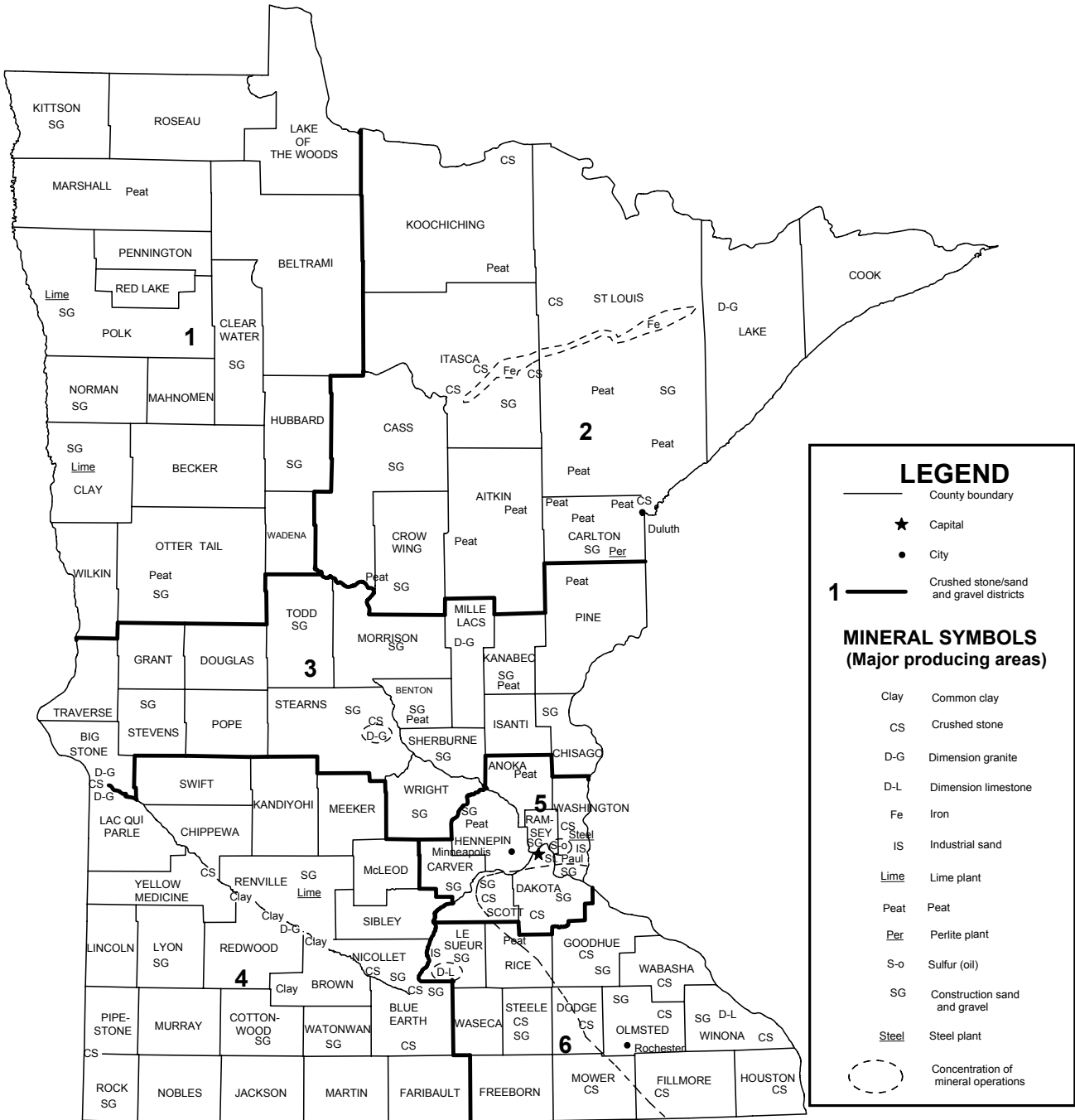


# MINNESOTA



## LEGEND

— County boundary

★ Capital

• City

**1** — Crushed stone/sand and gravel districts

## MINERAL SYMBOLS (Major producing areas)

- Clay Common clay
- CS Crushed stone
- D-G Dimension granite
- D-L Dimension limestone
- Fe Iron
- IS Industrial sand
- Lime Lime plant
- Peat Peat
- Per Perlite plant
- S-o Sulfur (oil)
- SG Construction sand and gravel
- Steel Steel plant
- (Dashed circle) Concentration of mineral operations



Source: Minnesota Department of Natural Resources, Division of Lands and Minerals/U.S. Geological Survey (2003)

# THE MINERAL INDUSTRY OF MINNESOTA

In 2003, the estimated value<sup>1</sup> of nonfuel mineral production for Minnesota was \$1.23 billion, based on preliminary U.S. Geological Survey (USGS) data. This was about a 5% decrease from that of 2002<sup>2</sup> and followed a 20.4% increase from 2001 to 2002. The State was 11th in rank (8th in 2002) among the 50 States in total nonfuel mineral production value, of which Minnesota accounted for about 3% of the U.S. total. (Because data for industrial sand and gravel and lime have been withheld to protect company proprietary data, the actual total values for 2001-03 are somewhat higher than those reported in table 1.)

In 2003, iron ore, by value, remained Minnesota's leading nonfuel raw mineral, followed by construction sand and gravel, crushed stone, industrial sand and gravel, dimension stone, and lime (descending order of value). Although offset somewhat by the increase in the production and value of construction sand and gravel, the drop in the production and value of iron ore resulted in a decrease in the State's total nonfuel raw mineral production value in 2003 (table 1). With a significant increase in production, industrial sand and gravel value was up about \$8 million; lime production was up, but its value was down slightly.

In 2002, Minnesota's increase in value largely resulted from a 6% rise in the production of iron ore; its value was up nearly 23%, or about \$194 million. The production and value of construction sand and gravel also significantly increased; its value was up \$20 million. The only decrease took place in the production and value of lime; its value was down about \$4 million. Most other nonfuel mineral commodity values showed increases, but were less than \$1 million and had little effect on the net change in total value. Common clay and gemstone values were unchanged (table 1).

Compared with USGS estimates of the quantities produced in the other 49 States in 2003, Minnesota remained first in the Nation in the production of iron ore, third in peat, and sixth in construction sand and gravel. Additionally, the State produced significant quantities of industrial sand and gravel and dimension stone.

The following narrative information was provided by the

---

<sup>1</sup>The terms "nonfuel mineral production" and related "values" encompass variations in meaning, depending upon the mineral products. Production may be measured by mine shipments, mineral commodity sales, or marketable production (including consumption by producers) as is applicable to the individual mineral commodity.

All 2003 USGS mineral production data published in this chapter are preliminary estimates as of July 2004 and are expected to change. Construction sand and gravel and crushed stone estimates are updated periodically. To obtain the most current information, please contact the appropriate USGS mineral commodity specialist. Specialist contact information may be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals/contacts/comdir.html>; alternatively, specialists' names and telephone numbers may be obtained by calling USGS information at (703) 648-4000 or by calling the USGS Earth Science Information Center at 1-888-ASK-USGS (275-8747). All USGS Mineral Industry Surveys and USGS Minerals Yearbook chapters—mineral commodity, State, and country—also may be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals>.

<sup>2</sup>Values, percentage calculations, and rankings for 2002 may differ from the Minerals Yearbook, Area Reports: Domestic 2002, Volume II, owing to the revision of preliminary 2002 to final 2002 data. Data for 2003 are preliminary and are expected to change; related rankings also may change.

Minnesota Department of Natural Resources' (DNR) Division of Lands and Minerals (DLM).<sup>3</sup> Production data in the following text are those reported by the DLM, based upon its own surveys and estimates. The data may differ from some production figures reported by the USGS. In Minnesota, the year 2003 saw continued strong mining activity in traditional sectors and a variety of new mineral-related research and exploration activities and tools.

## Exploration and Nonferrous Metallic Leasing

The exploration and development activity for copper, nickel, platinum, and palladium continued to strengthen in 2003. Three projects headed toward the development phase—Lehmann Exploration Management Inc.'s Birch Lake project, Polymet Mining Corp.'s Northmet Project, and Teck Cominco Ltd.'s Mesaba Project.

Lehmann Exploration's Birch Lake platinum-group-element project is at the eastern end of the Mesabi Iron Range where the Biwabik Iron Formation disappears into the basal contact of the Duluth Complex. This deposit was reported to contain an estimated 29 million metric tons (Mt) grading 3.94 grams per metric ton platinum equivalent. It had an average thickness of 24 meters (m) and occurs at a depth of about 490 m to 850 m. Additional information was available on the Internet at URLs <http://www.franconiaminerals.com/PGMProperties.asp> and [www.pge-birchlake.com](http://www.pge-birchlake.com).

Polymet Mining Corp. controlled the Northmet Deposit and secured an agreement with Cleveland-Cliffs Inc. to acquire the crushing, beneficiation, railroad, and other facilities of the former LTV Corp.'s iron ore mine. Polymet began a scoping study on January 5, 2004, to integrate the LTV steel facilities into the 2001 prefeasibility study.

Teck Cominco leased the Babbitt copper-nickel deposit and developed a new hydrometallurgical flowsheet by applying its patented CESL process. An environmental benefit was that this process neutralized the sulfide minerals in the tailings. Teck Cominco applied for a permit to take a 45,000-metric-ton (t) bulk sample in order to evaluate the metal extraction process. Additional information on the CESL process was available at URL <http://www.teckcominco.com/research/index.htm>.

The Duluth Complex was the focus of several other exploration projects. With an estimated total of 4 billion metric tons of identified resources averaging 0.66% copper and 0.2% nickel, there were nine identified subeconomic deposits within the mafic Duluth Complex in the vicinity of Babbitt, which is located about 110 kilometers due north of Duluth. These were polymetallic magmatic sulfide deposits containing platinum, palladium, gold, copper, nickel, cobalt, and silver hosted near the base of the Duluth Mafic Complex. Platinum-group

---

<sup>3</sup>Maryanna Harstad, Senior Planner, authored the text of the State mineral industry information provided by the Minnesota Department of Natural Resources' Division of Lands and Minerals.

elements were an important coproduct or byproduct in several of the deposits.

At least 13 companies continued work on exploration and development projects in Minnesota primarily for copper, nickel, and platinum-group metals. E.K. Lehmann & Associates Inc. drilled two core holes totaling 184 m in Duluth Complex rocks at a location termed the Partridge Area. Kennecott Exploration Co. drilled 14 boreholes in eastern Aitkin and western Carlton Counties on a buried magnetic anomaly. Most of this work was done on State mineral leases. Total depth drilled was 2,929 m.

Much of northern Minnesota has potential for gold and base metals in Archean greenstone environments. There were several identified prospects for gold or zinc-copper mineralization available for exploration through State mineral leases in the Lake Vermillion to Ely area as well as Itasca County. The next State mineral lease sale was planned for September 2004, to include parcels in Itasca, Kanabec, Mille Lacs, Lake, and St. Louis Counties.

The DLM maintained an archive of drill-core and related exploration data at its Hibbing office. Scanned copies of these archives may be accessed through the DNR Web site at URL <http://minarchive.dnr.state.mn.us>.

There were 192 active State metallic minerals leases covering 23,919 hectares (ha) as of December 31, 2003. A State metallic minerals lease sale was not held in 2003, but 11 metallic mineral leases were issued through the negotiated lease process. Two of these leases that were issued to E.K. Lehmann & Associates covered 372 ha in St. Louis County. The other nine leases covered 1788 ha and were issued to Kennecott Exploration in Aitkin County. A total of 84 leases covering 8,866 ha were terminated in 2003. These included four leases covering 227 ha in Carlton County, 57 leases covering 5,456 ha in Lake County, and 23 leases covering 3,184 ha in St. Louis County.

## Commodity Review

### *Industrial Minerals*

**Crushed Stone and Sand and Gravel.**—Minnesota's aggregate industry produced three types of materials: sand and gravel mined from glacial or alluvial deposits, crushed carbonate stone from quarries in southeastern Minnesota where natural gravel is scarce, and high-quality crushed rock from quarries in granite, quartzite, or traprock.

Aggregate was mined in all of the State's 87 counties. The Minnesota DNR, in its program to identify the location of future construction aggregate resources, completed its assessment of 18 counties. Additional information was available at URL [http://www.dnr.state.mn.us/lands\\_minerals/aggregatmaps.html](http://www.dnr.state.mn.us/lands_minerals/aggregatmaps.html).

A test program was initiated late in 2003 to evaluate the use of taconite byproducts as coarse aggregate for concrete and bituminous, including superpave hot-mix asphalt. The Minnesota Department of Transportation proposed the construction of a pavement test at its facility.

The USGS annual survey of aggregate resource producers for Minnesota compiled an annual estimate of total production and value. The year 2003 statewide total aggregate (construction

sand and gravel and crushed stone) was 57 Mt, which indicated that there was about a 6% increase from the 2002 statewide total of 53.7 Mt (table 1). In addition to the above production, some of the same quarries that produced crushed carbonate rock also produced granular carbonate (limestone or dolomite) rock, which was used for soil amendment or in the manufacture of cement. The Minnesota Department of Agriculture (MDA) analyzed the granular carbonate soil amendment, commonly called ag-lime, to report the neutralization potential. The MDA compilation listed total sales of ag-lime for 2003 as 778,000 t; 428,000 t (55%) was primary production from Minnesota quarries (data may be accessed on the Internet at URL <http://www.mda.state.mn.us/lime/tonnagestats.pdf>). High-purity silica sand was produced from the Jordan Sandstone bedrock formation.

**Dimension Stone.**—Minnesota's dimension stone industry had quarry production of anorthosite, dolostone, granite, and quartzite. Cold Spring Granite Co.'s greenstone (Lake Superior Green) was used in the National D-Day Memorial in Bedford, VA, and demand for its blackstone (Mesabi Black) significantly increased. The Vetter Stone Co. quarried the Oneota Dolomite for the National Museum of the American Indian in Washington, D.C. Travis Erickson Co. quarried pipestone for the center of the floor of the main room of this museum.

### *Metals*

**Iron Ore.**—Minnesota continued to rank first in the Nation in iron ore production, accounting for 78% (preliminary USGS estimate) of the 2003 domestic iron ore shipments. Iron ore pellet production continued to rank among the State's largest industries, contributing more than \$1 billion annually to Minnesota's economy.

The steel industry has undergone dramatic change; and this has led to a restructuring of Minnesota's taconite industry. United States Steel Corporation (U.S. Steel) completed the purchase of National Steel Corp., which included National Steel Pellet Co., now operated by U.S. Steel's Minnesota Ore Operations as Keewatin Taconite. The majority owner in Hibbing Taconite Co. was previously Bethlehem Steel Corp. but is now International Steel Group Inc. Eveleth Taconite Mining Co. (EVTAC) ceased operation and filed for Chapter 11 bankruptcy in May 2003; however, in November 2003, Cleveland Cliffs Inc. and Laiwu Steel Group Ltd. of China obtained the assets of EVTAC, restarted the plant and mine, and began producing pellets in December 2003 as United Taconite Co. According to the Minnesota DLM, iron ore production in Minnesota decreased from 39.3 Mt in 2002 to 36 Mt in 2003. It was estimated that production for 2004 would be approximately 40.6 Mt.

Mesabi Nugget, LLC completed construction of a pilot demonstration plant (PDP) in Silver Bay. The 22,700-metric-ton-per-year PDP was a joint venture between Cleveland Cliffs, Kobe Steel Ltd. of Japan, Steel Dynamics Inc., and Ferrometrics Inc. The PDP began operation in June 2003 and had had two successful campaigns. Several tons of pig iron nuggets were shipped to Steel Dynamics in Butler, IN, and were successfully converted into steel in their electric arc furnace. Planning was

currently underway for the construction of a 454,000-metric-ton-per-year iron nugget facility.

### Environmental Issues and Government Programs

The DLM's Environmental Cooperative Research Program addressed environmental and land-use impacts associated with mining. Typical research projects were cosponsored by industry, Federal agencies, or other units of government on a cost-share or in-kind service basis. Projects undertaken in 2003 included the following: characterization and modeling of acid rock drainage, mercury removal from induration offgas by wet scrubbers, and a hydrological and water quality study on in-pit disposal of taconite tailings. The State appropriated \$172,000 for mineral cooperative environmental research for the period July 2003 to June 2005. Matching funds or in-kind contributions from other entities were required by the appropriation.

The Iron Ore Cooperative Research Program funded research in iron ore and taconite processing. Research projects that were being funded during the current biennium (July 2003 through June 2005) included dust suppression in iron ore processing plants, a pellet fines removal system, magnetically enhanced hydroseparation, greenball characterization, Mesabi Range Geographic Information System workshop, use of hemicelluloses and cellulose as a pellet binder, taconite concentrator modeling, oxygen injection in a grate kiln, alternative fuels for traveling grate induration furnaces, accurate

in-house ore characterization, iron ore greenball porosity measurements, mercury exchange mechanisms in taconite processing plants, and a tailing water study. The total biennial budget for iron ore cooperative research was \$825,000, the State appropriation being \$550,000 and the taconite companies' contribution, \$275,000.

The Minerals Diversification Program funds research supporting the long-term health of the State's mining economy. This was achieved through improvements to the existing industry and by encouraging environmentally sound exploration and development of new mineral resources. Research projects funded during the current biennium (July 2003 to June 2005) included the following: Bedrock and Quaternary Geology of the Mesabi Range, Followup Mapping and PGE Evaluation of Mafic Intrusions (excluding Duluth Complex), and Mapping Aggregate Resources in Two Minnesota Counties. The State biennial appropriation for this program was \$344,000.

In addition to the Public Access to Minerals Information, available at URL <http://minarchive.dnr.state.mn.us>, the following information was available on the DNR Web site at URL <http://dnr.state.mn.us>: monthly data releases, information on mineral lease availability, aggregate resource maps, a seven-county Minneapolis-St. Paul metropolitan area aggregate resource map and report on projected availability of aggregate resources, and many online documents pertaining to mineral and mining research and exploration.

TABLE 1  
NONFUEL RAW MINERAL PRODUCTION IN MINNESOTA<sup>1,2</sup>

(Thousand metric tons and thousand dollars)

Mineral	2001		2002		2003 <sup>P</sup>	
	Quantity	Value	Quantity	Value	Quantity	Value
Clays, common	14	15	14	15	14	15
Gemstones	NA	6	NA	6	NA	6
Iron ore, usable	37,300	856,000	39,600	1,050,000	34,800	969,000
Lime	W	(3)	W	(3)	W	(3)
Peat	83	4,430	64	5,320	88	5,340
Sand and gravel:						
Construction	39,800	155,000	43,700	175,000	47,000	188,000
Industrial	W	(3)	W	(3)	W	(3)
Stone:						
Crushed	9,730	57,000	9,960	57,600	9,800	57,300
Dimension	16	11,800	22	12,400	23	12,300
Total	XX	1,080,000	XX	1,300,000	XX	1,230,000

<sup>P</sup>Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

<sup>1</sup>Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Value excluded to avoid disclosing company proprietary data.

TABLE 2  
MINNESOTA: CRUSHED STONE SOLD OR USED, BY KIND<sup>1</sup>

Kind	2001				2002			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	36	3,980	\$19,100	\$4.79	38	4,550	\$21,800	\$4.79
Granite	4	W	W	6.66	4	W	W	6.59
Dolomite	7	3,320	21,000	6.34	8	3,340	22,000	6.59
Quartzite	1	W	W	9.70	1	W	W	6.96
Total or average	XX	9,730	57,000	5.85	XX	9,960	57,600	5.78

W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.

<sup>1</sup>Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

TABLE 3  
MINNESOTA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 2002, BY USE<sup>1</sup>

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
<b>Construction:</b>			
<b>Coarse aggregate (+1 1/2 inch):</b>			
Macadam	W	W	\$3.86
Riprap and jetty stone	52	\$689	13.32
Filter stone	W	W	3.86
Other coarse aggregates	28	505	17.75
Total or average	80	1,190	14.93
<b>Coarse aggregate, graded:</b>			
Concrete aggregate, coarse	W	W	6.98
Bituminous aggregate, coarse	W	W	5.51
Bituminous surface-treatment aggregate	W	W	12.68
Railroad ballast	W	W	8.82
Other graded coarse aggregates	947	9,200	9.71
Total or average	1,150	10,500	9.20
<b>Fine aggregate (-3/8 inch):</b>			
Stone sand, bituminous mix or seal	W	W	4.41
Screening, undesignated	W	W	6.47
Total or average	193	990	5.13
<b>Coarse and fine aggregates:</b>			
Graded road base or subbase	W	W	4.00
Unpaved road surfacing	W	W	4.02
Crusher run or fill or waste	W	W	9.26
Terrazzo and exposed aggregates	W	W	11.02
Roofing granules	W	W	11.02
Other coarse and fine aggregates	2,100	10,700	5.08
Total or average	2,330	11,800	5.08
<b>Agricultural:</b>			
Limestone	135	812	6.02
Poultry grit and mineral food	(2)	(2)	33.30
Other agricultural uses	2	8	5.46
Total or average	137	820	5.99
Other miscellaneous uses and specified uses not listed	3	15	5.00
<b>Unspecified:<sup>3</sup></b>			
Reported	3,450	19,900	5.77
Estimated	2,600	12,000	4.65
Total or average	6,060	32,000	5.29
Grand total or average	9,960	57,600	5.78

W Withheld to avoid disclosing company proprietary data; included in "Total."

<sup>1</sup>Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

<sup>2</sup>Withheld to avoid disclosing company proprietary data; included in "Grand total."

<sup>3</sup>Reported and estimated production without a breakdown by end use.



TABLE 5  
MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 2002,  
BY MAJOR USE CATEGORY <sup>1</sup>

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Concrete aggregate (including concrete sand)	8,830	\$56,200	\$6.37
Plaster and gunite sands	317	1,890	5.97
Concrete products (blocks, bricks, pipe, decorative, etc.)	230	2,440	10.61
Asphaltic concrete aggregates and other bituminous mixtures	4,160	17,400	4.18
Road base and coverings <sup>2</sup>	9,130	28,700	3.14
Fill	4,260	8,140	1.91
Snow and ice control	237	1,210	5.09
Other miscellaneous uses <sup>3</sup>	131	1,020	7.78
Filtration	3	19	6.33
Unspecified: <sup>4</sup>			
Reported	8,080	24,400	3.02
Estimated	8,300	33,000	3.97
Total or average	43,700	175,000	3.99

<sup>1</sup>Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes roofing granules.

<sup>4</sup>Reported and estimated production without a breakdown by end use.

TABLE 6  
MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 2002, BY USE AND DISTRICT<sup>1</sup>

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products <sup>2</sup>	1,100	6,490	779	4,210	1,710	8,260
Asphaltic concrete aggregates and other bituminous mixtures	571	1,400	W	W	2,090	6,770
Road base and coverings <sup>3</sup>	W	W	1,010	4,330	2,950	8,220
Fill	375	512	194	609	566	733
Other miscellaneous uses <sup>4</sup>	1,660	3,450	102	308	121	518
Unspecified: <sup>5</sup>						
Reported	6	10	1,080	3,040	3,190	10,700
Estimated	1,200	4,100	1,300	4,600	2,200	9,600
Total	4,900	16,000	4,440	17,100	12,900	45,000
	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products <sup>2</sup>	689	3,760	4,070	30,700	1,030	7130
Asphaltic concrete aggregates and other bituminous mixtures	579	6,380	484	1,720	W	W
Road base and coverings <sup>3</sup>	1,370	4,720	623	4,740	W	W
Fill	241	677	2,740	4,960	138	472
Other miscellaneous uses <sup>4</sup>	23	172	138	1,130	495	1,730
Unspecified: <sup>5</sup>						
Reported	36	160	628	2,540	1	3
Estimated	1,200	5,200	540	2,100	1,900	7,500
Total	4,110	21,000	9,220	47,900	3,610	16,800
	Unspecified district					
	Quantity	Value				
Concrete aggregate and concrete products <sup>2</sup>	--	--				
Asphaltic concrete aggregates and other bituminous mixtures	214	478				
Road base and coverings <sup>3</sup>	1,220	2,300				
Fill	--	--				
Other miscellaneous uses <sup>4</sup>	--	--				
Unspecified: <sup>5</sup>						
Reported	3,140	8,010				
Estimated	--	--				
Total	4,580	10,800				

W Withheld to avoid disclosing company proprietary data; included in "Other miscellaneous uses." -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes plaster and gunite sands.

<sup>3</sup>Includes road and other stabilization (cement and lime).

<sup>4</sup>Includes filtration, roofing granules, and snow and ice control.

<sup>5</sup>Reported and estimated production without a breakdown by end use.