Barberry Creek Total Maximum Daily Load (TMDL)

Above Broadway (~1/4 mile), July 2003

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July 2006
Report # DEPLW0172

TABLE OF CONTENTS

PART I: WATERBODY DESCRIPTION, IMPAIRMENTS, TMDL TARGET, AND BMP IMPLEMENTATION RECOMMENDATIONS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

PART II: TMDL PLAN

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS USED

BMP	Best Management Practice
CCC	Criteria Chronic Concentration (for toxic contaminants)
CMC	Criteria Maximum Concentration(for toxic contaminants)
CSO	Combined Sewer Overflow
CWP	Center for Watershed Protection
ENSR	ENSR Corporation
GIS	Geographic Information System
IC	Impervious Cover
LA	Load Allocation
MDEP	Maine Department of Environmental Protection
MRSA	Maine Revised Statutes Annotated
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
PETE	Partnership for Environmental Technology Education
SI	Stressor Identification
SWAT	Surface Water Ambient Toxics
SWQC	(Maine's) Statewide Water Quality Criteria
TMDL	Total Maximum Daily Load
US EPA	U.S. Environmental Protection Agency
WLA	Waste Load Allocation

PART I: WATERBODY DESCRIPTON, IMPAIRMENTS, TMDL TARGET, AND BMP IMPLEMENTATION RECOMMENDATIONS

1. DESCRIPTION OF WATERBODY

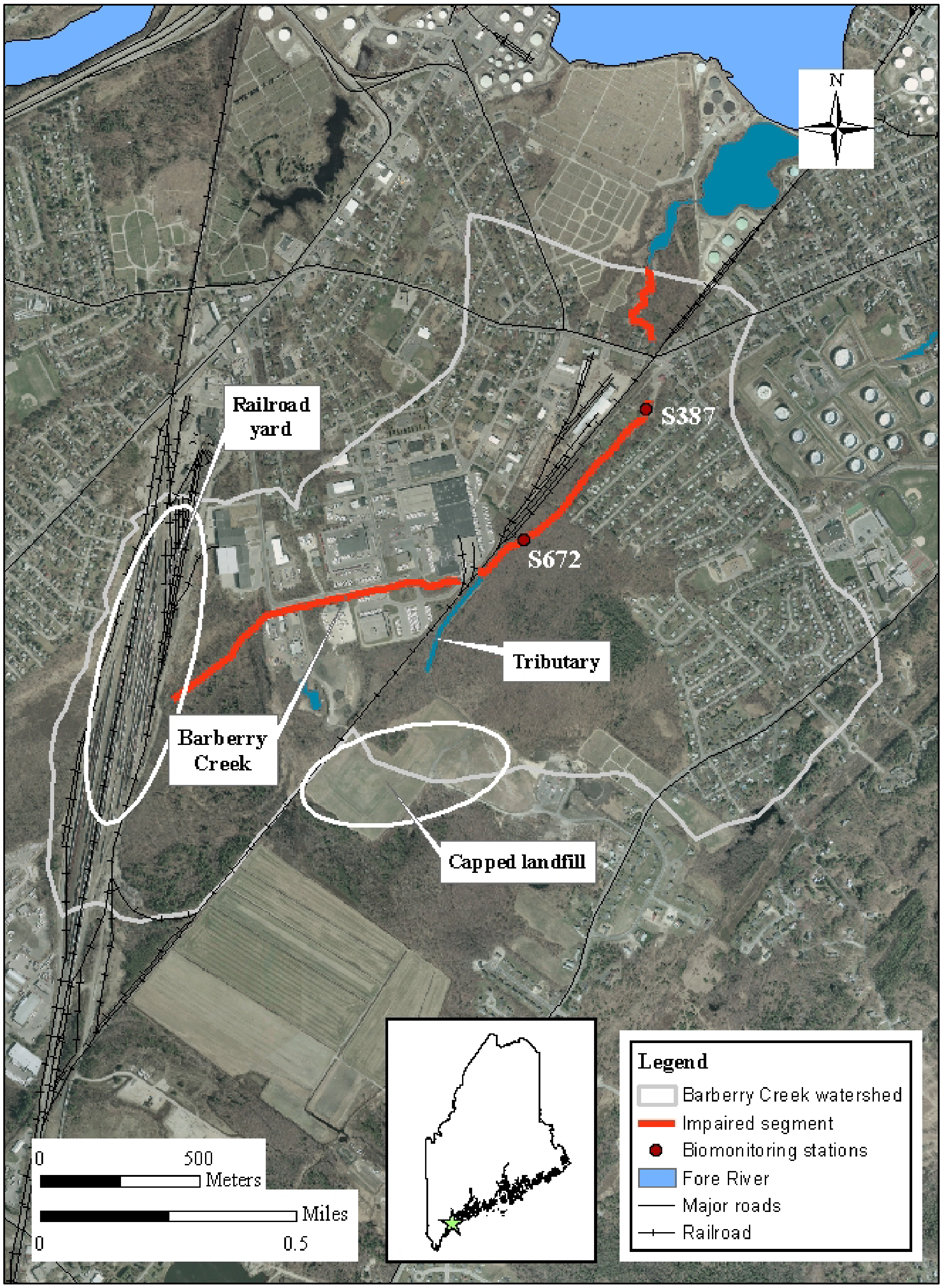
Description of Waterbody and Watershed

Barberry Creek (Fig. 1) is located in South Portland (southern Maine, 43°37'N, 70°17'W, HUC ME0106000105), and is of moderate length (~1.3 miles) and watershed size (786 acres). The stream originates in a wetland transected by a multi-track railway line (Springfield Terminal Railroad) and the Maine Central Railroad Rigby Yard. Below the wetland, the stream flows through a heavily industrialized area into a wooded area with a capped landfill, and then into a residential area and another wetland before flowing through a dammed up pond into the estuarine Fore River. A small tributary that originates near the landfill joins Barberry Creek below the industrialized area. Appendix E contains a set of photos of the stream.

During summer baseflow conditions, the stream has a wetted width of 3-4 m and a bankfull width of 4-6 m; water depth is generally 5-8 cm with a few deeper areas. The majority of the stream was channelized in the past, resulting in an overwidened channel with little sinuosity. The stream substrate is variable, ranging from 100 % sand and silt in the upper part of the watershed, to a mixture of sand (50-55 %), gravel (35-40 %), and silt and rubble (5 % each) in the central part, and bedrock outcrops in the lower part above the downstream wetland. The morphology of this low-gradient stream is a riffle-run system with some shallow pools. The riparian buffer along much of the stream consists of young trees with an understory of herbaceous plants and ferns, but in some areas invasive Japanese Knotweed (*Polygonum cuspidatum*), lawn, or roads have replaced a natural buffer.

The lower part of the watershed was first urbanized in the early 1900s and the upper part has become industrialized since the 1970s. On historic topographic maps, railway tracks can be seen paralleling the stream as early as 1891, and by 1923 the Rigby railway yard in the upper part of the watershed existed in essentially its present day configuration (Beneski 2000). The former South Portland municipal landfill, which was capped in 1998/1999, is located at the southeastern edge of the watershed (Fig. 1). The entire watershed is classified as a "regulated area" under the NPDES Phase II Stormwater Program.

Fig. 1. Barberry Creek watershed, impaired segment, and location of biomonitoring stations.



Note: Barberry Creek is culverted for ~200 m below S387 and hence is not visible as a stream in this area. The stream is also culverted and not visible upstream of where it crosses underneath the railroad tracks, upstream of S672.

Impaired Stream Segment

A 1.0 mile segment of Barberry Creek, which is classified as a Class C stream[1], was included in Maine's 2002 and 2004 303 (d) lists (MDEP 2002b, 2004b) of waters that do not meet State water quality standards. The listing was based on a preliminary stream assessment and sampling results from the Biological Monitoring Program of the Maine Department of Environmental Protection (MDEP; see next section). Additional data collected throughout the watershed in 2003 indicated that the entire stream (1.3 miles in length) is impaired (PETE/ MDEP 2005). As a result, this TDML covers the full stream length rather than a 1.0 mile segment (see Fig. 1).

2. DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS

Maine State Water Quality Standards

Water quality classification and water quality standards of all surface waters of the State of Maine have been established by the Maine Legislature (Title 38 MRSA 464-468). According to Maine's Water Classification Program, Barberry Creek is classified as Class C. Table 1 summarizes the water quality standards applicable to Barberry Creek. In order for a waterbody to attain its classification, all criteria must be met. The Maine Legislature also defined designated uses for all classified waters, which state that "Class C waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life."

Table 1. Maine water quality criteria for classification of Class C streams (38 MRSA § 465).

Numeric Criterion	
Dissolved Oxygen	5 ppm; 60% saturation
Statewide Water Quality Criteria (SWQC)	The chronic and maximum allowable instream values for specified toxic pollutants designated to protect uses specified in the Water Classification Program. Includes metals identified in NPS stormwater- Cadmium, Chromium, Copper, Lead and Zinc.
Narrative Criteria	
Habitat	Habitat for fish and other aquatic life
Aquatic Life (Biological)	Discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

[1] See Part II, section 2, Maine State Water Quality Standards for further explanation.

Through the use of macroinvertebrate sampling and associated community structure modeling, MDEP has implemented numeric tiered aquatic life criteria since 1992 as an interpretation of long-standing narrative criteria, and promulgated the numeric standards as rule in 2004. Maine's criteria are based on 20 years of data, from (currently) 768 river and stream and 126 wetland sampling locations, and over 1300 individual sampling events. The class C metrics from the statistical model are used as the numeric water quality compliance measure or TMDL end point for Barberry Creek.

For purposes of the TMDL, MDEP used a TMDL target of 12% IC as a surrogate for pollutant-specific concentration levels. However, MDEP also used pollutant-specific SWQC to assess both acute and chronic impacts of toxic contaminants. Water column samples from both baseflow and stormflow conditions were assessed and presented in Table 2.

Antidegradation Policy

Maine's anti-degradation policy requires that "existing in-stream water uses and the level of water quality necessary to sustain those uses, must be maintained and protected." (For designated uses of a Class C stream see previous section.) Additionally, MDEP must consider aquatic life, wildlife, recreational use, and social significance when determining "existing uses".

3. IMPAIRMENTS AND STRESSORS OF CONCERN

Detection of Impairments

Maine has an ongoing biological monitoring program within the MDEP, as well as biological criteria for the different classes of rivers and streams in Maine (38 MRSA § 465). The biomonitoring program uses a tiered approach to protecting aquatic life uses, and assesses the health of rivers and streams by evaluating the composition of resident biological communities (mainly benthic macroinvertebrates), rather than (or sometimes in conjunction with) directly measuring the chemical or physical qualities of the water (such as dissolved oxygen levels or concentrations of toxic contaminants)[1]. This biological assessment approach is extremely useful, especially for small streams impaired by stormwater runoff and the mix of associated pollutants, because benthic organisms integrate the full range of environmental influences and thus act as continuous monitors of environmental quality.

Description of Impairments

Maine's 2002 and 2004 303 (d) lists (MDEP 2002b, 2004b) note "Aquatic life"[1] as the impaired use for Barberry Creek with "Urban NPS"[3] as the potential source for the impairment. This assessment was based on data collected by the MDEP Biomonitoring unit on macroinvertebrate communities at one station in Barberry Creek in 1999 and 2003 (S387, see

[1] Note that all of Maine's water quality standards have to be met for a waterbody to attain its classification.

[3] The term "Urban NPS", on the 303(d) list, is a phrase used to characterize the wide variety of pollutant sources associated with runoff in a highly developed, urban watershed. "Urban NPS" is an older reference to what is now technically, a "point source" of pollutants addressed by Phase II stormwater regulations.

Fig. 1). The aquatic life criteria set for a Class C stream (Table 1) were not met in either year. Monitoring results were documented in the MDEP's SWAT (Surface Water Ambient Toxics) Program Reports (2001a, 2004a) as well as in the Urban Streams Project Report (PETE/MDEP 2005).

Stressors of Concern and Their Sources

To better understand urban impairments and their specific pollutant stressors, in 2003 MDEP launched a special project to collect a large amount of biological, chemical, and physical data throughout four urban watersheds, including the Barberry Creek watershed. The data collected under the "Urban Streams Nonpoint Source Assessments in Maine" project, or Urban Streams Project (PETE/MDEP 2005), were analyzed during a series of Stressor Identification (SI) workshops held in May and June 2004. For Barberry Creek, the SI analysis confirmed overall urban development as the primary factor responsible for stressors directly or indirectly linked to aquatic life impairments. Data from the urban streams project suggest that dissolved oxygen (DO) criteria are met. Although some additional monitoring suggests some DO suppression as a result of urban development, this potential stressor is expected to be addressed by a reduction in the effect of impervious cover in the watershed.

Three of South Portland's municipal stormwater outfalls discharge into the stream and are regulated under Maine's MEPDES Phase II, Stormwater Management permit. No MEPDES industrial waste water discharges were identified in the impaired segment of Barberry Creek and one commercial facility (Hannaford Brothers Company) has a small stormwater treatment and detention pond that was permitted under Maine's Site Location of Development law. The single combined sewer overflow (CSO) in the watershed (below MDEP biomonitoring station S387) is scheduled for removal by December 31, 2006 under South Portland's MEPDES wastewater discharge permit.

Following is a list of the four stressors that were identified in the stressor identification analysis as potential factors contributing to the impairment, and the data this determination was based on. Extensive documentation of sampling results is provided in Chapter 5 of the Urban Streams Report (PETE/MDEP 2005); Chapter 2 of the report details sampling methods and provides information on the SI analysis.

<u>Stressor 1: Presence of toxic contaminants</u>

Toxic contaminants include five of the metals that were monitored in 2003/2004 (Table 2). During baseflow conditions, iron and aluminum exceeded Maine's Statewide Water Quality Criteria (SWQC) CCC (Criteria Chronic Concentration). During stormflow conditions, aluminum, cadmium, copper, and zinc exceeded the SWQC CMC (Criteria Maximum Concentration) in the stream.

Table 2. Sampling results from station S387 (Fig. 1) in 2003 and 2004, exceedances are shaded.

	Metal concentration in ug/L					
	Aluminum	**Cadmium**	**Copper**	**Iron**	**Lead**	**Zinc**
Dry Weather or Baseflow Sampling						
7/15/2003		ND 0.5	ND 5	1,100[1]	ND 3	10
8/11/2003		ND 0.5	ND 5	940	ND 3	9
9/9/2003		ND 0.5	ND 5	930	ND 3	9
7/26/2004	240		2		ND 0.5	
9/7/2004	120		2		ND 1.25	
Wet Weather or Stormflow Sampling						
5/27/2003	**820**	**0.8**	**9**	2,800	4	**~47**
11/21/2003	**2,300**	ND 2	**9**	8,600	8	**60**
Statewide Water Quality Criteria						
CCC	87	0.32	2.99	1,000	0.41	27.1
CMC	**750**	**0.64**	**3.89**	**NC**	**10.52**	**29.9**

ND means no detect at the following minimum detection limit, blanks indicate no analysis for this parameter, NC means no criteria

[1] The 10% exceedance of the iron chronic criterion in one sample is not considered to be environmentally significant.

Stressor 2: Impaired instream habitat

A geomorphological survey found very low sinuosity (1.0) and channel overwidening as a result of extensive (100 % of stream length; Field 2003) channelization (Fig. 11 in Appendix E). A survey of large woody debris in the stream found a relatively good abundance (46 pieces in a 100 m stretch) but small size distribution of natural wood (average mean diameter 9 cm).

Stressor 3: Increased sedimentation

Visual analysis of stream substrate showed a dominance of fine sediment (50-55 % but up to 100 % in places). Analysis of Total Suspended Solids showed low levels during baseflow conditions but high levels during stormflows. Personal observations (Fig. 12 in Appendix E) also provided evidence for sedimentation problems.

Stressor 4: Low baseflow

A very small wetted perimeter at baseflow relative to bankfull area suggests reduced groundwater recharge of the stream due to inadequate infiltration of precipitation caused by high watershed imperviousness.

Stressor Discussion

The stressor identification process for Barberry Creek provided documentation for the conclusion that biological impairments are due primarily to a combination of stressors related to stormwater runoff from developed areas. The major sources are stormwater from the City of South Portland (regulated by a MEPDES stormwater general permit), and overland runoff from a highly urbanized drainage area. Recent studies (as summarized in CWP 2003) have shown that the percentage of impervious cover (IC) in a watershed strongly effects the health of aquatic systems because land surfaces no longer infiltrate rainwater and therefore cause increased amounts of stormwater to runoff into receiving streams. In general, stream quality declines as imperviousness exceeds 10 % of watershed area, and may be severely compromised at greater than 25 % (Schueler 1994, CWP 2003). In Maine, existing local data indicate that an impervious cover of 10-15 % is the upper limit for attainment of Class C aquatic life criteria (MDEP 2005).

Table 3 lists the possible sources responsible for the stressors identified during the stressor identification analysis. The italicized sources represent natural conditions, while the highlighted sources are related to watershed imperviousness. The stressor 'Presence of toxic contaminants', links to impervious surface runoff sources from: local roads and parking lots; winter road sand/road dirt; and snow disposal runoff. Of overall minor significance to Barberry Creek are one commercial source of stormwater which is treated (Hannaford Brothers Co.) and ine CSO in the lower part of the watershed (South Portland, below the biological monitoring stations), scheduled for removal by December 31, 2006. An old landfill and a railroad yard were also identified as potential anthropogenic sources of toxics, but evaluation of both sites indicates toxic runoff is unlikely, and baseflow data for Barberry Creek do not indicate any significant sources of pollution from groundwater (PETE 2005).

Table 3. Identified stressors and their sources in the Barberry Creek watershed. Sources representing natural conditions are italicized, those that are related to impervious surfaces are highlighted.

Stressor	**Importance**	**Sources**	
		Likely	**Possible**
1. Presence of toxic contaminants	High	Railroad yard	Documented spills
		Runoff from local roads and parking lots	*Natural sources*
			Snow disposal runoff
		Old, capped landfill	Atmospheric deposition
		Winter road sand/road dirt	Septic system leaks
2. Impaired instream habitat	High	Channelization	Increased storm flow volume
		Low gradient	
		Young age of trees in riparian zone	
3. Increased sedimentation	High	Overwidened channel	Winter road sand/road dirt
		Natural channel processes	High percentage of impervious surfaces
		Naturally sandy/silty substrate and soils	Erosion from land use activities
4. Low baseflow	Low	High percentage of impervious surfaces	Increased consumptive uses

From MDEP/PETE, 2005

4. PRIORITY RANKING, LISTING HISTORY, AND ATMOSPHERIC AND BACKGROUND LOADING

Priority Ranking and Listing History

The large number of streams listed on the 303 (d) list requires Maine to set priority rankings based on a variety of factors. Factors include the severity of degradation, the time duration of the impairment, and opportunities for remediation. Maine has set priority rankings for 303 (d) listed streams by TMDL report completion date, and has designated Barberry Creek for completion by 2005. Barberry Creek's priority ranking was raised on the 2004 303 (d) list (MDEP 2004b) when the stream was included in the Urban Streams NPS Assessment Project (PETE/MDEP 2005).

Atmospheric Deposition

Atmospheric deposition of pollutants (metals) that occurs within a watershed will reach a stream through runoff containing material deposited on land, direct contact of the stream with rain, and the settling of dry, airborne material on the stream surface. As for contaminated runoff, it is assumed that in watersheds with a relatively low percent imperviousness enough soil remains that most atmospherically deposited metals are buffered and adsorbed before they can reach the stream (except in watersheds sensitive to acidification). Where imperviousness is quite high, as in the Barberry Creek watershed (23 %), it is unknown whether (or how much) material deposited from the atmosphere reaches a stream with runoff. A reduction in the % impervious cover (IC) in the watershed would help in reducing any negative effects from pollutants derived from the atmosphere. Other potential sources (i.e., direct contact with rain, and deposition in the stream of airborne material) are considered to convey minimal loads to Barberry Creek because of the small surface area of the stream channel itself. On a larger scale, i.e., for Casco Bay, research has shown that atmospheric deposition accounts for a significant percentage of the inorganic nitrogen and mercury loading to the Bay (Sonoma Technology 2003).

Natural Background Levels

The entire Barberry Creek watershed has been affected by human activities and specific information on natural background levels of pollutants is limited. Natural background levels for aluminum are discussed in detail relative to baseflow exceedances of SWQC, CCC.

Baseflow SWQC Metals Exceedances

Aluminum concentrations in Barberry Creek exceed Maine's SWQC CCC (Table 1), when measured during both base and storm flow conditions. Iron measured during baseflow also exceeded the CCC by 10% on one out of three samplings events and therefore does not constitute a chronic problem. Aluminum was the only metal that consistently exceeded the CCC during baseflow measurements and no obvious anthropogenic aluminum sources were identified during the Urban Streams investigations (PETE 2005). The origin or background levels of aluminum and the toxicity of the observed concentrations will be treated separately for the purpose of the following discussion.

Aluminum is the most common element in the earth's crust (Lide, 1996). EPA lists this metal as a non-priority pollutant and states, 'EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 ug aluminum/L, …' (EPA, 2006). The non-priority status means aluminum it is not routinely measured in water quality samples, so comparative Maine data is limited. Baseflow aluminum from various locations throughout Maine demonstrates CCC and CMC exceedances are common under baseflow conditions (Table 4).

Table 4. Baseflow total aluminum results from several river and stream monitoring projects in Maine. Sites are upstream of point source discharges and show exceedances of Maine's CCC (87 ug/L) and CMC (750 ug/L).

Project/ Reference	# Samples	Sampling Years	Mean Aluminum Conc.(ug/L)	Range (ug/L)	Dominant Flow Condition	Dominant Upstream Landuse
Barberry Creek	***2***	***2004***	***180***	***120-240***	***Baseflow***	***Urban***
Bald Mt Brk, Aroostook County (1989, Fontaine)	7	1979-1984	256	100-360	Baseflow & Storm Mix	Forested
Bishop Mt Brk, Aroostook County (1989, Fontaine)	7	1979-1984	870	<100-1900	Baseflow & Storm Mix	Forested
MDEP Salmon Rivers Monitoring (2005, Whiting)	19	2000-2002	172	30-365	Baseflow	Forested
MDEP TMDL River Monitoring (2001, Miller)	104	1998	130	9-803	Baseflow with some High Flow Events	Forested & Rural Mix
MDEP TMDL Stream Monitoring (2005, Evers)	28	2005	169	20-1100	Baseflow	Urban & Suburban

Over half of the samples in these studies exceeded the CCC of 87 ug/L. The preponderance of relatively high concentrations from a variety of locations and studies implies that background levels of baseflow aluminum may exceed the CCC as a result of natural conditions. Observations suggest the CCC would likely be exceeded at locations with aluminum rich soils that contains clay (clay consists primarily of aluminum silicates). The Barberry watershed is dominated by 'Presumpscot' geologic formations which are characterized by silts and clays. Clay is highly erodible and is mobilized by moving water at the low velocities associated with baseflow conditions, as well as being carried into the stream during storm events.

The presence of elevated aluminum in Barberry Creek is attributed to natural background conditions for the following reasons:

1. The aluminum levels are comparable to background levels found in streams with forested watersheds.
2. No anthropogenic sources of aluminum were identified in the watershed during stream investigations.
3. The substrate of Barberry Stream is enriched by local clay deposits.

Maine's SWQC include an exemption for naturally occurring levels of toxic pollutants, such as aluminum [Chapter 584 §3.A.(1)], so that "…those waters shall not be considered to be failing to attain their classification because of those natural conditions." [MRSA Title 38 §464 (4)(C)].

The toxicity of the observed aluminum concentrations is separate from the origin issue because chronically high levels, whether natural or anthropogenic, may impact biota, depending on the forms of aluminum available in the stream. Aluminum is a dynamic element capable of combining with organic and mineral constituents in stream water to produce varying degrees of toxic effects. The dissolved forms are primarily responsible for the toxicity associated with the CCC value (as opposed to the form that may be bound to clay particles).

Since the Barberry Creek sampling measured total aluminum, which includes all forms, those site-specific aluminum data are inconclusive about toxicity. However, as shown above, high background levels of total aluminum are found in Maine watersheds that attain biological standards, which strongly suggest that chronic exceedances of aluminum do not generally manifest toxic effects under ambient baseflow conditions. Furthermore, the weight of evidence from the Barberry Creek Stressor ID analysis presented in this TMDL links biological impairments to stormwater conditions, not to the levels of aluminum or iron present during base or low flow conditions. If recommended controls (for stormwater, a more scientifically defensible source of biological stream impairment in Barberry Creek) fail to restore the stream to attainment status, then biological toxicity and aluminum speciation may warrant further investigation in Barberry Creek (or another locations in Maine where high concentrations of natural aluminum chronically occur).

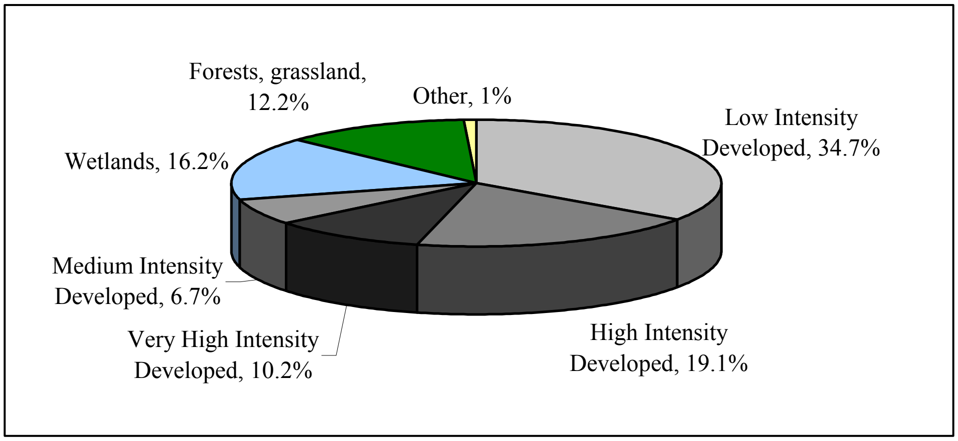
5. IMPERVIOUS COVER AND LANDUSE INFORMATION

Urban development primarily affects aquatic systems due to the high percentage of impervious cover (IC) present in urban areas. Effects include impairments in water quality, stream morphology, hydrology (Figs. 5-7 in Appendix E), and aquatic communities (CWP 2003). For Barberry Creek, the relationship between IC and the stressors identified for this waterbody is shown in Table 3. Stormwater runoff is water that does not soak into the ground during a rain storm but flows over the surface of the ground until it reaches a nearby waterbody. Stormwater runoff often picks up pollutants such as soil, fertilizers, pesticides, animal waste, and petroleum products. These pollutants may originate from driveways, roads, golf courses, and lawns located within a watershed[1]. The negative effects of urban stressors on overall stream quality can be reduced by disconnecting impervious surfaces from the stream so that runoff does not reach a waterbody untreated or by converting impervious surfaces to pervious surfaces. Implementation of other measures that address habitat restoration, flood plain recovery, and riparian recovery can be an effective and less costly first step in abatement. More information on these Best Management Practice (BMP) options is provided in section 7, Implementation Recommendations.

[1] For more information on stormwater issues visit the MDEP Nonpoint Source Pollution website at www.maine.gov/dep/blwq/doceducation/nps/background.htm

The % impervious cover in the Barberry Creek watershed was determined from landuse data and a conversion of landuse to % IC. Details regarding this procedure are given in Part II, section 1. Analysis showed that landuse is dominated by very high, high, medium, and low intensity development, which together account for 71 % of all landuses (Fig. 2). Wetlands, and forests and grasslands account for 16 % and 12 %, respectively, while other smaller landuses make up the remaining 1 %. Converting landuse to % IC, imperviousness in the Barberry Creek watershed was estimated to be 23 %. This percentage reflects the total amount of impervious cover in this watershed.

Fig. 2. Distribution of landuse types, with percentages, in the Barberry Creek watershed.



6. TOTAL MAXIMUM DAILY LOAD (TMDL) TARGET

Details regarding the determination of the TMDL target set for Barberry Creek are given in Part II of this document, and a brief summary is provided here. For further details please consult Part II.

The Stressor Identification (SI) analysis indicated that urban stressors have caused the impairment in the macroinvertebrate community and Barberry Creek's failure to attain aquatic life criteria. "Urban stressors" is a catch-all term encompassing a wide variety of effects caused by urbanization, with the majority of the effects being related, directly or indirectly, to stormwater runoff from impervious surfaces. Because of the major effect stormwater runoff has on aquatic systems (CWP 2003), the "Impervious Cover Method" (IC method), as employed by ENSR in a pilot TMDL (ENSR 2005), is used here to estimate current extent of impervious cover for the Barberry Creek watershed, and compare the results to a TMDL target % IC of 12 %. The target % IC was determined in accordance with MDEP guidance (MDEP 2005) using MDEP data, information from the literature, and local conditions.

7. IMPLEMENTATION RECOMMENDATIONS

The goal of this TMDL is to have Barberry Creek meet applicable water quality criteria that is to have the macroinvertebrate community attain Class C standards. Impairments observed in the aquatic communities in Barberry Creek have been attributed to urban stressors, including additional stormwater runoff. The following recommendation is specific to Barberry and will be implemented under Maine's NPDES Program:

- Eliminate sewage input from the Combined Sewer Overflow (CSO), (MDEP, NPDES Permit # ME10100633) to reduce toxic contaminant and nutrient input;
- The single CSO in the watershed is scheduled for removal by December 31, 2006 under the City of South Portland's MEPDES wastewater discharge permit

Stormwater effects can be lessened, water quality improved, and impairments curtailed by implementing best management practices (BMPs) and remedial actions in a cost-effective manner using the following adaptive management approach:

- Implement BMPs strategically through a phased program which focuses on getting the most reductions, for least cost, in sensitive areas first (for example, begin with habitat restoration, flood plain recovery, and treatment of smaller, more frequent storms);
- Monitor ambient water quality to assess stream improvement;
- Compare monitoring results to water quality standards (aquatic life criteria);
- Continue BMP implementation in a phased manner until water quality standards are attained.

Generally speaking, these abatement measures can take one of three forms: they can consist of general stream restoration techniques (including flood plain and habitat restoration), they can disconnect impervious surfaces from the stream, or they can convert impervious surfaces to pervious surfaces. In general, practices that achieve multiple goals are preferred over those that achieve only one goal (ENSR 2005). For example, installing a detention basin along with runoff treatment systems provides more effective abatement of stormwater pollution than installing detention BMPs alone. Because of the effort and cost involved in implementing these BMPs, a long-term strategy can be used to achieve water quality standards. For example, lower cost general stream restoration techniques that lessen stormwater effects immediately can be implemented in the short-term to initiate stream recovery.

The current extent of impervious cover in the Barberry Creek watershed is estimated at 23 % IC. This TMDL sets a target of 12 % impervious cover which can guide implementation efforts. A significant amount of work is needed to reduce the effect of percent impervious cover in the watershed. This work can include a reduction in the extent of impervious cover, or addition of stormwater management techniques that reduce the impacts of stormwater on the aquatic life in the stream.

For practical purposes, the IC calculations in this TMDL do not distinguish between directly connected and disconnected surfaces. In any watershed, the runoff from impervious cover reaches the stream through both direct and indirect conduits that represent varying levels of stormwater treatment. A comprehensive sub-watershed survey of outlet structures and storm drainages would be needed to completely differentiate the amount of 'effective'[1] IC. Municipalities and entities that own extensive impervious surfaces are encouraged to conduct such surveys. Because effective IC presents the greatest pollution risk, efforts to disconnect or convert impervious surfaces should be directed primarily at these areas to ensure maximum benefit. This approach is likely to accelerate stream recovery and reaching the goal of this TMDL, i.e., attainment of water quality criteria. If all water quality criteria are attained before the target % IC is reached, the need for further reductions in impervious cover would be reduced (or possibly eliminated). It should be noted, however, that while a sub-watershed survey would be ideal for comprehensive planning towards stream restoration, immediate stormwater remediation may be more beneficial in the short run. Disconnecting 'hot spots' and installing bioretention structures may move the stream closer to the water quality target than documenting the current extent of IC.

The following three sections list the options available for BMPs aimed at stream restoration techniques, and disconnection and conversion of impervious surfaces. Because many factors must be considered when choosing specific structural BMPs (e.g., target pollutants, watershed size, soil type, cost, runoff amount, space considerations, depth of water table, traffic patterns, etc.), the sections below only suggest categories of BMPs, not particular types for particular situations. Implementation of any BMPs will require site-specific assessments and coordination among local authorities, industry and businesses, and the public. Advice on the selection, design, and implementation of any remedial measures can be obtained from the MDEP (Bureau of Land and Water Quality, Division of Watershed Management), the Cumberland County Soil and Water Conservation District, or web-based resources (see Appendix D for suggestions).

In summary, implementation of remedial measures will occur under an adaptive management approach in which certain measures are implemented, their outcome evaluated, and future measures selected so as to achieve maximum benefit based on new insights gained. The order in which measures are implemented should be determined with input from all concerned parties (e.g., city, businesses, industry, residents, regulatory agencies, watershed protection groups). It is suggested that the City develop implementation recommendations by the end of 2006 and present them to the watershed stakeholders, the Cumberland County Soil and Water Conservation District, and the MDEP. In the annual report required each year by the MEPDES stormwater general permit (MS4), the City should highlight its efforts to meet the wasteload allocation of this TMDL.

Further details on the measures suggested below are provided in Chapter 5 of the Urban Streams Report (PETE/MDEP 2005). In addition, Appendix C lists BMPs in a matrix format in which traditional and newly developed ("Low Impact Development") BMP types are rated according to their ability to mitigate for impacts of impervious cover and applicability to certain urban situations (ENSR 2005). The matrix was developed by ENSR as a multi-use tool and thus contains some BMPs and IC impacts not directly applicable to Barberry Creek.

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[1] 'Effective' IC is impervious cover that is directly connected to the stream via hard surfaces or in close proximity, and from which runoff enters a waterbody untreated.

General Stream Restoration Techniques

Following is a list of general BMPs and stream restoration techniques and how they can alleviate stressors and improve stream health. Short-term implementation of these measures will complement the long-term strategy of disconnecting or removing impervious surfaces suggested above. Web-based information resources that can aid with planning and implementing these measures are given in Appendix D.

- Maintaining the riparian buffer where it is adequate, i.e., has a width of at least 23 m (75 feet), wherever possible, and is composed of native plants, including mature trees. Enhancing or replanting the riparian buffer where it is inadequate. An adequate buffer will filter runoff from commercial and residential lots, improves shading (which helps to keep water temperature low), and increases large woody debris availability, and food input. It will also provide terrestrial and aquatic habitat for insects with aquatic life stages, thus enhancing recolonization potential of the macroinvertebrate community.
- Reclamation of flood plains by returning these areas to a natural state will naturally moderate floods; reduce stress on the stream channel; provide habitat for fish, wildlife, and plant resources; promote groundwater recharge; and help maintain water quality. Protection of intact flood plains should be a high priority.
- Improving channel morphology (restoring sinuosity, pool availability and diversity, and flow diversity) by installing double wing deflectors and low crib walls in the stream (see Field 2003, Fig. 9a, or PETE/MDEP 2005, Chapter 5, Fig. 23) will improve flow conditions and habitat for macroinvertebrates. Because of the complex nature of channel restoration, any improvement activity will require the extensive involvement of a trained professional.
- Reducing erosion from land use activities with mulches, grass covers, geotextiles or riprap will reduce excess sedimentation. In streambank stabilization projects, use of woody vegetation is preferred over riprap in most cases.
- Reducing the input of winter road sand and road dirt by sweeping roads, parking areas or driveways will reduce excess sedimentation.
- Reducing the incidence of spills (accidental and deliberate) for example by improving education and training will reduce toxic contaminant input.
- Minimizing waste input from pets by picking up waste will reduce bacteria and nutrient input.
- Eliminating the potential for sewer/septic system leaks by regularly inspecting and maintaining sewer/septic systems will reduce toxic contaminant and nutrient input.
- Eliminating illicit discharges by detecting and eliminating discharges will reduce toxic contaminant and nutrient input.
- Minimizing lawn/landscaping runoff by minimizing fertilizer/pesticide use and using more efficient application methods will reduce nutrient and toxic contaminant input.
- Reducing the temperature of water discharged from a detention structure by redesigning and retrofitting existing detention with outlet structures (e.g., underdrains) that cool the discharge will reduce negative temperature effects on the stream.
- Investing in education and outreach efforts will raise public awareness for the connections between urbanization, impervious cover, stormwater runoff, and overall stream health.

- Encouraging responsible development by promoting Smart Growth or Low-Impact Development guidelines and the use of pervious pavement techniques will minimize overall effects of urbanization.
- Reducing new impervious cover by promoting shared parking areas between homes or between facilities that require parking at different times will reduce impacts related to impervious surfaces. Lowering minimum parking requirements for businesses and critically assessing the need for new impervious surfaces will have the same effect.
- Eliminating septic systems in the watershed by expanding the municipal sewer system will reduce toxic contaminant and nutrient input.
- Discouraging the use of pavement sealants on driveways and parking lots will reduce the input of toxic contaminants. A recent study showed that runoff from sealed parking lots could account for the majority of the PAH load in urban streams (Mahler et al. 2005). PAHs are a group of toxic contaminants with known negative effects on aquatic communities. Sealants are often applied for aesthetic reasons only, and decreasing their use represents a simple way to reduce the toxics load in runoff.

<u>Disconnection of Impervious Surfaces</u>

The purpose here is to prevent stormwater runoff from reaching the stream directly (via the storm drain system), thus reducing % IC. There are various options for achieving this goal:

- Channel runoff from large parking lots, roads or highways into
  - detention/retention BMPs (e.g., dry/wet pond, extended detention pond, created wetland), preferably one equipped with a treatment system (e.g., underdrains);
  - vegetative BMPs (e.g., vegetated buffers or swales);
  - infiltration BMPs (e.g., dry wells, infiltration trenches/basins, bio-islands/cells);
  - underdrained soil filters (e.g., bioretention cells, dry swales).
- Redesign and retrofit existing detention to provide extended detention for 6 month and 1 year storms.
- Guide runoff from paved driveways and roofs towards pervious areas (grass, driveway drainage strip, decorative planters, rain gardens).
- Remove curbs on roads or parking lots.
- Collect roof runoff in rain barrels and discharge into pervious areas.

All of these options for disconnection of impervious surfaces provide for a virtual elimination of runoff during light rains (which account for the majority of runoff events but not the majority of pollutant or stormwater input), reduction in peak discharge rate and volume during heavy rains, sedimentation or filtration of some pollutants, and improvement in groundwater recharge. Disconnection of impervious surfaces can often be achieved at reasonable cost and, unlike the removal of impervious surfaces (below), does not generally create material for disposal. These BMPs cover most sizes of impervious surfaces (private driveways and small building roofs to large parking lots and highways), and many have been widely used in cold climates. Disconnection of impervious surfaces is a particularly useful option in watersheds with relatively high imperviousness, such as the Barberry Creek watershed.

<u>Conversion of Impervious Surfaces</u>

This is achieved by replacing impervious surfaces with pervious surfaces, for example by using the following BMPs:

- Replace asphalt on little-used parking lots, driveways or other areas with light vehicular traffic with porous pavement blocks or grass/gravel pave.
- Replace small areas of asphalt on large parking lots with bioretention structures (bio-islands/cells).
- Replace existing parking lot expanses with more space-efficient multistory parking garages (i.e., go vertical).
- Replace conventional roofs with green roofs.

These options for conversion of impervious surfaces also provide for a virtual elimination of runoff during light rains (which account for the majority of runoff events), reduction in peak discharge rate and volume during heavy rains, filtration of some pollutants, and improvement in groundwater recharge. However, a number of problems exist with these options (e.g., removed asphalt or roofing shingles must be landfilled or recycled), and removal of existing impervious surfaces may be operationally unfeasible. Some of these BMPs are still in the experimental stage for cold climates and may not prove suitable for widespread implementation. As far as possible, construction or building projects should, however, consider these and other possibilities for reducing new impervious cover during the planning stages.

8. MONITORING PLAN

Maine DEP will evaluate the progress towards attainment of Maine's water quality standards by monitoring the macroinvertebrate community in Barberry Creek under the Biomonitoring Unit's existing rotating basin sampling schedule (next due in 2009). At the same time, the Streams TMDL unit will collect water chemistry samples during stormflow conditions to detect in-stream sediment trends and determine whether acute criteria of the Maine Statewide Water Quality Criteria for certain toxic contaminants are exceeded. Adaptive implementation of the remedial measures listed above should be pursued until water quality standards are met. Once water quality standards have been met in at least two sampling events with normal summer conditions (as defined by MDEP Biomonitoring Protocols) within a 10-year period (i.e., by 2015), no further remedial measures are required. If water quality standards continue to be violated once BMPs and restoration techniques have been implemented this TMDL will enter a secondary phase in which the approach proposed in this document will be reassessed.

PART II: TMDL PLAN

1. TMDL TARGET: LOADING CAPACITY AND IMPERVIOUS COVER

Loading Capacity

Loading capacity is the mass of pollutants that a waterbody can receive over time and still meet numerical or narrative water quality targets. Barberry Creek currently does not meet Maine's aquatic life criteria for a Class C stream (Part I, Table 1). For streams in urbanized areas, additional stressors affecting aquatic life exist in the form of non-pollutant impacts such as alterations in channel morphology and the flow regime or elimination of the riparian buffer. In this TMDL, the total extent of impervious cover (% IC) in the watershed is used as a surrogate for the complex mixture of pollutant and non-pollutant stressors attributable to stormwater runoff from developed areas. By reducing the % IC using the options listed above in Part I, section 5, Implementation Recommendations, a number of urban stressors and their sources can be addressed simultaneously (e.g., toxic load from runoff and road sand; habitat impairment due to storm flows; sedimentation problems from road sand and exposed soil; low flows related to high imperviousness).

The loading capacity of Barberry Creek is set at 12% IC, with a 2% margin of safety. The target % IC for Barberry Creek was selected by considering local conditions within the framework of the appropriate target range of 10-15 % IC established by MDEP for Class C waterbodies (MDEP 2005, attached in Appendix E).). Given the local conditions (i.e., the presence of a substantial length of riparian buffer which serves to offset the impact of other factors listed in Table 1), a target %IC of 12% was set for Barberry Creek.

Table 1. Conditions considered in selection of target % impervious cover for Barberry Creek.

Ameliorating conditions	Exacerbating conditions
Presence of a riparian buffer >10 m in width along 56 % of the stream (PETE/MDEP 2005)	Absence of riparian buffer along 26 % of the stream (PETE/MDEP 2005)
	Upstream wetland potentially contributing to elevated water temperature and lowered dissolved oxygen concentration
	Impermeable soils (clays and silts of glacial-marine origin) reducing infiltration potential

Impervious Cover (IC) Method

The IC Method was developed by the Center for Watershed Protection (CWP) to assess the impacts of urbanization on small streams and receiving waters, and to document the linkage between the % impervious cover in watersheds and instream water quality. The IC Method was used by ENSR in a pilot project to develop TMDLs for streams potentially impaired by urban nonpoint source pollution (ENSR 2005). ENSR selected the IC Method for their pilot project "primarily because it provides a strong and straightforward link between water quality impairment and causal factors" (ENSR 2005).

Impervious Cover and Landuse Information

As a first step for calculating the % impervious cover in the Barberry Creek watershed, the watershed boundary (Part I, Fig. 1) was determined. This was done based on a drainage map obtained from the City of South Portland and knowledge of actual stormwater drainage systems. Watershed imperviousness was determined from landuse data and a conversion of landuse to % IC. Landuse data were derived from "Maine_Combo_ Landcover", a GIS map layer developed by MDEP staff that combines data from Maine Gap Analysis Program (GAP) and USGS Multi Resolution Landcover Characterization (MRLC) coverages[1]. Both GAP and MRLC are based on 1992 Land-Sat TM satellite imagery. Metadata for Maine_Combo_Landcover are maintained by MDEP's GIS unit. Landuse information presented here includes the area above the downstream wetland, i.e., all areas draining into the impaired segment (Fig. 1). Within this area, land use is dominated by very high, high, low, and medium intensity development, which together account for 71 % of all landuses (Table 2, Fig. 1). Wetlands, and forests and grasslands account for 16 and 12 %, respectively, while other smaller landuses make up the remaining 1 %.

Table 2. Extent of various landuse types in the Barberry Creek watershed. Letters a-e shown in the first column refer to the (urban) land cover types listed in Table 3. (Note: different terms are used here than in Table 3 for landuse types b-f to more accurately reflect actual landuse; also see footnote to Table 3.)

Landuse Type		Acres	%
e	Low Intensity Developed	273	34.7
b, c	High Intensity Developed	150	19.1
-	Wetlands	127	16.2
a	Very High Intensity Developed	80	10.2
-	Forest (Upland Woody Vegetation)	62	7.9
d	Medium Intensity Developed	53	6.7
-	Grasslands	34	4.3
-	Other*	7	7.5
-	Total watershed area	786	100

* "Other" landuse types are [in order of decreasing area (≤3.1 acres) or percentage ≤0.4 %)] Water, Nonvegetated, and Tilled agriculture.

[1] To minimize uncertainties in precise landuse type (e.g., different types of urban developments, forests or wetlands), the original 20 "Maine_Combo_Landcover" types present in the Barberry Creek watershed were grouped into the ten generalized types shown in Fig. 1.

The method used to convert landuse to % IC was developed by MDEP staff (MDEP 2001b) by applying a % imperviousness formula to the "Maine_Combo_Landcover" GIS layer. The resulting values for imperviousness of certain land cover types in Maine are presented in Table 3. Calibration or groundtruthing (MDEP 2001b) of the method led to the addition of a multiplier to give a final formula for watershed % IC of:

$$\text{Watershed \% IC} = 0.85 \; * \left(\frac{\sum_{a}^{f} \left(\text{Acres of landuse type} * \text{Estimated \% IC} \right)}{\text{Total watershed area}} \right)$$

Where Acres of landuse type a-f[1] = see Table 2
Estimated % IC for land cover type a-f[1] in Maine = see Table 3
Total watershed area = see Table 2

Using this formula, % IC for the Barberry Creek watershed was estimated to be 23 %.

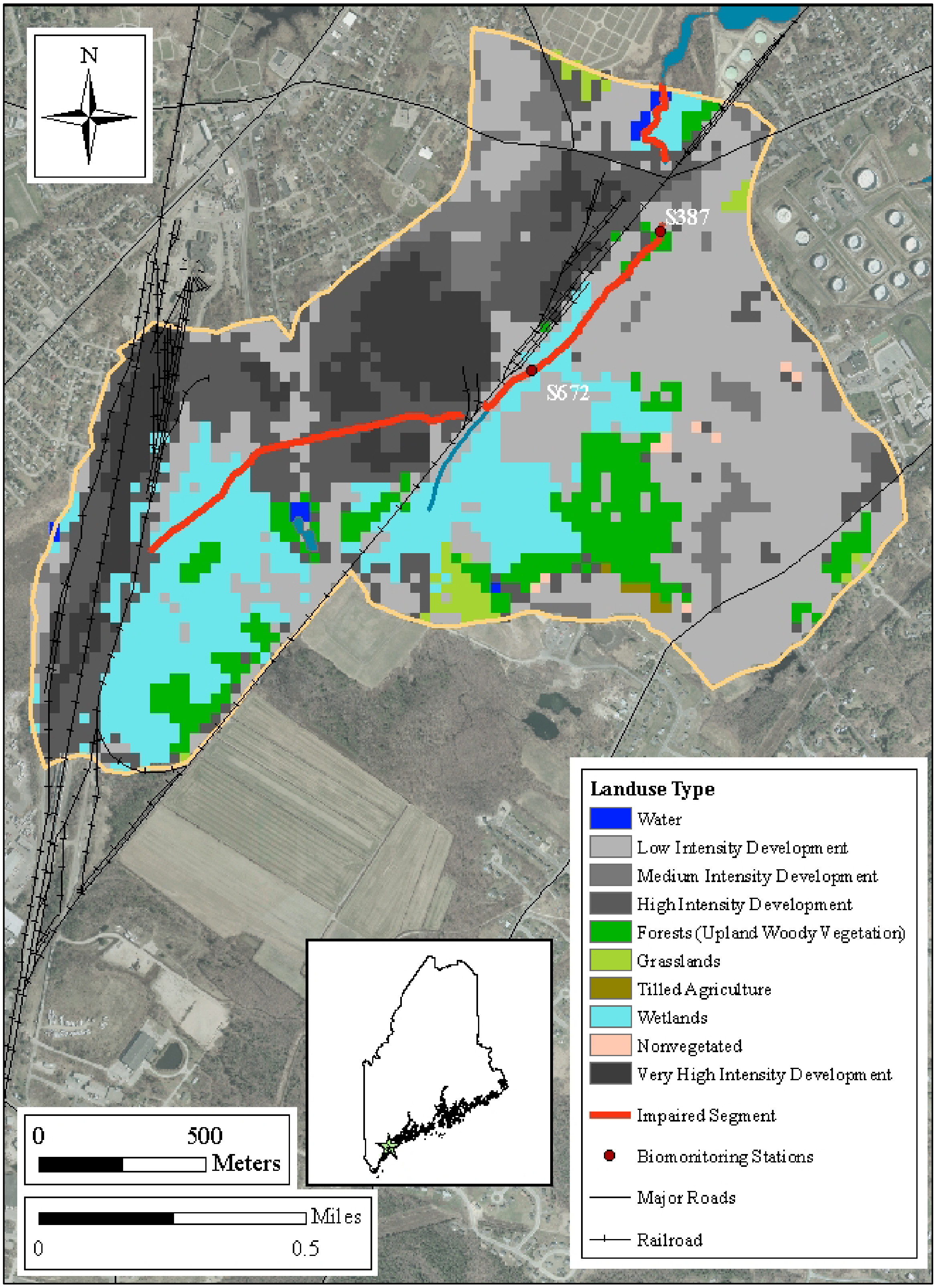
Table 3. Estimated % impervious cover (IC) for urban land cover* types in the "Maine_ Combo_Landcover" GIS map layer (MDEP 2001b). Letters a-f shown in the first column refer to the landuse types listed in Table 2.

Land Cover Type		Estimated % IC
a	Urban Industrial	90.20
b	Dense Residential Developed	56.50
c	Commercial-Industrial-Transportation	54.04
d	High Intensity Residential	27.11
e	Low Intensity Residential	17.26
f	Sparse Residential Developed	11.98

* Because of the way land cover types were derived from two GIS datasets, terms used here do not necessarily reflect the actual landuse (e.g., residential). Land cover types do, however, accurately reflect the extent of imperviousness due to development associated with each category.

[1] Landuse type 'f' does not occur in this watershed.

Fig. 1. Landuse in the Barberry Creek watershed.



Daily Pollutant Loads

Percent impervious cover (% IC) serves as a surrogate measure of the complex mixture of pollutants transported by stormwater. Maine's SWQC includes biological standards that respond not only to pollutant loads contributed by stormwater, but integrates additional environmental stressors such as flow and habitat alterations. Expression of the TMDL target in terms of % IC is especially useful for stormwater-impaired waters because the target is applicable at all times, whether the time step is instantaneous, hourly, daily, weekly, monthly, seasonal, or annual.

This TMDL also presents daily pollutant loads for two specific pollutants which serve as surrogates for the complex mix of pollutants commonly found in stormwater. Calculations of the total maximum daily loads for lead (Pb) and zinc (Zn) are presented in Appendix B. Pb and Zn are chosen as surrogate pollutants for the complex mixture of metals in stormwater because there are extensive data documenting their presence in stormwater. The CWP cites over 2,000 data points for each metal, and Pb and Zn are two metals most commonly detected at the highest concentrations in stormwater (CWP 2003). In addition to Pb and Zn being well documented in the stormwater data cited by CWP, these pollutants were also presented in samples from Barberry Creek (Part I, Table 2).

SWQC require water quality criteria be met for all streamflows of 7Q10 and above. Given the dynamic nature of stormwater run-off volume and resulting streamflows, the presentation of the daily loads in tabular and/or graphic form is used to express the daily maximum pollutant load which changes as daily streamflow varies.

The maximum daily load for NPDES-permitted sources (i.e., the wasteload allocation), the load for all other sources (i.e., the load allocation, which includes natural background and nonpoint sources), and a margin of safety are included in the TMDLs. The load allocation is included in the wasteload allocation because it is not possible to separate out the NPDES-permitted sources from all other sources, given the large number of regulated and unregulated sources and the variability of stormwater. A 5% explicit margin of safety was included by decreasing the applicable water criterion by 5% before calculating the allowable daily wasteload (which is also shown in Appendix B).

MDEP recommends the use of the imperious cover target to establish the implementation goals rather that the over pollutants specific TMDL loads because the % IC target will more effectively guide BMP's implementation to reduce stormwater impacts. Ultimate compliance with water quality standards for the TMDL will be determined by measuring instream water quality to determine when standards are attained.

Limitations of the Impervious Cover Method

The impervious cover (IC) method can be used to efficiently characterize water quality impairment and establish surrogate TMDL targets for % IC, or stormwater runoff volume. There are four limitations that affect the use of the method in Barberry Creek as follows:

1. Limitation: The IC model applies to 1st through 3rd order streams.
   Effect: Barberry Creek is a 1st to 2nd order stream, i.e., use of the model is appropriate.

2. Limitation: This method does not account for non-stormwater sources of pollutant loadings.
   Effect: There are no known non-stormwater point sources of pollution in the watershed. Violation of aquatic life criteria in this watershed is attributed to stormwater and/or nonpoint source pollution, exacerbated by instream and riparian habitat disturbances. However, two other stormwater related discharges are believed to be of minor importance:
   A. The Hannaford facility has a stormwater detention pond (with a treatment system) that is permitted under Maine's Site Law and drains ~8 acres or 1 % of total watershed. In general, wet detention ponds are designed not to discharge during dry conditions. Hannaford is a minor source because it is treated and drains a small area.
   B. The CSO is located in the lower part of the watershed below the monitoring stations (which provided the basis for the aquatic life criteria listing). The CSO is a minor source because it is scheduled for elimination in December 2006.

3. Limitation: This method does not account for dynamic internal stream processes that effect water quality.
   Effect: Generally, TMDL methods do not account for in-stream physical processes that directly affect habitat and biological organisms. Internal movement and shifting of the sediment has a direct effect on habitat suitability, but is not easy to quantify or included in TMDL analysis.

4. Limitation: Additional site specific information is required for identification and specification of Best Management Practices (BMPs) to achieve TMDL goals.
   Effect: Suggestions for BMPs, remedial actions, and restoration techniques aimed at removing identified stressors, or mitigating their effects, are made in Part I, section 5. Implementation of these BMPs will aid substantially in reducing the % IC and/or its effects. However, a reduction of the IC (or its effects) by the full 11 % (from 23 % to 12 %) will require site specific information for optimal implementation of BMPs.

2. LOAD ALLOCATIONS

All Load Allocations (LAs) are given the same 10 % IC allocation as the Waste Load Allocations (WLAs) (see next section). This approach was chosen because LAs must be accounted for but it was not feasible to separate the loading contributions from nonpoint sources, background, and stormwater. Adding a margin of safety of 2 % to the 10 % Load Allocation yields the Total Allocation of 12 % IC (see Table 7 and section 6.).

3. WASTE LOAD ALLOCATIONS

The City of South Portland has the only MEPDES wastewater permit in the watershed, (# ME0100633). The facility is allocated a waste load of zero ("0") because the CSO is scheduled for removal by December 31, 2006.

The entire Barberry Creek watershed is classified as a "regulated area" under the NPDES Phase II Stormwater Program. Under the stormwater program, municipal separate storm sewer system (MS4), construction, and industrial stormwater discharges are considered as point sources and are allocated as waste loads. In this TMDL, the total extent of impervious cover (% IC) in the watershed is used as a surrogate for the complex mixture of pollutant and non-pollutant stressors attributable to stormwater runoff from developed areas. The total allocation is set at 12 % IC. The 'WLAs' and 'LAs' are established at a % IC of 10 %, which allows for a margin of safety of 2 % IC, as shown in Table 4.

Table 4. Estimated target annual load and waste load allocations for Barberry Creek

	Allocations (% IC)
Combined Sewer Overflow (WLA)	0*
Waste Load Allocations, Load Allocations	10
Margin of Safety	2
Total Allocation (TMDL)	12

* The WLA for CSO (a combined discharge of wastewater and stormwater) is set at zero because the CSO is scheduled for elimination (separation) by December 2006. The WLA for stormwater remaining after separation is included in the 10% IC.

4. MARGIN OF SAFETY

The Barberry Creek TMDLs provide both explicit and implicit margins of safety (MOS). The % IC TMDL includes an explicit margin of safety of 2 % impervious cover which is reserved from the total loading capacity of 12%. This implicit MOS is sufficient to accounts for the uncertainty in the selection of a numeric water quality target of 12 % IC (within the range of 10-15% IC suitable for Class C streams) primarily because of the mitigating presence of a riparian buffer along a substantial portion of Barberry Creek. The 2% IC MOS allows for uncertainty and reduces the target to the lowest, most conservative part of the suggested target range for Class C streams. Furthermore, the 2% IC translates to an actual 17% MOS when 2% IC is compared to the 12% TMDL (2% IC / 12% IC = 16.7%).

The pollutant-specific TMDLs for Pb and Zn provide both an implicit and explicit MOS. An implicit MOS is included in the relatively conservative assumptions inherent is using SWQC for chronic effect as the TMDL target. In addition, calculation of the pollutant-specific WLAs for Pb and Zn provide an explicit 5% MOS which is applied to the appropriate SWQC before calculating the allowable daily wasteload allocations.

5. SEASONAL VARIATION

The TMDL was established to protect the stream during critical conditions throughout the year. The IC target will result in reductions in the effects of IC which will improve water quality for all flows and seasonal conditions (ranging from summer low flows, to high spring flows during snowmelt). The daily loads for Pb and Zn are expressed as a function of flow to assure SWQC are attained for all flows and seasonal conditions.

Critical conditions can occur for aquatic life and habitat in stormwater-impaired streams at both low and high flows. Frequent small storms can contribute large volumes of runoff and a mix of pollutants. High flows can cause channel alterations, increased pollutant loads from scouring and bank erosion, wash-out of biota, and high volume pollutant loading. Increased % impervious cover and the resulting increase in surface runoff reduces the amount of infiltrating rainfall that recharges groundwater. This diminished baseflow can further stress aquatic life and cause or contribute to aquatic life impairments through loss of aquatic habitat and increased susceptibility of pollutants at low flow. Furthermore, specific BMPs implemented will be designed to address loadings during all seasons.

6. PUBLIC PARTICIPATION

Public participation in the Barberry Creek TMDL development was ensured through several avenues, during 2 phases of review.

Phase 1

A preliminary review draft TMDL, which had been reviewed by MDEP staff (D. Courtemanch, J. Dennis, M. Evers, D. Miller, L. Tsomides, Bureau of Land and Water Quality), was distributed to watershed stakeholder organizations including:

- Pat Cloutier and David Pineo, City of South Portland
- Beverly Bayley-Smith, Casco Bay Estuary Project, Portland
- Mike Doan and Joe Payne, Friends of Casco Bay, South Portland
- Betty McInnes, Cumberland County Soil and Water Conservation District
- Mac Sexton, South Portland Land Trust
- Gary Nadeau, Hannaford Brothers Company

Paper and electronic forms of the *Barberry Creek TMDL, Draft Report* were made available for public review in three ways: the report was available for viewing at the Augusta office of the MDEP; it was posted on the MDEP Internet Website; and a notice was placed in the 'legal' advertising of a local newspaper. The following ad was printed in the Sunday editions of the Portland Press Herald on July 17 and 24, 2005:

> *PUBLIC NOTICE FOR BARBERRY CREEK -In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130, the Maine Department of Environmental Protection has prepared a Total Maximum Daily Load*

(TMDL) report (DEPLW0712) for Barberry Creek in South Portland, Cumberland County. This TMDL report estimates the current extent of impervious surfaces, and the reductions in impervious surfaces and application of general stream restoration techniques required to enable the stream to meet Maine's Water Quality Criteria.

A Public Review draft of the report may be viewed at the Maine DEP Offices in Augusta (Ray Building, Hospital St., Rt. 9) or on-line at: http://www.maine.gov/dep/blwq/comment.htm.

Send all written comments by August 15, 2005 to Melissa Evers, Maine DEP, State House Station #17, Augusta, ME 04333, or email: Melissa.Evers@maine.gov.

The U.S. Environmental Protection Agency (Region I) and interested public were provided a 30 day period (from July 15 to August 15, 2005) to respond with draft comments. This draft of Barberry Creek has also been summarized in PowerPoint for presentation at the Maine Water Conference and the annual meeting of New England Association of Environmental Biologists.

Phase 2

A final draft was submitted to EPA in 2005 and has undergone multiple changes due to emerging legal issues. As a result, the June, 2006 draft of the *Barberry Creek TMDL* will go out for an additional round of review and will be posted on the MDEP Internet Website for public comment from July 25 to August 8. MDEP will simultaneously post the 2005 *Draft Percent Impervious Cover TMDL Guidance for Attainment of Tiered Aquatic Life Uses.* The following list of interested parties and/or watershed stakeholders will be notified by email of the comment opportunity:

- Pat Cloutier and David Pineo, City of South Portland
- Karen Young, Casco Bay Estuary Project, Portland
- Mike Doan and Joe Payne, Friends of Casco Bay, South Portland
- Betty McInnes, Cumberland County Soil and Water Conservation District
- Mac Sexton, South Portland Land Trust
- Gary Nadeau, Hannaford Brothers Company
- Steve Hinchman, Conservation Law Foundation

Comments- Verbal comments from David Pineo, Engineer with South Portland were incorporated into this document. Additional comments were received and are included in Appendix A.

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Appendix A. – Public Comments and MDEP Response to Comments

From: CLOUTIER, PATRICK [mailto:PCLOUTIER@southportland.org]
Sent: Monday, August 08, 2005 3:26 PM
To: Melissa.Evers@maine.gov
Subject: Barberry Creek TMDL

Melissa

I 've reviewed the Draft TMDL report for Barberry Creek. I have the following comments;

1. Page 15, 6. Monitoring Plan. The next to the last sentence states no further remedial measures are required ' Once criteria have been met in at least two sampling events with normal summer conditions ...' It's not known if there is a specific timeline that the sampling events must occur within.

2. Page 18, 'Impervious Cover and Landuse Information', 3rd sentence. the drainage mapping obtained from the city has 2 foot contours and not the 10 m contours stated.

3. Is the 12% IC in the TMDL subject to change with better defined or improved information coming forward in the future?

Thank you.

Patrick Cloutier
Director
South Portland Water Resource Protection PO Box 9422 South Portland, Maine 04116-9422

MDEP Response-

From: Evers, Melissa [mailto:Melissa.Evers@maine.gov]
Sent: Monday, August 08, 2005 4:34 PM
To: CLOUTIER, PATRICK
Subject: RE: Barberry Creek TMDL

Patrick,

I'm pleased you read the document and were able to pick out problems. Here is a first response

1. Page 15, 6. Monitoring Plan. The next to the last sentence states no further remedial measures are required ' Once criteria have been met in at least two sampling events with

normal summer conditions ...' It's not known if there is a specific timeline that the sampling events must occur within.

The short answer is that under a timeline it would fall under our rotating basin schedule for Biomonitoring, which is every 5 years. Southern Maine is being done this year, so that puts it 5 years away, which might coincide well with improvements due to BMP implementation over the next few years.
Maine DEP also does a number of discretionary sites each year outside of rotating basins schedule, to address specific issues and needs. That means Maine DEP could go in and sample if the need was great enough and there is the option of using consultants that would collect samples according to
Maine DEP protocols, as well.

2. Page 18, 'Impervious Cover and Landuse Information', 3rd sentence. the drainage mapping obtained from the city has 2 foot contours and not the 10 m contours stated.

Thanks, we will correct that.

3. Is the 12% IC in the TMDL subject to change with better defined or improved information coming forward in the future?

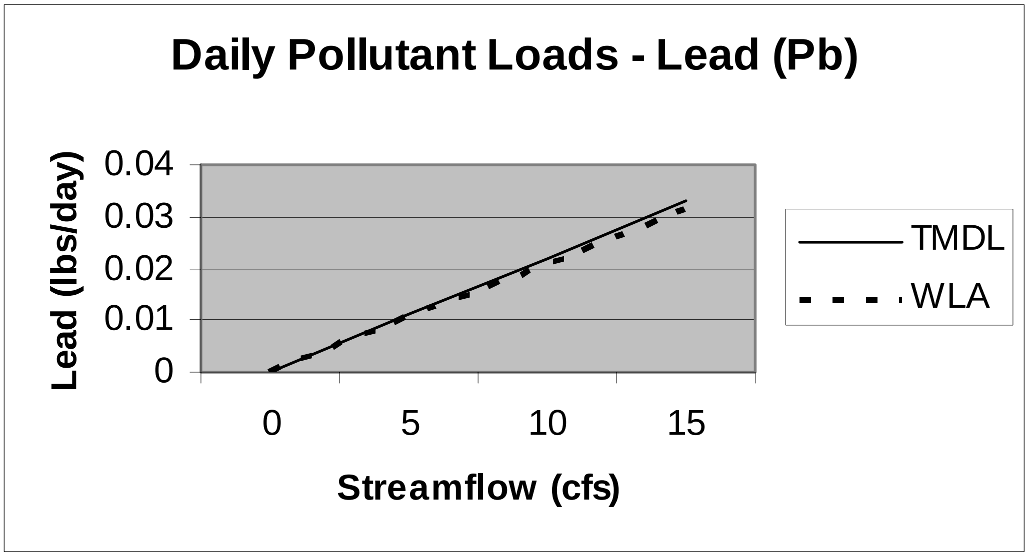
As stated in the TMDL, the 12% IC is a surrogate for range of impairments listed, conceptually, it is a catalyst to initiate BMP's and stream restoration. So while better, detailed information could change the estimated 12% IC figure, it wouldn't change the need to address and fix the problems in the stream. As long the aquatic life and dissolved oxygen violate criteria (and hence the Clean Water Act), we will need to develop a strategy to fix the problem. Maine DEP believes that the IC method provides a technically credible mechanism to begin addressing stream impacts due to stormwater and IC.

Anybody who has tried to fix an impaired stream knows that it is truly an iterative process, that the biological response is not completely predictable, despite more precise input numbers. We could have chosen a more precise, time consuming and expensive model for Barberry Creek, but the implementation endpoint would be the same. Given that, we would rather move as efficiently as possible to the endpoint, to begin the restoration process and retest the stream periodically to gauge progress.

The advantage the TMDL offers is to take Barberry off the 303d list and raise the watershed's eligibility for available restoration money.
Hopefully it will also serve to educate landowners and raise awareness of the problems affecting the stream.

Thanks for your input,
Sincerely,
Melissa Evers
MDEP

Calculated Daily Pollutant Loads for Barberry Creek

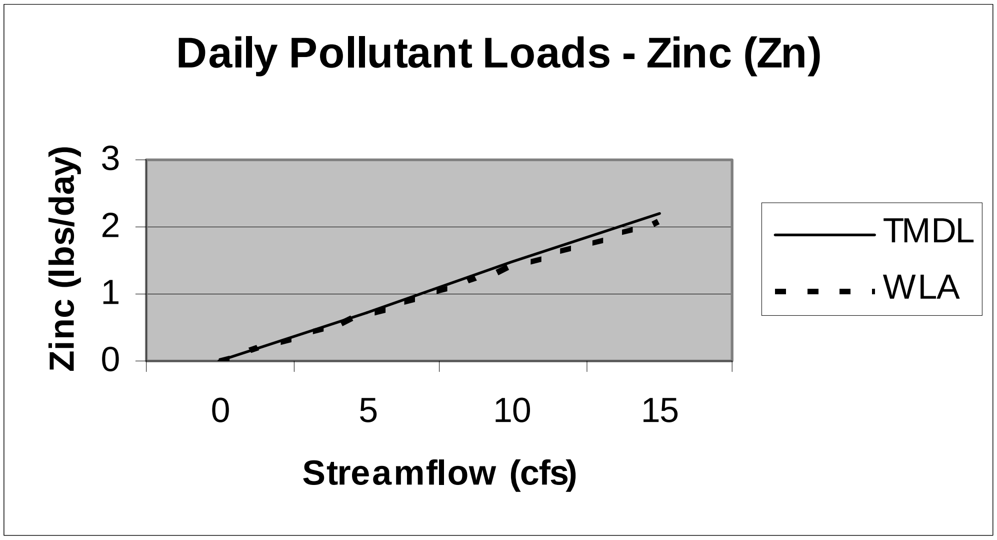


Calculated Daily Pollutant Loads for Lead in Barberry Creek displayed on graph.

Daily Lead (Pb) Pollutant Loads	Based on Maine SWQC @ 20 mg/l hardness Pb Criteria Chronic Concentration **CCC = 0.41 (ug/l)**	
Stream Flow[1] (cfs)	***TMDL[2] (lbs/day)***	***WLA (5%MOS)[3] (lbs/day)***
0.01	0.000022	0.000021
1	0.0022	0.0021
5	0.011	0.010
10	0.022	0.021
15	0.033	0.031

1. Stream Flow values based on the expected range of flows in Barberry Creek
2. TMDL = Total Maximum Daily Load calculated using flow and SWQC CCC
3. WLA = Waste Load Allocation is 95% of the TMDL or a 5% Margin of Safety calculated for the CCC

Calculated Daily Pollutant Loads for Barberry Creek



Calculated Daily Pollutant Loads for Zinc in Barberry Creek displayed on graph.

Daily Zinc (Zn) Pollutant Loads	Based on Maine SWQC @ 20 mg/l hardness	
	Zn Criteria Chronic Concentration **CCC = 27.1 (ug/l)**	
Stream Flow[1] (cfs)	***TMDL[2] (lbs/day)***	***WLA (5%MOS)[3] (lbs/day)***
0.01	0.0015	0.0014
1	0.15	0.14
5	0.73	0.69
10	1.46	1.39
15	2.19	2.08

4. Stream Flow values based on the expected range of flows in Barberry Creek
5. TMDL = Total Maximum Daily Load calculated using flow and SWQC CCC
6. WLA = Waste Load Allocation is 95% of the TMDL or a 5% Margin of Safety calculated for the CCC

Best Management Practices for Mitigating Impacts of Impervious Cover

2005, ENSR Corporation, Westford, MA

Management Practice	Runoff Volume (↑)	Peak Flow Rates (↑)	Bankfull Flow (↑)	Base Flow (↑)	Mod. Sed. Transport (↑)	Channel Morph. Changes [1]	In-Stream Temp. (↑)	Sediment Conc. (↑)	Nutrient Conc. (↑)	Metal Conc. (↑)	Hydrocarbon Conc. (↑)	Bacteria / Pathogens (↑)	Organic Carbon Conc. (↑)	MTBE Conc. (↑)	Pesticide Conc. (↑)	Deicer Conc. (↑)	New Development	Retrofit	Urban	Sub-Urban	Agricultural	Residential Sub-Division	Commercial	Industrial	Notes
	Ability to mitigate for impacts of IC																Applicability								
Traditional Practices																									
Created Wetland/Biofilter Detention	Moderate	Good	Moderate	Minimal	Moderate	Moderate	Adverse	Moderate	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	Moderate	Moderate	Well	Moderately	Moderately	Well	Well	Well	Well	Well	
Deep Sump Catch Basins	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Well	Well	Well	Well	Moderately	Well	Well	Well	Pre-treatment prior to exfiltration of BMPs
Exfiltration Swale	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well	Moderately	Moderately	Well	Well	Well	Well	Well	Permeable site soils required. Pre-treatment recommended.
Exfiltration Trench/Galley	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well	Well	Well	Well	Well	Well	Well	Well	Permeable site soils required. Pre-treatment recommended.
Extended Wet Detention	Minimal	Good	Moderate	Minimal	Moderate	Moderate	Adverse	Moderate	Moderate	Moderate	Good	Moderate	Moderate	Minimal	Moderate	Minimal	Well	Moderately	Moderately	Well	Well	Well	Well	Well	
Retention/Exfiltration Basin	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well	Moderately	Moderately	Well	Well	Well	Well	Well	Permeable site soils required. Pre-treatment recommended.
Sand/Organic Filter	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Well	Well	Well	Well	Well	Well	Well	Well	
Vegetated Filter Strip	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Well	Well	Moderately	Well	Well	Well	Well	Well	
Water Quality Inlet	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Well	Well	Well	Well	Well	Well	Well	Well	Includes proprietary hydrodynamic devices. Pre-treatment prior to exfiltration BMPs.
Water Quality Swale	Moderate	Good	Moderate	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Moderate	Good	Moderate	Moderate	Minimal	Moderate	Minimal	Well	Moderately	Moderately	Well	Well	Well	Well	Well	Dry swale with some exfiltration.
Wet Detention	Minimal	Good	Moderate	Minimal	Moderate	Moderate	Adverse	Moderate	Moderate	Moderate	Good	Adverse	Moderate	Minimal	Moderate	Minimal	Well	Moderately	Moderately	Well	Well	Well	Well	Well	
Low Impact Development Practices																									
Bioretention	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well	Well	Well	Well	Moderately	Well	Well	Well	
Comprehensive LID Site Design	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well	Not Applicable	Well	Well	Moderately	Well	Well	Well	Incorporation of LID practices to mimic pre-development hydrology.
Disconnecting Impervious Area	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Well	Well	Moderately	Well	Moderately	Well	Well	Well	
Flow Path Practices	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well	Not Applicable	Well	Well	Well	Well	Well	Well	Includes increasing roughness, sheet flow, flow path length and flattening slopes.
Green Roof	Good	Good	Good	Minimal	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well	Moderately	Well	Well	Moderately	Moderately	Well	Well	
Minimize Disturbance Area	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well	Not Applicable	Well	Well	Well	Well	Well	Well	Used as component of LID site design.
Minimize Site Imperviousness	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well	Not Applicable	Well	Well	Well	Well	Well	Well	Includes limiting use of sidewalks and reducing road/driveway length/width.
Pervious Pavement	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well	Well	Well	Well	Moderately	Well	Well	Well	
Preserve Infiltratable Soils	Good	Moderate	Moderate	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well	Not Applicable	Well	Well	Well	Well	Well	Well	Used as component of LID site design.
Preserve Natural Depression Areas	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well	Not Applicable	Well	Well	Well	Well	Well	Well	Used as component of LID site design.
Rain Barrels/Cisterns	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well	Well	Well	Well	Moderately	Well	Well	Well	
Rain Garden	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well	Well	Well	Well	Moderately	Well	Well	Well	
Soil Amendment	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well	Well	Moderately	Well	Well	Well	Moderately	Moderately	Used as component of LID site design.
Vegetation Preservation	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well	Not Applicable	Well	Well	Well	Well	Well	Well	Used as component of LID site design.

[1] Impacts include channel enlargement/incision/embededness, changes in pool/riffle structure and reduced channel sinuousity.

KEY
- Adverse Impact
- Minimal Mitigation
- Moderate Mitigation
- Good Mitigation
- Not Applicable
- Moderately Suited
- Well Suited

**WEB-BASED RESOURCES FOR INFORMATION ON
STORMWATER ISSUES AND BEST MANAGEMENT PRACTICES**

Note that this list is only a starting point and does not attempt to be comprehensive.

Center for Watershed Protection. Publications and Stormwater Management.
http://www.cwp.org/pubs_download.htm
http://www.cwp.org/stormwater_mgt.htm

City of Nashua, New Hampshire. 2003. Alternative Stormwater Management Methods. Part 2 – Designs and Specifications. City of Nashua, New Hampshire
http://ceiengineers.com/publications/nashuamanualpart2.pdf

Connecticut NEMO (Non-point Education for Municipal Officials). Reducing Runoff.
http://nemo.uconn.edu/reducing_runoff/index.htm

Connecticut River Joint Commissions (CRJC). 2000. Introduction to Riparian Buffers for the Connecticut River Watershed. CRJC, Charlestown, NH. 4 pp. www.crjc.org/buffers/Introduction.pdf

Cumberland County Soil and Water Conservation District. Technical Assistance.
http://www.cumberlandswcd.org/Technical%20Assistance.htm

Maine Department of Environmental Protection (MDEP). Stormwater Program, "think blue", Nonpoint Source Pollution education, and riparian buffer information.
http://www.maine.gov/dep/blwq/docstand/stormwater/
http://www.thinkbluemaine.org/
http://www.maine.gov/dep/blwq/doceducation/nps/background.htm
http://www.maine.gov/dep/blwq/docstream/team/riparian.htm

2003a. Maine Erosion and Sediment Control BMPs. Maine Department of Environmental Protection, BLWQ, Augusta, ME; DEPLW 0588.
http://www.maine.gov/dep/blwq/docstand/escbmps/

Maine NEMO (Non-point Education for Municipal Officials). Fact sheets.
http://www.mainenemo.org/publication.htm

Maine State Planning Office (MSPO). Sprawl & Smart Growth Resources.
http://www.state.me.us/spo/landuse/resources/sprawl.php

The Stormwater Manager's Resource Center.
http://www.stormwatercenter.net/

U.S. Department of Agriculture (US DA). US DA National Agroforestry Center, Visual Simulation for Resource Planning.
http://www.unl.edu/nac/simulation/

U.S. Environmental Protection Agency (US EPA). Stormwater Program, Low Impact Development (LID) page, and Encouraging Smart Growth.
http://cfpub.epa.gov/npdes/home.cfm?program_id=6
http://www.epa.gov/owow/nps/lid/
http://www.epa.gov/smartgrowth/

DRAFT
Maine Department of Environmental Protection

Percent Impervious Cover TMDL Guidance for Attainment of Tiered Aquatic Life Uses

This policy pertains to the innovative Impervious Cover Method (% IC) which was developed as one possible approach for Total Maximum Daily Load (TMDL) assessments in impaired rivers and streams (ENSR 2004). Many of these impaired waterbodies are located primarily in areas included in EPA's NPDES Phase 2 Stormwater Program maps for MS4s[1]. The guidelines in Table 1 apply biomonitoring data from the Maine Department of Environmental Protection (MDEP) to the % IC TMDL approach which links watershed impervious cover to stream quality. In a TMDL, the % IC method may be the sole method proposed to achieve the removal of impairments, or it may be supplemented by other abatement strategies designed to address distinct sources of stressors (such as effects of CSOs).

Table 1. Percent Impervious Cover (IC) Policy guidelines for expected attainment of Maine's designated aquatic life uses. TMDL (Loading Capacity), WLA, Waste Load Allocation; MOS, Margin of Safety.

Statutory Class	Class attainment demonstrated in MDEP data at % IC	TMDL Target Values for % IC (TMDL = WLA + MOS)		
		TMDL	**WLA[1]**	**MOS**
Class AA	~6 % [2]	Does not apply[3]		
Class A		<6 %	<5 % [4]	1 %
Class B	~8 %	7 - 10 % [4]	6 – 9 % [4]	1 %
Class C	~15 %	10 - 15 % [4]	8 – 13 % [4]	2 %

1 Load allocation (LA) is included in the WLA because it is not feasible to calculate separately.
2 For attainment determination, Classes AA and A are combined.
3 Because of the high-priority, sensitive nature of Class AA streams, application of a generalized method such as the % IC method is not advised.
4 Stream-specific targets will be chosen for each TMDL.

The goal of the TMDL is attainment of Maine's aquatic life criteria and the % IC target provides an engineering means to achieve that end. Target values represent the level of impervious cover that generally coexists with a biological community that meets aquatic life criteria as defined by Statutory Class. Achieving the % IC target requires the long-term implementation of Best Management Practices (BMPs) to effectively reduce stormwater quantity and improve quality. Each TMDL will suggest stream-specific (if possible) BMPs

[1] For maps, see www.maine.gov/dep/blwq/docstand/stormwater/maps/index.htm

and restoration techniques for short-term implementation to reduce urbanization impacts while long-term adaptive approaches are developed. No further reductions in % IC or implementation of BMPs will be required once aquatic life criteria are met (as determined by biological monitoring).

For each TMDL, MDEP staff will employ best professional judgment to set a single % IC value based on knowledge of site-specific conditions and aquatic life goals for the waterbody. These conditions can be either ameliorating or exacerbating, leading to a % IC recommendation near the upper or lower end of the range shown in Table 1 (column "TMDL"), respectively. Ameliorating conditions include existence of an adequate riparian buffer, demonstrated cold water input into the stream, an intact flood plain, or a highly permeable soil group. Exacerbating conditions include absence of an adequate riparian buffer, loss of the flood plain, an impermeable soil group, naturally stressful in-stream conditions (e.g., lower dissolved oxygen concentrations or elevated temperature due to an upstream wetland), a concentration of imperviousness in one reach of a stream, or a documented pollution legacy of the watershed (e.g., from long-established industrial site). Other ameliorating or exacerbating circumstances may be considered on a case by case basis.

The % IC guidelines in Table 1 are based on analysis of MDEP Biomonitoring Program data from 43 macroinvertebrate samples collected between 1994 and 2004 from 32 watersheds of first to third order in size[1] that were influenced by differing amounts of % IC (minimum 5 %) upstream of the sampled location (Appendix 1). Detectable changes in structural characteristics of aquatic assemblages (fish and benthic macroinvertebrates) are noted, in the scientific literature, to occur above ~10 % IC (Paul and Meyer 2001, CWP 2003). Analysis of Maine macroinvertebrate data supports this finding, with streams above 8 % IC rarely attaining Class B aquatic life numeric criteria (Code of Maine Rules 06-096, Chapter 579*: "Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams").* Class B criteria are designed to support the narrative standard of "no detrimental change in the resident biological community" (Title 38 MRSA §465). Class C is the lowest condition allowed for Maine rivers and streams, and "discharges to Class C waters may cause some changes to aquatic life". Class C criteria are designed to support the narrative standard of "maintenance of structure and function of the resident biological community." The Maine data also indicate that impervious cover of 15 % is adequate, in most cases, for attainment of Class C numeric aquatic life criteria. The % IC guideline ranges specified in Table 1, column "TMDL", were selected to cover % IC values found adequate to support water quality Classes B and C in Maine, while also accounting for the % IC quoted in the literature (10 %, CWP 2003) as impacting aquatic systems.

Tiered designated uses in Maine's water quality standards are designed to provide four levels of protection for rivers and streams. Waterbodies are assigned to a designated use class that represents the highest attainable goal condition, taking into account current environmental conditions (e.g., attainment status for dissolved oxygen, bacteria, and aquatic life standards) as well as socioeconomic factors. As shown in Table 2,

Table 2. Percent of river and stream miles in Maine's designated use

Statutory Class	% of total miles
Class AA	6 %
Class A	45 %
Class B	47 %
Class C	2 %

[1] The % IC method for urban stream TMDLs is only appropriate for streams of 1st to 3rd order.

most river and stream miles in the state are managed for Class AA/A[1] or Class B conditions and thus would require application of the <6 % or 7-10 % IC guidelines, respectively.

It is expected that an adaptive management approach to implementing stream restoration techniques and BMPs, including a reduction in % IC, will lead to an improvement in macroinvertebrate communities. If aquatic life criteria are not met after a first phase of implementation, the initial TMDL approach will be re-evaluated and further recommendations be made based on new insights gained.

References

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1. CWP, Ellicott City, MD. 142 pp.

ENSR Corporation. 2004. Draft, Pilot TMDL Applications using the Impervious Cover Method. Document # 10598-001-002.

Paul M.J., Meyer J.L. 2001. Streams in the Urban Landscape. Ann Rev Ecol Sys 32: 333-365.

[1] Very few Class AA/A waterbodies are currently in urban areas so that the % IC policy will be applied only rarely to such streams. MDEP's 2004 303(d) list includes no Class AA/A streams with "Urban NPS" as the potential source of aquatic life impairment.