CHAPTER 4
INVENTORY OF WATER WITHDRAWAL AND USE DATA AND INFORMATION

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4.1. INTRODUCTION

An inventory of water withdrawal and use information in the Great Lakes-St. Lawrence River basin was a key component of the Water Resources Management Decision Support System project. This effort included an assessment of the latest available water use data as it relates to withdrawals, in-stream uses, diversions and consumptive use. A Water Withdrawal and Use Technical Subcommittee was established early in the project to provide guidance and oversight to Great Lakes Commission staff and to serve in the conduct of this project element. This chapter describes the outcomes of the work of the Water Withdrawal and Use Technical Subcommittee. First, the background and history of regional water use data collection and reporting activities is described. The later sections address state and provincial programs associated with water withdrawal data collection, consumptive use, demand forecasting, and the Great Lakes Regional Water Use Database. The chapter concludes by examining how the states and provinces have incorporated agreements made through the Great Lakes Charter.

4.1.1 BACKGROUND AND HISTORY OF WATER USE DATA COLLECTION AND REPORTING

The individual jurisdictions of the Great Lakes-St. Lawrence River region have been involved with managing water resources for many decades. Traditionally, water management in the United States and Canada has focused on the manipulation of supplies of freshwater to meet the needs of a variety of users.

In North America, many existing sources of water are being depleted and stressed by withdrawals from aquifers and diversions from lakes, rivers and reservoirs to meet the needs of cities, farms, homes and industries. While the water rich region of the Great Lakes-St. Lawrence has been mostly immune from serious water shortages and water supply problems, smaller watersheds are beginning to be stressed in some parts of the Great Lakes-St. Lawrence River basin. This may occur in areas where local surface water supplies are inadequate to meet needs and/or where groundwater supplies are unreliable or of poor quality.

As other parts of the continent begin to experience water supply shortages, the Great Lakes may be viewed as a source of high quality freshwater to serve the needs of communities and industries located outside of the basin.

To generate a sense of how water resources are used, the U.S. Geological Survey (USGS) has compiled and disseminated estimates of water use for the United States at five-year intervals since 1950. In 1977, the United States Congress expanded USGS' water-use activities by establishing a National Water-Use Information Program, which, in cooperation with the states, collects reliable and uniform information on the sources, uses and management of water in the United States.

While the Great Lakes states work closely with the USGS through its National Water-Use Information Program, the concept of a region-specific bi-national water use data system to collect and maintain consistent and uniform data on withdrawals, diversions and consumptive uses of water has long been of interest to Great Lakes researchers and water resources program managers.

This interest was heightened when, in 1983, the Great Lakes governors and premiers appointed a Task Force on Water Diversion and Great Lakes Institutions. This Task Force was established from ongoing concerns about future management of the Great Lakes-St. Lawrence River and the perceived significant economic and environmental consequences to the region from large-scale diversions of Great Lakes water. The report of the Task Force, submitted in January 1985, addressed three main areas: the need for regional action in the area of water management; the need to protect the water resources of the Great Lakes-St. Lawrence; and the institutional capabilities and needs in the Great Lakes region. Out of this report came the Great Lakes Charter of 1985, a series of principles for the management of Great Lakes water resources.

Throughout its deliberations in 1983-1984, the task force was troubled by the lack of consistent, reliable technical information related to water withdrawal and use for the Great Lakes. The task force found that "the kind of reliable, comparable water use data needed to accurately project future needs or to forecast 'significant impacts' are not available now."

The Great Lakes Charter, signed by the Great Lakes governors and premiers in 1985, called for the establishment of a regional water use database that would provide a common base of data and information regarding the use and management of basin water resources and the establishment of systematic arrangements for exchanging and comparing water use data and information.

When working on the Charter, the states and provinces were also involved in some parallel projects and studies undertaken to describe and document individual state and provincial water use data collection and reporting programs and provide guidance on how to establish a consistent approach to managing the water resources of the Great Lakes basin. For example:

The Great Lakes Commission formed a Water Data Collection task force in early 1985 to evaluate regional data collection efforts. Through a survey process, the Commission's task force determined the extent of withdrawal, return flow and water consumption data in the Great Lakes states and provinces, along with the assessment, comparability and compatibility of the data. The results were published in an October 1985 report titled Survey and Preliminary Evaluation of the Existing Water Use Data Collection Systems in the Great Lakes State and Provinces. The Great Lakes Commission authored this report.

The USGS, in an extensive 1985-86 study undertaken with input from the Council of Great Lakes Governors' Water Resources Management Committee, examined and compared Great Lakes state and provincial data for nine water use categories. The December 1986 report titled Water Use Data Collection Programs and Regional Data Base in the Great Lakes-St. Lawrence River Basin States and Provinces (U.S. Geological Survey Open File Report 86-546, December 1986) influenced the design of the Regional Water Use Database.

After the signing of the Great Lakes Charter, a Water Resources Management Committee (WRMC) was established through the Council of Great Lakes Governors to work toward achieving the objectives of the Charter. Based upon recommendations of the WRMC in its February 1987 report to the governors and premiers titled "Managing the Waters of the Great Lakes Basin," the Great Lakes Commission was recommended to serve as the repository for the regional water use database. The function of the regional water use database is to store, aggregate, manipulate and display water withdrawal, diversion and consumptive use data (provided to the database by the Great Lakes states and provinces) for multiple categories of use.

The Regional Water Use Database has been operational since the summer of 1988, following a multi-year cooperative effort between the Great Lakes states and provinces and the U.S. Geological Survey to design and develop the database system. The operation and use of this database system represents one of several ongoing activities on behalf of the Great Lakes states and provinces to fulfill obligations of the Great Lakes Charter of 1985.

4.1.2 CHARTER MINIMUM REQUIREMENTS FOR WATER USE PROGRAMS AND DATA REPORTING

The Great Lakes Charter of 1985 established a need for a united regional position for regional water resources management and put forth a coordinated strategy to protect the Great Lakes from the effects of major diversion and consumptive use proposals. It provides a series of five principles for the management of Great Lakes water resources along with general guidelines for the implementation of those principles. One important recommendation provided for the development and maintenance of a regional water use database and the minimum requirements under which the database should operate. These guidelines are reaffirmed and expanded upon by recommendations developed by the Water Resources Management

Committee, in its 1987 report to the Great Lakes governors and premiers entitled, "Managing the Waters of the Great Lakes Basin." The Water Resources Management Committee was established by the Great Lakes-St. Lawrence River governors and premiers and charged with the identification of specific common water data needs, the development and design of a system for collecting comparable water resource management data, the recommendation of institutional arrangements to facilitate the data system, and the development of procedures to implement the prior notice and consultation process established under the Charter.

The Charter describes, in general terms, the types of data and information to be collected and exchanged among jurisdictions and a compliance mechanism to ensure jurisdictional participation. Under the "Implementation of Principle" section, the Charter lays out three components to a common base of data.

> 1. Each State and Province will collect and maintain, in comparable form, data regarding the location, type, and qualities of water use, diversion, and consumptive use, and information regarding projections of current and future needs.
>
> 2. In order to provide accurate information as a basis for future water resources planning and management, each State and Province will establish and maintain a system for the collection of data on major water uses, diversions, and consumptive uses in the Basin. The States and Provinces, in cooperation with the Federal Governments of Canada and the United States and the International Joint Commission, will seek appropriate vehicles and institutions to assure responsibility for coordinated collation, analysis, and dissemination of data and information.
>
> 3. The Great Lakes States and Provinces will exchange on a regular basis plans, data, and other information on water use, conservation, and development, and will consult with each other in the development of programs and plans to carry out these provisions.

Under the "Progress Toward Implementation" section, the Charter specifies a sequence of steps to be taken to implement the Charter and develop a Basin Water Resources Management Program. Among these steps are basic requirements in water use data collection and exchange activities that the jurisdictions must complete in order to participate in the prior notice and consultation process.

> 4. The prior notice and consultation process will be formally initiated following the development of procedures by the Water Resources Management Committee and approval of those procedures by the Governors and Premiers. Any State or Province may voluntarily undertake additional notice and consultation procedures, as it deems appropriate. However, the right of any individual State or Province to participate in the prior notice and consultation process, either before or after approval of formal procedures by the Governors and Premiers, is contingent upon its ability to provide accurate and comparable information on water withdrawals in excess of 100,000 gallons (380,000 litres) per day average in any 30-day period and its authority to manage and regulate water withdrawals involving a total diversion or consumptive use of Great Lakes Basin water resources in excess of 2,000,000 gallons (7,600,000 litres) per day average in any 30-day period.

Appendix --, "Regional Mandate for Great Lakes Water Resources Management," discusses, in greater detail, the developmental process of the Charter and its policy measures.

4.1.3 CHARTER OBJECTIVES FOR A REGIONAL WATER USE DATABASE

The Great Lakes Charter called for a common, regional database as a principal tool for regional water resources management. After the Great Lakes Charter was signed, the Water Resources Management Committee was charged with developing detailed measures for the implementation of the Charter provisions. In its 1987 report, the Committee presented recommendations for water quantity data collection and management, prior notice and consultation, and institutional arrangements for a centralized database. The report also lays out the objectives of regional information system, which is shown below:

> The establishment of a regional water-use database will assist management efforts by providing:

- the states and provinces, and federal and international agencies with better basic information that can be applied to development of a water budget for the Great Lakes Basin;
- a more accurate base of data on present in-basin uses from which to project future in-basin demands;
- consistent, and, to the extent possible uniform regional water-use data so that the uses and needs of individual jurisdictions may be compared and evaluated;
- a better understanding of the extent to which the cumulative effects of small-scale diversions and consumptive uses of Great Lakes water may affect lake levels and flows;
- information on which to base regional decisions relating to consumptive uses; and
- more accurate data to be applied to future research of the relationship between levels and flows and water use in the Basin.

It is clear that the Great Lakes Regional Water Use Database cannot be used to meet all the objectives listed above because it lacks the data quality and, in some cases, the scientific basis to perform such analyses. The next chapter section, "Water Resources Programs Related to Water Withdrawal and Use," discusses, in detail, how regional efforts in water use data collection fall short in meeting the database objectives set by the Committee.

4.2. WATER RESOURCES MANAGEMENT PROGRAMS RELATED TO WATER WITHDRAWAL AND USE

Water use data collection and reporting programs provide a means of measuring current demands on water resources and provide data to the Regional Water Use Database. Although many water resources management activities and programs in the Great Lakes-St. Lawrence River basin trace their origin to the 1985 Great Lakes Charter, the Great Lakes states and provinces have for many years prior to the Charter, maintained a variety of independent water use data collection, storage and retrieval systems. These programs that were present before the Charter, have been adapted to meet the Charter reporting requirements for withdrawals, uses, and diversions of more than 100,000 gallons (380,000 litres) per day average in any 30-day period.

4.2.1 PROGRESS MADE ON CHARTER DATA REPORTING PROCESSES

The Charter intended that all the states and provinces be in compliance with the minimum data collection requirement of water withdrawals in excess of 100,000 gallons (380,000 litres) per day in order to participate in the prior notice and consultation process. However, in practice this requirement has not been emphasized, with the result that consistency among jurisdictions with regard to the principles of the Great Lakes Charter has been lacking, and gaps exist in state/provincial water use data collection and reporting programs.

Table 1 below displays the perceptions of members of the Water Withdrawal and Use Technical Subcommittee regarding their jurisdictions' fulfillment of the Charter commitments for water use data collection programs. This information was collected through a survey given to the subcommittee members that them to rate how well their jurisdictions have met their commitments to two key Charter requirements: (1) collect accurate and comparable information for withdrawals in excess of 100,000 gallons (380,000 litres) per day average in any 30-day period and (2) report collected data for the agreed-to categories of use to the Regional Water Use Database Repository annually.[1] The members rated their jurisdictions' fulfillment of the Charter commitments according to the legislative and/or regulatory

[1] This second requirement is not stated explicitly in the 1985 Great Lakes Charter. The Charter mandated the formation of a Water Resources Management Committee to develop and design a system for the collection and exchange of comparable water resources management data. The Water Resource Management Committee recommended in its 1987 report to the governors and premiers that the jurisdictions provide collected data to the regional database repository annually. In return, the centralized repository would develop annual reports.

authority to cover water withdrawals within the water use category (legislative/regulatory fulfillment scale) and the implementation effort to provide the required water use data collection and reporting commitments for the water use category (implementation fulfillment scale). Ratings are based on a conventional five-point scale, from "0" meaning no legislative/regulatory authority or implementation effort to "4" meaning full legislative/regulatory authority or implementation effort. The survey is located in Appendix _. This information is qualitative and anecdotal but helpful to the discussion of water withdrawal and use data gaps and information needs.

Based on the survey, several conclusions may be drawn. About half of the members feel their jurisdiction is able to fulfill the Charter commitments in both legislative/regulatory authority and implementation effort for almost all water use categories. The other half of the members feels their jurisdiction is able to partially fulfill their commitments either by legislative/regulatory authority or implementation effort. A common trend among those who believe their jurisdiction partially fulfills their commitments is that legislative/regulatory authority appeared to be strong while implementation efforts were weak. Inadequate resources to carry out the reporting programs authorized through legislation or regulations may be the reason for this trend. Among all jurisdictions, the weakest water use categories for data collection appear to be self-supply domestic, irrigation, and livestock.

Subcommittee members expressed some difficulty in rating their state or province's performance for the hydroelectric power category due to several unique considerations. Major hydroelectric uses along the St. Lawrence and Niagara Rivers, where most of the quantity of hydroelectric water use occurs, are monitored much more closely than many of the smaller operations, and jurisdictions can generally use federal data for the regional database even if they have some authority to collect the water use data. For smaller hydroelectric uses, Indiana uses electricity generation data collected from the U.S. Federal Energy Regulatory Commission to calculate water use. However, New York does not make these calculations because it has more small hydroelectric users and the process would be more time consuming. Also, states and provinces report differently on instream hydroelectric uses. Ohio does not report instream uses because it considers them to be incidental uses with no associated water rights, but some other jurisdictions include these uses in their data reports. All states and provinces report non-run-of-the-river uses, which involve temporary storage of water so electricity can be generated to meet peak loads, but not many jurisdictions have these uses. Other water use categories also seem to have unique considerations that point to a general need for clarifying water use category definitions and determining whether categories should be reclassified.

Table 1: Jurisdiction Self Assessment of Fulfillment of Charter Data Collection Commitment

Water Use Category	Illinois		Indiana		Michigan		Minnesota		New York		Ohio		Ontario		Pennsylvania		Quebec		Wisconsin	
	L	I	L	I	L	I	L	I	L	I	L	I	L	I	L	I	L	I	L	I
Public Supply	4[1]	4	4	4	4	4	4	4	4	1	4	4	4	3	4	4	4	0	4	4
Domestic	1	4	4	4	0	0	4	4	4	1	4	4	4	3	2	2	4	0	4	0
Irrigation	N	N	4	4	1[3]	4	4	4	4	1	4	4	4	3[4]	4	2	4	0	4	0
Livestock	N	N	4	4	0	0	4	4	4	1	4	4	0	3[4]	4	0	4	0	4	0
Industrial	4	4	4	4	4	4	4	4	4	2	4	4	4	3[4]	4	4	4	0	4	3
Fossil Fuel	4	4	4	4	4	4	4	4	4	3	4	4	4	4	N	N	4	4[5]	4	4
Nuclear	4	4	N	N	4	4	N	N	4	4	4	4	4	4	N	N	4	N	4	4
Hydroelectric	N	N	0	4[2]	0	0	4	4	4	3	N	N	4	3	N	N	4	4[5]	4	4
Other	4	4	3	4	N	N	4	4	4	1	4	4	4	3	4	4	4	0	4	0

1. Illinois' watershed, which drains to Lake Michigan, is unique as it covers a relatively small area and most of it is served by established public water supplies, and therefore there are very few self-suppliers.
2. Indiana does not have the regulatory authority to require water usage reporting from 'Hydroelectric Power' plants, but they have furnished it voluntarily. Some of the data is also available on-line from the Energy Information Administration of DOE.
3. Michigan's water use reporting law requires annual reports from irrigated golf courses but not irrigated farms. For agricultural irrigation, the law directed the State to develop an estimation model. That model is now used to estimate agricultural irrigation water withdrawals on an annual basis -- based upon irrigated acreage and crop type data reported every five years in the federal Census of Agriculture.
4. Ontario provides water use estimates based on census data (1991, 1996, and 2001) for Irrigation, Livestock and Industrial water use. These categories are being reviewed to establish methodologies for more regular reporting.
5. For Québec, all data available for self-supply thermoelectric and hydroelectric power but not reported to the regional water use database annually.

Codes for Self Assessment of Data Collection and Reporting Programs

L - Legislative/Regulatory Fulfillment Scale
I - Implementation Fulfillment Scale
N - No water use occurs in this category within the basin
4 - covers total quantity of water withdrawals for the required data collection and reporting programs
3 - covers roughly ⅔ or more of the total water withdrawal quantity for the required data collection and reporting programs
2 - covers roughly ⅓ to ⅔ of the total water withdrawal quantity for the required data collection and reporting programs
1 - covers roughly ⅓ or less of the total water withdrawal quantity for the required data collection and reporting programs
0 - No legislative/regulatory authority within this water use category

4.2.2 STATE AND PROVINCIAL PROGRAMS, REGULATIONS, STATUTES AND AUTHORITIES

A survey of state/provincial water resources management programs, included in the WRMDSS project's "Report on State and Provincial Water Use and Conservation Programs in the Great Lakes-St. Lawrence Basin," shows that while jurisdictional water use data collection and reporting programs are similar in some ways, they have evolved differently and are unique in their development and function. Most jurisdictions use either a water withdrawal registration approach or a permitting system that allows for data collection for facilities in many water use categories that either withdraw or have the capacity to withdraw 100,000 gallons (380,000 litres) of water per day average over a 30-day period. A few jurisdictions also collect data or have requirements at lower usage rates.

The survey information compiled under the WRMDSS project suggests that the region is moving in the right direction, albeit slowly, regarding the development of programs necessary to facilitate a coordinated regional approach to water use data collection and reporting. This conclusion is based on a comparison of the information included in the 1986 USGS report. According to the USGS report, data collection programs in the mid-1980s relied mostly on estimated data, and the states and provinces used different water use categories. Currently, annual data submitted to the Great Lakes Regional Water Use Database fit within the prescribed categories of public supply, self-supply domestic, self-supply irrigation, self-supply livestock, self-supply industrial, self-supply thermoelectric (fossil fuel), self-supply nuclear, hydroelectric and other. Below is a summary of the state and provincial programs and the associated authorization. Tables 2 and 3 also provide summary information of the state/provincial programs.

4.2.2.1 Illinois

The state's Level of Lake Michigan Act (615 ILCS 50) allows the Illinois Department of Natural Resources (DNR), Lake Michigan Management Section to allocate all water coming from Lake Michigan allowed under the 1967 U.S. Supreme Court Decree. The DNR's administrative code, which outlines the process involved in issuing these permits, is found in Title 17 Chapter I (h) Part 3730, "Allocation of Water from Lake Michigan." The Illinois DNR's Lake Michigan Management Section receives monthly data from the 21 facilities that take water directly from Lake Michigan. The 200 permittees that use the water must report metered annual water use. No allocation permits are required for water coming from non-Lake Michigan sources, but the DNR's Illinois State Water Survey conducts annual surveys of public water suppliers and industrial facilities using more than 70 gallons per minute (100,800 gallons, or 381,500 litres, per day). Water use data comes from a combination of facility reports and estimates.

4.2.2.2 Indiana

Indiana's Water Resource Management Act (Indiana Code 14-25-7), enacted in 1983, requires registration of facilities with a withdrawal capacity of more than 100,000 gallons (380,000 litres) per day. The Indiana Department of Natural Resources (DNR), Division of Water collects annual data for all water use categories, but the state has no nuclear facilities. Authority for data collection comes from Indiana Code 14-25-7 for all of the categories but hydroelectric power generation. Indiana's four hydroelectric facilities voluntarily provide data. Facilities estimate their total water use for the categories of public supply, self-supply irrigation, self-supply thermoelectric (fossil fuel), and hydroelectric. Facilities measure and estimate data for the self-supply industrial and other categories, and the state estimates the majority of the data for self-supply domestic and self-supply livestock uses.

4.2.2.3 Michigan

Water use reporting occurs through the Michigan Department of Environmental Quality's (MDEQ) Drinking Water and Radiological Protection Division. Under Public Act 451 of 1994, Part 327, industrial,

power generation, and non-agricultural irrigation facilities that have the capacity to withdraw over 100,000 gallons (380,000 litres) of water in a 30-day period are required to register water withdrawals. As directed in Act 451, the MDEQ and state Department of Agriculture use a model to estimate agricultural irrigation water use. Public Act 399 of 1976, Part 15, requires public suppliers to register. The MDEQ has no authority and does not collect data for the categories of self-supply domestic, self-supply livestock, hydroelectric, and other. Facilities measure their water use for the categories of public supply, self-supply thermoelectric (fossil fuel), and self-supply nuclear. Self-supply industrial data comes from facility measurements and estimates. Golf course irrigation data is based on facility measurements and facility estimations.

4.2.2.4 Minnesota

A water appropriation permit from the Department of Natural Resources' Waters Division (DNR Waters) is required for all water withdrawals exceeding 10,000 gallons (37,900 litres) per day or 1 million gallons (3.79 million litres) per year. Minnesota Statutes 103G.255 to 103G.315 and Minnesota Rules 6115.0600 to 6115.0810 allow for implementation of the Water Appropriation Permit Program. Water data is collected for the nine Great Lakes Regional Water Use Database categories. Of registered facilities, 100 percent report for all categories but hydroelectric. Hydroelectric water use where water remains in the waterway (run of the river) is not considered a water use in the state, and all current basin hydroelectric uses are of this type. Hydroelectric data has come from U.S. Geological Survey five-year reports, and future reports will use Federal Energy Regulatory Commission data. Minnesota has no nuclear facilities in its portion of the basin. Data for all categories are measured by facilities for all categories.

4.2.2.5 New York

New York Codes, Rules and Regulations Part 675, requires registration of Great Lakes basin withdrawals greater than 100,000 gallons (380,000 litres) per day in a 30-day period. Public water suppliers are exempt, but based on the authority of NYCRR Part 601, the Department of Environmental Conservation issues permits to public water suppliers and uses permit quantities to estimate water use. The DEC collects water use data for all water use categories except for hydroelectric. The New York Power Authority and International Niagara Committee provide measurements of the state's two largest hydropower facilities, and the DEC, Federal Energy Regulatory Commission and Army Corps of Engineers are involved in other hydroelectric data collection. Most information is reported every other year, but reports occur annually for self-supply irrigation. All facilities registered in the categories of self-supply industrial, self-supply thermoelectric (fossil fuel), and self-supply nuclear make the required reports with partially measured data. Estimates are more frequently used for public supply and self-supply livestock data.

4.2.2.6 Ohio

Sections 1521.15 and 1521.16 of the Ohio Revised Code require facilities with the capacity to withdraw more than 100,000 gallons (380,000 litres) of water per day to register with the Ohio Department of Natural Resources. The DNR's Division of Water collects annual data on all of the nine water use categories used in the Great Lakes Regional Water Use Database, and 100 percent of registered facilities file reports. The state estimates data for the categories of self-supply domestic and hydroelectric. Facilities measure data for the public supply, self-supply irrigation, self-supply thermoelectric (fossil fuel), and self-supply nuclear categories. Facilities estimate data for the self-supply livestock category. Data for the self-supply industrial and other categories combine facility measurements and estimations.

4.2.2.7 Ontario

Ontario's Ministry of Environment and Energy (MOEE) regulates all types of water withdrawals with the Permit to Take Water (PTTW) program under Section 34 of the Ontario Water Resources Act (OWRA) of 1990. Withdrawals in excess of 50,000 litres (13,200 gallons) per day or that significantly interfere with other users require permits, which define maximum allowable water takings. The Ministry of Natural Resources (MNR) is responsible for reporting to the Great Lakes Regional Water Use Database, but relies on voluntary reporting because it lacks the authority to require reporting. The MOEE can require reporting under the PTTW program, but does not currently exercise this authority. Environment Canada and Statistics Canada collect water use data every two to three years for municipal users and every five years for industrial users. A 1996 Rural Water Use Survey conducted by the University of Guelph provides data for the self-supply domestic, self-supply livestock and self-supply irrigation categories. MNR contacts station operators to collect power generation water use data. Navigation data from the National Canal survey makes up the bulk of water use for the other category.

4.2.2.8 Pennsylvania

Under the Water Rights Act of 1939, public supply agencies must obtain a permit before withdrawing surface waters, but no rules and regulations govern the water allocation process. The Pennsylvania Department of Environmental Protection's Bureau of Watershed Management is responsible for water allocations and the Annual Water Supply Report. Chapter 109.701 (b) Rules and Regulations, administered by the DEP's Bureau of Water Supply and Waste Water Management, provides authority for collection of surface water public supply water use information. Administrative Code Section 1904-A (3) provides for data collection for other use categories. Data is collected for facilities using 100,000 gallons (380,000 litres) per day or more, but for non-public supply categories, the DEP does not have statutory power to gather data. Water use data is collected for all public supply facilities, and at least 80 percent of principal facilities in other categories. Data is compiled through facility measurements and estimates.

4.2.2.9 Québec

The Ministry of the Environment (MOE) oversees most of the water use in Québec (quality, hydrology), but several other ministries, agencies and municipalities share responsibilities. Under the Environment Quality Act, Québec has several regulations dealing with water use, mostly related to environmental and water quality impacts. The act requires a certificate of authorization (permit) from the Environment Minister before a variety of activities can occur on water bodies, including operation of a public water facility. The 1999 Water Resources Preservation Act prohibits transporting water outside Québec in most cases. Although the MOE has the legislative authority to collect and report on water use, it has not implemented any mandatory program and no resources are formally dedicated for that purpose. In view of what was needed to fulfill the provisions of the Great Lakes Charter, the Ministry of the Environment proceeded in 1994 to begin the collection of available data from other ministries and agencies.

4.2.2.10 Wisconsin

Wisconsin's Act 60, passed in 1985, provides for regulation of water withdrawals, diversions, and consumptive use. A water withdrawal must be registered if it will average more than 100,000 gallons (380,000 litres) per day in any 30-day period. Wisconsin diversions resulting in a loss of more than 2 million gallons (7.57 million litres) in a 30-day period require approval under Wisconsin State Statute 30.18. The state Department of Natural Resources collects water use data based on the authority in Wisconsin State Statute 281.35 and the associated rules in Natural Resources 142, Wisconsin Administrative Code. Wisconsin receives information that is either measured or estimated by facilities on an annual basis for all water use categories.

4.2.3 WATER USE DATABASE

The Great Lakes Regional Water Use Database provides a common base of data and information on water use in the Great Lakes basin as called for in the Great Lakes Charter of 1985. As describe in the previous section, entitled Charter Objectives for a Regional Water Use Database, the regional database was envisioned to be a primary vehicle in supporting water withdrawal decisions.

Housed at the Great Lakes Commission offices, the database uses a modified Microsoft Access7 software package using Visual Basic for Applications. A customized program, first prepared in 1987 by Acres International, Ltd. and revised in 1999/2000 by Eastern Michigan University's Center for Environmental Information, Technology and Application, performs routine database operations and includes standard data entry, retrieval and report generation options.

There are nine categories of use included in the Great Lakes Regional Water Use Database. These categories include public supply; self-supply-domestic; self-supply-irrigation; self-supply-livestock; self-supply-industrial; fossil fuel power; nuclear power; hydroelectric power; and other, which includes withdrawals for fish/wildlife purposes, low flow augmentation, navigation and recreation, among others. Each water-use category includes three types of withdrawal/discharge records: Great Lakes Surface Water (GLSW); Other Surface Water (OSW); and Groundwater (GW).

The system includes six drainage basins (Lake Superior; Lake Michigan; Lake Huron; Lake Erie; Lake Ontario; and the St. Lawrence River), which are numerically coded in the database. All states and provinces submit water use data to the database repository by basin of withdrawal. There are 22 possible combinations of the six basins and ten jurisdictions. Each jurisdiction's set of sub-basin records is comprised of nine sets of water-use category records. Each set of water-use category records are comprised of three sets of withdrawal/discharge type records.

Data submitted to the Regional Water Use Database is provided in either million gallons per day (U.S.) (mgd) or million litres per day (mld). There are also two measures of the quality of data provided for each record: level of accuracy and level of aggregation. The accuracy level indicates whether the withdrawals are 100 percent measured, more than 50 percent measured, or estimated. The level of aggregation indicates whether the withdrawal data originate from site-specific sources or from higher-level aggregate sources such as county or census databases.

4.2.4 FINDINGS

The region appears to be moving in the right direction, albeit slowly, regarding the development of programs necessary to facilitate a coordinated regional approach to water use data collection and reporting. Most jurisdictions collect some data at or below the Great Lakes Charter established 100,000 gallon (380,000 litre) per day threshold, but the ability of several jurisdictions to collect and report water use data for all water use categories is lacking. About half of the members of the Water Withdrawal and Use Technical Subcommittee feel their jurisdiction is able to fulfill the Charter data collection and reporting requirements in both legislative/regulatory authority and implementation effort for almost all water use categories. The other half tends to feel that their jurisdiction has relatively strong legislative/regulatory authority but weak implementation efforts.

Even in those jurisdictions with more formal and robust data collection and reporting programs, limitations to obtaining comprehensive and complete water use data may still exist due to the lack of high-quality data at the sector or facility level, inadequate enforcement, or often scarce resources for personnel and other needs to carry out the programs. Jurisdictions where multiple agencies are involved in the water use data collection and reporting process face additional challenges because of the additional coordination required. Jurisdictions that have mandatory reporting requirements built into their programs seem to be more effective than those that do not, due to the more stringent requirements that can be presented to water users and the availability of enforcement mechanisms. Currently, many states and

provinces lack the appropriate statutory or regulatory authority to implement mandatory reporting and/or permitting programs.

Progress has been made in the area of water use data collection and reporting since the Great Lakes Regional Water Use Database became operational in 1988, but the database has limited utility as a management tool due primarily to constraints in the data collection and reporting programs at the state/provincial level. The Great Lakes Regional Water Use Database does not meet all the objectives as a management tool as envisioned by the Water Resources Management Committee in 1987 because it lacks the high data quality that forms the scientific basis needed to inform activities such as trend analysis, demand forecasting and water resources planning in general.

Because the database is missing four years of data, the region lacks the ability to identify trends in water use, such as changes in overall demand, changes in demand for a single jurisdiction, and changes in demand for a single water use category. Trend analysis would provide a valuable planning tool and would allow decisionmakers to project the possible cumulative effects of water use. The states and provinces released in August 2002 the annual report for 1998 data. Reports for subsequent years (1999 and 2000) will be prepared shortly. The Commission will continue a regular, annual cycle to release reports in the early fall. As resources permit at the state and provincial level, data for 1994 to 1997 will be gathered and incorporated into the database.

If the utility of the database as a planning tool is not improved, the annual data collection and reporting becomes little more than an administrative exercise with limited value for the jurisdictions. Under such a scenario, jurisdictions are likely to encounter difficulties in securing funding and other resources for their individual data collection and reporting programs, and the region will continue to be unable to identify water use trends accurately.

The greatest obstacle to overcome is that most jurisdictions are unable to collect and report water use data on an annual basis for at least one water use category. At one extreme, due to staffing and other programmatic constraints, Pennsylvania and Quebec reported 1993 and 1994 data for all water use categories in the 1998 Regional Water Use Database Report.

Overall, the Great Lakes Regional Water Use Database suffers from the following limitations:

- Measured or metered data is lacking and the use of measurements or estimates to collect data varies by jurisdiction;
- The level of accuracy (overall quality) of water use data varies significantly by jurisdiction;
- Accuracy levels are not well documented (accounted) in the databaseto show the usefulness of data in analyses;
- Each jurisdiction follows its own schedule and protocols in data collection and reporting; and
- Jurisdictional programs differ from one another and suffer from lack of funding support and authority to fully develop and implement programs consistent with the Great Lakes Charter.

The most valuable water use data is accurate, which historically has been considered data that is based on site-specific metering and direct measurements. This type of information is not available for many of the water use categories comprising the Great Lakes Regional Water Use Database and can place a heavy administrative burden on the states and provinces. Other collection data processes, such as Michigan's agricultural water use model, have the potential to provide data that are consistent and highly accurate with strong confidence levels. Attaching better measurements of data accuracy and confidence levels would provide information on how close measurements and estimates are to actual withdrawal figures so that necessary improvements in data collection can be identified and pursued. In addition, water use category definitions need to be clarified, and categories may need to be reclassified to better meet regional decisionmaking needs.

The current database provides information that would support decisionmakers; the data shows the amount of water used and consumed in rough geographic areas, which helps identify how lakes will be affected. However, data submitted to the database is aggregated for multiple facilities, estimated in many cases, reported at an annual interval and in some jurisdictions, focused solely on surface water. This level of data quality is inadequate for identifying annual, or seasonal, trends of water use with the reasonable confidence needed for demand forecasts and other planning activities. In addition, aggregate data may not be particularly useful to support the decision-making standard currently being developed to consider proposals for water withdrawal in the Great Lakes Basin, especially those withdrawals made from tributaries of the Great Lakes that are shared by multiple jurisdictions. Such withdrawal proposals need to be considered within the context of the water available from each specific source (i.e., the aquifer or surface water body from which the withdrawal is proposed) so that hydrological and ecological sensitivities for specific sub-watersheds can be addressed. For stream withdrawals, where the quantity of water available is largely a function of the point on the stream where the withdrawal occurs, data should be reported for each individual withdrawal, noting its specific location. Since the data reported by most Great Lakes jurisdictions for most water use categories is an aggregation of data collected for specific withdrawals, reporting data in a less aggregated format should be possible without any major increase in the level of data collection effort. The same principal applies to the consumptive use of water.

Table 2: Summary of All Jurisdictions' Overall Water Use Reporting Programs, January 1, 1998

Jurisdiction	Agencies Involved (lead agency in bold)	Authorizing Laws/Regulations	Permit/ Registration (all water sources unless specified)	Public Participation in Permit Process	Total Principal Facilities	Percent Principal Facilities Reporting	Data Reporting Frequency	Data Compilation Methods	Consumptive Use Compilation Methods	Specificity of Primary Data to G.L Basin	Consistent with G.L. Charter	Funding	Staffing
Illinois	**Department of Natural Resources**; State Water Survey	Level of Lake Michigan Act; Regulation Title 17 Chapter I (h), Part 3730; Voluntary Survey	Permits for Lake Michigan allocations (surface water)	Public hearings held for applications	33	N/A	Annual/ Monthly	Facility measured	N/A (all water consumed)	Yes	Yes	$80,000 (70 DNR, 10 Survey) (G.L Basin)	1.35 FTEs (1 DNR, 0.35 Survey) (G.L. Basin)
Indiana	**Department of Natural Resources**	Indiana Code 14-25-7: Water Resource Management Act	Registration for more than 100,000 g/day capacity	None	540	100	Annual	Facility/state measured or estimated	State estimated	No	Mostly	$10,000 (estimate) (G.L. Basin)	0.2 FTEs (G.L. Basin)
Michigan	**Department of Environmental Quality**	Public Act 451 of 1994, Part 327 Public Act 399 of 1976, Part 15	Registration for public supply, some 100,000 g/day capacity	None	2,221	Nearly 100	Annual	Facility/state measured or estimated	Facility/state estimated	Yes	Mostly	$53,000 (annual fees) (G.L. Basin)	0.9 FTEs (G.L. Basin)
Minnesota	**Department of Natural Resources**	Statute 103G.265 to 103G.315; Rules 6115.0600 to 6115.0810	Permits for use of more than 10,000 g/day or 1 million g/year	Local units given 30 days for comments	118	Nearly 100	Annual with monthly data	Facility measured	State estimated	No	Yes	From State General Fund	0.4 FTEs (G.L. Basin)
New York	**NYS Department of Environmental Conservation**; USGS; ACOE; NYSDOH	NYSECL 15-1609 and 15-1501, NYCRR Parts 675 and 601	Reg. for more than 100,000 g/day use; public supply permits	Water Supply Permit Program only	641	N/A	Annual/ Biennial	Measured or estimated	Measured or estimated	Partially	Mostly	$35,367 (G.L. Basin)	0.65 FTEs (G.L Basin)
Ohio	**Department of Natural Resources, Division of Water**	Ohio Revised Code Sections 1521.15 and 1521.16	Registration for more than 100,000 g/day capacity	None	262	100	Annual	Measured and estimated	State estimated and facility measured	No	Yes	$19,410 (G.L. Basin)	0.3 FTEs (G.L. Basin)
Ontario	**Ministry of Natural Resources**; Ministry of Environment and Energy; Env't Canada	Ont. Water Res. Act: Sect. 34; Water Transfer and Taking Reg. 285/99. Other regs. may influence takings.	Permits for use of more than 50,000 L/day	Applications web posted for 30 days. Public can appeal decisions.	2,827	N/A	N/A	Measured and estimated	Province est. and facility measured (industrial)	Partially	Mostly	No specific, stable funding	1 FTE (G.L. Basin)
Pennsylvania	**Department of Env'tal Protection's Bureau of Watershed Management**	Chapter 109.701 (b) Rules and Regulations; Administrative Code Section 1904-A(3)	Surface withdrawal permits for public supply	Public comment for public supply	26	N/A	Annual	Facility estimated or measured	State estimated/ fac. est. or measured	Yes	Mostly	$6,700 (G.L. Basin)	0.1 FTEs (G.L. Basin)
Québec	Municipalities; Ministry of Agriculture and Fisheries; Industry; Hydro-Québec	Ministry of the Environment; Watercourses Act; Environment Quality Act; other ministries	Permit needed for public supply	Municipality gives public supply comments	171	70-100	When requested	Facility measured (industrial, electric only)	N/A (no systematic mechanism)	Only for hydro	No	$0	0 FTEs
Wisconsin	**Department of Natural Resources**	State Statute 281.35; Natural Resources 142, Administrative Code	Registration for more than 100,000 g/day use	None	414	100	Annual	Facility measured or estimated	Facility estimated	Yes	Yes	$14,000 (state-wide)	0.2 FTEs (state-wide)

Table 3: Summary Characterization of Water Use Permitting, Registration, and Reporting Programs

Jurisdiction	Characteristic	Water Use Category: Public Supply	Self-Supply Domestic	Self-Supply Irrigation	Self-Supply Livestock	Self-Supply Industrial	Self-Supply Thermoelectric	Self-Supply Nuclear	Hydroelectric	Other
Illinois	Permit/Reg.	Permit	N/A			Permit	N/A			Permit
	Water Source	Surface	-			Surface	-			Surface
	Threshold	All	-			All	-			All
	Capacity/Use	All	-			All	-			All
	Req'd Reporting	Yes	-			Yes	-			Yes
	Data Source	Permit program	No existing uses			Permit program	No existing uses			Permit program
Indiana	Permit/Reg.	Registration						N/A	None	Registration
	Water Source	All						-	-	All
	Threshold	100,000 g/day						-	-	100,000 g/day
	Capacity/Use	Facility capacity						-	-	Facility capacity
	Req'd Reporting	Yes						-	-	Yes
	Data Source	Registration program						No existing uses	Volunt. reporting	Reg. program
Michigan	Permit/Reg.	Registration	None	None	None	Registration			None	
	Water Source	All	-	-	-	All			-	
	Threshold	All	-	-	-	100,000 g/day			-	
	Capacity/Use	All	-	-	-	Facility capacity			-	
	Req'd Reporting	Yes	-	-	-	Yes			-	
	Data Source	Reg. program	Not reported	Modelling	Not reported	Registration program			Not reported	
Minnesota	Permit/Reg.	Permit[1]								
	Water Source	All								
	Threshold	10,000 g/day or 1 million g/yr.								
	Capacity/Use	Actual use								
	Req'd Reporting	Yes								
	Data Source	Permit program								
New York	Permit/Reg.	Permit	Registration						None	Registration
	Water Source	All	All						-	All
	Threshold	All	100,000 g/day						-	100,000 g/day
	Capacity/Use	All	Actual use						-	Actual use
	Req'd Reporting	No	Yes						-	Yes
	Data Source	Est. with permits	Registration program						Power agencies	Reg. program
Ohio	Permit/Reg.	Registration								
	Water Source	All								
	Threshold	100,000 g/day								
	Capacity/Use	Facility capacity								
	Req'd Reporting	Yes								
	Data Source	Registration program								
Ontario	Permit/Reg.	Permit	Permit[2]		None	Permit	Permit			
	Water Source	All	All		-	All	All			
	Threshold	50,000 L/day	50,000 L/day		-	50,000 L/day	50,000 L/day			
	Capacity/Use	Allowable use	Allowable use		-	Allowable use	Allowable use			
	Req'd Reporting	No	No		-	No	No			
	Data Source	Federal survey	Federal census		Fed. census	Federal survey	Voluntary reporting			
Pennsylvania	Permit/Reg.	Permit	None	None	None	None	N/A			None
	Water Source	Surface	-	-	-	-	-			-
	Threshold	All	-	-	-	-	-			-
	Capacity/Use	All	-	-	-	-	-			-
	Req'd Reporting	Yes	-	-	-	-	-			-
	Data Source	Permit program	State est.	Volunt. reporting	Not reported	Volunt. reporting	No existing uses			Not reported
Quebec	Permit/Reg.	Permit	None			None	None	N/A	None	N/A
	Water Source	All	-			-	-	-	-	-
	Threshold	All	-			-	-	-	-	-
	Capacity/Use	All	-			-	-	-	-	-
	Req'd Reporting	No	-			-	-	-	-	-
	Data Source	Prov. estimated	Province estimated			Env. Canada	Hydro-Quebec	No existing uses	Hydro-Quebec	No existing uses
Wisconsin	Permit/Reg.	Approval[3]	Approval/Reg.[3]	App/Reg	Permit	Approval/Registration[3]				
	Water Source	All	All	gwater	swater	All				
	Threshold	All	100,000 g/day	100,000	All	100,000 g/day				
	Capacity/Use	All	Facility capacity	Fac. cap	All	Facility capacity				
	Req'd Reporting	Yes	Yes	Yes	No	Yes				
	Data Source	Approval	Approval/Reg.	App/Reg	Volunt.	Approval/Registration				

KEY TO CHARACTERISTICS

Permit/Reg.: Does the jurisdiction have a water use permitting or registration program? If neither, the box for the category is marked "None" for no program or "N/A" for no existing uses and the next four categories are left blank.

Water Source: What water sources (i.e., groundwater, surface water, all) are included in the program?

Threshold: What is the use threshold for inclusion in the program?

Capacity/Use: Does the threshold apply to facility capacity, actual use, or allowable use? If the threshold applies to all uses, "All" is repeated.

Req'd Reporting: Is water use reporting required under the permit or registration program?

Data Source: What is the source of water use data for the 1995 Great Lakes Regional Water Use Data Base?

NOTES

[1] The hydropower category of Minnesota's water use permitting program only covers facilities that divert water out of the river channel. Currently, all Minnesota hydroelectric water uses in the Great Lakes watershed are in the river channel, so reporting

[2] Permits for the self-supply domestic category do not include individual residential use.

[3] Wisconsin has an approval process for many water uses that goes beyond registration but is not a complete permitting process.

4.3. CONSUMPTIVE USES OF GREAT LAKES WATER

4.3.1 DEFINITIONS AND CALCULATIONS

Consumptive use, as defined by the Great Lakes Regional Water Use Database is "that portion of water withdrawn or withheld from the Great Lakes basin and assumed to be lost or otherwise not returned to the Great Lakes basin due to evapotranspiration, incorporation into products, or other processes."[2] Consumptive use is one of several factors that affect the amount of water in lakes and other water bodies. In the Great Lakes Charter, the Great Lakes states and provinces agreed, "that new or increased diversions and consumptive uses of Great Lakes basin water resources are of serious concern." The International Joint Commission (IJC), in its 2000 report to the Governments of Canada and the United States, has recommended that federal, state, and provincial governments should exercise caution with regard to consumptive use of Great Lakes basin waters. Within the Great Lakes Charter, the governors and premiers set forth provisions for notifying and consulting each other on proposed diversions or consumptive uses of more than 5 million gallons (19 million litres) per day and called for increased and improved data collection on water use, diversion and consumptive use.[3]

Conceptualizing consumptive water use is difficult because the amount of water lost to the system is not easily determined, and means are not readily available to measure all water withdrawal and use processes. For instance, if water is "consumed" through evapotranspiration, the water may remain within the basin depending upon where it returns to the earth's surface as rainfall. Similarly, water incorporated into food or beverage products remains in the basin if the product is used or consumed within the basin. Additionally, calculated or measured consumptive uses need to consider the quality of return flows, which may be altered through chemical or thermal processes. The return flow of water may be so severely degraded as to render it unusable, in which case the water is essentially lost to the watershed.

To avoid confusion and establish a workable methodology for calculating, measuring or estimating consumptive water uses will require greater cooperation and coordination on the part of the Great Lakes states and provinces. A common definition along with coefficients that are agreed upon and consistently applied will be an important first step to allowing water resource managers to begin to make professional water consumption calculations in a more uniform manner. Two primary methods of calculating consumptive use are currently employed in the Great Lakes region: subtracting return flows (and conveyance losses) from overall withdrawals and applying a coefficient – a generally agreed-upon water loss as a percentage of withdrawals. This latter method is the one predominantly used in the Great Lakes-St. Lawrence basin.

4.3.2 DATA COLLECTION

The Great Lakes Regional Water Use Database has been providing aggregate information on water withdrawals, diversions and consumptive uses on an annual basis since 1988. All consumptive use figures contained in the annual database reports are provided by individual jurisdictions to the Great Lakes Commission. Table 5 includes the coefficients used by each of the Great Lakes states and provinces in calculating consumptive uses. Most of the consumptive use coefficients applied to the water withdrawal

[2] All the Great Lakes states and provinces use this definition, except Minnesota, which defines consumptive use as any water, not returned to its source (i.e., all groundwater). The U.S. Geological Survey (USGS) and the IJC use similar, but slightly different consumptive use definitions.

[3] The IJC's report, Protection of the Waters of the Great Lakes: Final Report to the Governments of Canada and the United States, (2000, p. 37) notes that the Mud Creek irrigation project in Michigan is the only consumptive use proposal to date large enough to trigger the Charter requirements. The proposal "went forward even though there were objections by some Great Lakes jurisdictions. ... Consequently, the Charter has not yet provided the impetus for an ongoing conversation among the jurisdictions on the subject of consumptive uses."

data submissions to the Great Lakes Regional Water Use Database originated with the USGS or the Technical Work Group of the Water Resources Management Committee, which was supported by the Great Lakes Commission. This group was established in 1988 to develop the protocols and methodology for data submittals to the regional water use database, including establishing uniform water withdrawal and consumptive use estimation procedures. Notwithstanding the lack of documentation or scientific basis for the consumptive use coefficients, state and provincial officials generally believe that the application of coefficients is useful to provide a general sense of consumptive losses by water use category.

Most Great Lakes states and provinces estimate consumptive use at the jurisdictional level, but Wisconsin and Michigan have basic legislative authority to require consumptive use reporting by facilities. Prompted by the Great Lakes Charter of 1985, Wisconsin passed legislation in the late 1980s that requires consumptive use reporting for seven water use categories: irrigation, livestock, thermoelectric power, commercial, industrial, mining, and public water systems. Michigan requires consumptive use reporting for the self-supply thermoelectric (fossil fuel) and self-supply industrial categories only.

Voluntary facility consumptive use reporting occurs in Indiana, New York, Ohio and Pennsylvania through water use registration forms or reports for facilities that use or have the capacity to withdraw 100,000 gallons (380,000 litres) of water per day. New York and Ohio request return flow from registered facilities in withdrawal reports, and Indiana collects return flow data in initial registration forms. In Pennsylvania, the reporting of withdrawals and return flows is only requested for thermoelectric (fossil fuel and nuclear) and industrial (not including mining). Pennsylvania uses this data to calculate consumptive use, but Indiana, New York and Ohio rely on established coefficients due to concerns over its accuracy. Ontario also has some voluntary reporting by industrial facilities, and this data is used for database submissions. Table 4 describes the facility consumptive use reporting processes and applications.

Table 4. Non-Estimated Processes for Consumptive Use Reporting by Facilities

Jurisdiction	Description	**Application**
Mandatory Reporting		
Michigan	Required for self-supply fossil fuel and self-supply industrial only	Submitted for database reports
Wisconsin	Required for all water use categories	Submitted for database reports
Voluntary Reporting		
Indiana	Return flow data for all facilities with the capacity of more than 100,000 gal/day included in initial registration form	Not used (concerns over accuracy)
New York	Consumption data for facilities using more than 100,000 gal/day included in withdrawal reports (public supply not included)	Not used (concerns over accuracy)
Ohio	Return flow data for self supply fossil fuel and self-supply nuclear facilities with capacity of more than 100,000 gal/day	Not used (concerns over accuracy)*
Ontario	Many industrial facilities provide data	Submitted for database reports
Pennsylvania	Return flow data included in withdrawal reports for self-supply categories of fossil fuel, nuclear and non-mining industrial	Submitted for database reports

*Although Ohio does not use this data, consumptive use for the self-supply fossil fuel category is reported by facilities, which apparently base their calculations on withdrawal and return flow data.

Following is a category-by-category description of the consumptive use coefficients used by the Great Lakes States and Provinces to estimate consumptive use of water for the Great Lakes Regional Water Use Database. The nine categories are: 1) public supply, 2) self-supply domestic, 3) self-supply irrigation, 4) self-supply livestock, 5) self-supply industrial, 6) self-supply thermoelectric (fossil fuel), 7) self-supply thermoelectric (nuclear), 8) hydroelectric; and 9) other.

4.3.2.1 Public Supply

All Great Lakes jurisdictions use between 10 and 15 percent as a coefficient to estimate consumptive use for this category. For Illinois, the coefficient does not apply to the Great Lakes basin because all public supply water is diverted from Lake Michigan and entirely consumed. States, provinces and the Great Lakes Commission could consider public supply as the USGS does, and calculate consumptive use by individual user categories (i.e., domestic, industrial) to simplify reporting without compromising data quality.

4.3.2.2 Self-Supply Domestic

The database defines self-supply domestic use as "water used for normal household purposes" or "residential water use." It includes various residential, commercial and institutional water uses. The category includes a multitude of uses that do not neatly fit into any of the other water use categories. Because many of these users are rural or unregulated, water use must be estimated. A coefficient of 75 gallons (284 litres) per day is used to estimate water use. The Great Lakes states and provinces use a coefficient between 10 and 15 percent of withdrawals to estimate consumptive use. These coefficients are exactly the same as public supply. The states and provinces generally agree these numbers provide a good starting point for estimating consumptive use.

4.3.2.3 Self-Supply Irrigation

Eight of the ten Great Lakes jurisdictions use a 90 percent consumptive use coefficient for irrigation. The exceptions are Ontario, which uses 78 percent, and Wisconsin, which uses 70 percent. Irrigation experts and practitioners prefer using evapotranspiration (ET) rates to estimate consumptive use instead of using what many feel is an inflated consumptive use coefficient for irrigation. In the field, ET rates are calculated for particular crops and locales using accepted formulas that consider factors such as the water holding capacity of the soil, the crop root zone, and climate. This scientific calculation of water needs allows for more efficient water use. If crops consume 90 percent of applied water, only 10 percent can be attributed to runoff and percolation. Irrigation is sometimes negatively viewed as a high consumption sector. However, sound conservation and application practices along with technological advances have contributed to a high level of water use efficiency. This means a smaller overall quantity of water is used than would be the case without newer technologies. This distinction between water use and consumption is unique to irrigation and should be incorporated into future discussions and policy decisions.

4.3.2.4 Self-Supply Livestock

This category includes water for livestock, feedlots, dairies, and other on-farm needs. Great Lakes jurisdictions use an 80 percent consumptive use coefficient for livestock except for New York and Wisconsin, which use 90 percent.

4.3.2.5 Self-Supply Industrial

This category includes industrial and mining activities. Coefficients vary more across states and provinces for this category than any other, ranging from 6 percent in Indiana to 25 percent in New York. Several jurisdictions use the type of plant and the Standard Industrial Classification (SIC) code to estimate

industry-specific consumptive use, which averages between 10 and 15 percent. Michigan and Wisconsin are the only Great Lakes jurisdictions that mandate consumptive use reporting by facilities. Michigan does not provide coefficients or technical guidance to assist facilities with their estimations, and about 30 percent of facilities that should report consumptive use do. In Wisconsin, consumptive use reporting by facilities is virtually non-existent due to program weaknesses and lack of enforcement.

4.3.2.6 Self-Supply Thermoelectric (fossil fuel and nuclear)

This category is reported as two distinct categories in the database, but most Great Lakes jurisdictions use the same coefficient for both nuclear and fossil fuel-powered facilities. In most Great Lakes jurisdictions, facilities measure withdrawals and provide that data to the state or province. Since the water is used for cooling purposes, but is not incorporated into products, consumptive use is generally reported to be between 1 and 2 percent. However, Wisconsin uses a low of 0.5 to 1 percent and Ohio uses a high of 14 percent for nuclear. Ohio estimates fossil fuel consumptive use based on individual plant withdrawals and return flows while Illinois and Pennsylvania thermoelectric coefficients relate to cooling processes. Variable water cooling and discharge techniques and evaporation rate issues bring uncertainty into consumptive use calculations for this category.

4.3.2.7 Hydroelectric

Hydroelectric power generation occurs when gravity causes water to fall and drive turbines. This category includes both "instream" and "offstream" uses. Instream means water remains within the water channel whereas offstream involves pumping and storing the water. The amount of evaporation that occurs in hydroelectric power generation is small, so consumptive use is assumed to be zero.

4.3.2.8 Other

This water category was created to include water used for purposes not reported in the other categories. Examples include withdrawals for fish/wildlife, environmental, recreation, navigation and water quality purposes. All jurisdictions report that the coefficient varies depending on the use, with the exception of Indiana, which uses a coefficient of 12 percent. Indiana's reasons for using this coefficient are unclear.

4.3.3 FINDINGS

Accurate and reliable water withdrawal and use data, which form the basis for many consumptive use calculations, are inadequate for providing meaningful and defensible consumptive use information. Currently, consumptive use data have been generated by multiplying the aggregate withdrawal quantity for each use category by a category-specific coefficient. Theoretically, the coefficient represents an average percentage of the water withdrawn that is consumed. Specific withdrawals may consume a smaller or larger percentage, but these differences tend to cancel out, providing an acceptable estimate of total consumption. But category-specific water use coefficients, even if they accurately represent an average consumptive use percentage (which is very much in question), are not suitable for application to individual withdrawals. Consumptive use figures are perhaps most reliable when they are based on location-specific and withdrawal-specific measured withdrawals and return flows. Otherwise, confidence levels for consumptive use data are low. Obtaining credible source-specific and withdrawal-specific consumptive use data will require an effort of considerably greater magnitude than has been thus far undertaken.

Where actual measurements of withdrawals or return flows/discharges are not feasible, such as for irrigation, livestock and rural uses, other reliable methods for calculating or estimating consumptive uses can be applied. Current evidence does not validate consumptive use coefficients, and jurisdictions do not generate comparable data with the current variety of coefficients.

Consumptive use data gathering is not holistically integrated into all water use programs, which produces insufficient administrative support. Wisconsin's experience illustrates this point. In an attempt to be true to the intent of the 1985 Great Lakes Charter, Wisconsin codified a consumptive use reporting program that requires coefficients for seven water withdrawal categories. However, the program has serious limitations because coefficient validity is difficult to prove and withdrawal data is largely estimated.

Some of the larger water withdrawal categories utilize the same coefficients for too many types of distinct activities that in reality use very different quantities of water. For example, manufacturing and mining could have very different consumptive use coefficients and mining practices can also include subcategories. Similarly, there is great variability among the types of uses in the self-supply domestic and livestock categories.

Table 5. Consumptive Use Coefficients By Water Use Category Among Great Lakes Jurisdictions and USGS◊

Water Use Category	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Ontario	Pennsylvania	Quebec	Wisconsin	USGS 1995
Public Supply	10-15%	15%*	10-15%	10-15%	10%*	10-15%	10-15%	10%*	10-15%	10-15%	N/A
Self-Supply Domestic	10-15%	15%*	10-15%	10-15%	10%*	10-15%	10-15%	10%*	10-15%	10-15%	10-15% of withdrawals and deliveries
Self-Supply Irrigation	90%	90%	90%	90%	90%	90%	78%	90%	90%	70%	40-100% of withdrawals and theoretical crop requirements
Self-Supply Livestock	80%				90%*	80%				90%*	10-100% of withdrawals
Self-Supply Industrial	For both mfg. & mining varies by plant and SIC code	6%	10-15%*	For both mfg. & mining varies by plant and SIC code	25%*	10%; except salt mining is 90%*	Facility measured; varies by plant and facility*	For both mfg. & mining varies by plant and SIC code	10% for pulp and paper industry	10.2% for both mfg. and mining	10-40 % depending on type of industry
Self-Supply Thermoelectric (Fossil Fuel)	Varies by individual plant; est. using makeup water for each system.	2%	1-2% for plants using once-through cooling; plant by plant analysis for wet cooling towers*	2%*	2%*	Negligible; estimates based on indiv. plant reports of withdrawals, return flows.	0.9% based on reports of increased local lake evaporation due to discharge of heated water to lakes.	Varies among individual plants.	10%; estimates obtained from USGS report	0.5% - 1%	1-100% varies greatly depending on type of plant and cooling process
Self-Supply Thermoelectric (Nuclear)	Varies by individual plant; est. using makeup water for each system.	N/A Indiana has no facilities in the basin	1-2% for plants using once-through cooling; plant by plant analysis for wet cooling towers.*	2%*	5%*	14%; based on reports of increased local lake evaporation due to discharge of heated water to lakes.	0.9% based on reports of increased local lake evaporation due to discharge of heated water to lakes.	Varies among individual plants.	10%; estimates obtained from USGS report	0.5% - 1%	1-100% varies greatly depending on type of plant and cooling process
Hydroelectric	Coefficient for all states is 0%										
Other	Varies among states and provinces; based on individual evaluations and best information available, except Indiana which uses a 12% coefficient for this category.										

◊based on Great Lakes Commission Survey, Spring, 2002
*denotes change from Great Lakes Regional Water Use Data Repository Representing 1993 Data

4.4. DEMAND FORECASTING

According to the International Joint Commission's *Protection of the Waters of the Great Lakes Final Report,* water supplies and future water demand within and out of the basin remain uncertain. Water demand forecasting may be a useful tool in reducing this uncertainty and in aiding the regional management of the Great Lakes water resources.

The Great Lakes Charter (1985) acknowledges the need for future water use demand assessments to guide future development, management and conservation of the water resources of the Great Lakes basin. The Charter recognizes that a key element of a Great Lakes basin water resources program is,

> Identification and assessment of existing and future demands for diversions, into as well as out of the Basin, withdrawals, and consumptive uses for municipal, domestic, agricultural, manufacturing, mining, navigation, power production, recreation, fish and wildlife, and other uses and ecological considerations.

Furthermore, at the WRMDSS project-sponsored May 15-16, 2002 Scenario Evaluation Workshop, attendees acknowledged that demand forecasting is an important planning tool relevant to any WRMDSS. (Refer to the Scenario Evaluation Workshop Summary Proceedings in Appendix III).

4.4.1 RECENT DEMAND FORECASTING EFFORTS

Presently, five of the ten Great Lakes jurisdictions (Illinois, Minnesota, Ohio, Ontario, and Pennsylvania) have employed demand forecasting in their water management programs. Table 6 below describes the status of demand forecasts within these five jurisdictions.

Table 6. Jurisdiction Demand Forecasting Efforts

Jurisdiction	Demand Forecasting Efforts
Illinois	The DNR does demand forecasting every 8 to 10 years, at which time the long-term demands of all permittees is reevaluated for a 20 to 40 year period.
Minnesota	*Demand forecasting is done for the Twin Cities Metro Area, but not statewide. Projections of water demands are required for new permit requests.*
Ohio	The state periodically produces regional water plans that include water use demand forecasting. The most recent forecasts were done in 1988 for northeast Ohio and 1986 for northwest Ohio. Other forecasts were done in the 1970s.
Ontario	Currently, MNR, MOE, Conservation Authorities and Environment Canada are involved in a multi-year study on water use and supply in the Ontario portion of the Great Lakes basin. This study includes demand forecasting. Previous demand forecasting has been undertaken at irregular intervals by the federal government
Pennsylvania	Demand forecasting is done for public water supply systems on a five to ten year basis with 50-year projections. The last demand forecasts were made in 1995 using the 1990 U.S. Census. With the assistance of the Pennsylvania State Data Center, the Division of Water Use Planning projects municipal populations for counties, which are applied to public water supply service areas with a system per capita usage.

Developing an appropriate demand forecasting methodology is a complicated undertaking, and methods of water demand forecasts will vary according to the scale and scope of the study area. In 1999, the IJC commissioned Donald Tate and Jeff Harris of GeoEconomics Associates to develop water demand forecasts for both the United States and Canadian portions of the Great Lakes basin. These water demand forecasts focused on five water use categories defined by Tate and Harris: agriculture, mineral extraction, manufacturing, thermal power, and municipal. This study uses five main parameters to forecast water demand:

1. *Total water intake* – the total amount of water added to the water system of a given facility, including amounts withdrawn from various sources and for various purposes, or end uses.
2. *Recirculated water* – water used at least twice in an industrial plant, and applied mainly to manufacturing and mineral extraction activities.
3. *Gross water use* – the total amount of water used.
4. *Water consumption* – water that is lost during use or in a production process.
5. *Wastewater discharge* – water that is returned to the environment in the form of water.

In an attempt to better understand future water demand in Ontario, the Ministry of Natural Resources undertook a demand forecasting project with the assistance of GeoEconomics Associates Incorporated between January and June 2002. The project was co-funded by Ontario with a matching grant from the GLPF.

The methodology used for water demand forecasting is based on the application of category specific (e.g. public water use) water use coefficients to water use drivers (e.g. population served by public water supply) where the growth of those drivers is expected to correlate with that of the water use. The water demand forecasting was carried out at the sub-sub-basin level for the years 2001, 2011, and 2021 projected from the base year of 1996. The water demand forecasting report is currently in the final review stage and will be available fall 2002.

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4.4.2 COMPLEXITY OF FORECASTS

Regardless of the methodology, future economic activity, population growth, technological advances, and climate change are examples of factors influencing the outcomes of demand forecasts.

Climate change is one example of an influential factor for which the future impacts in the Great Lakes basin are not well known and debated among experts. Predicting climate change impacts in a specific geographic location is particularly difficult given the current uncertainty associated with the state of the science. However, Donald Tate drew several general conclusions in a 2002 report commissioned by the province of Ontario: climate change will enhance natural climatic variability, average temperatures in North America will rise between 1 to 4 degrees Centigrade (2 to 7 degrees Fahrenheit), and changes in the atmosphere are beginning to affect the hydrologic cycle. Collaborative research with Environment

Canada and the U.S. National Oceanic and Atmospheric Administration show a lowering of water levels of up to one meter (3.28 feet), which may result in serious social, economic and environmental impacts. Climate change is a slow process and may have long-term adverse effects on water availability. Scientific understanding of global climate change must be integrated in long-term water demand forecasts as it evolves.

For purposes of regional water use planning and management, the weaknesses of demand forecasts must be recognized. Influential factors contain an element of uncertainty that constrains the accuracy of any demand forecast. In demand forecasting, uncertainty is reflected in high and low projections and by running the model through various future scenarios. Because uncertainty increases in developing long-term projections, forecasts typically project no more then ten years into the future. This presents a challenge to water managers who handle projects with planning horizons beyond ten years. Without the information generated from demand forecasts, projects would be more difficult to carry out and the projects would have greater uncertainty than currently exists. More sophisticated forecasting approaches should be developed to more accurately address factors that contribute to uncertainty.

Another weakness for demand forecasting is the accuracy of current water use data, which forms the basis of a demand forecast. Varied in scope and accuracy, water use data quality is dependent on collection and compilation processes of individual jurisdictions. Some jurisdictions have experienced resource cuts in their water use data collection programs, and these programs must continue at the federal and state/provincial levels to provide the data necessary for reasonable demand forecasts.

4.4.3 FINDINGS

Demand forecasting can be a useful water resources management tool informing water resources planning activities at the regional, jurisdictional and local levels.

Demand forecasting is an activity that has suffered from lack of financial and programmatic support at the jurisdictional level. Forecasts provide crucial information on where water demand is likely to increase and where financial and other resources may need to be applied to help address these priority areas. Without knowing what and where future demand is likely to be, planners and policymakers have difficulty developing and implementing effective and comprehensive water management programs that include elements such as water conservation and drought contingency planning.

The limitations and weaknesses of demand forecasting as a tool need to be recognized and understood and efforts need to be made to address these issues. As demand forecasting methodology is improved and refined, the ability to project water demand with greater certainty over longer planning horizons should be enhanced. This can help accommodate the longer-term planning horizons required for effective water resources management. The foundation of any comprehensive water demand forecast is reliable, accurate water use data.

4.5. RECOMMENDATIONS

1. **Develop state/provincial legislative and programmatic authority with adequate funding and technical support to carry out the water withdrawal and use commitments in the Great Lakes Charter and Charter Annex.**

All jurisdictions would benefit from increased authority and resources so they can better fulfill commitments they have made in the Charter and its Annex. At a minimum, all states and provinces should ensure they are able to provide accurate and comparable withdrawal information in excess of 100,000 gallons per day average in any 30-day period for all water use categories so decisionmakers have access to meaningful data. To ensure that all jurisdictions comply with their commitments, enforcement mechanisms should be reviewed, including the conditions for participation in the prior notice and consultation process.

2. **Evaluate the effectiveness of the database in supporting the decisionmaking process and adjust the collection of data to meet decisionmaking needs.**

The collection of data needs to match the ~~decisionmaking~~ needs that will result from the decisionmaking process that results from regional commitments. Initially, the current database should be evaluated to determine elements that need to be strengthened. This includes determining whether the current water use categories are clear and provide the best way for processing and using the data. Also, the database uses aggregate data, which may need to be further refined, particularly for sub-watersheds that are shared by jurisdictions, if more detail would support the decisionmaking process. Depending on needs, more information can be gathered on data accuracy and confidence levels so errors are quantified for more informed decisionmaking. Throughout the database evaluation and adjustment process, the states and provinces should be consulted so any new data collection process will receive their support.

3. **Provide a more uniform and consistent base of data and information through the state/provincial water use data collection and reporting programs to facilitate comparison and evaluation.**

Jurisdictions should work together to determine the appropriate level of data accuracy and consistency of withdrawal and consumptive use data within each water use category. The ten jurisdictions may consider working toward providing water use and consumptive use data that is site specific, accurate with high confidence levels (metered, measured or highly accurate estimations), collected at monthly intervals and include all water sources. This will ensure that data for all jurisdictions is comparable, accurate and applicable to a regional decision support system. Each water use category may have specific data collection needs that can be addressed by determining which type of data generation process is most effective. The states and provinces should regularly review water use data availability, collection and reporting on a category-by-category basis to recommend ways to improve this sector specific information.

4. **Develop reporting requirements for incorporation into state/provincial water use data collection and reporting programs.**

Reporting requirements instituted through statutory or regulatory powers would ensure that facilities provide necessary reports in a timely manner. The data collection process outlined in the Great Lakes Charter does not state that reporting should be required, but those jurisdictions that have been most successful in collecting good data have reporting requirements that are attached to compliance mechanisms, such as those within a permitting program.

5. **Revise and upgrade the Great Lakes Regional Water Use Database on a regular basis to make it a more useful planning tool.**

The Regional Water Use Database should become a more viable tool to assist in regional water resources management and planning activities, including developing detailed demand forecasts, creating a water budget, analyzing water use by jurisdiction, and understanding cumulative effects. More reliable and accurate data and information by water use category will be valuable to decisionmakers as they are faced with proposals for new or increased withdrawals or diversions. Data need to be collected at the scale that is appropriate for decisionmaking, and these needs may change over time. Some basic steps that will increase the utility of the database are improving software capabilities, as described in Table 7, establishing and honoring agreed-to data submittal schedules, preparing annual reports on a regular schedule and in a timely manner, continuing the process of reviewing data submittal requirements and methodologies by water use category and refining and expanding the metadata for the database. To reemphasize two of the points above, the states and provinces must commit to providing water use data in a timely manner, and the Great Lakes Commission must reciprocate by producing annual reports promptly. To improve the utility of the database as a planning tool, each annual report should include detailed recommendations that examine ways to alter or present information.

6. Establish authority to require consumptive use reporting that emphasizes reliable and accurate data by water use sector in state/provincial programs.

Measured consumptive use data would provide much more accurate detail about how much water is actually consumed (i.e., lost from the basin) from the various processes of water withdrawal and use. Where measured data is not feasible, research-driven improvements in the accuracy of estimates should be pursued. This would provide information to decisionmakers that would help in evaluation of future water withdrawal or diversion proposals.

Table 7: Software Needs and Recommendations

Presentation of interbasin diversion data: The current software reports total interbasin diversions (the amount of water transferred from the Great Lakes basin into another watershed or vice versa) using a water balance approach. Diversion totals for each water use category, jurisdiction, lake basin or Great Lakes basin are presented as the sum of incoming and outgoing diversions. A more useful way of presenting this information will be to present these data separately.

Presentation of intrabasin diversion data: Intrabasin diversion totals (water flowing from one lake into another, but not leaving the Great Lakes Basin) should also be presented separately and will allow the user to view the data separately rather than as an additive fixed total.

Incorporation of an advanced graphics program into the database: The current database allows production of very simple pie charts reflecting total withdrawals by jurisdiction. Advanced graphics capabilities will allow users to display and print complex and detailed data in multiple graphic styles. As data quality improves, graphics that display trends over years would be crucial in analyzing water demand.

GIS Applications: Spatial displays of water use data in a geographic information system (GIS) format would contribute to the analysis of regional water demand and localized, environmental effects.

Data submission: Annual data should be able to be submitted more quickly and efficiently, at the click of a button. Appropriate enhancement of the software should allow this type of timely, and almost immediate electronic submittal.

Refined table formatting: Jurisdictional users accumulate and submit the number of principal facilities, which are represented by a composite withdrawal figure for each water use category and withdrawal type. However, the actual number of principal facilities contributing to a particular value has not been incorporated into current reports. This enhancement will increase the utility and value of the reports.

Table accuracy: The 1998 water use tables have blank fields where data is not available. Future reports should have a non-numeric figure, rather than a blank, to indicate a lack of credible data for a particular field.

7. Utilize the same consumptive use coefficients, adopted by all jurisdictions, for each water use category.

Measured consumptive use data are not likely to be available in the near future for many water use sectors until new technologies are developed or current technologies become more economical. Creation of consumptive use reporting programs in jurisdictions where they do not currently exist will also take time, money and the exertion of political will. With these limitations in mind, the current approach of relying on consumptive use coefficients should be continued and information on coefficients improved. Additional research should be undertaken to document and establish uniform and consistent consumptive use coefficients. For certain categories such as self-supply industrial, subcategories should be established to provide for a more accurate application of the coefficients. Where facility supplied consumptive use data are available (either measured, calculated or estimated), states/provinces should provide this information to the Regional Water Use Database. This would allow for comparison of this data with the agreed-upon coefficients and new research.

8. Develop regular water demand forecasts to provide effective planning at the state/provincial level.

The states and provinces need to develop new water demand forecasts on a regular basis (e.g., every five years) with a timeframe of at least 20 years. These forecasts should be an integral component of water resources management activities. Each jurisdiction should conduct demand forecasts at a small scale, such as the major watershed or sub-watershed level, so projected changes in water demand and associated effects can be more easily identified for decisionmakers. Dedicated and long-term financial and technical support for demand forecasting is needed at the state and provincial level and should feed into regional demand forecasts.

9. Develop a uniform regional approach to demand forecasting.

Demand forecasting methodology developed at the regional level should be refined to address the need for longer planning horizons and uncertainty related to economic trends, demographic changes, climate change impacts, technological developments and sector improvements in water efficiency. Research and development of demand forecasting methodologies could be pursued among academic institutions around the Great Lakes basin. States and provinces should keep in mind the regional approach when performing demand forecasts at the watershed and sub-watershed level.

4.6. REFERENCES

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