Relative rainfall amounts and length of time since last rainfall can be viewed in Figure F-6 where E. coli bacteria results for five sampling stations are plotted against a rainfall curve over the sampling period. Duration since previous rain event could be one of several factors that might help explain the higher bacteria counts of the 9/8/2004 event. Though actual intensity could have been higher for a smaller storm, the precipitation

The quantity of water in the stream at the time of sampling can affect bacteria counts through dilution. Since the wet-weather sampling protocol for this study required that there be 72 hours without rain before a sample could be taken, Mill Brook was likely in a "baseflow" condition just before each sample. "Baseflow" is the water in the stream during periods without rainfall, and it is supplied by the adjacent alluvial aquifer. In other words, it is ground water discharge. Bacteria counts are measured in numbers of colony forming units or "colonies" of a certain group of bacteria per 100 ml. of water collected. Even if the rate of delivery of a certain type of bacteria through any of a number of different vectors were consistent across different sampling events, the quantity of water in the stream at the time of the sampling event may cause the sampling results to be quite different because of dilution.

In the case of Mill Brook over the period of sampling, we do not know the baseflow quantity in the stream because there is not an active stream gage in this area. However, we can make assumptions based on knowledge of a typical annual hydrograph for a stream in this region, which can be supported by comparisons with a "proxy" stream that is gaged. Typically, a good proxy stream will have a similar watershed size, relief, land use and land cover, geology, and climate. A typical stream in this region under normal or average annual rainfall conditions will follow a fairly predictable baseflow pattern throughout the year, where baseflow will typically be lowest in August and September, will gradually rise starting in October, and will peak in April before evaporation and transpiration begins to draw down the ground water tables again. This pattern is corroborated by the baseflow periods evident in the annual hydrograph of a proxy stream (USGS 01104455, Stony Brook, Unnamed Tributary 1, near Waltham, MA) located approximately 30 mi. from Rockport which has a comparable watershed size, topography and land use. The proxy stream follows the expected baseflow curve with the lowest baseflow observed in August, rising gradually through the fall and then peaking in early spring. The only variation observed in the proxy hydrograph is that in the spring of 2005, the peak in annual baseflow was delayed from the 3-year average of early April, and actually occurred in early May at approximately the same time as the 5/7/2005 sampling event in Rockport. Baseflows increased approximately 50 percent between early September and late November and rose by a factor of five between November and early May. Though the actual baseflow will not be the same between Rockport's Mill Brook and the proxy stream, the relative rate of baseflow and stream volume can be extrapolated for comparison purposes. This pattern of lowest baseflow during the September sampling round, somewhat higher in the November sampling round, and then much higher in the May sampling round may help explain some of the variation between bacteria counts observed in Mill Brook between sampling events. The very large increase in stream flow between November and May could explain a lot of the large variation between the bacteria counts from those two sampling events, with the concentration of bacteria strongly diluted by a much larger baseflow volume in May. The smaller relative variation in baseflow between the September and November sampling events (a 50 percent rise in the proxy stream) does not appear to entirely explain the significant drop in bacteria counts between those dates.

One final factor that should be considered is use of stormwater management BMP's. In particular, practically all of the municipally owned catch basins in the lower Mill Brook watershed study area were cleaned out between the September and November sampling dates. It is unknown how much impact this might have had on bacteria levels in the stream, but it may help explain some of the drop in bacteria levels. In conclusion, it is likely that several factors help explain some degree in the variation between bacteria counts between sampling events. These include a rise in baseflow volume tending to "dilute" bacteria concentrations, a drop in seasonal activity of land use by humans and animals, drop in water temperature (at least from the early September sampling date), length of time since last significant precipitation event, and catch basin cleaning in the lower Mill Brook watershed. It doesn't appear that the overall rainfall amount as measured by a rain gauge had a significant effect on bacteria counts at least for these specific events sampled.

Comparison of Wet-Weather Monitoring Rounds - TSS (Table F-1, Figure F-5)

Other than at two sampling stations, sampling stations K and L on Squam Brook with higher TSS measurements in the September sampling event, TSS measurements were highest during the November sampling event and in almost all cases, were significantly lower in the May sampling event. Some of the factors that might explain a variation in

TSS load measured in a stream include more natural factors such as intensity and volume of precipitation event and length of time since last significant runoff event. Other more human manipulated factors might include land use changes creating or exacerbating a sediment source to the stream, physical disturbance in the stream channel causing resuspension, and use of stormwater management BMP's which might be expected to reduce sediment sources to the stream. In this case, it is curious to note that the highest TSS measurements (other than the two stations in September that were noted above) were observed in the sampling round that occurred after most of the municipal catch basins were cleaned in the study area watershed. The November sampling round occurred three to four weeks following catch basin cleaning, so it isn't believed that the elevated TSS measurements were a direct result from catch basin cleaning. One possible explanation might be that catch basins with very high sediment volumes might have acted as "check" dams, preventing sediment from being flushed through drainage pipes into the stream. Cleaning the "clogged" basins may have allowed sediment to flow more freely through drainage pipes to be discharged to the stream. This conjecture is speculative. This phenomenon is a difficult one to explain.

Comparison of Wet and Dry-Weather Water Quality Monitoring within the Study Area

In 2002 and 2003, Woodard & Curran (W&C) conducted dry-weather water quality monitoring at five locations on the lower section of Mill Brook for the *Mill Brook Illicit Discharge Detection and Elimination Summary Report (2003).* Dry-weather monitoring was conducted for the same four types of bacteria (Total Coliform, Fecal Coliform, E.coli, Enterococci) in December, 2002, July 2003, and September 2003 at sampling locations corresponding closely with sampling stations used in this study, sampling station A Beach St-Downstream, sampling station C Mill Pond-Downstream, sampling station D Mill Pond Upstream, sampling station J Poole's Lane Upstream and sampling station K Squam Brook-Summit Ave Downstream. Figure F-7 shows a visual comparison of E. coli counts for the three dry-weather monitoring events with the three wet-weather monitoring events conducted as part of this study. In general, bacteria counts were much higher on the first wet-weather monitoring event and somewhat higher in the second wet-weather monitoring event than during the dry-weather monitoring with the exception of sampling station D Upstream of Mill Pond. Bacteria counts at sampling station D exhibited fecal coliform and E. coli counts somewhat comparable to the November 2004 wet-weather sampling during the July and September, 2003 dry-weather sampling. One interesting note is the dramatic variation in sampling results between the September 2004 wet-weather sampling and the September 2003 dry-weather sampling at these five stations.

2.7.2 Optical Brightener Testing

One week-long round of optical brightener testing was conducted in September, 2004. Optical brightener sampling involves anchoring a sampling pad in a flowing or standing water body for a period of time and then collecting the sampling pad and "reading" it for signs of fluorescent white dye after drying. Fluorescent white dye is commonly found in detergents. A positive reading for fluorescent white dye can indicate a source of sewage or gray water from a home or business. The test is used where high bacteria counts or nutrient measurements are found to help identify if they are from a human or non-human source.

Optical Brightener media were deployed in the field at five locations from September 1 to September 8, 2004. The five locations corresponded to water quality sampling locations as specified in Table F-2. The sampling period also corresponded to the first wet-weather WQ monitoring event of September 8, 2004 as reported above. Each clean gauze pad was deployed in either a plastic coated cage or plastic mesh bag and anchored in the stream using fishing line. At the end of the sampling period, each pad was retrieved, placed in a clean plastic sealable bag, and returned to the office where they were dried on a clothesline before being read under a black light for presence of fluorescent white dye. Optical brightener testing was done in close coordination with Rockport Board of Health staff who have performed this testing before, and results were read by an experienced Board of Health employee. Results as reported in Table F-2 were negative - no presence of fluorescent white dye detected, from four of the five sampling locations and a "possible" positive from one location, sampling station G just upstream from Railroad Avenue. No detection of the presence of fluorescent white dye at four locations only a "possible" presence at one location helps support a theory that high bacteria levels in these parts of the stream are more likely from a stormwater source than from a failing septic system or illicit sewer connection draining into the brook.

2.7.3 Preliminary Conclusions Drawn from Water Quality Monitoring Results

1. Very high bacteria counts were observed for the September 8, 2004 wet-weather water quality monitoring event. Comparison with dry-weather monitoring results from 5 of the same sampling stations from September 2003 suggest that wet-weather conditions may explain at least part of this striking variation. Other environmental and human-driven factors may also be at play.

2. With few exceptions, bacteria counts dropped significantly from the September 8, 2004 monitoring event to the November 24, 2004 monitoring event, and dropped significantly again from the November 24 monitoring event to the May 7, 2005 monitoring event. It is thought that the dilution factor of a rising stream baseflow may have played a significant role in these sampling results. Other factors, including change in seasonal land use, stream water temperature, length since previous rain event and cleaning of catch basins in the lower Mill Brook watershed may have also played a role.

3. Sampling Station D Upstream of Mill Pond consistently exhibits some of the higher bacteria counts across monitoring events (both wet- *and* dry-weather events) and bacteria types. Sampling Station D is receiving stream inputs from both Mill Brook and the Squam Brook tributary and is downstream of Railroad Avenue and its associated commercial district. Urban wildlife activity may also be contributing a bacteria source to this thick, wooded section of the brook.

4. Sampling Station C downstream of Mill Pond consistently has some of the lowest bacteria counts across the three monitoring events and across the four different types of bacteria. It appears that over the duration of the sampling event, the residence time of water in Mill Pond serves to both dilute and detain suspended bacteria.

5. Other than high counts of total coliform bacteria during the September sampling event, sampling station L off of Squam Hill Court also exhibited some of the lower bacteria counts between the three sampling events. This is interesting to note in relation to the fact that the Squam Brook watershed, the sub-drainage area for sampling station L, is unsewered and entirely served by septic systems for residential wastewater treatment.

6. Other than high counts at sampling stations K and L on the Squam Brook tributary at the September water quality monitoring event, TSS measurements were much higher during the November sampling event than the September or May sampling events. This observation is somewhat unexpected based on the fact that the catch basins in the lower Mill Brook watershed were cleaned between the September and November sampling events, which one may have expected to result in lower TSS measurements in the stream.

7. Almost entirely negative results (other than a "possible" positive at sampling station G upstream of Railroad Avenue) from optical brightener testing suggests that the elevated bacteria counts observed are more likely related to nonpoint source pollution factors than illicit sewer connections or failing septic systems in the lower Mill Brook watershed. However, additional periodic optical brightener testing may help confirm this.

3. Development of Nonstructural BMPs

3.1 Sediment Budget

Data was collected to construct a rough course sediment budget for the study area for the winter of 2004-2005. Throughout the winter of 2004-2005, estimates were made of the amount of sand deposited on the streets within the study area due to hazardous road conditions. The municipal catch basins within the study area were cleaned out in the first and second weeks of October of 2004 and then again in the second and third weeks of May 2005. This allowed the town to estimate the rate of sediment accumulation within each catch basin over a known period of time (approximately 7 months). Also, estimates were made on sediment removal from the study area from street sweeping conducted in the fall before the winter sanding season and again in the spring. Forty-four (44) municipal catch basins were identified within the study area. Twenty-three (23) privately-owned catch basins were also identified.

Catch Basin Cleaning – 1st Round. (See Appendix G for data sheets.) The total amount of sediment removed from the study area from the October 2004 round of catch basin cleanings was estimated at approximately 370 cubic feet (13.5 cubic yards.). The largest amounts of sediment were removed from catch basin # 5, 13, 14, 16 and 28 located at King Street and Beach Street, King Street, Holbrook Court, and Poole's Lane respectively, each with 25 cu. ft. or greater of sediment. Because there were no definitive records on the last time any of these catch basins had been cleaned, it isn't possible to extrapolate rates of accumulation from this data. The catch basins that were the most full of sediment were catch basin # 2, 5, 13 – 16, 28 and 30 which ranged from 25% - 50% full. At least one study (*Pitt, 1985*) concluded that catch basins can capture sediments up to approximately 60% of the sump volume. When sediment fills greater than 60% of their volume, catch basins no longer reliably capture sediment from storm flows. They can lose as much sediment to resuspension and washout as they capture. Because percent volume was calculated using total basin volume instead of more correctly as sump volume, it can be assumed that any basin that has reached 50% capacity is no longer effectively removing sediment from stormwater flows.

Catch Basin Cleaning – 2nd Round. (See Appendix G for data sheets.) The total amount of sediment removed from the catch basins in May 2005 were approximately 310 cu. ft. (11.5 cu. yds.), eighty-four percent (84%) of the volume that was removed the previous fall. The largest volumes were removed from catch basin #12 (not cleaned in the fall because it was not accessible) with 25 cu.ft., #'s 13 and 14 with 19 cu.ft., all from King Street. The catch basins with the highest average daily rate of accumulations (greater than 0.05 cu.ft. per day) between the two cleanings were catch basin #'s 1, 3, 5 though 7, 13 through 15, 23, and 28 through 31. Appendix G shows the catch basin data and highlights those catch basins with the most sediment removed, the highest percent full, or the highest average daily accumulation rate between the two cleanings. Those catch basins highlighted should be targeted for a more intensive cleaning schedule (up to monthly), while the others may function adequately with fewer cleanings per year.

Street Sweeping. Street sweeping was conducted in the study area in late October of 2004 and again in late April of 2005. It was estimated that 2 cubic yards of street sediments were removed from the area on each occasion.

Winter Street Sanding. An estimate of sand introduced to the study area through street sanding was made by reviewing Dept. of Public Works records. It was estimated that throughout the winter of 2004-2005 that approximately 25 loads of sand and salt were spread on streets within the study area. When the proportion of each 6 cu. yard. load that is comprised of salt is subtracted, this number translates into approximately 135 cubic yards of sand added to the study area. When compared to the approximately 2 yards removed in late April by street sweeping and the approximate 11.5 cubic yards removed in early May by catch basin cleaning, the amount of sediment that was "recovered" by catch basin cleaning and street sweeping represents approximately ten percent of the sediment known to have been deposited. Year after year of street sanding with only a 10 percent recovery rate from catch basin cleaning and street sweeping adds up very quickly to a significant sediment source to a watershed. It can be assumed that some portion of that is entering Mill Brook through the drainage system and through overland flow. Attenuation of these sediments (combined with sediments from many other sources) in Mill Pond will eventually cause the loss of this valuable and cherished resource.

3.2 Catch Basin and Culvert Cleaning Plan

A catch basin cleaning plan was developed to provide guidance to the town in managing the cleaning and sediment removal of municipal catch basins. The Catch Basin Cleaning Plan is located in Appendix H. The plan gives guidance on reasons for cleaning catch basins, on handling and disposal of catch basin cleanings and a catch basin cleaning schedule and includes a template catch basin cleaning reporting sheet. There does not appear to be a definitive source or a definitive schedule for cleaning catch basins. Different sources included guidance that basins should be cleaned a minimum of one to two times per year (*Aronson, 1983 in an EPA publication*), should be cleaned a minimum of four times a year (*MA DEP Stormwater Policy*), or should be cleaned up to five times a year (*NRCS pers. Com.*). There does seem to be consensus among sources that more frequent cleanings (up to once a month) maximizes the amount of sediment collected on an annual basis and thus reduces the amount that has the potential to be washed downstream through resuspension. Part of municipal stormwater management involves weighing the cost and efficiency of sediment recovery of more frequent cleanings against other forms of stormwater BMP's such as spending funds on retrofitting catch basins with deeper sumps to hold more sediments or more frequent street sweeping.

Promoting the use of the reporting sheet (template provided) will allow the town to keep track of which basins fill more quickly and which may need to be cleaned more frequently. At some point in the future if Rockport adopts a GIS-based mapping system, the information collected on the Reporting Sheets may be able to be incorporated into a town-wide GIS system to track sediment collection on a town-wide basis.

3.3 Street Sweeping Plan

A street sweeping plan was developed to provide guidance to the town in removing sediment and debris from municipal streets. The Street Sweeping Plan is located in Appendix I. The plan provides guidance on reasons for sweeping streets, disposal of street sweepings, and on a street sweeping schedule and includes a template reporting sheet for use by the Dept. of Public Works highway crew. As with the catch basin cleaning, there doesn't appear to be a definitive street sweeping schedule. The recommended frequency ranges from monthly with more frequent sweepings as needed (*NRCS, pers. Com.)* to weekly (*Claytor, 1999*). More frequent street sweeping may help reduce the number of annual catch basin cleanings needed to maintain optimal catch basin treatment capacity.

3.4 Stormwater Control By-law

The Town of Rockport is required to comply with the National Pollution Discharge Elimination System (NPDES) Stormwater Phase II general permit and the NPDES Phase II plan adopted by the town to meet the requirements of this program. NPDES Phase II is implemented by the U.S. Environmental Protection Agency (EPA) and the MA DEP. Under the NPDES Phase II permit and the Town of Rockport NPDES Phase II plan, the town is required to adopt a by-law that will regulate erosion and sediment control off of construction sites and will regulate the post-construction impacts of stormwater off of any new or redevelopment construction. As part of the Lower Mill Brook Nonpoint Source Pollution Assessment project, language from by-laws and ordinances developed for or enacted by other municipalities was reviewed for purposes of developing a draft by-law for the town of Rockport.

As part of this undertaking, project partners met with the town Planner, the Building Inspector who also serves as the town's Zoning Agent, the Director of Public Works, the Conservation Agent and the Board of Health Agent. They also met with the Rockport Planning Board, at their meeting of May 19, 2005 to discuss steps for the adoption of a stormwater control by-law for the town of Rockport. Project partners have also met with a representative from the City of Gloucester's Engineering Department which is in the process of updating the city's stormwater by-law. Further meetings with the Rockport Planning Board and City of Gloucester Engineering Dept. will be held in an effort to further refine a model by-law to meet the needs to the town of Rockport. Benefits for Rockport of working with the City of Gloucester as they update their own stormwater by-law are to take advantage of the expertise from a municipality that has already been implementing stormwater controls for several years; the town of Rockport benefiting from the greater staffing and financial resources of the much larger neighboring community; and the possibility of consistency between stormwater protections between the neighboring communities strengthening the protection for many of their shared resources.

Although there are some minimum requirements that must be incorporated into a stormwater management by-law to comply with the NPDES Phase II stormwater permit requirements, the town has a fair amount of latitude to choose how it administers the by-law. Some of the minimum requirements are that the by-law must:

1. Prohibit non-stormwater discharges into the municipal drainage system, including enforcement procedures and actions;
2. Control construction site runoff:
    a. apply to sites of 1 acre or more of disturbance;

b. require erosion and sedimentation controls;

c. include a process for public input;

d. ensure site plan review, including pre-construction review;

e. considers potential water quality impacts;

f. require control of construction waste; provide for site inspections; and

g. has procedures for enforcement of control measures.

3. Control Post Construction Stormwater Management from New Development and Redevelopment

    a. apply to sites of 1 acre or more of disturbance;

    b. require apply to projects that newly discharge runoff to the municipal stormwater drainage system;

    c. apply to projects that disturb 1 acre of land or more;

    d. require permanent stormwater controls to minimize water quality impacts;

    e. ensure long-term operation and maintenance of structural stormwater controls.

Some of the more important choices that town officials will need to make in drafting and adopting a stormwater management by-law are: Should it be a general or zoning by-law? Which town department or board should administer it? How should fees be collected, held and appropriated? There are of course pros and cons on both sides of the argument for a zoning or general by-law. Several points came out of reviewing model language and other literature on the subject. The more important issues are related to grandfathering provisions of zoning by-laws, enforcement provisions are different, and zoning by-laws would allow issuance of building permits and certificates of building occupancy to be contingent on compliance.

There are several factors that make both the Dept. of Public Works and the Rockport Planning Board the appropriate department or board for administering the by-law. Factors in favor of the Dept. of Public Works administering the stormwater by-law include the fact that it is a relatively large department in Rockport and might be better able to assume the added review requirements, and the Dept. of Public Works has staff that have training and experience in using and reviewing runoff calculations and hands-on experience in implementing stormwater management procedures. Factors in favor of the Planning Board administering such a by-law (if the stormwater by-law were to be adopted as a zoning by-law), are that the Planning Board already administers Site Plan Review and Sub-division Control and other zoning by-laws. The Planning Board has the ability to take consulting fees from applicants and could therefore hire an outside reviewer to provide the technical review. Potentially, some of the review tasks could be split between the Dept of Public Works and the Planning Board, but in any case, both departments should have input into the process. Both the Conservation Commission and Board of Health are likely too small, one full- or part-time agent with part-time support staff, to assume an additional review process. Both of these boards should have input into the review of the applications though.

Another aspect of the stormwater management and erosion and sediment control by-law that the town can choose are size thresholds for triggering review or requiring a permit. NPDES Phase II Stormwater permit requires that a minimum land disturbance area of 40,000 square feet trigger review and permit requirements. Many towns that have adopted stormwater management and erosion and sediment control by-laws have chosen to reduce this threshold of total land disturbance area in order to have the ability to implement runoff and sedimentation controls on a larger proportion of construction projects. If the town were to choose a much lower land disturbance threshold, it could also consider establishing lower filing requirements for the smaller projects that have less potential to create runoff and sedimentation impacts. Other aspects of a stormwater management by-law that the town could implement are regulations that encourage Low Impact Development (LID) and use of disturbance minimizing techniques and natural landscape features to encourage infiltration over or in conjunction with more traditional structural stormwater management techniques.

3.4.1 Construction Site Erosion and Sediment Control

The purpose of a construction site erosion and sediment control by-law is be to require construction sites of a determined threshold size to meet established performance standards for controlling erosion and sediment transport off the site. Currently only construction sites immediately adjacent to wetland resource areas which are required to receive an Order of Conditions from the Conservation Commission or development regulated by the Planning Board under Subdivision Control or Site Plan Review have any requirements for using erosion or sediment control BMP's. Yet a fair number of development or redevelopment projects that can include a significant amount of land disturbance and have the potential for large amounts of sediment transport are not regulated. In many of these cases, the construction site will be upslope of a catch basin which can introduce large quantities of sediment-laden runoff to the town drainage system which can quickly overburden the town's drainage infrastructure and ultimately end up in sensitive wetlands or coastal waters.

In Appendix J, draft stormwater by-law language is presented that includes a component requiring that an erosion and sediment control plan be approved as part of a Stormwater Management Permit. This model was developed by the Pioneer Valley Planning Commission.

3.4.4 Post-Construction Runoff

The purpose of a stormwater management by-law regulating post-construction stormwater runoff is be to require impacts to meet established performance standards minimizing impacts from post-construction runoff to sensitive wetland and coastal resource areas, to the town's drainage and sediment collection infrastructure and to adjacent properties. Most model by-law language requires proponents of development projects above a specified land-disturbance or building footprint threshold size to implement a combination of non-structural and structural BMP's such that impacts from post-construction are equivalent to or less than runoff from pre-construction conditions.

In Appendix K, a model stormwater by-law is presented that was developed for the neighboring south shore communities of Marshfield, Plymouth, and Duxbury. This model by-law which is still undergoing review and fine revisions was funded by the

Massachusetts Office of Coastal Zone Management (MA CZM) and is based on a model first drafted by MA DEP to meet the Massachusetts Stormwater Policy Guidelines. One strength of this model is that it the body of the by-law contains only the core principles of its purpose and functions. Associated regulations, also still under development, will provide the details of administration. This model, however, focuses almost entirely on post-construction runoff, and does not address construction site erosion and sedimentation control. If the Town of Rockport were to adopt this or similar model by-law language, it could choose to add construction site erosion and sediment control to the post-construction provisions of this model, or it could choose to adopt separate, stand-alone but compatible by-laws.

4. Structural BMP Feasibility and Design

The firm of Woodard &Curran was hired to evaluate the feasibility of implementing structural BMP's to reduce sediment and pollutant loads entering Mill Brook within the Study Area. In addition to their own familiarity with the lower Mill Brook watershed from their work on the *Mill Brook Illicit Discharge Detection and Elimination Summary Report (2003), Woodard & Curran* used the data collected by the project partners to conduct their feasibility analysis, including wet-weather water quality monitoring results for bacteria and suspended solids, mapping of sub-drainage areas within the study srea, mapping of catch basins and outfalls within the study area and data collected on depth, diameter, and inflow and outflow pipes for each catch basin and sediment volume removal from each catch basin.

Woodard & Curran's recommendations for structural BMP's in the lower Mill Brook watershed included a phased approach, dependent on town financial and staffing resources for implementation. These recommendations included:

1. **All catch basins in the lower Mill Brook watershed area be equipped with hoods.** A hood is an inverted elbow or similar device that is installed over the outlet pipe. It is designed to retain oils and other floatables within the catch basin sump to prevent them from flowing downstream to the storm drain outfall. These could cost approximately $250 per hood plus installation costs and require a minimum of a 3-foot deep sump for installation.

2. **Catch basin sumps be a minimum of four (4) feet deep.** The sump is the distance from the invert of the outlet pipe to the bottom of the catch basin. The total depth recorded for the following catch basins was four feet or less and should be targeted for increased sump depth: CB-2, CB-3, CB-16, CB-17, CB-19, CB-23, CB-30, CB-35, CB-37, and CB-38. However, some of these catch basins may not be "true" catch basins (e.g., direct discharges or infiltrating catch basins); these structural improvements should be implemented only after further inspection by the Rockport Department of Public Works. This would most likely require the complete replacement of the existing catch basin with a new pre-cast catch basin with an estimated cost of approximately $5,000 per replaced catch basin. However, costs could be significantly higher due to presence of shallow depth to bedrock in many Rockport locations.

3. **Erosion control should be implemented as needed from Pooles Lane to Railroad Avenue.** Mill Brook's natural stream banks have eroded at one location in this area in particular adjacent to the Rockport Housing Authority Mill Brook Park housing complex. (See also description under Section 2-5(6) under Monitoring Erosion and Sedimentation.) W&C recommends using "soil bioengineering" techniques, such as BioLog® or BioD-RollTM. These natural biodegradable products could be used to provide the needed protection until establishment of mature vegetation, which will resist erosion forces. These methods not only provide strong, sustainable, aesthetically pleasing water edges, but also provide habitats for aquatic & terrestrial wildlife and filter run off water. The cost in materials would be approximately $350 per 30 foot section of stabilized stream bank.

4. **Drainage system modifications should be made where catch basin discharge directly to the brook.** The following five (5) "catch basins" do not have sumps; rather

they discharge through the street directly into Mill Brook: CB-4 on Beach Street, CB-24 and CB-25 on Poole's Lane, and CB-33, and CB-34 on Railroad Avenue (also CB-45 at the base of Summit Avenue.) In some cases, inlet pipes were also observed in the catch basins, indicating that additional drainage is discharging untreated to the brook at this point. W&C recommends that these catch basins be relocated to one side of Mill Brook. These catch basins, once relocated, should meet the requirements of a hooded deep sump catch basin as described in this letter and in the Massachusetts *Stormwater Policy Handbook* (March 1997). Relocating these direct discharges into catch basins would require installation of one (and possibly two) new catch basins to capture this runoff before it enters the brook. As noted above, installation of a new catch basin would cost approximately $5,000.

5. Installation of Vortechnics® Stormwater Treatment Systems in an off-line configuration in or near Railroad Avenue on culverted portions of both Mill Brook and Squam Brook. W&C chose Vortechnics® instead of other brands of water quality BMPs because the Town of Rockport has already installed Vortechs® units in another area of town (Thatcher Road). Town staff is familiar with the operation and maintenance required for these BMPs. This unit removes contaminated sediment, floating hydrocarbons, and debris from stormwater through the use of centrifugal force and gravity settling. It is also equipped with baffles for flow control to eliminate turbulence and provide positive removal efficiencies throughout the full range of operation. The Vortechs® unit can achieve up to 80% total suspended solids removal. Depending upon size, the cost of the units would range from $40,000 to $50,000 *per unit* with additional costs for design and installation by a hired contractor.

Woodard & Curran's letter addressing feasibility of structural BMP's is included in Appendix L. These recommendations provide a valuable plan for the town to consider in using structural BMP's to help address stormwater and sedimentation issues in the lower Mill Brook watershed. In a meeting between the consultant and town of Rockport Dept. of Public Works director and staff, some of the constraints to implementing some of the recommendations were discussed. Some of these constraints included:

1. A minimum of a 3 foot sump was required to install a hood and not all catch basins in the lower Mill Brook watershed have a 3 foot deep sump.
2. In many locations, it may not be possible to install catch basins with the recommended 4-foot sump without involving expensive and possibly impracticable ledge removal.
3. One area noted in particular where bank stabilization efforts were recommended between Poole's Lane and Railroad Avenue is not under town control. This area is on the edge of two properties adjacent to the brook, one privately owned and one state-owned and under control of the local Housing Authority. If the property owners were willing, the town could offer to partner with them to address the erosion and sedimentation issue created by the eroding banks.
4. Installation of new catch basins (approximately $5,000 per unit) or the larger more sophisticated and effective Vortechs® units (approximately $40,000 to $50,000 per unit) have high costs associated with them. Individual catch basin cost may not seem high. However, a large number of them (at least 15 individual

basins) have been recommended for replacement. This could represent a large budget item for a town to undertake in any one year. With this in mind, the town could target replacement of a smaller number (two or three) a year to spread costs out over several budget cycles. The town could also pursue funding opportunities through state or federal grant programs focused on addressing sedimentation and pollution issues to coastal resources.

5. Installation of Vortechs® stormwater treatment units in Railroad Avenue on both the main branch of Mill Brook and the Squam Brook tributary could block traffic from passing on this heavily used thoroughfare in downtown Rockport for up to several days and disrupt traffic for up to a couple of weeks. To reduce the impacts to residents and businesses, the town could work with owners of the Whistlestop Mall and the Massachusetts Bay Commuter Railroad to re-route traffic around the work where possible.

6. It was identified by a senior Dept. of Public Works employee that drainage pipes in the Railroad Avenue area, in particular the northwest end of Railroad Avenue in Sub-Drainage Area F, which includes the culverted portion of Squam Brook, are significantly undersized. Undersized drainage pipes could reduce the effectiveness of a new stormwater treatment unit installed in that area. The town should evaluate the drainage pipes in this area and consider replacing them with appropriately-sized drainage pipes in conjunction to the installation of a Vortechs® stormwater treatment unit in this area or in a phased approach.

5. Outreach & Education of Town Boards/Officials

The project partners have been meeting and interacting with town staff on a regular basis regarding the nonpoint source pollution assessment of the lower Mill Brook during the project period. Town staff have made some valuable contributions to the project through in-kind matching services. At the same time, project partners have used these interactions as opportunities to impress on town staff the importance of controlling pollutant sources to Mill Brook.

During the project period, project partners also individually met with town boards and committees, including the Watershed Protection Committee, the Planning Board, the Conservation Commission, the Board of Health and the Dept. of Public Works Commissioners to inform them about the study and preliminary results and discuss with them the role that their respective committees can play in helping to control pollution sources to Mill Brook and other water bodies in town. At the culmination of the project, a presentation was made by the project partners at an advertised meeting of the Board of Dept. of Public Works Commissioners where the results and recommendations of the project were presented to the DPW Commissioners and the public.

6. Recommendations

6.1 Septic Systems

Continue to investigate whether there may be any accessory dwellings relying on septic systems for sewage disposal. Review of the Board of Health and Dept. of Public Works records identified only 14 parcels containing septic systems within the lower Mill Brook watershed. Town officials have suspected that there may be additional lots in particular on the west side of Mill Brook just above Mill Pond where town records may show that the dwelling is connected to the municipal sewer, but an auxiliary dwelling or summer cottage may exist on the lot that is not connected to the sewer. Town officials should continue pursuing the potential that additional dwellings may exist that are not connected to the municipal sewer in the study area.

6.2 Direct Discharge Outfalls

1. Map connectivity of municipal drainage system within the study area using GIS. As part of the Lower Mill Brook nonpoint source pollution assessment study, the catch basins were mapped in the study area, and critical information was collected about each basin, including diameter, depth, type of basin (sump, infiltration or direct discharge), and number, orientation and character of all inflow and outflow pipes. It was beyond the limits of this study to map the exact connectivity of each catch basin. However, the collected information gives the town a strong start in undertaking this important task. Mapping the connectivity of the catch basins in the downtown area is part of the Town of Rockport NPDES Phase II Stormwater Plan and should be completed as part of this plan.

2. Determine where the catch basins off Holbrook Court discharge within the watershed. One outfall pipe was discovered leading from a yard off King Street Court, but no municipal drainage pipes were observed behind Holbrook Court. Some of the catch basins on Holbrook Court were observed to accumulate sediments fairly rapidly and therefore, it might be assumed, also discharge some overflow and resuspended sediments to the downstream wetland. This is immediately upstream from the head of Mill Pond, it could be having a significant impact on the pond.

3. Request that the commuter railroad operator (Massachusetts Bay Commuter Railroad) submit plans and information to the town documenting the location and character of the railroad station drainage structures and where they discharge. The town has no documentation of the drainage structures at this railroad station and train layover facility. This is probably one of the areas in town of posing a high risk of possible contamination to surface waters through stormwater discharge to the adjacent Mill Brook. The town should require that the commuter railroad operator submit regular operation and maintenance (O&M) reports on their maintenance and cleaning of these drainage systems, and require mandatory reporting of any observation of contaminants that have entered the drainage system.

4. Smoke test individual pipes to determine their source. Require all applicable outfalls to become properly permitted under the MA Wetlands Protection Act, Rockport Wetlands By-law and federal regulations if applicable.

5. Adopt a town by-law forbidding any new, untreated outfalls to discharge into Mill Brook (and other streams in town.)

6. Remove or relocate the pipe blocking the flow of the stream and retaining debris in the culvert under Beach Street. An approximately 18 inch diameter metal pipe passes through the culvert under Beach Street. This pipe catches debris, reduces the hydraulic capacity of the culvert, increasing the potential for upstream flooding, and could impede or impact upstream eel passage.

6.3 Erosion and Sedimentation

1. Encourage the King Street property owner who is directing runoff from his or her property to the bank above Mill Brook in Mill Brook Meadow to use a dry well, vegetated swale or other means of infiltration rather than promoting erosion and overland flow on a steep bank leading to a stream. The Rockport Conservation Commission may be able to accomplish this through contacting the property owner and educating them about the possible impacts of the discharge and alternative techniques of addressing their runoff issues. Adopting a stormwater management by-law may help reduce the incidences of such discharges in the future.

2. The town should take whatever steps it can and follow all practicable recommendations to reduce the amount of sediments entering Mill Pond. Mill Pond is acting as a sink for upstream stormwater sediments. Sediments accumulating at the head of Mill Pond will gradually reduce the size of the pond and slowly convert it from an open water pond into an emergent wetland over time. Physical removal of these sediments is likely an impracticable alternative for the town from a financial and logistical perspective. Reducing upstream sediment inputs to slow the rate of accumulation and extend the life of the pond may be the town's only practicable alternative and should be made a high priority.

3. Address catch basins discharging sediment- and pollutant-laden stormwater directly to Mill Brook. See Structural BMP recommendation letter by Woodard & Curran.

4. Proactively address the collapsing retaining wall on the channelized portion of Squam Brook at the base of Summit Avenue. The town should investigate ownership of the retaining wall that separates the adjacent residential property from the stream channel at this location to determine if any easements exist. The town should work with the property owner through whatever means are available to repair or replace the retaining wall to prevent the cumulative sedimentation that is currently taking place and to prevent an all-out collapse that could release a huge load of sediment to the brook and create a significant flooding event in this area.

5. Address the sand deposition from the child day care facility play area accumulating in Mill Brook. The Rockport Conservation Commission or Dept. of

Public Works should contact the facility manager and discuss with them ways that the sand could be better contained on the site and prevented from deposition and accumulation in the stream. Pulling the play area away from the edge of the retaining wall by several feet and using a low landscaping tie retaining wall to contain sand in the play area, creating a modest vegetated buffer zone between the play area and the stream channel would help reduce the sand deposition.

6. Address eroding banks on section of stream adjacent to Rockport Housing Authority property. This erosion appears to be caused or exacerbated by a berm erected across the stream channel. The Rockport Conservation Commission should work with the Rockport Housing Authority which manages the land to remove any structures that are causing or worsening erosion of stream banks. The town should work with the Housing Authority to stabilize the banks to prevent further sedimentation of Mill Brook. See also Structural BMP recommendations letter by W&C for stream bank stabilization techniques.

6.4 Water Quality Monitoring

1. Conduct additional wet- and dry-weather Water Quality monitoring within the lower Mill Brook watershed during the summer and fall to determine if the high bacteria counts observed in the September 2004 sampling were an anomalous or predictable occurrence. Future sampling could most likely safely eliminate the total coliform count in order to reduce the cost of sampling since the total coliform indicator is the most general of the bacteria tests conducted and the least likely to be a strong indicator of human-derived pollutants.

2. The GIS data layers should be utilized for further analysis of the hydraulic features and nonpoint source pollution parameters in the study area. Further analytical techniques using GIS could include spatial representation of water quality monitoring results, network tracing, stormwater modeling, sediment loading to the brook, etc. in conjunction with other GIS layers which may be available from MassGIS, CZM, or other agency data libraries.

6.5 Street Sanding

When replacing or upgrading street sanding equipment, purchase equipment that allows the operator to easily gage and select application rates. Allowing the operators to easily gage and manipulate application rates between areas that require heavier sanding and those that require less could save the town money by more efficiently applying sand where it is most needed and could result in less sand being deposited within a given watershed. Based on the low recovery rate (less than 30 percent for the lower Mill Brook watershed for the winter of 2004-2005) from street sweeping and catch basin cleaning, winter street sanding could be having a significant impact on sediment load to sensitive wetland resources.

6.6 Catch Basin Cleaning

1. Increase the frequency of catch basin cleaning in the lower Mill Brook watershed and other areas where municipal drainage systems drain to critical areas such as freshwater streams or wetlands, water supply watersheds or coastal waters to the extent practicable, a minimum of once to twice a year.

2. Encourage town highway maintenance crews to fill out catch basin data sheets (sample in Appendix H) for each basin each time it is cleaned to start compiling a record of rates of accumulation to help determine which basins may need to be cleaned out more frequently than others.

3. Collect information on depth of sump (depth to bottom of catch basin from bottom of outflow invert), type of system (basin-to-basin or basin-to-manhole) and basin construction (pre-cast concrete, stone, brick, etc). These parameters were added to the model reporting sheet after the initial round of catch basin cleaning and data collection. It is important to collect this information for all catch basins within the lower Mill Brook watershed.

4. Make an effort to clean and collect data on CB 41 and CB 44 which were not cleaned as part of this study. CB 41 is located in the middle of Mill Brook Meadow and collects overland flow and flooding from the meadow and transfers it to Mill Brook via an outlet on the brook (Outfall #7). It was not cleaned during the October nor May catch basin cleaning rounds during this study because the ground around the catch basin was too saturated and would have lead to too much ground disturbance to take the vactor truck into the meadow to clean it. Sediments should be removed from this basin either by hand or via the vactor truck at a time when the ground is either very dry or frozen. CB 44 is located in the parking area to the commuter railroad station, just up from the entrance to the Ace Hardware store. It was initially mistaken as a railroad operator-maintained basin during this study, and therefore not cleaned. This basin is on town land and should be made part of the town's regular cleanings.

5. Work with private land owners within the lower Mill Brook watershed to have privately-owned catch basins cleaned and maintained on a regular basis.

6. Request that private land owners within the lower Mill Brook watershed keep a log of the maintenance and cleaning of their privately-owned catch basins and submit this information to the town on a regular (annual) basis.

6.7 Street Sweeping

1. Encourage highway maintenance crews to use the template street sweeping log sheet provided with the Street Sweeping Plan or an equivalent reporting sheet, to track street sweeping activities and estimate recovery rates.

2. Sweep streets regularly in areas that drain to sensitive wetland or coastal resource areas. More frequent street sweeping may help reduce the number of annual catch basin cleanings needed to maintain optimal catch basin treatment capacity and may reduce the amount of sediment entering wetland resources through drainage systems or overland flow.

3. When the town replaces or upgrades its existing street sweeping equipment, it should choose new equipment that has been demonstrated to remove finer particles and associated pollutants. Older models may pick up large-grain sized sands and other large debris, but have been demonstrated to have very low removal efficiency for finer particles or other pollutants.

6.8 Stormwater By-law

Implement an erosion and sediment control and stormwater management by-law(s) that requires construction sites and post-construction new development and redevelopment to meet established performance standards and provides for the administration, review and enforcement of the by-law by the town-approved authority, including the collection of reasonable fees and issuing of appropriate permits. The model by-laws provided in the Appendix J&K provide strong models on which to base its by-law(s). Town officials, particularly the Rockport Planning Board through it's interest in implementation of the zoning by-law and the Dept. of Public Works as the town entity responsible for complying with NPDES Phase II stormwater permit requirements, should work together with other town boards and departments including town counsel to draft by-law language that will be effective in minimizing runoff and sediment related impacts. The town should also use the resources of MA CZM which has offered its resources to assist the town in adopting a stormwater management by-law.

6.9 Structural BMP's

1. Install hoods in all catch basins in the lower Mill Brook watershed where adequate depth of sump allows. A hood is an inverted elbow or similar device that is installed over the outlet pipe. It is designed to retain oils and other floatables within the catch basin sump to prevent them from flowing downstream to the storm drain outfall. These are relatively inexpensive and easy to install. However, one constraint is that it requires a minimum of a 3-foot deep sump for installation. Not all catch basins in the lower Mill Brook watershed have sufficient sump depth to accommodate a hood.

2. Catch basin sumps be a minimum of four (4) feet deep. Approximately ten catch basins were identified in the study area with total depths 4 feet or less. Since the sump depth (the distance from the invert of the outlet pipe to the bottom of the catch basin) is less than the total depth, it can be assumed that these basins have less than the 4-foot recommended sump depth. Extending the sump depth would most likely require the complete replacement of the existing catch basin with a new pre-cast catch basin with an estimated cost of approximately $5,000 per replaced catch basin. However, costs could be significantly higher due to presence of shallow depth to bedrock in many Rockport locations. In many locations, it may not be possible to install catch basins with the recommended 4-foot sump without involving expensive and possibly impracticable ledge removal.

3. Erosion control should be implemented as needed from Pooles Lane to Railroad Avenue. Mill Brook's natural stream banks have eroded at one location in this area in particular adjacent to the Rockport Housing Authority Mill Brook Park housing complex. (See also description under Section 2.5 Monitoring Erosion and Sedimentation.) W&C recommends using "soil bioengineering" techniques, such as BioLog® or BioD-RollTM. These natural biodegradable products could be used to provide the needed protection until establishment of mature vegetation, which will resist erosion forces. These methods not only provide strong, sustainable, aesthetically pleasing water edges, but also provide habitats for aquatic & terrestrial wildlife and filter run off water. The cost in materials would

be approximately $350 per 30 foot section of stabilized stream bank. One constraint is that the land on which the erosion is taking place is operated by the local Housing Authority and is not under town control. The town could offer to partner with the Housing Authority to address the erosion and sedimentation issue created by the eroding banks.

4. Drainage system modifications should be made where catch basin discharge directly to the brook. Six (6) "catch basins" were identified that do not have sumps; rather they discharge through the street directly into Mill Brook. In some cases, inlet pipes were also observed in the catch basins, indicating that additional drainage is discharging untreated to the brook at these points. These catch basins should be relocated to one side of Mill Brook. When relocated, they should be made to meet the all requirements of a hooded deep sump catch basin as prescribed in the Massachusetts *Stormwater Policy Handbook* (March 1997). Relocating these direct discharges into catch basins would require installation of one (and possibly two) new catch basins to capture this runoff before it enters the brook. As noted above, installation of a new catch basin would cost approximately $5,000. Replacing a large number of catch basins at one time could represent a large budget item for a town to undertake in any one year. With this in mind, the town should target replacement of a smaller number (two or three) a year to spread costs out over several budget cycles. The town should also pursue funding opportunities through state or federal grant programs focused on addressing sedimentation and pollution issues to coastal resources.

5. Vortechs® Stormwater Treatment Systems should be installed in an off-line configuration in or near Railroad Avenue on culverted portions of both Mill Brook and Squam Brook. These units remove contaminated sediment, floating hydrocarbons, and debris from stormwater through the use of centrifugal force and gravity settling. It is also equipped with baffles for flow control to eliminate turbulence and provide positive removal efficiencies throughout the full range of operation. The Vortechs® unit can achieve up to 80% total suspended solids removal. The Town of Rockport has installed Vortechs® units in another area of town (Thatcher Road), and town staff is already familiar with the operation and maintenance required for these BMPs. Depending upon size, the cost of the units would range from $40,000 to $50,000 *per unit* with additional costs for design and installation by a hired contractor.

6. Installation of Vortechs® stormwater treatment units in Railroad Avenue on both the main branch of Mill Brook and the Squam Brook tributary could block traffic from passing on this heavily used thoroughfare in downtown Rockport for up to several days and disrupt traffic for up to a couple of weeks. To reduce the impacts to residents and businesses, the town should work with owners of the Whistlestop Mall and the Massachusetts Bay Commuter Railroad to re-route traffic around the work where possible.

7. It was identified by a senior Dept. of Public Works employee that drainage pipes in the Railroad Avenue area, in particular the northwest end of Railroad Avenue in Sub-Drainage Area F which includes the culverted portion of Squam Brook, are significantly undersized. Undersized drainage pipes could reduce the

effectiveness of a new stormwater treatment unit installed in that area. The town should evaluate the drainage pipes in this area and consider replacing them with appropriately-sized drainage pipes in conjunction to the installation of a Vortechs® stormwater treatment unit in this area or in a phased approach.

8. Installation of new catch basins (approximately $5,000 per unit) or the larger more sophisticated and effective Vortechs® units (approximately $40,000 to $50,000 per unit) have high costs associated with them The town should pursue funding opportunities through state or federal grant programs focused on addressing sedimentation and pollution issues to coastal resources.

7. Summary

The Lower Mill Brook assessment has assisted the town in addressing nonpoint source pollution issues in this coastal watershed. Periodic high bacteria counts measured in the waters of Front Beach and the mouth of Mill Brook and increasing visual evidence of sediment accumulation threatening Mill Pond have made town officials and residents aware that pollution issues exist. This study has helped identify the possible pollution sources and given the town some of the tools it will need to address the issues.

Through this project, the town has created a Geographic Information System (GIS) based map of the lower Mill Brook watershed including all identified septic systems, municipal and private catch basins, and direct discharge outfalls within the watershed, allowing for spatial analysis of these parameters. Three (3) rounds of targeted wet-weather water quality monitoring were conducted, one of which recorded a particularly high spike in bacteria counts during a rain event in early September, 2004. The subsequent two (2) monitoring events in November 2004 and May 2005 recorded lower counts but still elevated over acceptable limits established for swimming waters. As part of the nonstructural BMP development of the project, the town conducted catch basin cleaning and street sweeping in the watershed where data was collected on the catch basin infrastructure and on sediment collection. Comparison with records for winter street sanding highlighted a striking discovery that only approximately ten percent (10%) of the sand deposited through winter street sanding was "recovered" during the spring round of catch basin cleaning. This left over 120 cubic yards of sediment from one source unaccounted for in the watershed after only one winter. Catch Basin Cleaning and Street Sweeping Plans with template recording and data sheets were developed to help guide the town in the maintenance of these systems and encourage detailed record keeping to help develop a targeted approach to street sweeping and catch basin cleaning. Model by-law language was reviewed with two (2) models in particular being focused on for their strengths in the areas of construction site erosion and sediment control and post-construction stormwater management BMP's. Elevating awareness of town officials and residents on stormwater issues and BMP's that can be used to address them was a goal of the project. This was conducted throughout the study through working closely with town staff from different departments and meeting with individual boards in public meeting forums. Continued outreach and public discussion between town officials and the pubic will be necessary in particular to work towards a comprehensive stormwater management by-law that will be adopted and be successful for the town of Rockport.

Finally, many valuable recommendations were developed during the course of this study. In particular, recommendations for structural BMP improvement could help improve the town's recovery and removal rate of sediments from the lower Mill Brook watershed before they are able to enter the sensitive wetland and coastal resource areas. Some of the recommendations for structural BMP implementation have constraints including the physical constraint of very shallow bedrock throughout much of Rockport and ever-present financial constraints of a small town budget. Spreading the implementation of the recommendations over time and pursuing state and federal funding opportunities will help address some of these constraints. A comprehensive approach including reducing the source of sediment and other pollutants through erosion and sediment control, minimizing runoff from development, regular street sweeping and catch basin cleaning, and continuing to monitor and pursue the source of any wastewater detected in the watershed as well as improving treatment of these pollutants that do enter the town's stormwater system by upgrading the infrastructure as practicable, should help reduce impacts to the town's sensitive and valued freshwater and coastal resources.

References

Aronson, G., D. Watson, and W. Pisaro. 1983. *Evaluation of Catch Basin Performance for Urban Stormwater Pollution Control.* EPA-600/2-83-043

Klein, R., Urbanization and Stream Quality Improvement", in Water Resources Bulletin, American Water Resources Assoc., Vol. 15, No. 4, August 1979.

Massachusetts Dept. of Environmental Protection (MA DEP), "Fact Sheet: Management of Catch Basin Cleanings", April 2004

Massachusetts Dept. of Environmental Protection (MA DEP), Stormwater Policy Handbook, Vol. 1: Stormwater Management, 1997

Mill Brook Illicit Discharge Detection and Elimination Summary Report, Woodard & Curran for the Town of Rockport, 2003.

Mineart, P. and S. Singh. 1994. *Storm Inlet Pilot Study.* Woodward-Clyde Consultants. Alameda County Urban Runoff Clean Water Program. Oakland, CA

Pitt, R. 1985. *Bellevue Urban Runoff Project.* Final Report

Stormwater Manager's Resource Center, "Pollution Prevention Fact Sheets: Catch Basins"

Wellhead Protection Plan: Mill Brook Watershed, Rockport, Massachusetts, Town of Rockport, 2004

Appendix A: Parcels on Septic Systems in the Lower Mill Brook and Squam Brook Watersheds

Table A-1

Lower Mill Brook Watershed -- Parcels on Septic

MAP	LOT	ADDRESS	SEPTIC Y/N?	Last Inspected?	P/F?
11	25A	11 Haddow Rd.	y		
11	25B	9 Haddow Rd.	y		
11	25C	8 Haddow Rd.	Y	Inspctd. In 2004	Passed
11	25D	6 Haddow Rd.	Y		
11	25E	4 Haddow Rd.	Y	Inspctd in 2005	Failed
11	36	5 Haddow Rd.	Y	Inspctd. In 2004	Failed
11	52D	7 McKay's Dr.	Y	Inspctd. In 1991	Passed
11	52E	9 McKay's Dr.	Y		
11	52J	8 McKay's Dr.	Y	Inspctd in 1996	Passed
11	52K	10 McKay's Dr.	Y		

Table A-2

Squam Brook Watershed Parcels on Septic

MAP	LOT	ADDRESS	SEPTIC Y/N	Date	Title 5?
4	1	Squam Rd.	Y		
4	1A	Squam Rd.	Y		
4	2	Off Squam Rd.	N		
4	2A	37 Squam Rd.	Y		
4	2B	43A & 43B Squam Rd.	Y		
4	3	80 Squam Rd.	Y		
4	3A	Squam Rd.	N		
4	3B	Old Squam Path	N		
4	3C	78 Squam Rd.	Y		
4	4	61 Squam Rd.	Y		
4	10	Johnson's Quarry	Y		
4	15	Johnson's Quarry	N		
4	18	Johnson's Quarry	N		
4	21	Johnson's Quarry	N		
6	1	Gloucester Watershed	N		
11	23	Off Summit Ave.	N		
11	54	5 Squam Hill Crt.	Y		
11	55	7 Squam Hill Crt.	Y	1997	Y
11	57	6A & 6B Squam Hill Crt.	Y		
11	60	9 Squam Rd.	Y	1982	
11	61	11 Squam Rd.	Y	2004	Pumped
11	62	13 Squam Rd.	Y	2004	Pumped
11	63	15 Squam Rd.	Y		
11	64	17 Squam Rd.	Y		
11	65	19 Squam Rd.	Y		
11	66	21 Squam Rd.	Y		
11	67	23 Squam Rd.	Y		
11	69	25 Squam Rd.	Y		
11	70	27 Squam Rd.	Y		
11	71	Squam Rd.	N		
11	72	31 Squam Rd.	Y		
11	73	33 Squam Rd.	Y		
11	73A	35 Squam Rd.	Y		
11	75	Squam Rd.	N		
11	76	Squam Rd.	N		
11	76A	Squam Rd.	N		
11	77	26 Squam Rd.	Y		
11	78	22 Squam Rd.	Y		
11	78A	24 Squam Rd.	Y		
11	80	2 Reilly's Ln.	Y		
11	81	20 Squam Rd.	Y		
11	82	18 Squam Rd.	Y	1998	Y
11	88	16 Squam Rd.	Y		
11	89	29 Squam Hill Rd.	Y		
11	90	31 Squam Hill Rd.	Y		
11	91B	35 Squam Hill Rd.	Y		
11	91C	37 Squam Hill Rd.	Y		

Table B-1: Outfalls Identified on Lower Mill Brook

Figure No.	Outfall No.	W&C Report	Location/ Description	Size (in.)	Material	Notes
B-1	1	1	Under Beach St. 10' above downstream headwall; east side.	10	Iron	
B-2	2	*	Under Beach St., 25' above downstream headwall; source east side.	14	Clay	
B-2	3	*	Under Beach St., 35' above downstream headwall; source both sides.	8	Metal	abandoned pipe?
B-3	4	*	Under Beach St., 15' above upstream headwall; source west side.	18	Reticulated aluminum	
B-4	5	2	Channel wall 15' upstream of Millbrook Meadow headwall; source east	10	Reticulated aluminum	New pipe?
B-5	6	*	50' upstream of meadow headwall; source east side.	2	PVC	Has been observed w/ dry weather discharge; Observed 11/28/04 w/ strong discharge.
B-6	7	*	Across from catch basin in meadow: source catch basin. East side.	8	Metal	Half-submerged. End of pipe brok up.
-	8	12	Coming from a yard on King St. Crt.; source west side.	6	PVC	
B-7	9	13	Stormdrain outfall upstream of bridge at 9 RR Ave.; source west side	12	Clay	
B-8	10	14	110' downstream of RR. Ave. headwall; source west side.	8	Corrogated metal	Pipe exiting embankment at a stee slope. Appears to be from Rockpo Service Stn. Building.
-	11	*	Pipe coming from yard; source east side.	1	White PVC	Coming from yard?
B-9	12	15	80' below downstream headwall at RR. Ave.; source east side.	4	PVC	Pipe exiting yard behind RR Ave.
B-10	**13**	**16**	**60' below downstream headwall at RR. Ave.; source east side.**	**4**	**Corrogated plastic**	**From yard behind RR Ave.**
B-10	**14**	**17**	**60' below downstream headwall at RR. Ave.; source east side.**	**4**	**Corrogated plastic**	**From yard behind RR Ave.**
B-11	15	*	Under RR Ave. 38' below upstream headwall . East side.	18	Clay	Some water observed in pipe.
-	16	*	Under RR Ave. 33' below upstream headwall. East side.		Catch basin	Direct outfall from street with 24" concrete piipe inlet from west.
-	17	*	Under RR Ave. 7' below upstream headwall. East side.		Catch basin	Direct outfall from street with 24" concrete piipe inlet from west.
B-12	18	*	At base of upatream RR Ave. headwall; source east side.	5	Metal	Dry weather discharge observed; invert at water level.
B-13	19	4	23' up from upstream headwall at RR Ave.; source east side.	18	Corrogated metal	
B-14	20	5	46' up from upstream headwall at RR Ave.; source west side.	2	Corrogated plastic hose	Coming from restaurant?
B-14	21	6	46' up from upstream headwall at RR Ave.; source west side.	4	PVC	
B-15	22	*	58' up from upstream headwall at RR Ave.; source west side.	5	Asbestos?	*Half-submerged.*
B-16	23	*	81' up from upstream headwall at RR Ave.; source west side.	6	PVC	*Discharges parallel to brook.*
B-17	24	*	92' up from upstream headwall at RR Ave.; source west side.	1.5	White PVC	
B-18	**25**	**7**	**124' up from upstream headwall at RR Ave.; source west side.**	**12**	**PVC**	**Source Isinglass parking lot.**
B-19	26	8	134' up from upstream headwall at RR Ave.; source west side.	2	PVC	Pipe hidden in stone wall of chann signs of recent discharge.
B-20	27	9	142' up from upstream headwall at RR Ave.; source east side.	12	Corrogated metal	*In concrete wall of channel 8' upstream from #26*
B-21	**28**	**10**	**235' up from upstream headwall at RR Ave.; source west side.**	**12**	**Green PVC**	**Half submerged pipe: source Isinglass parking lot. Lots of orange floculents; dry discharge**
B-22	29	*	*Located far end of Isinglass parking lot; source west side.*	12	Green PVC	Half-submerged pipe; source
B-23	30	*	*Millbrook Park property; source west side.*	2	PVC	source fish pond?
B-24	31	*	15' downstream of footbridge; source west side.	6	Clay/ Asbestos	
B-25	32	11	Under cap stone; 10' upstream from footbridge; source east side.	18	Corrogated plastic	Ties into catch basin in Millbrook Park parking lot.
-	33	*	Under Poole's Ln.		Catch basin	Direct discharge from road; additio inlets
-	34	*	*Under Poole's Ln.*		Manhole	
-	35	*	Under Poole's Ln.		Catch basin	Direct discharge from road; additio inlets

* Not referenced in W&C report.
Bold typeface is used to highlight those outfalls with known permits. In the case of Outfalls #13 and 14, it is not possible to determine from the permit which of these two discharge pipes the permit applies to.

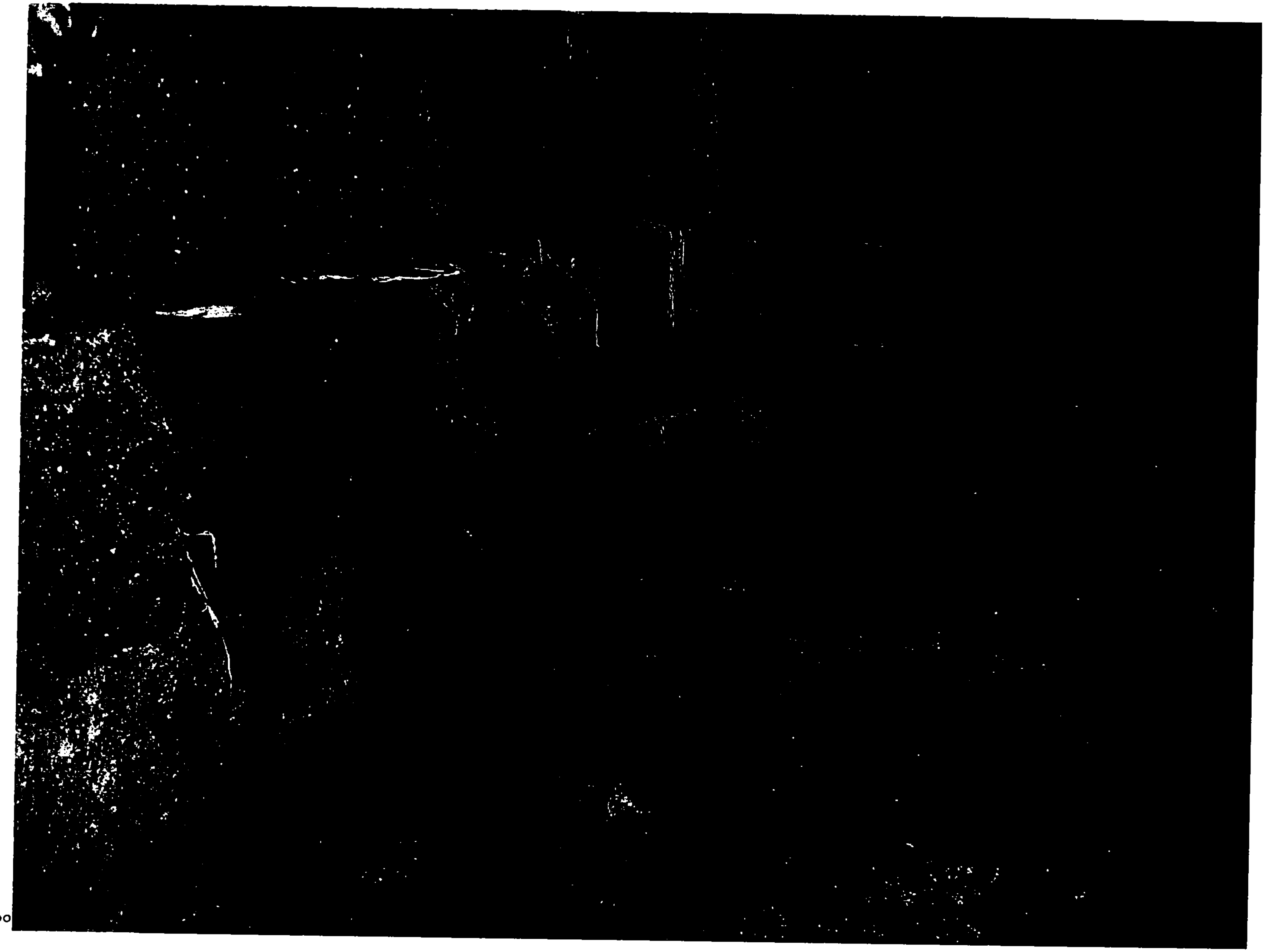

Figure B-1: Outfall #1

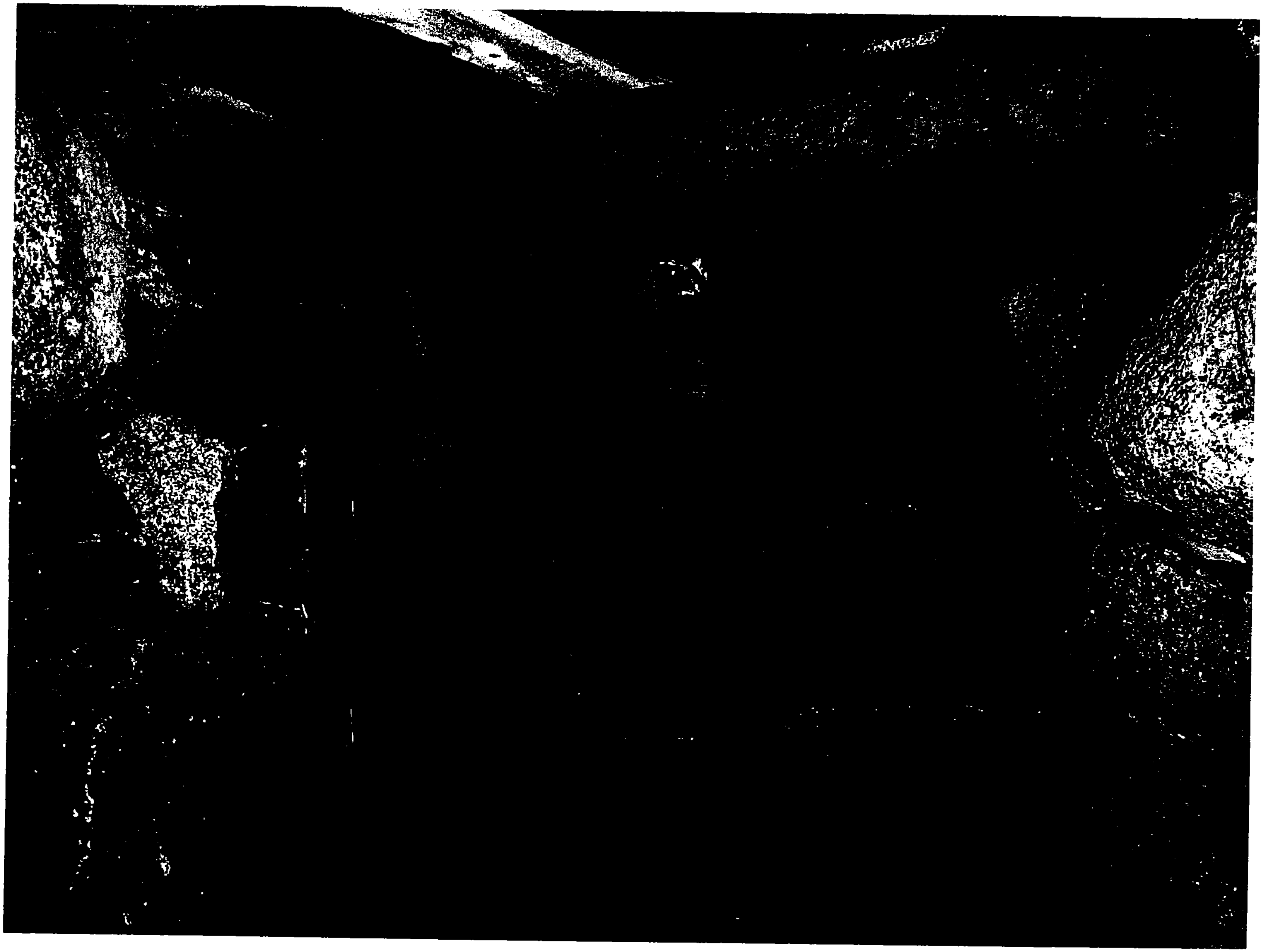

Figure B-2: Outfalls #2 and #3

Figure B-3: Outfall # 4

Figure B-4: Outfall #5

Figure B-5: Outfall #6

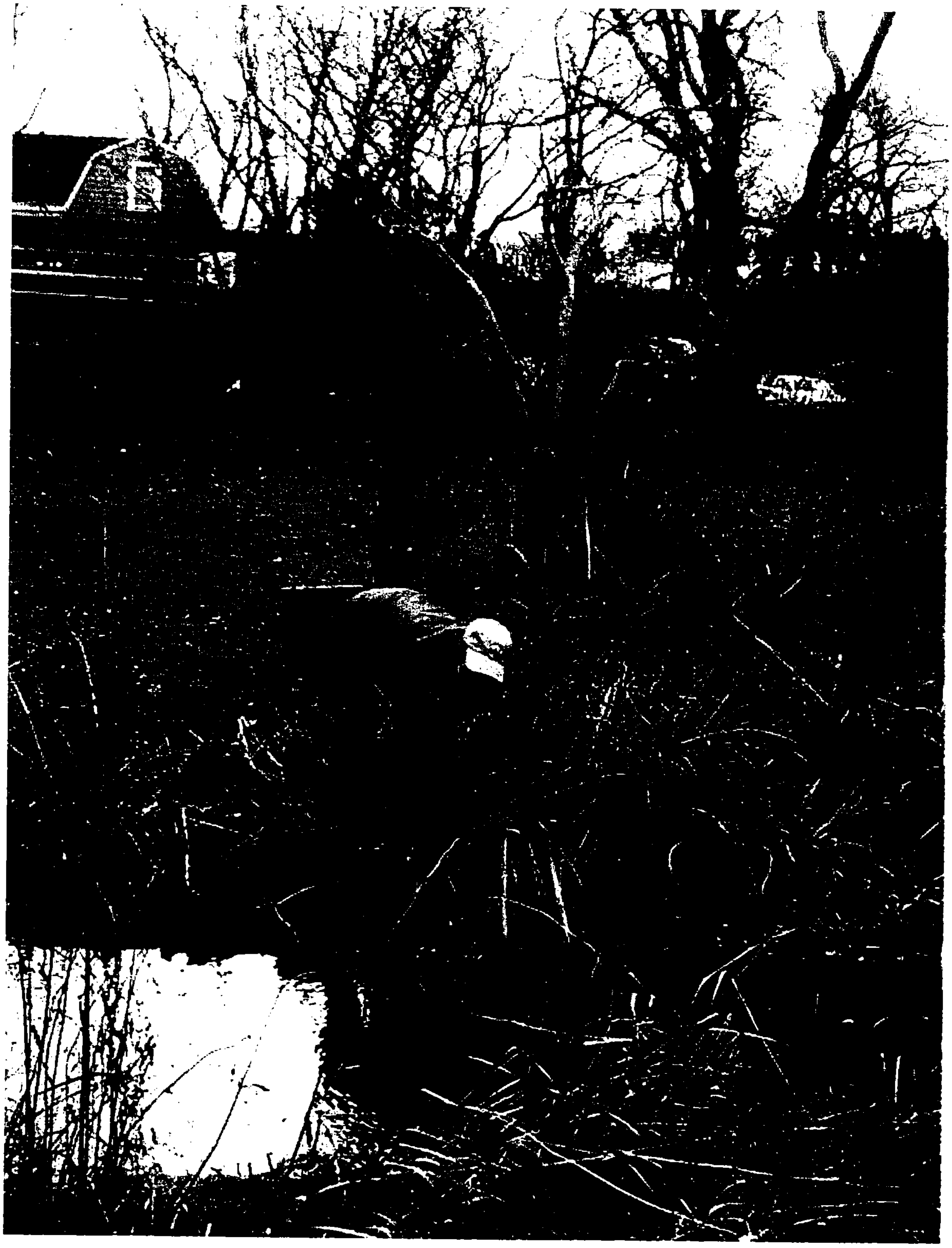

Figure B-6: Outfall #7

Figure B-7: Outfall #9

Figure B-8: Outfall #10

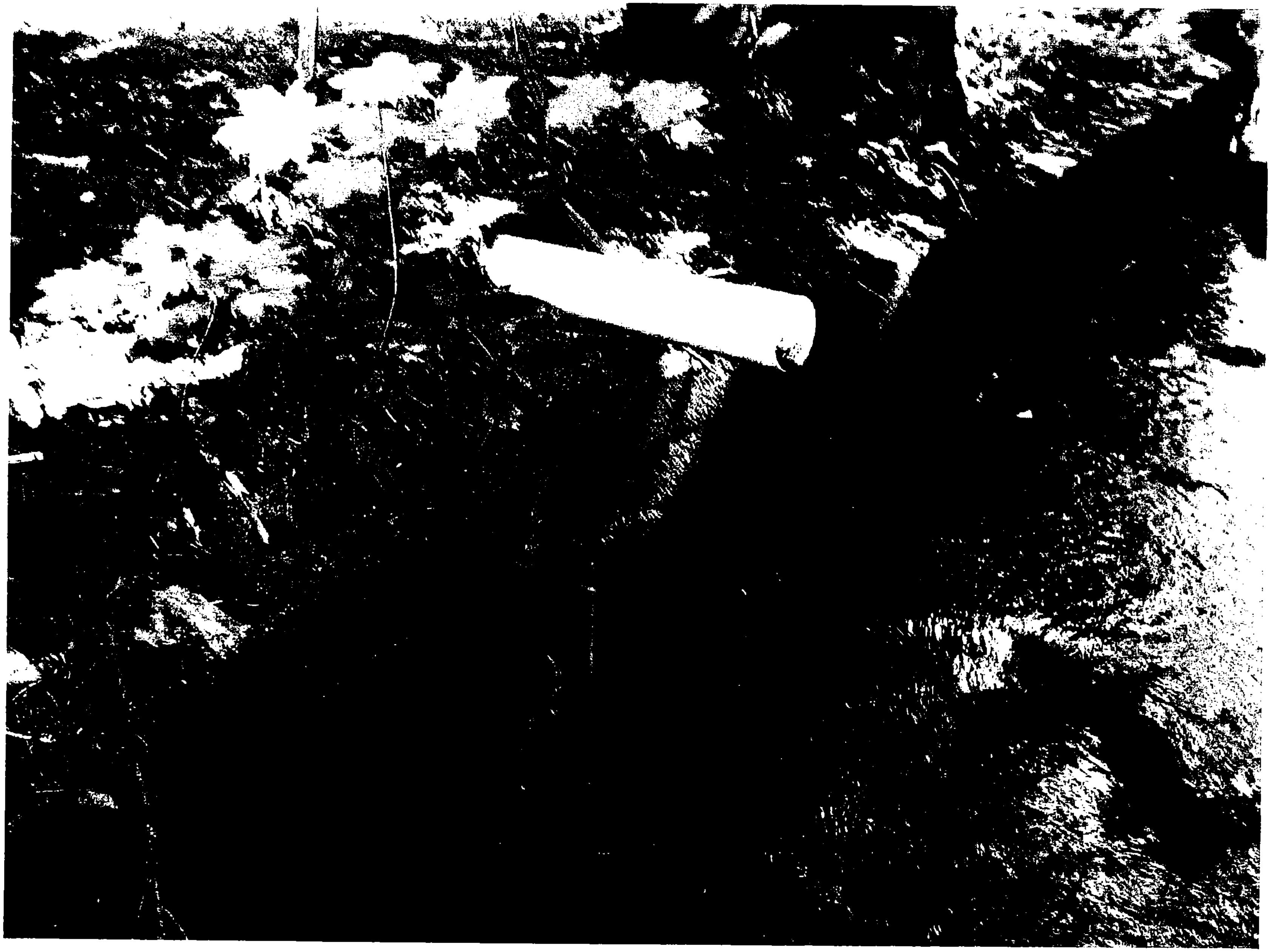

Figure B-9: Outfall #12

Figure B-10: Outfall #13 and #14

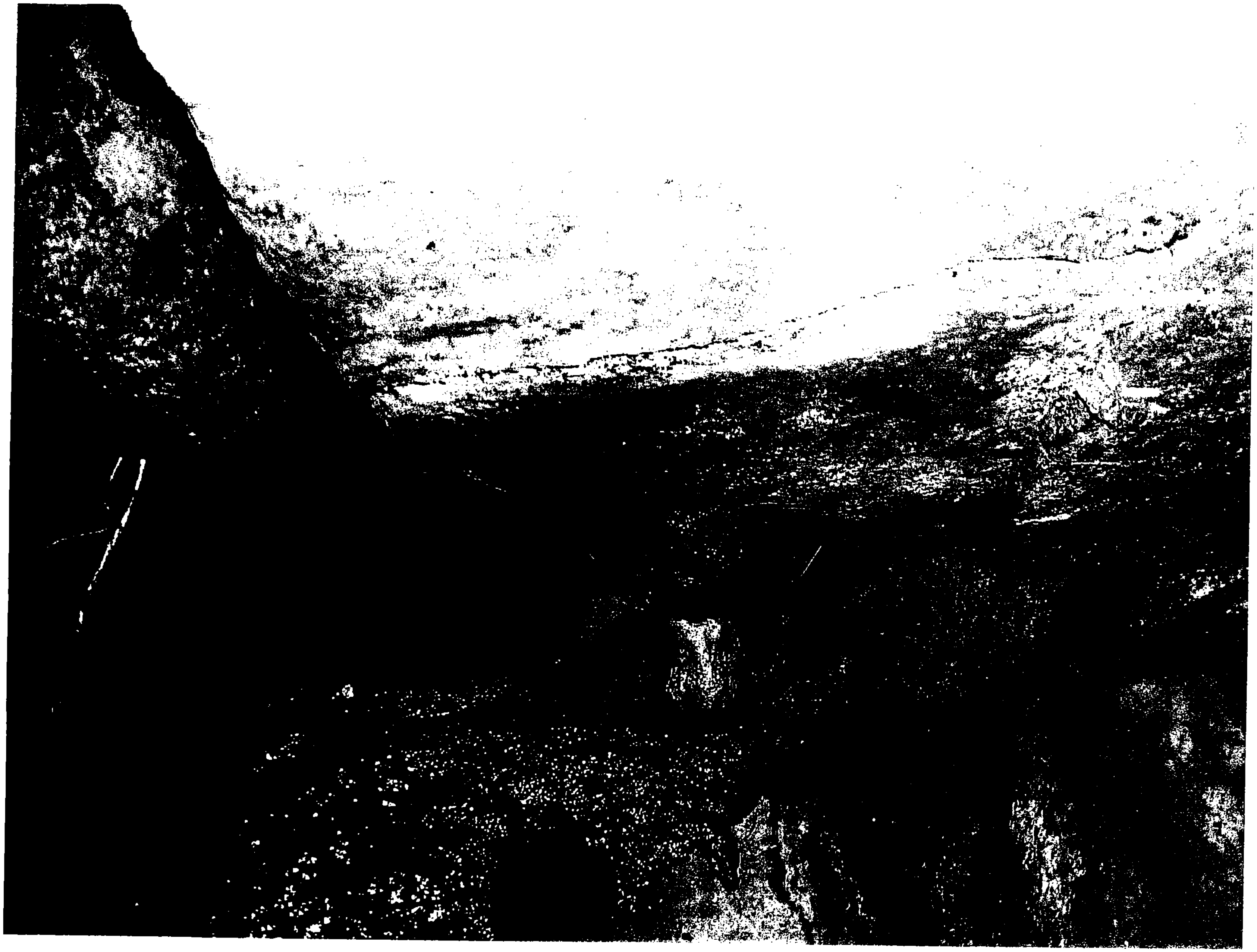

Figure B-11: Outfall # 15

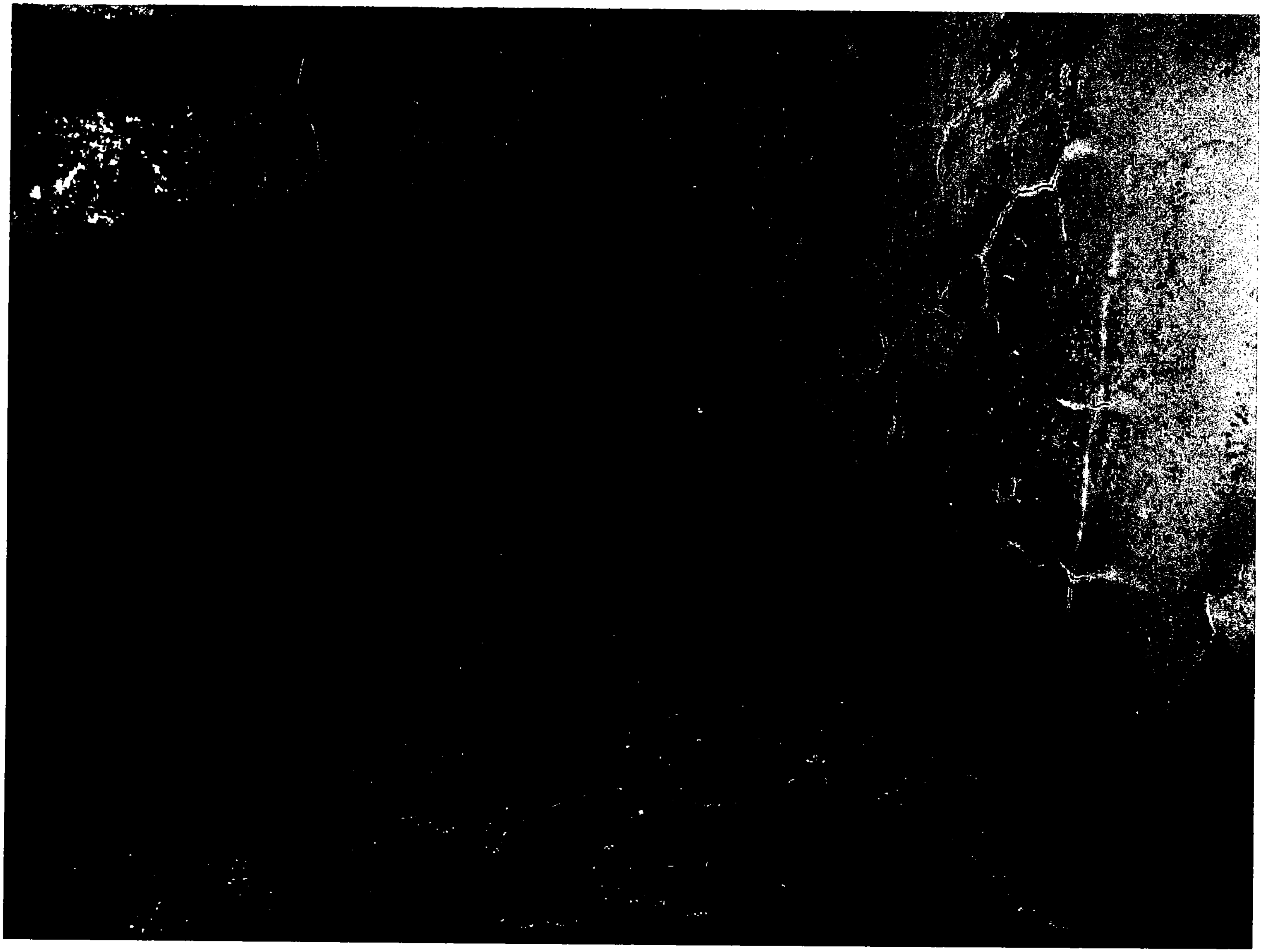

Figure B-12: Outfall #18

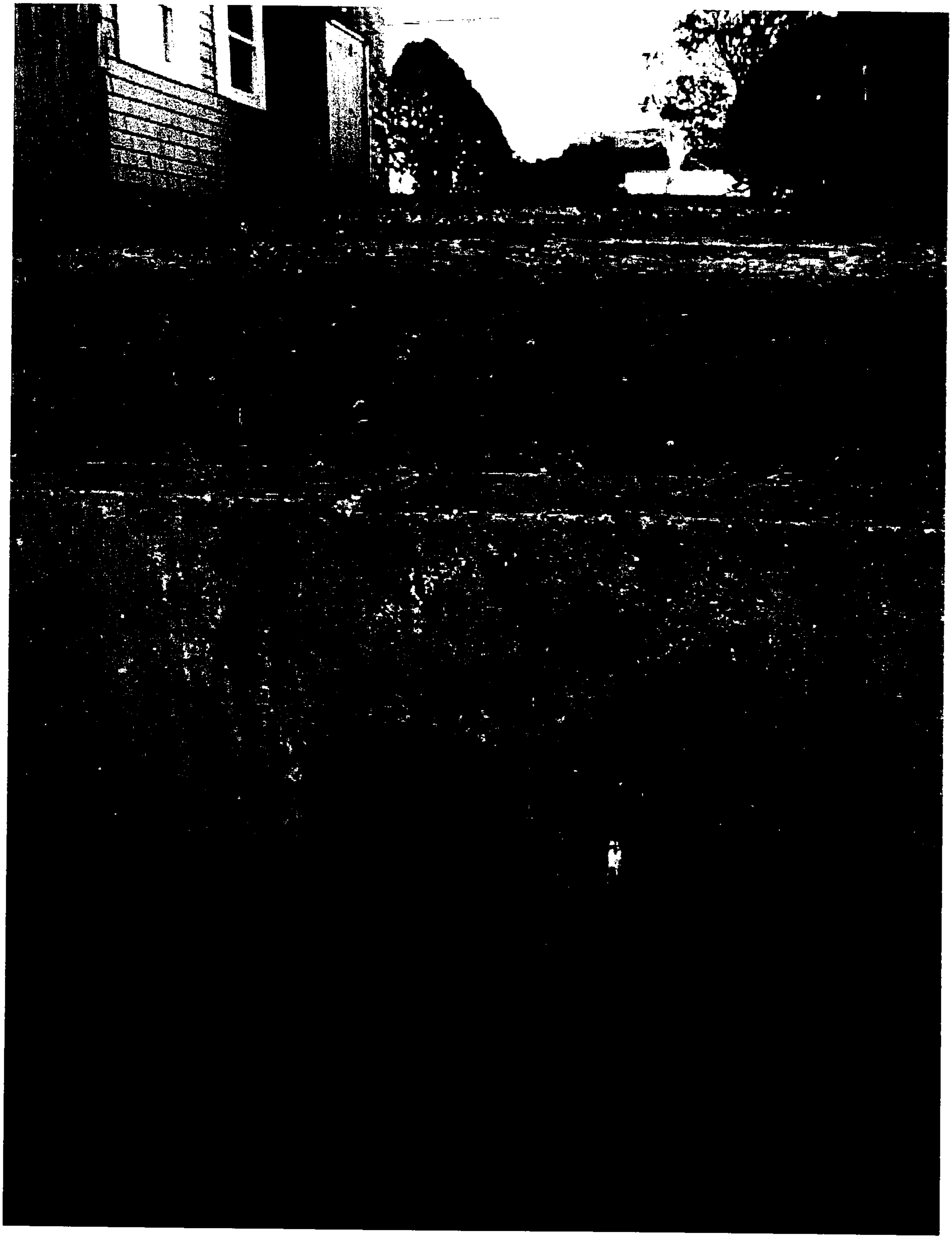

Figure B-13: Outfall #19

Figure B-14: Outfall #20 and #21

Figure B-15: Outfall #22

Figure B-16: Outfall #23

Figure B-17: Outfall #24

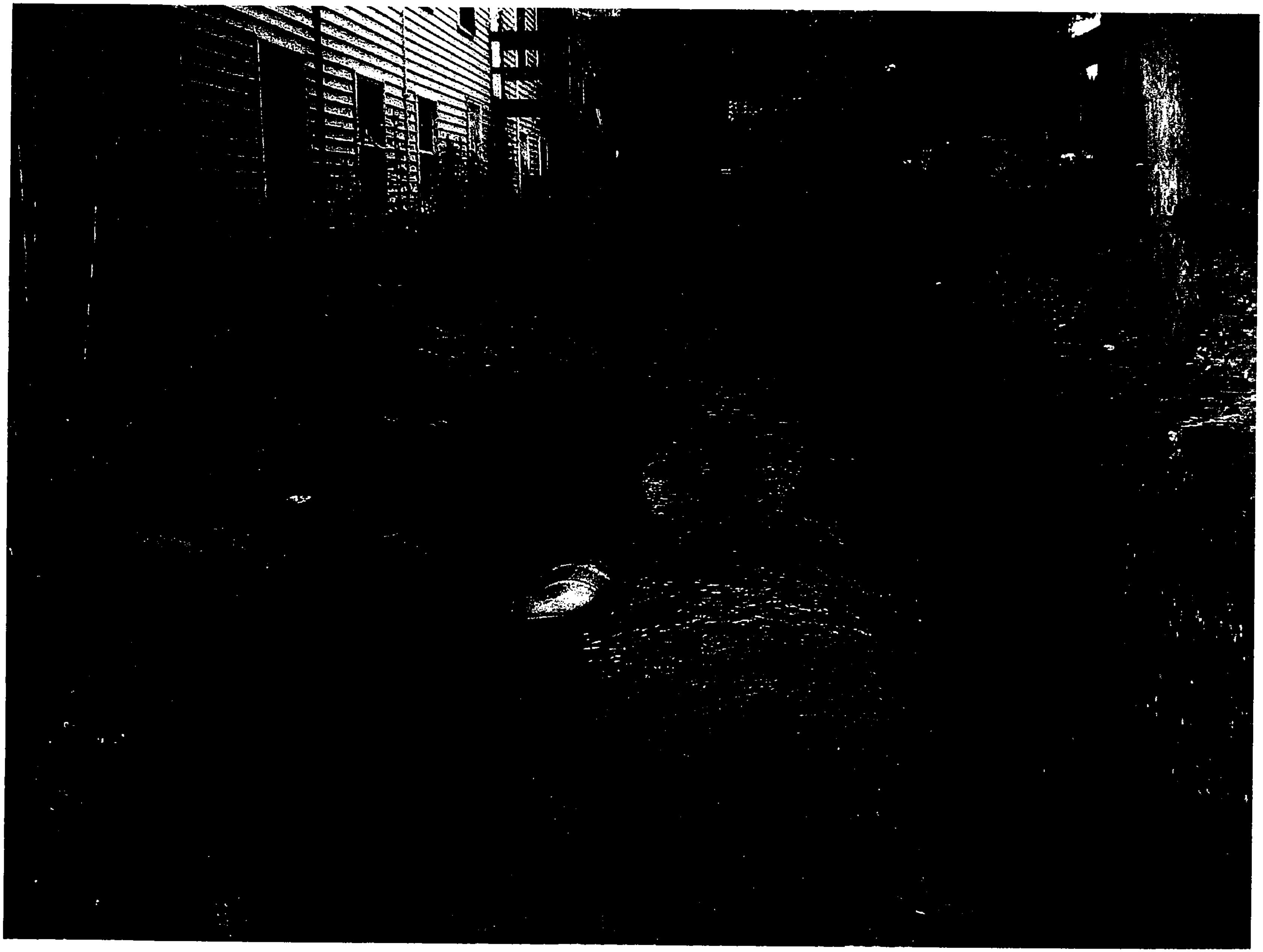

Figure B-18: Outfall #25

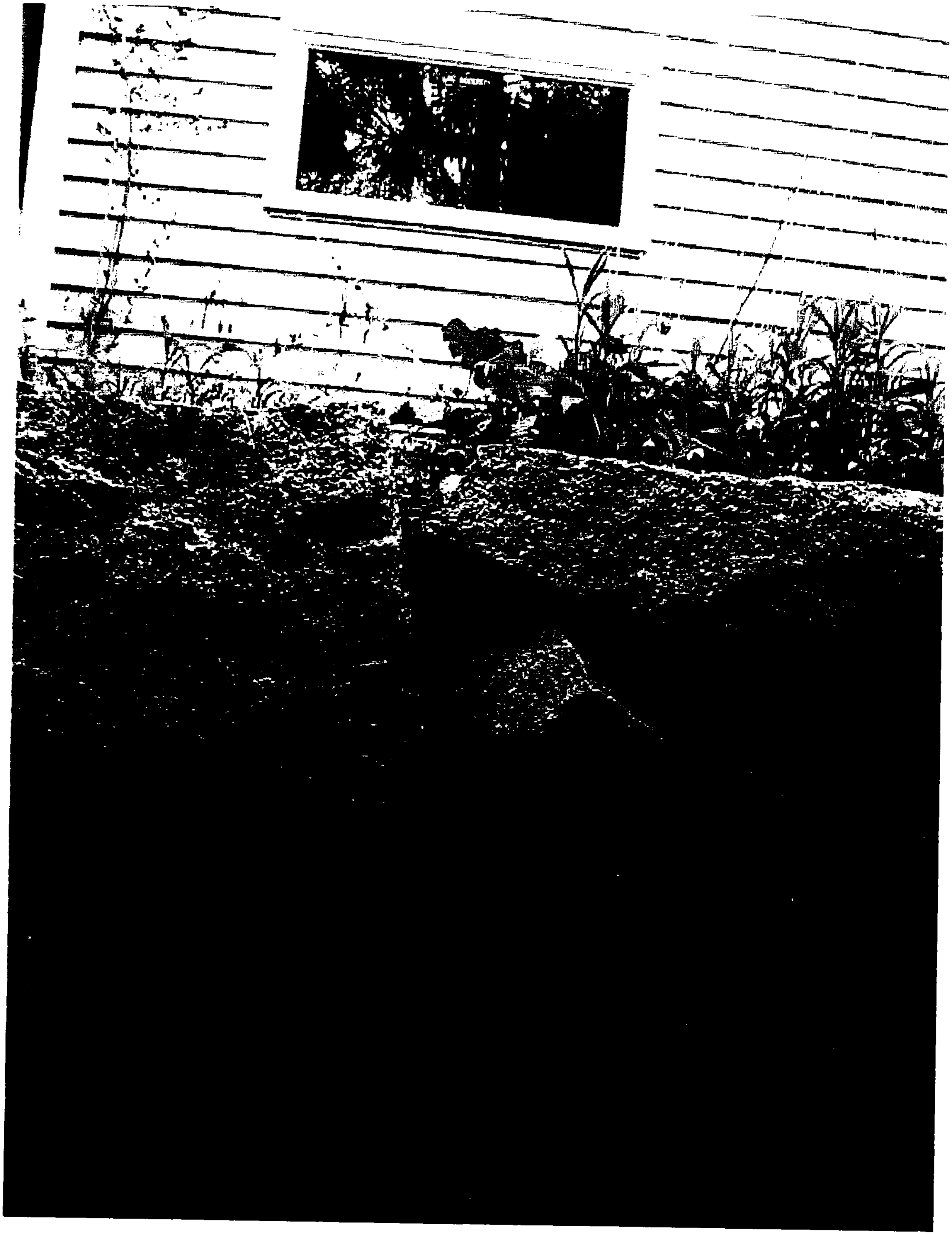

Figure B-19: Outfall #26

Figure B-20: Outfall #27

Figure B-21: Outfall #28

Figure B-24: Outfall #31

Figure B-25: Outfall #32

Table B-2
Environmental Permits for Outfalls in Lower Mill Brook Study Area

MAP	LOT	ADDRESS	OWNER	PERMIT TYPE	PERMIT #	DATE	PLANS?	ACTIVITY	OUTFALL Y/N?	OUTFALL #
11	38	5 Summit Ave.	Res.	Determ. of App.	RD #03-09	12/12/2003	Y	Construct porch, stairs, ramp	N	
11	51	Twin Light Circle	Res.	Order of Conditions	DEP #62-184	7/26/1994	Y	Construct 2 SFH's	N	
11	51	Twin Light Circle	Res.	Order of Conditions	DEP #62-200	5/27/1995	Y	Construct roads and utilities for residential subdivision; includes stormwater drainage and outfall to streambank.	N	
11	51	? Twin Light Circle	Res.	Determ. of App.	RD #00-22	7/13/2000	Drawing	Regrade rear yard; construct fence	N	
11	51H	? Twin Light Circle	Res.	Order of Conditions	DEP #62-400	7/12/2004	Y	Construct addition to existing house	N	
11	51N	16 McKay's Dr.	Res.	Determ. of App.		6/21/1983	Drawing	Construct new SFH	N	
12	51N	17 McKay's Dr.	Res.	Determ. of App.	RD #94-11	12/8/1994	Drawing	Construct new 2-car garage	N	
18	**170**	**17 Railroad Ave. (Isinglass Place)**	**Com.**	**Order of Conditions**	**DEP #62-90**	**4/21/1989**	**Y**	**Addition to commercial bldg., repair drainage, install new drainage, rip-rap stream bank, construct retaining wall on bank**	**Y**	**25,28**
18	**183**	**16 Railroad Ave.**	**Res.**	**Order of Conditions**	**DEP # 62-88**	**9/18/1988**	**Drawing**	**Install 6" PVC "interceptor" drain**	**Y**	**13or14**
18	184	18 Railroad Ave.	Com.	Determ. of App.	RD #98-10	4/23/1998	Drawing	Remove trees threatening bldg. fndtn. within 100' of brook	N	
18	187A	Henderson Crt.	Res.	Determ. of App.	RD #00-12	10/4/2001	?	Install 6' x 8' garden shed in Riverfront Area	N	
18	187B	Henderson Crt.	Public	Determ. of App.	RD #00-15	5/17/2000	N	Town installing new water line and hydrant	N	
18	301	4 King St. Crt.	Res.	Order of Conditions	DEP #62-298	6/8/1999	Y	Connect existing dwelling to municipal sewer	N	
18	302	3 King St. Crt.	Res.	Order of Conditions	DEP #62-298	6/8/1999	Y	Connect existing dwellings to municipal sewer	N	
18	303	1 King St. Crt.	Res.	Determ. of App.		3/24/2003	Drawing	Construct attached deck	N	
18	321	7 King St.	Res.	Determ. of App.		1/3/1992	N	Construct deck addition	N	
18	322	5 King St.	Res.	Determ. of App.		6/14/2000	Building plan	Construct building addition	N	
18	324	Beach & King Sts.	Com.	Order of Conditions	DEP #62-397	3/12/2003	Y	Demolish greenhouse and construct 2-story rental unit	N	
				WPA Emergency Cert.		6/24/2004	N	Repair roof damaged by fire?	N	
18	325	Millbrook Meadow	Public	Determ. of App.		1987	Drawing	Remove wooden stairs; construct granite stairs	N	
				Order of Conditions	DEP #62-119	9/24/1991	Drawing	Redistribute fill within 100' of brook	N	
				Determ. of App.	RD #99-6	5/20/1999	N	book	N	
				Order of Conditions	DEP #62-382	6/27/2002	Y	Restoration of man-made pond; construct natural stone eel ramp; native plantings	N	

Bold typeface is used to highlight permits that include stormwater discharge outfalls.

Appendix C: Photos of Selected Erosion and Sedimentation Locations

Figure C-1: Some erosion of bank behind King St. residence

Figure C-2: Collapsing retaining wall at base of Summit Ave.

Figure C-3: Accumulation of sand from play area behind Isinglass Place

Figure C-4: Eroding stream bank adjacent to Mill Brook Park

Appendix E: Water Quality Monitoring Lab Reports

Rockport Department of Public Works
34 Broadway
Rockport, MA 01966

Report No.: 31463

RE: BACTERIOLOGICAL ANALYSES OF SURFACE WATERS

SAMPLING: Non-potable water samples delivered by Julie McMahon on September 8, 2004.

FINDINGS:

Biomarine ID	Rockport Site ID	Time Sampled	Total Coliform per 100 mL	Fecal Coliform per 100 mL	E. coli per 100 mL	Entercocci Per 100 mL	TSS
31463A	(H) Railroad Ave 200m	1320	70,000	11,000	11,000	10,000	25
31463B	(I) Poole Ln downstream	1326	100,000	12,000	12,000	12,000	36
31463C	(J) Poole Ln (upstream)	1329	100,000	14,000	12,000	12,000	41
31463D	(K) Squam Brook Summit down	1333	130,000	13,000	11,000	10,000	497
31463E	(L) Squam Brook Squam Hill Ct.	1342	130,000	7,300	3,300	2,400	137
31463F	(D) Dup	1240	170,000	17,000	13,000	11,000	36

Report No.: 31463
September 14, 2004

FINDINGS:

Biomarine ID	Rockport Site ID	Time Sampled	Total Coliform per 100 mL	Fecal Coliform per 100 mL	E. coli Per 100 mL	Enterococci per 100 mL	TSS
31463G	(A) Beach St downstream	1200	53,000	8,000	3,100	6,300	30
31463H	(B) Beach St upstream	1207	23,000	6,500	2,000	430	39
31463I	(C) Millbrook Pond downstream	1214	4,000	2,300	1,300	1,600	21
31463J	(D) Mill Pond upstream	1235	180,000	15,000	8,000	14,000	41
31463K	(E) Henderson Ct Millbrook	1300	66,000	27,000	9,000	14,000	24
31463L	(F) Henderson Ct Squam	1307	130,000	47,000	16,000	16,000	34
31463M	(G) Railroad Ave upstream	1310	68,000	18,000	8,600	12,000	19

METHODS: *Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998* and EPA Method 1600, March 2000.

Jim Cirolenu/Assistant Lab Manager

Rockport Department of Public Works
34 Broadway
Rockport, MA 01966

May 12, 2005
Report No.: 32950

RE: ANALYSES OF SURFACE WATERS

SAMPLING: Non-potable water samples delivered by Julie McMahon on May 7, 2005 at 7:45 a.m.

FINDINGS:

Biomarine ID	Bottle ID	Rockport Site ID	Time Sampled	Total Coliform per 100 mL	Fecal Coliform per 100 mL	E. coli per 100 mL	Entercocci Per 100 mL	TSS
32950A	13	(H) Railroad Ave 200m	0729	4,300	570	380	110	7
32950B	9	(I) Poole Ln Downstream	0741	6,100	470	410	70	9
32950C	10	(J) Poole Ln Upstream	0743	2,700	520	450	<10	6
32950D	11	(K) Squam Brook Summit Down	0732	4,000	140	50	80	20
32950E	14	(L) Squam Brook Squam Hill Ct	0738	3,500	90	40	50	16.5
32950F	2	(A) Dup	N/A	1,500	260	220	60	3
32950G	5	(F) Dup	N/A	4,300	120	50	60	21

FINDINGS:

Biomarine ID	Bottle ID	Rockport Site ID	Time Sampled	Total Coliform per 100 mL	Fecal Coliform per 100 mL	E. coli Per 100 mL	Enterococci per 100 mL	TSS
32950H	1	(A) Beach St Downstream	0700	3,800	270	220	160	4
32950I	4	(B) Beach St Upstream	0700	3,700	270	180	110	8
32950J	3	(C) Millbrook Pond Downstream	0705	2,300	270	270	50	4
32950K	8	(D) Mill Pond Upstream	0715	4,000	700	670	50	9
32950L	7	(E) Henderson Ct Millbrook	0719	7,400	750	540	150	15
32950M	6	(F) Henderson Ct Squam	0723	4,300	70	70	80	23
32950N	15	(G) Railroad Ave Upstream	0725	3,800	660	640	100	30

METHODS: *Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998* and EPA Method 1600, March 2000.

Jim Grolenu/Assistant Lab Manager

Appendix F: Water Quality Monitoring – Results and Comparison

Table F-1

Lower Mill Brook Wet Weather Water Quality Sampling

Sampling Station	8-Sep-04					24-Nov-04					7-May-05				
	Total Coliform	Fecal Coliform	E. coli	Entero	TSS	Total Coliform	Fecal Coliform	E. coli	Entero	TSS	Total Coliform	Fecal Coliform	E. coli	Entero	TSS
(A) Beach St downstream	53,000	8,000	3,100	6,300	30	16,000	1,000	1,000	2,500	265	3,800	270	220	160	4
(A) DUP*	-	-	-	-	-	49,000	2,900	1,600	3,400	261	1,500	260	220	60	3
(B) Beach St upstream	23,000	6,500	2,000	430	39	19,000	140	130	300	23	3,700	270	180	110	8
(C) Millbrook Pond downstream	4,000	2,300	1,300	1,600	21	10,000	500	100	500	76	2,300	270	270	50	4
(D) Mill Pond upstream	180,000	15,000	8,000	14,000	41	170,000	1,900	1,900	1,300	312	4,000	700	670	50	9
D DUP*	170,000	17,000	13,000	10,900	36	-	-	-	-	-	-	-	-	-	-
(E) Henderson Ct Millbrook	66,000	27,000	9,000	14,000	24	110,000	1,200	800	1,300	134	7,400	750	540	150	15
(E) DUP*	-	-	-	-	-	190,000	1,200	1,100	400	131	-	-	-	-	-
(F) Henderson Ct Squam	130,000	47,000	16,000	16,000	34	32,000	1,900	1,700	300	97	4,300	70	70	80	23
(F) DUP*	-	-	-	-	-	-	-	-	-	-	4,300	120	50	60	21
(G) Railroad Ave upstream	68,000	18,000	8,600	12,000	19	68,000	1,600	1,600	1,000	117	3,800	660	640	100	30
(H) Railroad Ave 200m	70,000	11,000	11,000	10,000	25	48,000	1,100	1,000	200	105	4,300	570	380	110	7
(I) Poole Ln downstream	100,000	12,000	12,000	12,000	36	34,000	1,200	500	900	99	6,100	470	410	70	9
(J) Poole Ln (upstream)	100,000	14,000	12,000	12,000	41	38,000	1,400	1,100	1,300	92	2,700	520	450	10	6
(K) Squam Brook Summit down	130,000	13,000	11,000	10,000	497	18,000	500	400	200	192	4,000	140	50	80	20
(L) Squam Brook Squam Hill Ct.	130,000	7,300	3,300	2,400	137	2,400	50	10	20	9	3,500	90	40	50	16.5

* DUP = a duplicate sample taken at the same station for quality assurance of sample collection and analysis techniques.

Table F-2

Lower Mill Brook Optical Brightener Testing -- 9/1/2004 - 9/8/2004

Rockport Site ID	Date Deployed	Date Retrieved	Reading
(B) Beach St--Upstream	9/1/2005	9/8/2005	Negative
(C) Millbrook Pond--Downstream	9/1/2005	9/10/2005*	Negative
(G) Railroad Ave--Upstream	9/1/2005	9/8/2005	"Possible" Positive
(J) Poole Ln--Upstream	9/1/2005	9/8/2005	Negative
(K) Squam Brook--Summit Ave Downstream	9/1/2005	9/8/2005	Negative
(L) Squam Brook--Squam Hill Crt	9/1/2005	9/8/2005	Negative

* This sample was retrieved later than others due to too high flows at this location on 9/8/2005.

Appendix H: Catch Basin Cleaning Plan

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]