Interim
MPCA Mercury Policy

Revised
July, 2001

STAFF DRAFT

Table of Contents

Figures

Appendices

Summary

Background

More than six percent of Minnesota's 85,000 square-miles are covered by lakes, rivers and streams. And we like to fish these waters—both for sport and for food. But a particularly toxic form of mercury, methyl mercury, contaminates the fish in much of Minnesota and in many other states. Surprisingly, the fish in some of Minnesota's most remote, pristine lakes are among our most contaminated.

Methyl mercury is a nerve toxin, so eating too much contaminated fish can harm our health. Children and developing fetuses are particularly susceptible. Therefore, the Minnesota Department of Health—in its annual fish consumption advisory—provides guidance on how much fish is safe to eat. In addition, mercury contamination could also be affecting the health of fish-eating wildlife, like loons. The long-term solution to this problem is not to limit how much fish we eat, but to reduce the methyl mercury concentrations in the fish.

State-Level Policy Constraints

Because of our special concern for our lakes, Minnesota has been a national leader in trying to solve the mercury problem. But Minnesota can't solve the problem by itself. State-level policy options are limited by at least five important considerations:

1. Large wastewater mercury discharges have now mostly been eliminated or greatly reduced. In most waters in Minnesota, over ninety-five percent of the mercury falls from the atmosphere in rain or as dry fall-out.
2. Mercury is a naturally occurring element. About thirty percent of the mercury falling on or otherwise entering our lakes comes from natural sources. The remaining seventy percent is from man-made air pollution, most of which comes from many, widely-dispersed sources.
3. Up to ninety percent the airborne mercury landing on our lakes blows in from outside the state, and even outside North America. From ten to thirty percent of the mercury comes from in-state sources. Usually, individual air pollution sources within the Minnesota contribute only incrementally to the contamination of any particular lake or river within Minnesota.
4. Mercury is a problem in lakes because small amounts accumulate up the food chain to reach high levels in fish. There is about three times more mercury entering our lakes than in pre-industrial times. But other, still poorly understood, chemical and biological factors—including other pollutants—contribute to increased mercury accumulation in fish. In general, there is still a lot we don't know about the risks, sources, and science of the problem.
5. Mercury is released from many different types of sources—from broken thermometers to industrial smoke stacks. As a result, mercury emissions, discharges and disposal are currently regulated under a complex mix of state and federal statutes, rules and guidelines. There are comprehensive and specific regulations that apply to some sources—such as wastewater discharges—and no specific regulations for others. And some currently unregulated sources may be regulated federally in the near future.

Current Approach in Minnesota

While it is difficult to quantify the precise relationship between specific mercury releases and fish contamination in specific water bodies, we do know that less mercury entering the environment means less mercury in our lakes and—eventually—less mercury in our fish. Minnesota's approach to the problem has been to simultaneously: (1) limit direct mercury discharges to our lakes and rivers through NPDES permits; (2) reduce our own statewide mercury releases through a mixture of regulatory and non-regulatory efforts; (3) continue research; and (4) work to reduce mercury releases nationally and internationally.

Mercury Policy v. Legislative Report

Minnesota has struggled since at least the mid 1990's—along with other states and the federal government—to pull all the pieces of the mercury regulatory puzzle into a coherent whole. None of these consolidation efforts have been completely successful so far. At the state level, Minnesota's 1999 mercury reduction law sets a statewide reduction goal for the end of 2005, and lists strategies to help meet the goal. One of these strategies is soliciting voluntary mercury reduction agreements from otherwise unregulated mercury sources.

But translating the statewide reduction goals into a specific, comprehensive state mercury reduction policy—one that fairly and effectively addresses all significant sources of mercury pollution in the state—is no easy task. This document is not a comprehensive multi-media state reduction plan. Instead, the purpose of this policy is to describe and clarify the existing, still piecemeal, regulatory and non-regulatory framework covering mercury releases in Minnesota. In October 2001, the MPCA will submit a report to the legislature describing any ongoing problems with current state approaches and potential solutions.

"Interim" Policy

This policy document summarizes the existing state permitting policies for the current interim period as it is defined under the Clean Water Act—lasting for the next one to six years. In the Clean Water Act, the term "interim" has a specific regulatory meaning. It refers to the period between when the MPCA formally lists a water body on our 303(d) list of pollutant-impaired waters and when the U.S EPA approves our long-term plan to bring the water back into attainment with state standards. This federally required plan and analysis is called a total maximum daily load, or TMDL.

This document clarifies and provides notice of how MPCA staff is *generally* implementing existing permit requirements involving mercury during this current "interim" period in light of recent federal developments. Because the statutes and rules covering wastewater discharges are the most comprehensive of existing regulations, most of this document covers water discharges. This document also clarifies how the MPCA currently views the relationship between voluntary agreements and permits for regulated and unregulated air emission sources in Minnesota. Final permitting decisions, however, are case-by-case.

NPDES Permitting Guidance

Although wastewater discharges of mercury represent a small proportion of total releases in the state, such discharges can be significant for individual lakes and rivers. In addition, there are existing federal and state regulations that must be complied with. (For example, in letter dated May 22, 2001, U.S. EPA reiterates that NPDES permitting authorities, such as the MPCA, must comply with 40 CFR 122.44, including the requirement to determine whether the discharge will "cause or contribute to a water quality violation.") However, recognizing that air deposition is often the major source of mercury to most Minnesota waters, our intent is to allow as much flexibility as possible for most wastewater discharges.

Mercury source reduction is the preferred approach to meeting existing wastewater regulations because end-of-pipe controls are currently neither technically nor economically feasible. Therefore, we emphasize source reduction of mercury in conjunction with monitoring to document the reductions taking place. With some exceptions, the MPCA will not likely institute effluent limits for mercury for the current five-year permit cycle for existing wastewater discharge permits. Rather, most major dischargers and some smaller ones will likely be (1) required to monitor using low-level techniques and (2) encouraged to actively explore and implement mercury pollution prevention techniques.

The extension of monitoring requirements to minor (less than 1,000,000 gallons per day) discharges will depend on several factors, including laboratory capacity, the capacity to train more people in proper sampling techniques, and the results of MPCA collection of mercury data from stabilization pond discharges. New or expanding wastewater discharges, however, must complete nondegradation analyses, monitor using low-level techniques, receive permit limits, and if necessary, variances with compliance schedules. Exact requirements will often depend in part on whether or not the discharge is located within the Lake Superior Basin.

Air Emission and Land Application Permits

Many new or existing facilities and projects with mercury releases to air or land require permits from the MPCA. Some of these projects are partly or entirely unregulated by specific laws or rules. Such sources, however, are subject to standard environmental review and permitting analyses. For larger projects, environmental review can include multi-pathway risk assessments for air toxic emissions. For various technical and scientific reasons, however, extensive site-specific, multi-pathway risk assessments are probably not useful for most such projects. Some companies proposing projects may also be participating in the state mercury voluntary agreement program. However, the existence of a state voluntary agreement program does not mean that all otherwise unregulated releases will be automatically permitted. Nor does it mean that all state mercury reduction programs are voluntary. Previous MPCA guidelines for the voluntary agreements states that "voluntary efforts are by definition those that go beyond existing legal requirements." Admittedly, it is sometimes unclear what "existing legal requirements" are. For example, federal regulations for coal-fired power plants are evolving. For some other sources, state permit requirements—or potential requirements—are not well defined.

Final permit decisions for such sources are case by case. The MPCA will take into account ongoing and proposed voluntary actions, but mandatory permit conditions may be necessary and appropriate for specific projects. As part of the voluntary agreement program, the MPCA committed to not pursuing broad state mercury regulations in order to "make room" for a flexible, voluntary approach. Currently, however, the complicated interrelationship between the state voluntary agreement program, evolving wastewater and other regulations, EPA's decision to regulate power plant emissions, and the state's broad permitting authority continues to be a barrier to developing a coherent regulatory framework for mercury reductions in Minnesota.

Statewide TMDL

A federally approved mercury TMDL would likely allow increased flexibility for NPDES permit requirements, and potentially change other permitting policies. Currently, a mercury TMDL must first be completed for the Lake Superior basin in the year 2007 under current state Great Lakes Initiative rules. For the rest of the state, the MPCA has committed to a mercury TMDL by 2010. However, the MPCA is considering completing an accelerated generic "statewide" TMDL as the first phase of a longer-term state mercury plan. Such a plan for an accelerated statewide TMDL plan is contingent on ongoing discussions with EPA and others.

1.0 Introduction

1.1 What's Happened So Far

The MPCA's two-year Mercury Contamination Reduction Initiative was an ambitious attempt to develop a comprehensive state mercury policy. Advisory Council recommendations from this effort led to the 1999 Minnesota mercury reduction law, Minn. Stat. 116.915. Among other things, the 1999 law sets statewide mercury reduction goals. It also requires a variety of regulatory and non-regulatory strategies to reach these goals, including soliciting "voluntary agreements" from major unregulated air emission sources and others. The use of a non-regulatory approach as one state reduction strategy was adopted, in part, to help reduce current or future mercury releases from sources not covered by specific regulations.

The 1999 law, however, left some important details to be determined. Industry and others continue to express serious concerns about apparent conflicts between the flexible, voluntary spirit of the state law and existing and evolving state and federal regulations—particularly the tightening requirements for mercury in wastewater discharge permits.

The absence of a consistent, coherent regulatory framework—on both the federal and state level—creates some ongoing problems. First, individual proposed projects requiring MPCA permits still can be controversial, in part, because they act as the surrogate battleground for broader, unresolved issues. This can place large cost and time burdens onto individual projects as they come before the MPCA. Second, continuing regulatory uncertainty blurs the line between regulatory and non-regulatory efforts—potentially reducing the incentives for proactive voluntary efforts.

In October 2000, MPCA staff released a draft state mercury "policy" in another attempt to pull all the pieces together into one comprehensive state plan. We received many verbal and written comments on this draft. Some comments addressed specific permitting issues; many others addressed a variety of underlying technical and regulatory issues. MPCA staff has struggled to answer these difficult questions, many of which deal with the complicated relationship between expectations for non-regulatory, flexible programs and traditional command and control regulations.

This policy document summarizes how MPCA staff is implementing existing permitting policies. The document also attempts to address many of the comments on the October 2000 draft policy. But it is not a specific, comprehensive mercury contamination reduction plan for Minnesota. The MPCA is considering various options to move forward from here. A more comprehensive plan could include outlining the reductions likely to be needed from different sectors or sources if we are to reach our statewide goals. As described below, one possibility is that such a plan could be incorporated—directly or indirectly—as part of a generic, statewide or multi-state mercury total maximum daily load (TMDL) plan.

1.2 "Interim" Period Defined

This interim policy document describes the existing, still somewhat fractured, regulatory framework covering various mercury sources in Minnesota. An MPCA legislative report due in October 2001 will further evaluate the current situation and explore future policy options for Minnesota.

In this case, the term "interim" has a specific meaning under the Clean Water Act. It is the period between when a state formally adds a waterbody to their 303(d) list of pollutant-impaired waters and when it gets federal approval of a long-term quantitative plan to fix the impairment. This federally required plan and analysis is called a Total Maximum Daily Load, or TMDL. EPA has determined that states must develop TMDL plans for all mercury-impaired waters. The mercury-impaired waters on our state 303(d) list currently fall into this interim period. Normally, the responsible state agency, such as the MPCA, develops a TMDL plan for a given pollutant and submits it to the U.S. Environmental Protection Agency (EPA) for final approval.

For a federally approved TMDL plan, our mercury allocations must first be made for the Lake Superior basin in the year 2007. Statewide, the MPCA has committed to a mercury TMDL in 2010. However, the MPCA is considering as a first phase to complete an accelerated "statewide" TMDL plan within one year, mostly to allow more flexibility to wastewater dischargers. (See Appendix G) Federal TMDL rules, however, are under review again. Any plan for an accelerated, generic mercury TMDL is contingent on ongoing discussions with EPA and others.

1.3 Existing and Evolving Laws and Policies

Existing mercury-related regulations and initiatives have created a complex matrix of regulatory, non-regulatory and educational programs. Some of the most important of these include the Clean Water Act, Clean Air Act, land application permit program, the state mercury reduction law, the state air toxics review program and the Lake Superior Binational Program. Each of these programs has a role in reducing mercury. This document describes existing regulatory and non-regulatory programs that affect releases of mercury to air, water and land. In general, opportunities for proactive voluntary efforts exist largely where mandatory regulations are being considered but are not yet in place or where flexibility is built into the regulations**.**

There have been some important developments in mercury regulation over the last year. In December, 2000, the U.S. EPA announced plans to regulate emissions of mercury from coal fired power plants. These new regulations are not expected to be finalized until late 2004, with implementation not expected until late 2007. In addition, it is unlikely that any proposal to develop a federal Maximum Achievable Control Technology standard for mercury at taconite processing facilities would occur before 2007. Overarching all these program, the Total Maximum Daily Load (TMDL) schedule stretches until 2010. Whether regulatory or non-regulatory, it is the MPCA's intent to credit, or at least keep track of, reductions that occur from 1990 in any TMDL or other allocation process.

1.4 Guiding Principles

The MPCA proposes the following six guiding principles:

1. Minnesota's special interest in its many lakes and rivers means we should continue to be a national and international leader in reducing mercury releases. However, aggressive statewide release reductions that are significantly steeper than the national or international average will likely not result in commensurate environmental benefits to Minnesota;
2. For statewide releases, the MPCA reaffirms its commitment to reach the state mercury reduction goal for 2005—in part through voluntary reduction agreements—as long as it the current mix of strategies seems to be effective;
3. Existing state and federal requirements must be incorporated into appropriate permits. But within existing regulations, flexibility for wastewater discharges is warranted because, often, most of the mercury in a particular waterbody comes from air pollution sources;
4. The existence of Minnesota's voluntary agreement program does not necessarily mean that currently unregulated mercury releases in the state will remain unregulated in state permits;
5. New or expanded releases to air, water and land during the "interim" period may be allowed on a case by case basis by applying applicable rules and laws to the specific facts. For projects with significant increases, all reasonable pollution prevention and control options should be evaluated, and the MPCA may ultimately require economically feasible options to be implemented.
6. Aggressive efforts to reduce, collect, and properly manage mercury used in products should continue for several reasons. First, these sources contribute a large proportion of mercury entering the environment. Second, reducing releases from products tends to be cost-effective compared to other reduction strategies. Third, breathing elemental mercury vapors that may be released during spills or improper disposal can be a serious threat to human health.

In addition, we should consider whether an activity will change mercury methylation potential. As we measure progress in mercury reductions, the ultimate indicator of that progress will be decreases in mercury concentrations in the fish. The intermediate indicator will be decreases in mercury discharges and emissions from Minnesota sources. It may be possible to manage other factors that control how efficiently mercury is methylated; if mercury is not methylated and introduced to fish habitat, it will not bioaccumulate in fish. For instance sulfate-reducing bacteria in wetlands efficiently methylate mercury. There may be management options for streams that flow through such wetlands on their way to fish habitats. It may be desirable to not only minimize mercury concentrations, but also water fluctuations and sulfate concentrations among other factors.

Stakeholder Meetings

The MPCA held a series of meetings in October and November, 2000 with interested stakeholders, including MPCA staff, environmental groups, a Duluth citizen's group with an interest in mercury reduction, cities, other state agencies and the Minnesota Chamber of Commerce and Industry. This document has been revised in response to these comments. A separate responsiveness summary has also been prepared.

Voluntary Agreements and Permits
The Minnesota Mercury Reduction Law (Minn. Stat. 116.915) sets goals for reducing statewide releases of mercury to air and water (Appendix B). The goals are a 60% reduction by the end of 2000 and a 70% reduction by the end of 2005, compared to 1990 levels. The law also requires the MPCA to implement certain mercury reduction strategies including voluntary agreements with mercury emitters of over 50 pounds per year.

The law's reduction goals are one way to measure whether as a state we are making progress toward reducing Minnesota mercury releases. One strategy to help reach the goals is to solicit "voluntary agreements" from major unregulated air emission mercury sources. The MPCA staff agreed to not develop or pursue any new state mercury legislation or regulation as long as it appeared to us that reasonable progress was being made toward those goals. However, this voluntary strategy does not mean that all MPCA mercury policies or permit decisions are necessarily voluntary or non-regulatory.

Since the 1999 law was enacted, numerous actual and potential conflicts between voluntary agreements and mandatory conditions for mercury have arisen for various projects. MPCA guidelines on the voluntary agreement program state in part: "For individual projects, the agency cannot change its normal review, comment or decision-making process" because of the voluntary part of the program. The 1999 law does not directly address the permitting issue at all. In general, state regulatory and permitting authority remains unchanged by the 1999 mercury reduction law. .However, MPCA staff will attempt to take into account any ongoing or proposed voluntary commitments when determining permit conditions on a case-by-case basis.

2. Releases to Air

2.1 Sources
Over 95% of the mercury released in Minnesota to the biosphere (air, water, and the soil surface, but not counting landfills) are as air emissions. Minnesota's legislated goal (Minn. Stat. 116.915) is to reduce mercury releases statewide by at least 60% by the end of 2000 and by 70% by 2005, from a 1990 baseline. Preliminary results indicate that Minnesota will be near or exceed the intermediate goal of a 60% reduction by the end of 2000. Nearly all of these reductions have been associated with use and disposal of intentionally used mercury. If the 70% reduction goal in 2005 is to be achieved, based on the current inventory there must be reductions in the other two major sectors of incidental mercury emissions: energy (e.g., coal and oil) and material processing (e.g., taconite processing).

Existing federal and state regulations covering air emissions of mercury are outlined in Appendix C. These state and federal regulations remain in effect, of course, and the state can pursue or comment on federal legislation as it sees as appropriate. Minnesota's mercury reduction law also requires the MPCA to solicit "voluntary agreements" from state energy, taconite, and other industrial operations in Minnesota, many of which have mercury air emissions that are not covered by specific regulations. Existing mercury sources are expected to make steady progress on finding and implementing cost-effective release reductions. The MPCA sees voluntary

agreements as a complement to, not necessarily a replacement for, existing or future laws and regulations. As discussed above, last December, EPA announced a decision to develop mercury regulations for coal-fired power plants. Uncertainty regarding the timing, degree and technology choices available under this and other future federal regulations will have an impact on state-level efforts, including Minnesota's voluntary agreement program.

2.2 New or Expanded Air Emission Sources

The 1999 Minnesota mercury reduction law does not directly address new or expanded operations that result in increased mercury emissions. In some sectors, such as solid waste incineration, there are state standards that regulate additions of mercury to the statewide total. In other sectors, such as coal combustion, taconite processing, or sludge incineration, there are either no standards (i.e., coal fired boilers and taconite processing) or the standards are so high as to be ineffectual (i.e., sludge incineration). Other activities were sometimes ignored as mercury sources during the MPCA permitting process (e.g., electric arc furnaces; land application of sludge; oil refining; soil roasting).

There are two goals that the MPCA needs to achieve concerning any new atmospheric mercury emissions:

1. ensure that the facility does not significantly increase fish contamination or exceed water quality criteria through localized impacts and
2. ensure that total mercury emissions are as low as possible, in order to help reach the statewide mercury emission reductions.

Fortunately, these two goals are not only compatible, but can be synergistic. There are many forms of mercury in the environment. Ionized mercury, Hg(II), is the form of mercury that is most likely to contribute to local deposition (and therefore local fish contamination), and it is also the easiest to collect with pollution control equipment. So, enhanced mercury control (e.g., injection of activated carbon) will disproportionately reduce the potential for locally elevated fish contamination. Mercury source reduction efforts would also reduce the potential for local deposition in proportion to overall mercury reduction (all things being equal, such as chemistry of the stack gases).

In principle, effective control of Hg(II) will substantially reduce the potential for locally elevated atmospheric mercury deposition. In practice, effective control is difficult to predict during the design of a new facility. The form of mercury in stack gases, and therefore the ability to capture it, appears to be dependent on multiple factors, including temperature, background gas chemistry (e.g., SOx, NOx, chloride), and the nature of the particulate material in the stack gases. These multiple factors indicate the potential exists to manipulate mercury speciation for the most effective removal. The MPCA intends to catalog all remaining significant sources of air emissions of Hg(II) over the next year in order to evaluate their potential for localized impacts and potential control options.

To summarize, new or expanded releases to the air are possible, but as with water discharges, any new or increased releases are subject to increased regulatory scrutiny. Proposed projects with potential increases in mercury releases are subject to standard environmental review, including

analysis of the most cost-effective controls possible. Control costs for the new source can then be compared to the costs of controlling mercury releases from existing sources. On a case by case basis, the MPCA will propose mercury-related permit conditions—or even deny the permit—if the mercury release is likely to create unacceptable, direct human health or ecological impacts or otherwise represent an unacceptable contribution to the overall mercury problem.

2.3 Multi-Pathway Risk Assessment

Complex multi-pathway (inhalation, ingestion, and other routes) risk assessments are sometimes completed to assess the environmental impacts of proposed projects with potentially significant emissions of toxic air pollutants. There is, however, usually little benefit to performing such detailed risk assessments for mercury. First, existing atmospheric transport and deposition models, as well as in-lake cycling and methylation models are in general not yet accurate enough to justify the time and expense of running them. Second, most of the air emissions for most mercury air sources in Minnesota are in the form of elemental mercury— Hg(0)—which does not deposit locally in significant amounts. For air emission sources with the potential for substantial emissions of Hg(II), the MPCA's revised Air Toxics Guidance will contain a simplified risk assessment procedure to use as a screening tool to assess the potential for localized increases in mercury concentrations in fish. Given the lack of accuracy, detailed multi-pathway risk assessments for mercury are usually not worth the cost. Instead, the MPCA would prefer to see resources put into an effort to find cost-effective ways to reduce emissions, so the efforts benefit the environment instead of simply rationalizing anticipated mercury emissions.

Appendix D contains a summary of the issues concerning the multi-pathway risk assessment for mercury emissions.

2.4 Relationship to Water Discharges

In Minnesota, air emissions are the largest source of mercury releases to the biosphere. The consequences of releases are most serious in the aquatic environment where bioaccumulation of mercury in fish harms their consumers—humans and fish eating wildlife. So what part do water-borne mercury releases play in the overall mercury picture – and what is the nature of our ability to control direct releases to surface waters?

The impact of direct discharges containing mercury to surface waters can be quite variable. In the BWCAW air deposition directly to a lake and its watershed constitutes an estimated 98% of the mercury loading to those lakes, with 2% coming from the weathering of native rock in the watershed. There is no direct discharge from point sources to lakes in the wilderness. Conversely, a surface water discharge from a point source to a low-flow stream can make that point source a significant mercury contributor to that stream. However, air releases - both global and regional - remain the single biggest factor causing mercury pollution in Minnesota's lakes and streams.

3.0 Releases to Land

It is useful to differentiate between the release of mercury-containing materials to the top few inches of soil and the landfilling of mercury-containing wastes (landfills are largely isolated from the biosphere, although not completely). The top few inches of soil are part of the biosphere, and any mercury has ample opportunity to be subject to leaching and processes that promote volatilization to the atmosphere, such as bacterial activity, tillage, and exposure to sunlight. Releases of mercury to the surface of land can occur through land application of waste and through the use of materials for fill, fertilizer and other uses. Land application/treatment of many types of wastes occurs in Minnesota. The primary categories of wastes that are land applied include the following:

- Animal wastes (manure, paunch manure, and animal bedding).
- Biosolids (sewage sludge) that are generated from the processing of wastewater.
- Septage generated by individual sewage treatment systems and large drainfields.
- Industrial by-products, which include the following:
  Industrial wastewater and pretreatment sludges mainly from the processing of foods and beverages (dairy, vegetables, beer, meat, and poultry);
  Dairy processing wastes (rinse/wash waters, lactose, antibiotic milk, diatomaceous earth, whey, etc.);
  Ethanol processing wastes
  Corn silage / silage leachate from the processing of sweet corn;
  Sugar beet processing wastes (spoiled beets, beet pulp, tare wastes, lime, etc.);
  Ash. These consist of wood and mixed ashes (mixtures can include wood, coal, paper mill sludge, railroad tie chips, and manufacturing residues). There is some coal ash land applied in mixed ashes, as a liming material for biosolids, and on an experimental basis;
  By-product limes that are the result of treating drinking water and industrial process water, acetylene production, and refining sugar;
  Pulp and paper mill sludge mainly on a pilot project basis.
- Commercial wastes generated from small businesses such as animal slaughtering operations (wash waters), vehicle repair and maintenance facilities (sand and flammable trap wastes), restaurants (grease trap wastes), and others.
- Irrigated industrial and municipal effluents.
- Landfill leachate.
- Municipal compost.
- Petroleum contaminated soils.

These materials have been land-applied in Minnesota for many years with varying levels of regulation. Agricultural land is the primary destination for these wastes with farmers being the primary end users because of their value as soil amendments (with some exceptions such as petroleum-contaminated soil). There has also been some land application done on forest lands in the northeastern part of the state and on mine lands for reclamation.

It is likely that land-applied materials contain some level of mercury (because there are trace levels of mercury in virtually all materials) and some may be enriched with mercury because of

mercury disposal (e.g. biosolids) or because of concentration (e.g. some coal fly ash control systems happen to capture mercury that was in the coal). The transfer of mercury between media (air, water, and land) must be evaluated and the fate of mercury when land applied must be carefully managed in order to keep the mercury from becoming available to the food chain.

Because the global atmosphere is polluted with mercury, virtually all crop residues are undoubtedly slightly contaminated (leaves pick up mercury from the air). But this mercury is already circulating in the biosphere, so there is little point in trying to reduce mercury emissions by reducing the land-application of crop residues. The mercury in crop residues is not in any way a threat to the health of plants or any animals including humans; it is merely interesting that crop residues are part of the cycling of mercury in the biosphere.

Rather than being concerned about the mercury in crop residues, it is more important to try to reduce the land application of mercury that would not otherwise be in the biosphere. This mercury had been locked up geologically in coal, or as ores from which mercury has been purified for use in products such as dental amalgam, thermometers, fungicides, or the myriad of other historical uses. Once geological mercury is applied to the surface of soil and subject to bacterial processes, moisture, and sunlight, a significant proportion will eventually be volatilized to the atmosphere and added to the atmospheric pool of mercury that causes fish contamination. Even if the mercury concentration in a land-applied materials is not higher than the soil to which it is applied, it adds to the mass of mercury that will eventually go to the atmosphere. The mass of mercury land-applied is the number of concern, and not usually the concentration. An EPA-sponsored risk assessment showed that the mercury concentration usually present in land applied wastes do not present a direct health hazard. The hazard being discussed here is the cumulative problem of additional mercury being added to the biosphere, eventually adding to the contamination of fish that may be far from the land application site.

There is presently a lack of information as to the fate of mercury that is land applied. There are many questions related to this issue that are just beginning to be asked. What happens to the land applied mercury? Is it stable? How fast does it volatilize over time? Does it run off into surface water? Is it a significant contributor to the atmospheric pool? Does land application of the various wastes provide significant environmental benefits that outweigh the addition of mercury to the environment (reduced runoff because of increased vegetative growth, reduction of ground water contamination from landfills, etc.)? If commercial fertilizer imported to Minnesota were used in place of land-applied biosolids from a wastewater treatment plant, would more or less mercury become available in the environment?

3.1 Approach to prioritizing land application activities

Two basic criteria guide our actions with regard to mercury in land application. First, is the amount of mercury significant? The mass of mercury from various sources could be considerably different. Second, is the mercury bioavailable? For example, a process that produces methyl mercury in material intended to be land applied would not be favored over a process that stabilizes mercury in the land-applied material. When these two criteria are combined, four categories are formed (see Figure 1).

Figure 1. Land application approach taking into account the amount of mercury and its stability

Quadrant 1 Large Amount/Unstable	Quadrant 2 Large Amount/Stable
Quadrant 3 Small Amount/Unstable	Quadrant 4 Small Amount/Stable

Materials in Quadrant 1 (i.e., Large Amount/Unstable) would be the top priority for the MPCA to evaluate and determine whether land application is a suitable management option. Materials that were in Quadrant 4 (i.e., Small Amount/Stable) would be the lowest priority for MPCA evaluation. Unfortunately, there is no standardized method to evaluate stability of land-applied mercury. Leachate tests, such as the EPA's TCLP, are sometimes used to assess stability but there is presently no reason to believe that they are proportional to long-term stability in a real environment with interacting soil chemistry, bacteria, invertebrates, and sunlight.

3.2 Recommendations

The MPCA has the following recommendations:

- Collect existing information to help prioritize agency efforts related to land application of wastes and mercury concerns and identify where additional information and research are needed. An evaluation of existing research and information is needed to quantify the amount of mercury that is land applied with the various materials and determine the stability of these materials.
- Develop methods to quantify the stability of mercury in wastes that may be land applied.
- Conduct a risk assessment to determine limits for land application. Currently, the risk assessment which was used for land application of biosolids is missing some pathways or is based on inappropriate endpoints. The MPCA should work with EPA to develop more sensitive endpoints based on mercury release or increase in methylation potential associated with land application.
- Determine overall environmental impacts of land application as a management option for specific materials. When evaluating whether a material should be land applied, the mercury content of the alternative (e.g., fertilizer) should be considered, as should the alternative disposal or management options.
- Promote reduction of mercury in the processes that the waste comes from. The best method of reducing the mass of mercury in land applied materials is to reduce mercury itself, either through elimination of mercury bearing products or reduction of the use of materials that contain mercury as a contaminant (e.g., energy conservation would reduce the need for burning coal). Provide incentives and limits to reduce mercury in land applied materials.

- Identify imports of mercury containing materials for use in Minnesota. The MPCA should investigate the import of ash from out-of-state sources that is being used as a product (e.g., fill material).

4.0 Discharges to Water

The bedrock requirement of the water quality program is the protection of existing beneficial uses of water bodies and the level of water quality necessary to protect those uses (40 CFR 131.12(a)(i). This is the first of three tiers of EPA's anti-degradation policy. The parallel to this policy in Minnesota is found in Minnesota Rules Part 7050.0185, Subpart 1. The mercury water quality standard indicates the numeric pollutant level that must be achieved. A water-body that is impaired is a water-body that does not achieve the standard. Narrative standards, such as fish consumption advisories, can also serve as the basis for indicating impairment. The consumption of fish by humans is considered a beneficial use. Therefore, waterbodies with fish consumption advisories can be an indicator that use is impaired.

Waters that are not in attainment of water quality standards must be listed pursuant to section 303(d) of the Clean Water Act. The tool that is used in the water program to bring a water-body into attainment is called the TMDL, or Total Maximum Daily Load. The TMDL must account for all point and non-point sources of pollution with a margin of safety, and ultimately schedule the allocation of reductions that will achieve the standard or goal. For mercury this includes allocation for air emissions. It is expected that mercury TMDLs will be complex with a wide variety of source allocations. Complex TMDLs are considered to be iterative in nature. This presumes that the TMDL process will monitor the progress of reductions in attaining the standard and make adjustments, as available information will allow.

The second tier of non-degradation provides protection for water quality better than that necessary to meet the standard, and requires a treatment and socio-economic justification of the need to degrade water quality. The third tier is reserved for special protections for waters of high significance such that uses are maintained and protected. This may include prohibitions of discharges to waters, such as the ORVW-prohibited waters classified in Chapter 7050.

4. 1 Interim Water Quality Permitting Strategy for NPDES Discharges: Overview

Two recent events have renewed focus on wastewater discharges of mercury to surface waters. One is the recent promulgation by EPA of a new, low level mercury analytical method (Method 1631) capable of detecting measurable levels in virtually all surface waters and discharges. The previous method was a thousand times less sensitive and has been largely incapable of providing useful data.

The second event is the recent listing of mercury impaired waters pursuant to section 303(d) of the Clean Water Act. Impaired waters are indicated by either violations of numeric water quality standards for mercury or by fish consumption advisories as narrative standards. The numeric mercury water quality standard applicable in the Lake Superior Basin is 1.3 ng/l, while 6.9 ng/l is applicable in the remainder of the state. The fish consumption advisory issued by the Minnesota

Department of Health each year is used as the applicable narrative indicator of unacceptable levels of mercury contamination of fish for human consumption.

This interim mercury National Pollutant Discharge Elimination System (NPDES) permitting strategy is in response to listing of impaired water bodies for mercury under section 303(d) of the CWA. Total Maximum Daily Loads (TMDLs) must be developed for these impaired waters. TMDL listings for mercury encompass two regions covering the whole state, and are based on either water column measurements or fish consumption advisories. Present water column measurements are largely confined to the metropolitan area rivers and northeastern Minnesota. Fish tissue data have been collected in 856 lakes and 51 rivers throughout Minnesota.

TMDLs move through two phases: an initial or interim phase where information is gathered; and a development phase during which sources have loadings allocated to them. It is expected that the interim phase could require two permitting cycles to arrive at a point where eventual allocation of loadings to the various mercury sources can be made. The purpose of this interim policy is to provide guidance in monitoring and controlling the discharges of mercury from NPDES surface water dischargers until such time as these dischargers have been allocated loads through the allocation phase of the TMDL process.

4.2 Existing Discharges

4.2.1 Interim Program Monitoring and Limits

The MPCA's general authority to require monitoring in NPDES permits resides in MN Rules 7001.0150, Subp. 2, Item B. The MPCA has been delegated the NPDES program by the U.S.EPA and is responsible for applying all program related rules, regulations, and statutes (see EPA letter of May 17, 2001). The MPCA is responsible for assuring all water quality standards are met The MPCA must identify pollutants that are not meeting water quality standards, identify sources, and ultimately control those sources so that standards are met. Monitoring is essential to measuring pollutant levels and evaluating the need for control measures.

It is expected that most dischargers have never used the low-level methods to monitor mercury in their effluent. For this initial five-year permit cycle of the interim phase of mercury TMDLs, existing dischargers are expected to monitor mercury using low-level techniques. Whether and how often monitoring will be required depends, in part, on discharge rates because large discharges represent a large proportion of mercury released to the receiving water. Therefore, mercury monitoring is most likely to be required in NPDES permits for dischargers at or above 1,000,000 gpd discharge rate (major dischargers). Monitoring requirements may be applied to all dischargers between 200,000-1,000,000 gpd discharge rate only after three additional conditions are fulfilled. These conditions include (1) additional analytical lab capacity, (2) more sampling training for facility personnel and (3) evaluation of sampling data from stabilization ponds. Dischargers less than 200,000 gpd can be expected to monitor also if their discharges are which are anticipated to contain high levels of mercury.

The purpose of this monitoring is to gather data to establish the basis for effluent limits in subsequent permits. Limits will be placed in subsequent permits based on a determination of

reasonable potential to cause or contribute to a water quality standards violation, or (40 CFR 122.44(d)(1)). The preliminary effluent limitation that is utilized to make the reasonable potential determination will be based on the mercury chronic water quality standard applied directly to the discharge as a waste load allocation. Those existing dischargers with current limits and no low level mercury data will retain those limits in the initial reissuance and conduct low level monitoring. Those facilities that cannot meet these limits will be triggered into a compliance schedule that includes a Pollutant Minimization Plan. As described below, a variance may be required in the next permit reissuance.

For this first permit cycle, those few dischargers with *current* low-level mercury data will be evaluated for reasonable potential as their permits come up for reissuance. Where reasonable potential is demonstrated, a limit will be included in the permit along with a schedule to come into compliance with the effluent limit.

The MPCA voluntary agreement program and other pollution prevention and source reduction programs will be availableto NPDES dischargers for the initial permit reissuance cycle. This permit cycle corresponds with the timelines of the MMRI, which concludes in 2005 with a report to the Legislature on the nature of reductions achieved. The subsequent permit cycle will be open to all regulatory initiatives including reasonable potential determinations, effluent limitations, variances, compliance schedules, and specific facility-wide mercury reduction programs which may contain mass balance requirements.

Appendix E summarizes the interim strategy for existing discharges. Figures 2a and 2b illustrate the pathways that different existing discharges statewide (7050) and in the Lake Superior basin (7052) will follow.

4.2.2 Variances

There would be little need for existing, non-expanding dischargers to apply for a variance during the initial issuance period because most will only be monitoring, using the new low-level techniques.. Those few dischargers who currently have low level mercury data, and indicate the need for a limit based on “reasonable potential,” may request a variance during this initial issuance period.

We expect that if most of the dischargers required to do monitoring during this first five-year permit cycle also implement mercury source reduction programs, the number of variance requests could be greatly reduced. For example, data from a study in Maine and extrapolated to Minnesota suggests that current mercury levels for one-half of Minnesota’s municipal wastewater treatment plants are likely to already meet the 6.9 ng/l statewide mercury standard. If dischargers, during this initial permit cycle, could attain an approximate 50% reduction in mercury inputs to their plants, we expect that about 15-20% of existing dischargers would still not be in compliance and might therefore need variances. However, a higher percentage of wastewater dischargers in the Lake Superior Basin, where the mercury standard is 1.3 ng/l, will likely need variances.

4.2.3 Exemptions/Inclusions

Certain wastewater dischargers will likely be exempt from mercury requirements based on information that MPCA may have, or the discharger presents, that indicates the discharge contains no mercury beyond what they have in their source water. Other, small dischargers may be added because of specific information that elevated mercury levels may be in their discharge. Examples of likely exempt discharges include (1) non-contact cooling water without additives, (2) most stormwater permits, and (3) other small municipal dishcharges, pending evaluation of a Maine study. Likely inclusions, however, include major metropolitan stormwater permits, some industrial stormwater permits from facilities known to use or dispose or mercury, and peat mine discharges. Likely exemptions and inclusions will be refined and revised over the next year as specific permit applications are evaluated and more data becomes available.

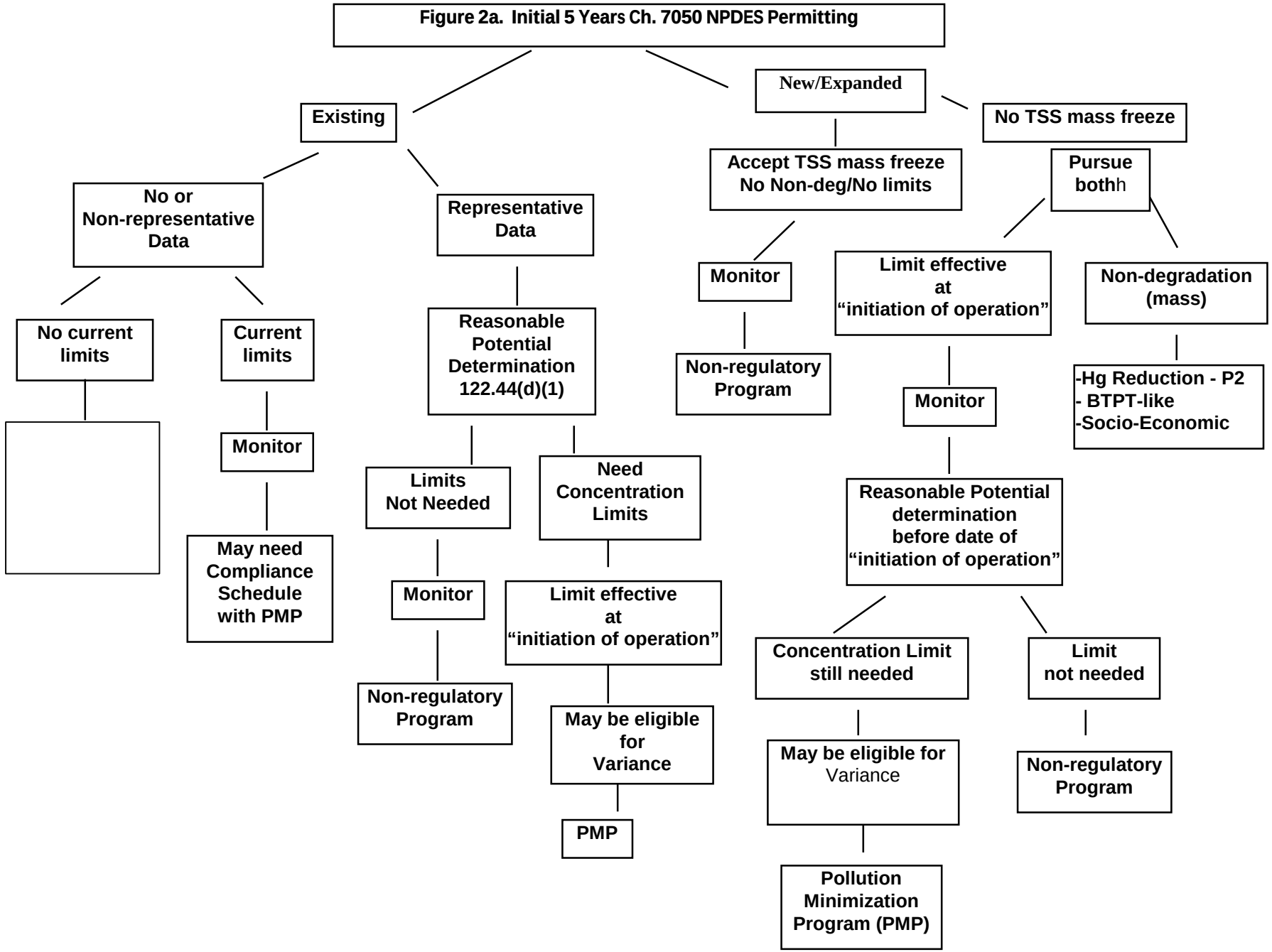
Figure 2a. Initial 5 Years Ch. 7050 NPDES Permitting
Existing
New/Expanded
No or Non-representative Data
Representative Data
Accept TSS mass freeze No Non-deg/No limits
No TSS mass freeze
Pursue both
No current limits
Current limits
Reasonable Potential Determination 122.44(d)(1)
Monitor
Limit effective at "initiation of operation"
Non-degradation (mass)
Non-regulatory Program
-Hg Reduction - P2
- BTPT-like
-Socio-Economic
Monitor
Limits Not Needed
Need Concentration Limits
Reasonable Potential determination before date of "initiation of operation"
Monitor
May need Compliance Schedule with PMP
Monitor
Limit effective at "initiation of operation"
Concentration Limit still needed
Limit not needed
Non-regulatory Program
May be eligible for Variance
May be eligible for Variance
Non-regulatory Program
PMP
Pollution Minimization Program (PMP)

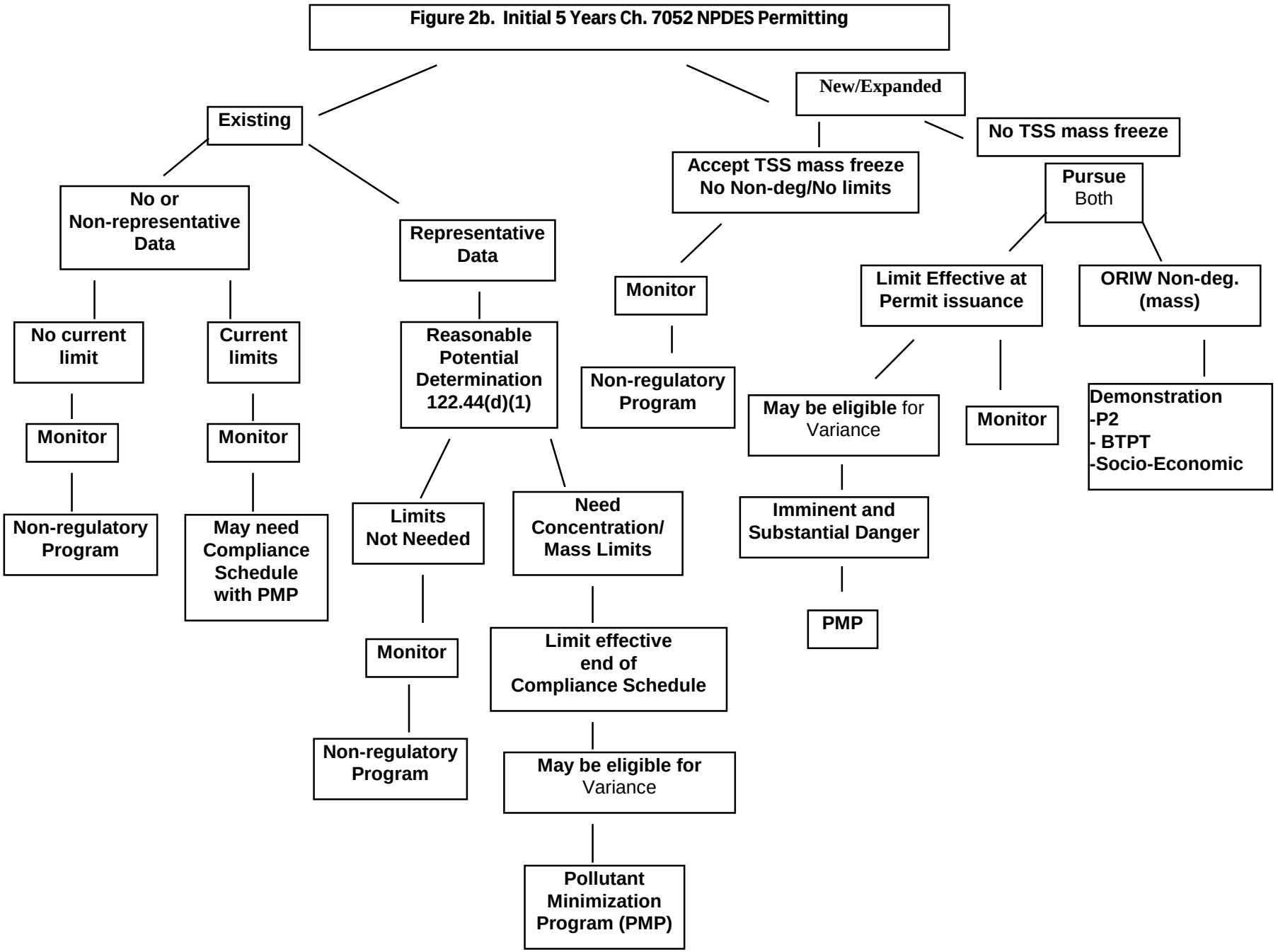
Figure 2b. Initial 5 Years Ch. 7052 NPDES Permitting
Existing
New/Expanded
No or Non-representative Data
Representative Data
Accept TSS mass freeze No Non-deg/No limits
No TSS mass freeze
Pursue Both
No current limit
Current limits
Reasonable Potential Determination 122.44(d)(1)
Monitor
Limit Effective at Permit issuance
ORIW Non-deg. (mass)
Monitor
Monitor
Non-regulatory Program
May be eligible for Variance
Monitor
Demonstration -P2 - BTPT -Socio-Economic
Non-regulatory Program
May need Compliance Schedule with PMP
Limits Not Needed
Need Concentration/ Mass Limits
Imminent and Substantial Danger
PMP
Monitor
Limit effective end of Compliance Schedule
Non-regulatory Program
May be eligible for Variance
Pollutant Minimization Program (PMP)

4.3 New or Expanded Discharges

4.3.1 ***Interim Program Permit Limits***

It is also expected that most new or expanded dischargers will not have used the new low level mercury method. During this interim permit phase these dischargers will also be expected to monitor effluents using the low level mercury method. This includes new dischargers at or above 1,000,000 gpd discharge rate. It also includes expanding dischargers whose discharge rate is currently at or above 1,000,000 gpd, and dischargers whose discharge rate upon expansion will be at or above 1,000,000 gpd (minors expanding to majors). Because these dischargers are proposing increases to impairment waters for mercury, their permits will contain effluent limits based a waste load allocation using the chronic water quality standard applied at the point of discharge. Tier 1 of EPA's antidegradation policy states that existing designated uses and the level of water quality necessary to protect those uses must be maintained (40 CFR 131.12(a)(1) and Minn. Rules Part 7050.0185). At a minimum, new or expanded dischargers can cause no further degradation to the receiving water. This is consistent with EPA policy (Carol Browner, testimony before the U.S. Senate, February 23, 2000) which is to allow at a minimum no further harm to non-attainment waters. The extension of monitoring and limits to other new/expanding dischargers between 200,000 gpd and 1,000,000 gpd discharge rate will be subject to the same three additional conditions previously noted for existing dischargers.

Permit limits will provide further reasonable assurance that these discharges do not cause or contribute to a mercury water quality standards violation 40 CFR 122.44(d)(1), and are in fact demonstrating "further reasonable progress" towards attaining the standard. These limitations will be effective at commencement of the new or expanded discharge (Chp. 7052), or the initiation of operation (Chp. 7050 related citation) Figure 2b shows the different paths that a permit for a new or expanded discharge could follow and the possible outcomes.

Appendix F summarizes the interim strategy from new or expanded discharges. Figures 2a and 2b illustrate the pathways that new or expanded discharges statewide (7050) and in the Lake Superior basin (7052) will follow.

4.3.2 Removal of limits

Dischargers can demonstrate through monitoring that no reasonable potential exists, and request the limit be removed. For expanded discharges, this can most effectively be accomplished prior to commencement of the increased discharge and before the limit would become effective. The discharger could request a permit modification, and participate in the voluntary program. If monitoring demonstrates reasonable potential, the limit is retained, the mercury reduction program (e.g., pollutant minimization program, or PMP) would proceed. For new dischargers, the limit could be removed through a permit modification after monitoring for a period of time. In both cases monitoring would continue for purposes of tracking nondegradation. In the Lake Superior basin, the removal of limits would not be allowed in the initial issuance.

4.3.3 Variances

Variances would need to be pursued in those instances where dischargers are unable to meet the Water Quality Based Effluent Limit (WQBEL). This is most likely to occur in the Lake Superior basin where the water quality standard is 1.3 ng/l (Chapter 7052). Variances for new or expanded discharges in the basin are allowed only when it can be demonstrated that there would be "imminent and substantial danger to public health and welfare" if a variance were not to be allowed. Otherwise it is presumed that new dischargers will have the capacity to meet the WQBEL.

In the remainder of the state subject to Chapter 7050, new or expended dischargers unable to meet a WQBEL for mercury would pursue variances according to Minn. Rules Part 7000.7000 and 7050.0190.

4.3.4 Nondegradation

In addition to the effluent limitation, the proposed new or expanded discharge will have to conduct a nondegradation review. In both Chapter 7052 and 7050 the mechanism triggering the review will be an increase in mass loading. The essential elements of the nondegradation demonstration in both chapters require the proposer of the discharge to address the level of treatment equivalent of "best technology in process and treatment." This would be required to preclude the new or increased loading; the nature of pollution prevention, pollutant reduction measures that may be employed; and any socio-economic development or benefits that may not occur if the proposed lowering of water quality is not allowed.

4.4 Stormwater

The MPCA has encountered situations where high mercury concentrations were documented in stormwater runoff. Specifically, runoff from a salvage operation, which was probably contaminated by mercury devices in salvaged vehicles, had high mercury levels. Currently, only one stormwater permit, which is for a salvage operation, has a mercury limit. The agency is also requesting mercury monitoring in large municipal stormwater discharges, specifically in Minneapolis and St. Paul.

In order to better understand the relative contributions from different stormwater sources, we have the following recommendations:

- The MPCA should coordinate with EPA and other states who have been evaluating mercury in stormwater.
- We should be looking for opportunities to monitor stormwater for mercury, including possibly mercury monitoring as part of TMDLs, monitoring in cooperation with business associations and submitting proposals to monitoring grant programs.

4.5 Lab Availability

Currently it would appear that there are only 4 commercial labs in the country that are accredited by states with reciprocal agreements in Minnesota to conduct EPA method 1631 for mercury. MPCA could expect other labs currently utilizing the method to obtain certification once demand increases. There is one lab certified in Minnesota (in Duluth). For the time being we need to be sensitive to the issue of lab availability, because other states are also requiring low-level mercury

monitoring. Monitoring requirements will be included in permits as permits are issued so that demand is "ramped up" with anticipated lab capacity.

In addition, the MPCA is initiating a training program for clean sampling of mercury in effluents (EPA method 1669). One such training session has already been held. More are anticipated. This will be important because the inability to collect quality data where the potential for contamination is high can only serve to undermine obtaining accurate documentation of mercury reductions or compliance with limits. The cost for sampling and analysis of individual low-level mercury samples collected by facility personnel is expected to be about $200-300.

5.0 Conclusions

One of the ways the MPCA reduces mercury contamination is fish is through various regulatory programs. In addition, the MPCA is participating in nonregulatory programs such as the Minnesota mercury reduction initiative and the Lake Superior Binational Program. It is our intent to integrate these programs so that the goal of reducing mercury is the overarching objective.

To that end, we have compiled this document that describes the current state of selected regulatory and nonregulatory policies that apply to mercury. As other programs such as TMDLs mature, the mercury policy will need to be updated. The current policy can be summarized as follows:

- Minnesota is committed to reaching statewide reduction goals through a combination of regulatory and nonregulatory mercury reduction efforts.
- The primary nonregulatory program is the Minnesota Mercury Reduction Initiative. In the Lake Superior basin, the statewide program is partnered with the Lake Superior Binational Program.
- Regulatory programs include limits on discharges and certain emissions. MPCA mercury programs are not all voluntary.
- Based on the current statewide inventory, if the 70% mercury emission reduction goal is to be achieved, there must be reductions in the energy (e.g., coal and oil) and material processing (e.g., taconite mining) sectors.
- The MPCA will not initiate new mercury emission control legislation or new industry-wide rule making while the existing Minnesota mercury reduction initiative continues, but existing permitting procedures and authority remains in place during the interim period. This policy does not create or change any legal authority or requirements. All decisions will continue to be made case by case as warranted by specific facts.
- The MPCA needs to evaluate the amount of mercury that is land applied in Minnesota and the availability of mercury in different land applied materials.
- Until the mercury TMDL allocations are made, the MPCA wastewater discharge requirements call for monitoring for most major dischargers and some others, with eventual evaluation of reasonable potential and establishment of limits based on water quality standards as outlined.

Appendix A

Background Information on Mercury as an Environmental Contaminant

This appendix contains the following sections:

- Mercury as a Persistent Bioaccumulative Toxic Chemical (PBT)
- Atmospheric Transport and Deposition
- Bioaccumulation of Mercury
- Need to Reduce Mercury Emissions Locally and Globally
- Mercury in coal, oil, ores
- Capturing mercury from stacks
- What do you do with mercury if it is captured?

Mercury as a Persistent Bioaccumulative Toxic Chemical (PBT)
Complete dilution in the environment effectively reduces the toxicity of most environmental contaminants. In most cases the toxicological truism "The dose makes the poison" holds, and once a chemical is well diluted in the environment, the chemical is unlikely to endanger plants and animals. However toxic chemicals that are persistent and can bioaccumulate after dilution are exceptions to the truism of dilution. Chemicals are said to be persistent in the environment if they only slowly degrade to their nontoxic components (e.g., PCBs only slowly degrade to carbon dioxide, chloride ions, and water) or they simply never lose their potential to be toxic (e.g., elements such as mercury, arsenic, and cadmium). When a bioaccumulative toxic chemical is persistent, there are strong grounds for restricting environmental release even at very low concentrations. Such chemicals are generally known as PBTs, or Persistent Bioaccumulative Toxic chemicals.

Mercury is the classic example of a PBT: it never degrades, it can bioaccumulate to toxic levels from benign concentrations, and it can cause serious health effects. To make the situation worse, it is unusually mobile in the environment, where its movement is analogous to the hydrologic cycle. Mercury can volatilize and be deposited elsewhere time after time. Atmospheric transport can be short (meters) or long (around the world).

Atmospheric Transport and Deposition
When liquid mercury evaporates, it is in its simple elemental vapor form, an uncharged gaseous atom (Hg(0), known as "mercury zero"). Hg(0) is relatively inert, in that it is not water soluble, and tends not to stick to atmospheric particles. As a result, when Hg(0) evaporates from liquid mercury, or is emitted from a smoke stack, it may stay in the atmosphere for months. The world-wide concentration of Hg(0) in rural areas is about 1.5 nanograms per cubic meter (ng/m3), which is thought to be about three times higher than natural levels. (At concentrations above 300 ng/m3, which may occur where mercury is spilled indoors, Hg(0) is unhealthy to breathe for extended periods.) Hg(0) follows air currents until it is oxidized through as-yet unclear chemical

mechanisms into a water-soluble ion (Hg(II), known as "mercury two"). Hg(II) has a tendency to stick to some types of small particles in the atmosphere, at which point it becomes particulate mercury (Hg(p)). Rain and snow wash Hg(II) and Hg(p) out of the atmosphere, to surface water and to land, a process call wet deposition . Hg(II) and Hg(p) can also fall to the earth's surface in the absence of rain, a process called dry deposition.

Some combustion sources produce Hg(0), Hg(p), and Hg(II). The relatively inert Hg(0) does not usually get caught by pollution control equipment and can be transported very long distances in the atmosphere. Hg(II), if produced, may be washed out by wet scrubbers, be present as a vapor, or associate with particulate matter, producing Hg(p). If powdered activated carbon is added before particulates are controlled, it is thought that most of the Hg(II) and a portion of the Hg(0) can be caught. Most Hg(II) that is emitted is likely to be deposited relatively close to the emission source, say within several thousand kilometers. Emitted Hg(0) is likely to be deposited relatively far from its emission source because the average time to oxidize Hg(0) to Hg(II) in the atmosphere is thought to be about a year.

Bioaccumulation of Mercury

Once mercury is deposited to a lake and its watershed it can be converted to methylmercury by bacteria. Methylmercury is the form of mercury that accumulates in fish tissue. Animals that eat fish may be exposed to harmful levels of mercury. The mercury concentration in fish may be a million times higher than that of the water they live in. This high bioaccumulation factor results in the irony that in the the wilderness of northern Minnesota it may be healthful to breathe the air that brings mercury to the lake, to drink the water from the lake, but not to eat the fish that grow in that water.

The methylation of mercury is mostly accomplished in low-oxygen portions of aquatic or wetland systems (such as the sediment) by the bacteria that convert sulfate to sulfide. In low sulfate systems, such as the lakes of northern Minnesota, the addition of sulfate may stimulate these bacteria, and the production of methylmercury. In high sulfate systems, high levels of sulfide may form mercury compounds that are unavailable for methylation, yielding relatively low levels of fish contamination.

However, sulfate is not the only variable that influences the proportion of mercury that is methylated in any given lake or stream, a proportion that is usually between 1% and 20%. Methylation efficiency is also influenced by: the availability of organic matter for the bacteria to consume, oxygen concentrations, temperature, pH, and light conditions. In any given lake or stream, reducing the loading of mercury will ultimately reduce the amount that is methylated and how much is bioaccumulated by fish. If all of the controlling factors (bacterial activity, pH, etc.) were held constant over time, the mercury concentration in fish would be directly proportional to any changes in mercury loading to a given lake.

Need to Reduce Mercury Emissions Locally and Globally

It was not understood until the early 1990s that the atmosphere carries significant amounts of mercury to remote regions of the earth. Areas closer to mercury emission sources do appear to receive greater amounts of mercury, but even lakes in relatively remote regions such as

Minnesota's Boundary Waters Canoe Area produce fish that contain mercury levels of concern. Elevated mercury concentrations in fish may be partly the result of other pollution (such as atmospheric transport of sulfate) that enhances the efficiency of methylation. But the general scientific consensus is that one would expect changes in the mercury contamination of fish to be roughly proportional to changes in mercury deposition. If one could reduce mercury deposition by 50%, one would expect fish contamination to be reduced by about 50% (perhaps after a lag time of some years due to slow release from watershed soils). The concentration of mercury in fish from a given lake differs among lakes in a given area because of differences in water chemistry, bacterial communities, watershed size, food chain length, and the resulting differences in bioaccumulation factors. But in principle every lake has a unique linear relationship between fish contamination and atmospheric deposition of mercury.

But to reduce mercury deposition by 50% is an ambitious goal. Only about 40% of deposition in Minnesota is due to mercury emissions in the United States and the rest is from global sources (half natural and half pollution). Totally eliminating U.S. emissions would therefore not even reduce mercury deposition by 50%. International action is needed if great strides are to be made in reducing mercury emissions and subsequent deposition. MPCA staff estimate that a 50% reduction in air emissions within Minnesota alone would result only in a 5% reduction in deposition.

About half of the global burden to Minnesota is from global pollution and the other half is mercury that has volatilized from natural geological sources. Geological sources are, of course, also the ultimate source of the anthropogenic (human-related) mercury releases. Human activity releases mercury from geological deposits rich in mercury, such as mercuric ores (cinnabar), and geological deposits with less mercury such as coal, oil, and ores processed for useful metals such as iron, gold, silver, lead, and zinc. Once released from its geologic store, mercury moves through the environment until it is re-buried in young geological materials such as ocean and lake sediments, peat deposits, and river deltas.

It is relatively straight-forward to reduce the mining and use of mercury by reducing or eliminating demand for mercury in commerce. Eliminating demand is important because once mercury is used in manufacturing or in products, it inevitably is introduced into the environment through leaks, spills, or product disposal. The only way to insure that mercury use does not contribute to environmental contamination is to find non-mercury substitutes. There is arguably a substitute for every use of mercury, of which there have been many through history. Fluorescent lamps are the leading example of a mercury use for which there is not yet an adequate substitute. While energy-efficient substitutes are being developed, lamp manufacturers should continue to lower the amount of mercury in each lamp, and consumers should employ proper disposal as a cost-effective way of keeping mercury out of the environment.

It is important to reduce mercury emissions in Minnesota for multiple reasons:

- Reducing emissions will result in some reduction in deposition in Minnesota due to short-range atmospheric transport.
- Reducing emissions will help reduce regional and global pollution, which contribute about 60% of Minnesota's mercury deposition.

- Reducing emissions in a manner that does not harm the economy provides an important model to the rest of the U.S. and world. There does not have to be a dichotomy between a strong economy and a clean environment.

Mercury in coal, oil, ores

Although it is clear how to use less mercury in products and manufacturing, it is not as straight-forward to reduce the amount of mercury that is incidentally released from use of geological materials where mercury is a trace contaminant, such as coal, petroleum, and metallic ores. The heating or burning of these materials releases the mercury from the earth. The mercury concentrations are very low, both in the material and in the flue gases, but the vast quantities of geological materials processed by industrial societies add significant quantities of mercury to the atmosphere. Existing pollution control equipment meant for control of SO_2, NOx, and particulate matter does not usually capture mercury effectively. The low concentrations of mercury in flue gases make it difficult to capture mercury even when mercury-specific controls are added.

Capturing mercury from stacks

The desire to capture mercury from flue gases is relatively new (since the early 1990s), and it is not yet known how best to do it for many types of air emissions. It may or may not be cost-effective to add mercury control to existing facilities, depending on the form and concentration of the mercury, the temperature of the flue gas, and whether there is physically space to add equipment. New technologies are being developed that may overcome today's limitations.

What do you do with mercury if it is captured?

Even if mercury can be captured from flue gases, it may not solve the mercury problem. If the mercury is captured with fly ash, it is not clear that the mercury will not enter the biosphere by volatilizing to the atmosphere or leaching to surface or groundwater, depending on what is done with the fly ash. Mercury associated with fly ash will be less likely to enter the biosphere if the ash is placed into a lined monofill that is capped and the leachate is monitored. Pure ash sets up almost like cement, and there would be little leachate, or methane gas production in a monofill that might otherwise carry mercury vapor to the biosphere. On the other hand, there is currently considerable interest in beneficially utilizing fly ash as an agricultural fertilizer, concrete component, or as an agent that solidifies wet soils prior to construction of roads, parking lots, and buildings. There may be relatively small concentrations of mercury in ash, but if it eventually volatilizes as a result of beneficial utilization, then capturing results in no net environmental gain.

Some industrial facilities use wet scrubbers to control SO_2 and particulate matter. Wet scrubbers are probably efficient at removing Hg(II) from flue gases, since Hg(II) is water-soluble. If the scrubber water is put back into the industrial process up stream of the stack, as is commonly done, then there is no net reduction in mercury emissions. In these cases the mercury simply cycles around until it eventually is emitted as Hg(0), which is not caught by the wet scrubber. It is possible to achieve a net reduction if the facility removes the mercury from the scrubber water before re-using the water – as Western Lake Superior Sanitary District has done in Duluth.

Appendix B

Minnesota's Mercury Reduction Law

116.915 Mercury reduction.

Subdivision 1. Goal. It is the goal of the state to reduce mercury contamination by reducing the release of mercury into the air and water of the state by 60 percent from 1990 levels by December 31, 2000, and by 70 percent from 1990 levels by December 31, 2005. The goal applies to the statewide total of releases from existing and new sources of mercury. The commissioner shall publish updated estimates of 1990 releases in the State Register.

Subd. 2. Reduction strategies. The commissioner shall implement the strategies recommended by the mercury contamination reduction initiative advisory council and identified on pages 31 to 42 of the Minnesota pollution control agency's report entitled "Report on the Mercury Contamination Reduction Initiative Advisory Council's Results and Recommendations" as transmitted to the legislature by the commissioner's letter dated March 15, 1999. The commissioner shall solicit, by July 1, 1999, voluntary reduction agreements from sources that emit more than 50 pounds of mercury per year.

Subd. 3. Progress reports. The commissioner, in cooperation with the director of the office of environmental assistance, shall submit progress reports to the legislature on October 15, 2001, and October 15, 2005. The reports shall address the state's success in meeting the mercury release reduction goals of subdivision 1, and discuss whether different voluntary or mandatory reduction strategies are needed. The reports shall also discuss whether the reduction goals are still appropriate given the most recent information regarding mercury risks.

HIST: 1999 c 231 s 150

Appendix C

Air Emissions of Mercury: Existing State and Federal Regulations

This appendix contains the following sections:

- Introduction
- Waste Combustors and Incinerators
- Sewage Sludge
- Maximum Achievable Control Technology (MACT)
- Coal-Fired Power Plants
- Minnesota Permit Limits Beyond Standards
- Minnesota's Mercury Reduction Initiative
- Voluntary Reduction Agreements
    - Regulatory Innovation
    - Role of the Minnesota Pollution Control Agency

Introduction
A few categories of air pollution sources are currently subject to specific mercury emission limits in Minnesota (waste combustors and incinerators). Other sources are subject to federal standards, but the limits are so high they have little real world impact. And some major sources may be federally regulated over the next decade—as the technology to control emissions becomes available (coal-fired power plants, others). Finally, some MPCA-issued permits have included mercury limits that go beyond existing rule-based requirements on a case-by-case review.

What follows is an overview of the various air regulations, followed by a summary table of the legal citations and applicable emission standards.

Waste Combustors and Incinerators
These facilities are one of the few types of mercury sources covered by air emission standards. The control technology of choice is currently activated carbon injection, but others are in development. Federal or state standards, or both, limit mercury emission rates from each of the following facility categories:

- municipal waste combustors;
- medical waste incinerators (federal); and
- hazardous waste combustors (federal).

Sewage Sludge
Relatively old federal regulations (from 1974) limit mercury emissions from sewage sludge incinerators, but the emission limits are so high (3,200 grams/day, but Minnesota's biggest sludge incinerator emits about 200 grams per day) that they have virtually no practical effect. EPA staff has indicated that mercury from sludge incinerators has not been further regulated

federally because total emissions did not appear to be significant on a national level. EPA staff has indicated they could reconsider their decision if new data become available.

Maximum Achievable Control Technology (MACT)

The MACT approach to regulating air toxics is set out primarily in Section 112(d) of the Clean Air Act, as amended in 1990. MACT shifted the federal air toxics approach from a risk-based approach to a technology-based approach. (A separate section of the Act required studies and a decision on whether to regulate toxic emissions from coal-fired power plants--see below). However, the MACT-based approach for mercury is limited by several factors, including: (1) a lack of effective existing control technology, (2) the generally low concentrations of mercury in flue gases, and (3) uncertainty and variability of both the costs and effectiveness of new control technologies. Other parts of Section 112 could be used to limit mercury emissions in the future, such as the residual risk, case-by-case MACT, and "Great Water" provisions.

Coal-Fired Power Plants

The Clean Air Act requires the U.S. EPA to study toxic air pollution from power plants in order to determine if additional regulations are necessary in order to protect public health. EPA reported its study to Congress in February 1998. That study concluded that of all toxic pollution examined, mercury posed the greatest concern to public health. The Clean Air Act also requires EPA then to determine whether to proceed with the development of regulations.

On December 14, 2000 EPA announced that it has decided that mercury air emissions from power plants should be regulated. EPA will propose regulations by December 2003 and will begin developing those regulations shortly. Industry, the public, and state, local and tribal governments will have an opportunity to participate in the process. Then, EPA is expected to issue final regulations by December 2004. Two electric utility groups have sued EPA for its decision to regulate coal-fired power plants under the MACT provision—instead of other possible provisions—of the Clean Air Act. The lawsuits are not necessarily directly challenging EPA's decision to regulate mercury from these facilities.

EPA's decision is accessible on EPA's mercury web site at: www.epa.gov/mercury

National Multi-Pollutant Approach

At the same time that the federal regulatory process to control mercury from coal-fired power plants will proceed, another approach is being be explored. Over the next two years, work will continue on a combined strategy to address all of the major pollutants emitted by power plants, including mercury, sulfur dioxide, nitrogen oxides and potentially, carbon dioxide.

The idea is that a comprehensive strategy that addresses all of these pollutants together will provide more certainty and flexibility to industry, making it the most cost-effective way to control the emissions.

Minnesota Permit Limits Beyond Standards

The MPCA has imposed or negotiated mercury emission limits in permits on a case-by-case basis using its broad authority under Minn. Stat. 116.07, subd. 4a.

The MPCA has included mercury limits in permits that go beyond rule requirements. These permits include:

- Potlatch/Cloquet Amendment No. 5;
- LTV Steel Mining (Schroeder)
- 3M Cottage Grove Hazardous Waste Incinerator;
- University of Minnesota Steam Plants (70% natural gas requirement partly due to mercury emissions)

The details of the mercury limits and conditions in these permits are available in a separate document prepared by Anne Jackson.

Table 1. Summary of legal citations for mercury emission limits and associated emission standards. (µg/dscm = micrograms per dry standard cubic meter of flue gas.)

Affected Source Category	Federal Citation	Limit	State Citation	Limit
Sewage Sludge Incinerators	40 CFR 60 subp. o (1974)	3200 g/day		
Municipal Waste Combustors: *Large*	40 CFR 60 subp. Eb, Cb	80 µg/dscm	7011.1201-1295	60 µg/dscm
Municipal Waste Combustors: *Small*	40 CFR 60 subp.AAAA, BBBB (2000)	80 µg/dscm	7011.4000 to 7011.4035 (Prp. 8/01)	80 ug/dscm
Medical Waste Incinerators (1997)	40 CFR 60 subp.Ec, Ce (1997)	550 µg/dscm	(7011.5016	(55 µg/dscm) (proposed for 2000)
Chlor-alkali Plants (19??)	40 CFR 60 subp.o	3200 g/day		
Hazardous Waste Combustors	40 CFR 63,subp.EEE (1999)	140 µg/dscm (exist) 45 µg/dscm (new)		
Coal Fired Power Plants	CAAA §112(n)	12/2004		
MACT (generally)	CAAA §112			
Commercial/ Industrial Incinerators	40 CFR 60 CCCC	470 ug/dscm		

Minnesota's Mercury Reduction Initiative

In 1999, Minnesota's legislature passed a law (§116.915) that mandates the MPCA to try a new approach to reducing mercury contamination, the Mercury Reduction Initiative. This legislation endorsed a consensus position developed over 18 months of discussion with an Advisory Council to the MPCA (consisting of 26 representatives from industry, environmental groups, government, and others). The MPCA was mandated to implement reduction strategies described on pages 31-42 of the Advisory Council's report. Recognizing that the overriding goal is to reduce state-wide mercury emissions in the most cost-effective way possible, the legislature adopted reduction goals but allowed industry to reach those goals in part through voluntary efforts.

(The Advisory Council recommendations focus on getting and keeping mercury out of consumer and industrial products as the cheapest way to reduce releases. The reduction goals are a 60% reduction by 2000 and 70% by 2005 (compared to a 1990 baseline). The law requires that the MPCA report on progress in reports to the legislature in October of 2001 and 2005. The great emphasis of the Council report is on the reduction of mercury emissions to the atmosphere.

Voluntary Reduction Agreements

The 1999 Mercury Reduction Initiative legislation requires the MPCA to solicit experimental voluntary agreements from companies within the state that release over fifty pounds of mercury per year by July 1, 1999. These facilities are electric utilities, taconite plants, an oil refinery, a sludge incinerator, and a steel mill. Smaller mercury sources are invited to have agreements, too. Smaller sources could also become involved indirectly through partnerships with larger mercury sources.

The voluntary agreements are intended, in part, to provide major sources with a simple, cost-effective mechanism to contribute to the statewide reduction goals, particularly if reducing their own stack emissions might not be immediately feasible. The program is also intended to be more than a simple mercury reduction strategy. It is also an experiment in regulatory innovation.

Representatives of the largest mercury emission sources in Minnesota requested guidelines from the MPCA regarding the expected content of the voluntary reduction plans. The MPCA sent out these guidelines in March 2000. Implementation of reduction options is at the discretion of each emission source. However, the MPCA expects that the public nature of cost-effectiveness information, coupled with the state-wide goals, will result in implementation of reductions.

Regulatory Innovation: Mercury sources are encouraged and expected to come up with their own innovative, cost-effective reduction techniques. Mercury sources are not restricted to reducing releases from their facilities alone; they can team with other mercury sources to come up with more cost-effective reductions. Experimental reduction techniques, trial and error, and innovative research efforts are also encouraged.

Role of the Minnesota Pollution Control Agency: The Agency will not dictate how—or how much—individual sources are to reduce mercury releases under the voluntary reduction program. The MPCA's formal role is limited to providing technical advice, reviewing proposals, and then verifying and tracking results. The agency will be evaluating the voluntary proposals using one general criterion: the plan must be aimed at producing verifiable mercury release reductions. The MPCA will regularly report results to the public and the legislature. Reporting and verification protocols will largely be worked out on a case-by-case basis.

In return for the major mercury sources putting forth a good faith effort to reach shared mercury reduction goals, the state will not initiate new, industry-wide mercury regulations. The companies, the state, and other parties are to spend their limited resources solving the mercury problem instead of wrestling with new legislation, parsing complex rule interpretations, or arguing over legal technicalities.

Voluntary Agreements To Date

Fourteen facilities have submitted voluntary agreements.. (Mercury-reduction plans from Olmsted County Public Works and WLSSD are similar to Voluntary Agreements.)

Eight Voluntary Agreements were developed by firms whose estimated mercury releases exceed 50 pounds per year: EVTAC, Hibbing Taconite, Koch Refining, MCES, Minnesota Power, National Steel Pellet, North Star Steel, and Xcel Energy.

Six of the Voluntary Agreements were developed by firms whose estimated mercury releases are less than 50 pounds per year: Alliant Energy, Great River Energy, Ispat Inland Mining, LTV Steel/Mining, Northshore Mining, and Ottertail Power. (The Olmsted County Public Works department and WLSSD would be on this list, but they prefer to be recognized as having reduction plans.)

We expect to get a Voluntary Agreement from and Marathon/Ashland Refining and U.S.-Steel if the program continues for another year or two at least.

The following list summarizes features of their various mercury reduction plans:

Elements in most of the Voluntary Agreements:

- Equipment inventories and labeling
- Education programs for employees, customers and communities
- Replacement plans for mercury-bearing equipment and devices
- Discussion of changes (purchasing, process-related, etc.) that have been made since 1990
- Plans to revise purchasing policies
- In-plant recycling programs
- Schedules for planned activities (many to begin this year, some to be completed this year)
- Annual progress reports

Projects in individual Voluntary Agreements:

- Changes in processing methods
- A menu of research projects conducted in cooperation with other groups
- A completed mass balance study
- Switching fuels from coal to natural gas
- Equipment upgrades
- Switching to low-mercury coal
- Coal "monitoring"
- Baseline estimates
- Installation and operation of mercury control equipment

Missing from nearly all Voluntary Agreements:

- Methodological and statistical support for baselines and mercury reduction estimates

Plans mentioned in some, but not all, Voluntary Agreements:

- Stack tests
- Community-wide recycling programs
- Mass balance studies

The MPCA has received reports from most of the Voluntary Agreement firms. Most of the reports have been submitted and we are compiling results. Some, but not all of the progress reports include estimates of some mercury reductions that have occurred up to the end of last year.

Appendix D

Mercury Multi-Pathway Risk Assessment

This appendix is divided into the following sections:

- Use of Models to Predict Local Contamination of Surface Waters
- ATR Relationship With Permit Review Procedure for New or Expanded Sources

Mercury Multi-Pathway Risk Assessment
The MPCA has the general authority to include mercury emission limits in permits on a case-by-case basis under Minn. Stat. 116.07, subd. 4a, and has done so in the past (see Appendix B: *Minnesota Permit Limits Beyond Standards*).

Use of Models to Predict Local Contamination of Surface Waters
It is difficult to document that any particular emission source is responsible for the mercury contamination of fish in any given surface water, even when the surface water is near the source. This difficulty is due to a) the sheer technological challenge of documenting mercury emission, atmospheric transport, deposition, methylation, and bioaccumulation, b) the relatively large background from regional and global sources, and c) many sources probably do not emit much Hg(II), the form of mercury that is likely to deposit locally (either because it is not produced, or because the Hg(II) is caught by pollution control equipment).

However, when a source has the potential to emit a significant amount of Hg(II), it may be possible to predict with a model that the source may add significantly to the mercury burden of fish in a local water body – even when it would not be practical to empirically document such an effect. Models can calculate the incremental increase in mercury in fish in surface waters from an emission source, but assume knowledge of the form of mercury emissions, that the forms do not change during dispersion, deposition rates of those forms, and the efficiency of methylation and bioaccumulation. If the model goes on to calculate the risk to humans or wildlife of the mercury emissions, it makes assumptions about the size and species of fish eaten, the number of fish meals per unit time, the body weight of the consumer, and the sensitivity of the consumer to methylmercury. This information is often unobtainable, although the processes undoubtedly occur. In the absence of information, models use reasonable assumptions that often yield reasonable but unverifiable predictions. As with all models, the conclusions are generally as uncertain as the assumptions.

This assessment of mercury models may be discouraging, but simplified models may yield some valuable qualitative conclusions about the degree and impact of local contamination of fish from a mercury emission source:

- The potential for local contamination goes down sharply if Hg(II) is controlled.

- Surface water with slow hydraulic flushing rates (e.g., lakes and backwaters) have more potential to be contaminated by local emission sources than do rivers and streams.
- Fish-eating wildlife may be more at risk from local emissions than the average fish-eating person (fish consumption per unit body weight is relatively high for loons, kingfishers, mink, and otters).
- For any given surface water, the most vulnerable human population may be subsistence anglers who eat a lot of fish, or it may be sport anglers that eat fewer fish that are higher on the food chain (large walleye, bass, or northern pike).

What can we glean from the use of models? That we currently cannot accurately predict the effect of mercury emissions on local fish resources; but nevertheless that if there are vulnerable surface waters, control of Hg(II) will minimize impacts on wildlife and humans.

Models may be run with conservative default assumptions in a "screening mode", with the understanding that if no significant increase in mercury contamination of fish is found, then there probably is no significant local concern. This strategy is efficient when the conservatively calculated increase is small, but creates work when the model yields a large increase. Is the large increase due to inaccurate default assumptions or real potential for risk? In such a case, there is pressure to substitute more accurate local information in place of default assumptions. Local information can take the form of actual local data or just assumptions that an expert feels is probably more representative of a particular situation than the model's defaults. In the case of mercury, there are so many uncertain steps in the modeling process that it may not be possible to reduce uncertainty to a tolerable level.

When some models predict risk of local mercury deposition from a new or expanded source, it is tempting to spend time adjusting assumptions to seek agreement among models – agreement that may not be appropriate, or even possible. An alternative response in such a case would be to conclude that in such cases it is appropriate to require control equipment specific to Hg(II).

ATR Relationship With Permit Review Procedure for New or Expanded Sources

Minimizing or controlling mercury emissions helps Minnesota achieve the twin objectives of (1) minimizing local mercury contamination and (2) reaching Minnesota's state-wide reduction goals. The MPCA has a general responsibility to scrutinize permit applications and set limits for the release of pollutants if needed. But what would be an appropriate procedure for the MPCA to translate the twin objectives into permit provisions that achieve the objectives?

The current permitting process is not helpful in this regard. There are existing regulations for the so-called criteria pollutants (SOx, NOx, carbon monoxide, lead, VOCs, and fine particulate matter). Other pollutants, for which the EPA has not developed criteria are termed "air toxics." The current MPCA policy for dealing with emissions of air toxics is to conduct an *Air Toxics Review* (ATR). An ATR is currently defined as only addressing the hazard of breathing a given chemical, a "single pathway" of human exposure to a toxic chemical. The hazard of ingestion after bioaccumulation is currently not included in an ATR for a proposed facility. Facilities requesting a permit may submit modeling concerning exposure to bioaccumulative chemicals ("multipathway analysis"), but it is not current MPCA policy to request such an analysis because

in the past it has often been time-intensive for both the applicant and the MPCA, and has often yielded results that have not changed the proposed project.

An inhalation-only ATR is not illuminating for mercury questions since there is almost negligible risk to breathing the atmospheric concentrations of mercury that are responsible for mercury contamination of fish. If there is any significant local risk to new mercury emissions, it would be through increased mercury concentrations in fish.

The issue of increased mercury exposure as a result of eating higher concentrations in fish could be pursued through a multipathway analysis, which is essentially the use of models, which we have seen are not necessarily accurate. The output of such models for mercury has high uncertainty, because of the uncertainty of the many factors that control mercury chemistry in stack gases, mercury deposition, methylation, bioaccumulation, and exposure through ingestion.

Multipathway analysis of mercury hs more uncertainties than inhalation exposure for pollutants , because:

- Mercury chemistry is relatively unstable on the way out of a stack -- and the chemistry determines whether there will or won't be local deposition. If the mercury does not deposit, then it does not get into fish.

- Inhalation exposure is only dependent on the modeled concentration in the air, which is the result of atmospheric dispersion. Dispersion is modeled relatively accurately, because it is a purely physical process, involving no chemistry or biology. In contrast, ingestion exposure is dependent on a much longer chain of events, each of which has uncertainty: modeled air concentration of particular chemical forms of mercury; calculated deposition rates of each form to soil and water; export coefficients from soil to the water; % conversion to methylmercury by bacteria; and degree of bioaccumulation through the aquatic food chain.

- Humans breathe at a relatively constant rate, whereas the degree of exposure through fish consumption is subject to non-constant factors (for both humans and wildlife). The amount of mercury ingested is dependent on the fish species, fish size, and the size and frequency of fish meals.

Unfortunately, under current ATR policy, the MPCA does not provide any guidelines for multipathway analysis of emitted bioaccumulative toxic chemicals such as mercury, dioxins, and furans. Without guidelines, facilities are free to determine which model to use and what assumptions to make within the model. For instance, a facility on a river may choose a small receptor area that includes the river, when a larger receptor area would include lakes that would be more sensitive to mercury deposition, albeit at lower deposition rates. The MPCA is currently revising its approach to project-specific mercury risk assessments in its ATR guidance.

Appendix E

Outline of the Interim Mercury Water Quality Strategy for Existing Discharges

Municipal/Industrial existing facility permit reissuance – statewide

Monitoring (method 1631 and perhaps method 245.7 in the future) and sampling (method 1669)

- Majors: minimum quarterly for life of the permit.
- Minors (>0.2 mgd): minimum semi-annual monitoring for life of permit concurrent with lab availability, sampling training, and evaluation of MPCA collected pond data.
- *Ponds: once each discreet discharge event*
- Storm-water: Case-by case; 4 times/year for "representative" discharge points
- List of exclusions (e.g., non-contact cooling water)
- List of inclusions because of anticipated mercury levels in effluent

Mercury Contamination Reduction Initiative (MCRI)

- Marketed to all dischargers for the initial 5 year permit cycle.

Mercury Toxicity Reduction Programs (TRPs)

- Included in subsequent 5 year permit reissuance cycle
- TRP facility specific language related to facility emissions/discharges, perhaps including mass balances for the facility
-

Mercury Permit Limits

- Facilities with current low-level effluent mercury data will be evaluated for "reasonable potential" for mercury limits. Those facilities with ***representative*** data that trigger "reasonable potential" will receive:
  1. An effluent limit based on concentration, if >10 data points.
  2. If <10 data points, additional data will be collected and then permit will be issued with a concentration limit.
  3. Effluent limits will be considered interim effluent limits until the allocation stage of the TMDL sets loadings and WQBELs. The TMDL allocation process needs to recognize and credit those who were most aggressive in seeking reductions.
  4. Effluent limits will be derived using the coefficient of variation and the EPA TSD statistical procedure for calculating WQBELs.
- Facilities with no current low-level mercury data will monitor during the current reissuance and be evaluated through a reasonable potential determination for an effluent limit in the subsequent permit reissuance.

Appendix F

Outline of the Interim Mercury Water Quality Strategy for New/Expanded Discharges

This appendix is divided into the following sections:

- All Expanded Dischargers
- New/Expanded Discharge (Municipal/Industrial) in Lake Superior Basin (Chp. 7052)
  - Outstanding International Resource Water (OIRW) and ORVW in basin
- New/Expanded Discharge (Municipal/Industrial) outside of the L. Superior Basin (Chp.7050)
  - Outstanding Resource Value Waters (ORVW) restricted
  - All Waters (assumes non-attainment)
    - Majors
    - Minors

All Expanded Dischargers

Freeze TSS loadings when possible to avoid need for a nondegradation demonstration.
Mercury is associated with total suspended solids (TSS). Freezing the TSS loading means that mercury loads will not increase. These dischargers would begin low level mercury monitoring and perhaps participate in the MCRI. Otherwise, the requirements for new or expanded dischargers will depend upon the applicable rule (Chp. 7050 or Chp. 7052) and the classification of the receiving water to which they will discharge (ORVW, OIRW, All Waters).

The inclusion of minor dischargers (200,000 gpd – 1,000,000 gpd discharge rate) will be dependent on analytical lab capacity, sampling training, and evaluation of MPCA collected pond data.

New/Expanded Discharge (Municipal/Industrial) in Lake Superior Basin (Chp. 7052)

Outstanding International Resource Water (OIRW) and ORVW in basin (*trigger based on action or activity)*

- The discharger will provide a nondegradation demonstration which includes:
  5. A Pollution Prevention analysis;
  6. A Best Technology in Process and Treatment-BTPT (includes mercury reduction activities) analysis;
  7. A socio-economic analysis related to the impact a denial of the lowering of water quality would entail.
- This would also include a permit limit reflecting the new or increased portions of the discharge and monitoring.
- Limits are effective upon **initiation of operation** of the new/expanded discharge.

- No variances allowed for new dischargers (exception if discharge is needed to preclude an imminent and substantial danger to public health and welfare such as a Superfund site, new plant replacing failed septic systems that reach surface waters, failure of a treatment system).

New/Expanded Discharge (Municipal/Industrial) outside of the L. Superior Basin (Chp.7050)

Outstanding Resource Value Waters (ORVW) restricted

- New/increased discharge triggered off effluent monitoring data (direct or indirect) that shows mercury is present in the discharge going to a non-attainment water.
- No "prudent and feasible alternative" to include BTPT type analysis for industrial dischargers, and additional influent or pretreatment oriented requirements for POTWs.
- Concentration-based effluent limit (WQS end-of-pipe) where there is "reasonable potential". Mass tracked as basis for trigger for future nondegradation reviews.

All Waters (assumes non-attainment)

- New/increased discharge triggered off effluent monitoring data (direct or indirect) that shows mercury is present in the discharge to a non-attainment water, and
    - A 200,000 gpd trigger, or
    - A 1% above baseline background concentration trigger.

Majors:

- *Pollution prevention/reduction*
- Additional treatment review
    8. End-of-pipe analysis, but reliance on pretreatment/collection system user requirements for POTWs. Concentration-based effluent limit (WQS end-of-pipe) where there is "reasonable potential". Mass tracked as basis for trigger for future nondegradation reviews, and
    9. BTPT type analysis for industrials
- Socio-economic impact analysis.

Minors:

- Pollution prevention/reduction
- Additional treatment review
    10. End-of-pipe analysis, but reliance on additional collection system user requirements for POTWs. Concentration-based effluent limit (WQS end-of-pipe) where there is "reasonable potential. Mass tracked as basis for trigger for future nondegradation reviews, and
    11. BTPT type analysis for industrials
- Socio-economic impact analysis.

Appendix G

Multi-Media: Total Maximum Daily Load

This appendix is divided into the following sections:

- Background
- EPA Requires TMDL's For Mercury
- Technical Complications
- Legal Complications
- Federal TMDL Pilot Projects
- Potential Statewide Minnesota TMDL
- Uncertainty Continues

Total Maximum Daily Load (TMDL): Background

Under the Clean Water Act, states must submit to EPA a list of all waterbodies still not meeting water quality standards even after implementation of technology-based effluent limits in NPDES permits. This list of impaired waterbodies is known as a 303(d) list. Once a waterbody is listed for a particular pollutant, states must develop a long-term plan to fix the problem and submit the plan to EPA for their approval. This written, quantitative plan is called a Total Maximum Daily Load, or TMDL. The TMDL normally calculates—using various models—an acceptable "loading" of the pollutant and then allocates the allowable loading among the various sources contributing to the problem. These sources include point and non-point sources.
In addition, under the Act, an "interim" period begins when a waterbody is added to the 303(d) list and ends only after EPA approves the TMDL. Wastewater discharges allowed in NPDES permits to impaired waters are particularly restrictive during this interim period. Minnesota's mercury-impaired waters on our 303(d) list currently fall within this "interim" period.

EPA Requires TMDL's For Mercury

The TMDL provisions of the Act had been largely ignored until the mid-1990's, when EPA began losing a series of TMDL related lawsuits. As a result EPA has reinvigorated the TMDL program, including requiring TMDLs for waters impaired partly or totally by atmospheric deposition. This means that state's must develop TMDL's for mercury-impaired waters even if point-source wastewater discharges of mercury are minimal—or non-existent. In addition, EPA has decided to require TMDL's not only for waterbodies exceeding numeric water quality criteria, but also for waters with mercury fish consumption advisories. While some states are under court order to complete TMDL's for mercury-impaired waters this year, Minnesota is not legally obligated to complete any mercury TMDL's until 2007.

New Federal Rules On Hold

In summer, 2000, EPA promulgated revised TMDL rules with some important changes, but subsequent legislation delayed implementation until October, 2001. The new EPA administration is currently reviewing the rule once again, and further changes appear likely.

Technical Complications

A "normal" TMDL would require, among other things, calculating an acceptable loading of the pollutant and allocating needed reductions to specific point and non-point sources. But there is so much we don't understand about the mercury problem that a "normal" TMDL analysis is very difficult—if not impossible in many cases.

For example, we still don't know a lot about why mercury accumulates to high levels in fish in some lakes and not in others—even when the mercury loading is the same. As a result establishing an "acceptable" loading is difficult. In addition, most of our lakes, particularly our remote lakes, receive mercury from many, widely-dispersed air emission sources. Establishing a clear link between the mercury in a specific lake and the mercury emitted by a specific air pollution source is extremely difficult and expensive—if it can be done at all. Finally, many waters in the Great Lakes region are under fish-consumption advisories. Therefore, completing mercury TMDLs for each so many specific waterbodies is impractical

Legal Complications

There are also legal complications. The TMDL allocations to point-source discharges—the "load" allocations—are implemented through NPDES permit limits. But there is no analogous legal mechanism to enforce allocations given to non-point sources, such as air deposition sources. So reductions allocated to air sources or other non-point sources of mercury would be implemented through a variety of so far mostly unspecified regulatory and non-regulatory mechanisms.

Federal TMDL Pilot Projects

EPA is currently testing the TMDL concept for mercury through two large-scale pilot projects. One pilot project is being completed on a lake in Wisconsin and the other is in Florida. Already overdue, EPA has delayed the release of the results of the pilot projects until a least late Summer, 2001. As part of the mercury pilot project TMDL reports, EPA is also planning to issue a comprehensive evaluation of the legal tools available to implement mercury TMDLs. EPA headquarters is also apparently in the process of developing separate guidance on how states should complete mercury TMDL's. The release date of this guidance in not clear.

The difficulties encountered by EPA's pilot projects have confirmed the daunting legal and technical complications of doing a "traditional" TMDL for mercury. Partly as a result, EPA Region 5 is starting a process to determine whether alternative approaches are legally and technically defensible, and they are soliciting suggestions from states. The National Wildlife Foundation has also recently suggested a conceptually simple "mercury phase-out" plan for states to implement in lieu of a standard TMDL.

The MPCA staff has been skeptical for some years of the feasibility of completing a "traditional" TMDL's for mercury because of the lack of adequate technical and information basis. Minnesota, in fact, declined an earlier offer to host one of the EPA pilot projects because of this skepticism. However, the science is clear in one regard: less mercury entering lakes means less mercury accumulating in fish. So as an alternative to simply delaying mercury reductions and TMDL plans until the science is clearer, MPCA staff has over the last year explored the possibility of an alternative approach. This approach is an accelerated, generic "statewide" (or multi-state) TMDL for mercury covering multiple phases over the next decade.

Potential "Statewide" Minnesota TMDL

As currently conceived by staff, the MPCA would focus on statewide reductions over the next five years—while continuing research on watershed-specific approaches that might be implemented in the future. The first five-year mercury reduction and research phase would be the first step in a long-term statewide mercury reduction plan. Such an approach could be a regional, multi-state plan done in cooperation with other states in the region, or through a state-by-state consistent approach approved by EPA.

There are several potential advantages to such a phased approach:

- First, completing a TMDL moves us out of the "interim" status. At least for most of the state, this would allow more flexibility in wastewater discharge permits—which is justified in cases where the vast majority of mercury in a waterbody is from air deposition. (Specific state and federal regulations, such as the Great Lakes Initiative (GLI) regulations, however, may limit this potential flexibility.)

- Second, the TMDL allocations could, but would not necessarily have to, allocate specific reductions or level of effort expectations to in-state air emission sources. In-state air emission allocations would have to be implemented through regulations for some sources and specific, but non-regulatory mechanisms for others. Past reductions would be accounted for in allocations. Up to 90% of the air emission reductions, however, would be allocated to EPA because about that proportion of the mercury landing on our waters comes from out-state sources.

- Third, and perhaps most importantly, a statewide TMDL could, conceptually, serve as the mechanism to develop the elusive, comprehensive, long-term multimedia mercury reduction plan for Minnesota.

One Potential Minnesota Statewide Approach Summarized

As currently conceived by staff, the Minnesota mercury TMDL approach could be based on the following assumptions:

1. Extensive atmospheric transport, deposition, and in-lake process modeling for most of our urban and remote waterbodies is not only unnecessary but probably futile. Our major air sources emit mostly elemental mercury—little of which deposits locally. Most of our mercury-impaired waters receive mercury from numerous, widely-dispersed air emission sources.
2. Neither existing atmospheric fate and transport models, nor existing in-lake mercury cycling model are accurate enough yet to justify the time and expense needed to use them to allocate mercury loading from air sources for specific waterbodies.
3. The latest mercury cycling model used in EPA pilot projects and elsewhere, although subject to improvement, does indicate that reductions in mercury deposition lead to approximately proportional reductions in mercury concentrations in fish. Based on this and other evidence, we know enough to say that reducing mercury input to our waters does reduce the amount of mercury in the fish.
4. Our existing lake-sediment coring data justify allocating up to ninety percent of needed mercury loading reductions to EPA, who would have responsibility for reducing these unspecified, out-state air emission sources;
5. Load allocations for in-state reductions would be phased and reevaluated periodically. For the first five-year phase of a statewide mercury TMDL, allocations would be broken down based the existing Minnesota statutory goal of a 70% reduction below 1990 levels by the end of 2005.
6. For this first TMDL phase, the specific allocations needed to meet this statewide goal could be by industry sector, by individual source, and/or by environmental media—including air emissions, water releases, land application;
7. Allocations to MPCA and OEA could be included to improve accountability and program progress;
8. MPCA would allow flexibility for waste-load allocations where warranted, while continuing to require or encourage efforts to reduce wastewater discharges through best management practices and pollution prevention;
9. Statewide mercury release allocations would include a margin of safety with an allocation allowance for new or increased sources of mercury releases as long as the source did not create unacceptable localized impacts;

10. MPCA would implement in-state load allocations, including air emissions allocations, through a variety of as yet unspecified regulatory and non-regulatory mechanisms and reevaluate these mechanisms every two years;
11. All verified in-state load reductions since 1990 would be credited;
12. In addition to addressing statewide releases as described above, MPCA would continue efforts to reduce national, and international mercury releases during the first five-year TMDL phase.
13. During the same period, Minnesota would continue to research in-lake chemical and biological processes that increase (or reduce) formation of methyl mercury and accumulation in fish. Site specific or general methods to reduce methyl mercury formation would be evaluated for potential future application in specific waters or watersheds;
14. Following the first five-year TMDL phase, the MPCA would evaluate and potentially begin to implement watershed or waterbody specific fish-contamination reduction approaches if warranted by new information.

Uncertainty Continues

Discussions with EPA and other states in the Great Lakes Region are ongoing. At recent regional meetings, there has been some discussion about the possibility of a uniform approach to completing mercury TMDL's for all the Great Lakes states. This approach presents some advantages. However, Minnesota does have lake sediment and other data justifying initial allocations that other states may not have at this time.