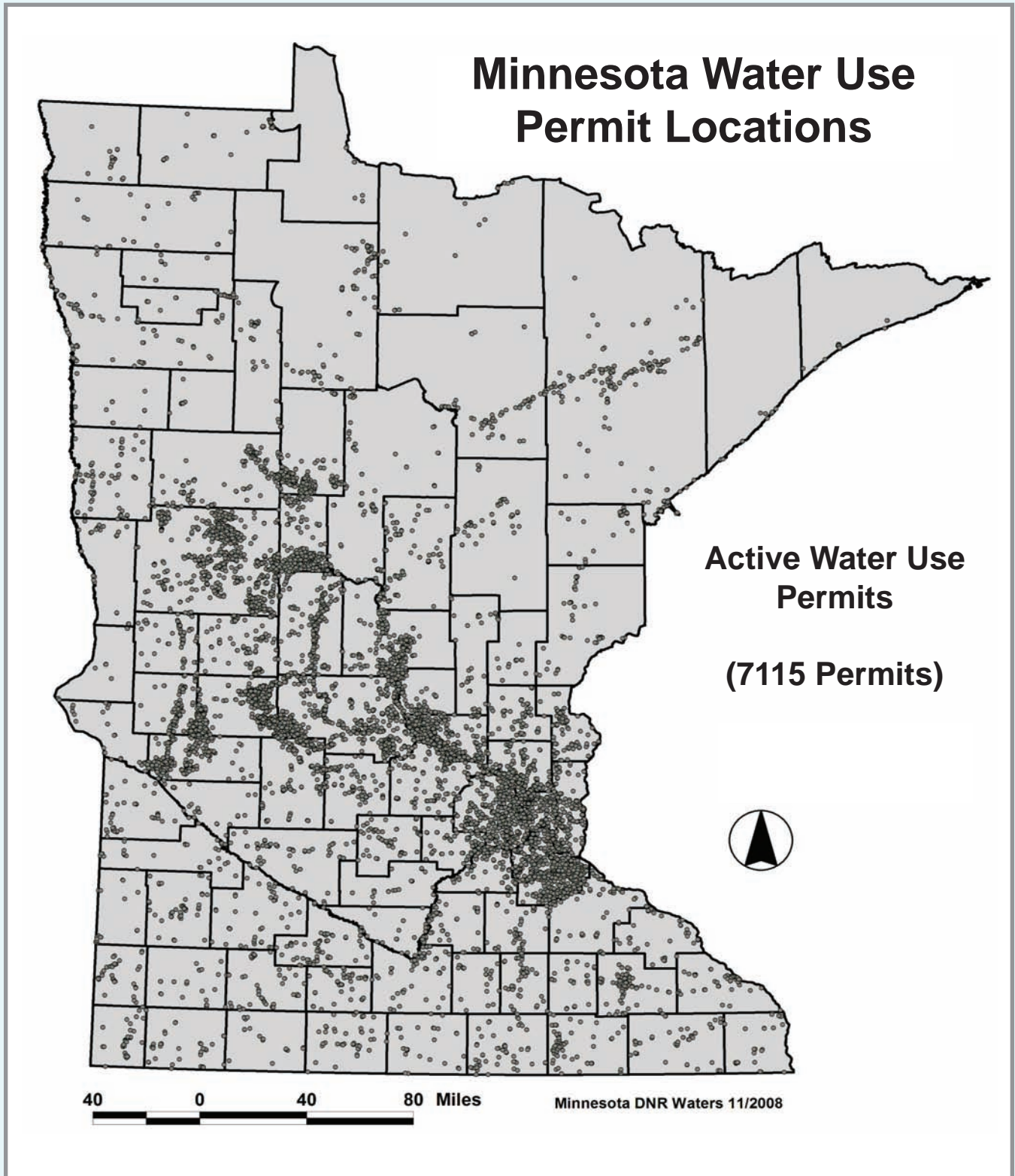


Chapter 4 **Water Use**





Introduction

Introduction

DNR water appropriations permits are required for all users withdrawing surface or ground water in excess of ten thousand gallons per day or one million gallons per year. Uses less than this, such as domestic use from private wells, do not require a permit from the DNR and therefore are not included in this chapter.

All permittees must use a flow meter or other approved method of measurement to determine the volume of water withdrawn and must submit an annual report of water use. Reported water use data are used for many purposes, such as documenting water conflicts, understanding the hydrology of aquifers from which water is withdrawn, and evaluating existing water supplies by monitoring use and the impact of that use. The data are reported on a calendar year basis. This chapter summarizes the reported water use data for calendar years (CY) 2006 and 2007.

[insert major water use categories text from last time



MAJOR WATER USE CATEGORIES

THERMOELECTRIC POWER GENERATION - water used to cool power generating plants. This is historically the largest volume use and relies almost entirely on surface water sources. Thermoelectric power generation is primarily a nonconsumptive* use in that most of the water withdrawn is returned to its source.

PUBLIC WATER SUPPLY - water distributed by community suppliers for domestic, commercial, industrial and public users. This category relies on both surface water and ground water sources.

INDUSTRIAL PROCESSING - water used especially in mining activities, paper mill operations, and food processing, etc. Three-fourths or more of withdrawals are from surface water sources. Consumptive use varies, depending upon the type of industrial process.

IRRIGATION - water withdrawn from both surface water and ground water sources for major crop and noncrop uses. Nearly all irrigation is considered to be consumptive use.

OTHER - large volumes of water withdrawn for activities including air conditioning, construction dewatering, water level maintenance and pollution confinement.

*Consumptive use is defined as water that is withdrawn from its source for immediate further use in the area and is not directly returned to the source (M.S. 103G.005, Subd. 8). Under this definition, all ground water withdrawals are consumptive unless the water is returned to the same aquifer. Surface water withdrawals are considered consumptive if the water is not directly returned to the source so that it is available for immediate further use.

Comparison of 2006 and 2007 Statewide Water Use

Water use in 2006 and 2007 were 1420.3 billion gallons (BG) and 1430.5 BG respectively. These values closely matched the highest reported water use of 2005. 2007 water use was 1% more than the 2006 total. Figure 1 is a comparison of the two years showing use by major category and the volume and percent change between the years. The largest increase in the two-year period was for irrigation, increasing by 15 BG or 13%. The largest decrease in use was for the category power generation, decreasing by 14 BG or 2%.

Figure 2 graphically shows the changes in use patterns for four main use categories (excluding power generation) from 1985 to 2007. Water use in 2007 for public supply increased to levels closely matching the high of 2003, a high-use year. Irrigation water use increased dramatically probably due to very dry conditions in 2006 and 2007 and increased acres

irrigated. Industrial processing water use is generally influenced by overall economic vitality and can be heavily influenced by fluctuations in large mine processing and mine pit dewatering operations on the Minnesota Iron Range.

here]

Comparison of 2006 and 2007 Statewide Water Use

Water use in 2007 was 1430.5 billion gallons (BG) and matches closely with the highest reported water use of 2005. Reported use in 2006 was 1% less than the 2007 total. Figure 1 is a comparison of the two years showing use by major category and the volume and percent change between the years. The largest increase in the two-year period was for irrigation, increasing by 15 BG or 13%. The largest decrease in use was for the

Figure 1

**Water Use Comparison by
Major Use Category: 2006 & 2007
(Billions of Gallons)**

Use Category	2006		2007		Change From 2006 to 2007	
	BG	% of Total	BG	% of Total	BG Change	% Change
Power Generation	852.9	60%	838.7	58%	-14.2	-2%
Public Supply	220.6	15%	226.9	16%	6.3	3%
Industrial Processing	163.8	12%	167.5	12%	3.7	2%
Irrigation	117.2	8%	132.3	9%	15.1	13%
Other	65.7	5%	65.2	5%	-0.5	-1%
Totals	1,420.3	100%	1,430.5	100%	+10.3	+0.7%

column totals may not sum due to independent rounding

Figure 2

**Minnesota Water Use
(excluding Power Generation) in Billions of Gallons**

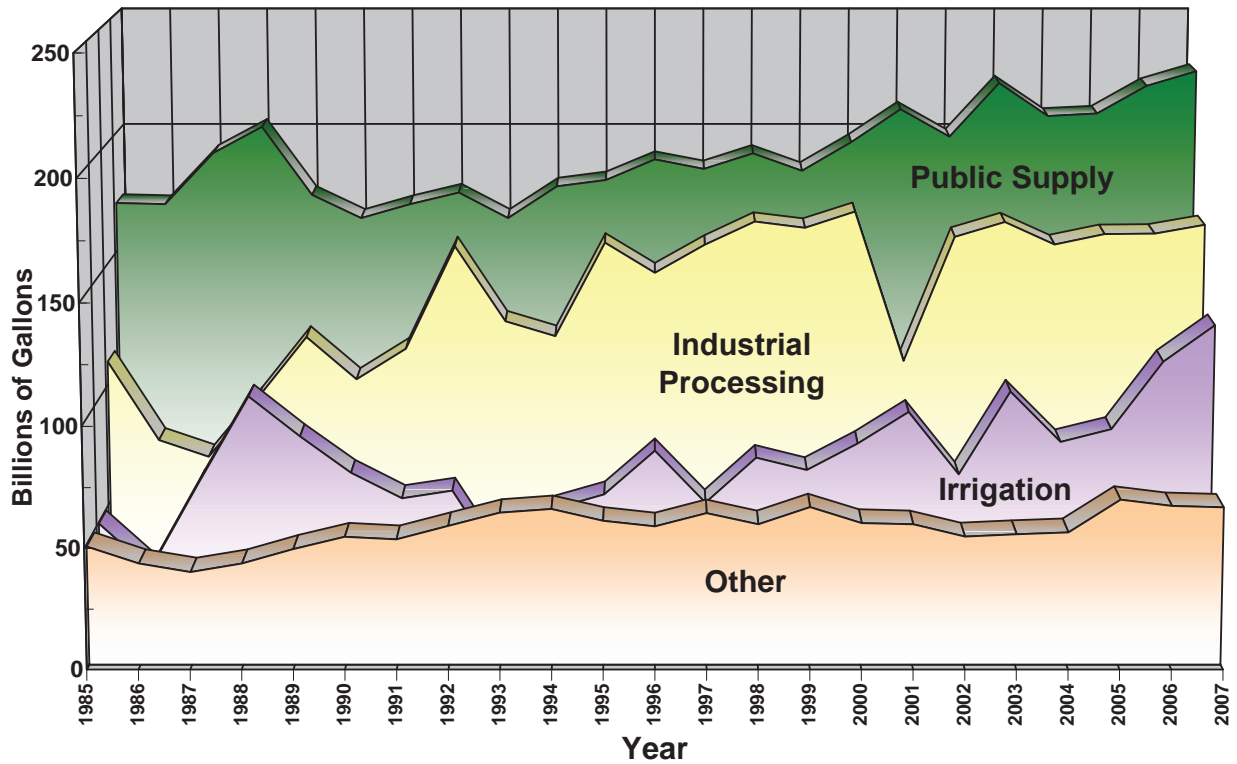
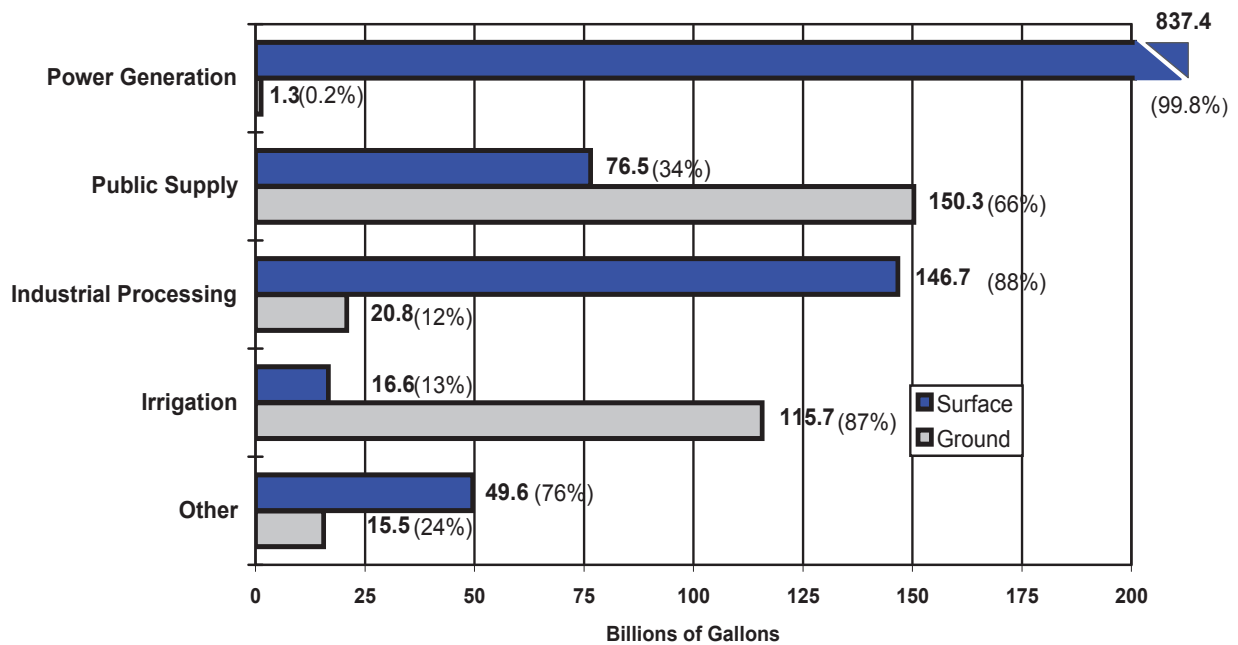


Figure 3

**Comparison of Surface and Ground Water Use by Category - 2007
Billions of Gallons (% of category)**



Power Generation

Figure 4 shows that power generation was the primary use in 8 of the 10 counties with the highest total use in 2007. Power generation accounted for 59% of all use reported in Minnesota for the year. Power generation in Goodhue and Wright Counties alone accounted for 24% of all reported use in 2007, largely due to power plant cooling. Surface water sources supply almost all of the water used for power generation. Most of the water is used for cooling purposes and is returned to the surface water source.



Figure 4

Appropriations by the Counties with the Greatest Use in CY 2007

Billions of Gallons

	County	Ground Water	Surface Water	Total	Primary Use
1)	Goodhue	2.3	228.7	231.0	Nuclear Power Cooling
2)	Dakota	32.3	107.8	140.1	Steam Power Cooling
3)	Hennepin	40.5	87.1	127.6	Steam Power Cooling
4)	Wright	4.7	109.2	113.9	Nuclear Power Cooling
5)	St. Louis	2.0	107.4	109.4	Steam Power Cooling
6)	Washington	14.0	82.6	96.6	Steam Power Cooling
7)	Itasca	1.0	66.7	67.7	Steam Power Cooling
8)	Cook	0.0	65.6	65.6	Mine Processing
9)	Ramsey	12.4	49.1	61.5	Steam Power Cooling
10)	Anoka	14.0	36.6	50.6	Municipal Waterworks

Billions of gallons 41% of all GW Use 83% of all SW Use 74% of Total Use



Public Water Supply

Public supply water use gradually increased from 1990 to 1999 due to population increases, higher demand for outdoor uses such as lawn watering and demands by industrial customers. After some fluctuations from 2001 to 2004, use in this category showed an increase in 2006 and 2007 back to 2003 peak levels. Sixty-six percent of public water supply use came from ground water in 2007, compared to 37% nationally (USGS, *Estimated Use of Water in the United States in 2000*).

Local water conservation programs that implement measures to improve water use efficiencies and promote the wise use of water can help communities reduce the need for expensive new municipal wells and water/wastewater treatment plants. Public water suppliers that serve more than 1,000 people are required to develop water supply plans and also implement demand management measures before requesting approvals for new supply wells. These efforts can help water customers and communities save money while helping to protect Minnesota's valuable water resources for future domestic and economic uses.

The water supply planning process has resulted in a general commitment on the part of Minnesota

communities to increase the monitoring of the impacts of their water supply systems on the aquifers from which they draw water. Numerous communities have made commitments to decrease their water usage by reducing their unaccounted water volumes, reducing the water used for lawn watering or increasing their water conservation education efforts.

Irrigation

Annual variations in the amount and distribution of rainfall can greatly affect the demand for irrigation water. New applications for major crop irrigation permits increased in 2006 and 2007. This apparent increase in irrigated acres, combined with low precipitation levels during the growing season, resulted in irrigation at peak levels exceeding all previous years.

Irrigation accounts for a relatively small amount (9%) of total water use in Minnesota. However, this use is significant because it is almost entirely consumptive and the majority is from ground water sources (87% in 2007). The timing of irrigation water use can be significant when evaluating regional water supplies and the potential for well interferences. Almost all irrigation water use occurs in the five-month period from May to September of each year.



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Industrial Processing

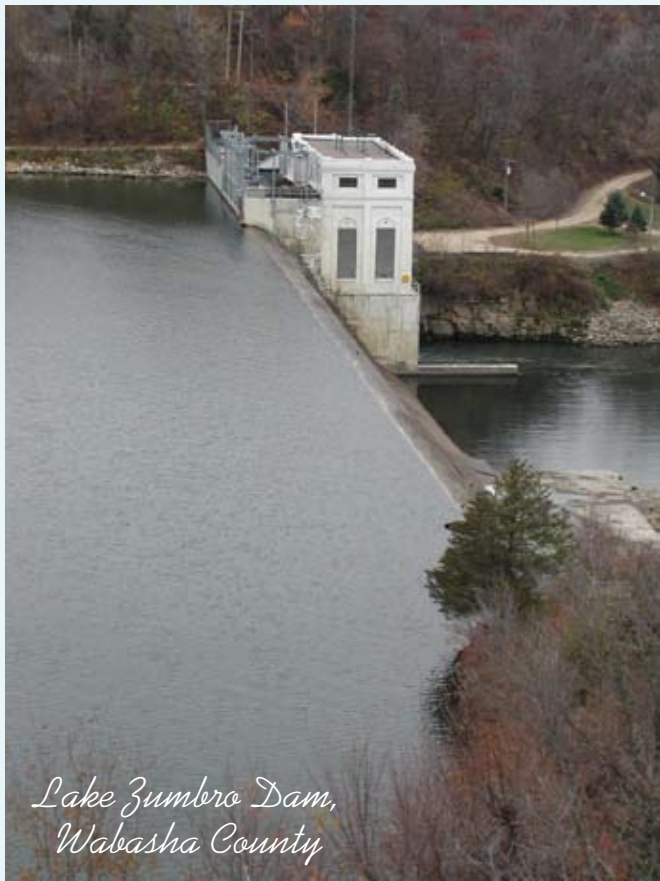
Industrial processing use maintained at a fairly stable level from 2002 to 2007, averaging 164 BG each year over the last 4 year period. Mine processing and pulp and paper processing accounted for the majority of water use reported for industrial processing.

Summary

Total water use in 2007 stayed at nearly the same record high level of 1430 billion gallons as in 2005. Power generation continues to account for the majority of use totaling 838.7 BG (or 59%) in 2007. Surface water accounts for 79% of all appropriations.

Other Uses

Other uses include air conditioning, water level maintenance, fisheries, temporary construction dewatering, pollution confinement, snow making and other specialty uses that represent about 5% of Minnesota's total water use.





An intensively irrigated portion of Sherburne County.

Radial patterns are from center pivot irrigation systems; in these cases, the water is supplied by wells.

**Reported Water Use by County
2006 - 2007 (Millions of Gallons)**

Reported Water Use

County	2006			2007			Primary Use	% of 2007 Total
	Ground	Surface	Total	Ground	Surface	Total		
1 Aitkin	126.8	1,339.6	1,466.5	126.8	1,916.8	2,043.6	Wild Rice Irrigation	92
2 Anoka	13,276.0	34,977.3	48,253.3	13,979.6	36,642.1	50,621.7	Municipal Waterworks	94
3 Becker	3,888.4	67.9	3,956.3	3,395.9	66.5	3,462.4	Major Crop Irrigation	69
4 Beltrami	714.9	1,701.5	2,416.4	746.9	1,365.2	2,112.1	Wild Rice Irrigation	64
5 Benton	4,820.1	3,745.0	8,565.1	5,798.1	3,779.3	9,577.4	Major Crop Irrigation	49
6 Big Stone	619.7	101.7	721.4	576.3	111.9	688.2	Major Crop Irrigation	50
7 Blue Earth	4,179.7	8,384.4	12,564.1	4,140.6	9,062.5	13,203.1	Steam Power Cooling	68
8 Brown	953.1	63.3	1,016.4	905.0	77.1	982.1	Major Crop Irrigation	46
9 Carlton	652.5	2,049.1	2,701.6	621.5	2,407.9	3,029.4	Pulp/Paper Processing	68
10 Carver	3,934.2	45.4	3,979.6	4,034.6	47.7	4,082.3	Municipal Waterworks	89
11 Cass	1,528.8	36.5	1,565.3	1,480.2	38.7	1,518.9	Major Crop Irrigation	42
12 Chippewa	622.2	34.8	657.0	629.9	147.1	777.0	Municipal Waterworks	67
13 Chisago	1,545.3	205.3	1,750.6	1,422.6	215.5	1,638.1	Municipal Waterworks	52
14 Clay	1,064.5	1,730.4	2,794.9	1,211.3	1,644.9	2,856.2	Municipal Waterworks	71
15 Clearwater	124.9	1,910.0	2,034.9	109.7	3,880.4	3,990.1	Wild Rice Irrigation	97
16 Cook	9.8	62,864.5	62,874.3	9.8	65,636.1	65,645.9	Mine Processing	99.7
17 Cottonwood	1,306.1	312.8	1,618.9	1,271.4	197.5	1,468.9	Municipal Waterworks	39
18 Crow Wing	2,437.5	841.0	3,278.5	2,172.8	774.2	2,947.0	Municipal Waterworks	42
19 Dakota	32,299.9	115,342.5	147,642.4	32,263.0	107,805.7	140,068.7	Steam Power Cooling	74
20 Dodge	573.2	15.3	588.5	570.6	46.3	616.9	Municipal Waterworks	58
21 Douglas	1,997.1	119.5	2,116.6	2,384.4	115.9	2,500.3	Major Crop Irrigation	49
22 Faribault	707.0	0.6	707.6	698.4	0.0	698.4	Municipal Waterworks	59
23 Fillmore	657.3	3,972.6	4,629.9	646.3	4,113.5	4,759.8	Hatcheries & Fisheries	86
24 Freeborn	1,562.5	27.3	1,589.8	1,578.7	24.6	1,603.3	Municipal Waterworks	75
25 Goodhue	2,207.4	216,821.9	219,029.3	2,268.6	228,671.9	230,940.5	Nuclear Power Cooling	92
26 Grant	929.5	0.0	929.5	980.1	0.0	980.1	Major Crop Irrigation	82
27 Hennepin	38,734.4	78,633.5	117,367.9	40,450.2	87,118.3	127,568.5	Steam Power Cooling	68
28 Houston	527.7	8.9	536.6	657.8	16.8	674.6	Municipal Waterworks	76
29 Hubbard	5,979.0	30.2	6,009.2	5,799.3	24.2	5,823.5	Major Crop Irrigation	83
30 Isanti	1,083.0	49.8	1,132.8	1,058.3	5.7	1,064.0	Municipal Waterworks	57
31 Itasca	967.2	71,101.2	72,068.4	961.1	66,681.1	67,642.2	Steam Power Cooling	83
32 Jackson	361.6	157.6	519.2	419.0	79.1	498.1	Municipal Waterworks	45
33 Kanabec	229.0	11.1	240.1	257.2	12.0	269.2	Municipal Waterworks	56
34 Kandiyohi	3,936.1	512.3	4,448.4	4,391.8	504.0	4,895.8	Major Crop Irrigation	42
35 Kittson	352.2	161.9	514.1	325.9	132.5	458.4	Major Crop Irrigation	51
36 Koochiching	39.1	17,238.1	17,277.2	38.5	16,573.2	16,611.7	Pulp/Paper Processing	96
37 Lac Qui Parle	1,417.9	49.4	1,467.3	1,397.3	64.9	1,462.2	Major Crop Irrigation	41
38 Lake	0.3	46,999.4	46,999.7	40.9	48,377.2	48,418.1	Mine Processing	99
39 Lake of the Woods	67.1	283.1	350.2	60.3	324.4	384.7	Wild Rice Irrigation	83
40 Le Sueur	1,470.5	5,594.1	7,064.6	1,471.6	5,498.3	6,969.9	Quarry/Mine Dewatering	79
41 Lincoln	534.9	15.7	550.6	598.7	26.3	625.0	Rural Waterworks	67
42 Lyon	1,616.1	163.5	1,779.6	1,834.8	158.0	1,992.8	Municipal Waterworks	65
43 McLeod	2,168.0	334.7	2,502.7	2,061.3	259.2	2,320.5	Municipal Waterworks	52
44 Mahanomen	92.0	6.4	98.4	96.3	3.9	100.2	Municipal Waterworks	87

**Reported Water Use by County
2006 - 2007 (Millions of Gallons)**

Reported Water Use

County	2006			2007			Primary Use	% of 2007 Total
	Ground	Surface	Total	Ground	Surface	Total		
45 Marshall	220.4	36.3	256.7	222.1	41.6	263.7	Municipal Waterworks	36
46 Martin	293.6	4,420.7	4,714.3	461.3	4,976.6	5,437.9	Steam Power Cooling	80
47 Meeker	1,928.9	16.2	1,945.1	2,152.6	29.6	2,182.2	Major Crop Irrigation	69
48 Mille Lacs	685.2	34.1	719.3	685.3	56.1	741.4	Municipal Waterworks	56
49 Morrison	5,501.2	221.9	5,723.1	6,349.0	172.7	6,521.7	Major Crop Irrigation	80
50 Mower	2,685.8	170.7	2,856.5	2,853.6	219.5	3,073.1	Municipal Waterworks	44
51 Murray	195.9	111.7	307.6	208.2	92.9	301.1	Municipal Waterworks	67
52 Nicollet	1,944.6	112.7	2,057.3	2,039.4	55.5	2,094.9	Municipal Waterworks	86
53 Nobles	1,192.3	78.4	1,270.7	1,194.4	69.4	1,263.8	Municipal Waterworks	94
54 Norman	144.4	0.0	144.4	146.6	0.0	146.6	Municipal Waterworks	85
55 Olmsted	6,508.2	14,245.3	20,753.5	6,486.8	13,773.4	20,260.2	Steam Power Cooling	47
56 Ottertail	17,554.4	26,557.0	44,111.4	19,709.0	28,899.8	48,608.8	Steam Power Cooling	57
57 Pennington	38.8	665.1	703.9	29.4	815.3	844.7	Municipal Waterworks	54
58 Pine	535.4	46.7	582.1	513.6	43.9	557.5	Municipal Waterworks	55
59 Pipestone	1,119.5	84.7	1,204.2	1,231.0	61.8	1,292.8	Rural Waterworks	45
60 Polk	573.5	4,659.0	5,232.5	541.8	5,908.7	6,450.5	Municipal Waterworks	53
61 Pope	11,221.3	31.0	11,252.3	11,742.1	35.9	11,778.0	Major Crop Irrigation	96
62 Ramsey	12,239.0	62,147.7	74,386.7	12,417.4	49,139.0	61,556.4	Steam Power Cooling	49
63 Red Lake	280.6	157.2	437.8	297.7	437.4	735.1	Wild Rice Irrigation	56
64 Redwood	434.5	97.8	532.3	420.9	61.8	482.7	Municipal Waterworks	77
65 Renville	919.4	100.3	1,019.7	831.3	113.0	944.3	Municipal Waterworks	45
66 Rice	2,807.5	495.7	3,303.2	2,699.7	300.4	3,000.1	Municipal Waterworks	76
67 Rock	642.1	57.2	699.3	668.0	55.4	723.4	Municipal Waterworks	51
68 Roseau	312.6	7.5	320.1	299.2	8.1	307.3	Municipal Waterworks	88
69 St. Louis	1,969.5	102,897.7	104,867.2	1,995.1	107,417.8	109,412.9	Steam Power Cooling	61
70 Scott	6,189.6	165.8	6,355.4	6,779.5	130.1	6,909.6	Municipal Waterworks	70
71 Sherburne	12,606.0	20,571.0	33,177.0	13,502.3	20,903.8	34,406.1	Steam Power Cooling	37
72 Sibley	671.4	42.8	714.2	822.7	21.7	844.4	Municipal Waterworks	68
73 Stearns	12,676.5	3,447.6	16,124.1	13,419.5	3,473.5	16,893.0	Major Crop Irrigation	57
74 Steele	1,894.0	1,064.7	2,958.7	1,861.1	580.2	2,441.3	Municipal Waterworks	72
75 Stevens	3,265.9	68.8	3,334.7	3,320.4	56.7	3,377.1	Major Crop Irrigation	75
76 Swift	5,363.5	43.9	5,407.4	6,315.1	18.2	6,333.3	Major Crop Irrigation	90
77 Todd	3,694.6	246.4	3,941.0	4,221.3	257.2	4,478.5	Major Crop Irrigation	82
78 Traverse	86.3	2.1	88.4	78.6	2.2	80.8	Municipal Waterworks	97
79 Wabasha	1,173.3	20.7	1,194.0	1,288.0	15.9	1,303.9	Municipal Waterworks	69
80 Wadena	4,109.8	679.0	4,788.8	4,952.7	851.7	5,804.4	Major Crop Irrigation	93
81 Waseca	677.0	29.5	706.5	676.5	28.5	705.0	Municipal Waterworks	89
82 Washington	13,054.4	84,037.2	97,091.6	13,961.7	82,592.9	96,554.6	Steam Power Cooling	83
83 Watonwan	1,024.3	15.5	1,039.8	1,123.1	22.4	1,145.5	Municipal Waterworks	59
84 Wilkin	369.5	145.3	514.8	346.3	99.7	446.0	Municipal Waterworks	67
85 Winona	2,447.3	975.0	3,422.3	3,527.3	1,048.2	4,575.5	Municipal Waterworks	32
86 Wright	4,585.1	124,417.8	129,002.9	4,719.7	109,162.2	113,881.9	Nuclear Power Cooling	96
87 Yellow Medicine	532.2	88.6	620.8	642.7	103.4	746.1	Rural Waterworks	50
Total			1,420,259			1,430,500		

Minnesota Reported Water Use

Category	2006	2007
Power Generation	(Millions of Gallons)	
Nuclear Power		
surface	327,430.4	321,771.3
ground	61.6	49.4
Steam Power Cooling		
surface	438,740.3	430,722.8
ground	588.5	406.8
Other Power		
surface	85,266.4	84,862.2
ground	845.9	846.5
Subtotal	852,933.1	838,659.0
Percent of Total	60%	59%
surface	851,437.1	837,356.3
ground	1,496.0	1,302.7
Public Supply		
Municipal Water Works		
surface	73,636.7	76,518.6
ground	143,034.9	146,230.0
Private Water Works		
surface	9.7	9.7
ground	709.5	744.4
Comercial & Institutional		
surface	0.0	0.0
ground	1,162.7	1,146.8
Cooperative Water Works		
surface	0.0	0.0
ground	2.2	2.1
Fire Protection		
surface	1.6	0.0
ground	12.3	18.3
State Parks, Waysides, Rest Areas		
surface	0.0	0.0
ground	49.2	51.2
Rural Water Districts		
surface	0.0	0.0
ground	2,003.0	2,138.7
Subtotal	220,621.8	226,859.8
Percent of Total	16%	16%
surface	73,648.0	76,528.3
ground	146,973.8	150,331.5

Minnesota Reported Water Use

Category	2006	2007
Irrigation	(Millions of Gallons)	
Golf Course		
surface	2,017.0	1,934.0
ground	6,954.0	7,727.7
Cemetery		
surface	3.9	4.5
ground	102.1	120.5
Landscaping		
surface	114.1	82.3
ground	980.1	1,163.2
Sod		
surface	73.3	124.4
ground	334.4	369.4
Nursery		
surface	172.6	177.3
ground	727.8	722.1
Orchard		
surface	12.0	11.9
ground	18.1	11.7
Non Crop		
surface	0.0	0.0
ground	27.7	16.5
Temporary		
surface	0.0	0.0
ground	25.7	0.0
Major Crop		
surface	3,131.0	3,145.7
ground	95,443.6	105,576.9
Wild Rice		
surface	7,022.7	11,156.6
ground	3.5	3.0
Subtotal	117,163.6	132,347.7
Percent of Total	8%	9%
surface	12,546.6	16,636.7
ground	104,617.0	115,711.0

Minnesota Reported Water Use

Category	2006	2007
Industrial Processing	(Millions of Gallons)	
Agricultural		
surface	8.2	3.5
ground	9,015.8	9,301.6
Pulp and Paper		
surface	25,994.9	25,346.7
ground	912.9	872.3
Mine		
surface	113,407.3	118,278.2
ground	113.0	95.4
Sand and Gravel Washing		
surface	3,268.7	2,540.3
ground	1,383.4	1,178.0
Industrial Process Cooling Once-through		
surface	211.9	203.3
ground	2,085.8	2,006.8
Petroleum or Chemical		
surface	118.0	289.9
ground	4,502.2	4,520.6
Metal		
surface	0.0	0.0
ground	1,327.2	1,431.7
Non-Metal		
surface	0.0	0.0
ground	1,064.1	990.6
Other		
surface	0.0	0.0
ground	399.8	408.7
Subtotal	163,813.2	167,467.6
Percent of Total	12%	12%
surface	143,009.0	146,661.9
ground	20,804.2	20,805.7
Other		
Air Conditioning		
Commercial & Institutional Building AC		
surface	258.8	267.9
ground	63.3	69.8

Minnesota Reported Water Use

Category	2006	2007
Heat Pumps & Coolant Pumps	(Millions of Gallons)	
surface	1.7	2.0
ground	0.0	0.0
District Heating		
surface	0.0	0.0
ground	107.5	112.4
Once Through Heating or AC		
surface	0.0	0.0
ground	1,680.2	1,531.0
Temporary		
Temporary Construction Non-Dewatering		
surface	0.4	0.0
ground	17.5	0.2
Temporary Construction Dewatering		
surface	311.1	211.7
ground	3,592.9	4,012.8
Temporary Pipeline and Tank Testing		
surface	22.5	0.1
ground	0.8	0.0
Other Temporary		
surface	87.2	42.3
ground	36.0	2.7
Water Level Maintenance		
Basin (Lake) Level Maintenance		
surface	2,340.5	874.3
ground	241.8	255.4
Mine Dewatering		
surface	22,012.8	24,840.2
ground	5.2	6.0
Quarry Dewatering		
surface	18,519.2	15,695.8
ground	0.0	0.0
Sand/Gravel Pit Dewatering		
surface	1,058.3	1,143.5
ground	2.9	0.7
Tile Drainage & Pumped Sumps		
surface	33.9	31.0
ground	20.6	19.4

Minnesota Reported Water Use

Category	2006	2007
Other Water Level Maintenance	(Millions of Gallons)	
surface	26.1	29.2
ground	1,561.3	1,902.0
Special Categories		
Pollution Confinement		
surface	0.0	0.0
ground	4,665.4	4,664.2
Hatcheries & Fisheries		
surface	5,750.7	6,050.8
ground	582.0	607.3
Snow Making		
surface	178.5	195.8
ground	215.0	249.2
Livestock Watering		
surface	0.0	2.4
ground	899.3	945.3
Other Special Categories		
surface	332.9	232.4
ground	1,101.6	1,167.5
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Subtotal	65,727.9	65,165.3
Percent of Total	5%	5%
surface	50,934.6	49,619.4
ground	14,793.3	15,545.9
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Grand Total (Millions of Gallons)	1,420,259	1,430,500
surface	1,131,575	1,126,803
ground	288,684	303,697

Water Use Efficiency at Ethanol Production Facilities

Water use efficiency is important in all areas of industry. There has been much interest in water use for expanding industries including ethanol production. The water use and ethanol production data come from several sources. About half of Minnesota's ethanol plants have a water use permit which requires direct reporting of water used each year. The other plants use water from municipal water suppliers. For the latter, a survey is conducted of their supply source to determine annual volumes. The ethanol production number is generally supplied by the Minnesota Department of Agriculture from the Ethanol Producers Payment program. Where that information is not available, production values from the Minnesota Pollution Control Agency (Air Quality Emission Inventory) reports are used.

The ratio of gallons of water used to gallons of ethanol produced from 1998 to 2007 is shown in the Table below. Generally the efficiency of operations has increased over time from 5.8 gallons of water used per gallon of ethanol produced in 1998 to 3.8 in 2007. Overall ethanol production used 2.4 billion gallons of water in 2007. This compares to 9.3 billion gallons reported for other agricultural processing purposes.

Gallons of water used per gallon of ethanol produced

Ethanol Producers	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Albert Lea (Exol/Agra Resources)	6.3	6.3	6.0	6.1	5.6	5.5	5.2	4.9	4.8	4.4
Atwater(Bushmill's Ethanol)									3.2	3.4
Benson (Chippewa Valley Ethanol)	3.3	3.5	4.8	3.5	3.5	3.1	3.2	3.6	3.4	3.7
Bingham Lake (Ethanol2000)	4.0	4.2	4.7	4.6	4.3	4.7	4.2	4.4	4.6	4.3
Buffalo Lake (Minnesota Energy)	10.6	6.2	7.1	6.9	7.0	5.8	4.6	4.5	4.5	4.2
Claremont (AI-Corn Clean Fuel)	4.6	4.3	4.1	4.2	3.9	5.4	4.5	4.3	4.1	3.7
Granite Falls (Granite Falls Energy)								5.3	4.0	2.8
Lake Crystal (POET Biorefining)								2.8	2.8	2.9
Little Falls (Central MN Ethanol)		5.9	4.8	4.2	4.1	3.8	3.5	4.2	4.3	5.0
Luverne (AgriEnergy)	4.9	5.8	5.2	4.8	4.7	4.6	4.5	4.5	4.5	4.7
Marshall (ADM) **	7.7	7.6								
Melrose (Dairy Proteins) *	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Morris (DENCO LLC)	9.3	10.0	12.3	8.2	6.0	6.1	6.0	6.1	5.9	6.4
Preston (POET Biorefining)	5.6	5.2	4.7	4.6	4.4	4.1	3.8	4.0	4.0	3.7
St. Paul (MN Brewing)		18.7	7.9	21.9	32.6	12.2				
Winnebago (Corn Plus)	4.1	3.5	3.5	3.5	4.5	4.1	3.9	3.9	3.4	4.1
Winthrop (Heartland Corn Products)	4.8	5.1	4.3	5.0	4.1	3.7	4.5	4.2	3.4	2.7

MN DNR Waters, 2009

Average of dry mill facilities	5.8	5.5	5.6	5.1	4.8	4.6	4.3	4.1	3.9	3.8
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* estimates based on approximate water use - process: waste cheese whey

** estimates based on percent ethanol production compared to other corn products from the same facility
Ethanol production continues for all years, but water use estimates unknown - process: wet mill corn