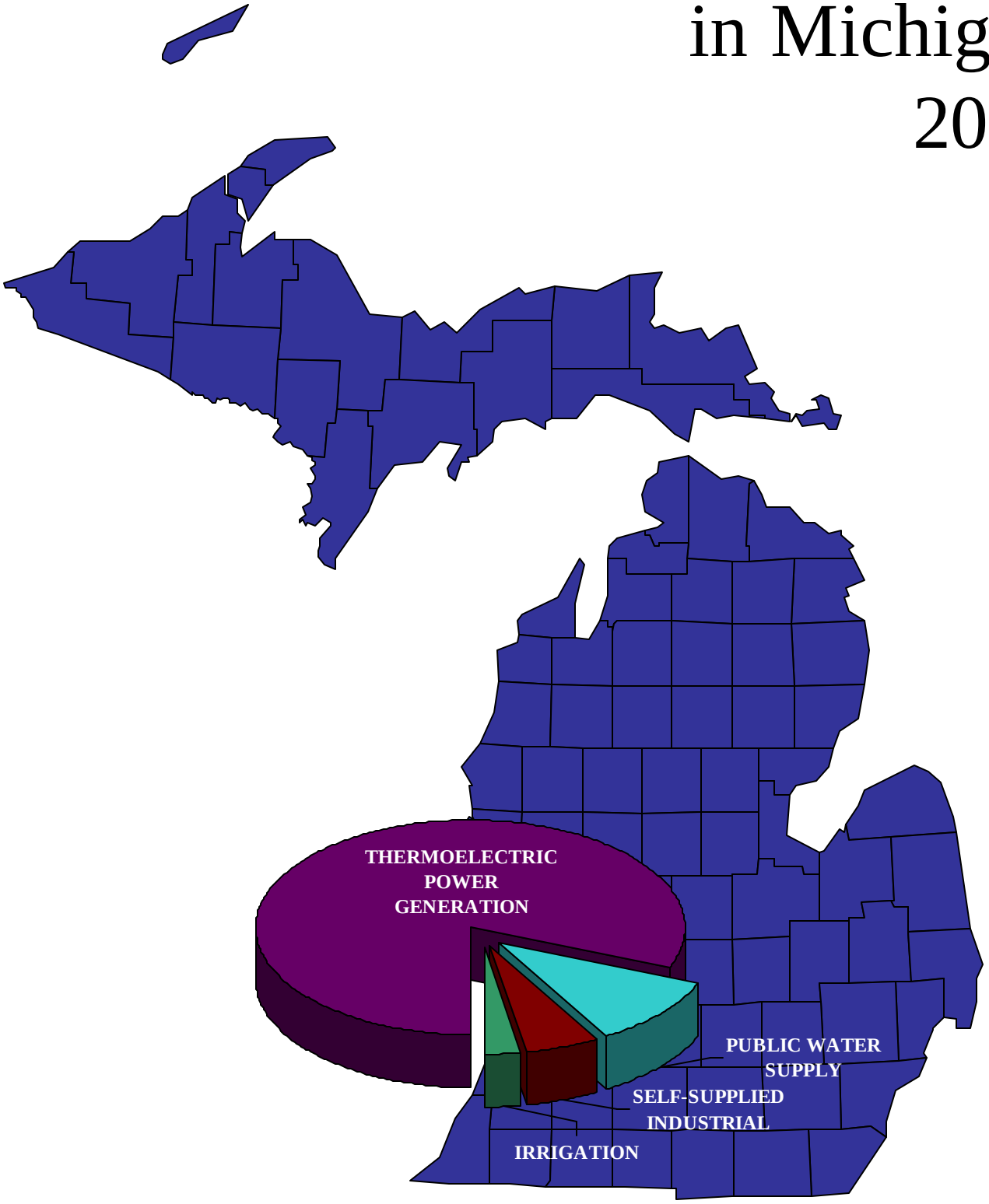
Water Withdrawals for Major Water Uses in Michigan 2004



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Michigan Department of Environmental Quality
Water Bureau

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Water Withdrawals for Major Water Uses in Michigan: 2004

Introduction

The Great Lakes Basin of North America includes the largest system of fresh water lakes in the world. This world class resource supports a complex web of economic and ecological activities that are fundamental to the prosperity and quality of life in eight American states and two Canadian provinces. At the national level, the Great Lakes Basin is a significant water use region, ranking third among the twenty one major watersheds in the United States for freshwater withdrawals. While the total volume of water withdrawn by facilities within the Basin is significant, the amount consumed (e.g. effectively lost during use due to evaporation, transpiration, and incorporation into products) is estimated between five and ten percent. The rest of the water is returned to the Basin, although often though different pathways. As water moves throughout the system, distinct patterns of withdrawal, consumption, and disposition occur within the larger dynamics of the overall hydrologic cycle.

At the center of the Great Lakes Basin is Michigan, a state whose peninsular shape is defined by four of the five Great Lakes. Water resources in Michigan are considered abundant, despite a climate with generally moderate precipitation and some inland areas that experience periodic water shortages during times of drought. The mix of water-using facilities in the state is complex, with withdrawals that range from small to exceptionally large in major sectors like thermoelectric power generation, self-supplied industrial, irrigation, and public water supply. While raw water withdrawn by these facilities is generally considered a free resource rather than a commodity, there are significant economic costs and ecological impacts associated with its capture, distribution, use, and discharge. Together, these major water uses support the commerce and character of the state.

Background

This report has been prepared by the Michigan Department of Environmental Quality to summarize information compiled in Michigan's Water Use Reporting Program. The overall goal of the program is to establish an environmental baseline and continuing assessment of major water uses, including power generation, industrial, irrigation, and public water supply. This fulfills key requirements of the Great Lakes Charter, a regional agreement signed by the states and provinces in 1985, and Michigan's water use reporting law (Part 327, Great Lakes Preservation, Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). All of the states and provinces with territory within the Great Lakes Basin are mandated to compile and report similar water use information.

Detailed water use data from the states and provinces are maintained by the Great Lakes Commission to facilitate regional policy-making and strengthen the legal defense against unwarranted diversions of Great Lakes water. The regional database also provides essential water use information for water resources planning to support power generation, industrial, irrigation, and public water supply activities in a manner consistent with sound environmental management. To achieve these objectives, close cooperation is maintained with the International Joint Commission and the United States Geological Survey.

Methodology

For the purposes of this report, data have been compiled for the major water use sectors in Michigan, including thermoelectric power generation, self-supplied industrial, irrigation, and public water supply. While there are other types of water uses that occur, it is estimated that these four categories account for over 95 percent of the total water withdrawals in the state. Collectively, they define Michigan's overall demand for water resources from the Great Lakes, inland surface sources, and ground water. Water withdrawals in the four sectors are defined as follows:

- **Thermoelectric Power Generation:** Water withdrawn for use by fossil fuel plants (using coal, oil, or natural gas) and nuclear plants. Water supplied to thermoelectric power plants by public water supply systems is not recorded in this sector.

- **Self-Supplied Industrial:** Water withdrawn for use in the manufacture of metals, chemicals, paper, and allied products. Mining water includes water used in the extraction or washing of minerals and liquids. Water supplied to industrial facilities by public water supply systems is not recorded in this sector.

- **Irrigation:** Water withdrawn and artificially applied on lands to assist in the growing of crops and pastures or in the maintenance of recreational lands such as golf courses and parks.

- **Public Water Supply:** Water withdrawn by community public water supply systems that provide year-round service to at least 15 service connections or serve an average of at least 25 residents. Community public water supply systems provide water for use by a variety of residential, public, commercial, and industrial facilities.

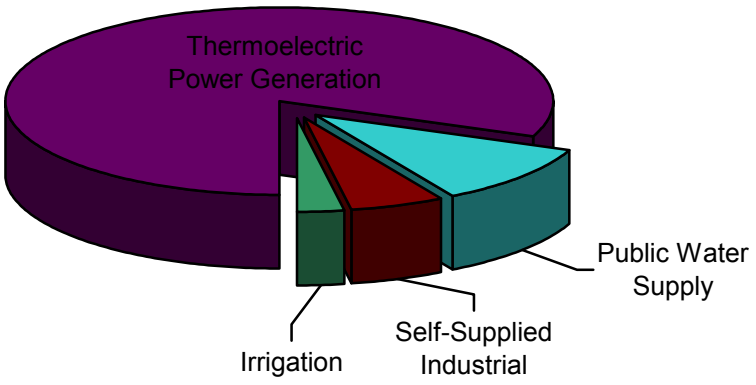
The water use reporting protocols established under Michigan law vary from major sector to sector. Thermoelectric power plants, self-supplied industrial facilities, and irrigated golf courses are required to report annually if they have the capacity to withdraw 100,000 gallons of water per day during any 30-day period. All community public water supply systems report water withdrawals on a monthly and/or annual basis. Agricultural irrigation withdrawals are estimated rather than reported using a computer model that utilizes weather, soils, and other resource data, including crop and acreage information reported in the Federal Census of Agriculture. Periodic estimates are also made for several smaller water use categories such as domestic and livestock water use, which are reported in the United States Geological Survey's National Water Use Information Program.

Michigan Summary

During 2004, Michigan's thermoelectric power plants, self-supplied industries, irrigators, and public water supply systems withdrew a total of 10,948 million gallons of water per day (MGD). This represents a total water volume of nearly four trillion gallons withdrawn during the year, enough to cover the entire state with about four inches of water. While substantial in terms of resource demand, it is estimated that over 90 percent of this water was returned to the Great Lakes, inland lakes and streams, and ground water after use. The nature of this distribution varies, however, as water is often returned to different sources after use.

The largest water withdrawals in Michigan during 2004 were made for thermoelectric power generation. Power plants accounted for 81 percent of total withdrawals and collectively withdrew four times more water than community public water supply systems, self-supplied industries, and irrigators combined (See Figure 1). Public water supply systems accounted for 10.5 percent of the total withdrawals in the state, serving 7.2 million persons representing a mix of residential, public, commercial, and industrial facilities. About six percent of water withdrawals were made by self-supplied industries that were not connected to public water supply systems. The remaining 2.7 percent of withdrawals were made by agricultural and golf course irrigators.

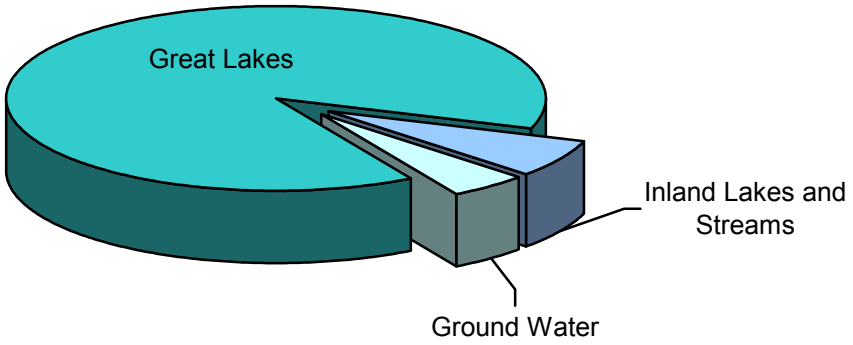
Figure 1: Water Withdrawals for Major Water Uses in Michigan: 2004



Type of Use	Number of Facilities	Water Withdrawn (MGD)
Thermoelectric Power Generation	44	8,885.00
Public Water Supply	1,437	1,144.20
Self-Supplied Industrial	380	628.76
Irrigation	2,187	290.28
Totals:	4,048	10,948.24

While there were significant differences among the major water use sectors, the primary source of water in the state was the Great Lakes and their connecting waters (See Figure 2). In fact, 89 percent of the total water withdrawn during 2004 was from Great Lakes sources, with 6.4 percent from inland surface sources and 4.8 percent from ground water. Thermoelectric power generation was the sector with the greatest dependence on the Great Lakes (95 percent), followed by public water supply (77 percent), and self-supplied industrial use (68 percent). In contrast, irrigation water was withdrawn primarily from ground water sources (64 percent), with only 1.7 percent from the Great Lakes.

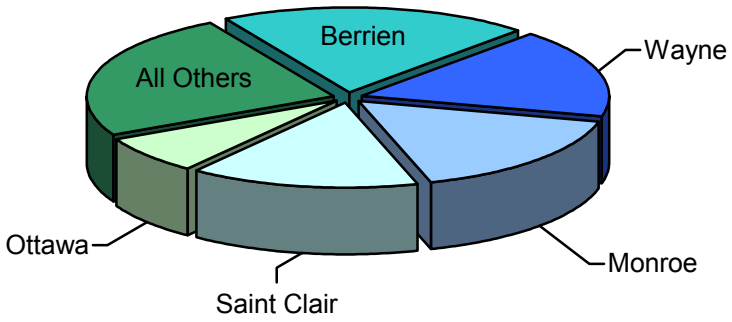
Figure 2: Sources of Water for Major Water Uses in Michigan: 2004



Water Source	Water Withdrawn (MGD)				
	TE Power Generation	Public Water Supply	Self-Supplied Industrial	Irrigation	Total
Great Lakes	8,404.23	879.18	426.60	5.00	9,715.01
In. Lks & Streams	476.67	17.77	113.06	98.36	705.86
Ground Water	4.10	247.25	89.10	186.92	527.37
Totals:	8,885.00	1,144.20	628.76	290.28	10,948.24

Table 1 summarizes total water withdrawals during 2004 for each of Michigan's 83 counties. Berrien County reported the largest water withdrawals in the state, accounting for 20 percent (2,228 MGD) of the total water withdrawn for thermoelectric power generation, public water supply, self-supplied industrial use, and irrigation (See Figure 3). Michigan's largest power generation facility, the Donald C. Cook nuclear plant, is located in Berrien County. The next largest water use counties were Wayne, Monroe, Saint Clair, and Ottawa. Together, facilities in these counties accounted for 56 percent of the water withdrawn statewide. The Great Lakes and connecting waters predominated as a source of water for the five largest water-using counties, supplying 96.4 percent of their combined water withdrawals. In each case, thermoelectric power plants withdrew the largest volumes of water, although virtually all of it was returned to the Great Lakes after use as a cooling medium.

Figure 3: Counties with Largest Water Withdrawals in Michigan: 2004



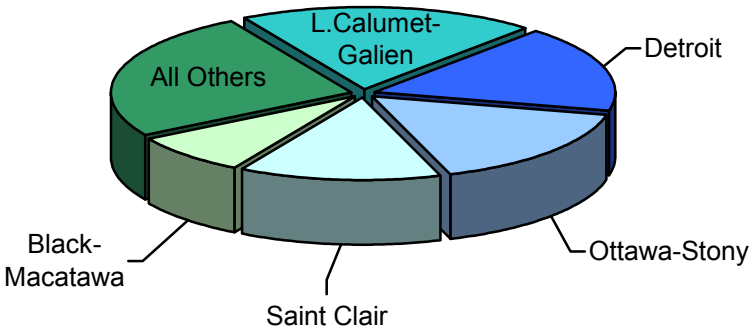
Name of County	Water Withdrawn (MGD)				
	TE Power Generation	Public Water Supply	Self-Supplied Industrial	Irrigation	Total
Berrien	2,199.36	16.18	2.09	10.03	2,227.66
Wayne	1,131.38	434.90	284.17	1.96	1,852.41
Monroe	1,755.50	13.46	9.99	4.07	1,783.02
Saint Clair	1,466.70	172.32	12.62	0.62	1,652.26
Ottawa	734.33	42.71	8.05	8.64	793.73
All Others	1,597.73	464.63	311.84	264.96	2,639.16
Totals:	8,885.00	1,144.20	628.76	290.28	10,948.24

Table 2 summarizes total water withdrawals by United States Geological Survey hydrologic basins in Michigan. The largest withdrawals were reported in the Little Calumet-Galien Watershed (Basin 04040001), accounting for 20 percent of the water withdrawn for thermoelectric power generation, public water supply, self-supplied industrial use, and irrigation (See Figure 4). Water withdrawals in the next four watersheds accounted for an additional 55 percent of total withdrawals statewide. They were the Detroit Watershed (Basin 04090004), the Ottawa-Stony Watershed (Basin 04100001), the Saint Clair Watershed (Basin 04090001), and the Black-Macatawa Watershed (Basin 04050002). As with counties, facilities within the five largest water-withdrawal watersheds relied almost exclusively (97.1 percent) on the Great Lakes and connecting waters as their source.

While water withdrawal data are reported with reasonable accuracy in Michigan, consumptive water use values are significantly more difficult to determine. It is generally agreed that overall consumptive water use in the state falls between 5 to 10 percent of total withdrawals, which would indicate a range of 547 MGD to 1,095 MGD during 2004. However, the process of estimating consumptive water use is

complicated by several factors. Overall, consumptive use varies from sector to sector, with the lowest rate for thermoelectric power generation and the highest rate for irrigation. Within a given sector consumptive use rates can also vary widely from facility to facility. This is particularly evident for self-supplied industries, where manufacturing and water use processes are diverse in nature.

Figure 4: Hydrologic Basins with Largest Water Withdrawals in Michigan: 2004



Name of Basin	Water Withdrawn (MGD)				
	TE Power Generation	Public Water Supply	Self-Supplied Industrial	Irrigation	Total
L.Calumet-Galien (04040001)	2,199.36	2.87	0.00	0.50	2,202.73
Detroit (04090004)	1,131.38	427.83	276.10	2.60	1,837.91
Ottawa-Stony (04100001)	1,755.50	3.44	8.59	3.30	1,770.83
Saint Clair (04090001)	1,466.70	14.15	12.70	1.53	1,495.08
Black-Macatawa (04050002)	809.27	46.41	6.84	8.87	871.39
All Others	1,522.79	649.50	324.53	273.48	2,770.30
Totals:	8,885.00	1,144.20	628.76	290.28	10,948.24

As more data are compiled in Michigan's Water Use Reporting Program, estimates of consumptive water use will improve. Longer-term trend analysis will also be undertaken for each water use sector to determine water supply and demand relationships over time. This information will support the continued development of safe, reliable public and private water supplies in Michigan and provide a continuing environmental baseline to ensure the protection and wise management of the waters of the Great Lakes Basin.

Table 1: 2004 Water Withdrawals for Major Water Uses in Michigan, by County*

County	Number of Facilities	Water Withdrawn (MGD)			
		Great Lakes	Surface Water	Ground Water	Total
Alcona	13	0.00	0.13	0.66	0.79
Alger	10	5.67	0.01	0.92	6.60
Allegan	151	0.00	8.01	10.24	18.25
Alpena	11	115.16	4.16	0.72	120.04
Antrim	33	0.00	0.35	3.23	3.58
Arenac	22	83.52	0.03	0.34	83.89
Baraga	6	1.20	0.01	0.00	1.21
Barry	45	0.00	1.04	2.63	3.67
Bay	55	553.96	2.44	0.20	556.60
Benzie	29	0.00	0.03	1.59	1.62
Berrien	168	2,211.38	4.61	11.67	2,227.66
Branch	110	0.00	9.76	16.81	26.57
Calhoun	79	0.00	5.06	23.89	28.95
Cass	93	0.00	3.03	15.02	18.05
Charlevoix	29	8.15	0.13	12.55	20.83
Cheboygan	14	0.00	0.34	1.45	1.79
Chippewa	15	3.10	0.10	1.12	4.32
Clare	10	0.00	0.17	1.32	1.49
Clinton	39	0.00	1.01	3.79	4.80
Crawford	12	0.00	0.08	1.44	1.52
Delta	23	61.35	0.61	0.35	62.31
Dickinson	12	0.00	19.20	3.18	22.38
Eaton	35	0.00	1.47	3.74	5.21
Emmet	47	0.00	0.04	4.69	4.73
Genesee	90	0.00	0.94	6.55	7.49
Gladwin	11	0.00	0.01	0.57	0.58
Gogebic	12	0.00	0.00	1.89	1.89
Grand Traverse	73	4.91	0.23	3.13	8.27
Gratiot	46	0.00	1.93	4.19	6.12
Hillsdale	45	0.00	1.28	5.22	6.50
Houghton	21	0.00	0.04	3.52	3.56
Huron	40	70.24	0.16	1.61	72.01
Ingham	51	0.00	232.99	40.86	273.85

County	Number of Facilities	Water Withdrawn (MGD)			
		Great Lakes	Surface Water	Ground Water	Total
Ionia	46	0.00	0.54	6.57	7.11
Iosco	20	1.29	0.27	0.49	2.05
Iron	22	0.00	0.26	2.27	2.53
Isabella	31	0.00	0.93	5.10	6.03
Jackson	76	0.00	1.30	13.76	15.06
Kalamazoo	120	0.00	9.04	65.08	74.12
Kalkaska	11	0.00	0.20	1.51	1.71
Kent	142	54.06	2.76	12.77	69.59
Keweenaw	5	0.02	0.00	0.04	0.06
Lake	5	0.00	0.00	0.32	0.32
Lapeer	38	0.00	0.75	0.70	1.45
Leelanau	50	0.02	0.17	1.70	1.89
Lenawee	62	0.00	4.75	4.23	8.98
Livingston	84	0.00	0.61	7.26	7.87
Luce	8	0.00	0.22	0.69	0.91
Mackinac	10	8.22	0.04	0.13	8.39
Macomb	57	4.27	2.34	1.56	8.17
Manistee	37	16.30	19.02	3.31	38.63
Marquette	33	273.19	19.22	2.88	295.29
Mason	38	25.36	0.35	1.39	27.10
Mecosta	30	0.00	0.90	4.79	5.69
Menominee	10	1.19	2.78	0.23	4.20
Midland	19	0.08	11.52	0.72	12.32
Missaukee	21	0.00	0.25	2.61	2.86
Monroe	50	1,768.06	4.50	10.46	1,783.02
Montcalm	97	0.00	4.90	28.86	33.76
Montmorency	5	0.00	0.15	0.13	0.28
Muskegon	76	262.12	4.77	9.05	275.94
Newaygo	41	0.00	1.82	4.37	6.19
Oakland	181	0.00	2.09	27.14	29.23
Oceana	36	0.00	0.98	3.18	4.16
Ogemaw	12	0.00	0.14	0.51	0.65
Ontonagon	10	6.79	0.04	0.14	6.97
Osceola	22	0.00	0.29	4.07	4.36
Oscoda	9	0.00	0.29	0.40	0.69

County	Number of Facilities	Water Withdrawn (MGD)			
		Great Lakes	Surface Water	Ground Water	Total
Otsego	30	0.00	0.13	2.48	2.61
Ottawa	153	692.90	92.84	7.99	793.73
Presque Isle	16	8.98	0.39	1.31	10.68
Roscommon	21	0.00	0.02	0.63	0.65
Saginaw	51	12.40	3.02	1.97	17.39
Saint Clair	107	1,651.17	0.28	0.81	1,652.26
Saint Joseph	193	0.00	22.68	52.24	74.92
Sanilac	37	0.17	0.19	2.34	2.70
Schoolcraft	6	5.16	6.20	0.03	11.39
Shiawassee	39	0.00	0.27	4.20	4.47
Tuscola	48	1.98	0.07	3.82	5.87
Van Buren	147	117.10	1.83	13.63	132.56
Washtenaw	83	0.00	14.41	10.65	25.06
Wayne	136	1,685.54	165.91	0.96	1,852.41
Wexford	17	0.00	0.03	6.80	6.83
Total	4,048	9,715.01	705.86	527.37	10,948.24

* This report is provided by the Michigan Department of Environmental Quality and was generated using data collected for the water use reporting program for thermoelectric power generation, public water supply, self-supplied industrial, and irrigation.

Index Map of Michigan Counties

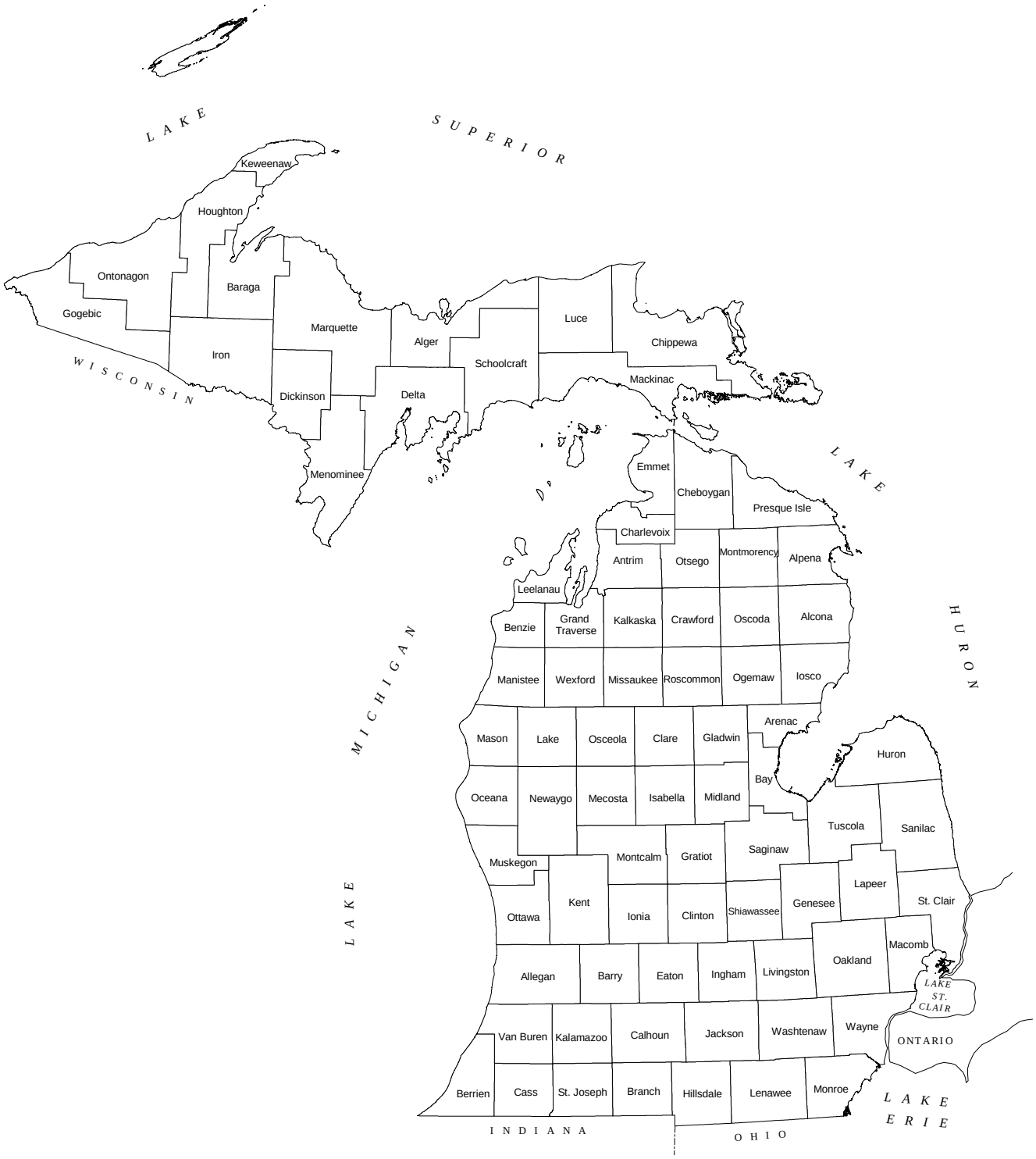


Table 2: 2004 Water Withdrawals for Major Water Uses in Michigan, by Hydrologic Basin*

Hydrologic Basin Code	Number of Facilities	Water Withdrawn ((MGD)			
		Great Lakes	Surface Water	Ground Water	Total
04010302	3	0.00	0.00	1.14	1.14
04020101	9	0.00	0.00	0.70	0.70
04020102	8	6.79	0.00	0.16	6.95
04020103	27	0.02	0.03	3.58	3.63
04020104	1	0.00	0.00	0.00	0.00
04020105	22	274.39	0.05	1.56	276.00
04020201	12	5.67	0.00	0.93	6.60
04020202	7	0.00	0.12	0.69	0.81
04020203	3	0.00	0.07	0.08	0.15
04030106	19	0.00	0.00	2.11	2.11
04030107	4	0.00	0.48	0.27	0.75
04030108	18	0.00	21.92	3.34	25.26
04030109	6	1.19	0.00	0.10	1.29
04030110	14	0.00	19.33	1.13	20.46
04030111	16	61.36	0.46	0.22	62.04
04030112	2	0.00	0.00	0.04	0.04
04040001	20	2,202.06	0.28	0.39	2,202.73
04050001	737	7.44	45.74	128.75	181.93
04050002	184	811.79	52.54	7.06	871.39
04050003	257	0.00	17.10	82.10	99.20
04050004	155	0.00	235.20	57.31	292.51
04050005	60	0.00	1.09	5.70	6.79
04050006	305	54.44	49.57	42.47	146.48
04050007	73	0.00	1.50	5.06	6.56
04060101	128	34.28	1.52	8.41	44.21
04060102	159	252.60	7.89	29.79	290.28
04060103	46	16.30	19.20	7.73	43.23
04060104	78	0.00	0.28	3.46	3.74
04060105	190	13.07	0.43	24.64	38.14
04060106	8	0.00	6.21	0.09	6.30
04060107	4	5.16	0.01	0.11	5.28
04070001	11	3.07	0.03	1.09	4.19
04070002	6	8.23	0.00	0.09	8.32

Hydrologic Basin Code	Number of Facilities	Water Withdrawn ((MGD)			
		Great Lakes	Surface Water	Ground Water	Total
04070003	21	11.58	0.29	0.99	12.86
04070004	28	0.00	0.27	1.67	1.94
04070005	5	0.00	0.02	0.35	0.37
04070006	18	112.57	4.50	1.17	118.24
04070007	53	0.09	0.68	4.62	5.39
04080101	43	84.73	0.27	0.82	85.82
04080102	21	0.25	0.69	0.36	1.30
04080103	66	1.89	1.06	2.13	5.08
04080104	72	227.72	0.01	0.47	228.20
04080201	40	0.08	11.54	1.93	13.55
04080202	65	0.00	2.64	9.22	11.86
04080203	107	0.00	2.33	11.83	14.16
04080204	104	0.00	1.40	4.60	6.00
04080205	43	0.80	0.28	3.58	4.66
04080206	52	566.25	2.77	0.26	569.28
04090001	72	1,491.33	0.85	2.90	1,495.08
04090002	20	6.15	0.18	0.24	6.57
04090003	127	7.93	3.61	20.02	31.56
04090004	166	1,677.54	158.09	2.28	1,837.91
04090005	179	0.17	23.24	17.98	41.39
04100001	41	1,758.80	1.84	10.19	1,770.83
04100002	88	9.27	7.31	8.12	24.70
04100003	9	0.00	0.17	0.23	0.40
04100006	16	0.00	0.77	1.11	1.88
Total	4,048	9,715.01	705.86	527.37	10,948.24

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Index Map of Michigan Hydrologic Basins