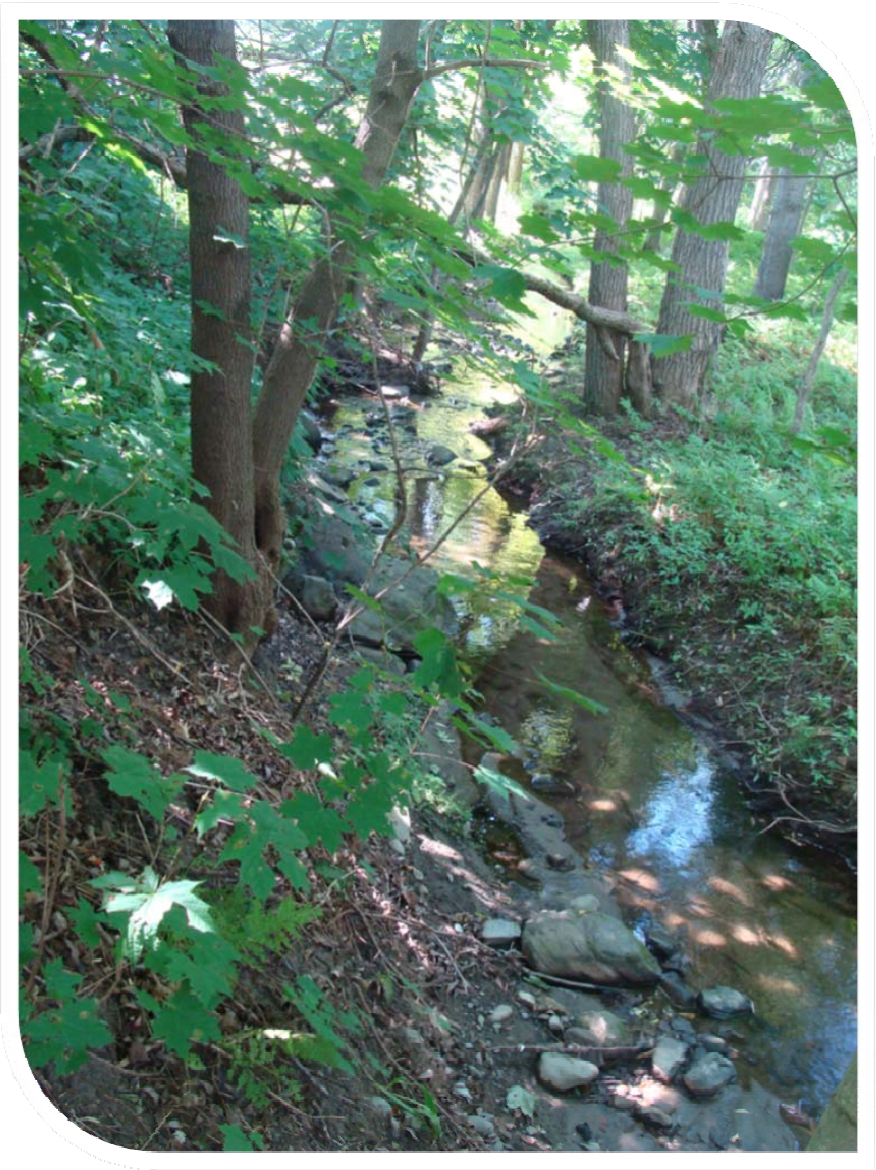
WHITTEN BROOK RESTORATION PLAN

Skowhegan, Maine



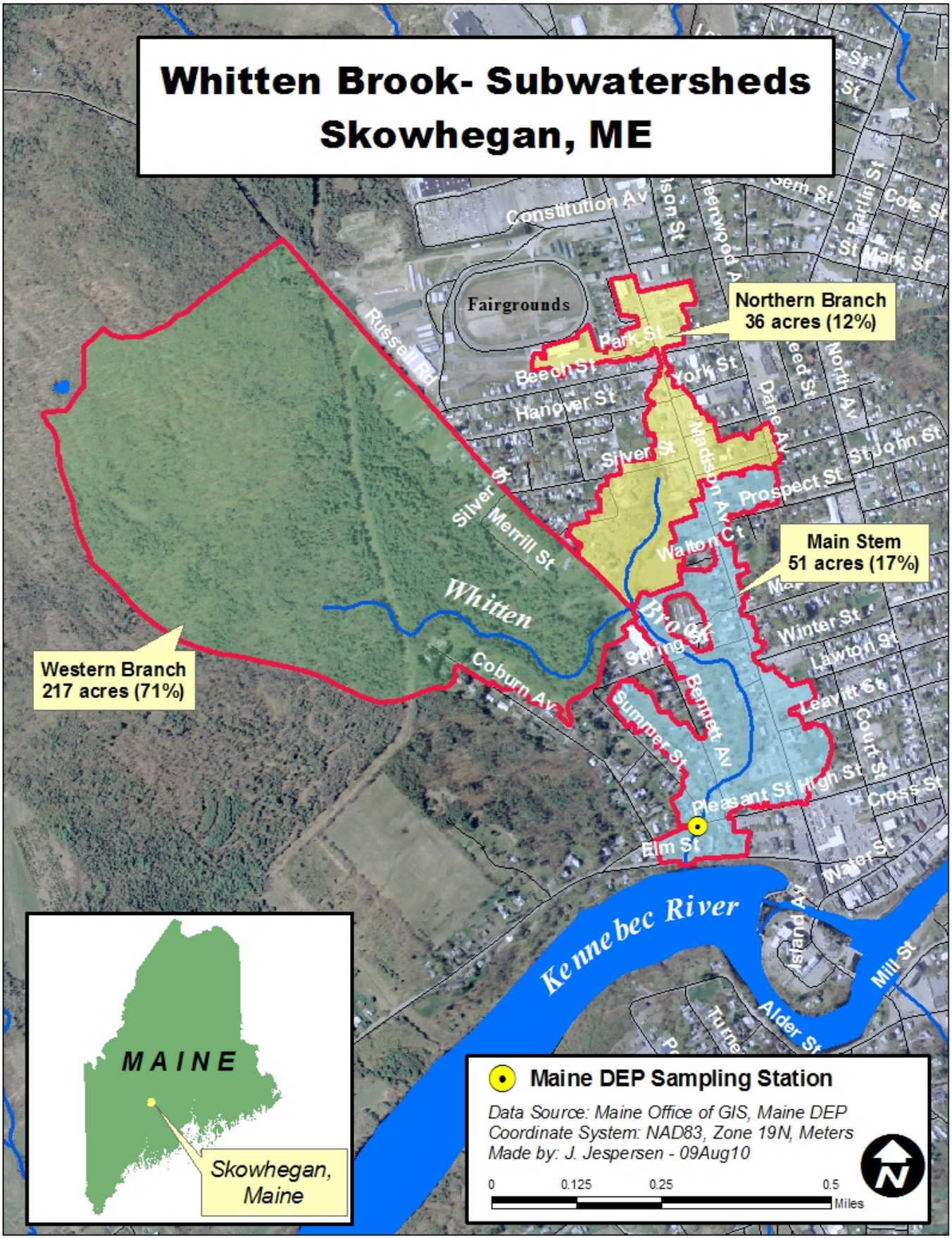
March 2011

FB environmental

Skowhegan Conservation Commission

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF ENVIRONMENTAL PROTECTION STATE OF MAINE


Whitten Brook- Subwatersheds
Skowhegan, ME
Northern Branch
36 acres (12%)
Main Stem
51 acres (17%)
Western Branch
217 acres (71%)
Fairgrounds
Constitution Av
Russell Rd
Park St
Beech St
Hanover St
York St
Silver St
Merrill St
Madison Av
Dane Av
North Av
Prospect St
St John St
Walton Ct
Whitten
Brook
Spring St
Winter St
Lawton St
Leavitt St
Coburn Av
Summer St
Bennett Av
Court St
High St
Cross St
Pleasant St
Elm St
Water St
Kennebec River
Island
Mill St
Alder St
MAINE
Skowhegan, Maine
Maine DEP Sampling Station
Data Source: Maine Office of GIS, Maine DEP
Coordinate System: NAD83, Zone 19N, Meters
Made by: J. Jespersen - 09Aug10
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WHITTEN BROOK
WATERSHED RESTORATION PLAN

Prepared by FB Environmental Associates, Inc.
in cooperation with the Town of Skowhegan, the Maine Department of Environmental Protection
and the U.S. Environmental Protection Agency.

March 2011

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EXECUTIVE SUMMARY

WHITTEN BROOK WATERSHED RESTORATION PLAN

PROJECT OVERVIEW

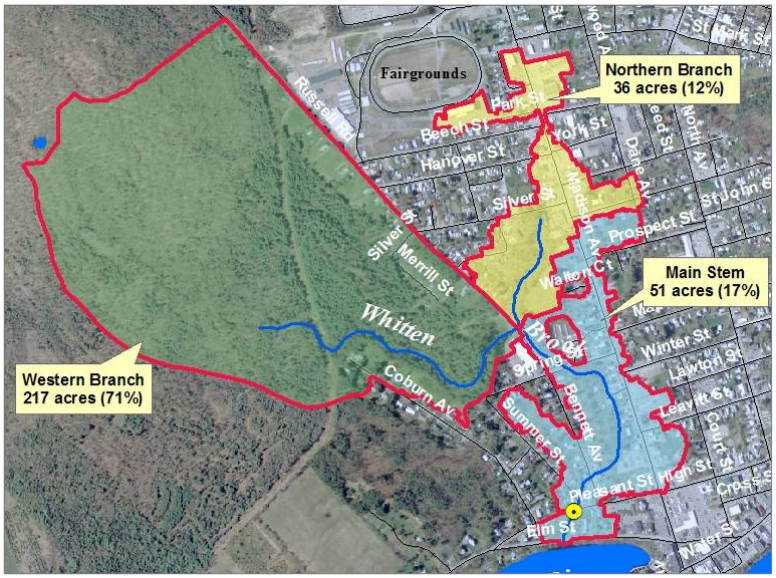
The Whitten Brook Watershed Restoration Project came to being as a result of a locally-supported and community-driven planning process with technical expertise from FB Environmental Associates (FBE) and the Maine Department of Environmental Protection (Maine DEP). The project was led by an advisory committee made up of representatives from the Town of Skowhegan, the Skowhegan Conservation Commission, Main Street Skowhegan, the Somerset County Soil & Water Conservation District, Maine Department of Transportation (Maine DOT), area businesses, and interested citizens. FBE was contracted by the United States Environmental Protection Agency (EPA) in partnership with Maine DEP to work with local stakeholders to develop a cost-effective and community-driven strategy to restore Whitten Brook.

The project includes the development of a Watershed Restoration Plan for Whitten Brook, including a series of five stakeholders meetings, a stream corridor survey, rapid geomorphic assessment, and a parcel-by parcel survey of impervious surfaces in the watershed. FBE led a series of planning workshops beginning in the summer of 2010 to identify and prioritize problems, define management objectives, and prioritize restoration strategies in the watershed that would bring the stream into compliance with state water quality standards, and restore habitat for native brook trout.

PURPOSE:
Restore watershed conditions in Whitten Brook so that the stream: 1) Attains state water quality classification standards, and; 2) Supports a healthy native brook trout fishery.

THE WHITTEN BROOK WATERSHED

Whitten Brook is a small stream with two primary branches. The headwaters (or western branch) originate in a large undeveloped forest north-north-west of Coburn Avenue near downtown Skowhegan. An unnamed stream, and Whitten Brook's only tributary, flows into Whitten Brook from the north (northern branch). The unnamed tributary joins Whitten Brook near Russell Road (main stem) and then flows another 0.5 miles south-east through a residential neighborhood, crossing under six roadways before flowing into the Kennebec River.



The "watershed" includes the area of land from which water flows into Whitten Brook or its tributary. The Whitten Brook watershed is considered a small watershed, with 304 acres (0.48 sq. mi.) of land in Skowhegan, Maine. The large undeveloped forestland in the western branch of the watershed (71% of the watershed area) is a unique natural feature of this urban watershed.

The Problem

Whitten Brook has been significantly impaired as a result of urbanization, especially along the Route 201 corridor. The primary culprit to the current impairment is the increased volume of stormwater runoff and associated pollutants flowing into the stream from impervious surfaces such as parking lots, roads and rooftops. In 2010, the Maine DEP conducted a comprehensive on-site watershed delineation to determine watershed boundaries and to map the extent of impervious cover (IC) in the watershed. The study examined the existing stormwater system and its impacts on the stream, and identified four major subcatchments that direct high volumes of stormwater and associated pollutants directly to the stream without treatment.

Stormwater carries dirt, oils, metals, and other pollutants off developed areas in the watershed resulting in increased erosion, sedimentation, and habitat degradation in the stream. In addition, former industrial land uses including a tannery, and corn factory on the stream resulted in changes to the stream's natural hydrology (impoundments). As a result, Whitten Brook does not meet state water quality standards for bacteria, aquatic life or habitat, and is classified as one of Maine's 31 "urban impaired" streams. State and federal law require that Whitten Brook be restored to meet water quality standards.

A good restoration plan acts as a road map pointing out where to start, what visits to make in the watershed, how long it will take to get there, how much it will cost, and how you know you've arrived.

Why Develop A Restoration Plan?

A watershed restoration plan helps identify problems, priorities and actions that are needed to improve the water quality of a stream or brook. Since each watershed is unique, the Whitten Brook Restoration Plan is also unique in order to address the major issues and concerns of both the community and the stream.

A Total Maximum Daily Load (TMDL) study conducted in 2007/08 by Maine DEP determined that the Whitten Brook watershed needs to have the characteristics of a watershed with 9% impervious cover (currently at 14%) in order to support Class B aquatic life use. The Whitten Brook Restoration Plan builds upon the goal set by the TMDL (as well as other recent watershed studies) and describes objectives to meet this challenge.

Successful development and later, implementation, of the Whitten Brook Watershed Restoration Plan depends primarily on the commitment and involvement of the community. Bringing together people, policies, priorities, and resources through a watershed approach helps blend science and regulatory responsibilities with social and economic considerations. These partnerships help strengthen the plan by increasing both public awareness of the problems and public commitment to the solutions. A community-based plan also provides other benefits such as attracting private, state and federal dollars for green jobs and green infrastructure, and providing opportunities for both recreational and aesthetic improvements.

WHAT THE PLAN INCLUDES:

Members of the Whitten Brook Advisory Committee have helped guide the watershed planning process since the project began in June of 2010, and will continue to guide efforts to implement the restoration plan over the next 10-15 years. The plan is divided into seven major sections:

Section 1 describes the purpose of the plan, provides background information about Whitten Brook, a description of the planning process, and brief descriptions of recent efforts in the watershed.

Section 2 describes the watershed, including a description of the subwatersheds, major stormwater outfalls, climate, topography, soils & geology, and land use.

Section 3 describes applicable water quality standards, a summary of water quality and biological assessment data collected in the stream, and the degree and causes of impairment in Whitten Brook including a description of impervious cover by subcatchments and by type of impervious cover (e.g. total area of parking lots vs. buildings, driveways, etc.). Sections 3.4 and 3.5 provide a summary of the watershed study conducted by FB Environmental in 2010 including a habitat assessment, rapid geomorphic assessment, and stormwater reconnaissance inventory.

Section 4 describes the watershed restoration goals and objectives including the Action Plan. Both structural and non-structural restoration opportunities and recommendations are discussed. Action strategies are presented in tables describing what needs to be done, how it will be done, who will help get it done, when it will be done, and how much it will cost. Restoration strategies are divided into a handful of primary categories (below). Section 4.4 provides an explanation of the stormwater retrofit prioritization process and outcomes, including a description of the five highest priority retrofit sites.

KEY RESTORATION CATEGORIES
Whitten Brook

- ☆ **Land Conservation & Land Use Planning-** Coordinate local efforts to increase the amount of land in permanent conservation while working with town officials to expand shoreland zoning to protect impaired streams and improve town stormwater rules.
- ☆ **Stormwater Best Management Practices (BMPs)-** Reducing the volume of stormwater and the pollutants it carries to Whitten Brook is a priority that can be accomplished through a variety of innovative conservation practices that capture, filter, cool, and slow runoff from paved areas, rooftops and other impervious surfaces.
- ☆ **In-Stream Restoration-** Once stormwater BMPs have been installed, in-stream restoration efforts can begin. These include restoring riparian buffers, defining a narrower-channel, and stabilizing eroding stream banks.
- ☆ **Education & Outreach-** Garner the support and cooperation from a diversity of community groups and agencies while educating business owners and citizens about the need and importance of stormwater control.
- ☆ **Municipal Maintenance Practices-** Work with municipal staff to improve existing stormwater infrastructure, winter sand/salt spreading, snow storage, and street sweeping.
- ☆ **Other Restoration-** Keep bass and other warm water/invasive/exotic species from entering the stream from the Kennebec River.

Section 4.5 projects reductions associated with stormwater runoff including effective impervious cover, sediment, nutrients and metals.

Section 5 describes who is in charge of administering the plan, and summarizes actions, costs and technical assistance needed to ensure progress.

Section 6 describes specific recommendations for monitoring and evaluating the effectiveness of restoration efforts. This includes criteria for measuring progress and measurable milestones along the way.

Reductions from Proposed Stormwater Retrofits:

Funding The Plan

Restoration of Whitten Brook will require a coordinated program supported by private, state, town, and federal funding. Private landowners owning businesses in the watershed can choose to implement recommended BMPs on a voluntary basis. Cost-share opportunities to retrofit existing impervious cover may be available at some point in the future, as well as grant-funding to set-up demonstration sites throughout the watershed. A high priority is to acquire funding for the installation of the proposed dry extended detention basin or other stormwater treatment option to capture runoff from Northern Madison Avenue.

The total estimated cost for implementing the Whitten Brook Restoration Plan is estimated at more than 1.3 million dollars over the next 10 - 15 years including all structural and non-structural recommendations. Costs are described in Sections 4 and 5. A long-term sustainable funding plan needs to be developed by the Technical Advisory Committee (TAC) in order to acquire the funds to achieve the proposed goals. This funding strategy will outline the financial responsibilities for all levels of the community, and should be revisited on an annual basis.

KEY ACTION STRATEGIES
for Restoring Whitten Brook 2011-2021

- **Develop a long-term sustainable funding plan for implementation.**
- **Expand land conservation efforts in the western branch of the watershed.**
- **Treat stormwater from Northern Madison Avenue to an extended detention basin or other BMP.**
- **Focus efforts on the five highest priority stormwater retrofit sites.**
- **Restore riparian buffers, and in-stream habitat.**
- **Implement a targeted education and outreach program focused on business owners, citizens, municipal employees and community groups.**
- **Work with the town to develop Shoreland Zoning for impaired streams.**

ADMINISTERING THE PLAN

The Skowhegan Conservation Commission (SCC) will work with Whitten Brook TAC, the Town of Skowhegan, local community groups, businesses and individuals to administer the Whitten Brook Restoration Plan. The SCC will convene the TAC at least annually to provide periodic updates to the plan, track and record progress made toward restoration, maintain and sustain action items, and make the plan relevant on an ongoing basis by adding new tasks as they develop. The SCC will track achievements, press coverage, outreach activities, number of retrofits sites repaired, number of volunteers, and amount of funding received.

NEXT STEPS

Successful implementation of a watershed restoration plan depends primarily on the commitment and involvement of community members. Therefore, the success of this plan will weigh heavily on the cooperation of the town, state, and key stakeholders to support the plan. The SCC and the TAC will need to enthusiastically engage the community in restoration activities and work together to develop a sustainable funding plan and acquire the necessary funds to implement it. The SCC should work with the Town of Skowhegan to officially adopt the plan, thereby raising awareness about the importance of restoration efforts and need for immediate action.

Project partners expect the restoration effort to be successful and believe that it may serve as a model for other impervious cover impaired streams across Maine, New England, and possibly the rest of the nation.

A community-driven plan is a locally-supported plan.

ACKNOWLEDGEMENTS

Whitten Brook Technical Advisory Committee (TAC):

Craig Denis, Conservation Commission
Jeff Dennis, Maine DEP
Greg Dore, Town of Skowhegan
Melissa Evers, Maine DEP
Sarah Luce, Landowner
Jennifer Olsen, Main Street Skowhegan
William Reid, Interested Citizen
Stephen Tibbetts, Maine DOT
Carol Weymouth, Somerset County SWCD
Peter Whitkop, Conservation Commission
John W. Youney, Landowner

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Jack Gibson, President, Somerset Woods Trustees
Ed & Jennifer Goff, Business Owners
Jeff Hewett, Town of Skowhegan
Ilene Lowe, Landowner
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Sarah Luce, Landowner
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TABLE OF CONTENTS

FIGURES AND TABLES

FIGURES

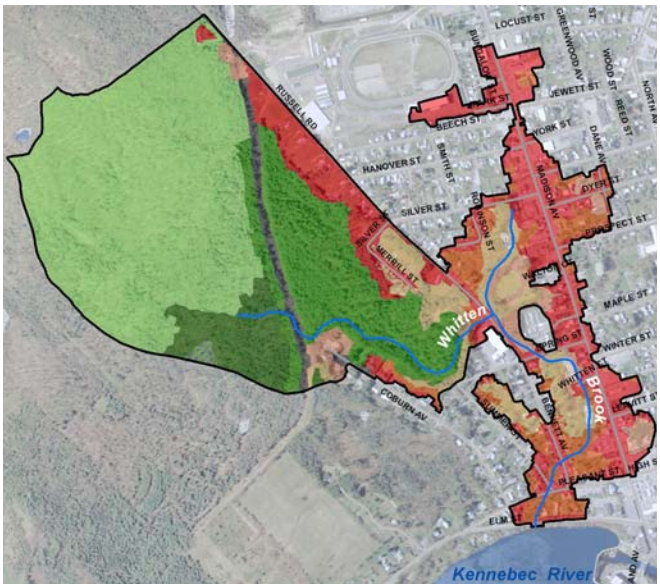
TABLES

1. Introduction

1.1. Purpose and Background

Small (1st order or headwater) streams, and the associated network of small connected wetlands help to sustain the biological productivity of downstream rivers, lakes and estuaries. These small streams also provide natural flood control, recharge the groundwater, and maintain water quality by trapping sediments and pollution from fertilizers and other pollutants. Small streams recycle nutrients, create habitat, and maintain biological diversity for plants and animals including fish species such as salmon and trout (Meyer et al. 2007). Small streams also provide intrinsic benefits to our communities by providing a sense of place for the people that live near them, a place for children to grow and explore the natural world around them.

Human activities such as land clearing and development and associated increases in urban runoff can have dire effects on the health of small streams and the plants and animals that live there. Poorly planned development can result in changes to riparian vegetation and watershed hydrology, water pollution, and the introduction of invasive species. Conservation efforts, including protecting the riparian zone around small streams, preserving the natural undeveloped forest buffers along these streams, and the use of low-impact development techniques will ultimately protect these small streams in the long run.



The red/orange tones in this aerial photo of the Whitten Brook watershed highlight developed land, while undeveloped land is represented by different shades of green.

Evidence suggests that the high percentage of developed land (commercial, industrial and residential land uses) in the Whitten Brook watershed have altered the natural hydrologic cycle of this small 1st and 2nd order headwater stream, resulting in increased surface water flow during storm conditions which carry large volumes of water and attached pollutants to Whitten Brook. The stream is listed as an impaired Class B stream on Maine's 303 (d) listing of impaired waters based on monitoring results of the macroinvertebrate community, physical habitat parameters and water chemistry from 2002-2007. The stream is listed for both non-attainment of aquatic life criteria and habitat, and for non-attainment of bacteria standards which has been addressed by Maine's Total Maximum Daily Load (TMDL) report (DEP, 2009).

The aquatic-life violation prompted the development of a draft Total Maximum Daily Load (TMDL) report (MDEP, 2008), which will be incorporated into a state-wide ***impervious cover (IC)*** TMDL using an IC target (DEP, in progress). The TMDL

> ***Impervious cover*** *refers to any surface that will not allow water to soak into the ground. Examples include paved roads and driveways, parking lots and roofs.*

set a target goal of 9% effective impervious cover, which will help reduce current pollutant loads from the watershed, mimic natural watershed conditions, and help restore Whitten Brook, and achieve Class B water quality standards.

The purpose of the Whitten Brook Watershed Restoration Plan is to restore Whitten Brook so that it:

1) Supports a healthy native brook trout fishery; and

2) Attains Maine's Class B water quality standards.

This can be accomplished with the commitment of a coordinated group of local community leaders, conservation groups, state and federal partners, and citizens of the watershed working together to implement a long-term (10-15 year) plan to restore Whitten Brook. The Whitten Brook Restoration Plan provides key actions needed to restore the stream, the timing of these actions, and the mechanism by which they will be accomplished.

1.2. Developing a Community-Driven Watershed Restoration Plan

A *watershed restoration plan helps identify problems, priorities and actions that are needed to improve the water quality of a stream or brook.* A good plan acts as a road map pointing out where to start, which stops to make in the watershed, how long it will take to get there, how much it will cost, and how you know you've arrived. Since each watershed is unique, the Restoration Plan should also be unique in order to address the major issues and concerns of the community.

A community-driven plan is a locally supported plan. Successful development of a watershed restoration plan depends primarily on the commitment and involvement of community members. Bringing together people, policies, priorities, and resources through a watershed approach blends science and regulatory responsibilities with social and economic considerations (EPA, 2008). The simple process of gathering information and learning about the watershed, sharing information with other residents about the history of the stream, recent changes in the watershed, and developing a cooperative understanding of the local resources with others in the community can be one of the most productive outcomes of the plan. These partnerships help strengthen the plan by increasing both public awareness of the problems and public commitment to the solutions.

The Town of Skowhegan has been involved in all facets of the plan including field surveys led by the project consultants.

The Town of Skowhegan has shown a strong commitment to work towards improving conditions in Whitten Brook. The citizens, particularly the conservation commission, have recognized the benefits of working with

each other and with watershed stakeholders to address a common problem. Through funding and oversight from the US EPA and Maine Department of Environmental Protection, and technical consulting by FB Environmental Associates, Skowhegan convened and actively participated in this watershed planning process. The involvement of all watershed landowners was encouraged through direct mailings, press releases and individual outreach to ensure that their interests were considered and their skills and experience could contribute to the process. This planning process has involved local officials, a number of state agencies, landowners, non-profits and other stakeholders, who have devoted many hundreds of hours to the Project. The community-based approach will continue through the implementation of the Watershed Management Plan.

The project leaders developed a structure to harness community involvement and provide community oversight for plan development and implementation (Figure 1). The Whitten Brook Restoration Plan has been led by a stakeholder group of representatives from the Town of Skowhegan, non-profit organizations in the watershed, and several state entities. The stakeholder group held a series of planning workshops to identify and prioritize problems, define management objectives, and prioritize protection restoration strategies. Planning meetings were attended by landowners, government officials, community organizations and others interested in the project. At these meetings, the stakeholder group and technical consultants provided information, invited participation on a Technical Advisory Committee (TAC), and solicited guidance for the plan's development and implementation. In October of 2010 the TAC was formally instated which identified the most pressing issues, developed the mission and goals for stream restoration, identified potential resources, and ultimately will approve the overall watershed restoration strategy detailed in this plan. Project partners expect the restoration effort to be successful and believe that it may serve as a model for other impervious cover impaired streams across Maine, New England, and possibly the rest of the nation.

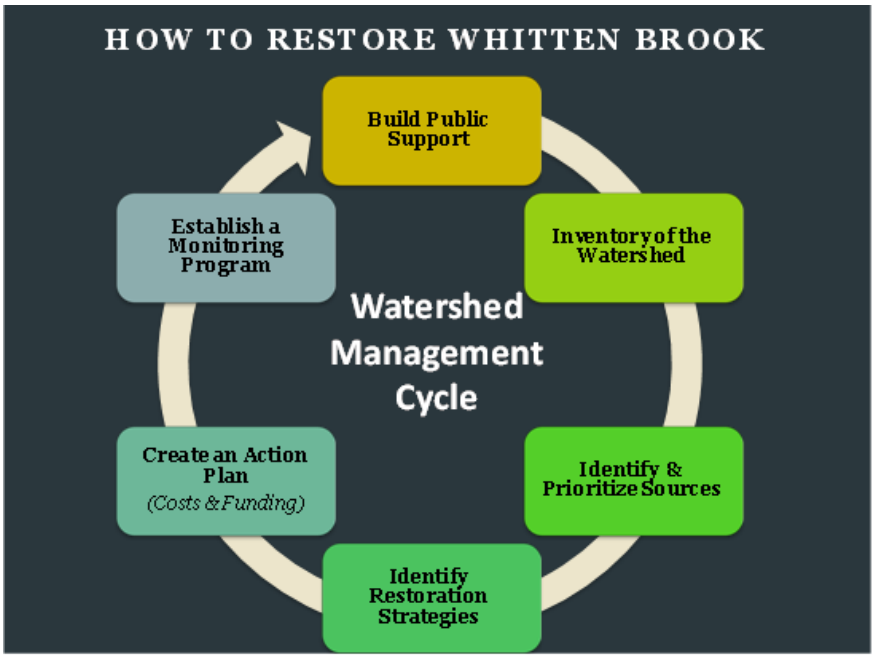


Figure 1. *Watershed Management Cycle. The Skowhegan community has embraced the watershed management cycle and should insure that this Plan is a "living document".*

In order to assure that restoration goals are reached, the community should consider this Plan to be a "living document". In other words, the goals and objectives of the Whitten Brook Watershed Restoration Plan should be revisited and revised on an annual basis.

1.3. Recent Efforts in the Watershed

The Skowhegan Conservation Commission (SCC) has an ongoing interest in restoring Whitten Brook. The Conservation Commission has been actively involved in the project since the development of the TMDL beginning in 2007. Both the US Environmental Protection Agency (USEPA) and the Maine DEP believe that restoration is attainable, and have provided both funding and staff support for the restoration efforts.

Whitten Brook Water Quality Assessment- Sampling data were collected by Maine DEP between 2002 and 2007 which included monitoring of the macroinvertebrate community, physical habitat parameters and water chemistry. Sampling results were compared to Maine's statutory Class B water quality standards and the stream was listed as impaired due to non-attainment of aquatic life criteria and for non-attainment of bacteria standards.

Whitten Brook Total Maximum Daily Load (TMDL)- To address the aquatic-life impairment, a draft Impervious Cover Total Maximum Daily Load (IC TMDL) report was developed for Whitten Brook by Maine DEP (MDEP 2008), which will be incorporated into a state-wide impervious cover (IC) TMDL using an IC target (MDEP, in progress). Non-attainment of bacteria standards in Whitten Brook has been addressed by Maine's Statewide Bacteria TMDL report (DEP, 2009). The draft IC TMDL for Whitten Brook identified the high percentage of developed land (commercial, industrial and residential land uses) in the Whitten Brook watershed as the primary culprit to the current aquatic life impairment. Changes in the hydrologic cycle include increased surface flow during storm conditions which carry large volumes of water and attached pollutants to Whitten Brook. The TMDL set a target goal of 9% effective impervious cover, which, if addressed will help reduce current pollutant loads from the watershed, mimic natural watershed conditions, and help Whitten Brook achieve Class B water quality standards.

Whitten Brook Watershed and Impervious Cover Delineation- An on-site detailed watershed delineation and impervious cover (IC) analysis was conducted by Maine DEP during the summer of 2010 to include the watershed's stormwater conveyance system. This survey documented the high % of IC in the watershed, particularly along the northern branch and main stem of Whitten Brook. The revised watershed boundary places impervious cover in the Whitten Brook watershed at approximately 14%. This study also delineated four major watershed subcatchments that carry stormwater directly from areas of high impervious area directly to the stream. IC levels in these subcatchments range from 43-74%. This survey supports the idea that the high percentage of IC, especially in the subcatchments, has led to dramatic impacts to the stream as a result of increased stormwater runoff and its associated pollutants.

SCC volunteers helped collect stream flow and temperature data for the 2010 watershed study.

Whitten Brook Watershed Study- Several members of the SCC volunteered their time to assist FB Environmental and Maine DEP with a Watershed Study in 2010. The study involved conducting a Level 1 Stream Corridor Survey, including a Rapid Habitat Assessment and Rapid Geomorphic Assessment of Whitten Brook. In addition, SCC volunteers participated in a Watershed Retrofit Reconnaissance Inventory (RRI) of the watershed in late August 2010. The RRI survey included a rapid field assessment of potential stormwater storage and on-site stormwater retrofit sites throughout the watershed. Typical sites that were investigated for possible retrofitting included culverts, storm drain outfalls, highway rights-of-way, open spaces, and parking lots (see Section 3.5). Results of these surveys are described in the *Whitten Brook Watershed Study* (FBE, 2010).

Maine DOT/Maine DEP Madison Avenue Investigation- The Maine DEP consulted with the Maine Department of Transportation (DOT) have been working cooperatively during the planning process to identify potential measures to reduce the impacts of stormwater from State Route 201 (aka Madison Avenue). The Northern Madison Avenue subcatchment consists of 21 acres of land in the upper watershed, with an estimated impervious cover of 74%, representing the highest percentage of IC in watershed. Runoff from the IC in this area drains to numerous storm drains along Madison Avenue, collecting in the stormwater system, which flows through a culvert into Whitten Brook between Madison Avenue and Robinson St. The two state agencies are working toward discussing and reviewing potential measures to treat the large volume of stormwater delivered to the stream before it reaches the stream. This may involve evaluating the feasibility of an extended detention basin north of the existing outfall.

Whitten Brook Stream Clean-Ups- In the fall of 2010, the SCC organized a stream clean-up for Whitten Brook utilizing volunteers from the Town of Skowhegan, the SCC and the Charleston Youth Center. Approximately 20 yards of debris was removed from the stream between the unnamed tributary to Whitten Brook and Bennett Avenue. The SCC has organized similar clean-ups for Whitten Brook in the past, and plans to continue these efforts in the future.

Youth volunteers helped remove 20 yards of trash from the stream in 2010.

Conservation Efforts in the Whitten Brook Watershed- Acquisition of land for conservation in the watershed has resulted in the long-term preservation of undeveloped forestland in the upper watershed. The Town of Skowhegan owns a small parcel near Russell Rd. also known as “The Whitten Brook Conservation Area”. In addition, the Somerset Woods Trustees (SWT) owns approximately 300 acres of land called "Coburn Woods". Some of this land was purchased recently to prevent potential heavy cutting and development in the sensitive, undeveloped headwater of Whitten Brook. Because Whitten Brook lacks adequate protection from development (no zoning for portions of the stream), ongoing efforts to protect the riparian habitat and large undeveloped blocks of land will be important for maintaining the existing water quality in the brook. Poorly planned development in the upper watershed will only cause further degradation despite efforts to retrofit developed areas in the watershed.

2. Watershed Characterization

A watershed is a geographic area in which all the water running off the land drains to a given stream, river, lake, wetland or coastal water. Large watersheds, like the Kennebec River watershed are made up of many smaller watersheds (also called subwatersheds). Whitten Brook is a subwatershed of the Kennebec River because all the water that flows overland to Whitten Brook flows into the Kennebec River via Whitten Brook. The Whitten Brook watershed is considered a small watershed, being comprised of just 304 acres (0.48 sq. mi.) of land near part of downtown Skowhegan, Maine (Figure 2).

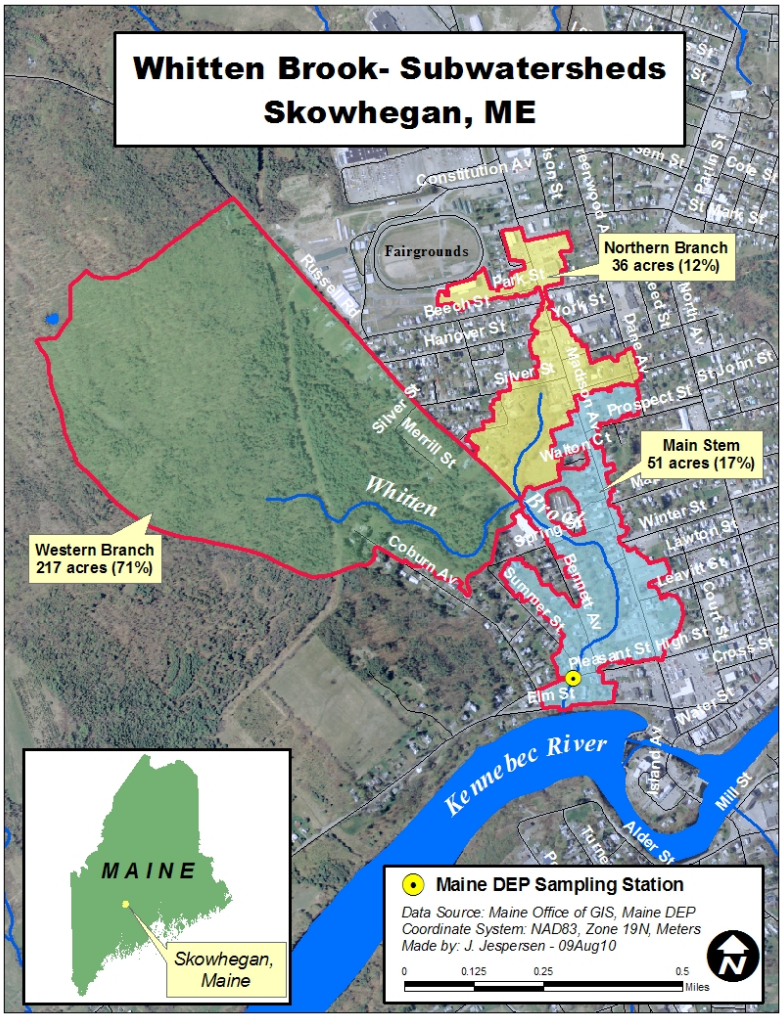


Figure 2. *Whitten Brook subwatersheds.*

The approximately 1.1 mile long stream flows primarily through residential neighborhoods, and is influenced by six different road crossings. Whitten Brook originates as a first order stream in a forested area north-west of Russell Road, and flows for approximately 0.6 miles before crossing under Russell Road where it meets with an unnamed first order stream. At this point it becomes a channelized second order stream running adjacent to Russell Road. After approximately half of a mile, the stream flows under Spring Street and Whitten Court, south-west under Bennett Avenue and Summer Street, through a concrete channel under Pleasant Street, and finally under Elm Street to the Kennebec River. The upper portion of Whitten Brook above Coburn Avenue is known by local fisherman for its native brook trout fishery.

2.1 Subwatersheds & Stormwater Outfalls

The Maine DEP 2010 watershed delineation and impervious cover (IC) analysis resulted in a revised accurate watershed boundary for Whitten Brook that incorporated the Town of Skowhegan's stormwater system. This system captures water in catch basins placed within the dense commercial and residential development and roadways in town. Water that does not flow into a stormwater catch basin either infiltrates into the ground, or as overland flow directly to the stream.

2.1.1. Subwatersheds

The Whitten Brook watershed consists of three major subwatersheds (Figure 2):

1) *The Western Branch* (217 acres), including the large area of undeveloped forestland west of Coburn Avenue and the CMP Right-of-Way;

2) *The Northern Branch* (36 acres), which consists of the watershed area that flows to the unnamed tributary west of Madison Avenue;

3) *The Main Stem* (51 acres) including the land area that flows to the area of Whitten Brook between the confluence of the two first order streams to the Kennebec River.

2.1.2. Subcatchments & Outfalls

The Whitten Brook watershed includes four subcatchments (Figure 3). These subcatchments are areas of land (like a subwatershed), but are driven by the location of the town's stormwater system. This system effectively collects stormwater and directs it to a known location or "outfall". The four subcatchments drain to four outfalls in Whitten Brook. This means that all the water and associated stormwater pollutants from parking areas, and roads flows directly to the stream without being treated first. This water can be highly toxic and flows in large volumes with high velocity during storm events.

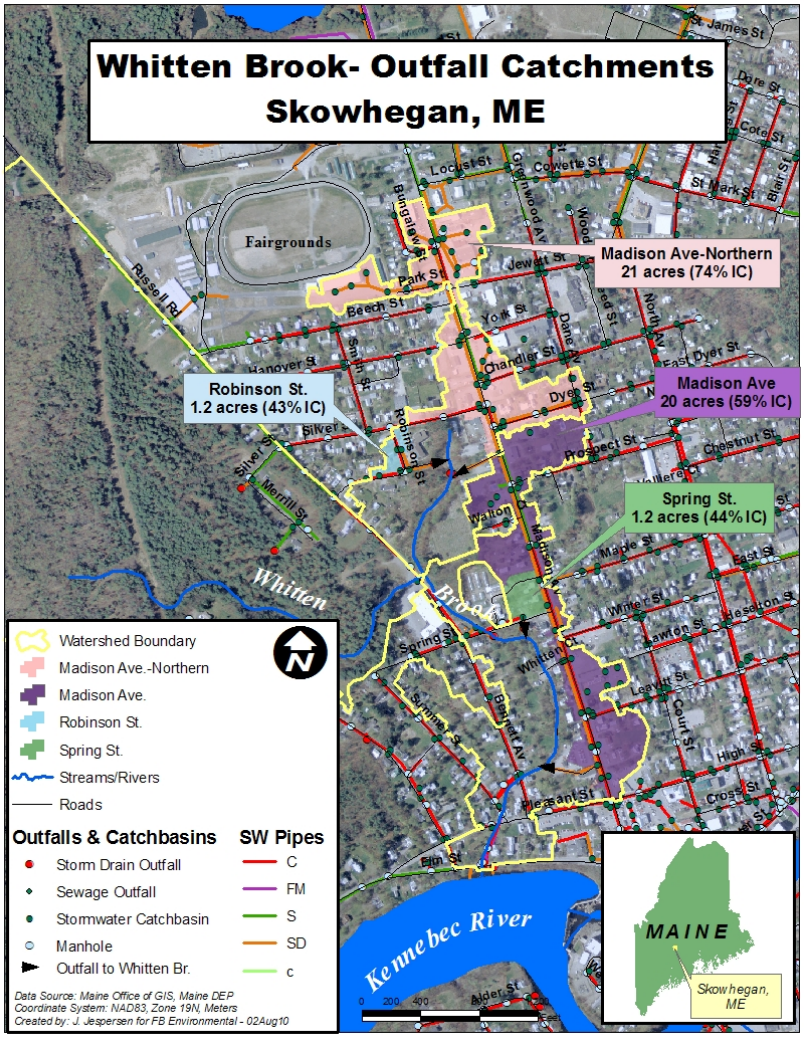


Figure 3. *Whitten Brook stormwater outfall subcathments.*

The four outfall catchments for Whitten Brook include:

1) *Northern Madison Avenue* exhibits the highest percentage of impervious cover (74%) of all the subcatchments. The outfall is located on the east-side of the unnamed tributary that flows to Whitten Brook between Madison Avenue and Robinson Street.

2) *Madison Avenue* collects stormwater from all of lower Madison Avenue to Pleasant Street.

3) *Robinson Street* includes a small (1.2 acre) subcatchment with a high level of impervious cover (43%). The outfall is located on the west-side of the stream adjacent to the Northern Madison Avenue outfall.

4) *Spring Street* is similar in size and comparable in IC to the Robinson Street subcatchment. The outfall is located on the east-side of Whitten Brook downstream of Spring Street.

The high percentage of IC (43-74%) in these subcatchments, has led to dramatic negative impacts to the stream as a result of increased stormwater runoff. Inadequate riparian buffers along some sections of the stream as well as the lack of stormwater treatment (including vegetated buffers) in developed areas of the watershed exacerbate the problems.

2.2 Climate

The climate in the Skowhegan region has been relatively consistent over the long term, exhibiting a mean July temperature of 67.5^{o} F, a mean January temperature of 15^{o} F, and an overall average temperature of 42.6^{o} F. The average annual precipitation is 39.57 inches including rainfall and snow equivalent. The average annual snowfall for the region is 73 inches. The frost free season usually ranges from 101 to 120 days. Skowhegan is the gateway to several of Maine's well known outdoor recreation areas including the western mountains, northern Kennebec Valley, and the central lakes region. Skowhegan is a destination in itself with a multitude of high quality streams, rivers, and lakes that provide ample opportunity for fishing and camping. People are drawn by the beautiful summers and snowy winters to participate in activities such as hiking, leaf peeping, snowmobiling, and skiing.

2.3 Physical Features of the Watershed

The physical characteristics of the Whitten Brook watershed (i.e. how steep or flat, what type of soils, etc.) explain a lot about how the stream may have behaved in the past, before the land was cleared for development. For example, if the soils in the watershed were comprised mostly of sand and other course material, then we'd expect that rainwater would easily be absorbed by the soil and the natural vegetation around the stream, and that recharge to the stream would largely be from groundwater. In contrast, if the soils were naturally high in clay, we might expect that rainwater would not infiltrate into the soil as easily, and there would be more overland flow to recharge the stream. Understanding the underlying physical nature of the watershed provides clues about how we might restore the stream by mimicking these natural conditions.

2.3.1 Topography

The topography of the Whitten Brook watershed ranges from approximately 455 ft. above sea level in the upper watershed to 170 ft. above sea level where it flows into the Kennebec River (Map 1, Appendix 1). The stream itself is fairly low gradient with few areas of fast moving water. Steep embankments are common along a majority of the stream reaches, with slopes greater than 30% common on at least one bank.

2.3.2 Soils & Geology

Soils in the watershed consist primarily of Adams loamy sand and Bangor very stony silt loam (Map 2, Appendix 1). Approximately 73% of the soils in the watershed have high infiltration rates, while the remaining 27% have slow infiltration rates. Soils with slow infiltration rates are located primarily in the forested area within the western branch of Whitten Brook's watershed, and along the stream corridor. A combination of steep slopes, poor infiltration, and poorly planned development can lead to soil erosion, a major cause of stream degradation. The largest areas of highly erodible and potentially highly erodible land in the Whitten Brook watershed are located in the western branch, and in several areas along the stream corridor (Map 3, Appendix 1).

The surficial geology of the Whitten Brook watershed is composed of three different types of glacial deposits (Map 4, Appendix 1). Fine grained deposits cover 44 acres (14%) of the watershed, coarse or medium grained deposits cover 115 acres (38%) of the watershed, and till covers 145 acres (48%) of the total watershed area. Glacial till includes a mixture of sand, silt, clay and stones and may include boulders. Till conforms to underlying bedrock and can also form drumlins and other glacial hills. Glacial till is most abundant in the upper (western branch) watershed in areas of steeper terrain.

Coarse-grained glaciomarine deposits of sand, gravel, and minor amounts of silt are located in flat to moderately sloping areas of the watershed along the Madison Avenue corridor and along the main stem of Whiten Brook. Fine-grained glaciomarine deposits include sand, clay and minor amounts of gravel. This material is commonly referred to as clayey-silt (the Presumpscot Formation). Sand is dominant in some places but may be underlain by finer grained sediment.

A significant sand and gravel aquifer (Type 1, 10-50 gallons/minute) underlies a portion of Northern Madison Avenue as well as portion of the western branch. The aquifer extends north and east of the fairgrounds outside of the watershed (Map 5, Appendix 1).

2.3.3 Land Use

A land use analysis of Whitten Brook shows that developed land in the watershed encompasses 44% of the total watershed area (Table 1). High intensity development dominates the developed land in the watershed (commercial and residential uses with impervious surfaces ranging from 50-100%).

Table 1. *Land use analysis for the Whitten Brook watershed.*

Land Cover Type	Area (acres)	% of Watershed
High Intensity Development	67.5	22%
Medium Intensity Development	20.4	7%
Low Intensity Development	12.2	4%
Developed Open Space	23.2	8%
Forest	170.7	56%
Other	10.2	3%
Total	**304**	**100%**

Forestland, dominated by deciduous forest, makes up more than half of the land area in the watershed (Map 6, Appendix 1). The large area of

undeveloped forestland in the western branch (or headwaters) of the stream is an important and beneficial feature of the Whitten Brook watershed. The Somerset Woods Trustees is a major landowner in the western branch and has made significant efforts to conserve this area in perpetuity (Map 7, Appendix 1). Unfortunately, the high percentage of developed land and impervious surfaces in the remainder of the watershed has resulted in increased runoff and changes to the hydrologic characteristics of the stream.

2.4 Land Use Projections

While population growth is currently slow in Skowhegan, there is potential for further development to occur in the watershed, particularly the headwater areas of Whitten Brook which currently provides valuable natural habitat and ideal conditions for good water quality. Skowhegan has a shoreland zoning ordinance that was developed in 1991, and last amended on June 8, 2009. This ordinance protection only for the portion of Whitten Brook below the confluence with the unnamed tributary and the western branch of the stream. The implementation plan offers suggested measures to provide further protection of the stream and the watershed.

An IC buildout analysis is being conducted for the Whitten Brook watershed as part as the statewide IC TMDL report to identify the potential impact of future development as allowed by current land use ordinances. The buildout analysis is a comparison of the existing extent of impervious cover (IC) in the Whitten Brook watershed with the IC from future development, assuming no change in current zoning regulations, which illustrates the potential impact of future development.

3. Causes of Impairment

Stormwater runoff is water that does not soak into the soil during a rain event but flows over the surface of the ground until it reaches a nearby waterbody. Stormwater flows quickly over impervious surfaces and picks up pollutants such as: metals, petroleum products, eroding soil from construction, winter sand, lawn fertilizers and pesticides. Urban watersheds degrade stream conditions because their extensive impervious surfaces (e.g., roads, parking lots, rooftops) interfere with natural stream hydrology. Stream sections in urban areas generally are "flashier" since they no longer infiltrate rainwater and discharge larger volumes of stormwater runoff over a shorter period of time (Allan and Castillo 2007).

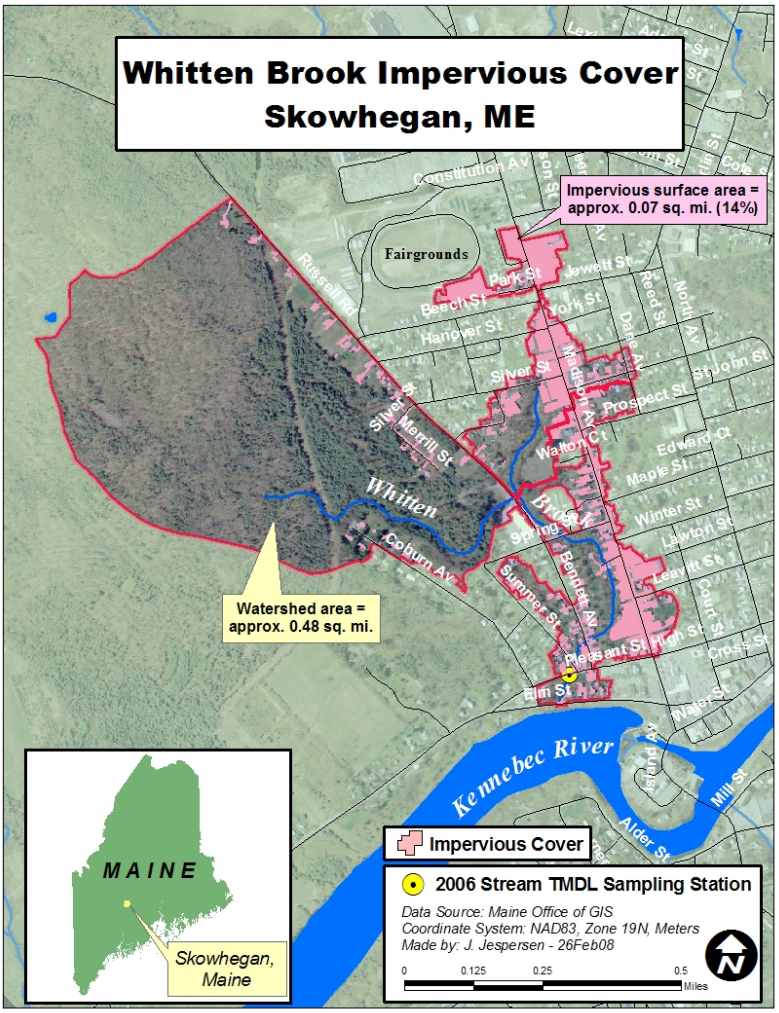


Figure 4. *Impervious cover in the Whitten Brook watershed.*

3.1 Impacts of Development: Impervious Cover (IC) Assessment

Increases in impervious cover (IC) pose significant risks to streams. Watersheds exceeding 12% IC often fail to meet aquatic life criteria and narrative water quality standards (Stanfield and Kilgore, 2006). Other research has shown that sensitive species of fish may decline in watersheds with 4-6% IC or less, and declines in sensitive macroinvertebrate species can occur at very low levels of urbanization (Wenger et al, 2008).

The current estimate of impervious cover in the Whitten Brook watershed is 14%, or 43 of the 304 acres in the watershed (Figure 4). Parking lots make up the majority of the impervious cover, followed closely by buildings and roads. Driveways and sidewalks make up the remaining 4% of the total IC in the watershed (Table 2). Maine DEP has established a target goal of 9% IC in order to restore the aquatic life in the stream to Class B standards. This means that based on

Table 2. *Types of IC in the Whitten Brook watershed.*

Type of IC	*Total IC (acres)*	*% of Watershed Area*	*% of Total Watershed IC*
Parking Lot	**16**	**5%**	**37%**
Building	**12**	**4%**	**28%**
Road	**11**	**4%**	**26%**
Driveway	**4**	**1%**	**8%**
Sidewalk	**< 1**	**< 1%**	**< 1%**
Total Impervious Area	**43**	**14%**	**100%**

existing IC in the watershed, a 36% IC reduction (equivalent to 15.5 acres) is needed to offset the effects that IC has on the stream.

Table 3. *Summary of IC for Whitten Brook subcatchments.*

Location	*Total IC (acres)*	*% of Total Watershed IC*	*% IC for Subcatchment*
Stormwater Subcatchments			
No. Madison Ave.	15.3	36%	74%
Madison Ave.	11.8	28%	59%
Spring St.	0.8	1.8%	43%
Robinson St.	0.5	1.2%	44%
Total Impervious Area	**28**	**66%**	**44 - 74%**

Efforts to reduce the impacts to the stream from impervious cover should focus on the areas in the watershed that exhibit the highest levels of IC with a direct connection to the stream. These areas include the major stormwater subcatchments. Levels of IC in these subcatchments range from 43-74% (Table 3). The Northern Madison Avenue subcatchment contains the most IC, and the highest % IC of the four subcatchments. This makes Northern Madison Avenue a high priority for treating stormwater before it reaches the stream.

3.2 Applicable Water Quality Standards and Criteria

Water quality in Whitten Brook must meet Class B standards as defined under Maine's Water Classification Program as designated by the Maine Legislature (Title 38 MRSA 464-468). The Maine Legislature also defined designated uses for all classified waters, which state that "Class B waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life." Table 4 (below) summarizes the narrative and numeric water quality standards applicable to Whitten Brook.

Table 4. *Maine water quality criteria for Class B waters (38 MRSA § 465).*

Parameter	Criteria for Compliance
Designated Uses	Water must be suitable for: drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation; an un-impaired habitat for fish and other aquatic life.
Dissolved Oxygen: *Year-Round*	May not be less than 7 ppm or 75% of saturation, whichever is higher.
Dissolved Oxygen: *October 1st-May 15th*	In order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean dissolved oxygen concentration may not be less than 9.5 ppm and the 1-day minimum dissolved oxygen concentration may not be less than 8 ppm in identified fish spawning areas.
E. coli **Bacteria**	Between May 15th and September 30th, the number of *Escherichia coli* bacteria in these waters may not exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 236 per 100 milliliters.
Discharges[1,2]	Must not cause adverse impact to aquatic life, and the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

3.2.1 Total Maximum Daily Load Studies

Water quality sampling data was collected in Whitten Brook between 2002 and 2007. This includes monitoring of the macroinvertebrate community, physical habitat parameters, and water chemistry. Sampling results were compared to Maine's statutory Class B water quality standards and the stream was listed due to non-attainment of aquatic life criteria (habitat and benthic-macroinbertebrates) and bacteria (*Escherichia coli*).

Whitten Brook Bacteria TMDL- Waterborne pathogens (bacteria) enter streams from a variety of sources including human sewage and the feces of other warm-blooded animals. Direct ingestion of water containing pathogens can cause gastrointestinal illness in humans. High numbers of indicator bacteria in water samples collected from Whitten Brook prompted the stream's status for non-attainment of Class B bacteria standards (Category 5A). This impairment has been addressed by Maine's Statewide Bacteria Total Maximum Daily Load (TMDL) report (DEP, 2009). The Whitten Brook Watershed Restoration Plan should not lose sight of the need to identify and address sources of bacteria in the stream. Actions to reduce the negative effects of impervious cover in the watershed will likely address sources of bacteria in the watershed since stormwater is known to carry bacteria from urban areas.

Impervious Cover TMDL- The (draft) Whitten Brook Impervious Cover TMDL (MDEP 2008) was developed in conjunction with local stakeholders in 2007 and 2008. According to Maine's 2006 303(d) list, the reason for the aquatic life impairment in Whitten Brook is unknown because it cannot be attributed to a specific pollutant, but is likely due to runoff containing a variety of pollutants associated with urban stormwater.

Since portions of the Whitten Brook watershed are highly developed (total impervious surface area of approximately 14%), impervious cover (IC) was used as a surrogate measure of the range of pollutants in stormwater for the TMDL. The TMDL sets a target goal of 9% effective impervious cover, which will help reduce current pollutant loads from the watershed, mimic natural watershed conditions, and help Whitten Brook achieve Class B water quality standards. Impervious cover will need to be reduced by 36% (15.5 acres treated) in order to meet this goal. Aquatic life assessments (biomonitoring of the benthic macroinvertebrate community) provide an appropriate endpoint to measure the progress of TMDL implementation. The Whitten Brook (draft) IC TMDL (Maine DEP 2008) will be incorportated into Maine's Statewide Impervious Cover TMDL (Maine DEP, in progress) to be released in 2011.

3.3 Water Quality and Biological Assessments

Monitoring data collected by Maine DEP between 2002-2007 indicated poor water quality in Whitten Brook. Ongoing inputs of polluted stormwater runoff from the urbanized portion of the watershed need to be addressed immediately. Monitoring results (described below) will serve as a baseline as improvements are made to address the water quality impairment. Changes in the biological community, levels of dissolved oxygen,

bacteria, as well as metals, chloride and other pollutants will provide information about the long-term health of the stream.

3.3.1 Biological Assessment

> ***Aquatic Benthic Macroinvertebrates*** *are aquatic animals without backbones that can be seen by the unaided eye and typically dwell on the bottom substrate of a waterbody (e.g., rocks, logs, sediment, plants). Examples include: insects (e.g., mayfly, dragonfly and caddis fly larvae); aquatic worms; amphipods (scuds); leeches; clams and snails.*

Macroinvertebrates make good indicators of biological health for many reasons. First, these organisms live on the bottom streams. Secondly, they have a wide range of species-specific pollutant tolerances. Third, they can be found in all but the most severely polluted or disturbed habitats. Lastly, they are practical and easy to sample using accepted and well-established sampling and analysis procedures (Maine DEP, 2011). The abundance and generic richness of the macroinvertebrate community in the stream is determined by counting the number of species or genera in a rock bag, which is placed on the stream bottom for approximately four weeks. This allows time for the macroinvertebrates to colonize the cobble habitat within the rock bag. Biologists collect and preserve all accumulated material from the rock bag and collect physical data such as water velocity, dissolved oxygen, temperature, conductivity, substrate composition (sand, gravel, stones, etc), and a physical description of the site and surrounding area (amount of tree cover, land use, etc). In the laboratory, macroinvertebrates are separated from sediment and debris and identified to the lowest possible taxonomic level (usually genus or species).

Rock bags were deployed in Whitten Brook approximately 23 meters upstream of the Elm Street crossing in 2002 and 2007. Monitoring results for 2002 and 2007 were similar. In both cases, the stream did not attain aquatic life standards (meaning it did not even meet Class C standards). The number of sensitive organisms was found to be very low for a small cold water stream like Whitten Brook. The *Ephemeroptera* (Mayfly) variable ranked only 5 out of a total richness of 33. Even though the stream is very sandy at this site, biologists would still have expected to find Mayflies in the family *Leptophlebiidae* (Tsomides, personal communication). Conductivity (measure of salinity) was higher than expected in 2007 event which reinforces information that stormwater is a major stress factor in Whitten Brook.

Biomonitoring is conducted by Maine DEP on a five-year rotation. Whitten Brook is scheduled to be sampled again in 2012. Once water quality standards have been met in at least two sampling events with normal summer conditions (as defined by MDEP Biomonitoring Protocols) within a 10-year period (i.e., by 2017), no further remedial measures are required.

3.3.2 Dissolved Oxygen (DO)

Dissolved oxygen (DO) is a measure of the amount of oxygen in the water that is available to plants and animals. The level of DO in a stream is used as an indicator of water quality and the type of life that the water can support. DO concentrations below 7 ppm (mg/L) can stress organisms, and DO concentrations below 1 mg/L can result in fish kills. DO is intimately connected to water temperature. Cold water has the ability to

retain more dissolved oxygen and create less physiological stress on aquatic organisms (Allan and Castillo, 2007).

DO measurements were collected in Whitten Brook in 2002, 2006 and 2007. Data collected in 2002 and 2006 correspond with the DEP biomonitoring data, collected in July and August. In 2006, DO was collected as part of a baseline sample between August and September, as well as storm samples collected in November and December. DO readings from all years ranged from 7.4 – 13.0 ppm. Lowest readings were associated with summer sampling, while the highest readings correspond with early winter storm samples. Dissolved oxygen measurements in Whitten Brook exceed the State Class B standard of 7 ppm.

3.3.3 Bacteria

Whitten Brook is classified as a category 5-A impaired stream because it does not meet Maine's Class B water quality criteria for *Escherichia coli* (*E.coli*) bacteria. The Class B threshold for *E.coli* pertains to samples taken between May 15th and September 30th, where the number of *E.coli* may not exceed a geometric mean of 64 counts/100 milliliters (mL) or an instantaneous level of 236 counts/100mL. Samples collected by Maine DEP in 2006 between August 30th and September 28th ranged from 139 counts/100mL to 261 counts/100 mL during base flow (dry) conditions. The highest sample (579 counts/100 mL) was collected on October 30th during storm flow conditions. Sampling notes from the 2006 monitoring season documented a sewage smell at the sampling site on two instances, as well as brown and white foam in the water on a third sampling date. High bacteria counts during base flow sampling conditions imply that there could be a local source of contamination (e.g. from leaky sewer pipes) rather than from stormwater.

Two major upgrades in the town sewer system have occurred since the 2006 sampling. First, in 2007 an aging sewer pump station on the edge of Whitten Brook (north of Elm St.) was replaced with a new station. All sanitary sewage and combined sewer overflows cross Elm Street to a manhole structure on the bank of the Kennebec River, and piped downstream along the river to its discharge point through the face of the North Channel dam (Dickey, 2007).

The pump station on Elm Street was replaced in 2007, followed by improvements to sewer pipes serving area residences in 2009.

In 2009, complaints from residents on Pleasant St., Elm St. and Coburn Avenue resulted in the replacement of potentially leaky or obstructed sewer pipes with new PVC pipes (Dickey, 2011). The town documented a decrease in infiltration following the replacement of the old pipes, suggesting that leaky pipes were a culprit to the problems with both the landowners and the stream. Follow-up bacteria sampling is needed to determine if bacteria levels continue to exceed state thresholds in spite of

these recent improvements. If bacteria levels continue to exceed thresholds, then bracket sampling upstream of the sampling site is needed to isolate potential sources of bacteria in the stream.

3.3.4 Metals, Chloride and Other Pollutants

Metals (such as zinc, lead, mercury, etc.), chloride, and other toxic pollutants (such as arsenic or DDT) are commonly found in high quantities in urban watersheds. These pollutants can be toxic in certain amounts or concentrations and are tested for to protect aquatic life and human health. Aquatic life criteria are used to assure that toxic pollutants are not present in quantities or concentrations that would acutely or chronically harm organisms living within or relying on the stream. Human health criteria are used to assure that toxic pollutants are not present in quantities or concentrations that would harm humans who eat organisms or drink water taken from the stream.

Concentrations of metals, including zinc (which can end up in urban stormwater as a result of automobile tire wear), are determined from water samples collected from the stream. Samples collected from Whitten Brook in 2006 were found to contain safe levels of these potentially toxic pollutants. Specific conductivity, which can be an indicator of *chloride* from excess road salt, and chloride data for Whitten Brook is limited to two samples collected in 2006 (182 µs/cm, and 45 mg/L, respectively on two different sampling dates). Since aquatic communities are thought to be impaired if chloride exceeds an average of 860 mg/L for acute (one hour) exposures, and an average of 230 mg/L for chronic (4-day) exposures (DEP 06-096 Chapter 584), these numbers do not indicate chloride enrichment in Whitten Brook. However, more data is needed to adequately assess chloride inputs, especially at the major stormwater outfalls that drain Madison Avenue.

Information gathered during the stakeholder process, and field evidence collected by local volunteers revealed that legacy pollutants may be a concern for Whitten Brook. *Legacy pollutants* are pollutants such as PCB's, dioxins, DDT, or other substances have already banned from production or use that contaminated the soil near the stream or sediments within the stream at some time in the past. While there is no known additional load occurring, concentrations of these pollutants accumulate in aquatic insects, or make it difficult for animals to survive and thrive. These contaminants are difficult and expensive to control. The Whitten Tannery was at one time operating along the main stem of Whitten Brook. Local residents remember a dam on the stream at this location which created a pond for ice skating in the winter. It's possible that industrial waste water was discharged to the stream/pond at this location contaminating sediments.

In addition, a gas station (later located at the site of the Whitten Tannery, now the Shell Station) reportedly dumped barrels of oil (on many occasions) into the pond at night, leaving an oily sheen in the water during the day (FBE 2010b). Soil testing is recommended for this portion of the stream to determine if legacy pollutants might be a concern. Similarly, in 2010, local volunteers from the Conservation Commission noticed an oily sheen in the water at the Northern Madison Avenue outfall. Concern for the source of this oily sheen prompted an investigation by Maine DEP to collect samples that might determine the type of oil contamination. It's likely that general parking lot and road runoff accumulates in the stormwater catch basins, and then is discharged with a storm (M. Evers, personal communication).

Conservation Commission volunteers have located an unknown source of fine, silty clay discharging from the two Madison Avenue outfalls. Clay can easily degrade habitat in the stream by embedding the stream bottom, and may be evidence that clay is infiltrating in from the underlying soil through the pipe system (Dennis 2011). Action is needed to identify the source of this clay by further investigating the storm drain system during storm events.

Stream temperature has a significant influence on the health of the aquatic life in the stream. Brook trout and other coldwater fish are particularly sensitive to thermal pollution. A study by Brungs and Jones (1977) found maximum weekly average temperatures for growth, and short-term maximum temperatures for brook trout survival (juveniles) of 19 ^{o} and 24^{o} C, respectively (Brungs and Jones, 1977). Impervious surfaces absorb and emit heat. Thus, heated stormwater runoff flows into and mixes with the stream increasing the base temperature of the water threatening the survivability of juvenile brook trout (UNHSC, 2011). Temperature data in Whitten Brook from the 2006 sampling season captured temperatures ranging from 11.7 ^{o} to 17.3 ^{o} C between August and September 2006. Instantaneous temperature readings collected in August 2010 (FBE, 2010) ranged from 14 ^{o} to 17 ^{o} C along the entire length of the stream, suggesting that water temperatures in Whitten Brook are within acceptable ranges for brook trout.

3.4 Geomorphic, Riparian and In-Stream Habitat Assessments

On August, 2010 staff from FB Environmental, Maine DEP, and volunteers from the Skowhegan Conservation Commission conducted a Level 1 Stream Corridor Survey for Whitten Brook. The primary use of the survey is to identify high-quality coldwater habitat as well as severe habitat or water quality problems. The survey consists primarily of visual observation of stream habitat characteristics, the presence of wildlife, and physical attributes of the stream, as well as a simple in-stream macroinvertebrate evaluation. The survey consists of two major types of evaluation: 1) A Rapid Habitat Assessment (RHA), and 2) a Rapid Geomorphic Assessment (RGA). Results of this survey can be used to raise public awareness and to help prioritize management objectives for stream restoration. Full report results are described in the *Whitten Brook Watershed Study* (FBE, 2010a).

3.4.1. Rapid Habitat Assessment (RHA)

The stream survey was divided into three major areas and nine stream reaches. Reach lengths were based on physical characteristics of the stream as well as man-made structures such as road crossings. Survey results characterize the overall health of Whitten Brook as poor-fair (Figure 5).

Habitat- Examination of the in-stream characteristics of Whitten Brook indicate the presence of several different habitat types within all reaches of the stream. The most prevalent habitats include pools, riffles and runs.

Nature of Particles in Stream Bottom/Embeddedness- Of particular concern is the extent of embeddedness in Whitten Brook. Overall, the stream reaches dominated by sand indicate continual movement of substrate, and

high levels of embeddedness (50-100%) as a result of high volumes of flow that moves these materials and eliminates fish habitat.

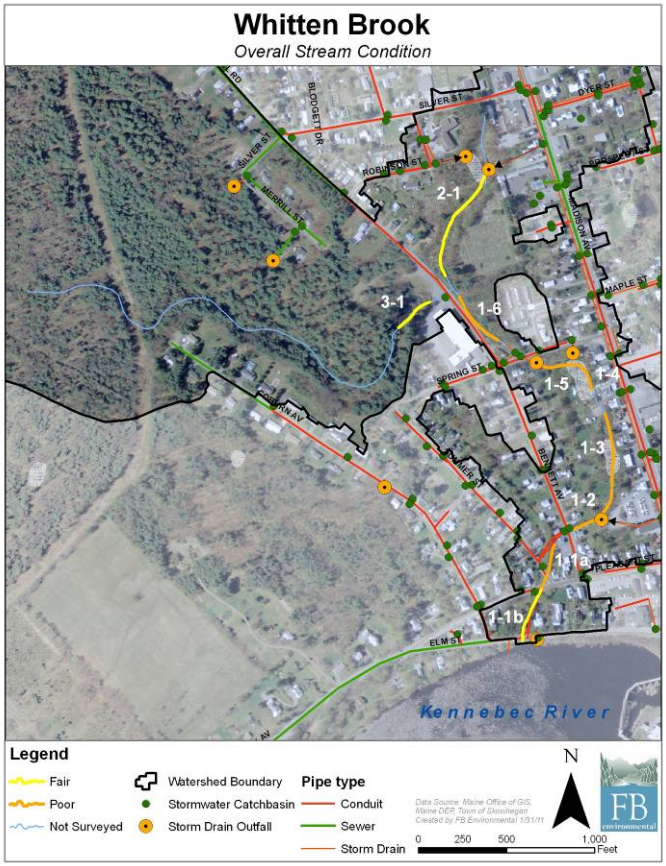


Figure 5. *Overall stream condition for Whitten Brook from the 2010 Watershed Study.*
**(Orange=Poor, Yellow=Fair, Blue=Unsurveyed)*

<u>*Woody Debris*</u>- The upper reaches of the stream including the portions of the western branch (Reach 3-1) and the northern branch (Reach 2-1) were found to have "plentiful" coarse woody debris. The upper portion of the mainstem (Reaches 1-3, 1-5 and 1-6) was characterized as having "many" "coarse woody debris, while the lower portion of the main stem, and one reach within the upper portion of the mainstem had "few" woody debris (Reaches 1-1a, 1-1b, 1-2 and 1-4).

<u>*Water Appearance/Odor*</u>- During non-storm flow conditions, the water in Whitten Brook is generally clear with a few notable exceptions. These include stretches that were light brown (Reach 1-4), orange (iron bacteria) (Reaches 1-1b, 1-2), foamy (Reaches 1-2, 1-6), smelled of rotten eggs or sulfur (Reaches 3-1, 1-6) and had an oily sheen (Reach 2-1). In addition to an oily sheen at Reach 2-1, a gasoline odor was present. Similarly, a petroleum scent was detected at Reach 1-1a. Personal communication with a resident at Reach 1-2 indicates that flushes of "gray water" flow through this stretch of stream from an upstream source. It is unclear whether this is wash water from a washing machine, car wash, or particles of clay. Further investigation is needed.

<u>*Streamside (Riparian) Vegetation and Water Temperature-*</u> Five of the nine stream reaches surveyed in Whitten Brook had good riparian cover (75%). Only one reach (Reach 2-1) exhibited 100% cover, while three of the reaches (Reaches 1-1b, 1-4, 1-6) had vegetation that shaded only 50% of the stream. Areas with low percentages of riparian cover were often located in highly residential areas with lawns or roadways adjacent to the stream, where trees had been cut in the recent past, or located within an emergent wetland with little tree cover. Instantaneous temperatures in Whitten Brook ranged from 14^{o} C (Reaches 1-6 and 2-1) to 17^{o} C (Reach 1-1b). Reaches 1-2, 1-3, 1-4 and 1-5 were consistently at 15^{o} C.

The existence of reasonably wide forest buffers along portions of the stream (especially the section that were not surveyed in the western branch), and sections of fair to good riparian cover, even in developed portion of the residential areas of the stream, are important features that have helped protect the stream from further degradation.

Eroding stream banks, clogged culverts, trash and debris, and development at the edge of the stream all contribute to poor water quality in Whitten Brook.

Streambank and Channel Characteristics- Whitten Brook is a narrow and relatively shallow stream with the exception of a few small pools greater than 2 feet deep, and the impounded stretch of stream (Reach 3-1). A majority of the stream has at least one bank with steep, eroding slopes above the stream, and vertical undercut banks at the stream. Degradation of natural streamside plant cover and collapsed banks is common. Discharging pipes (including storm drain outfalls) and/or ditches are present in all but one of the nine stream reaches (Reach 3-1), carrying storm water and attached sediment and pollutants, and causing erosion where the water meets the stream. Reaches that ranked poor exhibited man-made bank modifications, and few pools less than two feet deep. Artificial bank modifications, including in some cases, falling fences, failing retaining walls, culverts and road crossings, and foundations/building footings, cause erosion and sedimentation in the stream.

Visual Biological Survey- Similar to the Maine DEP 2002 and 2007 biomonitoring results, macroinvertebrates were found occasionally, but not in abundance. The exception was Reach 1-1b, the last reach before Whitten Brook flows into the Kennebec River. Approximately half-way down this reach macroinvertebrate populations were abundant in fast moving water (riffles). Snails, worms, a cranefly, small and medium mayflies, and caddisflies were documented in this reach. Results of this analysis provide further evidence that the benthic communities in Whitten Brook lack species richness, supporting the findings that habitat has been significantly altered. Small fish were documented in every reach from the Kennebec River, north to Reach 1-5. Amphibians, including frogs and salamanders were documented in three of the nine reaches.

Water Quality and Potential Pollution Sources and Problems- Water quality and potential pollution problems are common in the majority of stream reaches in Whitten Brook. Road crossings with unstable and eroding culverts, storm drains and stormwater outfalls, and ditches that drain directly to the stream, bank erosion, as well as trash and debris all contribute to the problem. Invasive plants pose another threat to water quality. Non-native, invasive plants such as purple loosestrife, Japanese knotweed, Japanese barberry, and honeysuckle were documented in many stream reaches. These plants replace native riparian vegetation, destabilize stream banks, make stream access difficult, and change habitat conditions that local wildlife depend on for survival.

3.4.2. Rapid Geomorphic Assessment (RGA)

A Rapid Geomorphic Assessment (RGA) provides screening-level information about the fluvial geomorphological characteristics of the stream (shape and stability of the stream) including the physical

processes related to water and sediment transport through the stream system. An RGA survey is useful for identifying stream reaches receiving large volumes of stormwater which can cause channel instability, and in identifing reaches that have been altered by human activities.

Geomorphic Condition of Whitten Brook:
"In Transition or Stressed"

Results from the 2010 RGA (FBE, 2010) were grouped into three major geomorphic conditions in order of condition from best to most affected, where: 1) In Regime; 2) In Transistion or Stressed; 3) In Adjustment. Whitten Brook is currently "In Transition or Stressed" based on the RGA. Five of the nine survey reaches meet this condition, while three reaches (Reaches 1-1b, 1-5, 1-6) require additional attention as they are "In Adjustment". This is not surprising considering the large volumes of stormwater entering the stream within these reaches. Results of the RGA should be used to target individual reaches that require additional assessment for restoration planning. A formal geomorphic assessment should be considered before in-stream restoration activities begin.

3.5 Stormwater Retrofit Reconnaissance Inventory (RRI)

Benefits of Stormwater Retrofits:
- Regulate stormwater runoff
- Reduce sedimentation
- Provide channel protection
- Reduce erosion & geomorphic change
- Improve community aesthetics
- Improve water quality
- Improve biological communities

Stormwater retrofits are structural stormwater management practices that can be used to address existing stormwater issues. In order to assess the potential for on-site stormwater retrofit opportunities in the Whitten Brook watershed, a Stormwater Retrofit Reconnaissance Inventory (RRI) was conducted in August 2010. Field teams led by FB Environmental, visited potential retrofit sites within the watershed on a lot-by-lot basis. The survey focused on areas with the highest percentage of impervious cover (four major stormwater outfall catchments). Survey results are based on the size of the retrofit site, the impervious area treated, site constraints, and the overall watershed restoration goal to reduce stormwater runoff from impervious areas. Results of this survey can be read in full in the *Whitten Brook Watershed Study* (FBE, 2010).

3.5.1 Retrofit Sites

Thirty-three sites were identified as potential stormwater retrofit opportunities in the Whitten Brook watershed (Maps 6 & 7, Appendix 1). With a few exceptions, retrofit opportunites were located in privately owned commercial parking lots, or within the state right-of-way along Rt. 201 (Madison Avenue). A few sites were located on residential properties or on publicly owned conservation land. The majority of sites require a combination of retrofit options including reducing unused impervious surfaces (parking) and bioretention. These types of retrofits utilize native vegetation for pollutant removal and flow reduction, and may include practices such as tree box filters, rain gardens, or vegetative planters. Tree box filters are the most common recommendation due to the large volume of stormwater runoff from Madison Avenue to the numerous stormwater catch basins. Tree box filters do an excellent job of filtering and retaining pollutants in stormwater so that they don't reach the stream.

In addition to the 33 RRI sites, the Maine DEP and Maine DOT worked with local stakeholders to determine the best possible treatment of stormwater runoff from the Northern Madison Avenue stormwater outfall. This outfall drains directly to the northern branch of the stream. Improvements to reduce stormwater volume and remove pollutants in this upper portion of the stream will help aleviate stressors in the lower portion of the stream. The working group recommends a feasibility study for installing a dry extended detention basin north of the current outfall to determine if the proposed BMP is feasible and appropriate. Potentially, stormwater could be rerouted to this basin rather than directly to the stream.

The constructed wetland between Russell Rd. and Upper Madison Avenue is the site of a proposed stormwater detention basin.

Along with project feasibilty, the steering committee is currently looking potential funding soruces for the basin. Effects on the ground-water at this site and effects of thermal pollution from the stormwater will both weigh heavily on the final project design. Detention ponds have been shown to have little to no reduction of high runoff temperatures (UNHSC, 2011), yet design features such as gravel outlet structures (not factored into the 2011 UNHSC study) can reduce the temperature of stormwater entering the stream. In addition, limiting the amount of mature vegetation (trees) removed during construction will help provide shading and promote lower water temperatures.

3.5.2 Demonstration Sites

Three sites were identified as good candidates for community demonstration projects in the Whitten Brook watershed. These include sites 1AW-3 (Fairgrounds), 2B-10 (Whitten Brook Conservation Area) and 2BW-5 (Whitten Court). The location of these sites and large extent of IC, make them ideal locations for demonstration projects. Demonstration projects will bring community awareness to the efforts needed to restore Whitten Brook, and therefore an integral part of the Action Plan (Section 4).

The Whitten Brook Conservation Area is a good candidate for a demonstration project.

4. Restoration Strategies

The Whitten Brook Watershed Study (FBE, 2010) and results from community stakeholder meetings in 2010 provide an excellent framework for identifying and understanding the sources of pollution and the problems that have resulted in poor water quality in Whitten Brook. This information has assisted with development of locally-driven solutions and the prioritization of actions to address the underlying problems. Successful restoration of the stream requires setting goals and developing objectives to help meet those goals. The Whitten Brook Restoration Plan provides key actions needed to restore the stream, the timing of these actions, and the mechanisms by which these actions will be accomplished.

4.1 Goals and Objectives for Restoration

The purpose of the Whitten Brook Watershed Restoration Project is to restore watershed conditions in Whitten Brook so that the stream: 1) attains water quality classification standards; and 2) supports a healthy native brook trout fishery. This can only be achieved with the commitment of a coordinated group of local community leaders, conservation groups, state and federal partners, and citizens of the watershed working together to accomplish common goals and objectives (Table 5).

Table 5. *Whitten Brook watershed restoration objectives (adapted from FBE, 2009).*

Goals	Watershed Restoration Objectives
Improve Water Quality:	Urban Pollutants: manage sources and transport of urban stormwater pollutants and nutrients to restore and protect watershed health and achieve applicable water quality standards (which includes supporting diverse healthy aquatic communities).
	Macroinvertebrates and Bacteria: improve stream conditions, protect watershed health, and achieve applicable water quality standards (which includes supporting diverse healthy aquatic communities).
Improve Physical Habitat:	Aquatic Habitat: improve aquatic, riparian, and floodplain habitat extent and quality to support the return and persistence of diverse native fish (especially brook trout) and macroinvertebrate communities.
	Terrestrial Habitat: improve riparian habitat extent and quality to support the persistence of native terrestrial communities and connectivity to aquatic and riparian habitats.
Improve Hydrology:	Stream Flow: protect and increase runoff infiltration and detention areas to normalize stream hydrographs and reduce stormwater flow to the stream.
	Channel and Floodplain Functions: protect and restore the extent, connectivity, and functions of streams, drainageways, wetlands, riparian areas and floodplains to improve bank stability and natural hydrologic functions and reduce risk to the built environment and human safety.

Many of the recommendations to restore Whitten Brook are referred to as Best Management Practices (BMPs). BMPs are conservation practices that are designed to minimize the discharge of stormwater and associated pollutants to the stream from impervious surfaces in the watershed. The EPA recommends that urban stormwater management plans include a combination of non-structural and structural BMPs for existing and new development to ensure long-term restoration success.

4.2 Structural Management Opportunities and Recommendations

Whitten Brook contains approximately 43 acres of impervious surfaces, with the largest and most connected impervious cover in the Madison Ave/Rt. 201 corridor. The RRI survey found that the majority of impervious surfaces in the watershed have no existing stormwater treatment in place, and that large quantities of stormwater are discharged directly to Whitten Brook via four major outfalls. Structural BMPs, or BMPs that are engineered to treat stormwater, will therefore make up the majority of treatment options for the Whitten Brook watershed. More detailed surveys of the proposed stormwater retrofit sites will be required, including some engineered designs, before these practices can be fully implemented.

4.2.1 Structural Toolbox

A number of different structural BMPs will be needed to restore Whitten Brook. Some of the major recommendations include an extended detention basin, tree box filters, rain gardens, and porous pavement. A description of these conservation practices are described in Appendix 2.

4.2.2 Structural Recommendations

An overall goal and focus of structural stormwater retrofits is to reduce the effects of impervious cover in the watershed by 36%.

An overall goal and focus of structural stormwater retrofits is for the Whitten Brook watershed to eventually exhibit the characteristics of a watershed with 9% impervious cover (currently at 14%). Focus areas for implementation of structural BMPs should utilize the list of 35 priortized retrofit sites in the watershed (Appendix 3), with immediate efforts focused on the highest priority sites. Priorizing retrofit sites will help direct restoration efforts.

If deemed appropriate in follow-up studies, implementation of an extended detention basin could address a significant portion of stormwater from northern Madison Avenue, and is estimated to reduce the effects of impervious cover in the watershed by amost half (17% of the 36% IC reduction needed to restore the stream- a complete engineering study would provide a more detailed reduction estimate for this site). It's critical that other structural recommendations are installed on both commercial and residential properties upstream of the proposed detention basin to pretreat runoff. Infiltration options such as open bottom catch basins should be investigated in areas of highly pervious soils (Tibbetts, personal communication) to help reach the overall IC reduction goal.

Table 6. *Structural BMP recommendations for the Whitten Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
STORMWATER				
# 1: Redirect Northern Madison Avenue Stormwater Outfall to an Extended Detention Basin or alternative BMP at site of former aquaduct.	1) Conduct feasibility study to determine basin effectiveness. 2) Maine DOT look into possibility of using NPDES funds. 3) Look into Maine Natural Resource Conservation Funding 4) Determine project costs 5) Hire a hydrogeologist to look at potential effects on groundwater 6) Contact Florida Power & Light regarding funding	1) TBD 2) MDOT 3) TAC 4) MDOT/MDEP 5) MDOT/SCC 6) SCC	1) TBD 2)Spring 2011 3) Spring 2011 4) Spring 2011 5) Spring 2011 6) Spring 2011	1) TBD 2) N/A 3) N/A 4) N/A 5) TBD 6) N/A
# 2: Install BMPs at highest and high priority retrofit sites throughout the watershed.	1) Prioritize retrofit sites by quality and type of source (well utilized vs. underutilized car habitat) 2) Review cost estimates for retrofit sites 3) Develop a landowner survey to understand willingness to participate 4) Develop/Implement a cost-share program for retrofit sites 5) Implement retrofits at highly visible sites	1) TAC 2) TAC 3) TAC, SCC, Main St. Skowhegan 4) TAC, SCC, SC-SWCD 5) SCC, SC-SWCD	1) Jan 2011 2) Jan 2011 3) June 2012 4) 2011-2021 5) 2012-2014	1) N/A 2) N/A 3) $1,500 4) $5,000 5) $115,000
# 3: Reduce rooftop runoff from residential and small commercial properties in the watershed.	Survey residential and small commercial properties to determine if rooftop runoff can be reduced on site	Volunteers/SCC, Consultants	2013	$2,500
# 4: Dissipate damaging effect of flow at stormwater outfalls.	1) Reduce stormwater inputs (see #1 and #2 above) 2) Install plunge pools, stable outlet aprons, and/or level spreaders where room allows at 4 major outfalls	1) MDOT/Maine DOT/TAC 2) MDOT/Town of Skowhegan	1) 2011-2021 2) 2012	1) See # 1, #2 above 2) $8,000
# 5: Improve/replace failing culverts throughout the watershed.	1) Conduct a culvert study-focus on undersized and failing culverts and fish passage issues 2) Repair/replace failing culverts	1) Town of Skowhegan, SCC, MDEP, Volunteers 2) Town of Skowhegan/MDOT	1) Fall 2012 2) 2013-2015	1) $ 1,500 2) TBD

4.3 Non-Structural Management Opportunities and Recommendations

Because structural BMPs are on the forefront of most watershed restoration projects, non-structural BMPs, which do not require extensive engineering or construction efforts, often receive little emphasis in watershed planning. However, these practices are extremely important components of overall restoration efforts (Clar, EPA 600/R-03/103) and can help reduce stormwater runoff and associated pollutants through operational actions such as prevention and good housekeeping practices, land use planning strategies, and targeted education and training.

4.3.1 Non-Structural Toolbox

Non-structural management measures were identified by local stakeholders over the course of several 2010 planning meetings. Many of these actions came about through a planning process in November that asked participants to describe problems in the watershed and help suggest solutions to fix them. The December TAC meeting built upon these responses, in which participants helped to develop a list of non-structural action items to restore the stream. A final tally of responses resulted in a list of non-structural BMPs in four major categories. Table 7. lists these recommendations, potential partners, timeframes and costs in five categories:

Administrative & Funding- Implementation of restoration activities in the watershed are estimated to cost over 1.35 million dollars over the course of the next 10-15 years. Therefore, a long-term sustainable funding plan, and a dedicated administrative organization is needed to implement the plan and ensure its success.

Education & Outreach will promote awareness of the connection between land use, water quality, and stream health. Therefore efforts, should focus on engaging communty groups, business, town maintenance crews, individuals and school groups.

Municipal Maintenance Practices are preventative measures that will reduce the amount of pollutants in stormwater runoff. The Town of Skowhegan Roads Department is already taking actions to better maintain roads in the watershed with water quality as a priority. Recommendations for future actions include evaluating the town maintenance schedule for storm drains, catch basins, ditches and culverts; evaluating and making improvements to sand/salt storage and spreading; and street sweeping. A regularly scheduled street sweeping and catch basin cleanout programs will reduce the amount of sediment and nutrients that enter the stream.

Stormwater catch basins require regular maintenance in order to remain clean and clear of debris, trash, and sediment.

Land Use Planning & Conservation are two popular tools for reducing pollutant loads from new development in the watershed. Conservation efforts can permanently preserve

Poorly planned new development can contribute to the existing excess sediment load in Whitten Brook.

undeveloped land, while land use planning can help promote the design and construction of development that will minimize and/or eliminate the effects of stormwater on the stream. Zoning can be an effective tool and will require support from the town and the communtiy. Improving shoreland zoning to protect the western branch (headwaters) of Whitten Brook should be a high priority for this impaired stream because it is not currently protected under town shoreland zoning regulations. *Remember, Whitten Brook is still protected under the Natural Resource Protection Act (NRPA)(38 M.R.S.A § 480-D(5)), which protects perennial streams and wetlands from adverse impacts of development. Therefore, any potential development adjacent to Whitten Brook and adjacent wetlands would be subject to NRPA and require a permit and review by the State of Maine. The local Code Enforcement Officer, and the planning board should be familiar with these laws so that new development is constructed in a way that will not cause adverse impacts to these resources.

As mentioned above, neither the western branch, nor the unnamed tributary of Whitten Brook are zoned, yet some other 1st order streams in Skowhegan are. Proposing an extension of voluntary zoning for the western branch of Whitten Brook will require a concerted effort to raise public awareness about the benefits of these changes. Without the full support of the community to improve shoreland zoning, assuring protection of this portion of Whitten Brook may be best accomplished through acquistion of the undeveloped land for conservation. The Somerset Woods Trustees are already a major landowner in the western branch with plans to continue their efforts to protect the stream and critical habitat in the area (Map 7, Appendix 1).

Source Control & Other Restoration Efforts include source control actions such as managmeent of toxic and landscaping waste, and erosion control. The Town of Skowhegan currently has a toxics collection and landscaping waste pick-up program in place. Stakeholders felt that it would be improtant to support or expand this program.

Other restoration efforts include some investigative work to determine the source of two potential stream pollutants. This includes using source tracking to locate the source of fine clay covering the stream bottom in the upper reaches of the stream, and locating the source of an oily sheen at the Northern Madison Avenue outfall. The Skowhegan Conservation Commission is currently working with Maine DEP to conduct sediment and water tests to determine the type of contaminant at this site (diesel, kerosene, etc.).

Lastly, under this category, determining the need for bass barriers to keep bass and other warm water, invasive, or exotic species from swimming up the Kennebec River into Whitten Brook. This will require meeting with a fishery biologist from the Maine Dept. of Inland Fisheries and Wildlife (MDIFW).

Table 7. *Non-Structural BMP recommendations for the Whitten Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
ADMINSTRATIVE & FUNDING				
# 1: Identify who "owns" the Whitten Brook Restoration Plan.	Technical Advisory Committee meets and decides who is the most appropriate entity to implement the plan	TAC	February 2011	N/A
# 2: Develop a long-term sustainable funding plan and apply for funds.	1) Develop a funding subcommittee 2) Develop a long-term sustainable funding plan 3) Apply for funding to support Action Items	1) TAC 2) TAC, SCC 3) TBD	1) March 2011 2) Spring/Summer 2011 3) Ongoing	1) N/A 2) N/A 3) $2,000
# 3: Consider a stormwater utility or other mechanism for baseline funding to support the plan.	Assess the pros and cons of developing a stormwater utility if implementation efforts are not successful.	TAC	2015	$2,000
EDUCATION & OUTREACH				
# 4: Garner support and cooperation from a diversity of different community groups and agencies.	1) Coordinate restoration efforts with MDOT, a large and important stakeholder in charge of maintaining Rt. 201 running through the heart of Whitten Brook's watershed and a major source of polluted runoff 2) Contact the Main Street Skowhegan and other civic organizations within Skowhegan. Work with these groups to raise awareness about the brook and the restoration process 3) Collaborate with the Public Works Dept. and acknowledge current efforts to improve the stream 4) Work with Cooperative Extension for buffer plantings and planting plans	1) SCC, Town of Skowhegan, MDOT 2) SCC, TAC 3) SCC, TAC 4) SCC	1) Dec 2010/Jan. 2011 2) January-July 2011 3) Ongoing 4) 2013-2014	1) N/A 2) N/A 3) N/A 4) N/A

Table 7. cont. *Non-Structural BMP recommendations for the Whitten Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
# 5: Educate business owners about the need and importance of stormwater control and retrofits.	1) Contact list of high priority businesses and determine willingness to participate 2) Develop a "Green Business" program encouraging and educating business owners on stormwater management, and recognize businesses that make changes 3) Speaking engagements at local business meetings 4) Encourage business owners to "Adopt" a stream segment 5) Work with the Main Street Skowhegan to engage business owners	1) TAC, MDEP 2) MDEP, TAC 3) TAC, SCC 4) TAC, SCC 5) SCC	1) Fall 2011 2) Jan 2012 3) June 2011 - June 2015 4) 2011-2021 5) 2011-2015	1) $500 2) $5,000 3) $250/yr 4) $1,500 5) $1,500
# 6: Educate citizens about how dirty stormwater is, and engage them in stream restoration efforts.	1) Work with local High School Teachers (Mary Finnemore/John Sterling) 2) Start a volunteer monitoring program to collect turbidity, DO, bacteria and sediment monitoring data 3) Encourage landowners to "Adopt" a segment of stream to keep clean 4) Develop monthly news articles 5) Storm drain stenciling. 6) Reach out to community members outside the watershed	1) MDEP, SCC, SC-SWCD 2) SCC, SC-SWCD, MDEP 3) TAC, SCC 4) TAC Members 5) Volunteers, School groups, SCC, SC-SWCD 6) TAC	1) Beginning 2011 2) Spring 2012 3) Beginning 2011 4) 2012-2018 5) Beginning 2012 6) Beginning 2011	1) $500/yr 2) $1,000/yr 3) $500/yr 4) N/A 5) $250/yr 6) $1,500
# 7: Engage school groups from elementary through high school.	1) Watershed education at local schools 2) Stream clean-ups 3) Volunteer Monitoring Program-storm sampling 4) Storm drain stenciling	1) MDEP, SC-SWCD, TAC Members 2) SCC, Town of Skowhegan, Volunteers 3) MDEP, SCC, Volunteers 4) SCC, Volunteers, SC-SWCD	1) 2011-2021 2) Annually 3) Summer 2011 4) Annually	1) $500/yr 2) $500/yr 3) $1,000/yr 4) $250/yr

Table 7. cont. *Non-Structural BMP recommendations for the Whitten Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
MUNICIPAL MAINTENANCE PRACTICES				
# 8: Evaluate existing town maintenance schedule and make recommendations to improve water quality.	1) Work with Public Works to determine frequency of maintenance for catch basins, culverts, and ditches 2) Assess current sweeping schedule 3) Educate staff regarding connection between maintenance and water quality	1) SCC, MDOT, MDEP 2) SCC, Town of Skowhegan 2) MDOT, MDEP, Town of Skowhegan	1) 2011 2) Annually	1) N/A 2) $500/yr
# 9: Evaluate and make improvements to town salt/sand spreading.	Collect information from Public Works Dept.; evaluate; improve	SC-SWCD, SCC, Consultant	2011/2012	$1,000
# 10: Recognize municipal maintenance efforts that improve the stream.	Evaluate the benefits and develop a dollar figure associated with these practices	TAC/Interested stakeholders, SCC	2011	$100/yr
# 11: Reduce rooftop runoff from residential and small commercial properties in the watershed.	1) Survey residential and small commercial properties to determine extent of rooftop runoff 2) Educate residential property owners and encourage disconnection from storm drain system 3) Develop an incentive program or cost-sharing for rain barrels or installation of infiltration BMPs	1) Volunteers/SCC, Consultants 2) Volunteers, SCC, SC-SWCD 3) TAC, Consultants	2013-2015	1) $1,500 2) $500/yr 3) $1,500
LAND USE PLANNING STRATEGIES				
# 12: Increase the amount of land in permanent conservation.	Work with stakeholders to expand the amount of land currently held by Somerset Woods Trustees in conservation land	SCC, Consultants, Land Trusts	Beginning 2011	TBD
#13: Expand town stormwater rules to cover development below the state threshold.	Work with Planning Board and Ordinance Committee to develop rules to protect water quality for all new development	SC-SWCD, SCC, Consultants	2011-2016	$5,000
# 14: Incorporate Whitten Brook Restoration into the Town Comprehensive Plan.	Contact Planning board to find out who wrote the plan, and whether Whitten Brook was addressed	SCC, Volunteers	Winter 2010	N/A

Table 7. cont. *Non-Structural BMP recommendations for the Whitten Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
# 15: Minimize erosion and habitat destruction caused by ATV's.	1) Develop a plan for enforcement of off-trail riding 2) Presentations at local ATV/Snowmobile Club	1) SCC, Maine Trails, Town of Skowhegan 2) TAC, Somerset Woods Trustees	1) 2012-2013 2) Annually	1) $500 2) $150/yr
#16: Include impaired headwater streams like Whitten Brook into Town Shoreland Zoning Rules.	1) Work with the Town to develop mandatory zoning to protect upper branches of the stream 2) Make appropriate amendments to the town zoning map	1) SCC, Consultant 2) Town of Skowhegan, Consultants	1) 2012-2014 2) 2014-2015	1) $4,000 2) $3,000
SOURCE CONTROL & OTHER RESTORATION EFFORTS				
#17: Expand and support ongoing source control programs.	Support toxics collection and landscaping waste pick-up program as well as street sweeping on municipal roads and commercial parking areas	SCC, TAC	Annually	N/A
#18: Provide oversight of sediment and erosion control practices in the watershed.	1) Ensure proper installation of BMPs 2) Provide education & training on installation	1) SCC, SC-SWCD, Consultants 2) SC-SWCD, Maine DEP, Consultants	1) Fall 2012 2) 2013-2015	1) $1,250/yr 2) $500/yr
# 19: Prevent bass and other warm water/invasive/exotic species from entering the stream from the Kennebec River.	Consult with MDIFW to determine: a) If existing thermal barrier is sufficient or if additional barrier is needed; b) Location of Brook Trout spawning activity; c) If regulation changes would enhance Brook Trout populations.	MDIFW/SCC	2011	N/A
#20: Locate the source of clay covering stream bottom in upper reaches of the stream.	Conduct source tracking upstream of deposition sites, and visit site frequently and during storms	SCC, MDEP, Town CEO	Spring 2011	N/A
#21: Locate the source of the oily sheen at the Northern Madison Avenue outfall.	1) Conduct source tracking upstream of sheen. 2) Determine if sheen is present under both base and storm flow conditions 3) Work with Maine DEP to test sheen for type of pollutant (diesel, kerosene, etc.)	1) Volunteers 2) Volunteers, Maine DEP 3) SCC, Volunteers	2011	$500/sample

4.4 Prioritization of Retrofit Sites

The Whitten Brook Stormwater Retrofit Reconnaisance Inventory (RRI Survey) was designed to serve as preliminary investigation of potential retrofit sites in the highly impervious portions of the Whitten Brook watershed, and to help priortize sites for the restoration plan. Results of the RRI Survey were presented at the November 2010 stakeholder meeting. In December 2010, the Whitten Brook Technical Advisory Committee worked on prioritizing these sites based on cost and volume/size of the impervious area treated. TAC members agreed that the criteria used to prioritize these sites should include landowner willingness to participate as well as whether the site is considered "hot" (how much traffic/potential pollution), or not.

In January 2011, several members of the TAC met again to discuss, and finalize the list of prioritized retrofit sites. The group tried to assign a value to two ranking parameters: 1) Value to the Stream; and 2) Ease of implementation.

Value to Stream- This parameter looked at not only the amount of impervious area that would be addressed, but at the likely relative contribution of pollutants that would be addressed. Assuming that the proposed detention basin located just upstream of the northern Madison Avenue stormwater outfall ("basin" in the spreadsheet) could be retrofitted to provide effective channel protection storage for stormwater discharging from the outfall, only low to medium priority was given to BMPs that would only address stormwater quantity issues within the watershed of this outfall. The exception to this rule was for tree boxes that will filter pollutants from runoff upstream of the proposed basin, and hot spots such as gas stations. Treatment of runoff from roofs, very lightly used parking and new car dealership display parking were given a relatively low score. Treatment of runoff from roads, service stations and high use/high turnover parking were given a relatively high score. Further consideration may be needed to account for the effects of thermal pollution from the low to medium priority sites.

Ease of Implementation- Reflects any knowledge of or anticipation of difficulties that might be encountered in implementing the retrofit. These included (1) the perceived likelihood that the landowner would be cooperative (Would they let the retrofit be installed on the property? Would they be willing to contribute to the cost of implementation?); (2) knowledge of potential site or infrastructure limitations (i.e. presence of utilities, etc) and (3) likely cost.

The overall priority assigned (Highest (HH), high (H), medium (M) or low (L)) was performed by Maine DEP after the meeting (due to insufficient time to accomplish this final step during the

Highest priority was given to projects that will provide the greatest benefit to the stream and are essential if the stream is to recover.

meeting) and was sent to the participants for review. Storage and treatment of Madison Avenue runoff and treatment of hot spots (e.g. gas stations) were given high priority regardless of the perceived ease of implementation. The remaining candidate BMP prioritization considered both importance to the stream and ease of implementation.

Based on the criteria described above 5 of the 35 retrofit sites were identified as highest priority, 7 as high priority, 12 as medium priority, and 11 as low priority (Appendix 3). The cost for implementing conservation practices at these sites is estimated to cost between $800,000 and $1,215,500 (Appendix 4). The five sites identified as highest priority (Table 8) account for just under half of the total cost (~ $310,000- $520,000).

Table 8. *Highest priority retrofit sites in the Whitten Brook watershed.*

Site ID	Proposed BMPs	Value to Stream *(1 High, 5 Low)* [1]	Ease of Implementation *(A high, E Low)*	Overall Priority *(HH=Highest)*
Basin	Divert pipe from CB to existing pond, reconstruct outlet structure, dredge pond	1	A	HH
2B-10	Define parking for 6-7 cars; remove asphalt from beside north end of building & re-vegetate w/conservation mix. Install diverter to rain garden. Fence seeded area to limit compaction.	1	A	HH
2BW-8	Install tree boxes to capture runoff from 201 and adjacent res/com homes & driveways	1	?	HH
Tree Boxes/201[2]	Install tree boxes to capture runoff from 201 and adjacent res/com homes & driveways	1	?	HH
2CW-1	Two tree boxes - one on each side of stormdrain	1	?	HH

[1] Ratings assume that the Dry Extended Detention Basin (Basin) will be installed.

[2] GIS analysis depicts a total of 30 catch basins within the watershed along Rt. 201. There are a total of 10 TB filters in the RRI survey. Three of these 10 are NOT along Rt. 201. Therefore, 7 TB filters were subtracted from the total number of catch basins along Rt. 201. Therefore, 23 TB filters were used for these calculations.

Highest prioritity sites can be further grouped and priortized into three major implementation projects:

1) A dry extended detention basin (Basin)

2) Tree box filters for all storm drains along Rt. 201

3) The Whitten Brook Conservation Area (2B-10)

Ease of implementation for tree box sites is currently uncertain until additonal information can be collected regarding potential conflicts with utilities, right of way limitations, and need for easements on adjacent property if the right of way is not adequate.

Tree box filters are recommended to reduce pollutants draining to all storm drains along Madison Avenue.

4.5 Pollutant Removal and Stormwater Flow Reduction

FB Environmental conducted a pollutant load analysis based of the 33 RRI sites and the proposed dry extended detention basin. The analysis estimates the amount of total suspended sediments (TSS), total phosphorus (TP), and zinc (Zn) loading to the stream in the absences of stormwater controls (BMPs), with stormwater controls, and the estimated percent reduction for each parameter (Table 9).

Table 9. *Estimated loading and load reductions for stormwater retrofit sites in the Whitten Brook watershed.*

	TSS (lb/year)	**TP (lb/year)**	**Zn (lb/year)**
Load Without BMPs	21,820	37	45
Load w/BMPs	14,052	13	29
% Reduction	**64%**	**36%**	**65%**

In additon to the significant reductions that can be expected for TSS, TP and Zn, proposed retrofits are estimated to treat 77% of the impervious cover at these sites, and reduce the effective impervious cover by 34% watershed-wide (14.7 of 43 total acres of IC in the watershed)(Table 10). Additional reductions can be expected from tree box filters on Madison Avenue that were not factored into the estimate due to lack of available information about the treatment area. (See Appendix 5 for a full description of the methods used to calculate reductions.)

Table 10. *Total IC treated and estimated reductions for retrofit sites in the Whitten Brook watershed.*

Estimated IC from RRI (Acres)	**Estimated IC Treated** (Acres)	**Estimated % Reduction in Effective IC**
19.2	14.7	34%

Additional pollutant removal can be expected for recommended non-structural BMPs (Section 4.3) including municipal maintenance practices (street sweeping and catch basin cleaning) which have the most quantifiable reductions. Adequate street sweeping, including commercial parking areas can significantly reduce sediment loads and play a major role in source reduction. However, reductions can vary depending on the type of equipment used (vaccuum vs. mechanical street sweeper), and the frequency of maintenance (monthly, annually, etc.). on the order of 10-20%

Implementation of non-structural BMPs will result in an estimated 10% reduction in pollutants to Whitten Brook.

Depending on cleanout frequencies of catch basins, it is expected that the range in annual pollutant removal efficiencies of 18-35% for total solids (TS) (which includes sediment and organic matter) and less than 1-2% for TP. The expected range in pollutant removal rates from street sweeping is 9-31% for TS, and 3-8% for TP. The lower end represents monthly street sweeping by a mechanical street sweeper, while the upper end characterizes the pollutant removal efficiencies using regenerative air/vacuum street sweeper at weekly frequencies (Law et al., 2008). In a slightly more urbanized watershed in southern Maine, pollutant reductions were estimated at 10-20% watershed-wide (FBE, 2009). A conservative estimate for Whitten Brook would therefore be a 10% reduction in pollutants watershed-wide as a result of planned non-structural management measures.

The Town of Skowhegan has a street sweeping/catch basin cleaning/storm drain maintenance program. The program involves systematically sweeping every street in town to clear them of winter sand at the end of March each year. Once completed, the town systematically sweeps a different region of town every Friday through spring and summer to keep roads clear of dirt, sand and debris. Every catch basin in town is cleaned of sand and debris once a year after the street sweeping is complete, and before the beginning of May.

A survey of the Whitten Brook watershed in August 2010 (FBE, 2010) documented several catchbasins that were completely clogged with sediment, debris and trash. These findings support the need to augment the current catch basin and street sweeing program in order to reduce pollutant loads to Whitten Brook.

4.6 Stream Restoration Opportunities

Improving habitat for native brook trout and other aquatic organisms is heavily dependent on whether stormwater inputs to the stream can be substantially reduced. The large volume of stormwater is more than the stream can naturally handle and has led to over-widening of the stream channel, erosion of stream banks, and embeddedness of the streambed. However great the need, stream restoration activities should be viewed as a Phase II approach to restoring Whitten Brook. Implementation of activities in the watershed that reduce the effects of impervious cover and stormwater are the highest priority.

In-stream restoration efforts should include restoration of riparian buffers and stabilizing eroding stream banks using bioengineering techniques such as wattles and live stakes, and defining a narrower channel that more closely resembles what the stream looked like before large volumes of stormwater were delivered via storm drains. In-stream restoration activities (Table 8) should be coupled with land use planning objectives (land conservation and improved zoning) to preserve and protect existing riparian habitat.

4.6.1 Riparian Habitat

The riparian zone is a naturally vegetated area along the edge of the stream. Riparian zones are ecologically diverse, providing habitat for a range of plants, insects, amphibians and birds. The vegetation and root systems in riparian areas help stabilize the stream banks by dissipating energy from high flows, reduce damage from flooding, and help filter and absorb sediments and nutrients. Riparian zones provide shade for the stream which is important to the health of coldwater fish and microorganisms because the cold water has the ability to retain more dissolved oxygen and create less physiological stress on aquatic organisms (Allan and Castillo, 2007).

Example of poor riparian cover in a residential neighborhood along the main stem of Whitten

Areas with low percentages of riparian cover along Whitten Brook are primarily located in highly residential areas with lawns or roadways adjacent to the stream, had been cut in the recent past, or located within an

emergent wetland with little tree cover. The existence of reasonably wide forest buffers along portions of the stream (especially in the western branch), and sections ranked fair to good riparian cover, even in developed portions of the residential areas of the stream, are important features that have helped protect the stream from further degradation (FBE, 2010). Land use planning strategies (Table 7) should be used to enhance preservation and improvements to these important riparian habitats.

4.6.2 In-Stream Habitat

Embeddedness of the streambed is of particular concern in Whitten Brook because sand and silt fill the spaces between the gravel and cobble on the stream bottom that provide habitat for aquatic insects. Streams with a diverse array of habitats (riffles, with gravel and/or cobble substrates, pools, and woody debris) support a healthier aquatic community compared to streams that lack these habitat features. These habitats are all present in varying degrees of quality and frequency within all reaches of the stream.

Woody debris in different stream reaches within Whitten Brook range from few to plentiful. In general, it appears that upper (headwater) portions of the stream have the most woody debris, and that the amount of woody debris lessens incrementally until there are only few notable pieces of woody debris within the downstream segments above the Kennebec River. In low-gradient sections of streams dominated by fine sediment particles (e.g., sand, silt, or clay) like Whitten Brook, large woody debris can be critical towards the maintenance of diverse communities since it is essentially the only stable substrate available to aquatic organisms (Smock et al., 1989; Allan and Castillo, 2007).

Because of the extent of embeddedness, restoration of in-stream habitat will require time after stormwater retrofits have been installed in the watershed to allow excess sediment to be naturally flushed downstream, and out of the system.

4.6.3 Geomorphic Stability

The geomorphic stability of Whitten Brook has been compromised by years of stream channel alteration including impoundments, straightening, increased volume of water from stormwater, removal of riparian vegetation, and culvertization at numerous road crossings. Results of the RGA survey (FBE, 2010) suggest that Whitten Brook is currently "in transition or stressed". Five of the nine survey reaches meet this condition, while three reaches (Reaches 1-1b, 1-5, 1-6) have been compromised even further.

The impoundment west of Russell Rd (Reach 3-1) is just one of many alterations that have changed the geomorphology of Whitten Brook.

A formal geomorphic study of Whitten Brook is needed before restoration efforts can begin to improve geomorphic stability and in-stream habitat. This should be considered a priority during early stages of the restoration process. However, reducing the amount of water delivered as stormwater, or

pre-treatment of stormwater from Northern Madison Avenue into a dry extended detention basin or other stormwater BMP would help limit the extent of widening, and consequentially erosion and embeddedness of the stream bottom as well as lower the temperature of stormwater delivered to the stream, and should be the first course of action before in-stream work begins.

Table 11. *In-Stream restoration recommendations for Whitten Brook.*

ACTION	HOW	WHO	WHEN	COST
IN-STREAM RESTORATION				
#1: Restore riparian buffers.	1) Focus on areas with lack of buffers & invasive plants 2) Remove invasive terrestrial plants	SC-SWCD, SCC, Consultants	2014-2016	$ 125,000
#2: Restore in-stream habitat (define a narrower channel).	1) Work with Maine DEP to determine feasibility of funding a formal geomorphic study of the stream 2) Hire Geomorphologist 3) Prioritize restoration sites and apply for funding 4) Implement restoration activities for high priority habitat	1) MDEP, TAC 2) TAC/SCC 3) TAC, SCC, SC-SWCD 4) Maine DEP/SCC	1) Spring 2011 2) 2011 3) 2011/2012 4) TBD	1) N/A 2) $ 10,000 3) N/A 4) TBD
#3: Stabilize eroding stream banks.	Utilize bioengineering methods such as wattles & live stakes.	SCC, Volunteers	Beginning 2013	$1,500
#4: Repair, replace, or enhance culverts.	1) Conduct a formal culvert study 2) Prioritize culvert restoration sites 3) Acquire funding and implement culvert repairs	1) SCC, Volunteers 2) SCC, Town 3) Town	2011-2012	1) N/A 2) N/A 3) TBD

5. Implementing the Plan

5.1 Plan Oversight & Adoption

The Whitten Brook Restoration Plan will be carried out by the Skowhegan Conservation Commission (SCC) in cooperation with the Whitten Brook Technical Advisory Committee (TAC) which consists of representatives from the SCC, the Town of Skowhegan, Main Street Skowhegan, Somerset County Soil & Water Conservation District, Maine DEP, Maine DOT, local businesses and residents. Local participation is an integral part of the success of this plan, and should include the on-going leadership of the Town of Skowhegan. The TAC will need to meet regularly and be diligent in coordinating resources to implement practices that will reduce the effects of urbanization in the Whitten Brook watershed.

It's anticipated that the Plan will require at least 1-2 years to initiate, and 10-15 years to implement. Sustainable funding, a good administrative process, and cooperation by partners and landowners are all variables that will lead to the success of the plan. If Class B standards are met before implementation of recommended actions are complete, then the goal of the plan has been met.

This plan will be presented to the Skowhegan Board of Selectmen in 2011 following review by the TAC, Maine DEP and local stakeholders. Formal adoption of the plan by the Town is highly recommended to help raise local awareness about the need for restoration efforts and to garner support needed to implement various aspects of the plan (especially municipal maintenance activities).

Recommended actions to restore Whitten Brook to Class B water quality standards are presented in Section 4 of this plan. These actions include 74 tasks in six different restoration categories.

5.2 Estimated Costs and Technical Assistance Needed

The cost of successfully implementing the Whitten Brook Watershed Restoration Plan is currently estimated at $1,356,000 over the course of the next 10-15 years (2011-2025) based on the recommended actions in Section 4. This includes both structural BMPs such as installing an extended detention basin, and tree box filters (Section 4.2), and non-structural BMPs such as improving shoreland zoning ordinances (Section 4.3). This general, 'best guess' estimate is based on the following assumptions:

Structural BMPs Cost Estimate	
Stormwater Retrofit Sites	$800,000 - $1,215,000
Other Stormwater Opportunities (Table 6)	$18,500
TOTAL	**$818,500 – $1,233,500**

Non-Structural BMPs Cost Estimate	
Administrative & Funding	$4,000
Education & Outreach	$57,000
Municipal Maintenance	$19,500
Land Use Planning	$21,500
Source Control/Other	$20,000
TOTAL	**$122,500**

**Note: These costs do not include the restoration efforts labeled TBD in the action plan in Section 4, the costs of acquiring undeveloped land for conservation in the western branch of the watershed, or for long-term water quality monitoring (Section 6). Therefore, the estimated costs are anticipated to exceed the projected total once additional knowledge is gained about the costs of these activities.*

A community restoration effort should be funded by all aspects of the community including local businesses and property owners; community groups; conservation groups; corporate sponsors; and the municipality.

A diverse source of funding and a sustainable funding plan is needed to match desired goals and objectives for restoration.

Stormwater Retrofits: State and federal agencies such as Maine DEP, Maine DOT, and EPA offer competitive grant programs to implement high priority stormwater retrofits in the watershed and in-stream restoration efforts, as well as select education and outreach activities.

Municipal Maintenance: Actions such as culvert repair, enhanced storm drain cleanout and street sweeping programs, and ordinance revisions should be supported by the Town through tax dollars, permit fees, or fees collected as a result of ordinance violations. Other funding sources such as local planning grants may help supplement these projects.

Land Conservation: Conserving land in the western branch of Whitten Brook is a high priority given the current lack of shoreland zoning. Past efforts by the Somerset Woods Trustees to conserve land in the western branch has resulted in the protection of a large area of forestland adjacent to the stream. Ongoing land conservation efforts will need the support of local conservation groups, conservation enthusiasts, and individual donors in order to prevent poorly planned development and long-term degradation in this portion of the watershed. Options such as obtaining easements within the buffer areas on the brook, and other areas near proposed development where intermittent channels have formed that flow to the stream, should also be considered in lieu of outright purchase.

Monitoring and Assessment: Future monitoring and assessment efforts will require a variety of sources of funding including Federal 319 money, municipal government, and private foundation grants. Federal Section 319 funding should be used to supplement local and state investments.

6. Methodology for Measuring Success

The Whitten Brook Watershed Study (FBE, 2010) and results from community stakeholder meetings in 2010 provide an excellent framework for identifying and understanding the sources of pollution and the problems that have resulted in poor water quality in Whitten Brook. This information has assisted with development of locally-driven solutions and the prioritization of actions to address the underlying problems. Successful restoration of the stream requires setting goals and developing objectives to help meet those goals. The Whitten Brook Restoration Plan provides key actions needed to restore the stream, but it is inevitable that new information, technology, and techniques will be learned and developed in the years to come.

6.1 Adaptive Management Components

An adaptive management approach is widely recommended for restoring urban watersheds. Adaptive management enables stakeholders to conduct restoration activities in an iterative manner. This provides opportunities for utilizing available resources efficiently through BMP performance testing and restoration monitoring activities. Stakeholders can evaluate the effectiveness of one set of restoration actions and either adopt or modify them before implementing effective measures in the next round of restoration activities. The adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short-time frame (e.g., 2 years). Rather, adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration activities. Implementation of this approach will ensure that required restoration actions are implemented and that Whitten Brook is monitored to document restoration over an extended time period.

The adaptive management components for the Whitten Brook Restoration Project will include:

Creating an Organizational Structure for Implementation- Since watershed restoration will require a considerable effort by several entities, a coordinating group should be established for the administration of the Whitten Brook Restoration Project and to coordinate the implementation of restoration activities. The Skowhegan Conservation Commission (SCC) can serve as this entity with guidance from the TAC, but may need a coordinating person or consultant to ensure that the momentum continues. In addition to municipal officials, this committee should involve the various business interests in the watershed to allow for a full consideration of all issues relevant to an effective, efficient and cost-effective restoration program.

Establishing a Funding Mechanism- A long-term funding plan should be established immediately to provide the financial resources to ensure that restoration actions can move forward over an extended time period. In addition to construction and organizational management costs, consideration should also be given to the type and extent of technical assistance needed to design, inspect and maintain stormwater BMPs. Technical assistance costs for the annual field monitoring program should also be considered. The TAC is currently evaluating options for establishing long-term funding to support the Whitten Brook Restoration Project. Clearly, funding is a critical element of sustaining the restoration process and once it is established, the management plan can be fully vetted and restoration activities can move forward.

Local youth learn about the importance of a healthy aquatic macroinvertebrate community in Whitten Brook.

Synthesizing Restoration Actions- This watershed management plan provides two sets of prioritized recommendations to support restoration (e.g., structural/non-structural recommendations for priority catchment areas and in-stream, riparian, and geomorphic recommendations for improvements to priority stream segments). All recommendations were developed by interested community stakeholders, with oversight by FB Environmental, Maine DEP, and members of the TAC. These two sets of recommendations need to be synthesized to create a unified watershed restoration strategy. Once a funding mechanism is established, the restoration program should begin in earnest by developing detailed designs for priority restoration activities on a project area basis and scheduling their implementation accordingly.

Continuing the Community Participation Process- The development of the Whitten Brook Watershed Restoration Plan has greatly benefited from the active involvement of an engaged group of watershed stakeholders with a diversity of skills and interests. The implementation of the Plan will require their continued and ongoing participation as well as additional community outreach efforts to involve even more stakeholders both in the watershed and the in the larger community of Skowhegan. A sustained public awareness and outreach campaign is essential to secure the long-term community support that will be necessary to successfully implement this project.

Developing a Field Monitoring Program- A field monitoring program is required to track the anticipated improvements to the aquatic health of the Whitten Brook watershed. Indeed, the overall goal of the watershed management planning process is the restoration of the aquatic health of Whitten Brook. Therefore, monitoring aquatic health as restoration actions are implemented is critically important. The monitoring program will also provide the necessary feedback on the effectiveness of restoration practices at the catchment and/or subwatershed level, and will support optimization of restoration actions through an adaptive management approach. A subcommittee, consisting of volunteers from the TAC will work together to develop this program.

Establishing Measurable Milestones- A restoration schedule that includes milestones for measuring the implementation of restoration actions and monitoring activities in the Whitten Brook watershed is critically important. Once the level of funding has been established to determine the extent of recommended action strategies that can be implemented each year, a detailed schedule featuring iterative implementation and monitoring activities should be developed.

6.2 Monitoring Program

A well designed monitoring program is a critical component of the Whitten Brook Restoration Project since it will establish the relative effectiveness and success of restoration recommendations against pre-implementation

(or "baseline") watershed conditions. The onset of the monitoring program should precede the implementation of restoration actions (to establish baseline conditions) and then continue concurrently throughout the duration of the project. The goals of the monitoring program should be two-fold. It should support both the assessment of overall aquatic health of Whitten Brook over time, and provide an evaluation of the effectiveness of restoration practices for improving the aquatic habitat on either a subwatershed or catchment area basis.

Monitoring program results will be analyzed on an ongoing basis in order to optimize the restoration process by implementing the most effective mitigation actions. This plan recommends that numerous restoration actions in a phased approach beginning with the highest priority BMPs first, such as the installation of stormwater BMPs to treat stormwater on northern Madison Avenue and on storm drains on Madison Avenue, followed by BMPs elsewhere. This project area approach should allow for considerable savings as compared to installing stormwater BMPs on an individual basis. The goal of these grouped actions will be to make a relatively large positive impact on the local catchment area and a relatively smaller positive impact on the entire watershed. Where financially feasible, the monitoring program should include measurement of the local improvement associated with individual measures to mitigate stormwater and the cumulative positive impact of a set of many restoration actions implemented over time.

Thus, the monitoring program will feature a two-tiered approach:

Ambient Whitten Brook Monitoring- An ambient stream monitoring program will support assessment of the overall health of the stream system;

Catchment Area and/or Subwatershed Monitoring- A set of specific monitoring programs will assess the performance of restoration actions.

Hydrologic, water quality and aquatic biological measurements may be required to identify success of restoration efforts. It would also be useful to include annual stream walks to assess the condition of the riparian corridor in relation to adjacent land use change. Stream walks can be coordinated with annual stream clean-ups sponsored by the SCC.

6.2.1 Ambient Whitten Brook Monitoring Program

An overall goal of the ambient monitoring program is to track the improvement of the watershed's overall aquatic health over time. A representative set of aquatic health indicators should be measured and interpreted on a predetermined timeframe (Maine DEP collects data every 5 years and is due to sample again in 2012). The set of aquatic health indicators should include characteristics that have been degraded by the urbanization of the Whitten Brook watershed. Measuring these characteristics each year will support accurate assessment of the success of restoration actions. The ambient monitoring program will likely include the following components:

Hydrology- Continuous stream flow measurements;

Water Quality- Continuous in-situ measurements and synoptic grab sampling and laboratory analysis for key water quality parameters;

Biology- Macroinvertebrate and fish surveys;

The number of surveys, the locations and number of sampling sites, and the specific measurements collected will be determined by the TAC monitoring subcommittee as the goals of the monitoring program become clear based on available resources and funding. The TAC may determine that a second macroinvertebrate site should be established downstream of the northern Madison Avenue stormwater outfall, or another location upstream of the Elm Street sampling site.

The ambient monitoring program should commence prior to implementation of mitigation measures in order to establish directly comparable baseline conditions. After each sampling event, data will be analyzed and compared to data collected during previous years. This data collection program and data analysis and interpretation protocol will support assessment of progress in restoring Whitten Brook.

6.2.2 Catchment Area Site-specific Performance Monitoring

Restoration of Whitten Brook will require implementation of numerous catchment area best management practices (BMPs) to reduce the adverse impacts of these areas on the aquatic ecosystem. A goal of the catchment area performance monitoring program is to quantify the effects of each set of restoration actions. This monitoring program will serve to validate the positive impact of restoration and will support the process of optimizing effectiveness in future mitigative actions. For example, the types of BMPs that are observed to be highly effective will be used more in the future while less effective BMPs will be phased out.

Monitoring for macroinvertebrates will help determine if the stream is meeting State water quality standards.

A site-specific performance monitoring program for a stormwater BMP may include measurement at the outlet of the catchment area for the following:

- Volumetric discharge rate throughout each of a set of storm events;
- Continuous recording of in-situ water quality parameters;
- Automated grab sampling for analysis of a set of water quality parameters including suspended solids, nutrients, oil and grease, and metals during storm events.

A more simplified version of these measurements can be established depending on the budget allocated for monitoring. Catchment area monitoring would be conducted prior to installation of BMPs in order to establish baseline conditions and following installation of BMPs to measure improvement in hydrologic and water quality conditions.

6.3 Measurable Milestones

It is critically important that a watershed restoration project schedule be established that provides clear and measurable milestones for implementation of mitigation actions and a monitoring program to support assessment of aquatic health recovery. This is best done on an interim basis for short-term (1 – 2 years), mid-term (2 – 5 years) and long-term (5 – 10 years) time frames.

Action strategies presented in Section 4 will serve as a guide for implementation efforts, but should be adapted as necessary. Once funding mechanisms and oversight authority have been established for the Whitten Brook Restoration Project, a detailed list and schedule of measureable milestones will be developed in conjunction with monitoring program development. Some examples of potential measurable milestones for the Whitten Brook Watershed Restoration Project might include:

Programmatic indicators that identify progress in administering the watershed management plan:

- Amount of grant funding secured for plan implementation
- Number of structural BMPs installed
- Number of structural BMPs inspected and maintained
- Number of acres of land put into permanent conservation
- Acres of IC treated by structural BMPs
- Number and types of non-structural restoration activities completed
- Acres of IC addressed by non-structural BMPs
- Changes to municipal ordinances for improved watershed protection

Environmental indicators that directly measure or relate to in-stream conditions:

- Number of monitoring stations meeting WQ standards
- In-stream pollutant load reductions
- Stream temperature
- Macroinvertebrate type, abundance and distribution
- Reduction in duration and frequency of peak flows
- Lineal feet of riparian habitat revegetated or protected from development

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