UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
Harvey Thorleifson, Director

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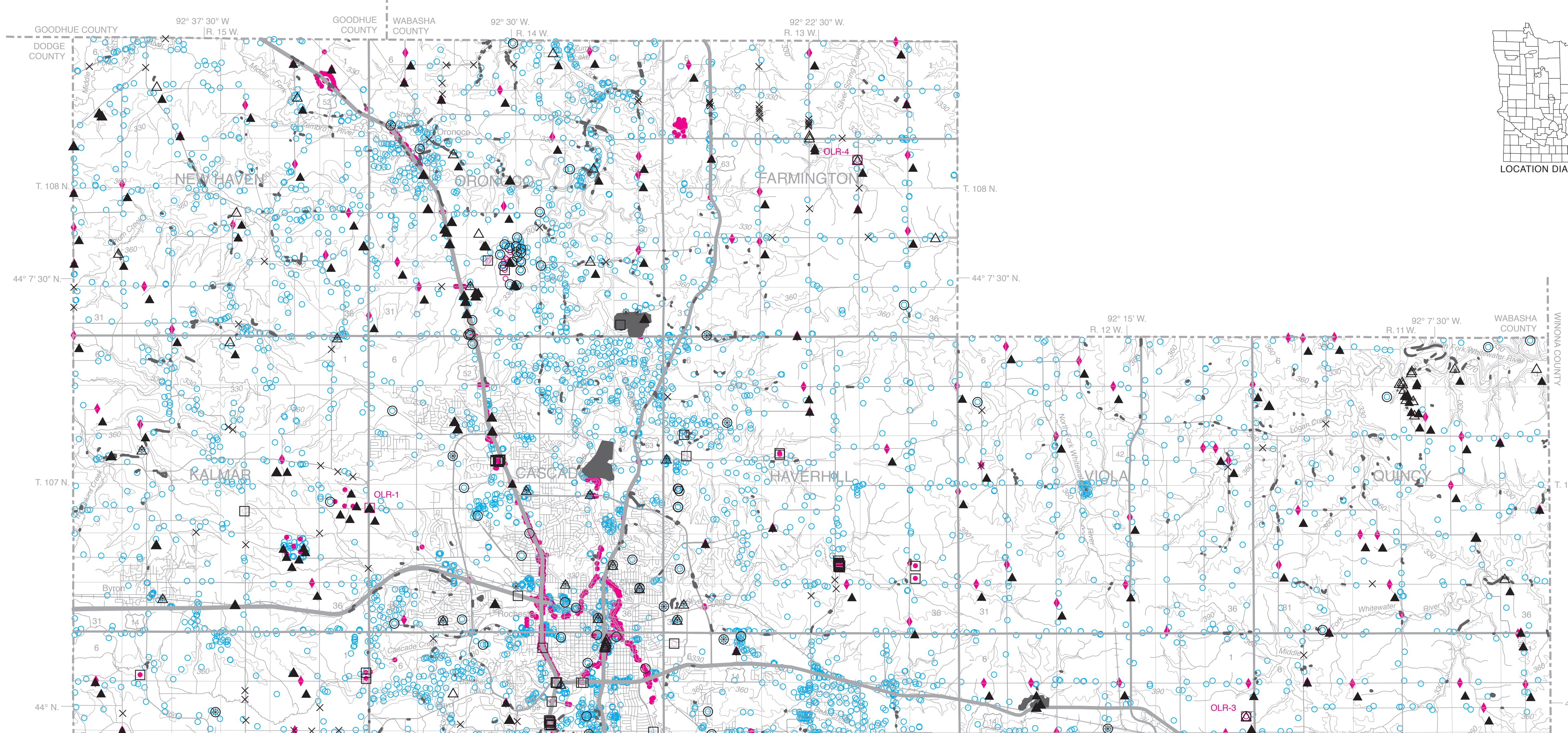

DATABASE MAP

By

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2020

GIS compilation by M.C. Pettus
Edited by Lori Robinson

Digital base modified from the Minnesota Department of Transportation BaseMap data; digital base annotation by Corey J. Betchwars.
Elevation contours were derived from the U.S. Geological Survey 30-meter Digital Elevation Model (DEM) by the Minnesota Geological Survey.
Universal Transverse Mercator Projection, grid zone 15
1983 North American Datum

SCALE 1:100 000
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS
CONTOUR INTERVAL 30 METERS

MAP SYMBOLS

- Record of water-well construction (well driller's log)
- Scientific investigation hole
- Rotary-sonic core sample
- Drill core sample
- Soil boring
- Cutting sample
- Borehole geophysical log
- Giddings probe hole
- Field site
- Textural analysis
- Passive seismic sounding
- Seismic refraction sounding
- Bedrock outcrop

Note: More than one symbol can occur at the same location

INTRODUCTION

The public health and economic development of Olmsted County are directly dependent on the wise use and management of its land and water resources. Geologic and hydrologic information are essential before decisions are made that affect natural resources. Although the amount of geologic information required for making specific decisions can vary, the information will not be used if it is unavailable when needed, or if it is available only in a highly technical form, or scattered in many different maps and reports. The databases described here address this need.

County Geologic Atlases, prepared jointly by the Minnesota Geological Survey and the Minnesota Department of Natural Resources, present detailed geologic and hydrologic information in an interpretive as well as descriptive form. Maps and texts summarize basic geologic and hydrologic conditions at a county scale, and interpret these conditions in terms of the impacts of possible land- and water-use decisions.

Several sources commonly provide information about an area or an individual property, but they may use different classification schemes to describe the same geologic materials. As a result, discrepancies in interpreting the data may arise or the different sources may appear to contradict each other. For example, water-well drillers may describe glacial till as "clay," but engineering records will describe it as "clayey sand." Both descriptions are acceptable for their original purpose of describing the physical attributes of the material. "Clay," the term used by well drillers, defines the general inability of the till to yield groundwater to a well. "Clayey sand," the term from the engineering record, defines the physical composition of the till relative to particle size and engineering properties. The geologist must take the analysis one step further and define the material in terms of how it formed rather than how it is to be used. In this example, till consists of an unsorted mixture of rock fragments ranging in size from clay to cobbles and boulders, and it is interpreted by the geologist to have been deposited directly by glacial ice. Understanding the process by which the material formed allows geologists to make predictions about what lies between and beyond data points.

All of the types of data described on this plate were interpreted by geologists or hydrogeologists to make them meaningful for mapping purposes. The 1:100,000 scale of the maps in this atlas was chosen because it shows the geologic and topical studies of the county while keeping the physical size of each plate to a manageable level. As a result, some detailed information that was gained by data interpretation and mapping cannot be shown on these maps or discussed in the texts. Some of this information is available in digital files that accompany the atlas.

Whether to use the atlas alone, or in combination with the databases, depends on the amount of detail needed. Generally, database information must be used to evaluate site-specific conditions.

THE DATABASE MAP

The types, locations, and density of information used to prepare the Olmsted County atlas are shown on this map. The data are described below to aid the user in assessing what types may be useful for a particular information need. The Database Map serves as a guide to the precision of the other maps in the atlas. It shows where data are sparse or lacking and interpretation and extrapolation were required to prepare the maps.

DRILL-HOLE INFORMATION

A **record of water-well construction (well driller's log)** is a water-well contractor's description of the geologic materials penetrated during drilling and the construction materials used to complete the well. Hydrologic data, such as the static water level and test-pumping results, are commonly included. Before any driller's log can be used, the location of the well must be verified, and a geologist must interpret the log. Driller's logs are the primary source of subsurface geologic and hydrologic data for Olmsted County; about 4,800 logs were used for this atlas.

Scientific investigation holes are drilled by various agencies to study the nature of the subsurface material. Geologic logs were generated that describe the material penetrated for each hole. In Olmsted County this includes holes drilled by the U.S. Geological Survey, Water Resources Division, including soil auger holes, test wells, and observation wells, to determine the hydrologic properties of local and regional aquifers.

Core samples were collected at various sites throughout Olmsted County as a means to establish the nature of the subsurface material. Rotary-sonic cores were collected by the Minnesota Geological Survey for this project from four sites in the county (labelled OLR-1 through OLR-4) to aid the interpretation of the Quaternary deposits and in determining bedrock depth and nature. The coring technique enables recovery of a continuous core, 3.5 inches (8.9 centimeters) in diameter, from glacial deposits and bedrock (where intersected). It provides excellent subsurface samples for detailed study and comparison with cuttings, geophysical logs, and driller's logs from surrounding sites. Detailed geologist's logs for the rotary-sonic cores are shown on Plate 4, *Quaternary Stratigraphy*. Bedrock core is most commonly collected using a diamond bit rotating at the end of a drill rod. A column of rock moves up the drill pipe and is recovered at the surface for study. Bedrock core exists for 165 sites in Olmsted County and are available for inspection at the Drill Core Library in Hibbing (the state repository for bedrock and earthen material core samples collected during exploration, engineering, and geoscience research programs across Minnesota, maintained by the Minnesota Department of Natural Resources). The Minnesota Department of Transportation collected core at 91 sites for roads and bridge foundations, the U.S. Natural Resources Conservation Service (formerly the U.S. Soil Conservation Service) collected core at 59 sites as part of a study of the South Zumbro Watershed, core was collected at 10 sites as part of the Minnesota Geological Survey Rochester-Olmsted Council of Governments study, the Natural Resources Research Institute collected three cores and Mathy Construction Company collected one core to study the carbonate rock formations in southern Minnesota, and one core was collected by the Minnesota Department of Natural Resources during installation of a groundwater observation well. The rotary-sonic core collected for this atlas are stored at the Drill Core Library in Hibbing, where they are available for inspection.

Soil borings are test holes drilled to obtain information about the physical properties of subsurface materials for engineering, mapping, or exploration purposes. They are logged by an engineer or a geologist using a variety of classification schemes based on particle sizes, penetration rate, moisture content, and color. Soil borings drilled by the U.S. Natural Resources Conservation Service and the U.S. Army Corps of Engineers are concentrated in the city of Rochester along the banks of the South Fork of the Zumbro River, Cascade Creek, and Bear Creek. Soil-boring data collected by the Minnesota Department of Transportation is concentrated along U.S. Highways 52 and 63, and Interstate 90. Descriptions of the geologic materials penetrated are interpreted by Minnesota Geological Survey geologists for mapping purposes.

Cutting samples collected during drilling provide physical evidence of subsurface geologic materials. Cuttings are the samples generated as the drill bit cuts through the subsurface material and are used to interpret and verify driller's logs. They are logged and stored at the Minnesota Geological Survey.

Borehole geophysical logs are collected by Minnesota Geological Survey staff, other government agencies, or private entities by lowering instruments down a well or drill hole and measuring the physical and chemical properties of the geologic materials through which the hole passes. Different logging techniques measure naturally occurring gamma radiation, spontaneous potential, and resistivity. Gamma logs characterize in graphic form the geologic formations penetrated. Spontaneous potential and resistivity are mainly used to locate water levels in wells and the depth of the well casing. An interpretive log is prepared by a geologist from the geophysical log and correlated with drilling samples from the same hole, information obtained from nearby outcrops, or a geophysical log from a nearby drill hole. Geophysical logs can provide high-quality subsurface geologic and hydrologic information for wells that have little or no other information available. Logs can be viewed at the Minnesota Geological Survey or accessed online (http://z.umn.edu/borehole_geo). The geologic interpretations are available through the County Well Index database described below.

Giddings probe holes are borings of glacial materials, 2 inches (5.1 centimeters) in diameter, collected by Minnesota Geological Survey staff using a truck-mounted hydraulic auger. A description was generated at every site and samples were taken for textural analyses at most locations. Samples were generally taken about every 5 feet (1.5 meters), at unit contacts, or where the geologist believed it was important.

OTHER INFORMATION

Field sites are natural and artificial exposures of unconsolidated Quaternary deposits that were described in detail; samples from many sites were texturally analyzed. Field sites include stream and river cuts, gravel pits, excavations, and road cuts.

Textural analyses express the proportion of sand-, silt-, and clay-sized particles that make up a sample. The samples analyzed were taken from natural and artificial exposures, Giddings holes, and the rotary-sonic cores. They are helpful in determining the origin, correlation, and hydrologic properties of unconsolidated sediments.

Passive seismic soundings provide information based on measurement and analysis of ambient shear- and surface-wave energy in the ground that allow a calculation of the depth to bedrock (thickness of unconsolidated deposits) beneath that point. The measurements employ a recording seismograph system that is implanted into the ground surface and records ambient ground vibrations in three orthogonal directions (two horizontal and one vertical) during a 16-minute interval. The method is called passive because no energy is directly input into the ground at the time of measurement, such as is the case for conventional seismic sounding. Instead, the unit measures background vibrations from a variety of natural and artificial sources that include wind, machinery, and traffic. The averaged horizontal spectra of the seismic noise is divided by the corresponding vertical spectrum, and the resulting Horizontal to Vertical Spectral Ratio (HVSR) should display a prominent peak that closely approximates the resonant frequency (shear wave) of the unconsolidated sequence overlying the bedrock surface (Chandler and Lively, 2014). In general, depth to bedrock calculated by this method can have errors up to 25 percent of the depth; however, in areas with little to no other data, this is still useful information and many soundings can be inexpensively collected over a short period of time with one or two operators. Ninety passive seismic stations were acquired in Olmsted County as part of this Geologic Atlas.

Seismic refraction soundings measure the time required for sound or pressure waves to travel from a source through the subsurface and be refracted back to a receiver. Travel time can be correlated with the density and rigidity of the geologic material. Precambrian and Paleozoic rocks commonly exhibit pressure-wave velocities that are 1.5 to 2.5 times those of unconsolidated Quaternary sediments below the water table. The spacing of the receivers (geophones) and the arrival times (measured in milliseconds) are used to calculate the depth to bedrock. Seismic refraction soundings are more labor intensive than passive seismic soundings, but can provide velocity information and higher-quality depth estimates. Twelve seismic refraction soundings were previously acquired in Olmsted County as part of earlier investigations by the Minnesota Department of Natural Resources.

Bedrock outcrops are exposures of solid rock at the land surface. Most are natural outcrops; however, some may be exposures created during construction or quarry operations. They serve as reference points for mapping and for checking the accuracy of subsurface data. Bedrock at or near the surface must be considered in land-use planning decisions such as pipeline routing, sewage-system design, and excavation.

DATABASE MANAGEMENT

All of the data shown on the map were plotted on maps at 1:24,000 or finer resolution and assigned inventory numbers. Included with the Olmsted County Atlas are regularly updated databases containing digital GIS files, developed to provide easy access and rapid retrieval of these site-specific data.

Computer storage and retrieval systems are ideal for manipulating large amounts of data because automated geologic databases can be designed to interact with other computer files, such as land-use data. Such interaction permits more efficient assessment of cause-and-effect relationships concerning natural resources than is commonly possible with manual files.

DIGITAL DATABASES

Computerized files were developed for point-source data such as wells and borings in Olmsted County. They use Public Land Survey descriptions, Universal Transverse Mercator (UTM), and latitude-longitude coordinates as location criteria; thus, they are compatible with the natural-resource databases housed at the Minnesota Land Management Information Center (LMIC). One computerized database developed for Olmsted County by the Minnesota Geological Survey is the County Well Index (CWI).

County Well Index (CWI)—Information from water-well records and other subsurface drill-hole data, such as exploration holes, is entered into this statewide database. Each well log is assigned a six-digit unique number and each exploration drill hole is assigned either a five- or six-digit unique number. These reference numbers are also used by state agencies and the Water Resources Division of the U.S. Geological Survey. Elevations are expressed in feet above sea level and were determined from either topographic maps (see the index to 7.5-minute quadrangles) or Minnesota's lidar high-resolution elevation dataset or Olmsted County's 2004 lidar 2-foot contour dataset. Elevations from the topographic maps are generally accurate to plus or minus 5 feet (1.5 meters) and the lidar elevations are generally accurate to within 3 feet (1 meter). The street address of each well is also included wherever possible to provide data users with a well-location system that is compatible with local regulatory programs. Software at the Minnesota Geological Survey is used to display and tabulate many of the data elements contained on the original well log. The program also denotes if there are additional data, such as borehole geophysical logs, cutting samples, or core, for an individual record.

The County Well Index is stored in a database that consists of 10 related tables. These tables contain information such as well depths, well construction, addresses, aquifers, dates drilled, static water levels, and pumping-test data. They also contain alternate well identifiers such as permit numbers or emergency-service numbers, and the well stratigraphy (the geologic materials encountered during drilling).

CWI application software developed by the Minnesota Department of Health provides two types of reports:

WELL LOG contains all the information about the well as it was reported by the contractor (Fig. 1). There may also be additional location information, land-surface elevation, aquifer designation, and remarks about the drill holes.

WELL STRATIGRAPHY contains the geologic log described by a well driller (Fig. 2). A geologist makes stratigraphic interpretations based on this description, and on her or his knowledge and understanding of the geology of Olmsted County. The interpretations are augmented in some cases by additional data sources, such as cuttings, borehole geophysical logs, or core. Only those drill holes with verified locations have stratigraphy assigned to them.

Other digital data—Details about other types of data shown on this plate are available in attribute tables for individual GIS shapefiles included in the atlas products. This includes information that is part of the Quaternary Data Index (QDI), an internal working database. The Quaternary Data Index contains information from field sites, rotary-sonic cores, soil borings, Giddings probe holes, soil auger holes, and textural analyses. Some detailed information associated with these data sources is not included in digital files that are part of this atlas. This includes descriptions of cutting samples, borehole geophysical logs, and additional information on passive seismic data. It is stored in various formats and can be obtained by request from the Minnesota Geological Survey.

Soil borings commonly contain detailed information that is not part of the files included in this atlas. The information can be accessed in either digital and paper files from the Minnesota Geological Survey. In addition, data may be obtained from the sources of the soil borings, such as the U.S. Natural Resources Conservation Service and the U.S. Army Corps of Engineers. Soil-boring data from the Minnesota Department of Transportation, Foundations Unit may be found on their web page (https://www.dot.state.mn.us/materials/foundations.html).

FUTURE DATA COLLECTION

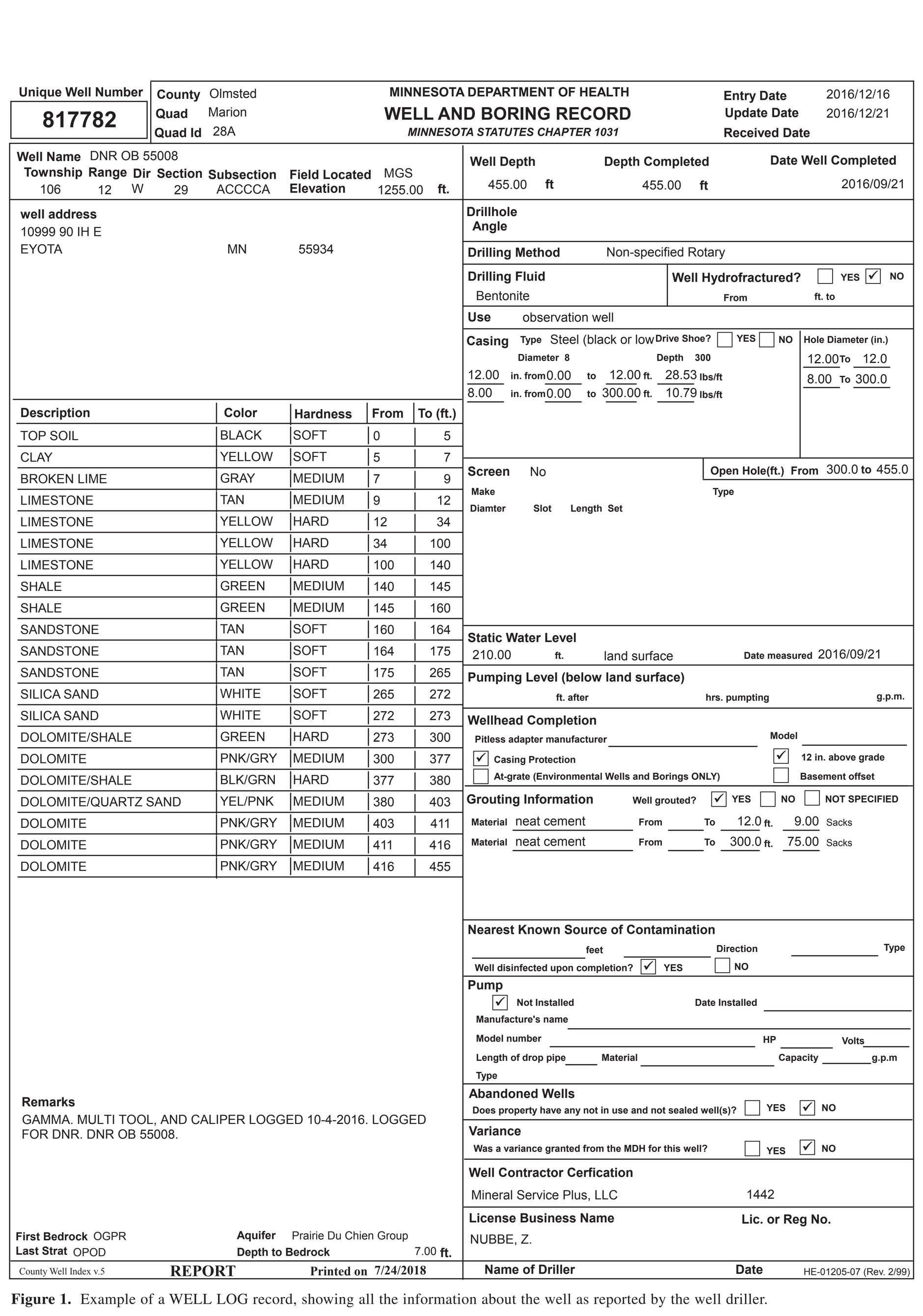
Additional geologic information is generated continuously as new water wells are drilled, construction activities expose more bedrock, or additional wells are tested for water quality. To address this, the library of information prepared for Olmsted County is flexible so that old data can be reevaluated in light of new information, and new forms of data can be added if required. The need to manage groundwater and other natural resources wisely will never become outdated. Future demands on these resources will require current data to assess the impacts.

ACKNOWLEDGEMENTS

The staff from the Environmental Resources Department of Olmsted County contributed greatly to the development of the County Well Index database. We thank local water-well contractors and landowners for their valuable assistance.

REFERENCE

Chandler, V.W., and Lively, R.S., 2014, Evaluation of the horizontal-to-vertical spectral ratio (HVSR) passive seismic method for estimating the thickness of Quaternary deposits in Minnesota and adjacent parts of Wisconsin: Minnesota Geological Survey Open-File Report 14-01.

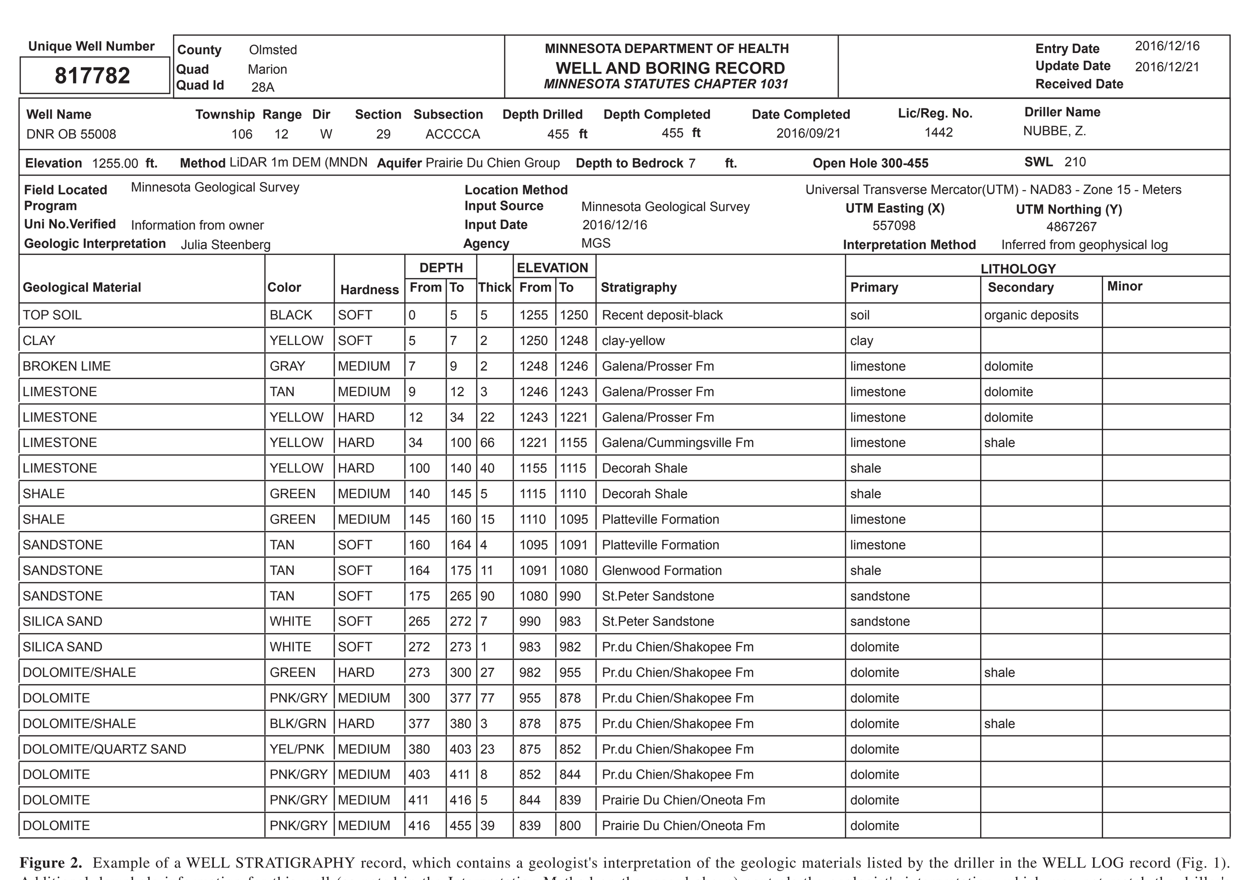


Unique Well Number 817782 — County Olmsted — Quad Marion — Quad Id 28A
MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD MINNESOTA STATUTES CHAPTER 1031
Entry Date 2016/12/16 — Update Date 2016/12/21

Description	Color	Hardness	From	To (ft.)
TOP SOIL	BLACK	SOFT	0	5
CLAY	YELLOW	SOFT	5	7
BROKEN LIME	GRAY	MEDIUM	7	9
LIMESTONE	TAN	MEDIUM	9	12
LIMESTONE	YELLOW	HARD	12	34
LIMESTONE	YELLOW	HARD	34	100
LIMESTONE	YELLOW	HARD	100	140
SHALE	GREEN	MEDIUM	140	145
SHALE	GREEN	MEDIUM	145	160
SANDSTONE	TAN	SOFT	160	164
SANDSTONE	TAN	SOFT	164	175
SANDSTONE	TAN	SOFT	175	265
SILICA SAND	WHITE	SOFT	265	272
SILICA SAND	WHITE	SOFT	272	273
DOLOMITE/SHALE	GREEN	HARD	273	300
DOLOMITE	PNK/GRY	MEDIUM	300	377
DOLOMITE/SHALE	BLK/GRN	HARD	377	380
DOLOMITE/QUARTZ SAND	YEL/PNK	MEDIUM	380	403
DOLOMITE	PNK/GRY	MEDIUM	403	411
DOLOMITE	PNK/GRY	MEDIUM	411	416
DOLOMITE	PNK/GRY	MEDIUM	416	455

Remarks: GAMMA, MULTI TOOL, AND CALIPER LOGGED 10-4-2016. LOGGED FOR DNR. DNR OB 55008.

Figure 1. Example of a WELL LOG record, showing all the information about the well as reported by the well driller.



Unique Well Number 817782 — County Olmsted — Quad Marion — Quad Id 28A
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Geological Material	Color	Hardness	Depth From	Depth To	Thick	Elevation From	Elevation To	Stratigraphy	Lithology Primary	Lithology Secondary	Minor
TOP SOIL	BLACK	SOFT	0	5	5	1255	1250	Recent deposit-black	soil	organic deposits	
CLAY	YELLOW	SOFT	5	7	2	1250	1248	clay-yellow	clay		
BROKEN LIME	GRAY	MEDIUM	7	9	2	1248	1246	Galena/Prosser Fm	limestone	dolomite	
LIMESTONE	TAN	MEDIUM	9	12	3	1246	1243	Galena/Prosser Fm	limestone	dolomite	
LIMESTONE	YELLOW	HARD	12	34	22	1243	1221	Galena/Prosser Fm	limestone	dolomite	
LIMESTONE	YELLOW	HARD	34	100	66	1221	1155	Galena/Cummingsville Fm	limestone	shale	
LIMESTONE	YELLOW	HARD	100	140	40	1155	1115	Decorah Shale	shale		
SHALE	GREEN	MEDIUM	140	145	5	1115	1110	Decorah Shale	shale		
SHALE	GREEN	MEDIUM	145	160	15	1110	1095	Platteville Formation	limestone		
SANDSTONE	TAN	SOFT	160	164	4	1095	1091	Platteville Formation	limestone		
SANDSTONE	TAN	SOFT	164	175	11	1091	1080	Glenwood Formation	shale		
SANDSTONE	TAN	SOFT	175	265	90	1080	990	St.Peter Sandstone	sandstone		
SILICA SAND	WHITE	SOFT	265	272	7	990	983	St.Peter Sandstone	sandstone		
SILICA SAND	WHITE	SOFT	272	273	1	983	982	Pr.du Chien/Shakopee Fm	dolomite		
DOLOMITE/SHALE	GREEN	HARD	273	300	27	982	955	Pr.du Chien/Shakopee Fm	dolomite	shale	
DOLOMITE	PNK/GRY	MEDIUM	300	377	77	955	878	Pr.du Chien/Shakopee Fm	dolomite		
DOLOMITE/SHALE	BLK/GRN	HARD	377	380	3	878	875	Pr.du Chien/Shakopee Fm	dolomite	shale	
DOLOMITE/QUARTZ SAND	YEL/PNK	MEDIUM	380	403	23	875	852	Pr.du Chien/Shakopee Fm	dolomite		
DOLOMITE	PNK/GRY	MEDIUM	403	411	8	852	844	Pr.du Chien/Shakopee Fm	dolomite		
DOLOMITE	PNK/GRY	MEDIUM	411	416	5	844	839	Prairie Du Chien/Oneota Fm	dolomite		
DOLOMITE	PNK/GRY	MEDIUM	416	455	39	839	800	Prairie Du Chien/Oneota Fm	dolomite		

Figure 2. Example of a WELL STRATIGRAPHY record, which contains a geologist's interpretation of the geologic materials listed by the driller in the WELL LOG record (Fig. 1). Additional downhole information for this well (as noted in the Interpretation Method on the record above) controls the geologist's interpretation, which may not match the driller's description of the geologic material penetrated.

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