Chapter 4

Lake Superior
Critical Pollutants Progress Report

Ontario power generation facility, Thunder Bay, Ontario.
Photo Credit: John Marsden, Environment Canada.

Lake Superior Lakewide Management Plan
2006

Chapter 4 Contents

Chapter 4
Lake Superior Critical Pollutants Progress Report

This report provides an update of activities related to critical pollutants in the Lake Superior Basin. It is organized to introduce the contents of two technical documents to be released later in 2006 and report on agency activities related to critical pollutants between 2004 and 2006. Those upcoming technical documents include:

- An assessment of the 2005 milestones from the Stage 2 LaMP and strategies for making progress toward the 2010 milestones; and
- A report on chemical integrity in Lake Superior that will be presented at the 2006 State of the Lakes Ecosystem Conference (SOLEC).

The technical milestones report will include a discussion of emerging contaminants and how they relate to Lake Superior. The chemical integrity report will include more detailed information on the concentrations of chemicals in the Lake Superior ecosystem and management recommendations.

4.0 THE ZERO DISCHARGE DEMONSTRATION PROGRAM

Reducing toxics loadings to Lake Superior is a key component in the effort to achieve a sustainable basin. The LaMP Stage 2 document sets a goal of eliminating discharges and emissions of the nine critical pollutants in the Lake Superior Basin by 2020, with interim targets in 2000, 2005, 2010 and 2015 (Table 4-1). The baseline for the reduction targets is 1990. The Lake Superior Binational Program's Zero Discharge Demonstration Program (ZDDP) is a unique experimental program intended to end the use of these nine critical pollutants in industrial processes or products, and to prevent their release in the Lake Superior Basin.

Table 4-1. Lake Superior load reduction schedule for the nine critical pollutants (percentage reductions).

Chemical	2000	2005	2010	2015	2020
Mercury	60	--	80	--	100
PCBs	33	60	95	--	100
Dioxin, HCB, OCS	--	80	--	90	100
Pesticides: Aldrin/Dieldrin Chlordane DDT/DDE Toxaphene	100	--	--	--	--

Why Zero Discharge for Lake Superior?

Among the Great Lakes, Lake Superior provides the best opportunity to achieve zero discharge and zero emission. The governments around Lake Superior announced *A Binational Program to Restore and Protect the Lake Superior Basin* in 1991, with an agreement to work together on the ZDDP and on broader ecosystem issues. The 1991 agreement stresses voluntary pollution prevention but acknowledges that enhanced mandatory controls may be necessary.

4.1 POLLUTANT CONCENTRATIONS IN THE ENVIRONMENT

Enforcement of environmental regulations, changes in industrial development patterns, implementation of pollution prevention, and the efforts of individual citizens have significantly reduced releases to Lake Superior. However, the goal of zero discharge and zero emission is a challenging one, and a significant amount of work remains to be done.

The ZDDP, and other programs, are aimed at reducing toxic chemicals at their sources, resulting in the eventual reduction in the ecosystem. Concentrations of a suite of toxic organic contaminants in water, including the Lake Superior critical and lakewide remediation pollutants, declined more than 50 percent between 1986-87 and 1996-97. Chemical contaminant data collected as part of the coordinated monitoring effort in 2005 will provide a current snapshot of concentrations in various components of the Lake Superior ecosystem

Table 4-2a identifies "yardsticks" for water quality in Lake Superior. These are standards from the four Lake Superior jurisdictions, current as of April 2006. These yardsticks will be used in determining the status of Lake Superior critical chemicals in the upcoming technical report. The most protective of these standards will be used for comparison purposes in this report. Table 4-2b shows concentrations of some persistent bioaccumulative toxic chemicals in Lake Superior water. As part of the technical reporting, the latest 2005 coordinated monitoring data will be added to Table 4-2b and compared to the yardsticks in Table 4-2a.

Table 4-2a. Jurisdictional Lake Superior water quality yardsticks for some LaMP critical pollutants (ng/L).

Pollutant	Water Quality Yardsticks (ng/L)			
	MN[1]	MI[1]	WI[1]	ON
PCBs	0.0045	0.026	0.003	1.0
HCB	0.074	0.45	0.22	6.5
Dieldrin	0.0012	0.0065	0.0027	1.0 (+Aldrin)
Chlordane	0.04	0.25	0.12	60
DDT	0.011	0.011	0.011	3.0 (∑DDE, DDD, DDT)
Mercury	1.3	1.3	1.3	200
Toxaphene	0.011	0.068	0.034	8.0
g-BHC (lindane)	80	25	18	10

[1] Water quality based standards for the Lake Superior states are based on the Great Lakes Water Quality Initiative methodology.

Table 4-2b. Concentrations (ng/L) of some critical pollutants in Lake Superior open lake water.

Pollutant	Open Lake Concentration
PCBs	0.0705[1]
HCB	0.014[2]
Dieldrin	0.126[2]
Chlordane	<0.03[3], 0.0099[4]
DDT	0.005[2] (p,p'DDE)
Mercury	0.71[5]
Toxaphene	0.7[6]
g-BHC (lindane)	0.357[3]

[1] Warren, G. (1996 data)
[2] Williams et al., 2004 (2001 data)
[3] Williams and Kuntz, 1999 (1997 data)
[4] Jantunen et al., in press (1996-1998 data)
[5] Dove, A. (2003 data)
[6] Muir et al. 2004 (1998 data)

A presentation summarizing current chemical contaminant concentrations and trends in the Lake Superior ecosystem was given at the Lake Superior Task Force meeting in November 2005 (Appendix C). Below is a summary of some key points discussed related to contaminant concentrations in the Lake Superior ecosystem:

- Lake Superior's physical, thermal, and biological properties make it unique and particularly sensitive to retaining PBT chemicals;
- Atmospheric deposition is main source of PBTs to the lake – some source regions have been identified;
- In general, concentrations of many legacy PBT contaminants have declined over time (i.e., government intervention has been effective);
- In most cases, concentrations in various media are decreasing at much slower rates or have leveled off over time;
- New chemicals of concern such as PBDEs are increasing in fish and sediments in Lake Superior; and
- Fish consumption advice is continually changing due to new monitoring data and new information on toxicological interactions of individual contaminants and contaminant mixtures.

4.2 LaMP ACCOMPLISHMENTS 2004 TO 2006

Actions undertaken or completed since the release of the LaMP 2004 report are summarized below. Earlier actions not reported in the 2004 update are also presented.

4.2.1 LaMP Chemical Reduction Activities

The following are the chemical reduction projects (directly related to the Lake Superior LaMP) that have been implemented since the LaMP 2004 update.

Figure 1. PCB transformer phase-out (Grand Marais, MN).

PCB Phase-out

- The Minnesota Pollution Control Agency (MPCA) used state and federal funding to work with three utilities to identify, test, and change-out 452 transformers suspected of containing PCBs.

Collections

- With Environment Canada and other partner funding, the six townships around the Thunder Bay area are conducting a hazardous waste collection event during 2006. The goal is to maximize the recycling of toxic compounds (e.g., mercury) and to minimize the disposal of hazardous waste through incineration.
- EcoSuperior, with support from Environment Canada and through a partnership with local small businesses, conducted an incentive program to divert electronic waste from a landfill. Participants were given a subsidy when they brought in computers and other electronic waste for recycling and proper disposal. Electronic waste contains many toxic substances, including mercury, and recycling is environmentally preferable to landfilling.
- EcoSuperior organized "Household Hazardous Waste Collections" in the Ontario North Shore towns of Nipigon, Red Rock, Schreiber, and Wawa. This initiative was supported by the Ontario Ministry of the Environment, Environment Canada, and participating municipalities. Events were well-publicized with high rates of participation.
- Under the Earth Keeper Initiative, the Central Lake Superior Watershed Partnership coordinated a Clean Sweep (hazardous waste collection) event in Michigan's Upper Peninsula. The "Clean Sweep" was sponsored by nine faith communities, two environmental groups, the Keweenaw Bay Indian Community, and Michigan Governor Jennifer Granholm's office of Faith-Based Initiatives. The Clean Sweep was an unprecedented success. A total of 45.7 tons of toxic materials were collected in the event, which was held on Earth Day, April 23rd. Wastes that were collected included: pesticides, herbicides, mercury (including over 40 pounds of raw mercury), oil-based paints and thinners, car batteries, anti-freeze, and harsh cleaners. The hazardous wastes

were distributed to the Delta County and Marquette County hazardous waste processing facilities. The Delta County facility received more hazardous waste in the Earth Keeper event (25.5 tons) than in the previous seven years, and the Marquette facility received (20.2 tons) more than it normally does in an entire year!

Figure 2. Mercury recovered in Ontario collections. Photo Credit: Jim Bailey, EcoSuperior.

- The Grand Portage Band conducted a "white-goods/appliances" removal for proper disposal in the fall of 2004 (130 units), and fall of 2005 (48 units). The Band plans to continue these collections at least annually.
- The Grand Portage Band conducted its first Business Hazardous waste removal during the summer of 2005. They collected and recycled 46 fluorescent lights. The Band anticipates that the amount of waste will increase as they continue to conduct these removals.

Open Burning Outreach

- Western Lake Superior Sanitary District (WLSSD) held a workshop called *Open Garbage Burning: Preventable Pollution* for local officials and produced a guide entitled *Clearing the Air: Tools for Reducing Residential Garbage Burning*. The workshop materials are available at: http://www.wlssd.com/Open_Burning/OB_Workshop.htm, and the guide is at: http://www.wlssd.com/Open_Burning/Clearing_the_Air_downloadvs.pdf.
- The Northwest Wisconsin Regional Planning Commission produced a video for open burning outreach with an emphasis on protecting Lake Superior.
- EcoSuperior conducted outreach to residents of rural communities around Thunder Bay, as well as to residents of the Canadian North Shore of Lake Superior. Activities included a workshop and multi-media campaign targeted at townships, parks, and First Nations communities.
- EcoSuperior set up displays discouraging open burning at pow-wows in the communities of Pays Plat, Pic River, and Rocky Bay.
- Guidance is being provided to seven rural townships in the vicinity of Thunder Bay to promote and increase recycling, and to reduce the practices of burning household garbage and garbage burning at landfills. Activities have included: a presentation to municipal officials on the hazards associated with garbage burning; qualitative audits of the individual landfills; and a follow-up training presentation for landfill staff in the late winter of 2006.
- A campaign to promote awareness of the hazards related to open burning was conducted with First Nations along the north shore of Lake Superior. Display booths, promotional materials, and presentations were available at a series of aboriginal conferences during 2004-2005. It was determined that the best method for transferring information is

through community events such as pow-wows, annual gatherings, and community feasts, and by publishing articles in local/First Nation publications. It was also determined that, in order for First Nations to move towards eliminating the practice of burning domestic garbage, additional and continued support is essential to establish a permanent recycling infrastructure. Presently, there are a limited number of First Nations that have available infrastructure to recycle or even for overall waste management. Support is needed in the form of long term financial commitments, capacity building, and education. The communities which committed to implementing a recycling project are Pic River First Nation, Pays Plat First Nation, Lake Helen (Red Rock) First Nation, and Biinjitiwaabik Zaaging Anishinaabek (Rocky Bay) First Nation. Ontario First Nations Technical Services Corporation prepared a proposal to establish a pilot recycling project for First Nations within the Lake Superior Watershed. The program is dealing with jurisdictional and policy issues prior to funding decisions and initiation of a recycling program.

- The Bad River Air Quality Department conducted a "Burn Barrel Buy Back Program" in the fall of 2005. Based upon windshield surveys of burn barrels located on the Reservation, and surveys conducted with tribal members who burn, this collection contributed to the reduction of approximately 2.5 tons/yr of pollution generated from backyard burning and a 25 percent reduction in the total number of burn barrels on the Reservation. To further the reduction of burn barrels and pollutants on the Reservation, another collection is scheduled for the spring of 2006.
- The MPCA used state and federal funding to work with four local governments to implement open burning abatement projects. The ongoing project has included a variety of activities including billboards, county fair displays, a compost bin outreach project, a video for firefighters, and a mini-drama presented to secondary schools by CLIMB Theatre.
- A second project for the MPCA was a barrel-for-a-barrel swap in which the agency purchased 100 rain barrels and exchanged them for burn barrels in the Duluth and Two Harbors, MN, area.

Figure 3. Burn barrels collected during MPCA's barrel-for-a-barrel swap. Photo Credit: Gina Temple-Rhodes, Western Lake Superior Sanitary District.

Mercury Products

- EcoSuperior, in conjunction with North Shore municipalities, has set up fluorescent light recycling programs for homeowners in Thunder Bay, Red Rock, and Wawa. The programs operate with the support of Environment Canada, Ontario Ministry of the Environment, and Ontario Power Generation. Many industries in North Shore towns also recycle fluorescent lights. MGM Electric Inc. in Thunder Bay operates a "pay-as-you-go" depot for commercial generators of fluorescent lights. This depot receives and recycles between 20 and 30 thousand spent lights per year.
- EcoSuperior, in cooperation with small business and industry, continues to operate effective programs to recycle standard, wall-mounted thermostats and fluorescent lights in Thunder Bay and North Shore communities. The thermostat program operates with support from Environment Canada, Ontario Ministry of the Environment, and Honeywell Inc.
- At the end of 2004, the City of Superior, Wisconsin, completed a three-year Wisconsin Great Lakes Protection Fund project for community-based mercury reduction. Over 400 pounds of elemental mercury, 10,000 fluorescent bulbs, and thousands of mercury devices were collected and recycled. Because of the city's outreach, all dentists in the city have installed mercury amalgam separators. In September 2004, the City of Superior received the National Pollution Prevention Roundtable's Most Valuable P2 Award for its outstanding educational outreach programs http://www.ci.superior.wi.us/publicwks/wastewater/p2index.htm.
- Murphy Oil USA and the City of Superior, Wisconsin, worked in partnership with funding from US EPA GLNPO to develop a mercury and PCB inventory at the refinery and develop a pollution prevention guidebook: "Prescription for Mercury and PCB Elimination, Mercury and PCB Reduction Guidance for Oil Refineries." http://www.ci.superior.wi.us/publicwks/wastewater/p2index.htm
- Ontario continues to support the *Switch Out* program for mercury switches in automobiles. There are currently 204 recyclers in Ontario registered in the *Switch Out* program, 28 of which were new participants as of 2005. In 2005, 11,550 mercury switches were collected in Ontario. Most auto recyclers on the Canadian side of the Lake Superior Basin participate in the *Switch Out* program.
- Wisconsin kicked off a mercury switch recycling service that is free to auto salvage operators. An auto recycling trade association is assuming responsibility for continuing the program as government funding expires.
- The Ontario Ministry of the Environment is working with partners to develop: fluorescent lamp recycling pilots aimed at municipalities and schools; a pilot program for recycling mercury thermostats; and a mercury clean sweep event for schools.

Figure 4. Mercury compounds collected at Ontario schools. Photo Credit: Jim Bailey, EcoSuperior.

- EcoSuperior has visited high schools in Thunder Bay, Red Rock, Geraldton, Manitouwadge, Marathon, and Wawa, Ontario, to encourage mercury removal. Significant quantities of mercury have been removed for recycling, including: elemental mercury, mercuric oxide, mercuric iodide, mercuric nitrate, scientific thermometers, and assorted equipment containing mercury.
- Keweenaw Bay Indian Community has received funding to provide a mercury thermometer exchange for Tribal members.
- In September 2004, the Lake Superior Binational Forum held a government and industry summit entitled "Getting to Zero: Mercury Reductions and the Zero Discharge Demonstration Program." Recommendations from the summit were used by a group of participants to develop a basin-wide mercury reduction project during the fall of 2004.
- In 2005, Wisconsin and Minnesota scoping projects determined opportunities for mercury reduction in Lake Superior Basin industries, particularly in the shipping industry. Forum industry members agreed to serve as peer mentors for a basin-wide mercury reduction project. WDNR and the City of Superior, Wisconsin, with input from the chemical committee and forum, developed a 12-page brochure to market the basin-wide mercury reduction and mentoring program for basin industries.
- The City of Superior, Wisconsin, received US EPA funding for 2005-6 to carry out the U.S.-side technical assistance for the basin-wide mercury reduction project. The grant will focus on the shipping industry with peer-to-peer mentoring available.
- A joint Work Group-Forum-Industry mentoring program is being conducted on the Canadian side of the Lake Superior Basin in order to audit and inventory elemental mercury at industrial facilities during 2005/2006. The mentor will also assist in assuring best purchasing and management practices, and will provide guidance for the responsible recycling of mercury, where required. Several site visits and workshops have already been conducted, and priority locations will involve any future paper mill and mine site closures and decommissioning exercises.

- Starting in May 2004, the MPCA swapped more than 255 mercury-free digital thermostats for mercury-containing thermostats in Grand Marais, Two Harbors, and Duluth, Minnesota.
- Red Cliff Band's mercury elimination coordinator carried out projects which included testing tribal buildings for mercury vapor with a Lumex, exchanging mercury thermometers and thermostats with digital models, and providing information to the community about mercury at health fairs and on a local radio program.

Ontario Landfill Workshop

- EcoSuperior, with the support of Environment Canada and Ontario Ministry of the Environment, conducted a workshop for townships, First Nations, and government officials involved in landfill operation. This workshop encouraged recycling, hazardous waste collection, and other waste minimization alternatives as well as discouraged open burning at landfills. EcoSuperior, with support from Environment Canada, is conducting a workshop for landfill attendants in March 2006.

Wastewater Infrastructure

- In January 2005, the Bayfield, Wisconsin, area broke ground for a new regional wastewater treatment plant. The plant is described as a "zero discharge" facility because it is designed to perform at a level that significantly exceeds state and federal standards. Local funding was supplemented by state and federal grants to pursue the "zero discharge facility" goal. In addition to conventional treatment, the plant will use an innovative filtering technology as well as energy saving and other green design elements on-site.

Sediment Remediation

- One of the first two U.S. *Great Lakes Legacy Act* projects was completed in November 2005 at Newton Creek and the Hog Island Inlet in Superior, Wisconsin (St. Louis River AOC). The $6.3 million project removed just over 60,000 tons of sediments contaminated predominantly with PAHs and lead. The Legacy Act project was the final step in the cleanup of 3-mile-long Newton Creek and Hog Island Inlet. Murphy Oil Co. in Superior cleaned up the upper reaches of Newton Creek in the mid-1990s, and Wisconsin Department of Natural Resources cleaned up the middle stretches in 2003. The project's connection to LaMP and RAP goals was instrumental in acquiring state and federal funding.
- Keweenaw Bay Indian Community's Sand Point stamp sand brownfields site soil cap/clean up project is scheduled to start in the spring of 2006. Capping and revegetating the site will reduce heavy metal sediment load entering Keweenaw Bay.

Superfund Activities

- The construction completion date for the Torch Lake Superfund Sites was September 23, 2005. The remedial action recommended under the Torch Lake Superfund Record of Decision for the Superfund Sites was for the uplands, capping with 6 inches of sandy loam with vegetative cover, and natural attenuation for Torch Lake proper. About half of the Superfund Sites were located within the Torch Lake AOC. The completed remedial actions help prevent additional copper and other heavy metal loadings to the lake by wind or water erosion from stamp sands and other mining by-products piled into and along the lake from historical mining and milling processes.

Inventory of Selected Toxic Chemicals for the Milestones Report, 2005

- In collaboration with U.S. efforts, the goal of this project is to complete the most recent Canadian inventory of sources and trends of selected toxic chemicals in the Lake Superior Basin. The information is being gathered from readily available sources, including government databases, private sector data, published documents, and other literature. Estimates of inputs from products, landfills, other sources and emissions from industrial, government, and energy-related sources will be compiled using accepted estimation methods. The inventory project will also review and update the 1990 LaMP Canadian baseline inventory with any new information as it becomes available.
- A similar inventory, funded by US EPA, is being developed on the U.S. side of the basin.
- Lake Superior Research Institute at University of Wisconsin, Superior, completed a US EPA funded project to evaluate priority sources and quality assurance information for dioxin emissions on the U.S. side of the basin.

Lake Superior Binational Forum Activities

- In February 2004, the Forum sent letters to local and regional schools, colleges and universities regarding mercury reduction and asking for input on how these institutions handle mercury usage and disposal and what challenges they face with respect to mercury use and disposal.
- A subcommittee of the Forum Chemical Committee was formed to work with a contractor on the mercury reduction project for the Lake Superior Basin to assist with peer-to-peer mentoring, industry visits, and moving the project forward.
- The committee helped to develop a workshop on mining trends and issues which was held in Hibbing, MN, in March of 2006.
- Additional Lake Superior Binational Forum activities are provided in Addendum 4A.

4.2.2 Other Projects Aligned with LaMP Goals

These are recent projects that were not a direct result of the LaMP but are in alignment with the LaMP goals:

Open Burning Survey

- The Minnesota Office of Environmental Assistance carried out a statewide survey of rural open burning practices. Residents of Northeastern Minnesota turned out to be better informed of the problems associated with open burning and had a lower rate of trash burning (36 percent) than the state as a whole (45 percent). Further information is available at http://www.moea.state.mn.us/lc/byburn/MOEABurnBarrelReport.pdf.

Air Defenders

- Air Defenders is an interdisciplinary, multi-media educational program and publicly available website (www.airdefenders.org) for students 10 years of age and older. It was developed by the State of Wisconsin in response to concerns related to household trash burning. Air Defenders is designed to help health officials and other community educators, as well as teachers, create hands-on classroom lessons for students about the dangers of burning trash. The Air Defenders kit has received national attention from US EPA for its focus on open burning. In 2004, the Wisconsin Department of Natural Resources received a Great Lakes National Program Office (GLNPO) grant to generalize the kit contents and produce and distribute 5,000 additional kits in the Great Lakes area. These kits were provided to the various state and provincial environmental agencies in late 2005.

Ongoing Collections

- The Northwest Wisconsin Regional Planning Commission conducts two annual clean sweep events in each Lake Superior County. In 2004, they completed a special project funded by the Wisconsin Great Lakes Protection Fund to conduct "milk run" collections. This cost-effective hazardous waste collection project was utilized by rural schools districts, government facilities, tribes, and small businesses.
- Grand Portage, Fond du Lac, Bad River, and Red Cliff either hold annual household hazardous waste collection events or offer sites where these materials can be brought for proper disposal.
- Grand Portage continues to implement a Pesticide Use Policy on the Reservation to help avoid unnecessary and unscrupulous spraying.
- In Minnesota, other hazardous waste collection programs are found in the Lake Superior Basin at WLSSD (both business and household), St. Louis County, Lake County, and Carlton County. Cook County contracts with WLSSD to conduct collections.
- In Michigan, other ongoing hazardous waste collection programs are found in Chippewa and Houghton Counties. In addition, there is a Clean Sweep program for mercury and pesticides in Marquette County. Information on both programs can be accessed at http://www.michigan.gov/deq/.

Wood Stoves

- A partnership of Environment Canada and the Hearth, Patio and Barbeque Association (HPBA) will be conducting a project to measure emissions from conventional woodstoves and verify historical emission factors.

Energy Conservation

- EcoSuperior delivers the "Energuide For Houses" program in Thunder Bay for Natural Resources Canada. This program advises homeowners on how to economically improve home energy efficiency and reduce emissions as part of Canada's climate change solution. Several hundred homes in Thunder Bay have been evaluated through this program. Retrofits that reduce energy consumption have been completed on many of these homes.
- EcoSuperior, in partnership with Thunder Bay Hydro, provided rebates for the purchase of Energy Star rated appliances, as well as education to homeowners about energy conservation. This program was extremely well subscribed.
- EcoSuperior, in partnership with Environment Canada, conducted programming and outreach as part of the Canadian “One-Tonne Challenge.” This program asks individual Canadians to take energy conservation measures sufficient to reduce greenhouse gas emissions by 1 tonne.
- LHB (a Duluth engineering/architectural firm) won a Lake Superior Binational Stewardship award for designing energy efficient buildings in and near the Lake Superior Basin, including Whole Foods Co-op, Minnesota Department of Natural Resource Consolidated Tower Headquarters, Members Cooperative Credit Union - Spirit Valley Branch, Northwoods Credit Union, and the McLean Environmental Living and Learning Center at Northland College.

Alternative Energy and Energy Issues

- Bad River passed a resolution (August 2005) approving a Renewable Energy and Energy Efficiency Tribal Task Force. As a result, they are currently collecting wind speed data for the possibility of wind energy development.
- Fond du Lac has received funding to pursue a biomass gasification unit which will be used at the Fond du Lac Ojibway School to reduce energy needs and costs. This unit will use wood left over from fire reduction work. Air monitoring of this unit will be conducted by the Fond du Lac air program. They are also looking into solar voltaic panels for the school.
- Fond du Lac has two anemometers installed and is getting good response from them. Data will be collected for a year, when decisions will be made as to the possibilities of wind energy on the reservation.
- Grand Portage is pursuing grants to set up a large wind turbine, as results from their anemometer studies were favorable for the possibility of wind energy development.
- WDNR is working with the state Public Service Commission to evaluate clean coal technologies that would have environmental benefits over traditional coal plants.

- The Federation of Municipalities announced a $50,000 Green Municipal Fund grant awarded to the town of Marathon to explore the feasibility of developing, constructing, and commissioning a mid-sized (20 to 50 MW) wind energy farm on the shores of Lake Superior. The field study involves the Town of Marathon and Marathon Pulp. Commissioning of the facility could provide a reduction of up to 56,000 tonnes of CO_2, 224 tonnes of NO_3, and 64 tonnes of SO_2, annually.
- Wind power proposals: Algoma – see 10 percent Renewable Energy Goal, below.

St. Louis River Mercury Total Maximum Daily Load (TMDL) Partnership

- A partnership of businesses, WLSSD, and environmentalists reviewed existing mercury reduction efforts in the lower St. Louis River region and developed a plan for filling gaps in these reduction activities. Further information is available at http://www.barr.com/PDFs/Papers/SLRP/SLRP%20mercury.pdf.

Sediment Remediation

- Using federal funding, the MPCA worked with a variety of partners in the St. Louis River AOC on a project to lay the groundwork for a Comprehensive Sediment Quality Management Plan. Partners continue to work together on the strategy. Further information is available at http://www.pca.state.mn.us/water/sediments/slr-qmp.html.
- Contaminated sediment characterization work has continued in Thunder Bay, Peninsula Harbour, and the St. Marys River AOCs.
- The Wisconsin Coastal Management Program is funding phase IV of the contaminated sediment GIS database for the St. Louis River AOC. The project represents a partnership between states and the St. Louis River Citizens Action Committee, and will allow mapping of contaminant concentrations throughout the AOC.
- Bad River and Red Cliff have been involved in the Ashland/NSP Coal Tar Site (Superfund) Remedial Investigation, as well the natural resources damage assessment. WDNR supports US EPA in its lead role on this Superfund site, which includes 10 acres of PAH-contaminated sediments in Chequamegon Bay.

Solid Waste Management

- In 2005, the Marquette County Solid Waste Management Authority removed over 75,000 pounds of toxic/hazardous material from the waste stream. These materials included household hazardous waste such as mercury, volatile organic compounds, and poisons.
- In 2005, the Marquette County Solid Waste Management Authority updated the landfill to run as a bioreactor, allowing the system to facilitate the treatment of waste. Part of this update was a cost reduction of leachate treatment from $0.06 to $0.003 per gallon discharged. This savings allows the Authority to invest in new technology and better controls.
    - Improvements include treatment of liquid wastes on-site and the break down and treatment of resilient toxic materials. Paint waste and metals are biologically treated and stabilized. The total control of batch treatment facilitates effective remediation of toxic/reactive materials found in the solid waste stream. Because

the system relies on treatment instead of dilution, the materials don't end up in the Lake.
    - The upgrade to the landfill also reduced the volume and increased the life of the facility. The organic portion of Marquette County's solid waste was reduced in volume by approximately 50 percent.

- As a result of legislative proposals and discussions, automobile manufacturers negotiated, through their trade association, the Alliance of Automobile Manufacturers (AAM), a 2004 agreement with Minnesota Waste Wise (MWW). Through the agreement, the MWW, a non-profit technical assistance arm of the Minnesota Chamber of Commerce, will operate a two year switch outreach, collection, transportation, and recycling program. About 350 salvage yards were found to be eligible. The collection program has begun with MWW conducting on-site visits. The Minnesota Office of Environmental Assistance will release a progress report in 2006.

- The Michigan Mercury Switch/Sweep (M2S2) Program began in August 2004 with a memorandum of understanding (MOU) between the Michigan Department of Environmental Quality (DEQ) and the Alliance of Automobile Manufacturers. The program's goal is to remove mercury switches from at least 80 percent of all end-of-life vehicles processed in Michigan annually. 8,000 switches were collected in the first year.

Stormwater

- Bad River conducted an annual flyover using hyperspectral, thermal, and straight photography for a non-point source pollution assessment with special focus on failed septics.
- Grand Portage will receive an EQIP grant (U.S. Dept. of Agriculture, Natural Resource Conservation Service, Environmental Quality Incentive Program) to create five rain gardens and conduct stream channel restoration near the lodge and casino. This is the beginning of numerous activities to reduce non-point source pollution in this area.
- Grand Portage has been complying with the NPDES Stormwater rules at construction sites.
- Education on the importance of stormwater controls to protect the western Lake Superior Basin is carried out cooperatively between the University of Wisconsin Extension, WDNR, Superior, Wisconsin, Duluth, Minnesota, South St. Louis County Soil Conservation District, and Minnesota Sea Grant. This includes the "View from the Lake" program conducted aboard the UW-Superior education vessel, the *L.L. Smith*, throughout the summer.

Wastewater Infrastructure

- The City of Thunder Bay, Ontario, completed construction of its new secondary sewage treatment facility. In addition to secondary sewage treatment, the new facility includes nitrification to eliminate ammonia from the wastewater. Plans for next year include construction of a cogeneration plant and a change in the disinfection process from chlorine treatment to ultraviolet radiation.

- Bad River completed the first phase of a long-term five-phase project, with the ultimate goal of bringing all failing systems up to code. Inspection and diagnosis of 146 septic systems and 69 septic tank systems within the boundaries of the Bad River Reservation were completed.
- Grand Portage completed a project extending sewer lines to connect 30 additional homes along the Lake Superior shoreline in the spring of 2004. They are planning to hook up more homes and businesses in the future.
- In the spring of 2006, Keweenaw Bay Indian Community will begin construction of sewer and water line extensions to serve lake front properties along the east shore of Keweenaw Bay.
- The City of Washburn, Wisconsin, completed an upgrade to its sanitary and storm sewers in 2005. A significant benefit of the project is the projected elimination (except for extreme "100 year" storms) of sewage bypasses to Lake Superior that have typically occurred during large storm events.

Monitoring

- The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) completed studies of 37 PBT contaminants (including 7 of the 9 zero discharge pollutants) in Lake Superior lean lake trout and lake whitefish.
- GLIFWC also compiled contaminant monitoring data in the Lake Superior ecosystem and presented the results in a presentation entitled, *Chemical Contaminants in Lake Superior: Current Status and Trends*, to the Lake Superior Task Force in November 2005. See Appendix C of the LaMP 2006 report.
- Red Cliff continued a Surface Water Quality Monitoring Program that tests 21 different locations on the reservation for 22 different parameters including mercury, dioxin 2,3,7,8-TCDD, PCBs, toxaphene, and chlordane. Keweenaw Bay, Grand Portage, Fond du Lac, and Bad River currently have in place or are developing similar surface water quality monitoring programs.
- Bad River collected one year's worth of total and methyl mercury in wet precipitation to: begin to characterize the extent of the mercury problem on the Reservation, supplement data from tribal fish assessments for methylation rates, and assess deposition changes over a short period of time.
- Bad River closed out one old Underground Storage Tank (UST) in October 2005. Another is still being monitored and they anticipate close out in June 2006.
- In 2005, MOE conducted a recovery study in the Kaministiquia River (which flows into the Thunder Bay Harbour). Sediment and water samples were collected and analyzed for contaminants such as metals, PAHs, PCBs, pesticides, and nutrients. Benthos samples were also collected for identification and enumeration.
- To address the "degradation of phytoplankton and zooplankton" beneficial use impairment in the Thunder Bay AOC, MOE conducted a total phosphorus and chlorophyll study in 2005.
- MOE collected sediment, water, and benthos in Lake George and Little Lake George in 2005. These two lakes are located within the St. Marys River AOC. Sediment and water were analyzed for contaminants such as metals, PAHs, TPHs, oils and greases, and

nutrients. Toxicity tests, using benthic invertebrates, were conducted using the collected sediment.
- MOE, with the assistance of Environment Canada, deployed suspended sediment traps upstream of the Bellevue Marine Park in the St. Marys River AOC in 2005. The purpose of this study was to determine the quality of the sediments depositing over the contaminated area, and to input this information into a sediment management plan.

Mercury at Taconite Processing Facilities

- Preliminary investigations by the Minnesota Department of Natural Resources indicate that the percent of ionic mercury can be increased by adjusting the taconite pelletizing process and that the ionic mercury can then be captured by wet scrubbers and may be diverted from emissions.
- Bench scale tests by industry show potential for mercury removal from effluent by taconite tailings. Levels in the final effluent were less than the Great Lakes Water Quality Initiative standard of 1.3 ng/L.

4.2.3 New Regulations and Policies Aligned with LaMP Goals

In addition to the activities described above, some government regulations and policies have taken place since the LaMP 2004 update that target releases of the nine chemicals slated for zero discharge. Those that are most closely aligned with contaminant sources in the Lake Superior Basin include the following:

Wisconsin Special Designation

- Lake Superior would be better protected from wastewater pollution under the 2005 proposed rule changes. These changes would expand the current state designation of Lake Superior tributaries currently classified as Outstanding Resource Waters, a designation triggering additional levels of protection. In addition, waters within one-quarter mile of the islands of the Apostle Islands National Lakeshore would also be classified as Outstanding Resource Waters. New or increased discharges in the Lake Superior Basin containing zero discharge pollutants would also be required to use best technology.

Figure 5. Boat at Silver Islet Harbor. Photo Credit: Carri Lohse-Hanson, MPCA.

Mercury Permitting Strategy

- In February 2000, the Michigan Department of Environmental Quality (MDEQ) implemented a mercury permitting strategy, including a multiple discharger variance. The strategy addresses implementation of US EPA's analytical Method 1631 in National Pollutant Discharge Elimination System (NPDES) permits issued during Fiscal Years (FYs) 2000 to 2004. The MDEQ has updated its strategy and multiple discharger variance for NPDES permits issued during FYs 2005-2009. The updates to the mercury permitting strategy include lowering the Level Currently Achievable (LCA) from 30 nanograms per liter (ng/L) to 10 ng/L and adding the option for reduced monitoring for facilities that average less than 5 ng/L of mercury in their discharge over a 12-month period. The revised strategy will further the goal of attaining the mercury water quality standard of 1.3 ng/L through the reduced LCA and continued implementation of pollutant minimization plans. In the Michigan portion of the Lake Superior Basin, all facilities are or will shortly be required to meet strict limits using US EPA approved sampling protocols and methods. Currently, one of the wastewater treatment plants and a landfill are required to meet the new LCA of 10 ng/L of mercury. In additional, a MDEQ Mercury Strategy Workgroup was formed in January 2006; this workgroup is developing a DEQ Mercury Strategy for Michigan.
- In Wisconsin, the WDNR initiated a requirement for municipalities that request a variance to the Great Lakes Water Quality Agreement water quality standard of 1.3 ng/L of mercury and discharge more than 1 million gallons per day. As part of the requirement, municipalities must submit a plan for a mercury minimization program. The plan must include implementation of best-management-practices for mercury by medical, dental, and school dischargers to the sanitary sewer system within two years, including the installation of amalgam separators at dental offices.

Amalgam Separation

- Ontario Regulation 196/03 requires dentists that place, repair, or remove mercury amalgams to install mercury separators that capture at least 95 percent of mercury particles and prevent discharge to sewers. It is estimated that the compliance rate for Ontario dentists is 99 percent, and the Royal College of Dental Surgeons of Ontario is following up on the 1 percent of remaining cases.
- The Superior District Dental Society (Marquette, Michigan), working with the Central Lake Superior Watershed Partnership and the Marquette Wastewater Treatment Plant, passed a resolution to voluntarily install mercury amalgam separators. The Dental Society represents 58 dental offices in Marquette and Alger County.
- According to the Minnesota Dental Association, there are currently 1,042 dental offices statewide that have already installed amalgam separators as part of the association's separator initiative. Another 300 offices have pledged to install separators. The participation rate is over 90 percent of all eligible offices.

Pesticides

- In 2005, an agreement was signed between the Ontario Ministry of the Environment and Health Canada Pest Management Regulatory Agency to coordinate surveillance,

outreach, and enforcement activities relating to pesticides. MOE Pesticide Specialists design and deliver programs annually. In 2004, pesticide vendors were visited by MOE staff to determine compliance issues and information needs of the vendors. This continued in 2005, resulting in reminder letters outlining the errors vendors were making in storage and display, as well as sources of information that could be supplied to their clients.

Ontario Hazardous Waste

- In Ontario, the *Land Disposal Restrictions (LDR) Regulation* (Ontario Regulation 461/05) prohibits the land disposal of untreated hazardous wastes, as well as requires that wastes meet specific treatment standards. These treatment standards will significantly reduce the harmful components in the waste, or minimize the ability of the hazardous components to enter the environment once they have been disposed. The new rules will also apply to approximately 85,000 tonnes of hazardous wastes imported from the U.S. and other provinces for land disposal in Ontario.

New Ontario Air Standards

- A new provincial air pollution regulation, Ontario Regulation 419/05: Air Pollution – Local Air Quality, came into effect on November 30, 2005. The regulation includes: setting new and updated air standards for 40 harmful pollutants; updating air dispersion models; and implementing a new approach to set and implement air standards more quickly.

Ontario Source Water Protection

- The *Clean Water Act* was introduced in legislature in December 2005 to address the recommendations from the Walkerton Inquiry which pertain to the protection of drinking water sources. Justice O'Connor's report recommends that "Drinking water sources should be protected by developing watershed-based source protection plans. Source protection plans should be required for all watersheds in Ontario" (D.R. O'Connor 2002). The report also recommends that "The Ministry of the Environment should ensure that draft source protection plans are prepared through an inclusive process of local consultation. Where appropriate, this process should be managed by conservation authorities" (D.R. O'Connor 2002). This is being implemented on Lake Superior by the Lakehead Region Conservation Authority and the Sault Ste Marie Region Conservation Authority.

Canada-Wide Standards

- Ontario will eliminate mercury emissions from its coal-fired electric power generation plants by 2010 as part of a proposed Canada-Wide Standard (CWS) agreement. The CWS will achieve a 52 percent reduction in mercury emissions from this sector by 2010 through the installation of control technology, plant closures, and fuel switching. The CWS sets provincial caps for mercury for existing plants and new plant standards for new

coal-fired plants. The CWS also sets emission limits for new plants, using the best available control technology economically achievable.

- Ontario continues to implement the Canada-wide Standards for mercury and dioxins/furans from municipal waste, sewage sludge, hazardous waste, and medical waste incinerators. In the past year, the ministry included these limits in the Certificates of Approval for sewage sludge incinerators, whose limits came into effect on December 31, 2005.
- The Ontario Ministry of the Environment is in the process of amending the Certificates of Approval for electric arc furnaces to include the dioxin/furan CWS limits which will come into effect on December 31, 2006 (phase 1) and December 31, 2010 (phase 2).

Proposed Revisions to the Canadian *Chlorobiphenyls Regulations* and the *Storage of PCB Material Regulations* under CEPA.

- Proposed changes will include specific deadlines for ending the use of PCBs and destroying PCBs in storage. The proposed revisions will also introduce new labeling requirements and provisions for reporting the destruction of PCBs in storage and reporting the destruction of the remaining PCBs in use. The earliest proposal for action involves the end of use of all PCB equipment containing levels in excess of 500 mg/kg by December 31, 2009.

Canadian-Ontario PCB Storage Phase-Out Initiatives

- Various commitments have been made in the Canada-Ontario Agreement regarding the destruction of PCB material currently in storage. Ontario has set a goal to destroy all PCBs in storage by 2008.
- Canadian Municipalities initiated the Green Municipal Fund to increase environmental quality.
- The Government of Canada has endowed $550 million to the Federation of Canadian Municipalities to establish and manage the Green Municipal Fund. The fund supports funding partnerships of municipalities with the public and private sector to undertake projects which increase air, water, and soil quality and climate protection. Funding by the town of Marathon is being used to study the feasibility of a wind farm to augment energy requirements of the surrounding community (see further details under the Alternative Energy and Energy Issues section above).

Improving the Great Lakes PCB Inventory

- As part of the Binational Toxics Strategy, the US EPA is currently compiling PCB disposal information for 2004 and updating the PCB transformer registrations. Upon completion of the update, the US EPA will re-evaluate data gaps within the inventory. Environment Canada, Ontario Region is currently working to update its inventory by canvassing facilities throughout Ontario, with the ultimate goal of being able to more accurately state the percentage reductions to be achieved by 2006. The GLBTS PCB Workgroup should further examine the overall PCB equipment inventory program and spearhead improvements in the database. This should be completed in order to ensure that adequate PCB capacitor and transformer inventories exist, and that they can be easily

accessed on a lake-by-lake basis. This improved Great Lakes inventory will allow for a better assessment of reductions to meet challenge goals in the Lake Superior Basin.

Ontario Targets 10 percent Renewable Energy by 2010

- The government of Ontario made a commitment to implement a Renewable Energy Policy with the goal to have 5 percent (1,350 megawatts) of all generating capacity to come from renewable energy sources by 2007 and 10 percent (2,700 megawatts) renewable energy by 2010. Renewable Energy projects planned for the Lake Superior Basin include a partnership of private investors and Pic River First Nation of White River to build the 23 megawatt Umbata Falls Hydroelectric project and the 99 megawatt Prince Wind Farm to be located in Prince Township, near Sault Ste Marie, Ontario. Further information is available at http://www.energy.gov.on.ca/index.cfm?fuseaction=english.renewable.

Ontario Targets Renewable Energy and Reductions to Greenhouse Gases

- Ontario Regulation 232/98 (*Landfilling Sites*) under CEPA requires the collection of landfill gas for new or expanding landfill sites larger than three million cubic metres or 2.5 million tonnes. The Thunder Bay landfill is licensed eight million cubic metres, and the facility is currently burning off methane gas and obtaining credits. The facility is also moving toward power production.

Minnesota Statewide Mercury Total Maximum Daily Load (TMDL)

- The MPCA is in the process of developing a statewide mercury TMDL. The TMDL focuses on deposition as the major source of mercury to Minnesota waters. The TMDL uses the more sensitive waters in northeastern Minnesota to drive emission reductions from sources in the state.

US EPA Regulations to Reduce Mercury Emissions from Coal-Fired Power Plant Emissions

- In 2005, US EPA issued the first-ever federal rule to permanently cap and reduce mercury emissions from coal-fired power plants. This rule makes the U.S. the first country in the world to regulate mercury emissions from coal-fired power plants. The Clean Air Mercury Rule will build on US EPA's Clean Air Interstate Rule to significantly reduce emissions from coal-fired power plants—the largest remaining sources of mercury emissions in the country. When fully implemented, these rules will reduce utility emissions of mercury from 48 tons a year to 15 tons, a reduction of nearly 70 percent.
- Although Wisconsin passed state regulations in 2004 to reduce mercury emissions from utilities by 75 percent by 2015, these regulations were superseded by the 2005 federal rule.

Tribal Activities

Figure 6. Grand Portage, Minnesota. Photo Credit: John Marsden, Environment Canada.

- Bad River has submitted a "final" draft to US EPA Region 5, requesting treatment in a manner as a state (TAS), under the *Clean Water Act*.
- Grand Portage completed the process of writing an Nonpoint Source Assessment Report (August 2004) and a Nonpoint Source Management Program (December 2004), and obtaining Treatment as a State (TAS) status from US EPA (January 2005).
- Grand Portage water quality standards were approved by US EPA on November 30, 2005. These standards are the same as or more restrictive than the State of Minnesota's standards.
- Bad River obtained Treatment as a State (TAS) designation under the Clean Air Act in February 2005 allowing the Tribe to comment on air pollution permits issued within 50 miles of the Reservation.

Great Lakes Regional Collaboration

- The Great Lakes Regional Collaboration effort resulted in a strategy adopted in December 2005. The strategy includes a series of recommendations, including the following related to toxic substances: 1) reduce and virtually eliminate sources of current priority pollutants, 2) prevent new chemical threats from entering the basin, 3) develop a sufficient knowledge base to address toxic chemicals in the Great Lakes environment, 4) protect public health and engage the public to do its part in reducing persistent toxic substance sources, and 5) address international sources.

4.3 CHALLENGES

4.3.1 Overall Challenges

More specific information on challenges will be contained in the milestones report that is currently under development. Generally the challenges can be summarized as follows:

- Inventories must be up-to-date and as accurate as possible. The PCB inventory has been a challenge as there is no comprehensive and up-to-date inventory.

- Outreach and coordination internally and externally are essential and must be strengthened.
- More easily achieved reductions have been accomplished, and the remaining sources will be more difficult to reduce.
- Out-of-basin sources continue to be a major source of deposition to the Lake Superior watershed.
- The topic of emerging chemicals must be addressed. As stated in the Emerging Contaminants section of this report: "Research that leads to development of criteria values for various relevant toxicological endpoints is sorely needed to judge the importance and potential impacts of the contaminant levels detected in the Lake Superior ecosystem."

4.3.2 Emerging Contaminants

The continuing discovery of chemicals used in industrial, agricultural, and personal applications in air, water, sediment, and biota has brought forth a formidable challenge for environmental scientists, managers, and policy makers. The universe of new chemicals being discovered in the environment is often lumped into a collective group referred to as "emerging contaminants". While it has been known for over 20 years that compounds such as pharmaceuticals enter the environment, improvements in instrumentation and analytical methodology for detecting chemical substances in environmental media have brought increased awareness and concern over the presence and potential risk that these chemicals may pose to the health of humans and other organisms in the environment (Daughton 2001).

What are emerging contaminants?

There are approximately 75,000 chemicals currently registered under the *Toxic Substances Control Act* (TSCA) inventory in the U.S. (US EPA 2005). Very few have regulations governing their release to the environment, and very few are the focus of contaminant monitoring programs (Daughton 2001). The term "emerging contaminants" has come to define an emerging awareness of the presence in the environment of many chemicals used in commerce, along with concern over the risk that these chemicals may pose to human and wildlife health.

Emerging contaminants are often grouped according to their typical anthropogenic uses. Examples of these groups include: flame retardants, fluorinated surfactants, personal care products, pharmaceuticals, detergents, plasticizers, antimicrobial agents, current-use pesticides, and others. Many of these compounds are released to the environment from municipal, industrial, and agricultural sources and source pathways (Daughton 2001). Table 4-3 provides an example list of some emerging contaminant groups, some of the chemicals that fall into those groups, and their general uses. These groups contain chemicals that may differ greatly in their chemical properties and level of understanding with regard to environmental fate and toxicology. Much research is being devoted to developing analytical methods for emerging contaminants, understanding their fate and transport properties in the environment, and determining what ecological and human health effects they may be causing.

Table 4-3. Examples of some common classes of emerging contaminants, some specific chemicals of interest in those groups, and some of their common uses.

Chemical Group	Examples of Chemical Uses
Flame Retardants • Polybrominated diphenyl ethers (PBDEs) • Polybrominated biphenyls (PBBs) • Tetrabromobisphenol A (TBBPA)	Retard flammability of plastics, foams, polymers, wiring insulation
Fluorinated Surfactants • Perfluorooctane sulfonate (PFOS) • Perfluorooctanoic acid (PFOA)	Fire fighting foams, water, oil, soil and grease repellents on surfaces such as carpets, fabrics, and upholstery
Personal Care Products • Triclosan • Benzalkonium chloride (BAC) • Synthetic musk fragrances	Anti-microbial soaps, perfumes, disinfectants, shampoos, etc.
Pharmaceuticals • Steroids • Hormones – estrogens and androgens • Caffeine • Cotinine	Over the counter, prescription, veterinary drugs
Detergents • Alkylphenol ethoxylates (APEs)	Industrial and institutional cleaning, metal finishing, textiles
Plasticizers • Phthalates	Added to plastic formulations to change rigidity
Current-use Pesticides • N,N-diethyltoluamide (DEET) • Dachtal • Chlorothalonil • Pyrethroid pesticides	Insect repellants, fungicides, insecticides, herbicides
Short Chain Chlorinated Paraffins (SCCP)	Mainly used in extreme pressure lubricants in the metal processing industry

What do we know?

Sources

Emerging contaminants are often found to be present in the environment in areas close to municipal sewage treatment facilities. Compounds such as pharmaceuticals and personal care products are rinsed down the drain, carried in runoff, or excreted as waste and end up at sewage treatment facilities. These compounds vary widely in their chemical properties, which affects how readily they are removed or broken down by current sewage treatment techniques. Depending on the chemical, current treatment can remove close to 100 percent of some of these chemicals, while others may only be reduced by less than 10 percent (Mills et al. 2005, Daughton 2001). Removal efficiency will also vary depending on the variety of compounds present and their concentrations in the input wastewater. Regardless of these removals as a co-benefit of current municipal sewage treatment, these facilities are not designed to specifically remove these compounds, and many are released to the environment. Concentrations in natural

surface waters (including oceans) generally range from ppb (µg/L) to ppt (ng/L) (Daughton 2001).

Once into the environment, the fate of these chemicals released from municipal sewage treatment varies widely depending on the chemical structure of the compounds. Thus, the relative ability of a compound to elicit a biological response or cause environmental stress will be related to how biologically active it is, its concentration, its persistence, and how it behaves in a mixture of other similar compounds. For instance, compounds that have an estrogenic mode of action are often expressed in estrogen equivalent concentrations that relate the relative estrogenicity of each compound to the most potent estrogen, 17β-estradiol (Legler 2001). Whole effluent toxicity (WET) and toxicity identification and evaluation (TIE) are two methods that have been developed for evaluating chemical mixtures present in various effluents for their potential toxicity (US EPA 1991a, b and c, US EPA 2000). WET approaches are commonly used to identify the total toxicity of an effluent while TIE approaches are aimed at identifying the individual chemical component/s that cause toxicity within an effluent (St J. Warne, 2003).

While municipal sewage treatment facilities are a major source for many types of emerging contaminants, many other sources exist. For instance, many compounds used as flame retardants and coatings to repel water, oil, and grease are used ubiquitously. While small releases can occur from industrial manufacturing facilities, most releases occur as volatilization from products the compounds are used in. Other sources of emerging contaminants include veterinary use of antibiotics and hormones in pets, runoff from agricultural activities such as pesticide application, and hormones and antibiotics used in cattle and other animal production.

Chemicals such as polybrominated diphenyl ethers (PBDEs) and perfluorooctane sulfonate (PFOS) were manufactured to resist breakdown, which makes them effective for their designed uses, but also means that they will resist breakdown in the environment. These properties have led to their global distribution through many of the same pathways that have led to global distribution of PCBs and many organochlorine pesticides. PBDEs and PFOS have been shown to bioaccumulate and are toxic to some organisms in laboratory studies (Haglund et al. 1997, McDonald 2002, Boudreau et al. 2003), but their true significance as environmental pollutants is still unclear.

Research

To date, much of the work on emerging contaminants has focused on monitoring for their presence in the environment and developing methods to evaluate their potential toxicity to various organisms. The universe of chemicals used by society includes thousands of compounds that have not been analyzed for, much less have any information on environmental fate and transport, toxicity, and persistence. Many questions remain about whether emerging contaminants are truly an environmental concern and how they should be managed.

The properties of many emerging contaminants and the uses they are designed for in society are the same properties that have led to concern when they are found in the environment. Many of these compounds are designed to be biologically active, and the compounds themselves, their breakdown products, or the presence of the compounds in a mixture may cause unintended responses by organisms living in the environment. The theory of endocrine disruption describes

how certain chemicals can behave in a similar manner to natural biological hormones, and when those chemicals are present at high enough concentrations in the environment, they can trigger unintended responses by the endocrine system. Examples of these types of responses that have been observed in organisms, particularly below municipal sewage treatment outflows, include reduced reproductive ability, abnormally elevated levels of certain proteins in male fish that are normally found only in females (i.e., vitellogenin), and intersex gonads, such as where female ovary tissue can be found distributed throughout the male testes (Giulio et al. 2004, US EPA 1997, Jobling et al. 2003).

Improving techniques in molecular biology allow researchers to measure responses to chemicals at the sub-cellular level. These techniques provide the possibility of being able to detect environmental stress at extremely low levels of biological organization. One of the big questions that remains unanswered is whether effects that are measured at the sub-cellular level have any relevance at higher levels of biological organization, such as at the population level. This missing link is critical to determining whether many of these compounds, that may cause observable effects to organisms near a point source, are actually causing harm on a greater scale.

Another concern is that these chemicals are not present individually in the environment. Chemicals in a mixture can interact in an additive, synergistic, or antagonistic manner. These types of effects are difficult to measure. While approaches such as WET and TIE offer some answers, prioritization of which anthropogenic chemicals currently in use are of the greatest concern is a growing challenge. These chemicals should be monitored and/or regulated to determine if their presence is a risk to the health of humans and other organisms in the environment. A further discussion on the questions and research gaps surrounding some emerging contaminants can be found on the US EPA's website at http://www.epa.gov/nerlesd1/chemistry/pharma/needs.htm.

Emerging contaminants in Lake Superior

Emerging contaminants have been detected in the Lake Superior ecosystem. Most studies to date have focused on brominated flame retardants (PBDEs and polybrominated biphenyls [PBBs]) as well as perfluorinated chemicals (PFOS and perfluorooctanoic acid [PFOA]). The following is an overview of some of these studies.

PBDEs have been detected in air at the Lake Superior Integrated Atmospheric Deposition Network (IADN) station at Eagle Harbor, MI (Strandberg et al. 2001). Concentrations of PBDEs were similar in air above all the Great Lakes and showed a strong urban signal from Chicago. Similar spatial results have also been found for PCBs.

Two classes of brominated flame retardants (total PBDEs and total PBBs) were measured in composites of six-year-old lake trout captured in 1997 from all the Great Lakes except Lake Michigan (Lake Michigan samples were not measured) (Luross et al. 2002). Lake Superior lake trout had the second highest PBDE concentrations (mean of 56 ppb) and the lowest PBB concentrations (mean of 0.25 ppb).

Archived lake trout tissue collected between 1980 and 2000 was analyzed for PBDEs and one PBB (#153) (Zhu and Hites 2004). Concentrations of PBB-153, a component of a flame

retardant banned in the 1970s, did not show a significant decreasing trend as many other banned chemicals (i.e., PCBs, DDT) have. PBDEs increased exponentially with a doubling time of every 3-4 years. Similar results were also found in lake trout and/or walleye from the other Great Lakes.

Total PBDEs were detected at a mean concentration of 7.9 ppb in bald eagle nestling blood plasma samples collected from the Wisconsin shores of Lake Superior in 2000-2001 (Dykstra et al. 2005). This compared to a mean total PCB concentration of 51.5 ppb and a mean DDE concentration of 13.4 ppb also in samples from 2000-2001 (Dykstra et al. 2005).

Sediment cores from six off-shore locations in Lake Superior were analyzed for ten PBDE congeners (Song et al. 2004). In general, and in contrast to concentrations of PCBs in the same samples, PBDE concentrations were increasing significantly in recent years. The authors estimated an annual PBDE loading rate for Lake Superior at 80-160 kg/year.

Perfluorinated chemicals have been reported for surface waters and in lake trout from Lake Superior (Furdui et al., 2006a; Furdui et al., 2006b). Mean PFOS and PFOA concentrations of less than 1 ng/L were lowest in Lake Superior compared to Lakes Ontario, Erie, and Huron (Furdui et al., 2006a). In lake trout, the mean PFOS concentration was 5 ng/g and again was lowest for lake trout from the five Great Lakes. Similarly, total perfluoroalkyl contaminants (sum of perfluorosulfonates and perfluorocarboxylic acids) were lowest in Lake Superior lake trout (mean 13 ng/g) (Furdui et al., 2006b).

Emerging contaminants and yardsticks of environmental quality and LaMP pollutant management categories

Although emerging contaminants have been detected in Lake Superior, it is difficult to assess their ecological impacts without criteria to indicate levels that cause harm. Research that leads to the development of criteria values for various relevant toxicological endpoints is sorely needed to judge the importance and potential impacts of contaminant levels detected in the Lake Superior ecosystem.

The Lake Superior LaMP has used the term “yardsticks” to summarize the concept of a standard, criteria, or guidance value with respect to water quality, sediment quality, or biota tissue concentrations. The LaMP “Lake Superior yardstick” for a contaminant is the most stringent standard, criteria, or guidance value for a medium from any of the jurisdictions around Lake Superior. The presence of pollutants at levels exceeding the Lake Superior yardstick was a factor used to identify critical chemicals for the LaMP.

The LaMP has two major management categories for pollutants: critical and prevention (Table 2-1 Lake Superior LaMP Stage 2, 1999). Lake Superior critical pollutants include those targeted in the Lake Superior Zero Discharge Demonstration Program as well as lakewide and local remediation pollutants. In general, the list of prevention pollutants for the Lake Superior LaMP was derived from lists of bioaccumulative toxic pollutants addressed through U.S. and Canadian environmental initiatives in the mid 1990s (the US EPA Great Lakes Water Quality Guidance, 1995, and the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem, 1994). Pollutants in the prevention category 1) do not exceed Lake Superior yardstick values in the

environment or 2) appear on the above-mentioned lists as bioaccumulative contaminants of concern, but have not been monitored in the Lake Superior environment.

The Lake Superior LaMP Stage 2 (1999) Appendix B describes the chemical pollutant management goal flow chart. Emerging contaminants do not fit easily into an established management category for Lake Superior because of the lack of yardstick values to judge potential impacts. In addition, there is no universe of accepted emerging concern contaminants as a starting point (such as provided by the GLI-COA lists for bioaccumulative pollutants in the 1990s). However, emerging contaminants fit into the overall management approach for Lake Superior prevention pollutants, which is to prevent the pollutants from becoming problems in Lake Superior in the future.

Emerging contaminants and the Lake Superior Binational Program

The Lake Superior Binational Program has recognized the importance of emerging contaminants to the future of management decisions in Lake Superior and to the overall health of the Lake Superior ecosystem. The milestones report that will be released later this year will include a list of strategies that lay a foundation for addressing issues related to emerging contaminants. Generally, the strategies will address the need for prevention, education, opportunities for pollution prevention, monitoring, and development of environmental quality yardsticks.

Monitoring efforts by the US EPA, Environment Canada, and Ontario Ministry of the Environment on Lake Superior in 2005 and 2006 will provide information on some emerging contaminants in air, precipitation, water, sediment, fish, and zooplankton.

4.4 NEXT STEPS

The LaMP Chemical Committee is preparing a milestones report for public comment. As noted previously, this report will assess progress towards the 2005 milestones from LaMP Stage 2 and the strategies for making progress towards the 2010 milestones. The draft should be available in Summer 2006 for public comment.

In addition, the Chemical Committee is preparing a chemical integrity report that will be presented at SOLEC 2006 in November 2006. This report will include more detailed information on the concentrations of chemicals in the Lake Superior ecosystem and management recommendations.

4.5 REFERENCES

Boudreau, T.M., P.K. Sibley, S.A. Mabury, D.C.G. Muir, K.R. Solomon. 2003. Toxicity of perfluorinated organic acids to selected freshwater organisms under laboratory and field conditions. MS thesis. University of Guelph, Guelph, ON, Canada.

Daughton, C.G. "Pharmaceuticals in the Environment: Overarching Issues and Overview," in Pharmaceuticals and Personal Care Products in the Environment: Scientific and Regulatory Issues, Daughton, C.G. and Jones-Lepp, T. (eds.), *Symposium Series 791*; American Chemical Society: Washington, D.C., 2001, pp. 2-38.

Dove, A., Environment Canada Surveillance Program. 2006. Personal communication, data from Lake Superior 2003 spring surveillance cruise, Ecosystem Health Division, Environment Canada, Burlington, Ontario.

Dykstra C.R., M.W. Meyer, P.W. Rasmussen, and D.K. Warnke. 2005. Contaminant Concentrations and Reproductive Rate of Lake Superior Bald Eagles, 1989–2001. *Journal of Great Lakes Research*. 31:227-235.

Furdui, V.I., Crozier, P.W., Reiner, E.J., Mabury, S.A. 2006a. Optimized trace level analysis of perfluorinated acids in the Great Lakes watershed. *Environ. Sci. Technol*., submitted.

Furdui, V.I., Stock, N., Whittle, D.M., Crozier, P.W., Reiner, E.J., Muir, D.C.G., Mabury, S.A. 2006b. Perfluoroalkyl contaminants in lake trout from the Great Lakes. Presented at the 41st Central Canadian Symposium on Water Quality Research, February 13 &14, 2006, in Burlington, Ontario, Canada.

Haglund P., Zook D.R., Buser H.R., Hu J. 1997. Identification and Quantification of Polybrominated Diphenyl Ethers and Methoxy-Polybrominated Diphenyl Ethers in Baltic Biota. *Environmental Science and Technology*. 31:3281-3287.

Jantunen, L.M., Helm, P.A., Ridal, J.J., Bidleman, T.F., *In Press*. Air-water gas exchange of organochlorine pesticides in the Great Lakes, including some chiral compounds. *Environmental Pollution*

Jobling, S., D. Casey, T. Rodgers-Gray, J. Oehlmann, U. Schulte-Oehlmann, S. Pawlowski, T. Baunbeck, A.P. Turner, C.R. Tyler. 2003. Comparative responses of mollusks and fish to environmental estrogens and an estrogenic effluent. *Aquatic Toxicology*. 65:205-220.

Legler, J. 2001. Development and application of in vitro and in vivo reporter gene assays for the assessment of (xeno-)estrogenic compounds in the aquatic environment. PhD thesis. Wageningen University, Utrecht, The Netherlands.

Luross, J.M., M. Alaee, D.B. Sergeant, C.M. Cannon, D.M. Whittle, K.R. Solomon, and D.C.G. Muir. 2002. Spatial distribution of polybrominated diphenyl ethers and polybrominated biphenyls in lake trout from the Laurentian Great Lakes. *Chemosphere*. 46:665-672.

McDonald, T.A. 2002. A perspective on the potential health risks of PBDEs. *Chemosphere*. 46(5):745-755.

Mills, M.A., G.D. Sayles, P. McCauley, R, Brenner, E.J. Kleiner. 2005. Wastewater treatment and its management of endocrine disrupting chemicals. Poster given at: United States Environmental Protection Agency Science Forum. Washington, D.C., May 16-18.

Muir, D.C.G., D.M. Whittle, D.S. De Vault, C.R. Bronte, H. Karlsson, S. Backus, and C. Teixeira. 2004. Bioaccumulation of Toxaphene Congeners in the Lake Superior Food Web. J. Great Lakes Res. 30:316-340.

Song, W., J.C. Ford, A. Li, W.J. Mills, D. Buckley, and K.J. Rockne. 2004. Polybrominated Diphenyl Ethers in the Sediments of the Great Lakes. 1. Lake Superior. *Environmental Science and Technology*. 38:3286-3293.

St J. Warne, M. 2003. A Review of the ecotoxicity of mixtures, approaches to, and recommendations for, their management. In *Proceedings of the Fifth National Workshop on the Assessment of Site Contamination*. National Environment Protection Council Service Corporation. Langley A, Gilbey M and Kennedy B (Eds). pp. 253-276.

US EPA (United States Environment Protection Agency). 1991a. *Technical support document for water quality-based toxics control.* Office of Water Enforcements and Permits, Washington, DC. EPA/505/2-90-001.

US EPA (United States Environment Protection Agency). 1991b. *Methods for toxicity identification evaluations.* TJ Norberg-King, DA Mount, EJ Durham, GT Ankley, LP Burkhard, JR Amaato, JT Lukasewycz, MK Schubauer-Berigan, L Anderson-Carnahan (Eds), EPA-600/6-91/003.

US EPA (United States Environment Protection Agency). 1991c. *Toxicity identification evaluation: Characterisation of chronically toxic effluents. Phase I.* EPA-600/6-91/005.

US EPA (United States Environment Protection Agency). 1997. Special report on environmental endocrine disruption: An effects assessment and analysis. EPA/630/R-96/012. Risk Assessment Forum, Washington D.C.

US EPA (United States Environment Protection Agency). 2000. Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing (40 CFR Part 136). EPA/821/B-00/004.

US EPA (United States Environment Protection Agency). 2005. http://www.epa.gov/region5/defs/html/tsca.htm

Warren, G., US EPA, Great Lakes National Program Office, personal communication. 1996 data.

Williams, D.J., K.W. Kuntz and V. Richardson. 2004. Lake Superior Surveillance Program: Spatial Distributions and Temporal Trends of Selected Parameters, with emphasis on 2001 Data. Environment Canada Report #EHD/ECB-OR/04-02/I. 50pp.

Williams, D.J. and K.W. Kuntz. 1999. Lake Superior Surveillance Program: Spatial Distributions and Temporal Trends of Selected Parameters, with emphasis on 1996-1997 Data. Environment Canada Report #EHD/ECB-OR/99-01/I. 44pp.

Zhu, L.Y. and R.A. Hites. 2004. Temporal Trends and Spatial Distributions of Brominated Flame Retardants in Archived Fishes from the Great Lakes. *Environmental Science and Technology*. 38:2779-2784.

ADDENDUM 4-A:
LAKE SUPERIOR BINATIONAL FORUM CHEMICAL COMMITTEE ACTIVITIES REPORT FOR 2004-2006

In February 2004, the Lake Superior Binational Forum sent letters to local and regional schools, colleges, and universities regarding mercury reduction. The Forum requested input on how these institutions handle mercury usage and disposal and what challenges they face with respect to mercury use and disposal.

Committee members worked with Lake Superior Work Group (SWG) members to help with a proposal to ban mercury thermometers in small communities, e.g. Manitouwadge, Ontario.

The Committee provided input to the SWG on their inventory of critical pollutant emission sources – including identifying additional significant source categories, ways to measure these sources, and identifying any missing sources of significance.

The Committee provided input to the SWG on their chemical strategies list including reviewing each strategy as to validity and currency, identifying gaps and identifying which activities were relevant to meeting the next milestones.

Committee members helped organize and plan a joint industry/Forum/SWG/Task Force meeting in September 2004 in Duluth to discuss issues and challenges faced by these groups toward achieving the goal of zero discharge.

The Committee sent comments to the Ontario Ministry of the Environment regarding the White Paper on Watershed-based Source Protection Planning and the Draft Ontario Source Protection Act.

A subcommittee of the Forum Chemical Committee was formed to work with a contractor on the mercury reduction project for the Lake Superior Basin to assist with peer-to-peer mentoring, industry visits, and moving the project forward.

The Committee is currently looking at developing a process for adding emerging chemicals of concern to the current list of critical pollutants.