Chapter Three

Inventory of Water Withdrawal and Use Data and Information

Introduction

An inventory of water withdrawal and use data and information in the Great Lakes-St. Lawrence River basin is 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 to provide guidance and oversight to Great Lakes Commission staff in the conduct of this project element. This chapter describes the outcomes of its work by focusing on the background and history of regional water use data collection and reporting activities; describing state and provincial programs for water withdrawal data collection, consumptive use and demand forecasting; and examining how the states and provinces have addressed commitments embodied in the Great Lakes Charter.

Background and History of Water Use Data Collection and Reporting

States, provinces and municipalities of the Great Lakes-St. Lawrence River region have a long history of water resources management, with a primary focus on manipulating freshwater supplies to meet the growing and ever-evolving needs of residents, businesses and other water use sectors.

Increasingly, across North America, many existing sources of water are being depleted or otherwise stressed by withdrawals from aquifers, lakes, rivers and reservoirs to meet these needs. While the Great Lakes-St. Lawrence River region has been largely immune from serious systemwide water shortages, conflicts and supply problems, individual watersheds are increasingly seeing such problems (on a short-term or extended basis) and the attendant ecological, economic and quality of life impacts.

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 U. S. Congress expanded USGS water use activities by establishing a National Water-Use Information Program which, in cooperation with the states, collects reliable and uniform nationwide information on the sources, uses and management of water (see Figure 3-1).

The Great Lakes states work closely with the USGS through its National Water-Use Information Program. However, the concept of a region-

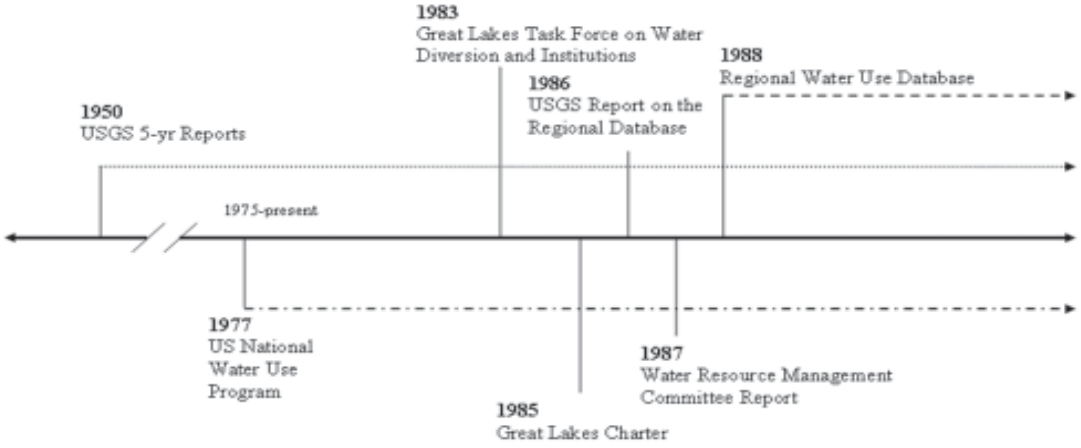

Figure 3-1
Timeline of Great Lakes water use data collection and reporting

specific, binational data system on water withdrawals, diversions and consumptive use has long been of interest to the region's policymakers, managers and scientists.

This interest was heightened in the early 1980s with growing concerns about the vulnerability of the Great Lakes-St. Lawrence River system to harmful large-scale out-of-basin diversions. To address this growing concern, the Great Lakes governors and premiers appointed a Task Force on Water Diversion and Great Lakes Institutions in 1983 to study the issue and offer recommendations. Its report, submitted in January 1985, spoke to the need to protect the water resources of the Great Lakes-St. Lawrence River system by enhancing program and institutional capabilities. The task force was particularly concerned over the state of technical information on water withdrawal and use, stating 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 centerpiece of the task force's efforts was the development of the Great Lakes Charter, signed by the Great Lakes governors and premiers in 1985. A non-binding "good faith" agreement, the Charter provides the principles and framework for strengthening water management activities in the binational Great Lakes-St. Lawrence River system. Among other items, it calls for the establishment of a regional water use database and arrangements for exchanging and comparing water use data and information.

Coinciding with Charter development and implementation were other state/provincial efforts to describe and document their individual water use data collection and reporting programs and to explore opportunities to establish a consistent regional approach to water management. In 1985, for example, the Great Lakes Commission formed a Water Data Collection Task Force to evaluate regional data collection efforts. Through a survey process, this task force determined the extent of withdrawal, return flow and water consumption data in the states and provinces, and also assessed the compatibility of the data. The results were published in an October 1985 report by the Great Lakes Commission titled *Survey and Preliminary Evaluation of the Existing Water Use Data Collection Systems in the Great Lakes States and Provinces.*

Further, in an extensive 1985-86 study undertaken with input from the Council of Great Lakes Governors' Water Resources Management Committee, the USGS examined and compared Great Lakes state and provincial data for nine water use categories. A December 1986 report titled *Water Use Data Collection Programs and Regional Data Base in the Great Lakes-St. Lawrence River Basin States and Provinces* influenced the subsequent design of the Great Lakes Regional Water Use Database.

Following the signing of the Great Lakes Charter, a Water Resources Management Committee (WRMC) was established through the Council of Great Lakes Governors to achieve the objectives of the Charter. In a February 1987 report to the governors and premiers, the WRMC recommended that the Great Lakes Commission serve as the repository for a regional water use database to store, aggregate, manipulate and display state/provincial water withdrawal, diversion and consumptive use data for multiple categories of use.

The Great Lakes Regional Water Use Database became operational in mid-1988. Database maintenance and operation has been provided by the Great Lakes Commission since that time in partial fulfillment of Great Lakes Charter obligations.

Charter Minimum Requirements for Water Use Programs and Data Reporting

The Great Lakes Charter of 1985 provides a regional framework for water resources management with the intent of protecting the Great Lakes region from ill-advised diversion and consumptive use proposals and their deleterious impacts on the region's ecological and economic health. It presents a series of five water management principles along with general guidelines for their implementation. Among others, an 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 were reaffirmed and expanded upon in the 1987 WRMC report, titled *Managing the Waters of the Great Lakes Basin.*

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 Principles" section, the Charter presents 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 are basic requirements in water use data collection and exchange activities that jurisdictions must complete in order to participate in the prior notice and consultation process.

> *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.*

Charter Objectives for a Regional Water Use Database

The Great Lakes Charter calls for development of a common, regional database as a principal tool for regional water resources management. In its 1987 report, the WRMC presented recommendations for data collection and management, laying out the objectives of a regional information system:

> *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.*

In its present form, the Great Lakes Regional Water Use Database meets most, but not all objectives. Among others, limitations of data as well as the lack of a scientific basis to perform such necessary analyses, compromise its utility.

Lake Michigan dunes with power plant in background

Water Resources Management Programs Related to Water Withdrawal and Use

Many state and provincial water resources management programs in the Great Lakes-St. Lawrence River region trace their origin to the 1985 Great Lakes Charter. However, for many years prior, the states and provinces have maintained a variety of independent water use data collection, storage and retrieval systems that have been adapted to meet Charter reporting requirements for withdrawals, uses, and diversions.

Progress Made on Charter Data Reporting Processes

The Charter commits the states and provinces to collect data on all water withdrawals in excess of 100,000 gallons (380,000 litres) per day in the interest of supporting its prior notice and consultation process. In practice, however, this requirement has not been emphasized, with a resultant lack of consistency among jurisdictions in Charter implementation.

Table 3-1 presents an assessment of jurisdictional efforts to fulfill Charter commitments for water use data collection programs. This information was collected by surveying members of the Water Withdrawal and Use Technical Subcommittee, who were asked 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 Charter commitments according to the legislative and/or regulatory 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. This information, while somewhat subjective, is helpful in identifying water withdrawal and use data gaps and information needs.

Several conclusions may be drawn from survey results. About half of the members indicate that their jurisdiction is presently able to fulfill Charter commitments in both legislative/regulatory authority and implementation effort for almost all water use categories. The balance indicate that their jurisdiction is presently able to partially fulfill commitments through legislative/regulatory authority or implementation effort. In most instances, constraints are found in implementation efforts, suggesting inadequate resources to carry out the reporting. Among all jurisdictions, the weakest water use categories for data collection appear to be self-supply domestic, irrigation and livestock.

Technical subcommittee members expressed some difficulty in rating their jurisdictions' 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. For smaller hydroelectric uses, some states, such as Indiana, use electricity generation data collected from the U.S. Federal Energy Regulatory Commission to calculate water use. New York, on the other hand, does not make these calculations because it has more small hydroelectric users and the process would be more time consuming.

States and provinces also report differently on instream hydroelectric uses. Ohio does not report instream uses because it considers them to be incidental uses, while some other jurisdictions do include these uses in their data reports. All states and provinces report offstream 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 have unique considerations that point to a general need for clarifying water use category definitions and determining whether categories should be reclassified.

[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.

Table 3-1
Fulfilling Data Collection Commitments Under the Great Lakes Charter
~Self Assessment by Jurisdiction~

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 drains to Lake Michigan and covers a relatively small area. 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 has provided the information voluntarily. Some of the data is also available online from the Energy Information Administration of the U.S. Department of Energy.
3. Michigan's water use reporting law requires annual reports from irrigated golf courses but not irrigated farms. For agricultural irrigation, the law directs the state to develop an estimation model. That model is now used to calculate 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 are available for self-supply thermoelectric and hydroelectric power but are 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 Great Lakes-St. Lawrence River basin
4 - Covers total quantity of water withdrawals for the required data collection and reporting programs
3 - Covers approximately 2/3 or more of the total water withdrawal quantity for the required data collection and reporting programs
2 - Covers approximately 1/3 to 2/3 of the total water withdrawal quantity for the required data collection and reporting programs
1 - Covers approximately 1/3 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

Chicago shoreline, looking at the Chicago River Lock and Controlling Works – a component of the Lake Michigan Diversion

State and Provincial Programs, Regulations, Statutes and Authorities

A survey of state/provincial water resources management programs 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. (See project report titled, *Report on State and Provincial Water Use and Conservation Programs in the Great Lakes-St. Lawrence Basin.)* 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 withdraw or have the capacity to withdraw 100,000 gallons (380,000 litres) of water per day averaged over a 30-day period. A few jurisdictions also collect data or have requirements at lower withdrawal rates.

Survey information compiled under the project suggests that the region is moving in the right direction, albeit slowly, in developing coordinated programs for water use data collection and reporting. According to a USGS report (Snavely, 1986), data collection programs in the mid-1980s relied primarily on estimated data, and the states and provinces used different water use categories. Significant progress has been made since that time. Currently, annual data submitted by jurisdiction to the Great Lakes Regional Water Use Database fit within 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." A summary of the state and provincial programs (and associated authorization) is presented below. Tables 3-2 and 3-3 also provide summary program information.

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 Lake Michigan withdrawals allowed under a 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 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 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 is available from a combination of facility reports and estimates.

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. 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; the state has no nuclear facilities. 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.

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,

Table 3-2
Summary of Water Use Reporting Programs by Jurisdiction *

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	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	$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	$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	$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	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	$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	$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	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	$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	$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	$14,000 (state-wide)	0.2 FTEs (state-wide)

*Based on status in 1998

Table 3-3
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		Federal 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 estimated	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. gwater	Permit swater	Approval/Registration[3]				
	Water Source	All	All		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				

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.
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 not a complete permitting process.

KEY TO TABLE 3-3 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 1998 Great Lakes Regional Water Use Data Base?

requires public suppliers to register. The MDEQ has no authority to collect data (and voluntary data is not provided) 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 is available from facility measurements and estimates. Golf course irrigation data is based on facility measurements and estimates.

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, provide for implementation of the Water Appropriation Permit Program. Water data is collected for the nine Great Lakes Regional Water Use Database categories. Registered facilities report on 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 been derived 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.

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 (DEC) 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.

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 (DNR). The DNR's Division of Water collects annual data on all nine water use categories in the Great Lakes Regional Water Use Database, and all 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 estimates.

Ontario

Ontario's Ministry of the Environment (MOE) 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 1963. 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 MOE can require reporting under the PTTW program, but does not presently 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.

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 (DEP) 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" uses. Data is collected for facilities using 100,000 gallons (380,000 litres) per day or more but the DEP lacks statutory power to gather data for non-public supply categories. 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.

Québec

The Ministry of the Environment (MOE) oversees most of the water use in Québec (i.e., quality, hydrology), but several other ministries, agencies and municipalities share responsibilities. Under the Environment Quality Act, Québec has several regulations addressing water use, primarily 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 the transport of 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. To fulfill the provisions of the Great Lakes Charter, MOE initiated, in 1994, the collection of available data from other ministries and agencies.

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 (DNR) 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.

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. It was envisioned to be a primary vehicle to support water withdrawal decisions.

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

The nine categories of use included in the Great Lakes Regional Water Use Database are outlined in the previous section. Figure 3-2 depicts water withdrawals by category. Each water use category includes three types of withdrawal/discharge

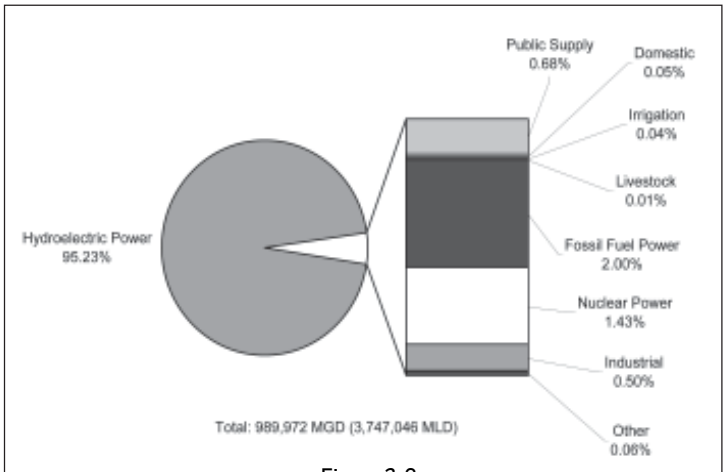

Figure 3-2
1998 water withdrawals by category

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 which, in turn, are comprised of three sets of withdrawal/discharge type records. Figure 3-3 shows water withdrawals by jurisdiction.

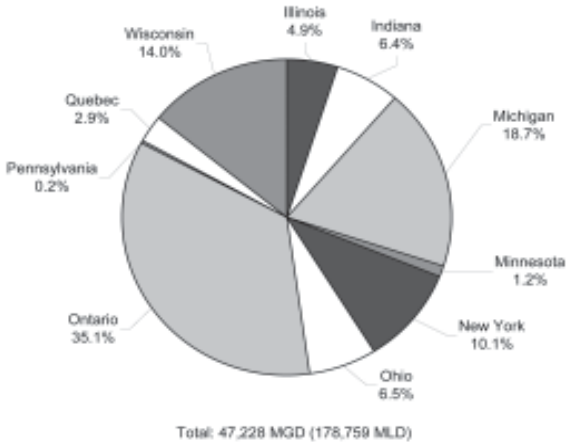

Figure 3-3
1998 water withdrawals by jurisdiction
(not including hydroelectric power)

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.

Discussion

Great Lakes jurisdictions have, over time, made significant progress in developing coordinated programs for water use data collection and reporting. Much work, however, lies ahead. 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 state that their jurisdiction is able to fulfill Charter data collection and reporting requirements in both legislative/regulatory authority and implementation effort for almost all water use categories. The balance believe that their jurisdiction has relatively strong legislative/regulatory authority but weak implementation efforts.

Even jurisdictions with more formal data collection and reporting programs are constrained by the lack of high-quality data at the sector or facility level, inadequate enforcement, and/or limited resources to implement programs. Jurisdictions where multiple agencies are involved in the data collection and reporting process face additional coordination challenges. Jurisdictions with mandatory reporting requirements appear to be more effective than those lacking them, given the more stringent requirements for water users and the availability of enforcement mechanisms. Currently, many jurisdictions lack the appropriate statutory or regulatory authority to implement mandatory reporting and/or permitting programs.

Progress has been made since the Great Lakes Regional Water Use Database became operational in 1988, but the database has limited utility as a management tool because it does not include site-specific data, and constraints in data collection and reporting programs at the state/provincial level have been experienced. Consequently, it lacks the high data quality needed to inform activities such as trend analysis, demand forecasting and water resources planning in general.

The database presently lacks four years of data from most jurisdictions (1994-1997) and, consequently, it has limited utility in identifying trends in water use, such as changes in demand at the systemwide, jurisdictional and water use category levels. Trend analysis would provide a valuable planning tool, allowing, among many other functions, projection of possible cumulative effects of water use.

The states and provinces released the 1998 annual database report in mid-2002. Water use data for 1999 and 2000 were recently submitted by most jurisdictions, and reports for these years will be prepared in 2003. As resources permit, data from 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 remain unable to identify water use trends accurately.

A leading obstacle to improving the utility of the database 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 program constraints, Pennsylvania and Quebec relied upon 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 is characterized by the following limitations:

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

Accuracy, of course, is a key consideration in database utility, but the database only indicates whether data is based on estimated use or site-specific metering and direct measurements. Measured data, however, is not presently available for many of the water use categories. Clarification of category definitions, including prospective reclassification, would also enhance database utility. A prime example is the need to track self-supply domestic separately from self-supply commercial water use.

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 impacts from specific withdrawals and annual/seasonal trends of water use. In addition, aggregate data may not be useful to support the decisionmaking standard currently being developed under Annex 2001 to the Great Lakes Charter, particularly for withdrawals from tributaries shared by multiple jurisdictions. Site-specific data is needed if the hydrological and ecological impacts of a prospective withdrawal are to be accurately assessed.

The data reported by most jurisdictions for most water use categories is an aggregation of data collected for specific withdrawals. Therefore, reporting data in a less aggregated format should be possible without a prohibitive increase in the level of the data collection effort. One inherent problem associated with more specific withdrawal data should be noted; as the level of withdrawal data aggregation decreases, the degree of accuracy also decreases (i.e., the tendency for instances of over-reporting and under-reporting to cancel each other out decreases as the data become more "localized").

Consumptive Use of Great Lakes Water

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, recommended that federal, state, and provincial governments should exercise caution with regard to consumptive use of

[2] All 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 withdrawals). The U.S. Geological Survey (USGS) and the IJC use similar, but slightly different, consumptive use definitions.

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 call 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 or may not remain within the basin depending upon where it returns to the earth's surface as rain or snowfall. Similarly, water incorporated into food or beverage products may or may not remain in the basin depending upon where it is consumed. 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 – in one sense – lost to the watershed.

Two primary methods of calculating consumptive use are currently employed in the Great Lakes region: subtracting return flows from overall withdrawals and multiplying withdrawal quantities by a coefficient that reflects the percentage of water loss. This latter method is the one predominantly used in the Great Lakes-St. Lawrence River basin. Greater cooperation and coordination on the part of the Great Lakes states and provinces is needed to establish a workable methodology for calculating, measuring or estimating consumptive use. A common definition, along with common and consistently applied coefficients, will be an important first step.

Data Collection

All consumptive use figures contained in Great Lakes Regional Water Use Database reports are provided by individual jurisdictions. Table 3-4 presents the coefficients used by each in calculating consumptive uses. Most of these coefficients originated with the USGS or the Technical Work Group of the Water Resources Management Committee. This group was established in 1988 to develop the protocols and methodology for data submittals to the water use database, including establishing uniform water withdrawal and consumptive use estimation procedures. Despite the lack of an overriding scientific basis for the consumptive use coefficients, state and provincial officials generally believe that their application 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 data 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 3-5 describes the facility consumptive use reporting processes and applications.

The following is a description of the consumptive use coefficients used by Great Lakes states and provinces to estimate consumptive use for the nine water use categories included in the Great Lakes Regional Water Use Database. Figure 3-4 shows the percentage of water consumed by each category of use.

Public Supply

All Great Lakes jurisdictions use between 10 percent and 15 percent as the coefficient to estimate consumptive use for this category. For

[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 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."

Table 3-4
Consumptive Use Coefficients by Water Use Category (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%	80%	80%	80%	90%**	80%	80%	80%	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.	N/A	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	1-2% for plants using once-through cooling; plant by plant analysis for wet cooling towers.**	N/A	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.	N/A	N/A	0.5% - 1%	1-100% varies greatly depending on type of plant and cooling process
Hydroelectric	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other	Varies based on use	12%	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	N/A (category not used)

* Based on Great Lakes Commission survey, Spring 2002

** Denotes change from Great Lakes Regional Water Use Data Base Repository representing 1993 data

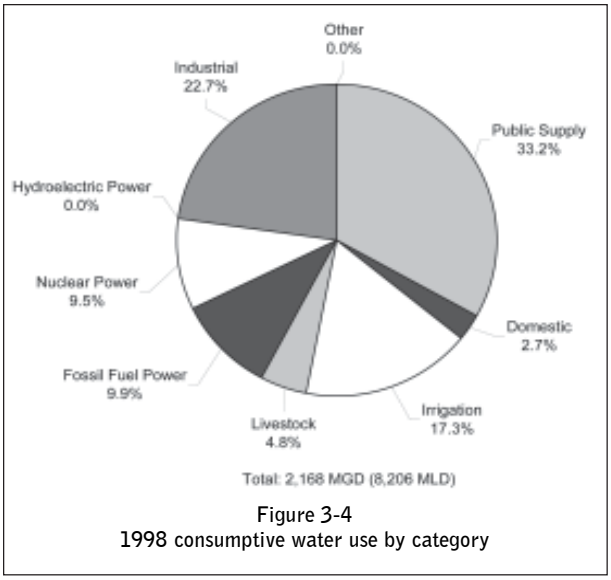

Figure 3-4
1998 consumptive water use by category

Illinois, the coefficient does not apply to the Great Lakes basin because all public supply water is diverted from Lake Michigan and entirely consumed.

Self-Supply Domestic

The database defines self-supply domestic use as "water used for normal household purposes" or "residential water use." The category includes a multitude of uses that do not neatly fit into any of the other water use categories, such as commercial and institutional uses. Many users are rural or unregulated, and, in those instances, water use is estimated at 75 gallons (284 litres) per capita per day. The Great Lakes states and provinces use a coefficient between 10 percent and 15 percent of withdrawals to estimate consumptive use.

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. Many irrigation experts and water resources managers prefer using evapotranspiration (ET) rates to estimate consumptive use instead of using what they believe to be an inflated consumptive use coefficient. 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.

Self-Supply Livestock

This category includes water for livestock, feedlots, dairies, and other on-farm needs. Great Lakes jurisdictions use an 80 percent consump-

Table 3-5
Measured 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 base their calculations on withdrawal and return flow data.

tive use coefficient for livestock except for New York and Wisconsin, which use 90 percent.

Self-Supply Industrial

This category includes industrial and mining activities, and coefficients range from 6 percent in Indiana to 25 percent in New York. Several jurisdictions use the type of industrial facility and the Standard Industrial Classification (SIC) code to estimate industry-specific consumptive use, which averages between 10 percent 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 only about 30 percent of facilities comply with reporting requirements. In Wisconsin, consumptive use reporting by facilities is virtually non-existent due to program weaknesses and lack of enforcement.

Self-Supply Thermoelectric (fossil fuel and nuclear-powered facilities)

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 percent and 2 percent. However, Wisconsin uses a low of 0.5 percent 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.

Hydroelectric

Hydroelectric power generation occurs when gravity causes water to fall and drive turbines. This category includes both "instream"(water remains within the water channel) and "offstream" (pumping and storage) uses. Evaporation in hydroelectric power generation is minimal, and consumptive use is assumed to be zero.

Other

This water category was created to accommodate all water uses not included in other categories. Examples include withdrawals for fish/wildlife, recreation, navigation and water quality purposes. All jurisdictions except Indiana report that the coefficient varies depending on the use. Indiana uses a coefficient of 12 percent, although the basis for this coefficient is unclear.

Discussion

Accurate and reliable water withdrawal and use data are essential in generating meaningful and defensible consumptive use figures. Currently, such data is generated by multiplying the aggregate withdrawal quantity for each use category by a category-specific coefficient. While the use of coefficients does provide valuable information, confidence in their application is often limited. For example, coefficient-calculated consumptive use data may not be accurate at a site-specific level and is more useful at a larger scale. Consumptive use data are most reliable when they are based on measured, location-specific withdrawals and return flows. Obtaining credible, location-specific consumptive use data will require substantial commitments of time and resources in all Great Lakes jurisdictions.

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 consumptive use coefficients cannot be validated by existing data and information and, due to the variance in use of coefficients among Great Lakes jurisdictions, data comparability can be problematic.

Wisconsin's experience illustrates this point. Consistent with the intent of the 1985 Great Lakes Charter, Wisconsin codified a consumptive use reporting program that requires coefficients for seven water withdrawal categories. Given the questionable validity of coefficients, and the fact that withdrawal data is largely estimated, the program has serious limitations.

Some of the larger water withdrawal categories use the same coefficients for many types of distinct activities that, in reality, have very different consumption characteristics. Similarly, there is great variability among the types of uses in the self-supply domestic and livestock categories, suggesting that a single coefficient for each category may be inadequate in determining actual consumptive use.

Demand Forecasting

Water demand forecasting is an essential tool in reducing uncertainty associated with the future status and use of Great Lakes water resources. The Great Lakes Charter acknowledges the need for such assessments to guide future development, management and water conservation activities in 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.*

Demand forecasting has also been acknowledged as an important planning tool in any decision support system – a key outcome of a Scenario Evaluation Workshop conducted in May 2002. (Refer to the Scenario Evaluation Workshop Summary Proceedings in the Appendix).

Recent Demand Forecasting Efforts

Five of ten Great Lakes jurisdictions (Illinois, Minnesota, Ohio, Ontario and Pennsylvania) presently employ demand forecasting in their water management programs. Table 3-6 below describes the status of demand forecasts within these five jurisdictions.

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 the United States and Canadian portions of the Great Lakes basin. These water demand forecasts focused on five water use categories: agriculture, mineral extraction, manufacturing, thermal power, and municipal. Their 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.

To better understand future water demand in Ontario, the Ministry of Natural Resources undertook a demand forecasting project with the assistance of GeoEconomics Associates in early 2002. The project was co-funded by Ontario with a matching grant from the Great Lakes Protection Fund.

Table 3-6
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.

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 water use. Forecasting was carried out at the sub-basin level for the years 2001, 2011, and 2021 projected from the base year of 1996.

In contrast to large-scale water demand analysis, small-scale studies with a narrower focus may take a different approach. An example is found with a water demand analysis of communities in northeastern Illinois. The Illinois Department of Natural Resources – Office of Water Resources contracted with Harza Consulting Engineers and Scientists to develop water demand forecasts of domestic, commercial and industrial water use under the Lake Michigan Allocation Program. The program allocates water to approximately 200 permittees located in four counties in northeastern Illinois. Water demand projections were developed for all permittees based on historic water use data and local demographic projections. The development of population, housing and employment projections was used for the demand forecast analysis. Additionally, the analysis used adjustment factors to account for system-specific conditions that cause water usage to vary among similar communities. The specific purpose of this demand forecasting effort is to review the current allocations and revise them to better reflect expected water use trends.

Complexity of Forecasts

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

Lake Ontario, Toronto's skyline in winter

Climate change is a leading example of an influential factor for which the future impacts in the Great Lakes basin are not well known and widely 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. For example, 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 shows a lowering of lake levels of up to one meter (3.28 feet) by the end of the century, 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 therefore be integrated in long-term water demand forecasts.

The weaknesses of demand forecasts must also be recognized in the interest of assessing their applicability to water resource management. Influential factors inject 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. Uncertainty increases in developing long-term projections, and most conventional economic forecasts 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. More sophisticated forecasting approaches need to be developed to reduce uncertainty.

Discussion

Demand forecasting is an essential tool for informing water resources planning and management activities at the state/provincial, regional, and local levels. Forecasts provide important information on where water demand is likely to increase and where financial and other resources may need to be directed to address priority areas.

The limitations and weaknesses of demand forecasting need to be recognized, understood and addressed. As forecasting methodology is improved and refined, and water use data become more reliable and accurate, the ability to project water demand with greater certainty over longer plan-

ning horizons will be enhanced. The foundation of any comprehensive water demand forecast is reliable and accurate water use data.

Findings and Recommendations

Findings

A number of findings can be derived from the assessment of state and provincial water use data collection programs. Many aspects of current state/provincial programs, for example, must be further developed and coordinated if regional water management efforts are to be strengthened and the full potential of the Great Lakes Charter and Annex is to be realized. 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 state that their jurisdiction is presently able to fulfill the Charter data collection and reporting requirements in terms of both legislative/regulatory authority and implementation effort for most water use categories. The balance state that their jurisdiction has relatively strong legislative/regulatory authority but weak implementation efforts. Jurisdictions that have mandatory reporting requirements built into their programs appear to be more effective than those that do not, due to the more stringent requirements and the availability of enforcement mechanisms.

Progress has been made in the area of water withdrawal and use data collection and reporting since the Great Lakes Regional Water Use Database became operational in 1988. The database, however, has limited utility as a management tool because it does not include site-specific data and constraints exist in the state/provincial data collection and reporting programs. Data is aggregated for multiple facilities, estimated in many cases, reported at an annual interval and, in some jurisdictions, focus solely on surface water. This level of data quality is inadequate for identifying hydrological impacts and associated ecological effects with the confidence needed for demand forecasts and other planning activities.

The current status of consumptive use accounting is similar to that of water use data collection. However, the level of confidence is much lower because the amount of water lost to the system is difficult to determine. Consumptive use calculations are inadequate for providing meaningful and defensible consumptive use information because they are based on partially estimated water withdrawal and use data. Current evidence does not validate consumptive use coefficients, and jurisdictions do not generate comparable data with the current variety of coefficients.

Demand forecasting is an essential water resources management tool for informing water resources planning activities at the regional, jurisdictional and local levels. Forecasts generate crucial information on where water demand is likely to increase and where financial and other resources may need to be applied to help address priority areas. Although demand forecasts are important, they often lack financial and programmatic support at the jurisdictional level. 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.

Recommendations

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

   All jurisdictions would benefit from increased authority and resources to better fulfill commitments they made in the Great Lakes Charter and its Annex. At a minimum, all states and provinces should ensure they are able to provide accurate and comparable information for withdrawals that exceed 100,000 gallons per day average in any 30-day period for all water use categories. 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 Great Lakes Regional Water Use Database in supporting the decisionmaking process and revise and upgrade as needed to make it a more useful planning tool.**

   Data collection must match the needs of the decisionmaking process. The current

database should be evaluated to determine elements that need to be strengthened. This includes determining whether the current water use categories are appropriate and provide the means to process and use data. The use of aggregate data should be refined, particularly for sub-watersheds that are shared by jurisdictions. A finer resolution of data is needed to assess ecological impacts, particularly at the sub-watershed and nearshore scale, while respecting the prospective need for confidentiality of site-specific data. Data accuracy and confidence levels need to be improved to better inform the decisionmaking process. Further. states and provinces must strive for comprehensiveness, consistency and collaboration in developing a regional water management program.

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, understanding cumulative effects, and recommending (on an ongoing basis) means to enhance database utility. 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 (see Table 3-7), 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.

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 should work toward providing water use and consumptive use data that are site specific, accurate with high confidence levels (metered, measured or highly accurate estimations), collected at monthly intervals, and inclusive of all water sources. This will ensure that data for all jurisdictions are 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 help ensure that facilities – and state/provincial agencies – provide necessary reports in a timely manner. The data collection process outlined in the Great Lakes Charter does not assert that the states and provinces must require reporting, 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. **Improve state/provincial consumptive use reporting processes to ensure reliable and accurate data.**

   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.

6. **Develop and apply uniform consumptive use coefficients for each water use category until such time that a better method of measuring consumptive water use is available.**

   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. Establishing consumptive use reporting programs in jurisdictions where they do not currently exist will also take time, resources and political commitment. With this in mind, current reliance on consumptive use coefficients should be continued, but those currently in use must be refined to be scientifically credible and uniformly adopted and applied. 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.

7. **Develop and regularly pursue a uniform regional approach to demand forecasting in the interest of strengthening jurisdictional and regional planning processes.**

   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 should be pursued among academic institutions around the Great Lakes-St. Lawrence Region. States and provinces should keep in mind the regional approach when performing demand forecasts at the watershed and sub-watershed level.

   New water demand forecasts need to be developed 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, long-term financial and technical support for demand forecasting is needed at the state and provincial level and should feed into regional demand forecasts.

Table 3-7
Software Needs and Recommendations

Presentation of interbasin diversion data: The software presently used for the Great Lakes Regional Water Use Database 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 is 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 geo-referenced and presented so that the user may 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: Geographical information system (GIS) applications, tools, and spatial displays of water use would contribute to the analysis of regional water demand and localized environmental effects.

Table 3-7
Software Needs and Recommendations (cont.)

Data submission: Annual data should be submitted quickly and efficiently, and at the click of a button. Enhancement of the software would 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 reports to date. Such an enhancement would increase the utility and value of the reports. For reasons of confidentiality, some data must remain aggregate.

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.

References

Blake, D. 2002. Report on State and Provincial Water Use and Conservation Programs in the Great Lakes-St. Lawrence Basin. Great Lakes Commission.

The Great Lakes Charter: Principles for the Management of Great Lakes Water Resources. 1985.

Great Lakes Commission. 1985. Survey and Preliminary Evaluation of the Existing Water Use Data Collection Systems in the Great Lakes and Provinces: Final Report of the Water Data Collection Task Force.

Great Lakes Commission. 2002. Annual Report of the Great Lakes Regional Water Use Database Repository Representing 1998 Water Use Data.

Great Lakes Governors Task Force on Water Diversion and Great Lakes Institutions. 1985. Final Report and Recommendations: A report to the governors and premiers of the Great Lakes states and provinces prepared at the request of the Council of Great Lakes Governors. January.

Great Lakes Water Resources Management Committee. 1987. Managing the Waters of the Great Lakes Basin: A Report to the Governors and Premiers of the Great Lakes States and Provinces.

IC 14-25-7 (Indiana Water Resource Management Act). 615 ILCS 50 (Level of Lake Michigan Act).

17 Ill. Adm. Code Part 3730 (Allocation of Water from Lake Michigan).

Illinois Department of Natural Resources, Office of Water Resources (prepared by Harza, Consulting Engineers and Scientists). 1998. 1998 Update of IDNR Lake Michigan Water Allocation.

International Joint Commission. 2000. Protection of the Waters of the Great Lakes: Final Report to the Governments of Canada and the United States.

Mich. P.A. 451 of 1994, Part 327 (Natural Resources and Environmental Protection Act).

Mich. P.A. 399 of 1976, Part 15 (Safe Drinking Water Act).

Minn. Rules 6115 (Public Water Resources).

Minn. Stat. 103G (Water Law).

6 NYCRR, Part 601 (Water Supply Applications).

6 NYCRR, Part 675 (Great Lakes Water Withdrawal Registration Regulations).

NYSECL 15-1501 (Water Supply).

NYSECL 15-1609 (Great Lakes Water Conservation and Management).

Ohio RC 1521 (Division of Water).

Ontario Water Resources Act (OWRA) of 1963

25 Pa. Code 109 (Pennsylvania Safe Drinking Water).

Pebbles, V. 2002. Measuring and Estimating Consumptive Use of Great Lakes Water. Great Lakes Commission.

Quebec R.S.Q. Chapter Q-2 (Environment Quality Act).

Quebec R.S.Q. Chapter R-13 (Watercourses Act).

Quebec Bill 73, 1999 Chapter 63 (Water Resources Preservation Act).

Snavely, D.S. 1986. 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.

Tate, D. 2002. The Walkerton Inquiry Commissioned Paper 22: Water Quantity and Related Issues: A Brief Overview. Ontario Ministry of the General Attorney: Toronto. www.walkertoninquiry.com/part2info/commissuepapers/06tate/22-Tate.pdf. 19 Sept. 2002.

Tate, D. and J. Harris. 1999. Water Demands in the Canada Section of the Great Lakes Basin, 1972-202. Ottawa: Canadian, IJC, and Water Demands in the United States Section of the Great Lakes Basin, 1985-2020. Washington D.C.: United States, IJC.

U.S. Geological Survey. 1998. Estimated Use of Water in the United States in 1995. U.S. Geological Survey Circular 1200.

Wisc. Admin. Code NR 142 (Water Management and Conservation).

Wisc. Statutes 281.35 (Water Resources Conservation and Management).