Stormwater Citizens Review Panel

Quarterly Meeting

December 3, 2014 at 12:00pm

Council Chambers

<u>Agenda</u>

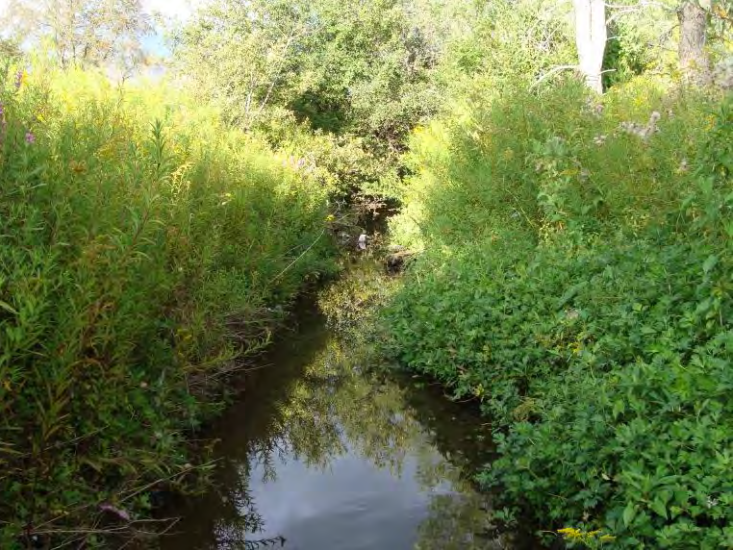
1. FB Environmental Presentation (F. Bell, J. Jespersen)
    a. Review of work to date
    b. Preliminary benthic monitoring results

2. Discussion: Draft Capehart Brook Watershed Management Plan

3. Sucker Brook Stream Corridor and Watershed Survey (W. Guglielmo)

4. MS4 General Permit – Permit Year 1 Report (P. Burbank)

5. Other items for discussion.



CAPEHART BROOK

Capehart Brook Watershed-Based Management Plan

Bangor, Maine

2nd DRAFT - November 2014

Prepared by:

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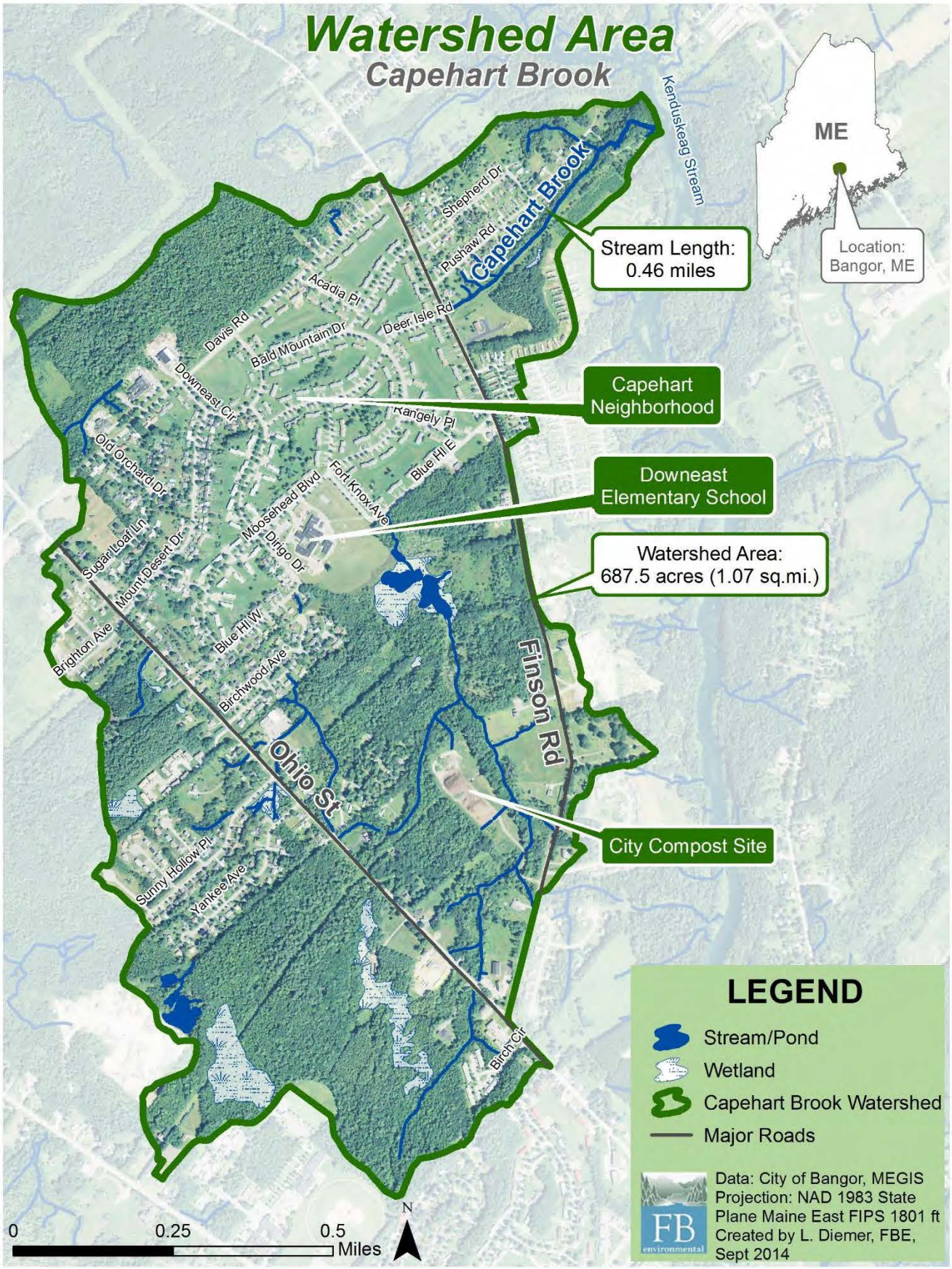
Watershed Area
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
Capehart Brook
Stream Length: 0.46 miles
Capehart Neighborhood
Downeast Elementary School
Watershed Area: 687.5 acres (1.07 sq.mi.)
City Compost Site
Finson Rd
Ohio St
Shepherd Dr
Pushaw Rd
Acadia Pl
Deer Isle Rd
Davis Rd
Bald Mountain Dr
Downeast Cir
Rangely Pl
Old Orchard Dr
Blue Hill E
Fort Knox Ave
Moosehead Blvd
Dirigo Dr
Sugarloaf Ln
Mount Desert Dr
Blue Hill W
Brighton Ave
Birchwood Ave
Sunny Hollow Pl
Yankee Ave
Birch Cir
LEGEND
Stream/Pond
Wetland
Capehart Brook Watershed
Major Roads
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
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CAPEHART BROOK WATERSHED-BASED MANAGEMENT PLAN

Prepared for and funded by:

City of Bangor, Maine

Prepared by:

FB Environmental Associates

2nd DRAFT ~ November 2014

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EXECUTIVE SUMMARY

CAPEHART BROOK WATERSHED-BASED MANAGEMENT PLAN

PROJECT OVERVIEW

The Capehart Brook Watershed-Based Management Plan serves as an update to the 2011 watershed management plan completed by SMRT, Inc. FB Environmental Associates (FBE) was contracted by the City of Bangor to update the original management plan and to provide recommendations for restoration initiatives within the watershed. The goal of the plan is to improve the aquatic habitat and water quality conditions in Capehart Brook so that it attains Class B water quality standards. This will be achieved using a combination of on-the-ground stormwater retrofits, municipal maintenance, community education and outreach, and monitoring activities that focus on treating, and where possible, disconnecting impervious cover (IC) that contributes to the stream's impairment.

View of Capehart Brook just upstream of its confluence with the Kenduskeag Stream.

Development of the plan included conducting a rapid habitat and geomorphic stream assessment, compiling and analyzing historical water quality data, updating the existing GIS land cover data, and creating a simple pollutant loading model for the Capehart Brook watershed. This information was used to identify water quality problems, define management objectives, and prioritize restoration strategies in the watershed.

GOAL:
Restore watershed conditions in Capehart Brook so that the stream attains State water quality classification standards for Class B surface waters.

THE CAPEHART BROOK WATERSHED

Capehart Brook is a small urban stream that originates under Finson Road through a 66" culvert and flows 0.46 miles before emptying into the Kenduskeag Stream. The stream is fed by a series of underground pipe and open drainage ditches from the City stormwater system. This stream was dredged by the Army Corps of Engineers in the 1950's, but has since become a "naturalized" stream that flows parallel to residential homes on Pushaw Road to the northwest and a utility access road to the southeast.

The Capehart Brook watershed covers approximately 688 acres and is located entirely within the City of Bangor. The majority of the watershed's development between Finson Road and Ohio Street contains former military base housing, now mostly owned by the Bangor Housing Authority for low-income housing.

THE PROBLEM

As one of Maine's 31 "urban impaired streams," Capehart Brook is impaired for aquatic life use as a result of urbanization from high-density residential neighborhoods (and some commercial development) within the watershed. According to the Watershed Science Institute's Watershed Condition Series, Technical Note 3 on the EPT Index, Capehart Brook is classified as having a "poor" water quality rating since the majority of macroinvertebrates found are associated with degraded water quality (WSI 2012). According to the 2012 *State-wide Impervious Cover Total Maximum Daily Load* (IC TMDL) report, the primary culprit to the current impairment is the increased volume of stormwater runoff and associated pollutants flowing into the stream from IC, which was estimated at 15% for the Capehart Brook watershed (Maine DEP 2012b). Recent land cover analyses estimate that 14.4% (99.3 acres) of the Capehart Brook watershed is covered by IC with roads and buildings (e.g. rooftops) making up a significant portion (62%).

Stormwater runoff from the Capehart Brook neighborhood flows directly into Capehart Brook.

Stormwater carrying dirt, metals, and other pollutants is conveyed directly from IC, such as parking lots, roads, and rooftops, to Capehart Brook with minimal pre-treatment, causing increased erosion, sedimentation, increased temperature, and habitat degradation in the stream (CWP 2003). Research shows that watersheds with IC greater than 12% often exceed criteria for aquatic life use (Stanfield and Kilgour 2006), and even lower levels of IC (4-6%) can significantly inhibit the abundance and diversity of fish and macroinvertebrate species (Wenger et al. 2008). Maine DEP currently establishes a target of 8% IC to meet aquatic life use criteria in Class B waters (Maine DEP 2012b). Based on the Maine DEP's target goal of 8% IC, a 44% IC reduction (equivalent to 44 acres) is needed to offset the effects that IC has on Capehart Brook. Maine DEP considers Capehart Brook to be a "highly restorable" stream, and therefore, of great interest for future mitigation and monitoring efforts by the City of Bangor.

Management measures described in this Plan will reduce effective IC in the Capehart Brook watershed by 44%. The Maine DEP target should be viewed as a guideline for achieving attainment. Every stream and its aquatic communities will respond differently to restoration activities, and Capehart Brook may or may not reach attainment before or after a full 44% IC reduction is achieved.

OBJECTIVE:
Based on the Maine DEP's target goal of 8% IC, a 44% IC reduction (equivalent to about 44 acres) may be needed to offset the effects that IC has on Capehart Brook.

WHY DEVELOP A WATERSHED-BASED MANAGEMENT PLAN?

A watershed-based management plan helps identify problems, priorities, and actions that are needed to improve the water quality of a waterbody. Since each watershed is unique, the Capehart Brook Watershed-Based Management Plan is also unique to address the major issues and concerns of both the community and the stream.

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.

The Capehart Brook Watershed-Based Management Plan builds upon the goal of reducing polluted stormwater runoff from reaching Capehart Brook and describes restoration objectives to meet this challenge. An Action Plan (Section 4) was developed based on feedback from the City of Bangor and the Stormwater Citizen Review Panel. These stakeholders discussed what they perceived to be the greatest threats to stream's water quality, and developed practical solutions to address them. Implementing all the recommended structural BMPs in the Capehart Brook watershed will likely disconnect 44 acres of IC in the watershed out of the 44 acres needed to reach the 8% effective IC target. Non-structural management measures may also reduce pollutants in the watershed by an additional 10% (Law et al. 2008, FBE 2011).

Reductions from Proposed Stormwater Retrofits:

44% Impervious Cover (IC)
40% Total Suspended Sediments (TSS)
22% Total Phosphorus (TP)
19% Total Nitrogen (TN)

KEY RESTORATION CATEGORIES
Capehart Brook

- ☆ **Stormwater Best Management Practices (BMPs)-** *Reducing the volume of stormwater and the pollutants it carries to Capehart 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.*
- ☆ **Stream Restoration-** *Improve habitat conditions in the stream using in-stream restoration efforts such as restoring riparian buffers and stabilizing eroding stream banks.*
- ☆ **Education & Outreach-** *Garner the support and cooperation from community groups while educating business owners, school children, and watershed residents about the need for and importance of clean water.*
- ☆ **Municipal Maintenance Practices-** *Work with municipal employees to improve existing stormwater infrastructure, catch basin cleaning, winter sand/salt spreading, snow storage, and street sweeping.*
- ☆ **Land Conservation & Land Use Planning-** *Coordinate local efforts to increase the amount of land in permanent conservation while working with City officials* to *expand riparian buffer zoning and improve City stormwater rules in order to protect impaired streams.*
- ☆ **Source Control-** *Identify and remedy known and unknown sources of illicit discharge to the stream.*
- ☆ **Water Quality-** *Continue and/or improve the water quality and macroinvertebrate monitoring.*

Successful development of the Plan, including final selection of key restoration strategies, requires an integrative and adaptive approach and depends primarily on the involvement of the City, its partners, and the watershed community. 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 provides opportunities for both recreational and aesthetic improvements. This Plan will help to foster further thinking about long-term strategies for improving the water quality and related natural resources within the Capehart

Brook watershed, and help to promote communication among citizens, municipalities, and state agencies. This Plan is contingent on landowner cooperation since most of the land is privately-owned by individuals (69%) or the Bangor Housing Authority (13%) (Appendix A, Map 14).

WHAT THE PLAN INCLUDES

The City of Bangor has helped guide the watershed planning process since the initiative began in 2010, and will continue to guide efforts to implement the Plan over the next 10 or more years. The Plan is divided into six major sections based on the USEPA's nine key planning elements for watershed management plans:

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

Section 2 describes the watershed, including climate, population statistics, growth trends, land cover, topography, land conservation, soils and geology, water resources, and stormwater/sewer infrastructure.

Section 3 provides an IC assessment of the watershed, describes applicable water quality standards, summarizes water quality and biological assessment data collected from the stream, and summarizes the results of a Stream Corridor Survey which included a habitat assessment, rapid geomorphic assessment, culvert inventory, and documentation of nonpoint source (NPS) pollution hotspots.

Section 4 describes watershed restoration goals and objectives. 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 several primary categories (shown below). Section 4.4 provides the results of a pollutant loading reduction analysis for the recommended structural retrofits.

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.

FUNDING THE PLAN

The total estimated cost for implementing the Capehart Brook Watershed-Based Management Plan is estimated at approximately $**650,000 or $65,000/year over the next 10 years**, including all structural and non-structural recommendations described in this Plan. The City has already taken the initiative to obtain funding for Phase I and II BMP implementation work within the Capehart Brook watershed. A long-term sustainable funding source has already been established through the Stormwater Utility fund, but additional strategies can and should be developed by the City of Bangor, particularly for monitoring efforts.

ADMINISTERING THE PLAN

The City of Bangor will administer the Capehart Brook Watershed-Based Management Plan. The City will convene 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 City will track achievements, press coverage, outreach activities, number of retrofits sites repaired, number of volunteers, and amount of funding received.

10-Year Cost Estimate for Restoring Capehart Brook			
Category	**Costs covered by existing City programs***	**New Costs to the City***	**New Costs to Other Stakeholders***
Structural BMPS			
Stormwater Retrofit Sites	**$$**	**$434,500**	**--**
Non-Structural BMPs			
Administrative & Funding	**$$**	--	--
Education & Outreach	$5,000	$8,500	$5,500
Municipal Maintenance	**$$**	$1,700	--
Land-Use Planning	**$$**	$500	TBD
Source Control/Other	**$$**	$83,500	--
TOTAL	**$5,000**	**$94,200**	**$5,500**
Monitoring Program			
Monitoring	**$$**	**$109,500**	**--**
GRAND TOTAL (10-yr)	**$5,000**	**$638,200**	**$5,500**

NEXT STEPS

The success of this Plan can be measured in several ways, as outlined in Section 6.3 on Measurable Milestones. These milestones fall under three categories: environmental, programmatic, and social indicators. These indicators can be used as performance measures to determine how well implementation activities are working and provides a means to track progress toward established goals and objectives. Key milestones identified in this Plan are provided in the table below.

Successful implementation of the Capehart Brook Watershed-Based Management Plan depends primarily on the commitment and involvement of community members. Therefore, the success of this Plan will weigh heavily on the support and cooperation of the City and key stakeholders. The City will need to enthusiastically engage the community in restoration activities, work together to maintain the sustainable funding plan, and acquire additional funds to implement the suggested Phase III work. The City should officially adopt the Plan, thereby raising awareness about the importance of restoration efforts and the need for immediate action.

Measurable Milestones			
Indicators	**Benchmarks***		
	2017	*2020*	*2025*
Environmental			
Enhance macroinvertebrate type, abundance, and distribution (meet Class B standards)	5%	50%	90%
Reduce peak flows, temperature, and pollutants in water coming out of the Finson Road culvert (reduce % IC)	5%	25%	44%
Programmatic			
Number of areas installed with structural BMPs	5	10	20
Number of culverts stabilized	2	4	8
Social			
Number of volunteers for stream clean-ups and plantings	50	100	200
Number of people participating in educational events	10	50	100

**Benchmark figures are cumulative from 2017 to 2020 to 2025*

ACKNOWLEDGEMENTS

The following individuals contributed their time, knowledge, and forethought to help develop the Capehart Brook Watershed-Based Management Plan:

Wynne Guglielmo, City of Bangor Environmental Coordinator
Peralie Burbank, City of Bangor Civil Engineer
Scott Gorneau, FABCO Industries, Inc. Regional Vice President
Brad Moore, City of Bangor Superintendent of the Wastewater Treatment Plant
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Patrick Quinn, Jr.
Lovern Stockwell

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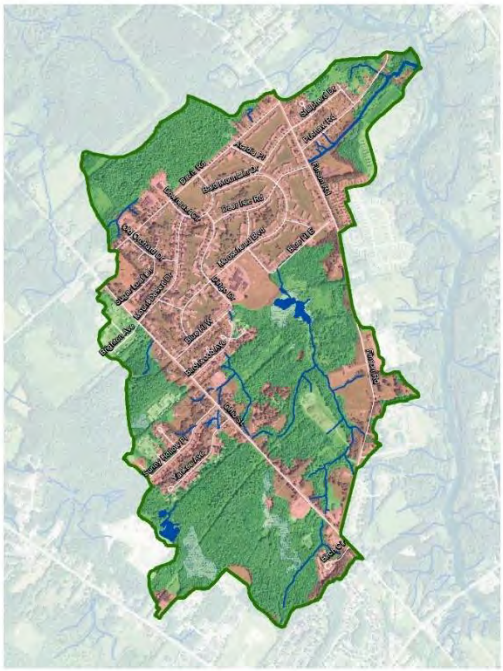
1. Introduction

1.1 Purpose and Background

Small (1st and 2nd order or headwater) streams and their associated network of wetlands help sustain the biological productivity of downstream rivers, lakes, and estuaries. These 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 natural flood control, recharge the groundwater, and maintain water quality by trapping sediments and pollution from fertilizers and other contaminants (Allan and Castillo 2007). Streams also offer intrinsic benefits to our communities by providing a sense of place for the people who live near them and a place for children to grow and explore the natural world around them.

The numerous benefits afforded by small stream networks are being threatened by human activities that lead to increases in urban runoff, such as land clearing and development. Poorly planned development most often results in riparian vegetation and watershed hydrology alterations, water quality degradation, and invasive species introduction. These consequences not only impact the health of aquatic life, but also our physical, social, and economic health. Conservation efforts, including protection of the riparian zone, preservation of undeveloped forest buffers, and implementation of low-impact development techniques that prevent stormwater runoff from developed areas will help protect these small streams for future generations.

Capehart Brook is an interesting example of the impact that human activities can have on the landscape. According to historical records, Capehart Brook was created as a sewage ditch draining former base housing built circa 1958 and was dredged to maintain the channel[1]. As a result, the "naturalized" portion of Capehart Brook is fed by a series of underground stormwater pipes and open ditches, part of the City's Municipal Separate Storm Sewer System (MS4), that converge under Finson Road. Today, the former base housing is a high-density residential neighborhood, complete with roads, driveways, and sidewalks that cannot filter stormwater. The network of open and closed drainage ditches throughout the watershed results in overland flow of stormwater runoff to stormwater pipes that eventually empty into Capehart Brook. The water quality in Capehart Brook is not meeting State Class B standards, and is threatening the health of downstream waterbodies, such as Kenduskeag Stream.



This map of the Capehart Brook watershed highlights developed (red) and undeveloped (green) land.

[1] Information obtained from Century Maine – Lost and Abandoned Sites blog (http://centurymaine.blogspot.com/2014/04/capeharts-abandoned-sewage-treatment.html)

Development of the former base housing (a.k.a Capehart Neighborhood) was completed without any stormwater mitigation strategies put in place to reduce runoff from residential areas. The installation of drainage ditches altered the hydrologic cycle and movement of water through the landscape. The high percentage of developed land (mostly residential, but some commercial land uses) in the Capehart Brook watershed has increased overland flow during storm conditions. Overland flow picks up a variety of pollutants from **impervious cover (IC)** before reaching Capehart Brook.

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

Capehart Brook was listed as impaired for aquatic life use by the Maine DEP beginning in 2006. The most recent listing in the 2012 *Integrated and Water Quality Monitoring and Assessment Report* by the Maine DEP places Capehart Brook under Category 4A for TMDL approval (Maine DEP 2012a). This listing was based on the non-attaining and indeterminate Class B determinations of 1997 and 2001 macroinvertebrate monitoring by the Maine DEP. Capehart Brook was also listed in the Maine DEP's Stormwater Management Law, Chapter 502 List of Urban Impaired Streams. The aquatic life violation prompted the inclusion of Capehart Brook in a *Statewide Impervious Cover Total Maximum Daily Load (IC TMDL) Report*, which was drafted in 2011 and published in 2012, and followed immediately by a watershed management plan by SMRT, Inc. in 2011 (Maine DEP 2012b, SMRT 2011). The IC TMDL set a target of 8% effective IC to help reduce current pollutant loads from the watershed and mimic natural watershed conditions (Maine DEP 2012b). Achieving this target will help restore habitat conditions in Capehart Brook so that it will attain Class B water quality standards. The Maine DEP considers Capehart Brook to be a "highly restorable" stream, and therefore, the Capehart Brook watershed is of great interest for future mitigation and monitoring efforts by the City of Bangor.

GOAL

The goal of the Capehart Brook Watershed-Based Management Plan is to provide management recommendations that will help improve aquatic habitat and water quality in Capehart Brook so that it meets Class B water quality standards.

This goal can be accomplished with the commitment of a coordinated group of local community leaders, conservation groups, city, state and federal partners, and citizens of the watershed working together to implement a 10-year plan to restore Capehart Brook. The Capehart Brook Watershed-Based Management Plan provides key actions needed to restore the stream, the timing of these actions, and the mechanisms by which they will be accomplished.

1.2 Developing a Community-Driven Watershed-Based Management Plan

A watershed-based management plan helps identify problems, list priorities, and outline actions that are needed to improve the water quality of a stream (EPA 2008). A good plan acts as a road map pointing out where to start, 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 watershed-based management plan should also be unique to address the major issues and concerns of the community.

Successful development of a watershed restoration plan depends primarily on the commitment and involvement of community members. These partnerships help strengthen the Plan by increasing both public awareness of the problems and public commitment to the solutions. Many of the recommendations of this Plan will require landowner cooperation with the City to implement retrofits on private or non-City-owned land. As such, it will be important to develop a strong education and outreach program that targets residents of the Capehart Brook Neighborhood in an effective and trusting way; once landowners understand the importance of restoring Capehart Brook, they may be more likely to participate in the restoration process.

The following groups or individuals have been identified as potential public participants to help finalize the Plan, and implement recommended actions to restore Capehart Brook:

- Church volunteers
- Bangor Housing Authority (BHA)
- Penobscot Christian School Board
- Downeast Elementary School
- Cyr Bus Lines
- Bangor Land Trust (BLT)
- Bangor Area Storm Water Group (BASWG)
- Maine DEP
- UMaine Cooperative Extension
- Penobscot Job Corps
- Bangor High School
- City of Bangor Dept. of Community & Economic Development

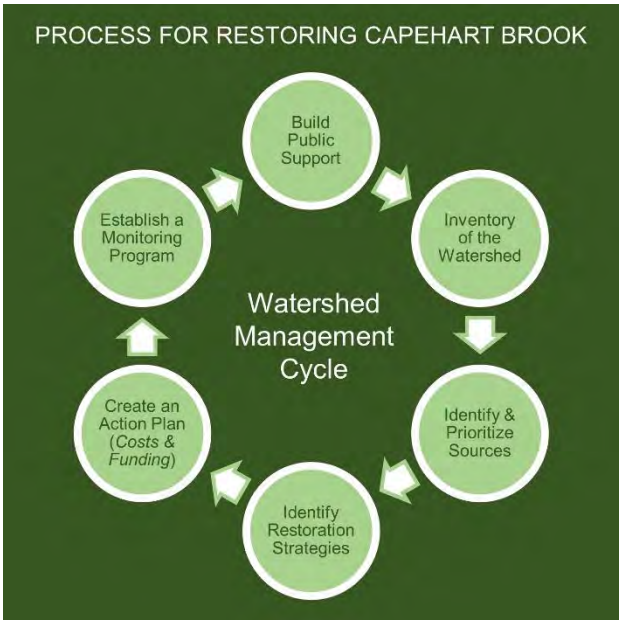


Figure 1. *Watershed Management Cycle. The City of Bangor has embraced the watershed management cycle and should ensure that this Plan is a "living document."*

The City of Bangor has shown a strong commitment to improving conditions at Capehart Brook. Several key recommendations from the 2011 Capehart Brook Watershed Management Plan have been or will be implemented by the City in the first two phases of restoration. Information about the Capehart Brook Watershed-Based Management Plan update was presented to the Stormwater Citizen Review Panel on June 4, 2014 to review the goals for restoring Capehart Brook. A meeting was also held with key City of Bangor staff on November 18, 2014 to review the draft Action Plan and make necessary revisions. A final presentation to the Review Panel on December 3, 2014 was designed to summarize the Plan content and solicit feedback on the Action Plan. The involvement of watershed stakeholders was encouraged through public access television to ensure that as many interests were considered. The Stormwater Citizen Review Panel comprises community members representing a variety of interests from local businesses, private landowners, municipal government, and education. The community-based approach will continue through the implementation of the Plan. An

illustration of the structure needed to harness community involvement and provide community oversight for Plan development and implementation is shown in Figure 1. To ensure that restoration goals are achieved, the community should consider this Plan a "living document." In other words, the goals and objectives of the Capehart Brook Watershed-Based Management Plan should be revisited and revised on an annual basis by the City of Bangor.

1.3 Recent Efforts in the Watershed

The City of Bangor has an ongoing interest in restoring Capehart Brook and has been actively involved in the watershed since 2009 when the City contracted the James W. Sewall Company to conduct annual water quality and flow monitoring. This was in response to the listing of Capehart Brook on the Maine 303(d) list of impaired waters beginning in 2006. Both the City and the Maine DEP consider Capehart Brook to be a priority watershed for restoration due to its high potential for success. An aerial map highlighting current efforts in the Capehart Brook watershed is provided in Figure 2.

Capehart Brook Water Quality Assessment - Macroinvertebrate, physical habitat, and water chemistry data were collected by the Maine DEP in 1997 and 2001. 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. The Maine DEP also conducted continuous water quality monitoring of temperature, dissolved oxygen, and conductivity from March to September 2011 and provided a water quality summary to the City.

From 2009 to 2011, the City of Bangor contracted the James W. Sewall Company to conduct continuous flow monitoring and discrete sampling of dissolved oxygen, conductivity, temperature, pH, and chloride. The data for Capehart Brook were included in the *Summary Water Quality Data Report for Five Impaired Streams* (James W. Sewall Company 2012). In 2012, the James W. Sewall Company was contracted only for discrete sampling of dissolved oxygen, conductivity, temperature, color, and pH. The results were included in the *Bangor Interim Report* (Kahl and Bigelow 2012). In 2013, the City of Bangor collected discrete samples for dissolved oxygen, conductivity, temperature, and pH. These efforts were funded in part by American Recovery and Reinvestment Act (ARRA) and the City of Bangor stormwater budget. Water quality results are discussed in Section 3. The City of Bangor has also recently collaborated with FBE to monitor benthic macroinvertebrates in summer of 2014.

Capehart Brook Total Maximum Daily Load (TMDL) - To address the aquatic life impairment, Capehart Brook was included in a Statewide IC TMDL using an IC target of 8% (Maine DEP 2012b). The IC TMDL for Capehart Brook identified the high percentage of developed land (primarily residential) in the Capehart Brook watershed as the primary cause of impairment.

Capehart Brook Stream Corridor Survey - An AmeriCorps team conducted a Level 1 Stream Corridor Survey, including a Rapid Habitat Assessment and Rapid Geomorphic Assessment of Capehart Brook in 2010. The results were reviewed by the Maine DEP (Dennis 2010), and the findings were helpful for the development of the 2011 Watershed Management Plan (SMRT 2011).

Capehart Brook Watershed Management Plan - The 2011 Watershed Management Plan for Capehart Brook was developed for the City of Bangor by SMRT, Inc. (SMRT 2011). The plan recommended installation of bio-retention cells in the open space area ditches, reduction of road width with porous sidewalks, retrofit of an existing wet pond at Sunny Hollow Place, and installation of residential rain gardens and barrels, among others. Two of these major recommendations have already taken place (see below); the retrofit of Sunny Hollow Place is currently being pursued by the City in Phase II.

Capehart Brook Restoration Project Phase I - Following the completion of the 2011 Capehart Brook Watershed Management Plan, the City of Bangor was awarded a Maine DEP 319 grant to implement some of the recommendations made in the plan. With this funding, the City installed two bio-retention cell systems at Rangeley Place South (in 2012) and the Downeast Elementary School (in 2013), as well as several residential rain barrels and rain gardens in 2012. More detailed descriptions of the Phase I projects is provided in the final report submitted by the City of Bangor to the Maine DEP (City of Bangor 2013).

Bio-retention cell retrofit at Rangeley South. Photo credit: City of Bangor.

Bio-retention Cells at Rangeley Place South and the Downeast Elementary School: The network of drainage ditches in the open space areas throughout the residential neighborhoods of the Capehart Brook watershed were targeted for bio-retention cell retrofits. The goal of the biocells is to reduce flow volume and filter pollutants by replacing portions of the existing open ditch network. These two bio-retention cell systems treat stormwater from 6.29 acres of lawn and 1.34 acres of IC (including a parking lot, rooftops, driveways, and two streets)[2]. The bio-retention cells at the Downeast Elementary School serve as an educational example of low-impact development. An estimated 5.7 tons of sediment, 6.6 lbs. of phosphorus, and 9.1 lbs. of nitrogen are kept from entering Capehart Brook annually as a result of the improvements.

Sidewalk Bridge: A sidewalk bridge was constructed along Blue Hill East Road near the Rangeley Place South area just upstream of existing catch basins to divert stormwater from the street to the sidewalk bridges where water can flow under and into the bio-retention cells for treatment. This was done to address concerns about the flat topography, which made it difficult to find effective locations for the bio-retention cells without major alteration to the landscape for drainage. This sidewalk bridge treats approximately 0.61 acres of IC[2].

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[2] *These figures were provided in the Phase I final report by the City of Bangor to the Maine DEP based on STEPL model results (City of Bangor 2013). Actual area of disconnected IC from these retrofits varies slightly using the NHDES Simple Method for estimating pollutant loading.*

Residential Rain Barrels and Rain Gardens: Penobscot Job Corps (PJC) volunteers installed 21 rain barrels and 3 rain gardens in the residential neighborhoods of the Capehart Brook watershed in 2012. Rain barrels were only given to residents upon request and after a brief training of proper use and maintenance was given to interested residents by PJC volunteers. As a result, an estimated 0.83 acres of IC was disconnected from Capehart Brook[3]. The rain barrels and rain gardens remove an estimated 0.21 lbs. of phosphorus and 1.2 lbs. of nitrogen from the water flowing to Capehart Brook.

Willow Stake Plantings – In the spring of 2014, willow wattles, willow stakes, and dogwood stakes were planted along Capehart Brook just downstream of the Finson Road crossing. The City of Bangor purchased the wattles and stakes from Norpine Landscaping in Kingfield, ME. Willows and dogwoods are fast-growing species that can quickly and effectively stabilize and revegetate stream banks.

Willow and dogwood stake plantings at the Finson Road crossing. Photo credit: City of Bangor.

Capehart Brook Stream Clean-Up – On April 26, 2014, the City organized a stream clean-up for six urban impaired streams, including Capehart Brook, utilizing 350 volunteers from the Church of Jesus Christ of Latter Day Saints. A significant amount of debris was removed from Capehart Brook between the Finson Road crossing and the outlet to the Kenduskeag Stream. The Church of Jesus Christ of Latter Day Saints is committed to conduct annual stream clean-ups at the six urban impaired streams, including Capehart Brook.

Conservation Efforts in the Capehart Brook Watershed - Acquisition of land for conservation in the watershed has resulted in the long-term preservation of undeveloped forestland in the watershed. The City of Bangor owns a 28-acre parcel off Ohio Street, also known as Brown Woods (Appendix A, Map 5).

NPDES MS4 Stormwater Program – To meet permit regulations under the Municipal Separate Storm Sewer System (MS4) program, the City of Bangor conducts Best Management Practices (BMPs) and Standard Operating Procedures (SOPs) to better regulate stormwater within the City, including the Capehart Brook watershed. These ongoing efforts include revised construction ordinances, City vehicle spill kits and reporting protocols, road salt/sand storage, street sweeping, and catch basin cleaning.

Bangor Area Storm Water Group – The Bangor Area Storm Water Group (BASWG) is an active group comprised of individuals from the City of Bangor, City of Brewer, Town of Hampden, Town of Milford, City of Old Town, Town of Orono, Town of Veazie, the University of Maine at Orono, University of Maine at Augusta, Eastern Maine Community College, the Dorothea Dix Psychiatric Center, and the Maine Air National Guard. The purpose of this group is help municipalities comply with the education, outreach, and public involvement requirements that are part of the six Minimum Control Measures mandated by the NPDES

Stormwater Program for MS4 communities. The BASWG uses a variety of techniques to promote better stormwater management and awareness, such as hosting public events, staff trainings, workshops, and stream clean-ups. Refer to their website for more information on current activities (www.baswg.org).

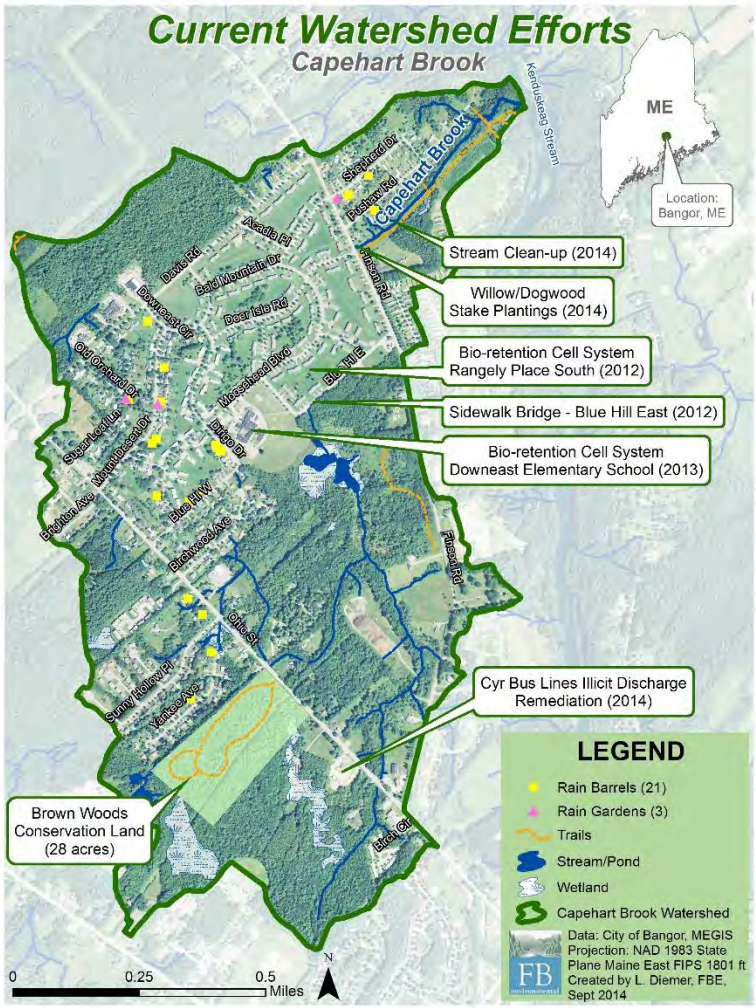


Figure 2. *Aerial map highlighting current efforts in the Capehart Brook watershed. Appendix A, Map 2.*

City of Bangor Stormwater Utility – In 2012, the City of Bangor established a stormwater utility, which generates funds through pro-rated fees from citizens. These funds can be used on various stormwater-related projects throughout the City, including the Capehart Brook watershed. The Stormwater Citizen Review Panel is comprised of a variety of stakeholders who review proposed uses of the stormwater utility fee funds.

Capehart Brook Restoration Project Phase II – The City of Bangor was recently awarded a 319 grant for $150,000 (with $125,000 in non-federal match) to continue restoration activities within the Capehart Brook watershed. The funds support the repair of the failing Sunny Hollow Place detention pond, installation of 155 catch basin inserts, and placement of four compact biofilter systems. This project will span two years beginning May 1, 2015. These retrofits will help remove suspended sediment from the stormwater that flows to Capehart Brook.

Oil Loading Decrease along Ohio Street – In October 2014, an underground drainage system/cesspool was discovered by City staff on Cyr Bus property within the Capehart Brook watershed. This system carried illicit connections from the Cyr Bus garage and office buildings to the City's Municipal Separate Storm Sewer System (MS4). Cyr Bus, City Staff, the Maine DEP, and Clean Harbors worked in cooperation to fully disconnect the illicit discharge and prevent oils, greases, sink discharge, and parts washer discharge from reaching Capehart Brook. Trichloroethylene

Cyr Bus cesspool removal. Photo credit: City of Bangor.

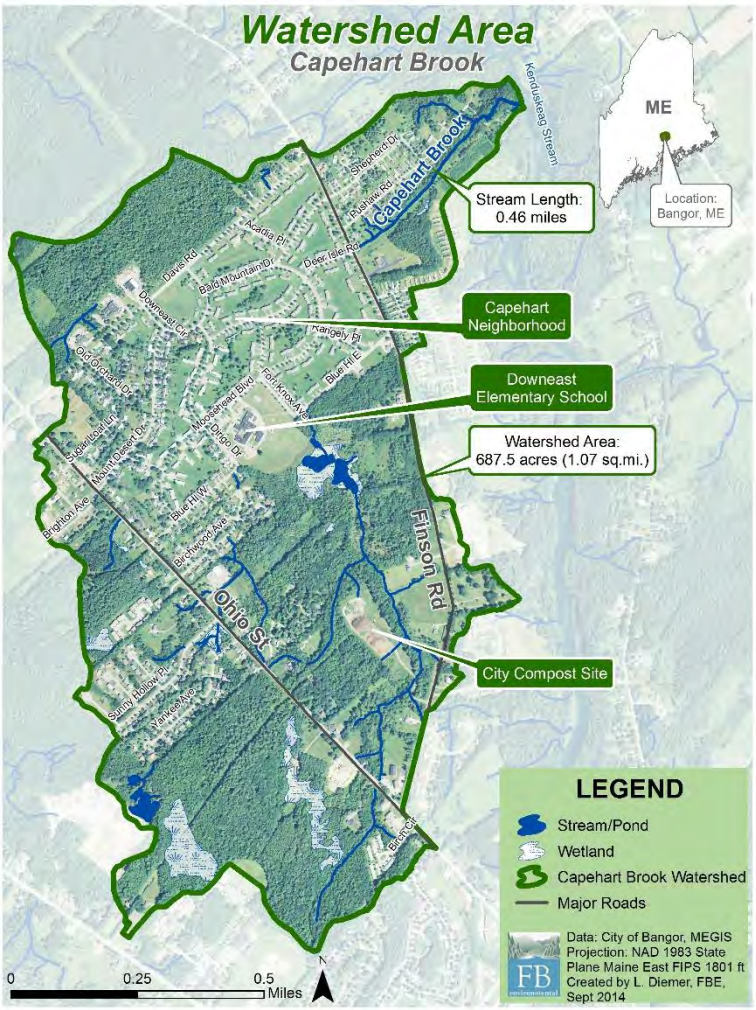
(TCA) and Trichloroethane (TCE) were detected in the bottom samples collected once the cesspool timbers were removed. FBE staff noted oily and milky sheens on the surface water of Capehart Brook during the 2014 Stream Corridor Survey in August; removal of this illicit discharge may help to alleviate these observed contaminations.

Other Efforts in the City - The City of Bangor has also installed stormwater placards at catch basins throughout the watershed to raise local awareness of the connection between what goes in storm drains and what ends up in nearby streams. A Stormwater Pollution Prevention Fact Sheet was also sent out to over 400 households in 2012 (City of Bangor 2013).

2. Watershed Characterization

A watershed is a geographic area in which all water drains to a given stream, river, lake, wetland, or coastal water. Large watersheds, such as the Kenduskeag Stream or Penobscot River watersheds, are comprised of many smaller or subwatersheds. Capehart Brook is a subwatershed of Kenduskeag Stream because all of the water that flows overland to Capehart Brook eventually makes its way to the Kenduskeag Stream.

The Capehart Brook watershed covers approximately 688 acres and is located entirely within the City of Bangor, Maine just west of the Kenduskeag Stream. Capehart Brook originates under Finson Road through a 66" culvert and flows 0.46 miles before emptying into the Kenduskeag Stream. The stream is fed by a series of underground pipelines and open drainage ditches from the City stormwater system. This stream was dredged by the Army Corps of Engineers in the 1950's, but has since become a "naturalized" stream that flows parallel to residential homes on Pushaw Road to the northwest and a utility access road to the southeast.



Aerial map of the Capehart Brook watershed area. Appendix A, Map 1.

2.1 Location & Climate

The City of Bangor is centrally located in the State of Maine, nestled in the Maine highlands about 30 miles from the coastal outlet of the Penobscot River. As Maine's third largest city and once the lumber capital of the world, the City of Bangor offers a variety of activities to those living in and visiting the area. The City is a cultural and entertainment center to the region and home to over 33,000 residents.

Over the last three decades (1981-2010), climate in the Bangor region has seen normal annual temperatures of 66.3 °F in summer, 20.8 °F in winter, and 44.3 °F overall, as well as a mean annual precipitation of 41.93 inches (NCDC 2014). Mean monthly air temperature and precipitation data have remained relatively consistent from 1953-2014 (Figure 3).

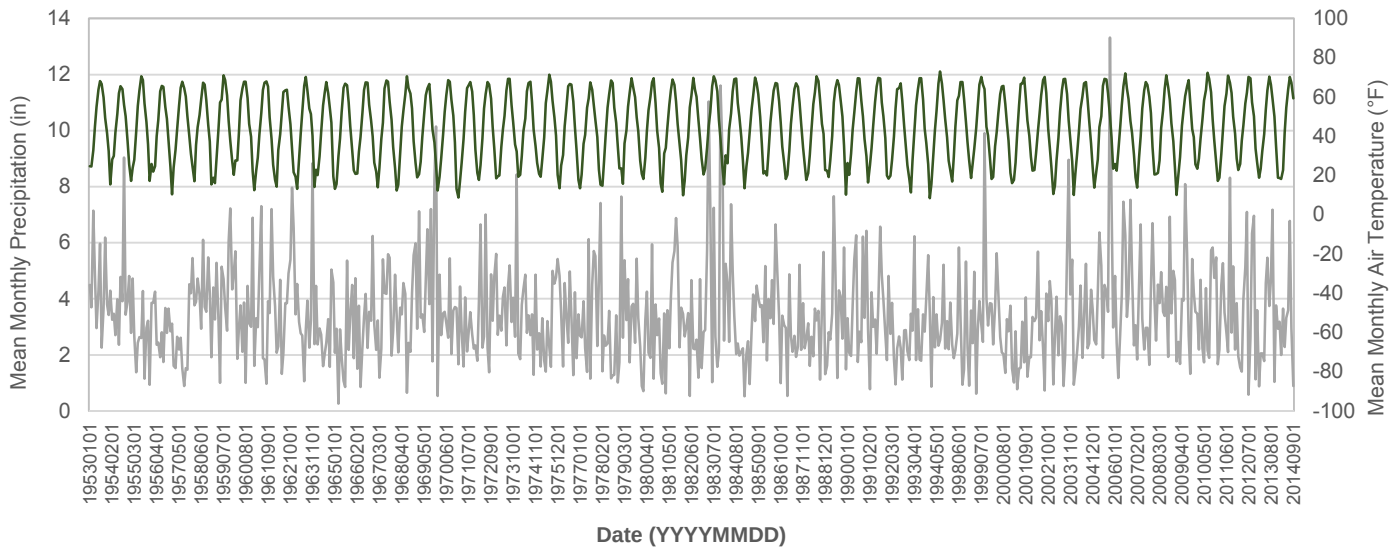


Figure 3. *Mean monthly air temperature (dark green) and precipitation (gray) from 1953 to 2014. Data were obtained from the NOAA National Climatic Data Center (NCDC) from the Bangor International Airport station (GHCND:USW00014606).*

2.2 Population, Growth Trends, and Land Use

Understanding population growth, demographics, and watershed development patterns provides critical insight to watershed management, particularly as it pertains to water quality.

2.2.1 Population and Growth Trends

The population of the City of Bangor has fluctuated over the past century, ranging from 24,803 in 1910 to its peak population of 38,912 in 1960 (Figure 4). The population decreased by 17% between 1960 and 1970 before stabilizing around 32,000 from 1970 to 2010. More recent population estimates for the City of Bangor show a 5% increase in the total population from 2000 to 2010 (Maine Office of Policy and Management 2010). Overall population growth since 1910 (past 100 years) shows increasing population.

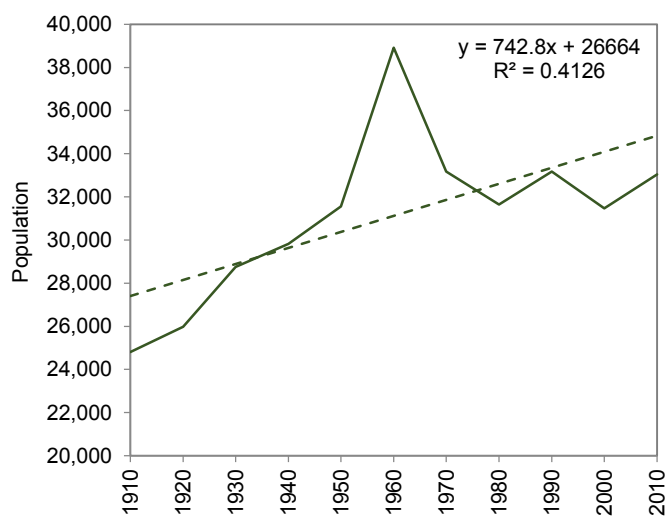


Figure 4. *Population and growth trends for Bangor, Maine. Note scale on y axis.*

Demographics within the City of Bangor show that the majority of the population is between the ages of 20-64 years old, and the number of people less than 20 years old exceeds the number of retirement age people (65+). The largest age group is 20-30 years old and comprises nearly 20% of the total population (Table 1, US Census American Fact Finder 2010).

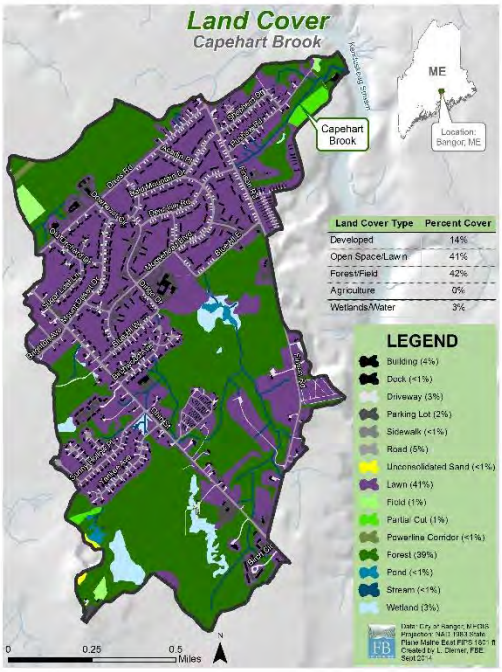
Table 1. *2010 population demographics for Bangor, Maine.*

CITY	TOTAL POPULATION	POPULATION AGED 0-19	POPULATION AGED 20-64	POPULATION AGED 65+
BANGOR, MAINE	33,039	7,409	20,876	4,754

In more recent decades, slower growth has been documented in the State of Maine compared to the national average. Despite this trend, the State of Maine has seen greater growth in the State's metropolitan or urban areas compared to rural areas. Bangor and other large urban service centers (Portland, Lewiston/Auburn, Augusta, Rockland, Sanford, Ellsworth, and Farmington) account for 87% of total population growth in Maine between 2000 and 2010 (Muskie School of Public Service 2012).

"Low-impact development (LID) is an approach to land development that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainages that treat stormwater as a resource rather than a waste product." – USEPA (http://water.epa.gov/polwaste/green/)

Growth figures and estimates suggest that the City of Bangor should consider the effects of current land-use regulations on local water resources. As the region's watersheds are developed, erosion from disturbed and developed areas increases the potential for water quality decline. Therefore, it is imperative that watershed communities incorporate **low-impact development (LID) techniques** into new development projects to minimize the effects of developed areas, allowing water to soak into the ground rather than flow into the storm drain system and Capehart Brook.



Land cover in the Capehart Brook watershed. Refer to Appendix A, Map 3.

2.2.2 Land Cover

Characterizing land cover within a watershed can highlight potential sources of nonpoint source (NPS) pollution that would otherwise go unnoticed in a field survey of the watershed. For instance, a watershed with large areas of developed land and minimal forestland will likely be more at risk from NPS pollution than a watershed with well-managed development and large tracts of undisturbed forest, particularly along headwater streams.

Comparing land cover within a watershed over time can also highlight significant changes. Over the past 100 years, the Capehart Brook watershed has experienced significant changes in land cover, largely as a result of new development. Land cover is an essential element in watershed modeling because it can help estimate the contribution of nutrients, sediment, and other pollutants from the watershed to the stream via stormwater runoff. Unmanaged forested land, for example, tends to deliver very little phosphorus downstream when it rains, while high density

urban land exports significantly more phosphorus from fertilizers, soil erosion, car exhaust, pet and human waste, failing municipal sewers, and many other sources. Excess nutrients, sediments, and other pollutants can stimulate algal blooms and embed critical habitat, both of which can alter the physical and chemical habitat within the stream.

As part of the watershed planning process, digital land cover data was updated by FB Environmental. A new data file was created that integrated IC (e.g. buildings, driveways, sidewalks, paved surfaces, decks, patios, parking lots, etc.) delineated by the City of Bangor, and water resources (e.g. wetlands, ponds, streams, etc.) provided by the Maine Office of GIS (MEGIS) online database (www.maine.gov/megis). The remaining land cover (e.g. fields, forests, lawns, partial cuts, powerlines, sandpits, etc.) was carefully reviewed by cross-referencing the National Agriculture Imagery Program (NAIP) 2013 imagery from the MEGIS online database and Google Maps 2014 imagery. This land cover update provided more accurate representation of the distribution of land cover categories throughout the watershed, particularly when compared to the MELCD raster data file based on 5-30 m resolution, SPOT 5 panchromatic imagery from 2004 (MEGIS online database).

Developed, impervious land (including buildings, driveways, sidewalks, roads, decks, patios, and parking lots) accounts for approximately 15% (99 acres) of the watershed, open space lawn accounts for approximately 41% (283 acres) of the watershed, and forested areas of primarily mixed hardwood/softwood species comprise 42% (284 acres) of the watershed (this includes partial cuts, powerline corridors, and fields; Figure 5). Wetlands and open water (e.g. streams and ponds) account for 3% (21 acres) of the watershed area. There is no active agriculture in the watershed.

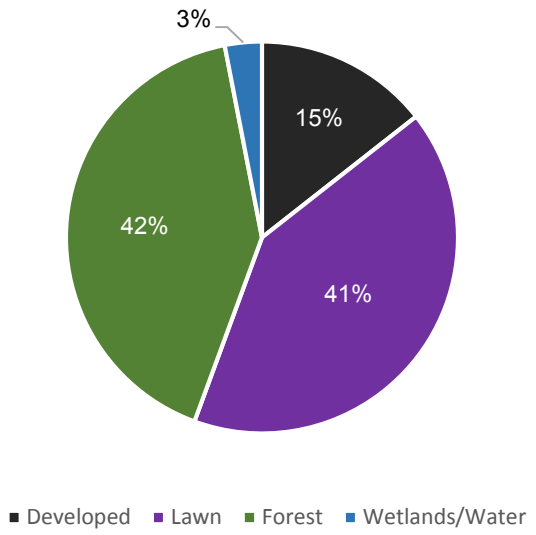


Figure 5. *Land cover in the Capehart Brook watershed. Numbers represent approximate acres for each land cover category.*

The extent of impervious cover in the Capehart Brook watershed is considered the primary cause of water quality impairment in the stream. Developed, impervious land replaces naturally vegetated areas and results in overland flow during rain and snow events. The stormwater picks up a variety of pollutants, and deposits them into the nearest ditch, catchbasin, stream or wetland. A more detailed discussion of the impact of IC on water quality is discussed in Section 3.

There are several commercial and residential developments within the Capehart Brook watershed, including a large residential development west of Finson Road and east of Ohio Street, the Downeast Elementary School along Moosehead Boulevard, the residential areas surrounding Shepherd Drive, Pushaw Road, Sunny Hollow Place, and Yankee Avenue, Bangor Housing Authority maintenance facilities located on the north side of Davis Road, two mobile home parks, and the City Compost Site.

	Capehart Neighborhood: The Bangor Housing Authority's Capehart neighborhood is a prominent feature in the watershed covering approximately 145 acres of land area that drains directly to Capehart Brook via the storm drain system. This area has been targeted for BMP implementation for both Phase I and II restoration efforts.
	Downeast Elementary School: Within the Capehart neighborhood system and covering approximately 10 acres of land off Moosehead Boulevard, Downeast Elementary School has a considerable amount of IC that directs stormwater to the storm drain system. A bioretention cell was installed in one of the open ditches to help slow down flow and filter pollutants before reaching Capehart Brook.
	Shepherd Drive and Pushaw Road Neighborhood: This neighborhood borders the northern side of Capehart Brook before its convergence with Kenduskeag Stream. Portions of the neighborhood within the Capehart Brook watershed consist of 72 housing lots, most of which are connected to City sewer (2 lots rely on septic). The City's stormwater infrastructure also drains IC throughout these neighborhoods directly to Capehart Brook.
	Cedar Falls Mobile Home Park: The northwest portion of the Cedar Falls Trailer Park is located within the Capehart Brook Watershed. Currently 54 mobile home lots are located within the watershed boundary. This park has a private collection system that is connected to the City sanitary sewer system.
	BHA Development on Davis Road: Bangor Housing Authority (BHA) owns development along the north side of Davis Road that covers approximately 6 acres within the watershed, and includes IC such as rooftops and parking lots that drain to the storm system and ultimately into Capehart Brook. These building include maintenance facilities and administrative offices for BHA.

	Sunny Hollow Place and Yankee Avenue: Located on the outer edge of the Capehart Brook watershed, these neighborhoods are also serviced by Bangor's storm drain and sewer network, and include 90 lots covering an area of approximately 40 acres.
	Colonial Pines Mobile Home Park: Located within a forested area in the southwest portion of the watershed off Ohio Street, Colonial Pines Mobile Home Park has a private collection system that is connected to the City sanitary sewer system. This park covers approximately 8 acres of the watershed. According to Beginning with Habitat data from the Maine Department of Inland Fisheries & Wildlife, this park has a public drinking well on site.
	Municipal Composting Facility: The City of Bangor Leaf Compost Site is located on Finson Road approximately 1,300 ft from its intersection with Ohio Street. This 17-acre site consists of 2.99 acres of IC. The facility is set up to process about 7,000 cubic yards of Type 1A Solid Waste consisting of leaf and yard waste, including lawn/grass clippings and possibly barnyard waste/manure. The site is adjacent to several small tributaries that flow to Capehart Brook. Stormwater controls are in place at the site, including two gravel compost pads underlain by GeoTech Fabric, a level lip spreader, two DHP culverts, a sediment trap, outlet, stone check dams, bark filter berming, and riprap outlet protection. The natural vegetated buffer also captures additional runoff and sediment from sheet flow excess. The City conducts quarterly inspections and stormwater monitoring under the existing O&M plan for the site (taken from the City of Bangor's Compost Operation & Maintenance Plan for PERMIT # S-022380-CB-A-E). Recent analyses of the compost composition revealed presence of pesticides. The City is currently working with the Maine DEP to resolve this issue and has since stopped accepting horse manure.

There are approximately 32.9 acres of roadway within the Capehart Brook watershed. The watershed has three primary roads: Finson Road, Davis Road, and Ohio Street. These primary roadways and their arterial streets are largely City-owned and maintained and provide the network for the City's sewer and stormwater infrastructure.

2.3 Physical Features

2.3.1 Topography

Capehart Brook is situated in the Penobscot River basin in the Maine highlands about 30 linear stream miles from Penobscot Bay and the Atlantic Ocean. The lowest point within the watershed (64 feet above sea level) is located at its convergence with Kenduskeag Stream. The highest point within the watershed (230 feet above sea level) is located to the southwest in the forested areas of the watershed. Refer to Appendix A, Map 4.

2.3.2 Land Conservation

Land conservation can provide significant benefits for the long-term protection of the water quality in Capehart Brook. Critical wildlife habitat and other environmentally sensitive land, and water resources, including riparian corridors, are just a few examples of areas targeted for conservation. In addition, land conservation provides low-impact, public recreational opportunities, such as hiking, to experience these natural resources.

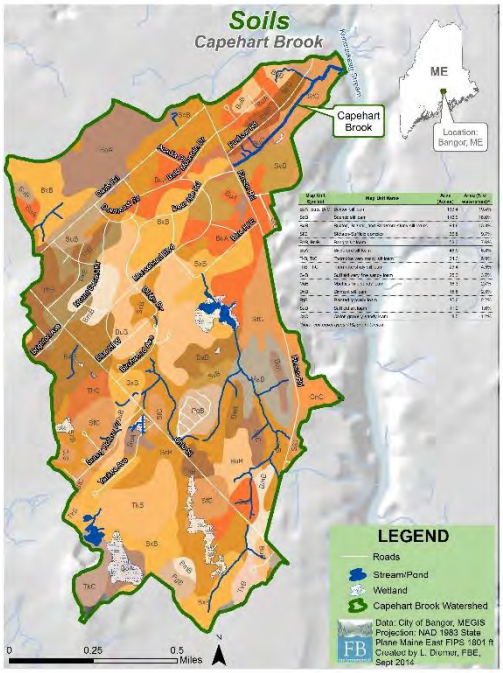
Brown Woods is the only parcel of conserved land located within the Capehart Brook watershed. This parcel covers approximately 28 acres in the forested area south of Ohio Street and just west of Yankee Avenue (Appendix A, Map 5). Owned by the Bangor Land Trust and maintained by the Bangor Parks & Recreation Department, this preserve offers walking trails and a picnic area to Bangor residents. There may be additional opportunities for conserving undeveloped land in the watershed. The City will coordinate with the Bangor Land Trust to secure potential parcels for conservation in the future.

2.3.3 Soils and Geology

The composition of soils surrounding Capehart Brook reflects the dynamic geological processes that have shaped the landscape over millions of years. About 30,000 years ago, the region was covered by a slow-moving continental glacier that scraped over mountains and valleys, whittling the landscape to the form we recognize today.

As the glacier began to recede, the sea flooded coastal river basins, including the Penobscot River Valley in which the Capehart Brook watershed is situated. Immense deposits of sediment (glacial till and finer glacio-marine silts and clays) washed out of the melting ice sheet. Sand and gravel accumulated in meltwater streams within the glacier and deposited as ridges, also known as eskers.

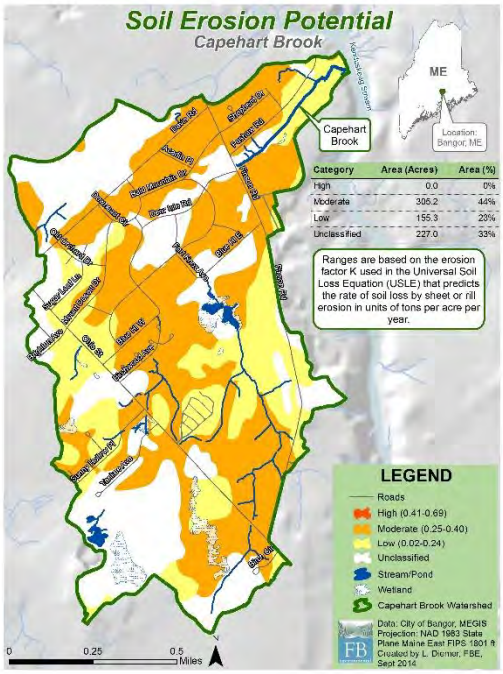
The local surficial geology along Capehart Brook is primarily eskers. Eskers are composed of gravel and sand, and may include glacial till deposits. The Capehart Brook watershed is comprised of glacial till and fine-grained, glacio-moraine deposits (Appendix A, Map 6).



Soil types in the Capehart Brook watershed are diverse and numerous. Appendix A, Map 7.

The Capehart Brook watershed is characterized by multiple soil series. Over 125 acres of the watershed is underlain by the Buxton soil series, which consists of very deep, moderately well-drained soils formed in glacio-marine deposits on coastal lowlands and river valleys. Buxton silt loam has a firm clay subsoil, high water-holding capacity, and slow permeability. Approximately 114 acres of the watershed is characterized by Scantic soil series. This soil series was also formed in glacio-marine deposits found in coastal lowlands and river valleys. Scantic soil is very deep and poorly-drained. It most commonly appears as a silt loam on a 1 percent slope with a clay subsoil, moderate water-holding capacity, and very slow permeability. Buxton Scantic and Biddeford stony silt loam soils comprise about 95 acres in the Capehart Brook watershed. These soils are moderately-well to very poorly-drained with a silty surface and a silt clay subsoil. The poorly-drained Scantic soil is dominant in this series. Water-holding capacity is high and permeability is very slow. The Stetson-Suffield Complex accounts for about 65 acres in the Capehart Brook watershed. This soil is characterized by mixed soil areas of well-drained sediments covering gravel and silts, which are underlain by clay. These soils are too complex to separate and have moderately-variable moisture-holding capacities and moderately-variable permeability.

Soils that characterize smaller portions of the watershed include the Bangor silt loam (~52 acres), Biddeford silt loam (~37 acres), Thorndike very rocky silt loam (~34 acres), Thorndike shaly silt loam (~29 acres), and Suffield very fine sandy loam (~25 acres). Bangor silt loam is characterized by deep, well-drained glacial till located in upland areas and have good water-holding capacity and moderate permeability. Biddeford silt loam is a very poorly-drained soil formed in very deep deposits of silt and clay. This soil has a very high water table and slow permeability. Thorndike very rocky silt loam is shallow, well-drained glacial till. This soil has moderate to low water-holding capacity and moderate permeability with 0 to 20 inches to shale bedrock with outcroppings common. Thorndike shaly silt loam is a moderately-deep, well-drained glacial till with moderate permeability. Bedrock occurs less than 20 inches from the surface. Suffield very fine sandy loam is characterized by deep, well-drained fine sandy loam over silt clay. This soil has high water-holding capacity and slow permeability (Penobscot County SWCD).



Most of the soils in the Capehart Brook watershed are categorized as having moderate soil erosion potential. Appendix A, Map 8.

<u>Other soils within the Capehart Brook watershed (accounting for <3% watershed area):</u>

Machias fine sandy loam (~18 acres)
Dixmont silt loam (~16 acres)
Plaisted gravelly loam (~15 acres)
Suffield silt loam (~11 acres)
Colton gravelly sandy loam (~9 acres)

Soil erosion potential is dependent on a combination of factors, including land contours, climate conditions, soil texture, soil composition, permeability, and soil structure

(O'Geen et al. 2006). Soil erosion potential should be a primary factor in determining the rate and placement of development within a watershed. Soils with negligible soil erosion potential are primarily low-lying wetland areas near abutting streams.

The soil erosion potential for the Capehart Brook watershed was determined from the associated erosion factor K used in the Universal Soil Loss Equation (USLE) that predicts rate of soil loss by sheet or rill erosion in units of tons per acre per year. This information was obtained from the U.S. Department of Agriculture National Resources Conservation Service's online Web Soil Survey for Penobscot County (http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx). The scores are rated from low to high, depending on the soil texture, structure, and organic matter content. Lower K values (and thus low soil erosion potential) are typically associated with clay-dominated soils. Sandy and silt loam soils range from low to moderate soil erosion potential, and silt-dominated soils typically exhibit a high soil erosion potential. High organic matter content can also help stabilize soils and reduce the erosion potential. Given that the erosion factor K is based on natural conditions, caution should be used when interpreting these ratings since they may be higher in areas that were disturbed by human activities (e.g. additions or depletions of organic matter, exposed or compacted surface materials from construction or development, etc.). Based on areas with a calculated K value, there are no high soil erosion potential areas located within the Capehart Brook watershed. However, moderate soil erosion potential is prevalent, accounting for 305 acres (44%) of land within the Capehart Brook watershed. Low soil erosion potential is less common in the watershed, comprising 155 acres (23%) of the watershed, and is concentrated in three major areas: the outlet of Capehart Brook, the eastern edge of the watershed, and the western area of the watershed along Ohio Street north of Birchwood Avenue.

Areas of moderate soil erosion potential should be monitored closely for erosion during and after any development projects to ensure that eroding soil is not degrading downstream water quality.

2.3.4 Wetlands, Streams, and Riparian Habitat

Wetlands provide many values to the local community, including *flood protection* by trapping and slowly releasing rainwater; *shoreline protection* along lakes, rivers, and streams by stabilizing soil through plant roots and absorbing the energy of waves; *groundwater recharge* by maintaining baseline conditions; *water quality* by acting as natural filters to remove, retain, or transform pollutants and sediments from nonpoint sources; and *habitat* by providing a niche for species to breed, nest, and raise their young, and acting as wildlife corridors (USEPA 2013). In addition, wetlands provide scenic beauty, recreational activities, and educational opportunities for the local community. Wetlands and riparian habitat in the Capehart Brook watershed are home to communities of fish, birds, mammals, and plants that depend on clean water to survive and flourish.

The Capehart Brook watershed drains 687.5 acres of land, and is host to 19.6 acres (2.9%) of National Wetland Inventory (NWI) mapped wetlands. There are 2.9 acres (0.4%) of open water, 3.5 miles of major open drainages or stormwater ditches, and 0.46 miles of naturalized stream. An assessment of riparian habitat within 75 feet of Capehart Brook indicates that there are approximately 5.8 acres (62%) of intact riparian buffer habitat present. The remaining 3.6 acres (38%) has a limited buffer with partial clearings leading either to the utility access road

to the south (1,522 linear ft) or the residential development along Pushaw Road to the north (542 linear ft). In addition, the U.S. Fish & Wildlife Service (USFWS) identified 9.6 acres of high value habitat within the Capehart Brook watershed, primarily located east of Finson Road and south of Pushaw Road. This high value habitat contains either rare, threatened, or endangered species or unique natural habitats. Refer to Appendix A, Map 9.

2.3.5 Stormwater and Sewer Infrastructure

The Capehart Brook watershed is considered a single catchment area where all water collected in the City's stormwater infrastructure is carried through a series of ditches (7.9 miles), underground pipes (5.9 miles), and catch basins (237) that empty the stormwater to Capehart Brook through a large culvert crossing at Finson Road. There are eight additional stormwater outfalls or discharges located east of the Finson Road culvert, and four outfalls or discharges located west of the Finson Road culvert. Stormwater outfalls are locations in which stormwater is delivered directly to the stream via a ditch or pipe. There are 13 documented stormwater outfalls in the Capehart Brook watershed. A list of outfalls with descriptions is provided in Appendix E.

The stormwater system is largely concentrated within the residential development between Finson Road and Ohio Street. The majority of stormwater runoff from parking areas, roads, private residences, and commercial areas in the watershed flows directly to the stream with minimal pre-treatment of pollutants or means to slow water flow during large storm events. As described previously, recent efforts in the watershed have attempted to treat a portion of this stormwater in a series of bio-retention cells at Rangeley Place South and the Downeast Elementary School. While the large expanse of grassy lawns provides some pre-treatment filtration of stormwater runoff, the shallow root structure of the grass makes it ineffective during large storm events.

The Capehart Brook watershed hosts a large network of stormwater and sewer lines for the Capehart Neighborhood. Appendix A, Map 10.

<u>Capehart Brook Watershed Sewer System</u>

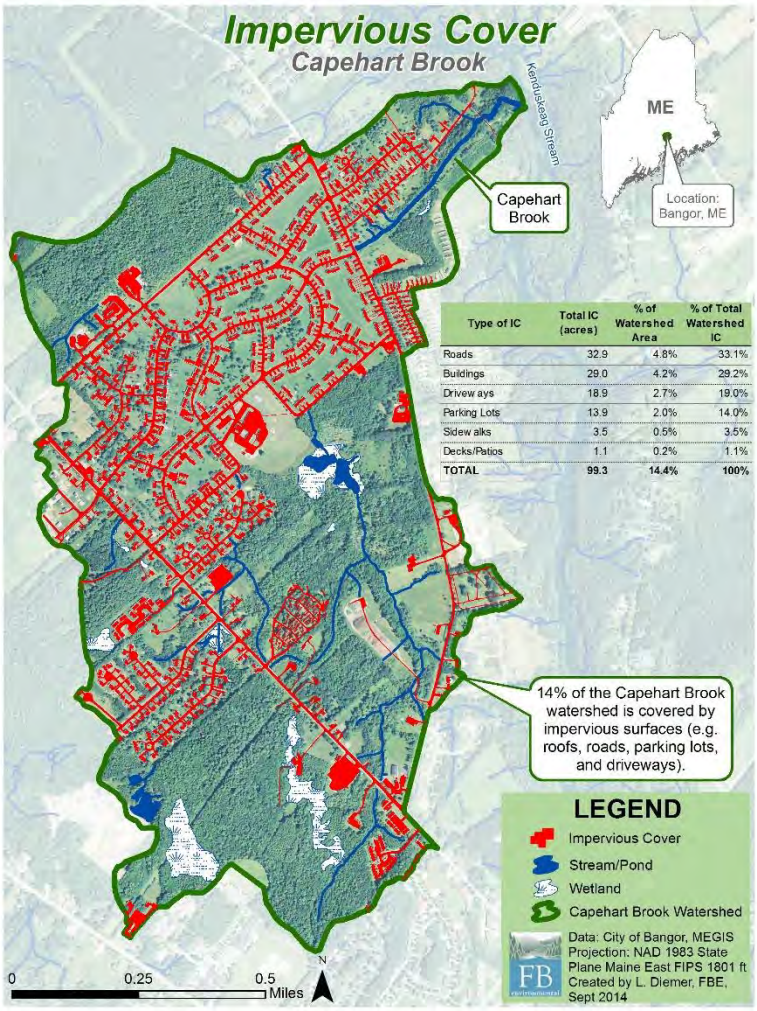
The majority of the Capehart Brook watershed, particularly in the residential complex between Finson Road and Ohio Street, is serviced by City sewer as a means of human waste disposal. There are currently 162 manholes and 6.95 miles of sanitary pipes in the watershed. An old sewer treatment facility, known as the Dow Air Force Base Wastewater Treatment Plant, was built in the 1950's at the downstream terminus of Capehart Brook, specifically for collecting waste from the military housing. Only primary treatment (settling) was done to the waste before it was dumped directly into the Kenduskeag Stream. In an effort to clean up the Kenduskeag, the City reconnected the facility's sewer to the rest of the City by 1973. It was sold in 1980 and many of the structures still remain.

Capehart Brook Watershed Septic Systems

While the majority of buildings within the Capehart Brook watershed are connected to the City sanitary sewer system, a portion of lots are not, and rely on private septic systems for their waste collection and disposal. These lots are concentrated in the southern end of the watershed along Ohio Street. It may be beneficial to conduct a septic system survey of the watershed and identify systems that may not be maintained properly or need to be replaced.

3. Causes of Impairment

Urban watersheds have a disproportionate amount of IC from paved roads, sidewalks, parking lots, driveways, and rooftops that prevent rain from percolating into the soil. These hard surfaces force rainwater to flow overland where it can collect a variety of pollutants, such as metals, winter sand and salt, pesticides, petroleum products, animal and human waste, fertilizers, and sediment. These pollutants are delivered to nearby waterbodies, bringing with them excess limiting nutrients, such as nitrogen and phosphorus, which can stimulate potentially harmful algal blooms. Boom and bust populations of algae can rapidly deplete oxygen in the water and potentially release more phosphorous bound to benthic sediments. Additionally, heavy precipitation events in urban watersheds can result in large water surges to receiving streams, which may be unable to accommodate the excess water. This can scour out streambeds and undercut banks, sending eroded sediment downstream to deposit as sand plumes and embed critical benthic habitat for aquatic macroinvertebrate communities. These disturbances to stream habitat and geomorphic structure pose a significant threat to the health and function of streams (Allan and Castillo 2007).



Type of IC	Total IC (acres)	% of Watershed Area	% of Total Watershed IC
Roads	32.9	4.8%	33.1%
Buildings	29.0	4.2%	29.2%
Driveways	18.9	2.7%	19.0%
Parking Lots	13.9	2.0%	14.0%
Sidewalks	3.5	0.5%	3.5%
Decks/Patios	1.1	0.2%	1.1%
TOTAL	99.3	14.4%	100%

Figure 6. *Impervious cover in the Capehart Brook watershed. Appendix A, Map 11.*

Capehart Brook was listed in 2006 as impaired for aquatic life use and was most recently listed in the *2012 Integrated Water Quality Monitoring and Assessment Report* (Section 303(d) list), as well as the Maine DEP's Stormwater Management Law, Chapter 502 list of Urban Impaired Streams (Maine DEP 2012b). As required by federal and state regulations under the Clean Water Act, the stream was included in the 2012 *Impervious Cover Total Maximum Daily Load (IC TMDL) Report* (Maine DEP 2012b). Capehart Brook was found to be impaired for aquatic life use as a result of stream habitat assessments showing macroinvertebrates not meeting Class B water quality criteria. Percent IC was used as a surrogate measure for the unspecified pollutants in stormwater likely contributing to the stream's degraded status.

3.1 Impacts of Development: Impervious Cover Assessment

Increases in the extent of impervious cover (IC) pose significant risks to streams (CWP 2003). Research shows that watersheds with IC greater than 12% often exceed criteria for aquatic life use (Stanfield and Kilgour 2006), and even lower levels of IC (4-6%) can significantly inhibit the abundance and diversity of fish and macroinvertebrate species (Wenger et al. 2008). Maine DEP currently establishes a target of 8% IC to meet aquatic life use criteria in Class B waters (Maine DEP 2012b). Approximately 14% (99 acres) of the Capehart Brook watershed is covered by IC (Figure 6). This estimate is based on updated digital land cover files of roads, driveways, buildings, decks/patios, parking lots, and sidewalks provided by the City of Bangor.

Roads and buildings (e.g. rooftops) make up a significant portion of the total watershed IC (62%; Table 2). This is followed closely by driveways (19%) and parking lots (14%). Decks and sidewalks serve as only a minor portion of the total watershed IC (3.6%). Based on the Maine DEP's target goal of 8% IC, a 44% IC reduction (equivalent to 44 acres) is needed to offset the effects that IC has on Capehart Brook.

Table 2. *Types and percent coverages of impervious cover (IC) in the Capehart Brook watershed.*

TYPE OF IC	TOTAL IC (ACRES)	% OF WATERSHED AREA	% OF TOTAL WATERSHED IC
ROADS	32.9	4.8%	33.1%
BUILDINGS	29.0	4.2%	29.2%
DRIVEWAYS	18.9	2.7%	19.0%
PARKING LOTS	13.9	2.0%	14.0%
SIDEWALKS	3.5	0.5%	3.5%
DECKS/PATIOS	1.1	0.2%	1.1%
TOTAL	**99.3**	**14.4%**	**100%**

Efforts to reduce in-stream impacts from IC should focus on areas within the watershed that exhibit the highest levels of IC with a direct connection to the stream. For Capehart Brook, the high-density residential area with a ditch network that drains directly to Capehart Brook should be the highest priority for treating stormwater.

3.2 Applicable Water Quality Standards and Criteria

Capehart Brook is designated as a Class B freshwater stream. According to Maine's Water Classification Program under the Maine Legislature (Title 38 MRSA 464-468), "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." A summary of the narrative and numeric water quality standards for Class B freshwaters is provided in Table 3.

Table 3. *Maine water quality criteria for Class B waters (38 MRSA § 465).*

PARAMETER	CRITERIA FOR COMPLIANCE
DISSOLVED OXYGEN (YEAR-ROUND)	May not be less than 7 ppm or 75% 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.
DISCHARGES	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.

3.3 Water Quality and Biological Assessments

Water quality data have been collected in the Capehart Brook watershed since 1997 by the Maine DEP, AmeriCorps, James W. Sewall Company, and the City of Bangor for multiple water quality parameters and physical site characterizations (Table 4). Refer to Appendix A, Map 15 for sample site locations and descriptions and Appendix B for raw water quality data.

Table 4. *List of available water quality monitoring data for Capehart Brook by year collected and agency the data was collected by.*

YEAR COLLECTED	AGENCY COLLECTED BY	PUBLISHED DATA SOURCE	DATA COLLECTED
1997	Maine DEP	Biomonitoring Program	Macroinvertebrates, physical description, temperature, conductivity
2001	Maine DEP	Biomonitoring Program	Macroinvertebrates, physical description, dissolved oxygen, temperature, conductivity
2010	AmeriCorps	Bangor Streams Survey Report	Stream habitat & geomorphic survey
2011	Maine DEP	Water Quality Summary	Temperature, dissolved oxygen, conductivity, chloride
2009-2011	James W. Sewall, City of Bangor	Summary Water Quality Data Report for Five Impaired Streams	Flow, dissolved oxygen, conductivity, temperature, pH, chloride
2012	James W. Sewall, City of Bangor	Bangor Interim Report, raw data	Dissolved oxygen, conductivity, temperature, color, pH, benthic macroinvertebrates
2013	City of Bangor	Raw data	Dissolved oxygen, conductivity, temperature, pH, macroinvertebrates
2014	FBE	Memo to City of Bangor	Macroinvertebrates

The following provides a description of water quality results for Capehart Brook. Analyses of these data will provide a baseline of comparison for future changes in the stream's water quality and provide the information necessary to assess the health and function of the stream.

3.3.1 Biological Assessment

Macroinvertebrates are aquatic insects, including mayflies, dragonfly larvae, caddisfly larvae, aquatic worms, amphipods, leeches, clams, and snails, that live on stream bottom substrates, such as rocks, logs, sediment, and plants. They serve as excellent indicators of water quality, depending on the amount and type of species present and their associated pollutant tolerances. EPT is an index of three orders of aquatic insects: Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies). These taxa are generally intolerant of pollutants and are found in less impacted, **oligotrophic** streams. Chironomidae (midges) are more tolerant of pollutants and are found in greater abundances in **eutrophic** streams.

Oligotrophic *– waterbodies exhibiting low productivity as a result of low nutrient and organic matter input.*

Eutrophic *– waterbodies exhibiting high productivity as a result of high nutrient and organic matter input. These surface waters are prone to harmful algal blooms.*

Protocol for sampling and analysis of macroinvertebrate surveys include deploying rock bags on the stream bottom for approximately four weeks, which allows macroinvertebrates enough time to colonize the rocks (Maine DEP 2011a). Bags are collected along with physical data (water velocity, dissolved oxygen, temperature, conductivity, description of substrate and site). The macroinvertebrate communities within the rock bags are separated and identified by lowest taxonomic group (genus or species). This generates data on the abundance and generic richness of the macroinvertebrate community present within the stream.

A macroinvertebrate survey was conducted in 1997 and 2001 by the Maine DEP Biomonitoring Program. A summary of results are provided in Table 5. According to the Watershed Science Institute's Watershed Condition Series, Technical Note 3 on the EPT Index, ***Capehart Brook would be classified as having a "poor" water***

Definitions

Total Mean Abundance: a count of all individuals in all replicate samples from a single site divided by the number of replicates.

Generic Richness: a count of the number of different genera found in all replicates from one site.

Relative Chironomidae Abundance: a count of all individuals from the order Chironomidae in all replicate samples from a single site divided by the number of replicates, and then divided again by the total mean abundance.

EPT Generic Richness: a count of the number of different genera from the order Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) in all replicate samples.

Definitions extracted directly from Appendix C-1: Methods for the Calculation of Indices and Measures of Community Structure Used in the Linear Discriminant Models from *Methods for Biological Sampling and Analysis of Maine's Rivers and Streams* (ME DEP LW0387-B2002).

quality rating since EPT generic richness values were less than 6 (WSI 2012). Additionally, 25-50% of the total mean species abundance were classified as Chironomidae, which is a taxonomic order ***associated with degraded water quality.*** Total mean abundance and generic richness for all species were generally lower than required for assessment purposes (total mean abundance > 50, generic richness > 15) by the Maine DEP. This was reflected in the final determination of "indeterminate" in 2001 when not enough organisms were collected to meet the minimum requirements for the model. The initial survey in 1997 found Capehart Brook to be not attaining for aquatic life use standards for Class B freshwater streams based on professional judgment by the Maine DEP.

Biomonitoring by the Maine DEP is conducted on a five-year rotation schedule. Capehart Brook was resampled by the City of Bangor and the Maine DEP in 2013 and the stream did not attain Class B status due to an insufficient population of mayflies. According to the Maine DEP Biomonitoring Protocols, the macroinvertebrate communities must meet water quality standards for two consecutive sampling events within a 10-year period for the stream to be considered attaining for aquatic life. The City of Bangor conducted follow-up biomonitoring in 2014, but results are not yet available. The City plans to continue annual biomonitoring at Capehart Brook at two locations along Capehart Brook.

Table 5. *Summary of biomonitoring surveys at Capehart Brook by the Maine DEP.*

SAMPLE DATE	TOTAL ABUNDANCE	GENERIC RICHNESS	RELATIVE CHIRONOMIDAE ABUNDANCE	EPT GENERIC RICHNESS	GENERA PRESENT	FINAL DETERMINATION
9/10/1997	18	12	0.22	4	Caddisfly, dragonfly, damselfly, fishfly, cranefly, midges, snails	Not Attaining
8/17/2001	30	14	0.50	1	Beetle, Dobsonfly, Cranefly, midges, mayfly, planaria, snails	Indeterminate
9/30/2013	U	U	U	U	U	Not Attaining

U = unavailable

3.3.2 Dissolved Oxygen (DO)

Dissolved oxygen (DO) is the concentration of oxygen dissolved in the water that is available for aquatic organisms and macrophytes. DO facilitates critical chemical reactions within the channel and benthic sediments that support life processes and functions. Depletion of available oxygen (known as hypoxia or anoxia) inhibits physiological functioning of aquatic life and its persistence can reduce the diversity and abundance of biota. DO fluctuates naturally on a diurnal basis depending on a suite of interactions and resource availability (e.g. light,

nutrients, organic matter, temperature, etc.). DO is often highest during the day when sunlight drives photosynthesis (produces oxygen), while DO is often lowest at night when autotrophic respiration and decomposition of organic matter dominates (consumes oxygen). The State of Maine and EPA sets a numeric criteria for DO at 7 ppm from May 15 to September 30. From October 1 to May 14, daily mean DO must be greater than 8 mg/L and the 7-day mean must be at least 9.5 mg/L.

DO was collected monthly using a YSI 85 multi-meter probe by the James W. Sewall Company and the City of Bangor from 2009 to 2013 (Table 6). DO readings conducted during the Maine DEP macroinvertebrate surveys in 2001 and 2013 were also included (Appendix B). These instantaneous DO readings ranged from 7.2 to 15.4 mg/L and 75 to 109% saturation with means of 10.7 mg/L and 93% saturation, respectively. These data show acceptable ranges for DO (mg/L and percent saturation) with the lowest DO occurring in summer. In the early spring and fall sampling months, Capehart Brook tended to be supersaturated with oxygen when respiration processes were slower and water temperatures cooler.

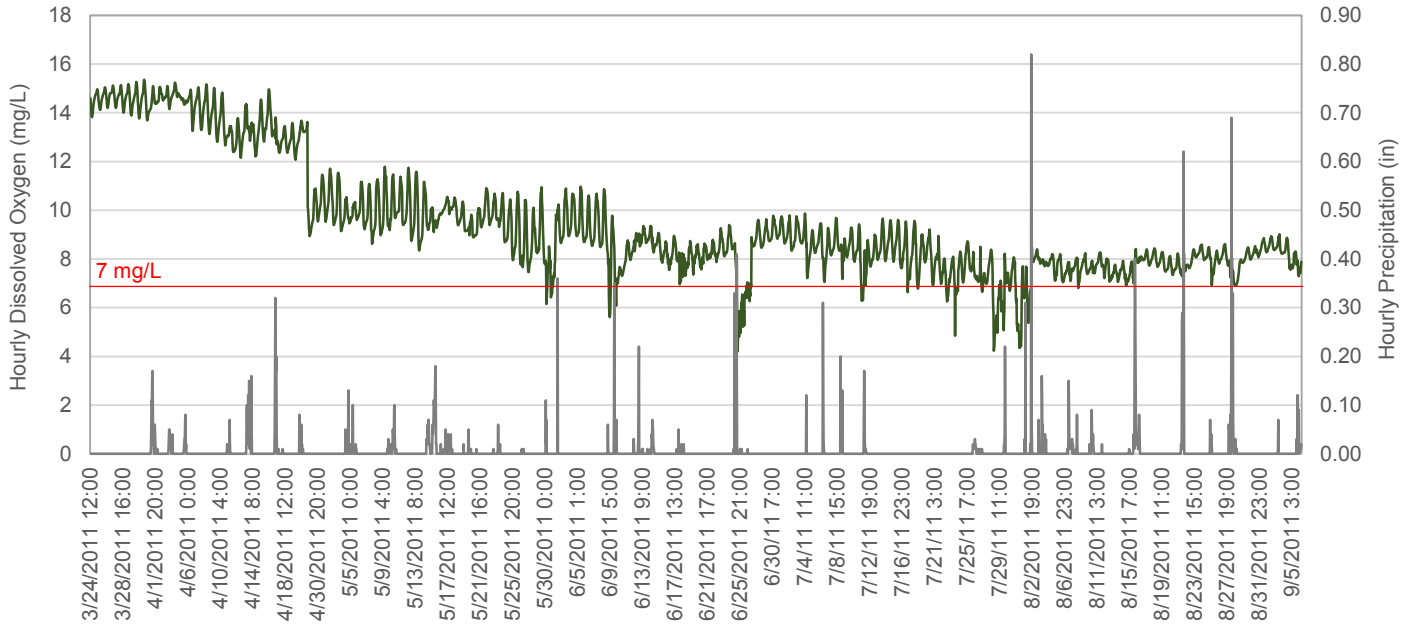


Figure 7. *Hourly dissolved oxygen concentration (dark green) for Capehart Brook from March to September 2011. Data were collected as part of the Bangor Stream Monitoring Project with assistance from the Maine DEP. Daily precipitation (gray) values were obtained from the NOAA National Climatic Data Center (NCDC) from the Bangor International Airport station (GHCND:USW00014606). Red line indicates a dissolved oxygen threshold of 7 mg/L, below which is considered hypoxic and detrimental to aquatic life.*

Continuous water quality logging by the Maine DEP in summer 2011 showed DO concentrations ranging from 7-10 mg/L in June with a few days approaching 4 mg/L (Figure 7). These low DO events occurred in conjunction with 0.5-1" summer rain events. Since rain events often increase water turbulence and the exchange of oxygen between water and the atmosphere, the Maine DEP suggested that these rain events may have flushed low DO water from a wetland upstream near Ohio Street. DO concentrations in July were at or below 7 mg/L with many days in late July having DO around 4-5 mg/L. These low DO events did not consistently correspond to significant rainfall. DO concentrations in August held above 7 mg/L with only one low DO reading on

August 2. The final conclusion by the Maine DEP was that Capehart Brook is impaired by low DO likely due to anthropogenic nutrient loading that causes large diurnal fluctuations in DO (> 2 mg/L; Maine DEP 2011b). An alternative explanation for low DO may be that the failing detention pond at Sunny Hollow adjacent to Ohio Street is flushing low DO water to downstream portions of Capehart Brook.

Table 6. *Summary of dissolved oxygen (mg/L and percent saturation) instantaneous readings using a YSI 85 multi-meter probe from 2001-2013 at Capehart Brook. Refer to Appendix B for the full data set.*

	DO (MG/L)			DO (% SATURATION)		
DATE RANGE	*Average*	*Minimum*	*Maximum*	*Average*	*Minimum*	*Maximum*
2001-2013	10.7	7.2	15.4	93	75	109

3.3.3 Chloride / Specific Conductivity

Specific conductivity is used as a surrogate measure for chloride concentrations, but conductivity includes all elements within a parcel of water that have an ionic charge, whether positive (Ca^{2+}, Na^{+}, K^{+}, Mg^{2+}) or negative (Cl^{-}, NO_3^{-}, SO_4^{2-}). Many of these ions are weathering products and reflect differences in parent geology. Chloride is of primary interest to management because it represents a large anthropogenic source of pollutants from excess road salt. Because of this, the concentration of chloride is directly linked to population density and percent IC and is thus linked to urban watersheds, where greater runoff from developed areas impacted by road salt application leads to high inputs of chloride (Daley et al. 2009). High chloride concentrations in streams and groundwater can be toxic to aquatic life and human health by disrupting extracellular function and osmotic activity.

The Maine DEP sets a standard of a mean 1-hour (acute) exposure of 860 mg/L for chloride and a mean 4-day (chronic) exposure of 230 mg/L for chloride (DEP 06-096 Chapter 584). Any chloride results greater than these standards are considered toxic to aquatic life. This standard does not directly apply to specific conductivity since it represents other elements in addition to chloride, but a relationship for converting specific conductivity to chloride can be easily done.

Data from discrete sampling by the Maine DEP, James W. Sewall Company, and the City of Bangor is provided in Table 7. Conductivity ranged from 90-545 µS/cm with a mean of 255 µS/cm. Chloride ranged from 50-150 mg/L with a mean of 83 mg/L. These are well within the numeric criteria for chloride established by the State. These data showed a poor relationship between specific conductivity and chloride, which Sewall suggests may have been due to the field kit method for measuring chloride and interferences of other charged elements in the water sample.

Continuous water quality logging by the Maine DEP in summer 2011 showed specific conductivity ranged from 200-400 µS/cm with maximum conductivity reaching 525 µS/cm on April 3rd, 2011 (Figure 8). Higher conductivity was observed in March and April during rain events when runoff from roads containing salt and

sand were flushed to streams. Rain events later in the summer resulted in dilution. The final conclusion by the Maine DEP was that conductivity levels stayed below chronic levels and are likely not inhibiting aquatic life.

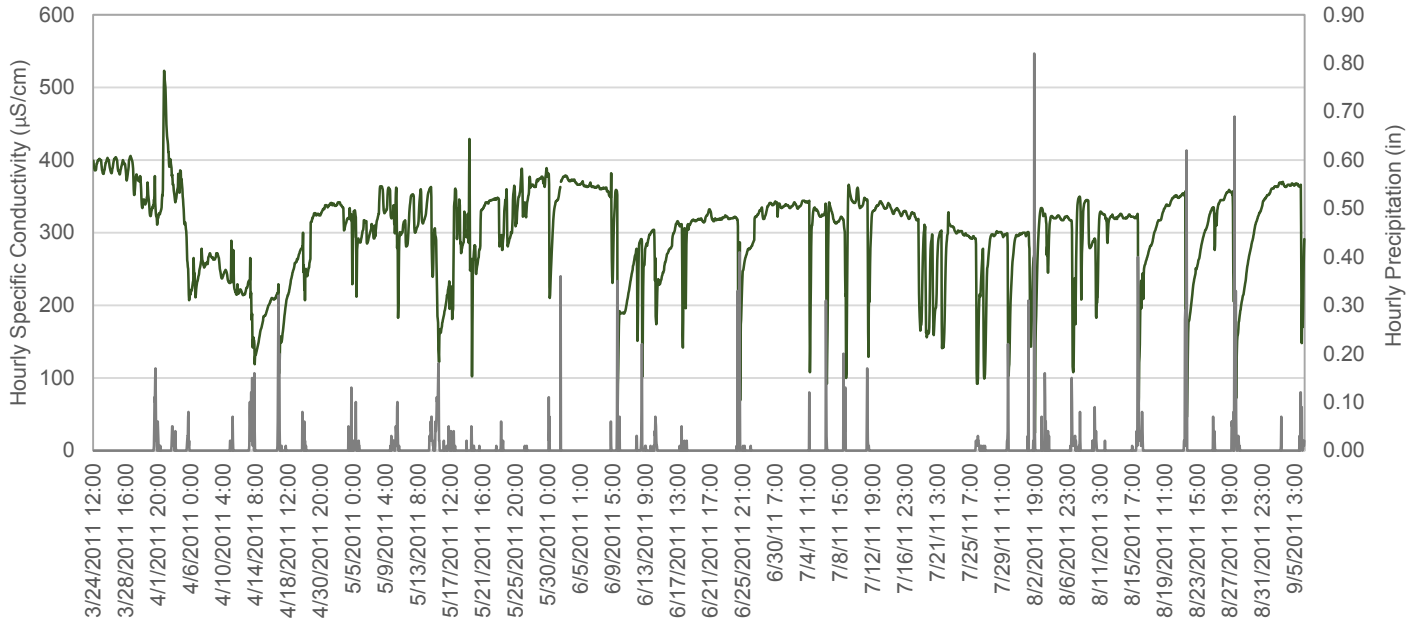


Figure 8. *Hourly specific conductivity (dark green) for Capehart Brook from March to September 2011. Data were collected as part of the Bangor Stream Monitoring Project with assistance from the Maine DEP. Daily precipitation (gray) values were obtained from the NOAA National Climatic Data Center (NCDC) from the Bangor International Airport station (GHCND:USW00014606).*

Table 7. *Specific conductivity (µS/cm) readings using a YSI 85 multi-meter probe and chloride (mg/L) measurements using a field kit from 1997-2013 at Capehart Brook. Refer to Appendix B for full data set.*

	SPECIFIC CONDUCTIVITY (US/CM)			**CHLORIDE (MG/L)**		
DATE RANGE	*Average*	*Minimum*	*Maximum*	*Average*	*Minimum*	*Maximum*
1997-2013	255	90	545	83	50	150

3.3.4 Water Temperature

Stream water temperature plays an important role in regulating chemical reactions (e.g. dissolvability of elements) within the water and can be adversely impacted by urban development. IC heat up quickly when exposed to direct sunlight. Stormwater runoff over these hot IC delivers unnaturally warm water to streams, also known as thermal pollution. High volumes of warm water from overland flow or groundwater mixes with cooler stream water, leading to increases in stream water temperature (UNHSC 2011). Stream temperature is also regulated by the amount of shading by riparian vegetation along stream banks. More open canopies allow sunlight to reach surface waters, which can heat up quickly during the day. Many fish species thrive under optimal water temperatures, which trigger reproductive functions and regulate growth of juvenile fish.

Maximum weekly and instantaneous temperature means of 19 °C (66.2 °F) and 24 °C (75.2 °F) were found to be the limit for juvenile brook trout survival (Brungs and Jones 1977). Capehart Brook, among many northern New England streams, should be able to support coldwater fish and other species.

Single reading temperature data collected by the James W. Sewall Company, the City of Bangor, and the Maine DEP from 1997-2013 is provided in Table 8. Temperature ranged from 0.9 °C (33.6 °F) to 19.7 °C (67.5 °F) with a mean of 10.4 °C (50.7 °F). These are well within acceptable and predictable limits of streams supporting coldwater fish species.

Continuous water quality logging by the Maine DEP in summer 2011 showed mean temperatures ranging from 16-18 °C (60.8-64.4 °F) in late summer (July and August) (Figure 9). Only one day reached 25 °C (77 °F) for a few hours during peak daylight hours. The conclusion by the Maine DEP was that temperature was not adversely affecting aquatic life in Capehart Brook.

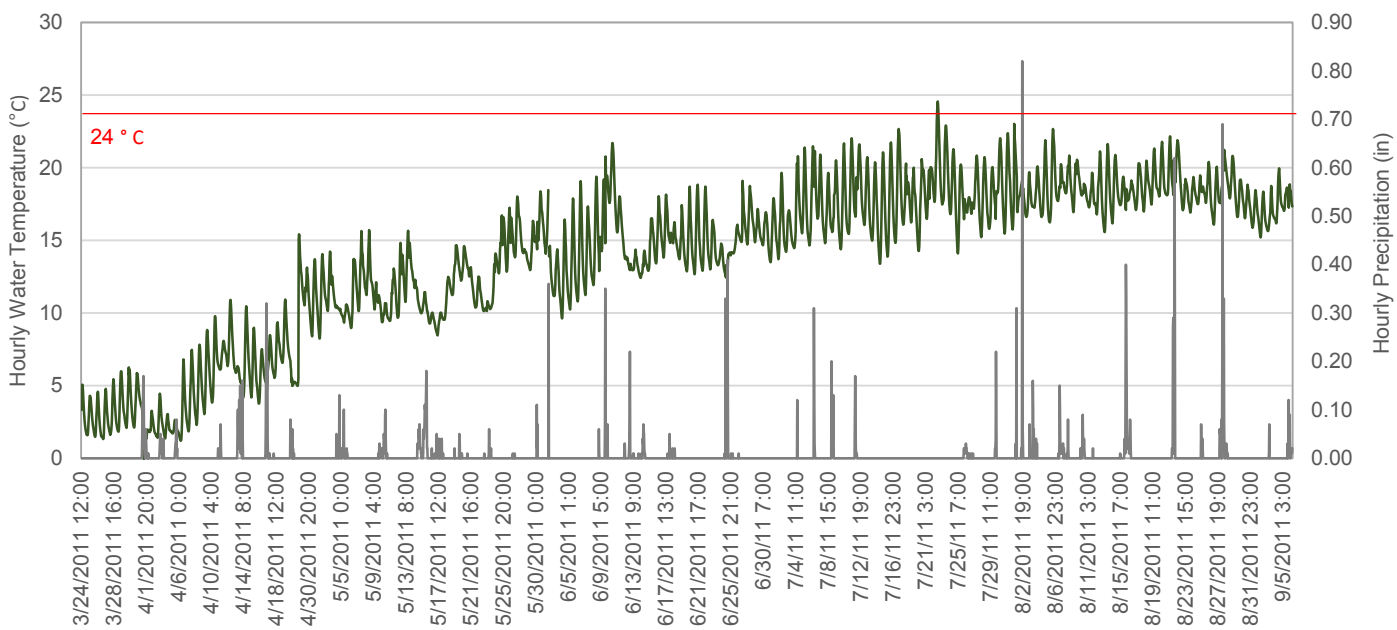


Figure 9. *Hourly water temperature (dark green) for Capehart Brook from March to September 2011. Data were collected as part of the Bangor Stream Monitoring Project with assistance from the Maine DEP. Daily precipitation (gray) values were obtained from the NOAA National Climatic Data Center (NCDC) from the Bangor International Airport station (GHCND:USW00014606). Red line indicates an instantaneous water temperature threshold of 24 °C, above which is considered detrimental to aquatic life.*

Table 8. *Temperature (°C) readings using a YSI 85 multi-meter probe from 1997-2013 at Capehart Brook. Refer to Appendix B for full data set.*

	TEMPERATURE (°C/°F)		
DATE RANGE	*Average*	*Minimum*	*Maximum*
1997-2013	10.4 / 50.7	0.9 / 33.6	19.7 / 67.5

3.3.5 pH

pH is a measure of the concentration of hydrogen ions in water on a logarithmic scale of 0 (acid) to 14 (basic). pH is determined by bedrock, acid rain deposition, wastewater discharge, and natural carbon dioxide fluctuations. pH regulates the solubility and biological availability of elements, including primary nutrients (phosphorus and nitrogen) and heavy metals. Low pH can release toxic metals and interfere with primary life functions. pH fluctuates naturally on a daily basis due to photosynthesis that consumes hydrogen ions for reaction processes. pH tends to be higher (more basic) during the day and be lower (more acidic) at night. These same daily patterns can be applied at the seasonal scale when photosynthesis becomes more prominent during the growing season. These fluctuations are typically very minor since there are buffering agents within the water (depending on contributing geology) that help protect against large swings in pH. Most aquatic organisms thrive under a pH environment of 6.5 to 8.5. Any values below or above this range can reduce the reproductive capacity of fish populations.

pH measurements collected by James W Sewall Company and the City of Bangor from 2009-2013 showed pH ranging from 7.0 to 8.3 with a mean of 7.8 (Table 9). These readings are within acceptable limits for aquatic life.

Table 9. *pH readings from 2009-2013 at Capehart Brook. Refer to Appendix B for full data set.*

	PH		
DATE RANGE	*Average*	*Minimum*	*Maximum*
2009-2013	7.8	7.0	8.3

3.3.6 Color

Color is the influence of suspended and dissolved particles in the water as measured by Standard Platinum Units (SPU). A higher color value indicates greater contribution of suspended particles that can make the water appear stained or dark. Sources of suspended and dissolved particles include organic (algae, decaying vegetation, tannins, lignins, etc) or inorganic (iron and manganese) forms and may depend on the dominant land use activities and contributing parent geology within the watershed. For instance, natural wetlands can be a significant source of organic matter that make the water appear brown from tannins, while anthropogenic disturbances can release eroded organic matter to streams and contribute to higher apparent color. Color values greater than 25 significantly reduce water clarity and the ability of sunlight to penetrate to the stream bottom, which can limit stream productivity.

Limited data are available for color since only two samples were collected in 2012 by the City of Bangor. These two readings were 10 and 30 SPU (Table 10). Because of this large range, it is difficult to make any conclusions about the condition of water clarity. The high color sample (30 SPU) taken in April 2012 may represent the spring freshet with high amounts of organic matter loading from the watershed. The lower color sample (10 SPU) taken in June 2012 is “clearer” and well below 25 SPU. This sample likely represents dry, summer

conditions for Capehart Brook. From the minimal data collected and the assumptions made, color at Capehart Brook seems fairly typical for northern New England streams.

Table 10. *Color (SPU) measurements in 2012 at Capehart Brook.*

DATE	COLOR (SPU)
4/18/2012	30
6/12/2012	10

3.3.7 Discharge

Discharge is a measure of stream flow, typically in units of cubic feet per second (cfs), and is a function of stream width, stream depth, and water velocity. Although no numeric criteria exists for this parameter, discharge is an important component of stream health, and should be incorporated in any stream monitoring design. Streams in urban environments with high coverage of IC are most at risk for flashy responses to storm events. High volumes of water run off IC and empty into receiving streams. To accommodate these influxes of water, most streams often experience expansion of stream bank width at the high water line, scouring of stream beds, and erosion of sediment. Eroded sediment along stream banks are deposited downstream in sand plumes where bottom substrates often become embedded with silts and sands. These large-scale disturbances can reduce habitat diversity for aquatic communities and alter habitat structure and function.

There are a number of ways to measure discharge with varying levels of accuracy. For Capehart Brook, the James W. Sewall Company deployed a data logger (Global Logger™) to measure water depth (or stage height) continuously every 15 minutes from 2009-2011. Four flow measurements at varying discharges (low to high) were conducted in the field using a current meter. From this, a flow rating curve was developed between direct flow measurements and corresponding stage height. The regression equation was applied to the continuous stage height data, and the subsequent mean daily flow results are presented in Figure 10. Flows ranged from 0.7 to 8.6 cfs with a mean of 2.0 cfs. Capehart Brook experienced lowest flows in summer when precipitation was low. Flow tends to increase rapidly in response to rainfall and recede quickly, indicating that Capehart Brook is a flashy stream. Flashy streams experience sudden surges in water level immediately following storm events and recede quickly in a similar manner. This creates a high disturbance environment that may not be conducive for most biological communities and tends to scour out banks and deposit sediment downstream where the stream cannot accommodate the enhanced flow volume.

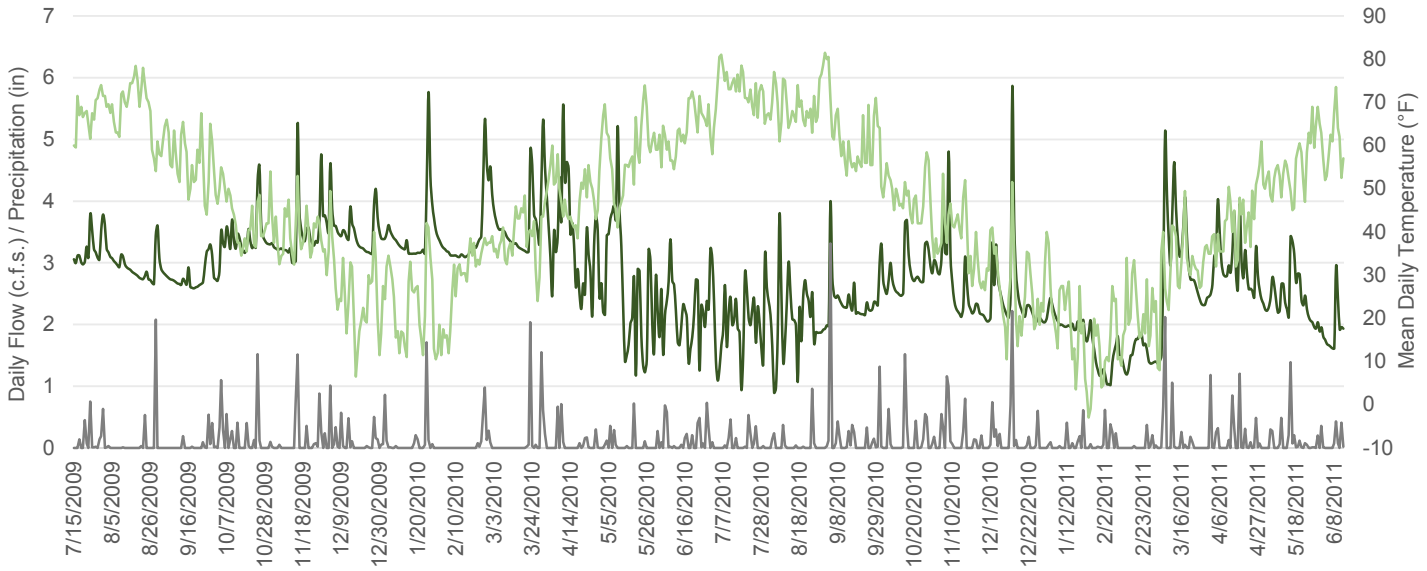


Figure 10. *Daily average flow (dark green) for Capehart Brook from July 2009 to June 2011. Data were collected as part of the Bangor Stream Monitoring Project with assistance from the James W. Sewall Company. Daily precipitation (gray) and temperature (light green) values were obtained from the NOAA National Climatic Data Center (NCDC) from the Bangor International Airport station (GHCND:USW00014606).*

3.4 Geomorphic, Riparian, and In-Stream Habitat Assessments

On August 28, 2014, a Level 1 Stream Corridor Survey was conducted by FBE staff Environmental and the City of Bangor for Capehart Brook based on methods described in the Maine DEP Stream Survey Manual (Maine DEP, 2009). The survey consists of two major types of evaluation: 1) a Rapid Habitat Assessment (RHA), and 2) a Rapid Geomorphic Assessment (RGA). The RHA relies primarily on visual observation of stream habitat characteristics, wildlife present, and gross physical attributes of the stream, as well as a simple in-stream macroinvertebrate evaluation. The primary use of the RHA is to identify high-quality coldwater habitat and any severe habitat or water quality problems. The reconnaissance-level RGA is focused on determining the impact that urbanization has on channel morphology. This type of survey is useful for identifying reaches receiving large volumes of stormwater that can cause channel instability, and identify reaches with signs of alteration from human activities. Information gathered from the RGA can be used to target specific stream reaches needing further assessment and restoration planning. Results of both surveys can also be used to raise public awareness and to help prioritize management objectives for stream restoration.

3.4.1 Rapid Habitat Assessment (RHA)

Capehart Brook was divided into six stream reaches (Reaches A1-A6). Reach lengths were based mainly on changes in physical characteristics of the stream, but in some cases were influenced by man-made structures such as road crossings and culverts. Survey results characterize the overall health of Capehart Brook as fair to poor (Figure 11).

Habitat- Typically, communities of coldwater fish (e.g., salmonids such as brook trout and Atlantic salmon) and other aquatic organisms (e.g., aquatic insects and other macroinvertebrates) are more robust in streams and rivers having a diverse array of habitats, especially those containing riffles with gravel and/or cobble substrates, and pools formed by scouring action behind boulders and downed pieces of large wood (e.g., tree trunks, logs) or other stream processes (Allan and Castillo, 2007). Examination of the in-stream characteristics of Capehart Brook indicates the presence of several different habitats across the six stream reaches. The most prevalent habitats include shallow pools, riffles, and runs.

Nature of Particles in Stream Bottom and Embeddedness- Gravel and cobbles provide fairly stable anchoring/attachment sites for macroinvertebrates, algae, and aquatic plants. The non-embedded spaces found between gravel and cobbles provide well-oxygenated spawning (egg-laying) sites for salmonids and excellent habitat for macroinvertebrates to crawl through and cling to.

Figure 11. *Survey reaches for the Level 1 Stream Corridor Survey conducted by FBE staff in 2014. Appendix A, Map 12.*

While all of the stream reaches contain a variety of substrate materials, some of the reaches in the upper portion of the stream (Reaches A4, A5, and A6) had more soft substrate (silt, sand, clay and mud) compared to the lower reaches (A1, A2, A3), which were dominated by hard substrates such as bedrock, rubble, cobble, and boulders. However, all of the reaches were found to have some degree of coarse gravel, rubble, or cobble at varying amounts.

Of particular concern is the extent of embeddedness in four of the six stream reaches (A3, A4, A5, and A6). Embeddedness refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud on the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) decreases. Embeddedness is a result of large-scale sediment movement and deposition. Overall, substrate in the stream reaches dominated by sand is continually moving, and therefore any salmonid habitat will be less resilient to withstanding high flow volumes, and may be virtually eliminated in these reaches.

Stream bottom conditions range from Good to Poor (Table A1, Appendix A). Reaches A1 and A2 represent Good stream bottom conditions, while A3, A4, and A6 score slightly lower with conditions characterized as Fair. Reach A5 stream bottom conditions rank as Poor due to a heavy accumulation of silt and sand (>75% embedded).

Woody Debris- Large pieces of wood in streams and small rivers help form pools and provide cover, which are important habitat needs of salmonids (Flebbe and Dolloff, 1995). Pools also trap leaves and twigs, which are an important food source for macroinvertebrates and for fish that eat the macroinvertebrates. Woody debris across the six stream reaches within Capehart Brook range from none (A6) to few (A1, A2, A3, A4, and A5).

The amount of large woody debris in rivers and streams in Maine may be significantly less than what existed prior to European settlement of North America (Magilligan et al. 2008). In addition, ongoing research in streams in the White Mountain National Forest region of New Hampshire and Maine suggests that additions of large woody debris to high-gradient, rocky-bottom streams has a positive impact on brook trout and macroinvertebrate communities.

Water Appearance/Odor- The water flowing in Capehart Brook during non-storm flow conditions is generally clear with a few notable exceptions. These include portions of reaches that were orange (Reach A6) due to iron oxidation, or had a milky surface sheen (Reach A5). A mild sewage odor was noted in one section in Reach A4, and a strong sewage odor was noted at the upstream end of Reach A6. No other unnatural odors were observed in the other reaches. It may be important to investigate potential cross-contaminations between the sewer and stormwater system upstream of the Finson Road crossing.

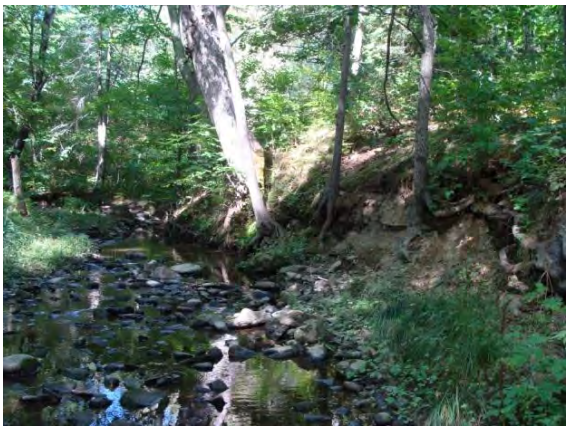
Streamside (Riparian) Vegetation and Water Temperature- Shading of streams is important to the health of coldwater fish species (e.g., brook trout and Atlantic salmon) and other aquatic organisms (e.g., aquatic insects and other macroinvertebrates) for a variety of reasons including the fact that cold water has the ability to retain more dissolved oxygen and create less physiological stress on aquatic organisms (Allan and Castillo 2007). A narrow stream like Capehart Brook (average wetted width ~ 7.5 feet) has a better chance of having good canopy cover compared to a larger stream or river. For Capehart Brook, three of the six stream reaches have good riparian cover (75% shaded; Reaches A1, A3, and A5). Two reaches exhibit 50% cover (Reaches A2 and A4), while the uppermost reach below Finson Rd. (Reach A6) has very little vegetative cover and is characterized as Poor. Areas with low percent cover are located near the highly developed residential areas and the Finson Road stream crossing. The City of Bangor has begun addressing this issue by planting willow stakes along the streambank in the spring of 2014.

Riparian cover is directly correlated with stream temperature. The greater the shading, the cooler the water temperature, and vice versa. Instantaneous temperatures collected within Capehart Brook range from 16.1 ˚C (Reach A6) to 20.4 ˚C (A4). Reaches A1 and A2 were 17 ˚C and 17.1 ˚C, respectively. Reach A5 and A3 had similar temperature readings at 19 ˚C and 19.3 ˚C, respectively. Reaches A1, A2, and A6 are below the reported maximum weekly average temperatures for growth, and short-term maximum temperatures for brook trout survival (juveniles) of 19 and 24 ˚C, respectively (Brungs and Jones, 1977). The temperature in Capehart Brook is Good, while riparian vegetation ranges from Good to Poor. Ironically, the lowest temperature was recorded

below Finson Rd. at the Finson Rd. culvert crossing. It would be expected that the reach with the lowest amount of riparian cover, and one of the greatest threats from NPS pollution and the large extent of algae would result in higher temperatures compared to other reaches. However, several factors may relate to the lower temperatures: 1) Capehart Brook flows underground above this point, so any discharge under low flow conditions would be the result of flow from this underground source, and 2) this was the final monitoring point of the day which was collected close to 6pm when air temperature is lower than earlier in the day. It is expected that a rain event on a sunny summer day would increase stream temperatures at this location dramatically as a result of the rainwater washing over warm roofs, driveways and roads.

Streambank and Channel Characteristics- Streambank and channel characteristics include bank shape (vertical or undercut, steeply sloping, gradual, or no slope), channel shape, and the extent of artificial bank modifications, such as rip-rap, retaining walls, etc. The nature of the soils and geology in the watershed, as well as within and adjacent to the stream, play a large role in the condition of the stream channel. Rocky streams lined with boulders and cobbles will tend to be more stable than a stream comprised of sand because sand is much lighter and can be picked up and moved downstream during high flow conditions.

Overall, Capehart Brook is a somewhat narrow (average wetted width of 7.5 ft.) and relatively shallow stream with the exception of one small pool greater than two feet deep. Three of the six reaches have at least one bank with steep, eroding slopes, and all reaches exhibit undercut banks at varying degrees of severity. Degradation of natural streamside plant cover and collapsed banks is common. Discharging pipes (including storm drain outfalls) and/or ditches are present in a majority of the reaches, carrying stormwater and attached sediment and pollutants, and causing erosion where the discharge meets the stream. Other pipes of unknown sources entering the stream were also documented along the stream corridor. Refer to Table 11 for more specifics.



Example of stream bank erosion (Reach A1).

Streambank and channel conditions within Capehart Brook range from Fair (A1, A2, A3, A4) to Poor (A5, A6). Undercut banks with steep slopes and bare soil, in addition to culverts/outfalls and road crossings has resulted in erosion and sedimentation in the stream. Protecting, restoring, and keeping riparian forests in good health and in a relatively undisturbed condition is vital for the long-term protection of Capehart Brook.

An obvious change in channel conditions occurs between Reaches 3 and 5, as the composition of the streambed changes from a rubble/bedrock/cobble dominated stream downstream, to a more gravel dominated stream upstream.

Visual Biological Survey- Benthic (stream bottom) communities act as continuous monitors of environmental quality over time, beyond individual water quality sampling events. The RHA utilized simple visual observations, including wildlife, fish, barriers, aquatic plants and algae, and presence and types of macroinvertebrates. The rock-rubbing method was used to collect macroinvertebrates.

Results of the visual survey indicate that green frogs (*Rana clamitans melanota*), a common frog species in Maine, are prevalent within the lower reaches of Capehart Brook. Small fish (1-2") were also documented in all of the six reaches, with slightly larger fish (3-4") documented in Reaches A2 and A6. Macroinvertebrates were found occasionally, but not in great abundance. Most notable were numerous small caddisfly larvae in Reaches A1 and A2. However, aquatic insects became less abundant upstream, and changed from a caddisfly-dominated stream to the more pollution-tolerant species, such as leaches, aquatic worms, and snails in the upstream reaches. This is largely due to the change in streambed composition (as described above), and an increase in stormwater inputs. A dead mole, squirrel, several frogs, and a baby bird were documented in the stream between Reaches A1 and A3. All of the animals appeared to be recently deceased, and the reason for the deaths are unknown. All the dead animals observed were intact, which does not suggest predation by wildlife or domestic cats.

A broken pipe in Reach A4 may be part of the old sewer system.

Water Quality and Potential Pollution Sources and Problems- Water quality and potential pollution sources are scored separately for each stream reach (Table 3, Appendix A). The most apparent problems stem from both known and unknown sources including eroding culverts, stormwater outfalls, ATV crossings, yard waste, trash, and undercut banks. Bank erosion is common, as well as trash and debris in most stream reaches. Despite a major volunteer trash clean-up in Capehart Brook in the spring of 2014, large quantities of trash were documented throughout the stream, indicating that more effort is needed to keep trash out of the stream (e.g. public education, installation of a trash guard(s) at outfalls, etc). The potential illicit discharge documented in Reach A4 (possibly a broken sewer pipe in the stream) is of particular concern and should be addressed immediately. Water quality in Capehart Brook ranges from Fair (Reaches A1, A2, and A3) to Poor (Reaches A4, A5, and A6).

3.4.2 Rapid Geomorphic Assessment (RGA)

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

Leaning trees, exposed roots, basal scour on the inside of meander bends, and steep bank angles are all indicators that the stream is widening, and were documented throughout the majority of Capehart Brook. The exception is Reach A6, where the major geomorphic process is aggradation. Indicators of aggradation include lateral bars, siltation in pools, mid-channel bars, poor lateral sorting of bed materials, and soft, unconsolidated bed. This is not entirely unexpected, as Reach A6 receives the largest volume of stormwater, which carries sediment from the developed areas in the watershed. While widening is the major geomorphic process in the downstream reaches, almost all of the reaches exhibited other geomorphic processes including degradation and planimetric form adjustment.

The upstream reaches have an "In Transition or Stressed" geomorphic position (A3, A4, A5, and A6). This illustrates that these reaches are in poor condition and experiencing adjustment outside the expected range of

natural variability. An increase in stream volume and water velocity from stormwater outfalls are likely candidates for the current position. Reach A2 is the only reach that is considered "In Regime," meaning that the stream reach is in good condition and dynamic equilibrium, which involves localized changes to its shape or location while maintaining process and function within the range of natural variability. This is intricately tied to the greater percentage of bedrock in this reach compared with the other reaches. The bedrock provides a stable streambed and stream bank, protecting the stream from the forces of erosion. Reach A1 has an "In Adjustment" geomorphic position, meaning that the stream is in fair condition and has experienced changes in channel form and fluvial processes outside of the expected range of natural variability.

3.5 Non-Point Source Stormwater Assessment

During the August 28, 2014 Level 1 Stream Corridor Survey, FBE staff also assessed Capehart Brook for possible non-point source (NPS) issues and documented all culverts. Six culverts were identified along the reach, five of which were written up for NPS issues. Other NPS issues noted were severe bank erosion upstream from the confluence with the Kenduskeag Stream, a possible corroded sewer pipe across the stream, seasonal bank instability from an ATV trail crossing, an unknown residential garden hose connection, and uncovered yard waste with cleared vegetation extending to the stream. Documented culverts and NPS sites are shown in Figure 11 and recommendations for NPS issues are provided in Table 11.

Table 11. *Non-point source (NPS) issues documented along Capehart Brook beginning at the confluence with the Kenduskeag Stream upstream to the Finson Road crossing.*

NPS #	SITE ID	PROBLEM	RECOMMENDATIONS	GPS LOCATION (UTM)	
				NORTHING	*EASTING*
1	NPS 1-01	Concentrated flow path of stormwater from trail and CH01 causing bare soil	Install turnout/runoff diverter on upper part of slope, plant/improve buffer to stabilize banks	515682.8	4964739.5
2	NPS 1-02	Severe streambank erosion/failure from down-cutting/incision at channel bend	Stabilize bank with cribbing	514999.8	4966162.5
3	NPS 2-02	CH03 – hanging culvert of unknown source along upper east bank	Armor drainage ditch with stone, identify source of outfall and remove	514964.0	4966111.0
4	NPS 2-03	Culvert at trail crossing off Pushaw Rd has severe streambank erosion and bank down-cutting/incision causing bare soil	Stabilize banks by installing a runoff diverter and improving buffer with plantings, pending landowner approval	514955.1	4966108.7
5	NPS 4-01	Possible corroded sewer line discharging to western bank of stream	Trace the source and remove	515640.3	4964703.2
6	NPS 4-02	ATV trail crossing with severe	Construct an ATV bridge crossing and stabilize both	515633.3	4964694.0

NPS #	SITE ID	PROBLEM	RECOMMENDATIONS	GPS LOCATION (UTM)	
				NORTHING	***EASTING***
		seasonal erosion problem	banks, pending landowner approval		
7	NPS 4-03	CH04 - culvert misaligned and depositing stormwater from Pushaw Rd in opposite direction of Capehart Brook flow	Treat with catchbasin inserts along Pushaw Rd	515633.3	4964694.0
8	NPS 5-01	Uncovered yard waste with cleared vegetation extending to stream; excessive build-up of sediment and milky sheen to surface water just downstream	Extend/improve buffer with plantings; compost yard waste	515622.2	4964681.9
9	NPS 6-01	Hose in stream with unknown connection to residential property	Check on source and remove	515601.6	4964665.2
10	NPS 6-02	CH05 – culvert outlet at Finson Rd crossing shows erosion from road due to lack of vegetation; observed heavy algae mats in stream and strong sewage odor	Stabilize banks with plantings or riprap armoring; investigate causes of odor and algae	515609.3	4964662.1
11	NPS 6-03	CH06/CH07 - concentrated flow path of stormwater from culvert	Armor ditch with stone or grass, improve buffer with plantings	514530.6	4965700.4

4. Restoration Strategies

The various studies conducted and reports completed for Capehart Brook, and feedback from three meetings with the Bangor Stormwater Citizen Review Panel and the City of Bangor staff in 2014 provided an excellent framework for identifying and understanding the sources of pollution and the problems that have resulted in poor water quality in Capehart Brook. This information has helped to develop locally-driven solutions and a prioritized list of actions that address the underlying causes of the stream's impairment. This section 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 Capehart Brook Watershed-Based Management Plan is to provide recommendations that will restore habitat and improve water quality so that Capehart Brook meets Class B water quality standards for the State of Maine. This can only be achieved through the commitment of a coordinated group of local community leaders, conservation groups, city, state and federal partners, and watershed residents working together to accomplish common goals and objectives. The following recommendations are contingent on landowner cooperation since 69% and 13% of the watershed is owned by private individuals and the Bangor Housing Authority (BHA), respectively; the City owns less than 10% of the watershed (Appendix A, Map 14). General watershed restoration objectives are outlined in Table 12, and serve as the foundation for specific recommendations made in the Action Plan (Tables 13-14).

Table 12. *Capehart Brook watershed restoration objectives.*

GOALS	WATERSHED RESTORATION OBJECTIVES
IMPROVE WATER QUALITY	Manage sources and transport of urban stormwater pollutants and nutrients. Achieve applicable water quality standards to support diverse and healthy aquatic communities.
IMPROVE PHYSICAL HABITAT	Improve aquatic habitat extent and quality to support the return and persistence of diverse native fish and macroinvertebrate communities. Improve terrestrial habitat extent and quality to support the persistence of native terrestrial communities and connectivity to aquatic habitats.
IMPROVE HYDROLOGY	Increase runoff infiltration and detention areas to normalize stream hydrographs and reduce stormwater flow to the stream. Restore the extent, connectivity, and functions of streams, drainages, wetlands, riparian areas, and floodplains to improve bank stability and natural hydrologic function and reduce risk to the built environment and human safety.

Many of the recommendations to restore Capehart 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 IC 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.

The 2011 Capehart Brook Watershed Management Plan provided over 60 recommendations that spanned a range from education, direct stream and riparian restoration, structural retrofits, and ordinance changes (SMRT 2011). Many of the suggestions were designed to address issues related to water quality of all surface water bodies in the City of Bangor. Some of these recommendations are included in the updated Plan with minor revisions, but several major recommendations have also been added.

4.2 Structural Management Opportunities and Recommendations

To achieve Class B standards in Capehart Brook, the *Statewide Impervious Cover Total Maximum Daily Load (IC TMDL) Report* set a target of 8% effective IC to help reduce current pollutant loads and flow volumes from the watershed (Maine DEP 2012b). Capehart Brook contains 99.3 acres (14.4%) of IC, with the largest and most connected IC in the residential development between Ohio Street and Finson Road; a 44% (~44 acres) reduction in effective IC is needed to achieve the State target of 8%. Using State 319 funds for the Capehart Brook Restoration Phase I Project, an estimated total of 2.17 acres of IC and 5.26 acres of lawn were disconnected from the stream through the installation of eight bioretention cells at Rangeley Place South, one bioretention cell at the Downeast Elementary School, and 21 rain barrels and 3 rain gardens scattered throughout the watershed[3].

Effective vs. Disconnected Impervious Cover
Effective IC is a developed area directly connected to a stormwater system that conveys water to nearby waterbodies. These areas can be "disconnected" with the implementation of Best Management Practices (BMPs) that slow and filter stormwater flow. For example, connecting a rain barrel or rain garden to a downspout can disconnect the contributing area of stormwater runoff from rooftops.

The majority of IC in the watershed has no existing stormwater treatment in place; therefore, large quantities of stormwater are discharged directly to Capehart Brook via one major outfall at the Finson Road crossing, and eight more outfalls or discharges along the downstream portion of the stream. Structural BMPs, or BMPs that are engineered to treat stormwater, will make up the majority of treatment options for the Capehart Brook watershed. Many of these structural BMP recommendations have already been designed and proposed by the City of Bangor as part of the Capehart Brook Restoration Phase II Project to be completed beginning May 2015 through May 2017. More detailed surveys of other proposed stormwater retrofit sites will be required, including some engineered designs, before these practices can be fully implemented.

An overall objective of structural stormwater retrofits is to reduce the effects of IC in the watershed by 44%.

[3] *The estimated IC disconnections for the Phase I BMP implementations were provided by the City using STEPL. Estimates of IC disconnections using the NHDES Simple Method vary slightly from these figures and are noted in Section 4.4.*

4.2.1 Structural Toolbox & Recommendations

As described in previous sections of this Plan, the 2011 Watershed Management Plan provided key structural recommendations that would achieve significant reductions in stormwater pollutants reaching Capehart Brook. The City has already begun implementation of these recommendations using 319 funding for Phase I (2012-2014) and now Phase II (2015-2017) work. Therefore, the recommendations in this Plan build on and improve current restoration objectives and actions. A description of recommended best management practices (BMPs) are described in Appendix C.

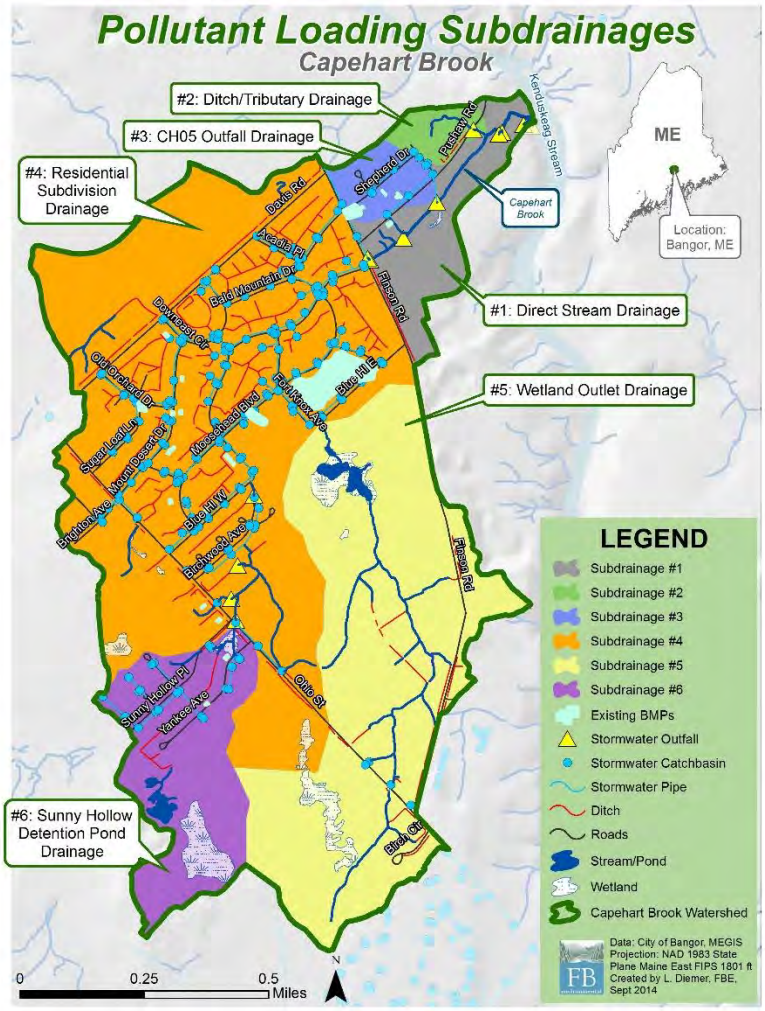


Figure 12. *Map of subdrainages for NHDES Simple Pollutant Loading Model. Appendix A, Map 13.*

A simple pollutant loading model was used to simulate TSS, TP, and TN loading reductions and resulting effective IC disconnections for the Capehart Brook watershed (refer to Section 4.4 and Appendix D for more details on methodology). For purposes of the model, the watershed was divided into subdrainages based on locations of major discharges or recommended BMP implementation sites (Figure 12). Specific BMP recommendations were applied to each subdrainage (Table 13). For instance, as part of the current Phase II project, retrofitting the existing detention pond at Sunny Hollow Place within Subdrainage 6 is a high priority recommendation. This retrofit will include a new outlet structure that will aerate flow to alleviate low dissolved oxygen water from impacting downstream reaches, particularly during large storm events. More details for these recommendations are provided in the Action Plan for stormwater retrofits and restoration strategies (Tables 14-15).

Based on knowledge of the funded work completed or to be completed by the City in the watershed, several scenarios were modeled for Subdrainage 4, the Capehart Neighborhood between Finson Road and Ohio Street, based on the City's current course of action (**Phase II - Option 1**), a suggested alternative course of action using existing allocated funding for Phase II (**Phase II - Option 2**), and a recommended next step for a potential Phase III project (**Phase III**).

Phase II - Option 1

The proposed design for the current Phase II project includes 155 catch basin inserts without filtration cartridges and 4 biofilter systems similar to the existing bioretention cell systems previously installed in the watershed at Rangeley Place South and the Downeast Elementary School. The catch basin inserts are designed to treat sediment and litter entering the storm drain system; however, they do not address flow volume or treat nutrients or other pollutants. The biofilter systems will address both stormwater quality and quantity, but the treatment area of only four biofilter systems is relatively small.

Phase II - Option 2

As an alternative to the proposed design for the Phase II project, it is recommended that catch basin inserts with filtration cartridges similar to the Fabco StormBasins are installed with underground storage chambers for infiltration of stormwater runoff. In addition to sediment, these alternative systems will also treat for nutrients, bacteria, and metals. This alternative option has long-term annual maintenance requirements that the City may deem too expensive (e.g. $470 per year per StormBasin), and therefore, the City may want to investigate alternative combinations of StormBasins and FocalPoints (bioretention systems) to suit their needs and sustainable maintenance capabilities. Also, consider redesigning or modifying the current retrofit at Sunny Hollow Place to treat stormwater quantity; this will allow the drainage area to be counted as an IC disconnection.

Phase III

In an effort to reach the goal of 8% effective IC in the watershed, the following steps are recommended for a future Phase III project to address flow and pollutants in the stream:

1) Install gravel wetlands or similar (e.g. rain gardens may also be sufficient) at two locations in the watershed where stormwater retrofits were supposed to be put in place in the original design plans for the neighborhoods, including one location near the private Penobscot Christian School along Birchwood Avenue and the second location along Ohio Street near the Sable Ridge neighborhood; and

2) Plant a combination of trees and rain gardens to infiltrate runoff from the large expanse of residental lawns and driveways (Table 14). The City can coordinate with UMaine Cooperative Extension or local engineers to help with designs, reach out to the Arbor Day Foundation for donations, and work with local volunteers, such as the Penobscot Job Corps, for plantings.

Gravel wetlands are an effective way to treat several acres of IC by reducing flow volumes and allowing time for filtration of sediment and nutrients. A land feasibility and flow study should be conducted before a design plan is developed for the two sites described above. It may be determined that another type of retrofit (e.g. rain garden) is more appropriate for a particular site.

Trees are becoming a more popular method of stormwater management, particularly in urban areas because they treat both stormwater quality and quantity, while also beautifying an area, among numerous other benefits.

When planting trees in the residential lawns areas in the Capehart Brook watershed, it will be important to coordinate with landowners for land access permission, which may become a limiting factor in final designs. The City should consult local foresters, engineers, or staff from the UMaine Cooperative Extension to determine tree species that will have the greatest impact on water storage and filtration, since water storage capacity varies by tree species. It was suggested that fruit tree species (e.g. apple trees) may be beneficial not only for stormwater infiltration, but also community interest. This will need to be weighed against other tree species (e.g. oak, pine, willow) that have much higher water storage capacities.

It is important to note that reduction estimates for tree plantings are based on mature trees with trunk diameters of more than 10 inches. As such, it will take several years for the trees to reach maturity and their full potential for stormwater infiltration. If time is an important factor to the City of Bangor, then they should select fast-growing tree species with a moderate to high water infiltration capacity.

Finally, the final cost of utilizing trees or rain gardens may also include the cost of installing curb drains or manipulating the landscape to direct stormwater to the planted trees or rain gardens. This cost was included in the Action Plan, but is a variable number depending on what the final designs will involve (e.g. type of tree species, size of tree species purchased, extent of stormwater flowpath manipulation to planted trees or gardens, etc.).

Additional Priority Actions

In addition, the following actions should be a priority for the City to pursue within the next year or so (as also described in Tables 14-15):

1) Address issues identified in the 2014 Stream Corridor Survey.
    a. Stabilize existing culverts/outfalls with direct discharge to Capehart Brook.
    b. Stabilize areas of stream bank erosion and replant sparsely-vegetated buffers.
    c. Conduct IDDE survey to identify and fix/eliminate potential illicit sources of discharge from multiple drainages along the stream.
2) Notify the Bangor Land Trust of lots for sale within the watershed and the need for expanding conservation areas within the Capehart Brook watershed.
3) Conduct fish and wetland surveys to identify potential areas for habitat improvement.
4) Develop a yearly fact sheet about restoration activities paid for by the Stormwater Utility fund to include in the Stormwater Utility bill to residents.
5) Conduct a fertilizer and septic survey within the watershed to determine potential sources of pollutants to Capehart Brook.

6) Work with City Council to expand rules on restricting or mitigating the impact of new development in impaired watersheds to better protect those streams.

Management measures described in this Plan will reduce effective IC in the Capehart Brook watershed by 44% and meet the restoration objective of having 8% effective IC in the Capehart Brook watershed. However, the Maine DEP target of 8% effective IC should be viewed as a guideline for achieving attainment. Every stream and its aquatic communities will respond differently to restoration activities, and Capehart Brook may or may not reach attainment before or after a full 44% IC reduction is achieved. Some retrofits, including the Sunny Hollow Place detention pond repair, cannot be counted toward the IC reduction because it will not reduce total flow volumes, but it will filter for pollutants and slow the rate of flow reaching downstream portions, thus reducing potential disturbances to aquatic habitat from flashy stream surges. Restoration of in-stream and riparian habitat conditions can also be accelerated with riparian buffer plantings, addition of woody debris to upper reaches of the stream where it is lacking, and stream bank stabilization in areas of severe sediment erosion.

These recommendations were presented to the Stormwater Citizen Review Panel in December of 2014. The decision by the City to move forward with Phase II Option 1 or 2 using approved 319 Phase II funding will depend on the overall value of each retrofit to stream health (e.g. amount of IC treated and type of pollutant addressed), compared to the ease and cost of implementation of each retrofit. The recommendation of this Plan is to implement retrofits that treat the major pollutants of interest (sediment, nitrogen, and phosphorus) and reduce the volume of stormwater flow to Capehart Brook by disconnecting IC. Option 2 is a viable alternative to Option 1 that meets this recommendation, but more detailed analyses and designs should be conducted by a qualified engineering firm.

Table 13. *BMP recommendations and their sediment and nutrient loading reduction estimates by subdrainage.*

DRAINAGE DESCRIPTION	BMP RECOMMENDATIONS	TOTAL AREA (ACRES)	PRE-DEV EFFECTIVE IC AREA (ACRES)	POST-DEV EFFECTIVE IC AREA (ACRES)*	TSS LOAD REDUCT. (LBS/YR)	TP LOAD REDUCT. (LBS/YR)	TN LOAD REDUCT. (LBS/YR)
DIRECT STREAM	Vegetated buffers in riparian zones (2,064 linear ft of potential plantings)	39.74	4.67	4.67	3,321	11	61
DITCH/TRIBUTARY	Conserve land	10.10	0.78	0.78	0	0	0
CH05 OUTFALL	Install 6 rain gardens and 10 rain barrels	15.39	3.89	0.12	2,135	9	26
RESIDENTIAL NEIGHBORHOOD	**Phase II - Option 1**: Install 155 catchbasin inserts without filtration cartridges and 4 compact biofilter systems similar to the bioretention cells at Rangely Place South	345.52	65.91	64.71	15,066	3	16
	Phase II - Option 2: Install Fabco StormBasins and chamber rows			56.91	6,906	24	95
	Phase III: Combine recommendations of Option 2, gravel wetland installation at two locations, 324 mature tree plantings, and 25 rain garden installations (~272 sq.ft. each)			26.91	26,555	77	312
WETLAND OUTLET	Conduct wetland survey and functional assessment to determine appropriate remediation efforts	202.52	13.57	13.57	0	0	0
SUNNY HOLLOW DETENTION POND	Repair existing detention pond at Sunny Hollow Place	74.24	9.15	9.15	6,721	22	80
	Total % Reductions with Phase II - Option 1			**5%**	**28%**	**8%**	**7%**
	Total % Reductions with Phase II - Option 2			**13%**	**20%**	**12%**	**10%**
	Total % Reductions with Phase II - Option 2 plus Phase III			**44%**	**40%**	**22%**	**19%**

**Only recommendations that reduce runoff from impervious surfaces can be counted as disconnections from effective IC area*

***Table 14**. Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
STORMWATER				
#1: Alleviate upstream contribution of low dissolved oxygen from a failing detention pond	1) Repair detention pond at Sunny Hollow and install outlet structure using existing Phase II funding allocation from Maine DEP. Consider working with engineers to redesign or modify the Sunny Hollow Place retrofit so that it reduces flow volumes and the treated area of IC can be counted as disconnected.	City of Bangor	2015-2017	$50,000*
#2: Reduce gross pollutants in stormwater flowing out of the Finson Road crossing	1) Install catch basin inserts and biofilter systems throughout residential development using existing Phase II funding allocation from Maine DEP [Phase II - Option 1].	City of Bangor	2015-2017	$225,000*
	a) Consider replacing Option 1 with Fabco StormBasin and chamber row systems that filter more TSS, TP, and TN and reduce flow volumes [Phase II - Option 2].			
#3: Reduce stormwater volume and temperature of water reaching Capehart Brook	1) Install gravel wetlands at two key locations in the watershed to filter and slow down water from the stormwater system as part of a Phase III initiative. Cost does not include labor to install [Phase III].	City of Bangor	2017-2020	$45,000
	2) Work with BHA and private landowners to plant multiple trees and rain gardens in the Capehart neighborhood lawn areas to reduce flow reaching the stormwater system as part of Phase III initiative. Use local volunteers for planting. Consult engineers for tree/plant placement. May need to install additional retrofits to direct stormwater [Phase III].	City of Bangor (with help from BHA, landowners, church/school groups, PJC)	2017-2020	$250,000
#4: Improve and/or stabilize existing culverts/stormwater outfalls	1) Address NPS issues identified in the Level 1 Stream Corridor Survey related to culverts/stormwater outfalls that discharge directly to Capehart Brook.	City of Bangor	2015-2020	$10,000
#5: Maintain a record of BMP implementation work	1) Track BMPs using the Maine DEP NPS Site Tracker.	City of Bangor	2015-2025	$200/yr**

*Funding already obtained by City through grants; In House = funding already part of City or other stakeholder budget; N/A = not applicable; TBD = to be determined

**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)

MDIFW = ME Dept. Inland Fisheries & Wildlife; BLT = Bangor Land Trust; BASWG = Bangor Area Stormwater Group, PCJ = Penobscot Job Corps

Table 14 (continued). *Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
STORMWATER				
#6 Maintain existing and future BMPs	1) Conduct annual maintenance as necessary on all existing and proposed BMPs (if selecting Option 2 for Phase II work). This cost does not include labor and equipment provided by the City.	City of Bangor	2015-2025	$25,000/yr
STREAM RESTORATION				
#1: Stabilize stream banks along the daylighted portion of Capehart Brook	1) Address NPS issues identified in the Level 1 Stream Corridor Survey related to stream bank erosion and lack of vegetated buffer. This is contingent on landowner cooperation and/or obtaining easements.	City of Bangor	2015-2020	$50,000
#2: Prevent warm water/invasive/exotic species from entering the stream from the Kenduskeag Stream	1) Conduct a fish/fish spawning survey to determine which fish species are using the stream.	City of Bangor (with help from MDIFW, Consultants)	2015-2020	$2,500
	2) Consult with MDIFW to determine if the existing thermal barrier is sufficient for the fish species desired, whether spawning areas for any sensitive fish species are active, and what actions can be taken to enhance fish habitat in the stream.	City of Bangor, MDIFW	2015-2020	N/A
#3: Protect and restore natural wetlands within the watershed	1) Survey major wetlands within the watershed for proper buffering and natural wetland functioning. This is contingent on landowner cooperation.	City of Bangor (with help from Consultants)	2015-2020	$5,000
	2) Place properties adjacent to the wetlands in conservation, if possible.	City of Bangor, BLT	2015-2025	TBD
	3) Work with landowners to revegetate degraded buffers around the wetlands. Contingent on landowner cooperation.	City of Bangor, Volunteers	2017-2025	TBD

*Funding already obtained by City through grants; In House = funding already part of City or other stakeholder budget; N/A = not applicable; TBD = to be determined

**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)

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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 through a variety of sources, including adaptations from the original 2011 Watershed Management Plan (SMRT 2011), personal communications with City of Bangor staff, feedback from the Stormwater Citizen Review Panel and other local stakeholders over the course of several public and non-public planning meetings. Table 15 lists these recommendations, potential partners, timeframes, and costs in five categories:

Administrative & Funding action items are a vital part of bringing both structural and non-structural BMP recommendations to fruition. The City has already taken significant leadership in this category by obtaining two 319 grants from the Maine DEP for implementation work within the Capehart Brook watershed. In addition, the recent establishment of a Stormwater Utility fee has set up a long-term sustainable funding plan for the City to implement stormwater management projects and restoration activities throughout all the impaired watersheds in the City. Additional funding can always be secured, and the City should be aware of and apply for funding opportunties as they arise.

Education & Outreach action items will promote awareness of the connection between land use, water quality, and stream health. Therefore, efforts should focus on engaging communty groups, businesses, town maintenance crews, residents, and school groups. This will likely be the most difficult category to fulfill within the Capehart Brook watershed given the history of the stream and the low level of interest or awareness by residents.

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

Land Use Planning & Conservation are two popular tools for reducing pollutant loads from new development in the watershed. Conservation efforts can permanently preserve 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 City and the community. Recommendations include expanding City stormwater rules to incorporate standards that are more protective of State minimums for stormwater management and extending shoreland zoning rules to protect more riparian habitat adjacent to Capehart Brook and other impaired streams (currently at 75 ft).

Source Control action items are recommendations that manage known sources of pollutants within the watershed. The City of Bangor provides contact information and drop-off locations for various household hazardous wastes on their website (http://www.bangormaine.gov/hhw). The City also conducts curbside yard waste (e.g. leaves, branches, etc.) collection in the fall, and yard waste can be brought to the Public Works Department any day of the year (except Sundays) during normal business hours. It is important to advertise these resources to residents. Other recommendations are based on observations during the 2014 Stream Corridor Survey, and include some investigative work to determine the source of several unknown sources of discharge to the stream. A portion of the stream exhibited a milky sheen on the water surface and bright green algae located downstream of a recent hydro-seeding site (private parcel on south side of Pushaw Road) adjacent to the stream; it is recommended that the source of this be confirmed and remedied. Lastly, it is recommended that a fertilizer use survey be conducted to document the rate and extent of fertilizer application on lawns and gardens within the watershed. This will provide helpful insight regarding typical fertilizer use in watershed, increase public awareness of the effects of fertilizers on water quality, help inform future watershed nutrient modeling efforts, and help determine whether more stringent fertilizer limits need to be put in place by the City.

***Table 15**. Non-Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
ADMINSTRATIVE & FUNDING				
#1: Apply for funding	1) Apply for state and federal grants and/or seek other funding to support implementation of planning recommendations, including Phase III work.	City of Bangor	Ongoing	In House
EDUCATION & OUTREACH				
#1: Garner support and cooperation from different community groups and agencies	1) Contact civic organizations within the City of Bangor and work with these groups to raise awareness about stream restoration.	BASWG	2015-2025	In House**
	2) Continue working with local volunteers on the annual stream clean-up.	Church of Jesus Christ of Latter Day Saints	Ongoing	$100/yr**
#2: Educate citizens about stormwater and engage them in stream restoration efforts	1) Organize an educational event for families that live in the impaired stream watersheds. This may include a hands-on outdoor event with water in the summer (e.g. identifying macroinvertebrates) or a walking tour down to the confluence with the Kenduskeag Stream.	BHA, BASWG, Maine DEP, Consultants, UMaine	2015-2020	$250/yr**
	2) Encourage citizens and school groups to “Adopt” a segment of stream or portion of the watershed to keep clean. This is contingent on landowner cooperation.	City of Bangor, BASWG	2015-2025	In House**
	3) Develop yearly one-page fact sheet to accompany the Stormwater Utility bill to update residents about restoration projects and educate residents on proper "housekeeping," including use of sand, salt, sealants, fertilizers, pesticides, trash, recycling, etc.	City of Bangor, Stormwater Utility budget	2015-2025	$500/yr**
	4) Establish BMP demonstration sites for residents to visit (aim for at least 1 site per impaired watershed).	City of Bangor (with help from BASWG, BHA)	2015-2020	$500**

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**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)

MDIFW = ME Dept. Inland Fisheries & Wildlife; BLT = Bangor Land Trust; BASWG = Bangor Area Stormwater Group, PCJ = Penobscot Job Corps

Table 15 (continued). *Non-Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
EDUCATION & OUTREACH (continued)				
#2: Educate citizens about stormwater and engage them in stream restoration efforts (continued)	5) Work with volunteers to install placards at high visibility catchbasins throughout the watershed.	City of Bangor	2015-2020	$500**
	6) Continue publication of annual press releases regarding proper use and maintenance of snowmobile and ATV trails.	City of Bangor	2015-2025	In House**
#3: Engage school groups from elementary through high school	1) Conduct watershed education at local schools.	Maine DEP, BASWG	2015-2025	$100/yr
	2) Work with Downeast Elementary School to establish a volunteer monitoring program at Site CB4. See Monitoring in Section 6 of the Plan.	Maine DEP	2015-2025	In House
#4: Design and install a nature trail along the stream to raise awareness of stream restoration and protection	1) Work with landowners and local partnerships to design a public trail along the stream. Contingent on landowner cooperation or land acquisition by BLT.	City of Bangor (with help from BLT, Consultants)	2015-2020	$1,000
	2) Utilize volunteers to help with installation of trail system. Contingent on landowner cooperation or land acquisition by BLT.	City of Bangor (with help from PJC, other Volunteers)	2015-2020	$5,000
	3) Install educational signs that focus on stewardship, stream-friendly landscaping practices, and proper trash disposal.	City of Bangor (with help from PJC, BASWG)	2015-2020	$1,500
#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.	BASWG, City of Bangor	2015-2020	In House
	2) Develop a “Green Business” program encouraging and educating business owners on stormwater management, and recognize businesses that make changes.	BASWG	2015-2025	$1,000**
	3) Encourage business owners to “Adopt” a stream segment or portion of the watershed to keep clean.	BASWG, City of Bangor	2015-2025	In House**
*Funding already obtained by City through grants; In House = funding already part of City or other stakeholder budget; N/A = not applicable; TBD = to be determined				
**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)				
MDIFW = ME Dept. Inland Fisheries & Wildlife; BLT = Bangor Land Trust; BASWG = Bangor Area Stormwater Group, PCJ = Penobscot Job Corps				

Table 15 (continued). *Non-Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
EDUCATION & OUTREACH (continued)				
#5: Educate business owners about the need and importance of stormwater control and retrofits (continued)	4) Work with commercial businesses, churches, and others with large impervious areas to reduce use of salt application.	City of Bangor, BASWG	2015-2025	In House**
MUNICIPAL MAINTENANCE PRACTICES				
#1: Re-evaluate the City's existing maintenance schedule	1) Work with Public Works to continue ongoing maintenance of catch basins, culverts, and ditches.	City of Bangor	Ongoing	In House**
	2) Continue annual sweeping schedule for roads.	City of Bangor	Ongoing	In House**
	3) Educate staff regarding connection between maintenance and water quality.	City of Bangor	Ongoing	In House**
#2: Re-assess and make improvements to City salt/sand spreading and storing	1) Work with Public Works to limit winter sand/salt spreading on road surfaces.	City of Bangor	2015-2025	In House**
	2) Ensure winter sand/salt is properly stored.	City of Bangor	2015-2025	In House**
#3: Review record of annual municipal maintenance practices by the City	1) Hire third party consultant to review record of annual municipal maintenance practices developed and maintained by the City.	City of Bangor (with help from Consultants)	2015-2025	$170/yr**
LAND USE PLANNING AND CONSERVATION				
#1: Increase the amount of land in permanent conservation	1) Work with BLT to expand the amount of land currently held in conservation, when opportunities arise.	BLT (with help from City of Bangor)	2015-2025	TBD**
#2: Expand City stormwater rules to incorporate standards that are more protective of State minimums for stormwater	1) Work with City Council to develop rules that protect water quality for all new commercial and residential development within impaired watersheds throughout the City.	City of Bangor	2015-2020	TBD**
#3: Incorporate the Capehart Brook Action Plan into the City Comprehensive Plan	1) Ensure that the Capehart Brook Action Plan is incorporated into the next City Comprehensive Plan, which was updated in 2012.	City of Bangor	2022	In House

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**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)

MDIFW = ME Dept. Inland Fisheries & Wildlife; BLT = Bangor Land Trust; BASWG = Bangor Area Stormwater Group, PCJ = Penobscot Job Corps

Table 15 (continued). *Non-Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
LAND USE PLANNING AND CONSERVATION (continued)				
#4: Work with landowners to designate trails for ATVs and snowmobiles where such activity is present.	1) Place signage to clearly mark out trails for ATVs and snowmobiles and install stream crossings. Contingent on landowner cooperation.	City of Bangor (with help from PCJ)	2015-2018	$500
#5: Extend shoreland zoning rules to protect more riparian habitat adjacent to impaired streams	1) Extend existing zoning rules from 75 ft to 100 ft or more from the high water line of impaired streams and their direct drainages.	City of Bangor	2015-2020	In House**
SOURCE CONTROL				
#1: Address unknown sources of discharge identified in the 2014 Stream Corridor Survey	1) Conduct an IDDE survey to identify unknown sources of discharge to the stream found during the 2014 Stream Corridor Survey.	City of Bangor	2015-2017	$5,000
	2) Repair or eliminate unknown sources of discharge.	City of Bangor	2017-2020	$50,000
	3) Conduct stormwater and sewer line inspections using smoke or dye testing to identify potential cross-contaminations and determine where upgrades are needed.	City of Bangor	2015-2020	$5,000
	4) Utilize canine scent tracking to detect potential human sources of bacteria.	City of Bangor (with help from ECS)	2015-2020	$2,500
	5) Utilize results from recent IDDE testing to determine if follow-up action is necessary.	City of Bangor	2014	In House
#2: Locate the source of the milky sheen and bright green algae in the middle reaches of Capehart Brook downstream of the Finson Road crossing	1) Conduct source tracking upstream of sheen and algae.	City of Bangor (with help from Volunteers, Maine DEP, Consultants)	2015-2017	$5,000
	2) Determine if sheen and algae is present under or after both base and storm flow conditions.		2015-2017	$1,000
	3) Work with Maine DEP to test sheen for type of pollutant.		2015-2017	$2,500

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Table 15 (continued). *Non-Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
SOURCE CONTROL (continued)				
#3: Expand and support ongoing source control programs	1) Support landscaping waste pick-up program as well as street sweeping on municipal roads and commercial parking areas.	City of Bangor	Ongoing	In House
#4: Determine fertilizer application rate within watershed	1) Conduct fertilizer survey of watershed to determine what portion of the residential lawns are fertilized and by how much on an annual basis.	City of Bangor (with help from Consultants)	2015-2017	$5,000
#5: Conduct a septic system survey	1) Identify lots that rely on septic systems by reviewing the City's sewer bill and comparing that list to all properties within the watershed.	City of Bangor (with help from Consultants)	2015-2017	$7,500
	2) Conduct a door-to-door survey of septic systems to identify the age and maintenance of each system.			
	3) Develop a list of priority properties to follow-up on.			
*Funding already obtained by City through grants; In House = funding already part of City or other stakeholder budget; N/A = not applicable; TBD = to be determined				
**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)				
MDIFW = ME Dept. Inland Fisheries & Wildlife; BLT = Bangor Land Trust; BASWG = Bangor Area Stormwater Group, PCJ = Penobscot Job Corps				

Table 15 (continued). *Non-Structural BMP recommendations for the Capehart Brook watershed.*

ACTION	HOW	WHO	WHEN	COST
MONITORING				
#1: Continue annual water quality monitoring program	1) Maintain or improve annual baseline water quality monitoring and assessment procedures, including stormwater monitoring at outfalls, annual benthic biomonitoring, and continuous data logging for multiple parameters (temperature, dissolved oxygen, conductivity, and discharge). Refer to Section 6 for more details.	City of Bangor, Maine DEP	Ongoing	$10,000/yr
#2 Utilize local volunteers or school groups to maintain or expand baseline water quality monitoring	1) Consider starting a volunteer monitoring program to collect discrete data on temperature, dissolved oxygen, and conductivity, and possibly expand monitoring to include pH and turbidity data collection on a regular basis. Volunteers may include students from the Downeast Elementary School.	City of Bangor, Maine DEP	2015-2025	$5,000
#3: Investigate contribution and sources of other pollutants	1) Collect water samples for analysis of other contributing pollutants, including heavy metals and bacteria, and determine if further action is necessary to mitigate their impact to the stream.	City of Bangor (with help from Consultants)	2015-2025	$2,000
#4: Establish a chloride-conductivity relationship	1) Conduct seasonal chloride-conductivity relationship testing so that conductivity collected during discrete or continuous sampling can be correctly converted to chloride concentrations and compared to State thresholds.	City of Bangor (with help from Consultants)	2015-2017	$2,500

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**Costs that can be applied to City-wide efforts in restoring impaired streams (1/6 of total cost)

MDIFW = ME Dept. Inland Fisheries & Wildlife; BLT = Bangor Land Trust; BASWG = Bangor Area Stormwater Group, PCJ = Penobscot Job Corps

4.4 Pollutant Removal and Stormwater Flow Reduction

Implementation of recommended structural BMPs is expected to disconnect 44 acres (44%) of impervious cover in the watershed.

FB Environmental conducted a simple pollutant loading analysis to estimate the amount of total suspended sediments (TSS), total phosphorus (TP), and total nitrogen (TN) loading to the stream based on pre- and post-development conditions. Pre-development conditions included existing BMPs implemented in 2012 and 2013 by the City of Bangor. Post-development conditions included proposed BMPs with the estimated percent loading reduction for each pollutant by subdrainage (Table 13). The combination of Phase II - Option 2 and Phase III has the greatest impact on pollutant loading reduction in the Capehart Brook watershed. Caution should be used when interpreting the modeled pollutant loading values as these values may change with a more thorough evaluation of the site-specific runoff and soil infiltration rates by a qualified engineering firm. The pollutant loading values provided in this Plan have been estimated using references from multiple sources and personal communication with engineers, but should be used as guidelines in the planning and decision-making process. Refer to Appendix D for specific references.

Table 16. *Estimated total post-development areas disconnected as a result of BMP implementation options.*

	TOTAL POST-DEV DISCONNECTED IC AREA (ACRES)	TOTAL POST-DEV EFFECTIVE IC REDUCTION (%)
EXISTING BMPS	1.8	1.8%
PHASE II - OPTION 1	1.2	1.2%
PHASE II - OPTION 2	9.0	9.1%
PHASE III	30.0	30.2%
OTHER PROPOSED RETROFITS	3.8	3.8%
TOTAL	**44.6**	**44.9%**

In additon to the reductions that can be expected for TSS, TP, and TN, proposed retrofits are estimated to reduce the effective IC from 14.2% (after existing BMPs are factored in) to 8.0% (assuming Phase II - Option 2, Phase III, and other proposed retrofits are implemented; Table 16). This will likely disconnect approximately 44.6 acres of IC needed to reach the 8% effective IC target. Since effective IC disconnections are based on runoff reductions, certain BMPs could not be factored in as disconnections, despite their substantial contribution to pollutant loading reductions; only recommendations that reduce runoff from IC can be counted as disconnections from effective IC area (Horsley Witten Group, Inc. 2011). These BMPs include the vegetated buffers in Subdrainage 1 and the detention pond retrofit at Sunny Hollow Place in Subdrainage 6. While the current design has a new outlet structure that will regulate flow, this will only delay the flow volumes to reduce the impact of flashy responses to storm events.

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

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 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%. A conservative estimate for Capehart Brook would be a 10% reduction in pollutants watershed-wide as a result of planned non-structural management measures (Law et al. 2008, FBE 2011).

The City of Bangor has a street sweeping/catch basin cleaning/storm drain maintenance program. The program involves systematically sweeping every street to clear them of winter sand in the spring each year. Every catch basin in the City is also cleaned of sand and debris once a year after the street sweeping is complete. Certain catchbasins that are noted for high sediment and debris volumes are flagged for more frequent cleaning.

5. Implementing the Plan

5.1 Plan Oversight & Adoption

The Capehart Brook Watershed-Based Management Plan will be carried out by the City of Bangor with local participation from other stakeholders when needed. Key staff from the City of Bangor will need to meet regularly and be diligent in coordinating resources to implement practices that will reduce the effects of urbanization in the Capehart Brook watershed.

The Plan will take 10 years to implement, depending on funding sources and availability. 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 Capehart Brook meets Class B water quality standards before implementation of recommended actions are complete, then the goal of the Plan has been met.

This Plan was presented to the Stormwater Citizen Review Panel in December 2014 following review by the City of Bangor. Formal adoption of the Plan by the City 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.

Recommended actions to restore Capehart Brook to Class B water quality standards are presented in Sections 4.2, 4.3, and 6.2. These actions include 32 tasks in 8 different categories.

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

5.2 Estimated Costs and Technical Assistance Needed

The cost of successfully implementing the Capehart Brook Watershed-Based Management Plan is currently estimated at $648,700 over the course of the next 10 years (2015-2025) based on the recommended actions in Section 4. This includes structural BMPs (Section 4.2), non-structural BMPs (Section 4.3), and monitoring efforts (Section 6.2). This general 'best guess' estimate is based on the following assumptions:

10-Year Cost Estimate for Restoring Capehart Brook				
	Category	**Costs covered by existing City programs***	**New Costs to the City***	**New Costs to Other Stakeholders***
Structural BMPS				
	Stormwater Retrofit Sites	**$$**	**$434,500**	**--**
	Retrofit Maintenance	**$$**	**$250,000****	**--**
Non-Structural BMPs				
	Administrative & Funding	**$$**	--	--
	Education & Outreach	$5,000	$8,500	$5,500
	Municipal Maintenance	**$$**	$1,700	--
	Land-Use Planning	**$$**	$500	--
	Source Control/Other	**$$**	$83,500	--
	TOTAL	**$5,000**	**$94,200**	**$5,500**
Monitoring Program				
	Monitoring	**$$**	**$109,500**	**--**
GRAND TOTAL (10-yr)		**$5,000**	**$638,200**	**$5,500**

**Note: These costs are estimates that may vary depending on actual costs of recommendations. The structural BMP cost estimate does not include funding already obtained by the City for Phase II work. This also does not include costs for future work that will be determined (TBD), such as restoring wetlands, purchasing land, etc.*

***This cost is not included in the total costs due to the high variability of the estimate, which is dependent on the final implementation of retrofits selected by the City. The cost presented here represents a conservatively high long-term operation and maintenance cost associated with 54 StormBasins.*

Restoration efforts should be funded by all aspects of the community, including local businesses and property owners, community groups, conservation groups, corporate sponsors, and the City.

Stormwater Retrofits: State and federal agencies such as the Maine DEP, Maine DOT, and USEPA 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. The City has already pursued State 319 funding for Phase I and II work, and should apply again for Phase III funding in 2016. The City of Bangor Department of Community and Economic Development may also help with beautification projects. Planting trees can be largely accomplished with local volunteers, along with help from the UMaine Cooperative Extension, the Arbor Day Foundation, and the City of Bangor.

Municipal Maintenance: Actions such as culvert repair, enhanced storm drain cleanout and street sweeping programs, and ordinance revisions should be supported by the City through the Stormwater Utility fee, as well as other 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 undeveloped land in the Capehart Brook watershed is of great importance to protect the watershed from further development. The City of Bangor owns a 28-acre parcel west of Ohio Street, known as Brown Woods. The City should work with the Bangor Land Trust to obtain additional land

for conservation with particular focus on large tracts of forest and land adjacent to wetlands. Long-term 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 of water quality in this watershed. Options such as obtaining easements within the riparian areas on the stream should also be considered in lieu of outright purchase. Utilizing conserved lands for public trail systems and educational kiosks are a good way to educate the public about watershed restoration efforts in the Capehart Brook watershed. There are currently two parcels for sale in the Capehart Brook watershed. One parcel is located near the stream itself and is owned by Vaughn Smith. The City may be able to work with the Bangor Land Trust and purchase the property with support from the Stormwater Utility fund.

Monitoring and Assessment: Future monitoring and assessment efforts will require a variety of sources of funding, including the City of Bangor, the Stormwater Utility fee, and private foundation grants.

6. Methodology for Measuring Success

While this Plan provides specific goals and key actions needed to restore Capehart Brook, it is inevitable that new information, technology, and techniques will be learned and developed in the years to come that may change the priorities of identified goals and actions. Therefore, the goals and priority of actions identified in this "living document" should be revisited and revised on an annual basis.

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 establishes 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 Capehart Brook is monitored to document restoration over an extended time period.

The adaptive management components of the Capehart Brook Watershed-Based Management Plan will include:

Creating an Organizational Structure for Implementation- Since watershed restoration will require a considerable effort, key personnel from the City of Bangor should be officially appointed and be responsible for administering and coordinating the implementation of this Plan.

Maintaining a Funding Mechanism- The City has already taken initiative in obtaining State 319 funding for Phase I and II work, and additional funding has been obtained through the City of Bangor's Stormwater Utility fund. The City of Bangor should evaluate other options for establishing long-term funding to support the actions in this Plan. Consideration should be given to the type and extent of technical assistance needed to design, inspect, and maintain suggested stormwater BMPs and the annual field monitoring program. Clearly, funding is a critical element of sustaining the restoration process and once it is established, the Plan can be fully vetted and restoration activities can move forward.

Determining Restoration Actions- This Plan provides a unified watershed restoration strategy with prioritized recommendations for restoration using a variety of methods, including structural, non-structural, in-stream, and riparian restoration actions. Since some of the recommended actions already have funding in place, an alternative option was given for current Phase II work as well as recommended next steps for future Phase III work with several smaller ventures that can be completed by the City at any time depending on funding and resource availability. The City should use the proposed designs in this Plan as a starting point for discussion with a qualified engineering firm that will design retrofits within the confine of the currently allocated

funding for the Phase II work. The City should then move forward with applying for Phase III work, as outlined in this Plan. Other restoration activities should be prioritized by the City and scheduled accordingly.

Improving the Community Participation Process- Implementation of this Plan will require ongoing community outreach efforts to involve more stakeholders both in the watershed and in the larger community of Bangor. 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. Much of the success of implementing the recommendations will be contingent on landowner cooperation since 69% of the watershed is privately-owned (Appendix A, Map 14).

Developing a Field Monitoring Program- A field monitoring program is necessary to track the anticipated improvements to aquatic health within the Capehart Brook watershed as restoration actions are implemented. The monitoring program will provide 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. The City of Bangor will maintain this program.

Establishing Measurable Milestones- A restoration schedule that includes milestones for measuring the implementation of restoration actions and monitoring activities in the Capehart 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. Refer to Section 6.3 for more details.

6.2 Monitoring Program

A well-designed monitoring program is a critical component of the Plan since it will establish the relative effectiveness and success of restoration recommendations against pre-implementation (or "baseline") watershed conditions. The current monitoring program should be maintained or improved with two primary goals: monitoring should 1) support the assessment of overall aquatic health of Capehart Brook over time, and 2) provide an evaluation of the effectiveness of restoration practices for improving the aquatic habitat. Refer to the monitoring section of the Action Plan in Table 15.

The monitoring program will feature a two-tiered approach:

Ambient Capehart 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 local church groups.

6.2.1 Ambient Capehart 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). The set of aquatic health indicators should include characteristics that have been degraded by the urbanization of the Capehart Brook watershed. Measuring these characteristics each year will support accurate assessment of the success of restoration actions. The ambient monitoring program should include the following components:

Hydrology: Continuous stream flow measurements

- Since Capehart Brook is a small urban stream with flashy responses to storm events, it will be important to continue stream flow monitoring, since flow will be reduced significantly with each acre of IC disconnected from implemented retrofits. The City may want to purchase a few sondes to rotate among the impaired watersheds within the City and establish a point person or company to maintain them year-round.

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

- Dissolved oxygen (DO) was found to be the main culprit for water quality degradation and inhibition of aquatic life function in Capehart Brook. Using data loggers for continuous readings would provide the best information, but discrete sampling can also be useful if conducted in the early morning (before 9am) or during storm events when DO is typically lowest.

- Other key water quality parameters to continue collecting (either continuously with data loggers or discretely with grab sampling) are water temperature and specific conductivity.

    - Discrete readings of specific conductivity should be collected along with grab samples for more precise laboratory analysis of chloride concentrations since field kit methods for measuring chloride can be inaccurate. This should be conducted in conjunction with simple field calibration curves. Once a more robust specific conductivity-chloride relationship is developed, only annual spot checks are needed to use specific conductivity as a surrogate measure for chloride. This is particularly important since there are State thresholds for chloride and not specific conductivity.

- Future monitoring should include weekly to monthly grab samples for primary nutrients (nitrogen and phosphorus) and chlorophyll-a. This should be taken during both wet and dry weather events (in conjunction with upstream wetland connection sampling) to determine when and where nutrients are impacting the stream.

- Combining turbidity sensors with stage loggers would provide important information about the flow-chemistry regime of Capehart Brook, particularly when paired with nutrient data during wet and dry weather events.
- It would also be beneficial to conduct bacteria sampling at potential source hotspots within the watershed and along the stream. This can be conducted along with canine scent detection of human waste to identify any areas of illicit discharge (e.g. leaky sewer pipes).
- The City should also consider conducting spot sampling for nutrients and pesticides in the tributary downstream of the City Compost Site to ensure that runoff is not causing impacts to Capehart Brook.

Biology: Macroinvertebrate and fish surveys

- Continue City-funded annual macroinvertebrate monitoring. This will provide crucial information on stream health and help gauge the success of restoration efforts in the watershed.

The number of surveys, the locations and number of sampling sites, and the specific measurements collected will be determined by the City of Bangor as the goals of the monitoring program become clear based on available resources and funding.

The ambient monitoring program should build on and enhance previous monitoring efforts in the watershed. After each sampling event, data should 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 Capehart Brook.

6.2.2 Catchment Area Site-Specific Performance Monitoring

Restoration of Capehart 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 mitigation 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.

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

- Volumetric discharge rate through a series of storm events;
- Continuous recording of in-situ water quality parameters;

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

Establishing indicators and numeric targets (benchmarks) to quantitatively measure the progress of the Capehart Brook Watershed-Based Management Plan will provide both short and long-term input about how successful the Plan has been in meeting the established goals and objectives for the watershed.

Indicators are derived from tasks identified in the Action Plan. While the Action Plan provided a description of tasks, responsible parties, schedule, and estimated annual costs associated with each task, the indicators are developed to reflect how well implementation activities are working, and provides a means by which to track progress toward established goals and objectives.

The following environmental, programmatic, and social indicators and associated benchmarks will help measure the progress of the Capehart Brook Watershed-Based Management Plan. These benchmarks represent short-term (2017), mid-term (2020), and long-term (2025) targets for improving water quality in Capehart Brook. Setting benchmarks allows for periodic updates to the Plan, maintains and sustains the action items, and makes the Plan relevant to ongoing activities. The City of Bangor will review the benchmarks for each indicator on an ongoing basis to determine if progress is being made, and then determine if the Plan needs to be revised if the targets are not being met.

Environmental Indicators are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. They include:

Environmental Indicators			
Indicators	**Benchmarks***		
	2017	*2020*	*2025*
Improvement of in-stream water quality & habitat			
a) Enhance macroinvertebrate type, abundance, and distribution *GOAL: Meet Class B standards (based on probabilities of meeting)*	5%	50%	90%
b) Reduce peak flows coming out of the Finson Road crossing culvert *GOAL: Disconnect 44% of IC within watershed*	10%	25%	44%
c) Reduce maximum stream water temperatures *GOAL: Disconnect 44% of IC within watershed*	10%	25%	44%
d) Reduce in-stream pollutants (TSS, TN, TP) *GOAL: Disconnect 44% of IC within watershed*	10%	25%	44%
Improvement of riparian habitat			
a) Revegetate riparian habitat adjacent to Capehart Brook** *GOAL: Plant 2,064 linear feet of riparian buffer*	10%	50%	100%
b) Protect vegetative buffer around wetlands** *GOAL: Revegetate all limited buffer areas*	10%	50%	100%

**Benchmark figures are cumulative from 2017 to 2020 to 2025*
***Contingent on landowner cooperation*

Programmatic Indicators are indirect measures of watershed protection and restoration activities. Rather than indicating that water quality reductions are being met, these programmatic measurements list actions intended to meet the water quality goal. They include:

Programmatic Indicators			
Indicators	**Benchmarks***		
	2017	*2020*	*2025*
Amount of funding secured for Plan implementation	$200,000	$400,000	$700,000
Number of areas installed with structural BMPs	5	10	20
Number of structural BMPs inspected and maintained	10	20	50
Acres of IC treated and disconnected by BMPs	10	25	44
Number of residential BMP demonstration project completed	1	2	3
Number of culverts stabilized	2	4	8
Number of voluntary septic system inspections	5	10	25
Number of wastewater or septic system upgrades	1	5	10
Number of acres of new land in conservation	1	5	10
Number of watershed-based educational materials distributed	250	500	1,000
Number of non-structural restoration activities completed	5	10	15
Number of municipal ordinance changes that relate to watershed protection	1	2	3

**Benchmark figures are cumulative from 2017 to 2020 to 2025*

Social Indicators measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvement. These indicators can be used to estimate impact of restoration activities on public perception and awareness of water quality issues. They include:

Programmatic Indicators			
Indicators	**Benchmarks***		
	2017	*2020*	*2025*
Number of volunteers for stream clean-ups and plantings	50	100	200
Number of certified contractors completing a BMP or LID training and certification program	1	3	5
Number of landowners with >10 acre lots participating in land conservation programs	1	2	5
Number of people participating in educational events	10	50	100
Number of stakeholders adopting a stream segment to keep clean**	1	5	10
Number of businesses participating in restoration activities	1	2	3

**Benchmark figures are cumulative from 2017 to 2020 to 2025*
***Contingent on landowner cooperation*

6.4 Conclusion

Watershed residents, landowners, business owners, and recreationalists alike should have a vested interest in improving the long-term water quality of Capehart Brook so that everyone can have access to clean water. The objective of the Capehart Brook Watershed-Based Management Plan is to reduce the effective IC in the watershed, moving toward the IC TMDL target of 44% effective IC reduction; this will reduce the volume and temperature of stormwater entering Capehart Brook as well as the amount of pollutants associated with developed areas. Reducing effective IC by 44% in the Capehart Brook watershed will cost approximately $65,000 per year over the next 10 years. Cost estimates are based on tasks identified in the Action Plan, which will need to be updated as the Plan is implemented and new action items are added. Implementation of this Plan over the next 10 years will require the dedication and hard work of state and municipal employees, watershed groups, and volunteers to ensure that the actions identified in this Plan are carried out accordingly.

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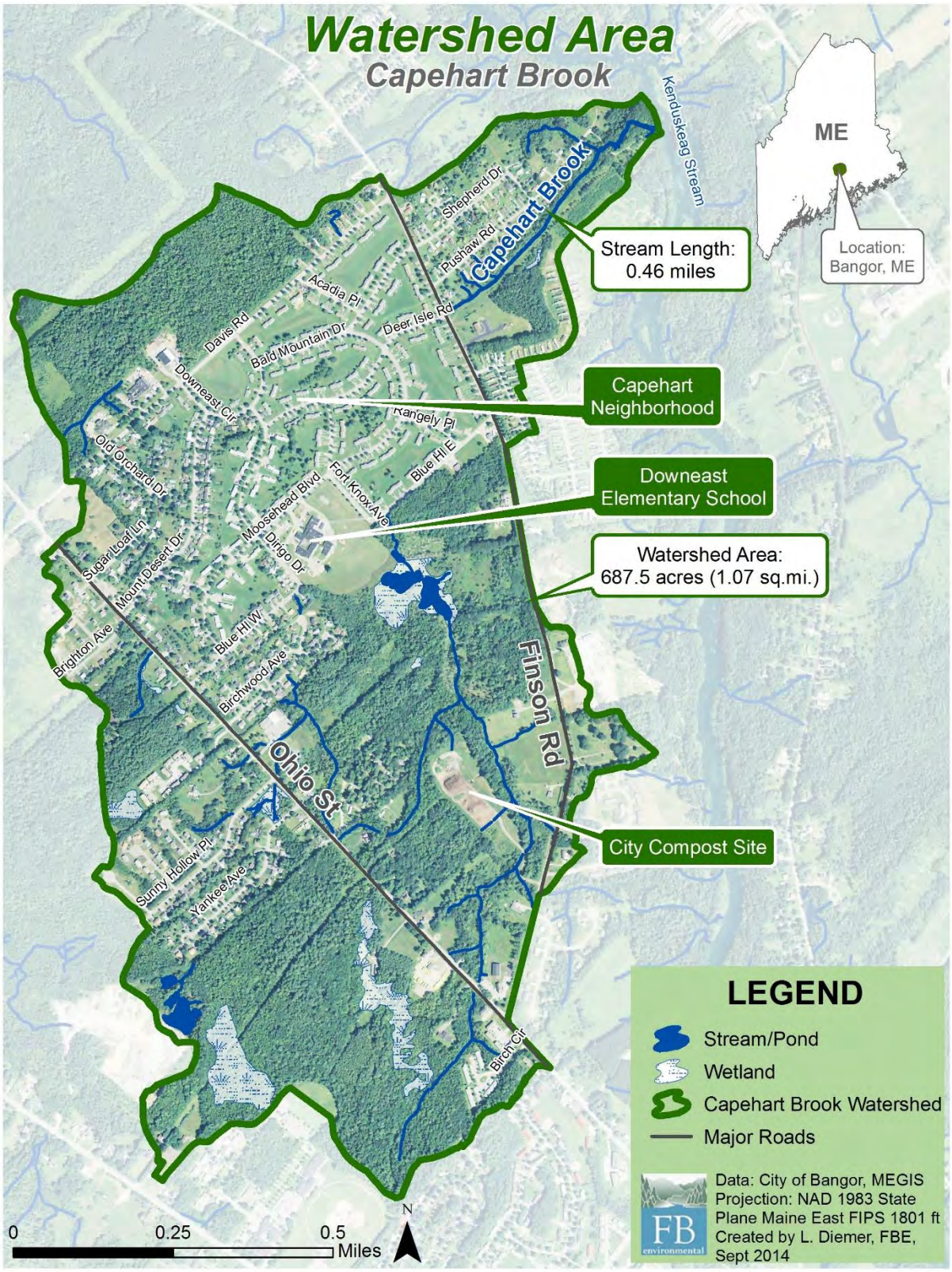
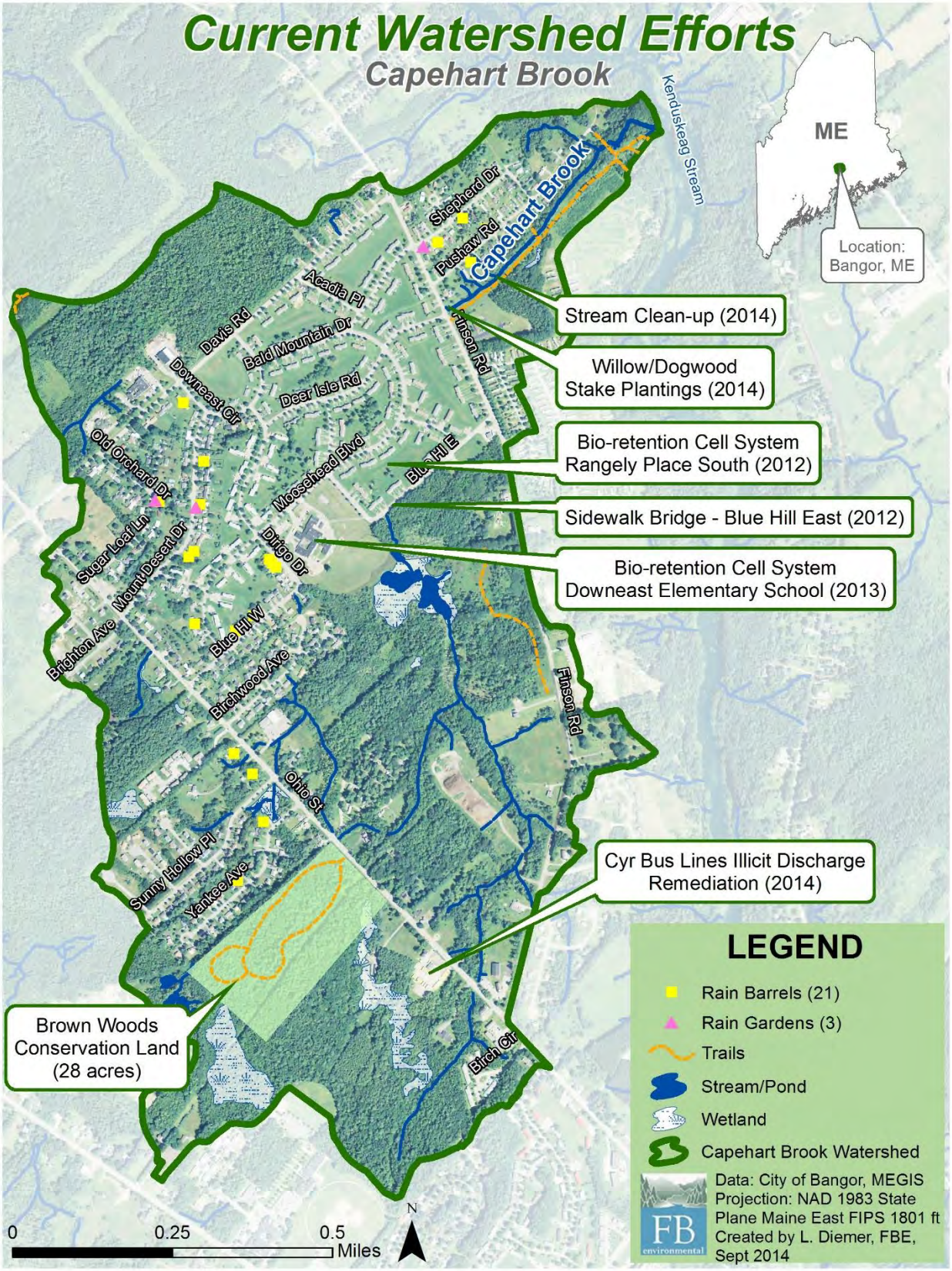
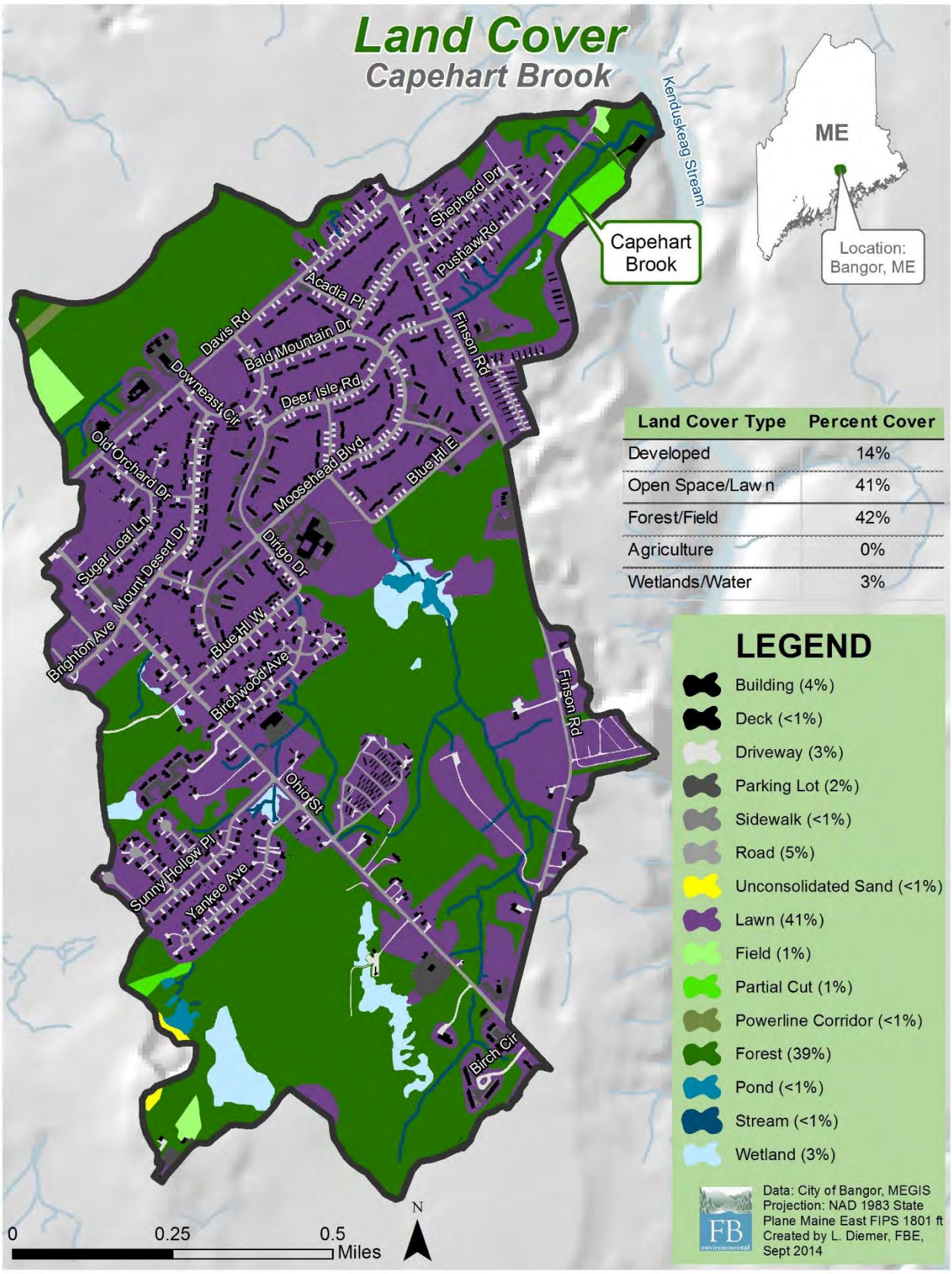
APPENDIX A. Watershed Maps



Map 1

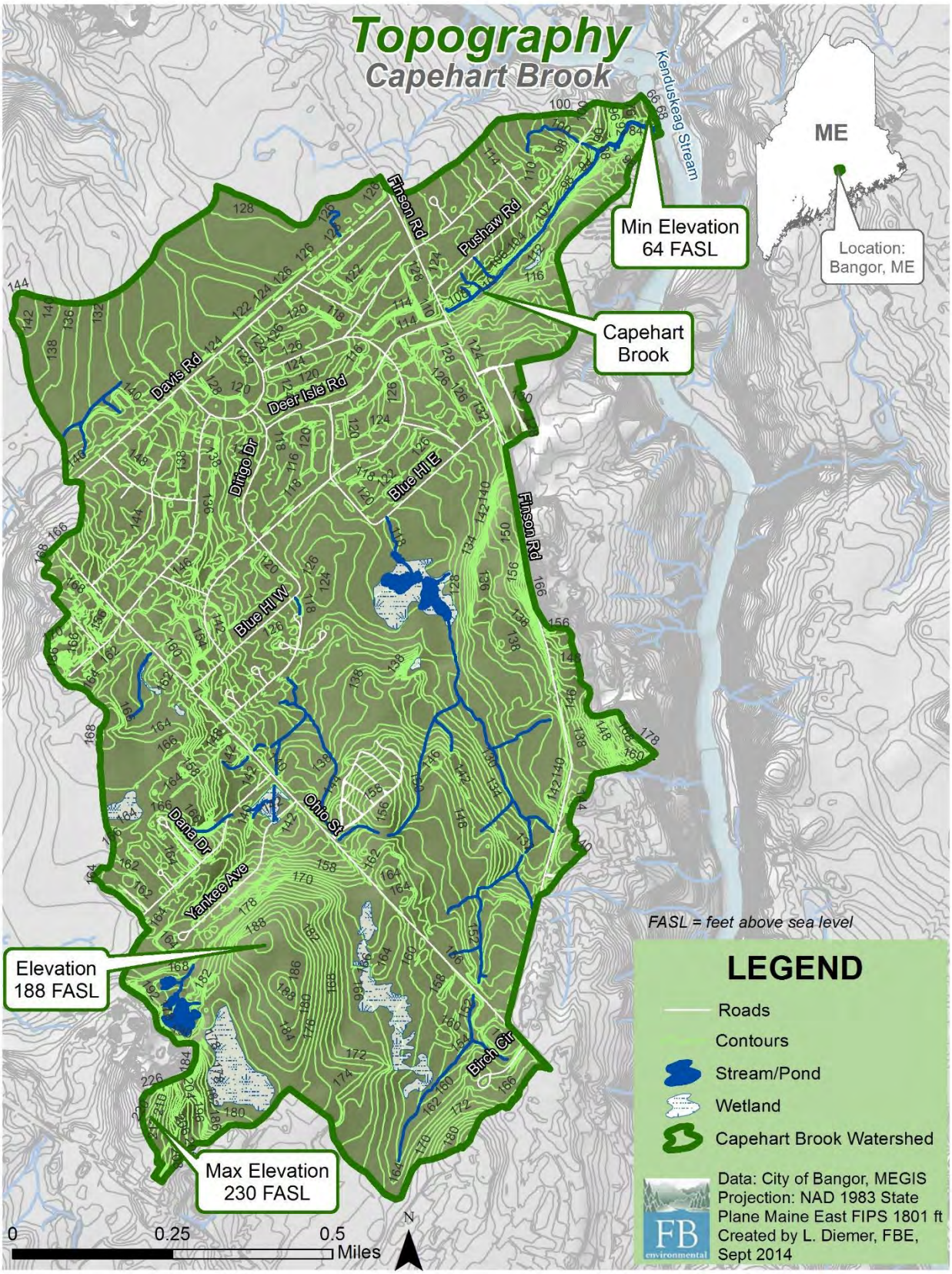

Current Watershed Efforts
Capehart Brook
ME
Location: Bangor, ME
Kenduskeag Stream
Capehart Brook
Shepherd Dr
Pushaw Rd
Acadia Pl
Davis Rd
Bald Mountain Dr
Finson Rd
Downeast Cir
Deer Isle Rd
Old Orchard Dr
Moosehead Blvd
Blue Hill E
Sugar Loaf Ln
Mount Desert Dr
Dirigo Dr
Brighton Ave
Blue Hill W
Birchwood Ave
Finson Rd
Ohio St
Sunny Hollow Pl
Yankee Ave
Birch Cir
Stream Clean-up (2014)
Willow/Dogwood Stake Plantings (2014)
Bio-retention Cell System Rangely Place South (2012)
Sidewalk Bridge - Blue Hill East (2012)
Bio-retention Cell System Downeast Elementary School (2013)
Cyr Bus Lines Illicit Discharge Remediation (2014)
Brown Woods Conservation Land (28 acres)
LEGEND
Rain Barrels (21)
Rain Gardens (3)
Trails
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

Map 2

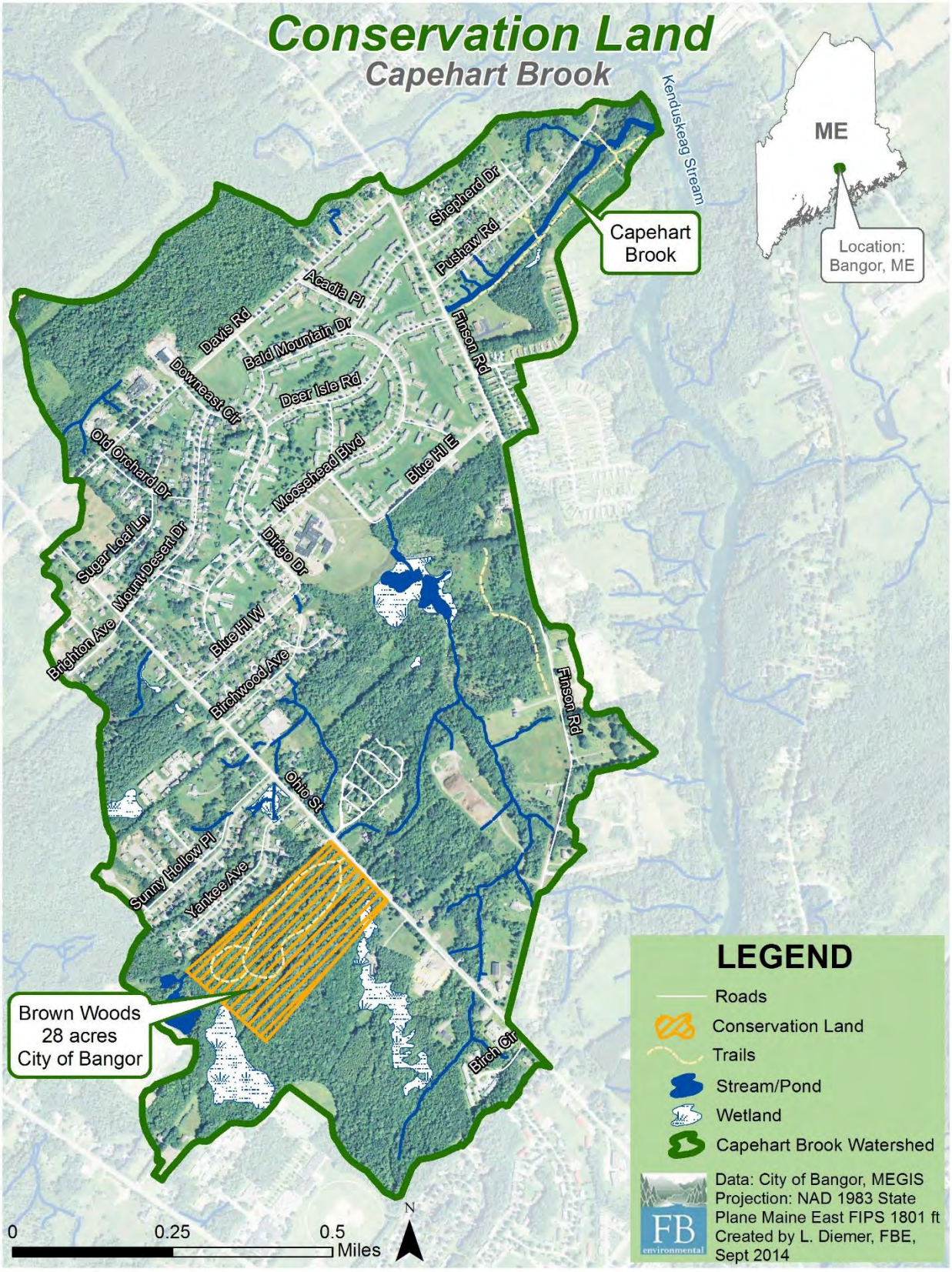


Land Cover Type	Percent Cover
Developed	14%
Open Space/Lawn	41%
Forest/Field	42%
Agriculture	0%
Wetlands/Water	3%

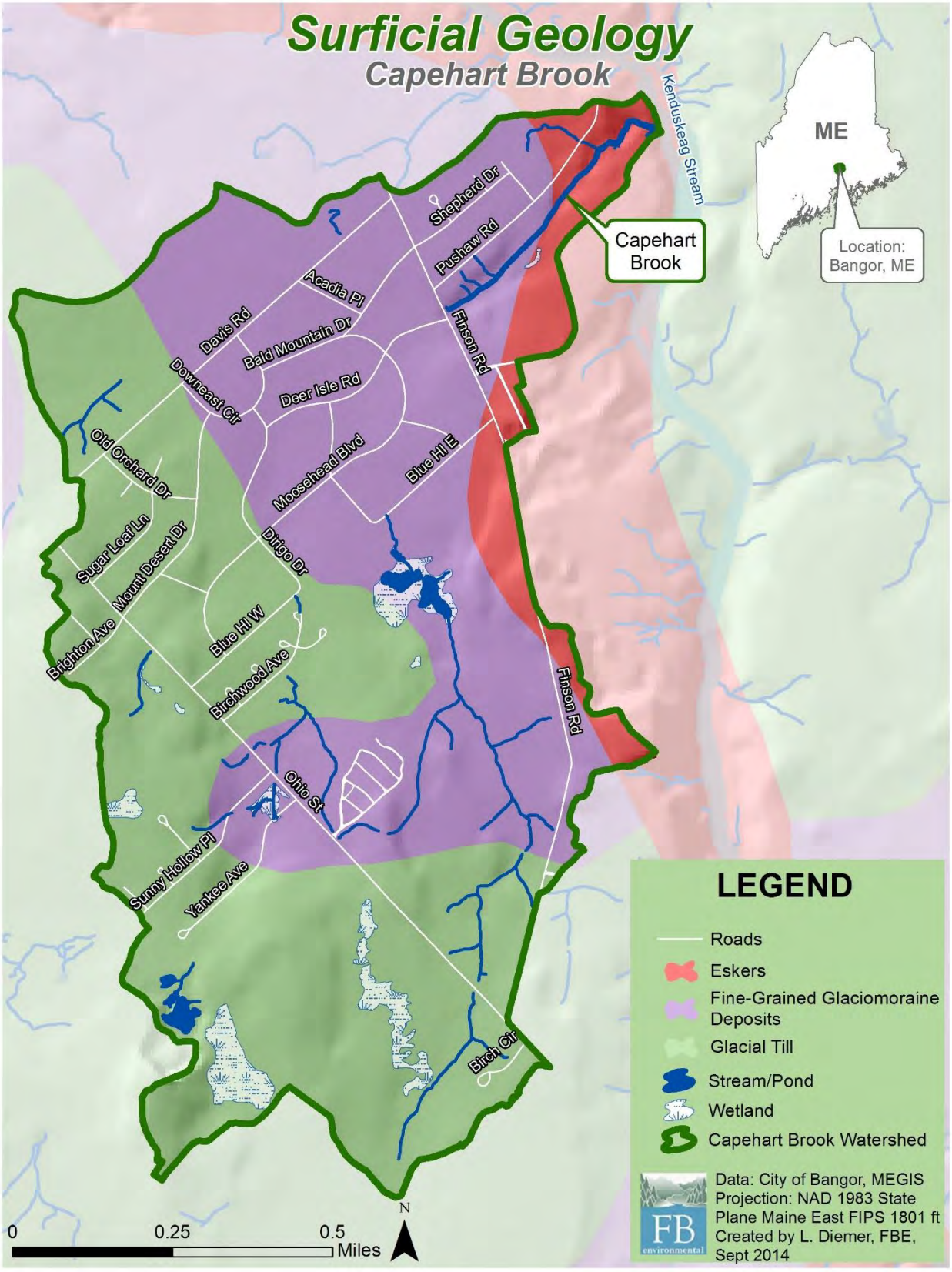
Map 3


Topography
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
Min Elevation 64 FASL
Capehart Brook
Finson Rd
Pushaw Rd
Davis Rd
Deer Isle Rd
Dirigo Dr
Blue Hill E
Blue Hill W
Ohio St
Dale Dr
Yankee Ave
Birch Cir
Elevation 188 FASL
Max Elevation 230 FASL
FASL = feet above sea level
LEGEND
Roads
Contours
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0 0.25 0.5 Miles
N

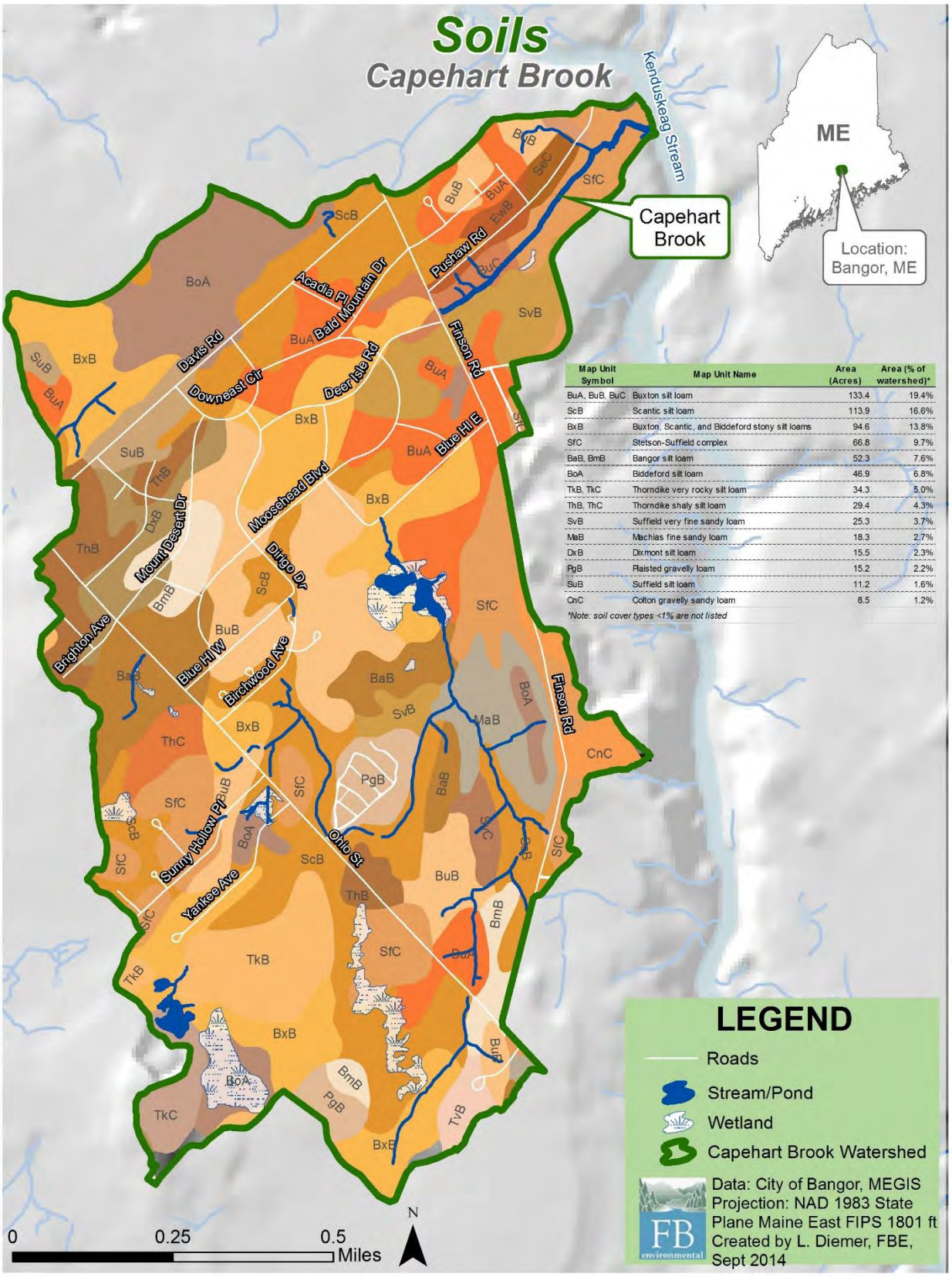
Map 4


Conservation Land
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
Capehart Brook
Shepherd Dr
Pushaw Rd
Acadia Pl
Davis Rd
Bald Mountain Dr
Finson Rd
Downeast Cir
Deer Isle Rd
Old Orchard Dr
Moosehead Blvd
Blue Hill E
Sugar Leaf Ln
Mount Desert Dr
Dirigo Dr
Brighton Ave
Blue Hill W
Birchwood Ave
Finson Rd
Ohio St
Sunny Hollow Pl
Yankee Ave
Brown Woods
28 acres
City of Bangor
Birch Cir
LEGEND
Roads
Conservation Land
Trails
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

Map 5


Surficial Geology
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
Capehart Brook
Shepherd Dr
Pushaw Rd
Acadia Pl
Davis Rd
Bald Mountain Dr
Finson Rd
Downeast Cir
Deer Isle Rd
Old Orchard Dr
Moosehead Blvd
Blue Hl E
Sugar Loaf Ln
Mount Desert Dr
Dirigo Dr
Brighton Ave
Blue Hl W
Birchwood Ave
Finson Rd
Ohio St
Sunny Hollow Pl
Yankee Ave
Birch Cir
LEGEND
Roads
Eskers
Fine-Grained Glaciomoraine Deposits
Glacial Till
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

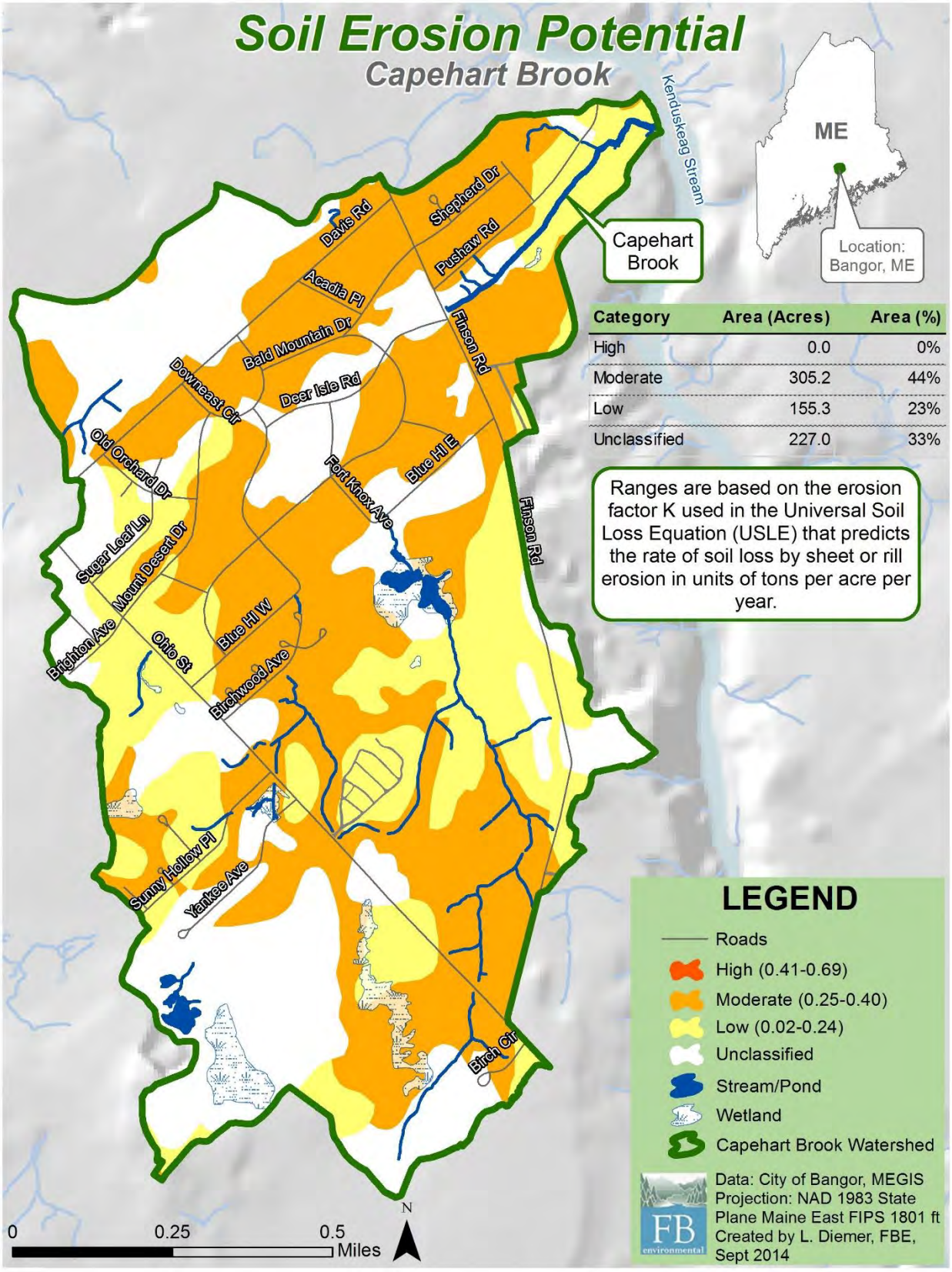
Map 6



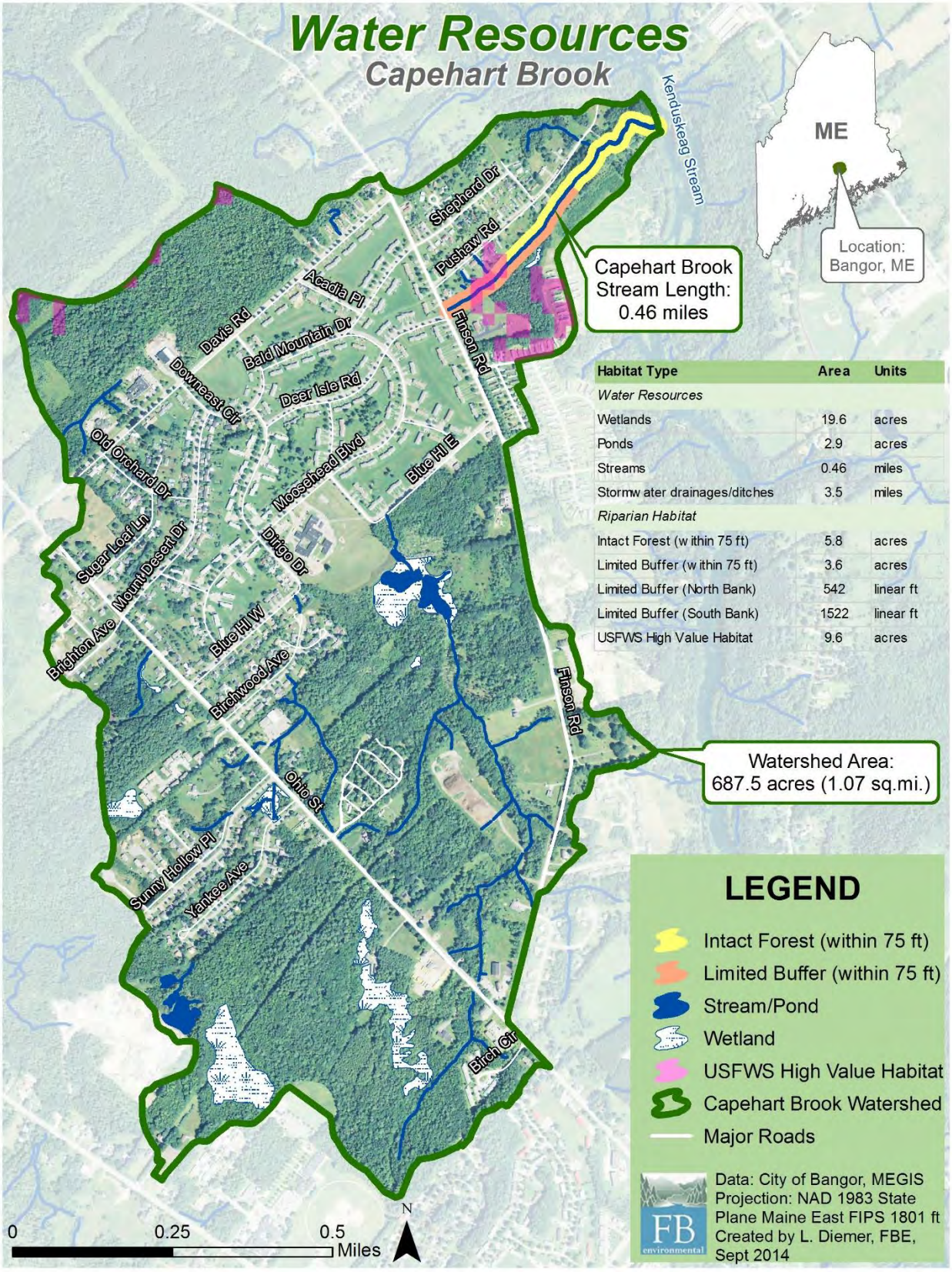
Map Unit Symbol	Map Unit Name	Area (Acres)	Area (% of watershed)*
BuA, BuB, BuC	Buxton silt loam	133.4	19.4%
ScB	Scantic silt loam	113.9	16.6%
BxB	Buxton, Scantic, and Biddeford stony silt loams	94.6	13.8%
SfC	Stetson-Suffield complex	66.8	9.7%
BaB, BmB	Bangor silt loam	52.3	7.6%
BoA	Biddeford silt loam	46.9	6.8%
TkB, TkC	Thorndike very rocky silt loam	34.3	5.0%
ThB, ThC	Thorndike shaly silt loam	29.4	4.3%
SvB	Suffield very fine sandy loam	25.3	3.7%
MaB	Machias fine sandy loam	18.3	2.7%
DxB	Dixmont silt loam	15.5	2.3%
PgB	Plaisted gravelly loam	15.2	2.2%
SuB	Suffield silt loam	11.2	1.6%
CnC	Colton gravelly sandy loam	8.5	1.2%

Note: soil cover types <1% are not listed

Map 7

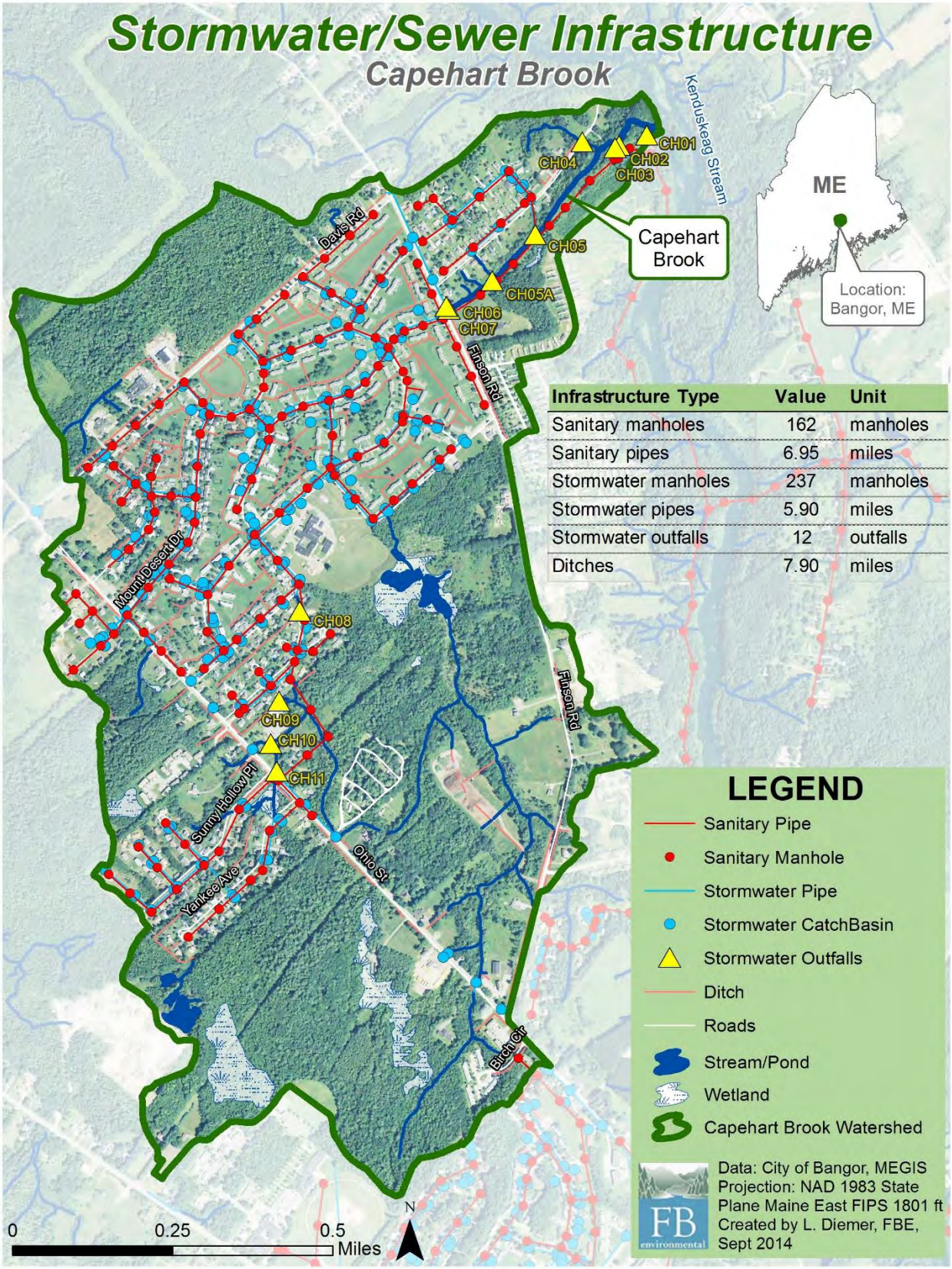

Soil Erosion Potential
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
Capehart Brook
Davis Rd
Shepherd Dr
Pushaw Rd
Acadia Pl
Bald Mountain Dr
Flinson Rd
Downeast Cir
Deer Isle Rd
Old Orchard Dr
Fort Knox Ave
Blue Hl E
Sugar Leaf Ln
Mount Desert Dr
Brighton Ave
Ohio St
Blue Hl W
Birchwood Ave
Sunny Hollow Pl
Yankee Ave
Birch Cir
Category | Area (Acres) | Area (%)
High | 0.0 | 0%
Moderate | 305.2 | 44%
Low | 155.3 | 23%
Unclassified | 227.0 | 33%
Ranges are based on the erosion factor K used in the Universal Soil Loss Equation (USLE) that predicts the rate of soil loss by sheet or rill erosion in units of tons per acre per year.
LEGEND
Roads
High (0.41-0.69)
Moderate (0.25-0.40)
Low (0.02-0.24)
Unclassified
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

Map 8



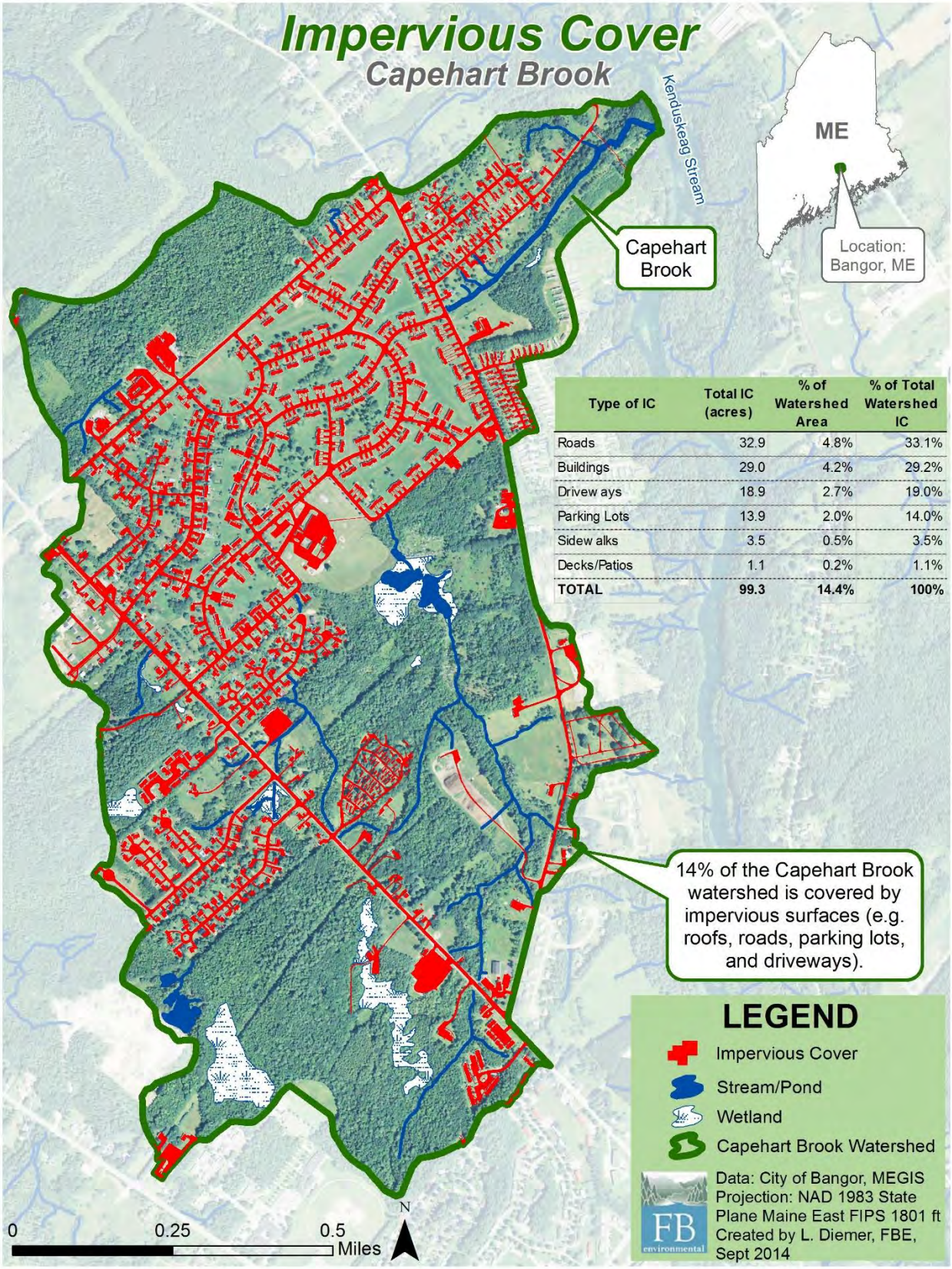
Habitat Type	Area	Units
Water Resources		
Wetlands	19.6	acres
Ponds	2.9	acres
Streams	0.46	miles
Stormw ater drainages/ditches	3.5	miles
Riparian Habitat		
Intact Forest (w ithin 75 ft)	5.8	acres
Limited Buffer (w ithin 75 ft)	3.6	acres
Limited Buffer (North Bank)	542	linear ft
Limited Buffer (South Bank)	1522	linear ft
USFWS High Value Habitat	9.6	acres

Map 9



Infrastructure Type	Value	Unit
Sanitary manholes	162	manholes
Sanitary pipes	6.95	miles
Stormwater manholes	237	manholes
Stormwater pipes	5.90	miles
Stormwater outfalls	12	outfalls
Ditches	7.90	miles

Map 10

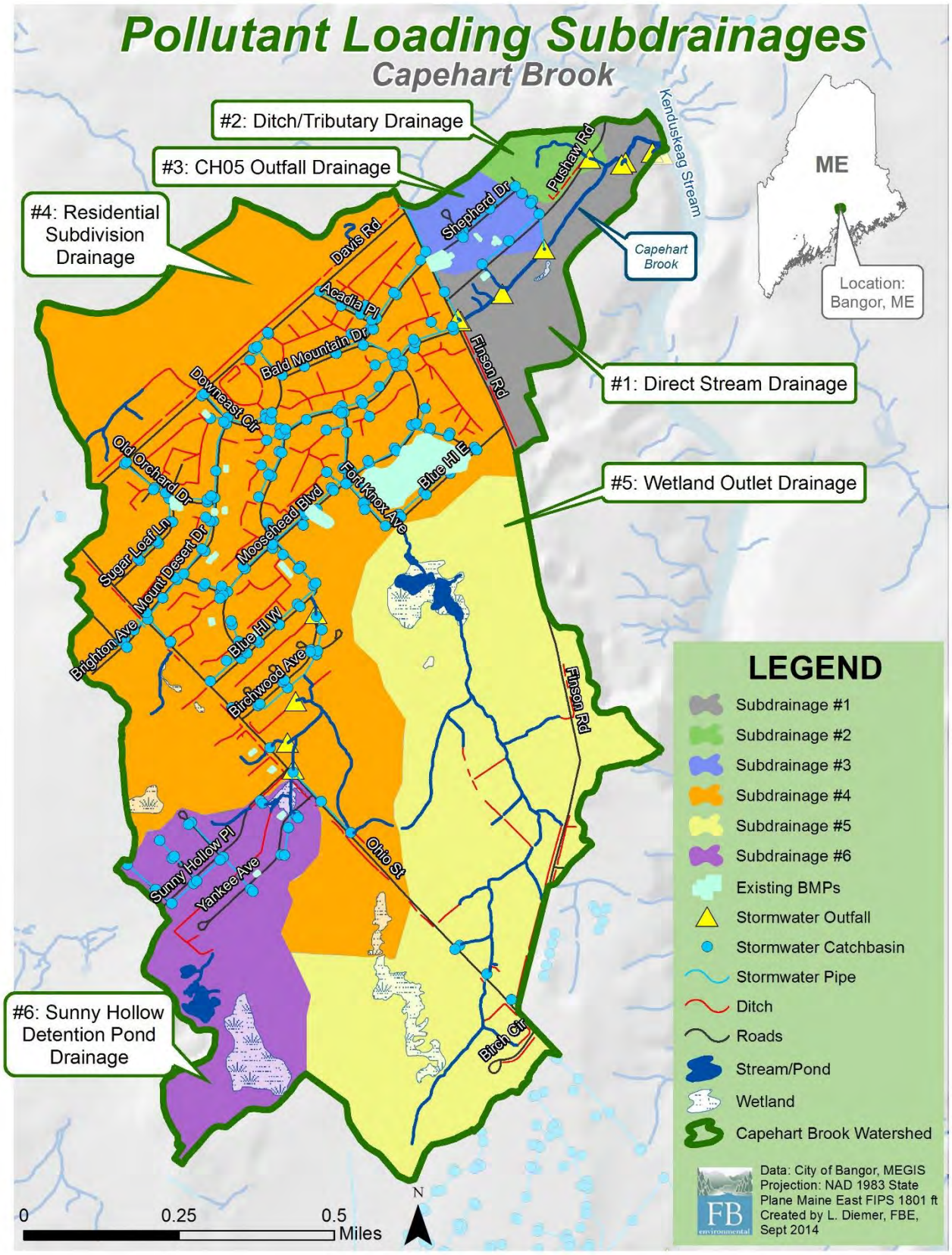


Type of IC	Total IC (acres)	% of Watershed Area	% of Total Watershed IC
Roads	32.9	4.8%	33.1%
Buildings	29.0	4.2%	29.2%
Drivew ays	18.9	2.7%	19.0%
Parking Lots	13.9	2.0%	14.0%
Sidew alks	3.5	0.5%	3.5%
Decks/Patios	1.1	0.2%	1.1%
TOTAL	**99.3**	**14.4%**	**100%**

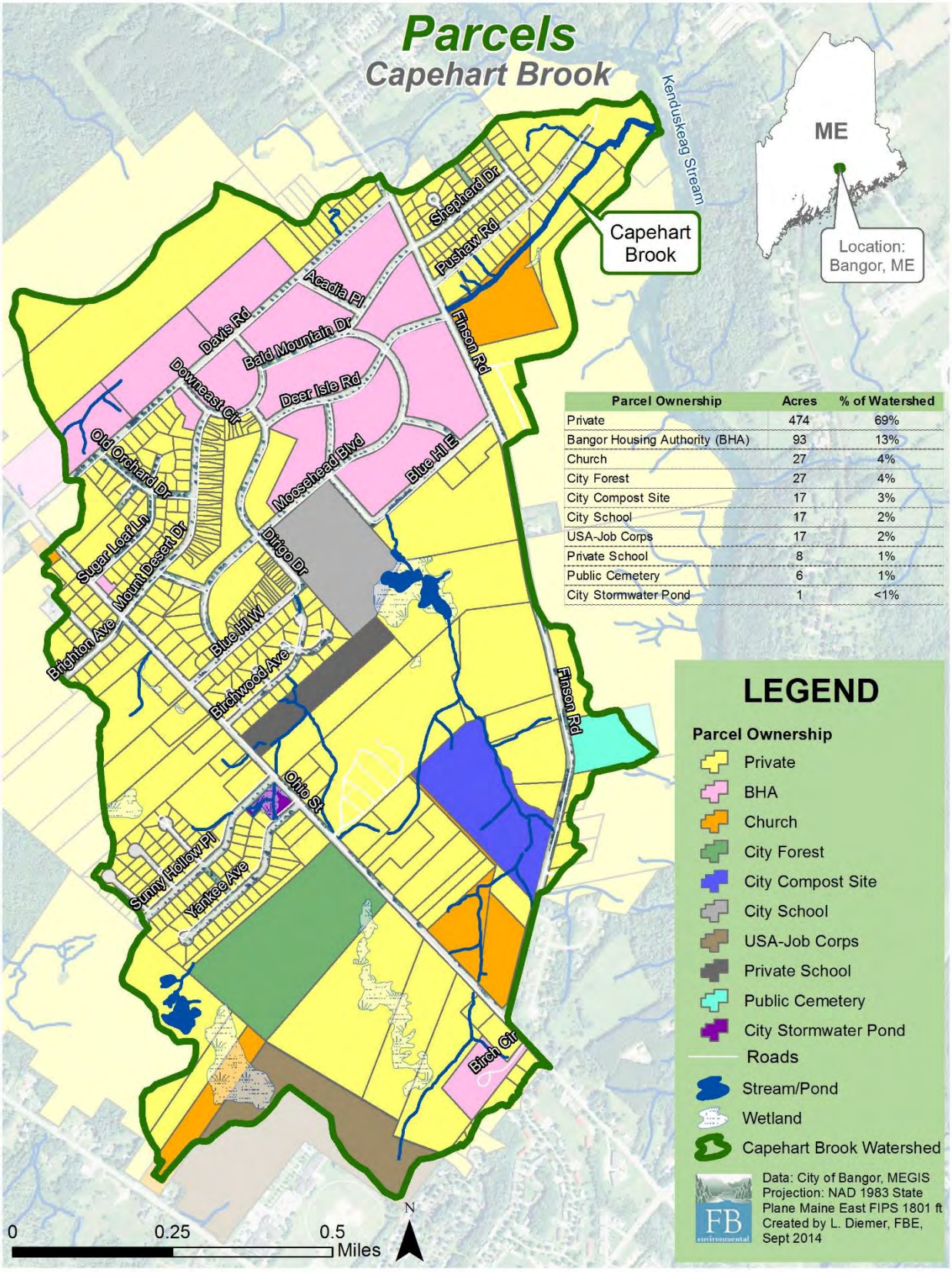
Map 11

2014 Stream Corridor Survey Reaches
Capehart Brook
A1
A2
A3
A4
A5
A6
1
2
3
4
5
6
7
8
9
10
11
Vizsla Ave
Shepherd Dr
Airedale Pl
Pushaw Rd
Finson Rd
0
250
500
Feet
N
LEGEND
Stream Reach Condition Ranking
3 - Fair
4 - Poor
Documented Culverts
NPS Sites
Paved Surfaces
Sanitary Pipe
Sanitary Manhole
Stormwater Pipe
Stormwater CatchBasin
Stormwater Outfalls
Trails
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB

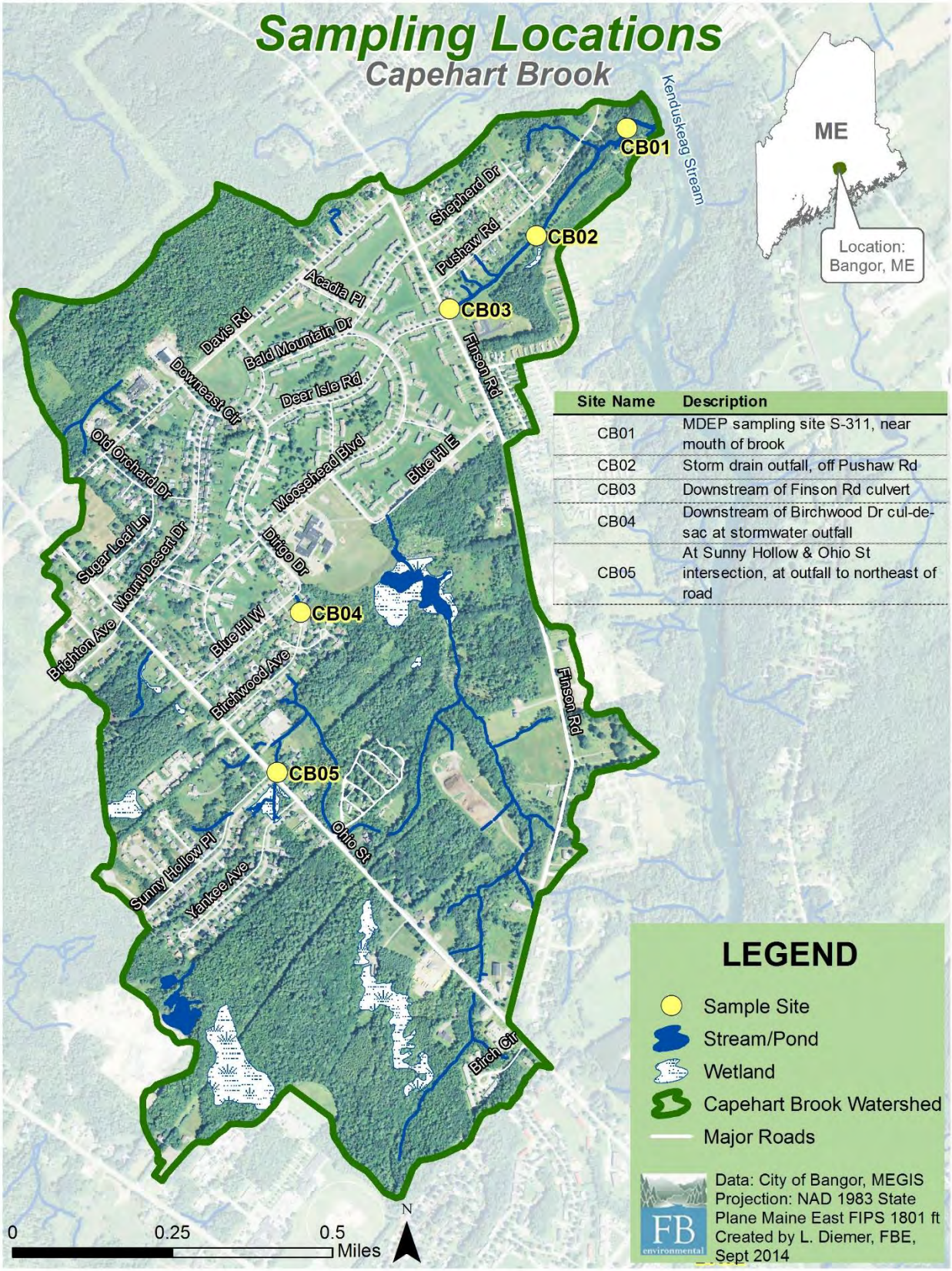
Map 12


Pollutant Loading Subdrainages
Capehart Brook
#2: Ditch/Tributary Drainage
#3: CH05 Outfall Drainage
#4: Residential Subdivision Drainage
#1: Direct Stream Drainage
#5: Wetland Outlet Drainage
#6: Sunny Hollow Detention Pond Drainage
Kenduskeag Stream
Capehart Brook
ME
Location: Bangor, ME
Pushaw Rd
Shepherd Dr
Davis Rd
Acadia Pl
Bald Mountain Dr
Finson Rd
Downeast Cir
Old Orchard Dr
Fort Knox Ave
Blue Hl E
Moosehead Blvd
Sugar Loaf Ln
Mount Desert Dr
Brighton Ave
Blue Hl W
Birchwood Ave
Sunny Hollow Pl
Yankee Ave
Otto St
Birch Cir
LEGEND
Subdrainage #1
Subdrainage #2
Subdrainage #3
Subdrainage #4
Subdrainage #5
Subdrainage #6
Existing BMPs
Stormwater Outfall
Stormwater Catchbasin
Stormwater Pipe
Ditch
Roads
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

Map 13


Parcels
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
Capehart Brook
Shepherd Dr
Pushaw Rd
Acadia Pl
Davis Rd
Bald Mountain Dr
Downeast Cir
Deer Isle Rd
Finson Rd
Old Orchard Dr
Moosehead Blvd
Blue Hill E
Sugar Loaf Ln
Mount Desert Dr
Dirigo Dr
Brighton Ave
Blue Hill W
Birchwood Ave
Ohio St
Sunny Hollow Pl
Yankee Ave
Birch Cir
Parcel Ownership | Acres | % of Watershed
Private | 474 | 69%
Bangor Housing Authority (BHA) | 93 | 13%
Church | 27 | 4%
City Forest | 27 | 4%
City Compost Site | 17 | 3%
City School | 17 | 2%
USA-Job Corps | 17 | 2%
Private School | 8 | 1%
Public Cemetery | 6 | 1%
City Stormwater Pond | 1 | <1%
LEGEND
Parcel Ownership
Private
BHA
Church
City Forest
City Compost Site
City School
USA-Job Corps
Private School
Public Cemetery
City Stormwater Pond
Roads
Stream/Pond
Wetland
Capehart Brook Watershed
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

Map 14


Sampling Locations
Capehart Brook
Kenduskeag Stream
ME
Location: Bangor, ME
CB01
CB02
CB03
CB04
CB05
Shepherd Dr
Pushaw Rd
Acadia Pl
Davis Rd
Bald Mountain Dr
Downeast Cir
Deer Isle Rd
Finson Rd
Old Orchard Dr
Moosehead Blvd
Blue Hl E
Sugar Loaf Ln
Mount Desert Dr
Drigo Dr
Blue Hl W
Brighton Ave
Birchwood Ave
Ohio St
Sunny Hollow Pl
Yankee Ave
Birch Cir
Site Name | Description
CB01 | MDEP sampling site S-311, near mouth of brook
CB02 | Storm drain outfall, off Pushaw Rd
CB03 | Downstream of Finson Rd culvert
CB04 | Downstream of Birchwood Dr cul-de-sac at stormwater outfall
CB05 | At Sunny Hollow & Ohio St intersection, at outfall to northeast of road
LEGEND
Sample Site
Stream/Pond
Wetland
Capehart Brook Watershed
Major Roads
Data: City of Bangor, MEGIS
Projection: NAD 1983 State Plane Maine East FIPS 1801 ft
Created by L. Diemer, FBE, Sept 2014
FB environmental
0
0.25
0.5
Miles
N

Map 15

APPENDIX B. Water Quality Data for Capehart Brook from 1997-2013

SITE	SAMPLE DATE	DO (MG/L)	DO (% SATURATION)	SPECIFIC CONDUCTIVITY (US/CM)	CHLORIDE (MG/L)	TEMP (°C)	PH
CB01	8/11/1997			327		19.7	
CB01	7/20/2001	8.8		498		18.6	
CB03	11/13/2009	12.7	98	244		4.6	8.1
CB03	12/19/2009	12.9	95	292	130	3.1	8.0
CB03	1/27/2010	13.0	92	173	70	1.6	8.0
CB03	3/4/2010	12.5	91	208	150	2.4	8.0
CB03	4/15/2010	11.1	96	232	62	9.4	7.8
CB03	5/13/2010	10.8	94	266	55	10.5	8.2
CB03	6/30/2010	7.7	81	295	80	17.8	7.9
CB03	8/26/2010	7.6	79	120	50	17.7	7.6
CB03	9/28/2010	8.2	86	278	100	17.4	7.8
CB03	10/28/2010	9.0	84	195	50	12.7	7.8
CB03	11/18/2010	11.1	89	174	130	6.3	8.0
CB03	12/15/2010	15.4	109	105	50	0.9	7.7
CB03	3/17/2011	12.6	87	90	110	3.6	7.7
CB03	4/19/2011	11.7	96	190	90	7.2	8.2
CB03	5/24/2011	10.9	98	268	50	10.8	7.5
CB03	6/14/2011	10.5	98	230	70	12.4	7.8
CB03	4/18/2012	8.4	80	370		12.7	8.3
CB03	5/11/2012	10.3	99	179		11.8	8.3
CB03	6/5/2012	9.6	86	257		11.8	7.9
CB03	6/12/2012	7.2	75	409		16.3	8.2
CB03	3/14/2013	11.3	90	161		5.2	7.8
CB01	3/14/2013	11.6	94	154		6.6	7.9
CB02	3/14/2013	9.5	85	153		9.7	7.5
CB01	3/29/2013	12.2	97	150		5.9	7.6
CB02	3/29/2013	11.7	94	152		5.6	7.5
CB03	3/29/2013	12.0	93	161		6.4	7.3
CB04	3/29/2013	12.1	95	128		6.2	7.6
CB05	3/29/2013	11.5	92	116		6.1	7.5
CB05	4/19/2013	10.3	92	136		10.6	7.0
CB01	5/10/2013	10.8	102	545		12.8	7.8
CB03	5/10/2013	10.3	97	542		11.7	7.6
CB04	5/10/2013	10.3	100	459		14.1	7.7
CB04	5/31/2013	9.5	93	292		14.4	7.8
CB01	5/31/2013	10.2	99	335		14.8	7.9
CB02	5/31/2013	10.4	102	347		16.1	7.7

APPENDIX C. Stormwater BMPs for Urban Watersheds

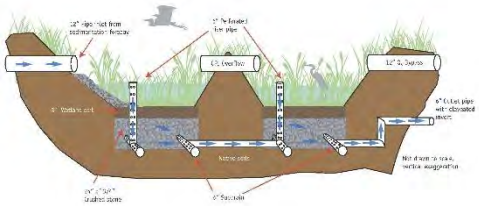
Bioretention/Biofilter: These shallow vegetated areas retain and filter stormwater runoff from impervious surfaces. Once stormwater infiltrates through the bioretention area, the water can be directed back into an existing storm drain, or back to the stream through a perforated pipe, allowing for additional subsurface treatment. Stormwater reaches the stream at a slower rate when bioretention is used thereby reducing pollutants and erosion along the stream bank.

Bioretention area *(Source: http://www.eng.umd.edu/)*

Detention Pond: Detention ponds are basins that are able to accommodate and infiltrate large volumes of stormwater, draining large storm events within 24-48 hours. The established native vegetation take up nutrients and slow water to allow for sediment settling; however, annual removal of biomass after mowing is required or decomposing plants over the winter into spring will re-release nutrients to downstream receiving waters.

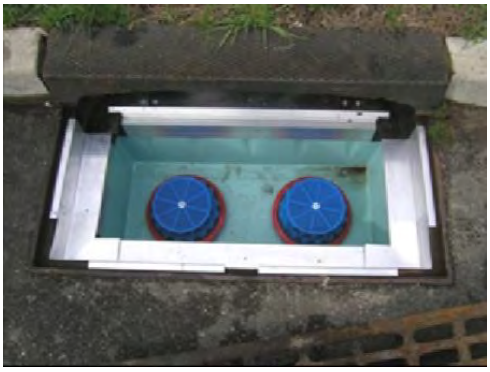
Detention Pond *(Source: http://www.stormwaterpartners.com)*

Subsurface Gravel Wetland: A subsurface gravel wetland is a horizontal-flow filtration system that functions like a natural wetland. Stormwater runoff reaches a pretreatment forebay through an inlet pipe to remove gross solids and sediment before flowing through two treatment basins that are lined with gravel and wetland soil for biological treatment by established native vegetation. Periodic removal of vegetation and accumulated sediment should be conducted to maintain proper function of the gravel wetland.



Subsurface Gravel Wetland *(Source: UNHSC 2012 Biennial Report)*

Catchbasin inserts with filtration: Catchbasin inserts are designed to capture large trash and debris and prevent them from being released downstream. Each insert comes with replaceable filtration cartridges that filter out fine sediment and nutrients, including nitrogen and phosphorus. Maintenance includes vacuuming and cleaning inserts at least once per year and replacing the filtration cartridges annually. This BMP design does not reduce flow volumes.



Catchbasin inserts with filtration *(Source: FABCO Industries, Inc.)*

Regrade Pavement: Regrading pavement in parking lots or driveways redirects stormwater into vegetated areas or other stormwater treatment alternatives rather than running down adjacent roads, storm drains, or nearby ditches, all of which lead to the stream. This BMP is a good option for paved areas because it reduces overall pollutant load and volume of stormwater reaching the stream during storm events.

Remove Pavement: If pavement is never or very rarely used, removing it will have a positive effect on the water quality of the stream. By replacing pavement with vegetation the

potential pollutants being washed off the pavement would infiltrate into the soil, rather than washing into the stream.

Culvert/Outfall Armoring: If not properly installed, erosion can occur around the openings of culverts and stormwater outfall pipes. This erosion poses a threat to stream water quality because the sediments and nutrients in the soil (such as phosphorus) go directly into the stream. The term "armoring" refers to the placement of rip-rap, or large angular stones, around the opening of a culvert or pipe. Rip-rap protects the water by holding soil in its place, even during severe storm events.

Armored culvert *(Source: Tribal Habitat Conference Blog, blogs.nwifc.org)*

Permeable Pavers: Permeable pavers can serve as a replacement for concrete in walkways and patios as well as pavement in driveways and parking lots. These blocks reduce stormwater runoff by allowing rainwater to pass through them into the underlying soil. Pavers offer the same functional capabilities as typical impervious surfaces such as pavement or concrete, while reducing the negative impact that stormwater has on stream health.

Rain Garden *(Source: http://www.grantsgardens.com)*

Rain Garden: These man-made shallow depressions in the soil are designed to capture and infiltrate stormwater flowing off impervious surfaces. Rain gardens are typically planted with native plants. Rain gardens are aesthetically and functionally appealing. By capturing and infiltrating runoff these gardens help to remove pollutants from stormwater and reduce stormwater runoff volume.

Rain Barrel: Rain barrels are large containers that capture runoff from gutter downspouts along rooflines. The water that is captured can be stored and recycled for other use, such a watering gardens. Maintenance includes annual clearing of any debris from the gutters and emptying the barrel regularly to ensure it does not overflow during storm events.

Trees: Planting trees in key areas where stormwater runoff may be flowing off impervious areas is an effective and easy-to-maintain way of reducing flow volumes and filtering pollutants. Mature trees can also intercept rainwater before it even reaches the ground.

Vegetative Buffer: Having a buffer, or naturally vegetated area along the stream corridor, is a simple and effective means of protecting stream water quality. Native plants, shrubs, and trees growing along the stream help reduce bank erosion, increase stormwater infiltration, and offer shade to the stream which moderates temperature in runoff. Buffers can be created by planting native trees and shrubs along the stream corridor.

APPENDIX D. Methods for Calculating Pollutant Load Reductions and Percent IC Treated

The methodology employed by FB Environmental to calculate the estimated annual runoff volume treated (effective impervious cover or IC reduction) and sediment and nutrient loading reductions at recommended sites within the Capehart Brook watershed is described below.

Literature research and personal communications with FABCO Industries, Inc. engineers provided estimates on the flow, sediment, and nutrient reductions associated with each existing and proposed best management practice (BMP). Table D1 documents the reduction estimates used for each BMP type by subdrainage for input to the simple pollutant loading model developed by the New Hampshire Department of Environmental Services (NHDES) (http://des.nh.gov/organization/divisions/water/wmb/section401/).

CALCULATING POLLUTANT LOADING REDUCTIONS

Pollutant loading reductions for total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN) were calculated using the NHDES Simple Method spreadsheet available online (http://des.nh.gov/organization/divisions/water/wmb/section401/).

1. Average annual precipitation was input to the model using 30-year precipitation normals (1981-2010) for the Bangor International Airport station. This data was downloaded from the NOAA National Climatic Data Center online at http://www.ncdc.noaa.gov/cdo-web/datatools/normals.

2. The model uses standard fertilizer application rates based on figures reported in the Center for Watershed Protection's Watershed Treatment Model manual. These values could not be altered. The City of Bangor currently has no fertilizer regulations; therefore, it was assumed that there would be no reductions in fertilizer application in the watershed. This can be easily changed once a fertilizer survey is conducted in the watershed and a sustainable strategy to reduce fertilizer use is developed by the City. It was also assumed that 25% of the lawns, gardens, etc. in the watershed are fertilized by private and commercial properties not owned by the Bangor Housing Authority. The Bangor Housing Authority claims that none of their properties, which cover about 75% of the residential neighborhoods in the watershed, use fertilizers.

3. The NHDES Simple Method bases calculations on subdrainages that outlet to a BMP treatment area. The Capehart Brook watershed was divided into six major subdrainages based on outfall drainages, land cover, and proposed BMP sites. Existing BMPs were incorporated within the subdrainages as disconnections (see calculations below).

4. A new digital land cover file was generated for the Capehart Brook watershed (refer to Section 2 for a description). This land cover file was used to input land cover acreage per subdrainage in the model. The model allows for a more detailed approach to quantifying loads from urban environments by separating land cover categories for roofs, parking lots, streets, highways, lawns, driveways, etc. The remaining land cover was simplified as either forest or open water and wetlands. For each land cover category, the percent impervious was input as 100% unless there was an existing BMP that led to an effective IC disconnection. In this case, the area of IC disconnection was calculated and subtracted from and then divided by the total IC in that subdrainage to determine the percent effective IC in the subdrainage.

    a. For rain barrels, each building was mapped using a list of addresses with installed rain barrels and the roof area calculated in ArcMap. With proper maintenance of the rain barrels by residents, it was assumed that rain barrels would disconnect 100% of the contributing rooftop area. These areas were summed per subdrainage and substracted from the percent IC under the residential roof land cover category in the model.

    b. For rain gardens and bioretention cells, the drainage area for each BMP was delineated in ArcMap. Based on research by the UNH Stormwater Center, a bioretention system reduces flow by 80% if properly sized for its drainage area. Therefore, the land use in each bioretention system drainage was determined, which resulted largely in impervious surface categories of roofs, driveways, and streets, and a factor of 0.8 was applied to each land cover category related to IC. The area of effective IC disconnected was summed for each subdrainage and subtracted from the percent IC under the respective land cover category in the model.

5. At this point, the model generated three values for each subdrainage: the total land area, the total effective IC area, and the total fertilized lawn area.

6. Lastly, removal efficiencies for post-development BMPs were input to the model for each subdrainage. After estimating the acres of IC disconnected as a result of a BMP (or series of the same BMP within a subdrainage), the information was plugged into the following equation as a modified removal efficiency that reflects the reduction in pollutant loading for that subdrainage based on a smaller treated area within the subdrainage:

$$\text{Modified \% TSS/TP/TN removal efficiency} = \frac{\text{(\% TSS/TP/TN removal efficiency)*(IC treated (acres))}}{\text{Total subdrainage area (acres)}}$$

If there were more than two types of BMPs within a subdrainage, then the modified removal efficiencies were summed.

7. Using these inputs, the model generated an overall summary of pollutant loading reductions and individual tabs for each pollutant broken out by subdrainage.

CALCULATING PERCENT IC TREATED

1. The estimated area of IC treated by each existing and proposed BMP was determined using literature values, personal communications with engineers, or aerial drainage delineations in ArcMap.

2. The total area of IC treated was multiplied by a BMP runoff reduction factor to obtain the effective IC disconnected as a result of BMP implementation (Table D1). This was dependent on the type of BMP. In some cases, a BMP did not result in runoff reduction, and even though it treated for pollutants, the treated area could not be counted as a true IC disconnection.

3. The effective IC disconnected for each BMP was summed by subdrainage and then summed for the entire watershed to calculate the total number of acres of IC treated. This was compared to the total number of acres of disconnected IC needed to reach an effective IC coverage of 8%.

Table D1. *Proposed post-development BMP reduction efficiencies by subdrainage*

SUB DRAINAGE	BMP TYPE	TOTAL IC (ACRES)	TOTAL IC TREATED (ACRES)	EFFECTIVE IC DISCONNECTION (ACRES)	FLOW REDUCTION (%)	TSS REMOVAL EFFICIENCY (%)	TP REMOVAL EFFICIENCY (%)	TN REMOVAL EFFICIENCY (%)	SOURCE
1	Vegetated buffers	4.7	4.7	0.0	0%	73%	40%	45%	McCarthy, J. 2008. New Hampshire Stormwater Manual: Vol. 1: Stormwater and Antidegradation. NHDES. Revision 1.0.
2	Land conservation	0.8	0.0	0.0	0%	0%	0%	0%	n/a
3	6 rain gardens; 10 rain barrels	3.9	4.7	3.8	80%	99%	65%	65%	McCarthy, J. 2008. New Hampshire Stormwater Manual: Vol. 1: Stormwater and Antidegradation. NHDES. Revision 1.0.
4	155 catchbasin inserts	65.9	26.0	0.0	0%	60%	0%	0%	Fabco, pers.comm.; Davis et al. 2009. Bioretention Technology: Overview of Current Practice and Future Needs. Journal of Environmental Engineering 135(3): 109-117.
4	4 biofilter systems	65.9	1.5	1.2	80%	90%	48%	66%	Fabco, pers.comm.; assumed similar to Rangeley Place South bioretention cell system
4	Fabco StormBasins with chamber rows	65.9	18.0	9.0	50%	80%	50%	40%	Fabco, pers.comm; proprietary documents
4	Gravel wetlands (2)	65.9	2.3	2.0	87%	99%	85%	64%	UNHSC. 2012. Biennial Report.
4	324 Mature Trees	65.9	12.5	10.0	80%	89%	74%	73%	MacDonagh 2014; National Tree Benefit Calculator (http://www.treebenefits.com/calculator/)
4	6,520 sq.ft. rain gardens	65.9	25.0	20.0	80%	85%	30%	20%	UNHSC. 2009. Biennial Report.
5	Wetland functional assessment	13.6	0.0	0.0	0%	0%	0%	0%	n/a
6	Detention pond retrofit	9.2	9.2	0.0	0%	70%	35%	45%	McCarthy, J. 2008. New Hampshire Stormwater Manual: Vol. 1: Stormwater and Antidegradation. NHDES. Revision 1.0.

APPENDIX E. List of Stormwater Outfalls

***CH11** – 24" Reinforced Concrete Pipe – Sunny Hollow Place wet pond drainage outfall*

This outfall drains the wet pond at the corner of Sunny Hollow Place and Ohio Street. The wet pond is connected to a stormwater system extending up the residential streets of Sunny Hollow Place and Yankee Avenue. The wet pond is currently failing and is a high priority for retrofit action by the City of Bangor.

***CH10** – 18" High Density Polyethylene Pipe – Ohio Street and Sable Ridge Pond drainage outfall*

This outfall drains a catch basin to the west of Ohio Street and is connected to Sable Ridge Pond on the western boundary of the watershed. Land use in this drainage area includes open fields, lawns, residential properties, and an apartment or condo complex. This outfall is not City-maintained.

***CH09** – Ditch behind residential properties*

This outfall drains a ditch that runs west-east behind residential properties along Birchwood Avenue. The ditch and outfall system are not City-maintained.

***CH08** – Ditch behind residential properties*

This outfall also drains a ditch that runs west-east behind residential properties along Blue Hill West Road. The ditch and outfall system are City-maintained.

***CH07** – 18" Corrugated Metal Pipe – Finson Road & Davis Road Drainage Outfall*

This outfall drains the areas of Davis and Finson Roads located north of the Finson Road crossing. The pipe system receives stormwater from a series of ditching and culverts located along the west side of Finson Road and north of Davis Road that drain commercial properties. Bacteria results for *E. coli* on April 7, 2014 indicate 5 col/100 mL, well below the State threshold of 104 col/100mL. This outfall was noted as having a concentrated flowpath of stormwater draining directly to the stream and should be stabilized.

***CH06** – Finson Road Ditch*

The Finson Road ditch outfall is located at the end of a ditch that runs along the eastern side of Finson Road south of the Finson Road crossing at Capehart Brook and north of the Cedar Falls Mobile Home Park entrance.

***CH05A** – Underground seep of unknown origin*

This is a recently discovered discharge to the stream originating from an underground seep. The source may be natural, but the City of Bangor is investigating further to ensure that there are no illicit connections. Bacteria results for *E. coli* on April 7, 2014 indicate 0 col/100 mL.

***CH05** – 35" Corrugated Metal Pipe – Pushaw Road drainage outfall*

The neighborhood surrounding Pushaw Road and Shepherd Drive just north of Capehart Brook is serviced by the City's storm drain system that brings stormwater from this area to the stream via outfall CH05. The outfall was first constructed

in 1985 and is located next to a heavily-used ATV trail. The culvert was noted as misaligned in the 2014 Stream Corridor Survey.

CH04 *– Rusted Corrugated Metal Pipe – End of Pushaw Road drainage outfall*

This is a rusted and collapsed culvert located at the end of Pushaw Road.

CH03 *– 12" Reinforced Concrete Pipe – From ditch on access road south of Capehart*

This outfall is located on the south side of Capehart Brook and brings stormwater from a ditch on the north side of an access trail that runs parallel to the stream. This outfall is not City-maintained.

CH02 *– 24"Corrugated Metal Pipe – Old Dow AFB WWTF drainage outfall*

This outfall is located before the access trail stream crossing along the south side of Capehart Brook and drains from the old Dow Air Force Base (AFB) WWTF. This outfall is not City-maintained. It was noted in the 2014 Stream Corridor Survey that this outfall flows after storm events, but the source of stormwater is unknown.

CH01 *– Old Dow AFB WWTF ditch*

This drainage ditch is located just before Capehart Brook meets the Kenduskeag Stream and drains from the upland area near the access trail and Old Dow Air Force Base WWTF. This ditch is not City-maintained and was noted as a potential NPS site causing sediment erosion to the stream in the 2014 Stream Corridor Survey.

66" Reinforced Concrete Pipe *– Finson Road culvert*

This concrete culvert marks the start of the jurisdictional portion of Capehart Brook. Stormwater from residential development is the main source of flow to this culvert. This drainage area also receives stormwater inputs from the Sunny Hollow Place and Yankee Avenue neighborhoods. This culvert was marked as having multiple NPS issues from lack of vegetated buffer, unstable structures, observed algal mats, and a noticeable sewage odor by the 2014 Stream Corridor Survey.

Sucker Brook

Stream Corridor and Watershed Survey

Bangor and Hampden, Maine

October 2014

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Sucker Brook
Stream Corridor and Watershed Survey

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October 2014

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Cover photos (clockwise from top left): Sucker Brook (Reach 1), Sucker Brook culverts with Greg Beane (Reach 4), Lotic Inc. staff at Sector 3, Sucker Brook (Reach 3). Source: City of Bangor

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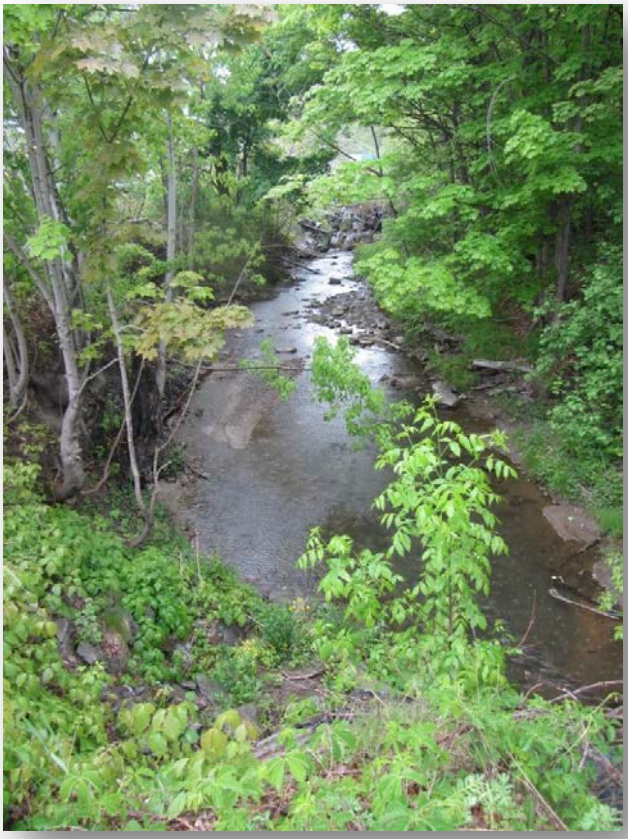

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1. BACKGROUND

Sucker Brook is a small tributary to the Penobscot River, flowing from Bangor into Hampden, Maine. The brook begins near the southeastern end of the runway at Bangor International Airport, flows south through the exchanges of I-95, I-395, and US Rt. 2, and enters Hampden in a semi-forested area adjacent to industrial development off of Route 202 in Hampden. The brook continues under Route 202, passing through a mix of agricultural, residential, and commercial development before entering the Penobscot River at Hampden's waterfront marina and park area.

View of an undeveloped section of Sucker Brook near Route 202 in Hampden, Maine.

The Sucker Brook watershed covers approximately 2.76 mi^2 (1,766 acres). The brook itself is approximately 3 miles long; 2.5 of which are listed on the State of Maine's list of impaired waters based on benthic macroinvertabrate bioassessments and dissolved oxygen (Maine DEP, 2012a). In 2002, the Maine Department of Environmental Protection (Maine DEP) classified Sucker Brook as a Class B freshwater stream[1]. In 2010, the stream's water quality standard came into question when data collected downstream of Old County Road suggested that the dissolved oxygen and aquatic life use was not meeting the standard of a Class B stream (Maine DEP, 2010)

In 2012, Maine DEP published a ***Total Maximum Daily Load (TMDL)*** Assessment Summary which determined that the largest source of stream channel alteration and pollution to Sucker Brook is stormwater runoff from ***impervious cover (IC)*** within the watershed (Maine DEP, 2012b). The Sucker Brook watershed currently has an impervious cover of approximately 25%. The TMDL determined that in order for the brook to support Class B aquatic life use, the watershed requires the characteristics of a watershed with 8% impervious cover. An 8% impervious cover represents a 68% reduction in stormwater runoff volume and associated pollutants when compared to the load that is currently being delivered to the brook.

Total Maximum Daily Load (TMDL) *is the total amount of a pollutant that a water body can receive and still meet water quality standards.*

Impervious Cover (IC) *refers to surfaces that do not absorb rain and may direct large volumes of stormwater into the stream. These include roads, parking lots, rooftops, and driveways.*

[1] *Water quality in Sucker 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."*

A combined stream corridor survey and watershed assessment for Sucker Brook will help to identify the many sources of pollutants in urban stormwater that is resulting in the water quality impairments (dissolved oxygen and aquatic life use). The survey was designed to identify and evaluate sources of soil erosion, habitat loss and unstable stream banks caused by excessive stormwater runoff. The surveys were conducted over the fall and summer of 2013, with follow-up work in the spring of 2014. This report presents the findings of both the stream corridor and watershed surveys.

2. SITE CONDITIONS

2.1 Topography

The elevation of Sucker Brook ranges from approximately 129 feet above sea level at the upper watershed near the Bangor International Airport, to approximately five feet above sea level at its confluence with the Penobscot River in Hampden. The stream is low gradient, with many areas of slow moving water. Steep banks are common among all of the reaches.

2.2 Land Use

Developed land makes up 69% of the total area of the Sucker Brook watershed. Developed open space makes up the largest area of the developed land (33%), followed by high intensity development (23%), medium intensity development (8%) and low intensity development (5%). Only 13% of the watershed is forested.

Several well-known landmarks in the watershed include the Bangor Municipal Golf Course in the northeast corner of the watershed, and Bangor International Airport in the northwest corner of the watershed. Large areas of industrial development make up the area between Odlin Road and I-95 in Bangor, along with Ammo Industrial Park and the Hampden Business Park, south of I-95 in Hampden. Residential development is largely restricted to the south-east corner of the watershed, south of Route 202, near the confluence of Sucker Brook and the Penobscot River in Hampden. Agricultural land is prominent in this area as well.

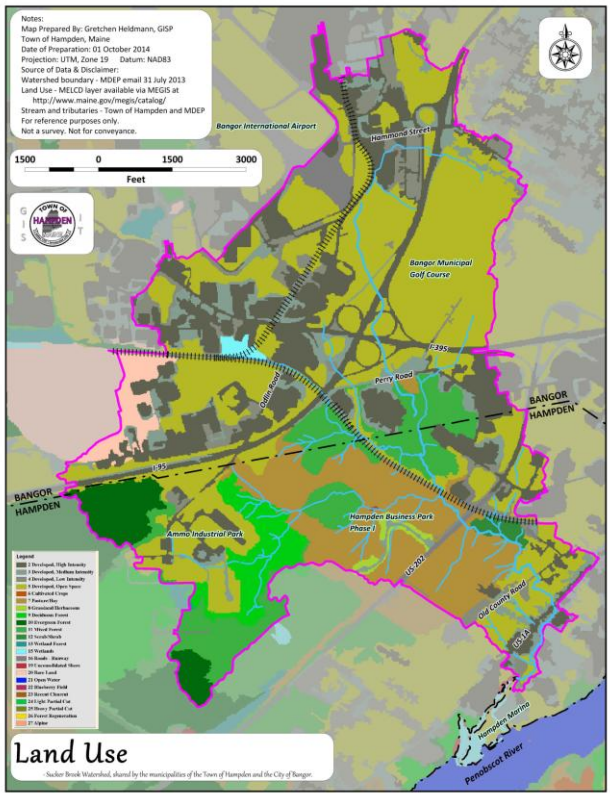


Figure 1. *Land uses in the Sucker Brook watershed. (Map 1, Appendix C)*

Example of a large area of impervious cover in the Sucker Brook watershed south of I-395.

2.3 Impervious Cover

Development within a watershed can greatly affect the water quality and health of a stream. Urbanized watersheds are usually less healthy than watersheds with a higher proportion of forestland and natural habitat. The urbanization of watersheds has a detrimental effect on watersheds largely due to the presence of impervious cover (roads, parking lots, driveways, rooftops, etc.), which prevents rainwater from being absorbed by the soil. As rainwater flows directly over the impervious areas, it picks up a wide range of pollutants such as nutrients, metals, hydrocarbons, bacteria and pathogens, fertilizers and pesticides, salt and sand, and trash and debris, and delivers it directly to the nearest waterbody- in this case, Sucker Brook.

There is a direct correlation between an increase in the percentage of impervious cover in a watershed and decreasing stream health (CWP, 2003). Studies of urban streams indicate that when impervious cover exceeds 10% of the watershed area, then streams begin to be affected by the development (Figure 2). A more recent study links high levels of impervious cover (>20%) to decreased summer base flow as a result of decreased groundwater recharge (Kauffman et al., 2008), which could have major implications on aquatic life in streams.

The Sucker Brook watershed is considered highly impervious, with an impervious area of approximately 25-30%.[2] According to the Center for Watershed Protection Impervious Cover (IC) Model, at 25% streams move from "impacted", to non-attaining (or impaired). IC in the Sucker Brook Watershed is at the threshold between impacted and impaired. Under state and federal water quality regulations, Sucker Brook is

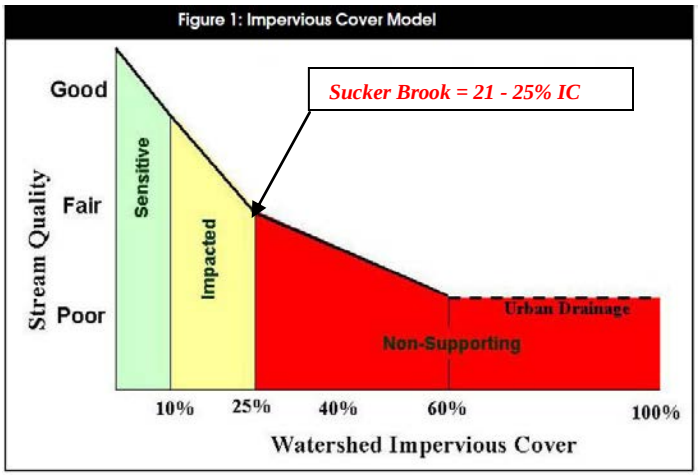


***Figure 2**. The Impervious Cover Model, showing the relationship between percent impervious cover and stream quality. (Source: CWP, 2003)*

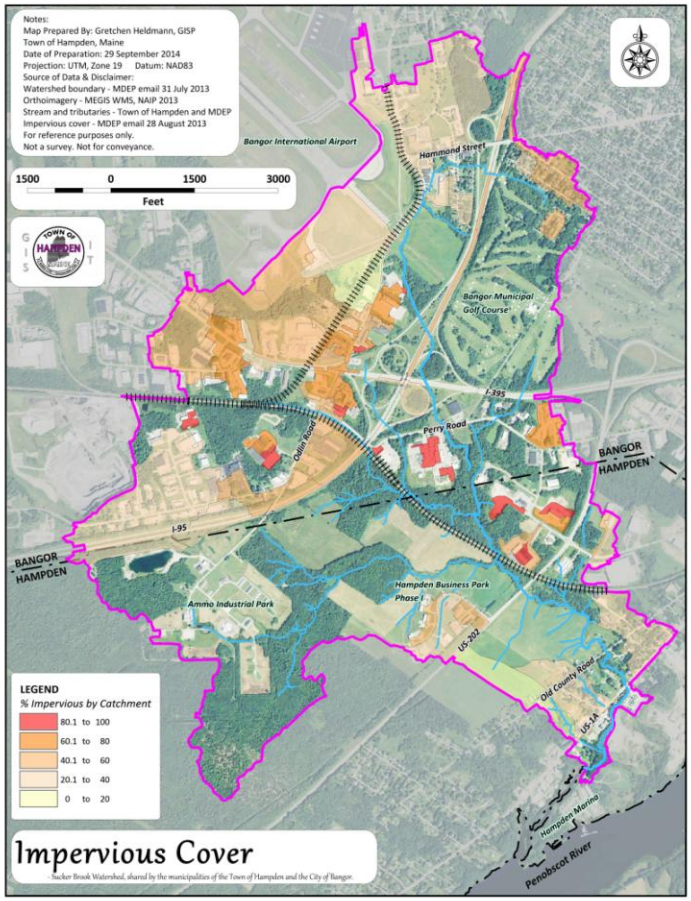


***Figure 3**. Impervious cover in the Sucker Brook watershed. (Map 2, Appendix B)*

[2] The Maine DEP Impervious Cover TMDL calculated IC in the Sucker Brook watershed at 25%. In 2013, the Maine DEP conducted an assessment of IC in the watershed, and estimated IC at 22% (see Table 1).

required to meet Class B standards for aquatic life use. In order to meet that standard, the watershed should be retrofitted to reflect the characteristics of a watershed with 8% impervious cover - equivalent to a 68% reduction in stormwater runoff volume. This can be accomplished using a variety of Stormwater Best Management Practices such as stream buffers, rain gardens, bioretention devices, or pervious parking.

Maine DEP conducted a detailed analysis of IC in the watershed to determine the types and extent of IC in the watershed (Figure 3, Table 1). The analysis indicates that parking lots, roads and buildings make up 86% of the total IC in the watershed, and cover approximately 19% of the land area in the watershed. In general, the western portion of the watershed is of greatest concern due to the large areas of IC.

Table 1. *Sucker Brook Impervious Cover Analysis.*[3]

Sucker Brook Watershed Impervious Analysis (Acres)			
Type/Location	**Total Area (Acres)**	**Total IC (%)**	**% of Total Watershed**
Parking	162.8	42.3	9.3
Road	98.7	25.7	5.6
Building	67.6	17.6	3.9
Airport	25.7	6.7	1.5
Driveway	16.4	4.3	0.9
Sidewalk	7.3	1.9	0.4
Quarry Pit	5.9	1.5	0.3
Total Impervious	**384**	**100%**	**22%**

3. STREAM CORRIDOR SURVEY

The Level 1 stream corridor survey (SCS) was conducted in August 2013 to identify and assess elements of aquatic habitat within Sucker Brook. Survey methods were based on protocols developed by EPA's Regional Office in Seattle, Washington, and modified by Maine Department of Inland Fish and Wildlife's (MDIFW) Fisheries Research Section (Bangor, Maine) and Maine DEP's *Maine Stream Team Program*. The stream corridor survey consisted of documenting visual observation of stream habitat characteristics, wildlife present, and gross physical attributes of the stream. A simple in-stream macro-invertebrate evaluation was also performed.

The survey consists of two major parts: 1) A Rapid Habitat Assessment (RHA), and 2) a Rapid Geomorphic Assessment (RGA). The design of the stream corridor survey methods and analyses are biased towards small to medium-sized wadeable streams and rivers.

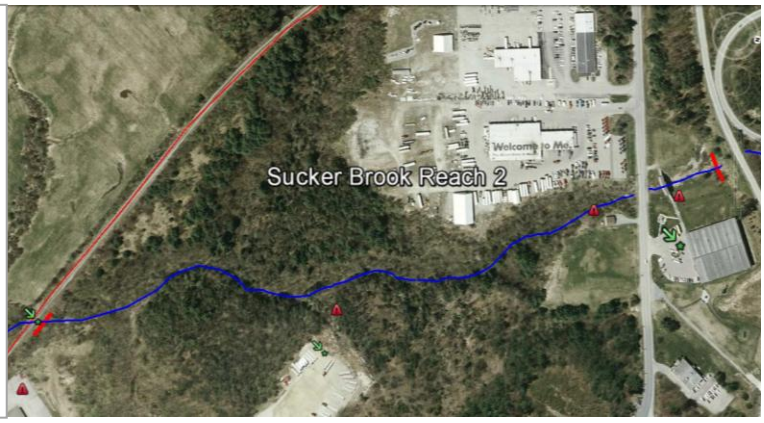
3.1 Rapid Habitat Assessment (RHA) Methods

Sucker Brook was divided into four stream reaches with a total of ten survey sites; four within Reach 1, three within Reach 2, two within Reach 3 and one within Reach 4 (next page).

[3] Maine DEP conducted an impervious cover analysis of the Sucker Brook watershed in 2013. The analysis included a breakdown of IC by cover type, and by subwatershed.

Reach 1: Reach 1 extends from the southern end of the runway at Bangor International Airport, through the I-95/I-395 interchange, and ends just past the culvert under the I-95N /I-395 exit ramp. This reach includes 6 culverts and a large area of impervious cover south of Odlin Rd. Reach 1 survey results were divided into four subreaches (1-1 through 1-4).

Reach 2: This reach extends from just below the I-95 exit ramp by the transportation museum, to the railway. It includes one road crossing and a large mixed forested floodplain. Reach 2 includes three subreaches (Reach 2-1 through 2-3).



Reach 3: The third reach extends from the rail line to the entrance to the Lane Construction yard. It includes four major road crossings and the Perry Farm, which did not allow access for this survey (right). Reach three includes two subreaches (Reach 3-1 and 3-2).

Reach 4: The last reach extends from the entrance of the Lane Construction yard to the culvert under the Marina Rd. While very short, this reach captures a great deal of stormwater runoff. Below the culvert Sucker Brook is tidally influenced.

The brook was apportioned among eight environmental professionals, technical staff, and several trained volunteers over the course of one day. The reaches were delineated based upon length, access, stream conditions, and number of personnel available. Reach 3 differs from the other reaches in that it has a much larger agricultural component than the other reaches. Unfortunately, the survey team did not have access to most of this reach. It is understood that there is a large pasture area with direct access to Sucker Brook, and there has historically been manure input along this reach.

3.2 Rapid Habitat Assessment (RHA) Results

Results of the RHA were tabulated and scored for comparison across stream reaches by site according to the Maine DEP scoring methodology (Varricchione, 2009, right), for each of the major stream characteristics.

Scoring System Used for Sucker Brook Stream Corridor Survey

1 *= problems not apparent/conditions appear to be in Very Good*

2 *= minor problem/conditions appear to generally be Good*

3 *= moderate problem/conditions appear to generally be Fair*

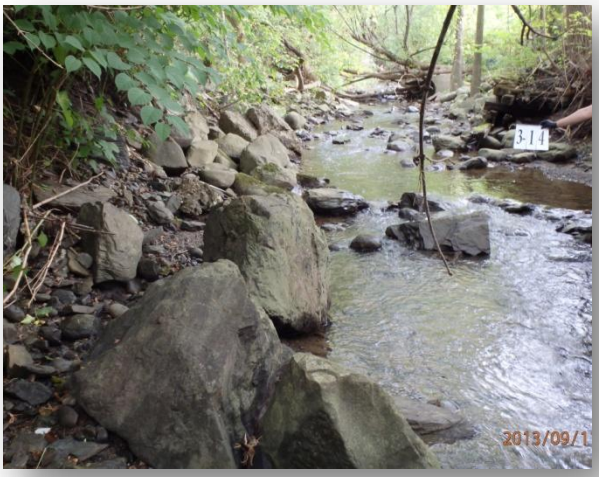
4 *= major problem/conditions appear to generally be Poor*

5 *= severe problem/conditions appear to generally be Very Poor*

Preliminary scores are presented as both tables (Appendix A) and maps (Appendix B, Map 3). All subreaches were scored individually, and then combined into a final reach score to represent each of the four major reaches. Scores are based upon best professional judgment after reviewing the available information such as field notes, photographs, and other observational data (including maps and aerial photographs).

3.2.1 Habitats

Typically, communities of coldwater fish (e.g., salmonids such as brook trout and Atlantic salmon) and other aquatic organisms (e.g., aquatic insects and other benthic (stream bottom) macroinvertebrates, which are food sources for fish) are more robust in streams and rivers having a diverse array of habitats – especially those containing riffles, with gravel and/or cobble substrates, and pools, formed by scouring action behind boulders and downed pieces of large wood (e.g., tree trunks, logs) or other stream processes (Allan and Castillo, 2007). These communities act as continuous monitors of environmental quality over time, because organisms that are more "sensitive" to pollution such as mayflies, caddisflies, dragonflies and stoneflies will be abundant in clean water with lots of dissolved oxygen; whereas, streams with low dissolved oxygen and lack of suitable habitat will have less of the sensitive organisms, and more of the "tolerant" organisms such as blackflies, midges, aquatic worms, and snails.



Example of different habitat types in Reach 3.

Examination of the in-stream characteristics of Sucker Brook indicates that the presence of habitat varies by stream reach. Reach 3 was found to have the most habitats present (pools, riffles, runs, cascades, and rapids), while Reach 1-1, a subreach of Sector 1, had the least (pools only). All other reaches (or subreaches as is the case for Reach 1 with four subreaches), had at least two or three habitats present. The most prevalent habitats include pools, riffles and runs. Average pool depth was between 1-2 ft. with the exception of reach subreach 1-3 and 3-2 with average pool depth greater than 2 ft. The most number of pools greater than 2 ft. were documented in Reach 3 (7 pools), and Reach 4 (12 pools). Deeper pools such as those documented in the lower reaches of Sucker Brook provide habitat for fish to spawn and rear their young. Reaches with low frequency of deep pools may be the result of aggradation (see RGA Results, Section 2.3).

3.2.2 Nature of Particles in Stream Bottom/Embeddedness

Of particular concern is the extent of embeddedness. Embeddedness refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish decreases. Embeddedness is a result of large-scale sediment movement and deposition. Rocks and snags provide fairly stable anchoring/attachment sites for macroinvertebrates, algae, and aquatic plants. When the spaces found between rocks and snags are not embedded, these types of substrates provide well-oxygenated spawning (egg-laying) sites for salmonids and excellent habitat for macroinvertebrates(food source for fish).

Stream Bottom (substrate) Material Size Classes:

Size Class	Millimeters	Inches	Approximate Relative Size
Bedrock	> 2048	> 80	Bigger than a car ; (a.k.a. ledge)
Boulder*	> 256	> 10.1	Bigger than a basketball
Cobble	64 – 256	2.5 - 10.1	Tennis ball to basketball
Gravel	2 – 64	0.08 – 2.5	Peppercorn to tennis ball
Sand	0.06 – 2.00	0.002 – 0.08	Salt to peppercorn
Silt	< 0.06	< 0.002	Finer than salt

* * Some scientists break out another group within the boulder category as "Rubble", which range from approximately from 10 to 20 inches in diameter (i.e., small boulders; larger than a basketball but smaller than a beach ball).

Half of the reaches were dominated by silt/clay/mud (1-1, 1-2, 2-3, 3-1, 3-2), three were comprised mainly of cobble (1-3, 1-4, 4). Rubble or boulders were present at reaches 1-3, 1-4, 3-1, and 4. Bedrock was not documented within any of the reaches.

Example of gravel and cobble substrate in Reach 4.

Overall, the extent of embeddedness through the stream varied from "not embedded" to "completely embedded". The most common extent was "mostly embedded" (75% of substrate embedded) (1-3, 1-4, 3-1, 3-2). Only reach 2-3 was determined to be "completely (100% embedded". This may be due in part to the steeply

sloping banks (>30%) and undercut banks in this section which has resulted in a wide, shallow channel. Stream bottom conditions ranged from Good (Reach 4), to Poor (Subreaches 1-1, 1-2, 2-3, 3-1, 3-2). The remaining reaches scored Fair (Table A1, Appendix A).

3.2.3 Woody Debris

Large pieces of wood in streams and small rivers help form pools and provide cover (important habitat needs of salmonids; Flebbe and Dolloff, 1995), as well as trap leaves and twigs, which are an important food source for macroinvertebrates, which are a common food source for fish. Woody debris in Sucker Brook ranges from few to plentiful. The majority of the upper and lower reaches of the stream were found to have "few" coarse woody debris (Subreaches 1-1 through 1-3, Reach 3, and Reach 4), while the middle portion of the stream was characterized as having "many" or "plentiful" coarse woody debris (1-4, 2-2, 2-3).

In low-gradient sections of streams and small rivers dominated by fine sediment particles (e.g., sand, silt, or clay) on the stream bottom, large wood 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).

Example of woody debris in Reach 2.

Some local scientists theorize that the amounts of large wood in rivers and streams in coastal (and perhaps other) regions of Maine may be significantly less than prior to European settlement of North America (Magilligan, et al., in press). (Scientists in other regions around the U. S. have proposed similar hypotheses for their own locales.) Recently, the Maine Forest Service developed standards for placing wood into streams to enhance cold water fisheries habitat (MDOC, 2012). Also, ongoing unpublished research conducted in streams in the White Mountain National Forest region of New Hampshire and Maine has suggested that additions of large wood to high gradient, rocky-bottomed streams in that area has a strong positive effect on brook trout and macroinvertebrate communities. The continued research of the potential benefits of large wood in streams and rivers is expected to have an increasing influence on restoration designs in Maine.

Iron rich brown/orange discharge at Reach 3.

3.2.4 Water Appearance/Odor

The water flowing in Sucker Brook is generally clear with no odor, with occasional algae on rocks in the stream, especially in Reach 1 and Reach 4. Exceptions include reaches in the middle of the stream, where water color was documented as light brown (3-1), dark brown (3-2), foamy (2-2, 3-1, 3-2), smelled of oil (2-2), or had a sheen (2-1, 3-1). Iron-rich water was documented at a few locations in Reach 2 and 3, which may be naturally occurring. Several sites of concern were documented in developed areas (commercial and agricultural) near the stream.

3.2.5 Streamside (Riparian) Vegetation and Water Temperature

Shading of stream waters is important to the health of coldwater fish species (e.g., brook trout and Atlantic salmon) and other aquatic organisms (e.g., aquatic insects and other macroinvertebrates) for a variety of reasons, including the fact that cold water has the ability to retain more dissolved oxygen and create less physiological stress on aquatic organisms (Allan and Castillo, 2007). A generally narrow stream like Sucker Brook has a better chance of having good canopy cover compared to a larger stream or river.

Three of the ten reaches/subreaches documented during the stream corridor survey have 100% shading (1-2, 2-2, 2-3), and five of the ten reaches sites have good riparian cover (75% cover) (1-1, 1-3, 3-1, 3-2, 4). Subreach 1-4 and 2-1 had the least amount of shading at 50%, and 0% respectively.

Since riparian cover is directly correlated with stream temperature, the better the shading, the cooler the water temperature and vice versa. Unfortunately, stream temperature was not recorded at any of the reach sites during the survey, so no correlations can be made.

Example of good (top) and poor (bottom) riparian shading in Reach 2. Bottom photo is near the Cole Land Transportation Museum in Reach 2.

Streamside (riparian) vegetation in Sucker Brook was scored using the Maine DEP scoring methodology (Varricchione, 2009). While riparian cover is one of the most important variables of stream health and habitat, it is not the only variable used to score the streamside vegetation. Other variables include: the extent of small and large woody debris, root wads, types of vegetation present, vegetative overhang, and adjacent land uses, among others. Results were tabulated for comparison purposes (Table A2, Appendix A). Scores for this category ranged from Good (1-2, 2-3) to Poor (1-1, 3-1), while the remainder of the reaches scored Fair.

3.2.6 Streambank and Channel Characteristics

Streambank and channel characteristics include bank shape (vertical or undercut, steeply sloping, gradual or no slope), channel shape, and the extent of artificial (human-made) bank modifications such as rip-rap or retaining walls. The nature of the soils and geology in the watershed, as well as within and adjacent to the stream, play a large role in the condition of the stream channel. For example, rocky streams lined with boulders and cobbles tend to be more stable than a stream comprised of sand, because sand is much lighter and can be picked up and moved easily downstream during high flow conditions.

Stream Width
Sucker Brook

Reach 1	3 ft. - 5 ft.
Reach 2	4 ft. - 9 ft.
Reach 3	4 ft. - 7 ft.
Reach 4	19 ft.

Overall, Sucker Brook is a narrow and relatively shallow stream (3 ft. - 9 ft.), with the exception of a few wide shallow reaches (2-2, 2-3, 3-1), and two narrow and deep reaches (Reach 3-2 and Reach 4). Reach 3 and Reach 4 contain the most number of pools greater than 2 ft. deep (7 pools and 12 pools, respectively). These pools are important because they provide potential habitat for fish.

A majority of the streambank contains vertical undercut banks, or is steeply sloping. With the exception of subreach 2-2, stream banks in all other reaches are either vertical/undercut, or steeply sloping (greater than 30% slope). Evidence of collapsed, eroded or undercut banks was present at a majority of the reaches. Reach 4 was documented as having severe collapsed banks.

Streambank and channel conditions ranged from Good (3-2) to Poor (4). A majority of the reaches ranked Fair (Table A1, Appendix A). Reach survey sites that ranked Poor mainly exhibited 75-100% bank modification and had few pools with no pools greater than two feet deep, with the exception of Reach 4-1.

Examples of artificial bank modification in Reach 3 (top), and Reach 4 (bottom).

Bank modifications were most often related to discharging pipes and culverts, and road crossings which cause erosion and sedimentation in the stream. Keeping riparian forests in good health and in a relatively undisturbed condition will be vital towards the long term protection of Sucker Brook.

3.2.7 Visual Biological Survey

As described in Section 3.2.1, benthic communities act as continuous monitors of environmental quality over time, beyond individual water quality sampling events. The Riparian Habitat Assessment (RHA) was

used as a biological survey in this project. The RHA utilized simple visual observations including wildlife, fish, barriers to flow or fish passage, aquatic plants and algae, and presence and types of macroinvertebrates. Several methods were used to collect macroinvertebrates including rock-rubbing, stick-picking, and leaf-pack sorting.

Macroinvertebrates in Sucker Brook were present, but generally rare with the exception of one reach, in which no macroinvertebrates were found.

Evidence of mammals (deer, muskrat, gopher) were documented at fewer than half of the reach survey sites (1-1, 1-3, 1-4, 2-3). Fish were documented at six of the ten reach survey sites (1-1, 1-4, 2-1, 3-1, 3-2, 4), and amphibians were documented at four of the ten reaches (2-2, 2-3, 3-1, 4). Macroinvertebrates were present, but generally rare, at all of the sites with the exception of Reach 2-2 where none were found at all. Water striders, aquatic worms, blackflies, beetle larvae, and snails were the common insects identified. A caddisfly was documented in Reach 4. With the exception of the caddisfly, the other insects found in the stream are typically less sensitive to environmental pollution, and are often dominant in polluted urban streams.

Barriers to fish passage include natural features such as cascades (Reach 3) and culverts (all reaches except Reach 3). A formal fish and culvert survey should be considered in the future to document the valuable fish habitat and specific species and need for fish passage, culvert conditions, and the need for replacing or retrofitting existing culverts. Common problems with culverts include hanging culverts and long stretches of stream sections that have been culvertized; both factors are barriers to fish passage. The ultimate goal for improving culverts is to maintain or replicate natural stream channel or flow conditions, pass peak flows, improve habitat connectivity within Sucker Brook, and comply with state fish passage regulations.

3.2.8 Water Quality and Potential Pollution Sources and Problems

Water quality problems were common in all of the stream reaches in Sucker Brook, some causing more of an impact than others. The most apparent problems were related to the prevalence of stormwater runoff draining from large impervious areas such as roads, parking lots, and commercial and residential areas. Discharging pipes (including storm drain outfalls) and/or ditches that drain directly to the brook are present in all but one (2-3) of the ten surveyed reaches/subreaches. Runoff from stormwater outfalls and impervious areas reportedly has the greatest impact on water quality in Reach 1, while Reach 2, with a large forested buffer, may experience less severe effects from the runoff. Garbage and litter were most severe in and adjacent to the brook in Reaches 1 and 4.

Water quality and potential pollution sources were scored separately for each subreach (Table A3, Appendix A). Water quality ranged from Good (1-2, 1-2, 1-4, 2-1, 2-3) to Poor (1-1, 2-2, 4). The remainder of the reaches scored Fair. With the exception of Reach 2-3 (Very Good), survey results suggest there is a moderate to major problem when it comes to potential pollution sources in Sucker

Brook. However, none of the reaches ranked Severe/Very Poor for water quality and potential pollution sources.

Examples of discharging pipes or stormwater outfalls in Reaches 1, 3 and 4.

3.3 Rapid Geomorphic Assessment (RGA) Methods

The Rapid Geomorphic Assessment (RGA) was the second major component of the stream corridor survey for Sucker Brook. This type of survey is based on methods described in the Maine DEP Stream Survey Manual (Maine DEP, 2009). The RGA provides screening–level information about the fluvial geomorphological characteristics of the stream (shape and stability of the stream system), including the physical processes related to water and sediment transport through the stream system. There are four major geographic processes assessed through this type of survey: aggradation, degradation, widening, and planimetric form adjustment. These are discussed in more detail below. This type of survey is useful for identifying reaches receiving large volumes of stormwater which can cause channel instability, and identify reaches with signs of alteration from human activities. Stream reaches used for this survey were the same as described in 3.1 above. Information gathered from the RGA can be used to target specific stream reaches in Sucker Brook for further assessment and restoration planning.

3.4 Rapid Geomorphic Assessment (RGA) Results

The RGA survey documented four major geomorphic processes:

AGGRADATION occurs when sediment loads accumulate in the stream. This happens when the sediment load increases (due to natural processes or human activities) and the stream lacks the capacity to transport it. Piles of sediment in a stream can re-direct flow against the banks, causing erosion (Maine DEP, 2009). Evidence of aggradation includes several features, including but not limited to: lateral bars, embeddedness, siltation in pools, a soft unconsolidated bed, and evidence of deposition around bank structures. Aggradation was recorded in Sucker Brook at all reaches, except Reach 4 and the lower portion of Reach 3 (3-2). The most common evidence of aggradation in these reaches is a result of substrate embeddedness, mid-channel bars, and siltation in pools.

Soft unconsolidated sediment (causing silty brown color in water), and formation of mid-channel bars was evident in Reach 2.

Elevated tree roots and/or root fans, as seen above in Reach 4, are indicators of degradation.

DEGRADATION occurs when the stream cuts deeper into the land. One result of degradation is that bridge footings can be undermined and exposed. Degradation can sometimes be caused by straightening and shortening a channel, which increases the slope of the stream. The water flows faster down this steeper slope

and has extra energy to move sediment, causing the stream channel to cut deeper or degrade. Other causes of degradation include increases in peak flows and frequency due to activities such as poorly planned urbanization, agriculture, and forest practices (Maine DEP, 2009), and an increase in the intensity and volume of rain events.

Evidence of degradation includes elevated tree roots, or root fans above the channel bed, bank height increases, and absence of depositional features such as bars. Degradation was most apparent at Reach 3-2 and Reach 4-1. All other reaches exhibited little to no evidence of degradation.

WIDENING occurs when banks collapse, and the stream becomes wider and shallower. A wider, shallower stream does not have the same capacity to transport sediment, so sediment can build up in the channel. Widening is a process that typically follows aggradation or degradation geomorphic phases. Widening occurs because the stream bottom materials eventually become more resistant to erosion (harder to move) by the flowing waters than the materials in the stream banks (Maine DEP, 2009).

Collapsed streambanks, and buildup of sediment in the stream channel has resulted in a wide, shallow stream in the upstream portion of Reach 3.

Evidence of widening includes fallen or leaning trees or fence posts, large organic debris, exposed tree roots, and steep bank angles throughout the reach, among others. Widening was most evident in Reaches 3-1 and 1-3. All other reaches exhibited some characteristics of widening. It is likely that increased delivery of stormwater has resulted in widening in these reaches.

Example of planimetric form adjustment in Reach 3 showing cut-off channels and mid-channel bars.

PLANIMETRIC FORM ADJUSTMENT is the change that can be seen from the air when looking down at a stream or river, showing that the stream's pattern has changed. This can happen because of human intervention (such as straightening the bends of the stream with heavy equipment). Planform changes also occur during floods. When there is no streambank vegetation with roots to hold soil in place, rivers cut new channels in the weak part of the bank during high water events. When not a result of direct human manipulation, planform adjustments typically are responses to aggradation, degradation, or widening geomorphic phases (Maine DEP, 2009).

Evidence of planimetric form adjustment includes formation of chutes, cut-off channels, and bar forms that are poorly formed, reworked or removed. Reaches 1-1 and 3-1 were the only ones that exhibited any evidence of planimetric form adjustment.

The RGA results were used to calculate the Stability Index and assign a geomorphic condition to each of the stream reaches (Varricchione, 2009). The Stability Index is calculated to assess reach stability (aggradation, degradation, widening, or planimetric form adjustment). Survey results are lumped into three major geomorphic conditions in order of condition from best (In Regime) to most affected (In Adjustment), where:

GEOMORPHIC CONDITION

In Regime= Where Stability Index is ≤ 0.20

In Transition or Stressed= Where Stability Index is between 0.21- 0.40

In Adjustment= Where Stability Index is ≥ 0.41

Results of the RGA survey indicate that Sucker Brook is currently in transition or stressed (Table 2; Table A4, Appendix A). Six of the ten subreaches met this condition, while one subreach (Reach 3-1) is in adjustment. Note however, that Reaches 1-1 and 1-2 were on the cusp of being "In regime". Reaches 1-3, 1-4 and 2-1 met the conditions for "In regime", indicating that these subreaches are more stable than the others.

Table 2. *Geomorphic Condition for subreaches of Sucker Brook.*

Reach ID	Stability Index	Geomorphic Position
1-1	0.22	In transition or stressed
1-2	0.21	In transition or stressed
1-3	0.14	In regime
1-4	0.16	In regime
2-1	0.15	In regime
2-2	0.26	In transition or stressed
2-3	0.27	In transition or stressed
3-1	0.43	In adjustment
3-2	0.35	In transition or stressed
4	0.35	In transition or stressed

3.5 Summary of Findings

Using the Maine DEP scoring criteria (Varrichione, 2009), a score was assigned to compare the overall condition of each subreach within the brook based on the combination of parameters described in sections 3.1 through 3.4, above. Generally, the overall stream condition represents an average of these conditions. Best professional judgment was used to assign the final score.

Upon review of the findings from this screening-level survey of representative reaches of Sucker Brook, this water resource appears to be in Fair condition (Table 3). An overall score was assigned to each of the full reaches (1, 2, 3, 4) by averaging the scores for all subreaches within a given reach (Figure 4).

Table 3. *Stream condition ranking for subreaches of Sucker Brook.*

Reach ID	Riparian Shading	Gen. Conditions	*Stream Bottom*	*Streambank / Channel*	*Water Quality*	*Potential Pollution Problem*	*RGA*	*Average Score*	*Overall Condition*
1-1	2	4	4	3	4	4	3	**3.4**	Fair
1-2	1	2	4	3	2	3	4	**2.7**	Good
1-3	2	3	3	3	2	4	3	**2.9**	Good
1-4	3	3	3	3	2	4	2	**2.9**	Fair
2-1	5	3	3	4	2	3	2	**3.1**	Fair
2-2	1	3	3	3	4	3	4	**3.0**	Fair
2-3	1	2	4	3	2	1	4	**2.4**	Good
3-1	2	4	4	3	3	4	5	**3.6**	Fair
3-2	2	3	4	2	3	4	5	**3.3**	Fair
4	2	3	2	4	4	4	4	**3.3**	Fair

1 *= Problems not apparent / conditions appear to be very good;* ***2*** *= Minor problem / conditions appear to generally be good;* ***3*** *= Moderate problem / conditions appear to generally be fair;* ***4*** *= Major problem / conditions appear to generally be poor;* ***5*** *= severe problem / conditions appear to generally be very poor.*

Given the high percentage of impervious cover in the watershed, and the numerous documented stormwater outfalls that deliver stormwater directly to the stream, it is clear that impervious cover (IC) and associated stormwater runoff is a major water quality issue in Sucker Brook. In addition, follow-up surveys are needed to assess the condition of tributaries that flow into Sucker Brook, and a follow-up survey is needed to assess the condition of the large stretch of Reach 3 that was not accessible during this survey due to active agricultural activities. This may require additional focused landowner outreach.

Watershed and stream restoration planning is needed immediately in order to improve conditions within the stream. Land use changes such as new development in previously undeveloped areas in the watershed should be designed appropriately to limit additional stormwater runoff. The City of Bangor and the Town of Hampden need to work actively with their development communities such as local business groups or municipal economic development committees, to encourage preservation of riparian areas and floodplains in order to maintain a healthy river system. Additionally, the City and Town should begin prioritizing implementation strategies such as voluntary best management practices or changes to their land use ordinances to include mandatory requirements, to prevent stormwater and associated pollutants (eroded soil, trash, winter sand, fertilizer and lawn care chemicals) from entering the stream. These suggested strategies will require a significant amount of public education and outreach, and stakeholder engagement. Reducing the effects of impervious cover, and redirecting or treating stormwater before it reaches the stream will help prevent severe shifts in the stream's geomorphology and improve in-stream habitat for aquatic life.

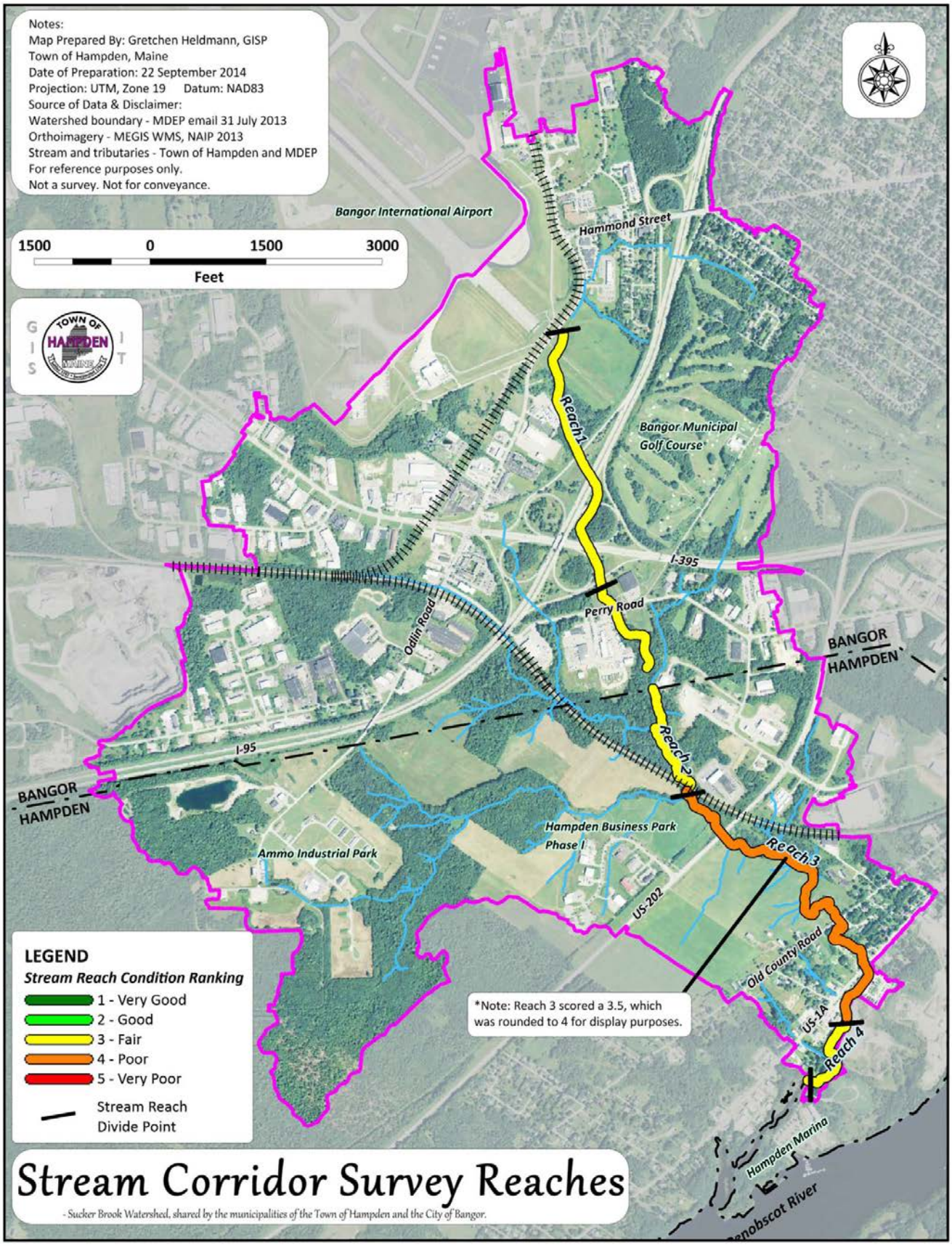


Figure 4. *Stream conditions map.*

4. WATERSHED SURVEY

The Sucker Brook watershed survey was based upon the method formalized by the Maine DEP *Stream Team Program* (Volume I): A Citizen's Guide to Basic Watershed, Habitat, and Geomorphology Surveys in Stream and River Watersheds (2009). The survey was designed specifically to identify sources of stormwater runoff and degradation to riparian areas in the Sucker Brook watershed.

The watershed survey was conducted in two phases; the first phase was completed in September 2013, and the second phase in June 2014. The purpose of the 2013 survey was to document land use types and nonpoint source pollution issues throughout the watershed. The purpose of the 2014 survey was to identify high priority "hot spots" that could be the target for future watershed implementation projects. For both surveys, the watershed was divided into six sectors (Figure 5).

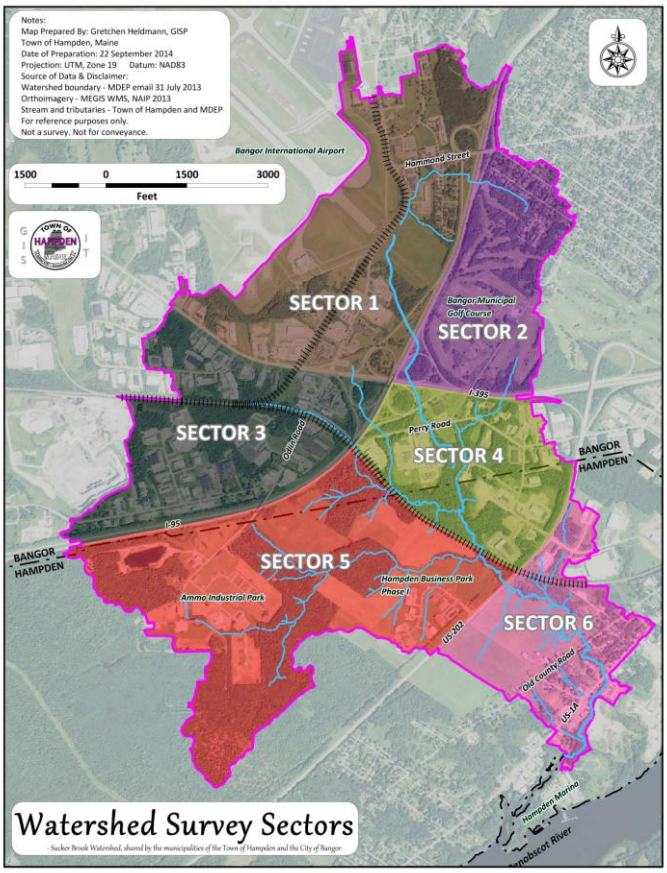


Figure 5. *Watershed survey sector map (Map 4, Appendix C).*

4.1 Sector Descriptions

The six watershed survey sectors include the land area from the Bangor International Airport at the north end (Sector 1), to just north of the Penobscot River in Hampden, Maine (Sector 6) at the southern end. The sectors vary in size, shape and land use type. Development intensity varies across sectors, but roads, forested areas, residential areas, agricultural lands and commercial/industrial development parks are all present within the watershed.

Example of a large area IC within a commercial development near VIP in Sector 1.

<u>Sector 1:</u> Sector 1 extends from the Bangor International Airport below Union Street on Route 15, south to the Interstate 395 and Interstate 95 interchange, and west to Ban air Road. This sector is heavily developed (commercial and industrial land uses). This sector has relatively large areas of impervious cover, with facilities and businesses such as Eastern Maine Medical Center

Family Medicine, Bangor Savings Bank and the Ramada Inn. Sector 1 is completely within the City of Bangor.

Sector 2: The boundaries of Sector 2 extend from the northern boundary of Sector 1 south to Hammond Street. This sector includes a portion of the residential area south of Hammond Street, to the Bangor Municipal Golf Course, reaching almost as far eastward as Webber Street. It cuts through approximately the middle of the golf course, south to Interstate 395, and includes all area west to the I-395/I-95 interchange. This sector is heavily residential and contains a lot of developed open space used for recreation including Fairmont Park and a large portion of the golf course. Sector 2 is located completely within the City of Bangor.

Example of a typical residential neighborhood off Hammond Street in Sector 2.

Sector 3: Sector 3 is located entirely within the City of Bangor, south of Sector 1, north of the Bangor/Hampden town line, and east of the Lane Quarry off Odlin Road. Like Sector 1, this sector is highly developed relative to the sectors to the south, and includes a long stretch of rail line, and the intersection of Odlin Road and Hammond Street (Rt. 2). Multiple catch basins and stormwater outfalls were documented in this sector. Some of the facilities and businesses within the sector include Gold's Gym, Evergreen Waste, Sergeant Corporation, United Rentals, and New England Salt Supply.

Numerous catch basins in Sector 3 collect road runoff and redirect stormwater directly to Sucker Brook.

Sector 4: Sector 4 is located east of Sector 3, and south of Sector 2. The northern portion of the sector is located in Bangor, while the southern portion is located in Hampden. This sector includes the area south and east of the I-395 and I-95 interchange. Specifically, this sector is bound by I-395 to the north, I- 95 to the west, and the railroad tracks to the south. Although not nearly as developed as Sectors 1 and 3, Sector 4 contains several locations with large amounts of impervious area, such as the Cole Museum, Freightliner, and N.S. Giles.

Runoff resulting from compacted grass and gravel in Sector 4.

Sector 5: Sector 5 is located almost entirely within the Town of Hampden, with the exception of a small portion of land adjacent to a tributary that flows to Sucker Brook in the northeast corner of the sector. This sector extends southeast and southwest from the intersection of the train tracks near Perry Road and I-95. It includes Ammo Industrial Park, the Hampden Business Park, a portion of Route 202, and large tracts of agricultural land. Route 202 and the train tracks serve as the southeast and northeast boundaries of this sector, respectively. The prominent commercial and industrial developments include Ammo Industrial Park and the Hampden Business Park, which includes businesses such as Clean Harbors, Hampden Veterinary Clinic, Wight's Sporting Goods, and Central Maine Diesel.

Example of a business park in Sector 5 in Hampden.

Sector 6: Sector 6 is located entirely within the Town of Hampden, and is southeast of Sectors 4 and 5 including the last section of Sucker Brook before it flows into the Penobscot River. This sector includes a mix of residential and commercial buildings, the intersection of Route 202 and the railroad to the north, and a portion of Route 1A. Some of the notable locations in this sector include the Hampden Trailer Park, a storage unit facility, and the Perry Farm.

View of the agricultural land adjacent to Sucker Brook in Sector 6.

4.2 Methodology

In September 2013, environmental professionals paired off to survey each of the six watershed survey sectors. Field teams surveyed multiple sites within each of the six sectors using official field forms and/or field notes. More than 100 nonpoint source pollution (NPS) sites were documented across the six sectors. GPS cameras were used to document the location of each NPS site. Only 38 of the NPS sites were documented using approved field forms. The other 60+ sites were documented as field notes without field forms. Sector 3 had the most number of documented NPS sites.

Field forms and field notes were sorted and entered into a common spreadsheet for analysis. For purposes of consistency and accuracy in reporting, only the 38 NPS sites documented in 2013 with field forms were used in the analysis for this report. Following data entry, each of the 38 sites were assigned a unique Site ID corresponding to the six sectors. While field teams documented NPS problems at each observed site, recommendations were not always included. However, some of these sites were revisited by staff from the City of Bangor and the Town of Hampden during a "hot spots" survey in June 2014 using the

knowledge gained about the watershed from the 2013 survey. The survey targeted high priority locations within each of the six sectors. This included locations believed to be most damaging to the water quality in Sucker Brook.

No official field forms were used to document the 2014 hot spots, but field notes included information on hot spot site location, identified problems, and recommendations. This information was entered into an Excel spreadsheet for analysis, and maps were created to show the location of these sites (Appendix B, Maps 5 - 11).

4.3 2013 Watershed Survey Results

Thirty-eight sites were formally surveyed during the 2013 watershed survey. These sites were located throughout the six sectors with the majority being in Sectors 1 and 3. This is not surprising given the large area and high intensity of developed land within these sectors compared with the other sectors. Documented NPS sites were located in close proximity to commercial and industrial facilities, roads, and residential buildings.

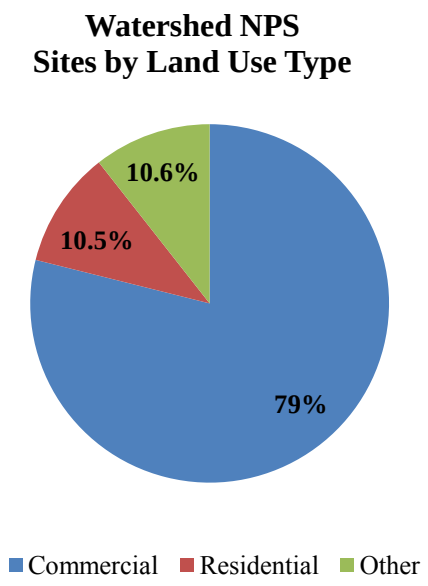


Figure 6. *NPS sites by land use type.*

Additional hand-written field notes for 60 other NPS problems sites were documented with the name of the business. These sites are not addressed in this report simply because they are additional field notes and not formally reported on the official field data sheets. For this reason, there are no formally documented sites in Sector 5, and only one in Sector 4, though field notes indicate at least 37 other locations that may be contributing to poor water quality in Sucker Brook in these two sectors. This reduction in survey size should be noted for future watershed work, as many of these sites may need attention. Furthermore, a large area of agricultural land adjacent to the stream in Sector 3 was inaccessible to survey teams, and should be considered in future watershed planning activities.

Close to 80% of the documented NPS sites from the 2013 survey are located on commercial lands, and approximately 10% on residential lands (Figure 6). Combined, other land uses, such as public parks, or other municipal land (e.g. golf course) comprise the remaining 10% of documented NPS sites.

Several areas were identified as having the potential, due to high traffic or site activities, to be hot spots for discharging pollutants to Sucker Brook. Activities conducive to pollutant dispersal (vehicle idling, wash areas, storage, etc.), were observed during the watershed survey. Sectors 1, 3 and 4 have a heavier industrial component than the other sectors; they also have a much heavier traffic component, and many intersections in these sectors lead to long vehicle idle times. Many of these intersections (such as the Odlin Rd./Rt. 202 intersection) contain numerous catch basins that direct runoff from the intersection into the stream, making these sectors more likely to have moderate to severe petroleum inputs.

A common factor across all six survey sectors was the management of stormwater runoff from roofs and impervious surfaces. A considerable number of residential homes (> 60%) had roof gutters and downspouts that were directed onto impervious surfaces (driveways, walkways, etc) rather than being infiltrated into the ground via lawn area, rain gardens, infiltration trenches or drywells. Runoff discharging from roof downspouts has the force to sweep over driveways and walkways and collect any oil, pet wastes, grass clippings, leaves, excess fertilizer and herbicides, or other potential pollutants, and dump them into the municipal storm drain system, which discharges into Sucker Brook with little to no treatment.

The largest proportion of residential NPS sites are located in Sectors 2 and 4. In addition to pollution from residential development, a major consideration in Sector 2 is the municipal golf course, which without proper management has the potential to contribute excess pesticides and fertilizers directly into Sucker Brook. Fortunately, the golf course is managed by the City of Bangor, and is an Audubon-certified course, meaning the use of pesticides, herbicides, and fertilizers is carefully controlled both in terms of storage and application. Pesticides, herbicides and fertilizers are located in a locked building and the City employs agronomists to care for the fairways and greens.

Agricultural land uses in Sector 6 are a concern, as a large cattle farm (known as the Perry Farm) is located within this sector. Historically, animals have had access to the brook. Without proper management of farm animals, Sucker Brook is more at risk to soil erosion as a result of cattle in and adjacent to the stream, and addition of bacteria and nutrients from animal waste. Proper fencing along the brook, targeted bridge placement for cattle crossing, and nutrient management should be considered within this portion of the watershed.

4.4 2014 Hot Spot Survey

In June 2014, a hot spot survey was conducted throughout the six watershed survey sectors visited in 2013. A total of 39 sites were documented as hotspots; eleven of which overlapped with formally documented NPS sites from the 2013 survey (Figure 7). The number of hot spots within each sector ranges from two (Sector 2) to eleven (Sector 3). Sectors 1 and 3 have the greatest number of documented hot spots. This is not surprising based on the extent of impervious cover (IC) in these sectors, and the high number of NPS sites documented in these sectors during the 2013 survey.

Problems that were identified at these hot spots include idling, hydrocarbons, sediment and erosion issues, chemical and metal exposure and the presence of nutrients. Recommendations to remediate these issues include installing rain gardens and/or biofilters, increasing vegetation, installing water diversions, swale or drainage work, and bank stabilization.

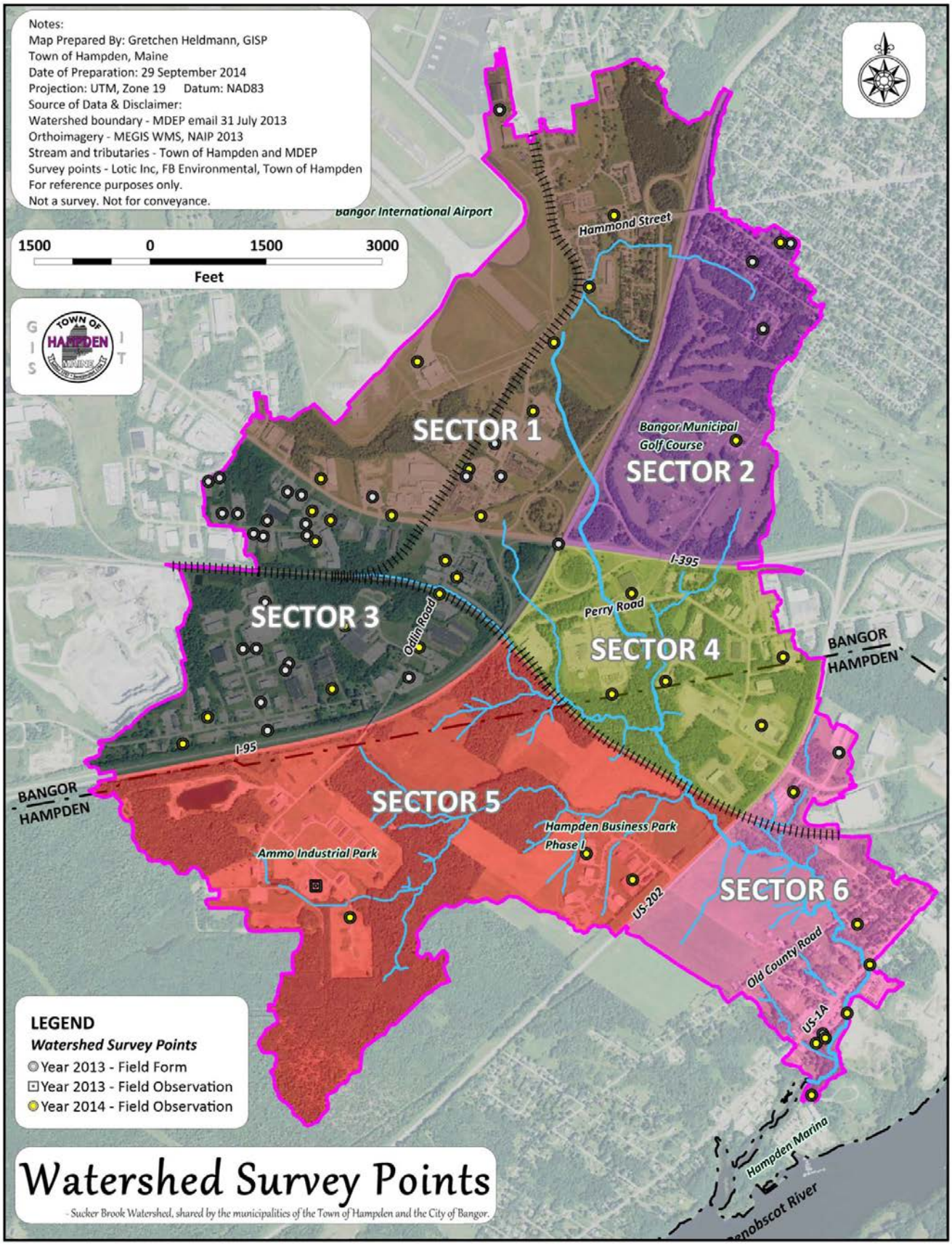


Figure 7. *2013 Watershed Survey and 2014 Hot Spot Survey results map. (Map 5, Appendix B)*

Documented NPS sites from the 2013 watershed survey and the 2014 hot spots survey were combined to eliminate duplicate sites, for a total of 67 sites (Figure 7 and Table C1, Appendix C). Sector specific maps are presented in Appendix B (Maps 6 - 11).

4.5 Next Steps

The 2013 watershed survey and 2014 hot spot survey served as a preliminary investigation for documenting sources of NPS pollution in the Sucker Brook watershed. Additional investigation is needed to prioritize and develop detailed designs for the high-priority NPS sites. The City of Bangor and Town of Hampden should work cooperatively to develop a watershed plan that includes the following recommendations:

From Stream Corridor Survey

Actions are needed to improve the physical, chemical, and biological conditions in Sucker Brook so that it meets the State Class B water quality criteria for aquatic life.

1. Develop a list and cost estimate of habitat and riparian restoration options (watershed plan);
2. Sample water quality at select stormwater outfalls;
3. Conduct a culvert survey – upgraded for stability, fish passage, and geomorphic conditions;
4. Fish survey – identify and document the state of the existing fish population and make recommendations for habitat enhancement projects.

From Watershed Survey

Actions are needed to reduce the effects that impervious cover and stormwater are having on Sucker Brook. This includes increased flow, delivery of pollutants, thermal pollution, and changes in habitat and stream morphology.

1. Reduce flow to stream/disconnect impervious cover;
2. Develop a prioritization methodology for highest impact sites;
3. Develop a pollutant load and flow reduction estimate for sites (watershed plan);
4. Engage stakeholders (watershed plan);
5. Set milestones for restoring water quality;
6. Identify demonstration sites (IC reduction or Low Impact Development strategies).

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APPENDIX A

RHA Summary Tables

Table A1. *Stream Bottom, Sreambank and Channel Conditions for Sucker Brook.*

Reach ID	Substrate & Stream Bank Conditions			
	Stream Bottom Conditions	**Score**	**Stream Bank/Channel Conditions**	**Score**
1-1	Dominant Substrate: Silt/clay/mud Embeddedness: Somewhat (5-25%) Large Wood Presence: Few Presence of Organic Matter: Plentiful	4	0-25% bank modification; no pools >2ft deep; shallow pools 1-2ft deep; avg distance b/t pool 12.5ft	3
1-2	Dominant Substrate: Silt/clay/mud Embeddedness: Somewhat (5-25%) Large Wood Presence: Few Presence of Organic Matter: Occasional	4	0-25% bank modification; no pools >2ft deep; shallow pools 1-2ft deep; avg distance b/t pool 3ft; runs present	3
1-3	Dominant Substrate: Cobble Embeddedness: Mostly (75%) Large Wood Presence: Few Presence of Organic Matter: Plentiful	3	0-25% bank modification; 1 pool >2ft deep; avg. distance b/t pools 5ft; riffles present.	3
1-4	Dominant Substrate: Cobble Embeddedness: Mostly (75%) Large Wood Presence: Many Presence of Organic Matter: Plentiful	3	0-25% bank modification; no pools >2ft deep; shallow pools 1-2ft deep; avg distance b/t pool 3ft; riffles and runs present	3
2-1	Dominant Substrate: Gravel Embeddedness: Somewhat (5-25%) Large Wood Presence: Few Presence of Organic Matter: Occasional	3	25-50% bank modification; no pools >2ft deep; shallow pools <1ft deep; avg distance b/t pool 10ft; riffles present	4
2-2	Dominant Substrate: Sand Embeddedness: Halfway (50%) Large Wood Presence: Plentiful Presence of Organic Matter: Occasional	3	0-25% bank modification; no pools >2ft deep; shallow pools 1-2ft deep; avg distance b/t pool 15ft; riffles present	3
2-3	Dominant Substrate: Silt/clay/mud Embeddedness: Completely (100%) Large Wood Presence: Plentiful Presence of Organic Matter: Plentiful	4	0-25% bank modification; no pools >2ft deep; shallow pools 1-2ft deep; avg distance b/t pool 25ft; runs present	3
3-1	Dominant Substrate: Silt/clay/mud, gravel, cobble, rubble, boulder Embeddedness: Mostly (75%) Large Wood Presence: Few Presence of Organic Matter: Occasional	4	0-25% bank modification; 4 pools >2ft deep; avg distance b/t pool 90ft; riffles, runs, cascades and rapids present	3
3-2	Dominant Substrate: Silt/clay/mud, sand Embeddedness: Mostly (75%) Large Wood Presence: Few Presence of Organic Matter: Plentiful	4	0-25% bank modification; 3 pools >2ft deep; avg distance b/t pool <50ft; runs and cascades present.	2
4	Dominant Substrate: Cobble Embeddedness: Not embedded Large Wood Presence: Few Presence of Organic Matter: None	2	25-50% bank modification; 12 pools >2ft deep; avg. distance b/t pools 20ft; riffles and runs present.	4

***Table A2**. Riparian Vegetation Conditions for Sucker Brook.*

Reach ID	Streamside (Riparian) Vegetation & In-Stream Temperature Conditions			
	Shading of Stream by Vegetation	**Score**	**General Conditions**	**Score**
1-1	75%	2	Small woody debris and vegetative overhang common; undercut banks present; manmade structures and lawns common; evidence of collapsed/eroded banks; garbage/litter adjacent to stream common and present in stream; mud, silt or sand in or entering the stream present, actively discharging pipes and other pipes or ditches entering stream common.	4
1-2	100%	1	Large woody debris present and small woody debris and vegetative overhang common; trees, bushes, and shrubs common; tall grasses and ferns present; actively discharging pipes and other pipes or ditches entering stream common.	2
1-3	75%	2	Large woody debris present and small woody debris and vegetative overhang common; undercut banks present; manmade structures present and lawns common; evidence of collapsed/eroded banks; bare soil present; other pipes discharging into stream present and ditches entering the stream common.	3
1-4	50%	3	Woody debris and vegetative overhang present, undercut banks, manmade structures and lawns common; evidence of collapsed/eroded banks; other pipes or ditches entering stream common.	3
2-1	0%	5	Root wads present and overhanging vegetation common; undercut banks common, manmade structures present and lawns common; bare soil present; evidence of collapsed/eroded banks; ditches entering the stream present.	3
2-2	100%	1	Woody debris and overhanging vegetation present; garbage/litter adjacent to and in the stream present; foam or sheen on bank present; actively discharging pipes present.	3
2-3	100%	1	Overhanging vegetation present; evidence of collapsed/eroded banks.	2
3-1	75%	2	Large woody debris and overhanging vegetation common; small woody debris present, undercut banks present; manmade structures common; evidence of collapsed/eroded banks; garbage/litter adjacent to and in stream present; foam or sheen on bank present; mud, silt or sand in or entering the stream present; actively discharging pipes and other pipes entering the stream present.	4
3-2	75%	2	Large woody debris and overhanging vegetation common; small woody debris present, undercut banks common; deepwater, turbulence or foam common; bare soil present; evidence of collapsed/eroded banks; mud/silt or sand in or entering the stream common.	3
4	75%	2	Woody debris and vegetative overhang present; undercut banks common; evidence of natural streamside plant cover degraded; banks collapsed/eroded common; garbage/litter adjacent to or in stream common; other pipes or ditches entering the stream present.	3

Table A3. *Water Quality Issues and Potential Pollution Source Conditions for Sucker Brook.*

Reach ID	Water Quality Issues & Potential Pollution Sources			
	Water Quality Issues	**Score**	**Potentially Significant Sources of Pollution**	**Score**
1-1	Water clear; no odor; abundance of organic matter; garbage/litter adjacent to and in stream; mud, silt or sand in or entering stream; actively discharging pipes and other pipes or ditches entering the stream; abundance - occasional algae; erosion	4	Manmade structures; commercial residences; laws; pipes, ditches and culverts; discharge from this portion of Odlin Rd and other stormwater conveyances; drainage from BIA landing approach; lawn waste or runoff; road and roof runoff; trash dump; industrial areas; erosion; stormwater outfalls and outfalls draining large impervious areas	4
1-2	Water clear; no odor; actively discharging pipes and other pipes or ditches entering the stream; occasional algae	2	Pipes, ditches and culverts; road runoff; area behind Ground Round	3
1-3	Water clear; no odor; abundance of organic matter present; pipes or ditches entering the stream, erosion, occasional algae	2	Manmade structures; commercial residences; lawns; pipes and ditches; bare soil; road and roof runoff; stormwater outfalls and outfalls draining large impervious areas	4
1-4	Water clear; no odor; pipes or ditches entering the stream; occasional algae; iron bacteria; abundance of organic matter	2	Manmade structures; commercial residences; lawns; pipes and ditches; bare soil (drainage from I-95 & I-395); road and roof runoff; commercial and road construction; roof and road runoff; culvert from 95 and drainage from I-95 & I-395; stormwater outfalls and outfalls draining large impervious areas; industrial areas	4
2-1	Water clear; no odor; small area of sheen on water; ditch under bridge entering stream; occasional algae	2	Manmade structures; lawns; road runoff; bare soil; ditch under bridge; drain pipe from freightliner dealer	3
2-2	Water clear; some oily odor further upstream; brownish orange foam; garbage/litter adjacent to and in stream; foam on bank; actively discharging pipes; occasional algae	4	Drainage pipe from Freightliner dealer	3
2-3	Water clear; no odor; occasional algae; erosion; abundance of organic matter	2	Erosion (bank)	1
3-1	Water clear - light brown; foam and oily sheen on water but rare; garbage/litter adjacent to and in stream; mud, silt or sand in or entering stream; actively discharging or other pipes entering stream; occasional algae	3	Manmade structures; erosion; pipes; residential areas; road and lawn runoff; housing and commercial development; agricultural lands located out of site area; stormwater outfalls and outfalls draining large impervious areas	4
3-2	Water dark brown; no odor; abundance of organic matter; deep water, turbulence or foam; mud, silt or sand in or entering the stream	3	Bare soil; commercial residences; erosion; road runoff; agricultural lands, commercial development; industrial areas; stormwater outfalls and outfalls draining large impervious areas	4
4	Water clear; no odor; garbage/litter adjacent to and in stream; pipes and ditches entering the stream	4	Erosion (banks); commercial residences; road runoff; mining or gravel pits; stormwater outfalls and outfalls draining large impervious areas	4

Table A4. *Geomorphic Position of Sucker Brook.*

Reach ID	Major Geomorphic Process	Notes	Stability Index	Geomorphic Position	Preliminary Score
1-1	Aggradation	Coarse materials in riffles embedded; siltation in pools; poor lateral sorting of bed materials	0.22	In transition or stressed	3
1-2	Aggradation	Coarse materials in riffles embedded; siltation in pools; poor lateral sorting of bed materials; soft, unconsolidated bed	0.21	In transition or stressed	4
1-3	Aggradation	Lateral bars; siltation in pools; poor lateral sorting in beds; soft, unconsolidated bed	0.14	In regime	3
1-4	Aggradation	Lateral bars; coarse materials in riffles embedded	0.16	In regime	2
2-1	Aggradation	Coarse materials in riffle embedded; siltation in pools	0.15	In regime	2
2-2	Aggradation	Lateral bars; coarse material in riffle embedded; siltation in pools; mid-channel bars; soft, unconsolidated bed; deposition in the overbank zone	0.26	In transition or stressed	4
2-3	Aggradation	Coarse materials in riffle embedded; siltation in pools; soft, unconsolidated bed; evidence of deposition in/around bank structures; deposition in the overbank zone	0.27	In transition or stressed	4
3-1	Aggradation	Lateral bars; coarse materials in riffles embedded; siltation in pools; mid-channel bars; deposition on point bars; evidence of deposition in/around bank structures; deposition in the overbank zone	0.43	In adjustment	5
3-2	Widening	Fallen/leaning trees/fence posts/etc.; exposed tree roots; basal scour on inside meander bends; steep bank angles through most of subject reach; length of bank scour >50% through subject reach	0.35	In transition or stressed	5
4	Degradation	Channel incision into undisturbed overburden/bedrock; elevated tree roots/root fan above channel bed; bank height increases; suspended armor layer visible in bank	0.35	In transition or stressed	4

APPENDIX B

Stream & Watershed Maps

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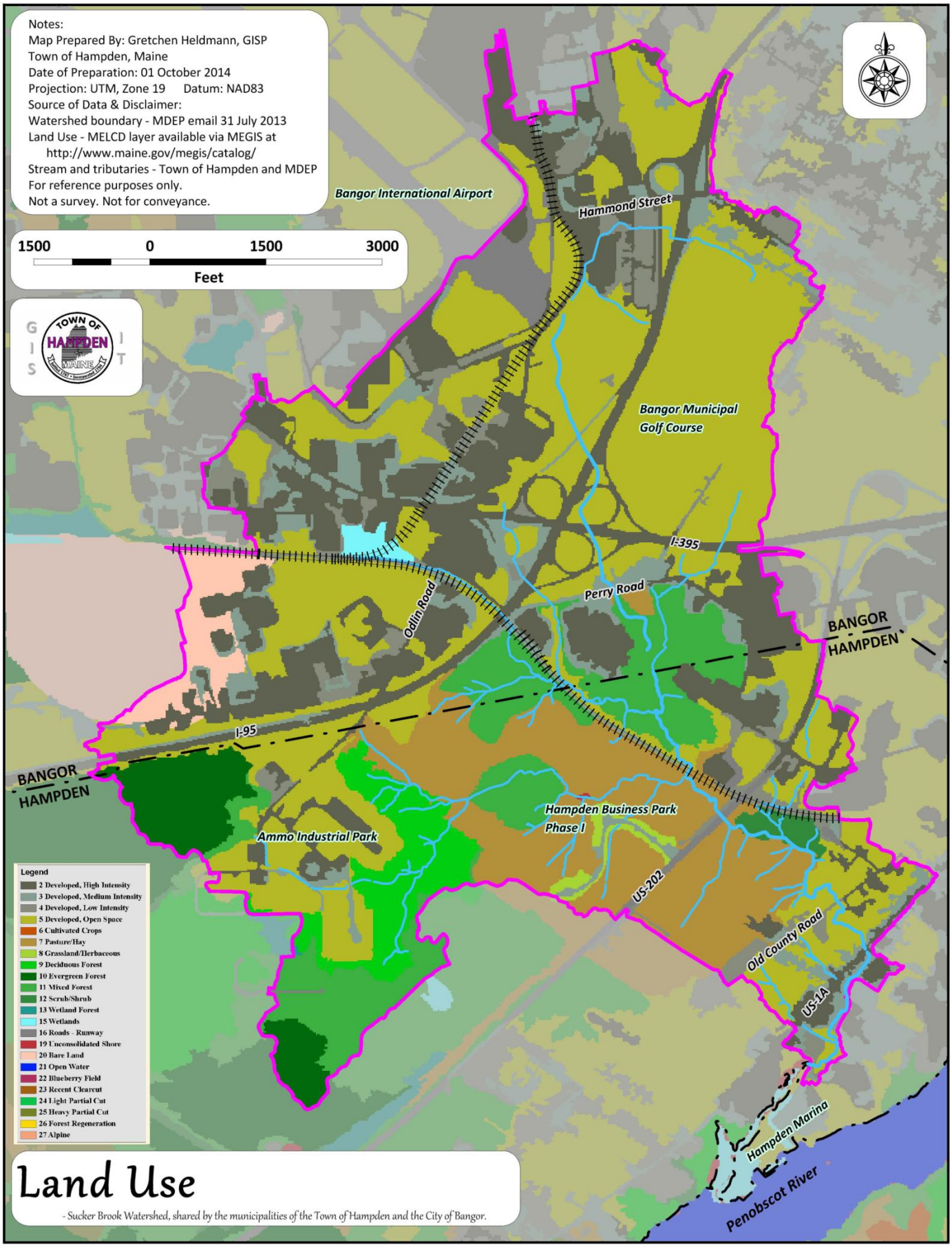
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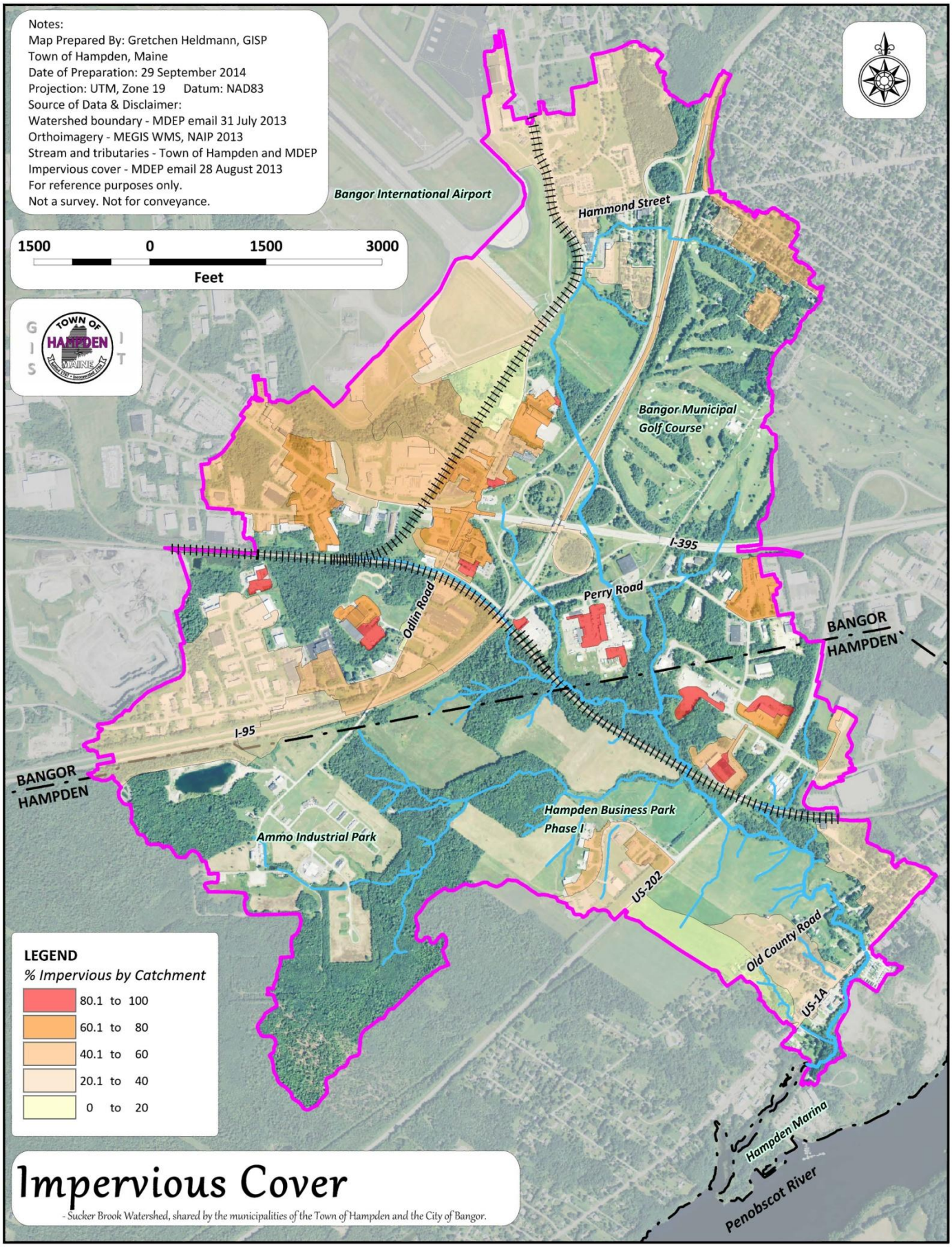
Town of Hampden, Maine
Date of Preparation: 01 October 2014
Projection: UTM, Zone 19 Datum: NAD83
Source of Data & Disclaimer:
Watershed boundary - MDEP email 31 July 2013
Land Use - MELCD layer available via MEGIS at
http://www.maine.gov/megis/catalog/
Stream and tributaries - Town of Hampden and MDEP
For reference purposes only.
Not a survey. Not for conveyance.
1500 0 1500 3000
Feet
Bangor International Airport
Hammond Street
Bangor Municipal Golf Course
I-395
Perry Road
Odlin Road
BANGOR
HAMPDEN
I-95
Hampden Business Park Phase I
Ammo Industrial Park
US-202
Old County Road
US-1A
Hampden Marina
Penobscot River
Legend
2 Developed, High Intensity
3 Developed, Medium Intensity
4 Developed, Low Intensity
5 Developed, Open Space
6 Cultivated Crops
7 Pasture/Hay
8 Grassland/Herbaceous
9 Deciduous Forest
10 Evergreen Forest
11 Mixed Forest
12 Scrub/Shrub
13 Wetland Forest
15 Wetlands
16 Roads - Runway
19 Unconsolidated Shore
20 Bare Land
21 Open Water
22 Blueberry Field
23 Recent Clearcut
24 Light Partial Cut
25 Heavy Partial Cut
26 Forest Regeneration
27 Alpine
Land Use
- Sucker Brook Watershed, shared by the municipalities of the Town of Hampden and the City of Bangor.

Map 1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Town of Hampden, Maine
Date of Preparation: 29 September 2014
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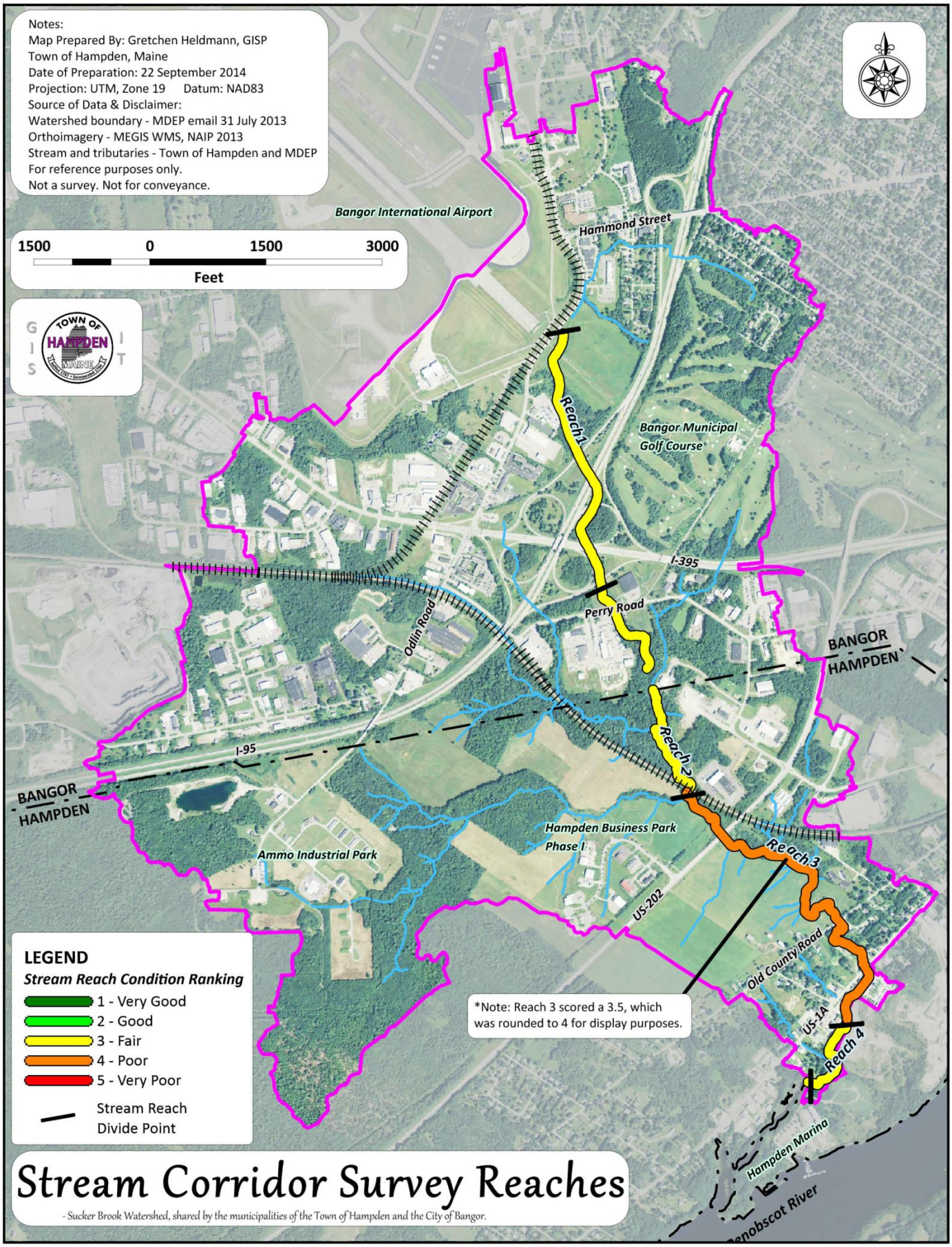
Source of Data & Disclaimer:
Watershed boundary - MDEP email 31 July 2013
Orthoimagery - MEGIS WMS, NAIP 2013
Stream and tributaries - Town of Hampden and MDEP
Impervious cover - MDEP email 28 August 2013
For reference purposes only.
Not a survey. Not for conveyance.
1500 0 1500 3000
Feet
TOWN OF HAMPDEN MAINE
GIS
Bangor International Airport
Hammond Street
Bangor Municipal Golf Course
I-395
Perry Road
Odlin Road
BANGOR
HAMPDEN
I-95
Hampden Business Park Phase I
Ammo Industrial Park
US-202
Old County Road
US-1A
Hampden Marina
Penobscot River
LEGEND
% Impervious by Catchment
80.1 to 100
60.1 to 80
40.1 to 60
20.1 to 40
0 to 20
Impervious Cover
- Sucker Brook Watershed, shared by the municipalities of the Town of Hampden and the City of Bangor.

Map 2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Town of Hampden, Maine
Date of Preparation: 22 September 2014
Projection: UTM, Zone 19 Datum: NAD83
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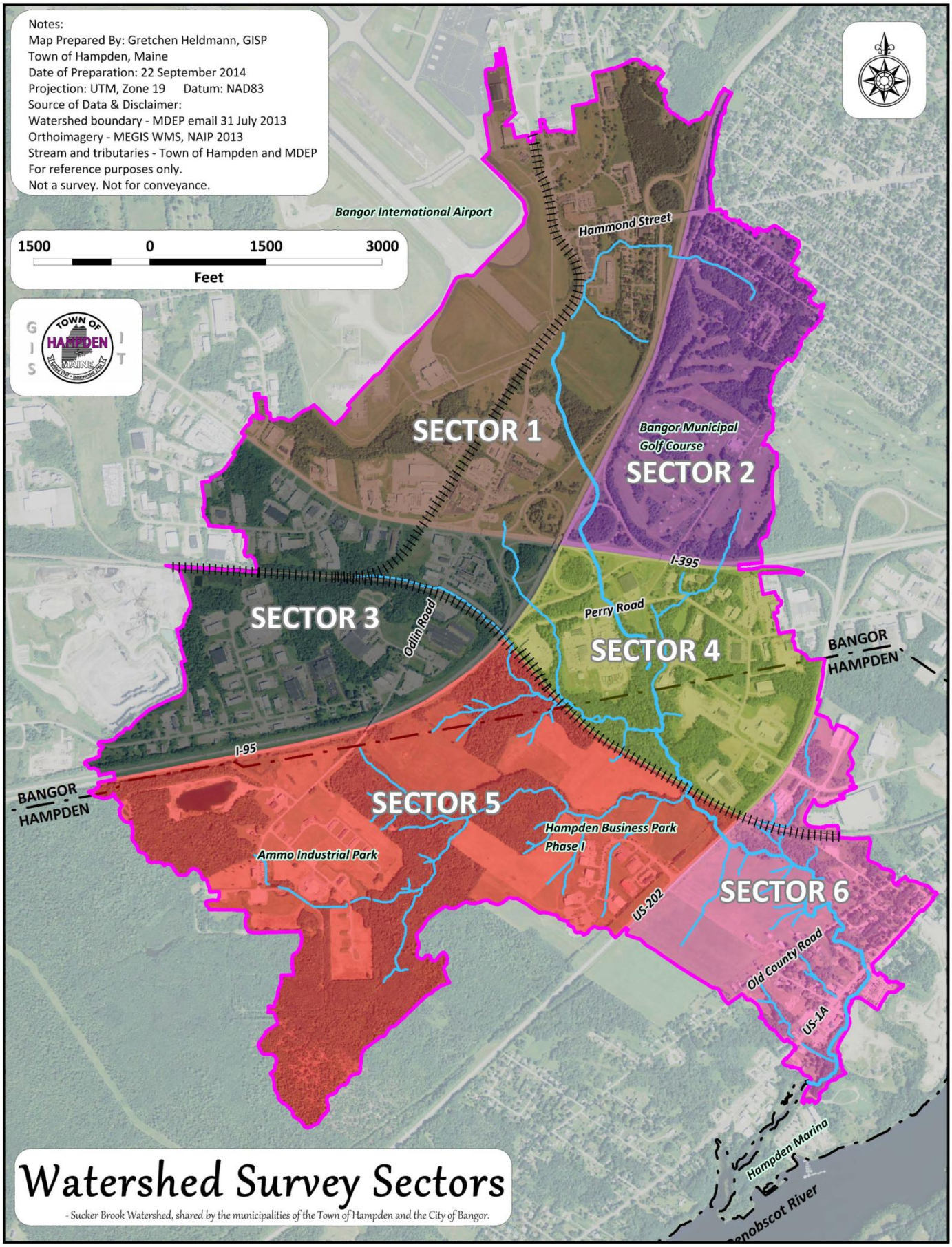
Orthoimagery - MEGIS WMS, NAIP 2013
Stream and tributaries - Town of Hampden and MDEP
For reference purposes only.
Not a survey. Not for conveyance.
1500 0 1500 3000
Feet
Bangor International Airport
Hammond Street
Reach 1
Bangor Municipal Golf Course
I-395
Perry Road
Odlin Road
BANGOR
HAMPDEN
Reach 2
I-95
Hampden Business Park Phase I
Ammo Industrial Park
Reach 3
US-202
Old County Road
US-1A
Reach 4
Hampden Marina
Penobscot River
LEGEND
Stream Reach Condition Ranking
1 - Very Good
2 - Good
3 - Fair
4 - Poor
5 - Very Poor
Stream Reach Divide Point
*Note: Reach 3 scored a 3.5, which was rounded to 4 for display purposes.
Stream Corridor Survey Reaches
- Sucker Brook Watershed, shared by the municipalities of the Town of Hampden and the City of Bangor.

Map 3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Town of Hampden, Maine
Date of Preparation: 22 September 2014
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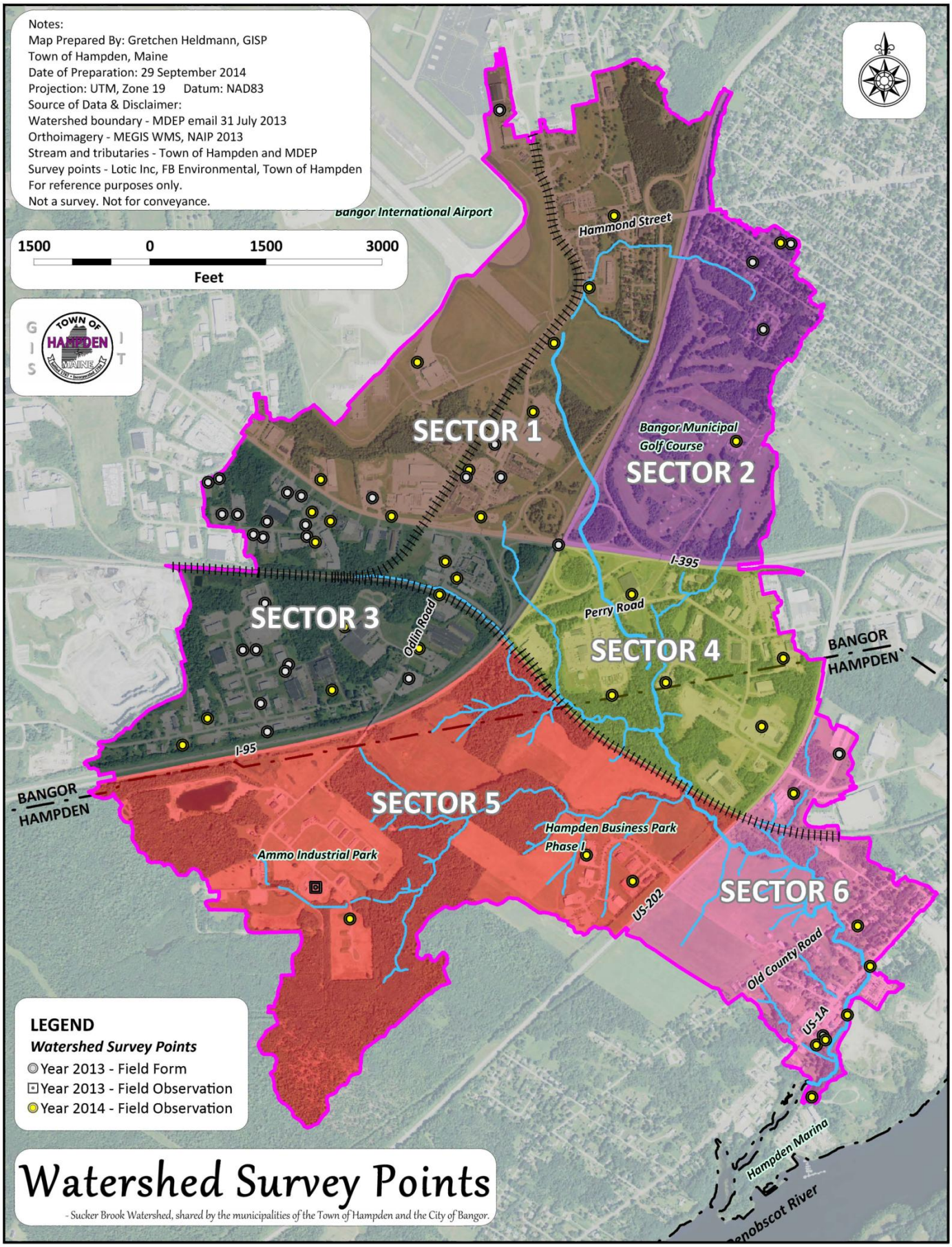
Source of Data & Disclaimer:
Watershed boundary - MDEP email 31 July 2013
Orthoimagery - MEGIS WMS, NAIP 2013
Stream and tributaries - Town of Hampden and MDEP
For reference purposes only.
Not a survey. Not for conveyance.
1500 0 1500 3000
Feet
Bangor International Airport
Hammond Street
SECTOR 1
Bangor Municipal Golf Course
SECTOR 2
I-395
SECTOR 3
Odlin Road
Perry Road
SECTOR 4
BANGOR
HAMPDEN
I-95
BANGOR
HAMPDEN
SECTOR 5
Hampden Business Park Phase I
Ammo Industrial Park
US-202
SECTOR 6
Old County Road
US-1A
Hampden Marina
Penobscot River
Watershed Survey Sectors
- Sucker Brook Watershed, shared by the municipalities of the Town of Hampden and the City of Bangor.

Map 4



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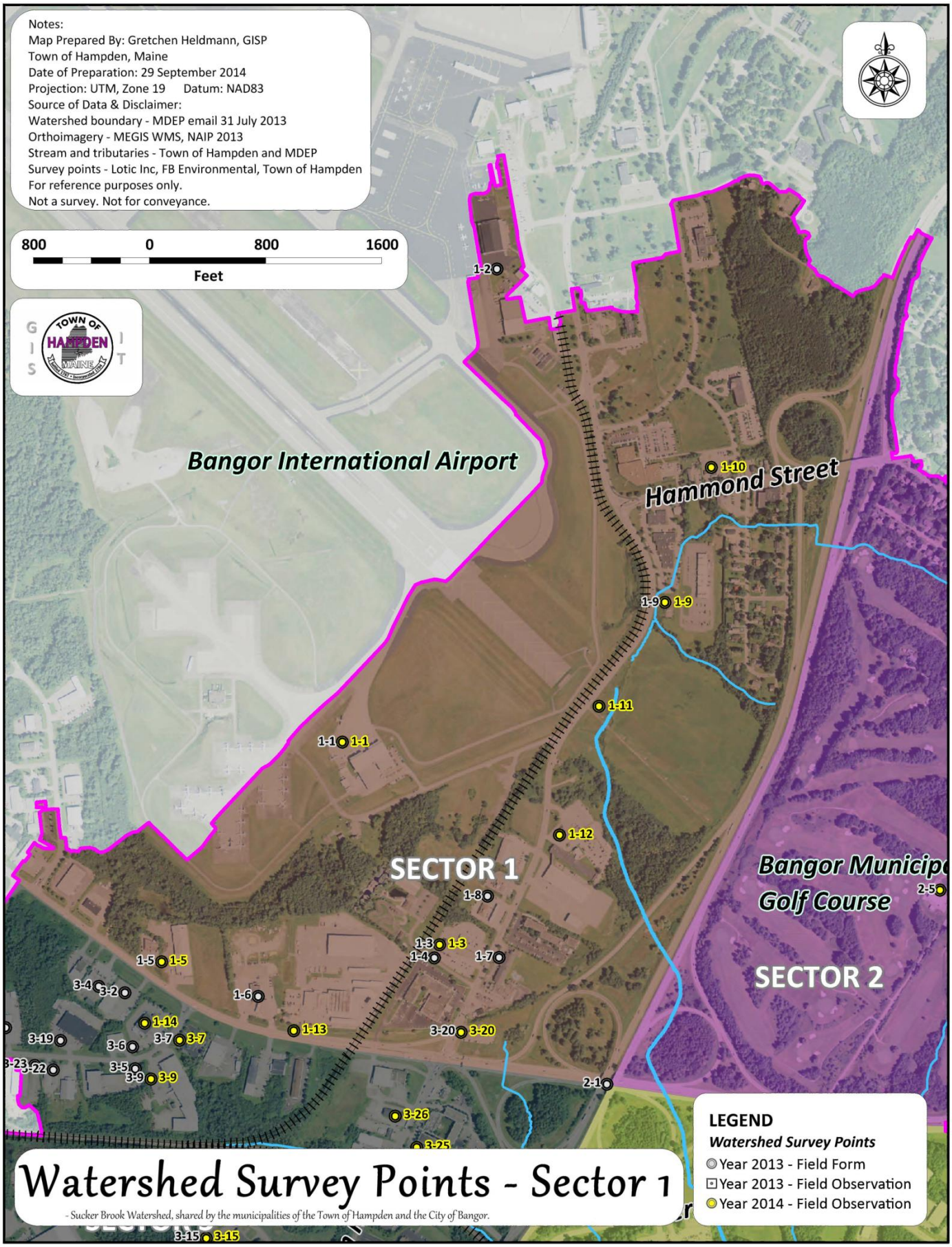

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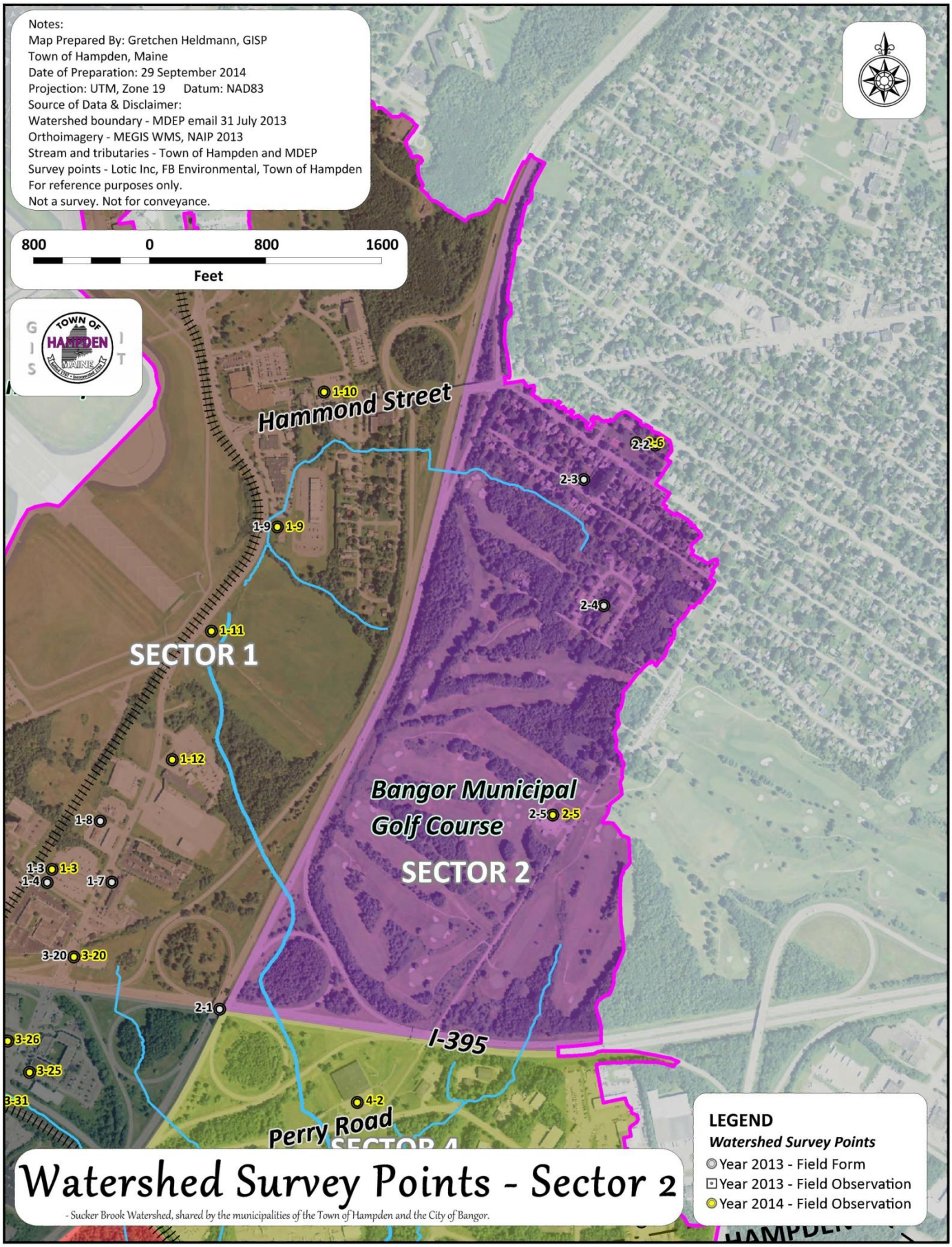

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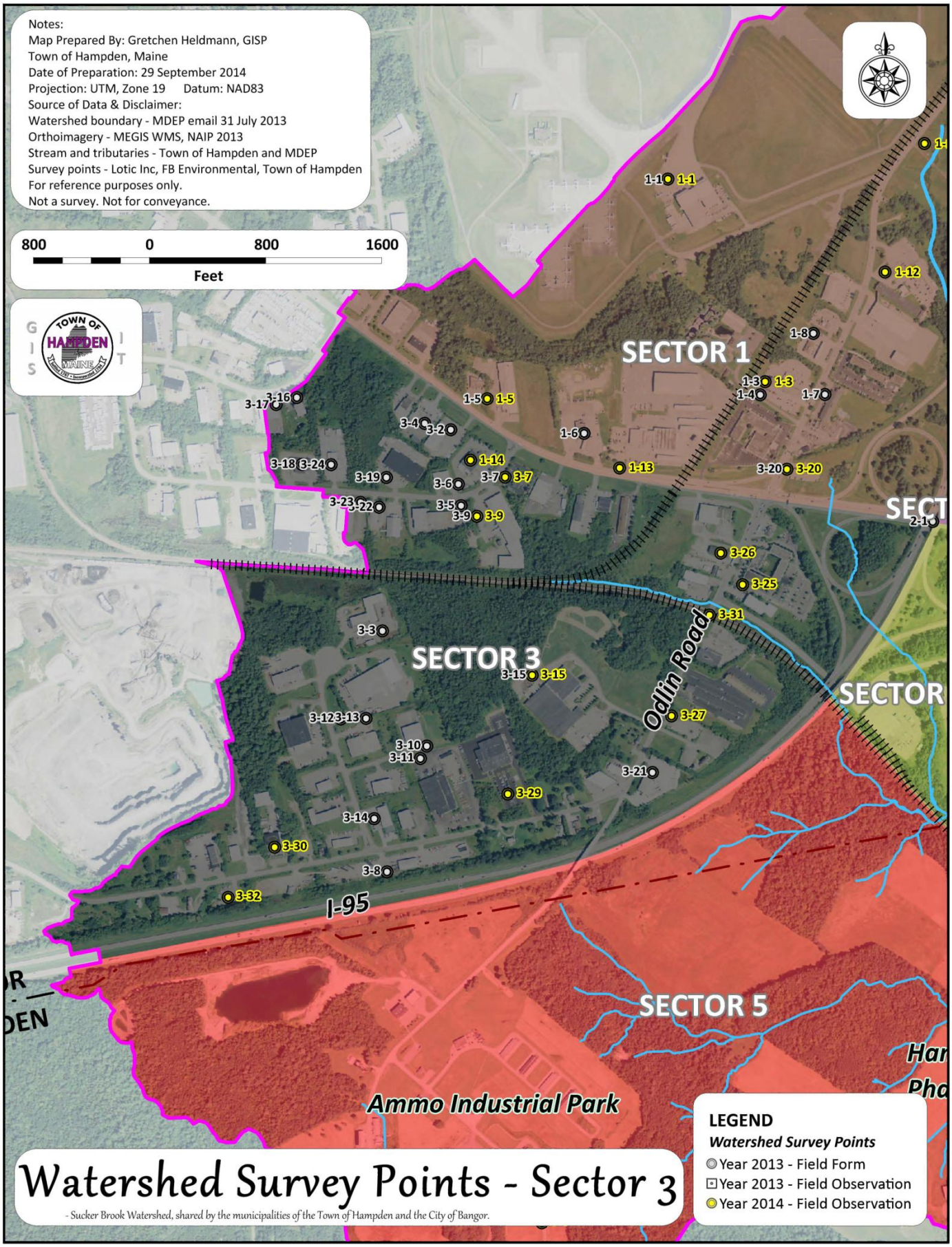
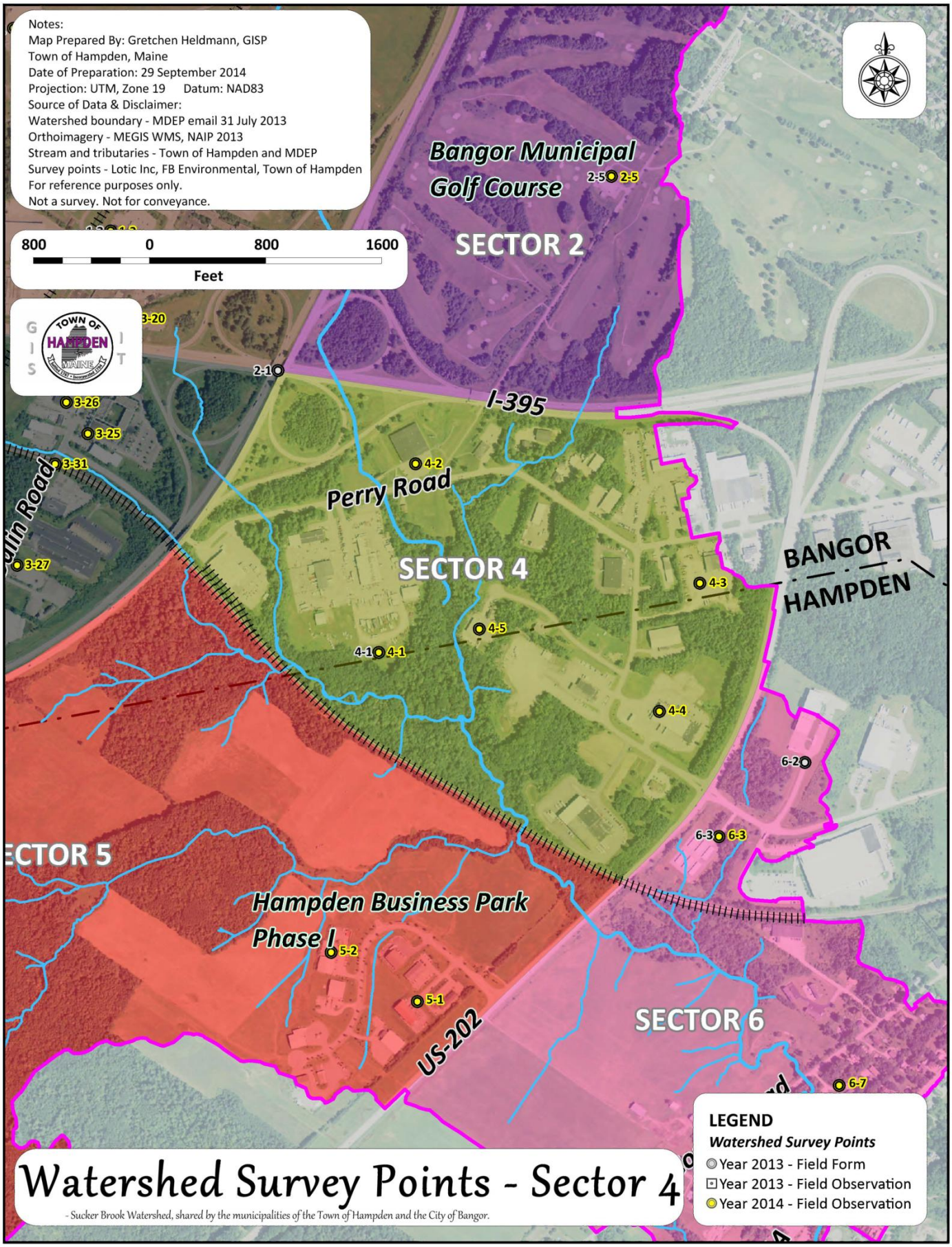


Map 8 (Sector 3)



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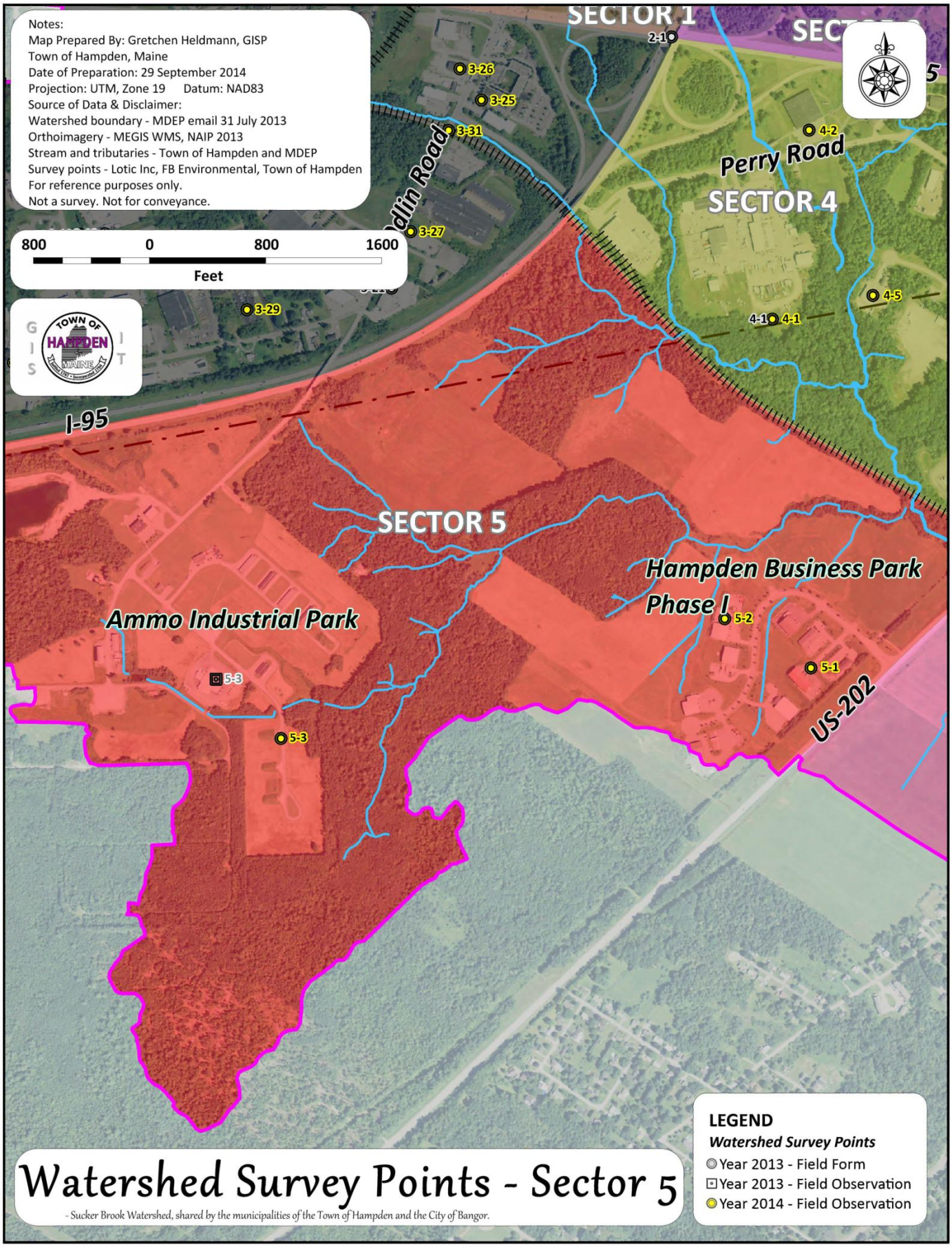
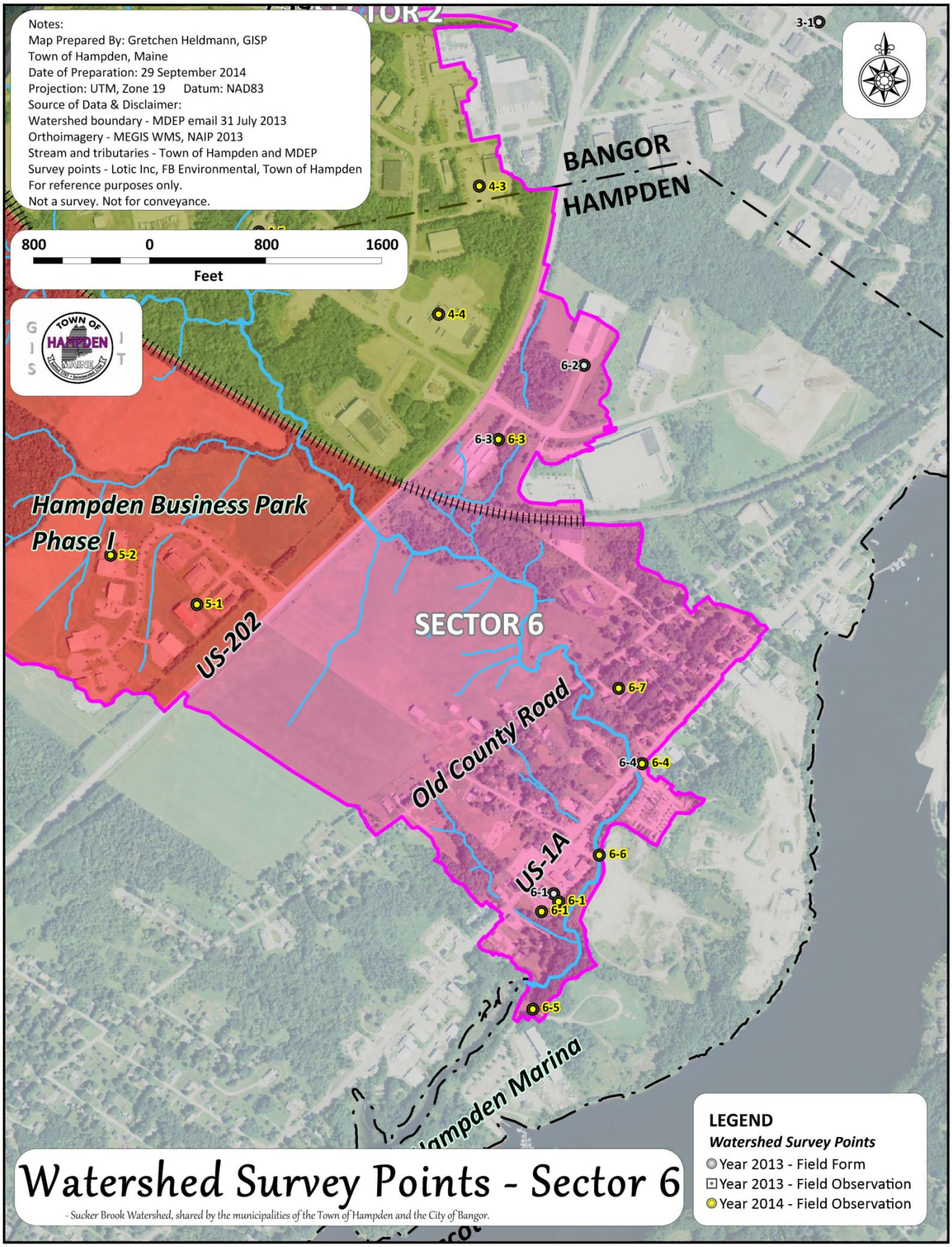


Map 10 (Sector 5)



Map 11 (Sector 6)

APPENDIX C

2013 & 2014 Pollutant Sources & Recommendations

Table C.1. 2013 & 2014 Pollutant Sources & Recommendations

Site ID	Year Surveyed	Location	Identified Problems	Recommendations
1-1	2013, 2014	C&L Aviation; C& L Aerospace	Unknown	Rain gardens in existing swale, grade and install turnout at employee parking
1-2	2013	Maine Aero	Direct flow to stream, blacktop erodes into basin, catch basin behind storage, large areas of IC	TBD
1-3	2013, 2014	Rear of Hammond Lumber & Black Beards & EconoLodge & Ramada Inn	High use lots, dog walking	Catch basin insert in front of egress at Ramada Inn
1-4	2013	Roads/Parking near the Ramada Inn	Pet waste, drainage from high-use parking lot, dumpster runoff/"juice"	Improve storm water controls, stencil storm drain, insert hydro carbon filter
1-5	2013, 2014	Magazines Inc. - outer Hammond St.	Direct flow to stream, algal growth in standing water, erosion, disturbed soil near wetland	Stabilize and vegetated eroded areas; dust collector on roof; catch basin inserts placed down gradient
1-6	2013	Mobil Leadbetter	Hot spot, in and out constant traffic, quick turn around, oil greases, metals	Install hydrocarbon filters at filling stations-diesel & gasoline filling stations/islands
1-7	2013	Irving & Hojo's (Odlin Rd & Rt 100/R Cloverleaf)	Hydrocarbons & metals from traffic/interchange, high salt use	Irving - filter; Hojo's sediment filter
1-8	2013	Irving, Subway, Tim Horton's, VIP	Hydrocarbons & metals from heavy vehicle traffic, high salt use; uncovered dumpster, potholes	Hydrocarbon filter
1-9	2013, 2014	Maine Enterprise Business Park (including Northeast cardiology, Sunbury, Hope House, Elks, Red Cross, Maine Savings Bank and residential properties; EMMC Family Medicine, Spekhardt Dental	High potential for chlorides, hydrocarbons from idling; fertilizer/pesticide use	Rain gardens, biofilters, winter barley to absorb chlorides; repair culvert at Elks, filter sediment, nutrients, hydrocarbons & metals in catch basins
1-10	2014	Bangor Savings Bank	Hydrocarbons, 3 catch basins located in parking lot	More vegetation to control runoff, more islands, potential focal point in parking area

Site ID	Year Surveyed	Location	Identified Problems	Recommendations
1-11	2014	Bangor International Airport approach area	no data	Focal point with no vegetation, biofilters on either side
1-12	2014	Days Inn + Ground Round	Hydrocarbons, idling, buses/trucks parked	Rain garden, open up curbing to create diversion, detention pond
1-13	2014	Triangular grass area in front of Hammond Lumber	no data	Diversion on grass triangle at merge from Odlin to outer Hammond
1-14	2014	Stratham Tire	Container of de-icers (magnesium chloride), lots of staining on lot	Rain garden
2-1	2013	I95 Corridor & I95/I395 Intersection	Oil, greases, lubricants, brine/salt, sand, hydrocarbons, trash	TBD
2-2	2013	Residential & Fairmont Park	Moderate use of salt, nutrients, sediment, pesticides, herbicides	TBD
2-3	2013	Residential Area (Silver and Graham Area - residential area south of Hammond St)	High salt use, nutrients, sediment, pesticides, herbicides, direct flow to stream	TBD
2-4	2013	Residential (Fairway Road and New York St Area, nestled between Webster in the east and I95 to the west)	Moderate use of salt, nutrients, sediment, pesticides, herbicides, perforated manholes present; direct flow to stream	TBD
2-5	2013, 2014	Bangor Municipal Golf Course	Nutrients, chlorides, sediments, potential toxics from pesticides + herbicides	Cover sand piles
2-6	2014	Fairmount Park	no data	Potential for rain gardens
3-1	2013	Ditch	ponding of water on impervious area; slight odor	TBD
3-2	2013	Sebco	Large impervious parking area, loading docks	TBD

Site ID	Year Surveyed	Location	Identified Problems	Recommendations
3-3	2013	DOWD Industrial	Potential lubricants and dust from steel area, potential for metal runoff; drains to catch basin	Close dumpsters
3-4	2013	Freihofer's	Impervious and gravel, some erosion, storage, some puddling in graveled area	TBD
3-5	2013	Building #40	Nutrients from lawn, sheet flow to ditch	TBD
3-6	2013	Car service station and store	Stains, leaks/spills in driveway/parking, erosion at culvert	TBD
3-7	2013, 2014	Machias Savings Bank	High use parking and traffic area, high turnover area, coal tar; Hot spot	Lots of vegetation, everything is contained
3-8	2013	JD Raymond	Oils, greases, lubricants, lots of foamy water out of building, open containers; clogged culvert	Add gravel/resurface entire area by I95, good housekeeping and BMPs needed
3-9	2013, 2014	Evergreen Waste	Potential nutrient issues, commercial parking lot, dumpsters	Focal point; detention pond or bioretention cell to deal with huge volume coming off parking lot to outfall, swale, storage cell
3-10	2013	Webber Manufacturing	Construction/bare soil- site is at least 300+ x 400+ ft., silt	TBD
3-11	2013	Fairpoint	90% impervious, moderate use parking- runoff flows to ditch which flows to stream	Treat runoff in swale between Fairpoint and Weber; close dumpsters
3-12	2013	Coca Cola (distribution center)	Loading dock is potential hot spot	Reduce runoff by diverting roof gutters into swale, stop mowing perimeter
3-27	2014	New England Salt Supply	Lots of sediment/salt, uncovered piles, 3 sided storage bins	Sediment piles need covering

Site ID	Year Surveyed	Location	Identified Problems	Recommendations
3-28	2014	615 Odlin Road	Hot spot	Enhance swale with biofilter
3-29	2014	PCHC (Odlin Road)	Hot spot	Erosion from winter plowing damage
3-30	2014	739 Odlin Road	Plugged culvert	Clean out culvert
3-31	2014	Intersection of Odlin + Railroad	Hydrocarbons, creosote, sediment, waxes, metals	Biofilter
3-32	2014	Harvey Paving + Seal Coating	Major off site tracking, erosion, uncovered sediment piles	Biofilter
4-1	2013, 2014	Freightliner	Hydrocarbons from parking lot	Fabco hydrocarbon filter, stabilize vegetation
4-2	2014	Cole Museum	Test BMPs	winter barley, shade trees along both sides of brook
4-3	2014	CB (Chadwick-BaRoss)	Sediments issues/tracking/erosion	Recommend rock/gravel yard
4-4	2014	R.H. Foster, Foster's Mobil and Service	Hydrocarbons. Detention pond issue?	Hydrocarbon filter
4-5	2014	N.S. Giles	pH, hydrocarbons, TSS, sediments, collapsing stream bank	NPRA issue- biofilter
5-1	2014	Hampden Business and Commerce Park (Hampden Vet Clinic, Wight's Sporting Goods, U.S. Blades, Haverlock Estey & Curran CPAs, Central Maine Diesel, Homans Associates, John W. Kennedy Company, Penske)	Frequent deliveries to Wight's, low traffic businesses; idling, oils & metals	Already existing vegetation, rain gardens, possible biofilters
5-2	2014	Clean Harbors	Sediment issues, erosion, potential oils and metals	Biofilters, plunge pool, fix collapsed culvert, berm perimeter of storage area, possible rain gardens, develop snow plow BMP and boundary
5-3	2013, 2014	Ammo Park (Alternative Auto body, BSP, Universal Detailing, other unnamed small businesses)	Sediment issues, potential oils and metals from auto body shop; grass in swale at BSP chlorotic	Existing naturally low land drainage areas, lots of existing vegetation. Lots sold are going to be designed to treat on site. When site is developed institute SW controls and treatment at that time; treatment for nutrients/metals in swale at BSP

Site ID	Year Surveyed	Location	Identified Problems	Recommendations
6-1	2013, 2014	Rawcliffe Carwash & Bosch Auto Service, Rawcliffe's Garage & Hampden Auto Center	Sediment issues in back, old cars lodged in banks and stream at car wash; oil, greases, lubricants, salt, surfactants and waxes, hydrocarbons and metals at garage, unlabeled drums	Gabion baskets, silt filter, grease catch
6-2	2013	Bangor Daily News	Salt use and nutrients, outfall present	TBD
6-3	2013	A*1 Safe Storage	Catch basin with asphalt, silt fence falling, sedimentation issues, salt use	Upper level pond needs cleaning and conduct a BMP inspection on lower pond, silt fence needs to be removed, repair rills on upper area and reseed and stabilize, catch basin needs cleaning
6-4	2013, 2014	Hampden Trailer Park	Severe erosion and sediment issues, open dumpster (leachate), above ground heating oil tanks, trash, animal waste	Stabilize banks, education & outreach on closing dumpster lids and remove unused above ground heating oil tanks
6-5	2014	City of Bangor snow dump entrance	Sediment and mud tracking	Add 100 ft rock apron to egress
6-6	2014	Lane Construction	Erosion problems along banks, failing culvert/fish passage improbable	Stabilize banks, remove culvert and provide an open channel for fish passage
6-7	2014	Residential Areas off Old County Rd.	Nutrient runoff, residential area is steep/topographically higher	Catch basin inserts along Main St.

APPENDIX D

Stream Corridor Survey Photos

Reach 1

Slow moving portion of Sucker Brook in Reach 1.

Reach 2

Section of Sucker Brook flowing through a wooded area in Reach 2.

Reach 3

Example of a pool documented in Sucker Brook in Reach 3.

Reach 4

Steep, eroding banks within Reach 4 resulting in a fallen tree.

APPENDIX E

Stream Watershed Survey Photos

Sector 1

A portion of Sucker Brook flowing near the Red Cross.

Sector 2

Ponded area near the brook at the Bangor Municipal Golf Course.

Sector 3

Eroding ditch along Odlin Road in Sector 3.

Sector 4

Slow moving area and overgrown well in Sector 4.

Sector 5

An agricultural access road crosses Sucker Brook in Sector 5.

Sector 6

Steep bank above Sucker Brook in Sector 6.

APPENDIX F

2014 Watershed Survey Hot Spot Photos

Sector 1

Site 1-9. Northeast Cardiology is one of several businesses at the Maine Enterprise Business Park. Potential pollutants: Chlorides, hydrocarbons, fertilizer and pesticides. Recommendations: Rain gardens, biofilters, catch basin inserts.

Site 1-12. Days Inn and Ground Round. Potential Pollutants: Hydrocarbons from idling vehicles and parked cars and trucks. Recommendations: Rain garden, detention pond.

Sector 2

Site 2-5. Bangor Municipal Golf Course. Potential Pollutants: Nutrients, chlorides, sediments, pesticides and herbicides. Recommendations: Continue implementing management plan; cover sand piles.

Site 2-2. Fairmont Park & Residential Areas. Potential Pollutants: Salt use, nutrients, pesticides, herbicides, direct flow to stream. Recommendations: TBD

Sector 3

Site 3-15. Sargent Corporation. Potential Pollutants: Bare soil, erosion, petroleum in parking lot. Recommendations: Resurface mud parking lot with course gravel, 100-ft rock apron on egress.

Site 3-26. Jimar Construction. Recommendations: Add swale or drainage ditch in front, install bioretention/focal point.

Sector 4

Site 4-1. Freightliner. Potential Pollutants: Hydrocarbons from parking lot. Recommendations: Hydrocarbon filter, stabilize vegetation.

Site 4-2. Section of Sucker Brook in Reach 2, Sector 4 near the Cole Land Transportation Museum. Potential Pollutants: Possible failing BMPs- needs testing. Recommendations: Winter barley, shade trees along both side of brook.

Sector 5

Site 5-2. Clean Harbors. Potential Pollutants: Sediments, oils and metals. Recommendations: Biofilter, plunge pool, rain garden, fix collapsed culvert, install berm around perimeter, snowplow BMPs.

Site 5-3. Ammo Park and Associated Businesses. Potential Pollutants: Sediments, oils and metals from auto body shop, grass swale at BSP chlorotic. Recommendations: Stormwater controls when sites are developed.

Sector 6

Site 6-1. Rawcliffe's Car wash, Bosch Auto Service and Hampden Auto Center. Potential Pollutants: Sediments, old cars in bank and in stream, hydrocarbons, metals, unlabeled drums, etc. Recommendations: stream banks need stabilization and vehicles removed from stream banks; hydrocarbon filter for each catch basin at Garage & Auto Center

Site 6-5. City of Bangor Snow Dump Entrance. Potential Pollutants: Sediment and mud tracking. Recommendations: Change location or add 100ft rock apron to egress.

MS4 Annual Report
Permit Year 1 (2013-2014)

City of Bangor, Maine

in compliance with the requirements of
Maine Pollutant Discharge Elimination System
MS4 Permit No. MER041026

September 15, 2014

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Introduction

The City of Bangor, Maine, operates a regulated small Municipal Separate Storm Sewer System (MS4). The MS4 is allowed to discharge stormwater as authorized by the State of Maine in accordance with MS4 Permit No. MER041026. This report represents the activities taken to comply with this permit.

Summary of Minimum Control Measures

The City's activities for achieving permit compliance are detailed in the following sections.

▪ MCM 1 - Public Education and Outreach

Most of the work on this MCM, including development of a Stormwater Awareness Plan, was undertaken as a collaborative regional effort through participation in the Bangor Area Stormwater Group (BASWG). Please refer to the BASWG Annual Report for Permit Year 1, incorporated herein by reference.

➢ BMP 1 – Regional collaboration

The City actively participated in the BASWG and its programs to achieve permit compliance.

- ***Measureable Goal 1 – BASWG meeting attendance***

Measure	Statement of attendance
Responsibility	Municipal Stormwater Manager
Date	Annual Report

City staff attended and participated in the BASWG meetings. Attendance is documented in the BASWG meeting minutes.

- ***Measureable Goal 2 – Regional plan implementation***

Measure	Annual documentation of City-specific accomplishments
Responsibility	Municipal Stormwater Manager
Date	Annual Report

The City is implementing the Stormwater Awareness Plan as developed collaboratively at a regional level through the BAWSG. The plan addresses salt management with municipal winter maintenance decision makers. The plan and the City's participation is documented in the BASWG Annual Report.

➢ BMP 2 – Permit Awareness Plan

The City developed and implemented a municipal Permit Awareness Plan to educate City personnel about stormwater in general and the MS4 permit requirements.

- ***Measureable Goal 1 – Permit Awareness Plan development***

Measure	Permit Awareness Plan provided to DEP
Responsibility	Municipal Stormwater Manager
Date	February 28, 2014

The City developed a Permit Awareness Plan. It was submitted to DEP on February 26, 2014. The City received approval of the plan from DEP on March 4, 2014.

- ***Measureable Goal 2 – Permit Awareness Plan implementation***

Measure	Progress report on implementation Evaluation of progress (PY3) In-depth assessment (PY5)
Responsibility	Municipal Stormwater Manager
Date	Annual Report

The City implemented the Permit Awareness Plan. The material was presented to most staff via email for individual learning and remaining staff at meetings. Follow-up was done by department heads. A presentation was given to the Planning Board on June 17, 2014, as documented by the agenda for that meeting (***Appendix A***).

➢ Additional activities

The City's Wastewater Treatment Plant and staff provide community education and outreach programs to grade school, middle school, and high school students as well as college students each year. Each tour of the entire facility is followed by a question and answer session and lasts approximately 1.5 hours. During this permit year, 36 students and adults took the WWTP tour and learned about the importance of clean water.

▪ MCM 2 - Public Involvement and Participation

➢ BMP 1 – Regional collaboration

The City actively participated in the BASWG and its programs to achieve permit compliance.

- ***Measureable Goal 1 – Public notice***

Measure	Statement of compliance with example
Responsibility	Municipal Stormwater Manager
Date	Annual Report

The City complied with applicable public notice requirements. BASWG meeting notices and agendas are published in the City's weekly calendar and posted on the municipal website. One of these calendar postings with agenda is included in ***Appendix B*** as an example.

- ***Measureable Goal 2 – Public event***

Measure	Documentation of event participation and any additional City-specific accomplishments
Responsibility	Municipal Stormwater Manager
Date	Annual Report

The City participated in one public event organized through the BASWG, the Garden Show and Spring Fling. Peralie Burbank from Engineering staffed the informational booth for two hours on Friday, April 4, 2014. Her daughter, Sophie Hallett, volunteered as "Stormy the Duck" for four hours on Saturday, April 5, 2014. Photographs of Stormy are shown below. Further documentation is included in ***Appendix C***.

➢ Additional activities

The City continued membership of the Lower Penobscot Watershed Coalition and was a key member of the Maine Winter Maintenance Task Force which developed the *Snow & Ice Control Environmental BMP Manual*. Other partners in the task force include: Maine DEP, the Maine DOT and the Maine Local Roads Program. The City has also forged a partnership with the Bangor High School science department and UMaine's engineering department. Under a National Science Foundation grant, the

students built water quality sensors and placed them in impaired streams around the state. One honors student collected water samples for phosphorus analysis in all of Bangor's urban impaired streams for a research project. The City is committed to working with other community partners on stormwater issues.

▪ MCM 3 - Illicit Discharge Detection and Elimination

The City adhered to its Illicit Discharge Detection and Elimination (IDDE) plan as submitted to DEP for approval and revised per DEP's request on March 19, 2014.

➢ BMP 1 – Storm sewer system infrastructure map

- ***Measureable Goal 1 – GIS database maintenance***

Measure	Description of any database changes and list of layers relevant to MS4
Responsibility	Municipal Stormwater Manager
Date	Annual Report

The City maintained the database and edited data as needed. There were no substantial changes to the database. One layer was added to depict known stormwater structures monitored for MCM 5. The GIS layers relevant to the MS4 program are listed below.

General Features	*Hydrologic Features*	*MS4 Features*
Contours	Draw	Culvert
CityFootprint	Pond	Ditch
Road_Centerline	River	Stormwater_CatchBasin
Roads_Private	Wetland	Stormwater_Outfalls
Roads_Public	Stream	Stormwater_Pipe
Railroad		Stormwater_Manhole
Zoning	*Private Features (known)*	Stormwater_Pretreatment
Trails	Private_CatchBasins	Stormwater_StorageTank
	Private_Manhole	Stormwater_Structure
	Private_Pipe	Watersheds
	Private_Structures	BMPs

- ***Measureable Goal 2 – System map***

Measure	MS4 system map
Responsibility	Municipal Stormwater Manager
Date	Annual Report

The general system map showing the MS4 boundaries, MS4 stormwater pipes and ditches with estimated total lengths, roads and water bodies is included as ***Appendix D***.

➢ BMP 2 – Non-stormwater discharge ordinance implementation

- ***Measureable Goal 1 – Awareness and reporting mechanism***

Measure	Post stormwater ordinance information and hotline phone number on website
Responsibility	Environmental
Date	June 30, 2014, for PY 1 Annual Report

The City has a link to the stormwater discharge ordinance on its municipal stormwater website page. The website also has a hotline phone number where anonymous reports about possible violations can be reported. The web address is *http://www.bangormaine.gov/stormwater*.

- ***Measureable Goal 2 – Incident report investigations***

Measure	Report of number of incidents by watershed and a narrative describing general trends
Responsibility	Engineering and Environmental
Date	Annual Report

The City investigated all reports of potential violations of the non-stormwater discharge ordinance. Reports were mostly received through phone calls. Each incident report was be recorded in the incident report database and investigated in accordance with the City's IDDE plan. A summary of incidents is included in ***Appendix E***.

- ***Measureable Goal 3 – Identification of potential hot spots***

Measure	Location and description of potential hot spots PY 1 – Penjajawoc Stream watershed
Responsibility	Engineering and Environmental
Date	Annual Report

The City reviewed its GIS data, available aerial photography, internet business listings, and the MSGP permit holder and no exposure list from DEP to create a list of potential hot spots in the Penjajawoc Stream watershed. The list of potential hot spots is included in ***Appendix F***.

- ***Measureable Goal 4 – Hotspot investigation and remediation***

Measure	Documentation of findings and remediation measures taken
Responsibility	Engineering and Environmental, Code Enforcement as needed
Date	Annual Report

The City will investigate potential hotspots, document findings, and work toward resolving any problems found in the Penjajawoc Stream watershed in PY 2. There were no PY 1 requirements for this Measureable Goal.

➢ BMP 3 – Dry weather outfall inspections

Inspecting outfalls during dry weather allows the City to check for unauthorized discharges and possible cross-connections with the sanitary system.

- ***Measureable Goal 1 – Outfall inspections***

Measure	Report of number of outfalls inspected
Responsibility	Engineering
Date	Annual Report

The City requested that the order of watersheds be changed for ditch inspections and dry weather outfall inspections. These changes were made for improved coordination with regard to our IDDE work.

The City conducted dry weather outfall inspections for the Birch Stream watershed on May 30 and the Capehart Brook watershed on May 8 and May 9, 2014. There were 12 outfalls identified in Birch Stream, and 11 in Capehart Brook, including the outfall at the start of each.

- ***Measureable Goal 2 – Outfall documentation***

Measure	List of outfalls inspected with descriptions and test results
Responsibility	Engineering
Date	Annual Report

The City's GIS mapping has been updated with information from the outfall inspections. Descriptions of the outfalls, including test results, and maps showing outfall locations are included in ***Appendix G*** for both Birch Stream and Capehart Brook.

- ***Measureable Goal 3 – Illicit discharge tracking***

Measure	Description of source tracking and resolution for each illicit discharge
Responsibility	Engineering
Date	Annual Report

There were three outfalls with dry weather flow in Birch Stream and five in Capehart Brook. In each case, the flow was traced to determine the source. All flows were from detained stormwater or acceptable non-stormwater discharges. None of the flows were contaminated by sewage. A summary of findings is presented in the following table.

	Outfall ID	Source	Test Results	Resolution
Birch Stream	BR02	roadway drainage from Capehart development, Griffin Rd and Ohio St	27 col/100 ml *E. coli*	acceptable source: stormwater runoff, possible groundwater intrusion
	BR09	catch basins at Airport Mall	0 col/100 ml *E. coli*	acceptable source: stormwater runoff, possible groundwater intrusion
	BR10	canals at BIA	sampled routinely through other programs	acceptable source: stormwater runoff that has been detained
Capehart Brook	CH02	drain from abandoned WWTP	10 col/100 ml *E. coli*	acceptable source: groundwater
	CH03	foundation drain from abandoned WWTP	non-detect for human *Bacteroides*	acceptable source: groundwater
	CH05A	flow was noticed coming into the brook below waterline, but no pipe found	0 col/100 ml *E. coli*	acceptable source: assumed to be natural groundwater flow
	CH07	roadway drainage from Finson Rd and Davis Rd	5 col/100 ml *E. coli*	acceptable source: stormwater runoff
	CH11	detention pond at Sunny Hollow development	sampled by DEP	acceptable source: stormwater runoff that has been detained

➢ BMP 4 – Illicit discharge detection program

The City inspected open ditches to identify and eliminate sources of illicit discharge into the MS4 in accordance with the City's IDDE plan.

- ***Measureable Goal 1 – Open ditch inspections***

Measure	Map depicting ditches inspected with inspection dates
Responsibility	Engineering
Date	Annual Report

The MS4 ditches in the Birch Stream and Capehart Brook watersheds were surveyed on April 10 and April 18, 2014. Most of the ditches were grassed and in good working condition. There was some litter, but the litter did not appear to affect stormwater flow. There was no litter in the airport area. Areas needing repairs or maintenance and unknown pipes were recorded and photographed. In addition, other non-ditch items such as stormwater ponds in need of maintenance were noted. Maps showing the ditch locations are included in ***Appendix H***.

- ***Measureable Goal 2 – Ditch discharge documentation***

Measure	Identification of possible illicit discharge
Responsibility	Engineering and Environmental
Date	Annual Report

The following table summarizes the concerns noted during ditch inspections.

	Concern	Reported	Follow-up / Resolution
Birch Stream	Erosion at intersection of Godfrey and Wyoming	Email to BIA env. compliance on 7/1/14	Area had been site of auto accident. Repaired and reseeded.
	Pipe entering culvert near kennel on Ohio Street	Memo to Code on 6/6/14	*pending investigation by Code Enforcement*
	Crushed culvert in ditch along Maine Ave by DHHS building	Email to DPW on 7/10/14	*pending corrective action from Public Works*
	Significant ditch erosion on Griffin Rd near Eldur building	Email to DPW on 7/10/14	*pending corrective action from Public Works*
Capehart Brook	Erosion in ditches on Finson Road	Memo to DPW on 4/11/14	Repaired and inspected May 2014
	Unknown pipe in ditch at 830 Finson	Memo to Code on 6/6/14	*pending investigation by Code Enforcement*
	Clogged culverts at Assembly of God church and Cedar Fall MHP	Memo to DPW on 4/11/14	Reminder email to DPW 6/6/14; maintenance completed June 2014 and inspected
	Eroding banks at SW pond on Brighton Avenue (MCM 5 issue)	Memo to Code on 4/11/14	*pending action by Code Enforcement*
	Mulch needed at 3-lot site on Pushaw Rd (MCM 4 issue)	Memo to Code on 4/11/14	*pending action by Code Enforcement*
	Improper stabilization, significant rills at site on Davis Rd (MCM 4 issue)	Memo to Code on 4/11/14	*pending action by Code Enforcement*
	Discharge pipe into Capehart Brook at end of Birchwood Avenue	Memo to Code on 6/6/14	*pending investigation by Code Enforcement*
	Pipe from house on Birchwood Ave with unknown discharge type	Memo to Code on 6/6/14	*pending investigation by Code Enforcement*
	Ponding in roadway at 20-24 Pushaw Road	Memo DPW on 4/11/14	Added to stormwater "needed improvements" list

- ***Measureable Goal 3 – Illicit discharge tracking***

Measure	Description of illicit connections, test results, and resolution
Responsibility	Engineering
Date	Annual Report

There was one unknown pipe discharging to a ditch in the Birch Stream watershed, and three in the Capehart Brook watershed. Photographs and locations of these pipes have been forwarded to Code Enforcement for follow up by a plumbing inspector. Memoranda for documentation of illicit discharge tracking and MCM 4 and 5 follow-up requests have been included in ***Appendix I***.

➢ BMP 5 – Illicit connections

With infrastructure that is old and complex, such as the City's, there is the potential for illicit sanitary sewer connections to the MS4 system.

- ***Measureable Goal 1 – Identification and removal of illicit connections***

Measure	Identification and removal of illicit sanitary connections to the MS4
Responsibility	Engineering
Date	as soon as practicable

The City identified and removed illicit connections to the MS4 system found during routine records review, field work, and maintenance on the sanitary sewer system.

- ***Measureable Goal 2 – Reporting of illicit connections***

Measure	Report of illicit connections to MS4 found
Responsibility	Engineering
Date	Annual Report

The following table lists the illicit connections found and removed.

date discovered	address or location	estimated flow and type	date removed
9/18/2013	Market Street overflow	intermittent combined overflow	11/12/2013
8/14/2014	Ohio St cross-connection	intermittent sanitary overflow	8/15/2014
9/18/2013	Center St sewer structure	intermittent combined overflow	9/30/2013

➢ BMP 6 – Septic systems

The City will comply with permit requirements regarding septic systems. There were no measureable goals for PY 1.

- ***Measureable Goal 1 – Identify septic systems***

Measure	List and map of septic systems in the Penjajawoc watershed
Responsibility	Engineering and Code Enforcement
Date	June 30, 2016, for PY3 Annual Report

- ***Measureable Goal 2 – Evaluation of septic systems***

Measure	List and documentation of potentially failing systems in the Penjajawoc watershed, and description of any possible water quality effects
Responsibility	Plumbing Inspector (Code Enforcement)
Date	June 30, 2017, for PY4 Annual Report

- ***Measureable Goal 3 – Inspection and enforcement***

Measure	Description of resolution for any failing systems in the Penjajawoc watershed
Responsibility	Plumbing Inspector (Code Enforcement)
Date	June 30, 2018, for PY5 Annual Report

➢ BMP 7 – Hydrant flushing

The City is coordinating with the Bangor Water District (BWD) regarding water line and hydrant flushing to determine if either is a significant contributor of pollutants to the MS4.

- ***Measureable Goal 1 – Coordination with utility***

Measure	Report on coordination with BWD and results of evaluation
Responsibility	Municipal Stormwater Manager
Date	PY1 Annual Report

The City provided the BWD with GIS layers showing the extent of the municipal urbanized area, and the highest priority watersheds (Penjajawoc and Capehart). The City gathered information from the BWD including the number and location of hydrants.

Because the chlorides introduced through the bleeder valves outweigh the potential chlorides from hydrant flushing, the City worked with BWD to resolve this as a priority issue and will revisit the hydrant flushing issue in the next permit year.

- ***Measureable Goal 2 – Prioritized mapping***

Measure	Map of waterline and hydrant locations in Penjajawoc and Capehart watersheds, water quality progress report from BWD, status update report for Annual Report
Responsibility	Municipal Stormwater Manager
Date	December 30, 2014 for inclusion in PY2 Annual Report

The City is working with BWD to complete hydrant mapping in the priority watersheds by December 30, 2014.

- ***Measureable Goal 3 – Annual water quality progress report***

Measure	Water quality progress report from BWD
Responsibility	Municipal Stormwater Manager
Date	PY3, PY4 and PY5 Annual Reports

- ***Measureable Goal 4 – IDDE ordinance***

Measure	Report on water line and hydrant flushing as a significant contributor of pollutants to the MS4 and an update on subsequent actions
Responsibility	Municipal Stormwater Manager
Date	PY3 and PY4 Annual Reports

➢ Additional Activities

- ***Catch basin inspections***

Known MS4 catch basins in urban impaired stream watersheds were inspected and documented during this permit year. Follow up on potential illicit discharge and additional investigations are in process in the Birch Stream and Capehart Brook watersheds. Working documents are included in ***Appendix J***. A summary of results for these two watersheds and the status of the follow-up work in the other watersheds will be provided in the next annual report.

- ***Bangor Water District bleeder valves***

One of the more striking illicit discharge discoveries identified during catch basin inspections was the presence of bleeder valves placed directly into catch basins. These bleeder valves are owned by the Bangor Water District (BWD). Bleeder valves are a public health necessity because they keep the water supply adequately chlorinated, but they should be placed in sanitary sewer manholes. The City discovered that BWD bleeder valves were placed in catch basins in most urban impaired stream watersheds. The bleeder valves in the Capehart Brook watershed (Doe Drive) and Arctic Brook watershed (near Broadway Shopping

Center) have been shut off and will be removed. The City is working with the BWD to have all the bleeder valves shut off and permanently removed from catch basins. Documentation on this effort will be provided in the next annual report.

- ***Sampling***

The City conducted water quality sampling as part of its IDDE program. A summary of water quality sampling completed in this permit year is included in ***Appendix K***. Some of the sampling events are discussed in other sections of this report. The City is currently reviewing the sampling data and working on action items based on this review.

▪ MCM 4 – Construction Site Stormwater Runoff Control

The City relies on the Maine Construction General Permit (MCGP). Developers and contractors are notified of the requirement to file for coverage under the MCGP in the packet of information that accompanies the building permit application.

➢ BMP 1 – Construction activity tracking

- ***Measureable Goal 1 – Construction site stormwater runoff control plan***

Measure	Construction site stormwater runoff control plan
Responsibility	Municipal Stormwater Manager
Date	March 21, 2014, for PY1 Annual Report Status update in PY2, PY3, PY4, PY5 Annual Reports

The City developed an inter-departmental plan to track development, permitting, and construction activities. This plan was submitted to DEP on March 21, 2014.

- ***Measureable Goal 2 – Construction activity tracking***

Measure	Description of database function and screen shots of data entry interface, status updates on database functioning and changes
Responsibility	Municipal Stormwater Manager
Date	March 21, 2014 for PY1 Annual Report Status update in PY2, PY3, PY4, PY5 Annual Reports

The City developed and implemented a database to track permitted construction activity that disturbs one or more acres within the urbanized area. The tracking database was fully operational by March 21, 2014, as was reported to DEP on that date.

➢ BMP 2 – Construction inspections

The City inspects construction sites for compliance with the MCGP and Chapter 500, Stormwater Management.

- ***Measureable Goal 1 – Inspect construction sites***

Measure	Number of sites and number of site inspections completed
Responsibility	Engineering
Date	Annual Report

The City inspects sites in urban impaired watersheds at least three times over the course of construction and other sites at least two times. There were 58 construction sites inspected during this permit year, with 155 documented inspections.

- ***Measureable Goal 2 – Documentation of inspections***

Measure	Database report of inspections
Responsibility	Engineering
Date	Annual Report

A database report listing inspections is included in ***Appendix L***. In this report, inspections are listed in chronological order and are identified by type as first, second, follow-up or final. It is also noted whether corrective actions, such as repairing a silt fence, were required. (In most cases, if corrective actions are required, these instructions are conveyed to workers on site and handled immediately. Repeat or severe problems are forwarded to Code Enforcement as summarized in MG 3 below.) Documentation of construction site inspections, including forms and photographs, is on file at the City.

- ***Measureable Goal 3 – Follow-up for violations***

Measure	Report listing sites with violations and the steps taken to bring those sites into compliance
Responsibility	Code Enforcement Officer
Date	Annual Report

Stormwater violations are reported by the inspectors to the City's Code Enforcement Department for follow-up and resolution. The Code Enforcement Officer enforces compliance with stormwater regulations and issue notices of violation when necessary. A list of sites reported to Code Enforcement is included in ***Appendix M***. Documentation is on file at the City.

MCM 5 – Post Construction Stormwater Management in New Development and Redevelopment

BMP 1 – Program to address stormwater runoff

- ***Measureable Goal 1 – Develop post construction stormwater management plan***

Measure	Post construction stormwater management plan
Responsibility	Municipal Stormwater Manager
Date	March 21, 2014, for PY1 Annual Report Status update in PY2, PY3, PY4, PY5 Annual Reports

The City is developing an inter-departmental plan to track development, permitting, and construction activities in order to comply with the requirements of this MCM. A plan was submitted to DEP for approval on March 21, 2014. Implementation of the plan is ongoing as software and processes evolve and improve.

- ***Measureable Goal 2 – Encourage use of LID techniques***

Measure	LID statement on site development permit application
Responsibility	Planning
Date	March 21, 2014, for PY1 Annual Report

The City encourages developers to use LID techniques. The City requires developers to include written confirmation in their site development application that LID techniques were considered and, if LID techniques are not used, an explanation of why LID techniques will not be implemented. The new site development application was submitted to DEP on March 21, 2014.

- ***Measureable Goal 3 – Engineering review***

Measure	List of sites reviewed and number of O&M plans required
Responsibility	Engineering
Date	Annual Report

Proposed developments were reviewed by a professional engineer for compliance with stormwater laws. There were 22 developments reviewed, which contained 13 new stormwater structures with O&M plans. The proposed developments reviewed are shown in chart below.

	Review Date	Applicant	Project Name	Street	Type (SLOD, Site)	Stormwater Controls	Perm. Structures	O&M Plan	Watershed
1	7/15/2013	Moyse Ventures, Inc.	extend existing subdiv.	Brighton Ave.	Site	existing pond	No	NA	Capehart/Osgood
2	7/15/2013	Hardy Associates	storage building	45 Dowd Road	Stormwater, Site	detention pond	Yes	Yes	Sucker
3	7/31/2013	St. Joseph's	medical office building	954 Broadway	SLOD, Site	wet pond	Yes	Yes	Kenduskeag
4	8/19/2013	Cross Insurance	grade and fill	700 Stillwater	Site	none	No	NA	Penjajawoc
5	8/23/2013	BIA	canal fill project BIA		SLOD, Site	none	No	NA	Birch Stream
6	9/3/2013	Leadbetters	storage building	1105 Hammond	SLOD, Site	none	No	NA	Sucker
7	10/16/2013	Bangor Housing Authority	pavement maintenance	Birch Circle	Site	tree box filter	Yes	Yes	Capehart
8	10/23/2013	Leadbetters	c-store, car wash	1065 Broadway	Site	underdrain swales, treatment ditches	Yes	Yes	Kenduskeag
9	10/29/2013	Inland Western, LLC	drainage maintenance	Broadway	Site	added culverts, cleared vegetation	Yes	NA	Arctic
10	12/16/2014	Marriott Residence Inn	Marriott	Dutton	Site	culverts	Yes	Yes	Penobscot
12	2/11/2014	ERG Realty	restaurant & retail	573 Stillwater	SLOD, Site	update underdrain detention pond	Yes	Yes	Penjajawoc
13	2/24/2014	Plisga & Day	Judson Heights flag lot	Balsam & Heather	SLOD, Site	none required	No	NA	Kenduskeag
14	2/27/2014	JRG Properties	Burleigh Rd. Apartments	33 Burleigh Rd	Site Rev	existing pond has capacity	Yes	Yes	Kenduskeag
15	2/28/2014	Bomarc Comm. Properties Inc.	Bomarc Self Storage II	Bomarc Road	Site	none	No	NA	Penjajawoc
16	3/21/2014	EMMC	chiller relocation	State	Site Rev	sedero only required	No	NA	Penobscot
17	3/27/2014	American Iron & Metal	site upgrades	2630 Broadway	Site, DEP SW	underdrained soil filters	Yes	Yes	Kenduskeag
18	4/15/2014	CMI Inc.	Crossroads	930 Stillwater Ave.	Site Rev	existing underdrain soil filters	Yes	Yes	Penjajawoc
19	4/25/2014	Queen City Mining Quarry	quarry	1381 Hammond St. Ext.	Site	internally drain, roadside buffers	No	NA	Shaw
20	5/30/2014	Eastern Maine Healthcare	medical office building	Corporate Dr.	SLOD, Site	underdrained detention pond	Yes	Yes	Sucker
21	6/4/2014	Stillwater Crossing	drive-thrus to existing building	461 Stillwater	Site Rev	existing system has capacity	Yes	Yes	Penjajawoc
22	6/9/2014	Bangor Motorsports	storage building	Hammond	Site Rev	none	No	Yes	Shaw

➢ BMP 2 – Documentation of stormwater structures

- ***Measureable Goal 1 – Record new structures each year***

Measure	Description and location of new structural BMPs installed
Responsibility	Engineering
Date	Annual Report

The City documented the new stormwater structural BMPs approved to be built in 2014. There were 16 documented through the end of PY 1.

Site ID	Site Name/Project	Address	Structures
BMP-002	St Joseph medical office building	954 Broadway	detention pond
BMP-011	Leadbetters	1065 Broadway	underdrained swales
BMP-012	BHA - Birch Circle	1160 Ohio St	tree box filter
BMP-013	TIMKA-Geaghans	Dutton Street	stormwater treatment bed
BMP-018	Irving gas station	633 Hogan Rd	tree box filters, O/W separator
BMP-021	EMMC Patient Tower	489 State St	pervious pavement
BMP-022	ANG-Aviation Readiness Center	Hayes Ave	subsurface gravel wetland
BMP-023	Hope House	185 Indiana Ave	porous pavement, plunge pools
BMP-024	Town Place Suites - Marriott	236 Sylvan Road	bioretention cell
BMP-027	ERG-Bangor Cinema	557 Stillwater	detention pond
BMP-029	Spekhardt Dental bldg	70 Corporate Drive	bioretention cell
BMP-030	JRG Properties	33 Burleigh Rd	detention pond
BMP-031	Banres-Marriott	Dutton St	detention pond
BMP-032	Hardy Associates	154 Hildreth St	underdrain filter
BMP-033	CMI-Brohill	930 Stillwater Ave	underdrain filter
BMP-034	American Iron & Metal	2630 Broadway	underdrain filter

- ***Measureable Goal 2 – Research records for existing structures***

Measure	Description and location of structural BMPs approved for installation in previous years
Responsibility	Engineering
Date	Annual Report

The City researched records and plans to document existing stormwater structural BMPs for 2013. Structures from other years that were subject to redevelopment were also included.

Site ID	Site Name/Project	Address	Structures	Installed
BMP-001	Hardy Associates	45 Dowd Rd	detention pond	2013
BMP-003	St Joseph parking lot	275 Center St	underdrained soil filter	2013
BMP-004	Stillwater Crossing	461 Stillwater Ave	underground wet pond; underdrain soil filters	2013
BMP-005	Town Fair Tire	962 Stillwater Ave	underdrained soil filter	2013
BMP-006	BHA - Nason Park	140 Hancock St	pervious pavement	2013
BMP-007	BHA - Griffin Park	Griffin Rd	pervious pavement, tree box filters, stormcrete	2013
BMP-008	Pilgrim Orthodox Presbyterian Church	375 Mt Hope Ave	underdrained soil filter	2013
BMP-010	Dunbar & Brawn	203 Hildreth St	underdrained soil filters	2013
BMP-014	Bangor Baptist Church	1476 Broadway	roof filter drains; riprap apron	2013
BMP-015	Husson University	Husson Ave	wet pond; riprap aprons	2013
BMP-016	UMA Caribou Hall parking lot	307 Maine Ave	bioretention cell	2013
BMP-017	McDonalds	655 Hogan Rd	pervious pavement; tree box filters	2013
BMP-019	Meadowbrook Ridge - Phase 3	Chickadee Lane	underdrained soil filters	2013
BMP-020	ALSID	878 Stillwater Ave	drip line filter, underdrained basins	2013
BMP-025	Lyons Ledge Subdivision	Wellesley Ave	bioretention ponds	2010
BMP-026	Leadbetters	1105 Hammond St	detention pond	2005

- ***Measureable Goal 3 – Obtain maintenance records***

Measure	List of maintenance performed on each documented BMP and enforcement actions taken
Responsibility	Engineering (for tracking), Code Enforcement Officer (for enforcement)
Date	Annual Report

There were no self-inspections or maintenance records submitted for the documented BMPs. It was anticipated that 16 self-inspections or maintenance records would be submitted for the documented BMPs. This list will be provided to Code Enforcement for follow-up.

➢ BMP 3 – Inspections

The City inspected sites with post construction BMPs as described in the City's Post Construction Stormwater Management Plan.

- ***Measureable Goal 1 – Inspect a percentage of sites***

Measure	Number of sites inspected by the City
Responsibility	Engineering
Date	Annual Report

The City inspected 8 sites. Documentation is on file at the City.

- ***Measureable Goal 2 – Tracking and documentation***

Measure	Summary of sites and function
Responsibility	Engineering
Date	Annual Report

The City tracked results of the inspections and provide a summary in the annual report to include the following:

- Cumulative number of documented sites discharging to the MS4: 34
- Number of sites discharging to MS4 that were reported to the City: 0
- Number of sites with documented functioning BMPs: 4
- Number of sites with requiring maintenance or remedial action: 4

- ***Measurable Goal 3 – Follow up for non-functioning post construction BMPs***

Measure	List of sites with non-functioning BMPs, follow up actions taken, and results
Responsibility	Code Enforcement Officer
Date	Annual Report

The City will follow up with the owners/operators of any non-functioning structural BMPs in the chart listed below.

Site ID	Site Name/Project	Address	Structures	Corrective Action Required
BMP-001	Hardy Associates	45 Dowd Rd	detention pond	build the pond
BMP-005	Town Fair Tire	962 Stillwater Ave	underdrained soil filter	remove sediment, establish vegetation
BMP-008	Pilgrim Orthodox Presbyterian Church	375 Mt Hope Ave	underdrained soil filter	remove silt and debris, establish vegetation
BMP-020	ALSID	878 Stillwater Ave	drip line filter, underdrained basins	repair erosion rills, remove stagnant water, establish vegetation

▪ MCM 6 – Pollution Prevention/Good Housekeeping for Municipal Operations

The City works to prevent or reduce runoff from municipal operations.

➢ BMP 1 – Pollution prevention at facilities

- ***Measureable Goal 1 – Update municipal inventory***

Measure	Inventory of properties, facilities and activities
Responsibility	Environmental Coordinator
Date	Annual Report

The City's inventory of properties and facilities that could potentially contribute to stormwater pollution is provided in the table below.

Facility	Building/Potential Source of Pollution	Location
Bangor International Airport	Salt/sand shed	117 Maine Avenue
	7 Jetways	287 Godfrey Blvd
Community Connector	Bus storage and wash	497 Maine Avenue
Parks and Recreation	Bangor Municipal Golf Course	Webster Avenue
	Golf course equipment storage/sand storage	Webster Avenue
	Small equipment storage/maintenance	647 Main Street
Fleet Maintenance	Fleet Maintenance/Motor Pool	481 Maine Avenue
Parking Garages	Columbia Street Parking Deck & Garage	Columbia Street
	Pickering Square Parking Garage	100 Broad Street
Public Works Department	Sand-salt storage	530 Maine Avenue
	Vehicle Shelters	530 Maine Avenue
	Zero Sort Recycling Drop Off Center	530 Maine Avenue
	Public Works storage (sand)	530 Maine Avenue
	Bus/Garage	497 Maine Avenue
Wastewater Treatment	Treatment Plant	760 Main Street

- ***Measureable Goal 2 – Operation and maintenance plans***

Measure	List of O&M plans
Responsibility	Environmental Coordinator
Date	Annual Report

Operations and Maintenance Plans (O&M) are a component of the Storm Water Pollution Prevention Plans (SWPPPs).

Facility	O&M Document
Fleet Maintenance / Motor Pool	MS4 SWPPP
Department of Public Works	MS4 SWPPP
Community Connector (formerly Bangor Area Transit [BAT])	MSGP SWPPP
Bangor International Airport (BIA)	MSGP SWPPP contained in ICP (Integrated Control Plan)
Wastewater Treatment Plant (WWTP)	NPDES/MEPDES Waste Discharge SWPPP
Parks & Recreation	*(voluntary)* MS4 municipal garage-style SWPPP
Golf Course Maintenance Building	*(voluntary)* MS4 municipal garage-style SWPPP

The City also has SPCC Plans for City Hall, Parks & Recreation, and BIA including the Tank Farm.

- ***Measureable Goal 3 – Employee training***

Measure	Report on municipal staff training
Responsibility	Environmental Coordinator
Date	Annual Report

In December 2013 and January 2014, staff received the following trainings. All sessions included discussion about stormwater and ways to prevent migration by good housekeeping, spill response; leaks and small spills from vehicles and equipment.

- 10 staff members were trained, certified and passed an examination to be 24 hour HAZWOPER trained. All participants suited up in Level A & Level B gear.
- 41 staff members were HAZWOPER refreshed to maintain 24 hour certification.
- 83 staff members were RCRA trained which included an understanding of hazardous waste; proper storage; housekeeping; minor spills and leaks reporting; universal and e-waste components and stormwater awareness. In addition to staff who normally encounter hazardous waste and oils, this RCRA awareness included staff from City Hall Departments including

finance, risk assessment, information technology; code enforcement, planning and economic development and maintenance staff.

In May 2014, 13 staff members were trained in using water quality/field sampling equipment. This training was conducted by the HACH Manufacturer's rep. Staff members from the WWTP, Sewer Department, GIS, BIA and Engineering attended.

➢ BMP 2 – Good housekeeping

The City maintains streets, catch basins and other conveyances and structures to prevent or reduce pollution in stormwater.

- ***Measureable Goal 1 – Street sweeping***

Measure	Report on street sweeping
Responsibility	Director of Public Works
Date	Annual Report

The City swept all publicly accepted paved streets and publicly owned paved parking lots at least once this year as soon as possible after snowmelt. Other street sweeping takes place as needed.

- ***Measureable Goal 2 – Catch basin evaluation***

Measure	Summary of catch basins cleaned and evaluated
Responsibility	Director of Public Works for cleaning Environmental for evaluations
Date	Annual Report

The City's Public Works crew cleans catch basins by street on a yearly schedule. They also track problem basins for more frequent cleaning. During the cleaning, they note the amount of sediment accumulated and any other problems. They also sketch inlet locations for later comparison to GIS data (to verify mapping or identify locations for IDDE investigations). Locations of catch basins cleaned are recorded by street and GPS coordinates and tracked on a spreadsheet that is available to City staff on the server. This year 97 catch basins were cleaned before the cleaning equipment stopped functioning. Replacement equipment is in the budget for the next fiscal year.

In addition, known MS4 catch basins were inspected in the urban impaired stream watersheds. For more information about these inspections, refer to ***MCM 3, Additional Work***.

- ***Measureable Goal 3 – Repairs and upgrades***

Measure	Summary of stormwater structure repairs
Responsibility	Director of Public Works
Date	Annual Report

The City repaired and upgraded stormwater conveyances, structures and outfalls as necessary during routine work. Work orders were generated by public request, opportunistic inspection, or other means. Some of these repairs specifically requested as part of the MS4 inspections are listed in the tables in ***MCM 3, BMP 3***.

➢ BMP 3 – Municipal SWPPPs

- ***Measureable Goal 1 – SWPPP implementation***

Measure	Status update on SWPPP implementation
Responsibility	Public Works Director, Fleet Maintenance Supervisor, WWTP Superintendent
Date	Annual Report

The City has implemented SWPPPs at the Fleet Maintenance facility, Public Works facility and the WWTP (formerly an MSGP SWPPP). SWPPPs are kept on site and implemented as required.

➢ Additional activities

The City hosted the 18th Annual Household Hazardous Waste Day on October 5, 2013. The City of Bangor and 16 neighboring communities participated in the event, and a significant amount of hazardous waste was potentially prevented from entering stormwater. Please refer to the BASWG Annual Report for further information.

At the 12th Annual American Folk Festival held in August of 2013, the City had 2 grease boxes set up for all vendors to utilize who prepared food. The grease boxes were provided by Maine Standard Biofuels and were removed from the waterfront on Monday morning after the weekend event. Using these boxes prevented potential clogging of the sewer lines and mishandling of fats, oils and greases.

Appendix A – Permit Awareness Documentation

Burbank, Peralie

From: Burbank, Peralie
Sent: Thursday, June 12, 2014 11:28 AM
To: Moore, Brad; Gould, David; Martin, Jeremy; Bird, Jason
Subject: Stormwater 101
Attachments: Stubbed Attachments.htm

This message's contents have been archived by the Barracuda Message Archiver.
Bangor Stormwater Program 2014 comp.pptx (8.3M)
Permit Awareness Plan.pdf (62.4K)

Here is the presentation that must be given before June 30 along with a table showing permit requirements. Please make sure the presentation is given and the follow-up (informal questions) is done. Then send me an e-mail letting me know the date and the results, including any questions or concerns you have. This will go into our annual report to DEP (and EPA).

Thanks,
Peralie

_____

Peralie M. Burbank, PE
Engineering Department
City of Bangor
73 Harlow Street
Bangor, ME 04401
phone 207.992.4252
fax 207.992.4194

Burbank, Peralie

From: Moore, Brad
Sent: Tuesday, June 24, 2014 9:29 AM
To: Councilors; Conlow, Cathy
Cc: Burbank, Peralie
Subject: Stormwater Utility
Attachments: Stubbed Attachments.htm

This message's contents have been archived by the Barracuda Message Archiver.
Bangor Stormwater Program 2014 comp.pptx (7.1M)

Good morning,

As you are aware, a stormwater utility was established last year and we are now collecting revenue to support the work that is required to operate and maintain the utility. The utility was formed in response to the requirements imposed on Bangor by the Maine DEPs' Municipal Separate Storm Sewer System General Permit. One of the obligations is to annually educate public officials and that is the purpose of this email. I have attached a power point presentation describing the elements of our program and our obligations which most of you have seen in the past.

The main components of our program are; 1)education and outreach, 2) public involvement and participation, 3) illicit discharge detection and elimination which requires analytical testing of some stormwater, 4) construction site stormwater runoff control, 5) post-construction runoff control, and 6) pollution prevention and good housekeeping for municipal operations. I am available if there is a desire to discuss these elements in more detail and/or review the presentation as a group. I can also provide a printed version of the presentation if needed.

Please contact me if you have any questions or concerns regarding this information.

Thank you,
Brad

Bradley Moore
Superintendent
Bangor Wastewater Treatment Plant
760 Main Street
Bangor, ME 04401
207 992 4471
207 947 3537 Fax

THIS MESSAGE, INCLUDING ANY FILE OR ATTACHMENT TRANSMITTED WITH IT, IS INTENEDED ONLY FOR THE USE OF THE INDIVIDUAL OR ENTITY TO WHICH IT IS ADDRESSED AND MAY CONTAIN INFORMATION THAT IS PRIVELEDGED, CONFIDENTIAL AND EXEMPT FROM DISCLOSURE. Please notify the sender if you have received this message in error. Any review or distribution by others is strictly prohibited. Recipients should be aware that replies to this message may not be considered confidential and may therefore be subject to public disclosure. If you received this communication in error, destroy all copies of this message, attachments and/or files in your possession, custody and any other copies you may have created, and notify the sender at 207-992-4470 or at the sender's e-mail address listed above.

PLANNING BOARD AGENDA

TUESDAY, JUNE 17, 2014, 7:00 P.M.

THIRD FLOOR COUNCIL CHAMBERS, CITY HALL

CONSENT AGENDA

1.	**PLANNED GROUP DEVELOPMENT/DEVELOPMENTAL SUBDIVISION**	**236 Sylvan Road – Maine Course Hospitality Group** **Planned Group Development and Developmental Subdivision Approvals for the Towne Place Suites Hotel and the Courtyard Marriott located at 236 Sylvan Road in a General Commercial and Service District – Maine Course Hospitality Group, applicant.**

PUBLIC HEARINGS

2.	**ZONE CHANGE**	**15-17 Bower Street – Richard P. VanSyckle, III** **To amend the Land Development Code by changing two parcels of land located at 15-17 Bower Street from Urban Residence One District to Urban Residence Two District. Said parcels containing approximately 13,060 sq. ft. Richard P. VanSyckle, III, applicant. C.O. # 14-202.**

3.	**ZONE CHANGE**	**<u>Bomarc Road – Bomarc Commercial Properties LLC</u>** **To amend the Land Development Code by changing part of a parcel of land located on Bomarc Road from Rural Residence and Agricultural District to Urban Industry District. Said part of a parcel of land containing approximately one-half acre. Bomarc Commercial Properties, LLC, applicant. C.O. # 14-203.**

<u>NEW BUSINESS</u>

4.	**PLANNING BOARD REVIEW/ DISCUSSION**	**Stormwater Awareness Presentation.**

<u>APPROVAL OF MINUTES</u>

5.	**PLANNING BOARD APPROVAL**	**Planning Board Approval of Minutes.**

Appendix B – Meeting Publication

To: Honorable Chair and Members of the Bangor City Council
From: Catherine M. Conlow, City Manager
Subject: **REVISED** Weekly Meetings – **March 17, 2014**
Date: March 14, 2014

Mar. 17	**(Mon)**	5:15 p.m.	Finance Committee
		Immediately Following	Government Operations Committee
Mar. 18	**(Tue)**	3:45 p.m.	Bangor Water District – 614 State Street
		5:15 p.m.	Business & Economic Development Committee
		7:00 p.m.	Planning Board
Mar. 19	**(Wed)**	3:00 p.m.	Public Health Advisory Board
		4:00 p.m.	Bangor Housing Authority – 161 Davis Road
		5:00 p.m.	Board of Appeals
		5:15 p.m.	**Executive Session 1 MRSA 405 6 (c) – Contracts – Hollywood Casino, 500 Main Street**
Mar. 20	**(Thur)**	9:00 a.m.	Bangor Area Stormwater Group (BASWG) – Veazie Town Office
		7:00 p.m.	Historic Preservation Commission
Mar. 21	**(Fri)**	4:00 p.m.	School Committee-Budget Workshop

Unless otherwise noted, all meetings are held: City Council Chambers, Bangor City Hall, 73 Harlow Street.

Bangor Area Storm Water Group Meeting
March 20, 2014; 9:00 am – 11:30 am
Location: ***Veazie Town Office, Veazie, Maine***
AGENDA

9:00 am **Welcome and Introductions** (5 min)

9:05 am **Permit Check-in** (20 min)
Review of PY1 permit requirements and remaining work

9:15 am **Review of the Top 10 Stormwater Audit Violations** (60 min)
Discussion and Q&A with DEP Staff

Lack of Communication	Code Enforcement Issues
Construction Inspections Documentation	O&M Plans (General)
O& M Plan Location	O&M Plan Knowledge
SPCC Compliance	SWPP-related Documentation
Non-allowable stormwater discharges	Storage Issues

10:15 am ***Coffee Break*** *(15 minutes)*

10:30 am **Organizational Business** (15 min)
- Approval of BASWG meeting minutes
- Budget
- Review and Approval of Bylaw changes
- Contractor Annual Performance Review Process
- Maine Salt Management Task Force Video Conference (3-18-14)
- Other Announcements

10:45 am **Education and Outreach** (15 min)
- Bangor Garden Show volunteers and plans
- Planning for Spring street and stream clean-ups

11:00 am **Hydrant Flushing Check-in**

Note: Each municipality should come prepared to discuss progress they have made and questions they have for DEP/other members

11:30 am ***Meeting Adjourns***
Tentatively followed by DIMS Planning Committee meeting from 11:30am – 1:00pm

Return to Schedule

Appendix C – Public Event Documentation

doodle.com/export/pdf?pollId=ms6zxfkhta2f7mtb&adminKey=2v4ff7cf&locale=en_US

	Fri 4				Sat 5				Sun 6		
	10:00 AM - 12:00 PM	12:00 PM - 2:00 PM	2:00 PM - 4:00 PM	4:00 PM - 6:00 PM	10:00 AM - 12:00 PM	12:00 PM - 2:00 PM	2:00 PM - 4:00 PM	4:00 PM - 6:00 PM	10:00 AM - 12:00 PM	12:00 PM - 2:00 PM	2:00 PM - 4:00 PM
Peralie Burbank			OK								
Tracy Drew					OK	OK					
Gretchen								OK			
Mike Gladu	OK	OK									
Scott Wilkerson		OK	OK								
Bob Osborne	OK										
Patrick Decker				OK							
lamarr clannon									OK		
Lou Colburn					OK	OK					
Phil Ruck										OK	
Rob Yerxa									OK	OK	
Belle Ryder				OK							
Bill Murphy							OK	OK			
Brooks Gay										OK	
Brian Bernosky											OK
Curt Davis											OK
Ruth Chavez		OK									
Rosemary Bezanson							OK				
Count	2	3	2	2	2	2	2	2	2	3	2

Bangor Area Storm Water Group

73 Harlow Street
Bangor, Maine 04401

think blue

clean water starts with you!

Bangor:
Jeff Allen, Treasurer
992-4183

Brewer:
Ken Locke
989-5417

Hampden:
Robert Osborne, Chair
862-3034

Milford:
Mike Gladu
827-2072

Old Town:
John Rouleau
827-3974

Orono:
William Murphy
866-5051

Veazie:
Joseph Hayes
947-2781

Bangor International Airport:

Dorothea Dix Psychiatric Center:

Eastern Maine Community College:
Dan Belyea
947-4664

Maine Air National Guard at Bangor:
Lt. John Cronin
404-7407

University College of Bangor:
Patrick Decker
262-7730

University of Maine:
Scott Wilkerson
581-3049

April 3, 2014

Sophie Hallett
C/O Peralie M. Burbank, PE
Engineering Department
City of Bangor
73 Harlow Street
Bangor, ME 04401

Dear Sophie Hallett:

Please accept my thanks for volunteering to work at the BASWG booth at the BDN Garden Show and Spring Fling at the Cross Insurance Center, Bangor. According to our records you have volunteered to serve in costume as BASWG mascot “Stormy the Duck” from 10:00 am to 2:00 pm on Saturday April 5, 2014.

You will enter the building through the main entrance and indicate to the attendant that you are a BASWG volunteer and can show this letter as evidence of that.

Respectfully,

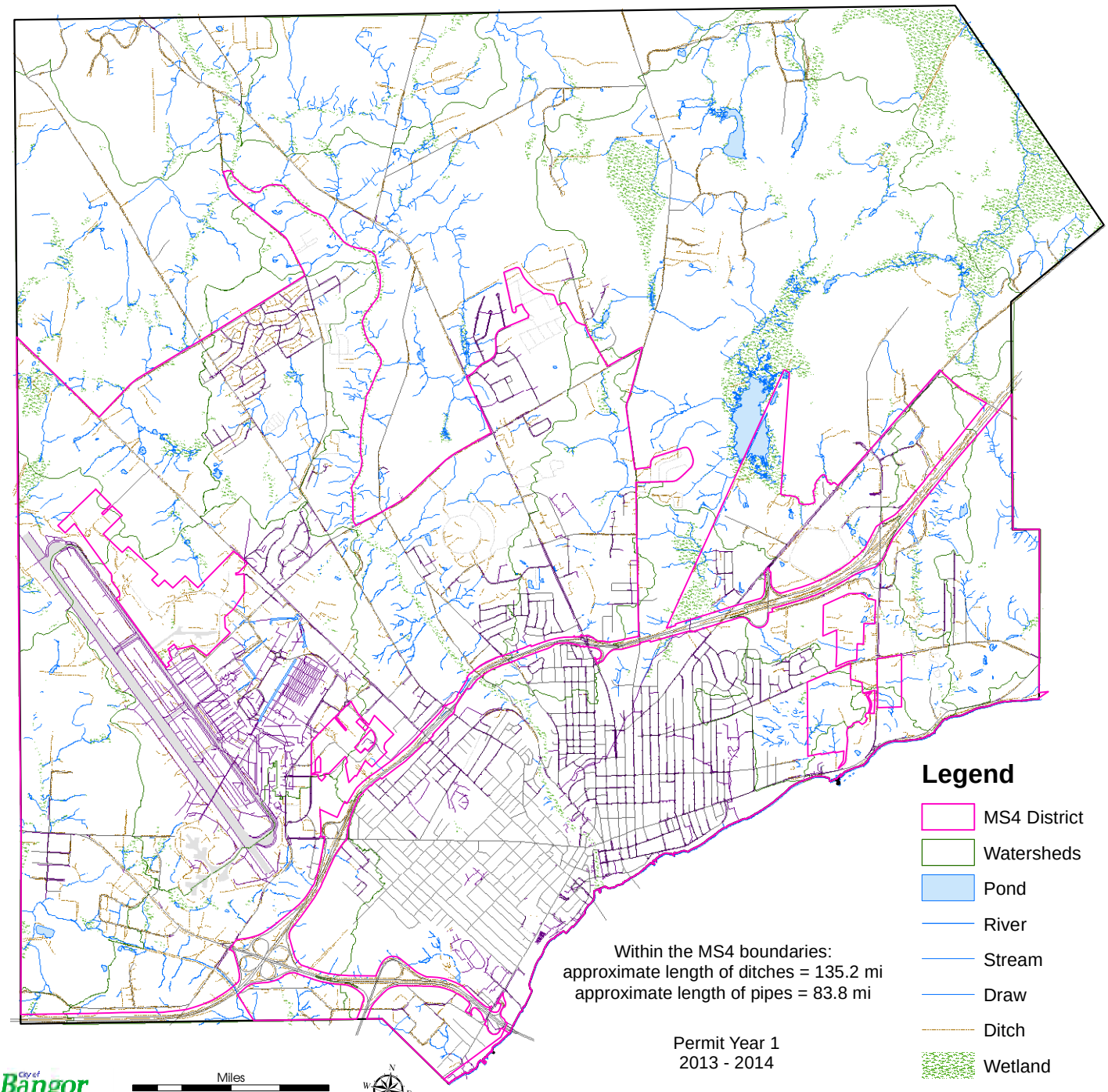
Robert Osborne
Chair, Bangor Area Storm Water Group

Please don't "fowl" our waters!

Don't "duck" your responsibilities!

Appendix D – System Map

STORMWATER FEATURES IN BANGOR



Legend

- MS4 District
- Watersheds
- Pond
- River
- Stream
- Draw
- Ditch
- Wetland
- Stormwater Pipe

Within the MS4 boundaries:
approximate length of ditches = 135.2 mi
approximate length of pipes = 83.8 mi

Permit Year 1
2013 - 2014

City of Bangor Maine
www.bangormaine.gov

Miles
0 0.3 0.6 0.9 1.2
1" = 1800' @ 24"x24"

N W E S

Appendix E – Summary of Incidents

MS4 ~ Summary of IDDE Incident Reports

Notice Date	Street Address	Description of Problem	Indicators of Problem	Resolution	Closed
8/7/2013	Pierce Street	sanitary sewer overflow	visible discharge of sewage	Solids removed, liquid infiltrated into grassed area. No direct release to MS4 or waterways.	Yes
8/16/2013	Webster St	paint thinner dumped in catch basin	visual	Educated painter. No further problem expected.	Yes
8/26/2013	517 Hammond Street	possible drainage of gray water from camper to catchbasin	sewage odor, drain hose to catch basin	City staff visited site and spoke with owner of camper. No further problem expected.	Yes
8/29/2013	railroad tracks	herbicides may harm Urban Impaired Streams	posted notification of herbicide useage	No problem. DEP consulted and in agreement.	Yes
9/5/2013	165 Allen Street	basement water being pumped out to catch basin	hose draining basement to catch basin	Told owner that contaminated water could not be pumped to ground. Owner will clean out basement and re-install sump. No further action needed.	Yes
9/6/2013	193 Elm St	concrete truck washout into catch basin`	contractor seen washing truck into catch basin	Contractor trained truck drivers on proper washout procedures and forwarded meeting sign-in sheets as proof. No further problem expected with this contractor.	Yes
9/6/2013	69 Second Street	pool being drained to catch basin	hose from pool to catch basin	Verified correct procedures followed. Offered assistance if needed. No further problem expected.	Yes
9/6/2013	Boyd Street, State Street	sanitary sewer overflow from manholes	evidence of previous discharge from manholes	Manhole repaired. Residual paper products removed. Reported to DEP. No further problem expected.	Yes
9/30/2013	145 Harlow Street	wash water flowing into catchbasin	wash water flowing into catch basin	Educated contractor. No further problem expected.	Yes

Notice Date	Street Address	Description of Problem	Indicators of Problem	Resolution	Closed
10/3/2013	980 State Street	water of unknown source running across road	water running across road	Water District fixed main. Chlorine not an issue. No further problem expected.	Yes
10/8/2013	I-95	bare soil near unprotected catch basin during construction work	bare soil near catch basin	Area paved. No further problem expected.	Yes
10/18/2013	796 Union St	paint may have entered catch basin	paint on asphalt near catchbasin	Determined to be highway marking paint. No further problem expected.	Yes
10/21/2013	198 Ohio Street	kitty litter and trash in catch basin	evidence of pet waste and trash in catch basin	Catch basin cleaned by Public Works. Will place markers in spring.	Yes
11/8/2013	1193 Hammond Street	fuel leaked from tank punctured in accident	fuel on roadway	Spill cleaned. No discharge went to ditches. No further problem anticipated.	Yes
11/9/2013	824 Stillwater Ave	sewage discharging from manhole from line blockage	visible discharge from manhole	Blockage removed and lines cleaned. Investigation revealed source of blockage. Action taken to notify owners and educate.	Yes
11/13/2013	92 Perry Rd	hydraulic fluid leaked from vehicle	truck was leaking fluid when leaving NH Bragg	Spill cleaned by City staff. No fluid reached MS4 or waters of state. File closed per DEP.	Yes
11/13/2013	799 Mt Hope Avenue	construction debris dumped on vacant site	sounds of large trucks dumping materials	Referred to DEP who determined there were no compliance issues.	Yes
12/11/2013	1627 Union Street	paint rinse water dumped on ground	traces of paint in yard	Visited site and spoke with owner. Verified proper disposal practices. Anticipate no further action required.	Yes
1/21/2014	Cleveland St / Texas Ave	sewage discharage from mahole	sewage overflowing from manhole	Repaired failed sewer main. Reported to DEP. No further problems anticipated.	Yes
1/22/2014	1722 Broadway	bank erosion behind commercial establishment	rills in bank of stream	Visited site. Will work with owner's engineering during plan review process if decide to proceed. Will reopen if needed.	Yes

Notice Date	Street Address	Description of Problem	Indicators of Problem	Resolution	Closed
2/7/2014	563 Odlin Rd	vehicle wash water could potentially enter MS4	vehicle wash water in parking lot	Spoke with owner and provided educational materials. Holding tank being installed. Do not expect further issues.	Yes
3/4/2014	287 Godfrey Blvd	tank sump bled and overfilled product recovery tank	visual spill into containment area	Spill cleaned with sorbants. Canopy will be placed over product delivery area. Cleanup accepted by DEP.	Yes
3/14/2014	95 Allen Court	sewage on ground and in basement	visible discharge	No sewage entered MS4 or waterbodies. Reported to DEP. No further action required.	Yes
3/30/2014	100 Pickering Square	sewage discharge from manhole during pleak flow and high tide	visible sewage discharge	sewage re-entered system; report filed with DEP	Yes
4/9/2014	1100 Hammond	blockage caused manhole to overflow	large area of ponded water over manhole	Sewage vacuumed. Area was limed. DEP notified.	Yes
4/25/2014	Pickering Square	broken radiator hose leaked fluid	spilled radiator fluid	Cleaned by City crew and reported to DEP. Drains to combined system so no issues expected.	Yes
5/5/2014	8 Jowett Street	pool draining	hose into catch basin	Water not chlorinated. Acceptable discharge. No issue.	Yes
5/28/2014	28 Patten St	sump discharge to catch basin	pipe draining water	Requested owner re-direct discharge to grassy area. No further action required.	Yes
6/6/2014	Virginia Lane	construction with no sediment/erosion control in place	no erosion/sediment control	Env. Coordinator visited owner and explained requirements.Erosion control in place at follow-up inpsection. No further action expected.	Yes
6/17/2014	928 Union St	rinse water enter MS4	visible discharge entering ditch	Pipe removed. No further action required.	Yes
6/18/2014	422 Perry Rd	fuel spill from damaged vehicle being towed	spilled fuel in roadway	Perry Rd clean up by DPW. Adjacent site cleaned up by Clean Harbors. DEP report attached. No further action needed.	Yes

Notice Date	Street Address	Description of Problem	Indicators of Problem	Resolution	Closed
6/18/2014	Perry Road	spill from vehicle	spilled oil in roadway	Spill absorbed and swept. DEP and Clean Harbors involved. No further action by City expected.	Yes
6/24/2014	395 N. Main St, BREWER	spill of antifreeze	visible spill	Cleaned up by Bangor Public Works under direction and to satisfaction of DEP.	Yes
6/26/2014		transmission fluid leak from stage setup	leaking fluid	Cleaned with speedy-dry. Picked up by Veolia. Reported to DEP. No further action required.	Yes
6/26/2014	54 Mt Desert Drive	sewage overflow at manhole	sewage overflowing	Blockage in sewer line repaired. Line flushed. Storm drain flushed. No further action expected.	Yes

Appendix F – Penjajawoc Potential Hot Spots

Penjajawoc Watershed HotSpot Potential List

No.	Site	Address	Property Use
1	Darlings	114 Sylvan Road	oil change facility
2	Southern Penob. Voc Sch	200 Hogan Road	auto service technician training
3	Davis Oil	208 Kittridge Road	oil company
4	MDOT	219 Hogan Road	oil change facility
5	Varney	260 Hogan Road	oil change facility
6	Quirk	295 Hogan Road	oil change facility
7	Quirk	307 Hogan Road	oil change facility
8	EMCC	354 Hogan Road	auto service technician training
9	Quirk	377 Hogan Road	oil change facility
10	Darlings	403 Hogan Road	oil change facility
11	Swett's	451 Hogan Road	oil change facility/fuel station
12	Sullivan Tire	47 Bangor Mall Blvd	oil change facility
13	Irving	633 Hogan Road	fuel station
14	AutoZone currently	753 Stillwater	oil storage
15	AutoZone proposed	754 Stillwater	oil storage
16	Mr. Quick	765 Hogan Road	oil change facility
17	Blue Seal Feed	876 Stillwater Ave	fertilizer/nutrient enrichment
18	Wal-Mart	900 Stillwater Ave	fertilizer/nutrient enrichment
19	VIP Tires & Service	911 Stillwater Ave	oil change facility
20	Sears	Bangor Mall	oil change facility
21	City of Bangor	Kittredge Rd	closed landfill

Appendix G – Outfalls

Birch Stream Outfalls

N
W E
S

0 50 100 200 Feet

August 2014

City of Bangor Maine
www.bangormaine.gov

Birch Stream Outfalls

N
W E
S

0 50 100 200 Feet

August 2014

City of Bangor Maine
www.bangormaine.gov

Birch Stream Outfalls

N
W E
S

0 5 10 20 Feet

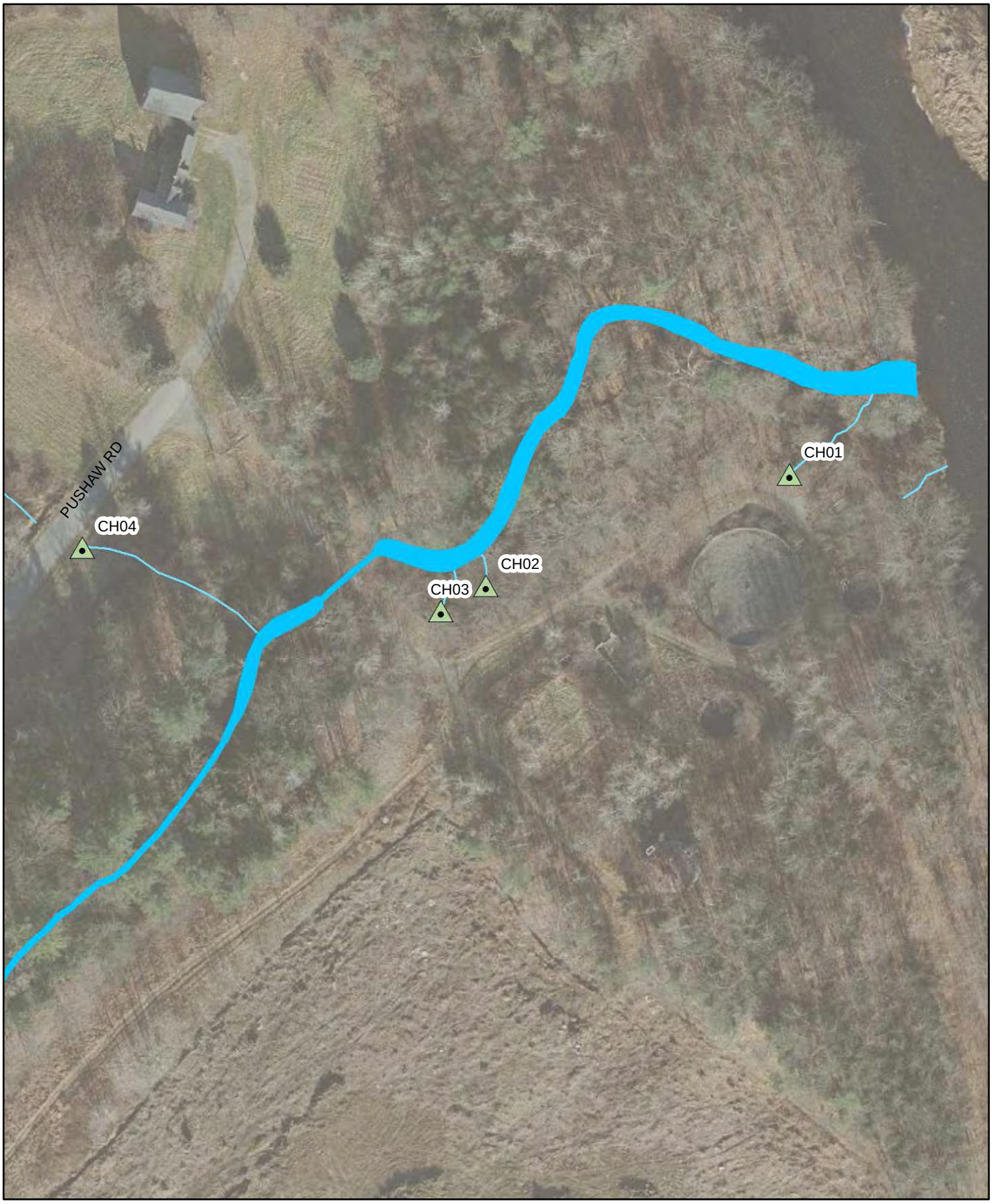
August 2014

City of Bangor Maine
www.bangormaine.gov

Birch Stream Outfalls

Outfall ID	*Material*	*Size (in)*	*Comment*	*Fed From*	*City Maintained*	*Inspection*	*Testing*	*Comments*
BR01	DITCH	NA		GRIFFIN RD DITCH	Y	5/8/2014	N	
BR02	RCP	36	DW FLOW	OHIO ST DRAIN SYSTEM	Y	5/8/2014	Y	27 col/100 ml E. coli; pipe repair needed; emailed DPW 5/12/14, repaired 6/4/14
BR03	DITCH	NA		OHIO ST DITCH	Y	5/8/2014	N	
BR04	CMP	15		GRIFFIN PARK	N	5/9/2014	N	
BR05	CMP	15		GRIFFIN PARK	N	5/9/2014	N	
BR06	CMP	15		GRIFFIN PARK	N	5/9/2014	N	dry channel; no evidence of recent flow
BR07	DITCH	NA		NORTHGATE	N	5/9/2014	N	
BR08	PVC	4		UNKNOWN	N	5/9/2014	N	
BR09	CMP	36	DW FLOW	AIRPORT MALL CATCHBASIN	N	5/9/2014	Y	0 col/100 ml E. coli
BR10	RCP	66X88	3 CHANNEL BOX	BIA CANAL	Y	5/9/2014	N	head of Birch Stream; fermentation odor, staining from de-icing fluids; sampled for other programs
BR11	CMP	24		AIRPORT MALL CATCHBASIN	N	5/9/2014	N	
BR12	PVC	4		UNKNOWN	N	5/9/2014	N	

Capehart Brook Outfalls



N
W E
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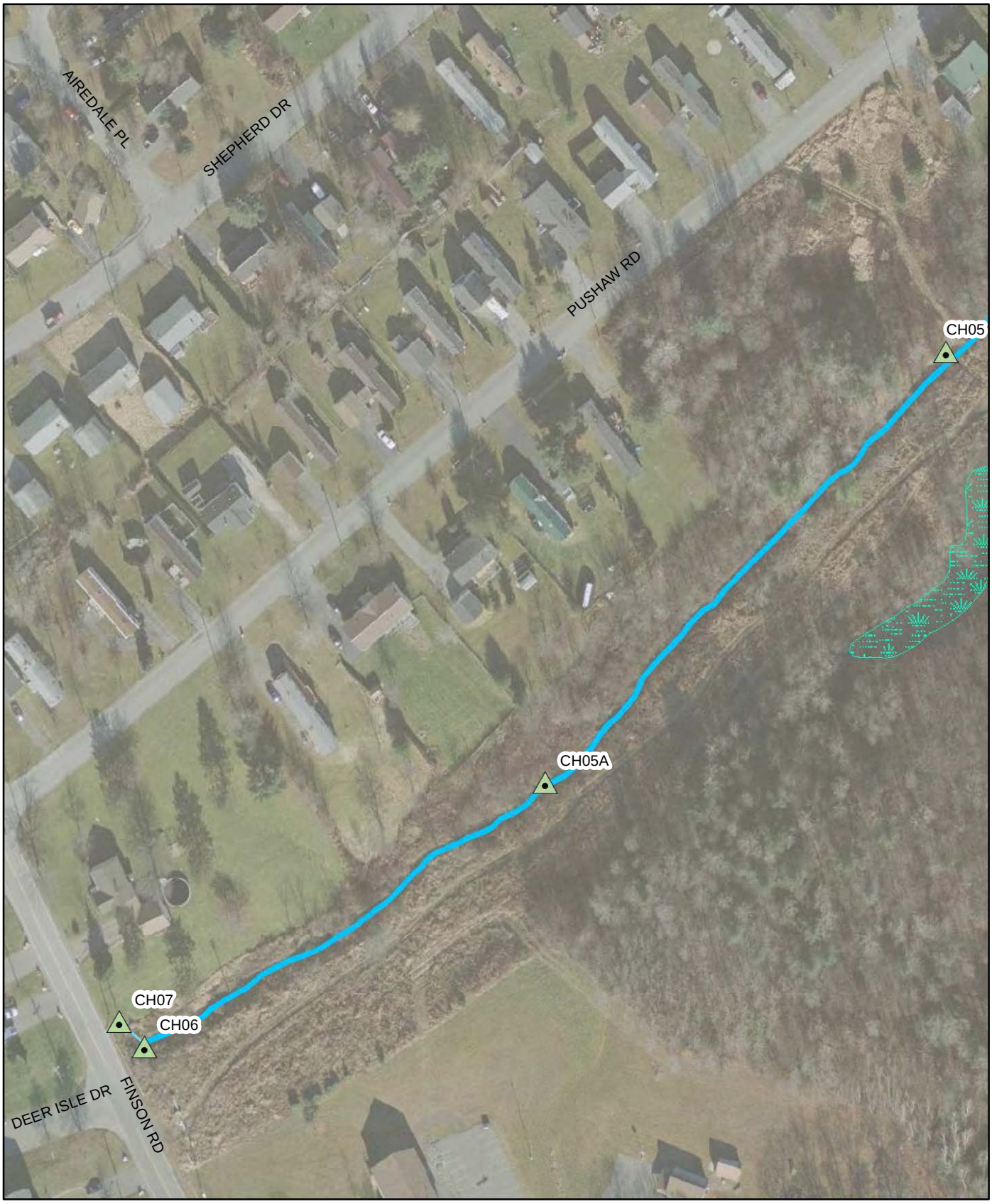
0 50 100 200 Feet

August 2014

City of Bangor Maine
www.bangormaine.gov

Capehart Brook Outfalls



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0 62.5 125 250 Feet

August 2014

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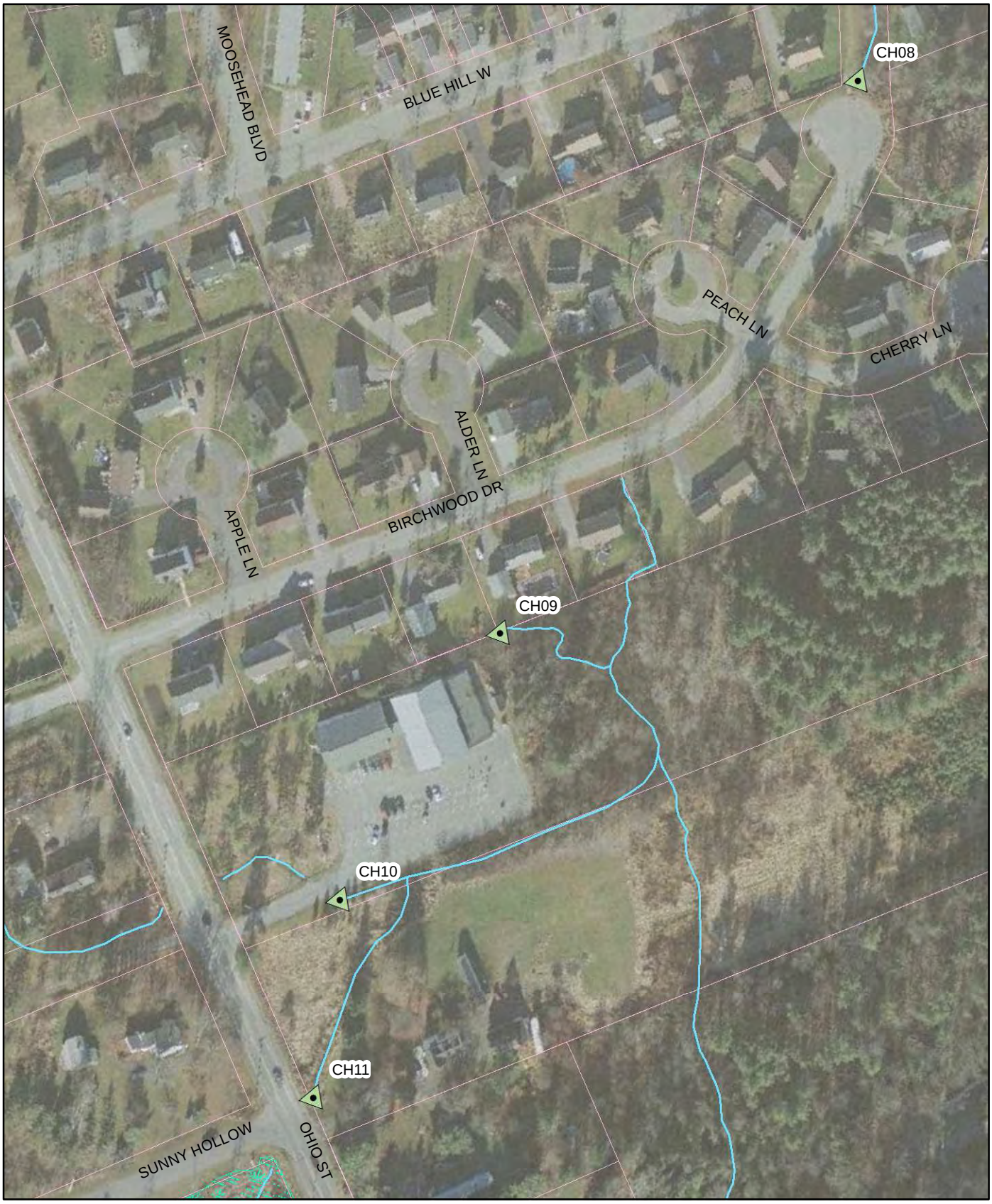
Capehart Brook Outfalls



N
W E
S

0 80 160 320 Feet

August 2014

City of Bangor Maine
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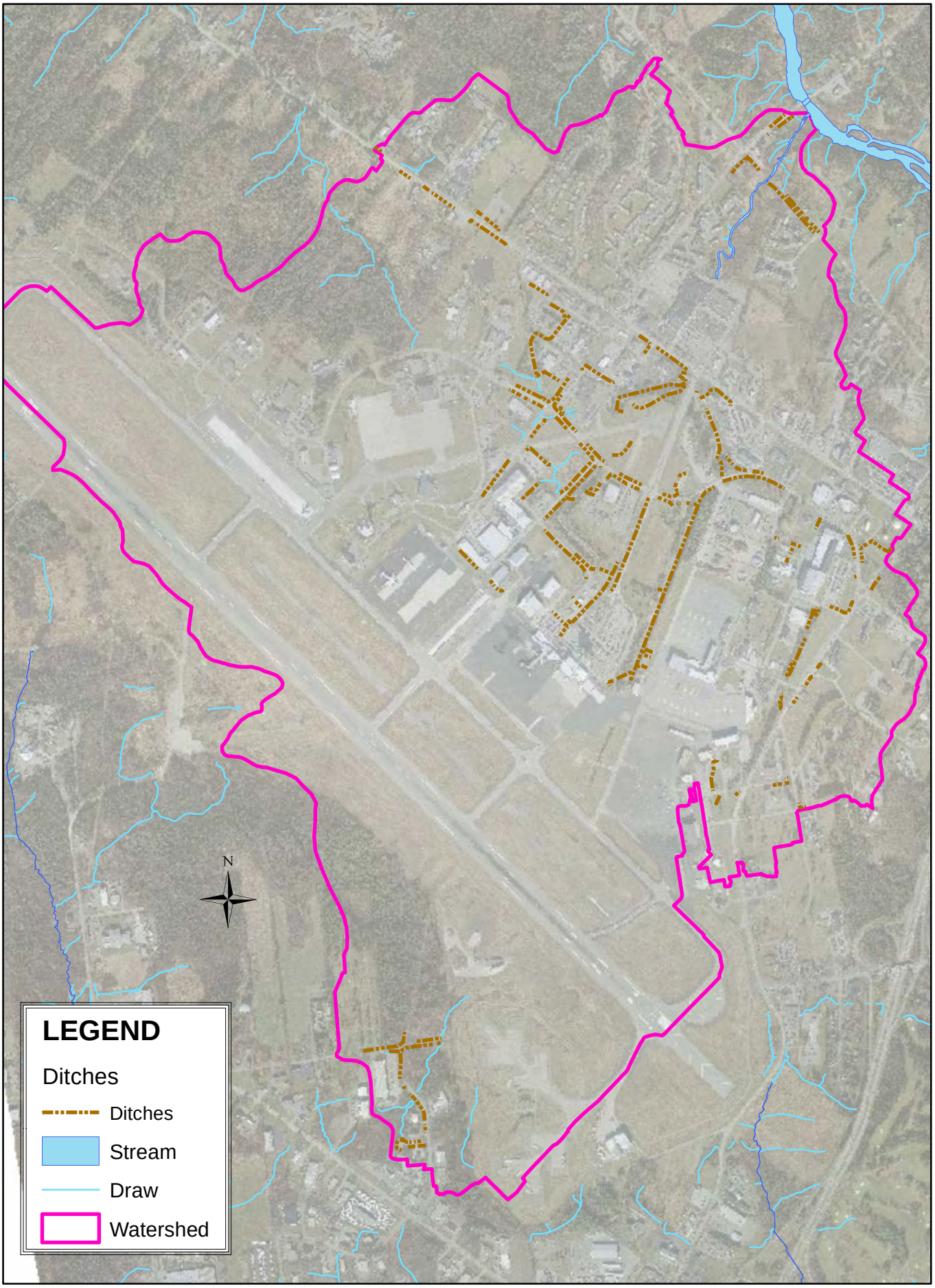
Capehart Brook Outfalls

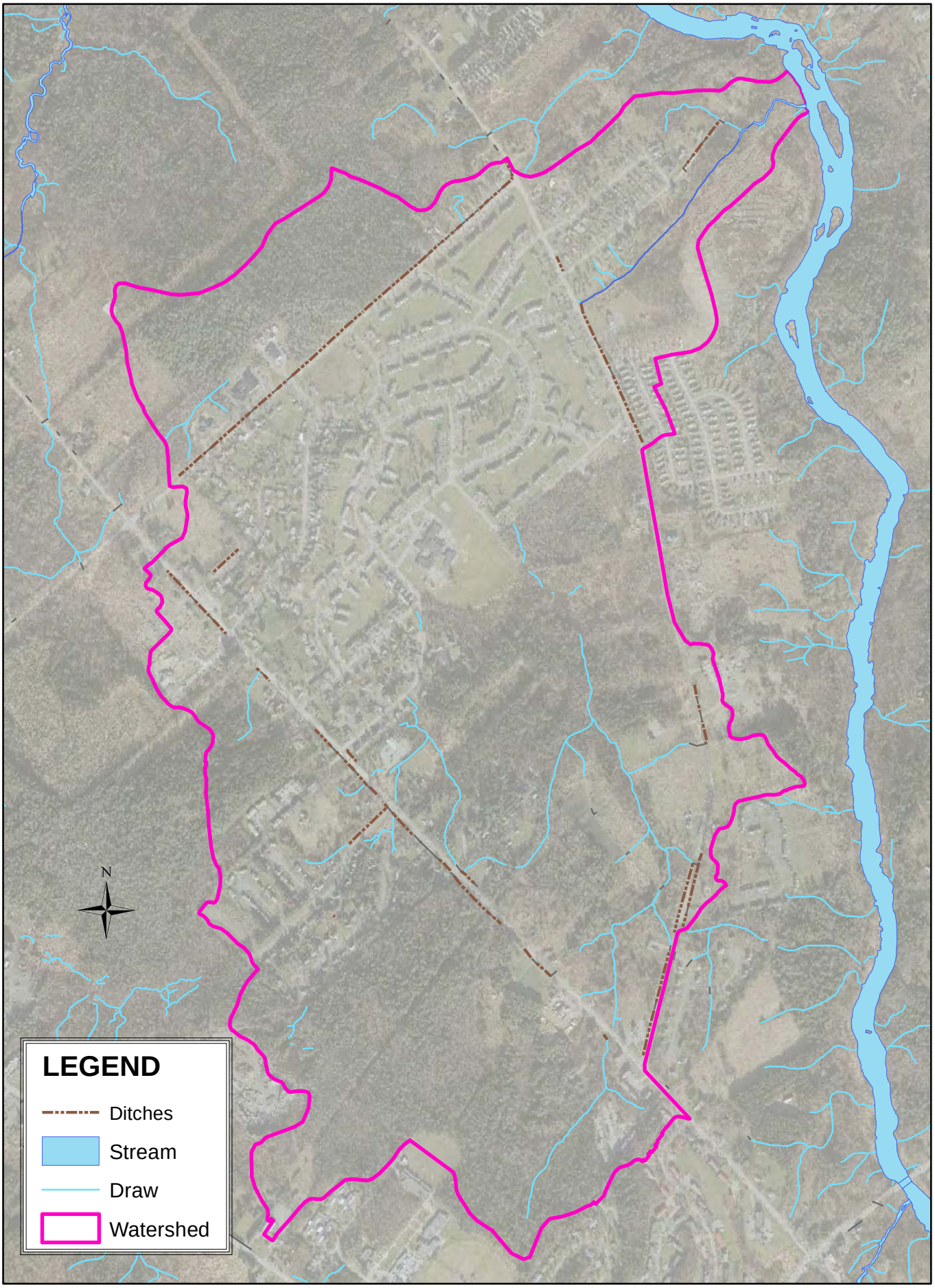
Outfall ID	*Material*	*Size (in)*	*Comment*	*Fed From*	*City Maintained*	*Inspection*	*Testing*	*Comments*
CH01	DITCH	NA		OLD CAPEHART WWTP	N	5/30/2014	N	
CH02	CMP	24	DW FLOW	OLD CAPEHART WWTP	N	5/30/2014	Y	10 col/100 ml E.coli; mildew odor
CH03	RCP	18	DW FLOW	OLD CAPEHART WWTP	N	5/30/2014	Y	non-detect Bacteroides
CH04	CMP	UNK		CULVERT	Y	5/30/2014	Y	rusted and collapsed; should be replaced with rip rap at discharge
CH05	CMP	35		PUSHAW RD DRAINAGE	Y	5/30/2014	N	
CH05A	UNK	UNK	DW FLOW	UNKNOWN	N	5/30/2014	Y	0 col/100 ml E. coli;flows underground
CH06	DITCH	NA		FINSON RD DRAINAGE	Y	5/30/2014	N	
CH07	CMP	18	DW FLOW	FINSON RD/DAVIS RD DRAINAGE	Y	5/30/2014	Y	5 col/100 ml E. coli
CH08	DITCH	NA		LAWN DRAINAGE BEHIND HOUSES	Y	5/30/2014	N	
CH09	DITCH	NA		LAWN DRAINAGE BEHIND HOUSES	N	5/30/2014	N	
CH10	HDPE	18		SABLE RIDGE DETENTION POND	N	5/30/2014	N	collapsed at end, should be repaired
CH11	RCP	24	DW FLOW	SUNNY HOLLOW DETENTION POND	Y	5/30/2014	N	head of Capehart Brook; subject of DEP sampling

Appendix H – Ditch Inspection Maps

Birch Stream Watershed MS4 ditches surveyed April 2014 for PY 1



Capehart Watershed MS4 ditches surveyed April 2014 for PY 1



Appendix I – Ditch Inspection Follow-up

INTEROFFICE MEMORANDUM

TO: Jeremy Martin, Code Enforcement
FROM: Peralie Burbank, Engineering
SUBJECT: IDDE ditch inspection follow-up for Capehart Brook and Birch Stream Watersheds
DATE: June 6, 2014
CC: Brad Moore, Wynne Guglielmo

As part of the MS4 permit requirements, the City must verify that pipes discharging to the MS4 convey stormwater or allowable non-stormwater discharges. I have attached pages 18 and 19 of the MS4 permit that list the allowable discharges. During our field inspections in April, we noted the pipes from unknown sources.

Please check your records or investigate these locations in person as necessary to determine the sources and verify that the pipes convey allowable discharges. Verification needs to be completed and documented before June 30, the end of the permit year.

Let me know if you need further information. Thank you for helping the City comply with the MS4 permit requirements.

Pipe at 830 Finson Road.

Pipe discharging directly into Capehart Brook at end of Birchwood Avenue. Newly constructed house nearby.

House at 47 Birchwood Avenue has three pipes discharging directly into Capehart Brook. Two appear to be roof drains (allowable), the other is from an unknown source. The height above ground suggests this third pipe might be from a non-allowable source.

Hose entering culvert in front of Carden Kennels at 880 Ohio Street.

INTEROFFICE MEMORANDUM

TO: Jeremy Martin, Code Enforcement
FROM: Peralie Burbank, Engineering
SUBJECT: MS4 construction site concerns
DATE: April 11, 2014
CC: Brad Moore, WWTP Superintendent

During the MS4 ditch inspections yesterday we noted two construction sites and one post-construction BMP site requiring enforcement. Please follow-up on these and let me know the results so I can add them to the record.

1. The three-lot Pray subdivision on Pushaw Road (off Finson Rd) does not have any mulch in place. There is mud on the site that could enter the MS4. This site was visited by Brenda in Code Enforcement a year ago. Subsequent inspections in the past year have shown the site to be in compliance with erosion and sediment control. The contractor's name, according to our inspection records, is Higgins.

2. The new house in the Moyse subdivision on Davis Road, near the corner of Ohio Street, has no mulch on the lawn. There are significant rills on the sloped lawn, and sediment has reached the ditches. There is also a silt fence that has been undermined allowing silt to enter the wetland near the road. This site is in violation of the erosion and sediment control regulations. According to the sign at the site, the contractor is D&D Construction in Hermon. The phone number is 848-2784.

3. The stormwater pond at the corner of Wellesley Way and Brighton Avenue has eroding banks. This pond outlets directly to the City's MS4, so it must be repaired to prevent sediment from entering our system. The pond is labeled as Stormwater Treatment Pond 1B on the plans. The required O&M plan for stormwater structures should include information about repairing side slopes if needed.

Thanks for taking care of these issues.

Appendix J – Catch Basin Inspection Follow-up

Birch Stream Watershed – CB Inspection Follow-up Worksheet

CB ID	Street	Date Insp	Issue	Follow up
E03-3007	Airport	6/24/14	Perforated man hole cover	DPW to replace
E03-3013	Airport	6/24/14	Uncover	Additional field work required
F03-3077	Airport	6/24/14	Replaced by trench drain?	Additional field work required
F04-3030	Maine Ave & Aviation Dr	6/19/14	Perforted sewer manhole cover	DPW to replace
G03-3012	Airport	6/24/14	Collapsing	DPW to repair
G03-3028	Airport	6/24/14	3 labels, 1 manhole. Potential ID	gw intrustion - no sewer in vicinity
~~G03-3029~~	~~Airport~~	~~6/24/14~~	~~3 labels, 1 manhole. Potential ID~~	duplicate - deleted in GIS
~~G03-3029A~~	~~Airport~~	~~6/24/14~~	~~3 labels, 1 manhole. Potential ID~~	duplicate - deleted in GIS
G03-3041	Airport	6/24/14	Possible food waste draining. Video and PIC 001-003 (6/24/14)	reported to Airport Env staff
G03-3043	Godfrey Blvd	6/24/14	Collapsing manhole, will be repaired this season	DPW to repair
G03-3052	Airport	6/24/14	trench needs pumping, oil sheen present, Potential ID	needs cleaning - reported to airport staff
G04-3005	Airport, Gen Aviation	6/19/14	Close to oil tank, needs to be moved	working with tenant for secondary containment
G04-3010	Airport, Gen Aviation	6/19/14	Potential ID, Picture 007 and 008 + movie (6/19/14)	POTENTIAL ILLICIT DISCHARGE
G04-3039	Hayes St	6/17/14	Flow, potential ID	Additional field work to verify mapping
G04-3056	Hayes St	6/17/14	Potential ID, flow after 96 hrs w/out rain, needs to be lowered	DPW to repair
G04-3070	Airport	6/17/14	Has flow, potential ID	adjacent sewer has grease deposits
G04-3071	ANG Property	6/17/14	Has flow, potential ID	underdrain from building - ok
G04-3081	Johnson St.	6/17/14	Erosion issues, uncover	DPW to repair
H02-3020	Airport	6/24/14	Flow, trough carrying water. Potential ID Whiskey Ramp	possible petroleum from ANG base
H03-3030	Utah Ave	6/17/14	Flow, potential ID	collects from underdrains - ok
H03-3031	LL Bean Call Ctr pkg lot	6/17/14	Heavy flow, potential ID	collects from several CBs in lot - ok
H03-3047	Maine Ave & Godfrey Blvd	6/17/14	Strong flow, potential ID	collects from several sources - ok
H04-3038	Airport	6/17/14	Strong flow after 96 hours w/out rain	Additional field work required to verify inlet source
H04-3066	Union St	6/17/14	Covered by buses	Additional field work required
H04-3081	Union St	6/19/14	Could not locate- covered by skate park?	Additional field work required
H04-3093	Godfrey Blvd	6/19/14	Needs to be fixed	DPW to repair
I03-3008	Illinois Ave	6/19/14	Potential ID, Pic 003 + 004 (6/19) Water appears to be seeping up from ground	natural flow path shown on plans - ok
J03-3028	Union St	6/19/14	Baseball field covered, sand piles	Additional field work required
J03-3033	Randolph Ln	6/17/14	Perforated sewer manhole cover	DPW to replace
J04-3040	Bolling Dr	6/17/14	Heavy flow, potential ID	gw intrusion but sewer being replaced
J04-3047	Bolling Dr	6/17/14	Heavy flow, potential ID	gw intrusion but sewer being replaced
J04-3087	Bolling Dr	6/17/14	Needs to be lowered	DPW to repair

Capehart Brook Watershed – CB Inspection Follow-up Worksheet

CB ID	Street	Date Insp	Issue	Follow up
L03-3004	42 Doe Drive	6/6/2014	bleeder valve; chlorine present	turned off - BWD will relocate
K04-3011	Ohio St	6/6/2014	petroleum odor	test with PID
L03-3005	33 Fawn Ct	6/6/2014	raised, needs to be lowered	DPW to repair
L03-3006	22 Fawn Ct	6/6/2014	raised, needs to be lowered	DPW to repair
L03-3007B	Fawn Ct	6/6/2014	drainage problems	DPW to pump and investigate
L03-3009	Dana Dr	6/6/2014	drainage problems	DPW to pump and investigate
L03-3023	20 Birch Rd	6/6/2014	potential ID	field verify source of pipe
L03-3036	Cherry Ln	6/6/2014	foam, bubbles	field verify source of pipe
M03-3010	Blue Hill W	6/6/2014	potential ID, sewage odor	POTENTIAL ILLICIT DISCHARGE
M03-3019	Moosehead Blvd	6/6/2014	raised, needs to be lowered	DPW to repair
M03-3035	Moosehead Blvd	6/6/2014	raised, needs to be lowered	DPW to repair
M03-3060	Sugarloaf Ln	6/10/2014	potential ID	field verify source of pipe
M03-3065	Mt Desert Drive	6/10/2014	raised, needs to be lowered	DPW to repair
M03-3092	Downeast Circle	6/10/2014	erosion issues, Picture 009	DPW to repair
M04-3000	Ft Knox / Blue Hill E	6/10/2014	potential ID, possible sewer flow from drainage pipe	POTENTIAL ILLICIT DISCHARGE
M04-3010	Ft Knox / Moosehead	6/10/2014	18" elbow, potential IDDE	POTENTIAL ILLICIT DISCHARGE
M04-3039	Deer Isle Dr	6/6/2014	drainage problems, Picture 015	DPW to pump and investigate
N03-3009	Davis Rd	6/6/2014	Picture 005 + 006, potential ID	POTENTIAL ILLICIT DISCHARGE
N03-3010	Davis Rd	6/6/2014	Picture 003 + 004, potential ID	POTENTIAL ILLICIT DISCHARGE
N04-3005	Moosehead / Deer Isle	6/6/2014	foam	POTENTIAL ILLICIT DISCHARGE
N04-3014	Deer Isle Dr	6/6/2014	picture 007, smell (potential ID)	POTENTIAL ILLICIT DISCHARGE
N04-3021	Acadia Pl	6/5/2014	improve drainage, Picture 002	DPW to pump and investigate
N04-3022	Acadia Pl	6/5/2014	smell, potential ID	POTENTIAL ILLICIT DISCHARGE

Appendix K – IDDE Water Quality Sampling

IDDE Water Quality Sampling in Permit Year 1 (2013-2014)

Location	*Sample Location*	*Date*	*Done by*	*E. coli (col/100mL)*	*Human Bact. (CEs/100mL)*	*Comments*
Birch Stream	BR-04	7/8/2013	EPA	1,300	-----	
Birch Stream	BRBBHYD	7/8/2013	EPA	687	-----	
Birch Stream	BR-04	2/25/2014	EMSL	-----	988	
Birch Stream	BRBBHYD	3/25/2014	EMSL	-----	115	
Birch Stream	BR02	5/9/2014	City	27	-----	
Birch Stream	BR 16	5/9/2014	City	0	-----	
Capehart Brook	CB-01	7/8/2013	EPA	2,620	-----	
Capehart Brook	CB-01A	2/25/2014	EMSL	-----	2,625	
Capehart Brook	CB-01A	4/3/2014	City	5,900	-----	
Capehart Brook	CB-03	4/3/2014	City	1,900	-----	
Capehart Brook	CB-02	4/7/2014	City	10	-----	
Capehart Brook	CB-03A	4/7/2014	City	0	-----	unmapped outfall with flow
Capehart Brook	CB-03 CH05	4/7/2014	City	114	-----	under Finson Road
Capehart Brook	CB-03 CH07	4/7/2014	City	5	-----	side of Finson Rd
Capehart Brook	CH03	6/5/2014	EMSL	-----	Non Detect	
Kenduskeag Outfall	CSO 11	7/9/2013	City	541 & 821	-----	
Kenduskeag Outfall	CSO 11	7/9/2013	EPA	687	-----	
Kenduskeag Outfall	CSO 11	12/5/2013	City	291		
Kenduskeag Outfall	CSO 11	3/25/2014	EMSL	-----	6,537	
Kenduskeag Outfall	CSO 11	5/1/2014	City	582 & 540	-----	
Kenduskeag Outfall	CSO 11	5/14/2014	City	118	-----	
Kenduskeag Outfall	CSO 11	5/20/2014	City	155 & 213	-----	
Kenduskeag Outfall	CSO 11	5/27/2014	EMSL	-----	233	after Market St cap
Kenduskeag Outfall	CSO 11	6/2/2014	City	641	-----	
Kenduskeag Outfall	CSO 11	6/11/2014	City	124	-----	
Kenduskeag Outfall	CSO 11	6/14/2014	City	727	-----	
Kenduskeag Outfall	CSO 11	7/30/2014	City	602 & 711	-----	after Bangor Tire cap
Mt. Pleasant Cem.	Mt. Pleasant Cem.	5/20/2014	City	272	-----	
Mt. Pleasant Cem.	K-TRIB	5/27/2014	City	299 & 172	-----	
Mt. Pleasant Cem.	K-TRIB	5/27/2014	EMSL	-----	128	
Mt. Pleasant Cem.	G05-4038	6/14/2014	EMSL	-----	Non Detect	
Penjajawoc	PJ-2-3	7/8/2013	EPA	1,300	-----	
Penjajawoc	PJ-2-3	2/25/2014	EMSL	-----	Non Detect	
Penjajawoc	outfall to Penobscot	6/30/2014	City	236	-----	
Penjajawoc	Evergreen Wds pipe	7/1/2014	City	0	-----	

Appendix L – Construction Inspections

MS4 ~ Construction Inspections by Date

Site ID	Insp Date	Inspector	First Insp	Sec Insp	Follow-up	Final Insp	Corrective Actions
2013-001	8/14/2013	Guglielmo	✓				
2013-002	8/14/2013	Burbank	✓				
2013-003	8/14/2013	Burbank	✓				✓
2013-004	8/14/2013	Burbank	✓				
2013-007	8/14/2013	Burbank	✓				
2013-008	8/14/2013	Burbank		✓			✓
2013-010	8/14/2013	Burbank	✓				
2013-011	8/14/2013	Burbank	✓				✓
2013-014	8/14/2013	Burbank	✓				✓
2013-029	8/14/2013	Burbank	✓				✓
2013-002	8/15/2013	Allen				✓	
2013-008	8/15/2013	Guglielmo			✓		✓
2013-011	8/15/2013	Guglielmo			✓		
2013-029	8/15/2013	Guglielmo			✓		✓
2013-008	8/19/2013	Burbank			✓		✓
2013-011	8/19/2013	Burbank			✓		
2013-029	8/19/2013	Guglielmo			✓		✓
2013-029	8/20/2013	Guglielmo			✓		✓
2013-029	8/21/2013	Guglielmo			✓		✓
2013-005	9/3/2013	Guglielmo	✓				
2013-009	9/3/2013	Guglielmo	✓				
2013-013	9/3/2013	Guglielmo	✓				✓
2013-027	9/3/2013	Guglielmo	✓				
2013-029	9/3/2013	Guglielmo			✓		✓

Site ID	Insp Date	Inspector	First Insp	Sec Insp	Follow-up	Final Insp	Corrective Actions
2013-011	9/23/2013	Guglielmo			✓		✓
2013-023	9/30/2013	Guglielmo	✓		✓		✓
2013-001	10/7/2013	Guglielmo		✓			✓
2013-016	10/7/2013	Guglielmo	✓				
2013-018	10/7/2013	Guglielmo	✓				
2013-021	10/7/2013	Guglielmo	✓				
2013-008	11/1/2013	Guglielmo				✓	
2013-010	11/1/2013	Guglielmo				✓	
2013-011	11/1/2013	Guglielmo			✓		
2013-016	11/1/2013	Guglielmo		✓			
2013-017	11/1/2013	Guglielmo	✓				✓
2013-018	11/1/2013	Guglielmo		✓			✓
2013-023	11/1/2013	Guglielmo	✓				
2013-003	11/4/2013	Guglielmo		✓			✓
2013-004	11/4/2013	Guglielmo		✓			
2013-005	11/4/2013	Guglielmo				✓	
2013-007	11/4/2013	Guglielmo		✓		✓	
2013-009	11/4/2013	Guglielmo		✓			
2013-012	11/4/2013	Guglielmo	✓				✓
2013-013	11/4/2013	Guglielmo		✓			✓
2013-021	11/4/2013	Guglielmo		✓			
2013-025	11/4/2013	Guglielmo	✓				
2013-026	11/5/2013	Guglielmo	✓				
2013-029	11/5/2013	Allen		✓			✓
2013-022	11/7/2013	Guglielmo	✓				
2013-011	11/13/2013	Guglielmo				✓	

Site ID	Insp Date	Inspector	First Insp	Sec Insp	Follow-up	Final Insp	Corrective Actions
2013-022	11/13/2013	Guglielmo		✓			✓
2013-029	11/15/2013	Guglielmo			✓		✓
2013-017	12/10/2013	Guglielmo		✓			
2013-015	1/10/2014	Martin	✓				
2013-015	1/15/2014	Guglielmo		✓			
2013-023	1/15/2014	Guglielmo			✓		✓
2013-025	1/15/2014	Guglielmo		✓			✓
2013-009	1/16/2014	Guglielmo				✓	
2013-019	1/16/2014	Guglielmo	✓				✓
2013-028	1/16/2014	Guglielmo	✓				
2014-015	1/16/2014	Guglielmo	✓				
2013-001	1/28/2014	Guglielmo				✓	✓
2013-004	1/28/2014	Guglielmo				✓	
2013-006	1/28/2014	Guglielmo				✓	
2013-020	1/28/2014	Guglielmo	✓				✓
2013-003	1/29/2014	Guglielmo				✓	
2013-012	1/29/2014	Guglielmo				✓	
2013-013	1/29/2014	Guglielmo				✓	
2013-014	1/29/2014	Guglielmo				✓	
2013-015	1/29/2014	Guglielmo				✓	
2013-016	1/29/2014	Guglielmo				✓	
2013-017	1/29/2014	Guglielmo				✓	
2013-018	1/29/2014	Guglielmo				✓	
2013-019	1/29/2014	Guglielmo			✓		
2013-022	1/29/2014	Guglielmo				✓	
2013-024	1/29/2014	Guglielmo	✓				

Site ID	Insp Date	Inspector	First Insp	Sec Insp	Follow-up	Final Insp	Corrective Actions
2013-025	1/29/2014	Guglielmo			✓		✓
2014-003	1/31/2014	Guglielmo	✓				✓
2014-009	1/31/2014	Guglielmo	✓				✓
2013-023	2/11/2014	Allen		✓			✓
2014-002	2/25/2014	Guglielmo	✓				✓
2014-008	3/5/2014	Guglielmo	✓				✓
2013-020	3/7/2014	Guglielmo		✓			✓
2014-001	3/7/2014	Guglielmo	✓				
2014-002	3/7/2014	Guglielmo			✓		✓
2014-008	3/7/2014	Guglielmo		✓	✓		✓
2013-019	4/1/2014	Burbank		✓			
2013-023	4/1/2014	Burbank			✓		
2013-024	4/1/2014	Burbank		✓			
2013-025	4/1/2014	Burbank			✓		✓
2013-029	4/1/2014	Burbank			✓		✓
2014-002	4/1/2014	Burbank		✓			
2014-009	4/1/2014	Burbank		✓			
2014-002	4/2/2014	Burbank			✓		✓
2013-006	4/10/2014	Burbank			✓		✓
2013-013	4/10/2014	Burbank			✓		✓
2014-003	4/10/2014	Guglielmo		✓			✓
2013-023	4/22/2014	Guglielmo			✓		
2013-025	4/22/2014	Burbank			✓		✓
2013-027	4/22/2014	Burbank		✓			
2013-029	4/22/2014	Burbank			✓		✓
2014-006	4/22/2014	Burbank	✓				✓

Site ID	Insp Date	Inspector	First Insp	Sec Insp	Follow-up	Final Insp	Corrective Actions
2014-008	4/22/2014	Burbank			✓		✓
2014-009	4/28/2014	Guglielmo			✓		✓
2013-026	5/2/2014	Guglielmo			✓		✓
2014-007	5/13/2014	Guglielmo	✓				✓
2014-016	5/13/2014	Guglielmo	✓				✓
2014-017	5/13/2014	Guglielmo	✓				
2014-019	5/13/2014	Guglielmo	✓				
2014-020	5/13/2014	Guglielmo	✓				
2014-021	5/13/2014	Guglielmo	✓				
2014-005	5/14/2014	Guglielmo	✓				✓
2014-015	5/14/2014	Guglielmo	✓				✓
2014-020	5/14/2014	Guglielmo			✓		✓
2014-004	5/15/2014	Guglielmo	✓				✓
2014-016	5/19/2014	Guglielmo		✓			✓
2014-016	5/20/2014	Guglielmo			✓		✓
2014-004	5/21/2014			✓			✓
2014-004	6/10/2014	Guglielmo			✓		✓
2014-005	6/10/2014	Guglielmo		✓			✓
2014-016	6/10/2014	Guglielmo		✓			✓
2014-021	6/10/2014	Guglielmo		✓			
2014-023	6/10/2014	Guglielmo	✓				✓
2014-024	6/10/2014	Guglielmo	✓				
2014-025	6/10/2014	Guglielmo	✓				✓
2014-027	6/10/2014	Guglielmo	✓				✓
2014-026	6/11/2014	Guglielmo	✓				
2014-028	6/11/2014	Guglielmo	✓				✓

Site ID	Insp Date	Inspector	First Insp	Sec Insp	Follow-up	Final Insp	Corrective Actions
2013-019	6/25/2014	Guglielmo				✓	
2013-020	6/25/2014	Guglielmo			✓		✓
2013-024	6/25/2014	Guglielmo				✓	
2013-025	6/25/2014	Guglielmo				✓	
2014-001	6/25/2014	Guglielmo		✓			✓
2014-004	6/25/2014	Guglielmo			✓		✓
2014-006	6/25/2014	Guglielmo		✓			✓
2014-007	6/25/2014	Guglielmo		✓			
2014-008	6/25/2014	Guglielmo			✓		✓
2014-022	6/25/2014	Guglielmo			✓		✓
2014-002	6/26/2014	Guglielmo		✓			✓
2014-025	6/26/2014	Burbank		✓			✓
2014-027	6/26/2014	Burbank		✓			✓
2014-012	6/30/2014	Guglielmo	✓				✓
2014-015	6/30/2014	Guglielmo		✓			✓
2014-020	6/30/2014	Guglielmo		✓			✓
2014-029	6/30/2014	Guglielmo	✓				✓
2014-010	7/1/2014	Guglielmo	✓				✓
2014-016	7/1/2014	Guglielmo		✓			
2013-023	7/15/2014	Burbank			✓		✓
2014-004	7/25/2014	Martin			✓		✓

Appendix M – Construction Sites Referred to Code Enforcement

MS4 ~ Construction Sites Referred to Code Enforcement

Site ID	Site Name/Project	Address	Watershed	Construction Complete
2013-001	Epstein Properties	878 Stillwater Ave	Penjajawoc	☑
2013-006	Pray on Pushaw Rd	59-71 Pushaw Rd	Capehart	☑
2013-008	Stillwater Crossing	461 Stillwater Avenue	Penjajawoc	☑
2013-011	Pilgrim Orthodox Presbyterian Church	375 Mount Hope Avenue	Penobscot	☑
2013-013	Moyse subdivision	Davis Road	Other	☑
2013-017	Dunbar & Brawn	203 Hildreth St	Shaw	☑
2013-020	residence	649v Essex Street	Kenduskeag	☐
2013-023	Hardy Associates-Dowd	45C Dowd Rd	Sucker	☐
2013-025	Spekhardt Dental	70 Corporate Dr	Sucker	☑
2013-026	EMMC tower	489 State St	Penobscot	☐
2013-029	Meadowbrook Ridge Condominiums-Phase 3	35-40 Primrose Place, Camden Court	Penjajawoc	☐
2014-002	Leadbetters	1049 and 1097 Broadway	Kenduskeag	☐
2014-005	Bangor Cinema/ERG Realty	557 Stillwater Ave	Penjajawoc	☐
2014-008	Cross Insurance Center stormwater	off Dutton Street	Penobscot	☑
2014-025	residence	482 Rolling Meadow Drive	Penjajawoc	☐
2014-027	residence	210v Virginia Lane	Penjajawoc	☐