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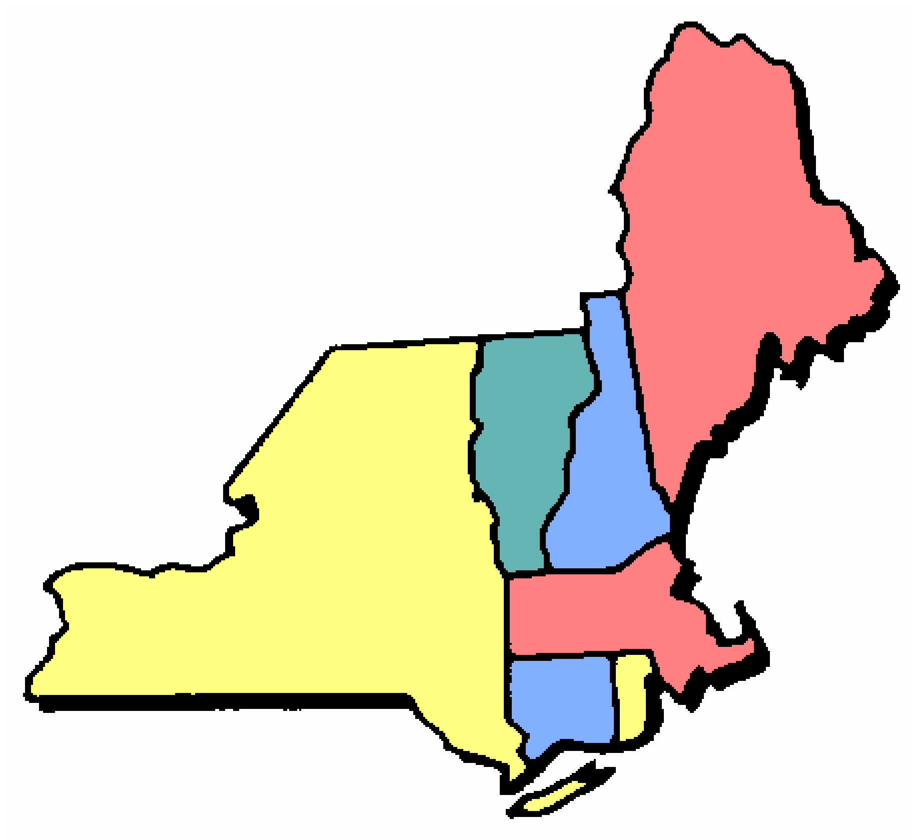
Northeast Regional Mercury Total Maximum Daily Load



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New Hampshire Department of Environmental Services
New York State Department of Environmental Conservation
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New England Interstate Water Pollution Control Commission

April 2007

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Acknowledgements

This TMDL was developed by a technical committee made up of representatives of each of the Northeast states and the New England Interstate Water Pollution Control Commission (NEIWPCC). Team members include Traci Iott (Connecticut DEP); Andrew Fisk and Barry Mower (Maine DEP); Rick Dunn, Russell Isaac, and C. Mark Smith (Massachusetts DEP); Gregg Comstock and Robert Estabrook (New Hampshire DES); Jay Bloomfield and Scott Quinn (New York State DEC); Scott Ribas and Elizabeth Scott (Rhode Island DEM); Tim Clear and Neil Kamman (Vermont DEC); and Beth Card and Susannah King (NEIWPCC). The team acknowledges the support of the NEIWPCC Executive Committee, as well as support from their agencies, and assistance from other divisions and agencies in the development of the TMDL. The team also acknowledges the assistance of the Northeast States for Coordinated Air Use Management (NESCAUM), who provided vital information for this effort.

The TMDL was modeled closely after the Minnesota Pollution Control Agency's Minnesota Statewide Mercury Total Maximum Daily Load and thus many of the concepts and ideas are applied in this document. The Northeast Regional Mercury TMDL project team acknowledges the excellent work put forth by Minnesota and thanks them for their contribution to reducing mercury in the environment.

Executive Summary

Mercury is a potent neurotoxin that poses risks to human health. Exposure to this toxic metal occurs when humans consume fish that contain mercury's most toxic form, methylmercury. The majority of mercury in the environment is released into the air, but it reaches waterbodies through atmospheric deposition. In order to protect their populations from the harmful effects of mercury, states issue fish consumption advisories that provide information on the types and quantities of fish that can be safely consumed. Six of the seven Northeast states have statewide fish consumption advisories for mercury for all freshwaters. However, fish consumption advisories are intended to be temporary until pollution can be reduced to levels that allow for safe fish consumption.

This Total Maximum Daily Load (TMDL) document outlines a strategy for reducing mercury concentrations in fish in Northeast waterbodies so that water quality standards can be met. This will require reductions from mercury sources within the Northeast region, U.S. states outside of the region, and the global contribution. In the Northeast, the majority of mercury pollution is a result of atmospheric deposition. Thus, the TMDL is based primarily on reduction of atmospheric deposition, which can be achieved through reductions in anthropogenic mercury emissions.

Impaired Waters

In the Northeast, over 10,000 lakes, ponds, and reservoirs, and over 46,000 river miles are listed as impaired for fish consumption primarily due to atmospheric deposition of mercury. Many of these waterbodies are listed due to statewide fish consumption advisories for mercury. Section 303(d) of the Clean Water Act requires that states develop TMDLs for impaired waters by establishing the allowable pollutant loading from all contributing sources at a level necessary to achieve the applicable water quality standards. The TMDL allocates load between point sources (wasteload allocation) and nonpoint sources (load allocation).

Existing and Target Fish Tissue Concentrations

A regional fish tissue database was used to calculate mean, 80^{th}, and 90^{th} percentile mercury concentrations for standard length fish. Four fish species were considered, but smallmouth bass was chosen as the target fish. The TMDL was calculated as a range of values using the 80^{th} and 90^{th} percentile mercury concentrations for smallmouth bass. The 80^{th} and 90^{th} percentile mercury concentrations for a standard length (32 cm) smallmouth bass are 0.860 ppm and 1.14 ppm, respectively. Because this TMDL is for seven states with different criteria for fish tissue mercury, the EPA fish tissue criterion for methylmercury of 0.3 ppm is used as the target fish tissue concentration for the regional TMDL. Two states, Connecticut and Maine, use fish tissue criteria more stringent than 0.3 ppm and TMDL calculations based on these criteria are provided in Appendix B.

Mercury Sources

In a general sense, regional sources of mercury pollution include wastewater discharges and atmospheric deposition. The mercury wastewater load was estimated using a regional median mercury effluent concentration calculated from all available mercury effluent data in the region and the sum of design flows for NPDES permitted facilities in the region (excluding facilities that primarily discharge cooling water or discharge to marine waters). Based on a regional median effluent concentration of 4.2 ng/l and sum of design flows of 13,322 MGD, the wastewater load is estimated to be 77 kg/yr.

The 1998 Northeast Regional Mercury Emissions Inventory provides estimates of mercury emissions from a number of sources in the Northeast and is considered the baseline for purposes of establishing needed reductions. 1998 was prior to the enactment of significant mercury reduction requirements in the region and therefore represents an appropriate baseline to correspond with measured fish tissue concentrations. Total emissions for the region are reported as 12,494 kg/yr. Modeling of 1998 mercury emissions data produces an estimate of the amount of mercury deposited to the region from regional, national, and international sources. Based on this modeling, the mercury atmospheric deposition load to the region is 6,506 kg/yr, with 4,879 kg attributable to anthropogenic sources.

Calculation of TMDL

The steps used to calculate the TMDL are outlined in Table ES-1. Using the existing fish concentrations of 0.860 and 1.14, and the target fish tissue mercury concentration of 0.3 ppm, a range of reduction factors from 0.65 to 0.74 was calculated. The total existing source load was calculated from the point source load (wastewater discharges) and nonpoint source load (atmospheric deposition based on modeling of mercury emissions), and is equal to 6,583 kg/yr. The TMDL was then calculated using the total source load and the reduction factor. The wasteload allocation was determined by keeping the wastewater contribution equal to the same percentage as it was in the total source load. The load allocation was calculated by subtracting the wasteload allocation from the TMDL and then was divided between natural[1] and anthropogenic sources. Because over 98 percent of the total load is due to atmospheric deposition, reductions focus on the load allocation. Necessary reductions were divided into three phases, 1998-2003, 2003-2010, and 2010 on, and were also allocated between in-region and out-of-region sources.

[1] Natural sources of mercury include volcanoes, geologic deposits, and volatization from the ocean.

Table ES-1: Summary of the Northeast Regional Mercury TMDL

	Value (80th percentile)	Value (90th percentile)	Unit	Source
Background Information				
Area of the Region (includes CT, MA, ME, NH, NY, RI, VT)	307,890		km^2	NESCAUM
Proportion of Deposition due to Anthropogenic Sources	0.75			Kamman and Engstrom 2002
TMDL Base Year	1998			
TMDL Phase I Implementation Period	1998-2003			
TMDL Phase II Implementation Period	2003 -2010			
TMDL Phase III Implementation Period	2010 on			
Water Quality Goal				
Target Fish Mercury Concentration	0.30		ppm	EPA Fish Tissue Criterion
Existing Level in Fish (32 cm Smallmouth Bass)	0.86	1.14	ppm	NERC Dataset
Reduction Factor (RF) [(Existing Level - Target Level)/Existing Level]	0.65	0.74		
Base Year Loadings				
Point Source Load (PSL) - Wastewater Discharge	77		kg/yr	PCS data
Modeled Atmospheric Deposition	5,405		kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Modeled Natural Atmospheric Deposition[1]	526		kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Modeled Anthropogenic Atmospheric Deposition, Anthropogenic Nonpoint Source Load (ANPSL)	4,879		kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Natural Nonpoint Source Load (NNPSL) Atmospheric Deposition (Based on Deposition is 25% Natural and 75% Anthropogenic)	1,626		kg/yr	
Total Nonpoint Source Load (NPSL) [ANPSL + NNPSL]	6,506		kg/yr	
Total Source Load (TSL) [NPSL + PSL]	6,583		kg/yr	
Percentage of TSL due to PSL	1.2%			

[1] The global contribution to the atmospheric deposition modeling includes some natural sources of mercury. The modeled natural atmospheric deposition is subtracted from the total modeled atmospheric deposition to avoid double counting of the natural contribution.

Loading Goal				
Loading Goal [TSL x (1-RF)]	2,296	1,732	kg/yr	
TMDL				
Wasteload Allocation (WLA) [Keep at 1.2% of TSL]	27	20	kg/yr	
Load Allocation (LA) [Loading Goal - WLA]	2,269	1,712	kg/yr	
Natural Load Allocation[1] (NLA)	1,626	1,626	kg/yr	
Anthropogenic Load Allocation (ALA) [LA - NLA]	643	86	kg/yr	
Overall Reductions to Meet TMDL				
Necessary In-Region Atmospheric Deposition Reductions to Meet ALA	1,816	2,055	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet ALA	2,420	2,738	kg/yr	
Percent Reduction in Anthropogenic Atmospheric Deposition Necessary to Meet ALA	86.8%	98.2%		
TMDL Implementation Phase I (50%)				
In-Region Portion of ANPSL	2,092		kg/yr	
In-Region Reduction Target (50% from baseline)	1,046		kg/yr	
Necessary In-Region Atmospheric Deposition Reductions to meet Phase I Target	1,046		kg/yr	
In-Region Atmospheric Deposition Reductions Achieved in Phase I	1,549		kg/yr	NESCAUM, based on modeling of 1998 and 2002 emissions inventories
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Phase I Target	0		kg/yr	
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Final TMDL	267	506	kg/yr	
Out-of-Region Portion of ANPSL	2,787		kg/yr	
Out-of-Region Reduction Target (50% from baseline)	1,394		kg/yr	

[1] Deposition due to natural sources remains the same over time, so the natural load allocation is equal to the existing natural deposition.

Necessary Out-of-Region Atmospheric Deposition Reductions to Meet Phase I Target	1,394		kg/yr	
Additional Out-of-Region Atmospheric Deposition Reductions to Meet Final TMDL	1,026	1,345	kg/yr	
TMDL Implementation Phase II (75%)				
In-Region Portion of ANPSL	2,092		kg/yr	
In-Region Reduction Target (75% from baseline)	523		kg/yr	
Necessary In-Region Atmospheric Deposition Reductions to meet Phase II Target	1,569		kg/yr	
In-Region Atmospheric Deposition Reductions Achieved in Phase I	1,549		kg/yr	NESCAUM, based on modeling of 1998 and 2002 emissions inventories
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Phase II Target	20		kg/yr	
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Final TMDL	247	486	kg/yr	
Out-of-Region Portion of ANPSL	2,787		kg/yr	
Out-of-Region Reduction Target (75% from baseline)	697		kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet Phase II Target	2,090		kg/yr	
Additional Out-of-Region Atmospheric Deposition Reductions to Meet Final TMDL	330	648	kg/yr	

TMDL Implementation Phase III
The Phase III timeline and goal will be set following re-evaluation of mercury emissions, deposition, and fish tissue concentrations in 2010. At the onset of Phase III, remaining reductions will be addressed as follows: Major air point sources will be addressed through the application of more stringent control technology requirements and/or emission limits, economically and technically feasible/achievable, taking into account advances in the state of air pollution controls and the application of transferable technologies used by other sources, to achieve maximum emission reductions. Emissions from area sources will be controlled to the maximum extent feasible using best management practices and pollution prevention approaches.

Regional TMDL Atmospheric Deposition Goal

The mercury TMDL for the region ranges from 1,732 to 2,296 kg/yr, or 4.75 to 6.29 kg/d. This is divided into a wasteload allocation of 20 to 27 kg/yr and a load allocation of 1,712 to 2,269 kg/yr. The load allocation for natural sources is 1,626 kg/yr, leaving an anthropogenic load allocation of 86 to 643 kg/yr. Implementation of this goal is divided into three phases. Phase I, from 1998 to 2003, sets a goal of 50 percent reduction, from in-region and out-of-region sources, from the 1998 baseline. With in-region reductions of 1,549 achieved as of 2002, the in-region reduction goal has been exceeded. Phase II, from 2003 to 2010, sets a goal of 75 percent reduction. This leaves 20 kg/yr for in-region reductions necessary to meet this target. In 2010, mercury emissions, deposition, and fish tissue concentration data will be re-evaluated in order to assess progress and set a timeline and goal for Phase III to make remaining necessary reductions to meet water quality standards. Not enough data are currently available to accurately assess reductions from out-of-region sources.

Adaptive Implementation

The TMDL is structured to separately show loading goals for in- and out-of-region sources and is expected to be done adaptively in order to evaluate the calculated 86.8 to 98.2 percent reduction from anthropogenic sources. The Northeast states have already reduced deposition by approximately 74 percent between 1998 and 2002 and have reasonable assurances (including product legislation and emissions controls) in place to assure attainment of Phase II goals on an adaptive basis. To meet out-of-region goals, Northeast states recommend EPA implement plant-specific MACT limits for mercury under Section 112(d) of the Clean Air Act to control power plant emissions by 90% by cost-effective and available technologies.

Abbreviations

AEG – Anthropogenic Emissions Goal

ALA – Anthropogenic Load Allocation

ANPSL – Anthropogenic Nonpoint Source Load

C – Concentration

CAA – Clean Air Act

CAMR – Clean Air Mercury Rule

CEC – Commission for Environmental Cooperation

CT DEP – Connecticut Department of Environmental Protection

d – Day

dscm – Dry Standard Cubic Meter

EFMC – Existing Fish Mercury Concentration

EGU – Electrical Generating Unit

EPA – United States Environmental Protection Agency

Hg – Chemical symbol for mercury

ICI – Industrial/Commercial/Institutional

kg - Kilogram

l – Liter

lb - Pound

LA – Load Allocation

MACT – Maximum Achievable Control Technology

MAP – Mercury Action Plan

MassDEP – Massachusetts Department of Environmental Protection

ME DEP – Maine Department of Environmental Protection

mg – Milligram

MGD – Million Gallons per Day

MMP – Mercury Minimization Plan

MOS – Margin of Safety

MTF – Mercury Task Force

MWC – Municipal Waste Combustor

MWI – Medical Waste Incinerator

NARAP – North American Regional Action Plan

ng - Nanogram

NEG-ECP – Conference of the New England Governors and Eastern Canadian Premiers

NEI – National Emissions Inventory

NEIWPCC – New England Interstate Water Pollution Control Commission

NERC – Northeastern Ecosystem Research Cooperative

NESCAUM – Northeast States for Coordinated Air Use Management

NEWMOA – Northeast Waste Management Officials' Association

NH DES – New Hampshire Department of Environmental Services

NLA – Natural Load Allocation

NNPSL – Natural Nonpoint Source Load

NPDES – National Pollutant Discharge Elimination System

NPSL – Nonpoint Source Load

NSRC – Northeastern States Research Cooperative

NYS DEC – New York State Department of Environmental Conservation

oz - Ounce

PDNS – Proportion of Deposition due to Natural Sources

POTW – Publicly Owned Treatment Works

ppb – Parts per Billion

ppm – Parts per Million

PSL – Point Source Load

Q - Flow

RF – Reduction Factor

RI DEM – Rhode Island Department of Environmental Management

SSI – Sewage Sludge Incinerator

TBtu – Trillion British Thermal Units

TFMC – Target Fish Mercury Concentration

TMDL – Total Maximum Daily Load

TSL – Total Source Load

VT DEC – Vermont Department of Environmental Conservation

UNEP – United Nations Environment Programme

WLA – Wasteload Allocation

WWTF – Wastewater Treatment Facility

yr – Year

Definition of Terms

Atmospheric Deposition – the mass transfer of gaseous, aerosol, or particulate contaminant species from the atmosphere to the earth's surface

de minimis – insignificant; a Latin expression meaning "of minimum importance"

Dry Deposition – mass transfer of gaseous, aerosol, or particulate contaminant species from the atmosphere to the earth's surface in the absence of precipitation

Fish Consumption Advisory – guidelines issued by state public health agencies on amounts of and frequency that certain fish can be eaten; can be statewide, regional, or waterbody-specific.

Gaseous Mercury – mercury occurring in the dry-phase, as either reactive gaseous mercury (Hg^{2+}) or gaseous elemental mercury (Hg^{0})

Nonpoint Source Pollution – diffuse sources of pollution to water from land use or atmospheric deposition of pollutants

Northeast States – Connecticut, Maine, Massachusetts, New Hampshire, New York State, Rhode Island, and Vermont

Point Sources – wastewater discharges and all other pollutant sources that enter the receiving water through a pipe or channel

TMDL – total maximum daily load – the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards

Wet Deposition – mass transfer of dissolved gaseous or particulate contaminant species from the atmosphere to the earth's surface via precipitation

1 Introduction

1.1 Water Quality and Health Concerns

Mercury is a toxic metal that is released to the environment through natural and human processes. Most commonly, the gaseous and particulate forms are released to the atmosphere, which are then deposited onto land and water in precipitation. Once in the water, the mercury can be converted to its most toxic form, methylmercury, which accumulates in fish and aquatic organisms. Humans are exposed to methylmercury and subject to its associated health effects when they consume contaminated fish. The challenge posed by mercury is significant, and the New England Interstate Water Pollution Control Commission (NEIWPCC) and its member states[1] are increasingly involved in this complicated issue.

In the Northeast, fish consumption advisories that have resulted from elevated levels of mercury in certain fish species are of great concern. The vast majority of this mercury can be attributed to atmospheric deposition. The major challenge that the Northeast states face is the lack of available options to control out-of-state sources of atmospheric deposition, despite nearly a decade of work that has resulted in regional reductions in mercury emissions and discharges of approximately 70 percent. The mercury TMDL provided in this document has been developed by the Northeast states in an effort to address mercury impaired waters and region-wide fish consumption advisories. The ultimate goal of the Northeast states is to control all sources of mercury, both in-region and out-of-region sources, to levels where water quality standards for fish consumption are met.

1.2 TMDL Requirements and Process

The TMDL process is straightforward: states are required by the Clean Water Act to identify water bodies that are failing to meet their water quality standards. The regulations then require that any impaired waterbody be analyzed to determine the daily amount, or load, of a pollutant it can assimilate without violating the state's applicable water quality standards. That daily load is then broken down into an amount attributed to point sources and nonpoint sources, and specifies where and when reductions will be made so the load is not exceeded.

Specifically, Section 303(d) of the Federal Clean Water Act requires each state to (1) identify waters for which effluent limitations normally required are not stringent enough to attain water quality standards, and (2) to establish TMDLs for such waters for the pollutant of concern. TMDLs may also be applied to waters threatened by excessive pollutant loadings. The TMDL establishes the allowable pollutant loading from all contributing sources at a level necessary to achieve the applicable water quality standards. A TMDL must account for seasonal variability and include a margin of safety (MOS) to account for uncertainty of how pollutant loadings may impact the receiving water's quality.

The TMDL report and attached documents are submitted to the U.S. Environmental Protection Agency (EPA) as a TMDL under Section 303(d) of the Federal Clean Water Act, 40 CFR 130.7. The regulations do not in anyway preclude multi-state or regional TMDLs and in-fact EPA Regions 1 and 2 have had success in approving TMDLs that are prepared by more than one state. In accordance with those same regulations, it is understood that the Regional Administrator shall approve or disapprove the loadings provided not later than 30 days. It is also understood that if the Regional Administrator disapproves the loadings he shall establish loadings within 30 days of the disapproval. The states are aware that if the

[1] NEIWPCC'S member states include Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

Regional Administrator approves the loadings being submitted in the attached documents, they are then required to incorporate those loadings into their water quality management plans.

2 Background Information

2.1 Fish Consumption Advisories

States issue fish consumption advisories to inform the public about the recommended fish consumption levels for their waters. Advisories provide information on limiting or avoiding consumption of particular species of fish from specific waterbodies, a group of waterbodies, or an entire state. Nationwide, 48 states currently have fish consumption advisories in place, including all of the Northeast states.

For the most part, fish consumption advisories are issued by each state's public health agency and vary from state to state. All of the New England states have statewide advisories for all freshwaters and New York State has waterbody-specific advisories as well as regional advisories, including blanket advisories for all waters in the Adirondack and Catskill regions. A summary of statewide fish consumption advisories for sensitive and general populations is shown in Table 2-1 below.

Table 2-1 Summary of Statewide Fish Consumption Advisories[1] for Freshwaters

State	Sensitive[2] Population	General Population
CT	No more than 1 meal/month of fish other than trout caught in any Connecticut fresh waterbody; no limits on consumption of trout.	1 meal/week for all freshwater fish other than trout caught in any Connecticut fresh waterbody; no limits on consumption of trout.
MA	Avoid eating fish from any fresh waterbodies.	Limit consumption of affected species to 2 meals/month.
ME	For all freshwater fish other than brook trout and land locked salmon, do not eat any meals; for trout and salmon, 1 meal/month.	For all freshwater fish other than brook trout and land locked salmon, 2 meals/month; for trout and salmon, 1 meal/week.
NH	1 meal/month of freshwater fish (8 oz for pregnant and nursing women, 3 oz for children under 7); when eating bass and pickerel, limit consumption to fish 12 inches or less in length.	Four 8 oz meals/month of freshwater fish; when eating bass and pickerel, limit consumption to fish 12 inches or less in length.
NY	Do not eat any fish from specific listed waterbodies. Avoid pickerel, northern pike, smallmouth bass, largemouth bass, walleye, and yellow perch from Adirondack Mountain and Catskill Mountain waters.	Except where otherwise provided in listed waters, no more than 1 meal/week of fish taken from New York State freshwaters.
RI	Do not eat any fish from Rhode Island ponds, lakes, or rivers.	1 meal/month of most freshwater fish, avoid bass, pickerel, and pike.
VT	walleye – eat none lake trout, smallmouth bass, chain pickerel, American eel – 1 meal/month largemouth bass, northern pike – 2 meals/month brook trout, rainbow trout, brown trout, yellow perch – 3-4 meals/month brown bullhead, pumpkin seed – no advisory All other freshwater fish – 2-3 meals/month	walleye – 1 meal/month lake trout, smallmouth bass, chain pickerel, American eel – 3 meals/month largemouth bass, northern pike – 6 meals/month brook trout, rainbow trout, brown trout, yellow perch, brown bullhead, pumpkin seed – no advisory All other freshwater fish – 9 meals/month

[1]Some advisories are based on mercury *and* other fish contaminants.
[2]Sensitive populations are defined as follows:
CT: Women who are pregnant, women who plan to become pregnant within one year, women who are nursing, children under six
MA: Pregnant women, women of child-bearing age, nursing mothers, children under 12
ME: Pregnant and nursing women, women who may get pregnant, children under 8
NH: Pregnant and nursing women, women who may get pregnant, children under 7
NY: Women of childbearing age, infants, children under 15
RI: Young children, women who are pregnant, nursing, or planning to have a baby in the coming year
VT: Women of childbearing age (particularly pregnant women, women planning to get pregnant, and breastfeeding mothers) and children under 6

2.2 Section 319 Nonpoint Source Assessments and Categorization of Atmospheric Deposition as a Nonpoint Source

A great majority of the nation's remaining water quality problems can be attributed to nonpoint source pollution. The 2000 U.S. EPA National Water Quality Inventory Report found that nonpoint source pollution is the leading source of impairment to the nation's rivers, lakes, and coastal waters (U.S. EPA

2002). Section 319 was added to the Clean Water Act in the amendments of 1987 in order to address nonpoint source pollution. Section 319 highlights three main strategies for addressing polluted runoff by: (1) requiring states to prepare assessments of nonpoint source problems; (2) requiring that states develop management programs to address the problems identified in these assessments; and (3) creating a grant program that allows EPA to fund state programs for nonpoint source assessment and control. Furthermore, the state assessment reports are required to identify waters impaired or threatened by nonpoint source pollution, to identify the categories, subcategories, or individual sources contributing to the nonpoint source pollution problem, and to recommend the best management practices or measures to be used to control each category or subcategory of source (Clean Water Act, Section 319(a)(b)(h)and(i)).

Section 319 addresses nonpoint sources of water pollution. EPA publications classify atmospheric deposition as nonpoint source water pollution with statements such as: "Atmospheric deposition and hydromodification are also sources of nonpoint source pollution"(U.S. EPA 1994). Out-of-state mercury sources, namely coal-fired power plants, therefore fall within Section 319. Currently, New York State and each of the New England states has an approved Section 319 plan covering portions of its navigable waters, including portions impaired by mercury pollution.

2.3 Massachusetts' TMDL Alternative and EPA Justification for Disapproval

Over the past several years, the Northeast states have worked closely with EPA Region 1 on several TMDL innovations projects, including a project to develop regional recommendations for accurately reporting impaired waters in Category 4b of the Integrated Report. The Integrated Report is a single document that integrates the reporting requirements of Clean Water Act Sections 305(b) and 303(d). States place their waters in one of five categories based on what available data say about the condition of the waterbody. Category 4b includes impaired waters that do not require a TMDL because other pollution control requirements are stringent enough to implement the applicable water quality standard and is more recently described in the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act,* which was issued by EPA on July 29, 2005. The New England States and New York State all provided input on this approach through the TMDL innovations process, and endorsed the concept. In fact, the approach used by the Massachusetts Department of Environmental Protection (MassDEP) described below was similarly used by the Maine Department of Environmental Protection (ME DEP) and Rhode Island Department of Environmental Management (RI DEM) in their 2004 303(d) submissions. For the 2004 listing cycle, none of the approaches were approved by EPA.

In 2004 the Commonwealth of Massachusetts submitted to EPA a document titled "A TMDL Alternative Regulatory Pathway Proposal for the Management of Selected Mercury Impaired Waters." The document was a supplement to MassDEP's 2004 Integrated List and sought to document that other pollutant control requirements were in place such that water quality standards would be met and development of a TMDL would not be required. Massachusetts described how it was effectively implementing a comprehensive management plan to address in-state sources of mercury and that a combination of federal, regional, and state controls on mercury were and are the most effective way of addressing water quality impairments due mainly to atmospheric deposition. Examples of these in-state controls include but are not limited to pollution prevention programs and regulatory controls on mercury emitters such as municipal waste combustors, dentists, and schools. The plan focused on a goal of virtual elimination of mercury sources in Massachusetts and the entire New England region.

In a letter dated June 21, 2006, EPA disapproved MassDEP's alternative regulatory pathway to move 90 lakes and ponds impaired solely by atmospheric deposition from Category 5 to Category 4b of the state's Integrated List of Waters. EPA cited that the estimates in the proposal and its own estimates indicate that a significant percentage of mercury from atmospheric deposition comes from international sources for which there are no state or federal controls. As a result EPA determined that the approach did not meet the necessary requirements for demonstrating that the actions taken will result in the attainment of water quality standards in a reasonable amount of time. Specifically, in its response to MassDEP, EPA stated the following:

> *"EPA regulations require states to list water quality segments still requiring TMDLs where certain controls including other pollution control requirements 'required by local, State, or Federal authority' are insufficient to achieve applicable water quality standards. (See 40 CFR §130.7 (b)1(iii))."*
>
> *"While Massachusetts describes its strong mercury reduction program, as well as the New England wide mercury reduction efforts, Massachusetts has not demonstrated that other pollution control requirements exist that are sufficient to implement the Commonwealth's water quality standards for mercury within a reasonable amount of time. See 40 CFR 130.7(b)(1)(iii). In spite of the strong state, regional, and federal mercury reduction efforts, it will be difficult to achieve water quality standards, due in part to the contributions from non-U.S. sources (i.e., the global reservoir)."*

It was determined by EPA in its disapproval documentation that the "best way to address mercury impaired waters is within the context of the 303(d) listing process…" As such, the states in the Northeast have put their energies and efforts into that process with this regional TMDL.

2.4 Section 303(d) Listing for Mercury Impaired Waters – Category 5m

Waters are to be listed in Category 5 of the Integrated Water Quality Monitoring and Assessment Report if "available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed (U.S. EPA 2005a)." This category represents Clean Water Act §303(d) – waters that are listed as impaired and are to be reviewed and approved by EPA.

On March 8, 2007, EPA released guidance on utilizing a modified Category 5, known as Category 5m, for waters on the 303(d) list that are impaired primarily by atmospheric deposition of mercury. The guidance on Listing Waters Impaired by Atmospheric Mercury Under Clean Water Action Section 303(d) describes use of subcategory "5m" as a voluntary approach to listing waters impaired by mercury from atmospheric sources. Category 5m is EPA's recognition that even if a state has a comprehensive mercury management approach, when water quality impairments are primarily caused by atmospheric deposition, in-state controls alone cannot lead to attainment. Category 5m could serve as a placeholder for states to defer TMDL development until later in the schedule. The approach, however, does not and cannot statutorily remove the obligation for a TMDL to be developed at some point in time, and EPA literature on this approach specifically notes that the agency is not suggesting that TMDLs are inappropriate tools for mercury impairments.

The information regarding Category 5m shared at the annual meeting of the Association of State and Interstate Water Pollution Control Administrators in August 2006 specified that multi-state efforts towards regional goals or targets are encouraged. It is in the spirit of regional cooperation and goal setting that this TMDL has been prepared and it is done so with the understanding that the Clean Water Act requires it.

2.5 Northeast Regional Commitment to Reducing Regional Sources of Mercury

The Conference of the New England Governors and Eastern Canadian Premiers (NEG-ECP) is an organization of the governors of the six New England states and the premiers of the five Eastern Canadian provinces (New Brunswick, Newfoundland & Labrador, Nova Scotia, Prince Edward Island, and Québec). The governors and premiers collaborate on regional issues and take action on policy areas including the environment, energy, economic development, trade, security, and ocean issues.

In June 1997, the NEG-ECP charged its Committee on the Environment to develop a regional Mercury Action Plan (MAP). Subsequently, a draft framework for the MAP was developed by representatives of the states and provinces, and then finalized and agreed upon by the NEG-ECP in June 1998. The MAP identifies steps to address those aspects of the mercury problem in the region that are within the region's control or influence and sets an overall regional goal to virtually eliminate the discharge of anthropogenic mercury into the environment to ensure that serious or irreversible damage attributable to these sources is not inflicted upon human health and the environment (Committee on the Environment of the Conference of the New England Governors and Eastern Canadian Premiers 1998).

The six action items set forth in the MAP: 1) established a regional task force to implement the plan; 2) specified emissions limits for major mercury sources that are considerably more stringent than federal requirements; 3) supported pollution prevention efforts to reduce mercury use in products and increase collection and recycling of mercury-added products where environmentally preferable alternatives do not exist; 4) directed state and provincial agencies to implement outreach and education programs about mercury; 5) supported coordination of mercury research and environmental monitoring efforts to track results; and 6) called for retirement of the U.S. federal mercury stockpile. Implementation of the MAP has been very successful. All of the New England states have developed and implemented numerous legislative and regulatory actions to address mercury sources.

In accordance with the MAP, a regional Mercury Task Force (MTF) was formed by representatives of the New England states and Eastern Canadian provinces. This group meets annually and reports on progress in meeting the goals of the MAP. The MAP originally set forth a goal of 50 percent reduction of regional mercury emissions by 2003, and then in 2001 set another interim goal of 75 percent reduction by 2010. In 2003, the MTF reported that the goal of 50 percent had been exceeded with reductions achieved amounting to approximately 55 percent[1] (Conference of New England Governors and Eastern Canadian Premiers 2003). This overall reduction was primarily due to an 84 percent reduction in emissions from municipal waste combustors (MWCs), a 98 percent reduction in emissions from medical waste incinerators (MWIs), and a 93 percent reduction in emissions from chlor-alkali facilities (NESCAUM and the New England Governors and Eastern Canadian Premiers Mercury Task Force 2004). The 2005 status report indicates that substantial progress has already been made toward the 2010 goal (The Conference of New England Governors and Eastern Canadian Premiers Mercury Task Force and The Committee on the Environment of the Conference of New England Governors and Eastern Canadian Premiers 2005).

In August 2003, the MTF adopted a regional goal that 50 percent of dental offices in the region would install amalgam separators by the end of 2005. This goal has been exceeded and the MTF now has new goals of 75 percent separation installation by the end of 2007 and 95 percent by the end of 2010. In 2005, it was estimated that states had the following rates of amalgam separator installation: Connecticut – 65 percent, Maine – 95 percent, Massachusetts – 74 percent, New Hampshire – 95 percent, Rhode Island – 25 percent, and Vermont 15 percent (The Conference of New England Governors and Eastern Canadian

[1] The MAP Regional Reductions of 55 percent from 1998 emissions and the 74 percent reductions shown in Section 7.7.2 for the Phase I implementation for in-region differ because the MAP looks at reductions for the New England states and the Eastern Canadian provinces, whereas this TMDL covers the New England states and New York.

Premiers Mercury Task Force and the Committee on the Environment of the Conference of New England Governs and Eastern Canadian Premiers 2005). Installation of amalgam separators is instrumental in reducing mercury in wastewater.

While New York State is not a member of the NEG-ECP, they were active participants in the 1998 regional mercury study and in the development of the MAP. New York State remains committed to reducing mercury in their state and has established its own Mercury Task Force to coordinate mercury issues within their state. Additionally, New York State participates in regional efforts coordinated by NEIWPCC, the Northeast States for Coordinated Air Use Management (NESCAUM), and the Northeast Waste Management Officials' Association (NEWMOA). Similar to the New England states, New York State has enacted legislation to control use of mercury in products, require installation of amalgam separators, and has set strict emissions limits for MWCs. As a result, mercury emissions in New York State from this sector decreased more than 85 percent from 1998 to 2002, contributing to a decrease of approximately 63 percent in overall state mercury emissions in the same time period.

As of 2006, all of the Northeast states have passed legislation to address mercury in products. Individual laws and requirements vary by state, but legislation addresses bans on disposal of mercury-added products, bans on sale or distribution of mercury-added novelties and measuring devices, requirements for installing amalgam separators, requirements for labeling of mercury-added products, prohibition of primary and secondary schools purchasing or using mercury, removal of mercury switches from automobiles, and requirements on recycling of mercury-added products. Connecticut, Massachusetts, Maine, New Hampshire, and New York have all passed legislation to reduce mercury emissions limits from coal-fired utilities. Detailed information on individual state legislation and programs is provided in Section 10.1. Controls on mercury-containing products contribute to reductions in mercury in wastewater and mercury emissions from MWCs and MWIs.

Because the Northeast states have made nationally significant reductions to in-state sources of mercury as a result of their regional action plan, and have collectively developed a peer-reviewed dataset of fish tissue contaminants, it was determined that a regional TMDL would be the most effective strategy to work toward eliminating the need for fish consumption advisories in the Northeast.

2.6 Control of In-State Sources not Sufficient to Meet Water Quality Standards

Using 1998 emissions data, atmospheric deposition modeling undertaken by NESCAUM estimates that 43 percent of the anthropogenic mercury deposited in the Northeast is attributed to sources within the region. The remaining 57 percent can be attributed to sources outside of the region, from other U.S. states and international sources. When modeling was undertaken with 2002 emissions data, it was estimated that 19 percent of anthropogenic mercury deposited in the region originated from within the region and 81 percent can be attributed to out-of-region sources. As discussed in the previous section, the Northeast states are already aggressively addressing mercury sources within their region, and they have additional enforceable controls coming into effect that will demonstrate reductions are continuing in addition to the reductions shown here by the 2002 data. But, in-region reductions are not sufficient to make the fish safe to eat. More stringent national and international controls are necessary to reduce out-of-region sources to the level that will allow for safe fish consumption.

3 Applicable Water Quality Standards and Fish Tissue Criteria

Two of the Northeast states, Maine and Massachusetts, have adopted methylmercury fish tissue criteria as part of their water quality standards. For all toxic pollutants not otherwise listed, Massachusetts uses the recommended criteria published by EPA pursuant to Section 304(a) of the Clean Water Act. This holds true for mercury, so Massachusetts uses the EPA methylmercury fish tissue criterion of 0.3 ppm. In addition, NY has a water quality standard that considers exposure to mercury through fish consumption expressed as a water column concentration. Although not all states have adopted a fish tissue criterion as part of their water quality standards, each state has a fish tissue concentration that they consider as a part of their basis for developing fish consumption advisories. Water quality criteria and fish consumption advisory values are shown in Table 3-1 below.

Table 3-1 Water Quality Criteria and Fish Consumption Advisory Values for Mercury

	CT	ME	MA	NH	NY	RI	VT
Fish tissue concentration (ppm)	0.1	0.2 *	0.3 *	0.3	1.0	0.3	0.3

*These numbers are fish tissue concentrations that have been adopted as fish tissue criteria in state water quality standards. The numbers for the other states are the fish tissue concentrations that these states consider as part of their basis for developing fish consumption advisories.

3.1 Assessment of Fish Contaminants

For the most part, for listing purposes, states do not assess waters by measuring mercury in the water column, but rather monitor mercury in fish tissue. For states with methylmercury fish tissue criteria, if fish samples do not meet the criterion, the waterbody is listed as impaired for fish consumption. Where states do not have fish tissue criteria, specific or all waters for which fish consumption advisories have been issued are considered to be impaired for fish consumption use, subject to the state's assessment and listing methodology. For the purpose of this TMDL, fish tissue concentrations in wet-weight fillets are considered the TMDL endpoint.

4 Fish Tissue Mercury Concentrations

4.1 Fish Tissue Monitoring Dataset

In 2000, the Northeast States Research Consortium (NSRC), then a program of the USDA Forest Service Northeastern Research Station, sponsored the establishment of a Northeast North American mercury workgroup (known as the Northeastern Ecosystem Research Cooperative (NERC) Mercury Consortium) to compile and analyze as large an assembly of mercury data as practical, from a wide variety of environmental matrices, focusing on freshwater ecosystems. A fish tissue database that covers the entire NSRC study region (New England states, New York State, eastern Ontario, Quebec, and the Canadian Atlantic Provinces) was assembled as part of this initiative (Evers and Clair 2005).

A group of scientists from the NERC Mercury Consortium assembled existing fish mercury databases from agencies and organizations in the study area, resulting in a database that spans the geographic range from 39.5 to 54.7 N latitude and 53.9 to 79.5 W longitude, which includes all of the Northeast states. Contributing datasets originated from monitoring programs carried out by provincial and state governments for the purpose of risk assessment, random probability surveys conducted within the United States, and other datasets derived from large-scale research initiatives. NERC scientists collected geo-referenced datapoints from 24 research and monitoring projects to create an aggregate 19,815 datapoints (Kamman, et al. 2005).

In order to be retained in the dataset, fish data had to meet a number of requirements. Only fish mercury measurements analyzed using cold-vapor atomic absorption or cold-vapor atomic fluorescence spectroscopy were retained. The fish had to be collected in 1980 or later. Data from the Great Lakes and St. Lawrence River were excluded because these waterbodies were outside the focus of the NSRC assessment. Only mercury concentrations derived from fish fillets or whole fish were retained (Kamman, et al. 2005).

The dataset was subject to a series of validation checks to ensure data quality, including checks to detect outlier, mis-transcribed, or incorrect datapoints. Validity checks identified a number of datapoints with values that were either excessively high, presented in the wrong unit of measure, or mis-attributed to the wrong species. These datapoints were either corrected or removed from the database. Of the 19,178 original records submitted to the database, 15,305 met screening criteria, passed validity checks, and were retained (Kamman, et al. 2005).

The final dataset contains mercury measurements for 64 freshwater fish species with yellow perch and brook trout being the most prevalent species. Data were only analyzed for the 13 species that either had 1000 or more mercury measurements, or were present in nine or more of the projects. These 13 species were brook trout, brown bullhead, brown trout, eastern chain pickerel, lake trout, landlocked salmon, largemouth bass, northern pike, smallmouth bass, walleye, white perch, white sucker, and yellow perch (Kamman, et al. 2005).

The NERC dataset is clearly appropriate for the development of a regional mercury TMDL due to its geographic coverage and the fact that is has already gone through both validation and peer-review processes. For the purpose of this TMDL, length-standardized mercury concentrations were calculated for four species, using a subset of the NERC dataset that included only data from the New England states and New York State. The four species considered were smallmouth bass, largemouth bass, walleye, and yellow perch. Mean, 80th, and 90th percentile mercury concentrations for standard length fish were calculated for each of the four fish species. Characteristics for these fish are shown in the table below.

Table 4-1 Standard Lengths and Mercury Concentrations of Selected Freshwater Fish Species in the Northeast

Species	Standard Length (cm)	Mean Hg Concentration (ppm) at Standard Length*	80th percentile Hg Concentration (ppm) at Standard Length	90th percentile Hg Concentration (ppm) at Standard Length
Smallmouth bass (*Micropterus dolomieu)*	32	0.69	0.86	1.14
Largemouth bass (*Micropterus salmoides*)	36	0.61	0.90	1.05
Yellow perch (*Perca flavenscens*)	20	0.38	0.52	0.69
Walleye (*Sander vitreus*)	45	0.60	0.82	0.93

*Standard lengths were derived as dataset-wide mean lengths.

4.2 Areas of Elevated Concentration

In the Northeast, there are known localized areas where elevated fish tissue concentrations, as compared to background regional levels, have been observed (Evers, et al. 2007). Typically, areas of elevated concentration are associated with natural conditions, such as enhanced watershed sensitivity, in combination with anthropogenic factors including water-level manipulation, enhanced deposition of acid-forming precursors, and enhanced mercury deposition. These areas include the western Adirondack Mountains in New York, the Upper Connecticut River in New Hampshire and Vermont, the middle and lower Merrimack River in New Hampshire, the Upper Androscoggin River in Maine and New Hampshire, and the Western Upper Kennebec River in Maine. Fish mercury concentrations in these areas are expected to decrease with implementation of this TMDL, but the response may vary from the rest of the region, so these areas will be more closely monitored during the implementation period.

In addition, areas of elevated concentration can be a result of high levels of localized atmospheric deposition. This is the case for an area in northeastern Massachusetts where fish mercury concentrations are elevated as a result of high deposition in that area. Fish from this area are not included in the regional dataset and the regional TMDL will not cover this area. Instead, this area will be addressed separately by MassDEP.

5 Northeast Regional Approach

5.1 Impaired Waters

In the Northeast, there are a total of 10,175 lakes, ponds, and reservoirs, 25 river segments, and an additional 46,207 river miles impaired for fish consumption primarily due to atmospheric deposition of mercury. The breakdown for each state is shown below in Table 5-1. A full list of impaired waters can be found in Appendix A. In addition to waters currently listed as impaired, this TMDL is also intended to apply to any waterbodies that may be identified in the future as impaired for mercury primarily by atmospheric deposition.

Connecticut, Maine, and New Hampshire all have statewide advisories, and therefore list all freshwaters as impaired for fish consumption due to mercury. Massachusetts, Rhode Island, and Vermont also have statewide advisories, but they only list waters that have been assessed and found to be impaired on their lists of impaired waters. New York State does not have a statewide advisory, but has a large number of waterbodies listed as impaired for fish consumption due to atmospheric deposition of mercury.

Table 5-1 Northeast Waterbodies Impaired Primarily by Atmospheric Deposition of Mercury

State	Lakes, Ponds, and Reservoirs	Rivers
Connecticut	2,267	5,380 miles
Maine	5,782	31,199 miles
Massachusetts	90[1]	0[2]
New Hampshire	1,945[3]	9,628 miles
New York	63[4]	14 segments
Rhode Island	18	0[5]
Vermont	10[6]	11 segments
Total	**10,175**	**46,207 miles; 25 segments**

[1]Those impaired solely due to atmospheric mercury deposition.
[2]Massachusetts has additional river segments impaired due to local mercury sources that are not covered by this TMDL.

[3]Includes impoundments.
[4]Includes five segments of Lake Champlain counted as one waterbody.
[5]Rhode Island has additional river segments impaired due to mercury. However, it has not yet been determined whether local sources not covered by this TMDL contribute to the impairment.
[6]Includes eleven segments of Lake Champlain counted as one waterbody.

5.2 Selection of Existing Fish Mercury Concentration Based on Standard Size Fish

To best utilize the extensive NERC dataset and make the strongest comparisons of fish mercury concentrations from different waterbodies and sampling years, mercury concentrations are calculated for a standard-length fish. Mercury concentration increases with both age and length, so when comparing mean concentrations from all fish, it is important to account for this relationship. Calculated fish mercury concentrations were statistically adjusted, using analysis of covariance to a nominal "standard-length" fish. The standard length was derived as the dataset-wide mean length for the species, and concentrations of standard-length fish were estimated using least-squares means accounting for the Type III model sums-of-squares (Kamman, et al. 2005). From a statistical standpoint, this is the most appropriate approach in that variance in fish mercury attributable to length is minimized at the dataset-wide mean length. It is recognized that many fish will be above the standard length and therefore higher in mercury. This is addressed by basing this TMDL analysis on the 80th and 90th percentiles of the distribution of all length-standardized fish evaluated. This is more protective than using a mean or median concentration value.

In developing this TMDL, the states considered using four different species of fish for calculating necessary reductions (see Table 4-1). After examining data for all four species, it was decided that smallmouth bass should be the target fish, as it is the species that bioaccumulates mercury most efficiently (based on comparison of mean, 80th, and 90th percentile concentrations) and is ubiquitously distributed amongst the Northeast states. Use of this species will allow for the highest common level of protection. The majority of the fish in the regional dataset were collected in the early to mid 1990s and therefore concentrations used in this TMDL may be somewhat higher than if fish collection coincided with the 1998 timeframe of the emissions and deposition data. To address this uncertainty, the existing fish concentration is presented as a range from the 80th to 90th percentile mercury concentration. As shown in Table 4-1, the 80th and 90th percentile mercury concentrations based on the standardized length for smallmouth bass are 0.860 and 1.14 ppm, respectively.

5.3 Target Fish Mercury Concentration

As discussed previously, the Northeast states consider different fish mercury concentration guidance values as part of their basis for establishing fish consumption advisories. These numbers range from 0.1 ppm for Connecticut to 1.0 ppm for New York State. Different issues are weighed when establishing fish consumption advisories than those considered in setting a regional TMDL. For example, eating fish has health benefits and those benefits are weighed against the health risks posed by mercury contamination. The risks from contamination for children and women of childbearing age differ from those posed to men and older women and the health benefits of eating fish may also differ for these age groups. In developing a TMDL, the issue being considered is minimizing contamination in fish as the benefit and the risks in this case are the costs of preventing the contamination. Based on these considerations for the regional TMDL, 0.3 ppm is used as the overall regional target fish mercury concentration to be consistent with EPA's methylmercury fish tissue criterion. Implementation of this TMDL will serve as a first step toward eliminating fish consumption advisories in the Northeast states. For purposes of demonstrating compliance with individual states' water quality standards, reduction goals for Maine's and Connecticut's lower fish tissue criteria are included in Appendix B.

On August 2, 2006, Benita Best-Wong, EPA Headquarters, Director, Assessment and Watershed Protection Division issued a memorandum titled *Clarification Regarding Phased Total Maximum Daily Loads*. The memorandum included a section on TMDLs with staged implementation that highlighted mercury TMDLs as scenarios where staged implementation would be appropriate. The section makes specific references to situations where achievement of water quality standards is dependent on long-term reductions in atmospheric deposition. Per this memorandum the appropriate terminology to describe such a TMDL is staged implementation. In this TMDL prepared by the Northeast states, staged implementation will be used not only to meet the 0.3 ppm methylmercury fish tissue criterion, but the other fish tissue concentration goals for Maine and Connecticut as well.

5.4 Proportionality of Mercury Reductions

This TMDL is based on an assumption that a decrease in mercury emissions will result in a proportional decrease in mercury deposition, a decrease in mercury deposition will result in a proportional decrease in mercury loading to waterbodies, and ultimately, a decrease in mercury loading in waterbodies will result in a proportional decrease in mercury concentrations in fish. This follows the analyses presented by the EPA *Mercury Maps* Model, which is a modification of the Mercury Cycling Model. The effects of the approach have been evaluated by Kamman, et al. (2006) for the region. EPA's *Mercury Maps* model relates changes in mercury air deposition rates to changes in mercury fish levels and indicates that for long-term equilibrium conditions, the ratio of current to future air deposition rates will equal the ratio of current to future fish tissue concentrations (U.S. EPA 2001). This model predicts a linear relationship between reduced atmospheric inputs and mercury levels in fish. The rate of change in fish mercury will vary among Northeast waterbodies due to different conditions that affect the production of methylmercury and bioaccumulation of methylmercury. These factors include watershed area, productivity, acidification status, sulfate loading, and water-level manipulation. However, empirical evidence is mounting that biological mercury concentrations are reduced in proportion to emissions and resultant deposition reductions (Evers, et al. 2006 and Florida Department of Environmental Protection 2003).

6 Source Assessment

6.1 Northeast States Emissions Inventory

In 1998, NESCAUM prepared *Atmospheric Mercury Emissions in the Northeastern States* to refine the emissions inventory figures developed by EPA for the Northeast region in conducting their national evaluation of atmospheric mercury emissions in accordance with the requirements of the 1990 Clean Air Amendments. Refinements were made based on facility-specific information collected by state air quality agencies, including stack test data, fuel use rates, air pollution control devices, and other operational parameters (NESCAUM 2005). The inventory quantifies mercury emissions representative of the year 1998 for combustion, manufacturing, and area sources in New England, New York State, and New Jersey. The study was a combined effort of the state and provincial air, waste, and water management agencies in the Northeast states and eastern Canadian provinces and was intended to serve as an information resource to these agencies and as a foundation for future regional initiatives, including the development of a coordinated action plan to reduce the environmental and public health impacts of mercury (NESCAUM 1998).

The inventory is divided into direct and area sources. Direct sources, which include combustion and manufacturing sources, typically release emissions from a stack and are large enough to be associated with a specific geographic location. Area sources are typically small, but there may be a large number of them, and they are not usually associated with emissions from a stack. Area sources include categories such as fossil fuel residential heating, fluorescent lamp breakage and recycling, laboratory use, dental use, and crematories. As seen in Figure 6-1, approximately 87 percent of the mercury emissions inventory can be attributed to direct sources. About 9 percent of the direct emissions are due to manufacturing sources, with the remainder being attributed to the various combustion sources. The largest combustion sources were municipal waste combustors (MWCs) at 56 percent and electric utility boilers at 12 percent (NESCAUM 1998). Table 6-1 provides a full summary of emissions by category. NESCAUM's regional inventory included New Jersey, but emissions data reported here include only New England and New York State.

Figure 6-1 Breakdown of Major Sources of Northeast Regional Mercury Emissions

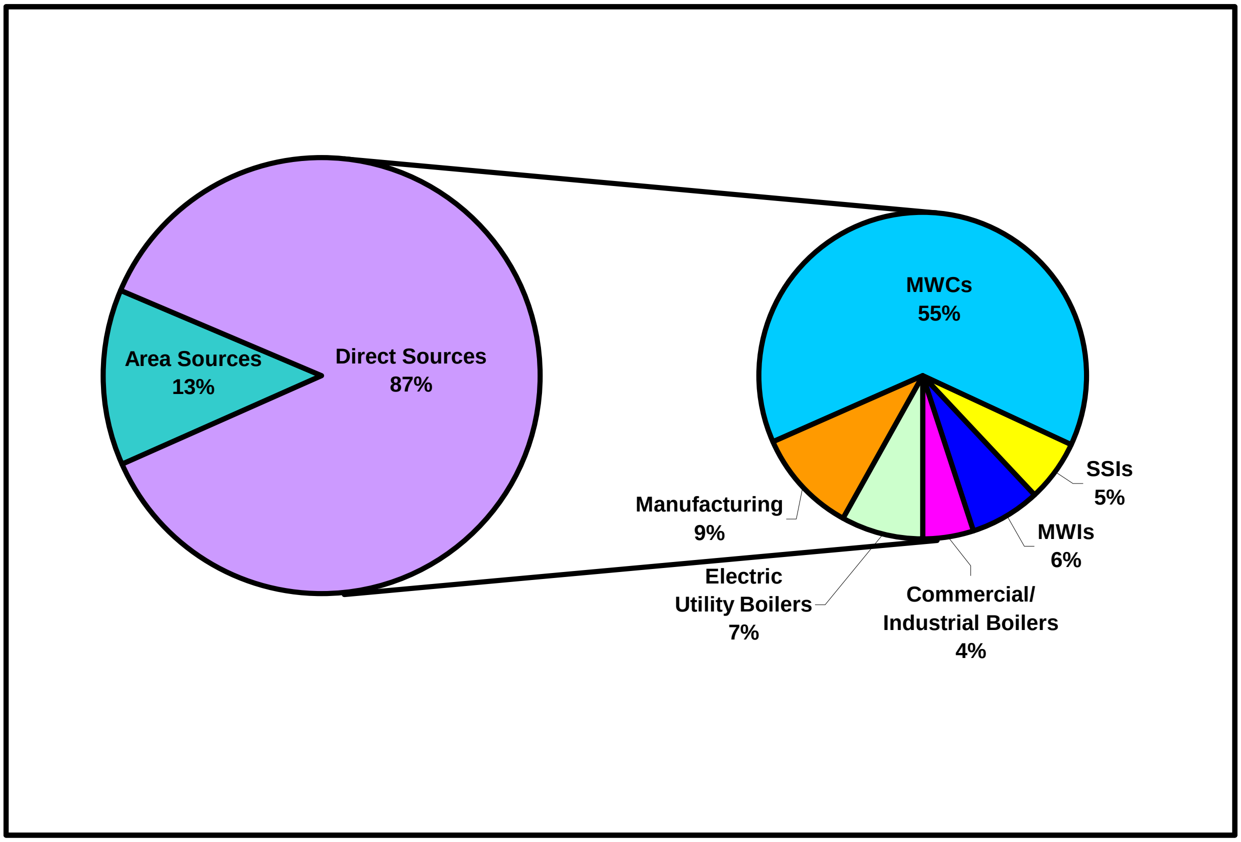

Table 6-1 1998 Northeast[1] Regional Mercury Emissions Inventory

Mercury Source Categories	Emissions Estimate (kg/yr)	Percent of Inventory
Direct Sources		
Combustion Sources		
Municipal Waste Combustors	6,896	55.2
Sewage Sludge Incinerators	657	5.3
Medical Waste Incinerators	758	6.1
Commercial/Industrial Boilers	552	4.4
Fossil Fuel-Fired	449	3.6
Wood-Fired	103	0.8
Electric Utility Boilers Total	864	6.9
Coal-Fired	697	5.6
Oil-Fired	142	1.1
Natural Gas-Fired	18	0.1
Wood-Fired	7	0.1
Total Combustion Sources	9,727	77.9
Manufacturing Sources		
Secondary Mercury Production	319	2.6
Cement Manufacturing	305	2.4
Lime Manufacturing	15	0.1
Steel Foundries	17	0.1
Chlor-Alkali Facilities	460	3.7
Misc. Industrial Processes	3	0.02
Total Manufacturing Sources	1,119	9.0
Total Direct Sources	**10,846**	**86.8**
Area Sources		
Residential Heating	575	4.6
Industrial Processes	1,073	8.6
Electric Lamp Breakage & Recycling	379	3.0
General Lab Use	48	0.4
Dental Preparation and Use	70	0.6
Crematories	70	0.6
Latex Paint	506	4.0
Total Area Sources	**1,648**	**13.2**
Total Emissions	**12,494**	**100**

[1] NESCAUM's original Northeast inventory included New Jersey, but data presented here are for New England and New York State only.

6.2 Atmospheric Deposition Modeling

NESCAUM has performed atmospheric deposition modeling using the Regional Modeling System for Aerosols and Deposition (REMSAD). This is a Eulerian grid model that includes atmospheric transport and chemistry. The REMSAD model uses tagging, which allows tracking of emissions through space and time. Tags can be individual sources, source types, and source regions (Graham, et al. 2006). NESCAUM conducted two modeling runs, one using 1998 emissions inventory for the Northeast region and one using 2002 emissions inventory for the Northeast region. Both modeling runs used 1996 meteorology data and 1999 or 2001 out-of-region emissions data depending on the source type (e.g. area sources vs. electric-generating units). Boundary conditions were obtained from the global mercury model GEOS-CHEM. The Northeast region, as defined by NESCAUM, includes the New England states, New York State, and New Jersey, whereas this TMDL defines the Northeast region as the New England states and New York State. Consequently, NESCAUM's modeling separated contributions from New England and New York State/New Jersey as one unit, but did not separate the contributions of New York State and New Jersey. NESCAUM was able to provide estimates of the separate contributions of New York State and New Jersey by splitting each of the contributing source categories based on location and amount of emissions, and then apportioned the deposition from the model runs accordingly (John Graham, electronic mail, December 19, 2006). The model results shown below for U.S. sources account only for anthropogenic sources of mercury and do not include atmospheric deposition of mercury from natural sources. Results for global sources include a natural component, which is further discussed below.

Table 6-2 Modeled Mercury Atmospheric Deposition (kg/yr) in 1998 and 2002 for the Northeast[1] Region

Source	Northeast States	Rest of the U.S.	Global Sources[2]	Total
1998 Modeled Total Deposition	2,092	1,207	2,106	5,405
1998 Modeled Natural Deposition	0	0	527	527
1998 Modeled Anthropogenic Deposition	2,092	1,207	1,580	4,879
2002 Modeled Total Deposition	543	791	2,106	3,440
2002 Modeled Natural Deposition	0	0	527	527
2002 Modeled Anthropogenic Deposition	543	791	1,580	2,914

[1]Northeast region includes the New England states and New York State.
[2]Global sources include recirculating historical emissions from the U.S.

The global source estimate includes approximately 253 kg/yr (2,106 kg/yr x 0.12) attributable to primary natural sources. This value is based on the global modeling that the boundary conditions were derived from, where approximately 12 percent of the inventory was from primary natural emissions. The global source contribution also includes recirculating natural source emissions from the U.S. Based on the assumption used in this TMDL that deposition is 75 percent anthropogenic and 25 percent natural (Kamman and Engstrom 2002, further discussed in Section 7.2), the contribution of recirculating natural source emissions is set at 13 percent, so that the contributions of primary natural emissions and recirculating natural source emissions sum to 25 percent. Based on this assumption, recirculating natural source emissions are equal to 274 kg/yr (2,106 kg/yr x 0.13). No other natural sources were accounted for in the regional deposition modeling. When global natural sources are subtracted from the total deposition results, the total anthropogenic deposition is 4,879 kg/yr for 1998 and 2,914 kg/yr for 2002. In order to avoid double counting of natural mercury deposition, modeled natural deposition was excluded from TMDL calculations. Modeled anthropogenic deposition was used as a base from which to estimate total regional natural mercury deposition based on regional studies that estimate regional deposition is 25 percent natural and 75 percent anthropogenic (Kamman and Engstrom 2002). This is further discussed in Section 7.2.

6.3 Point Sources to Water

There are 3,119 National Pollutant Discharge Elimination System (NPDES) permitted facilities discharging to the waters of New England and New York State. These include publicly owned treatment works (POTWs), as well as industries such as pulp and paper mills, chlor-alkali plants, and manufacturers of lighting equipment, chemicals, and metals.

To estimate the point source mercury load for the region, mercury monitoring data and design flow data were used. All available point source mercury monitoring data from 1988 to 2005 were obtained from the participating states. For any facility with multiple measurements, all data points were averaged to calculate a mean mercury concentration for each facility. These mean values were all combined into one dataset and the median mercury concentration for the region was calculated. This value, 4.2 ng/l, was used as a typical point source mercury concentration for the region. Facilities discharging to coastal waters were excluded from design flow calculations, but concentration data from coastal facilities were retained because the amount of available mercury effluent data is small and there is no reason to believe that mercury effluent concentrations would differ between facilities discharging to marine and fresh waters.

Design flow data for all NPDES permitted facilities in the region were obtained from EPA Region 1, New York State Department of Environmental Conservation (NYS DEC), and Vermont Department of Environmental Conservation (VT DEC). Facilities that primarily discharge cooling water were not included in point source mercury load estimates because their discharges do not contain appreciable amounts of mercury. Facilities that discharge to marine waters were also excluded because this TMDL targets only freshwaters. A median value was calculated from the available data and used as an estimate for any facilities for which design flow data were not available. The known and estimated design flows for all regional facilities were then summed together. This value was used with the regional point source concentration estimate of 4.2 ng/l to estimate the total point source load. The breakdown of effluent concentrations and design flows by state is shown below in Table 6-3.

Table 6-3 Mercury Point Sources to Water

State	Number of Facilities w/ Data	Mean Concentration (ng/l)	Median Concentration (ng/l)	Sum of Design Flows (MGD)
CT	114	1.3	1.2	7,105
ME	186	17.3	7.3	515
MA	5	22.9	7.7	1,791
NH	0	13.0	4.2	138
NY	50	17.8	9.8	3,622
RI	3	233.3	200.0	56
VT	10	1.3	1.3	95
Northeast Region	369	13.0	4.2	13,322

*****Because no effluent data were available for New Hampshire, the regional median and means are used as estimates.

7 Development of a Regional Total Maximum Daily Load

7.1 TMDL Formulation

The TMDL formulation used for this regional mercury TMDL is similar to the Minnesota Statewide Mercury TMDL, approved by EPA March 27, 2007, which employs a total source load (TSL) and reduction factor (RF) to define the desired TMDL. In general, the three-step process to determine a TMDL is to (1) determine the existing load for point and nonpoint sources; (2) define the target loads; and (3) calculate load reduction factors necessary to achieve the target values. The total source load (TSL) and reduction factor (RF) are then combined to give the TMDL for the area of concern as shown in Equation 1.

Equation 1: $TMDL = TSL \cdot (1-RF)$

where: TMDL is the total maximum daily load (kg/yr) that is expected to result in attainment of the target fish mercury concentration specified in Section 5.3

TSL is the existing total source load (kg/yr), and is equal to the sum of the existing point source load (PSL) and the existing nonpoint source load (NPSL) and

RF is the reduction factor required to achieve the target fish mercury concentration (see Section 7.3 for calculations)

Once the TMDL is calculated in accordance with Equation 1, the allowable load can then be allocated among the point sources, nonpoint sources and an explicit MOS (if necessary) in accordance with the conventional TMDL formula shown as Equation 2 below.

Equation 2: $TMDL = WLA + LA + MOS$

where: WLA = Wasteload Allocation or point sources

LA = Load Allocation or nonpoint sources

MOS = Margin of Safety

Each of the terms used in Equations 1 and 2 are further discussed in Sections 7.2 through 7.7 followed by a presentation of the final TMDL in Section 8.

7.2 Calculation of Existing Total Source Load (TSL)

Calculation of the existing Total Source Load (TSL) of mercury, in kg/yr, is presented below in Equation 3 and is the sum of the existing point source and nonpoint source loadings.

Equation 3: $TSL = PSL + NPSL$

The calculation for PSL is presented below in Equation 4 and is estimated for the region based on the total design flow of wastewater treatment facilities and the median effluent mercury concentration. The PSL is the product of the regional median mercury concentration in effluent and the sum of design flows for each permitted facility in the region.

$$\text{Equation 4: } PSL = C_{med} \cdot \sum Q_i$$

where: C_{med} = Median mercury concentration in effluent of NPDES permitted discharges

Q_i = Design flow of each NPDES permitted discharge (excluding cooling water and marine discharges)

C_{med} is derived from all available point source mercury monitoring data obtained from the participating states, and is equal to 4.2 ng/l (see Table 6-3). The sum of regional design flows, excluding facilities that primarily discharge cooling water or discharge to coastal waters, is 13,322 MGD (see Table 6-3). Based on Equation 4 and the data presented in Table 6-3, the existing PSL is 77 kg/yr.

When stormwater is addressed in a TMDL, it is generally included with the point source load and subsequently included in the wasteload allocation. However, most mercury in stormwater comes from atmospheric deposition. Therefore, as atmospheric deposition is considered a nonpoint source and addressed in the LA, stormwater is accounted for in the nonpoint source load. The contribution of mercury from other sources to stormwater is assumed to be inconsequential and therefore is estimated to be zero in the WLA.

The nonpoint source load (NPSL) calculation, as presented below in Equation 5, reflects the contributions of natural (NNPSL) and anthropogenic (ANPSL) sources of mercury deposition.

$$\text{Equation 5: } NPSL = NNPSL + ANPSL$$

The only significant nonpoint source can be attributed to atmospheric deposition. Other contributions, such as land application of municipal sewage sludge, are assumed to be insignificant. As discussed in Section 6.2, the modeled anthropogenic atmospheric mercury deposition (ANPSL) for 1998 is 4,879 kg/yr.

Based on results of several paleolimnological studies in the Northeast, background or natural mercury deposition estimates range from 15 percent to 35 percent of circa year 2000 deposition fluxes (Perry, et al., 2005, Norton, et al. 2004, Seigneur, et al. 2003, Kamman and Engstrom 2002, Lorey and Driscoll 1998, and Norton, et al. 1997). These values are consistent with other published values from the upper Midwest and elsewhere. For the purposes of this TMDL, the paleolimnological studies are used to conclude that the proportion of deposition due to natural sources (PDNS) in the Northeast is 25 percent of the total deposition load. Natural sources cannot be controlled and are expected to remain at the same long-term average; therefore all mercury reductions must come from anthropogenic sources. The NPSL and NNPSL can be calculated from Equations 6 and 7 below.

$$\text{Equation 6: } NPSL = ANPSL / (1-PDNS)$$

$$\text{Equation 7: } NNPSL = NPSL \cdot PDNS$$

Based on these equations, an ANPSL of 4,879 kg/yr, and a PDNS of 0.25, NPSL is equal to 6,506 kg/yr and NNPSL is equal to 1,626 kg/yr.
Knowing the PSL and NPSL, the 1998 TSL can be calculated in accordance with Equation 3 as shown below:

$$\text{1998 TSL} = 77 \text{ kg/yr} + 6{,}506 \text{ kg/yr} = 6{,}583 \text{ kg/yr}$$

Based on these values, existing point source loads represent 1.2 percent and existing nonpoint source loads represent 98.8 percent of the 1998 TSL.

7.3 Reduction Factor (RF)

The calculation for the RF is presented below in Equation 8 and is based on the reductions required to achieve the target fish mercury concentration.

Equation 8: RF = (EFMC – TFMC)/ EFMC

where: EFMC = the existing fish mercury concentration for the selected fish species

TFMC = the target fish mercury concentration for meeting water quality standards

As discussed in Section 5.2, the EFMC for this study is a range from 0.860 to 1.14 ppm which represents the range from 80^{th} to 90^{th} percentile concentrations based on standardized length for smallmouth bass. As discussed in Section 5.3, the TFMC is equal to 0.3 ppm[1]. Inserting these values into Equation 8 results in a RF range of 0.65 to 0.74.

7.4 TMDL Calculation

As previously mentioned, the TSL is equal to 6,583 kg/yr (see Section 7.3) and the RF ranges from 0.65 to 0.74 (see Section 7.4). Inserting these values into Equation 1 yields a TMDL range of 1,732 to 2,296 kg/yr. This is the total allowable loading of mercury that, over time, is expected to result in meeting the target mercury fish concentration of 0.3 ppm.

7.5 Wasteload Allocation (WLA)

According to Equation 2, the calculated permissible load (TMDL) of mercury that will not cause the applicable water quality standards to be exceeded is the sum of the wasteload allocation (point sources), load allocation (nonpoint sources) and an explicit MOS, if applicable. As explained in Section 7.7, an implicit MOS is used for this study which infers an explicit MOS of zero. Therefore the TMDL is equal to the sum of the WLA and LA. As discussed in Section 7.2, point sources primarily consist of discharges from NPDES wastewater treatment facilities and the only significant nonpoint source is atmospheric deposition. Consequently, the total load is apportioned between wastewater and atmospheric loads.

As discussed in Section 7.2, the existing point source load for the entire region is 1.2 percent of the TSL for mercury, which is de minimis and expected to further decline based on enacted mercury products legislation and increasing required use of dental amalgam separators throughout the region. According to EPA's *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, point source discharges are considered insignificant if the loading or cumulative loading of all point sources to the receiving water are expected to account for a small or negligible portion of the total mercury loadings (U.S. EPA 2006a). All significant decreases in mercury loading to the region will come from reductions

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[1] All calculations in Section 7 are based on the regional TFMC of 0.3 ppm. Values differ for Connecticut and Maine based on their TFMCs of 0.1 and 0.2, respectively. Calculations based on these values can be found in Appendix B.

in atmospheric deposition (i.e., load allocation). As a result, the WLA is set at 1.2 percent of the TMDL, which is equivalent to 20 to 27 kg/yr.

The WLA in this TMDL is regional and is not specific to each particular state or source. Instead of allocating the WLA among sources, mercury reduction will be accomplished through mercury minimization plans (MMPs) and the continuation of region-wide mercury reduction efforts. MMPs help ensure that discharges have no reasonable potential to cause or contribute to an exceedance of water quality standards. EPA believes that a requirement to develop a MMP may provide dischargers with sufficient information to voluntarily and economically reduce mercury discharges (EPA 2006a).

7.6 Load Allocations

7.6.1 Load Allocation Calculations

As discussed in Section 7.5, application of a reduction factor range of 0.65 to 0.74 to the TSL results in a regional mercury loading goal range (i.e., TMDL) of 1,732 to 2,296 kg/yr. Subtracting the wasteload allocation range of 20 to 27 kg/yr from the mercury loading goal in accordance with Equation 2, and assuming an explicit MOS of zero for reasons discussed in Section 7.7, yields a regional mercury LA range of 1,712 to 2,269 kg/yr. However, as discussed in Section 7.2, 1,626 kg of the TSL is due to natural sources of mercury and cannot be controlled (this number represents the natural load allocation or NLA). The anthropogenic load allocation (ALA) can be calculated using Equation 9 below.

$$\text{Equation 9: } ALA = LA - NLA$$

Using this equation with the LA range of 1,712 to 2,269 kg/yr and NLA of 1,626 yields an ALA range of 86 to 643 kg/yr. This represents the range of anthropogenic atmospheric deposition goals for the Northeast states, to be achieved through reductions in both in-region and out-of-region sources.

7.6.2 Necessary Reductions to Meet LA

In order to meet the ALA range of 86 to 643 kg/yr, atmospheric deposition due to anthropogenic sources must be reduced by 86.8 to 98.2 percent [100 · (4,879 – 643)/4,879] or [100 · (4,879 – 86)/4,879]. Necessary reductions to meet the LA are divided into in-region and out-of-region contributions. Reductions are divided into three phases, Phase I from 1998 to 2003, Phase II from 2003 to 2010, and Phase III beginning in 2010 with an end date to be determined in 2010. The timeline and goals for Phases I and II are set to correspond with the NEG-ECP regional MAP. In 2010, mercury emissions, deposition, and fish tissue concentration data will be re-evaluated with current information. This information will be used to set an end date and reduction goal for Phase III, which will represent completion of necessary reductions to meet water quality standards. Based on updated data, the final TMDL goal may differ from the 86.8 to 98.2 percent reduction presented in this document. This will be further described in Section 9.

Based on an 86.8 to 98.2 percent reduction in anthropogenic sources, mercury reductions amount to 4,236 to 4,793 kg/yr, which would be 1,816 to 2,055 kg/yr from in-region sources and 2,420 to 2,738 kg/yr from out-of-region sources. The goal for Phase I (1998-2003) is a 50 percent reduction, or 1,046 kg/yr from in-region sources and 1,394 kg/yr from out-of-region sources. As of 2002, in-region sources had been reduced by 1,549 kg/yr, so the in-region goal for Phase I was exceeded. Not enough data are currently available to accurately assess reductions from out-of-region sources. The goal for Phase II (2003-2010) is a 75 percent reduction, or 1,569 kg/yr from in-region sources and 2,090 kg/yr from out-of-region sources. Based on in-region reductions achieved as of 2002, in-region reductions of 20 kg/yr are necessary to meet the Phase II goal.

Based on calculations presented in this document, once Phase II goals are successfully met, in-region sources will need to be reduced by an additional 247 to 486 kg/yr and out-of-region sources will need to be reduced by an additional 330 to 648 kg/yr to meet the final TMDL goal in Phase III. However, as discussed above, mercury emissions, deposition, and fish concentration data will be re-evaluated at the completion of Phase II in 2010. If necessary, reductions for meeting the target fish concentration will be revised based on updated data. As further discussed in Section 9, TMDL goals will be implemented in an adaptive fashion.

7.7 Margin of Safety

Regulations require that a MOS is required in a TMDL to account for uncertainty that may be present in the calculations. A MOS can either be explicit (e.g., additional percentage load reduction), implicit in the calculations, or a combination of the two. For this mercury TMDL, the MOS is implicit because of the following conservative assumptions used to develop this TMDL:

- The 80th to 90th percentile fish mercury concentrations based on a standard length smallmouth bass were used. Smallmouth bass has the highest concentrations of the four species selected for calculation (see Table 4-1). The vast majority of fish have concentrations lower than this. According to Equation 1, the higher the EFMC, the higher the RF and the lower the TMDL. Consequently, selection of a relatively high fish concentration incorporates a margin of safety into the analysis.
- Atmospheric sources of mercury in the Northeast are categorized as 25 percent natural (Kamman and Engstrom 2002), but could range from 15 to 35 percent, based on a number of regional studies. Given the Northeast region's location downwind of mercury sources and the fact that available sediment cores are largely from more rural sites less impacted by direct air emissions sources, the percentage of baseline deposition attributable to natural sources across the region may be lower than the 25 percent used in this analysis. Use of a lower value, such as 15 percent, would have resulted in lower required reductions in anthropogenic sources.

7.8 Seasonal Variation and Critical Conditions

Seasonal variations and "...critical conditions for stream flow, loading, and water quality parameters" are discussed in 40 CFR 130.7(c)(1). The regulation provides that: *"for pollutants other than heat, TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical WQS with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. Determinations of TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters"*. Mercury deposition and concentrations in water vary due to seasonal differences in rain and wind patterns, but this variation is not relevant because mercury concentrations in fish represent accumulation over their life spans. Factors such as size and waterbody conditions have greater effect on mercury concentrations than seasonal variation.

There are some factors, such as water chemistry and water level fluctuations that make conditions more favorable for mercury accumulation in fish. However, these are not short term critical conditions, but rather factors that contribute to the accumulation of mercury in fish over long periods of time.

7.9 Daily Load

Because this TMDL addresses mercury accumulation in fish over long periods of time, annual loads are more appropriate for expressing mercury loading goals. Therefore, the calculations are based on annual loads. However, in order to comply with current EPA guidance, the TMDL is also expressed as a daily load.

8 Final TMDL

The conventional equation for a TMDL is as follows: TMDL = WLA+LA+MOS. As described in Section 7.7, the MOS is implicit for this TMDL, and therefore, it is not necessary to include an explicit MOS in the calculations. Calculation of the WLA and LA are described in sections 7.5 and 7.6 respectively. The TMDL equation for the Northeast region is described below in annual (Equation 10) and daily (Equation 11) loads. The ranges shown correspond to use of the 80^{th} and 90^{th} percentile existing mercury concentrations in smallmouth bass to calculate the TMDL as discussed in Section 5.2.

Equation 10: Annual Load = TMDL **(1,732 to 2,296 kg/yr)** = WLA (20 to 27 kg/yr) + LA (1,712 to 2,269 kg/yr) + MOS (implicit)

Equation 11: Daily Load = TMDL **(4.75 to 6.29 kg/d)** = [WLA (20 to 27 kg/yr) + LA (1,712 to 2,269 kg/yr) + MOS (implicit)] /365

The WLA is defined for this mercury TMDL as 1.2 percent of the TMDL to ensure that water point source mercury loads remain de minimis.

9 Implementation

This regional TMDL will be implemented using adaptive implementation in order to ensure calculated reduction targets are appropriate as measured mercury fish tissue concentrations decline. If fish tissue concentrations decline to levels that meet water quality standards before an 86.6 percent to 98.2 percent reduction in anthropogenic loadings is achieved, targets will be adjusted based on that monitoring.

Implementation has been divided into three phases. The timeline and goals for the first two phases align with the NEG-ECP Regional MAP. Phase I is from 1998 to 2003 with a goal of 50 percent reduction and Phase II is from 2003 to 2010 with a goal of 75 percent reduction. The goal of Phase III will be to make any further necessary reductions to meet the target fish mercury concentration. However, the exact timeline and reduction goal for this phase cannot be determined until mercury emissions, deposition, and fish tissue concentrations are re-evaluated in 2010. The goal for Phase III may or may not match the 86.8 to 98.2 percent reduction that current calculations show. To meet the necessary reductions required in Phase III, major air point sources will be addressed through the application of more stringent control technology requirements and/or emission limits, economically and technically feasible/achievable, taking into account advances in the state of air pollution controls and the application of transferable technologies used by other sources to achieve maximum emission reductions. Emissions from area sources will be controlled to the maximum extent feasible using best management practices and pollution prevention approaches.

9.1 State and Regional Implementation

9.1.1 Implementation of Wasteload Allocation

In 2005, it was estimated that approximately 72 percent of dentists in New England had installed amalgam separators. As the point source load for this TMDL was based on data from 1988 to 2005, the regional point source load has most likely already decreased as a result of amalgam separator installation. As of 2006, all of the Northeast states have legislation that requires installation of amalgam separators, which will further reduce mercury loads in wastewater. As of 2006, all of the Northeast states have comprehensive mercury products legislation. This will result in additional reductions in mercury concentrations in wastewater by reducing mercury input from household uses. Individual NPDES permitted facilities can further decrease their mercury loads by implementing MMPs. These would constitute practices or procedures that a facility would follow in order to reduce mercury in their effluent.

9.1.2 Adaptive Implementation of Load Allocation

EPA's Clean Air Mercury Rule (CAMR) became effective May 18, 2006. All states that received a mercury budget under CAMR are required to either comply with the rule or develop their own rule. Because they do not have any coal-fired utilities, Rhode Island and Vermont did not receive a mercury budget under CAMR and are therefore not required to develop a state plan (NACAA 2007). The five remaining Northeast states have chosen to develop their own rules. None of the Northeast states will participate in the interstate trading that is allowed under CAMR. Table 9-1 provides a summary of state rules. Implementation of these state-based rules will go a long way toward meeting the deposition goals set by this TMDL, as coal-fired utilities are one of the most significant sources of emissions in the region.

Table 9-1 Northeast State Mercury Control Programs for Coal-Fired Utilities

State	Rule
CT	On or after July 1, 2008, coal-fired utilities are required to meet an emissions rate equal to or less than 0.6 lbs of mercury per trillion British thermal units (TBtu) or meet a rate equal to 90 percent reduction, whichever is more readily achievable. On or before January 1, 2012, CT DEP will conduct a review of mercury emission limits applicable to affected units and may adopt regulations to impose more stringent limits.
ME	Currently all coal-fired utilities and other facilities in Maine have a mercury emissions limit of 50 lbs/yr. Recently enacted legislation changes the limit to 35 lbs/yr in 2007 and 25 lbs/yr in 2010. A mercury reduction plan would also be required for any facility emitting more than 10 lbs/yr.
MA	Phase I, which takes effect January 1, 2008, requires that each facility capture at least 85 percent of mercury in the coal burned, or emit no more than 0.0075 lbs of mercury per net gigawatt-hour of electricity generated. Phase II, which takes effect October 1, 2012, requires that facilities capture at least 95 percent of the mercury in coal burned, or emit no more than 0.0025 lbs of mercury per net gigawatt-hour of electricity generated.
NH	An Act Relative to the Reduction of Mercury Emissions provides for 80 percent reduction of mercury emissions from coal-burning power plants by requiring installation of scrubber technology no later than July 1, 2013 and provides economic incentives for earlier installation and greater reductions in emissions.
NY	Phase I requires a 50 percent decrease by January 1, 2010 and Phase II will implement a unit-based limit for each power plant facility. This will result in an estimated 90 percent decrease from current levels, which will result in total emissions of 150 lbs/yr or less.

In addition to enforceable controls on coal-fired utilities, the next phase of the NEG-ECP MAP focuses on reductions from four other sectors: sewage sludge incinerators (SSIs), MWCs, area sources, and residential heating/commercial and industrial oil combustion. SSIs will be addressed by the now mandatory installation of amalgam separators in all Northeast states and reducing use of mercury-added products by consumers and the health care sector. Reductions will be achieved from MWCs by pollution prevention efforts, mercury-added product legislation, and possibly enhanced pollution controls. Emissions from area sources are likely to decrease as a result of pollution prevention initiatives. Limited data on the residential heating/commercial and industrial oil combustion sectors make it difficult to set emissions targets for this sector, but emissions can be reduced through modifications to fuels combusted, shifting to lower mercury oils, energy conservation efforts, and increased use of renewable energy sources.

Through the NEG-ECP MTF process, New England states have made a commitment toward the virtual elimination of mercury. As mentioned previously, while New York State is not a member of the NEG-ECP, they too have made a state-wide commitment to reduce mercury. These goals and commitments are complimentary to this TMDL. Between 1998 and 2002, regional mercury deposition was reduced by approximately 74 percent. Since 2002, a number of mercury reduction programs have been implemented and many regulations have passed, to further reduce regional mercury deposition. However, as updated deposition modeling has not been undertaken, these reductions are not yet quantifiable. The regional emissions inventory and deposition modeling will be updated in 2010. With the implementation of reduction programs and legislation since 2002, and full implementation of legislation that has been passed, the Northeast states are addressing all mercury sources within their control.

This TMDL includes an in-region implementation plan that takes into account the significant reductions already made by the Northeast states and the need for updated emissions inventory and deposition modeling at the end of Phase II. An appropriate implementation plan based on that updated information will be developed for Phase III. Because the Northeast states are already addressing all mercury sources within their control, additional controls are not expected of in-region sources as part of the implementation for Phases I and II. In order for this TMDL to be fully implemented, greater reductions are needed from out-of-region sources.

9.2 Adaptive National Implementation

As this TMDL has shown, there is a need to make significant reductions in anthropogenic emissions of mercury in order to meet states' water quality standards. The Northeast states demonstrate below through their assurances that significant regional reductions have already been met and continuing reductions will be made. Research undertaken by states has shown that significant reductions in mercury emissions translate into timely and significant reductions in fish tissue concentrations. As described further in Section 10.1, MassDEP has seen timely and significant decreases in fish tissue mercury concentrations with a decrease in local mercury emissions (Hutcheson, et al. 2006). Timely reductions will yield immediate public health and environmental quality improvements for the Northeast states.

CAMR became effective May 18, 2006. The first phase of the rule, which will be achieved in 2010, will reduce emissions nationwide by about 21 percent. The second phase will reduce emissions by about 70 percent and will be achieved sometime after 2018. This phasing of the national CAMR is insufficient to meet the adaptive implementation of this TMDL. The rule established a cap-and-trade program, which will allow power plants to purchase emissions reduction allowances from other power plants and potentially bank these allowances to meet compliance requirements in future years.

Prior to the finalization of CAMR, EPA was considering two options for controlling mercury emissions from coal-fired power plants. The first option would mean EPA would, pursuant to Section 112(n) of the CAA, set National Emission Standards for Hazardous Air Pollutants (HAPs) for power plants and adopt a Maximum Achievable Control Technology (MACT) standard for mercury. The second option would revise EPA's December 2000 determination that regulation of power plants under Section 112(n) was "necessary and appropriate." With the finalization of CAMR, EPA chose the second option and used Section 111 of the CAA to set standards for mercury emissions. EPA determined that regulation of mercury under a cap-and-trade program was sufficient to protect public health.

As the Northeast states have argued in the Opening Brief of Government Petitioners dated January 11, 2006 in the matter of *State of New Jersey, et al. vs. United States Environmental Protection Agency*, the implementation of a strict plant-specific MACT for mercury under section 112(d) of the CAA would result in at least 90 percent control of mercury emissions by cost-effective and available technologies. Further, enacting a MACT standard under section 112(d) would require compliance within three years of the effective date of the standard.

This TMDL adds a second dimension to the legal arguments presented by the Northeast states in the lawsuit mentioned above by calculating for the first time the extent of reductions needed to meet water quality standards in the region's listed waters and remove fish consumption advisories. This TMDL further establishes the need for emissions reductions over much shorter timeframes. The results of research conducted in Massachusetts show that mercury emission reductions can quickly translate into reductions in fish tissue concentrations.

The Northeast states are recommending adaptive implementation of this TMDL and that a strict 90 percent MACT standard be enacted under section 112(d) be promulgated to meet the national implementation requirements of the TMDL for Phase II (2003-2010). As discussed previously, this TMDL calls for an 86.8 to 98.2 percent reduction in order to meet the target fish tissue concentration. However, the TMDL will be implemented adaptively, so that as regional and national controls are implemented, the response in fish tissue as a result of emissions and deposition reductions will be monitored. If necessary, reduction goals will be modified based on the response seen in fish tissue monitoring.

10 Reasonable Assurances

This regional TMDL for mercury allocates the reduction of pollutant sources to waterbodies throughout the Northeast between point sources, which have been classified as de minimis, and nonpoint sources. States are required to provide reasonable assurance that those nonpoint sources will meet their allocated amount of reductions, which can be much more challenging than documenting reasonable assurances for point source reductions. The actions that provide these assurances take place at the state, national, and international level and are described below.

10.1 State Level Assurances

There are a variety of ways in which a state or states can provide reasonable assurances. These include the implementation of pollution control measures, developing and implementing nonpoint source control plans and, if available, other state regulations and policies governing such facilities. As described in Section 2.3, the Northeast has a strong commitment to reducing mercury in the environment. The New England states participate in the NEG-ECP MTF and are committed to the regional MAP. As part of the

MAP, the New England states have adopted emission limits for large MWCs that are three times more stringent than what EPA requires. This has already resulted in a 90 percent reduction in emissions from this sector. Mercury products legislation adopted in all Northeast states will further reduce these emissions. The MAP also requires a limit for MWIs that is ten times more stringent than EPA requirements. All of the states, including New York State (which is not part of the MTF), have aggressive programs for mercury reduction. The MAP is an adaptive management plan with a goal of virtual elimination.

In 2005, NESCAUM prepared *Inventory of Anthropogenic Mercury Emissions in the Northeast* to update their mercury emission inventory with 2002 emissions data. The project was partially undertaken to assist the NEG-ECP in their effort to assess progress in meeting the goals of the MAP. Table 10-1 shows that substantial reductions in mercury emissions have been made for the majority of sources. Overall, regional mercury emissions decreased by 70 percent between 1998 and 2002. The greatest decreases came from MWCs (87.0 percent), MWIs (96.6 percent), and Commercial/Industrial Boilers (50.5 percent). These emissions reductions have resulted in a 74 percent reduction in atmospheric deposition of mercury, as described in Section 7.6.2.

Table 10-1 Comparison Between 1998 and 2002 Regional Mercury Emissions Inventories

Mercury Source Categories	**1998 Emissions Estimate (kg/yr)**	**Percent of 1998 Inventory**	**2002 Emissions Estimate (kg/yr)**	**Percent of 2002 Inventory**	**Percent Decrease**
Direct Sources					
Combustion Sources					
Municipal Waste Combustors	6,896	55.2	896	23.9	87.0
Sewage Sludge Incinerators	657	5.3	382	10.2	41.9
Medical Waste Incinerators	758	6.1	26	0.7	96.6
Commercial/Industrial Boilers	552	4.4	273	7.3	50.5
Fossil Fuel-Fired	449	3.6	245	6.5	45.4
Wood-Fired	103	0.8	29	0.8	71.8
Electric Utility Boilers Total	864	6.9	864	23.0	0
Coal-Fired	697	5.6	697	18.6	0
Oil-Fired	142	1.1	142	3.8	0
Natural Gas-Fired	18	0.1	18	0.5	0
Wood-Fired	7	0.1	7	0.2	0
Total Combustion Sources	9,727	77.9	2,441	65.1	74.9
Manufacturing Sources					
Secondary Mercury Production	319	2.6	0	0	100
Cement Manufacturing	305	2.4	239	6.4	21.6
Lime Manufacturing	15	0.1	4	0.1	73.3
Steel Foundries	17	0.1	17	0.5	NA
Chlor-Alkali Facilities	460	3.7	0	0	100
Misc. Industrial Processes	3	0.02	3	0.08	NA
Total Manufacturing Sources	1,119	9.0	263	7.0	76.5
Total Direct Sources	**10,846**	**86.8**	**2,704**	**72.1**	**75.1**
Area Sources					
Residential Heating	575	4.6	637	17	-10.8
Industrial Processes	1,073	8.6	411	11	61.7
Electric Lamp Breakage & Recycling	379	3.0	179	4.8	52.8
General Lab Use	48	0.4	48	1.3	0
Dental Preparation and Use	70	0.6	66	1.8	5.7
Crematories	70	0.6	118	3.1	-68.6
Latex Paint	506	4.0	0	0	100
Total Area Sources	**1,648**	**13.2**	**1,048**	**27.9**	**36.4**
Total Emissions	**12,494**	**100**	**3,752**	**100**	**70.0**

In addition to region-wide reductions that provide reasonable assurances, each state has a number of mercury reductions programs. These programs are described below for each of the Northeast states.

Connecticut

In 1990, the Connecticut General Assembly adopted the Toxics in Packaging Act that required elimination of mercury from most packaging within two years. In 1992, Connecticut was one of the first states to pass a law restricting the level of mercury in alkaline batteries. The Universal Waste Rule, which was adopted in 2001, outlines management practices for four specific waste streams, including thermostats and lamps, to reduce mercury in the solid waste stream. Also in 2001, Connecticut DEP provided mercury education and training to used car dealers, auto recyclers, State of Connecticut fleet operations, and City of Hartford fleet operations. Between February 2000 and February 2001, over 283 lbs of mercury and mercury compounds were removed from school science laboratories.

In 2002 Connecticut enacted comprehensive legislation, An Act Concerning Mercury Education and Reduction, targeting the virtual elimination of discharges of anthropogenic mercury to the environment by establishing a program to eliminate non-essential uses of mercury in consumer, household, and commercial products. The first provisions were effective in 2002 and it was fully implemented in 2006. Mercury-containing products such as novelties, fever thermometers, and dairy manometers were banned from sale. After July 1, 2006 the sale or distribution of other mercury-added products containing more than one hundred grams or 100 parts per million of mercury is prohibited, unless the product is specifically exempted from the statutory phase-out requirements, or the department grants a modified or conditional exemption. In addition, manufacturers of mercury-added products are required to meet a number of other provisions under the law to notify, label and provide collection systems. CT DEP works closely with the Interstate Mercury Education and Reduction Clearinghouse to coordinate these actions on a regional basis.

The law also places restrictions on the sale and distribution of elemental mercury and its use. Under this authority the Department adopted best management practices on the use and handling of mercury in dental offices, among other practices, requiring the installation of amalgam separators to trap and remove mercury amalgam from their wastewater discharges.

In 2000, CT DEP revised their air regulations to require stringent controls on resources recovery facilities. Sources subject to the regulation were required to meet an emission limit of 0.80 mg/dry standard cubic meter (dscm) (an 85 percent reduction) by December 2000 and to reduce to 0.028 mg/dscm by June 2002. As discussed in Section 9.1, Connecticut has passed legislation that will decrease emissions from coal-fired power plants by at least 90 percent.

Maine

Maine has a law that bans the disposal of mercury-added products and requires that all mercury-added products are recycled. As of January 1, 2002 the sale of mercury fever thermometers is banned in Maine, mercury-added products must be labeled to clearly inform the purchaser or consumer that mercury is present, and the product must be disposed of properly. All dental offices were required to install amalgam separators by December 31, 2004. As of January 1, 2006 the sale of mercury-added thermostats is banned. Effective July 1, 2006 mercury-added barometers, esophageal dilators, flow meters, hydrometers, hygrometers, manometers, pyrometers, sphygmomanometers, and thermometers cannot be sold in Maine. Also effective the same day, mercury switches or relays cannot be sold individually or as a product component. Incineration and landfill disposal of cathode ray tubes was banned after January 1, 2006. An Act to Regulate Use of Batteries Containing Mercury was signed into law in March 2006 and provides for labeling of button cell batteries that contain mercury, prohibits disposal of these batteries in landfills and incinerators, and requires retailers to provide for take back of these batteries from customers. An Act to Limit Human Exposure to Mercury has a goal to transition to mercury-free dentistry. An Act to Require that Hazardous Waste be Removed from Junked Vehicles includes a requirement for removal of mercury switches.

As described in Section 9.1, currently all facilities in Maine have a mercury emissions limit of 50 lbs/yr. Recently enacted legislation makes the limit more strict and requires a mercury reduction plan for any facility emitting more than 10 lbs/yr.

Massachusetts

The Mercury Management Act, passed in 2006, requires end-of-life recycling of mercury-containing products, prohibits disposal of mercury in trash and wastewater, bans the sale of specific products containing mercury, directs schools and state government to stop purchasing mercury-containing items, establishes a program for removing switches from vehicles, and requires manufacturers both to notify the state of products with mercury content, and to establish end-of-life collection and recycling programs. In April 2006, regulations took effect that require most dental practices and facilities in Massachusetts to install and operate amalgam separator systems, recycle mercury-containing amalgam wastes, and periodically certify their compliance with the requirements. Prior to the regulations, MassDEP implemented a voluntary program with the Massachusetts Dental Society to encourage early installation and use of amalgam separators by dentists.

The Municipal Waste Combustor Rule required facilities with a capacity greater than 250 tons/day to meet an emissions standard of 28 µg/dcsm by December 2000 and to develop material separation plans for products containing mercury. Massachusetts also has strict controls on mercury emissions from coal-fired power plants. These regulations are described in more detail in Section 9.1

MassDEP recently conducted a study to examine changes in fish tissue mercury concentrations in an area of Northeastern Massachusetts with elevated mercury deposition due to local emissions sources. Over the study period, local mercury emissions decreased by 87 percent, and as a result, fish tissue mercury concentrations decreased an average of 25 to 32 percent (Hutcheson, et al. 2006). Consistent decreases were seen 48 months after emissions controls were put in place. This response time was much shorter than was expected. The results of this study emphasize the point that decreases in mercury emissions will result in timely decreases in fish mercury concentrations.

New Hampshire

New Hampshire legislation puts restrictions on the mercury content of batteries and establishes notification requirements for manufacturers of mercury-added products. New Hampshire has a ban on the sale of toys, games, cards, ornaments, or novelties that contain mercury and mercury fever thermometers. No school can use or purchase elemental mercury, mercury compounds, or mercury-added instructional equipment and materials in a primary or secondary classroom. Legislation required all dental practices to install amalgam separators by October 2005.

Any MWC with a design capacity to burn 100 tons/day or more must reduce emissions to achieve no more than 0.028 mg/dscm or at least 85 percent control efficiency. All MWIs must achieve an emissions limit of 0.055 mg/dscm. As described in Section 9.1, New Hampshire recently passed legislation to limit mercury emissions from coal-fired power plants.

New York

A law adopted in September 2005 prohibits the sale and distribution of some mercury-added products including thermostats, barometers, esophageal dilators, bougie tubes, gastrointestinal tubes, flow meters, hydrometers, hygrometers, psychrometers, manometers, pyrometers, sphygmomanometers, thermometers, and switches and relays. The law also requires manufacturers and trade associations dealing in mercury-added products to report certain information to DEC. Regulations effective in May 2006 prohibit the use of non-encapsulated elemental mercury in dental offices and require dentists to recycle any elemental mercury or dental amalgam waste generated in their offices. Dental facilities are required to install, properly operate, and maintain mercury amalgam separation and collection equipment. Although not mandated by law, New York State is working on pollution prevention efforts for health care facilities, an automobile switch collection and recycling project, and a dairy manometers identification and removal program.

New York State has an emission limit for large MWCs (greater than 250 tons/day) of 28 μg/dscm or 85 percent removal, whichever is less stringent. Regulations were recently passed for oal-fired utilities, the details of which are provided in Section 9.1

Rhode Island

The Mercury Reduction and Education Act requires the phase-out of mercury-added products, labeling, collection plans, bans on certain products, and elimination of mercury from schools. No mercury fever thermometers can be sold after January 1, 2002. After January 1, 2003, no mercury-added novelty can be sold in Rhode Island, unless its only mercury component is one or more mercury-added button cell battery. No school can use or purchase for use bulk elemental or chemical mercury or mercury compounds for use in primary or secondary classroom. After January 1, 2006 mercury-added products can only be disposed of through recycling or disposal as hazardous waste. Legislation now requires removal and collection of mercury switches from automobiles. RI DEM currently has a voluntary self certification program for installation of amalgam separators, and legislation that passed in 2006 requires dental offices to install amalgam separators by July 2008.

Rhode Island has a mercury emissions limit of 0.055 mg/dscm for all MWIs.

Vermont

Vermont passed the nation's first mercury labeling law in 1997 and then passed Comprehensive Management of Exposure to Mercury in 2005, with amendments in 2006. This law establishes a comprehensive approach to reducing the exposure of citizens to mercury released in the environment through mercury-added product use and disposal, including requirements that manufacturers of mercury-added products provide notice to the agency and report on total mercury contained in certain products, a ban on the distribution or offering for sale of mercury-added novelties, fever thermometers, thermostats, and dairy manometers, and other devices, and to modify the existing labeling requirements for mercury-added products and packaging by expanding the types of products subject to labeling. It also bans the disposal of mercury-added products such as thermostats, thermometers, automobile switches, and bulbs in landfills and incinerators, requires source separation of discarded mercury-added products, and requires solid waste management facilities to inform customers of disposal bans and collection programs for mercury-added products. The law also prohibits purchase and use of mercury-added products and elemental mercury in primary and secondary schools. Dental practices are required to follow mercury waste management practices as established by the State of Vermont and Vermont State Dental Society and to install dental amalgam separators by January 2007. Hospitals are required to submit a mercury reduction plan to the agency every three years.

10.2 National and International Assurances

The Northeast region's ability to achieve the calculated TMDL allocations is dependent on the adoption and effective implementation of national and international programs to achieve necessary reductions in mercury emissions. Given the magnitude of the reductions required to implement the TMDL, the Northeast cannot reduce in-region sources further to compensate for insufficient reductions from out-of-region sources. While EPA and the federal government are involved in the programs described below, further efforts are necessary to assure that the goals of this TMDL are met.

CAMR, which regulates mercury emissions from Electrical Generating Units (EGUs) under Section 111(d) of the CAA, requires an eventual reduction in mercury emissions of 70 percent at full implementation of the rule, sometime after 2018. CAMR is a two-phase rule, with the first phase requiring reductions in mercury of approximately 20 percent coming as a co-benefit of reductions in sulfur dioxide and nitrous oxides to be made by 2010. Between 2010 and 2018, the CAMR provides for a cap and trade program that is proposed to make further reductions with eventual reductions of 70 percent at some date after 2018.[1]

Additional national mercury reduction programs include the National Vehicle Mercury Switch Recovery Program, which will cut mercury emissions by up to 75 tons over the next 15 years by removing mercury-containing light switches from scrap vehicles before they are flattened, shredded, and melted to make new steel. EPA was a founder of Hospitals for a Healthy Environment (H2E), a movement to promote environmental sustainability in health care. Among H2E's goals is the virtual elimination of mercury waste.

The Commission for Environmental Cooperation (CEC) is an international organization created by Canada, Mexico, and the United States under the North American Agreement on Environmental Cooperation. It was established to address regional environmental concerns, help prevent potential trade and environmental conflicts, and promote effective enforcement of environmental law. The CEC has developed the North American Regional Action Plan (NARAP) on Mercury with the goal of reducing man-made mercury releases to North America through international and national initiatives. The NARAP has provisions regarding risk management approaches to address mercury emissions, processes, operation, and products; waste management; and research, monitoring, modeling, inventories, and communication activities.

The United Nations Environment Programme (UNEP) established its Mercury Programme in 2003. The program has a long-term objective "to substantially reduce or eliminate uses and anthropogenic releases of mercury through the implementation of national, regional and global actions, thereby significantly reducing global adverse impacts on health and the environment"(United Nations Environment Programme 2006). Among other actions, the UNEP Mercury Programme will assist countries to identify and understand mercury problems in their countries and implement actions to mitigate them.

11 Public Participation

As this is a regional TMDL that covers seven states, the public participation process will be dictated by each state's procedure for public notice of a TMDL. The TMDL will be available on NEIWPCC's

[1] The Northeast states have filed a suit (*State of New Jersey, et al. vs. United States Environmental Protection Agency*) against U.S. EPA challenging CAMR's legality – how its limits were calculated and the establishment of the trading program.

website and the website for each state's environmental agency. There will be a 45-day comment period and some states will hold public meetings. Following the comment period, the TMDL technical team will consider all comments received and revise the TMDL document accordingly.

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Appendix A: Northeast Waters Impaired Primarily by Atmospheric Deposition of Mercury

Connecticut

All waters

Maine

All waters

Massachusetts

- Aaron River Reservoir
- Ames Pond
- Ashumet Pond
- Assabet River Reservoir
- Lake Attitash
- Baldpate Pond
- Bare Hill Pond
- Big Pond
- Boons Pond
- Buffumville Lake
- Burr's Pond
- Chadwicks Pond
- Chebacco Lake
- Lake Cochichewick
- Cornell Pond
- Crystal Lake
- Lake Dennison
- East Brimfield Reservoir
- Flint Pond
- Forest Lake
- Fosters Pond
- Gales Pond
- Gibbs Pond
- Great Herring Pond
- Great South Pond
- Haggetts Pond
- Hamblin Pond
- Hickory Hills Lake
- Holland Pond
- Hood Pond
- Hoveys Pond
- Johns Pond
- Johnsons Pond
- Kenoza Lake
- Lake Lashaway
- Lewin Brook Pond
- Locust Pond
- Long Pond, Dracut/Tyngsborough
- Long Pond, Rochester

- Lowe Pond
- Martins Pond
- Mashpee Pond
- Massapoag Lake
- Massapoag Pond
- Miacomet Pond
- Mill Pond
- Millvale Reservoir
- Monponsett Pond
- Newfield Pond
- Lake Nippenicket
- Noquochoke Lake
- North Watuppa Lake
- Nutting Lake
- Otis Reservoir
- Pentucket Pond
- Lake Pentucket
- Peters Pond
- Plainfield Pond
- Pomps Pond
- Pontoosuc Lake
- Populatic Pond
- Pottapaug Pond Basin
- Quabbin Reservoir
- Quacumquasit Pond
- Rock Pond
- Lake Rohunta
- Lake Saltonstall
- Sheep Pond
- Silver Lake
- Snake Pond
- Snipatuit Pond
- Somerset Reservoir
- Stevens Pond
- Sudbury Reservoir
- Tom Nevers Pond
- Turner Pond
- Upper Naukeag Lake
- Upper Reservoir
- Wachusett Reservoir
- Waite Pond
- Wakeby Pond
- Walden Pond
- Lake Wampanoag
- Warners Pond
- Wenham Lake
- Wequaquet Lake
- Whitehall Reservoir
- Whiting Pond
- Wickaboag Pond
- Willet Pond

New Hampshire

All waters

New York

- Salmon River Reservoir
- Susquehanna River, Lower, Main Stem (0603-0016)
- Susquehanna River, Lower, Main Stem (0603-0015)
- Susquehanna River, Lower, Main Stem (0603-0013)
- Susquehanna River, Lower, Main Stem (0603-0002)
- Susquehanna River, Main Stem (0601-0182)
- Susquehanna River, Main Stem (0601-0040)
- Susquehanna River, Main Stem (0601-0020)
- Goodyear Lake
- Susquehanna River, Upper, Main Stem
- Chenango River, Lower, Main Stem
- Chenango River, Middle, Main Stem
- Chenango River, Upper, Main Stem
- Unadilla River, Lower, Main Stem
- High Falls Pond
- Taylorville, Elmer Falls Ponds
- Effley Falls Reservoir
- Moshier Reservoir
- Sunday Lake
- Soft Maple Reservoir, Soft Maple Pond
- Beaver Lake, Beaver Meadow Pond
- Francis Lake
- Stillwater Reservoir
- Halfmoon Lake
- Dart Lake
- Big Moose Lake
- Lower Sister Lake
- Upper Sister Lake
- Russian Lake
- North Lake
- Forked Lake
- Carry Falls Reservoir
- Tupper Lake
- South Pond
- Lake Eaton
- Indian Lake
- Long Pond
- Cranberry Lake
- Red Lake
- Meacham Lake
- Lake Champlain, Main Lake, North
- Lake Champlain, Main Lake, Middle
- Lake Champlain, Main Lake, South
- Lake Champlain, South Lake
- Lake Champlain, Cumberland Bay

- Saranac River, Franklin Falls Pond
- Polliwog Pond
- Poultney River, Lower, and tributaries
- Schaghticoke Reservoir
- Chase Lake
- Sand Lake
- Spy Lake
- Schroon Lake
- Alder, Crane Ponds
- Kings Flow
- Round Pond
- Rock Pond
- Lake Durant
- Schoharie Reservoir
- Lily, Canada, Stewarts Land, West Lakes
- Stoner Lakes
- Ferris Lake
- Amawalk Reservoir
- West Branch Reservoir
- Boyd Corners Reservoir
- Diverting Reservoir
- Bog Brook Reservoir
- East Branch Reservoir
- Titicus Reservoir
- Cross River Reservoir
- Breakneck Pond
- Chodikes Pond
- Rondout Reservoir
- Ashokan Reservoir
- South Lake, North Lake
- Dunham Reservoir
- Neversink Reservoir
- Loch Sheldrake/Sheldrake Pond
- Rio Reservoir
- Swinging Bridge Reservoir
- Pepacton Reservoir
- Cannonsville Reservoir

Rhode Island

- Watchaug Pond
- Meadowbrook Pond (Sandy Pond)
- Tucker Pond
- Larkin Pond
- Hundred Acre Pond
- Yawgoo Pond
- Alton Pond
- Ashville Pond
- Wincheck Pond
- Yawgoog Pond
- Locustville Pond

- Wyoming Pond
- Browning Mill Pond (Arcadia Pond)
- Boone Lake
- Eisenhower Lake
- Quidneck Reservoir
- Tiogue Lake
- J.L. Curran Reservoir (Fiskeville Reservoir)

Vermont

- Poultney River, Mouth upstream to Carvers Falls
- Lower Otter Creek, Below Vergennes WWTF
- Little Otter Creek – Lower – From mouth upstream Falls/Ledge West Route 7
- Lower Dead Creek, From Mouth Upstream
- Chittenden Reservoir
- Lake Champlain – Otter Creek Section
- Lake Champlain – Port Henry Section
- Lake Champlain – Southern Section
- Lake Champlain – Missisquoi Bay
- Lake Champlain – Northeast Arm
- Lake Champlain – Isle LaMotte
- Lake Champlain – St. Albans Bay
- Lake Champlain – Mallets Bay
- Lake Champlain – Burlington Bay
- Lake Champlain – Main Section
- Lake Champlain – Shelburne, Bay
- LaPlatte River, At Mouth
- Missisquoi River, Mouth Upstream to Swanton Dam
- Lamoille River, Mouth to Clarks Falls Dam
- Winooski River
- Winooski River, Alder Brook Upstream to Bolton Falls Dam
- Harriman Reservoir
- Sherman Reservoir
- East Branch Deerfield River, Below Somerset Dam
- Grout Pond
- Somerset Reservoir
- Upper Deerfield River, Below Searsburg Dam
- Searsburg Reservoir
- Moore Reservoir
- Comerford Reservoir
- Lake Salem

Appendix B: Necessary Reductions to meet Water Quality Standards in Maine and Connecticut

Because this is a regional TMDL and the majority of states do not have adopted fish tissue criteria, the target fish tissue concentration was set at the EPA fish tissue criterion of 0.3 ppm. Maine has adopted a fish tissue criterion of 0.2 ppm into their water quality standards, and therefore a higher level of reduction will be necessary for water quality standards to be met in that state. Connecticut's Water Quality Standards (2002) state that:

> *Surface waters and sediments shall be free from chemical constituents in concentrations or combinations which will or can reasonably be expected to: result in acute or chronic toxicity to aquatic organisms or otherwise impair the biological integrity of aquatic or marine ecosystems outside of any dredged material disposal area or areas designated by the Commissioner for disposal or placement of fill materials or any zone of influence allowed by the Commissioner, or bioconcentrate or bioaccumulate in tissues of fish, shellfish and other aquatic organisms at levels which will impair the health of aquatic organisms or wildlife or result in unacceptable tastes, odors or health risks to human consumers of aquatic organisms or wildlife…*

The Connecticut Department of Public Health has set a level of 0.1 ppm in fish tissue as the concentration at which there is a risk to humans from consumption of fish. Thus, in order for Connecticut's narrative water quality standards to be met, they must achieve a concentration of 0.1 ppm in fish tissue and therefore will need further reductions than set out for the region by this TMDL.

Necessary reductions to meet water quality standards in Maine and Connecticut are shown below. Both of these calculations require reductions in anthropogenic mercury deposition greater than 100 percent. However, this number is based on the percentage of deposition due to anthropogenic sources, and there is much uncertainty associated with this number. Various studies have found this percentage to be between 65 and 85 percent. Use of a lower percentage results in a greater percent reduction from anthropogenic sources, whereas a higher percentage has the opposite effect.

Because of this uncertainty, adaptive management will be used when implementing the reductions necessary to meet the TMDL.

Necessary Reductions to Meet Maine Water Quality Standards

	Value (80th percentile)	Value (90th percentile)	Unit	Source
Background Information				
Area of the Region (includes CT, MA, ME, NH, NY, RI, VT)	307,890	307,890	km^2	NESCAUM
Proportion of Deposition due to Anthropogenic Sources	0.75	0.75		Based on work by Kamman and Engstrom 2002 and Norton, et al. 2006
TMDL Base Year	1998	1998		
TMDL Phase I Implementation Period	1998-2003	1998-2003		
TMDL Phase II Implementation Period	2003 -2010	2003 -2010		
TMDL Phase III Implementation Period	2010 on	2010 on		
Water Quality Goal				
Target Fish Mercury Concentration	0.20	0.20	ppm	Maine Water Quality Standards
Existing Level in Fish (32 cm Smallmouth Bass)	0.86	1.14	ppm	NERC Dataset
Reduction Factor (RF) [(Existing Level - Target Level)/Existing Level]	0.77	0.82		
Base Year Loadings				
Point Source Load (PSL) - Wastewater Discharge	77	77	kg/yr	PCS data
Modeled Atmospheric Deposition	5,405	5,405	kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Modeled Natural Atmospheric Deposition[1]	526	526	kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Modeled Anthropogenic Atmospheric Deposition, Anthropogenic Nonpoint Source Load (ANPSL)	4,879	4,879	kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Natural Nonpoint Source Load (NNPSL) Atmospheric Deposition (Based on Deposition is 25% Natural and 75% Anthropogenic)	1,626	1,626	kg/yr	Kamman and Engstrom 2002
Total Nonpoint Source Load (NPSL) [ANPSL + NNPSL]	6,506	6,506	kg/yr	

[1] The global contribution to the atmospheric deposition modeling includes some natural sources of mercury. The modeled natural atmospheric deposition is subtracted from the total modeled atmospheric deposition to avoid double counting of the natural contribution.

Total Source Load (TSL) [NPSL + PSL]	6,583	6,583	kg/yr	
Percentage of TSL due to PSL	1.2%	1.2%		
Loading Goal				
Loading Goal [TSL x (1-RF)]	1,531	1,155	kg/yr	
TMDL				
Wasteload Allocation (WLA) [Keep at 1.2% of TSL]	18	13	kg/yr	
Load Allocation (LA) [Loading Goal - WLA]	1,513	1,141	kg/yr	
Natural Load Allocation[1] (NLA)	1,626	1,626	kg/yr	
Anthropogenic Load Allocation (ALA) [LA - NLA]	-113	-485	kg/yr	
Overall Reductions to Meet TMDL				
Necessary In-Region Atmospheric Deposition Reductions to Meet ALA	2,141	2,300	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet ALA	2,852	3,064	kg/yr	
Percent Reduction in Anthropogenic Atmospheric Deposition Necessary to Meet ALA	102.3%	109.9%		
TMDL Implementation Phase I (50%)				
In-Region Portion of ANPSL	2,092	2,092	kg/yr	
In-Region Reduction Target (50% from baseline)	1,046	1,046	kg/yr	
Necessary In-Region Atmospheric Deposition Reductions to meet Phase I Target	1,046	1,046	kg/yr	
In-Region Atmospheric Deposition Reductions Achieved in Phase I	1,549	1,549	kg/yr	NESCAUM, based on modeling of 1998 and 2002 emissions inventories
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Phase I Target	0	0	kg/yr	
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Final TMDL	592	751	kg/yr	
Out-of-Region Portion of ANPSL	2,787	2,787	kg/yr	

[1] Deposition due to natural sources remains the same over time, so the natural load allocation is equal to the existing natural deposition.

Out-of-Region Reduction Target (50% from baseline)	1,394	1,394	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet Phase I Target	1,394	1,394	kg/yr	
Additional Out-of-Region Atmospheric Deposition Reductions to Meet Final TMDL	1,458	1,671	kg/yr	
TMDL Implementation Phase II (75%)				
In-Region Portion of ANPSL	2,092	2,092	kg/yr	
In-Region Reduction Target (75% from baseline)	523	523	kg/yr	
Necessary In-Region Atmospheric Deposition Reductions to meet Phase II Target	1,569	1,569	kg/yr	
In-Region Atmospheric Deposition Reductions Achieved in Phase I	1,549	1,549	kg/yr	NESCAUM, based on modeling of 1998 and 2002 emissions inventories
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Phase II Target	20	20	kg/yr	
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Final TMDL	572	731	kg/yr	
Out-of-Region Portion of ANPSL	2,787	2,787	kg/yr	
Out-of-Region Reduction Target (75% from baseline)	697	697	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet Phase II Target	2,090	2,090	kg/yr	
Additional Out-of-Region Atmospheric Deposition Reductions to Meet Final TMDL	762	974	kg/yr	
TMDL Implementation Phase III				
The Phase III timeline and goal will be set following re-evaluation of mercury emissions, deposition, and fish tissue concentrations in 2010. At the onset of Phase III, remaining reductions will be addressed as follows: Major air point sources will be addressed through the application of more stringent control technology requirements and/or emission limits, economically and technically feasible/achievable, taking into account advances in the state of air pollution controls and the application of transferable technologies used by other sources, to achieve maximum emission reductions. Emissions from area sources will be controlled to the maximum extent feasible using Best Management Practices and Pollution Prevention approaches.				

Necessary Reductions to Meet Connecticut Water Quality Standards

	Value (80th percentile)	Value (90th percentile)	Unit	Source
Background Information				
Area of the Region (includes CT, MA, ME, NH, NY, RI, VT)	307,890	307,890	km^2	NESCAUM
Proportion of Deposition due to Anthropogenic Sources	0.75	0.75		Based on work by Kamman and Engstrom 2002 and Norton, et al. 2006
TMDL Base Year	1998	1998		
TMDL Phase I Implementation Period	1998-2003	1998-2003		
TMDL Phase II Implementation Period	2003 -2010	2003 -2010		
TMDL Phase III Implementation Period	2010 on	2010 on		
Water Quality Goal				
Target Fish Mercury Concentration	0.10	0.10	ppm	Connecticut Department of Public Health
Existing Level in Fish (32 cm Smallmouth Bass)	0.86	1.14	ppm	NERC Dataset
Reduction Factor (RF) [(Existing Level - Target Level)/Existing Level]	0.88	0.91		
Base Year Loadings				
Point Source Load (PSL) - Wastewater Discharge	77	77	kg/yr	PCS data
Modeled Atmospheric Deposition	5,405	5,405	kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Modeled Natural Atmospheric Deposition[1]	526	526	kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Modeled Anthropogenic Atmospheric Deposition, Anthropogenic Nonpoint Source Load (ANPSL)	4,879	4,879	kg/yr	NESCAUM, based on modeling of 1998 Emissions Inventory
Natural Nonpoint Source Load (NNPSL) Atmospheric Deposition (Based on Deposition is 25% Natural and 75% Anthropogenic)	1,626	1,626	kg/yr	Kamman and Engstrom 2002
Total Nonpoint Source Load (NPSL) [ANPSL + NNPSL]	6,506	6,506	kg/yr	
Total Source Load (TSL) [NPSL + PSL]	6,583	6,583	kg/yr	

[1] The global contribution to the atmospheric deposition modeling includes some natural sources of mercury. The modeled natural atmospheric deposition is subtracted from the total modeled atmospheric deposition to avoid double counting of the natural contribution.

Percentage of TSL due to PSL	1.2%	1.2%		
Loading Goal				
Loading Goal [TSL x (1-RF)]	765	577	kg/yr	
TMDL				
Wasteload Allocation (WLA) [Keep at 1.2% of TSL]	9	7	kg/yr	
Load Allocation (LA) [Loading Goal - WLA]	756	571	kg/yr	
Natural Load Allocation[1] (NLA)	1,626	1,626	kg/yr	
Anthropogenic Load Allocation (ALA) [LA - NLA]	-870	-1,056	kg/yr	
Overall Reductions to Meet TMDL				
Necessary In-Region Atmospheric Deposition Reductions to Meet ALA	2,465	2,545	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet ALA	3,284	3,390	kg/yr	
Percent Reduction in Anthropogenic Atmospheric Deposition Necessary to Meet ALA	117.8%	121.6%		
TMDL Implementation Phase I (50%)				
In-Region Portion of ANPSL	2,092	2,092	kg/yr	
In-Region Reduction Target (50% from baseline)	1,046	1,046	kg/yr	
Necessary In-Region Atmospheric Deposition Reductions to meet Phase I Target	1,046	1,046	kg/yr	
In-Region Atmospheric Deposition Reductions Achieved 1998-2002	1,549	1,549	kg/yr	NESCAUM, based on modeling of 1998 and 2002 emissions inventories
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Phase I Target	0	0	kg/yr	
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Final TMDL	916	996	kg/yr	
Out-of-Region Portion of ANPSL	2,787	2,787	kg/yr	

[1] Deposition due to natural sources remains the same over time, so the natural load allocation is equal to the existing natural deposition.

Out-of-Region Reduction Target (50% from baseline)	1,394	1,394	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet Phase I Target	1,394	1,394	kg/yr	
Additional Out-of-Region Atmospheric Deposition Reductions to Meet Final TMDL	1,891	1,997	kg/yr	
TMDL Implementation Phase II (75%)				
In-Region Portion of ANPSL	2,092	2,092	kg/yr	
In-Region Reduction Target (75% from baseline)	523	523	kg/yr	
Necessary In-Region Atmospheric Deposition Reductions to meet Phase II Target	1,569	1,569	kg/yr	
In-Region Atmospheric Deposition Reductions Achieved 1998-2002	1,549	1,549	kg/yr	NESCAUM, based on modeling of 1998 and 2002 emissions inventories
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Phase II Target	20	20	kg/yr	
Remaining In-Region Atmospheric Deposition Reductions Necessary to Meet Final TMDL	896	976	kg/yr	
Out-of-Region Portion of ANPSL	2,787	2,787	kg/yr	
Out-of-Region Reduction Target (75% from baseline)	697	697	kg/yr	
Necessary Out-of-Region Atmospheric Deposition Reductions to Meet Phase II Target	2,090	2,090	kg/yr	
Additional Out-of-Region Atmospheric Deposition Reductions to Meet Final TMDL	1,194	1,300	kg/yr	
TMDL Implementation Phase III				
The Phase III timeline and goal will be set following re-evaluation of mercury emissions, deposition, and fish tissue concentrations in 2010. At the onset of Phase III, remaining reductions will be addressed as follows: Major air point sources will be addressed through the application of more stringent control technology requirements and/or emission limits, economically and technically feasible/achievable, taking into account advances in the state of air pollution controls and the application of transferable technologies used by other sources, to achieve maximum emission reductions. Emissions from area sources will be controlled to the maximum extent feasible using Best Management Practices and Pollution Prevention approaches.				