

THE MINERAL INDUSTRY OF MINNESOTA

In 1998, the preliminary estimated value¹ of nonfuel mineral production for Minnesota was \$1.73 billion, according to the U.S. Geological Survey (USGS). This was about a 3% increase from that of 1997,² and followed a 9% increase from 1996 to 1997. The State ranked eighth (seventh in 1997) among the 50 States in total nonfuel mineral production value, of which Minnesota accounted for more than 4% of the U.S. total.

In 1998, iron ore accounted for more than 85% of the State's nonfuel mineral production value, while construction sand and gravel and crushed stone accounted for about 7% and 5%, respectively. Most nonfuel minerals increased in value in 1998, led by an \$40 million increase in the value of iron ore and a \$13.5 million rise in crushed stone. Peat, lime, and common clay values also increased, while construction and industrial sand and gravel values showed small decreases. (Listings of mineral commodities are in descending order of change.) In 1997, Minnesota's increase in value resulted from the increased values of iron ore, construction sand and gravel, and crushed stone; the only significant decrease was about a \$10 million drop in the value of industrial sand and gravel. Lime, peat, and gemstones showed small decreases, and common clays were unchanged.

Compared to USGS estimates of the quantities produced in the other 49 States in 1998, Minnesota remained first² in the Nation in iron ore. The State rose to 4th from 5th in peat and to 9th from 12th in dimension stone, while dropping to 10th from 7th in construction sand and gravel. Additionally, the State produced significant quantities of industrial sand and gravel.

The following narrative information was provided by the Minnesota Department of Natural Resources' (DNR) Division of Lands and Minerals (DLM).³ Production data in the following text are those reported by the DLM, based on its

¹The terms "nonfuel mineral production" and related "values" encompass variations in meaning, depending on the minerals or 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 1998 USGS mineral production data published in this chapter are preliminary estimates as of February 1999 and are expected to change. For some mineral commodities (for example, construction sand and gravel, crushed stone, and portland cement), estimates are updated periodically. To obtain the most current information, please contact the appropriate USGS mineral commodity specialist. A telephone listing for the specialists may be retrieved over the Internet at <http://minerals.usgs.gov/minerals/contacts/comdir.html>; by using MINES FaxBack at (703) 648-4999 from a fax machine with a touch-tone handset (request Document #1000 for a telephone listing of all mineral commodity specialists); or by calling USGS information at (703) 648-4000 for the specialist's name and number. All Mineral Industry Surveys—mineral commodity, State, and country—also may be retrieved over the Internet at <http://minerals.usgs.gov/minerals>; facsimile copies may be obtained from MINES FaxBack.

²Values, percentage calculations, and rankings for 1997 may vary from the *Minerals Yearbook, Area Reports: Domestic 1997, Volume II*, owing to the revision of preliminary 1997 to final 1997 data. Data for 1998 are preliminary and expected to change, while related rankings may also be subject to change.

³Maryanna Harstad, Senior Planner, authored the text of State mineral industry information provided by the DLM.

own surveys and estimates. They may differ from some production figures reported to the USGS.

Metals

According to the DLM, in 1998, the iron mining industry in Minnesota produced about 47.5 million metric tons of iron ore, nearly all of which was in concentrated pellet form. Based on DLM data, this was up 1.8 million tons from that of 1997 and accounted for more than 73% of domestic production that was supplied to the U.S. steel industry. [Based on USGS data, the State's 1998 production was down about 700,000 tons from nearly 48 million tons produced in 1997 and was about 64% of the domestic supply (including imports and exports) of nearly 74 million tons.] Production occurred primarily at seven taconite plants on the Mesabi iron range in northeastern Minnesota. Inland Steel Mining Co. became Ispat Inland Inc. in 1998 as Ispat International N.V. completed its acquisition of Inland Steel Co. Ispat Inland Inc. is now the owner and operator of the Minorca Mine. The DLM projected that production in 1999 was expected to be down from 1998 as two of the seven taconite plants announced reductions because of a surge of foreign steel imports into the United States.

Industrial Minerals

Minnesota's aggregate industry produces two types of materials: 1) sand and gravel mined from glacial or alluvial deposits, and 2) crushed rock from two subgroups—carbonates, limestone, and dolomite from quarries in southeastern Minnesota where natural gravel is scarce, and noncarbonates, including granite, quartzite, or traprock from quarries elsewhere in the State. Aggregate has been or is currently being mined in all of the State's 87 counties. An estimated 51 million tons or more of aggregate is consumed each year in Minnesota, the value of which exceeds \$187 million. The current statewide production ratio of natural gravel to crushed stone is estimated to be roughly 3:1. Industry trade associations estimate that there are roughly 1,200 aggregate producers. Moreover, some of the same quarries that produce crushed limestone and dolomite used as aggregate also produce granular carbonate rock, which is used for soil amendment or for the manufacture of cement. The Minnesota Department of Agriculture (MDA) analyzes the granular carbonate soil amendment, commonly called ag-lime, to assess the neutralization potential. The MDA compilation lists 1998 total sales of 885,000 tons of ag-lime, of which more than 530,000 tons (60%) was primary production from Minnesota quarries.

Aggregate consumption continued to rise in Minnesota in four roughly equal, general categories of use—public roads, public works projects, private residential construction, and commercial/industrial applications. Using public roads as an example, more than 214,000 kilometers of public roadway must be maintained in the State, and according to the Minnesota Department of Transportation (MNDOT), total

government investment in the State's transportation infrastructure was projected to be \$2.4 billion for the 3-year period 1997-99. Aggregate consumption generally is driven by the factors of the economy and the population. According to the DLM, growth in the aggregate industry annually has been roughly 2% to 3% in recent years. Minnesota's population is projected to rise at a rate of 48,000 per year.

The State's "North Shore" corridor along Lake Superior has a relative scarcity of aggregate resources. The DNR worked on a project for MNDOT and for Lake County to identify new and potential areas of aggregate resources in this area to meet future road construction project needs.

In 1997, a diverse group of organizations met informally to discuss mutual concerns related to aggregate mining in Minnesota. An "Ad Hoc Aggregate Committee" (AHAC) was subsequently formed and has since been further enhanced with participation from State agencies, local government, the aggregate industry, trade associations, and The Nature Conservancy. The committee's goals have been to identify and highlight common areas of concern and urgency relative to aggregate resources. In 1998, the committee collected key information from a variety of sources about Minnesota aggregate resources, which is summarized in a 1998 report entitled "Minnesota Aggregate Resources—Road to the 21st Century."

In 1998, the Minnesota legislature appointed a 12-member Aggregate Resources Task Force (ARTF), for which the AHAC provides information and assistance in setting the Task Force's agenda. The ARTF, which includes four members from the State's House of Representatives, four from the State Senate, two from local government, one member from the aggregate industry, and one member with experience in prairie conservation, examines issues regarding the need for and use of the State's aggregate resources. During 1999, the Task Force's plan was to seek input from the aggregate industry, State agencies, county and local units of government, environmental organizations, and other interested parties on a variety of topics such as: resource inventory, resource depletion, mining practices, nuisance problems, safety, competing land uses, land use planning, native prairie conservation, environmental review, permit requirements, reclamation, recycling, transportation of aggregates, and the aggregate material tax. The Task Force was scheduled to report its findings to the State legislature on February 1, 2000.

Clay production is derived from seven mines, mainly for two general purposes. Kaolin is mined for use in Portland cement production and also for making bricks and tiles. Common clay and shale are also mined for bricks and tiles. Since 1995, four new mines have opened.

Exploration

In 1998, the State of Minnesota issued two nonferrous metallic mineral leases covering almost 310 hectares of land in St. Louis County to Rendrag, Inc. The leases were issued through the preference rights leasing system, under which State lands are continually available for leasing after having first been offered through public sale. These leases are the second and third leases issued under this lease-by-application system.

The State issued a peat lease to Koochiching County for 325 hectares in the Pine Island bog located northwest of Big Falls. The Pine Island Bog contains approximately 405 hectares of high-quality fibric sphagnum peat moss at an average thickness of 2 meters. Below the sphagnum cap lies a more decomposed, humic peat and a lower-quality sphagnum moss peat. The primary term of the lease is 3 years, during which time the county must secure an approved assignment of the lease to a qualified party, or the lease terminates. If the county secures a qualified developer, the lease extends for 22 more years—a total term of 25 years. The county was in the process of securing a qualified developer.

Cominco America, Inc., exploring for base and precision metals, drilled one hole to a depth of 153 meters in Carlton County. Lehmann Exploration Co. has been working on a program designed to locate hardrock metallic materials, principally platinum and palladium with associated copper and other minerals. The company drilled one hole to a depth of 780 meters in St. Louis County.

Minnesota Iron and Steel Co. (MIS) drilled a number of shallow holes at the old Butler Taconite operation to see if a concentrated enough bulk sample of taconite could be obtained. Polymet Mining Corp. drilled 14 reverse circulation holes at a site near properties formerly owned by AMAX Gold Corp. The total length of the holes was almost 2,000 meters. Cuttings from this operation were used to obtain a bulk sample for metallurgical testing for base and precious metals.

Legislation and Government Programs

The 1998 Minnesota Legislature appropriated \$10 million for grants for the construction of as many as three direct reduction iron (DRI) processing facilities. The Commissioner of Trade and Economic Development and the Commissioner of Natural Resources must jointly agree on and issue the grants. The money will be available for grants until June 30, 2003. Prior to 1998, the Minnesota Legislature appropriated a significant amount of funding for development of DRI technology during the 1997 legislative session. The Department of Trade and Economic Development (DTED) received \$3 million and the DNR received \$500,000.

The DTED allocated funds for Minnesota Iron and Steel to support the company's plans to build the first U.S. fully integrated sheet minimill in Nashwauk, MN. The project incorporates a taconite iron ore mine, concentrator, pelletization plant, DRI facility, melting furnace, and a thin-slab caster and hot strip mill to produce high quality hot-rolled sheet steel for the automotive market.

Cleveland-Cliffs, Inc. applied for a grant to complete the feasibility study for its Northshore Project. Cleveland-Cliffs is exploring the possibility of constructing and operating a pig iron production facility at the company's Northshore plant in Silver Bay.

Partnership Projects.—The second annual Minnesota Minerals Education Workshop was held in August 1998 at Mankato State University. The 3-day workshop, a collaborative effort of State and Federal agencies, professional associations, educational institutions, and the mining industry, included speakers, hands-on classroom activities, and field trips about geologic formations and mining operations. Sixty-

eight teachers from throughout the State took part in field trips to various quarries, processing facilities, and reclamation sites. Participants attended classroom sessions and presentations led by geologists, researchers, educators, and industry professionals and received a notebook of classroom activities, supporting resource materials, mineral identification kits, and samples of Minnesota rocks and minerals. Feedback from teachers attending these workshops has been overwhelmingly positive.

Research and Environmental Technologies.—The Iron Ore Cooperative Research Committee, representing the seven active taconite operations in Minnesota, the DNR, and three public and private minerals research organizations in the State, continued to collaborate on research projects designed to support the Minnesota’s producing taconite operations. Current projects include process modeling, pelletizing binders, instrumentation, and application of advanced statistical methods.

The State, through the Minnesota Legislature, allocated an additional \$500,000 of grant funding in 1998 to the \$650,000 allocated in 1997 to support the demonstration of advanced technologies at the State’s seven active taconite operations. The funds are available for research into technologies that reduce energy consumption, reduce environmental emissions, improve productivity, and/or improve pellet quality. The first recipient of grant funding was National Steel Pellet Co. for the installation of a mine and plant process control upgrade.

Ispat Inland Inc. proposed to dispose of taconite tailings in some of its existing mine pits to reduce the cost of tailings

dike construction, risks associated with dam failure, the land required for tailings basins (including wetlands), energy usage for pumping tailings, and the potential for dust generation. Before such disposal can occur, the risk of impacting ground water quality must be assessed. The Minnesota Health Department (MHD) conducted a Health Risk Assessment to evaluate the proposal using information generated by the Iron Ore Cooperative Research In-Pit Taconite Tailings Disposal Project. This study identified fluoride, manganese, molybdenum, arsenic, and boron as parameters that occurred at levels near or above water quality standards in at least some field or experimental situations. The reactions controlling concentrations of all parameters except boron were determined through the study. In the assessment, the MHD concluded that Inland’s project presented no significant risk to the health of the human population down-gradient from the operation. The information is also being applied for evaluations in the Supplemental Environmental Impact Statement being prepared by the DNR.

The DNR, in cooperation with several of the taconite producers, is studying the use of sewage sludge, composted solid municipal waste, paper wastes, and Duluth Harbor dredge spoils as soil amendments for revegetating coarse taconite tailings. Results to date have been successful. The long-term goal is to determine successful methods to use waste products accumulating on the landscape for mineland reclamation, thereby reducing disposal costs for the paper and municipal industries and reclamation costs for the taconite industry.

TABLE 1
NONFUEL RAW MINERAL PRODUCTION IN MINNESOTA 1/ 2/
(Thousand metric tons and thousand dollars unless otherwise specified)

Mineral	1996		1997		1998 p/	
	Quantity	Value	Quantity	Value	Quantity	Value
Clays: Common	11	W	W	W	W	W
Gemstones	NA	148	NA	5	NA	1
Iron ore, usable	46.800	1,330,000	47.900	1,430,000	47.200	1,470,000
Peat	20	1,540	29	1,500	25	1,660
Sand and gravel: Construction	31.800	107,000	34.500	127,000	32.900	124,000
Stone:						
Crushed	12.100	59,000	14.600	75,000	15.400	88,500
Dimension metric tons	25.400	10,700	35,000	18,300	35,000	18,300
Combined values of other industrial mineral and values indicated by symbol W	XX	35,100	XX	23,900	XX	23,700
Total	XX	1,540,000	XX	1,680,000	XX	1,730,000

p/ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined values" data.

XX Not applicable.

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

2/ Data are rounded to three significant digits; may not add to totals shown.

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

Kind	1996				1997			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	42 r/	6,990 r/	\$32,400 r/	\$4.63 r/	32	7,350	\$35,600	\$4.85
Granite	4	2,130	11,200	5.27	4	W	W	W
Dolomite	4 r/	2,030 r/	9,940 r/	4.91 r/	4	3,080	16,900	5.49
Sandstone and quartzite	8 r/	W	W	W	5	W	W	W
Traprock	1	W	W	W	--	--	--	--
Total	XX	12,100	59,000	4.88	XX	14,600	75,000	5.15

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

1/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 3
MINNESOTA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 1997,
BY USE 1/ 2/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Coarse aggregate (+1 1/2 inch):			
Macadam	47	\$295	\$6.28
Riprap and jetty stone	218	2,000	9.19
Filter stone	145	883	6.09
Other coarse aggregate	W	W	15.15
Coarse aggregate, graded:			
Concrete aggregate, coarse	702	5,060	7.21
Bituminous aggregate, coarse	183	1,310	7.14
Bituminous surface-treatment aggregate	89	635	7.13
Railroad ballast	793	5,300	6.68
Other graded coarse aggregate	W	W	6.57
Fine aggregate (-3/8 inch):			
Stone sand, concrete	14	57	4.07
Stone sand, bituminous mix or seal	343	1,860	5.41
Screening, undesignated	42	192	4.57
Other fine aggregate	W	W	4.28
Coarse and fine aggregates:			
Graded road base or subbase	2,350	11,400	4.83
Unpaved road surfacing	400	1,530	3.83
Terrazzo and exposed aggregate	W	W	8.64
Crusher run or fill or waste	45	309	6.87
Other coarse and fine aggregates	W	W	4.85
Other construction materials	3,050	17,000	5.57
Agricultural:			
Agricultural limestone	230	1,260	5.49
Poultry grit and mineral food	(3/)	(3/)	22.58
Special:			
Asphalt fillers or extenders	5	23	4.60
Other specified uses not listed	(3/)	(3/)	8.47
Unspecified: 4/			
Actual	4,130	18,600	4.51
Estimated	1,660	6,100	3.69
Total	14,600	75,000	5.15

W Withheld to avoid disclosing company proprietary data; included with "Other construction materials."

1/ Data are rounded to three significant digits, except unit value; may not add to totals shown.

2/ Includes dolomite, granite, limestone, sandstone, quartzite, and traprock.

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

4/ Includes reported and estimated production without a breakdown by end use.

TABLE 4
MINNESOTA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 1997, BY USE AND DISTRICT 1/ 2/

(Thousand metric tons and thousand dollars)

Use	District 3		District 4		District 5		District 6	
	Quantitv	Value	Quantitv	Value	Quantitv	Value	Quantitv	Value
Construction aggregates:								
Coarse aggregate (+1 1/2 inch) 3/	--	--	131	1,120	309	2,690	W	W
Coarse aggregate, graded 4/	W	W	W	W	1,170	7,720	W	W
Fine aggregate (-3/8 inch) 5/	W	W	W	W	(4/)	(4/)	W	W
Coarse and fine aggregate 6/	W	W	413	2,140	3,560	17,900	505	1,970
Other construction materials 7/	--	--	W	W	W	W	--	--
Agricultural 8/	--	--	W	W	W	W	W	W
Special 9/	--	--	--	--	W	W	--	--
Other miscellaneous use	--	--	--	--	--	--	--	--
Unspecified: 10/								
Actual	W	W	W	W	--	--	W	W
Estimated	W	W	428	1,890	W	W	692	2,890
Total	2,640	12,300	2,940	17,600	5,640	31,300	3,340	13,900

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

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Production reported in District 2 was included in "District 3" to avoid disclosing company proprietary data; no crushed stone production in District 1.

3/ Includes filter stone, macadam, riprap and jetty stone, and other coarse aggregate.

4/ Includes concrete aggregate (coarse), bituminous aggregate (coarse), bituminous surface-treatment aggregate, railroad ballast, and other graded coarse aggregate.

5/ Includes stone sand (concrete), stone sand (bituminous mix or seal), screening (undesigned), and other fine aggregate.

6/ Includes crusher run (select material or fill), graded road base or subbase, other coarse and fine aggregates, terrazzo and exposed aggregate, and unpaved road surfacing.

7/ Includes roofing granules and waste material.

8/ Includes agricultural limestone and poultry grit and mineral food.

9/ Includes asphalt fillers or extenders.

10/ Includes reported and estimated production without a breakdown by end use.

TABLE 5
MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1997,
BY MAJOR USE CATEGORY 1/

Use	Quantity (thousand metric tons)	Value (thousands)	Value per ton
Concrete aggregate (including concrete sand)	8,510	\$38,800	\$4.56
Plaster and gunite sands	132	908	6.88
Concrete products (blocks, bricks, pipe, decorative, etc.)	251	977	3.89
Asphaltic concrete aggregates and other bituminous mixtures	3,450	17,900	5.18
Road base and coverings	9,990	28,300	2.84
Road stabilization (cement)	136	838	6.16
Road stabilization (lime)	7	29	4.14
Fill	1,820	3,640	2.00
Snow and ice control	223	559	2.51
Railroad ballast	231	770	3.33
Roofing granules	28	119	4.25
Filtration	34	248	7.29
Other miscellaneous uses	303	892	2.94
Unspecified: 2/			
Actual	2,050	9,330	4.54
Estimated	7,350	23,200	3.16
Total or average	34,500	127,000	3.67

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Includes reported and estimated production without a breakdown by end use.

TABLE 6
MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1997, BY USE AND DISTRICT 1/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (including concrete sand)	970	5,380	542	2,350	1,570	5,200
Concrete products 2/	W	W	81	506	154	675
Asphaltic concrete aggregates (and other bituminous mixtures)	360	1,140	W	W	1,380	4,730
Road base and coverings	1,260	3,150	1,080	3,180	4,200	10,100
Fill	121	172	161	375	213	312
Snow and ice control	33	99	40	88	72	151
Other miscellaneous uses 3/	196	463	470	1,880	W	W
Unspecified: 4/						
Actual	W	W	W	W	W	W
Estimated	1,710	5,060	511	1,810	1,060	3,360
Total	4,710	15,700	3,740	12,900	8,880	27,600
Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (including concrete sand)	491	2,560	W	W	W	W
Concrete products 2/	54	311	W	W	W	W
Asphaltic concrete aggregates (and other bituminous mixtures)	494	4,350	546	2,950	W	W
Road base and coverings	999	3,030	2,330	8,510	120	404
Fill	175	563	938	1,620	208	594
Snow and ice control	47	130	W	W	W	W
Other miscellaneous uses 3/	W	W	W	W	W	W
Unspecified: 4/						
Actual	W	W	W	W	W	W
Estimated	1,230	4,910	1,090	2,940	1,750	5,170
Total	4,020	17,900	10,200	40,300	2,930	12,100

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

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Includes plaster and gunite sands.

3/ Includes filtration, railroad ballast, road stabilization, and roofing granules.

4/ Includes reported and estimated production without a breakdown by end use.