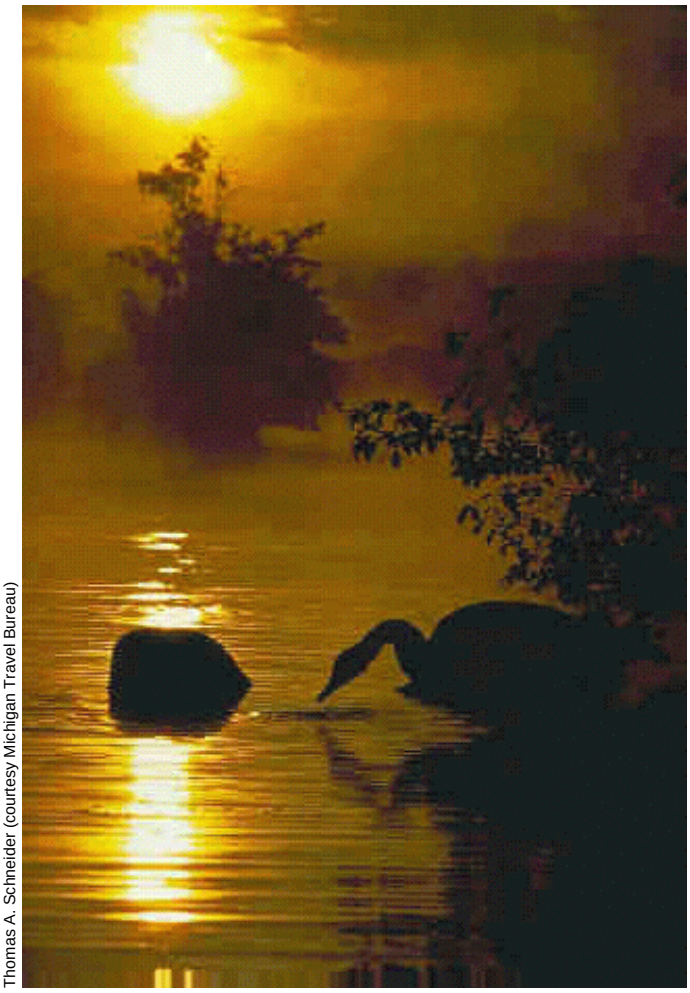
CHAPTER V
NEXT STEPS FOR THE GREAT WATERS PROGRAM



Thomas A. Schneider (courtesy Michigan Travel Bureau)

This report describes significant new scientific and programmatic developments relevant to the Great Waters program since the *Second Report to Congress* (June 1997). These developments support and build on the three broad conclusions presented in the *First* and *Second Reports to Congress*:

- Atmospheric deposition can be a significant contributor of toxic chemicals and nitrogen compounds to the Great Waters. The relative importance of atmospheric loading for a particular chemical in a given waterbody depends on many factors, including characteristics of the waterbody, properties of the chemical, and the kind and amount of atmospheric or water discharges.

- A plausible link exists between emissions into the air of Great Waters toxic pollutants of concern, the atmospheric deposition of these pollutants (and their transformation products), and the concentrations of these pollutants found in water, sediments and biota, especially fish and shellfish. For mercury, fate and transport modeling and exposure assessments predict that the anthropogenic contribution to the total amount of methylmercury in fish is, in part, the result of anthropogenic mercury releases from industrial and combustion sources increasing mercury body burdens (i.e., concentrations) in fish. Furthermore, the consumption of fish is the dominant pathway of exposure to methylmercury for fish-consuming humans and wildlife. However, what is known about each stage of this process varies with each pollutant (for instance, the chemical species of the emissions and its transformation in the atmosphere).

- Airborne emissions from local as well as distant sources, both within and outside the U.S., contribute pollutant loadings to waters through atmospheric deposition. Determining the relative roles of particular sources contributing to specific waterbodies is complex, requiring careful monitoring, atmospheric modeling, and other analytical techniques.

As Chapter II showed, there has been significant progress in environmental research since the *Second Report to Congress*, particularly in monitoring and modeling pollutant transport and loadings at the regional and national scale. As a result, spatial and temporal trends in pollutant emissions, loadings, and effects are becoming clearer as the identified research gaps are being addressed.

Strategic Themes of EPA's Great Waters Program

(1) The EPA will continue ongoing efforts to implement section 112 and other sections of the CAA and use results from this report in the development of policy that will reduce emissions of the Great Waters pollutants of concern.

(2) The EPA recognizes the need for an integrated multimedia approach to the problem of atmospheric deposition of pollutants to waterbodies and will continue to pursue implementation of programs available under various Federal laws to reduce the human and environmental exposure to pollutants of concern.

(3) The EPA is committed to supporting research activities that address the goals of section 112(m) of the CAA.

Chapter III described more than 60 relevant programs and activities, ranging in scale from local to international, many of which directly or indirectly contribute to reducing loadings and exposures for many of the pollutants of concern. Collectively, these programs and activities show a high level of interagency, intergovernmental, and public-private cooperation. In addition, those programs led or supported by EPA have advanced the strategic themes and recommended actions developed in the *First* and *Second Reports to Congress* (see text box), including pursuing integrated multimedia approaches to environmental protection. These programs have also furthered the Agency's *Clean Air, Clean Water, International, Pollution Prevention,* and *Sound Science* goals under the Government Performance and Results Act.

Chapter IV summarized notable developments in science and tools since the *Second Report to Congress*. Because of the large scale and technical complexities of the problems, considerable time, effort, and resources have been expended to develop tools to understand and resolve them. In part because of the efforts of the Great Waters program, there is now a greater level of coordination among research agencies and institutions to target areas of critical uncertainty and suspected threats to human health and the environment. Some of the recently-developed tools and research programs will generate important new data and findings that will be available for future *Great Waters Reports to Congress* and will enable EPA to make further progress in reducing the harmful effects of atmospheric deposition to the Great Waters.

Like the *Second Report to Congress*, the key conclusions of this report and recommendations for continued or further action are organized by the subject areas EPA is required to assess under the Great Waters provisions of the CAA, namely the sources and loadings of the pollutants of concern to the Great Waters, and their environmental and public health effects. In addition, this chapter addresses the description of any revisions to CAA and other Federal requirements, standards, and limitations, (if such revisions are necessary), as well as whether the pollutants of concern have caused any exceedances of water quality or drinking water standards.

In general, deposition rates of the air pollutants of concern to the Great Waters are decreasing or remaining steady. Also, while we observe a trend toward reduced concentrations of these pollutants in water and other media for many atmospherically deposited pollutants of concern, this is not the case for all of them. Potential human health risks are greatest for those individuals who consume fish from contaminated waterbodies. Some pollutants continue to contribute to significant and widespread ecological problems in the Great Waters.

Substantial uncertainties remain about the extent, sources, fate and effects of atmospheric deposition. This report supports continued research targeted toward addressing remaining uncertainties and providing decisionmakers with the tools and information they need to assess potential risks and determine whether further action is necessary to reduce them. The Agency believes that considerable continued effort is justified to address critical remaining uncertainties, improve the characterization of the contribution of atmospherically deposited pollution to the Great Waters, and to further reduce this pollution.

V.A POLLUTANT SOURCES

In the past 2 years, new models and model enhancements, tools, and emissions inventories, including long range transport atmospheric modeling (e.g., RELMAP), source "fingerprinting," back trajectory analysis, EPA's National Toxics Inventory, and the Great Lakes Regional Air Toxics Emission Inventory, have provided new information to help identify sources of pollutants which are deposited to waterbodies. Emissions of some Great Waters pollutants of concern have decreased, while others remained constant or varied. Additional emission reductions are expected to result from continued implementation of current regulations and nonregulatory programs, as well as development of future regulations, pollution prevention initiatives, and voluntary actions.

FINDINGS AND CONCLUSIONS

- **Emissions and numbers of U.S. anthropogenic sources have declined for mercury, lead, dioxins and furans, and the banned and restricted use substances.** For example, lead emissions in the Great Lakes region declined at a rate of 6.4 percent per year from 1982 to 1993 reflecting the national decline in lead emissions resulting from the phase-out of leaded gasoline in automobiles.

- **Emissions from U.S. anthropogenic sources for NO_x have remained relatively constant. For cadmium, emissions in the Great Lakes region have not shown a trend since the 1980s. Trends for POM/PAHs are not known.** For example, nationwide NO_x emissions have fluctuated around 21 to 23 million metric tons per year from 1988 to 1997.

- **The sources of atmospheric deposition vary, depending on the pollutant.** As an example, sources of atmospherically-deposited mercury include emissions from industrial and combustion sources, emissions from natural sources such as volcanoes, and re-emission from mercury-contaminated soils and water. These sources can be in the U.S. or other countries, and the mercury emissions can be deposited near the source or transported long distances across international borders. Some point sources emit significant amounts of reactive chemical forms of mercury which are deposited locally, near the source of emissions. Determining a more complete picture of atmospheric deposition to the Great Waters requires ascertaining the contributions of each of the relevant sources.

- **Local sources, including urban areas, can have a large impact on local pollutant deposition rates.** Recent research under the AEOLOS[1] project continues to show that the diffuse emissions of urban areas (i.e., urban plumes) can significantly affect nearby deposition rates. For example, deposition rates of PCBs and polycyclic aromatic hydrocarbons (PAHs) have been found to be elevated over southern Lake Michigan near the Chicago urban area. Therefore, estimates of pollutant loadings and net flux at the waterbody-scale (e.g., for Lake Michigan) may be sensitive to the placement of monitoring sites.

- **Loadings of banned pesticides to the Great Waters are primarily from sources that are difficult or may not be practical for EPA, States, or tribes in the U.S. to further regulate.** Although there are no major sources of banned pesticides in the U.S., loadings continue from remaining consumer stocks, evaporation from soils, resuspension of contaminated sediments, and

[1] Atmospheric Exchange Over Lakes and Oceans Surfaces (see page IV-13)

airborne transport from other countries. Future reductions must come from clean up of existing stockpiles and contaminated sites and reductions in airborne pollutants transported from other countries. Research continues at EPA and other institutions on soil remediation methods that will reduce emissions of these pollutants from contaminated sites.

- **Implementation of existing EPA regulations is expected to further reduce emissions of mercury, NO_x, POMs, dioxins and furans, cadmium, lead, and hexachlorobenzene, and contribute to declines in deposition of these pollutants.** The EPA regulations issued over the last few years will significantly reduce known sources of these Great Waters pollutants of concern. For instance, the emission standards and guidelines for municipal waste combustors and for hazardous/medical/infectious waste incinerators will reduce mercury and dioxin emissions from these sources by greater than 90 percent from 1990 when fully implemented in 2000 and 2002, respectively. Emission standards for hazardous waste-fired combustors were issued in 1999 and are expected to be implemented in 2002. This rule will reduce dioxins and furans by 70 percent, as well as other pollutants such as mercury. In addition EPA's NO_x SIP call, when implemented, is expected to reduce NO_x emissions by about one million metric tons during the summer ozone season, contributing to a projected decline in NO_x emissions through 2005.

- **Developments in pollution models and source information are improving our ability to identify and quantify sources and deposition of pollutants.** In recent years, EPA and NOAA have continued to develop and refine models and source information in order to improve emissions estimates and understanding of the relative importance of various sources to atmospheric deposition. For example, the long range atmospheric transport model RELMAP[2] was used to estimate domestic and global mercury deposition and RADM[3] was used to estimate coastal NO_x deposition. However, there is still a critical need for key inventory information on the pollutants of concern (e.g., ammonia, speciated data for metals, more accurate data for pollutants emitted in small quantities, locational data for area and mobile sources) in order to generate more effective model estimates that can be used in control strategy decisions.

RECOMMENDATIONS FOR CONTINUED AND FURTHER ACTION

- *Within any limitations imposed by court rulings, EPA will ensure the timely implementation of NO_x control strategies already put in place, such as the NO_x SIP call and emission standards and guidelines for municipal waste combustors, as well as the Tier 1I tailpipe standards, which are expected to significantly reduce on-road mobile source NO_x emissions throughout the year. The EPA will proceed with full implementation of the section 126 rule to achieve the required NO_x reductions by May 1, 2003. Finally, EPA will encourage innovative, nonregulatory approaches to reducing NO_x emissions such as "Smart Growth" planning in urban areas and energy conservation programs.*

- *The EPA will continue to develop and implement technology-based standards and guidelines under sections 111, 112, and 129 of the CAA that will achieve further reductions of Great Waters pollutants of concern. For instance, EPA expects to complete MACT standards mandated by section 112 for source categories which emit pollutants of concern (e.g., chlorine manufacturing*

[2] Regional Langragian Model of Air Pollution

[3] Regional Acid Deposition Model

[chlor-alkali plants], coke ovens [pushing, quenching and battery stacks], industrial boilers, institutional and commercial boilers, iron and steel foundries, and refractory manufacturing) by 2002. Also, EPA expects to complete regulations under section 111 and 129 for commercial and industrial waste incinerators by November 15, 2000, and for small municipal waste combustors by 2001. In addition, EPA expects to finalize the list of area source categories by 2003 and expects to complete regulations by 2004 for the area source categories published in the integrated urban air toxics strategy on July 19, 1999.

- *The EPA expects to complete collection and analysis of information on mercury emissions and controls for coal-fired utility boilers and issue the regulatory determination for air toxics from electric utilities by December 15, 2000.*

- *Under the residual risk program, EPA will assess risks associated with exposures from emissions of Great Waters toxic pollutants of concern, using risk, exposure, and other relevant public health and environmental information developed by EPA offices and its partners. These assessments will focus on the risk remaining from categories of air toxics sources (or individual sources within the categories) for which MACT standards have been applied, and include assessing the public health risk from eating fish contaminated by these sources and risks to ecosystems. Where analyses indicate unacceptable adverse effects to public health or the environment from these sources of pollutants, EPA will pursue appropriate actions to reduce risks.*

- *The EPA will continue to explore ways to integrate the authorities within single media statutes and their programs (i.e., CAA, Clean Water Act) in order to support multimedia strategies to reduce pollutants of concern to the Great Waters. This includes building on recent progress to increase communication and program coordination between EPA's Air and Water programs (e.g., pulp and paper "cluster" rule). For example, EPA's Office of Water and Office of Air and Radiation (OAR) will consider how to involve the air program in review of TMDLs that list air sources.*

- *The EPA will encourage innovation among States to address local air sources of persistent, bioaccumulative toxics and promote voluntary pollution prevention actions, where appropriate. For instance, EPA will document the results of projects under way nationwide to reduce, collect, and recycle mercury-containing products and disseminate the information broadly.*

- *The EPA will continue to encourage phase-out and safe disposal of banned and restricted Great Waters substances (e.g., "clean sweeps" for banned pesticides). The EPA, working with NOAA and other Federal and State partners, will continue to monitor levels in the environment (e.g., fish tissue levels) to verify trends in loadings.*

- *The EPA expects to complete development of a Mercury Research Strategy in 2000. The Strategy will describe the key research questions for mercury that EPA plans to address over the coming 5 years and will identify other technical and scientific issues that are important to the Agency's efforts in addressing mercury.*

- *The EPA expects to finalize in 2000 the Dioxin Reassessment following peer review. This report will update our scientific understanding of the health risks resulting from exposure to dioxins.*

- *The EPA will improve the public's "Right to Know" about certain toxic compounds. The EPA will implement the rulemaking which added dioxin and other persistent, bioaccumulative, toxic*

chemicals to the Toxic Release Inventory and lowered the reporting threshold for these and other listed chemicals under the TRI. The EPA also expects to issue to the public by 2001 the first TRI reports that include these substances.

- *The EPA will continue to lead efforts to research viable controls for sources of pollutants of concern. For example, research will continue on mercury from combustion processes, including modifying the mixtures and inputs of fuel, and more effective control devices on emitted gases and particles. This research will also evaluate costs and relative effectiveness of control options.*

- *The EPA will continue to provide leadership in reducing transboundary transport of mercury, DDT, PCBs, chlordane, and other toxic pollutants of concern by achieving assessment and reduction goals contained in international agreements (e.g., Great Lakes Binational Strategy, CEC[4] North American Regional Action Plans, UN/ECE LRTAP[5] Heavy Metals Protocol). The EPA will support efforts to share technology, information and expertise with other countries on reducing releases to the environment and on cost-effective alternatives. The EPA will also continue to provide support to the international negotiations on persistent organic pollutants under the United Nations Environmental Programme.*

- *The EPA will continue to pursue international agreements to reduce transboundary NO_x, including negotiating an ozone annex to the US/Canada Air Quality Agreement.*

- *The EPA will continue to support joint work with States and industry to fill gaps in source categories and further refine emission measurement methods and inventories for Great Waters pollutants of concern (e.g., speciated data on pollutants such as metals and PAHs for the Great Lakes RAPIDS inventory and for the National Toxics Inventory) so that they can be used effectively in models being developed.*

[4] Commission for Environmental Cooperation

[5] United Nations Economic Commission for Europe Long Range Transboundary Air Pollution Convention

V.B CONTRIBUTION OF ATMOSPHERIC DEPOSITION TO POLLUTANT LOADINGS IN THE GREAT WATERS

Research, monitoring, and modeling of pollutant inputs to the Great Waters has continued to provide important information about loadings. Recent results from available data indicate that atmospheric inputs of some pollutants of concern are decreasing while others remain constant. However, there is considerable uncertainty in the data because of limited monitoring, technological barriers, and variable collection and analytical methods, making it difficult to adequately characterize historical as well as current conditions and to discern pollution trends. In addition, not all Great Waters waterbodies or all pollutants of concern have been studied.

FINDINGS AND CONCLUSIONS

- **Based on available data, atmospheric deposition of lead, cadmium, POM/PAHs, PCBs, and some pesticides (e.g., DDT, hexachlorocyclohexanes, dieldrin) to the Great Lakes has continued to decline in recent years.** Similar trends are seen in some other Great Waters.

- **Based on available data, atmospheric deposition of nitrogen compounds has remained relatively unchanged in the Great Waters in recent years.** This correlates with a relatively constant trend in NO_x emissions during the same period. Considerable uncertainty exists, however, concerning dry deposition of nitrogen compounds and wet organic nitrogen deposition.

- **Despite recent declines, atmospheric deposition continues to be a significant contributor of certain pollutants to some Great Waters.** For example, one researcher has reported that atmospheric deposition contributes 70 to 90 percent of the direct lead inputs to the Long Island Sound. In the Great Lakes, according to another study, the relative contribution of dioxins and furans from the atmosphere ranges from 5 to 100 percent. Various studies of nitrogen deposition to Atlantic and Gulf Coast bays and estuaries indicate that 2 to 38 percent of total nitrogen inputs are attributable to atmospheric deposition.

- **While run-off from fertilizer application, farm animal operations, waste treatment, industrial effluents, and crop residues continues to be the largest contributor to total nitrogen loadings, atmospheric inputs of nitrogen compounds to the Great Waters are much higher than natural rates.** Although atmospheric loading rates of inorganic nitrogen appear to have leveled off, the rates remain many times greater than natural rates and have the potential, when combined with other loadings such as runoff, to overwhelm the assimilative capacities of surface waters. Research is ongoing into the lesser known but apparently important forms of nitrogen deposition (e.g., dry deposition, organic nitrogen). In addition, nitrogen saturation of upland forests, grasslands, and agricultural fields may occur in some areas and could significantly increase the rate of nitrogen transport from upland watersheds to coastal waters in the future, even if atmospheric loading rates remain constant.

- **Although considerable uncertainty remains, EPA's 1997 *Mercury Study Report to Congress* estimates, based on a modeling analysis, that one-third (52 tons) of the anthropogenic mercury emitted annually in the U.S. is deposited in the continental U.S., along with an estimated 35 tons from the global reservoir (which includes U.S. anthropogenic as well as natural and re-emitted mercury emissions).** These results to date suggest that the remaining two-thirds (~ 107 tons) of annual U.S. anthropogenic emissions are transported beyond U.S. borders, where they diffuse into the global reservoir. As U.S. anthropogenic emissions are

reduced, the relative contribution from the global pool will be even larger, particularly if similar control actions are not undertaken in other countries. Studies of mercury deposition to certain Great Waters indicate that atmospheric deposition contributes between 10 and 85 percent of the total mercury loadings to these waterbodies. Because a deposition monitoring network for mercury has only recently been established, there are not yet sufficient data to determine monitored trends in mercury deposition levels.

- **Certain banned and restricted use pesticides are projected to be the first pollutants of concern to be reduced to concentrations below current atmospheric detection limits in the Great Lakes atmosphere, indicating that risk management strategies are having the intended impact.** Based on recent academic research on atmospheric pollutant concentrations in the Great Lakes region, DDT and DDE, followed by dieldrin and chlordane, are estimated to fall below current detection limits in the atmosphere between 2010 and 2020. Hexachlorocyclohexane and hexachlorobenzene are projected to fall below current detection limits in the atmosphere over the Great Lakes by 2030 and 2060, respectively. These estimates assume current rates of long-range transport of these pollutants into the region. Because of their persistence, it should be noted that elimination of these pollutants in the atmosphere does not mean that concentrations would be eliminated in deposited media (e.g., sediments) by these dates. However, these estimates indicate that reduction strategies in the Great Lakes, along with the original bans or restrictions on the use of these substances, are having the intended effect.

- **Significant progress has been made involving monitoring and modeling research focused on the factors that affect pollutant fate and transport in regional-scale air masses and in watersheds.** Since the *Second Report to Congress*, there have been significant advances in monitoring and modeling of pollutant transport and loadings at both regional and national scales. Recent accomplishments include data collection and analysis of results from the AEOLOS project, establishment of the Mercury Deposition Network (part of the National Atmospheric Deposition Program), applications of the HYSPLIT/TRANSCO[6] computer program, development of the Models-3 community multiscale air quality modeling system, monitoring established by the South Florida Mercury Science Program, and progress on the Lake Michigan Mass Balance Study. The Integrated Atmospheric Deposition Network, an international effort to monitor air toxics deposition, has produced a long-term data set on loadings trends in the Great Lakes. As in past years, much of the research on modeling of pollutant loading rates has focused on mechanisms of direct pollutant deposition to surface waters (e.g., pollutant exchange mechanisms, surface microlayers). However, a growing area of research addresses factors, such as the effects of land cover, weather events, that affect the fate and transport of pollutants in watersheds and tributaries. For example, a variety of factors influence how much deposited mercury will be methylated and incorporated into the food chain, including lake and watershed characteristics, water chemistry, and the length of the food chain.

- **Long-range transport from other U.S. regions or other countries is estimated to contribute significantly to atmospheric loadings of pollutants of concern to the Great Waters.** As stated above, EPA estimates that 35 tons of mercury from the global reservoir (derived from both foreign and U.S. sources) are deposited annually in the U.S., representing 40 percent of the total mercury deposition to the U.S. In a modeling study conducted in the northeastern U.S., sources from outside the study region contributed 30 percent of the mercury loadings within the study region and the global reservoir contributed approximately 20 percent. Another modeling study

[6] Hybrid single particle Lagrangian integrated trajectory/transfer coefficient (see page II-31)

conducted to assess sources of dioxin to the Great Lakes basin shows that sources as far as central Canada may influence deposition of dioxin to the lakes.

RECOMMENDATIONS FOR CONTINUED AND FURTHER ACTION

- *By summer 2000, EPA expects to develop a work plan to assess atmospheric deposition on a regional basis. This work plan would include: targeting State-identified impaired waterbodies; examining what rules or activities are in place that address impairment caused by atmospheric deposition; and, determining what, if any, additional actions are necessary to address impairment caused by atmospheric deposition. In addition, EPA expects to revise this work plan every two years based on updated scientific information and stakeholder input.*

- *The EPA will work with national deposition monitoring programs, States, National Estuary Programs, NOAA, and other research institutions to establish monitoring sites in coastal areas where they do not already exist, as appropriate. The EPA will encourage expansion of the National Atmospheric Deposition Program's Mercury Deposition Network, the continuation of other toxics deposition monitoring networks, such as the Integrated Atmospheric Deposition Network, and the development of a national air toxics monitoring network to support assessment of the contribution of long-range transport to deposition of Great Waters pollutants of concern in the U.S. and to evaluate the impact of urban sources.*

- *The EPA will encourage the use of standard monitoring methods to enable comparison of data and trends analysis. Where methods for measuring atmospheric deposition for pollutants of concern do not exist, EPA, working with NOAA and other Federal colleagues and key institutions such as the National Atmospheric Deposition Program, will continue to lead and support efforts to develop technology and establish standard methods (e.g., POM and PAH, mercury species, dissolved organic nitrogen, and dry deposition of pollutants).*

- *The EPA will continue to work with NOAA and other scientific partners to develop, refine, and validate modeling tools that help us to better understand the pathways of the pollutants of concern -- from emissions to transport to deposition to fate to environmental and human health effects.*

- *The EPA will work with NOAA and other agencies to better quantify the indirect loadings of atmospheric deposition to the Great Waters through the development of tools that can quantify watershed transport of pollutants of concern.*

- *The EPA will continue to support international efforts to quantify the transboundary contributions of pollutants of concern, such as the Commission for Environmental Cooperation efforts to assess continental pollutant pathways and the Binational Strategy challenge to assess global sources of pollutants to the Great Lakes.*

V.C ENVIRONMENTAL AND PUBLIC HEALTH EFFECTS

Because the *Second Report to Congress* discussed potential adverse human health and environmental effects from exposure to the Great Waters pollutants of concern in considerable detail, this report focused on observed changes in exposure levels and trends in observed effects, to the extent that data were available. Scientific research has continued to improve our understanding of the toxic effects of the pollutants of concern, including endocrine disruption. Concentrations of some of the pollutants of concern in the environment have decreased in recent years, while others have remained constant or are variable. At some locations, mercury concentrations are at levels sufficient to produce adverse health effects for certain groups consuming large amounts of contaminated fish (e.g., young children, pregnant women and their developing fetuses, women of child-bearing age, and populations that subsist on fish), as well as ecological risks.

FINDINGS AND CONCLUSIONS

- **Available monitoring data indicate that concentrations of dioxin/furans and PCBs, in the sediment, water, and biota of several of the Great Waters appear to be declining, while concentrations of lead, cadmium, mercury, and POM/PAH are too variable for a trend to be discerned.** For example, concentrations of PCBs in biota have continued to decline in the Great Lakes, with PCB concentrations in St. Lawrence River fish decreasing by a factor of 30 since 1975. Trends in concentrations of lead, cadmium, mercury, and POM/PAH were more variable or could not be discerned from the available data. Although recent research did not address contamination levels of all pollutants of concern, no identified studies indicated increasing levels of pollutants of concern in the Great Waters.

- **Available monitoring data indicate that various pollutant concentrations in sediments, water, and/or biota of the Great Waters have been detected at levels resulting in exposures that are high enough to cause adverse environmental effects.** As was reported in the *Second Report to Congress*, a number of regional- and national-scale assessment and monitoring programs (e.g., the National Sediment Quality Survey, Benthic Surveillance Project) suggest that the ecological health of many Great Waters are impaired by pollution that is partially attributable to atmospheric deposition. Further evidence of ecological impairment includes research results indicating that up to 30 percent of the loons in the northeastern U.S. have mercury levels sufficiently high to cause adverse effects.

- **Excess nitrogen loadings can cause algal blooms (including harmful algal blooms), shifts in aquatic vegetation, fish declines and kills, and shellfish bed losses.** The NOAA Estuarine Eutrophication Surveys indicate that the adverse effects of excess nitrogen loadings are currently evident to some degree in approximately 89 percent of the U.S. coastal Great Waters. Numerous studies on individual estuaries have estimated that 20 to 40 percent of total loading of nitrogen compounds can come from atmospheric deposition, with the rest of the loading originating from water discharges or land-use activities.

- **Fish consumption is the primary pathway of human exposure to mercury, is an important pathway for dioxin and PCBs, and may be an important pathway for various other Great Waters toxic pollutants. While such exposures may not be of concern for most of the general population, for certain pollutants and contamination situations, certain groups such as young children, developing fetuses, subsistence fish-eating populations, and others who consume large amounts of contaminated fish, may be at risk.** For mercury specifically,

exposures do not appear to pose a health risk to people consuming average amounts of fish , but sensitive sub-populations (e.g., young children, and pregnant women and their developing fetuses) with higher than typical fish consumption are at risk. Also at risk are subsistence fish-eating populations who consume large amounts of fish. The extent of risk for these groups depends on the amount of fish consumed and the mercury concentrations present in the fish.

- **The role of transformation processes on certain pollutants once they are emitted is an important phenomenon which can increase their toxicity and persistence in the environment.** For instance, mercury emitted by industrial or combustion processes becomes much more toxic and biologically available after it is deposited in the environment and transformed to methylmercury. Another example is the transformation of alpha- and gamma-hexachlorocyclohexane to beta-hexachlorocyclohexane (HCH). More research on these transformation processes is needed to better understand their role and to develop appropriate responses.

- **Evidence for adverse effects from endocrine disrupting chemicals continues to be found.** Recent research provides additional evidence of the adverse effects of endocrine disruptors on both wildlife and humans, and at least two Great Waters pollutants of concern (i.e., PCBs and dioxins) are known to possess endocrine disrupting capabilities. The EPA has worked with various governmental and non-governmental interests to develop a screening and testing approach for systematically identifying endocrine disruptors and quantifying their effects.

RECOMMENDATIONS FOR CONTINUED AND FURTHER ACTION

- *The EPA will continue to support the development and validation of modeling tools which address the transport and fate of pollutants in ecosystems and characterize risk, such as the Total Risk Integrated Methodology. The EPA will also continue to support the improvements in inventories, monitoring data, and human and environmental effects information necessary to effectively apply these tools.*

- *In conjunction with its related efforts on persistent, bioaccumulative, toxic pollutants (e.g., the Great Lakes Binational Strategy and the Persistent, Bioaccumulative Toxics Initiative), EPA will identify and evaluate additional pollutants which may be of concern to the Great Waters.*

- *The EPA expects to explore one or more community-based pilot projects to develop and examine methodologies for characterizing local risks and to work with stakeholders on risk reduction strategies. In conducting such pilot studies, the EPA will consider cumulative risks presented by exposures to air toxics emissions in the aggregate, including exposures through noninhalation pathways, such as consumption of contaminated fish from waterbodies affected by deposition of air toxics.*

- *The EPA will continue to support work to quantify the ecological effects of atmospheric deposition. For instance, EPA will support research to answer critical questions related to the assessment of pollutant exposures for varying life stages and for species at various levels of the food chain.*

- *The EPA expects to complete, by December 2000, the new Water Quality Criterion Methodology for Human Health to better reflect pollutants that bioaccumulate and the Nation's changing fish consumption patterns.*

- *The EPA will work with NOAA, US Fish and Wildlife Service, other Federal agencies, States, and tribes to expand the geographic coverage and consistency of waterbody monitoring to enable more accurate characterizations of the extent of contamination and ecosystem effects due to atmospheric deposition of Great Waters pollutants of concern. In addition, EPA will increase efforts to implement nationally-consistent methods and protocols for assessing contaminants in fish and wildlife and establishing consumption advisories.*

- *The EPA, working with States, tribes, and other relevant partners, will continue to support efforts to improve awareness and understanding of fish consumption advisories among populations most at risk to exposure to the Great Water pollutants of concern.*

- *The EPA will provide leadership for efforts to examine the mechanisms of action and resulting effects (e.g., reproductive failure, death, species diversity, ecological sustainability) of exposures to realistic concentrations of common contaminants, alone and in combination. The EPA will also lead the development of predictive models to assess likely effects of single and multiple stressors and alternative environmental conditions on individual aquatic plants and animals, populations, communities, and ecosystems.*

- *The EPA will continue to pursue as a priority its research plan for endocrine disruptors, covering ten broad categories of research needs: basic research, biomarkers, database development, exposure determination, exposure follow-up, mixtures, multidisciplinary studies, risk assessment methods, hazard identification, and sentinel species.*

- *The EPA will accelerate work to better quantify the water quality benefits of air pollution controls in order to provide decisionmakers with critical information on environmental strategies to reduce the extent of contamination by Great Waters pollutants of concern. By 2001, EPA expects to conclude a pilot study of the economic benefits of reducing nitrogen deposition in a particular estuary, developing methodologies that could be applied to other waterbodies.*

V.D EXCEEDANCES OF WATER QUALITY OR DRINKING WATER STANDARDS

Atmospheric deposition and other inputs of pollutants of concern to the Great Waters can result in exceedances of drinking water standards and surface water quality guidance and criteria, posing threats to human health and the environment. Recent data indicate that water quality standards in place for drinking water supplies in the Great Waters are not being exceeded for the pollutants of concern; however, surface water quality guidance and criteria are being exceeded in some of the Great Waters.

FINDINGS AND CONCLUSIONS

- **The pollutants of concern cause no exceedances of water quality standards in place for drinking water supplies in the Great Waters.** Pollutant levels in both the Great Lakes and Lake Champlain are below primary drinking water standards and other thresholds of water quality. Data indicate that most of the Great Lakes nearshore waters can be used as a source of drinking water with normal treatment. Similarly, Lake Champlain was not associated with any violations of standards in place for drinking water supplies due to Great Waters pollutants of concern from 1986 to 1995. Further reductions in pollutant concentrations may reduce the cost of drinking water treatment in some areas.

- **Primarily because of contamination with metals and nutrients from a variety of sources, some of which are atmospheric, approximately 40 percent of the Nation's surveyed rivers, lakes, and estuaries have been found to have contaminant levels exceeding water quality criteria and, therefore, discourage basic uses, such as fishing and swimming.** In lakes and rivers, nutrients and metals are the most widespread pollutants, and agriculture is the most common source; however, atmospheric deposition has also been identified as a source. In estuaries, nutrients are the most widespread pollutants with industrial point dischargers, urban runoff, and storm sewers identified as the most common pollutant sources. Atmospheric deposition has also been identified as a significant source of nitrogen loadings, directly to the water surface and indirectly via runoff, to most coastal waters where measurements have been made.

- **While the Great Lakes generally are safe for swimming and other recreation, virtually all of the surveyed shoreline area shows unfavorable conditions for supporting aquatic life and is impacted by toxic organic chemicals that appear in fish tissue samples at much higher concentrations than in water samples.** This is partially due to persistent toxic pollutant burdens, such as PCBs and PAHs, in the food web. Several of the Great Lakes States identified air pollution among other sources as contributing to impaired water quality.

RECOMMENDATIONS FOR CONTINUED AND FURTHER ACTION

- *The EPA expects to complete the development of national water quality criteria for nutrients for lakes, reservoirs, rivers, streams, estuaries, and coastal waters. This includes developing waterbody-specific guidance manuals to help State and tribal agencies: (1) classify and assess their waters in terms of nutrient condition; (2) develop region-specific water quality standards; and (3) plan management responses to nutrient pollution. Where sufficient data are available, EPA also expects to develop specific target ranges for total nutrient loads that States can use in the development of their standards.*

- *The EPA expects to complete a pilot project to demonstrate total maximum daily load allocations for two waterbodies receiving mercury from atmospheric deposition. This pilot project will evaluate the integration of air and water program technical tools and authorities, and will examine emission reduction options. The EPA will also work with States that have identified waterbodies whose impairment may be the result of atmospheric deposition to develop tools to assist in establishing TMDLs that account for air sources. For example, based on the outcome of the pilot project, EPA will explore the possibility of providing States with modeled regional baseline and projected deposition estimates for several Great Waters pollutants of concern.*

- *The EPA, in partnership with the Chesapeake Bay watershed States, will account for nitrogen deposition as a part of an effort to improve water quality in the Bay and its tributaries. The Chesapeake Bay partners have committed to working to integrate a cooperative, statutory program so that these waters could be removed from the list of impaired waters by 2010.*

- *The EPA, working with the Great Lakes States, will ensure implementation of the Great Lakes Water Quality Guidance.*

- *The EPA will continue to work with its Federal agency partners such as NOAA, and with States, tribes, and local agencies to improve understanding of the relationship and relative contribution of atmospheric deposition and water pollution. The EPA expects to develop guidance to assist National Estuary Programs, States, tribes and local organizations, among others, to evaluate the role of air deposition in assessing water quality.*

V.E SUMMARY AND KEY RECOMMENDATIONS

The EPA expects that the many ongoing and scheduled future regulatory and voluntary programs and activities, many of which are described in this report, will further reduce the impact of air deposition of pollutants of concern on the Great Waters. These include, but are not limited to:

- Establishing remaining MACT and section 112(c)(6) standards for sources emitting Great Waters pollutants of concern;

- Implementing EPA's strategy for the Residual Risk program, which assesses the risk remaining from MACT source categories (including those emitting Great Waters pollutants of concern), and issuing additional standards, as appropriate, within the required 8 years of the MACT standard being promulgated for the source category;

- Implementing programs to control NO_x, such as regional strategies to reduce NO_x emissions (e.g., the NO_x SIP call and the rulemaking by EPA in response to States' petitions under CAA section 126), Tier II/Gasoline sulfur rules for cars, and emission standards and guidelines for municipal waste combustors, as well as encouraging voluntary approaches to reduce these emissions;

- With NOAA and other Federal agency partners, completing the strategy described in the Clean Water Action Plan issued in 1998, which addresses remaining obstacles to establishing "fishable and swimmable waters for all Americans"; and,

- Completing and implementing national multimedia action plans for persistent, bioaccumulative toxics (PBT) under the Agency's PBT Initiative.

Development and implementation of these and other programs and initiatives described in this report should not require revisions to requirements, standards, and limitations pursuant to the CAA and other Federal laws. Consequently, EPA expects that these programs should help to assure protection of human health and the environment from atmospheric deposition to the Great Waters. However, in order to ensure continued progress in reducing sources and loadings of atmospheric deposition to the Great Waters, and to further reduce the environmental and public health effects, EPA will:

- Continue to support the maintenance and expansion of efforts to monitor Great Waters pollutants of concern in order to evaluate the relative contributions of local, regional, and long-range transport to deposition in the U.S., as well as natural versus human-made sources;

- Continue to develop and implement regulations and pollution prevention programs regionally and nationally, including multimedia programs, in order to reduce the release and impact of sources of Great Waters pollutants of concern within the U.S.;

- For Great Waters pollutants not emitted by U.S. sources, work within international frameworks to reduce sources of these pollutants;

- Support model development and research that establish and, if possible, quantify the linkages from emissions to atmospheric deposition to waterbody loadings to adverse public health and the environmental effects of Great Waters pollutants of concern in order to enable effective risk management decisions;

- Encourage and support the establishment of common baselines and measures of progress in order to better assess trends and health of Great Waters and other waterbodies affected by atmospheric deposition; and,

- Work to increase public awareness of risks of exposure to Great Waters pollutants of concern.

The EPA is committed to continuing to address air deposition of pollutants into the Nation's waters as a priority matter. To that end, and to assure continued coordination of the many related tasks involved and outlined in this report, EPA will develop a detailed biennial work plan for implementation actions beginning this year and updated every two years. As EPA develops and implements plans, programs and initiatives with NOAA and its other Federal, State, tribal, industry and community partners, we expect to make significant, measurable progress toward our goal of assuring the protection of human health and the environment from adverse effects attributable to atmospheric deposition of pollution to the Great Waters.