Water Use in MINNESOTA, 1985

Prepared by Lee C. Trotta, U.S. Geological Survey
Published by
the State of Minnesota
Department of Natural Resources Water-Use Map Series, 1991
(Photo credits, clockwise from top-left: Minnesota Office of Tourism; Minnesota Office of Tourism; Ritchie Industries; Minnesota Office of Tourism)

ABSTRACT

This report is part of the National Water-Use Information Program and is an assessment of water use in Minnesota for the 1985 data year. Data are based on permit reporting and water-use estimates stored in the Minnesota Water-Use Data System.

Minnesota received an annual average precipitation of 104,000 Mgal/d (million gallons per day) and stream inflow of 3,430 Mgal/d. These inputs provide an abundant source of water from 15,292 lakes, 17,000 miles of fishable streams, and 14 principal aquifers. Daily per capita use for domestic purposes ranges from 88 gallons, for people in rural areas, to 175 gallons, for those in urbanized areas. Minnesota led the nation, in 1985, in surface-water withdrawn for mining (271 Mgal/d). Withdrawal of ground water in Minnesota is predominatly by public suppliers (262 Mgal/d). Thermoelectric power (1,476 Mgal/d) is the largest user of surface water, accounting for 52.1% of all water withdrawn in Minnesota. However, over 90% of this water was returned to Minnesota's streams, and withdrawals for thermoelectric power decreased 14 percent from 1980 to 1985.

INTRODUCTION

How does a drought or a wet year affect our water-use habits? What kind of pumpage may be lowering the water table? Who depends on the river for their water? Questions like these are answered best by periodic assessments of Minnesota's comprehensive data base on water use. This report is an assessment of water use in Minnesota for the 1985 data year. It describes withdrawals by source, region, and use category.

In 1978, the National Water-Use Information Program was created to collect, store, and disseminate water-use data. Its goals include (1) determining the quantities, consumption, and purpose of water withdrawals, (2) devising standard methods of data collection and analysis, (3) computerizing the data through the Aggregated Water-Use Data System (AWUDS), and (4) making this information available to water-resources policy makers.

DATA COLLECTION

At least eight State and local agencies collect site-specific data associated with water use (Trotta, 1988). Water-use data in Minnesota are generally reported by major users to State agencies as part of State permit requirements. Estimates are made based on population and average withdrawal rates for the self-supplied domestic and non-irrigation agriculture water-use categories. Data have been transferred to the national data system

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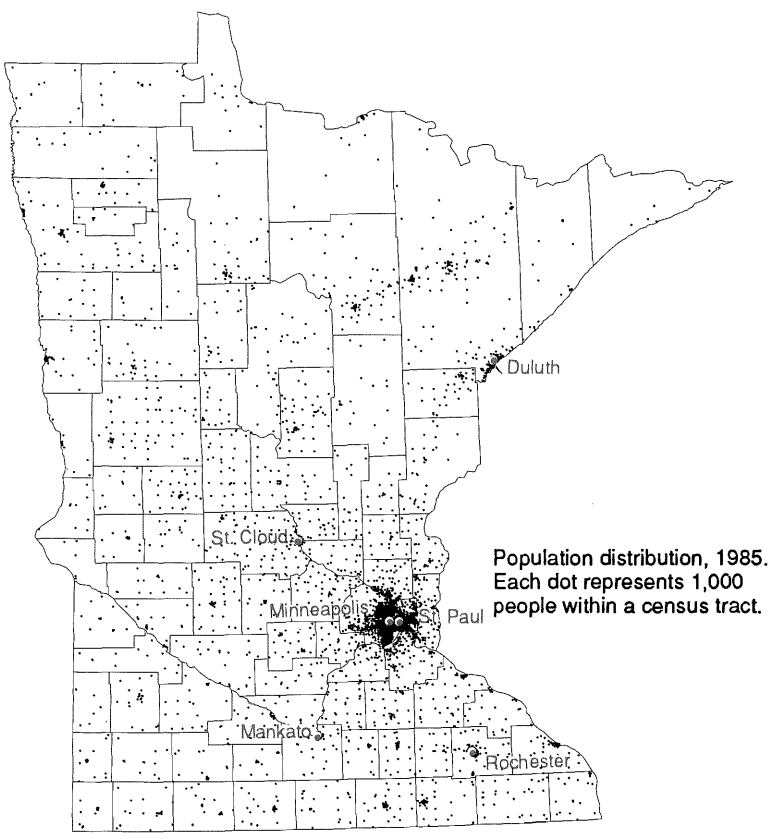
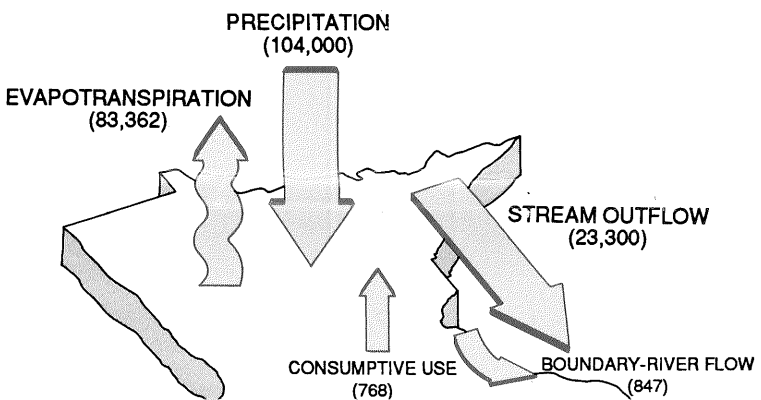


Population Distribution

Table 1.--Total water use, by river basin, 1985

[Total water use in million gallons per day. Totals may not agree due to independent rounding.]

Basin name	State basin code	Hydrologic unit code	Domestic	Agriculture	Irrigation	Industrial	Commerical	Mining	Thermo-electric
Baptism-Brule	1	04010101	.38	0	.03	.01	0	0	0
Beaver-Lester	2	04010102	20.5	.01	0	2.54	1.55	94.9	0
St. Louis	3	04010201	10.4	.16	.06	23.6	2.08	78.5	72.8
Cloquet	4	04010202	.91	.02	.00	0	0	.10	0
Beartrap-Nemadji	5	04010301	.28	.08	.02	0	0	0	0
Mississippi Headwaters	7	07010101	4.03	.32	1.06	.20	.09	0	100
Leech Lake	8	07010102	1.10	.19	.76	.03	.01	0	0
Prairie-Willow	9	07010103	3.09	.24	3.26	22.4	.12	45.4	0
Elk-Nokasippi	10	07010104	5.73	1.00	31.5	5.18	.23	.11	0
Pine	11	07010105	.91	.14	.25	.02	.01	.12	0
Crow Wing	12	07010106	3.62	1.13	8.18	.60	.05	.01	0
Redeye	13	07010107	1.88	.99	7.83	.12	.04	0	0
Long Prairie	14	07010108	3.33	.85	6.26	.45	.15	0	0
Platte-Spunk	15	07010201	4.04	5.02	11.4	10.4	.31	0	0
Sauk	16	07010202	6.09	8.34	10.0	1.23	.22	0	.21
Clearwater-Elk	17	07010203	10.7	3.17	11.6	.92	.41	3.02	349
Crow	18	07010204	7.66	4.18	12.0	.92	.22	.08	0
South Fork Crow	19	07010205	5.94	1.53	.84	2.44	.50	.19	0
Twin Cities	20	07010206	230	.57	4.13	59.1	32.5	16.0	104
Rum	21	07010207	8.26	.99	1.16	1.04	.19	.02	0
Upper Minnesota	22	07020001	.77	.34	2.98	.14	.04	0	2.59
Pomme de Terre	23	07020002	1.71	.65	8.92	.13	.09	0	0
Lac qui Parle	24	07020003	1.38	.49	1.30	3.09	.05	.04	0
Hawk-Yellow Medicine	25	07020004	5.71	1.48	1.27	.75	.25	0	.73
Chippewa	26	07020005	3.67	1.47	18.7	.25	.12	0	0
Redwood	27	07020006	1.68	.68	.23	.17	.08	.47	0
Middle Minnesota	28	07020007	9.12	1.33	1.10	1.72	.49	2.64	1.07
Cottonwood	29	07020008	4.28	1.19	1.27	.51	.22	0	.20
Blue Earth	30	07020009	2.49	1.01	.61	4.59	.05	0	83.7
Watonwan	31	07020010	4.75	.75	1.65	.53	.24	0	9
Le Sueur	32	07020011	6.22	.94	.51	.78	.31	.13	0
Lower Minnesota	33	07020012	44.3	2.37	2.57	10.9	3.84	7.34	65.9
Upper St. Croix	34	07030001	.25	.21	0	.06	0	0	0
Kettle	35	07030003	1.70	.40	.06	7.51	.03	1.47	0
Snake	36	07030004	2.04	.55	.11	.90	.05	0	0
Lower St. Croix	37	07030005	10.4	.60	.73	1.42	.23	.07	231
Rush-Vermillion	38	07040001	12.4	.81	11.6	8.00	.52	.51	427
Cannon	39	07040002	15.0	2.07	7.89	3.28	.64	2.09	0
Buffalo-Whitewater	40	07040003	6.33	1.34	.08	2.23	.70	0	0
Zumbro	41	07040004	12.1	2.14	1.87	2.70	.67	0	.99
La Crosse-Pine	42	07040006	.64	.21	0	.05	.02	0	0
Root	43	07040008	4.23	2.70	.19	.71	.12	.07	0
Coon-Yellow	44	07060001	.52	.35	0	.04	.02	0	0
Upper Iowa	46	07060002	.58	.25	0	.04	.02	0	0
Upper Wapsipinicon	47	07080102	.01	.01	0	0	0	0	0
Upper Cedar	48	07080201	4.29	.76	1.72	2.24	.19	0	.02
Shell Rock	49	07080202	2.93	.20	.43	.53	.17	0	0
Winnebago	50	07080203	.14	.06	.46	0	0	0	0
Des Moines Headwaters	51	07100001	2.22	1.11	1.70	.26	.10	.02	0
Upper Des Moines	52	07100002	.17	.06	0	0	0	0	0
East Fork Des Moines	53	07100003	.35	.18	.01	.02	.01	0	0
Bois de Sioux	54	09020101	.37	.16	.32	0	0	0	0
Mustinka	55	09020102	.93	.33	.06	.05	.02	0	0
Otter Tail	56	09020103	6.98	1.33	8.01	.85	.23	0	37.7
Upper Red	57	09020104	3.85	.09	.04	.53	.23	0	0
Buffalo	58	09020106	2.22	.41	2.43	.06	.03	.04	0
Elm-Marsh	59	09020107	.46	.11	0	.01	.03	0	0
Eastern Wild Rice	60	09020108	1.31	.53	.16	.11	.03	.22	0
Sandhill-Wilson	61	09020301	4.39	.16	.16	.57	.25	0	0
Red Lakes	62	09020302	.72	.19	5.43	.01	.01	0	0
Red Lake	63	09020303	1.99	.36	.18	.27	.12	.93	0
Thief	65	09020304	.28	.12	0	0	0	0	0
Clearwater	66	09020305	1.60	.39	15.6	.03	.02	.05	0
Grand Marais-Red	67	09020306	.36	.07	0	.01	.01	0	0
Snake	68	09020309	.71	.14	0	.05	.02	0	0
Lower Red	69	09020311	.51	.10	.03	1.96	.02	0	0
Two Rivers	70	09020312	.82	.15	.30	.04	.02	0	0
Roseau	71	09020314	.92	.31	0	.07	.03	0	0
Rainy Headwaters	72	09030001	1.32	.04	0	.27	.07	18.3	0
Vermillion	73	09030002	.96	.04	0	.02	.01	.06	0
Rainy Lake	74	09030003	.42	.03	0	.01	0	0	0
Upper Rainy	75	09030004	.02	.02	0	40.7	0	0	0
Little Fork	76	09030005	.95	.07	0	.06	0	0	0
Big Fork	77	09030006	.53	.09	.06	.01	0	0	0
Rapid	78	09030007	.08	.04	.89	0	0	0	0
Lower Rainy	79	09030008	.23	.01	0	.02	.01	0	0
Lake of the Woods	80	09030009	.25	.11	0	0	0	0	0
Upper Big Sioux	81	10170202	.03	.06	0	0	0	0	0
Lower Big Sioux	82	10170203	1.56	.69	.70	.18	.09	.01	0
Rock	83	10170204	2.94	.89	1.01	.70	.12	.01	0
Little Sioux	84	10230003	1.94	.24	.02	1.21	.10	0	0
TOTALS			532	62.9	214	231	49.4	273	1,476



Water Budget

The water resources of Minnesota follow a continuous cycle from the earth to the atmosphere, and back again. Minnesota received an annual average precipitation of 104,000 Mgal/d and stream inflow of 3,430 Mgal/d. These inputs are offset by the 768 Mgal/d consumed by man's use of water, the 23,300 Mgal/d in streams that leave the State (see Trotta, 1990), and the 83,362 Mgal/d returned to the atmosphere by evapotranspiration (evaporation from water bodies or soils and transpiration by plants). The figure shown

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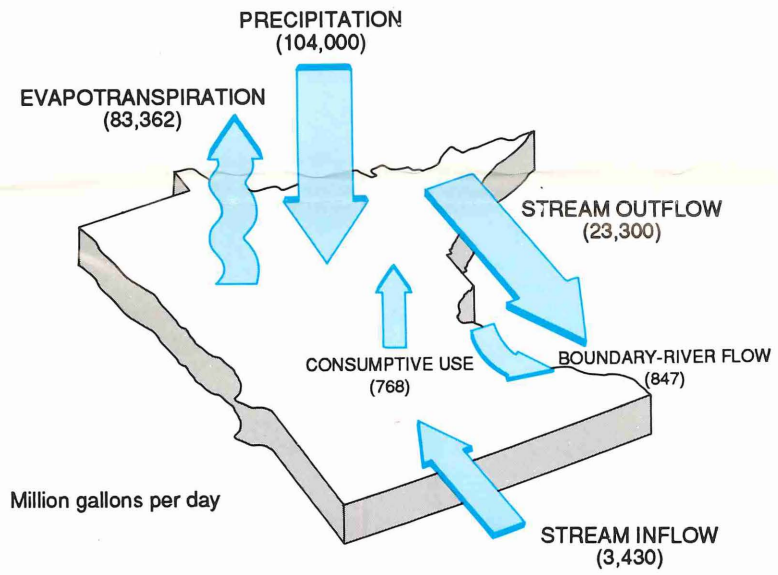

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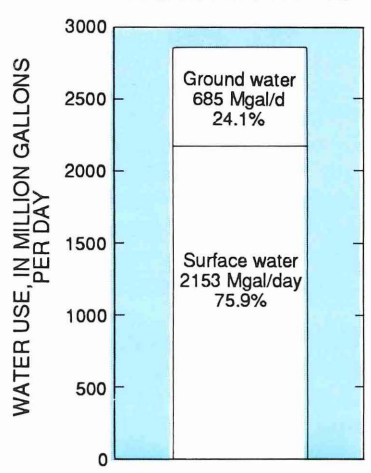
Sources of Water

Due to its abundance, surface water accounted for 76 percent of all withdrawals in 1985. Minnesota's shorelines edge 15,292 lakes -- including Lake Superior, and 17,000 miles of fishable streams (Minnesota Office of Tourism, 1988) -- including major water-supply sources such as the Mississippi and Minnesota Rivers.

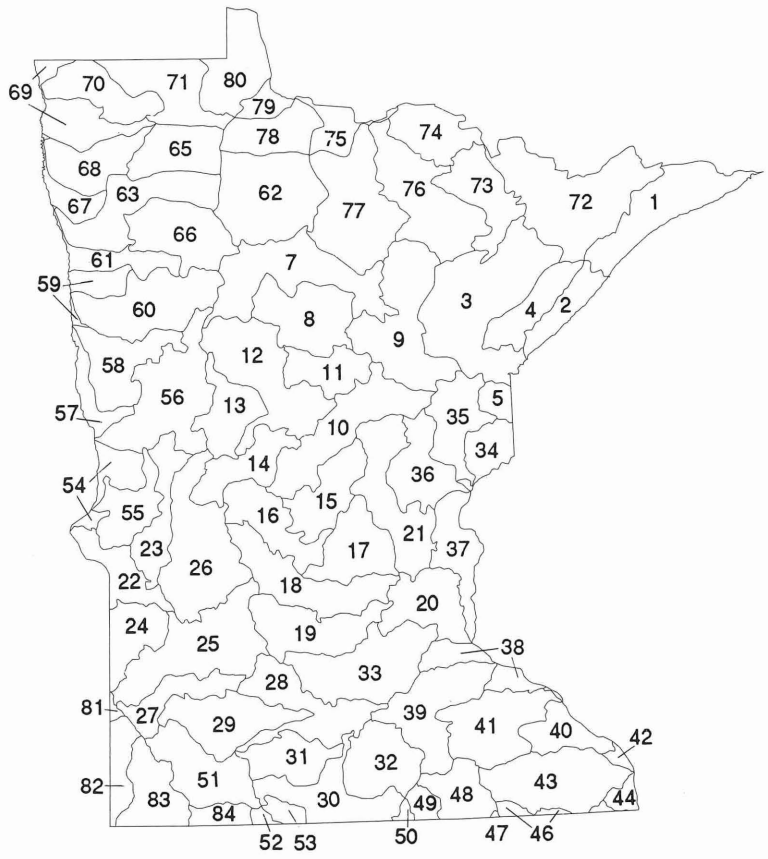
Examination of total water use by basin shows a broad area of intensive use in central Minnesota. This is related to public supply and irrigation. The Prairie-Willow, Beaver-Lester, and St. Louis basins reflect heavy withdrawals for iron-ore mining.

Ground water occurs in cracks and pore spaces between soil particles, and between or within rocks. When such earth materials can yield sufficient quantities of water, they are termed aquifers. There are 14 principal aquifers in Minnesota (Adolphson, Ruhl, and Wolf, 1981). For the purposes of categorizing water use, these can be grouped into seven hydrogeologic units. These units are, in order of increasing age, sand and gravel of Quaternary age, Cretaceous, Upper Carbonate, St. Peter and Prairie du Chien-Jordan, Red River-Winnipeg, Ironton-Galesville and Mount Simon-Hinckley, and crystalline bedrock. Though population is widespread and not all units are present throughout the State, ground water is the domestic supply for 80 percent of the population.

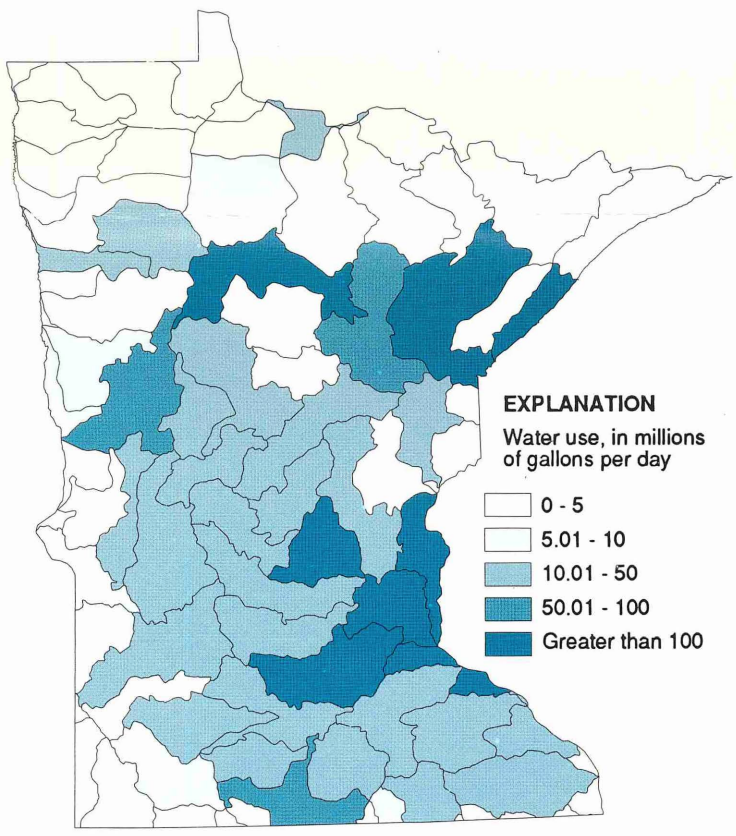
Water Sources



Source total water use during 1985, in million gallons per day (Mgal/d) and percent (%).



State Basin Codes



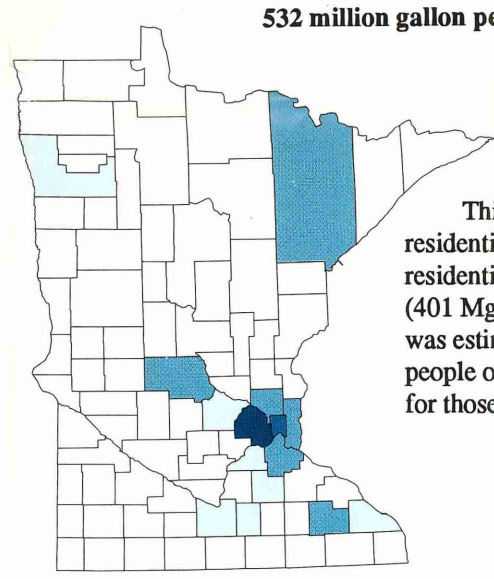
Total Water Use, by River Basin

Water use

0 - 5

5.01

Domestic
532 million gallon per day



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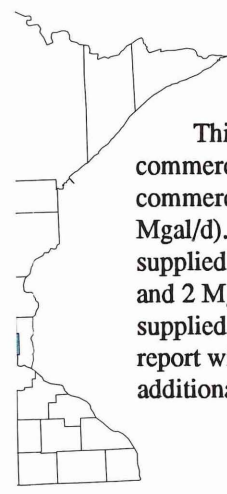
Commercial
49 million gallons per day



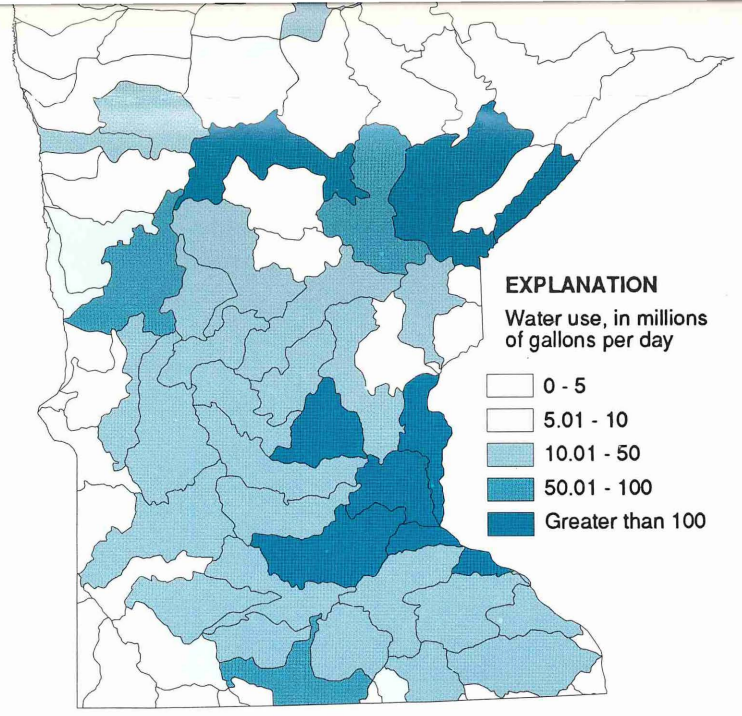
This category includes both self-suppl
commercial withdrawals (26 Mgal/d) and
commercial deliveries from public supplies
Mgal/d). Permit reports indicate that of the
supplied total, 24 Mgal/d was from ground
and 2 Mgal/d was from surface water. Mos
supplied systems are too small to be require
report withdrawals, and no estimates of this
additional use have been made.

Table 2.--Estimated withdrawals from Minnesota aquifers, 1985

[Units in million gallons per day]

Aquifers	Agriculture and irrigation	Self-supplied domestic and commercial	Self-supplied mining and industrial	Self-supplied thermoelectric	Public supply	Total
Sand-and-gravel	115	91.0	48.0	23.5	157	434
Cretaceous	6.07	1.06	.15	.07	2.65	10.0
Upper carbonate	5.10	3.42	2.54	0	8.94	20.0
St. Peter and Prairie du Chien-Jordan	43.7	22.2	21.4	0	72.6	160
Red River-Winnipeg (not present in A-A')[1]	.54	.46	0	0	0	1.00
Ironton-Galesville and Mount Simon-Hinckley	13.2	10.4	5.50	2.7	18.1	50.0
Crystalline bedrock	.48	6.54	0	0	2.98	10.0
TOTAL	184	135	77.6	26.3	262	685

[1] A-----A' Trace of hydrogeologic section



Total Water Use, by River Basin

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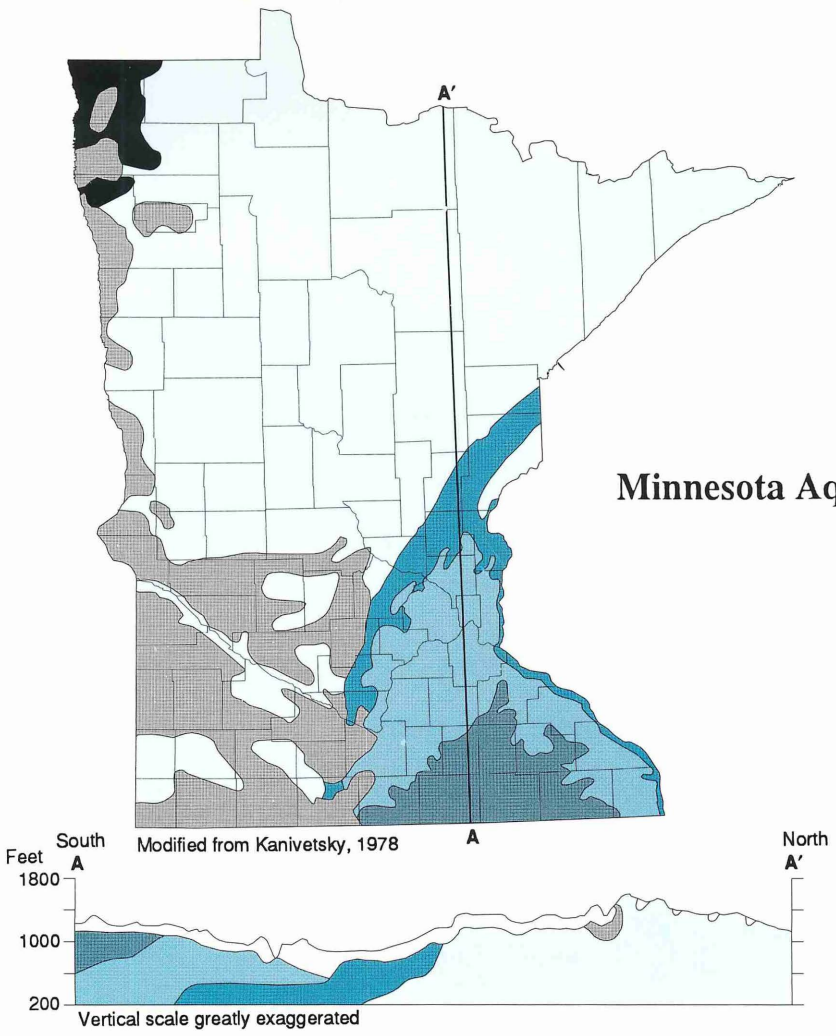


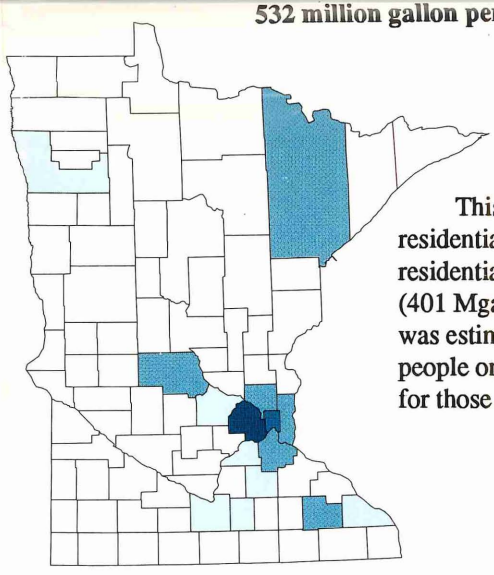
Minnesota Aquifers

SCALE 1: 6,023,000

0 25 50 75 100 MILES

0 25 50 75 100 KILOMETERS

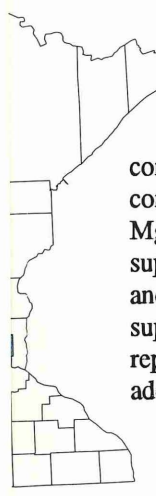
532 million gallon per day



This categor
residential withdra
residential deliveri
(401 Mgal/d). Da
was estimated to r
people on private
for those on public

Commercial

49 million gallons per day



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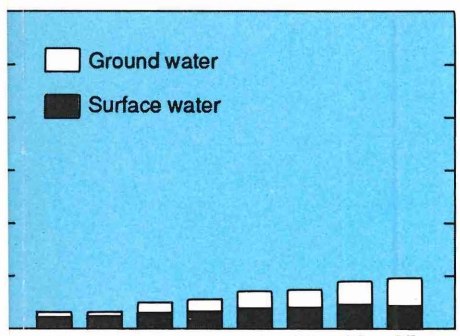
commercial deliveries from public supplies
Mgal/d). Permit reports indicate that of the
supplied total, 24 Mgal/d was from ground
and 2 Mgal/d was from surface water. Mos
supplied systems are too small to be require
report withdrawals, and no estimates of this
additional use have been made.

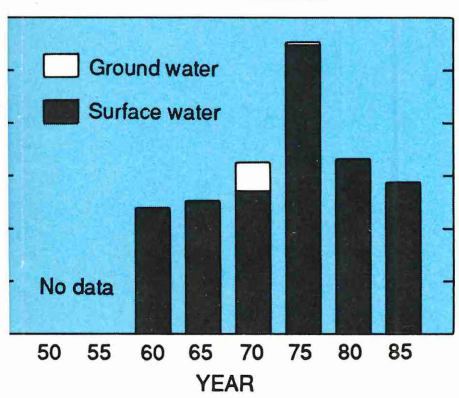
Water Withdrawals

ALS OF WATER WITHDRAWN FOR PUBLIC SUPPLY
HERMOELECTRIC PURPOSES IN MINNESOTA

PUBLIC SUPPLY



THERMOELECTRIC



ta from McKichen, 1951; McKichen, 1957;
Kichen and Kammerer, 1961; Murray, 1968;
rray and Reeves, 1977; Solley, Chase, and
nn, 1983; Solley and others, 1988.

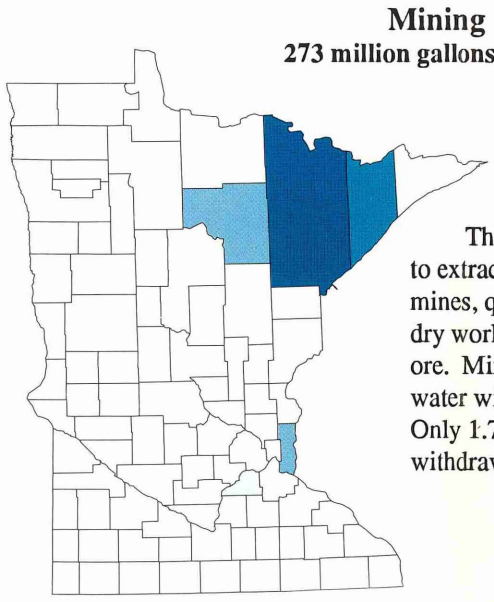
WATER USE, BY CATEGORY AND BY COUNTY

Availability and Description of Data

Most of the data presented in this report were collected and computerized by the Minnesota Department of Natural Resources (MDNR). The data are maintained on the U.S. Geological Survey (USGS) minicomputer in the Minnesota Water-Use Data System (MWUDS), cooperatively developed by the MDNR and the USGS. Many water-resources planners and policy makers in Minnesota are aware of MWUDS and make frequent use of it. The MWUDS has the capability to divide the water-use categories shown here into about 50 subcategories (Trotta, in press). The availability of this water-use information is made known through published reports presentations at committee meetings and conferences. Details on individual water-use categories in Minnesota are given by Young and Woods (1987), Woodward (1985), and Trotta (1989). Highlights are also given with each category map below. The water-use data available in each state have been combined and entered into several national reports on water use in the United States (Solley and others, 1988; L.C. Trotta, written commun., 1989). Specific figures on water-use in Minnesota are available from MDNR upon request.

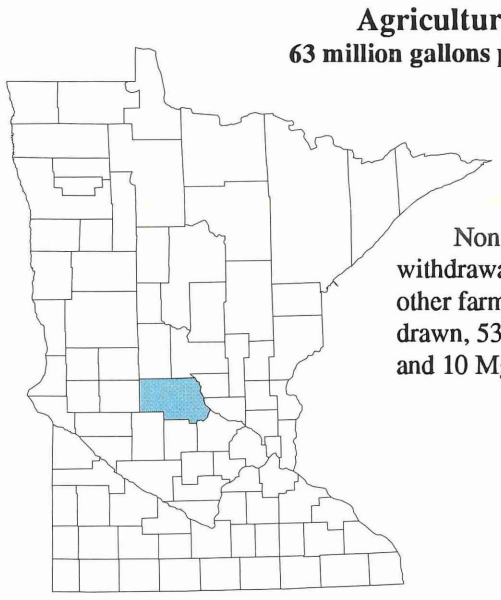
T
by Cate

Mining
273 million gallons per day



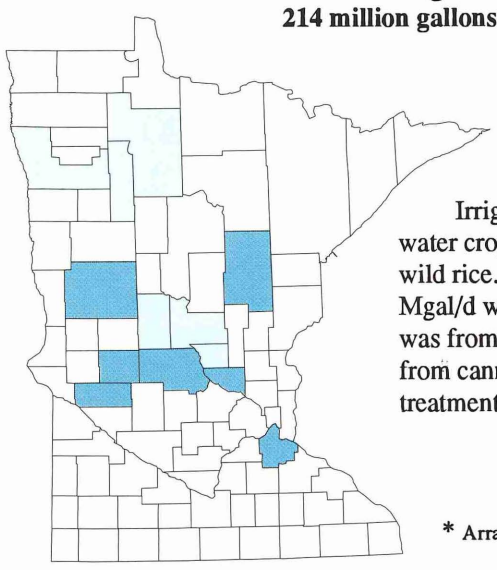
This category includes both water used to extract ores and water removed from mines, quarries, and gravel pits to provide a dry working environment. Iron is the major ore. Minnesota led the nation in surface-water withdrawn for mining (271 Mgal/d). Only 1.7 Mgal/d of ground water were withdrawn.

Agriculture
63 million gallons per day



Non-irrigation agriculture includes withdrawals for livestock, fish farms, and other farm purposes. Of the total withdrawn, 53 Mgal/d was from ground water, and 10 Mgal/d was from surface water.

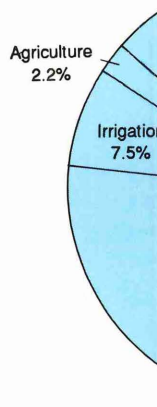
Irrigation
214 million gallons per day *



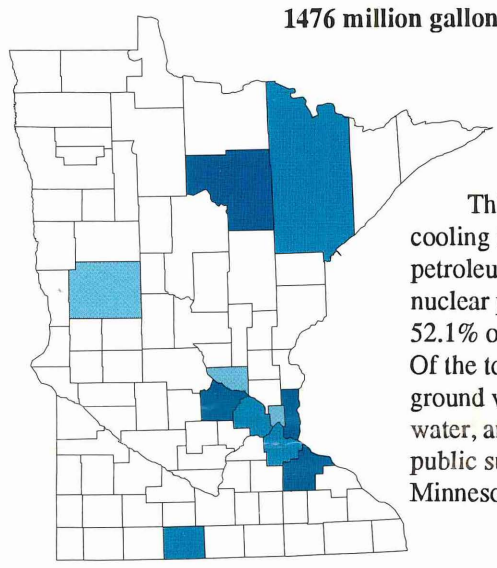
Irrigation withdrawals are used to water crops, such as corn, soybeans, and wild rice. Of the total withdrawn, 131 Mgal/d was from ground water, 78 Mgal/d was from surface water, and 5 Mgal/d was from cannery wastewater or sewage-treatment-plant effluent.

* Arranged over entire year for comparison purposes.

Wat



Thermoelectric
1476 million gallons per d



This cate
cooling in our
petroleum-base
nuclear powerp
52.1% of all wa
Of the total wit
ground water,
water, and 2 M
public supplies
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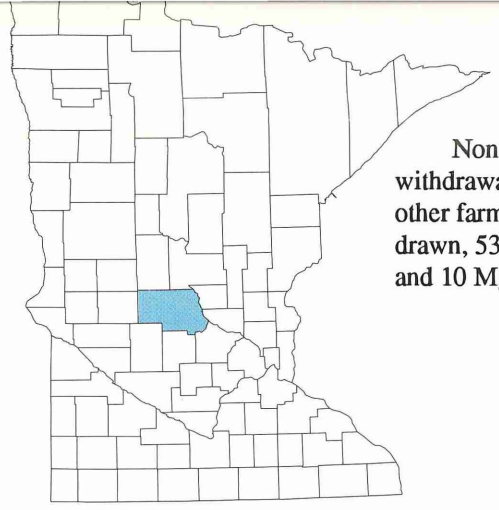
Counties of Minnesota



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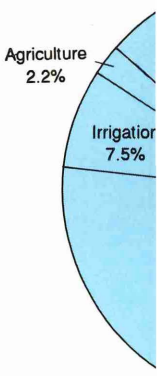

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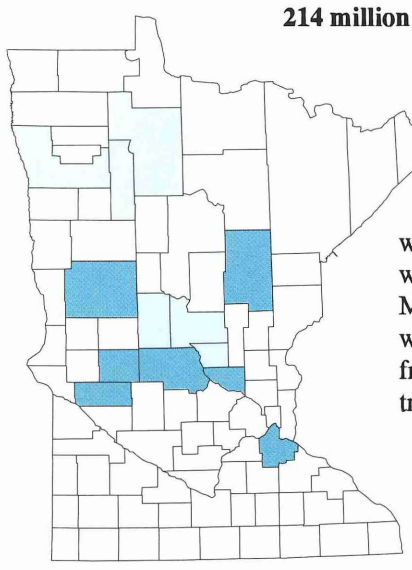

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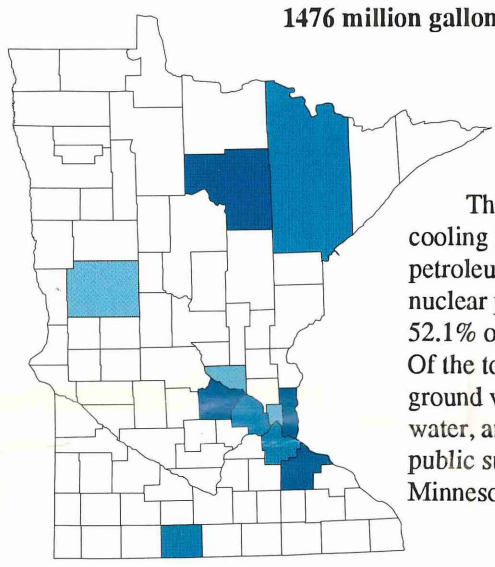

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petroleum-base
nuclear powerp
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Of the total with
ground water, 1
water, and 2 Mg
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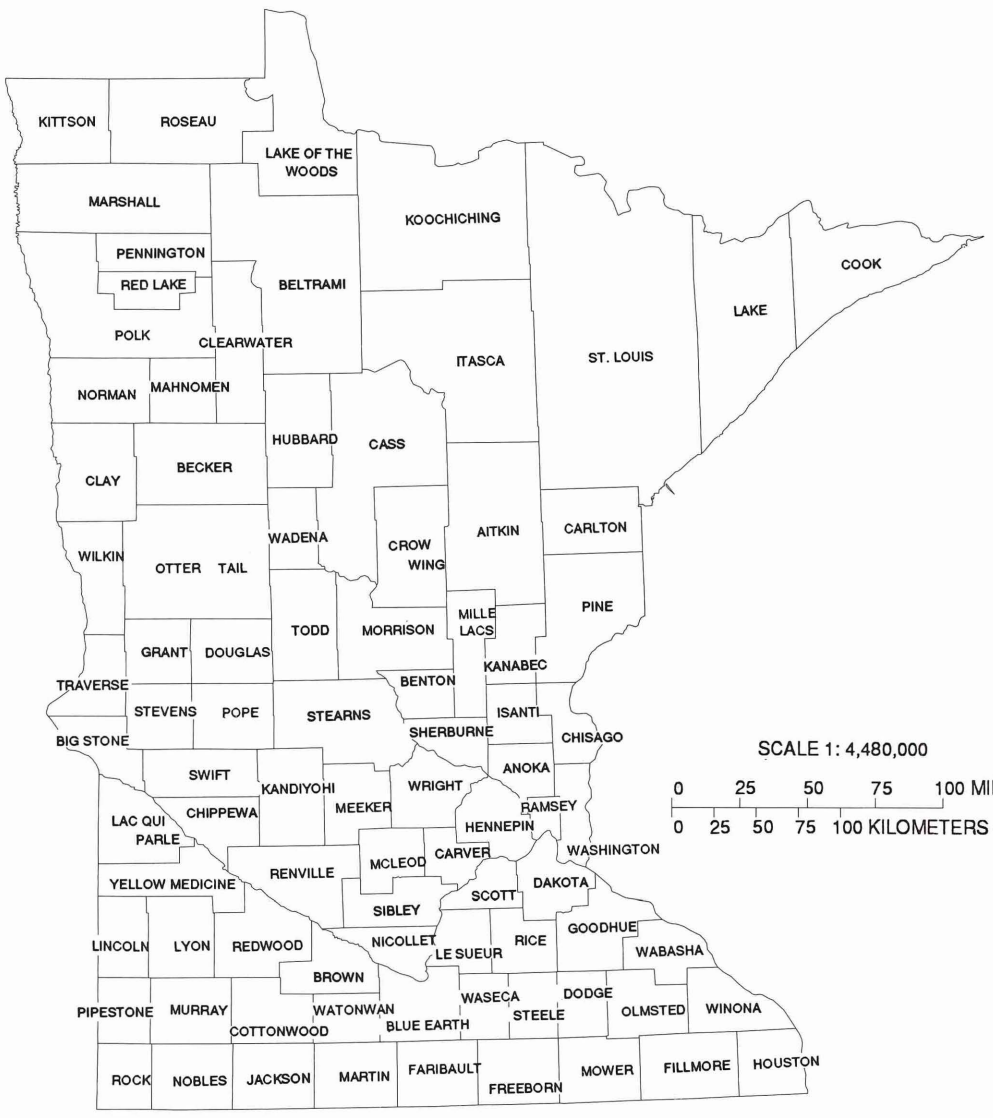
Minnesota's str

Counties of Minnesota



Trends in Wate

Water withdrawn from the environment may be categorized as either self-supplied or publicly supplied. The largest withdrawal of ground water in Minnesota is by public suppliers (262 Mgal/d). Public suppliers provide water to residential, commercial, industrial, or thermoelectric users. Public suppliers are, therefore, conveyers, rather than users of water. Although total withdrawals decreased 9 percent from 1980 to 1985, withdrawals for public water supply increased 8 percent in the same period. This increase outpaced the 3 percent increase in Minnesota population, and reflects a long-term upward trend.

Thermoelectric power production is the largest user of surface water. However, most of the water is returned to Minnesota's streams. Withdrawals for thermoelectric power decreased 14 percent from 1980 to 1985, continuing a downward trend since the all-time peak which occurred around 1975. These dates coincide with the startup of our 2 water-efficient nuclear powerplants.

WATER USE IN MILLION GALLONS

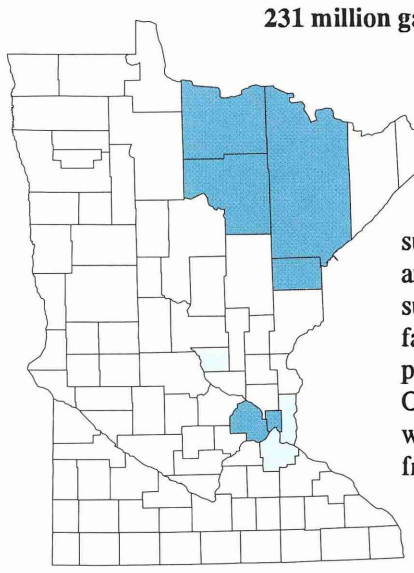
Total Water Use, by Category and by County

Water use

0 - 5

5.01

Industrial
231 million gallons per day



This category includes both self-supplied industrial withdrawals (184 Mgal/d and industrial deliveries from public supplies (47 Mgal/d) used in the manufacture of a product (for example, taconite, paper, or wood in north-central Minnesota). Of the self-supplied withdrawals, 76 Mgal/d was from ground water, and 108 Mgal/d was from surface water.

g
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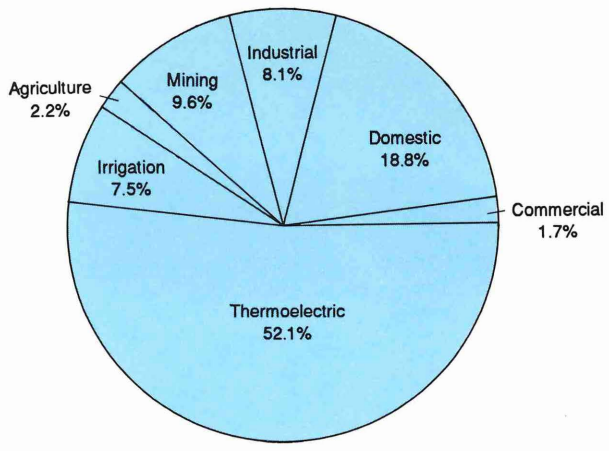
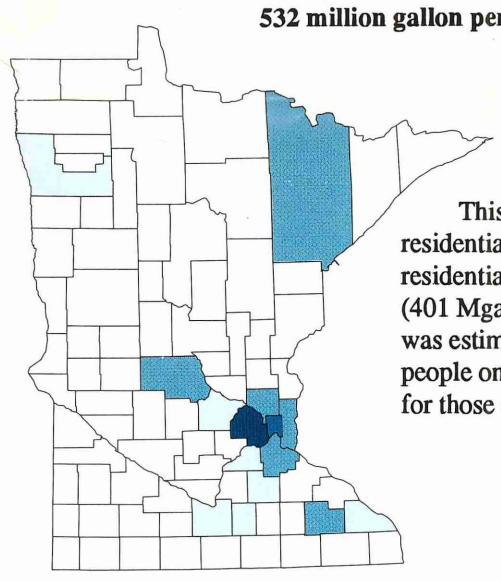
withdrawn for mining (271 Mgal/d).
1.7 Mgal/d of ground water were
rawn.

Water Use, by Category
1985



Domestic
532 million gallon per day



This categor
residential withdra
residential deliver
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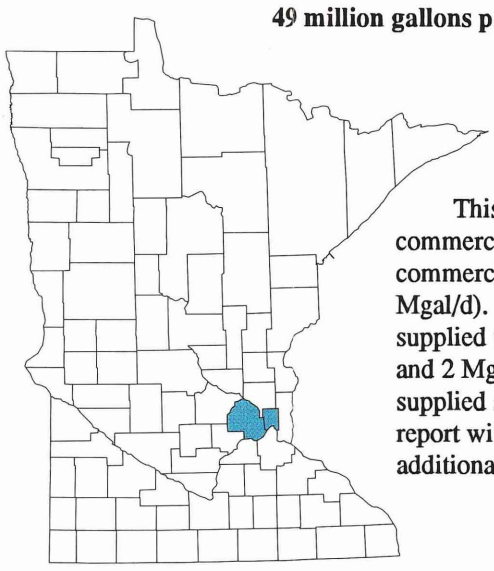
people on private
for those on publi

Commercial
49 million gallons per day



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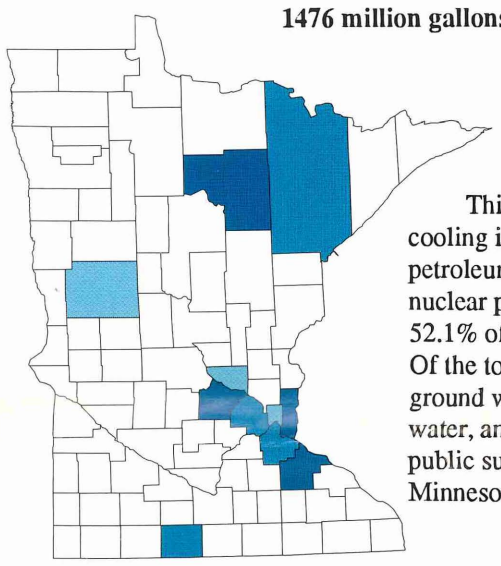
additional use have been made.

Thermoelectric
1476 million gallons per day



This category includes water used for cooling in our 32 fossil-fueled (coal and petroleum-based) powerplants and our 2 nuclear powerplants, and it accounts for 52.1% of all water withdrawn in Minnesota. Of the total withdrawn, 1 Mgal/d was ground water, 1,473 Mgal/d was surface water, and 2 Mgal/d was delivered from public supplies. Over 90% was returned to Minnesota's streams.

Population Growth

Trends in Water Use

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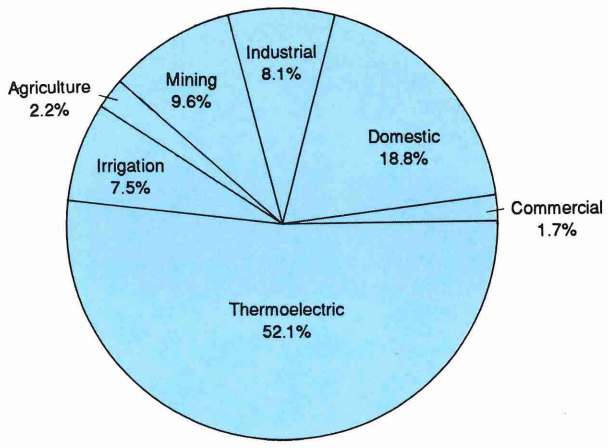
Water Use, by Category
1985



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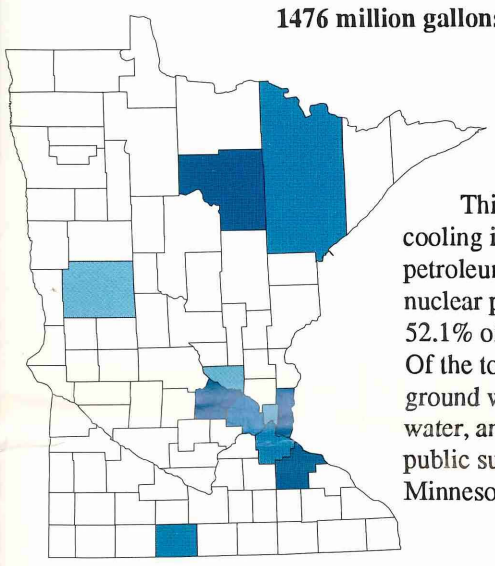

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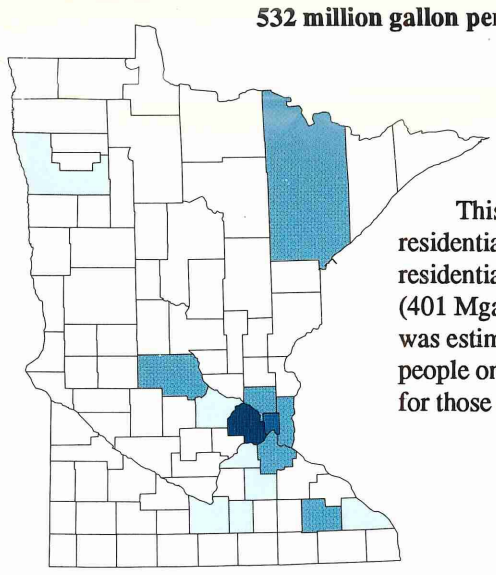
532 million gallon per day



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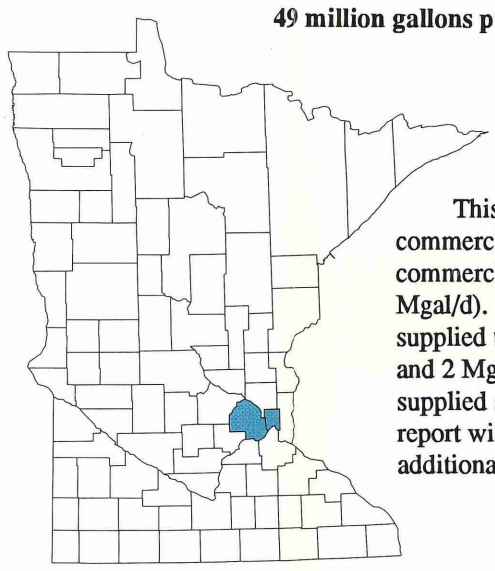
49 million gallons per day



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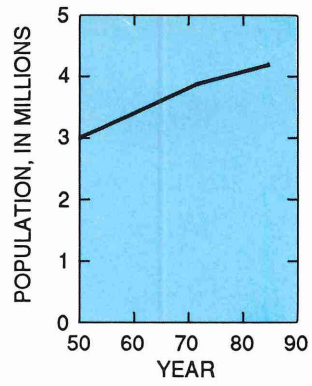
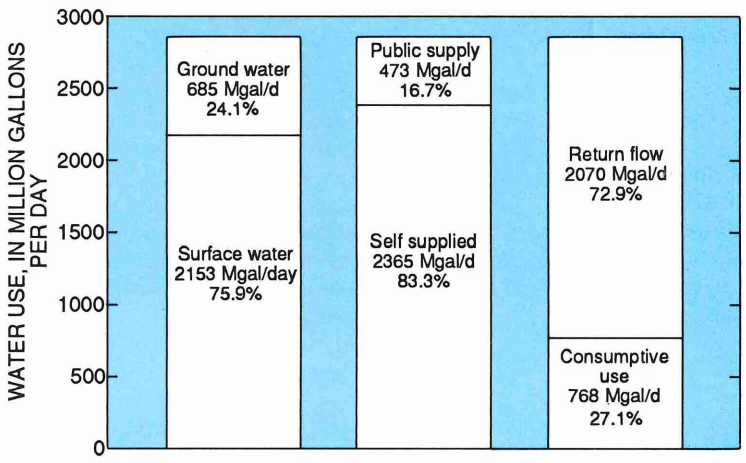
Population Growth



Data from U.S. Bureau of the Census, 1985.

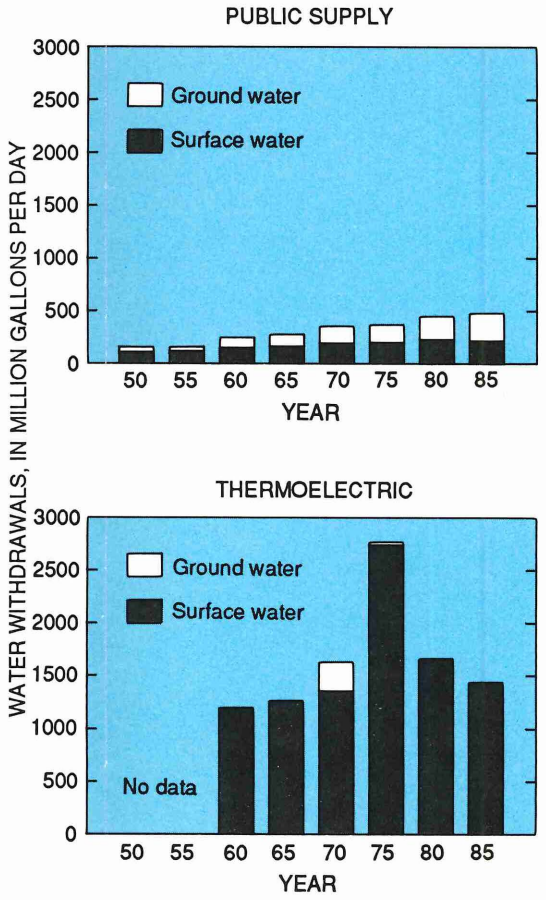
Water Sources and Disposition



Source and disposition of total water use during 1985, in million gallons per day (Mgal/d) and percentage (%).

Water Withdrawals

YEARLY TOTALS OF WATER WITHDRAWN FOR PUBLIC SUPPLY AND THERMOELECTRIC PURPOSES IN MINNESOTA



Data from McKichen, 1951; McKichen, 1957; McKichen and Kammerer, 1961; Murray, 1968; Murray and Reeves, 1977; Solley, Chase, and Mann, 1983; Solley and others, 1988.

e,
County

EXPLANATION

Water use, in million gallons per day

- 0 - 5
- 5.01 - 10
- 10.01 - 50
- 50.01 - 100
- Greater than 100

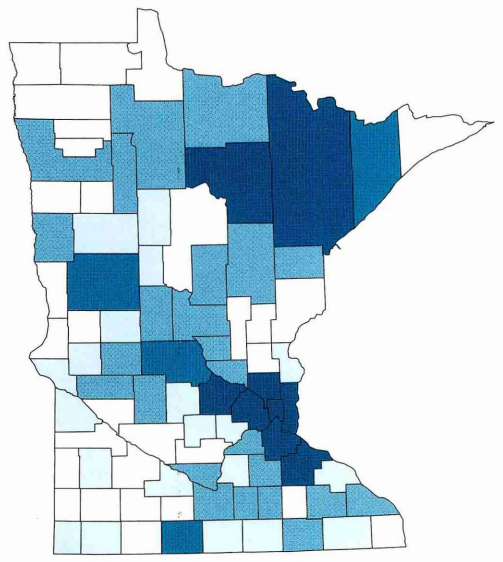
SCALE 1: 9,050,000

0 50 100 MILES

0 50 100 KILOMETERS

Base from U.S. Geological Survey Digital Line Graphs, Minnesota quadrangles, 1:100,000

Total Water Use, by County



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gallons per day

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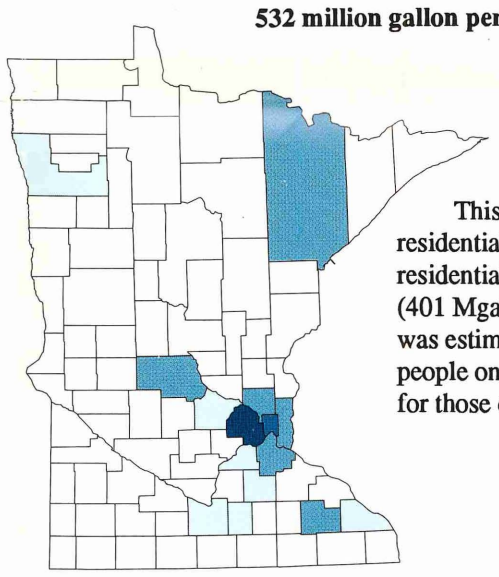
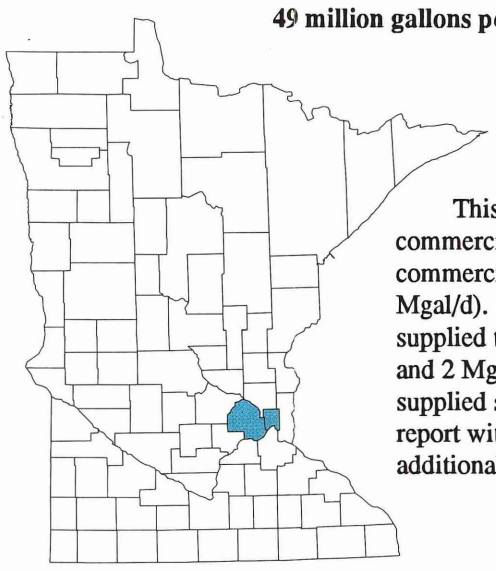
532 million gallon per day



This category includes both private residential withdrawals (131 Mgal/d) and residential deliveries from public supplies (401 Mgal/d). Daily per capita water use was estimated to range from 88 gallons, for people on private wells, up to 175 gallons, for those on public supply.

mmercial
1.7%

Commercial
49 million gallons per day



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Kanivetsky, Roman, 1978, Hydrogeologic map of Minnesota, bedrock hydrogeology: Minnesota Geological Survey State Map Series S-2, 11 p., 2 pl.

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1.7%

Domestic

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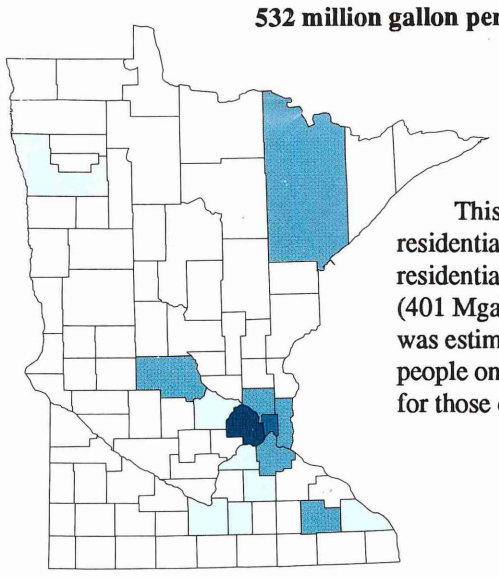

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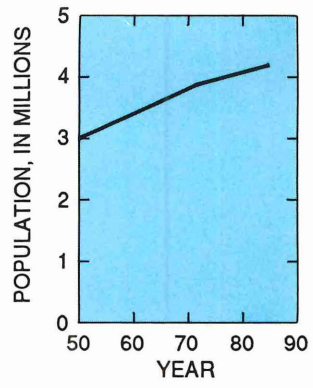
Population Growth



Data from U.S. Bureau of the Census, 1985.

Water Withdrawals

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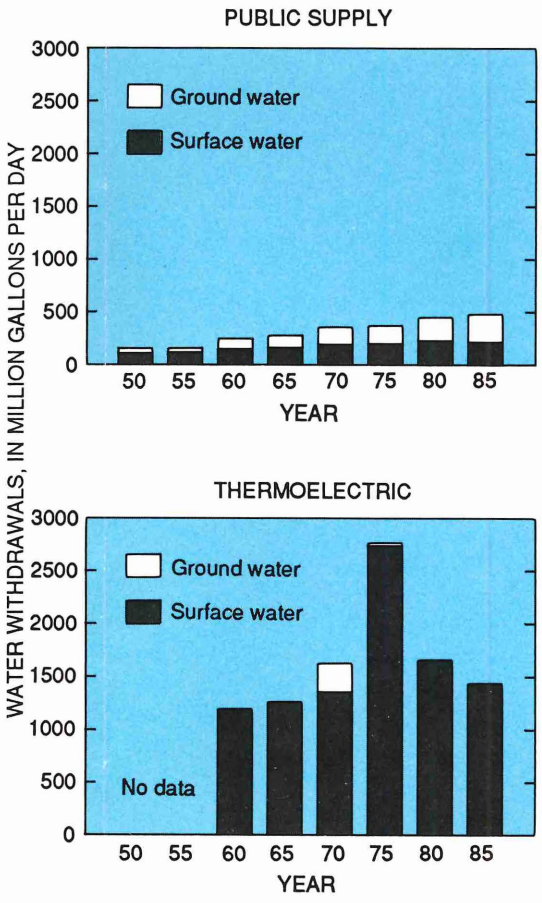

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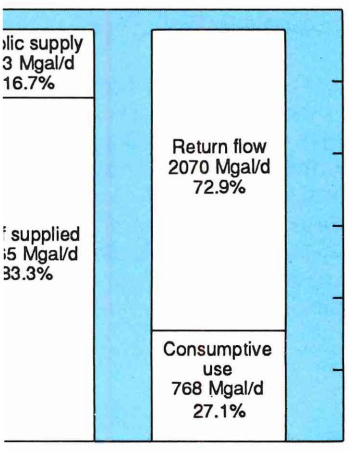
er Sources Disposition



f total water use during 1985, in (Mgal/d) and percentage (%).

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