Aitkin County, Minnesota - Aggregate Resources

Sand and Gravel Potential

aitk_sgp

Metadata Summary

Originator

Minnesota Department of Natural Resources, Division of Lands and Minerals, Mineral Potential Evaluation Section

Abstract

This spatial dataset consists of information about the geology, geological characteristics, and sand and gravel potential for Aitkin County, Minnesota. Seven fields relate to the surficial geology of the map unit, including a major sediment, minor sediment, landform, surficial geology description, probability (unit certainty), depositional variability, and lobe provenance. Five fields relate to sand and gravel characteristics, including sand and gravel probability, quality, texture, overburden thickness, and sand and gravel thickness. These characteristics were used to calculate the aggregate potential of the map unit for sand and gravel.

Browse Graphic

none available

Time Period of Content Date

2013

Currentness Reference

The map was compiled digitally (ArcMap 10.1) using a 10-m digital elevation model (DEM) as a basemap and then was refined in the areas covered by a higher resolution, 2-m LiDAR elevation model when those data became available late in the compilation process. Map units were created based on field observations, sample test data, air-photo interpretations, U.S.G.S. 1:24,000 topographic map interpretations and digital soil information from National Resource and Conservation Service (NRCS) soil survey for Aitkin County (Soil Survey Geographic Database, SSURGO).

Access Constraints

Use Constraints

Acknowledgement of the Minnesota Department of Natural Resources is appreciated for products derived from these data.

Distributor Organization

Minnesota Department of Natural Resources, Division of Lands and Minerals

Ordering Instructions

Aitkin County's aggregate resource spatial datasets (shapefiles & file geodatabase) are included in the file Aitkindata.zip, accessible from the MN DNR Aggregate Mapping web page:
http://www.dnr.state.mn.us/lands_minerals/aggregate_maps/completed/index.html
The spatial datasets include: sand and gravel resource potential, test-holes drilled, geologic field observations, aggregate pits, Minnesota Geological Survey (MGS) County Well Index (CWI) data points, Mn/DOT Aggregate Source Information System (ASIS) points, and Mn/DOT ASIS pit quality table.

Online Linkage

Click here to download data. (See Ordering Instructions above for details.) By clicking here, you agree to the notice in "Distribution Liability" in Section 6 of this metadata.

Full Metadata

Aitkin County, Minnesota - Aggregate Resources:
Sand and Gravel Potential
aitk_sgp

Section 1 Identification Information

Originator

Minnesota Department of Natural Resources, Division of Lands and Minerals, Mineral Potential Evaluation Section

Title

Aitkin County Aggregate Resources: aitk_sgp (sand and gravel potential)

Abstract

This spatial dataset consists of information about the geology, geological characteristics, and sand and gravel potential for Aitkin County, Minnesota. Seven fields relate to the surficial geology of the map unit, including a major sediment, minor sediment, landform, surficial geology description, probability (unit certainty), depositional variability, and lobe provenance. Five fields relate to sand and gravel characteristics, including sand and gravel probability, quality, texture, overburden thickness, and sand and gravel thickness. These characteristics were used to calculate the aggregate potential of the map unit for sand and gravel.

Purpose

The purpose of this project and data is to identify and classify potential construction-aggregate resources in Aitkin County, Minnesota. This mapping is being done in accordance with the 1984, Minnesota Statue 84.94, Aggregate Planning and Protection law directing the Minnesota Department of Natural Resources (DNR), in cooperation with the Minnesota Geological Survey (MGS), and the Minnesota Department of Transportation (MnDOT) to identify and classify potential aggregate resources.

The Sand and Gravel Potential spatial database is an interpretative data product intended to be used for planning purposes. For example, a community may want to differentiate and protect resources by their quality; they may want to separate resource extraction from other uses to minimize land-use conflict; or they may want to reduce haulage cost by identifying sources in proximity to a project because aggregate is a high bulk, low price commodity and transportation costs can significantly affect price.

The most up-to-date topographic, soil, and test-hole data were used in the construction of this data. New data were also gathered during the mapping effort, at a scale appropriate for the final map scale of 1:50,000. However this is a regional reconaissance-scale map and it is still necessary to conduct a detailed investigation to verify the information before investing in a deposit or making site-specific decisions. Factors that were not included in the preparation of this map include ownership, zoning, environmental considerations and protection or easement status.

Time Period of Content Date

2013

Currentness Reference

The map was compiled digitally (ArcMap 10.1) using a 10-m digital elevation model (DEM) as a basemap and then was refined in the areas covered by a higher resolution, 2-m LiDAR elevation model when those data became available late in the compilation process. Map units were created based on field observations, sample test data, air-photo interpretations, U.S.G.S. 1:24,000 topographic map interpretations and digital soil information from National Resource and Conservation Service (NRCS) soil survey for Aitkin County (Soil Survey Geographic Database, SSURGO).

Progress

Complete

Maintenance and Update Frequency

None planned

Spatial Extent of Data

Aitkin County, Minnesota

Bounding Coordinates

-93.81
-93.05
47.16
46.15

Place Keywords

Aitkin County, Minnesota

Theme Keywords	aggregate potential, sand and gravel, surficial geology, geological characteristics, probability, quality
Theme Keyword Thesaurus	
Access Constraints	
Use Constraints	Acknowledgement of the Minnesota Department of Natural Resources is appreciated for products derived from these data.
Contact Person Information	Aggregate Resource Mapping Program, Industrial Minerals Geologist or GIS Specialist Minnesota Department of Natural Resources, Division of Lands and Minerals 500 Lafayette Road St. Paul, MN 55155-4045 Phone: 651-259-5959 FAX: 651-296-5939 E-mail: kevin.hanson@state.mn.us
Browse Graphic	none available
Browse Graphic File Description	
Associated Data Sets	Aitkin County's aggregate resource spatial datasets (shapefiles & file geodatabase) are included in the file Aitkindata.zip, accessible from the MN DNR Aggregate Mapping web page: http://www.dnr.state.mn.us/lands_minerals/aggregate_maps/completed/index.html The spatial datasets include: sand and gravel resource potential, test-holes drilled, geologic field observations, aggregate pits, Minnesota Geological Survey (MGS) County Well Index (CWI) data points, Mn/DOT Aggregate Source Information System (ASIS) points, and Mn/DOT ASIS pit quality table.

Section 2 Data Quality Information

Attribute Accuracy	
Logical Consistency	
Completeness	The sand and gravel potential data was compiled digitally (ArcMap 10.1) using a 10-m digital elevation model (DEM) as a basemap and then was refined in the areas covered by a higher resolution, 2-m LiDAR elevation model when those data became available late in the compilation process. Map units were created based on field observations, sample test data, air-photo interpretations, U.S.G.S. 1:24,000 topographic map interpretations and digital soil information from National Resource and Conservation Service (NRCS) soil survey for Aitkin County (Soil Survey Geographic Database, SSURGO).
Horizontal Positional Accuracy	1:50,000
Vertical Positional Accuracy	Not applicable.
Lineage	PRIOR WORK A hand-colored, draft, surficial geology map of Aitkin County, commissioned by the DNR and completed in 1981 by H. Hobbs, MGS, along with review comments by M. Eng, DNR Lands and Minerals, and H.E. Wright, Univ. of Minn., Dept. of Geology and Geophysics were helpful in the construction of this map (Hobbs, 1981). Surrounding maps of surficial geology and aggregate potential of Carlton, (Friedrich, 2009; Knaeble and Hobbs, 2009), Itasca (Meyer, Jennings and Jirsa, 2005; Meyer and Jirsa, 2005), Kanabec (Friedrich, 2012), Mille Lacs (Arends, 2008), and Pine (Patterson and Knaeble, 2001 and 2002) counties, the Mesabi Range (Jennings and Reynolds, 2005), Kathio State Park (Anderson, 1998) and the Chippewa National Forest (Jennings, unpublished, MGS open file data), helped with the regional context of this map. Observations represented on a large scale map of Savanna State Park by M. Oberhelman, DNR (1996) were also considered.

Interpreted records of drillers' logs of water wells, compiled and made available electronically (County Well Index or CWI) by the Minnesota Department of Health (MDH) and the MGS were used where available. An aggregate dataset compiled and maintained by MnDOT (Aggregate Source Information System, ASIS) that is comprised of data pertaining to aggregate quality, including pit sheets and shallow test-hole logs, was valuable where available.

METHODS

The distribution, abundance and quality of aggregate (sand and gravel) resources depends mainly on glacial processes. This resource map is derived from—and therefore emphasizes—glacial landforms, the processes that formed them, and the interpreted distribution of near-surface sediment associated with those landforms. Reconnaissance field work was conducted by Kostka in October, 2008 and the fall of 2009 and drilling and a gravel pit inventory were completed by him between June through October of 2010. Jennings reviewed these data and added new field observations over the spring and summer of 2012.

Exposures were located by driving the study area on section-line and forest roads and consisted mainly of artificial excavations including short-lived road cuts or construction sites and longer-exposed gravel pits. Exposed sediment type and sedimentary structures were used to verify the inferred processes responsible for creating the landforms and to predict the unexposed distribution of sediment within the landform. If no natural exposures were found, a shovel, auger, truck-mounted soil probe or back-hoe were used in places to sample the near-surface geologic material (up to 24 feet). Jennings completed 107 test holes and Kostka, 138 during their respective field seasons.

A portion of the samples collected were analyzed by MnDOT for grain size and quality (n=48) and by the DNR, Hibbing for grain size (n=78). This is, however, a large and complex county and even with this number of samples and observations, the mapping must be considered reconnaissance-level field work requiring further testing to define and develop a gravel pit.

MAP CONSTRUCTION

The map was compiled digitally (ArcMap 10.1) using a 10-m digital elevation model (DEM) as a basemap and then was refined in the areas covered by a higher resolution, 2-m LiDAR elevation model when those data became available late in the compilation process. Map units were created based on field observations, sample test data, air-photo interpretations, U.S.G.S. 1:24,000 topographic map interpretations and digital soil information from National Resource and Conservation Service (NRCS) soil survey for Aitkin County (Soil Survey Geographic Database, SSURGO).

The characteristics used to determine the final aggregate categories are listed in bold and defined where necessary and are:

- landform;
- major sediment;
- minor sediment;
- sand and gravel probability, the likelihood that sand and gravel occurs within that landform;
- unit certainty, a relative measure of how easily delineated a certain map unit is based on its geomorphic expression;
- texture of the sediment in the landform which in some cases is based on a grain-size analysis and in other cases on the interpreted texture associated with a landform;
- quality of the sand and gravel which in some cases is determined from the presence or absence of deleterious material and in other cases is inferred based on the path of the ice that deposited it (see provenance, below);
- depositional variability within a landform type, or how varied the processes are in a given depositional setting;
- provenance or source of the material carried by a given ice lobe;
- observed sand and gravel thickness associated with that landform as gleaned from well records, borings or surface exposures;
- overburden thickness if sand and gravel are present, as gleaned from well records, borings or surface exposures.

Landforms that may be comprised of sand and gravel and therefore result in a higher class ranking are glacial stream valley, terrace or bar; spillway terrace; collapsed stream sediment; collapsed channels, and interlobate complex (see glossary for geologic landform definitions). All of these landforms were created by flowing water that had the potential to sort sediment and concentrate sand and gravel. However, some of these landforms had greater depositional variability than others (interlobate complex, collapsed stream sediment, and collapsed channels). Processes that did not sort sediment as well may have also been operative in these landforms therefore, unsorted layers may be complexly interlayered with, or bury the sorted sediment. Landforms with poor texture, that is, sediment too fine or too poorly sorted to be considered aggregate include lake plain, channelized lake plain, delta or shallow lake, dune or eolian features, streamlined till, scoured lake floor, low-relief washed till plain, alluvial valley, beach, hummocky moraine and hummocky till.

The major sediment in a landform is based on direct observation where available or inferred from the geologist's understanding of how the landform was created where no data were available. Minor sediment was also either observed or inferred from the typical variation within the landform or the facies changes (normal progression of depositional environments over time or space) that are normally associated with that depositional setting. Sediment type is defined by the distribution of, in order of size: clay, silt, sand, gravel, cobbles and boulders. Glacial sediment is of mixed grain size—a diamict—meaning a bimodal mixture comprised of a matrix of fines that contains coarse clasts. Standard geologic description methods are followed for major and minor sediment wherein the word order indicates relative abundance (e.g. sand and gravel). The conjunction and means equal amounts. The preposition "with" in "sand with gravel" means more sand than gravel; "sand with a trace gravel" means even less gravel. Modifiers come before the main sediment type (e.g. silty sand) and are used in accordance with position on the NRCS texture triangle.

Texture is evaluated in the context of how well suited a deposit is for aggregate use (good, poor, moderate). A deposit that is primarily fine sediment (clay and silt) or a mixture (diamict) has a poor distribution of grain sizes for aggregate purposes. Glacial stream sediment is a mixture of gravel and sand with minor amounts of fine-grained sediment (silt and clay) and has a good to moderate texture depending on the ratio of gravel to sand (need some gravel and crushable material) and the presence of fines (need some silt for binder but not too much).

Sand and gravel probability is the geologist's interpretation, based on available data, of how likely a given depositional setting is to have produced sand and gravel (high, moderate, low, very low). In a glacial environment, sand and gravel are secondary deposits created as the glacial sediment is washed and fines winnowed. Original sediment texture, distance of transport and energy of transport are factors that affect sorting. The depositional variability of a landform and presence of data points affect probability.

Quality is a measure or estimate of the presence of sound, durable, lithologically suitable and dimensionally favorable clasts in a gravel (high, moderate, low). Clasts that break easily, absorb water, freeze, break, dissolve, expand when wet, have a high length to width ratio or react chemically are considered deleterious. Clast assemblages associated with a given ice-source area and flow path are related to lobe provenance. See the section below, Geologic History as it Pertains to Sand and Gravel Distribution, for images of the clasts typically associated with a given provenance. The lobes that deposited sediment in the area now delineated as Aitkin County, or combinations of deposits that result from the overlapping extent of slightly different-aged lobes and post glacial events are Superior, Itasca, Brainerd sublobe, St. Louis sublobe, and glacial Lake Aitkin-Upham. Recent sediment not directly linked to a glacial lobe is of mixed provenance.

Finally, the observed sand and gravel thickness and overburden thickness are single values in the attribute table if only one record was available for a landform; if multiple records were available, a range of thicknesses is given.

RESULTS
Sand and gravel resources are scarce in much of Aitkin County owing to non-deposition, burial by non-aggregate-bearing units or the low-lying nature of the units which places them below the water table and organic deposits. The quality of the aggregate varies greatly because Aitkin County was affected by four different ice lobes, each bearing a lithologically distinct assemblage.

High, discontinuous ridges in the central and southern part of the county that project above the wetland-dominated landscape contain aggregate in places. The courses of former glacial streams commonly followed and reworked by modern streams have discontinuous deposits of sand and gravel. Subglacial tunnels—broad, lake-filled lowlands—in the southeastern part of the county contain narrow ridges of gravel within them. They may have fan complexes bearing sand and gravel where they discharged at the ice margin.

Source Scale Denominator

24000

Section 3 Spatial Data Organization Information

Native Data Set Environment

ArcGIS Desktop versions: 9.3, 10.0, 10.1

Geographic Reference for Tabular Data	
Spatial Object Type	Vector
Vendor Specific Object Types	Polygon
Tiling Scheme	None

Section 4 Spatial Reference Information

Horizontal Coordinate Scheme	UTM
Ellipsoid	GRS80
Horizontal Datum	NAD83
Horizontal Units	Meters
Distance Resolution	
Altitude Datum	Not applicable
Depth Datum	Not applicable
UTM Zone Number	15E north

Section 5 Entity and Attribute Information

Entity and Attribute Overview	The polygons were delineated to represent geological features, geological characteristics, and aggregate potential for sand and gravel.
Entity and Attribute Detailed Citation	See beyond Section 7 for detailed field and attribute information

Section 6 Distribution Information

Publisher	Minnesota Department of Natural Resources, Division of Lands and Minerals, Mineral Potential Evaluation Section
Publication Date	2014
Contact Person Information	Aggregate Resource Mapping Program Industrial Minerals Geologist or GIS Specialist Minnesota Department of Natural Resources, Division of Lands and Minerals 500 Lafayette Road St. Paul, MN 55155-4045 Phone: 651-259-5959 FAX: 651-296-5939 E-mail: kevin.hanson@state.mn.us

Distributor's Data Set Identifier	Aitkin County Aggregate Resources, Sand and Gravel Potential
Distribution Liability	The State of Minnesota makes no representations or warranties express or implied, with respect to the use of the information contained herein regardless of its format or the means of its transmission. There is no guarantee or representation to the user as to the accuracy, currency, suitability, completeness, usefulness, or reliability of this information for any purpose. The user accepts the information "as is." The State of Minnesota assumes no responsibility for loss or damage incurred as a result of any user's reliance on this information. All maps, reports, data, and other information contained herein are protected by copyright. Permission is granted to copy and use the materials herein for any lawful noncommercial purpose. Any user of this information agrees not to transmit or provide access to all or any part of this information to another party unless the user shall include with the information a copy of this disclaimer.
Transfer Format Name	
Transfer Format Version Number	
Transfer Size	mb for data, mb for associated maps
Ordering Instructions	Aitkin County's aggregate resource spatial datasets (shapefiles & file geodatabase) are included in the file Aitkindata.zip, accessible from the MN DNR Aggregate Mapping web page: http://www.dnr.state.mn.us/lands_minerals/aggregate_maps/completed/index.html The spatial datasets include: sand and gravel resource potential, test-holes drilled, geologic field observations, aggregate pits, Minnesota Geological Survey (MGS) County Well Index (CWI) data points, Mn/DOT Aggregate Source Information System (ASIS) points, and Mn/DOT ASIS pit quality table.
Online Linkage	Click here to download data. (See Ordering Instructions above for details.) By clicking here, you agree to the notice in "Distribution Liability" above.

Section 7 Metadata Reference Information

Metadata Date	2014
Contact Person Information	Aggregate Resource Mapping Program, Industrial Minerals Geologist or GIS Specialist Minnesota Department of Natural Resources, Division of Lands and Minerals 500 Lafayette Road St. Paul, MN 55155-4045 Phone: 651-259-5959 FAX: 651-296-5939 E-mail: kevin.hanson@state.mn.us
Metadata Standard Name	Minnesota Geographic Metadata Guidelines
Metadata Standard Version	2.1
Metadata Standard Online Linkage	http://www.lmic.state.mn.us/gc/stds/metadata.htm

Table Name	Field Name	Definition	Valid Values	Descriptions
aitk_sgp.dbf				
	SEDIMENT_1	Text, 50	Complex of diamicton and sorted sediment; Diamicton; Diamicton, silt and clay; Laminated silt and clay; Sand; Sand and gravel; Sand with gravel; Sandy silt; Sandy silt to silty sand; Silt and sand over diamicton; Silty clay and clayey silt	Sediment 1: the major sediment in a landform is based on direct observation where available or inferred from the geologist's understanding of how the landform was created where no data were available. Sediment type is defined by the distribution of, in order of size: clay, silt, sand, gravel, cobbles and boulders. Glacial sediment is of mixed grain size—a diamict—meaning a bimodal mixture comprised of a matrix of fines that contains coarse clasts. Standard geologic description methods are followed for major and minor sediment wherein the word order indicates relative abundance (e.g. sand and gravel). The conjunction and means equal amounts. The preposition "with" in "sand with gravel" means more sand than gravel; "sand with a trace gravel" means even less gravel. Modifiers come before the main sediment type (e.g. silty sand) and are used in accordance with position on the NRCS texture triangle.
	SEDIMENT_2	Text, 50	Bedrock slabs; Clay; Clay, gravel; Cobbles, boulders, silt; Diamicton; Laminated silt and clay; Organics, sand; Sand and gravel; Sand, gravel and silt as cover or lag; Sand, gravel, silt and clay; Sandy diamicton; Silt; Silt and clay; Silt over eroded (strath) surface; Silt, clay, trace gravel	Sediment 2: the minor sediment was also either observed or inferred from the typical variation within the landform or the facies changes (normal progression of depositional environments over time or space) that are normally associated with that depositional setting. Sediment type is defined by the distribution of, in order of size: clay, silt, sand, gravel, cobbles and boulders. Glacial sediment is of mixed grain size—a diamict—meaning a bimodal mixture comprised of a matrix of fines that contains coarse clasts. Standard geologic description methods are followed for major and minor sediment wherein the word order indicates relative abundance (e.g. sand and gravel). The conjunction and means equal amounts. The preposition "with" in "sand with gravel" means more sand than gravel; "sand with a trace gravel" means even less gravel. Modifiers come

				before the main sediment type (e.g. silty sand) and are used in accordance with position on the NRCS texture triangle.
	SGPOT_DESC	Text, 300		A comprehensive description of each record based on a landform-sediment approach.
	LANDFORM	Text, 50	See Below	
			Alluvial Valley	Holocene and modern stream valleys that have been adjusting to precipitation and groundwater flow since the end of the last glaciation. In places stream courses follow the path of former glacial meltwater streams; sediment is primarily sand, silt and muck with gravel where coarser glacial stream sediment is being reworked.
			Beach	Narrow ridge(s) or slope surrounding modern lakes or wetlands; created by wave, wind and ice action; sediment is primarily well sorted sand in laterally continuous horizontal layers, coarser in places owing to reworking of pre-existing glacial sediment. May include finer-grained lake sediment.
			Channelized Lake Plain	Similar to lake plain but appearing in a subtle, broad linear depression. May be a channel that was then infilled by lake sediment, burying coarser material, or a channel cut into the lake sediment.
			Collapsed channel	Broad, elongated and irregular lowland; interpreted as stream channels that were formerly supported by ice; may represent former subglacial tunnels or channels with ice walls; although erosional in origin they have the potential to contain depositional ridges of sand and gravel (eskers) but also irregularly infilled by supraglacial, hummocky till, lake sediment and muck.
			Collapsed stream sediment	Narrow, irregular, low ridges; sediment is poorly sorted gravel and sand intercalated with diamicton; in places fines up to silt; interpreted to have been deposited in crevasses or low areas on the ice surface by running water and gravity or in subglacial tunnels.
			Delta or shallow lake	Gently sloping surface found between higher ground and flat lake plain; interpreted as deposited by streams entering lake and by

				reworking of pre-existing sediment by stream and lake. Varies in texture owing to changing lake levels but primarily silty sand to sandy silt in facies relationship (lateral and vertical changes) with clay and silt (lake sediment) and sand and gravel (stream sediment).
			Dunes or eolian feature	Low relief, undulating surface with or without discrete dunes; primarily located in former glacial lake plain and along major stream valleys; sediment is homogeneous, well sorted sand; interpreted as formerly active sand sheet that is now stabilized by higher water table and vegetation.
			Glacial stream sediment, terrace or bar	Channels, flat surfaces paralleling channels, streamlined forms within channels or lake plains or fans sloping away from former ice margins; sediment is primarily well sorted and bedded sand and gravel with silt. Interpreted as glacial meltwater stream sediment. In the northwest corner and south central map area, includes channels of spillway origin (lake drainage); may include non-glacial stream sediment.
			High relief thrust moraine	Large, irregular hills interpreted to be thrust blocks created by the Itasca lobe based on occurrence of similar features northwest of Aitkin County. Sediment is primarily diamicton but in other occurrences, thrust blocks are documented to have disrupted and include bedrock units.
			Hummocky moraine	Broad linear zone interpreted as demarcating the limit of an ice advance. Generally comprised of till but may be interspersed with collapsed stream sediment.
			Hummocky till	Irregular hills of unsorted deposit interspersed with irregular areas of sorted sediment and ice-walled lake plains; interpreted as originating in an unstable layer on unevenly down-wasting ice and may be sorted in places as a result of resedimentation.
			Ice-walled lake plain	Flat-topped hill with steep side slopes and somewhat circular outline; sediment is silt, clay and fine sand, laminated to layered; commonly with diamict layers or flow till; sorted sediment common along the edge of hill; sediment is interpreted to have accumulated in ice-walled depression in stagnant ice and was sorted to

				some degree by settling through standing wat
			Ice-walled lake plain or till with a silty cap	Interfluves of spillway channels in northwest corner of map area; sediment is silt and fine sand over glacial sediment; interpreted as either deposits of a higher stage lake or waning flow deposits of a flood from a glacial lake basin to the northwest or wind deposits that were preferentially deposited and/or preserved on till highlands.
			Interlobate complex	Broad and complex ridges, flat-topped in places; sediment is highly variable and includes sand and gravel layered with diamicton; may fine up to silt; interpreted as having been deposited in low areas on ice, between confluent lobes, or along margins of buried stagnant ice by running water and gravity.
			Lake plain	Level area of bedded to massive silt and clay; includes sand, trace gravel; may be overlain by modern organic material; interpreted as offshore lake deposits of glacial lakes Aitkin and Upham II or smaller post-glacial lakes.
			Low-relief till plain, washed	Undulating to nearly level surface of subdued and commonly streamlined expression; sediment is primarily diamicton but has the potential to have a coarse lag resulting from the removal of finer particles by water and/or be capped with a drape of fine sediment; interpreted as having been washed by water of a lake or stream.
			Scoured lake floor or underflow deposits	Description not available
			Spillway terrace	Bars and terraces in sinuous channels oriented down-gradient from former glacial lake basin; sediment is primarily sand and gravel; interpreted as spillway deposits associated with draining of a lake.
			Streamlined till	Streamlined low hills oriented generally with interpreted ice-flow direction; sediment is dense diamicton; interpreted as having formed beneath active ice.
	Potential	Text, 75	See Below	
			Significant Potential for Sand and Gravel Resources	These are geologic units that are inferred to contain sand and gravel based on their mode of formation and/or data exhibiting geologic characteristics associated with sand-and-gravel-bearing landforms.

				Existing gravel pit and MnDOT aggregate sources within these units are considered to be identified, or known resources that increase the level of confidence for that map unit.
			Nonsignificant Potential for Sand and Gravel Resources	These are units that generally have little or no potential for significant aggregate resources based on their geologic interpretation or lack of sufficient data to support a classification as a significant aggregate resource. These units typically contain clay, silt, fine sand, unsorted sediments and only very thin layers of sand and gravel. Units may include aggregate resources that are too small to map or with significant overburden.
	CLASS	Text, 75	See Below	
			High Potential for Sand and Gravel Resources	Includes landforms such as glacial stream valley, interlobate complex, and collapsed stream sediment. Predominant sediment typically consists of sand and gravel. The probability that a potential sand and gravel resource exists within any map unit is high. Deposit thickness ranges from 0-80 feet with generally less than 15 feet of overburden. Unit certainty is high as is unit probability. The sand and gravel resources occurring in this unit are large in areal extent and the textural characteristics are moderate to good. The quality is moderate to high relative to other sand and gravel resources within Aitkin County.
			Moderate Potential for Sand and Gravel Resources	Includes landforms listed above and collapsed channel, spillway terrace, and delta or shallow lake sediment. The predominant sediment is sand with varying amounts of gravel but fine sediment and diamicton do occur. The probability that a potential sand and gravel resource exists within any map unit is moderate to high. Deposit thickness typically ranges from 0-40 feet but in some landforms can be greater. Burial is typically greater than a high-quality deposit but is not typically over 25 feet. The sand and gravel resources occurring in this unit are moderate to moderately large (5-15+ acres) in areal extent and the textural characteristics are moderate to good. The quality is typically moderate to high relative to other sand and gravel resources within Aitkin County.
			Low Potential for Sand and Gravel Resources	May include any of the above landforms, but also lake plain, ice-walled lake plain, low-relief washed

				till plain, alluvial valley, or beach. Predominant sediment varies but is typically sand with silt and diamicton and only small amounts of gravel. The probability that a potential sand and gravel resource exists within any map unit is moderate to very low. Deposit thickness typically is less than 10 feet but ranges from 0-35 however, overburden thickness ranges from 25-40 feet and may present a barrier to mining. The sand and gravel resources occurring in this unit are moderately small to small in areal extent and the textural characteristics are generally good to very poor.
			Limited Potential for Sand and Gravel Resources	May include any of the above landforms, but also channelized lake plain, dune or eolian features, streamlined till, hummocky moraine and hummocky till. The deposits of this unit contain diamict, clay, silt and sand with only limited gravel. The probability that a significant sand and gravel resource exists within this unit is moderate to very low. A limited potential rating includes circumstances where characteristics are unknown; there were insufficient data to give a higher ranking; there was limited access to the area or there were no obvious sand-and-gravel-bearing landform associations at the surface.
	PROBABLTY	Text, 20	High, Moderate, Low, Very low	Also known in the map as 'Unit Certainty'. A relative measure of how easily delineated a certain map unit is based on its geomorphic expression;
	SGPROBLTY	Text, 20	High, Moderate, Low	The likelihood that sand and gravel occurs within that landform;
	TEXTURE	Text, 20	Good, Moderate, Poor, Very poor	Texture is the sediment in the landform which in some cases is based on a grain-size analysis and in other cases on the interpreted texture associated with a landform. Evaluated in the context of how well suited a deposit is for aggregate use (good, poor, moderate). A deposit that is primarily fine sediment (clay and silt) or a mixture (diamict) has a poor distribution of grain sizes for aggregate purposes. Glacial stream sediment is a mixture of gravel and sand with minor amounts of fine-grained sediment (silt and clay) and has a good to moderate texture depending on the ratio of gravel to sand (need some gravel and crushable

				material) and the presence of fines (need some silt for binder but not too much).
	QUALITY	Text, 20	High, Moderate, Low	Quality is a measure or estimate of the presence of sound, durable, lithologically suitable and dimensionally favorable clasts in a gravel (high, moderate, low). Clasts that break easily, absorb water, freeze, break, dissolve, expand when wet, have a high length to width ratio or react chemically are considered deleterious. Clast assemblages associated with a given ice-source area and flow path are related to lobe provenance. See the section in the published aggregate map titled, Geologic History as it Pertains to Sand and Gravel Distribution, for images of the clasts typically associated with a given provenance. The lobes that deposited sediment in the area now delineated as Aitkin County, or combinations of deposits that result from the overlapping extent of slightly different-aged lobes and post glacial events are Superior, Itasca, Brainerd sublobe, St. Louis sublobe, and glacial Lake Aitkin-Upham. Recent sediment not directly linked to a glacial lobe is of mixed provenance.
	DEP_VARBLTY	Text, 20	High, Moderate, Low	Depositional variability within a landform type, or how varied the processes are in a given depositional setting.
	DOM_LITHO	Text, 30	Ex: Superior; St. Louis sublobe; Itasca; Brainerd sublobe; Mixed	Lobe provenance or source of the material carried by a given ice lobe. For more information on the various ice lobes that crossed Aitkin County view the published aggregate resource map from the DNR.
	THICKNESS	Text, 15	5-15, 10-30, 20-100+, N/A	Gives range of minimum and maximum thickness if sand and gravel are present, as gleaned from well records, borings or surface exposures.
	OVERBURDEN	Text, 15	0-100+, 0-5, 10-50, N/A	Gives range of minimum and maximum thickness for overburden if sand and gravel are present, as gleaned from well records, borings or surface exposures.