Baseline Sustainability Data for the Lake Superior Basin

Final Report to the Developing Sustainability Committee
Lake Superior Work Group
Lake Superior Binational Program

November 2000

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Funding provided by U.S. Environmental Protection Agency, Region 5, Grant No. X995434-01

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Executive Summary

This project gathered baseline data for a suite of socioeconomic sustainability indicators drawn from the Lake Superior Binational Program 1995 *Ecosystem Principles and Objectives for Lake Superior* (EPO). Guided by the "best bet" measures identified by the Developing Sustainability Committee of the Superior Work Group, the project researchers sought data that showed baseline conditions or trends in sustainability without requiring new data to be collected. The project protocol section and Appendix 2 describe the criteria established for obtaining, managing, and analyzing data relevant to the sustainability indicators. Section 3 summarizes the status of data acquired for the project. Section 4 describes many of the sustainability measures in detail, as summarized below.

Among the measures of the "Reinvestment of Natural Capital" indicator, only the amount of sustainable forestry is addressed in this report. Four certification programs operate in the Lake Superior Basin. The SmartWood program of the Forest Stewardship Council has certified 206,473 acres. The Canadian Standards Association has not yet certified any forests in the Basin. Most large forest products companies have signed on to the American Forest and Paper Association's Sustainable Forestry Initiative, some using ISO 14001 standards, but no acreage figures were found. Ontario has a number of programs to encourage sustainable forestry, as does the Great Lakes Forest Alliance.

U.S. and Canadian census data show trends in some measures of the "Quality of Human Life" indicator: population density and migration, family structure, incidence of crime, and travel to work. Population in the U.S. portion of the Basin declined 4 percent from 1930 to 1990 and 8 percent from 1980 to 1990, while the U.S. population increased 102 and 10 percent, respectively. Mean population density was 9.95 persons per square kilometer in the U.S. part of the Basin in 1990 and 2.19 persons/km^2 in the Ontario part of the Basin in 1991. More than 60 percent of Basin residents lived in the same house as they did five years earlier, and more than 80 percent lived in the same U.S. county or Canadian census subdivision. An increasing percentage, nearly 30 percent, of Basin households in the U.S. have members 65 or older. More than 60 percent of seniors in the Ontario Lake Superior Basin live with their immediate families, but 82 percent of the rest live alone. The percentage of family households and married-couple households, as well as the number of persons per household, declined between 1980 and 1990. The Basin's crime rate varied over time and by specific area, but was generally much lower than the U.S. average. Between 1980 and 1990, the percentage of workers driving alone to work rose from 58 to 73 percent, while fewer carpooled or walked to work, mirroring national trends.

Information gathered on another quality-of-life measure, transportation infrastructure in the Basin, includes sections on road and bridge condition, traffic volumes, public transit, airports, railroads, and Lake Superior ports, with the greatest detail for Michigan. In the Upper Peninsula, 51 percent of roads were in good or excellent condition, 25 percent fair, and 24 percent poor or very poor in 1999, an improvement since 1997, when 31 percent were in poor or very poor condition. An independent study concluded that Michigan counties currently have only 11 percent of the funds needed to bring county roads and bridges up to a "good" level during 1999-2008. The situation is similar in northeastern Minnesota and Wisconsin. Projections for 2020 in Wisconsin include extreme or severe traffic congestion areas in parts of the Lake Superior Basin.

Michigan overall has seen a 38 percent increase in highway miles traveled between 1984 and 1998. A limited survey of traffic volumes in the Michigan part of the Basin from 1987 to 1998 shows an average 34 percent increase in traffic in regional population centers and little change in most rural areas. Use of carpool parking lots in the Michigan Lake Superior Basin increased from 21 vehicles in 1975 to 154 in 1987, then declined steeply to 56 vehicles in 1995 before rising again to 88 in 1999. The number of airline passengers in the Michigan portion of the Basin declined 18 percent from 1978 to 1998 but has been relatively stable during the 1990s.

The level of educational attainment in the U.S. Lake Superior Basin rose between 1980 and 1990 but continued to lag behind the three states and the U.S. in the percentage of college graduates (16.1 percent of adults in 1990, compared to 20.3 percent nationally). However, 78 percent of adults in the Basin had completed at least 12 years of school, compared to 75 percent nationally. In the Ontario census subdivisions within the Basin, 66 percent of adults in 1996 had completed secondary school, 12 percent were college graduates, and another 10 percent had some college education.

Measures of the "Resource Consumption" indicator for which relatively extensive information is available are availability of recycling programs, landfill capacity and incineration volume, types and quantities of electric power generation, quality and volume of aquifers, status of forest resources, and degree of urban sprawl (represented by population density maps and data on the duration of commute to work). The main generalization about recycling and household hazardous waste (HHW) collections in the Basin is that participation is much higher and materials recovery greater in Minnesota and Wisconsin, where statewide programs are well developed and certain materials are banned from landfill disposal. Large areas of the Michigan part of the Lake Superior Basin have no recycling or HHW programs at all, and very little information was available on Ontario programs.

Many landfills and unlicensed dumps within the Lake Superior Basin have closed. Some are part of cleanup programs. Data is not complete or uniform enough to draw Basin-wide conclusions about trends in waste disposal, other than that the total disposed by landfill or incinerator appears to exceed 2 million cubic yards per year. The only Refuse Derived Fuel incinerator operating within the Basin—in Duluth, Minnesota—has accepted only sewage sludge since mid-1999 and is expected to shut down completely in 2001.

Most of the electric power generated in the Basin comes from fossil fuel generators using coal, natural gas, fuel oil, or wood waste; the remaining 15 to 20 percent of power is hydroelectric. Total power generated in the U.S. part of the Basin increased 47 percent from 3,204 gigawatt-hours in 1985 to 4,719 gigawatt-hours in 1995. Nearly three quarters of the total comes from the watershed surrounding Marquette, Michigan; another 15 to 18 percent is generated in the Duluth-Superior region. The amount of power purchased also increased. The average residential consumer in 1998 used 7,750 kilowatt-hours, and the average use per consumer for all sectors (residential, commercial, industrial) was 35,340 kWh. Ontario expects to have excess generating capacity through 2009. Renewable energy sources other than hydroelectric account for a small percentage of generation in the Basin.

Total water use from all sources in the U.S. portion of the Lake Superior Basin increased 25 percent from 682 million gallons per day in 1985 to 851 Mgal/day in 1995. Half or more of this

water was used for power generation, 22 to 34 percent for mining, and 10 percent or less each for public supply and industry. Groundwater supplied only about 5 percent of water used by all sources but served about half of all residents. Some areas are heavily dependent on groundwater, especially for household and public supply. The six largest municipalities in the Ontario portion of the Basin (about 79 percent of the total population) used the equivalent of 23.3 Mgal/day in 1996, 45 percent for domestic supply, 30 percent commercial/institutional, and 14 percent industrial. About 14 percent of total use came from groundwater. Water sources and treatment processes used by Ontario municipalities and aquifers used in the U.S. Lake Superior Basin are summarized. Wastewater treatment systems for the same areas are also discussed; actual flows in nearly half of the U.S. wastewater systems in 1996 equaled or exceeded their design flows.

Some information is available on forestry resources remaining in the Basin states, though not specifically for the Basin itself. The Great Lakes Forestry Alliance reported in 1995 that timber growth in Michigan, Minnesota, and Wisconsin exceeded harvest by 90 percent and timber volume increased from about 25 billion cubic feet in 1952 to more than 50 billion cubic feet in 1992. The three states have 51.5 million acres of forest land, of which 3.2 million acres are either reserved as parks and wilderness or classified as unproductive. Of the productive land, 26 million acres are nonindustrial private forests, 18 million acres are publicly owned, and 4 million acres are owned by forest-products companies. The Canadian National Forestry Database Program has tables of forest area, classification, ownership, and productivity by province or territory. Maps present the information visually, but there are no Basin boundaries or statistics.

Very little information was found for measures of the "Awareness of the Capacity for Sustainability" indicator, other than incorporation of ecological design into building codes, which also relates to the "Resource Consumption" indicator. Natural Resources Canada's Office of Energy Efficiency has developed standards and voluntary programs for energy efficiency in new and existing private homes and commercial buildings, but there has been relatively little participation within the Lake Superior Basin to date. However, one NRCan representative noted that most houses currently built to code approach the program's original energy efficiency target. The U.S. Green Building Council has developed a rating system for new and existing commercial, institutional, and high-rise residential buildings and is working on separate rating systems for residences and buildings constructed before 1995. The USGBC certification program does not appear to be active within the Lake Superior Basin, however.

"Economic Vitality" is one of the best-represented indicators in this report, including measures of per capita income, cost of living, extent of poverty, local employment trends, and diversity of communities' economies. Median family and household incomes within the U.S. Lake Superior Basin were below the national and Michigan, Minnesota, and Wisconsin medians in 1979 and 1989 but were improving somewhat by 1993. The medians varied considerably by county. Mean per capita income in 1990 for the U.S. part of the Basin was $11,029, compared to US$19,268 in 1996 for the portion of the Ontario Lake Superior Basin that reported income data.

As a partial gauge of the cost of living, housing costs in the U.S. Lake Superior Basin as a percentage of income were generally higher than for the U.S. or the three states in 1980, but by 1990, housing costs within the Basin were somewhat lower than average. Considerable variability exists among the 16 counties.

The extent of poverty for all persons, families, and children increased in the U.S. portion of the Basin between 1979 and 1989 at a faster rate than for the U.S. overall during that period. Only persons 65 and older improved their status. Poverty rates varied by group from 7 to 17 percent. Poverty rates varied considerably from county to county. In the portion of the Ontario Lake Superior Basin that reported income data in 1996, 13 percent of families, 39 percent of unattached individuals, and 16 percent of private households were considered low-income. As in the U.S., some areas had much higher rates than others.

Unemployment within the U.S. Lake Superior Basin averaged about 2.1 points above the national rate for five sample years between 1975 and 1995, but rates varied considerably both over time and from county to county. Unemployment rates in the Basin trended generally downward from 11.9 percent in 1985 to 6.7 percent in 1995 but remained higher than the U.S. or the three states. The 1996 unemployment rate in the Ontario portion of the Basin was 9.1 percent.

Professional and related services, wholesale and retail trade, and manufacturing employed 53 percent of U.S. Lake Superior Basin residents in 1980 and 58 percent in 1990, compared to 59 and 58 percent nationally. Manufacturing employed 21 percent of workers nationwide in 1980 but only 11 percent of Basin workers. Those figures had dropped to 17 and 10 percent, respectively, by 1990. Mining employed 8 percent of Basin workers in 1980 and 4 percent in 1990; both rates are considerably higher than the 1 percent or less nationwide. Agriculture, forestry, and fisheries employed less than 2 percent of Basin workers both years, compared to nearly 3 percent nationwide. In the Ontario part of the Basin in 1996, professional and related services, wholesale and retail trade, and personal, entertainment, and recreation services employed 51 percent of workers, with another 13.5 percent employed in manufacturing.

The four largest industries by percent of earnings within the U.S. Lake Superior Basin in 1987 were state and local government, services, retail trade, and durable goods manufacturing. Services topped the list in 1997, followed by state and local government, but no single category was clearly the third most important overall among the 16 Basin counties. Seven industries (nondurable goods manufacturing, durable goods manufacturing, retail trade, mining, transportation and public utilities, federal civilian government, and construction) were among the top three industries in 6 or fewer counties each, suggesting an increase in economic diversity or instability. Services, durable goods manufacturing, and state and local government were the top three contributors to earnings in the three states both years. Durable goods manufacturing declined most in the three states during the period, while finance, insurance, and real estate grew fastest in Michigan and Wisconsin. Services grew fastest in Minnesota. Retail trade had the slowest growth from 1987 to 1997 in 5 of 16 counties, followed by state and local government and transportation and public utilities. Services and construction were the fastest growing industries in 4 counties each, and durable goods manufacturing grew fastest in two counties. Seven other industries were the fastest growing in one county each.

Additional data gathered but not incorporated into this report and gaps in the data are discussed in Section 5. Appendix 1 contains a table of data sources and contacts, organized by sustainability indicator and measure. Appendix 2 describes inclusion/exclusion criteria for data reported by county. Appendices 3-5 contain tables, figures, and maps, respectively. A set of bookmarks for Internet sites relevant to the project is attached as Appendix 6.

1. Introduction

This project gathered baseline data for a suite of socioeconomic sustainability indicators drawn from the Lake Superior Binational Program 1995 *Ecosystem Principles and Objectives for Lake Superior* (EPO). Guided by the "best bet" measures identified by the Developing Sustainability Committee (DSC) of the Superior Work Group, the project researchers sought data that showed trends in sustainability without requiring new data to be collected. The first step was to establish a protocol for obtaining, managing, and analyzing baseline data relevant to the sustainability indicators in order to describe current conditions, discern trends, and identify gaps in the data.

Evaluating the time and effort required to format data for the proposed sustainability indicators was also important. An Internet search of Federal, State, Provincial, and local agencies provided useful data, such as 1990 U.S. census block demographics. Canadian census data for 1996 (and later, 1991 and 1986) had to be purchased once the appropriate reporting unit was identified. Census demographic data is thus available across the entire Basin and has the advantage of collection at regular time intervals. Some other data covers only part of the Basin or is derived from a one-time study and so may be less useful. However, such studies may address particular indicators better than some traditional measures designed for other purposes and may be replicated elsewhere in the future. Therefore, accumulating information from one-time or geographically limited studies was part of this project from its inception.

As data was obtained on some indicators, both trends and gaps in data by geographic area or time emerged. Other gaps simply represent an incomplete information search. Appendix 1 documents the information sources consulted for each sustainability measure. For some indicators, the most promising sources of information may not yield results. Some measures that are highly relevant to sustainability, especially the measures of the awareness of the capacity for sustainability, either do not exist yet or appear difficult to quantify. For example, it probably will be difficult to determine popular support for environmental regulations without a survey focused on that topic. Media coverage of sustainability-related issues can theoretically be documented but obtaining such information consistently across geographic and time boundaries will be challenging.

The project met its goal of obtaining and analyzing data for at least 15 to 20 measures as initial sustainability indicators. The focus was on measures for which (1) data is currently available, (2) comparable data will likely be available in the future, and (3) data can be used as is or with relatively minor modification, such as selecting a subset from a statewide or national database. Data for some measures took considerable time to compile, often because of the need to determine which data belonged within the Lake Superior Basin. However, subsequent updates will benefit from that initial time investment in that only new locations will need investigation.

This report, including the digital data obtained, will be provided to the Developing Sustainability Committee and U.S. Environmental Protection Agency on CD because many of the files are quite large. For this reason, no figures or maps and only two tables are incorporated into the text. Instead, the figures, tables, and maps appear in order as PDF files in three separate appendices. The files can be viewed with Acrobat Reader, available for free download at www.adobe.com/products/acrobat. The project also accumulated printed materials, which are filed in folders by sustainability indicator and measure. Those files will be maintained by the DSC.

2. Project Protocol

A basic challenge of this project was to create a database for the Lake Superior Basin from data that is reported by political, census, or organizational boundaries that generally do not coincide with the natural Basin boundary. In some cases, a number of data-reporting units fall completely within the Basin and must be joined together for analysis. Sometimes, only part of a given reporting unit falls inside the Basin. That unit must be counted in, out, or given a weighting factor to reflect how much is counted in. To analyze such data, one must superimpose the Basin boundaries on the data boundaries. Geographic information system (GIS) software, which combines relational database and mapping features based on spatial coordinates, is best suited to this task.

In order for sustainability indicators to be consistently evaluated over time, it is important to document the source of all data, digital or printed, and how the data was manipulated for the project. Such information is known as metadata, or data about data, and is similar to documenting a chain of ownership. Documentation of the metadata is part of the Quality Assurance Project Plan approved by Region 5 of the U.S. Environmental Protection Agency for this project.

Digital data was imported into ArcView 3.1 GIS software from the Environmental Systems Research Institute (ESRI), where it could be linked to maps for analysis. Some data was brought into ArcView by counties and merged into a database for the 24 U.S. counties that are at least partly in the Lake Superior Basin. Other data was available for the entire U.S. or a region larger than the Basin and had to be selected or clipped to the Basin boundary in cookie-cutter fashion, using ArcView's features.

For U.S. data reported by census block group (CBG), available for all 24 counties, the population is 423,907 in CBGs that are mostly within the Lake Superior Basin. Another 212,717 persons reside in CBGs mostly outside the Basin in those same counties. The land area in the 24 counties represented by CBGs mostly in the Basin is 42,606 km2. CBGs mostly outside the Basin contain 49,123 km2. Therefore, while 54% of the land area of the 24 counties falls outside the Lake Superior Basin, two-thirds (67%) of the population lives in the Basin (Appendix 2).

To determine if data reported at the county level should be considered in or out of the Lake Superior Basin for a given county, ArcView was used to select individual CBGs that fall mostly or wholly within the boundary of the Lake Superior Basin. The population represented by all the CBGs in a county that are mostly inside the Basin was compared to the population in the remaining CBGs. If more people resided within the Basin, that county was included in the data analysis. The sixteen U.S. counties considered in the Basin by this process are Alger, Baraga, Gogebic, Houghton, Keweenaw, Luce, Marquette, and Ontonagon, Michigan; Ashland, Bayfield, Douglas, and Iron, Wisconsin; and Carlton, Cook, Lake, and St. Louis, Minnesota. The eight counties that are partly in the Lake Superior Basin, but mostly outside, are Chippewa, Mackinac, Iron, and Schoolcraft in Michigan; Vilas in Wisconsin; and Aitkin, Itasca, and Pine in Minnesota. Chippewa County is included in some measures, however, because its major population center, Sault Ste. Marie, is partly in the Basin.

In Ontario, the political and census boundaries are somewhat more complex. The area that includes the Lake Superior Basin consists of 36 census subdivision units, including parts of three

large "unorganized" districts, two cities, 13 First Nations reserves, one town, and 18 townships. Census reporting units and dates differ from those used in the U.S. While the U.S. Census is conducted the first year of each decade (e.g., 1980, 1990), Canadian Census data is collected at five-year intervals (1991, 1996, etc.)

Data was initially purchased for census subdivisions (CSDs), which are roughly comparable to minor civil divisions (city, village, township, county) in the U.S. Of the 36 CSDs within the Lake Superior Basin, five are First Nations reserves that did not participate in the 1996 Census. “Area Profiles” were purchased from Statistics Canada for the other 31 Lake Superior Basin census subdivisions, along with files that can be converted to ArcView shapefiles for mapping of the data. The total population represented by the 31 CSDs is 253,225 in 1991 and 255,475 in 1996.

The census enumeration area (EA) in Canada is the smallest standard geographic area for which census data is reported. The EA is also the nearest equivalent to the census block group level in the U.S. However, the Statistics Canada 1996 Census Dictionary indicates that nearly one-half of EA boundaries changed between the 1991 and 1996 censuses. Such variability can be problematic for tracking socioeconomic sustainability indicators over time within a particular EA but should not greatly affect the aggregate data for the 354 EAs Basin-wide. Another potential drawback to data reported by enumeration area is that land area and population density data are not reported at that level, but those values can be calculated in ArcView with the calcapl extension and Albers Equal-Area projection for the conterminous U.S. Because the CSDs do not display such features as population density adequately, EA data for 1991 was purchased, in addition to CSD data for 1986, 1991, and 1996.

As with U.S. census block groups, it is necessary to decide how to handle the four CSDs that are only partly within the Lake Superior Basin: Thunder Bay, Unorganized (population 8,168, most of which probably lives in the Basin); Algoma, Unorganized, North Part (population 7,450); Sudbury, Unorganized, North Part (population 7,463); and Sault Ste. Marie (population 81,476, at least half of which probably lives in the Basin). At least half the land area of Thunder Bay, Unorganized and Sault Ste. Marie appear to be in the Basin, but only about one-third of Algoma, Unorganized and one-ninth to one-tenth of Sudbury, Unorganized. Therefore, if entire CSDs are considered either in or out of the Basin, Thunder Bay, Unorganized and Sault Ste. Marie would be counted in; the Algoma and Sudbury unorganized CSDs would be counted out. By that method, the total population of the Lake Superior Basin in Ontario is calculated as 238,695 in 1991 and 240,562 in 1996.

An alternative is to apply a multiplier to each of the four units based on the percentage of land area that falls within the Basin. (This approach is not necessarily more accurate because land area is not directly correlated with population.) The population would then be calculated as 197,693 in 1991 and 199,052 in 1996, or about 40,000 persons less than the previous method. Although the population grew overall during the five-year period, 18 CSDs lost population, 12 gained, and one did not report in 1996. The population change in individual CSDs ranges from a loss of 33.8% to a gain of 24.0%. The 1990/1991 combined population of the Lake Superior Basin in Canada and the U.S., using the multiplier method for Ontario, is 621,600.

A limitation of the U.S. Bureau of the Census 1990 census block group demographics is that no data is reported for earlier years. The Census Bureau's customer service confirmed that TIGER

census block group demographics files are available only for 1990. However, the USA Counties 1998 CD-ROM has large quantities of demographic and economic data from the Census Bureau and other sources, reported by county, state, and U.S. levels. Such information is useful for identifying trends within the Basin over time for different socioeconomic factors and comparing them with trends across Michigan, Minnesota, Wisconsin, and the United States as a whole.

After the 2000 census, trends since 1990 can be examined at the finer geographic scale of census block groups, which are more closely fitted to the Lake Superior Basin boundaries. However, it should also be noted that the USA Counties CD contains considerably more data than the TIGER files, including some topics, such as crime, that are not in the TIGER files at all. It is recommended that both forms of U.S. Census data be used in the future.

Some USA counties data is available directly from the Internet via <http://venus.census.gov/cdrom/lookup>, but the tables are not currently set up for conversion to a spreadsheet. Similarly, some data is available from Statistics Canada in the form of community profiles for census subdivision units at <http://ww2.statcan.ca/english/profil>. However, the data is much more limited than the 1996 Census "Area Profiles for user-specified Census Subdivisions" purchased from Statistics Canada for the 31 Lake Superior Basin census subdivisions.

The primary advantage of using census data for both the U.S. and Canada is that large amounts of relevant demographics data are collected at regular intervals, generally yearly or every ten years, and made available to the public. The disadvantage is that census data addresses only about one-quarter of the 39 socioeconomic sustainability measures in the EPO and are unevenly spread across the suite of “best bets” measures.

3. Data Acquisition Status

As of September 2000, at least some data had been obtained for 31 of the 39 measures selected by the DSC as sustainability indicators, plus nine related measures. Fifteen of the DSC measures are discussed at length in the section on baseline data and trends, along with five added measures. All but two of the remaining measures have potential data sources identified or references to information from other committees elsewhere in the Lake Superior Lakewide Management Plan (LaMP) 2000. Information gaps will be discussed in more detail in section 5. The status of each measure is summarized in Table 3.1 on the next two pages. Some of the data obtained does not address the measure directly or completely, as described in more detail under the appropriate indicator at the end of this section. Appendix 1 documents the data obtained and sources for each measure.

At an October 1999 Lake Superior Monitoring Conference sponsored by the U.S. EPA and Environment Canada in Sault Ste. Marie, Ontario, some effort focused on evaluating the feasibility and relevance of each sustainability measure. Feasibility is the likelihood that data is currently available in some form for the measure. Relevance is the perceived importance of the measure as an indicator of socioeconomic sustainability within the Lake Superior Basin. It was determined that the six measures constituting the “Reinvestment of Natural Capital” indicator have medium to low feasibility but high relevance. The eight measures of the “Quality of Human Life” indicator have high feasibility and medium relevance. The nine measures of the “Resource

Consumption" indicator have medium to low feasibility and high relevance. The seven measures of the "Awareness of the Capacity for Sustainability" have low feasibility but high relevance, and the nine measures of the "Economic Vitality" indicator have high feasibility and medium to high relevance. The data obtained to date has generally confirmed the October 1999 assessment.

The project has created databases, spreadsheets, or comprehensive summaries across the entire Basin, primarily from census data except as noted, for the measures following Table 3.1. Additional, but less complete, information has been compiled for other measures.

Table 3.1
Status of Sustainability Indicator Data Acquisition as of September 2000

Measure	*Canada*	*USA*
Reinvestment of Natural Capital		
The amount of sustainable forestry occurring on the land	1	1
The extent of watershed management or restoration programs	2, 4	2, 4
Native fisheries and wildlife stocking	3, 4	3, 4
Exotic species control and native plant repatriation	2, 4	2, 4
Reclamation of mining operations and industrial sites	2, 4	2, 4
Replacement of wetlands and biotic diversity	4, 5	4, 5
Quality of Human Life		
Incidence of crime	1	1
Demographics of migration (especially loss of extended families)	1	1
Demands for social services	5	2
Transportation infrastructure status	1	1
Extent of recreational and cultural opportunities	3	3
Citizen involvement in decision making	5	3
Public access to lake shores	5	3
Population density	1	1
*Educational attainment	1	1
*Type of commute to work	1	1

1 = Data obtained, analyzed, and discussed in the next section
2 = Some data obtained but either not analyzed or somewhat incomplete
3 = Little or no data obtained but potential sources identified
4 = Some overlap with other LaMP chapters; relevant references identified
5 = No data obtained; no potential sources identified
* = Additional related measures not identified in the EPO

Table 3.1 (continued)

Measure	*Canada*	*USA*
Resource Consumption		
Availability of recycling programs	3	1
Amount of forest and mining resources that remain in the Basin	2, 4	2, 4
Types and quantities of electric power generation	1	1
Quality and volume of aquifers	1	1
Density of and stressors related to tourism	2	2
Depletion of wildlife and fisheries	2, 4	2, 4
Landfill capacity and incineration volume	2	1
Degree of urban sprawl (see population density and duration of commute)	1	1
Loss of native flora	3	3
*Wastewater treatment	1	1
*Type of heating fuel by household	5	1
*Duration of commute to work, aggregate and average	5	1
Awareness of the Capacity for Sustainability		
Depth of environmental and sustainability education curricula in schools	5	3
Promotion of resource conservation programs	2	2
Incorporation of ecological design into building codes	1	1
Extent of zoning regimes	5	3
Popular support for environmental regulations	5	5
Community outreach programs by natural resource agencies	2	2
Media coverage of sustainability related issues	5	5
*Extent of business/industry sustainability-related initiatives	5	3
Economic Vitality		
Per capita income	1	1
Cost of living	2	1
Extent of poverty	1	1
Local employment trends	1	1
Regional trade balance	3	3
Diversity of communities' economies	1	1
Facilitation of transitional economics	2	2
Value-added industry	2	2
Regional and local tax bases	5	2

1 = Data obtained, analyzed, and discussed in the next section
2 = Some data obtained but either not analyzed or somewhat incomplete
3 = Little or no data obtained but potential sources identified
4 = Some overlap with other LaMP chapters; relevant references identified
5 = No data obtained; no potential sources identified
* = Additional related measures not identified in the EPO

Reinvestment in Natural Capital:

Amount of Sustainable Forestry (acres of forest land certified by the SmartWood Program of the Forest Stewardship Council and forest products companies with SmartWood chain-of-custody certification; no forest land in the Lake Superior Basin of Ontario certified by either SmartWood or Canadian Standards Association; information on different sustainable forestry certification programs and links to forest products companies).

Quality of Human Life Indicator:

Incidence of Crime (serious crime per 100,000 population reported by police to the Federal Bureau of Investigation, for 16 Basin counties in the U.S; serious crime per 100,000 population reported by police forces to the Canadian Bureau of Justice Statistics division of Statistics Canada for 22 census subdivisions).

Demographics of Migration, especially loss of extended families (family and non-family households, single-parent households, same house previous year or five years previous, relatives 65 and older in the household for 540 census block groups and 16 Basin counties in the U.S. and 31 census subdivisions in Ontario).

Demands for Social Services (U.S. only: supplemental security income and Aid to Families with Dependent Children payments by 16 Basin counties in the U.S.; households receiving public assistance, persons in homeless shelters, and persons on the street by 540 U.S. census block groups; links to information about state human services programs).

Transportation and Communication Infrastructure Status (Michigan Dept. of Transportation data on aviation, highways, ports, public transit, and railroads, average daily traffic, and carpool parking lot occupancy; limited information from Minnesota, Wisconsin, and Ontario).

Population Density (by 540 U.S. census block groups and 16 Basin counties in the U.S., and by 354 census enumeration areas in Ontario).

Resource Consumption Indicator:

Availability of Recycling Programs (Michigan county solid waste management plans, Minnesota "SCORE" reports of recycling data, Western Lake Superior Sanitary District reports on household hazardous waste disposal, Wisconsin Dept. of Natural Resources recycling data by county, Northwest [WI] Regional Planning Commission data by county/locality on household and very small quantity generator hazardous waste collections).

Forest and Mining Resources (No Basin-specific information but some potentially useful data, mainly for Ontario).

Types and Quantities of Electric Power Generation (U.S. Geological Survey water-use data by watershed; U.S. Energy Information Administration by power plant in the U.S. Lake Superior Basin; Statistics Canada by power plant in the Ontario Lake Superior Basin).

Quality and Volume of Aquifers (U.S. Geological Survey water-use data by watershed for public, commercial, domestic, industrial, power, mining, livestock, irrigation, and sewage treatment; USGS Ground Water Atlas of the United States, Segment 9; Environment Canada Municipal Water Use Data for municipalities with population greater than 1,000, only six of which are in the Lake Superior Basin).

Landfill Capacity and Incineration Volume (list of closed and operating landfills in 8 Basin counties in Michigan and volume of solid waste deposited in 1996-99; closed and operating licensed landfills, landfill size and total waste deposited in landfills from 1991-97, and solid waste generated by 4 Basin counties in Minnesota; volume of solid waste deposited in 1995-

99 in 3 Basin landfills in Wisconsin, plus list of 53 closed landfills; total waste generated and landfilled in the Ontario Lake Superior Basin).

Degree of Urban Sprawl (can be tracked visually by mapping changes in population density over time in 540 U.S. census block groups and 354 Ontario census enumeration areas; other indicators are changes in aggregate and average travel time to work, amount of farm land, and urban vs. rural population by 16 Basin counties in the U.S).

Additional Data (changes over time in percentage of homes using gas, fuel oil, electric, wood, coal, or other heat by 540 census block groups and 16 Basin counties in the U.S.; wastewater treatment by community for the U.S. Basin counties and 6 Ontario municipalities with populations of 1,000 or more, from 1998 U.S. EPA Clean Water Needs Assessment, 1996 Environment Canada Municipal Water Use Database, and state agency records).

Awareness of the Capacity for Sustainability:

Education (highest level of educational attainment by 540 U.S. census block groups and 16 counties in U.S., and by 31 census subdivisions in Ontario).

Economic Vitality Indicator:

Per Capita Income (also household income by 540 census block groups and 16 Basin counties in the U.S.; by 31 census subdivisions in Ontario; also family income by 16 U.S. counties).

Cost of Living (U.S. only; median mortgage payments and rent as percentages of median household and family income by 16 U.S. counties in the Basin).

Extent of Poverty (persons and children in poverty by 540 census block groups and 16 Basin counties in the U.S.; low-income families by 31 census subdivisions in Ontario; also elderly in poverty by 16 Basin counties in the U.S.).

Local Employment Trends (by sector and job type for 540 U.S. census block groups, 16 Basin counties in the U.S., and 31 census subdivisions in Ontario).

Regional and Local Tax Bases (property taxes, state and federal support by 16 Basin counties in the U.S. only).

Internet sites maintained by government agencies and the Environmental Systems Research Institute were the most productive sources of data (see Appendices 1 and 6). All of the U.S. data was obtained at no charge, though the USA Counties 1998 CD-ROM would have cost $150 had we not been able to borrow it. Much of the Canadian data except for watershed boundaries and water use from Natural Resources Canada had to be purchased. Some of the Canadian data is also in a form that provides a less detailed picture of the Lake Superior Basin (e.g., census data that can be divided only into 31 blocks across the Ontario portion of the Basin, compared to 540 census block groups on the U.S. side).

4. Baseline Data and Trends

Some of the data obtained for this project represents a baseline year, generally 1990 for the U.S. and 1991 for Canada, so as to coincide with census years whenever possible. Other data that is available for multiple years helps identify trends.

After the 2000 U.S. census and 2001 Canadian census results are released, additional trend information for some socioeconomic measures will be available, especially for portions of the Lake Superior Basin that are in Canada. In the meantime, trends in some measures can be derived from the USA Counties 1998 CD-ROM and periodic reports by government agencies. The following are summaries of some baseline data and trends that have been examined. Excel tables and charts with data downloaded from the USA Counties 1998 CD-ROM, purchased from Statistics Canada, and obtained from other sources are included in the tables and figures (Appendices 3 and 4). ArcView-generated maps appear in Appendix 5.

In all cases, reference to the 16 U.S. Lake Superior Basin counties or the Ontario census subdivisions means those units considered as a whole. Individual counties or subdivisions may deviate from the overall trends, as is frequently noted in the discussion. Not all Ontario census subdivisions reported data in all categories, particularly income. Each measure indicates the number of subdivisions included. Much of the Ontario data represents a 20 percent sample, resulting in rounding errors, particularly noticeable if the sample population is small. For example, numbers whose sum should be 100 percent may total 95 or 105 percent. Population per square kilometer uses actual population.

4.1 Population per Square Mile or Kilometer, Urban and Rural

The following statistics on population density relate to both the "Quality of Human Life" and the “Resource Consumption” (degree of urban sprawl) indicators:

The population per square mile declined between 1980 and 1990 in 15 of 16 Lake Superior Basin counties in the U.S. Population density increased during the same period for the U.S. and each of the three states (table 4.1a). Overall, the losses in population in the Basin were from "urban" parts of the counties, which had a population decrease of 15.4 percent. The rural population in the counties rose 2.1 percent overall (ranging from a 13.5 percent decrease in Luce County to a 64.7 percent increase in Gogebic County). Baraga (and perhaps Gogebic) County apparently had some "urban" areas shrink below the threshold value so that they were classified as rural in 1990. Both Baraga and Gogebic declined in total population by 6 to 8 percent. Overall population for the 16 counties dropped 4.0 percent from 1930 to 1990 and 8.0 percent from 1980 to 1990. The U.S. population increased 101.9 and 9.8 percent during the same periods.

Population densities within the Basin in 1980 ranged from 2.9 in Cook County, Minnesota, to 40.7 in Marquette County, Michigan. In 1990, those values had dropped to 2.7 and 38.9, respectively. For the U.S., the 1980 population per square mile was 64.0. Minnesota's population density was 51.2, Wisconsin's was 86.5, and Michigan's was 162.6. In 1990, the values had increased to 70.3, 55.0, 90.1, and 163.6, respectively. U.S. Census 1990 TIGER census block group data for the 540 CBGs mostly in the Lake Superior Basin shows a range of 0.1 to 5,640 persons per square kilometer, with a mean of 9.95, equivalent to 25.8 per square mile overall.

For the 31 participating Ontario census subdivisions that are part of the Lake Superior Basin, data from Statistics Canada shows an overall population density of 1.29 and 1.28 persons per square kilometer in 1991 and 1996, respectively (table 4.1b). If the Algoma and Sudbury unorganized districts, which lie mostly outside the Basin, are removed from the data set, density increases to 2.19 and 2.17 persons per square kilometer. Unlike the U.S. data, which is based on

land area only, the Ontario data includes land and water area, thus lowering the calculated population density. (For comparison, the population density for the U.S. part of the Basin would be 8.72 persons/km^2 instead of 9.95 if water area were included.) The population density in 1991 ranged from 0.08 in Thunder Bay, Unorganized, to 1,393 persons per square kilometer on the Pic Mobert South First Nations Reserve. The urban areas of Sault Ste. Marie and Thunder Bay had densities of 367.8 and 352.9, respectively. Maps 4.1a-e show population per square kilometer for the entire Lake Superior Basin and three subsets of the Basin. Note that the two Basin-wide maps differ in the values displayed in their legends. Map 4.1f shows the change in population density in the Ontario portion of the Basin from 1991 to 1996.

4.2 Population Migration

The following statistics on population migration relate to the "Quality of Human Life" indicator:

Of U.S. residents age five years or older, 53.3 percent lived in the same house in 1985 and 1990, about the same as the 53.6 percent who lived in the same house in 1975 and 1980 (table 4.2a). In Michigan, Minnesota, and Wisconsin, 55.6 to 56.4 percent of residents lived in the same house in 1975 and 1980, while 55.5 to 57.3 percent lived in the same house in 1985 and 1990. Overall, residents of the 16 Lake Superior counties were slightly less likely to have moved to a different house in either five-year period, with 57.7 percent in the same house in 1980 as they were in 1975 and 60.8 percent in the same house in 1985 and 1990. The range for 1975-80 was from 45.8 percent in Marquette County, Michigan, to 70.8 percent in Ontonagon County, Michigan. In 1985-90, the range was 54.3 percent in Marquette to 75.5 percent in Iron County, Wisconsin.

Overall, more than three-quarters of persons five years and older resided in the same county in 1975-80 and in 1985-90 in the Basin, the three states, and the U.S. (Some may not have lived in the same county during 1985-90 as they did in 1975-80, however.) The same-county-of-residence range in 1975-80 was from 69.8 percent in Marquette County to 88.1 percent in Ontonagon County; the national average was 78.7 percent. In 1985-90, the same-county range was 73.4 percent in Houghton County, Michigan, to 86.2 percent in Gogebic County, Michigan, compared to the national average of 78.7 percent.

During both periods, Keweenaw County stood out from the other 15 counties in that only 4.8 and 8.5 percent of residents, respectively, moved elsewhere in the same county. The other counties ranged from 14.9 to 27.9 percent of residents in 1975-80 and 14.7 to 24.5 percent of residents in 1985-90 who moved within the same county. In other words, if Keweenaw County residents moved at all, they generally moved from another county.

For the 540 U.S. TIGER census block groups that lie mostly within the Lake Superior Basin, 60.8 percent of the 396,400 residents age 5 and older lived in the same house in 1985 and 1990, and 22.4 percent moved within the same county during the same period. Therefore, 83.2 percent of residents within the Basin lived in the same county in 1985 and 1990, a figure within 0.4 percentage point of the calculation for the 16 Lake Superior Basin counties from the USA Counties 1998 CD-ROM.

In the 29 Ontario census subdivisions (CSDs) that lie mostly in the Lake Superior Basin, 62.7 percent of residents did not move between 1991 and 1996 (table 4.2b). An additional 27.2

percent moved within the same CSD; therefore, 90.0 percent resided in the same CSD in 1991 and 1996. The percentage of non-movers ranged from 51.2 in Lake Helen to 81.8 in Whitesand, both First Nations Reserves. The percentage of non-movers plus non-migrants (same CSD) ranged from 69.8 in Lake Helen to 95.2 in Prince Township. (CSDs with fewer than 100 residents were excluded, given that the 20 percent sample exaggerates percentages.)

Lake Superior Basin residents were less mobile between 1991 and 1996 than residents of Ontario or Canada as a whole. In Ontario, 56.9 percent of residents did not move between 1991 and 1996, while 22.7 percent moved within the same CSD; therefore 79.6 percent lived in the same CSD both years. Similarly, 56.7 percent of Canadian residents did not move and 23.0 percent moved within the same CSD, a total of 79.7 percent in the same CSD. Between 1986 and 1991, 52.0 percent of Ontarians and 53.3 percent of Canadians did not move, while 22.7 and 23.2 percent, respectively, moved within the same CSD. Therefore, 74.7 percent of Ontario and 76.5 percent of Canadian residents lived in the same CSD in 1986 and 1991.

4.3 Family and Nonfamily Households and Households with Seniors

The following statistics on household and family structure relate to loss of extended families under the "Quality of Human Life" indicator:

In 1980, 71.8 percent of households in the 16 U.S. Lake Superior Basin counties were classified as "family" households, compared to 73.2 percent nationwide and from 71.8 to 74.9 percent in Michigan, Minnesota, and Wisconsin (table 4.3a). By 1990, the percentage of family households had declined in all 16 counties to 67.2 percent overall for the Basin counties (66.9 percent for the 540 Basin CBGs), the three states (to 68.6 to 71.3 percent), and the U.S. (to 70.2 percent). Nonfamily households increased from 28.2 to 32.8 percent of all households in the Lake Superior Basin over the same period.

Although there was a steady increase in the number of married-couple households between 1970 and 1990 in the U.S., Minnesota, and Wisconsin, all but two of the 16 Lake Superior counties and Michigan overall showed an increase in 1980 but a decrease in 1990. The other two counties (Gogebic and Ontonagon) decreased each decade. The number of married-couple households as a percentage of family households declined between 1980 and 1990 within the Basin but remained higher than the national average. Nationally, 82.1 percent of family households were headed by married couples in 1980 and 78.6 percent in 1990. In the 16 Lake Superior counties, 85.8 percent of family households in 1980 and 82.4 percent of family households in 1990 were headed by married couples (81.7 percent in the 540 Basin CBGs).

Between 1970 and 1990, the number of persons per household declined steadily in the Lake Superior Basin (from 3.06 to 2.45), the three states, and the U.S. (from 3.11 to 2.63). The decline in the Basin was faster than in the U.S. overall but only slightly faster than the three states. In the 540 Basin CBGs, there were 2.57 persons per household and 3.85 persons per family in 1990.

The number of households with persons 65 years of age or older increased nationwide, in all three states, and in 15 of the 16 Lake Superior counties (all except Keweenaw) between 1980 and 1990. The percentage of all households with senior residents increased nationally from 22.8 to 24.1 over the same period and from 26.8 percent to 29.6 percent in the Lake Superior Basin

counties. The percentages of households with seniors in both 1980 and 1990 were higher by 3.0 to 6.7 percentage points in the Lake Superior counties than in their respective states. Maps 4.3a-b show the percentage of population age 65 or older in the Lake Superior Basin and Michigan's Keweenaw Peninsula.

In the 29 Ontario census subdivisions mostly within the Lake Superior Basin for which 1996 data is available, 72.3 percent of all private households were classified as family, higher than the 16 U.S. Lake Superior counties in either 1980 or 1990 (table 4.3b). The range for areas with at least 100 households was from 62.5 percent in Beardmore Township to 96.9 percent in Prince Township. Of those families, 84.2 percent were headed by married couples, ranging from 70.6 percent in Fort William First Nations Reserve to 105.0 percent in Beardmore and 97.6 percent in Conmee Township.

The average number of persons per family in 1996 was 3.03, with 44.1 percent two-person, 23.5 percent four-person, and 22.6 percent three-person families in the Ontario Lake Superior Basin (table 4.3c). The average number of persons per household was 2.55, comparable to the U.S. Basin census block groups in 1990.

The Canadian census does not report the number of households with persons age 65 or older, but does provide more detail about whether the seniors live alone, with family, or with others (table 4.3b). In the 29 census subdivisions mostly within the Lake Superior Basin, 61.3 percent of seniors live in families. Of the 38.8 percent who do not live with their immediate families, 82.0 percent live alone, 14.4 percent live with relatives, and 3.2 percent live with non-relatives.

4.4 Family, Household, and Per Capita Income

The following statistics on household, family, and per capita income relate to the "Economic Vitality" indicator:

In 1979, 14 of the 16 U.S. Lake Superior Basin counties had median family and household incomes below the national and Michigan, Minnesota, and Wisconsin medians (table 4.4a). Only Lake and St. Louis Counties in Minnesota were above the U.S. median and comparable to the state medians. The median U.S. family income was $19,917, and the median household income was $16,841. The 16 Lake Superior counties ranged from median family incomes of $11,705 in Keweenaw County, Michigan, and $12,138 in Iron County, Wisconsin, to $21,959 in Lake County and $20,903 in St. Louis County, Minnesota. Median household income ranged from $9,076 in Keweenaw County and $9,944 in Iron County to $20,382 in Lake County. In the 540 Basin CBGs in 1990, mean household income was $26,964.

By 1989, all 16 Lake Superior counties were well below the national and state median family and household incomes. The median U.S. family income was $35,225 and the three states ranged from $35,082 to $36,916. In contrast, the 16 counties ranged from $18,459 in Keweenaw County to $31,150 in St. Louis County. The median U.S. household income was $30,056, and the states were $29,442 to $31,020. The 16 counties ranged from $13,821 in Keweenaw County to $25,137 in Marquette County, Michigan.

Among the 3,143 U.S. counties ranked by median family income, the 16 Lake Superior counties ranked from #229 to #2,963 in 1979 and from #873 to #3,012 in 1989, an average drop in ranking over the decade of 233 places. Similarly, the median household income rank for the Lake Superior counties ranged from #167 to #3,055 in 1979 and from #1,091 to #3,077 in 1989. The average drop in median household income ranking between 1979 and 1989 for the counties was 290 places. Only 66 counties (2 percent of the U.S. total) ranked lower than Keweenaw County in 1989 household income. (However, it should be noted that household income does not necessarily equate with well-being, especially in relatively undeveloped places like Keweenaw County, where some residents have chosen lifestyles that don't require much income.) The 1993 median household income for the 16 U.S. Lake Superior counties continued to lag the national median of $31,241 and state medians of $32,200 in Wisconsin to $33,239 in Minnesota. The range was $19,424 in Keweenaw County to $30,541 in Marquette County. However, the counties showed some recovery in median household income rank in 1993, ranging from #882 to #2,888, an average gain in rank of 152 since 1989.

Clearly, median family and household income within the U.S. Lake Superior Basin counties is below the national median and state medians for Michigan, Minnesota, and Wisconsin. After losing ground between 1979 and 1989, the 16 counties did improve their median household income rank somewhat by 1993.

In Ontario, $57,429 was the average family income in 1996 (in Canadian dollars, equivalent to US$42,165 at the 1.362 1995-96 average exchange rate) for the 23 Census subdivisions mostly in the Lake Superior Basin that reported income data (table 4.4b). The range was from $38,408 (US$28,200) in Fort William First Nations Reserve to $76,235 (US$55,973) in Terrace Bay Township. Average household income was $49,884 (US$36,626), ranging from $37,613 (US$27,616) in Fort William to $67,809 (US$49,786) in Terrace Bay.

The 1996 average per capita income for all persons 15 years and older was $26,243 (US$19,268). Again, Fort William had the lowest average income at $18,944 (US$13,909), but Manitouwadge Township topped the list at $37,047 (US$27,200). For persons 15 years and older who were not living in a family unit, average income was lower overall at $22,858 (US$16,783), ranging from $14,642 (US$10,750) at Fort William to $38,816 (US$28,499) at White River Township.

Mean per capita income for the 535 populated U.S. census block groups (CBGs) that are mostly in the Lake Superior Basin (in 24 counties) was $11,029 in 1990. The range was $1,440 for a CBG representing Marquette Branch Prison to $43,262 for a CBG southwest of Marquette.

4.5 Housing Costs

The following statistics on housing costs also relate to the "Economic Vitality" indicator. No direct information is available on the cost of living within the 16 U.S. Lake Superior Basin counties as compared to other areas, but some inferences can be made from housing costs.

The median monthly mortgage payments for the 16 U.S. Lake Superior counties in 1980 ranged from $252 in Keweenaw County, Michigan, to $381 in Marquette County, Michigan, compared to $366 nationally and $363 to $381 in Michigan, Minnesota, and Wisconsin (table 4.5). In fact,

Marquette was the only county whose median mortgage payment was at or above the median for the U.S. and the three states. In 1990, monthly mortgage payments within the Basin were considerably below the U.S. and states, ranging from $402 in Ontonagon County, Michigan, to $564 in Marquette County, Michigan. The national median had risen to $737, and the three states ranged from $651 to $724.

A similar pattern exists for monthly gross rent. In 1980, the median rent ranged from $164 in Baraga County, Michigan, and Ashland County, Wisconsin, to $228 in Marquette County, Michigan. The national median was $243, and the three states ranged from $234 to $250. By 1990, the gap between the 16 Lake Superior Basin counties and the U.S. and state medians had grown larger. The 16 counties ranged from $231 in Keweenaw County, Michigan, to $333 in Marquette County, Michigan. The national median in 1990 had risen to $447, while the three states ranged from $399 to $423.

As a partial gauge of the cost of living within the Lake Superior Basin, the median monthly mortgage and rent payments in 1980 and 1990 can be calculated as a percentage of median household income in 1979 and 1989, respectively. In 1980, the median mortgage payments as a percent of median household income in 11 Lake Superior counties were higher than the U.S. median of 26.1 percent and the medians of 22.7 to 25.9 percent for Michigan, Minnesota, and Wisconsin. One county's median equaled that of the U.S. but was higher than any of the three states. Four counties had a median mortgage as a percent of household income lower than the U.S. The median mortgage payment in 1980 ranged from a low of 15.0 percent of median household income in Lake County, Minnesota, to 35.4 percent in Iron County, Wisconsin.

In 1990, only five Lake Superior counties had median mortgage payments as a percentage of household income higher than or equal to the U.S. median of 29.4 percent. Eleven counties had lower mortgage percentages than the U.S. median, though only four were less than the state values of 25.2 to 28.1 percent. The range was 21.0 percent in Lake County, Minnesota, to 35.9 percent in Keweenaw County, Michigan. Median rent as a percentage of median household income in 1980 was lower than the U.S. value of 17.3 percent in 10 of the 16 U.S. Lake Superior counties, though only five were below the state averages (15.6 to 15.9 percent). The values ranged from 12.9 percent in Lake County, Minnesota, to 26.4 percent in Keweenaw County, Michigan.

The median rent as a percentage of median household income in 1990 is 17.8 for the U.S and 16.3 to 16.4 percent for the three states. Values for the 16 Lake Superior counties range from 13.9 percent in Lake County, Minnesota, to 20.1 percent in Keweenaw County, Michigan. Twelve counties have lower rent percentages than the U.S., and seven have lower rent percentages than Michigan, Minnesota, or Wisconsin.

In summary, mortgage payments as a percentage of household income were generally higher in the Lake Superior Basin counties than in the U.S. and the three states in 1980. By 1990, both mortgage and rent payments in most of the 16 counties were lower as a percentage of household income than in the U.S. or the three states overall. As housing costs make up a significant portion of the cost of living, it appears that, at least for 1990, the cost of living may be lower in the Lake Superior Basin counties than in the country as a whole. However, considerable variability exists among the 16 Lake Superior Basin counties.

4.6 Extent of Poverty

The following statistics relate to the "Economic Vitality" indicator as well:

For persons of all ages within the U.S. Lake Superior Basin for whom poverty status was established, 10.4 percent were below the poverty level in 1979 (table 4.6a). That figure had risen to 14.5 percent in 1989 (14.0 percent based on the 540 Basin CBGs), a rate of increase higher than the states of Michigan, Minnesota, and Wisconsin and the U.S. overall over the same period. The U.S. poverty rate for 1979 was 12.4 percent and 13.1 percent in 1989. The 1979 poverty rate for counties within the Lake Superior Basin ranged from a low of 4.4 percent in Lake County, Minnesota, to a high of 17.0 percent in Houghton County, Michigan. In 1989, those same counties again were the extremes, with rates of 9.5 percent and 21.0 percent, respectively.

For persons age 65 and older within the Lake Superior Basin, 13.9 percent fell below the poverty level in 1979 and 12.5 percent in 1989, paralleling improvements in the U.S. and the three states over the same decade (table 4.6a). However, the poverty rate for seniors was higher within the Basin in 1989 than for any of the three states overall, which ranged from 9.1 percent in Wisconsin to 12.1 percent in Minnesota. The 1989 rate was only slightly below the national average of 12.8 percent, whereas the 1979 rate within the Basin was 13.9 percent, compared to the national average of 14.8 percent.

Poverty rates among families within the U.S. Lake Superior Basin rose from 7.3 percent in 1979 to 10.2 percent in 1989 (table 4.6b). Although the 1989 rate within the Basin was about the same as for the U.S. overall (10.0 percent), the Lake Superior counties had family poverty rates higher than their respective states. Among children 18 years of age or younger, the poverty rate rose from 10.6 percent in 1979 to 17.1 percent in 1989 within the Basin (17.3 percent based on the 540 Basin CBGs). The poverty rate also increased in 1989 nationwide to 17.9 percent and in the three states overall (to 12.4 percent in Minnesota, 14.6 percent in Wisconsin, and 18.2 percent in Michigan), but the Lake Superior Basin rate jumped 6.5 percentage points from 1979 to 1989, compared to 1.9 points for the U.S. (table 4.6b). Map 4.6 shows the percentage of children in poverty within the U.S. Lake Superior Basin.

In summary, with the exception of persons 65 and older, the trend of persons, families, and children in poverty within the U.S. Lake Superior Basin ran counter to sustainability between 1979 and 1989. In addition, the poverty rates increased faster over the period within the Basin than for the U.S. overall.

Although no trend information has been obtained for Ontario, data is available from 1996 on the percent of low-income economic families, unattached individuals, and private households. Low-income families are defined as families who spend 20 percentage points more of their income on food, shelter, and clothing than the average Canadian family of comparable size and degree of urbanization. Economic families are a group of two or more persons who live in the same dwelling and are related to each other by blood, marriage, common-law or adoption.

In 1996, 12.8 percent of economic families in the 22 Canadian census subdivisions mostly within the Lake Superior Basin that report this income data were low-income families (table 4.6c).

Among unattached individuals, 38.7 percent were low income, and 15.6 percent of all private households were low income. The highest percentage of low-income economic families (18.1) was in Gillies Township, with Sault Ste. Marie not far behind at 16.6; the lowest percentage (2.6) was in Conmee, Neebing, and Oliver Townships. Results were similar for private households, with 15.6 percent considered low income. Again, Gillies and Sault Ste. Marie had the largest low-income percentages, at 28.7 and 19.4, respectively. Neebing and Oliver Townships had the smallest percentage of low-income private households, 1.8 and 2.7, respectively. The percentage of low-income unattached individuals ranged from 0.0 percent in Neebing and Dorion to 60.5 percent in Prince Township and 45.7 percent in Sault Ste. Marie.

4.7 Incidence of Crime

The following statistics on crime relate to the "Quality of Human Life" indicator:

Serious crimes (crime index) per 100,000 population reported by police to the Federal Bureau of Investigation (FBI) for the 16-county U.S. Lake Superior Basin area are significantly below the national average in 1977, 1980, 1985, 1990, and 1995 (table 4.7a). The only counties that are above or near the national crime rate are Luce County, Michigan, in 1980; Cook County, Minnesota, in 1995; and Douglas County, Wisconsin, in 1977, 1980, 1990, and 1995. The crime rate within the Basin is also below the average for the three states, except Wisconsin in 1977, which had a slightly lower rate. As is the case for the rest of the U.S. and the three states, the crime rate fluctuates up and down over time and varies considerably from county to county. The eight Michigan counties within the Basin are consistently well below the crime rate for Michigan overall. The four Minnesota counties within the Basin are generally below the average crime rate for Minnesota, except for Cook County, which was higher in 1990 and 1995, and St. Louis County in 1977. Of the four Wisconsin counties within the Lake Superior Basin, only Douglas County is significantly above the statewide average, except for 1985 (which, along with 1986 and 1987, shows an order of magnitude drop in the number of crimes from previous and subsequent years, believed to be erroneous). Ashland County was above the Wisconsin crime rate in 1977 but still well below the U.S. average.

The national crime rate per 100,000 in 1977 was 5,046, compared to 3,853 for the Basin (range 1,773-5,747). In 1980, the national rate of 5,893 compares with 4,245 for the Basin (range 1,765-6,033). In 1985, the national rate was 5,242 and the Basin rate was 3,030 (range 1,266-4,077). The national rate of 5,826 in 1990 compares with a Basin rate of 3,377 (range 1,709-6,087). In 1995, the national rate was 5,356, while the Basin rate was 3,288 (range 1,241-6,117).

In terms of sustainability, serious crime is consistently less of a problem within the Lake Superior Basin than it is for the United States as a whole. However, it can't be said that crime is decreasing over time, which would be an even more positive indicator.

The Canadian Bureau of Justice Statistics (CBJS), a division of Statistics Canada, was able to provide 1986 and 1996 data on violent, property, and drug crimes for an area covering about two-thirds (22) of the census subdivisions in the Ontario Lake Superior Basin, grouped into 9 police territories. (The values for Marathon, however, were all zero for both years.) Data for most of the other areas probably exists but is stored by the name of the police force reporting it. There is no direct cross reference between police force name and census subdivision, so the ap-

propriate data is difficult to locate. CBJS staff caution that no direct comparison should be made with the U.S. crime rate statistics because the two countries differ in the specific crimes grouped under similar headings. Also, the CBJS crime tables do not include “crimes per 100,000 persons” for most locations. The Michigan Tech GEM Center calculated those values, using population statistics from 1986 and 1996 census area profiles.

The portion of the Ontario Lake Superior Basin covered by the data includes the population centers of Thunder Bay, Sault Ste. Marie, Red Rock, and Terrace Bay and the rural districts of Thunder Bay, Manitouwadge, Nipigon, and White River, but excludes Marathon, which did not report. Several trends are apparent (table 4.7b). Population increased only 1.5 percent between 1986 and 1996, from 222,240 to 225,474, while violent crime increased 60 percent from 1,156 to 1,849 per 100,000 persons. Property crimes decreased 16 percent, from 6,860 to 5,792 per 100,000 persons, and drug crimes increased 43 percent, from 220 to 315 per 100,000 persons.

While municipal police forces and the Ontario Provincial Police reported increases in violent crime between 1986 and 1996 in most areas, White River (which had the highest rate in 1986 of the 9 areas for which we have data, 2,432 per 100,000) and Manitouwadge saw their rates drop about 50 percent. The rate reported for the Nipigon rural district (including Beardmore, Dorion, Lake Helen 53A, Nipigon, Pays Plat 51, and Rocky Bay 1) doubled during the period to 2,971 per 100,000, the highest rate in 1996. White River and Manitouwadge also reported sharp decreases in property and drug crimes. The highest property crime rate in 1986 was 8,108 in the City of Thunder Bay; the lowest was 1,933 in Red Rock Township. The highest property crime rate in 1996 was 6,278 in the City of Sault Ste. Marie; the lowest was 1,237 in Manitouwadge. The drug crime rate was highest in White River in 1986 (631 per 100,000) and the Nipigon rural district in 1996 (559 per 100,000). The lowest rate in 1986 was in the Thunder Bay rural district (Conmee, Fort William 52, Gillies, Neebing, O’Connor, Oliver, Paipoonge, Shuniah, and Thunder Bay Unorganized) at 27 crimes per 100,000 people. Manitouwadge had the lowest drug crime rate in 1996, at 59 crimes per 100,000 persons.

4.8 Employment Trends

The following statistics on the civilian unemployment rate relate to the "Economic Vitality" indicator:

For five years chosen from annual data (1975, 1980, 1985, 1990, and 1995), the civilian unemployment rate in the 16 U.S. Lake Superior Basin counties averaged about 2.1 points above the U.S. average and above the averages for their respective states (table 4.8a). For example, the unemployment rate in the four Basin counties in Minnesota was consistently higher than for Minnesota overall, 2.8 points on average but nearly double the Minnesota rate of 6.0 percent in 1985.

The civilian unemployment rate for 1975 was 8.5 percent in the U.S., 12.5 percent in Michigan, 5.9 percent in Minnesota, and 7.0 percent in Wisconsin. The 16-county Basin average was 8.3 percent, ranging from 6.2 percent in Iron County, Wisconsin, and Lake County, Minnesota, to 22.0 percent in Luce County, Michigan.

In 1980, the U.S. rate dropped to 7.1 percent, but the three states changed very little. The Basin counties rose 2.1 points to 10.4 percent, ranging from 7.8 percent in Douglas County, Wisconsin, to 15.9 percent in Keweenaw County, Michigan.

The U.S., Minnesota, and Wisconsin rates changed little between 1980 and 1985, but Michigan dropped 2.5 points to 9.9 percent, while the Basin counties rose to 11.9 percent, 4.7 points above the U.S. and higher than any of the three states. In fact, Cook County, Minnesota, had the lowest rate in the Basin at 8.6 percent but was still 1.4 points above the U.S. average. Keweenaw County had the highest rate at 26.8 percent, with Ontonagon and Baraga Counties not far behind at 20.1 and 19.4 percent, respectively.

Unemployment dropped in all locations except Cook County in 1990, to 5.6 percent for the U.S. and 7.6, 4.9, 4.4, and 7.2 percent in Michigan, Minnesota, Wisconsin, and the 16 Basin counties, respectively. The 16-county range was 5.7 percent in Ontonagon to 15.2 percent in Keweenaw.

The trend continued generally downward in 1995 to unemployment rates of 3.7 to 5.4 percent in the U.S. and the three states and 6.7 percent for the 16 counties, ranging from 5.2 percent in Lake County, Minnesota, to 13.1 percent in Keweenaw County.

In the 29 Ontario census subdivisions mostly within the Lake Superior Basin, the 1996 unemployment rate for the population 15 years and over was 11.5 percent (table 4.8b). For the population 25 years and older, the unemployment rate was 9.1 percent. By location the rates ranged from 0 to 100 percent; the extremes, which occur in adjacent First Nations reserves, appear to be the result of small populations and the 20 percent census sample. The most populated areas, Sault Ste. Marie and Thunder Bay, had unemployment rates for persons 25 years and older of 9.4 and 8.6 percent, respectively. In areas with population greater than 200 in the labour force, the range was from 2.3 percent in Terrace Bay Township to 31.0 percent in Beardmore Township.

4.9 Labor Force by Industry Sector and Occupation Classification

The following employment statistics relate to the diversity-of-local-economies measure of the "Economic Vitality" indicator:

The U.S. census (USA Counties 1998) divides employment into 11 industry and 4 occupation categories (plus unemployed workers), while the Canadian census uses 18 industry and 10 occupation categories, the latter divided into 57 subcategories. To compare statistics from the U.S. and Ontario portions of the Lake Superior Basin, the Canadian categories were grouped prior to analysis to correspond as closely as possible to their U.S. counterparts. The groupings appear in Appendix 3 in tables 4.9a-f. Both the U.S. and Canadian censuses report employment data for persons 15 years and older. Summary statistics appear in table 4.9g on the following page for the U.S. and the 16 Lake Superior counties (1980 and 1990) and for the 29 Ontario census subdivisions that lie mostly within the Lake Superior Basin (1996).

Table 4.9g
Employment by Industry Sector

16 U.S. Lake Superior Basin Counties					
Rank 1980	*Industry Category*	*Workers 1980 (%)*	*Rank 1990*	*Industry Category*	*Workers 1990 (%)*
1	Professional and Related Services	22.8	1	Professional and Related Services	26.3
2	Wholesale and Retail Trade	19.3	2	Wholesale and Retail Trade	21.0
3	Manufacturing	11.0	3	Manufacturing	10.2
4	Unemployed Workers	10.2	4	Unemployed Workers	9.0
5	Mining	7.9	5	Transportation, Communications, and Other Public Utilities	6.7
6	Transportation, Communications, and Other Public Utilities	7.2	6	Public Administration	5.1
7	Public Administration	5.4	7	Construction	5.0
7	Construction	5.4	8	Personal, Entertainment, Recreation Services	4.3
9	Personal, Entertainment, Recreation Services	3.8	9	Mining	4.0
10	Finance, Insurance, and Real Estate	3.3	10	Finance, Insurance, and Real Estate	3.8
11	Business and Repair Services	2.0	11	Business and Repair Services	2.9
12	Agriculture, Forestry, and Fisheries	1.6	12	Agriculture, Forestry, and Fisheries	1.7

United States					
Rank 1980	*Industry Category*	*Workers 1980 (%)*	*Rank 1990*	*Industry Category*	*Workers 1990 (%)*
1	Manufacturing	21.0	1	Professional and Related Services	21.9
2	Wholesale and Retail Trade	19.1	2	Wholesale and Retail Trade	19.9
3	Professional and Related Services	19.0	3	Manufacturing	16.6
4	Transportation, Communications, and Other Public Utilities	6.8	4	Transportation, Communications, and Other Public Utilities	6.6
5	Unemployed Workers	6.5	5	Finance, Insurance, and Real Estate	6.5
6	Finance, Insurance, and Real Estate	5.6	6	Unemployed Workers	6.3
7	Construction	5.5	7	Construction	5.8
8	Public Administration	4.9	8	Public Administration	4.5
9	Business and Repair Services	3.9	8	Business and Repair Services	4.5
9	Personal, Entertainment, Recreation Services	3.9	10	Personal, Entertainment, Recreation Services	4.3
11	Agriculture, Forestry, and Fisheries	2.8	11	Agriculture, Forestry, and Fisheries	2.5
12	Mining	1.0	12	Mining	0.6

Table 4.9g, continued

29 Ontario Lake Superior Basin Census Subdivisions					
Rank 1996	*Industry Category**	*Workers 1996 (%)*	*Rank 1996*	*Industry Category**	*Workers 1996 (%)*
1	Professional and Related Services	19.6	7	Public Administration	6.6
2	Wholesale and Retail Trade	16.3	8	Construction	5.7
3	Personal, Entertainment, Recreation Services	15.1	9	Business and Repair Services	3.5
4	Manufacturing	13.5	10	Finance, Insurance, and Real Estate	3.3
5	Unemployed Workers	11.5	11	Agriculture, Forestry, and Fisheries	2.8
6	Transportation, Communications, and Other Public Utilities	8.1	12	Mining	2.1

*Grouped by comparable U.S. industry category. See tables 4.9a-f for more information.

In the 16 U.S. counties that border Lake Superior, the top employment sector was professional and related services (health, education, etc.), which employed 22.8 and 26.3 percent of the labor force in 1980 and 1990, respectively. Those percentages are higher than in the U.S., Michigan, Minnesota, and Wisconsin. The professional services category was third nationwide in 1980 (19.0 percent) and first in 1990 (21.9 percent). In Michigan, it ranked second (19.2 percent) in 1980 and first in 1990 (21.4 percent). Professional services employed the largest number of Minnesota workers in 1980 and 1990, with 21.0 and 23.8 percent, respectively. In Wisconsin, professional services employed 19.2 percent in 1980 and 21.4 percent in 1990, second place in both cases.

The second largest number of Lake Superior county workers in both 1980 and 1990 were employed in wholesale and retail trade, 19.3 and 21.0 percent, respectively, somewhat higher percentages than in the U.S., Michigan, and Wisconsin. In all areas examined except Keweenaw County, Michigan, the percentages were at least slightly higher in 1990 than in 1980.

Manufacturing employed 11.0 percent of Lake Superior county workers in 1980 and 10.2 percent in 1990, a much lower level than the U.S. and the three states. In 1980, manufacturing employed the largest percentage of workers in the U.S. (21.0), Michigan (27.0), and Wisconsin (26.6), though it ranked only third in Minnesota (19.1 percent). In 1990, manufacturing had dropped into third place nationwide (16.6 percent), while remaining in first place in Michigan and Wisconsin and third place in the Lake Superior counties.

With more than half of the workers in the 16 counties employed in professional and related services, retail, and manufacturing, none of the other job sectors employed more than 10 percent of the workforce. The fourth largest number of employees in the Lake Superior Basin counties were unemployed, 10.2 percent in 1980 and 9.0 percent in 1990. Nationally, unemployed workers comprised the fifth largest category in 1980 (6.5 percent) and sixth largest in 1990 (6.3 percent); the "unemployed" category ranked fourth to sixth in the three states both years.

Mining ranked fifth in employment in the Basin in 1980 (7.9 percent) but dropped to ninth by 1990 (4.0 percent). Nevertheless, mining was considerably more important to the Lake Superior Basin economy than to the U.S. or the three states as a whole. In 1980, mining employed 16.1 percent of workers in Lake County, Minnesota, 14.6 percent in Ontonagon County, Michigan, and 12.3 percent in Marquette County, Michigan. By 1990, mining still employed 13.5 percent of Ontonagon County workers, but only 5.5 percent of Lake and 6.3 percent of Marquette County workers. In the U.S. and the three states, mining ranked last of the twelve categories, employing from 0.1 to 1.0 percent of workers in 1980 and 0.1 to 0.6 percent in 1990.

In Ontario, the educational and health and social service divisions together are comparable to the U.S. professional and related services category. As in the 16 U.S. Lake Superior Basin counties for 1980 and 1990, these industry sectors employed the largest number of workers in 1996 (20.2 percent) in the Ontario census subdivisions that lie mostly in the Lake Superior Basin. Likewise, wholesale and retail trade employed the second largest number of workers, 16.8 percent. In third place, employing 15.6 percent of workers, were the categories believed to be comparable to the U.S. "personal, entertainment, and recreational services" category, consisting of accommodation, food, and beverage service and other service. The fourth largest category, at 14.0 percent, was manufacturing, followed by unemployed workers at 11.5 percent.

The employment sector statistics for the U.S. and Canadian portions of the Lake Superior Basin are generally similar. The main difference is that mining employs a smaller percentage of workers in the 29 Ontario census subdivisions than the 16 U.S. counties. However, mining declined by nearly 50 percent in the U.S. counties between 1980 and 1990, and the Ontario data is from 1996, which may reflect a continued decline in mining employment over time throughout the region. The other difference is that the category corresponding to personal, entertainment, and recreational services employs a larger percentage of workers in Ontario (15.1 percent in 1996) than in the U.S. counties (4.3 percent in 1990). Part of this variation may result from different groupings of job sectors under similar headings in the U.S. and Canada, a possibility that requires clarification.

The process of combining the 57 Canadian occupational categories reported in the census subdivision profiles into the equivalent of the four major categories used in the USA Counties 1998 CD-ROM required more subjective judgment than the industry sectors. One obvious difference is that the sum of the percentages in the four U.S. occupational categories is about 72 percent of the labor force, while the Canadian occupations add up to approximately 100 percent. Again, more detail is available in tables 4.9h-m.

The relative ranking of the four occupational categories is the same for the 16 Lake Superior counties, the U.S., Michigan, Minnesota, and the 29 Ontario Lake Superior Basin census subdivisions: (1) technical, sales, and administrative support, (2) managerial and professional specialty, (3) operators, fabricators, and laborers, and (4) precision production, craft, and repair. In Wisconsin, the ranking is the same for 1990, but in 1980, category three employed 0.8 percent more workers than category two. The percentages of the workforce employed in each category are summarized in table 4.9n on the following page.

Table 4.9n
Employment by Occupational Category

16 U.S. Lake Superior Basin Counties					
Rank 1980	*Occupational Category*	*Workers 1980 (%)*	*Rank 1990*	*Occupational Category*	*Workers 1990 (%)*
1	Technical, sales, and administrative support	23.4	1	Technical, sales, and administrative support	26.2
2	Managerial and professional specialty	18.7	2	Managerial and professional specialty	21.1
3	Operators, fabricators, and laborers	16.2	3	Operators, fabricators, and laborers	13.7
4	Precision production, crafts, and repair	13.6	4	Precision production, crafts, and repair	11.1

United States					
Rank 1980	*Occupational Category*	*Workers 1980 (%)*	*Rank 1990*	*Occupational Category*	*Workers 1990 (%)*
1	Technical, sales, and administrative support	28.3	1	Technical, sales, and administrative support	29.7
2	Managerial and professional specialty	21.2	2	Managerial and professional specialty	24.7
3	Operators, fabricators, and laborers	17.1	3	Operators, fabricators, and laborers	13.9
4	Precision production, crafts, and repair	12.1	4	Precision production, crafts, and repair	10.6

29 Ontario Lake Superior Basin Census Subdivisions					
Rank 1996	*Occupational Category*	*Workers 1996 (%)*	*Rank 1996*	*Occupational Category*	*Workers 1996 (%)*
1	Technical, sales, and administrative support	49.1	3	Operators, fabricators, and laborers	14.9
2	Managerial and professional specialty	25.6	4	Precision production, crafts, and repair	10.2

Figures 4.9a-v summarize the percentages of civilian workers in 1990 by type of industry, occupation type, and economic sector for the U.S., the three states, and for Basin census block groups in each of 19 counties and the Lake Superior Basin overall. Note that the census block group figures reflect only the portion of each county that is mostly in the Basin.

4.10 Personal Income and Earnings by Industry

These measures relate to the “Economic Vitality” indicator.

In 14 of the16 U.S. counties mainly in the Lake Superior Basin, earnings as a percent of total personal income increased from a range of 42.8 to 67.6 percent in 1987 to a range of 47.7 to 65.0 percent in 1997 (table 4.10, figs. 4.10a-b, U.S. Bureau of Economic Analysis “BEArfacts”). Yet each county in both 1987 and 1997 had a lower percentage of earned total income than the states of Michigan, Minnesota, and Wisconsin, which ranged from 67.1 to 69.7 percent. Most of the counties decreased the percentage of personal income from both transfer payments and dividends, interest, and rent between 1987 and 1997. While transfer payments comprised 18 to 37 percent of personal income in 1987 and 18 to 32 percent in 1997 among the counties, the three states ranged from 13 to 15 percent in 1987 and 14 to 16 percent in 1997. Transfer payments are from government programs, such as Social Security and Aid to Families with Dependent Children.

The Bureau of Economic Analysis also reported the three largest industries by percent of earnings for each county and state, as well as the industry with the slowest and fastest growth between 1987 and 1997 (table 4.10). State and local government was the largest contributor to earnings among the 16 counties in 1987, followed by services. The two switched positions in 1997. Retail trade and durable goods manufacturing were among the top three industries for at least half of the counties in 1987. In 1997, seven industries (nondurable goods manufacturing, durable goods manufacturing, retail trade, mining, transportation and public utilities, federal civilian government, and construction) were among the top three industries in 6 or fewer counties each. In Michigan, durable goods manufacturing, services, and state and local government led the way in both 1987 and 1997. For Minnesota and Wisconsin in both years, services were the largest contributor to earnings, followed by durable goods manufacturing and state and local government. Thus, there is generally more variability over time in the three largest income-producing industries among the counties than in the states as a whole.

The three states witnessed the slowest growth (or fastest decline) in durable goods manufacturing between 1987 and 1997, while retail trade had the slowest growth in 5 of the 16 counties, followed by state and local government and transportation and public utilities, which were slowest in 3 counties each. Finance, insurance and real estate grew fastest in Michigan and Wisconsin, while services grew fastest in Minnesota. Services and construction were the fastest growing industries in 4 counties each. Durable goods manufacturing grew fastest in two counties, and finance, insurance, and real estate, federal civilian government, mining, state and local government, transportation and public utilities, and nondurable goods manufacturing grew fastest in one county each.

4.11 Educational Attainment

The highest level of educational attainment of persons 25 years of age and older (referred to as "adults" below) within the Lake Superior Basin is relevant to the "quality of human life" indicator. Although not a direct measure of environmental education, the following statistics also relate to the “Awareness of the Capacity for Sustainability” indicator:

In 1980, 70.0 percent of adults in the 16 U.S. Lake Superior Basin counties completed 12 or more years of school, compared to the national average of 66.5 percent and state rates of 68.0 percent in Michigan to 73.1 percent in Minnesota (table 4.11a). By 1990, the rates had risen to 78.4 percent in the Basin, 75.2 percent nationally, and 76.8 to 82.4 percent in the three states.

However, only 13.7 percent of adults in 1980 and 16.1 percent of adults in 1990 in the Lake Superior Basin had completed college, compared to 16.2 and 20.3 percent of adults nationally for the same years. The Lake Superior counties' proportion of college graduates also lagged the three states in both years, and the educational attainment gap widened. The percentage of adults in the Basin who had some college or an associate degree was at or just above the U.S. averages of 15.7 in 1980 and 24.9 percent in 1990.

Census information from Ontario on educational attainment is not directly comparable to U.S. data because it is based on persons age 15 and older and is from 1996. Including data from 15- to 24-year-olds, many of whom have not completed their education, skews the results toward a lower overall educational attainment level than in the U.S.

In the 29 census subdivisions mostly in the Lake Superior Basin, 11.0 percent of the population age 15 and older did not complete 9th grade, while 13.8 percent completed secondary school and 29.9 more obtained a trade certificate or other non-university education (table 4.11b). An additional 10.7 percent obtained a bachelor's degree or higher and 8.9 percent had some college education. Of persons 15 and older, 63.3 percent had completed at least secondary school.

Adjusting the university education figures by subtracting the number of current students age 15-24 from the population 15 and older raised the population with at least a bachelor's degree to 12.1 percent, those with some college education to 10.1 percent, and those who had completed at least secondary school to 65.9 percent.

By location, the percentage of the population that had completed less than grade 9 ranged from 4.3 in Conmee Township to 35.7 percent in Pic Mobert South Reserve. The attainment of a bachelor's degree or higher ranged from 0.0 percent in Dubreuilville Township and Lake Helen, Pays Plat, Pic Mobert North and South, and Whitesand Reserves to 20.1 percent (adjusted for current students) in Prince Township. In Prince Township 31.3 percent had some university education, while no residents of Pays Plat, Pic Mobert North, or Whitesand Reserves had attended college.

4.12 Mode and Duration of Travel to Work

The following statistics on transportation relate to both the "Quality of Human Life" and “Resource Consumption” indicators:

Census statistics on the mode and time spent traveling to work can be interpreted as measures of sprawl and lifestyle choices. Trends are not yet available for travel time to work because data was collected for the first time as part of the 1990 census. However, a geographic trend can be noted in that the average travel time to work in 1990 for the 16 U.S. Lake Superior counties (15.8 minutes) was lower than the U.S. as a whole (22 minutes) or the three states (17 minutes in Wisconsin to 21 minutes in Michigan).

The trend in mode of travel to work, however, is not positive for sustainability in any of the geographic areas. Between 1980 and 1990, the percentage of workers driving alone to work within the Lake Superior Basin rose from 57.7 percent to 72.8 percent, an increase of 15.1 percentage points, or 26 percent, a rate of increase higher than the U.S. or any of the three states overall (table 4.12a, figs. 4.12a-b). However, the 1990 rates remain slightly higher for the U.S. (73.2 percent) and the states (73.8 percent in Minnesota to 81.5 percent in Michigan) than within the Lake Superior Basin.

Over the same period, the percentage of workers within the Basin who carpooled dropped from 22.9 percent to 13.6 percent, a 40 percent decrease (table 4.12a, fig 4.12c). Similar declines occurred in the U.S. and in the three states overall. The percentage of workers within the Lake Superior Basin who carpool was slightly greater than for the U.S. and the states in both 1980 and 1990.

The number of people walking to work also declined between 1980 and 1990 in all geographic areas examined (table 4.12a, fig. 4.12d). In the Lake Superior Basin, the percentage dropped from 11.4 in 1980 to 7.1 in 1990. The percentage of walkers in the U.S. and the three states ranged from 4.5 to 8.5 percent in 1980 and 3.1 to 5.5 percent in 1990, so a greater percentage of workers walk to work in the Basin than in the larger geographic areas.

Public transportation, mainly buses, carried 3.5 percent of Lake Superior Basin workers in 1980 and 1.8 percent in 1990 (table 4.12b). In the U.S. overall, 6.4 percent of workers in 1980 and 5.3 percent in 1990 rode public transit. The three states ranged from 2.5 percent to 5.5 percent in 1980 and 1.6 to 3.6 percent in 1990. Less than one half percent of workers in the Lake Superior Basin, the three states, and the U.S. overall bicycled to work.

The number of people working at home in the Basin increased from 2.6 percent in 1980 to 3.6 percent in 1990, the only even slightly positive commuting trend toward sustainability (table 4.12a). The actual number of people working at home increased in all areas, except for Ashland County, Wisconsin, and Baraga County, Michigan, but the percentage of home workers was unchanged in Minnesota and declined slightly in Wisconsin between 1980 and 1990.

The number of vehicles per occupied housing unit for the 16 U.S. Lake Superior Basin counties was 1.65 in 1990 (1.64 for the 540 Basin CBGs). The number is comparable to the national average of 1.67 and somewhat lower than the 1.72 to 1.77 vehicles per occupied housing unit in Michigan, Minnesota, and Wisconsin (table 4.12c).

In Ontario, 1996 data for the 28 Lake Superior Basin census subdivisions that reported the mode of travel to work does not include a category "drove alone," as in the U.S. However, 79.0 percent of workers are reported as drivers and 8.3 percent as passengers (tables 4.12d-f). Walkers made up 7.6 percent of workers, while 3.0 percent rode public transit, and 1.0 percent bicycled. The Canadian data is also divided into categories for males and females. More men than women drove (82.0 vs. 75.3 percent), while more women were passengers (10.2 percent of women, 6.8 percent of men). Walkers were only 5.9 percent of men but 9.6 percent of women. Men were twice as likely as females to bicycle to work, though only 1.4 percent of them chose that means of transportation.

4.13 Home Heating Fuel

The following statistics on home heating fuel relate to the “Resource Consumption” indicator:

Although home heating is not specifically included in any of the sustainability measures identified in the EPO, it is somewhat similar to types and quantities of electric power generation. In 1980, the most common primary source of home heating in the 16-county U.S. Lake Superior Basin was fuel oil or kerosene, followed by utility gas, bottled-tank-LP gas, electricity, wood, and coal/coke (tables 4.13a-b). By 1990, utility gas had increased by 21.7 percent, displacing fuel oil, which decreased by 37.2 percent. Moving from fifth into third place, with an increase of 134.5 percent since 1980, was wood heat. Bottled, tank, and LP gas gained 5.4 percent but dropped into fourth place, while the number of homes with electric heat rose 32.5 percent but dropped into fifth place. Homes using coal or coke heat declined by 67.9 percent.

In the U.S. as a whole, the relative rankings did not change from 1980 to 1990. Electric heat increased most (60.5 percent), while remaining in second place behind utility gas, which rose 9.8 percent. Fuel oil decreased by 23.3 percent but remained in third place. Bottled, tank, and LP gas increased 15.6 percent, wood heat increased by 40.1 percent, and coal/coke declined 28.8 percent. Nationally, 57 percent of homes heated with gas in 1990, 26 percent used electric heat, 12 percent used fuel oil, 4 percent used wood, and 0.4 percent heated with coal or coke.

Of the total 180,565 homes in the Basin counties in 1990, 87,280 (48 percent) were heated with gas, 53,248 (29 percent) with fuel oil, 24,626 (14 percent) with wood, 14,086 (8 percent) with electricity, and 402 (0.2 percent) with coal or coke. Of some concern to sustainability within the Basin is the trend toward increased use of wood heat, which typically releases more pollutants to the air than sources such as natural gas. Also, the source of the wood for fuel is probably trees within the Basin, while most of the other sources probably come from outside the Basin.

4.14 Incorporation of Ecological Design into Building Codes

This measure is included under the "Awareness of the Capacity for Sustainability" indicator, though it also relates strongly to "Resource Consumption" both in terms of energy and materials conservation.

Natural Resources Canada's Office of Energy Efficiency developed the voluntary R-2000 HOME Program in 1982 to encourage building of energy-efficient houses (http://oee.nrcan.gc.ca/english/newhouses_r2000.cfm). Houses built to the R-2000 standard exceed the efficiency level required by building codes and other regulations. Through October 2000, more than 4,000 R-2000 homes in Ontario and 8,000 in Canada have been built and certified, 52 in the Thunder Bay region, 12 in the Sault Ste. Marie region, and 52 in the Sudbury region, though the latter are most likely all outside the Lake Superior Basin (Dominique Thibault of NRCan, e-mail 11/7 and 11/14/00). Only one builder in the Basin is currently licensed to build R-2000 homes. NRCan reports that fewer R-2000 Homes have been built in recent years. Factors leading to this decline likely include decreased federal funding and promotion of the program, the end of electric utilities’ incentive programs, and low energy prices. However, most houses currently built to code are close to the original R-2000 performance target.

For existing homes, EnerGuide for Houses (EGH) is a similar rating system with national standards, licensed Home Performance Experts, and offices within the Lake Superior Basin in Sault Ste. Marie and Thunder Bay (http://energuide.nrcan.gc.ca/houses/choose_e.htm). At the homeowner's request, an EGH advisor investigates the energy-related features of the house and estimates the home's annual energy requirements. A detailed report recommends appropriate energy efficiency retrofits and measures to maintain or improve ventilation and comfort level. The house receives an EGH rating label and can earn an upgraded rating and label if a second evaluation is completed after improvements are made. Evaluation costs vary, but EcoSuperior in Thunder Bay's regular rate is $85 (Ellen Mortfield, 11/10/00 e-mail messages). Special promotions or coupons offer substantial savings, such as $50-off coupons at a recent home show.

The Housing, Buildings, and Regulations Division of Natural Resources Canada reports the following EnerGuide evaluations from the program's start in September 1998 through October 2000: 83 houses in the Thunder Bay region, 48 in the Sault Ste. Marie region, and 870 in the Sudbury region (Sylvain Blais e-mail messages, 11/7/00). Most, if not all, of the latter are probably outside the Lake Superior Basin. Evaluations have been completed for 4,924 houses in Ontario and 19,167 in Canada. Only 6 of the houses in Thunder Bay and Sault Ste. Marie have undergone second evaluations, but a survey indicates that 70 percent of participants overall did implement some of the recommended improvements but did not request a second evaluation.

Sault Ste. Marie Naturally Green evaluated 72 homes as of November 2000 (Luc Seguin "Arctic Seal" e-mail, 11/4/00). EcoSuperior of Thunder Bay has completed 125 evaluations. Both programs may have completed some evaluations not yet reported to NRCan or for some buildings that don't quite meet EnerGuide Program criteria, accounting for the discrepancy between the NRCan and contractor numbers (Ellen Mortfield, 11/10/00 e-mail). Both areas began their programs in 1999. Environment Canada and the Province of Ontario funded a Green Home Visit Program through 1998, which reached 1,500 households in Sault Ste. Marie and the Algoma District, according to Sault Ste. Marie Naturally Green (www.gca.ca/SAULT.htm).

The Green Communities Association, one of the providers of the EnerGuide program, notes that new houses built to the Ontario Building Code score in the low to mid 70s, while older, unimproved houses score 0 to 50. Very energy efficient homes score 80 or higher. Investment in energy efficiency also increases market value. According to a study conducted for the U.S. EPA and published in the October 1998 *Appraisal Journal*, Energy Star homes in the U.S. sell for an average of $8,000 more than unimproved homes, two to four times the builder's upgrade costs.

Natural Resources Canada also has a Commercial Building Incentive Program to promote energy efficient features in commercial and institutional building design (http://cbip.nrcan.gc.ca). Owners of eligible buildings may be awarded up to $80,000 during the program's duration, April 1, 1998, to March 31, 2004. Program requirements are based on the 1997 Model National Energy Code for Buildings (MNECB) and CBIP Technical Guidelines. Eligible buildings must use 25 percent less energy than the MNECB requires as a minimum. The MNECB is voluntary and complements the 1995 National Building Code. If adopted or adapted by a province, territory, or municipality, the MNECB provisions will become law. A separate code—the Model National Energy Code for Houses—applies to residential buildings. NRCan staff searched their database for CBIP-certified buildings in Basin locations but found only one incomplete application, for a health care building in Wawa (Andre Vanasse e-mail, 11/14/00).

Another voluntary energy-efficiency program, developed by the U.S. Green Building Council (www.usgbc.org), is the LEED Green Building Rating System for new and existing commercial, institutional, and high-rise residential buildings. The LEED system evaluates the site suitability, energy efficiency, conservation of materials and resources, indoor environmental quality, and water conservation. The USGBC is developing separate rating systems for residences and buildings constructed before 1995. LEED ratings rely on credits earned in the various categories and has four levels of certification: bronze, silver, gold, and platinum. No LEED workshops are currently planned in the Midwest other than Missouri. The USGBC has been contacted to determine if there are any LEED buildings in the Lake Superior Basin.

4.15 Transportation Infrastructure and Traffic Volumes

This measure, which includes information on roads, traffic volumes, public transit, airports, railroads, and Lake Superior ports, relates to both the "Quality of Human Life" and "Resource Consumption" indicators. The section on Michigan Transportation Fund and supplemental snow removal revenues also relates to local and regional tax bases under the “Economic Vitality” indicator. More complete data is presented for Michigan than other parts of the Lake Superior basin because it is accessible on the Internet. Similar data is probably available from the other states and Ontario once the proper contact persons are located.

Highways and Bridges. The Wisconsin Department of Transportation (WisDOT) estimates a pavement lifetime of 50 to 60 years, with proper prevention and maintenance, before reconstruction is required (*Wisconsin State Highway Plan 2020 Summary Report*, November 1999). Concrete pavement lasts in original condition for 24-30 years, followed by 10-15 years of patch and grind, then resurfacing that adds another 18 years of life. Asphalt pavement lasts in original condition for 15-18 years, gains another 15-20 years after resurfacing and another 15-20 years after a second resurfacing; after that, reconstruction is needed. Pavement performance is measured in terms of roughness, structural integrity, and rutting.

Bridges in Wisconsin are expected to last 50 to 80 years, with proper maintenance. About 15-20 years after construction, the deck requires an overlay (resurfacing), which adds another 15-20 years of life. After that, the deck must be replaced but can be resurfaced again about 15 to 20 years later. After that, the entire bridge and supporting structure must be replaced.

According to the Michigan Department of Transportation (MDOT), as of 1999 the 8 Lake Superior Basin counties in Michigan had 6,967 miles of road (5.7 percent of the state total), classified as follows: 877 state trunkline, 1,452 county primary, 3,382 county local, 93 city major, 383 city local, and 780 miles federal. The MDOT *5 Year Road and Bridge Program 2000-2004* reported 20 percent of the Superior Region’s roads in poor condition and 80 percent in good condition in 1998. The Superior Region consists of all 15 Upper Peninsula counties, including the 8 that lie mostly in the Lake Superior Basin. Of MDOT's seven regions, only the North Region (northern Lower Peninsula) had a higher proportion of "good" roads, 84 percent. Statewide, 73 percent of roads and 80 percent of bridges were reported in good condition. “Good” condition now includes ratings of “excellent” and “fair,” while “poor” condition combines “poor” and “very poor.” According to the MDOT table, “Statewide Pavement Miles Surface Condition for Report Year 1999,” 50.7 percent of roads were in good or excellent condition, 25.0 percent fair, and 24.4

percent poor or very poor. These figures represent an improvement since 1997, when 45.2 of roads were good to excellent, 24.3 percent fair, and 30.7 percent poor or very poor.

In 1999, almost 58 miles of state trunkline in the Superior Region were resurfaced or reconstructed, 7 bridges were upgraded, and passing lanes were added at 4 locations. According to the MDOT plan, "the 2000-2004 Program for road preservation and capacity improvement work will upgrade almost 250 of the Superior Region's more than 1,800 miles. This includes 27 miles of new passing relief lanes. Of the region's 464 bridges, 12 bridges (2.6%) will be improved in 2000 and 2001." Plans for the Lake Superior Basin portion of the region during 2000-2004 call for repair/resurfacing of 7 bridges, removal of one bridge over an abandoned railroad, reconstruction or relocation of another bridge, construction of 6 passing lanes (12.6 miles), and resurfacing or improvement of 110.7 miles of road. MDOT will also conduct a traffic and pedestrian study of the U.S. 41 corridor from the Michigan Tech campus through downtown Houghton and M-26 west of the Portage lift bridge.

In March 2000, Public Sector Consultants completed a study, *Michigan Roads, Streets, and Bridges: Ten-Year Investment Requirements,* for the County Road Association of Michigan and the Michigan Municipal League. The study concludes that revenues available to counties in Michigan cover only 11 percent of the estimated investment needed to bring county road and bridge systems up to a “good” level during 1999-2008. For municipalities, available revenues cover only 29 percent of the estimated investment requirement for municipal street and bridge systems over the same period. Based on a 1999 survey of all Michigan county and municipal road officials, 40 percent of county paved primary roads are in good condition, 37 percent in fair condition, and 23 percent in poor condition. County paved local roads are 39 percent in good condition, 35 percent in fair condition, and 26 percent in poor condition. Of the 6,551 bridges on the local road system, 32 percent are structurally deficient or functionally obsolete. The report does not include a breakdown of the survey results by county or region. It does note that travel on Michigan roads increased more than 35 percent from 1984 to 1997, during which time population increased only 8 percent.

In the Arrowhead Region of northeast Minnesota, trunk highways (U.S. 2 and 53, TH 61, 169, 210, and I-35) and other roads are important for logging-related businesses and grain hauling, as well as tourism (Arrowhead Regional Development Commission (ARDC), *Northeast Minnesota Freight Study,* 1999). The freight study recommends upgrading the entire trunk highway system to the ten-ton standard, improving and promoting alternative highway corridors to ease congestion, and promoting the use of alternative modes, such as railroads, instead of highways.

The *Long Range Trunk Highway Plan for Northeast Minnesota* that ARDC and the Minnesota Department of Transportation (Mn/DOT) developed in 1999 covers the entire Minnesota portion of the Lake Superior Basin. An analysis of the system shows that needs outstrip proposed construction, which is based on available funding, particularly in the areas of reconstruction, major construction, bridge replacement, and other. The plan recommends priority funding of projects that manage and preserve the trunk highway system's pavements and bridges, which would require annual investments of $29 million to meet performance guidelines. Reconstruction projects should give priority to trunk highway segments that "provide the greatest net benefits in terms of safety and economic efficiency," along with modest investments for traffic safety and access management modifications. Mn/DOT is committed to reconstructing TH 61 along Lake Superior

from Two Harbors to Grand Marais. Other projects, such as completing four-lane improvements on the Cross Range Expressway (TH 169), are needed but are beyond the funding projected for the region.

The Wisconsin Department of Transportation's *Wisconsin State Highway Plan 2020 Summary Report* (November 1999) describes a "sizable backlog of improvement needs" on the 11,800 miles of State Trunk Highways and 4,600 bridges. Two of the 5 STH subsystems, Corridors 2020 Backbone or Connector routes, are designed to carry high volumes of car and heavy truck traffic. The 1,550-mile Backbone network of primarily multi-lane routes connects major population and economic centers. Connectors are 2,100 miles of two- and four-lane highway that connect key communities and regional economic centers to the Backbone routes. Completion of planned multi-lane expansion of Backbone routes and ongoing maintenance and preservation of the entire Corridors 2020 system are WisDOT's highest priority, along with bridge improvements that will avoid posting of load restrictions or bridge closures. At funding levels called for by the plan, statewide road deficiencies will be reduced from 30 percent in 2000 to 6 percent in 2020; bridge deficiencies will be reduced from 7 percent in 2000 to 2 percent in 2020. In the Lake Superior Basin region of Wisconsin, the only Backbone route is U.S. 53 in Douglas County. Connectors are U.S. 2 from Superior to Hurley and the northern parts of U.S. 63 and Wisconsin 13 south of Ashland.

In Ontario, the Northern Transportation Program of the Ministry of Northern Development and Mines (MNDM) in conjunction with the Ministry of Transportation, establishes highway program priorities (www.gov.on.ca/MNDN/nordev/nortrae.htm). A June 16, 2000, news release announced the fifth consecutive year of record funding for northern highways, a total of almost $900 million since 1996. As in other parts of the Lake Superior Basin, the Northern highway network supports the movement of people, raw materials, and finished projects and is important to tourism. The total roads budget for 2000/2001 is $246 million for the Northern Region, which includes the entire Ontario Lake Superior Basin (and a much larger area). Of 64 carryover and new road projects listed for 2000-2001 in the northwestern and northeastern regions, about 11 are in the Lake Superior Basin.

MNDM funds and establishes program priorities in conjunction with the Ministry of Natural Resources for construction and reconstruction of 10,000 km of roads needed to manage Crown timber and mineral resources and access recreational lands. The 2000/2001 budget is $2.86 million in the Resource Access Roads Program. MNDM also manages Winter Roads and Remote Airports Programs to serve isolated Northern Native communities, all of which appear to be north of the Lake Superior Basin. Other programs are transportation logistics consulting services that "provide practical advice to shippers to improve their competitive position in export markets," and financial assistance to the Ontario Northland Transportation Commission "in support of essential transportation services and for tourism and community development."

Roadway Traffic Volumes. A map of traffic congestion in Wisconsin by the year 2020, assuming no capacity expansion, shows extreme or severe congestion on Corridors 2020 routes through Superior, parts of Ashland, and Hurley (WisDOT, *Wisconsin State Highway Plan 2020 Summary Report*, November 1999). Large segments of U.S. 2 and Wisconsin 13 north of Ashland to Washburn are predicted to experience moderate congestion in 2020. Among legislatively

approved or potential major projects in Wisconsin through 2020, only one affects the Lake Superior Basin: U.S. 2 between Superior and Ashland.

Average miles driven annually per auto in Wisconsin rose more than 31 percent between 1980 and 1997, from 9,782 to 12,848 miles. The miles driven in Wisconsin were 11 percent higher than the U.S. average in 1997. Average miles per gallon of gasoline over the 1980-1997 period increased 34 percent from 16.1 to 21.6 (comparable to the U.S. as a whole) but changed little since 1991 because of the growing number of less fuel efficient cars sold each year (Wisconsin Energy Bureau, *Wisconsin Energy Statistics – 1999,* www.doa.state.wi.us/boe/publications/energy_stats.asp).

In the Superior Region (Upper Peninsula) of Michigan, the average vehicle miles traveled in 1998 was 2.27 billion, 4.4 percent of the statewide total (MDOT, *Michigan Transportation Facts & Figures,* December 1999). Average vehicle miles traveled is the mileage driven by all vehicles in one year. MDOT reports that "highway travel in Michigan is increasing at a far greater rate than the state population," 38 percent between 1984 and 1998. The increase is attributed to longer distances traveled to work and other destinations, plus increases in tourism and recreation. No separate figures are provided for the Superior region.

MDOT publishes annual average 24-hour traffic volume maps and commercial traffic volume maps, with data listed for locations across the state. For the purposes of this report, the GEM Center for Science and Environmental Outreach selected sites to provide a geographic representation across the Lake Superior Basin. No other factors, such as upward or downward trends in traffic, were considered. For two of the selected sites that showed apparent sudden increases or decreases in traffic, MDOT checked their database and discovered changes in the exact segment of highway monitored from one year to the next. Using additional data not included on the statewide traffic map, MDOT provided revised figures, as noted in table 4.15a and figures 4.15a-b. Most of the six sites in or near regional population centers stayed the same or increased in traffic volume between 1987 and 1998; their average increase was 34 percent. Most of the seven rural sites stayed about the same or declined slightly over the same period, except for M-28 west of Sand River, between Marquette and Munising, which more than doubled. Commercial traffic increased between 1990 and 1998 at all but two locations (table 4.15b, figs. 4.15c-d). A more detailed examination of the available data would be required to determine if the selected sites are representative of the Lake Superior Basin.

Public Transportation. Seven public transit authorities operate in the Michigan Lake Superior Basin: countywide systems in Gogebic, Ontonagon, Marquette, Alger, Luce, and Chippewa Counties and service in the cities of Houghton and Sault Ste. Marie. Table 4.15c summarizes their services. Intercity bus routes operate within the region along U.S. 41 from Calumet to Marquette and south to Escanaba, where they connect south to Green Bay and Chicago, west along U.S. 2 to Ironwood and Duluth, and east to Mackinaw City and the Lower Peninsula. For Michigan as a whole from 1978 to 1998, intercity bus ridership declined from a high of 1,909,372 in 1980 to a low of 510,646 in 1993. Miles traveled dropped correspondingly from 12,680,000 to 4,650,000. Ridership and miles traveled rebounded to 685,000 and 5,600,000, respectively, in 1998. No intercity passenger rail service operates in the Upper Peninsula.

Sixteen carpool parking lots are currently maintained by MDOT on routes that traverse the Michigan Lake Superior Basin. The total number of vehicles using carpool lots in the Basin, as measured during the annual Condition and Count Survey taken at the same time each year, rose from 21 in 1975 to 154 in 1987, then declined steeply to 56 in 1995 (table 4.15d, fig. 4.15e-h). Since then, carpool lot usage has rebounded to 88 vehicles in 1999. Trends in usage of individual lots vary considerably. As noted previously, U.S. Census data for the Lake Superior Basin counties reflects a drop in carpool participation from 1980 to 1990. For all carpool lots in Michigan statewide from 1983-1989, the average daily number of cars parked was 3,598, declining to an average of 2,524 from 1990-1998. MDOT also provided tables of random counts of vehicles in Superior Region carpool lots from 1995 to 2000 (table 4.15e). These random counts, from different days of the week and months of the year, show considerable variability. Most respondents to carpool parking lot user surveys from 1994, 1996, and 1999 appreciated the carpool lots, but a number noted problems with keeping the lots plowed in winter (tables 4.15f-h). Others suggested paving and lighting some lots.

The Western U.P. Planning and Development Regional Commission and Central U.P. Planning and Development Commission administer Michigan's Ridesharing Program to promote carpools and vanpools. WUPPDR has no participants as of August 2000, and CUPPAD's program has been in operation for only a few months. WUPPDR has coordinated rideshare or vanpool programs since 1980, with some gaps, but staff could recall only three businesses that had participated. MDOT's Rideshare Coordinator had no additional information.

Some nonmotorized facilities, such as bike lanes, have been developed along highways within the Michigan Lake Superior Basin. The Wisconsin Department of Transportation (WisDOT) published the *Wisconsin Bicycle Transportation Plan 2020* in December 1998. Among the recommendations of the plan are to consider improvements for bicyclists in all road projects, both urban and intercity (rural); accommodations for bicycles at the time of roadway construction typically add only a small amount to overall project costs. The plan also notes that "land use and development actions are centered around making bicycling trips more practical, through the construction of clustered developments that are contiguous to the existing built-up areas of communities. Mixed use development and neighboring shopping districts are also land use patterns that should be pursued." Internal neighborhood connections in new developments are expected to benefit both bicyclists and pedestrians.

A statewide pedestrian planning process in Wisconsin began in summer 1999, and a transit plan will be developed when state highway planning is complete (WisDOT, *Wisconsin State Highway Plan 2020 Summary Report*, November 1999).

Aviation. Of Michigan's 129 publicly owned airports, 8 are in the Lake Superior Basin (MDOT *Michigan Airport System Plan Report: MASP 2000*, January 2000). Only one of the state's 107 privately owned public-use airports is located within the Basin, in Marquette County.

The MDOT Superior Region (Upper Peninsula) projects an increase in total air operations of 26.7 percent, from 248,578 flights in 1998 to 314,900 in 2020, similar to a statewide projected increase of 27.9 over the same period. MASP 2000 has seven system goals: serve significant population centers, serve significant business centers, serve significant tourism/convention centers, provide access to the general population, provide adequate land area coverage, provide ade-

quate regional capacity, and serve seasonally isolated areas. In terms of meeting these goals, all airports have been assigned to one of three tiers. Tier 1 airports, which respond to critical or essential state airport system goals, "should be developed to their full and appropriate level." Tier 2 airports, which complement the Tier 1 system and/or respond to local community needs, should focus on "maintaining infrastructure with a lesser emphasis on facility expansion." Tier 3 airports "duplicate services provided by other airports and/or respond to specific needs of individuals and/or small businesses." They will receive only minimal safety enhancements, such as runway cones and wind socks.

By MDOT's definition, a population center is a minor civil division of 5,000 or more people with a population density of at least 250 per square mile. By 2020, the Lake Superior Basin in Michigan will have five population centers: Ironwood, Houghton-Hancock, Ishpeming-Negaunee, Marquette, and Sault Ste. Marie. Four Basin airports are classified as Tier 1 for population centers: Houghton County Memorial, Gogebic-Iron County, Sawyer, and Chippewa County International, all currently classified D-III, which can accommodate Boeing 747, McDonnell Douglas DC-10, or Lockheed L-1011 aircraft (table 4.15i). Ishpeming-Negaunee is considered "not served" as a population center because the airport is more than 30 minutes away.

Business centers are Travel Analysis Zones (TAZ) with 3,000 or more employees. The five population centers listed above will also be business centers in 2020 by this definition. Ironwood, Ishpeming-Negaunee and Sault Ste. Marie are not served adequately as business centers. Houghton County Memorial and Sawyer are Tier 1 and Gogebic-Iron County and Sault Ste. Marie Muni-Sanderson are Tier 2 for business centers. Tier 1 airports respond to 95 percent of business centers; Tier 2 airports bring the service level to 100 percent.

The 293 tourism and convention centers in Michigan are TAZs that generate $30,000 or more in annual lodging use tax. Sixteen centers in the Lake Superior Basin are served by the same four Tier 1 airports as the population centers, plus Hanley Field in Munising (which would require an upgrade from A-I to B-II class to handle larger aircraft) and a recommended new airport in Baraga County. Tier 2 airports for tourism and convention centers are Luce County, Ontonagon County, Sault Ste. Marie Muni-Sanderson, and a recommended new airport in Paradise (western Chippewa County).

Tier 1 airports for general population access include Houghton County Memorial, Gogebic-Iron County, Sawyer, and Chippewa County International. Land area coverage for general aviation pilots should provide access to an airport with a paved runway within 30 miles for emergency landings. Tier 1 airports for this purpose are Houghton County Memorial, Gogebic-Iron County, Sawyer, Munising Hanley Field (if upgraded to B-1), Luce County, Ontonagon County, Chippewa County International, and the recommended new airport in Baraga County. Three airports in the Basin, Houghton County Memorial, Sawyer, and Chippewa County International will serve the Tier 1 regional capacity requirement of 125 percent of forecasted demand. No airports in the Basin serve areas classified as isolated; only 7 airports statewide fit that category.

Four airports in the Michigan Lake Superior Basin provide scheduled passenger service from the following locations: Houghton/Hancock, Ironwood, Marquette, and Sault Ste. Marie County. All four had fewer passengers in 1998 than in 1978, as did the Upper Peninsula as a whole with a 30.8 percent decrease over the period, though numbers have fluctuated during the period

(MDOT, *Michigan Transportation Facts & Figures,* December 1999). The passenger levels in 1978 and 1998, respectively, are as follows: Houghton/Hancock 51,824 and 47,741 (7.9 percent decrease), Ironwood 20,511 and 4,201 (79.5 percent decrease), Marquette 85,496 and 84,126 (1.6 percent decrease), and Sault Ste. Marie County 25,389 and 13,607 (46.4 percent decrease). Overall, the number of passengers declined 18 percent in the Lake Superior Basin and 30 percent in the Upper Peninsula. During the same period statewide, the number of passengers nearly tripled; passenger levels in the Metro Detroit area more than tripled. Figure 4.15i and table 4.15j provide more detail.

Railroads. The Northeast Minnesota Freight Study, completed in 1999 by the Arrowhead Regional Development Commission, notes that rail lines in that region are well used, particularly for the coal and taconite industries. The seven taconite companies use rail exclusively to move iron ore to Lake Superior ports. The *Compare Minnesota* report (Minnesota Department of Trade and Economic Development, www.dted.state.mn.us) shows rail lines extending northwest and west from Duluth.

Commercial Ports. Five of Michigan's 39 commercial ports border Lake Superior (MDOT, *Michigan Transportation Facts & Figures,* December 1999). Marquette ranked second to Detroit in 1996 tonnage at 10,557,000 tons, mainly iron ore. Other Lake Superior ports and their 1996 cargoes are 165,715 tons at Ontonagon, 50,000 tons at Munising, 22,000 tons at Sault Ste. Marie, and 2,000 tons at Houghton-Hancock. The total 1996 tonnage for Michigan ports was 94,885,721. In addition to cargo vessels, four passenger-only ferries operate seasonally on Lake Superior: Houghton to Isle Royale, Copper Harbor to Isle Royale, Isle Royale to Grand Portage, Minnesota, and Munising to Grand Island.

Two Lake Superior ports, Duluth, MN/Superior, WI and Two Harbors, MN, ranked 18th and 48th, respectively, in total tons among U.S. water ports in 1997 (U.S. Bureau of Transportation Statistics, www.bts.gov/ntda/nts/NTS99/data). Although Duluth-Superior ranked 17th in 1990, the port handled 2.8 percent more cargo in 1997 (41.9 tons) than in 1990 (40.8 tons). Two Harbors' rank didn't change, but it handled 13.5 tons in 1997 as compared to 12.3 tons in 1990, a 9.8 percent increase. The Minnesota Department of Trade and Economic Development *Compare Minnesota* report lists statistics for commerce at four Minnesota ports: Duluth-Superior, Two Harbors, Silver Bay, and Taconite Harbor. Shipments in 1996 totaled 64,873,840 tons, with a 1987-1996 average tonnage of 65,502,621. Iron ore accounted for about 70 percent of Minnesota commodity shipments on the Great Lakes in 1996. The Northeast Minnesota Freight Study, completed in 1999 by the Arrowhead Regional Development Commission, notes that Duluth/Superior ships and receives many types of goods, but the other three Minnesota ports ship only taconite to other Great Lakes ports.

Michigan Transportation Fund and Supplemental Snow Removal Revenues. In Michigan, all state fuel taxes and license plate fees are deposited in the Michigan Transportation Fund (MTF). The fund currently collects over $1.7 billion in revenue each year (Michigan Department of Transportation, Bureau of Finance, *Michigan Transportation Facts & Figures*, December 1999). This revenue is shared among city, county, and state transportation agencies for construction, maintenance, and operation of Michigan systems. Up to 10 percent of the funds are distributed to the Comprehensive Transportation Fund to support railroads and other public transportation systems. MTF funds collected for distribution to Michigan Lake Superior Basin

counties, cities, and villages in 1998 were $21,141,222, or 2.5 percent of the state total, $835,829,507 (table 4.15k). MTF supplemental snow removal funds for the Basin were $2,703,287, or 42.7 percent of the 1998 state total, $6,334,010 (table 4.15l).

4.16 Types and Quantities of Electric Power Generation

Measures of electric power generation relate to the resource consumption indicator. Electric power data for the entire United States is available on the Internet from the Energy Information Agency (EIA) of the U.S. Department of Energy (www.eia.doe.gov/cneaf /electricity). Databases include power generation by utility company, peak demand output of individual plants, and energy use per consumer by utility and sector (residential, commercial, industrial, and all sectors). The U.S. Geological Survey also reports total power generation and subsets for hydroelectric and thermoelectric (fossil fuel) generation by watershed as part of their national water-use database, updated every five years (http://water.usgs.gov/watuse). The USGS data is convenient because it is already linked to the watersheds that make up the U.S. portion of the Lake Superior Basin. However, according to USGS water-use staff, 1995 is probably the last year for watershed-based data to be reported. Also, USGS guidelines for compiling power generation data recommend several sources of data to water-use personnel: EIA data, utility company records, or state agencies (USGS, *National Handbook of Recommended Methods for Water Data Acquisition,* http://water.usgs.gov/pubs). This flexibility means that different states may not use the same source of information or that the source used one year may not be the same one used five years later. Therefore, this project also extracted data for the U.S. Lake Superior Basin from the EIA databases, which gather information annually from electric power utilities and nonutilities.

For the 15 subbasins of the U.S. Lake Superior Basin, the USGS water-use data shows an increase in total electric power generation, from 3,204 gigawatt-hours (million kilowatt-hours) in 1985 to 3,639 gigawatt-hours in 1990 to 4,719 gigawatt-hours in 1995 (tables 4.16a-c, fig. 4.16a). Most of that power is thermoelectric; the rest is hydroelectric (tables 4.16a-c, figs. 4.16b-c). The Dead-Kelsey watershed, surrounding Marquette, Michigan, produced 73 percent of the total power all three years. The St. Louis watershed in the Duluth-Superior area added 15 to 18 percent of the total. Of the total power generated in the Basin, 79 to 86 percent comes from fossil fuel plants. It appears that the USGS data includes only utility power generators, not nonutilities.

EIA-861 files, available for 1992 through 1998 on the Internet, provide data on net generation, transmission, and distribution of electric power by utility company (tables 4.16d-g). These files summarize the total operations of each utility, which may include areas both inside and outside the Lake Superior Basin. EIA-860A files list each utility's power plants by individual generating unit, type, fuel, and summer and winter capability (peak demand output) (files EIA-860TYPE3). Combining the two files produces estimates of the power generated within the Basin for each utility: 4,154.6 gigawatt-hours in 1992, 4,601.5 gigwatt-hours in 1995, and 5,002.2 gigawatt-hours in 1998 (table 4.16h). Note that the EIA figure for 1995 differs from the USGS watershed total by less than 2.5 percent. Power generated in the Basin increased 20 percent from 1992 to 1998. Power purchased from utilities and nonutilities increased by 89 and 1,117 percent, respectively, during the period (those figures are for total operations of the utilities and may differ for the Basin-only portion). Eight company power plants generated an additional 2,182.8 gigawatt-hours in the Basin in 1998; their total power consumption was 2,187.8 gigawatt-hours

(EIA-860B *Annual Electric Generator—Nonutility*, 1998, www.eia.doe.gov/cneaf/electricity). Nonutility data is confidential prior to 1998.

In 1998, 14 utilities operated a total of 30 power plants in the U.S. Lake Superior Basin, and 8 private companies operated 8 more plants in the Basin (tables 4.16i-l, EIA *Inventory of Electric Utility Power Plants in the United States 1999* and *Inventory of Nonutility Electric Power Plants in the United States 1998*, www.eia.doe.gov/cneaf/electricity). Only two utility plants (Minnesota Power's M. L. Hibbard in Duluth, Minnesota, and Northern States Power's Bayfront in Ashland, Wisconsin) and one private plant operated by Potlatch in Cloquet, Minnesota, use a renewable energy source, wood. In the Ontario portion of the Basin, 11 utilities and private companies operated 28 power plants (table 4.16m, Statistics Canada, *Electric Power Generating Stations - 1998*).

The EIA also publishes electric energy use per consumer by residential, industrial, and commercial sectors. Data extracted from the EIA 1998 "Retail Electricity Sales" tables for the 29 utilities operating in the Lake Superior Basin can be used to calculate the following averages of energy use: 7,750 kilowatt-hours per residential consumer, 6,108,000 kwh per industrial consumer, 44,120 kwh per commercial consumer, and 35,340 kwh per consumer for all sectors (table 4.16n). Note that consumers may include households and businesses. Overall energy use per consumer is higher for the Basin than for Michigan, Minnesota, or Wisconsin, mainly because industrial energy use is much higher. Commercial energy use per consumer is lower in the Basin than in any of the three states, as is residential energy use, except for Michigan, which is slightly less than for the Basin. According to EIA state electricity profiles, utility and nonutility generation per person is 10,240 kwh (rank 36) in Michigan, 10,030 kwh (rank 37) in Minnesota, and 10,790 kwh in Wisconsin (rank 34). (See www.eia.doe.gov/cneaf/electricity/st_profiles.)

Canada's Energy Outlook 1996-2020 (http://nrn1.nrcan.gc.ca:80/es/ceo/toc-96E.html) notes that "a significant amount of excess generating capacity exists in all regions of Canada" because demand has not reached the level predicted when new power plants were built in the 1970s and 1980s. Demand is projected to grow at an average annual rate of 1.3 percent in Ontario and 1.0 percent in Canada overall between 1995 and 2020, compared to 2.6 percent annually from 1980 to 1995. From 2010-2020, Ontario will add 3,650 megawatts of new gas-fired and 3,300 megawatts of clean coal-fired capacity. Several hydroelectric plants will be redeveloped, but none appear to be in the Lake Superior Basin. Renewable resources are projected to quadruple between 1995 and 2020, but will contribute only 3 percent of total power generation.

A report by the nonprofit Union of Concerned Scientists (UCS), *Powerful Solutions for Wisconsin: Seven Ways to Switch to Renewable Electricity*, cites Wisconsin's proactive policies, such as a Climate Change Action Plan, that encourage investment in energy efficiency and renewable energy (www.ucsusa.org).

> A UCS analysis for Wisconsin found that an 800 MW mix of new renewables would create about 22,000 more job-years than new gas and coal plants over a 30-year period. A study by the Wisconsin Energy Bureau found renewables would produce over three times more jobs, income and economic activity than the same amount of electricity generated from new coal and natural gas power plants. They also found that a 75 percent increase in renewable energy use by 2010 (equal to 775 MW of new renewables) would generate approximately 3,316 more jobs, $81

> million in higher disposable income and a $165 million increase in gross state product than conventional power plant investments. This scenario also would reduce 20 percent of the growth in electricity sector CO_2 emissions between 1990 and 2010 and save an estimated $60 million per year in potential future environmental regulations on carbon emissions.

As of 1998, renewables, mainly hydropower, supplied less than three percent of Wisconsin's electricity. A 1993 UCS report, *Powering the Midwest*, identified biomass (crops of switchgrass and hybrid poplars) as a potential source of 30 percent of Wisconsin's energy needs at 5 cents per kilowatt-hour and 60 percent for an extra penny of production costs. Wind power could provide almost half the state's total demand at 6 cents per kilowatt-hour and is particularly suited to areas near Lake Superior. Solar energy may help reduce peak loads during hot weather. Wisconsin has developed a statewide daylighting design services program to educate architects, builders, and engineers on incorporating daylighting into Wisconsin building practices.

The nonprofit RENEW Wisconsin is working with utilities to seek national third-party certification for their renewable power products, to which about 70 percent of Wisconsin energy customers currently have access (http://renewwisconsin.org/greenpow.html). For example, RENEW negotiated an agreement with Wisconsin Electric Power to supply its Energy for Tomorrow program with renewable energy generated primarily in Wisconsin, with public support and marketing assistance from RENEW and Wisconsin's Environmental Decade.

Another UCS report, *Assessing Wind Resources in Minnesota: A Guide for Landowners, Project Developers and Power Suppliers*, provides guidance in assessing potential wind resources. The report includes a map of annual average wind power in the U.S. that shows moderate wind power classes along Lake Superior.

4.17 Other Energy-Related Data

Additional energy-related data comes from the Wisconsin Energy Bureau publication, *Wisconsin Energy Statistics – 1999* (www.doa.state.wi.us/boe/publications/energy_stats.asp). Most of the data is statewide, but some relates to the Lake Superior Basin. A map of Wisconsin petroleum pipelines shows the Murphy Refinery in Superior and three crude oil pipelines operated by Lakehead Pipeline Company through Superior: one from Canada through Minnesota, one extending southeast to Chicago, and one eastward across the basin to Canada via Sarnia, Ontario. A map of coal transportation routes shows a unit train (coal-only) route and Lake Superior trans-shipment point in Superior and a truck shipment route to Northern States Power's Bay Front power plant in Ashland, which burns wood and coal. That plant's consumption of coal dropped from 2,708 tons in 1980 to 216 tons in 1996 and 357 tons in 1998. Sulfur dioxide emissions have declined from 1.8 to 1.6 pounds per million Btu between 1990 and 1998, still short of the goal set by the state in 1993 to reach an emission rate of 1.2 pounds SO_2 per million Btu.

Total per capita energy consumption from all sources (coal, natural gas, petroleum, and electricity) in 1997 was 359.5 million Btu in Minnesota, 352.8 million Btu in Wisconsin, and 333.1 million Btu in Michigan. Their respective ranks among the 50 states were 25, 26, and 31. The highest total per capita consumption was in Alaska (1,143.5 million Btu). The lowest was 201.0 million Btu in Hawaii. These figures compare to a national average of 351.2 million Btu.

Total greenhouse gas emissions from all sectors in Canada are projected to be 8.2 percent higher in 2000, 19 percent higher in 2010, and 36 percent higher in 2020 than in 1990 (*Canada's Energy Outlook 1996-2020*). Emissions from power generation are expected to rise significantly after 2010, when aging nuclear plants are replaced by fossil fuel plants; this transition will not impact the Ontario Lake Superior Basin directly because no nuclear plants are located there.

Other potentially useful energy information is data on federal and state fuel-use taxes, which would help gauge transportation-related fuel consumption trends. The U.S. Department of Transportation reports this information by state, so it was hoped that the state treasury or revenue departments could provide data by county, city, or region. However, the states gather information from individual fuel distributors, who do not break down the information by location within the state. A fuel tax specialist for the U.S. DOT Bureau of Transportation Statistics was unaware of any other source of information.

4.18 Water Use and Groundwater Quality and Availability

Water use, quality, and availability are measures of the "Resource Consumption" indicator. The U.S. Geological Survey (USGS) has compiled water-use data for the 15 subbasins that comprise the U.S. Lake Superior Basin: Baptism-Brule, Beaver-Lester, Cloquet, St. Louis, Beartrap-Nemadji, Bad-Montreal, Black-Presque Isle, Ontonagon, Keweenaw Peninsula, Sturgeon, Dead-Kelsey, Betsy-Chocolay, Tahquamenon, Waiska, and Lake Superior (water.usgs.gov/watuse, tables 4.18a-c). The USGS 1992 *Ground Water Atlas of the United States, Segment 9* (Hydrologic Investigations Atlas 730-J) presents data on groundwater quality and availability in Michigan, Minnesota, and Wisconsin. Environment Canada provided 1996 municipal water-use data for the 6 municipalities in the Ontario portion of the Basin with 1,000 or more residents (www.ec.gc.ca/water contains summaries by province only).

Total water use from all sources in the U.S. portion of the Basin increased 25 percent from 681.9 million gallons per day (Mgal/d) in 1985 to 851.5 Mgal/d in 1995 (fig.4.18a). Water use is measured in eight categories: public supply, commercial, household wells, industrial, power generation, mining, livestock, and irrigation. In the Lake Superior Basin between 1985 and 1995, 48 to 60 percent of water use (347 to 484 Mgal/d) was related to power generation, with another 22 to 34 percent (181 to 292 Mgal/d) used in mining operations (figs. 4.18b-c). Public supply accounted for 10 percent or less (57 to 82 Mgal/d), as did industrial use (52 to 64 Mgal/d). The other categories together contributed less than 2 percent of water use. Groundwater supplied only about 5 percent of water used by all sources Basin-wide, but served about half the population; some areas depend heavily on groundwater (figs. 4.18d, f-h).

The population in the U.S. part of the Basin increased from 394,100 in 1985 to 460,570 in 1995 (fig. 4.18e). The percentage of people served by public surface water supplies was 49 percent in 1985, 54 percent in 1990, and 52 percent in 1995 (figs. 4.18f-k). Two watersheds along the Minnesota shore, Beaver-Lester and St. Louis, together accounted for 69 to 78 percent of the population served by surface water supplies each year. Public wells supplied 29, 22, and 28 percent of the Basin population, while private household wells supplied 22, 24, and 20 percent in 1985, 1990, and 1995, respectively. The data for the three years is somewhat puzzling, especially for some subbasins, in the relative change in the number of people served by surface water and groundwater. However, the changes could be the result of offsetting trends. For example, new

construction in areas not served by public systems increases the population served by household wells. At the same time, other areas, especially those where groundwater contamination has occurred, may connect to public supplies, either surface water or groundwater. (State drinking water agencies, such as the Michigan Department of Environmental Quality's Drinking Water and Radiological Protection Division, should be consulted for more specifics about the records under their jurisdiction.)

The household per capita water use from private wells was 57 gallons/day in 1985, 55 in 1990, and 71 in 1995 (fig. 4.18l). Household per capita water use from public supplies was 123 gallons per day in 1985, 137 in 1990, and 63 in 1995 (fig. 4.18m). The drop in 1995 parallels the drop in the Beaver-Lester watershed from more than 400 to 55, which suggests that some of the water use attributed to households in 1985 and 1990 came from other sources. Total per capita water use from public supplies was 186 gallons per day in 1985, 255 in 1990, and 220 in 1995 (fig 4.18n).

The population served by public water supplies ranged from 76 to 80 percent between 1985 and 1995, while 20 to 24 percent of the population supplied their own water from private wells (figs. 4.18o-t). Groundwater as a percentage of total water use by public supplies and private household wells was 33 percent in 1985, 29 percent in 1990, and 51 percent in 1995 (fig 4.18u). In 1995, 100 percent of the total water use by public supplies and private household wells in 6 subbasins came from groundwater. Groundwater use Basin-wide increased from 20.8 to 44.3 million gallons per day from 1985 to 1995 (fig. 4.18v).

In the Ontario portion of the Basin, according to Environment Canada Municipal Water Use Data, total water use in 1996 for the six municipalities with 1,000 or more residents was 88,014 cubic meters per day (m^3/d or 23.3 Mgal/d), distributed as follows: 44.5 percent domestic supply (39,195 m^3/d or 10.4 Mgal/d), 29.8 percent commercial and institutional (26,253 m^3/d or 6.9 Mgal/d), 14.3 percent industrial (12,556 m^3/d or 3.3 Mgal/d), and 11.4 percent other (10,010 m^3/d or 2.6 Mgal/d) (table 4.18d, figs. 4.18w-x). The six municipalities—Marathon, Nipigon, Red Rock, Sault Ste. Marie, Terrace Bay, and Thunder Bay—served 189,866 people, about 79 percent of the Lake Superior Basin population in Ontario. The overall per capita water use was 123 gallons per day, ranging from 65 in Sault Ste. Marie to 194 in Red Rock. Only about 14 percent of the water use in the six municipalities came from groundwater, in Sault Ste. Marie and Marathon.

Nipigon Township and Marathon reported water quantity problems in 1988 and 1991, respectively, caused by drought. Marathon also had one well down in 1991 with quality problems. A land slump into the Nipigon River caused quality problems for Nipigon Township in 1990. Sault Ste. Marie and Red Rock reported no use restrictions or boil days in 1995, while Thunder Bay had 120 days of use restrictions (Environment Canada, Municipal Water Use Data, 1996).

The Ontario Ministry of the Environment monitors drinking water systems through its Drinking Water Surveillance Program. Priority for inclusion of water supplies in the program depends on population exposure, geographical location, risk of contamination, and available laboratory capacity. Executive summaries of the 1993-1995 and 1996-1997 reports include information on ten water supplies in the Lake Superior Basin (www.e.gov.on.ca/envision/techdocs). The program tests about 200 bacteriological, inorganic, organic, and radiological parameters in raw

and treated water at the plants and in the distribution systems. Unless noted otherwise in the individual water supply descriptions below, no known health-related guidelines were exceeded.

The Beardmore Water Treatment Plant, a package plant with conventional treatment, has a design capacity of 1,300 m^3/day and serves about 500 people. The water source is the Blackwater River, and treatment includes corrosion control and disinfection. More than 11,000 water quality tests were performed from 1993 to 1997. The plant generally produced water of good quality, which was maintained in the distribution system.

Manitouwadge, population 4,500, was served by five wells with a total pumping capacity of 13,200 m^3/day. Treatment included disinfection with chlorine and pumping through aeration towers to remove objectionable levels of hydrogen sulfide. More than 7,000 tests were performed from 1993 to 1995. The water produced was of good quality, but contained numerous minerals and salts at levels above aesthetic guidelines. Quality was maintained in the distribution system.

Marathon's population of approximately 5,100 was served by 6 wells with a pumping capacity of 9,800 m^3/day that tapped several aquifers. No treatment or disinfection was used. Nearly 8,000 water-quality tests were performed from 1993 to 1995. The water exceeded numerous aesthetic guidelines but was of acceptable quality as pumped and in the distribution system.

Water from the Nipigon River is pumped through sand filters and disinfected to serve a population of about 2,500 in Nipigon Township. Plant capacity is 3,700 m^3/day. More than 5,500 tests were performed during 13 sample events from 1993 to 1995, and 7 samples exceeded the Ontario Drinking Water Objective Maximum Acceptable Concentration of 1.0 FTU for field and lab turbidity. An additional 2,433 tests were performed in 7 sample events in 1996 and 1997. Three more treated water samples exceeded the 1.0 FTU level. Turbidity was also identified as a problem in 1990 for Nipigon in the Municipal Use Database results reported above. Water at the plant and in the distribution system was of adequate quality. The Ministry of the Environment attributed elevated test levels for color, dissolved organic carbon, and turbidity in the treated water to lack of conventional treatment at the facility.

The Red Rock water treatment plant pumps water from Lake Superior to serve a population of 1,400. The plant has a design capacity of up to 3,000 m^3/day, using conventional treatment and pH adjustment, fluoridation, and disinfection. From 1993 to 1995, 5,683 tests performed in 15 sample events produced one treated water sample with field and lab turbidity levels above the Maximum Acceptable Concentration of 1.0 FTU. The problem sample was taken while the up-flow solids contact clarifier was out of service for maintenance. An additional 1,765 tests performed in 5 sample events during 1996 and 1997 did not exceed health guidelines. Reported water quality was acceptable from 1993 to 1995 and good from 1996 to 1997 both at the plant and in the distribution system.

Sault Ste. Marie, Ontario, serves a population of 85,000 by pumping a combination of surface water from Lake Superior and groundwater from four wells in two aquifers through a direct filtration system. The plant uses ammonia to produce a chloramine residual for disinfection. Plant capacity is 20,800 m^3/day, with up to 50 percent of the supply coming from the wells. More than 5,300 tests in 14 sample events at the treatment plant and 5,400 tests in 23 sample

events from the well supply were performed from 1993 to 1995. In 1996 and 1997, 1,540 tests were performed in 4 sample events in the treatment plant and distribution system. Water quality from the plant and in the distribution system was good during all five years.

The privately owned Terrace Bay water treatment plant supplies water from Lake Superior to both the Kimberly Clark pulp mill and the town's population of 2,600. The only treatment is disinfection. Information on pumping capacity is unavailable. From 1993 to 1997, 3,024 tests were performed in 7 sample events, and the water quality was rated acceptable at the plant and in the distribution system.

Thunder Bay's Bare Point water treatment plant pumps water from Lake Superior through a direct filtration system to a population of about 64,500 in the north part of Thunder Bay. The plant's design capacity is 91,000 m^3/day. Some 6,500 tests were performed in 21 sample events from 1993 to 1997. The Ontario Drinking Water Objective for lead (10 µg/L) was exceeded in some homes, a problem being addressed by the City of Thunder Bay (though evidently not resolved, as it was mentioned in both the 1993-1995 and 1996-1997 reports). Water quality was good except for the deterioration [lead contamination] in some areas of the distribution system.

The Loch Lomond water treatment plant, which serves about 47,500 people in the southern part of Thunder Bay, partially treats water from Loch Lomond by disinfecting the supply and adding sodium silicate for corrosion control. Plant capacity is 77,200 m^3/day. No health-related problems appeared in the 4,448 tests performed in 16 sample events from 1993 to 1995, and water quality was acceptable both at the plant and in the distribution system. During 1996-1997, however, some samples from the distribution system had high lead levels. Elevated levels of color and organic carbon were attributed to the lack of full treatment. In October 1997, *Giardia* and *Cryptosporidium* were discovered in the water supply, and the Medical Officer of Health in Thunder Bay issued a boil order that remained in effect at the time of the report's publication in June 1998.

Wawa's water treatment plant partially treats water from Lake Wawa, using only fluoridation and disinfection, to serve 4,500 people. The plant design capacity is 8,110 m^3/day. More than 2,500 tests were performed in 8 sample events from 1993 to 1997. One treated water sample exceeded the 10 µg/L Maximum Acceptable Concentration for lead, but subsequent samples showed the lead level to be well below the guideline. The first sample may have reflected inadequate flushing of standing water from the pipes. Water from the plant and in the distribution system was of acceptable quality.

Ontario has launched Operation Clean Water, which updates and strengthens the Ontario Drinking Water Standards through a new Drinking Water Protection Regulation for large waterworks (systems that serve six or more residences, use more than 50,000 liters of water per day, or have the capacity to supply at least 250,000 liters per day). In August 2000, the Ministry of the Environment issued a discussion paper, *Protecting Drinking Water for Small Waterworks in Ontario,* to solicit input through November 15, 2000, from Ontario residents on regulations or other protection measures for smaller water supplies not currently covered under the new regulation (www.ene.gov.on.ca/ envision/waterreg).

The U.S. Environmental Protection Agency maintains the Safe Drinking Water Information System for all public water supplies in the U.S. (www.epa.gov/water). The records for water supplies within the Lake Superior Basin were not examined for this report. In 1998, however, the Michigan Tech GEM Center for Science and Environmental Outreach compiled a record of contaminant, treatment-technique, and monitoring violations for the public water supplies in the 15 counties of Michigan's Upper Peninsula, 9 of which are at least partly in the Lake Superior Basin. The analysis found that of approximately 1,035 U.P. public water supplies, 26 percent had no water quality violations, 44 percent had monitoring violations only, and 30 percent had contaminant violations sometime between 1988 and 1997 (fig 4.18y). In 1996, the percentages of Upper Peninsula public water supplies with contaminant and monitoring violations, 9 percent and 30 percent, respectively, were somewhat higher than for the U.S. overall, 8 percent and 22 percent respectively (table 4.18e, fig. 4.18z). Some supplies with contaminant violations also had monitoring violations. Contaminant violations occur when a health-based standard is exceeded (for coliform bacteria, lead, nitrate, or copper). Failure to perform a required treatment technique, such as adequate filtration of a surface water supply, is also a violation (grouped in the analysis above with monitoring violations). A monitoring violation occurs when a required test is either not performed or not reported to the state regulatory agency at the required frequency. Monitoring violations don't necessarily indicate a problem with the water supply, but lack of regular monitoring can allow problems to go undetected.

The U.S. Geological Survey doesn't have good estimates of aquifer volumes, but the *Ground Water Atlas of the United States* provides general water-quality information and well yields for the Lake Superior region, as described below. The U.S. Environmental Protection Agency's "Surf Your Watershed" web site lists the area of principal bedrock aquifers within each USGS subbasin (www.epa.gov. surf). Of the 15 subbasins in the U.S. Lake Superior Basin, three in Minnesota have no principal aquifer. Adding the area occupied by each principal aquifer in all the subbasins gives the following results: no principal aquifer, 12,222 square miles (mi^2); Jacobsville aquifer, 2,277 mi^2; Cambrian-Ordovician aquifer system, 2,119 mi^2; Silurian-Devonian aquifer, 135 mi^2; and Lower Cretaceous aquifers, 143 mi^2. (The areas with "no principal aquifer" apparently correspond to the USGS "crystalline bedrock aquifer" below.)

The surficial aquifer system, consisting of sediments deposited by glaciers or glacial meltwater, extends discontinuously across the Basin. Generally, the glacial deposits are thinner in northern Minnesota, Wisconsin, and Michigan than in other areas of those states, having been lost to erosion. Where a bedrock aquifer is present below the surficial aquifer system, the two are usually connected hydraulically. Bedrock aquifers may be exposed at the surface in rock outcrops or roadcuts but also extend below the surface to varying extents and depths, where wells can tap their water supplies.

Of the nine largest aquifer systems in the Michigan-Wisconsin-Minnesota-Iowa region, only five are present to any extent within the Lake Superior Basin. The surficial aquifer system is the "most widespread, extensively used, and easily accessible source of water" in the region. The surficial deposits receive water from precipitation or runoff, store and transmit water to streams as baseflow or to aquifers below as recharge. Because of their proximity to the surface and human activity, surficial aquifers and the wells completed in them are generally more vulnerable to contamination than deeper aquifers. However, the water quality in surficial aquifers is often better than in deeper deposits, where the water has had more opportunity to dissolve aesthetically

undesirable chemicals, such as iron or sulfate, from the surrounding rock. Confined aquifers are protected from surface contamination to varying degrees by overlying layers of dense rock or clay that do not transmit water readily. Artesian or flowing wells tap confined aquifers.

The Cambrian-Ordovician aquifer system is the second largest groundwater source in the region. It underlies much of the Basin in the eastern U.P. and from Superior to the Bayfield Peninsula in Wisconsin. It consists of the Munising, Trempeauleau, Prairie du Chien, and Trenton-Black River aquifers, mainly sandstone and sandstone-dolomite rock types. The Cambrian-Ordovician aquifer is found below the Silurian aquifer in the southern Upper Peninsula and under the entire Lower Peninsula, where it is briny and not considered an aquifer. The Trenton-Black River aquifer in the U.P. underlies the Cambrian-Ordovician and is partially confined by the shaly Richmond group (and by the Maquoketa confining unit on the Bayfield Peninsula); it is used mostly for domestic supply. The Prairie du Chien group, which underlies the Trenton-Black River, is an important water source in parts of the eastern U.P. Below that, the Ironton-Galesville aquifer consists of the Au Train Formation, Miner's Castle Sandstone, and the Chapel Rock Sandstone of the Munising Group. The lowest aquifer in the Cambrian-Ordovician aquifer system is the Mt. Simon aquifer, consisting of the Hinckley Sandstone in northern Minnesota, the Bayfield Sandstone in Wisconsin, and the lower part of the Chapel Rock Sandstone in the eastern U.P. of Michigan. The more deeply buried the rocks of this aquifer system are (i.e. the farther south they are), the higher the dissolved-solids content and the poorer the water quality. In the northern areas of the U.P., where the rock is at or near the surface, dissolved solids are less than 500 milligrams per liter. Some areas may have objectionable amounts of iron and manganese, which are not threats to health and can be removed by water treatment methods.

The Silurian-Devonian aquifer, of limestone or dolomite with solution-enlarged fractures, underlies only 135 square miles of the Tahquamenon subbasin in the eastern U.P. In the southeastern U.P., this aquifer yields up to 100 gallons per minute from wells 10 to 350 feet deep. This aquifer system in the Lower Peninsula contains brines but has a dissolved-solids concentration of 250 to 500 milligrams per liter in the U.P., where it is near the surface and overlain by the surficial aquifer.

The Cretaceous aquifer, present under 143 square miles of the St. Louis subbasin in Minnesota, is mainly sandstone with water of marginal quality due to sulfate dissolved from gypsum, important only because it is the sole source of groundwater in some areas.

The Precambrian Jacobsville sandstone aquifer occupies parts of nine subbasins in the U.P. and Iron County, Wisconsin. It is the eighth largest groundwater source in the four-state region, yielding enough water for domestic or small-community supplies. Where present, it may be the only source of groundwater. If the surficial aquifer is present, wells are generally not drilled into the bedrock. Dissolved-solids concentrations are only slightly higher than in the overlying surficial deposits, generally less than 1,000 milligrams per liter. The Jacobsville provided about 6.5 million gallons of water per day in 1985, evenly divided among public supply, domestic and commercial, and industrial, mining, and thermoelectric uses.

The crystalline-rock aquifer forms the bedrock surface in the largest part of the Basin. It yields small to moderate amounts of water and is important because it is the only source in many areas. In the Minnesota portion of the Lake Superior Basin, four rock types make up the crystalline-

rock aquifer: the North Shore Volcanic Group of lava alternating with sedimentary rocks with water that ranges from fresh to salty (91 to 74,300 mg/l total dissolved solids (TDS)); meta-sedimentary rocks in parts of St. Louis and Carlton Counties with generally fresh water (126 to 2,420 mg/l TDS); the Biwabik Iron Formation along the Iron Range in St. Louis County with generally fresh water (157 to 388 mg/l TDS) that may contain high concentrations of iron and manganese; and undifferentiated Precambrian rocks with water ranging from fresh to salty (96 to 2,450 mg/l TDS). In northern Wisconsin and Michigan's Keweenaw Peninsula, the rock types are lava flows or igneous and metamorphic rocks. Maximum yields in the lava are 25 gallons per minute and generally less than 5 gallons per minute from the other rocks.

4.19 Wastewater Treatment

This measure was not among those identified by the Developing Sustainability Committee. It relates most closely to the "Quality of Life" indicator, as it is similar to the transportation and communication infrastructure measure, but it is also relevant to the "Resource Consumption" indicator.

The U.S. Environmental Protection Agency Office of Wastewater Management conducted a Clean Water Needs Survey of publicly owned, municipal wastewater collection and treatment facilities in 1996. For each facility (listed by state), the resulting database lists the population served, expected future population, average daily wastewater flow in 1996, design flow at that time, and future design flow (www.epa.gov/owm).

For the Lake Superior Basin of Michigan, the 1996 Clean Water Needs Survey Report 2 lists 30 wastewater treatment facilities, which served 103,547 people in 1996 and treated 23.84 Mgal/d of wastewater (table 4.19a). The design flow was 31.24 Mgal/day, and the future design flow was 32.54 Mgal/d for an expected population of 123,701. Two additional wastewater facilities, with a combined design flow of 0.32 Mgal/d, were planned to serve 2,558 more people. The data shows 12 facilities with 1996 average daily flows below their respective design flows and 18 facilities with daily flows at or above their design flows. Only three of the facilities list a future design flow higher than the 1996 level. One facility has a lower future than existing design flow, even though the 1996 daily flow exceeded the design, which suggests an error in the data.

The Michigan Department of Environmental Quality Surface Water Quality Division in the Marquette regional office provided a database of currently operating publicly owned wastewater facilities in the U.P., from which data on facilities in the Lake Superior Basin was selected (table 4.19b). The DEQ list includes 41 facilities, some of which are new since 1996; others are not on the EPA survey list, perhaps because they did not respond to the survey. The DEQ database includes year of construction and design flow for 27 facilities and populations for 17. Of the 21 facilities listed by both sources that have design flow data, only 10 have values that agree reasonably well for either existing or future design flow. Part of the discrepancy may result from comparing 1996 and 2000 data, but it should be investigated further.

The Clean Water Needs Survey listed 21 facilities in the Lake Superior Basin of Minnesota serving a population of 61,706 and a projected future population of 69,104 (table 4.19c). The wastewater flow was 46.93 Mgal/d in 1996, compared to a design flow of 56.84 and a future design flow of 70.29. Thirteen facilities had average daily flows below their design, and 8

equaled or exceeded their design flows. Fifteen facilities listed a higher future design flow, including those that exceeded the current design. However, some of the increased future design flows were still below the 1996 average daily flows, a situation that requires explanation. No additional facilities within the Basin were planned as of 1996.

The Minnesota Pollution Control Agency (MPCA) provided a list of National Pollutant Discharge Elimination System permits for the Lake Superior Basin by watershed, which reported permitted flows for 30 municipal/domestic supplies, some privately owned, as of 1997. Of the 21 facilities on both the EPA and MPCA lists, most have similar permitted and design flows (table 4.19d). The MPCA list also includes permitted discharges from industrial, federal, dredging, and other sources.

In Wisconsin, the EPA survey lists 19 facilities serving a population of 47,185 in 1996 and a projected future population of 47,972 (table 4.19e). The 1996 existing and design flows were 10.04 and 8.83 Mgal/d, respectively. Here, 13 facilities had average daily flows below design flow, 6 were at or above design flow in 1996, and 5 had higher future design flows. Three facilities with flows above the current design listed a lower future design flow, which suggests a problem with the data (unless some major nonresidential wastewater generator was expected to leave the system). Four new facilities were planned for Wisconsin communities within the Basin.

Environment Canada provided 1996 Municipal Water Use Data for Ontario. The data includes six municipalities within the Lake Superior Basin that provided sewage treatment to a population of 197,858, about 82 percent of the Ontario Basin total (table 4.18d). The average daily flow of treated sewage was 30.81 Mgal/d. All of the municipalities, except Terrace Bay (which has waste stabilization ponds, or "lagoons," serving most of its population), chlorinated their effluent before discharging it. Only Marathon and one of Sault Ste. Marie's two wastewater plants had secondary treatment. The others, including part of Marathon, had only primary treatment as of 1996. The population in the municipalities with no sewage treatment was 7,954. Figures 4.19a and b show the population in the six municipalities from 1971 to1996 and the percentages of their 1996 populations served by public water, sewers, and sewage treatment, more than 90 percent in each case. (Some municipalities also serve populations outside their borders, accounting for percentages above 100.)

More detailed information about industrial discharges and municipal wastewater treatment within the Lake Superior Basin can be found in the 1995 *Lake Superior LaMP Volume II, Stage 1, Appendix 5* (www.epa.gov/glnpo/lakesuperior) and the Ontario Ministry of the Environment *1996 Waste Water Discharges Summary* (www.ene.gov.on.ca/envision/techdocs).

4.20 Landfill Capacity and Incineration Volume

Six landfills (four Type II municipal solid waste and two Type III industrial or ash) operate within the Michigan Lake Superior Basin counties, in addition to 11 transfer stations, 8 licensed landfills that are now closed, and 5 landfills that are not operating (table 4.20a). The landfills are regulated by the Waste Management Division of the Michigan Department of Environmental Quality. Total cubic yards of waste disposed in the six operating landfills were 1,081,749 in 1996; 827,548 in 1997; 996,668 in 1998; and 992,605 in 1999 (table 4.20b, fig. 4.20).

Some of the waste originated outside the Lake Superior Basin, but the percentage can't be determined from the available data. Some waste generated within Basin counties was deposited in landfills in Michigan but outside the Basin: 369,451 cubic yards in 1996; 61,043 in 1997; 47,517 in 1998; and 52,795 in 1999 (table 4.20c). No figures are available for waste generated within the Basin but landfilled outside Michigan. The only data on waste generation by county within Michigan comes from county solid waste management plans, available for 5 of the 8 Basin counties (Chippewa, Gogebic, Houghton, Marquette, and Ontonagon), generally as current-year estimates. Michigan has a Perpetual Care Fund, which totals $1,624,092 for 10 operating or closed landfills within the Basin in fiscal year 2000 (table 4.20a).

Only one municipal solid waste landfill and one industrial waste landfill remain in operation within the Minnesota portion of the Lake Superior Basin, both in St. Louis County (table 4.20d). The Cook County landfill, which operated from 1988 to 1999, closed because of "rising operating costs and shrinking waste receipts," according to the *Report on 1998 SCORE Programs* (www.moea.state.mn.us). The Western Lake Superior Sanitary District's Refuse-Derived Fuel incinerator closed in 1999, except for incineration of sewage sludge until 2001, after which time all sludge will be land applied and the incinerator will be shut down. Waste disposed in landfills or incinerated within the Basin between 1991 and 1997 ranged from 89,582 tons (approximately 268,700 cubic yards) in 1994 to 133,983 tons (401,900 cubic yards) in 1991 (table 4.20e). (The conversion of tons to cubic yards is based on U.S. EPA figures in *Characterization of Municipal Solid Waste in the United States: 1990 Update.)* More than half of the waste in each year after 1991 was incinerated. Only a small percentage originated outside the Basin. Waste generated in the Minnesota portion of the Basin but disposed elsewhere ranged from 0 in 1996 and 1997 to 27,657 tons (83,000 cubic yards) in 1994 (table 4.20f).

Another 12 landfills in the Basin have closed. Nine of them are part of the Closed Landfill Program administered by the Minnesota Pollution Control Agency. The 1994 Landfill Cleanup Act established the program, the first of its kind in the country, "to initiate cleanup actions, complete closures, take over long-term operation and maintenance and reimburse eligible parties for past cleanup costs at the 106 qualified closed state-permitted landfills" (*Minnesota Closed Landfill Program 1998 Annual Report*). Funding for the program comes from the Solid Waste Management Tax, up to $90 million in state general obligation bonds, funds transferred from the financial assurance accounts of closed landfills, and settlements from landfill-related insurance policies. None of the closed landfills in the Minnesota Lake Superior Basin pose an immediate threat to environment or health. Two are classified D, generally meeting closure standards. Six others are classified C, meaning that they lack an approved cover or require minor repair or installation of gas vents. One that is rated B (requiring remediation to control gas migration, groundwater contamination, and/or provide an adequate cover) was scheduled to begin design of the cover and a passive gas vent system in FY2000 (*Minnesota Closed Landfill Program 1999 Annual Report*).

The Minnesota Office of Environmental Assistance released the *Minnesota Solid Waste Policy Report* in January 2000 for public comments (www.moea.state.mn.us/policy/99policy.cfm). The report and appendices are included on the Lake Superior Sustainability Indicators Project data CD accompanying this report.

Two municipal solid waste landfills and one industrial ash landfill operate in the Wisconsin portion of the Lake Superior Basin. Another industrial landfill for paper sludge operated by Fort James in Ashland closed in 2000. Total waste disposed in these landfills between 1995 and 1999 ranged from 89,316 cubic yards in 1998 to 191,645 cubic yards in 1999, according to the Wisconsin Department of Natural Resources (table 4.20g). One landfill in Washburn County, outside the Basin, has accepted waste from Basin counties, from 42,075 cubic yards in 1996 to 231,820 cubic yards in 1999 (fig. 4.20h). Another 53 landfills within the four Lake Superior Basin counties have closed (table 4.20i).

A summary of Wisconsin's Solid Waste Management Program, with links to additional information, can be found at www.dnr.state.wi.us/org/aw/wm. Based in part on a comprehensive groundwater protection law enacted in 1984, Wisconsin revised its solid waste rules in 1988 to require clay liners and leachate collection systems, among other design improvements to new landfills. Municipalities that closed their non-engineered dumps by October 1992 were reimbursed by the State for 50 percent of their closure costs beyond $10 per capita; this incentive program provided funds to close 373 dumps. The solid waste rules were revised again in 1996 to require composite liners above the clay liners and a composite final cover system. Wisconsin notes that its solid waste program, which exceeds Federal standards, was the first in the nation to be approved by the U.S. Environmental Protection Agency.

It proved very difficult to obtain detailed information on waste generation in the Ontario portion of the Lake Superior Basin. The Ontario Ministry of the Environment Waste Management Policy Branch provided the following estimates for the Basin: 278,000 tons (834,000 cubic yards) of waste generated in 1999; 19,000 tons (57,000 cu yds) diverted from landfill disposal; 259,000 tons (777,000 cu yds) landfilled. Waste generation averaged 10 pounds per capita per day. The waste covered by the estimates includes all municipal solid waste but excludes most construction, demolition, land-clearing, and yard wastes, sewage sludge, junked autos, and used tires. Note that the Basin population estimate of 152,000 is considerably lower than the population of 240,562 obtained from the 1996 census data (or 199,052, using a multiplier for the four CSDs only partly in the Basin).

4.21 Recycling Programs

Recycling and other waste reduction opportunities vary considerably by location within the Lake Superior Basin. Some areas, most notably the Western Lake Superior Sanitary District in northeastern Minnesota, have highly developed programs for residents and businesses that now divert significant amounts of materials, including hazardous chemicals, from the waste stream. Other areas, particularly rural areas of Michigan (and probably Ontario), have no waste reduction programs at all.

Michigan. County solid waste plans with information about recycling are available for only five counties in the Michigan Lake Superior Basin. Two other counties have no recycling programs. Very few curbside recycling programs exist in the Michigan part of the Basin (table 4.21a). Curbside programs serve only 8 of 61 local units of government in Chippewa, Houghton, and Marquette Counties. None of the other counties have curbside programs. Recycling rates range from 5 to 7 percent of the solid waste generated in the four counties for which we have data. Chippewa County recycled an average of 1,614 tons of materials annually from 1990

through 1999 (fig. 4.21a). The amount rose steadily from 67 tons during the latter half of 1989 to 2,024 tons in 1995 before dropping 18 percent in 1996, when beverage glass was no longer accepted. Tons of recyclables collected began to rise again in 1997. Marquette County collected an average of 2,704 tons of recyclables annually between 1993 and 1997, with amounts tapering off 16 percent since 1995 (fig. 4.21a). Houghton County's used oil recycling program has collected 45,260 gallons from the public since 1994, increasing 54.4 percent from 6,125 gallons to 9,455 gallons in 1999 (data from Rock Oil Refining, Stratford, Wisconsin).

Residents of Chippewa and Marquette Counties have access to household hazardous waste collections, annually in Chippewa County and monthly at four locations in Marquette County from May to October. Any Upper Peninsula resident can dispose of pesticides or products containing mercury through the Michigan Department of Agriculture's Clean Sweep Program, but the wastes must be brought to Marquette or Escanaba. One agricultural Clean Sweep collection and one household hazardous waste collection were held in each Lake Superior Basin county during the 1990s, funded by grants. Marquette County's program has collected from 6,500 to nearly 12,000 pounds of miscellaneous household hazardous wastes plus 1,500 to 6,800 gallons of motor oil and other wastes each year from 1993 to 1997.

The Environmental Assistance Division of the Michigan Department of Environmental Quality maintains the Michigan Recycled Materials Market Directory, a variety of other recycling links and publications, and lists of recycling sites and household hazardous waste collection programs (www.deq.state.mi.us/ead/recycle). The Michigan Recycling Coalition, Upper Peninsula Recycling Coalition, and Michigan Composting Council also provide resources to Lake Superior Basin residents in Michigan.

Minnesota. In Minnesota, the SCORE program provides funding to each county to support waste reduction programs. Wastes that are banned from disposal in landfills include antifreeze, used oil and filters, vehicle batteries, tires, fluorescent and high-intensity discharge bulbs, household hazardous wastes, and major appliances. State law requires at least one recycling center per county, convenient sites for collecting recyclables, at least one drop-off or curbside collection in cities with 5,000 or more residents, and curbside collection in non-metropolitan cities with populations greater than 20,000. Counties are also required to encourage recycling of commercial, industrial, and institutional solid waste.

In the four Minnesota Lake Superior Basin counties, recycling rates are much higher than in Michigan, ranging from 26 percent of municipal solid waste generated in Cook County to 49 percent of the waste generated in part of St. Louis County (*Report on 1998 SCORE Programs,* Minnesota Office of Environmental Assistance) (table 4.21b). The recycling rates are even higher according to the formula established by the state, which includes data on banned materials, on-site disposal, and yard waste and source reduction program credits. The recycling goal for non-metropolitan area counties in 1998 was 35 percent or more. The majority of residents in each county, except Cook, are served by curbside recycling programs. Each county has access to household hazardous waste collection or drop-off programs.

The Western Lake Superior Regional Household Hazardous Waste Program diverted the following materials from the waste stream in 1998, nearly all of it originating within the Lake Superior Basin: 18,268 gallons of paints and other liquids requiring disposal; 29,440 gallons of

paints, motor oil, and other recyclable liquids; 240 pounds of recyclable batteries; 37,523 oil filters, household products, fluorescent lamps, and other recyclable items; and 36,390 pounds of lab-packed and other solid wastes requiring disposal (table 4.21c). Nearly 5,600 households participated. In 1999, 5,312 households disposed of the following materials: 21,339 gallons of waste liquids; 30,112 gallons of recyclable liquids; 500 pounds of recyclable batteries; 41,727 recyclable items; and 37,525 pounds of lab-packed and other solid wastes. All figures are from the Program's *Annual Facility Activity Reports.*

The Western Lake Superior Sanitary District (WLSSD) has the most comprehensive approach to waste reduction and pollution prevention in the Lake Superior Basin (www.wlssd.duluth.mn.us; *Western Lake Superior Sanitary District Comprehensive Solid Waste Management Plan Update*. July 1999). Programs include waste reduction, recycling, yard waste composting, household hazardous waste, Very Small Quantity Generators (VSQG), land disposal, and public education. The District's solid waste processing and wastewater treatment facilities operate as an integrated system.

A District ordinance enacted in 1990 requires residents to separate recyclable materials from their garbage and to hire a collector for their solid waste (to minimize illegal dumping, open burning, or on-site burial of wastes). The Regional Household Hazardous Waste Collection Program, which includes all of the Minnesota Lake Superior Basin, also was established in 1990 under an agreement with the Minnesota Pollution Control Agency. Yard waste was banned from the solid waste stream in 1991. Recyclable materials were prohibited from the District solid waste processing facility, beginning in 1992 with glass, newsprint, aluminum, tin cans, and plastic milk and laundry detergent bottles. In 1995, all #1 and #2 coded plastic containers, office paper, magazines, and catalogs were added to the program. Mercury reduction programs began in 1993, starting with a MercAlert education program and button battery collections. More recently, the District has begun an education program to discourage backyard burning of wastes, which can release dioxin to the air. A Clean Shop program for VSQGs began in 1994, accepting up to 660 pounds of hazardous waste per small business each year. More than 600 bicycles were collected in the District's 1997 Bike Recycle program. Local businesses and the Scottish Rite Masons collaborated to rebuild bikes for Duluth children and purchase bike helmets with funds from recycling the 10 tons of scrap metal collected.

Other business-oriented pollution prevention efforts in Minnesota include the Minnesota Materials Exchange (www.mnexchange.org) and the Minnesota Technical Assistance Program (MnTAP) of the University of Minnesota (www.mntap.umn.edu). The Northeast Minnesota Materials Exchange, coordinated by WLSSD, connects businesses with reusable goods to those who can use them. The Great Lakes Center Salvage Materials (www.mnexchange.org/Greatlk.htm) acts as a clearinghouse for a variety of free salvage materials.

Two winners of Governor's Awards for Excellence in Waste and Pollution Prevention in 1997-1998 are from Duluth: the Stowe Environmental School, which reduced its annual solid waste disposal by 89 tons; and LHB Engineers & Architects, a leader in building design that incorporates energy and resource efficiency and indoor air quality (*Report on 1998 SCORE Programs).*

Wisconsin. The Wisconsin Department of Natural Resources Bureau of Waste Management collects annual recycling data from "responsible units," generally townships, counties, tribes, or sanitary districts. For this project, the data was compiled for responsible units in the four Wisconsin Lake Superior counties (table 4.21d-e). Since 1995, newspaper, magazines, glass (clear, green, and brown), cardboard, aluminum, steel/bimetal, and #1 and #2 plastics have been banned from landfill disposal. In many areas, other materials also were recycled. Recyclables diverted from the waste stream totaled 5,321 tons in 1997, 23,922 tons in 1998, and 4,644 tons in 1999. An unusually large amount of demolition waste in Douglas County accounts for the jump in 1998. In Ashland County, recyclables were 27 percent of the municipal solid waste generated, rising to 32 percent in 1998. Bayfield County residents recycled an even larger percentage of their waste, 45 percent in 1997 and 38 percent in 1998. No other details were available about recycling within the Basin, but all Wisconsin residents have access to community recycling programs, according to the DNR (www.dnr.state.wi.us/org/aw/wm/recycle).

Northwest Cleansweep was established in 1995 to provide for reduction, reuse, and disposal of hazardous household, agricultural, and very small quantity generator waste in rural Wisconsin counties. The program covers a 10-county area of Wisconsin, including the four Lake Superior Basin counties. It is coordinated by the Northwest Regional Planning Commission, which provided a copy of "Appendix A: Northwest Cleansweep Summary of Activities and Schedule" for 1995-1999 household hazardous waste and 1996-1998 VSQG collections. Collections were held in eight locations within the Basin each year. Some areas were served each year, others on a rotating basis.

During the first five years of the program, more than 60 tons of household hazardous wastes were collected from within the Basin (table 4.21f). Another 7.7 tons were collected from VSQGs in the Basin during 1996-1998, raising revenues of nearly $17,000 in support of the program (table 4.21g). During the first three years, the cost per pound of waste disposed in the 10-county region decreased from $2.84 to $1.55, and the total amount of waste collected increased. Paints, solvents, and adhesives made up 65 percent of the materials in a typical collection event. Nearly 13,000 light bulbs, most of them mercury-containing fluorescent tubes, were collected region-wide in 1996 and 1997. Of the materials collected, 63 percent were either reused or recycled.

The Wisconsin DNR has a list of contacts for waste reduction and recycling information, including business recycling by sector, waste reduction business outreach by region, financial assistance, education, recycling markets, and technical assistance (www.dnr.state.wi.us/org/aw/wm/contacts).

Ontario. Repeated attempts to obtain information from several sources about recycling programs in northern Ontario failed. Some data was not at the level of detail needed to separate the Lake Superior Basin from the rest of Ontario. In other cases, the appropriate contact person was unavailable or did not get back to us and could not be reached for follow-up. The Recycling Council of Ontario has a database of recycling, composting, reuse, and household hazardous waste program contacts in larger municipalities. In the Lake Superior Basin, however, only Sault Ste. Marie and Thunder Bay are included (www.rco.on.ca/3rs). Sault Ste. Marie has a curbside "bluebox" recycling program that serves 21,725 single-family dwellings, 600 rural dwellings, and 15 multi-unit residences with weekly collection. The estimated quantity collected is 2,615 tonnes. Thunder Bay's curbside "bluebox" recycling program serves 43,000 single-family dwel-

lings, 3,653 rural dwellings, and 6,859 residential units in multi-unit buildings. Unfortunately, there is no estimate of the quantities of materials recycled. The only other information comes from The Ontario Ministry of the Environment Waste Management Policy Branch, which estimates 19,000 tons (57,000 cu yds) of materials diverted from landfill disposal within the Ontario Lake Superior Basin, about 6.8 percent of the waste generated.

4.22 Agricultural Lands

The following statistics on farm land relate to the "Resource Consumption" indicator, often in tandem with the degree of urban sprawl:

Between 1978 and 1992, the number of farms in the 16-county U.S. Lake Superior Basin declined from 3,771 to 2,618, or 30.6 percent. Nationally, the decline in the number of farms was 14.7 percent over the same period. Declines in Michigan, Minnesota, and Wisconsin ranged from 21.4 to 23.9 percent. The decline in the percent of land in farming from 1982 to 1992 was 1.8 percent for the U.S. overall and 2.3 to 5.0 percent in the three states. Fourteen of the 16 Lake Superior counties declined at a rate as low as or lower than the national average (1.8 percent to no change); only Carlton County, Minnesota, and Ashland County, Wisconsin, declined faster, by 5.3 and 2.6 percent, respectively. While 41.8 percent of U.S. land was in farming in 1992, along with 27.7 percent of Michigan, 50.4 percent of Minnesota, and 44.5 percent of Wisconsin, the only Basin counties with 10 percent or more farm land were Bayfield, Wisconsin (10.3 percent), and Carlton, Minnesota (20.6 percent). The other counties ranged from 0.1 to 8.4 percent.

4.23 Sustainable Forestry Practices and Remaining Forest Resources

The acreage of forest lands within the Basin that are managed sustainably is a measure of the "Reinvestment in Natural Capital" indicator, while the amount of forest resources remaining relates to the "Resource Consumption" indicator.

Four certification systems currently operate within the Lake Superior Basin: the Sustainable Forestry Initiative of the American Forest and Paper Association (AF&PA), the Canadian Standards Association, the SmartWood certification program of the Forest Stewardship Council (FSC), and the International Standards Organization (ISO) 14001. The Certified Forest Products Council (www.certifiedwood.org)—an independent, nonprofit, business initiative to promote responsible forest products buying practices in North America—outlines the differences among the systems.

The Sustainable Forestry Initiative provides guidelines for forest management to AF&PA members but does not have specific performance standards or third-party verification. A 1997 Independent Expert Review Panel praised SFI's training of loggers and education of private forest owners but cautioned that "verification of improved practices will be essential to the credibility of the SFI programs over the long haul" (www.sampsongroup.com/sfi). Most large forest-products companies in the Basin support SFI.

The Canadian Standards Association has environmental management policy and procedures that were developed by industry and the Canadian government and are subject to third-party auditing

(www.sfms.com). Performance standards are under development. So far, no Canadian forests within the Lake Superior Basin have CSA certification.

SmartWood is the third-party auditor accredited by the Forest Stewardship Council to certify forest management practices and forest product chain-of-custody in the Great Lakes region, using performance standards developed by environmental non-governmental organizations (www.fscus.org). SmartWood-certified products can carry the FSC label. FSC working groups, with diverse stakeholder and public participation, are developing region-specific certification standards based on FSC's worldwide Principles and Criteria for Forest Management. The Institute for Agriculture and Trade Policy in Minneapolis is coordinating the development of standards for the Great Lakes region.

ISO 14001 is an international, third-party process certification system that has no specific performance standards for forest management. Some forest-products companies, such as International Paper, are using ISO 14001 for independent audits in conjunction with the Sustainable Forestry Initiative (www.internationalpaper.com).

According to a SmartWood "List of Certified Operations in the Lake States, July 2000," three organizations in the Lake Superior Basin are certified for forest management: Big Creek Forestry in Marquette, Michigan, with 7,154 acres; Keweenaw Land Association of Ironwood, Michigan, with 155,000 acres; and the Minnesota Department of Natural Resources, with 393,306 acres. According to Steve Lane of the Minnesota DNR, only 44,319 acres of the DNR lands are in the Lake Superior Basin, all in Aitkin County (11/2/2000 e-mail message). Total forest land currently certified within the Basin, therefore, is 206,473 acres. Two wood products businesses, Horner Flooring in Dollar Bay, Michigan, and North Country Lumber in Mellen, Wisconsin, have chain-of-custody certification. Rossi American Hardwoods, based in Connecticut but owner of Northern Hardwoods in South Range, Michigan, is also chain-of-custody certified. Two more chain-of-custody certified companies, Aspen Lumber and Connor Sports Flooring, have operations in Iron County, Michigan, and probably process wood from the Basin. As recently as April 1999, only Keweenaw Land Association, Minnesota DNR, and Connor Sports Flooring had been certified.

The Ontario Ministry of Natural Resources (MNR) has developed a *Policy Framework for Sustainable Forests* to guide management of Crown forests (www.mnr.gov.on.ca/MNR/forests/forestdoc). The "Lands for Life" land-use planning process produced a publication, *Ontario's Living Legacy Land Use Strategy*, in July 1999, for management of 39 million acres of Crown lands and waters. In the *1999 Ontario Forest Accord—A Foundation for Progress*, representatives of the forest industry, environmental groups, and the MNR reached consensus on 31 commitments to establish new parks and protected areas.

Ontario has also created the Managed Forest Tax Incentive Program (MFTIP) in which landowners prepare and follow a Managed Forest Plan in exchange for paying only 25 percent of the residential property tax rate. MNR administers the program through the Ontario Forestry Association (www.oforest.on.ca) and Ontario Woodlot Association.

Wildlife Habitat Canada, other conservation groups, and forestry groups (including the Ontario Forest Industries Association, the Canadian Pulp and Paper Association, and the Canadian

Forestry Service) established the Forest Stewardship Recognition Program in 1998 "to promote awareness and appreciation for stewardship, sustainable practices and forest biodiversity conservation in Canadian forests" (www.ofia.com/Sustain.enviro/).

Potlatch owns more than 340,000 acres of timberland in Minnesota, making it the state's largest private landowner (www.potlatchcorp.com). These lands provide about 10 percent of the fiber used in the company's wood product mills, one of which (a pulp mill) is within the Lake Superior Basin, in Cloquet. The company supports SFI and follows the voluntary guidelines to protect water quality and visual quality of timberlands that it helped Minnesota develop.

The nonprofit Great Lakes Forest Alliance has developed a customized set of criteria and indicators to guide public and private forest management in Michigan, Minnesota, Ontario, and Wisconsin (www.lsfa.org). The Alliance (under its former name, the Lake States Forestry Alliance, which did not include Ontario) also presented the Lake States Regional Forest Resources Assessment in 1994 to the Lake States Governors Conference on Forest Resources. The Alliance published the final report, *Forest Resource Trends and Opportunities in the Lake States: A Continuing Resources Renaissance*, in 1995. The report found that timber growth exceeds harvest in the three-state region by 90 percent. Timber volume increased from about 25 billion cubic feet in 1952 to more than 50 billion cubic feet in 1992. The three states have 51.5 million acres of forest land, of which 3.2 million acres are either reserved as parks and wilderness or classified as unproductive. Of the productive land, 26 million acres are nonindustrial private forests, 18 million acres are publicly owned, and 4 million acres are owned by forest-products companies.

The Canadian National Forestry Database Program has tables of forest area, classification, ownership, and productivity by province or territory. Maps present the information visually, but there are no Basin boundaries or statistics. The Basin contains part of four boreal shield ecosystems: Thunder Bay-Quetico, Lake Nipigon, Abitibi Plains, and Lake Temiscaming Lowland.

5. Additional Data and Gaps

Project researchers obtained data relevant to other baseline status measures or temporal trends in the Lake Superior Basin that have not yet been analyzed in either Excel or ArcView. This data, for 16 Basin counties in the U.S., includes local tax base from the U.S. Census Bureau (percent of revenue from property taxes and state/federal payments, plus per capita expenditures). Some information on facilitation of transitional economies, mining resources (especially in Ontario), and environmental and sustainability education in schools has also been gathered. Additional Statistics Canada data, obtained late in the project, includes demographic data by census subdivisions for 1986 and 1991 and by census enumeration areas for 1991, expanding the coverage of existing trends. Of this newly acquired data, only population density by enumeration area was examined for this report. Maps reflecting a number of 1990 census block group demographic measures in the U.S. Lake Superior Basin are not referenced in the report because they are not in final form, but they are included in the project data CD.

Table 3.1 shows the status of data acquisition for each sustainability indicator. Gaps in the data are of two types. Most gaps simply represent measures that have not yet been investigated fully.

However, some of the gaps are in measures that may be difficult to quantify uniformly across the Basin, if at all. Many such measures relate to the “Reinvestment in Natural Capital” and “Awareness of the Capacity for Sustainability” indicators. Some measures, such as the extent of recreational and cultural opportunities or media coverage of sustainability-related issues, are so open-ended that it would be hard to know when to stop acquiring data. A sampling method would be needed to address this problem.

Some promising data was gathered at an inappropriate scale, commonly at the state, provincial, or Federal levels. A number of studies, surveys, and databases that are available from Statistics Canada's Canadian Socioeconomic Information Management system initially appeared promising. Statistical Data Documentation System reports have titles such as "Environmental Statistics," "Industry Statistics for Environmental Applications," and "Pollution Abatement and Control Survey." Some of the reports even indicated that data was reported by major drainages or census units, including those in Ontario. However, calls to several of the contacts revealed that the published reports do not contain data at that level of geographic detail. In some cases, more detailed data is available only to "internal sponsors," though it may eventually be made public.

Other survey reports, such as "Environmental Protection Expenditures in the Business Sector 1995," are based on 2,000 to 3,000 surveys distributed across Canada. Again, the finest geographic reporting level is by province. Obviously, data from the Province of Ontario as a whole is not likely to represent the sparsely settled regions north of Lake Superior. Yet it is encouraging that such environmental statistics are now more commonly collected and that data is becoming available in digital form for use with GIS software. The major limitations, not surprisingly, remain funding and staff resources in various agencies.

Cost of living is an example of a measure for which we have obtained somewhat indirect information, in the form of rent and mortgage payments as a percentage of household or family income. The U.S. Bureau of Labor Statistics (BLS) was expected to be the best source of cost-of-living information. Unfortunately, the BLS compiles statistics for the entire six-state Midwest region and reports data only by U.S. city averages and Midwest city class sizes (population greater than 1.5 million, 50,000 to 1.5 million, and less than 50,000). No information specific to the Lake Superior Basin is available. State agencies typically rely on the BLS for cost of living information. The Federal Reserve Bank of Minneapolis may have some relevant information, but such seems unlikely.

Acknowledgments

Funding for this project was provided by a grant from the United States Environmental Protection Agency, Region 5. The GEM Center for Science and Environmental Outreach at Michigan Technological University contributed more than 360 hours of additional staff time to complete the project data collection and report. The Developing Sustainability Committee of the Lake Superior Work Group developed the “best bet” baseline sustainability indicators and measures that were researched for this project. The committee also edited an interim project report for incorporation into Chapter 9 of the Lake Superior Management Plan (LaMP 2000).

Many individuals from government agencies and other organizations were very generous with their time in answering questions and locating needed data that was not available on the Internet. The project benefited greatly from the assistance of three Michigan Tech students: environmental policy graduate students Cristi Corey and Abhijit Banerjee and environmental engineering undergraduate Bob Proudfit. Mike Hyslop of the Environmental Monitoring and Mapping Laboratory in the School of Forestry and Wood Products at Michigan Tech provided geographic information systems training and assistance.