Total Maximum Daily Load (TMDL) Study For Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH:

Dinsmore Brook in Windham, NH

Photo Credit: New Hampshire Department of Transportation

April 18, 2008

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Total Maximum Daily Load (TMDL) Study For Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH:

Dinsmore Brook in Windham, NH

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Table of Contents

List of Tables

List of Figures

1. Introduction

Section 303(d) of the Clean Water Act (CWA) and the Environmental Protection Agency's Water Quality Planning Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water quality limited segments that are not meeting designated uses under technology-based controls for pollution. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollutant sources and instream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources.

The purpose of this study is to develop a TMDL for chloride in the Dinsmore Brook watershed located in Windham, N.H. The goal is to reduce chloride loads so that water quality standards for all the designated uses affected by chloride pollution are met in all areas of the Dinsmore Brook watershed.

2. Problem Statement

a. Waterbody Description

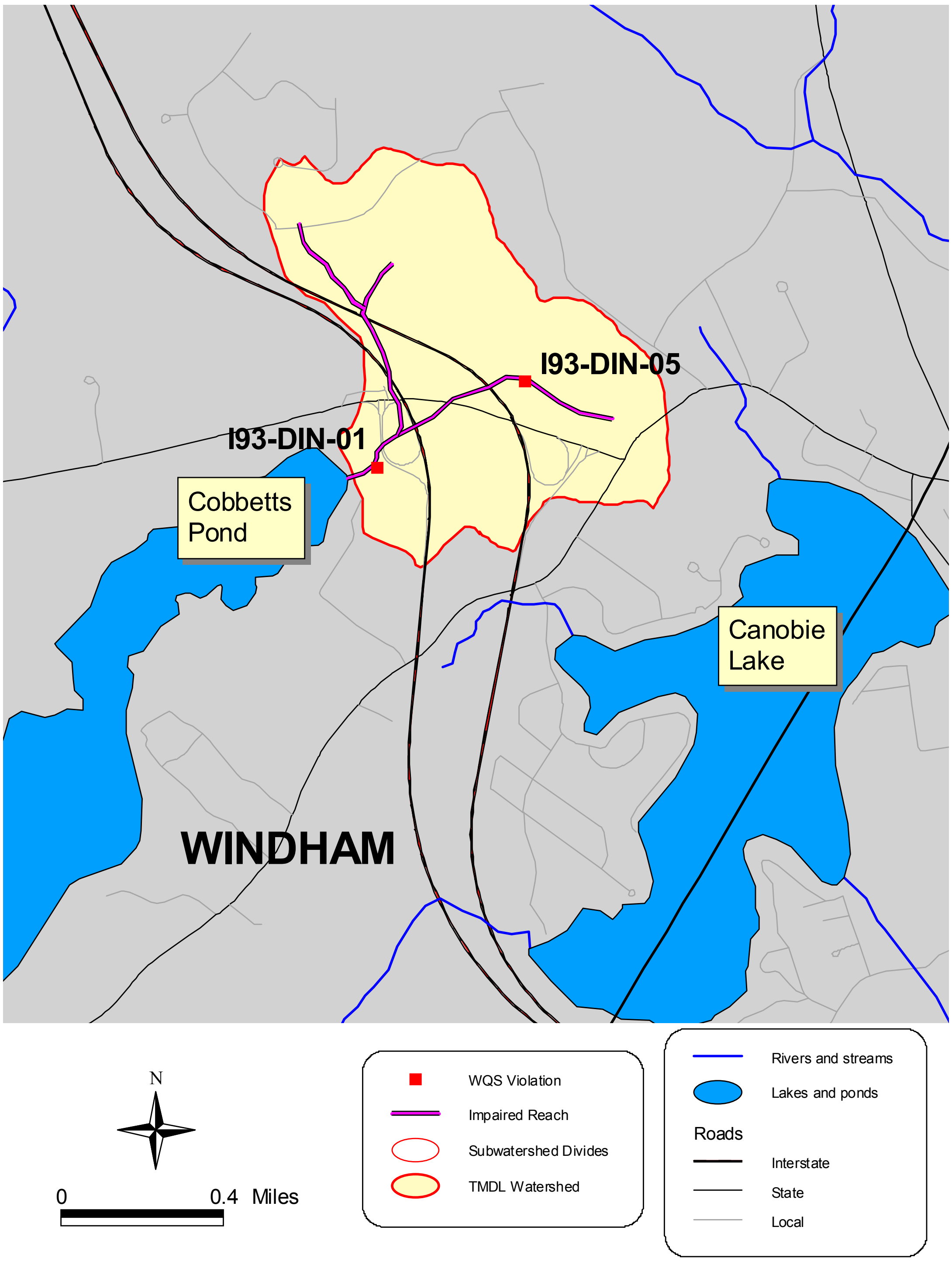
The assessment unit for this TMDL is Dinsmore Brook (NHRIV700061204-01). It is a stream segment of 1.5 miles located in Windham, N.H. The watershed for this assessment unit is 0.55 square miles (Figure 1). Land use characteristics of the watershed are listed in Table 1.

Table 1: Land use in the Dinsmore Brook watershed

Land Use and Demographics	**Dinsmore Brook Watershed**	**Units**
Agriculture	4.19	% of area
Cleared	10.53	% of area
Developed	6.68	% of area
Forested	60.64	% of area
Transportation	14.78	% of area
Wetland	3.18	% of area
Drainage Area	0.55	Square miles
Population	103	People
Housing Units	30	Number
Population Density	186	People/sq.mi.
"Urbanized Area" Classification	28.6%	% of area

Data Source: DES (2007b)

Figure 1: Impaired Assessment Units and Water Quality Violations in the Dinsmore Brook Watershed



b. Applicable Water Quality Standards and Water Quality Numeric Targets

Water Quality Standards determine the baseline water quality that all surface waters of the State must meet in order to protect their intended (designated) uses. They are the "yardstick" for identifying where water quality violations exist and for determining the effectiveness of regulatory pollution control and prevention programs. The standards are composed of three parts: designated uses; criteria; and antidegradation regulations.

In New Hampshire, all state surface waters are classified as either Class A or Class B, with the majority of waters being Class B. A general description of designated uses for each classification may be found in state statute, RSA 485-A. According to New Hampshire's Consolidated Assessment and Listing Methodology (CALM; DES, 2005), designated uses for New Hampshire surface waters include those shown in Table 2.

The second major component of water quality standards is the "criteria." These are numeric or narrative criteria which define the water quality requirements for Class A or Class B waters. Criteria assigned to each classification are designed to protect the designated uses for each classification. A waterbody that meets the criteria for its assigned classification is considered to meet its intended use. Water quality criteria for each classification may be found in RSA 485-A:8, I-V [www.gencourt.state.nh.us/rsa/html/L/485-A/485-A-8.htm] and in the State of New Hampshire Surface Water Quality Regulations (Env-Ws 1700) [www.des.nh.gov/rules/env-ws1700.pdf].
The CALM (DES, 2005) describes the methodologies for comparing water quality data with the criteria to assess designated use support.

The third component of water quality standards consists of antidegradation provisions which are designed to preserve and protect the existing beneficial uses of the State's surface waters and to limit the degradation allowed in receiving waters. Antidegradation regulations are included in Part Env-Ws 1708 of the New Hampshire Surface Water Quality Regulations. Antidegradation is not a consideration for this TMDL study.

Dinsmore Brook is a Class B waterbody. According to Env-Ws 1703.21, the water quality criteria for chloride in nontidal Class B waterbodies to protect aquatic life is that concentrations should not exceed 860 mg/L for acute exposures or 230 mg/L for chronic exposures. Acute aquatic life criteria are based on an average concentration over a one-hour period and chronic criteria are based on an average concentration over a period of four days (EPA, 1991) The frequency of violations for either acute or chronic criteria should not be more than once every three years, on average (EPA, 1991).

Table 2: Designated Uses for New Hampshire Surface Waters

Designated Use	DES Definition	Applicability
Aquatic Life	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.	All surface waters
Fish Consumption	Waters that support fish free from contamination at levels that pose a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.	All tidal surface waters
Drinking Water Supply	Waters that with adequate treatment will be suitable for human intake and meet state/federal drinking water regulations.	All surface waters
Primary Contact Recreation (i.e. swimming)	Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water.	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life.	All surface waters

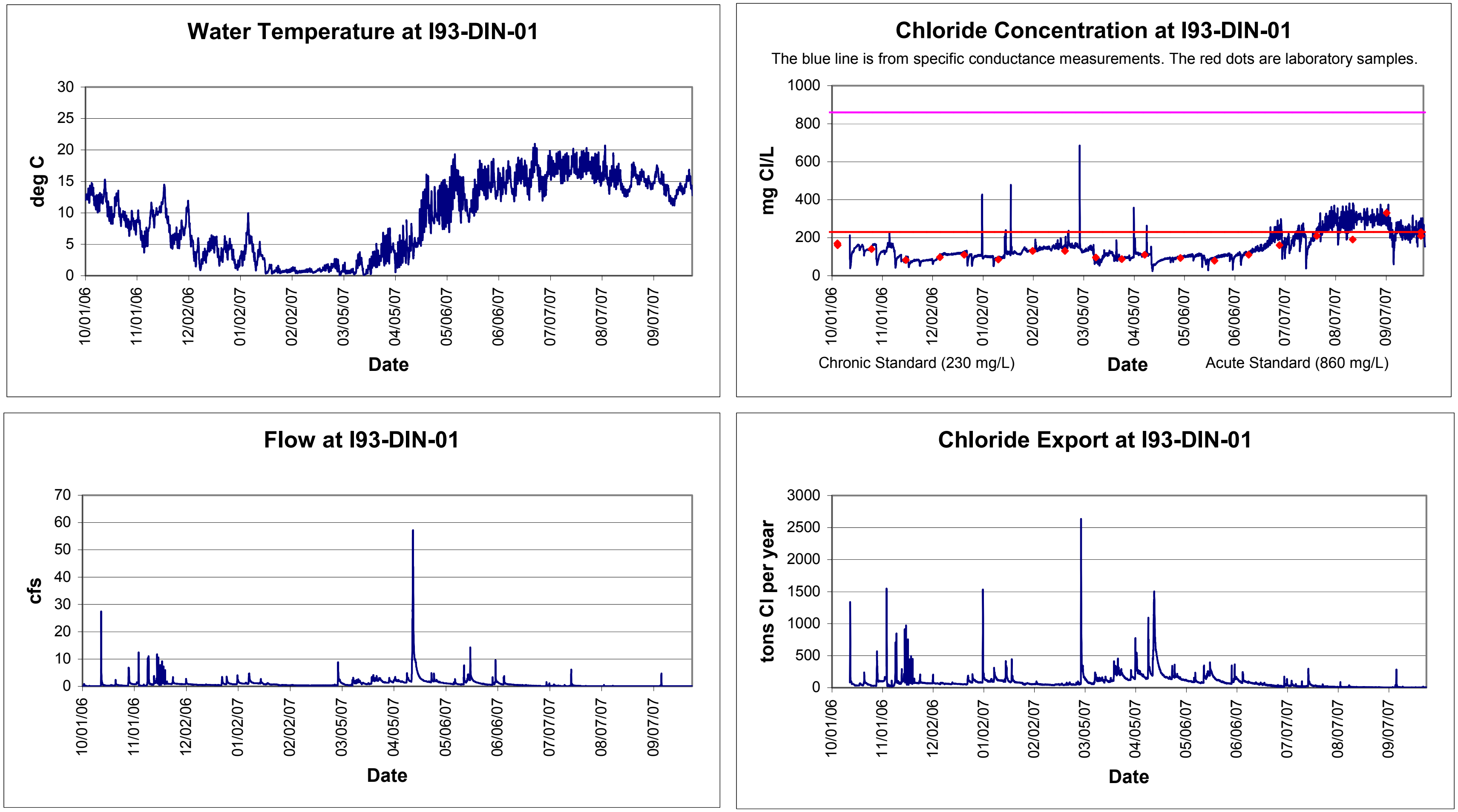
3. Dinsmore Brook Receiving Water Quality Characterization

In the winters ending in 2003, 2004, 2005 and 2006, the New Hampshire Department of Environmental Services (DES), the US Environmental Protection Agency (EPA), and the New Hampshire Department of Transportation (DOT) monitored chloride in watersheds in the vicinity of I-93 in southern New Hampshire. Chloride concentrations were primarily measured in winter with near continuous specific conductance readings by data loggers[1]. DES placed the assessment unit NHRIV700061204-01 on New Hampshire's 2006 Section 303(d) list because measurements of chloride concentrations through 2005 demonstrated exceedences of State surface water quality standards. This assessment unit, along with all rivers and lakes in the state, is also listed as impaired for the fish consumption designated use due to the state-wide fish consumption advisory for mercury.

For this TMDL study, DES, EPA and DOT developed a monitoring program to collect a comprehensive and standardized dataset for chloride, stream flow, and chloride imports to and exports from the watershed (DES, 2006). The monitoring plan was implemented between July 1, 2006 and September 30, 2007. The data from this monitoring program have been summarized in a Data Quality Audit (DES 2007a) and a Data Report (DES 2007b). The difference between the TMDL monitoring and the previous efforts is that data were collected at the same time at all stations to allow comparison between stations under similar conditions. Stream flow data were collected so that chloride flow duration curves and export calculations could be made. Figure 2 shows the near continuous measurements of temperature, chloride, stream flow, and chloride export (product of chloride concentration and stream flow) at station I93-DIN-01 between October 1, 2006, and September 30, 2007. The average values for these parameters over the year were 9.12 ^{o}C, 148.95 mg Cl/L, 0.97 cfs, and 92.44 tons Cl/yr, respectively. For perspective, typical concentrations of chloride in New Hampshire rivers in 1920, before salt was used as a deicer, were 1.3 mg Cl/L (Hall, 1975).

[1] Data loggers are devices which can be programmed to read and store values from sensors deployed in the field at a set frequency. For this study, data loggers were used to record measurements of water temperature and specific conductance in various streams every 15 minutes.

Figure 2: Time Series of Temperature, Chloride, Stream Flow and Chloride Export at Station I93-DIN-01

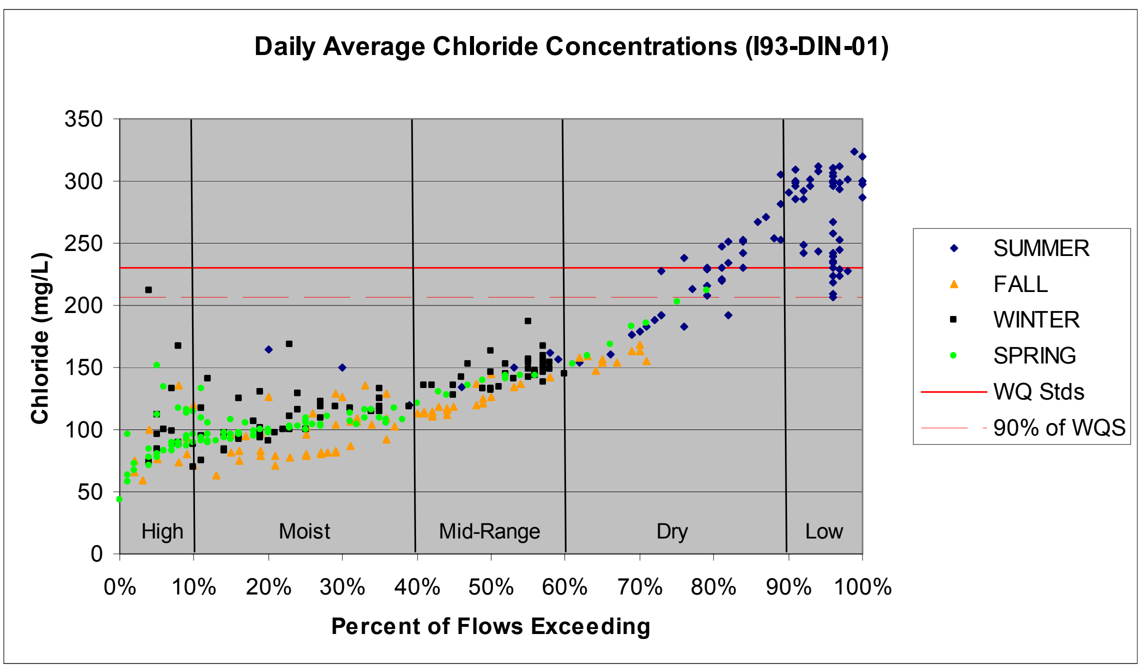


Data Source: DES (2007b)

The monitoring for the TMDL study detected violations of the chronic water quality standard. At station I93-DIN-01 (Figure 1) the water quality violated the chronic standard for 68.5 days of the year (18.8 percent). All of the locations in the watershed at which violations of water quality standards have been detected are shown in Figure 1. The violations on this figure are from a compilation of all relevant data from 2002-2007 (DES, 2007b). The number of violations and the exact dates when these violations occurred are summarized in a data report (DES, 2007b).

Concentration-flow duration curves were used to document how the chloride concentration changed with stream flow (DES, 2007b). For these plots, the measured stream flow on a date was converted to the percent of the time when that flow level is exceeded. The methods for the historical flow duration calculations are provided in a data report (DES, 2007b). The concentration-flow duration plot for station I93-DIN-01 is shown in Figure 3. This figure indicates that the highest concentrations occur when stream flows are low (flow exceedence percentiles of 60-100 percent, “dry” or “low flow” conditions). Violations of the water quality standard occurred exclusively in the summer. However, concentration-flow duration plot indicates that that low stream flow is the critical condition for violations.

Figure 3: Concentration-Flow Duration Plot for Station I93-DIN-01



Data Source: DES (2007b)

4. Source Characterization

Chloride in the form of salt is imported to the study watersheds from several major sources: Roadway deicing, food waste (e.g., sewage), water softeners, atmospheric deposition, and roadway salt pile runoff. DES estimated the mass of salt imported from each source. Details on how these estimates were made are provided in a data report (DES, 2007b). For the TMDL, groundwater was considered a pathway for chlorides, not an independent source.

All of the chloride imported to the watershed is eventually delivered to the impaired reach through stormwater runoff and groundwater flow. Stormwater flow through municipal storm sewer systems (MS4) covered by the Phase II stormwater program regulations will be considered a point source for this TMDL (EPA, 2002). The balance of the stormwater runoff will be considered a non-point source. Twenty nine percent of the watershed is covered by the MS4 Phase II program (Table 1); therefore, 29% of the chloride load will be considered a point source.

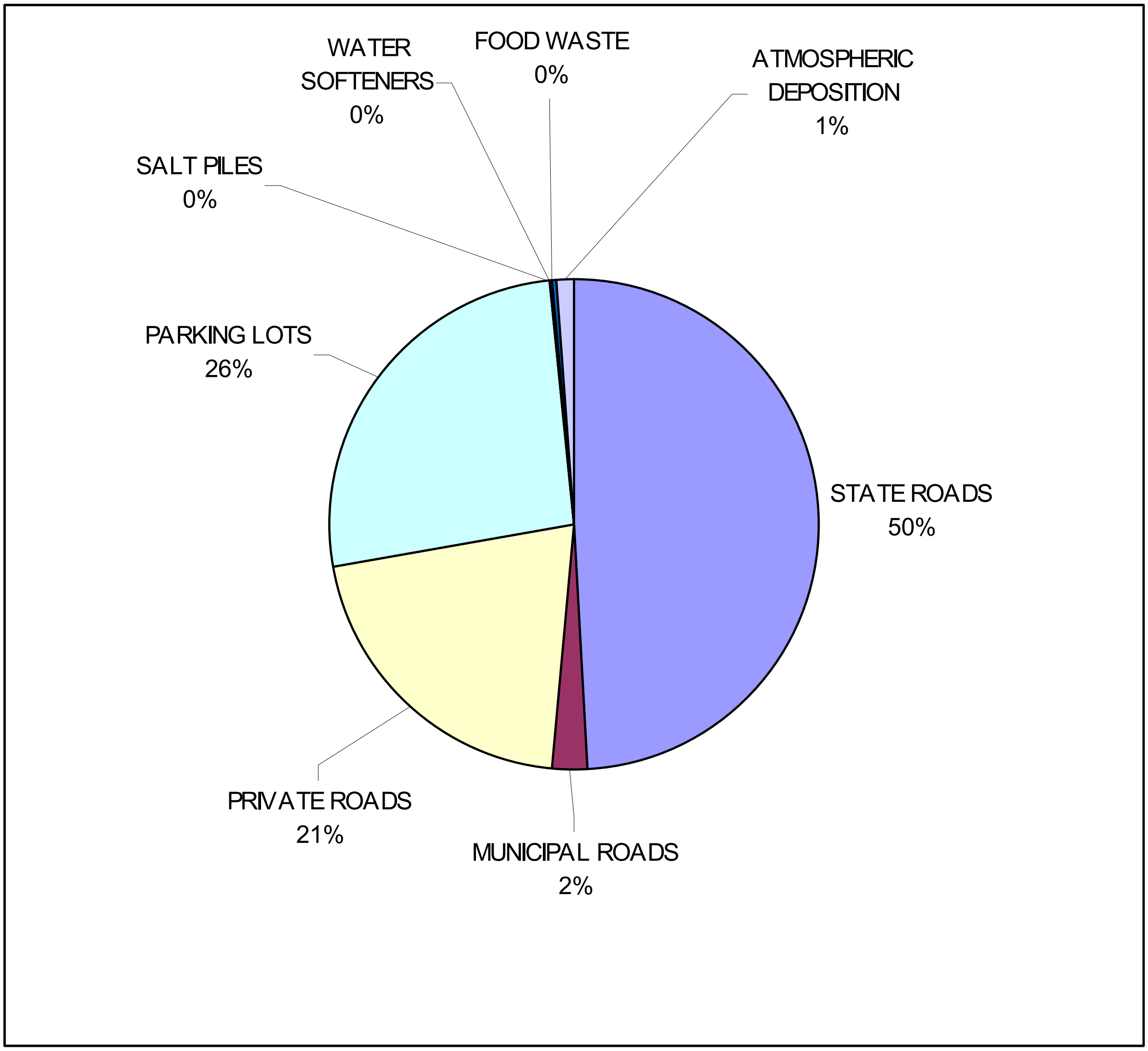
The salt imports for the period July 1, 2006 to June 30, 2007 are listed by source in Table 3. DES has assumed that the salt imports for this period would be the same for the October 1, 2006 to September 30, 2007 period (to match the water quality record). The only salt import source with a seasonal cycle is deicing and no deicing occurs during the summer months. A total of 166.5 tons of salt was imported to the watershed at an average rate of 301.3 tons of salt per square mile of drainage area. The contribution of each source to the total load is shown in Figure 4. Deicing of roadways and parking lots accounted for 98 percent of the imports, with state roads being the single largest source (49 percent). There were no salt piles in the watershed. Water softeners, food waste, and atmospheric deposition were minor components.

Table 3: Sources of Salt to the Dinsmore Brook Watershed

Source	**Agency/Town**	**Salt Imports (tons salt/yr)**
State Roads	NHDOT PS 514	24.7
	NHDOT PS 528	57.0
Municipal Roads	Windham	4.0
Private Roads	Windham	34.3
Parking Lots	Windham	43.4
Salt Piles	Windham	0.0
Water Softeners	NA	0.7
Food Waste	NA	0.5
Atmospheric Deposition	NA	1.7
Total		166.5

Data Source: DES (2007b)

Figure 4: Relative Contribution of Each Source to the Total Salt Imports to the Watershed



Data Source: DES (2007b)

5. TMDL and Allocations

a. Definition of a TMDL

According to the applicable federal regulations, 40 CFR Part 130.2, the total maximum daily load (TMDL) for a waterbody is equal to the sum of the individual loads from point sources (i.e., waste load allocations or WLAs), and load allocations (LAs) from nonpoint sources (including natural background conditions). Section 303(d) of the CWA also states that the TMDL must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety (MOS), which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. In equation form, a TMDL may be expressed as follows:

$$TMDL = WLA + LA + MOS$$

where:
WLA = Waste Load Allocation (i.e., loadings from point sources)
LA = Load Allocation (i.e., loadings from nonpoint sources including natural background)
MOS = Margin of Safety

TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure (40 CFR, Part 130.2 (i)). The Dinsmore Brook TMDL will be expressed as a load duration curve following guidance from EPA (EPA, 2007). The MOS can be either explicit or implicit. If an explicit MOS is used, a portion of the total allowable loading is actually allocated to the MOS. If the MOS is implicit, a specific value is not assigned to the MOS. Use of an implicit MOS is appropriate when assumptions used to develop the TMDL are believed to be so conservative that they are sufficient to account for the MOS.

b. Determination of TMDL

i. Seasonal Considerations/Critical Conditions

Section 303(d) of the CWA states that the TMDL must be established at a level necessary to attain the applicable water quality standards with seasonal variations. In Table 4, the factors which can influence chloride concentrations have been listed, along with how those factors will be manipulated to ensure that the TMDL will result in attainment of water quality standards during critical conditions.

Table 4: Factors for Determining Critical Conditions

Factor	Effect on Chloride Concentration	Selection of Critical Condition
Season	Figure 3 shows that most violations occurred during the summer season during a period of low stream flow.	The TMDL will be expressed as a load duration curve to set limits for low flow periods during the summer season.
Stream Flow	Figure 3 shows that chloride concentrations increase as stream flows decrease. The critical hydrologic condition is 60-100 percent flow exceedences ("dry" or "low flow" conditions).	The TMDL will be expressed as a load duration curve to accurately describe the acceptable load at each stream flow.
Location	The proximity of salt sources can affect the chloride concentration in the waterbody.	Data from the year round station with the most violations of the water quality standard will be the basis for the TMDL.
Water Quality Standard	Either the acute or chronic water quality standard must be chosen to set the target for the TMDL.	The chronic standard will be the basis for the TMDL target because most of the violations in the watershed were of the chronic standard. The chronic standard is also lower than the acute standard.

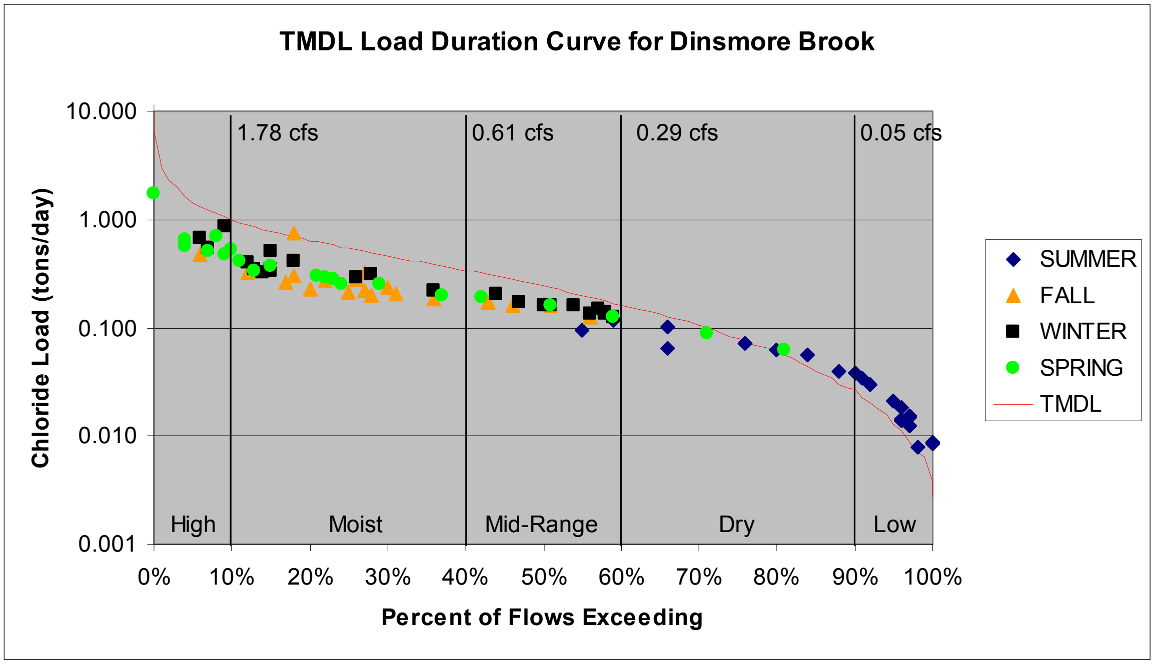
ii. Margin of Safety

An explicit Margin of Safety (MOS) will be used in the TMDL calculation. The TMDL will be set at 90 percent of the chronic water quality standard (90%*230 mg C/L = 207 mg Cl/L). This assumption is equivalent to holding 10 percent of the loading in reserve to account for scientific uncertainty.

iii. TMDL Calculation

The TMDL will be expressed as a load duration curve following guidance from EPA (EPA, 2007) and in compliance with the approved Quality Assurance Project Plan (DES, 2006). The TMDL will be 90 percent of the chronic water quality standard (207 mg Cl/L) multiplied by each stream flow in the four-day average flow duration curve. The four-day average flow duration curve was used because the chronic water quality standard applies to four-day average concentrations. The TMDL will be set for the outlet station of the watershed, I93-DIN-01, because the watershed is small. Figure 5 shows the TMDL load duration curve and the existing loads measured at I93-DIN-01 between October 1, 2006 and September 30, 2007. The units for the TMDL are tons of chloride per day. At each point on the TMDL curve, the waste load allocation for MS4 permittees is 28.6 percent of the TMDL and the load allocation for non-point sources is 71.4 percent of the TMDL (not shown on figure). The margin of safety is explicit. The TMDL load duration curve is not expected to change; therefore, this TMDL is relevant to all existing and future impairments due to chloride in the Dinsmore Brook watershed.

Figure 5: TMDL Load Duration Curve at Station I93-DIN-01



The TMDL can be alternatively expressed as a percent reduction goal (PRG) to guide implementation. The method for calculating the PRG was described in the approved Quality Assurance Project Plan (DES, 2006). In summary, each individual chloride export value was compared to the TMDL. If the value was higher than the TMDL, the percent by which this value would need to be reduced to reach the TMDL was calculated. All of the individual PRGs calculated for the "dry" hydrologic condition were grouped and the 90th percentile value calculated (DES, 2007b). Even though many water quality violations occurred in the "low flow" hydrologic condition, the "dry" condition was chosen for this calculation following guidance in EPA (2007). Low flow conditions are extreme events which are not representative of typical conditions; reliable data from these extreme events are difficult to obtain. The four-day averaging period was used for this calculation to be consistent with the chronic water quality standard and the TMDL load duration curve. For the Dinsmore Brook watershed, the PRG was determined to be 24.3 percent for the October 1, 2006 to September 30, 2007 period. The total salt imports to the watershed during this period were 166.5 tons of salt per year. Therefore, salt imports to the watershed should be less than 126.0 tons of salt per year in order to attain water quality standards.

iv. Allocation of Loads

In 2006, DOT and DES established an interagency Salt Reduction Workgroup. The purpose of the workgroup is to advise DES and DOT on this TMDL and all other chloride TMDL studies in the I-93 corridor until these studies are completed, and then to advise and assist with implementation of required salt load reductions. The workgroup includes representatives from the following: DES; DOT; EPA; the Federal Highway Administration (FHWA); the selectmen's office of each town with area in a TMDL watershed; the public works department of each town with area in a TMDL watershed; the University of New Hampshire Technology Transfer (T2) Center; private winter road and parking lot maintenance companies; motorist associations; the State Police; the Southern New Hampshire Regional Planning Commission; the Nashua Regional Planning Commission; and the Rockingham Planning Commission. Representatives from pertinent watershed organizations an state-wide environmental organizations will be invited to join the workgroup in 2008.

In 2008, the Salt Reduction Workgroup will determine the final load allocations by sector in the implementation plan. There will be an opportunity for public comment on the implementation plan. However, as a starting point, draft allocations are presented in Table 5 based on the following assumptions:

- Ninety-eight percent of the salt imports to the watershed were for deicing activities. Therefore, essentially all of the salt import reductions will need to come from reduced deicing loads. The percent reduction in salt imports will be the same for state, municipal, and private roads and parking lots.
- The allocation for salt pile runoff will be zero because there were no salt piles in the watershed and any new salt and salt-sand piles should be covered.
- The existing loads from water softeners, food waste, and atmospheric deposition will be used as the allocation for these sources.

Table 5: Existing Salt Imports and Load Allocations

Source	Agency/Town	FY07 Salt Imports (tons salt/yr)	Allocation of Loads (tons salt/yr)
State Roads	NHDOT PS 514	24.7	18.6
	NHDOT PS 528	57.0	42.9
Municipal Roads	Windham	4.0	3.0
Private Roads	Windham	34.3	25.8
Parking Lots	Windham	43.4	32.7
Salt Piles	Windham	0.0	0.0
Water Softeners	NA	0.7	0.7
Food Waste	NA	0.5	0.5
Atmospheric Deposition	NA	1.7	1.7
Total		166.5	126.0

6. Implementation Plan

a. Statutory/Regulatory Requirements

Section 303(d)(1)(C) of the CWA provides that TMDLs must be established at a level necessary to implement the applicable water quality standard. The following is a description of activities that are planned to abate water quality concerns in the Dinsmore Brook watershed.

b. Description of Activities to Achieve the TMDL

i. Implementation Plan

To implement this TMDL, salt imports to the watershed for deicing must be limited to the allocated loads in Table 5. State law (RSA 485-A:12.II) provides that "If, after adoption of a classification of any stream, lake, pond, or tidal water, or section of such water, including those classified by RSA 485-A:11, it is found that there is a source or sources of pollution which lower the quality of the waters in question below the minimum requirements of the classification so established, the person or persons responsible for the discharging of such pollution shall be required to abate such pollution within a time to be fixed by the department."

The details of an implementation plan will be developed by the Salt Reduction Workgroup in 2008 (see section 5(b)(iv) for information on the workgroup). The plan will require that owners of property on which salt is applied track and report the amount applied. This will be compared with allocations on an annual basis to determine compliance with RSA 485-A:12 and the load allocations of Table 5. It should be noted that the load allocations in the TMDL do not include an allowance for future growth, so any future construction of additional roads or parking lots in the Dinsmore Brook watershed would necessitate additional load reductions elsewhere in the watershed beyond the allocations in Table 5.

The draft implementation plan will be made available for public comment after it is developed by the workgroup.

ii. Monitoring

Pending the availability of resources, specific conductance will be monitored at 15-minute intervals with data loggers at the outlet station for the watershed, I93-DIN-01, from July 1, 2007 to June 30, 2016. Stream flow will be estimated using regression relationships with the USGS Beaver Brook gage. The data will be analyzed by DES for violations of the acute and chronic water quality standards and percent reduction for critical conditions following the procedures used in this report. The number of violations, the percent reduction goals during the critical conditions, and the salt imports to the watershed will be tracked for each year. DES will evaluate changes in these values using multivariate linear or logistic regression with climate variables (e.g., the DOT Winter

Severity Index, flow) as covariates. A trend will be considered significant if the coefficient of the year term in the equation is significant at the $p<0.05$ level. A minimum of five years of data (and most likely 10 years) will be needed before trend analysis can be performed. Biomonitoring should be completed after water quality standards for chloride have been met at station I93-DIN-01 to verify that there are no additional impacts to aquatic life from chlorides or other contaminants.

7. Public Participation

a. Description of the Public Participation Process

EPA regulations (40 CFR 130.7 (c) (ii)) require that calculations to establish TMDLs be subject to public review. The Dinsmore Brook TMDL was released for public comment on January 2, 2008. The comment period lasted until February 8, 2008. The report was posted on the DES (www.des.nh.gov/wmb/tmdl) and the Rebuilding I93 (www.rebuildingi93.com) websites. A letter announcing the release was distributed to 132 members of a stakeholder group, consisting of the Water Quality Standards Advisory Committee, the Lakes Management and Advisory Committee, the Rivers Management Advisory Committee, the Local River Management Advisory Committees, the New Hampshire Water Council, local and regional conservation organizations, and the Salt Reduction Workgroup. DES also issued a press release which generated stories in several local papers.

b. Public Comment and DES Response

DES received comments from six organizations or individuals by the deadline:

- New Hampshire Department of Transportation
- New Hampshire Fish and Game Department
- Appalachian Mountain Club, Conservation Law Foundation, Environment New Hampshire, New Hampshire Audubon, and the New Hampshire Rivers Council
- Sierra Club
- Carol Pynn
- John Sokul, Hinkley, Allen and Snyder LLP

DES paraphrased the comments from each letter and provided responses in the following sections.

Comments from the New Hampshire Department of Transportation

1.1 The applicable water quality standard for the TMDL should be 250 mg Cl/L, not 230 mg Cl/L.

Category: No change

Response: The assessment unit for this TMDL is impaired for the aquatic life use support designated use. The EPA and DES standard for the protection of aquatic life is 230 mg Cl/L. DES conducted a review of the toxicological literature related to road salt (DES, 2007c). The report concluded that 230 mg Cl/L was the appropriate standard for the

TMDL to be protective of humans, wildlife, aquatic organisms, and most vegetation. Therefore, by setting the TMDL at the level necessary to achieve the 230 mg Cl/L standard, the TMDL addresses impacts associated with chlorides on the instream, benthic, and riparian communities. The secondary drinking water standard for chloride is 250 mg Cl/L. This standard is based on taste and odor issues, not human health. It is not appropriate for the TMDL because it is not the lowest applicable water quality standard and is not related to the impaired designated use.

1.2 The ten percent margin of safety is too high given the large amount of data collected for this study.

Category: No change

Response: A margin of safety is required for the TMDL to account for any lack of knowledge concerning the relationship between pollutant loads and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). DES selected ten percent as the margin of safety for the TMDL in the Quality Assurance Project Plan (DES, 2006), which was reviewed and approved by DOT, USGS, and EPA. There is not compelling evidence that the uncertainty in the relationship is greater than or less than ten percent. Furthermore, given the divergent comments on this topic (see comment 2.1 from AMC et al.), there is not consensus that a larger or smaller margin of safety should be adopted for policy reasons.

2.1 The error in the salt imports for parking lots is larger than the required salt reductions.

Category: No change

Response: While there may be sizeable error in the salt import estimates for private parking lots, the estimates were made based on the best available science anywhere in the country. In fact, the import estimates used for the TMDL were based on locally derived data. Plymouth State University spent one year researching this issue through painstaking local data collection and nation-wide research (Sassan and Kahl, 2007). Better estimates for salt application by this sector do not exist. An accurate salt accounting system will be needed to reduce the error in the salt import estimates as we move forward with implementation.

3.1 The relationship between specific conductance and chloride concentrations is not accurate for the summer low flow period for which violations of the water quality standard were observed.

Category: No change

Response: DOT claims that the same mechanisms that caused the 2006 dry season data at station I93-DIN-01 to be rejected appears to recur in 2007. This is not the case. For the low flow period of between July 15 and October 15, there were 5 paired measurements of chloride and specific conductance in both 2006 and 2007. In 2006, all five of the paired measurements failed the quality control tests (DES, 2007a, Table 9). In 2007, only one of the five pairs failed the tests (DES, 2007a, Appendix B). Therefore, the data collected during the low flow period in 2007 was considered valid for the TMDL, while the 2006 data was not.

DOT characterizes the 2007 low flow period as the "period for which the regression calculated chloride concentration is 128 mg/L greater than the laboratory measured chloride concentration". In fact, this claim only applies to one of the five pairs of chloride and specific conductance measurements. This pair failed the quality control test as noted above; however, four other pairs passed the test during the same period. DES used the regression equation between specific conductance and chloride from the Quality Assurance Project Plan for all of the Dinsmore Brook measurements. DES did not use a separate regression equation for the low flow period at this station.

DOT argues that during low flow periods "ions will be induced to migrate to the terminals by the electric current emitted by the terminals themselves. Without any flow to flush the ions away from the probe, the readings will increase and become more erratic until there is an event to flush the ions away." The data collected at this station does not support this claim. For the one pair of specific conductance and chloride measurements that failed the quality control test, the cause of the failure appears to be from ionic stratification in the water column, not the attraction of ions to the probe. A hand-held meter measured specific conductance near the datasonde when the chloride sample was collected. If ions had been slowly attracted to the datasonde under stagnant conditions, we would expect that a hand-held meter, freshly inserted into the water, would read a different value. In fact, the hand-held meter and the datasonde measured similar values 1,108 and 1,028 uS/cm, respectively.

<u>Comments from the New Hampshire Fish and Game Department</u>

1. New Hampshire Fish and Game Department has reviewed both documents and found them to be thorough and well done. As human activities increase on the land, the impacts to aquatic resources become ever more visible, and the people of New Hampshire lose a valuable and integral part of their community and natural heritage. These studies and the reduction of chlorides in aquatic ecosystems are essential to the protection and conservation of our aquatic resources.

Category: No change
Response: No change requested

<u>Comments from the Appalachian Mountain Club, Conservation Law Foundation, Environment New Hampshire, New Hampshire Audubon, and the New Hampshire Rivers Council</u>

1.1 The TMDL does not address impacts that can be associated with chlorides including instream, benthic, and riparian communities.

Category: No change
Response: The assessment unit for this TMDL is impaired for the aquatic life use support designated use. The EPA and DES standard for the protection of aquatic life is 230 mg Cl/L. DES conducted a review of the toxicological literature related to road salt (DES, 2007c). The report concluded that 230 mg Cl/L was the appropriate standard for the TMDL to be protective of humans, wildlife, aquatic organisms, and most vegetation.

Therefore, by setting the TMDL at the level necessary to achieve the 230 mg Cl/L standard, the TMDL addresses impacts associated with chlorides on the instream, benthic, and riparian communities. See also the response to comment 4.2 from AMC et al.

1.2 The TMDL does not ensure that water quality standards will be met in all locations in the watershed.
Category: No change
Response: For the study design, DES established continuous monitoring stations at the outlets of each of the four watersheds. Two of the watersheds were small (Dinsmore Brook and North Tributary to Canobie Lake) and the outlet stations were considered to be representative of the whole watershed. For the Policy-Porcupine and Beaver Brook watersheds, DES chose additional locations in the watersheds to represent worst-case conditions based on monitoring data from 2002-2006. Water quality at these worst-case stations was monitored continuously during the TMDL study. In both watersheds, the water quality was worse at the outlet station than at the "worst-case" station. In Policy-Porcupine Brook, the chronic water quality standard was violated for a total of 87.7 days at the outlet station (I93-POL-01V) compared to 66.0 days at the "worst case" station (I93-POL-04X) (DES, 2007b, Table 13). In Beaver Brook, water quality violations did not occur at either station; however, the average chloride concentration at the outlet station (09-BVR) was 67.58 mg/L compared to 55.86 mg/L at the "worst case" station (10A-BVR) (DES, 2007b, Table 10). Therefore, DES believes that attainment of the standards at the outlet stations should result in attainment of standards throughout the watershed.

1.3 The TMDL does not state when water quality standards will be met.
Category: Carry forward to implementation plan
Response: This comment is relevant to the implementation plan, which has not yet been drafted. The comment will be carried forward to the Salt Reduction Workgroup to consider when developing the implementation plan.

2.1 The ten percent margin of safety is inadequate. A more protective margin of safety is needed.
Category: No change
Response: The margin of safety is to take into account any lack of knowledge, or scientific uncertainty, concerning the relationship between the loading targets and water quality standards. Here, the official TMDL for this study is the load duration curve shown in Figure 5. The basis of this curve is a 20-year flow record and the water quality standard. Therefore we believe that the targets are reasonably accurate and there is no need for a margin of safety greater than ten percent. While AMC et al.'s comments identify a number of scientific uncertainties related to chloride loadings, those uncertainties are relevant to determining how the TMDL will effectively be implemented, not to the TMDL itself.

2.2 The study does not address the impacts of future development in the watershed.
Category: No change

Response: The TMDL for the watersheds was set at the total amount of road salt that the watershed can assimilate. Aside from a margin of safety, all of the TMDL was allocated to existing sources. However, in Section 6(b)(i) of the TMDL, it states that "any future construction of additional roads or parking lots in the TMDL watersheds would necessitate additional load reductions elsewhere in the watershed beyond the allocations in Table 5." Therefore, the provision for future growth in the watershed is a trading system between current and new sources.

2.3 The final allocations of loads by sector should be made available for public review and comment.
Category: Accept
Response: The allocations of loads will be developed by the Salt Reduction Workgroup, which is a public process. In response to other comments (see AMC et al. comment 5.1), additional members will be added to this group. DES will add an opportunity to comment on draft allocations developed by this group. If necessary, DES will amend the TMDL to incorporate more specific wasteload allocations following public comment.

2.4 The allocations of loads should be split into more categories (e.g., by sector and by town or DOT patrol shed).
Category: Accept
Response: The Tables 3 and 5 in the TMDL will be revised to stratify both the salt import estimates for FY07 and the allocations of loads by town and patrol shed.

2.5 The TMDL should be based on chloride concentrations during the low flow hydrologic condition, not the dry hydrologic condition.
Category: No change
Response: The official TMDL for this study is the load duration curve shown in Figure 5. This curve covers all hydrologic conditions. The alternative expression of the TMDL used data from the dry hydrologic condition to approximate the salt reductions needed to guide implementation. EPA guidance (EPA, 2007) advises against using the low flow hydrologic condition for such an alternative expression of the TMDL because of the small sample size for these conditions. Regardless, the official TMDL is expressed for all flows, including low flow hydrologic conditions.

2.6 The TMDL should ensure that violations of the acute water quality standard for chlorides do not occur.
Category: No change
Response: The TMDL was based on the chronic standard for chlorides because this standard was violated far more frequently than the acute standard. The chronic standard is also lower than the acute standard (230 and 860 mg/L, respectively). Therefore, if the chronic standard is met, acute violations are unlikely. Of all of the stations monitored for the TMDL, there were only two where acute violations occurred but chronic violations did not (08-SHB and I93-BVRU03-01). These violations occurred for a total of 5 hours out of the 84,960 hourly average measurements made at all of the sites. Therefore, the 10 percent margin of safety for the TMDL should be sufficient to protect against the likelihood of this occurrence (0.006%).

2.7 The TMDL should be established with daily load allocations, not yearly.
Category: No change
Response: For this study, the TMDL, wasteload allocation, and load allocation are shown on the load duration curve shown in Figure 5. The units for this curve are tons of chloride per day, which meets the requirements of expressing the load allocations as daily loads.

2.8 The percent reduction values on Table 5 should be clearly labeled as being relative to salt loads in the October 1, 2006 to September 30, 2007 period.
Category: Accept
Response: DES agrees that the percent reduction values are confusing in Table 5. These values will be removed from the final version of the report.

3.1 The final implementation plan should be made available for public review and comment.
Category: Accept
Response: The final implementation plan will be developed by the Salt Reduction Workgroup, which is a public process. In response to other comments (see AMC et al comment 5.1), additional members will be added to this group. DES will add an opportunity to comment on implementation plan developed by this group.

4.1 Monitoring in the watersheds should continue year-round to capture violations in the summer.
Category: No change
Response: The sampling design for the long-term monitoring program is for year-round monitoring at station I93-DIN-01 in the Dinsmore Brook watershed.

4.2 The implementation monitoring plan should include biomonitoring to detect direct impacts to aquatic life.
Category: Accept
Response: Until the water quality standards for chloride have been achieved in the TMDL watersheds, biomonitoring is not necessary because impacts to aquatic resources have already been demonstrated through water quality monitoring. However, DES agrees that biomonitoring should be completed after water quality standards for chloride have been met to verify that there are no additional impacts to aquatic life from chlorides or other contaminants. Aquatic life may be affected by sources other than road salt in these watersheds.

4.3 The implementation monitoring plan should include stations throughout the watershed to detect "hot spots" of chloride concentrations.
Category: No change
Response: See response to AMC et al. comment 1.2.

4.4 Implementation monitoring must not be "pending resources". A fully-funded monitoring program is critical.

Category: No change
Response: DES agrees that a fully-funded program is necessary. However, State and federal funding for water quality monitoring in the future cannot be guaranteed. Therefore, all programs must be considered to be "pending the availability of resources".

5.1 The Salt Reduction Workgroup should have members from pertinent watershed associations and state-wide environmental organizations.
Category: Accept
Response: DES agrees that representatives from pertinent watershed associations and state-wide environmental organizations should be invited to join the workgroup.

Comments from the Sierra Club

1.1 The boundaries of the stream segment should be justified based on monitoring data.
Category: No change
Response: In 2002, DES created assessment units for all stream segments in the state. The segments were developed using a standardized process described in the memorandum dated March 29, 2002. Monitoring in a variety of locations near the I-93 roadway in 2002-2006, detected chloride violations in one of the assessment units for Dinsmore Brook. The reported water quality violation triggered the need for a TMDL study of this assessment unit. For the TMDL study, DES delineated a watershed which contributed to the impaired assessment unit. The outlet of the watershed was set at the furthest downstream location in the impaired assessment unit where a temporary stream gage could be installed (station I93-DIN-01). All of the contributing assessment units upstream of that station were included as the TMDL study area. Therefore, monitoring data were used to select the assessment unit for the TMDL study and hydrology was used to define the watershed boundaries of the study area.

2.1 The TMDL should inventory NPDES permits for chloride discharges.
Category: No change
Response: DES obtained information on NPDES-permitted discharges in the study watersheds. None of the discharges had numeric limits for chlorides and none of the permittees were required to provide monitoring data on chloride loads. No municipal wastewater treatment facilities discharge in the study watersheds. Therefore, an inventory of NPDES permittees will provide no additional information about chloride loads to the watersheds.

3.1 The TMDL should not be based on the percent reduction goal relative to FY07 because FY07 was a mild year.
Category: Accept
Response: The official TMDL is the load duration curve in Figure 5. The TMDL is not based on FY07 conditions, but rather on a twenty-year flow record. The source of the confusion is Table 5. The allocation of loads in Table 5 is an alternative expression of the TMDL to aid in developing the implementation plan. The percent reduction values were

added to Table 5 to provide a reference to FY07 conditions. DES agrees that including the percent reduction values on this table is confusing. The percent reduction values will be removed from Table 5.

4.1 The allocations of loads in the TMDL are only draft. There should be opportunity to comment on the final allocations.
Category: Accept
Response: See response to AMC et al. comment 2.3.

4.2 The TMDL should be established with daily load allocations, not yearly.
Category: No change
Response: See response to AMC et al. comment 2.7.

4.3 The TMDL does not have an implementation plan.
Category: Accept
Response: See response to AMC et al. comment 3.1.

4.4 The TMDLs do not provide for the expected growth from the I-93 expansion.
Category: No change
Response: See response to AMC et al. comment 2.2.

4.5 The TMDL does not include an enforcement plan for private chloride discharges.
Category: Carry forward to implementation plan
Response: This comment is relevant to the implementation plan, which has not yet been drafted. The comment will be carried forward to the Salt Reduction Workgroup to consider when developing the implementation plan.

<u>Comments from Carol Pynn, Windham NH</u>

1. I do believe that the Total Maximum Daily Load should be looked at from a different angle. If it was called Total Minimum Daily Load it would make more sense. That approach would indicate the amount of salt minimally necessary to make the roads safe…The fact that NH must spend great amounts of money to replace contaminated wells speaks volumes to the overuse of this de-icer…All we are doing by literally dumping salts, especially on minor roads, is enabling drivers to continue at speeds well over the speed limit.

Category: No change
Response: Section 303(d) of the Clean Water Act defines a TMDL as the maximum load of a contaminant that is possible while still achieving water quality standards. Therefore, while this comment is valid, DES must prepare the TMDL in the manner set forth by the law. Furthermore, DES does not have expertise with road maintenance and is not able to establish minimum salt application rates necessary to maintain road conditions. As part of the implementation plan, DES hopes to work with DOT and other partners to develop a set of best management practices to help road crews to use less salt while still maintaining safe roadways.

Comments from John H. Sokul, Hinkley, Allen and Snyder LLP

1. We do not have time to retain an engineer to review the draft study's assumptions and conclusions. We reserve the right to do so.

Category: No change
Response: DES initially provided a 30 day comment period on the draft report (January 2 to January 31, 2008). At the request of Hinkley, Allen and Snyder, DES extended the comment period for another 8 days (until February 8, 2008).

2. Future growth in the study area should be addressed and accounted for in the draft study.

Category: No change
Response: See response to AMC et al. comment 2.2.

3. The landowner represented by Hinkley, Allen and Snyder owns a piece of property in the TMDL watershed which is expressly zoned for commercial development.

Category: No change
Response: Comment noted. No change requested.

8. References

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