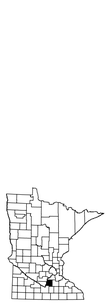
Minnesota Department of Natural Resources
Division of Lands and Minerals
William C. Brice, Director

AGGREGATE RESOURCES
LE SUEUR COUNTY, MINNESOTA

Jonathan B. Ellingson
2003



Scale 1:100,000

0 1 2 3 4 Miles
0 1 2 3 4 5 6 Kilometers

(Aggregate resource mapping units delineated at 1:50,000)

The purpose of this project is to identify and classify potential construction aggregate resources (sand, gravel, and crushed stone) in Le Sueur County, Minnesota. Having locally available, low cost construction aggregates is fundamental to building and maintaining public infrastructure and private sector development. Therefore, this information is intended to assist local planners and others in making comprehensive land-use and zoning decisions regarding aggregate resources, introducing aggregate resource protection, spreading the burden of development, and promoting orderly and environmentally sound development of the resource. To accomplish these goals, two map plates and a comprehensive data set on CD-ROM were created. Plate A shows a detailed breakdown of all identified and potential aggregate resource deposits. Plate B shows surficial geology and includes a description of the methodologies used for mapping. The maps and digital data are designed to provide information to support land use decisions, such as zoning ordinances, permitting decisions, and protection of aggregate resources.

There are several factors related to aggregate resources that affect their availability, usability, and supply. These factors include the transportation costs, the quality of the material, and land-use conflicts. Aggregate materials are high-bulk, low-value commodities, which means transportation costs can account for a considerable amount of the delivered price. Having a local supply of aggregate means lower costs for public and private projects. Aggregate products, such as concrete and asphalt, have specific quality requirements depending on the end use.

Therefore, aggregate deposits must be evaluated in relation to quality standards. At the same time, land-use conflicts between aggregate mining and urban development are becoming more common. Land-use conflicts can be caused by cities expanding into adjacent rural areas, aggregate resource deposits being covered by new development, or new development occurring adjacent to aggregate sources. As a result, the distance from the aggregate source to its consumers is increasing. Due to the increased use of aggregate materials in and around urban areas, aggregate resources are being depleted rapidly.

With these and other issues in mind, the 1984 Minnesota Legislature passed a law (Minn. Stat, sec 84.94, Aggregate Planning and Protection) that directs the Minnesota Department of Natural Resources, in cooperation with the Minnesota Geological Survey and the Minnesota Department of Transportation (MN/DOT), to identify and classify potential aggregate resources where urbanization or other factors are resulting, or may result, in a loss of aggregate resources. When the mapping is completed, the information is provided to local governments and the public. Since this is a reconnaissance-level survey of aggregate resources, site-specific evaluations are still necessary prior to any development of the resource, especially in regard to aggregate quality or environmental review. Factors such as ownership, zoning, protected waters and wetlands, environmental permitting, and other individual site characteristics are not part of the geological resource data summarized here.

AGGREGATE POTENTIAL: For the purpose of this study, aggregate potential is defined as an assessment of the relative probability that an aggregate deposit exists within a given area, with emphasis placed upon geologic evidence, parameters, and interpretation at the reconnaissance level. Economic feasibility evaluation or other related parameters were not considered in this study. This assessment does not imply that economic aggregate deposits exist everywhere within a given map unit designated as "Potential Sand and Gravel Resources" or "Potential Crushed Stone Resources." Rather, that within such a map unit, geologic processes were active that could have created aggregate deposits at specific sites. Geologic measurements of aggregate deposits remain constant, but economic criteria and environmental permitting vary across time and place. Important site-specific factors such as ownership, zoning, protected waters and wetlands, environmental permitting, distance to markets, royalties, and individual site characteristics, such as access, all contribute to the final "potential" of a specific parcel; however, these factors were not included in this study.

POTENTIAL SAND AND GRAVEL RESOURCES: Geologic units that are inferred to contain sand and gravel. These units exhibit the geologic characteristics that typically produce sand and gravel deposits. Existing gravel pit and MN/DOT aggregate sources lying within these units indicate identified or known resources. The geologic units having potential for sand and gravel include alluvial features (flood plains, terraces, and fans), glacial outwash features (channels and terraces), and ice-contact features (eskers and kames). These units typically contain sorted sand and gravel with little silt or clay. For a further discussion of these mapping units, refer to the Classification Methodology of Aggregate Resources section of this plate.

HIGHLY DESIRABLE SAND AND GRAVEL DEPOSITS: Glaciofluvial features, such as terraces and outwash channels. These deposits are very large in areal extent[1]. These deposits consist of sand and gravel with thicknesses typically ranging from 15 to 75+ feet, with less than 5 feet of overburden. The probability[2] that a potential sand and gravel deposit exists within this unit is high to very high. The textural characteristics[3] of these deposits are classified as good to very good. The quality[4] is typically moderately high to very high relative to all deposits within Le Sueur County.

MODERATELY DESIRABLE SAND AND GRAVEL DEPOSITS: Glaciofluvial features, such as outwash channels and terraces; ice-contact features, such as eskers and kames; as well as Holocene age terraces, floodplains, and fans. These deposits are moderately small to large in areal extent with sand and gravel thicknesses typically ranging from 10 to 50+ feet, with less than 10 feet of overburden. The probability that a potential sand and gravel deposit exists within this unit is moderately high to very high. The textural characteristics of these deposits are moderate to very good, with the quality ranging from moderately high to high.

LESS DESIRABLE SAND AND GRAVEL DEPOSITS: Glaciofluvial features, such as outwash channels and terraces; ice-contact features, such as eskers and kames; and alluvial features such as flood plains, terraces, fans, and sand bars. These deposits are moderately small to very large in areal extent and consist of sand and fine sand with thicknesses ranging from 0 to 50+ feet, with overburden thicknesses between 0 to 40+ feet. The probability that a potential sand and gravel deposit exists within this unit is moderate to very high. The textural characteristics of these deposits are moderately poor to good, with the quality ranging from moderately low to high.

POTENTIAL CRUSHED STONE RESOURCES: Carbonate (limestones and dolomites) bedrock from the Prairie du Chien Group and sandstone bedrock from the Jordan Sandstone Formation that are suitable for crushing. These units are inferred to be relatively thick (10 to 50+ feet), with overburden thicknesses ranging from 0 to 50 feet. Quarries located within these units indicate identified or known resources.

HIGHLY DESIRABLE CRUSHED STONE DEPOSITS: Carbonate (limestones and dolomites) bedrock units that are very large in areal extent, and contain materials suitable for crushing. These units have thicknesses ranging from 30 to 50+ feet, with overburden thicknesses typically less than 10 feet. These units have a very high probability of containing potential crushed stone deposits. The quality of these units is high.

MODERATELY DESIRABLE CRUSHED STONE DEPOSITS: Carbonate (limestones and dolomites) bedrock units that are moderate to very large in areal extent, and contain materials suitable for crushing. These units have thicknesses ranging from 20 to 40+ feet, with overburden thicknesses typically less than 10 feet. These units have a high to very high probability of containing potential crushed stone deposits. The quality of these units is high.

LESS DESIRABLE CRUSHED STONE DEPOSITS: Carbonate (limestones and dolomites) and sandstone bedrock units that are moderately large to very large in areal extent, and contain materials suitable for crushing. These units have thicknesses ranging from 10 to 50+ feet, with overburden thicknesses ranging from 0 to 50 feet. These units have a moderately high to very high probability of containing potential crushed stone deposits. The quality of these units is moderately high to very high.

LIMITED POTENTIAL FOR AGGREGATE RESOURCES: Units that generally have little or no potential for significant aggregate resources. These units exhibit geologic characteristics that are typically not consistent with significant aggregate deposits. The geologic units having limited potential include collapsed glaciofluvial channels, glacial lake plains, ground moraines, colluvial slopes, small alluvial deposits, or bedrock with overburden thicknesses typically greater than 50 feet. These units typically contain clay, silt, fine sand, unsorted sediments (till), or very thin layers of sand and gravel. These units may include aggregate deposits that are too small to map.

LIMITED POTENTIAL FOR AGGREGATE DEPOSITS: Units that include glacial features such as collapsed glaciofluvial channels, ground moraines, glacial lake beds, colluvial slopes, and small alluvial features such as flood plains and streams. The probability that a significant aggregate deposit exists within this unit is very low to moderate. The aggregate deposits occurring in this unit are very small to moderately small in areal extent and typically consist of finer material (sand with some gravel). The thicknesses of these aggregate deposits are typically less than 20 feet, with overburden thicknesses sometimes reaching over 100 feet. The textural characteristics are poor to moderately poor with the quality ranging from low to moderate. These units also contain carbonate bedrock units with an overburden thickness of greater than 50 feet. In a few areas on the map, a dotted pattern (indicating crushed stone resources potential) can be seen, lying over this mapping unit. In this case, there is crushed stone potential, but there is limited sand and gravel potential.

IDENTIFIED AGGREGATE RESOURCES: Areas where aggregate resources (sand, gravel, and/or crushed stone) have been or are currently being mined. Pit and quarry locations have been gathered from several different sources, including topographic maps, aerial photographs, county records, county highway department maps, soil surveys, MN/DOT files, fieldwork, gravel operators, and other miscellaneous sources. The pits and quarries range in size from less than 1 acre to greater than 50 acres and may be active, inactive, depleted, or reclaimed. The aggregate quality of the pits varies.

Gravel Pits: Locations were gathered from several different reference sources. Any given pit may be active, inactive, depleted, or reclaimed. The color indicates the relative size of the pit.

- Large - larger than 15 acres
- Medium - approximately 5 to 15 acres.
- Small - less than 5 acres.

Gravel Pits - MN/DOT files: Locations gathered from ASIS, the Minnesota Department of Transportation's Aggregate Source Information System listing of aggregate sources. Test hole logs, sieve, and quality test data are available. The color indicates the relative size of the pit.

- Large - larger than 15 acres
- Medium - approximately 5 to 15 acres.
- Small - less than 5 acres.

Quarries: Ordovician carbonate (limestone and dolomite) quarries used for either crushed stone or dimension stone; and industrial sand quarries where carbonate bedrock is removed to access the Cambrian sandstone bedrock. Any given unit may be active, inactive, depleted, or reclaimed. The color indicates the relative size of the quarry.

- Large - larger than 15 acres
- Medium - approximately 5 to 15 acres.
- Small - less than 5 acres.

OTHER FEATURES:

WETLANDS: Wetland area.

WATER: Lakes or rivers.

[1] Areal Extent - the size, horizontal extent, or distribution of a unit (e.g., area in acres).
[2] Probability - the degree of certainty that aggregate exists within a mapping unit.
[3] Textural Characteristics - particle size distribution - the percent of gravel or sand versus silt or clay (e.g., sieve analysis).
[4] Quality - the characteristics of the material - soundness (e.g., magnesium sulfate test), durability (Los Angeles rattler test), and mineral makeup (percent deleterious material such as shale, iron oxide, and unsound chert).

Classification Methodology for Aggregate Resources

The aggregate resources of Le Sueur County were divided into seven categories: 1) highly desirable sand and gravel deposits, 2) moderately desirable sand and gravel deposits, 3) less desirable sand and gravel deposits, 4) highly desirable crushed stone deposits, 5) moderately desirable crushed stone deposits, 6) less desirable crushed stone deposits, and 7) limited potential for aggregate deposits.

The sand and gravel resources were divided into these categories based on the host geological feature, probability (certainty) that sand and gravel exists within a unit, sand and gravel thickness, overburden thickness, deposit size (areal extent), textural characteristics (sieve analysis), quality (soundness and durability) of the material, and the sediment description as observed in the field (Table 1). For example, a flood plain deposit typically hosts sand and gravel, thus the feature may have potential. If the deposit has a gravel pit located on or adjacent to it and sand and gravel were encountered by drilling during fieldwork, it has a very high probability. If that deposit is 30 feet thick with 2 feet of overburden and covers 40 acres in areal extent, the aggregate thickness, overburden thickness, and deposit size are all in the high to very high category. If the texture indicates a high percentage of gravel and the quality meets MN/DOT specifications, then this flood plain deposit is categorized as a highly desirable sand and gravel deposit. Even if a deposit has good geological characteristics for sand and gravel, one economic factor, such as haul distance costs, could make a deposit less economically desirable, but economic factors were not considered in this study.

Crushed stone resources were divided into three categories: 1) highly desirable, 2) moderately desirable, and 3) less desirable, based on overburden thickness, deposit thickness, probability, deposit size, environment of deposition, bedrock description, and quality. The deposit thickness, environment of deposition, and bedrock description took into account the thickness of consolidated beds, the presence of shale and unconsolidated beds, and other field observations. Limestone/dolomite beds that are more massive and durable create higher quality aggregate. The presence and quantity of interbedded shale lowers the aggregate quality. If the overburden was less than 50 feet thick, the unit was considered accessible, and if it was less than 20 feet thick, it was considered more accessible. The probability, deposit size, and quality were determined in a similar manner to that of the sand and gravel category.

The areas identified as limited aggregate potential did not meet the above-mentioned criteria for either sand and gravel or crushed stone. The deposits may have been too small in areal extent, not thick enough, have too much overburden, may not have met the quality specifications, or contained material too fine in size.

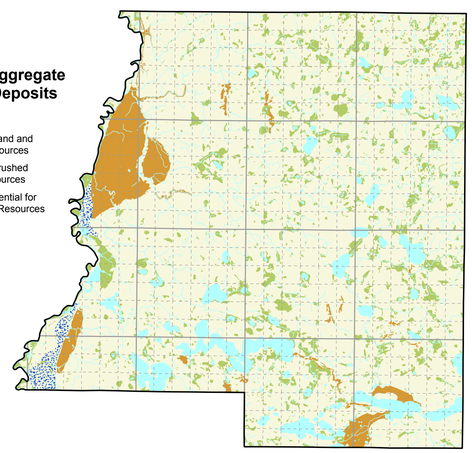
Along with aggregate potential, all known identified sources of aggregate were mapped. This included gravel pits and quarries ranging in size from less than an acre to more than 50 acres. These gravel pits and quarries may be active, inactive, depleted, or reclaimed, but represent an area where aggregate is or has been mined.

Table 1. Sand and Gravel Potential

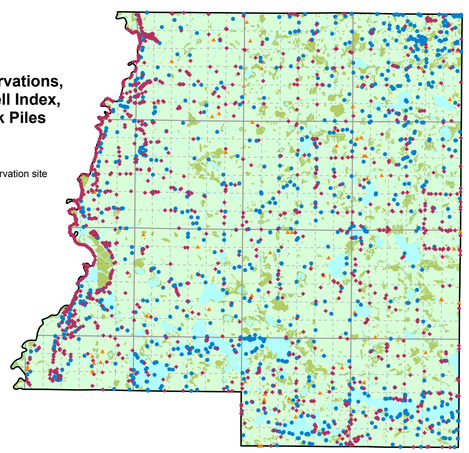
Characteristics	Desirability Rating			
	Highly	Moderately	Less	Limited
Surficial Geology Features	Glaciofluvial outwash channels and terraces	Outwash channels and terraces; kames and eskers; alluvial terraces, fans, bars, floodplains	Outwash channels and terraces; kames and eskers; alluvial terraces, fans, bars, floodplains	Moraines; collapsed channels; glacial lake beds; colluvial slopes; small alluvial features
Sediment Description	Sand and gravel	Sand and gravel	Sand with occasional gravel	Clay/silt/sand with occasional sand and gravel
Probability[1]	High to very high	Moderately high to very high	Moderate to very high	Very low to moderate
Sand and Gravel Thickness (in feet)	15-75+	10-50+	0-40+	0-20+
Overburden Thickness (in feet)	0-5	0-10	0-50+	0-100+
Sand and Gravel Deposit Size (areal extext)	Large to very large (40-50+ acres)	Moderately small to large (10-40 acres)	Moderately small to very large (10-50+ acres)	Very small to moderately small (0-10 acres)
Sand and Gravel Textural Characteristics	Good to very good	Moderate to very good	Moderately poor to good	Poor to moderately poor
Sand and Gravel Quality[2]	Moderately high to very high	Moderately high	Moderately low to high	Low to moderate

[1]Probability is the degree of certainty that aggregate exists within a unit.
[2]Quality is defined in terms of soundness, durability, and mineral make-up.

Note: The colors are associated with aggregate potential desirability (i.e., highly desirable, moderately desirable, less desirable, limited potential for aggregate deposits).



Significant Aggregate Resource Deposits are defined as those deposits most likely to be explored and evaluated for future commercial use. They include all the moderately and highly desirable sand, gravel, and crushed stone deposits, as well as very large areas of finer sand and gravel that could be blended with coarser material to make more highly desirable deposits.



The field observation sites were logged during the field seasons in the summer and fall of 2002 and spring of 2003. Field work consisted of driving every accessible road in the county looking for outcrops and exposures of geological sediments, as well as drilling test holes where needed and where landowner permission was granted. Sediments exposed in road cuts, stream exposures, excavations such as basements, judicial ditches, construction projects, trenches (cable, pipe, tiling), and even animal holes offered several places where the surficial materials, glacial stratigraphy, and bedrock formations were observed. A total of 1,151 observation sites were logged in the county. The County Well Index (CWI) is an online database maintained by the Minnesota Geological Survey that contains over 300,000 wells drilled throughout Minnesota. As of 2001, when the CWI data were obtained, approximately 950 of these wells are located in Le Sueur County. Almost two-thirds of the wells contained geological descriptions that were found to be useful for this study. The rock pile sites were observed and recorded during field work and consist of sites where rocks were placed into significant piles that could be used for rip-rap or for crushing.

Aggregate Resources:
Aerial photograph interpretation, field work, and delineation of mapping units by Jonathan B. Ellingson, 2002-2003, County Aggregate Mapping Program, Division of Lands and Minerals, Minnesota Department of Natural Resources. Source information included aerial photographs from NAPP (National Aerial Photography Program), 1991-1992, 9" x 9" color infrared photos at 1:40,000; DOQs (Digital Orthophoto Quadrangles) at 1:12,000 from USGS (United States Geological Survey); DRGs (Digital Raster Graphics) at 1:24,000 from USGS; 7.5-minute USGS topographic quadrangles at 1:24,000 (dating from 1965-1993); the Soil Survey of Le Sueur County, 1989 (ground conditions from 1985), from the USDA-NRCS (United States Department of Agriculture - Natural Resources Conservation Service; and CWI (County Well Index) database from the Minnesota Geological Survey, downloaded in 2001.

Base map data sources:
Lakes, wetlands, and rivers from National Wetland Inventory, U.S. Fish and Wildlife Service, compiled at 1:24,000 from aerial photography (1979-1988) and spot field checked.
Public Land Survey - PLS Project, 2001, Minnesota Department of Natural Resources, Division of Lands and Minerals.
Roads from MN/DOT Basemap 2001 - Roads, Minnesota Department of Transportation, BaseMap Development Group, Surveying and Mapping Section.
Civil Townships and Municipal Boundaries from MN/DOT Basemap 2001 - Civiltwp and Muni, Minnesota Department of Transportation, BaseMap Development Group, Surveying and Mapping Section.

GIS database design and cartography by Renee Johnson. Database assistance by Jason Barnum and Erika Rowe. Field and drilling assistance by Ricco Rilhiluoma and Jason Barnum.

Prepared with support from Le Sueur County.

This project includes a CD/ROM of maps, data, and metadata in a digital format and the following plates:
Plate A, Report 360, Aggregate Resources
Plate B, Report 360, Surficial Geology