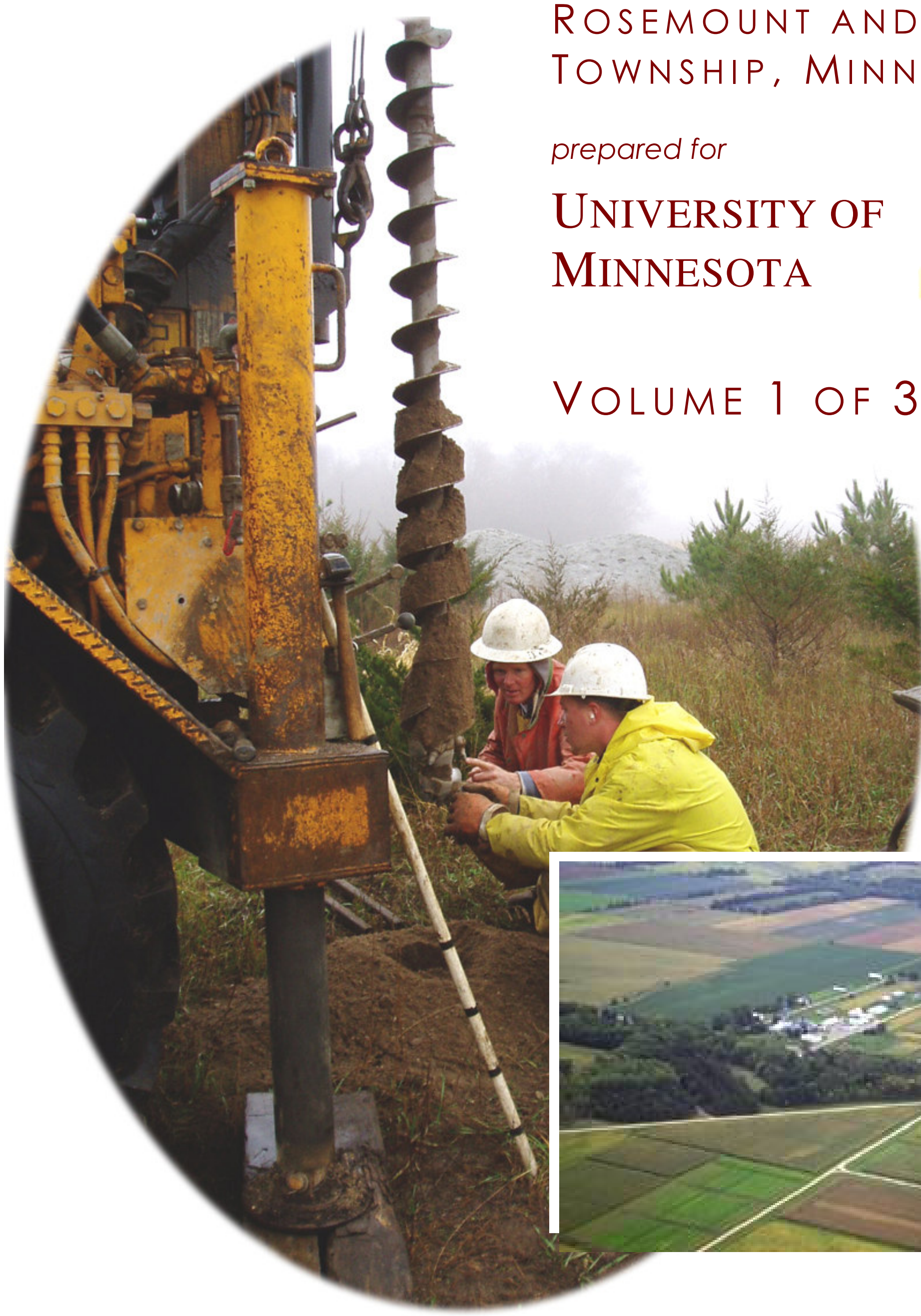
Geological Assessment
UMore Park
Rosemount and Empire Township, Minnesota

prepared for

University of Minnesota

Volume 1 of 3



September 3, 2008

prepared by

ProSource Technologies, Inc.

in association with

J.D. Lehr, PA

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1.0 INTRODUCTION

In 1947-1948, the U.S. government deeded to the University of Minnesota about 7,973 acres of land in Dakota County ("UMore Park"). In December 2006 the University's Board of Regents decided to pursue concept master planning on the approximately 5,000 acres in the northern sector of UMore Park. As part of the concept master planning process, an aggregate assessment began in early September 2007 to identify the location, quantity and quality of gravel.

During the first several decades of industrialization in the Twin Cities area construction aggregates were produced very close to their final use. Over the past 150 years local sources of construction aggregates have become either depleted or sterilized by competing land uses causing aggregate mining to be concentrated in those few undeveloped areas that happened to be endowed with valuable geologic materials.

From the early 1960's to the early 1980's Hennepin and Washington counties produced the majority of the aggregate consumed in the seven-county Twin Cities area. Since the early 1980's Dakota County has been one of the leading producers of construction aggregates in the state with approximately 10 million tons of production annually for the past several years. During this time most of Dakota County's aggregate production has originated in the general vicinity surrounding UMore Park.

Recognizing the regional significance of the long-time suspected sand and gravel resources on the UMore Park property the University of Minnesota Board of Regents authorized the formulation of a Request for Proposal entitled *Geological Assessment University of Minnesota Outreach, Research & Education (UMore) Park* (RFP #386-2007-0626).

This report is a summation of the Geological Assessment of UMore Park as specified in the above mentioned RFP and as completed by ProSource Technologies, Inc. and J.D. Lehr, PA between September 2007 and May 2008. The structure of the following paragraphs follows the structure of the RFP document and ProSource's proposal in response to it.

1.1 Purpose and Project Understanding

The identification of construction aggregate resources, the demarcation of those areas where potential mining activities will occur, and the plan for reclamation are important steps in allowing the University to plan for and secure approvals for the development of the northern 5,000 acres at UMore Park.

The University has hired under a separate contract a consultant, Jonathan Wilmshurst of Jess Resources, to oversee the geological evaluation of UMore Park and act as an intermediary technical person between the ProSource team and the University. The ProSource team worked very closely throughout the project with Wilmshurst to ensure that the information collected met the needs of the University for the long term.

The University's goal for the project was to achieve a sufficient understanding of the location, quality and quantity of marketable construction aggregates to inform decisions on potential mineral extraction, operations and reclamation in conjunction with the potential future development of a master planned community on the property. To accomplish this ProSource agreed to perform the following tasks:

- Complete a Phase I drilling and testing program on the approximately 5,000 acre property, with 450 holes completed by January 31, 2008 and any additional detailed drilling (Phase II) and final data report completed by May 30, 2008, or as agreed to with the University.
- Create a detailed database, including maps and logs, which will be used to perform an economic evaluation of the deposits on the property and for future extraction planning and development planning purposes; and
- Locate each hole drilled and catalogue and store (on UMore Park property) recovered materials for future use (20-year shelf life).

An in-depth interpretive report was not part of the scope of the RFP. Neither were any of the several potential derrivitive mapping products requested. It is assumed that these derrivative mapping products will be prepared at a future date as part of another related project.

The University provided ProSource with a previously prepared, localized evaluation of geological resources performed by R.K. Hoagberg Associates.[1, 2] The University also provided ProSource with use of a heated building for use as a field laboratory and a nearby building to store the archive samples.

1.2 Site Location and Description

The geological assessment was completed on the approximately 5,000 acres located in the northern portion of the property owned by the University of Minnesota located in the southern part of the City of Rosemount and northern portions of Empire Township, Dakota County, Minnesota (Figure 1). UMore Park is a portion of the land acquired by the United States Army during World War II for use in the manufacture of smokeless gunpowder and related products. The Gopher Ordnance Works (GOW) operated on the UMore Park property briefly during the later months of the war. Portions of the facility were still in the construction phase when the plant closed in 1945. Since then a portion of the land has been used primarily for agriculture purposes including research. The current landscape of UMore Park is primarily cultivated fields, a few fenced pastures and scattered wooded areas of varying size. These wooded areas are more numerous in the eastern portions of the property where they commonly contain remnants of the former Gopher Ordnance Works. Old roads associated with the GOW are also quite numerous, especially in the eastern parts of the property.

[1] Hoagberg, R. K. Associates, 2003a, Inventory and valuation of aggregate resources, UMore Park, Dakota County, Minnesota: RHA Report No. 0311, 131 p.

[2] Hoagberg, R. K. Associates, 2003b, Exploration for additional sand and gravel resources: An addendum to Inventory and valuation of aggregate resources, UMore Park, Dakota County, Minnesota: RHA Report No. 0317, 117 p.

2.0 GEOLOGICAL ASSESSMENT

2.1 Scope of Work

This section outlines the procedures that the ProSource team used to provide to the University information on the location, quality and quantity of marketable construction aggregates so that they can make informed decisions on mineral extraction, operations and reclamation in conjunction with the future development of a master planned community on the UMore Park property. The following tasks were completed by the ProSource team to achieve the level of understanding of the location, quality and quantity of marketable aggregates that is being requested by the University. Please note that all figures referenced are included under the "Figures" tab or "Plates" tab of this report.

2.2 Drilling Plan and Approach

ProSource performed a reconnaissance-level geological evaluation (Phase I) of the sand and gravel deposits that underlie the northerly 5000 acres at UMore Park by initially drilling a 200-meter grid of test holes. Due to the heterogeneous nature of glacial sediments, comprehensive evaluations of sand and gravel aggregate deposits in such complex terrains often require test hole spacing of 200 feet or less[3], so the 200-meter test hole grid should indeed be considered reconnaissance in scope.

Creation of the proposed test hole grid for the northern 5,000 acres of the UMore Park property (Figure 2) originated with the construction of a 100-meter grid. Beginning the Phase I drilling program with this 100-meter grid already designed allowed for a test hole and sample numbering scheme that is unified between the Phase I drilling program and the infill Phase II drilling that occurred in selected areas. The origin of this 100-meter grid is near the southwest corner of section 4; Empire Township at UTM coordinates 4,950,000 mN and 490,900 mE (Figure 2). The 100-meter grid consists of a total of 56 north-south oriented rows with as many as 40 test holes spaced 100 meters apart along the length of each row. The test holes on adjacent rows are offset or staggered by 50 meters.

The 200-meter test hole grid proposed for the Phase I drilling program was created by selecting from the 100-meter grid every other north-south oriented row beginning with row A and every other hole along those rows (Figure 2). According to the Minnesota Geological Survey's most recent assessment of the aggregate resources of the Twin Cities[4] there is small area of about 115 acres in the northeast corner of UMore Park that has very little potential for sand and gravel deposits so the drilling grid was not extended into this area. This area of low potential was confirmed as a result of this study as being somewhat larger that previously mapped.

The location in the field of each proposed drill site was accomplished using a combination of a Trimble Model 5800 Total Station GPS and Trimble S6 Optical Total Station each with a

[3] Barksdale, R.D., ed., 1991, The aggregate handbook: National Stone Association, Washington DC.

[4] Southwick, D.L., Jouseau, M., Meyer, G.N., Mossler, J.H., and Wahl, T.E., 2000, Aggregate resources inventory of the seven-county metropolitan area: Minnesota: Minnesota Geological Survey Information Circular 46, 91 p.

horizontal/vertical accuracy of ± 0.1 foot. Horizontal coordinates used are based on the Universal Transverse Mercator (UTM) Zone 15 grid and elevations are made in reference to NAVD88.

Once the proposed test hole location was identified in the field with GPS, a wooden lath labeled with the test hole number and marked with flagging was driven into the ground. Actual test hole locations were finalized only after the drilling contractor had conducted utility location meetings with the Gopher One Call utility locators and after approval of each test hole location by the University. In many cases proposed test hole locations were adjusted to accommodate a variety of University concerns for certain proposed drill sites. Prior to harvest during the months of September, October and November many proposed test hole locations were adjusted to avoid impacting crops and damaging sensitive fields. This was of particular concern in the area of research plots in the western portions of the property. Certain areas were not explored at this time because of the increased likelihood of encountering contamination resulting from the operation of the Former Gopher Ordnance Works. Test hole locations were offset in those cases where the proposed location occurred within 25 feet of Gopher Ordnance Works building remnants. Those proposed Phase I test hole locations that were eliminated by the University for potential environmental concerns are summarized below:

PointID	X	Y	PointID	X	Y
Y1600	493,300	4,951,600	EE1700	493,900	4,951,700
Y1800	493,300	4,951,800	EE1900	493,900	4,951,900
Y2000	493,300	4,952,000	EE2100	493,900	4,952,100
Y2200	493,300	4,952,200	EE2300	493,900	4,952,300
AA1500	493,500	4,951,500	GG1800	494,100	4,951,800
AA1700	493,500	4,951,700	GG2000	494,100	4,952,000
AA1900	493,500	4,951,900	OO2400	494,900	4,952,400
AA2100	493,500	4,952,100	OO2600	494,900	4,952,600
AA2300	493,500	4,952,300	WW2400	495,700	4,952,400
CC1600	493,700	4,951,600	WW2800	495,700	4,952,800
CC1800	493,700	4,951,800	YY1700	495,900	4,951,700
CC2000	493,700	4,952,000	YY2300	495,900	4,952,300
CC2200	493,700	4,952,200	YY2500	495,900	4,952,500
CC3200	493,700	4,953,200	YY2700	495,900	4,952,700

As snow accumulated and drifted during the winter, especially along fence lines and tree lines, difficult access to certain proposed drill sites caused some locations to be slightly offset.

From the beginning of the project it was assumed that parts of the UMore Park property would be found to contain economic quality and quantities of sand and gravel. It was also assumed, that in some areas, the 65 foot maximum depth specified in the RFP for flight auger drilling would not be sufficient to have penetrated the economic interval. Or in other words, some test holes were expected to terminate while still in economic sand and gravel. It was planned from the beginning of the project that these areas would receive follow up Phase II drilling. It was assumed that the Phase II drilling program would consist of a mixture of additional flight auger drilling in areas where the deposits are less than 65 feet thick and rotasonic drilling in areas where the bottom of the deposit was not encountered in the upper 65 feet.

In order to meet the University's desire to complete the project over the winter season, the Phase II drilling program had to begin before the entire Phase I drilling program had been completed. Phase II rotasonic drilling commenced on January 17, 2008 in the western part of the property and continued intermittently and simultaneously with flight auger drilling until April 23, 2008, generally working across the property from west to east. The Phase II flight auger drilling program began on February 21, 2008 at which time 421 Phase I flight auger test holes had been completed leaving only those excluded areas and the main Gopher Ordnance Works area yet to be covered by the Phase I flight auger drilling pattern. The Phase II flight auger drilling program was interrupted from March 17 to March 27, 2008 to complete the Phase I auger drilling in the main Gopher Ordnance Works area. Phase II auger drilling was completed April 22, 2008 and the Phase II rotasonic drilling was completed on April 23, 2008.

A meaningful yet simple test hole and sample numbering system on a project of this size can be helpful to reduce data entry error and also hopefully makes the final dataset easier to work with for the end user. The test hole numbering system used is a combination of a letter(s) representing the test hole row and a four digit number representing the distance in meters north of UTM 4,950,000 (Figure 2). With this system one can readily discern that a test hole from row KK is east of one from row Y. Likewise the second part of the test hole number indicates how far north on the property the test hole is located.

2.3 Drilling Procedures

Large diameter flight augers (>8 inches) are key to obtaining accurate sand and gravel samples and have been shown to more accurately represent coarser sediment than four- to six-inch augers[5]. Each of the Phase I test holes were drilled using nine-inch diameter solid shaft flight augers. The first two weeks' of Phase I auger drilling was subcontracted to WDC Wells and Exploration and carried out using a CME model 85 drilling rig. The remainder of Phase I and all of Phase II auger drilling was carried out by Braun Intertec using a CME model 750 all-terrain drilling rig.

Each flight auger test hole was drilled using the "corkscrew" method[6] of drilling of sand and gravel deposits whereby each length of flight auger is advanced into the ground using a minimum amount of rotation so as to reduce the amount of mixing between different stratigraphic layers. According to this method, when the desired depth for sampling had been reached, the auger string was then pulled straight from the hole without rotation ("dead pulled"). As augers were retrieved from the ground, material from previously drilled and sampled intervals was removed and discarded. When the required sampling interval was reached, the outer portion of the material on the augers representing

[5] Ellingson, J.B., 2003, Analysis of drilling and sampling techniques used to obtain representative and accurate samples in coarse grained sand and gravel deposits: Minnesota Department of Natural Resources, Division of Lands and Minerals Report 347, 33 p.

[6] Timmons, B. J., 1994, Prospecting for natural aggregates: An update, Part 3: Rock Products, v. 97, no. 10, p. 43-46, 54.

contamination from the upper walls of the borehole was scraped off (see photographs below. Samples were taken from the interior portion of each five-foot length of auger and placed into a five-gallon bucket for handling.

Augers prior to scraping off

After scraping, ready to sample

The more frequent the sampling (i.e., every five feet), the more accurate the stratigraphic control of each sample would be. However, sampling every five feet becomes very time consuming and therefore very costly. We proposed to sample the material encountered in each test hole in the following fashion:

Target Sampling Intervals	Alternate Sampling Intervals
0-5 feet	0-5 feet
5-15 feet	5-25 feet
15-30 feet	25-45 feet
30-45 feet	45-65 feet
45-65 feet	

Sampling the zero to five-foot interval in both options is important because, based on our experience with the conditions at properties surrounding the UMore Park property, the top of the sand and gravel interval (bottom of the overburden) is often encountered in the three- to five-foot range. The target sampling strategy shown above was used for the first few weeks of the project, however after that time the alternate sampling intervals were used. No single sampling run was longer than 20 feet as specified in the RFP.

The goal for each Phase I and Phase II flight auger test hole was drill to a depth of 65 feet or encounter the bottom of the economic sand and gravel interval. The following plan for the possibility of encountering obstructed drilling conditions prior to reaching either 65 feet of depth or the bottom of the commercial sand and gravel interval was agreed upon. In situations where the obstruction occurred in the upper 30 feet, the drill was relocated within approximately 10 feet and began a new test hole. There were four instances where obstruction occurred at depths ranging from 10 to 26 feet and in each of these cases the second attempt penetrated the obstruction. The initial attempt at these locations is differentiated from the second and successful attempt by the addition of the letter “A” to the end of the test hole number (PointID). These first attempts do not have either coordinates or elevations assigned to them on the drilling logs or in the database

Upon completion of each flight auger test hole they were backfilled with cuttings, and when necessary supplemented with imported sand from a nearby gravel pit. The wooden stake with the test hole number and flagging was then placed into the ground marking the test hole location until it was mapped with at a later time with GPS. The rotasonic test holes were abandoned according to a plan described in Appendix A.

2.4 Logging System

There are no existing standards that entirely satisfy the aggregate industry’s specific needs for logging (describing) glacial sand and gravel in deposits such as the Rosemount outwash plain. The ASTM Unified Soil Classification System by itself does not provide enough detail to discern economic sand and gravel deposits from sub-economic or non-economic materials. For this reason and to provide the University with a consistent final product, ProSource employed a single drill rig to complete all of the proposed flight auger test holes so that each hole drilled would be logged in a consistent manner by J.D. Lehr according to procedures he developed over the years working for Twin Cities’ area aggregate producers.

Rotasonic drill cores were collected simultaneously with the auger drilling program during the Phase II drilling program and were transported to the field laboratory by Aric Olsen to be logged and sampled by J.D. Lehr at a later time. The logging system used on this project along with some relevant background information is summarized below.

The primary geologic attributes that make sand and gravel deposits valuable in the Twin Cities area market are, in general order of importance:

- Percentage gravel;
- Deposit thickness;
- Overburden thickness;
- Lithologic composition and degree of weathering;
- Gradation of the sand fraction;
- Percentage of silt and clay (minus 200 mesh);
- Percentage of the deposit below the water table;

- Spatial extent of deposit; and
- Particle shape.

Known deposits in the vicinity of the Rosemount outwash plain generally have a desirable thickness of sand and gravel that is mostly above the local water table and is overlain consistently by relatively thin overburden. Since the Rosemount outwash plain was deposited by the Superior lobe glacier, the lithologic composition of known deposits is also consistently very good where there has been no mixing with Des Moines lobe materials. The age of the Rosemount outwash plain is fairly young in geologic terms resulting in generally low-grade weathering of individual rock fragments. Known sand and gravel deposits in the Rosemount outwash plain also fairly easily produce a variety of sand products, meaning that the sand gradation, the particle shape and the amount of silt and clay present are also generally acceptable to the industry. By far the most important geologic attribute of economic sand and gravel deposits in the Rosemount outwash plain area is the percentage of gravel present.

The logging system used treats the non-economic materials somewhat different from those materials that may represent commercial sand and gravel. The overburden and materials that underlie the economic materials are generally not logged with as much sedimentologic detail as the economic and sub-economic sand and gravel intervals, but great attention is paid to accurate depth determinations. In other words, it is more important to know if the overburden is six or eight feet thick than whether it was silty clay or clayey silt. On the other hand, a sand lens a foot or two thick within a sequence of sand with 30 percent gravel may be described after it has been homogenized with the remainder of the five-foot sample because that is the way it would be mined.

In the logging system used, the first part of the description is that of the predominant material present in that interval (see test hole logs). Examples are: topsoil, silt, clay, sand, sand & gravel, till and sandstone.

Next, for granular intervals (economic and sub-economic sand and gravel intervals) the sand fraction is described according to the commonly used geologic grain size classification system of Wentworth[7] (Figure 3). This classification provides necessary detail on the predominant range of grain sizes present within the sand fraction (five size fractions).

The next part of the logging system is an optional modifier for the sand fraction. If no comments are made in this section, then the sand has a silt and clay content (minus 200 mesh) of about three to five percent and contains no other deleterious fines such as iron-oxide staining. Sand that is properly graded from fine to very coarse and with a minus 200 mesh content of three to five percent can readily be used to produce a variety of sand products. A description of sand modifiers used in this logging system is presented below.

[7] Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, v.30, p. 377-392.

SAND MODIFIER TERM	EXPLANATION
Clean	Less than approximately three percent minus 200 mesh
Slightly Dirty	Approximately five to 10 percent minus 200 mesh
Dirty	Approximately 10 to 15 percent minus 200 mesh
Very Dirty	Greater than approximately 15 percent minus 200 mesh
Slightly Iron-Stained	Small amount of iron-oxide present, usually in very thin layers that upon mixing with the remainder of the interval becomes unnoticeable
Iron-Stained	Thicker and more widespread presence of iron-oxide layers
Very Iron-Stained	Pervasive iron-oxide

The next part of the proposed logging system describes the relative percentage of gravel (plus #4 sieve) present in the samples. Because percentage gravel is the single most important geologic factor that determines the value of a sand and gravel deposit in the Twin Cities market, one of the project goals was for every 5-foot sample collected to have the percentage gravel determined in the laboratory according to procedures outlined in a following section. In some instances where either the percentage gravel or the sample volume was low, the interval sampled then was greater than 5 feet. Upon receiving the results of the sample gradations, the drilling logs and database were updated so that terms used for relative percentage gravel shown on the drilling logs equate to the actual percentage gravel determined as follows.

RELATIVE PERCENTAGE GRAVEL TERM	ACTUAL PERCENTAGE GRAVEL PRESENT
Sand. No Gravel.	Less than 1 percent
Sand. Very minor trace gravel	1 to 5 percent
Sand. Very minor gravel	5 to 15 percent
Sand. Minor gravel	15 to 25 percent
Sand & Gravel	25 to 40 percent
Gravel & Sand	Greater than 40 percent

The next part of the logging system used describes the gravel size fraction of the sample. Here the logging system used deviates slightly from the Wentworth classification. Rather than use the terms granules, pebbles, cobbles and boulders to describe the variously sized gravel fractions, the term *gravel* is used to encompass all of these Wentworth size classifications, thereby eliminating any bias in the users of the data set as to what is the difference between a pebble and a cobble for example. Detail on the size classification within the gravel fraction comes from referring to actual particle diameters in inches. This part of the drilling log usually includes only the maximum gravel particle size present in the interval when the gravel fraction is fairly evenly graded from fine to coarse. In some cases where the gravel fraction has a bimodal distribution, the gravel fraction may be described as "*…minor gravel to two inches, mostly less than 1/2 inch*" for example.

The size fraction from two to 4.75 mm, also known in the local aggregate industry as *buckshot*, represents the upper end of "fine aggregate", according to industry usage while the two to four mm fraction represents the lower end of the gravel size class, or *granules* of the Wentworth classification. In the logging system used the coarser portion of the two to 4.75 mm size fraction is grouped with the fraction 4.75 mm to 3/8 inch and referred to as "pea gravel" while the finer fraction (approximately #8 to #10 sieves) is included in the very coarse sand fraction (Figure 3).

As described above, samples were collected from each five-foot length of flight auger drilled into a five-gallon bucket. These samples were then immediately transferred onto individual steel pans for each five-foot interval where they were mixed then logged according to the system described above and photographed.

For the photographs, each pan containing a 5-foot sample was marked to indicate from what depth interval it was collected. Each photograph also contains a label on a chalkboard indicating the test hole number. Photographs are organized electronically so that the filenames reflect the test hole number and the sampled interval (testholenumber fromdepth-todepth). Photographs are grouped into file folders/directories by alphabetical row.

An additional attribute that has proven useful to log during flight auger evaluation of sand and gravel deposits is drill action. Intervals where gravel is indicated by the combination of the field geologist's and the driller's interpretation of the way the drill behaves were noted and are part of the final drilling log. This attribute is not recorded for rotasonic test holes.

Materials sampled and logged were designated as economic, sub-economic or non-economic in the field based on J.D.'s experience with evaluating other properties in the vicinity of the Rosemount outwash plain. This economic classification was in some cases adjusted later in the project in consultation with Jonathan Wilmshurst and with the laboratory testing results in hand. Considering the large volume of sand and gravel present on the UMore Park property and the resulting long time period over which this material may be mined necessitates looking ahead and predicting what will constitute *economic* and *sub-economic* in the future. As a very general guideline, 20 percent total gravel and 20 foot deposit thickness were used as the economic/sub-economic threshold. However, there are many areas with results less than this threshold that are included here as economic based on data from nearby test holes.

A very brief geologic interpretation is also included on each the drilling logs. For the materials overlying bedrock, the geologic term that implies the origin of the various sediments is noted on the drilling logs. Examples of these terms are topsoil, loess, till, outwash, and lacustrine sediment. If bedrock is encountered, an interpretation of to which stratigraphic unit it belongs will be shown in the geologic interpretation column.

Other information that is recorded on the drilling logs includes

- Ground water depth, if encountered;
- General site conditions including whether the test hole is located below or above natural grade;
- Drilling method, drilling rig used and drilling contractor;
- Beginning and ending dates and times for each test hole;
- Name of the person who prepared the drilling log;
- Record of the sampling runs made;
- Intervals that were sampled; and
- Any general comments about the test hole or the drilling process.

2.5 Sample Collection Procedures and Management

For each of the flight auger test holes drilled samples collected from each five-foot interval drilled were placed onto steel trays at the drill site for logging and photographing. If the break between non-economic materials (overburden for example) and either sub-economic or economic materials occurred within a five-foot interval, these materials were kept separate in the trays. A goal was to achieve a sample size of approximately 25 pounds or more for each five feet of granular material sampled; while at the same time keeping the amount of material representing borehole side wall scrape to a minimum. For those samples from intervals less than five feet thick, the decision whether to sample them separately or combine with an adjacent sample was generally based on the amount of sample available for that partial interval.

After the materials in each tray were logged and photographed in the field, those intervals that were classified as either economic or questionably economic were transferred into sample bags marked according to the following convention: TestHoleNumber:FromDepth-ToDepth, for example C1700:20-25. For this sampling phase of the project we used the type of plastic woven sample bags (sand bags) that are customarily used in the industry for this purpose. These samples were delivered usually twice daily to the field testing laboratory set up in the building provided by the University where they were analyzed. The non-economic materials sampled were discarded at the drill site and mostly used to backfill the test holes.

A very unique and useful feature of the building provided to ProSource by the University is the presence of large-scale drying ovens that in the past were used by agronomy researchers. Once at the field testing laboratory, up to 100 samples at a time were placed into the four drying ovens and were usually sufficiently dried overnight to be screened. Upon removal from the ovens, the raw five-foot samples were screened using a Gilson Model TS-1 testing screen into the following size fractions, plus 1-1/2 inch, 1-1/2 inch to ¾ inch, ¾ inch to #4 sieve and a minus #4 sieve (sand) fraction. The weights of each gravel (+#4) size fraction were recorded onto laboratory data entry sheets and later entered into the project database. At this time photographs of the screened samples were also taken. These photographs are named and organized in the same manner as the field sample photographs described above. Next, the entire gravel fraction of each 5-foot sample was combined for the creation of an archive composite sample of the entire gravel fraction sampled for each test hole.

The minus #4 mesh fraction of each five-foot sample was sub sampled to create a single composite sample of the minus #4 mesh fraction for the entire granular interval in each test hole according to the following procedures. A 500 ml laboratory measure was used to sub sample the minus #4 mesh size fraction so that each 100 ml of sample represented 1 foot of interval sampled. In other words, for a sample representing five feet, 500 ml of minus #4 mesh material was sub sampled from that interval and for a sample representing 8 feet, 800 ml was sub sampled. This method provided the University with the requested sample size of one half pound of the minus #4 portion for each foot of granular material encountered according to the following reasoning. Assuming a density for the minus #4 mesh material of 2.65 g/cm^3 and 1 ml = 1 cm^3, then 500 ml of material representing five feet weighs 1,325 grams or 2.9 pounds. An archive composite sample of the minus #4 mesh size fraction for an interval from five to 65 feet weighs approximately 34 pounds. The minus #4 mesh material that remained after the sub sample has been taken was discarded into a pile outside of the field laboratory building. The University has agreed to dispose of this material (mostly sand) at their cost.

The minus #4 mesh material composite sample was then thoroughly mixed and an approximately 1000 gram sub sample was selected in the same manner described above. These 1000 gram sub samples were then sub-sampled to approximately 400 ml (1,060 g) of minus #4 mesh material and subjected to sieve analysis using an Intermatic sieve shaker and ATM Products testing sieves. The following sieves specified in ASTM C33 were used in the sieve analysis of the minus #4 mesh fraction: #4, #8, #16, #30, #50, #100, and #200. The weight of each size fraction was recorded on a laboratory data entry sheet and later entered into the project database. The minus #4 mesh materials remaining after this sieve analysis were discarded.

2.6 Sample Archive/Data Management

To insure a long shelf life the archive composite samples were placed into new plastic pails with tightly closing covers and catalogued according to the following procedure. After completion of each sieve analysis of the gravel fraction for each interval sampled the gravel fraction was transferred into a 5-gallon plastic pail for long term storage.

Likewise, the minus #4 mesh fraction that remained after the 1000 gram sub sample had been taken was also placed into 3-gallon plastic pail for long term storage. Each archive sample pail was marked in three separate ways. First, the sample number was written on the outside of the pail using a permanent black marker. An aluminum tag with the sample number embossed onto it was wired to the handle of each sample pail. An additional wooden tag with the sample number written on it was placed inside of each sample pail.

The following convention was used to label the archive composite samples. TestHoleNumber:FromDepth-ToDepth-S for the minus #4 mesh size fraction and TestHoleNumber:FromDepth-ToDepth-G for the plus #4 mesh size fraction. Each pail was securely sealed with a cover and organized onto wooden pallets in the storage building at the Lone Rock trailhead.

2.7 Final Products and Database

The results of all test hole logging, sample photographs, laboratory test results and GPS and GIS mapping are herein provided to the University so that this information can be used to perform an economic evaluation of the deposits underlying the UMore Park property; plans for the future mining of the property; and in the ultimate planning and development of the new community. The final products of the completed project are listed below.

- Drilling logs including the location, depth, and description of materials encountered[8]
- Field sample photographs[9]
- Laboratory sample photographs[10]
- Laboratory test data summary sheets prepared for each test hole from the electronic databases[11]
- Map showing the locations of each test hole drilled[12]
- Map showing the total thickness of overburden encountered[13]

[8] Filename: Final Drilling Logs - Geological Assessment, UMore Park.pdf

[9] Filename: PointID fromdepth-todepth.jpg. Photographs are grouped into file folders/directories by alphabetical row.

[10] Filename: PointID fromdepth-todepth.jpg. Photographs are grouped into file folders/directories by alphabetical row.

[11] Filename: Laboratory Test Data Summary Sheets.pdf

[12] Filename: Plate 1 – Test Holes Drilled.pdf

- Map showing the total thickness of sand and gravel encountered[14]
- Map showing the spatial variation of percentage of gravel present in each hole sampled[15]
- Map showing material encounterd at the bottom of the economic interval[16]
- Map showing the elevation of the bottom of the economic deposit[17]
- Map showing the results of a calculation of volume of non-commercial materials that overlie the sand and gravel deposits (overburden)[18]
- Map showing the results of calculations of the amount of economic sand and gravel and areas that are likely non-commercial in nature[19]

Data collected on the field drilling logs was entered into a database created and managed using the geotechnical and geoenvironmental software gINT version 8.0. Laboratory test data generated throughout the course of this project were managed using Microsoft Excel with portions of the data pasted into gINT for portrayal on the drilling logs. The details of the project databases are described in Appendix B.

A drilling log has been prepared for each test hole drilled using the report writing functions of gINT. It was decided that a consistent vertical scale was more important than fitting each log to a single page.

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[13] Filename: Plate 2 – Overburden Thickness.pdf

[14] Filename: Plate 3 – Total Thickness of Economic Sand and Gravel.pdf

[15] Filename: Plate 4 – Weighted Average Percent Gravel.pdf

[16] Filename: Plate 5 – Material at Bottom of Deposit.pdf

[17] Filename: Plate 6 – Elevation of Bottom of Deposit.pdf

[18] Filename: Plate 7 – Overburden Volume Estimate.pdf

[19] Filename: Plate 8 – Sand and Gravel Volume Estimate.pdf

We have provided the final products and the project database in a variety of digital file formats on DVDs. The field and laboratory sample photographs are provided only in their native jpg file format. The printed versions of the drilling logs, the laboratory test data summary sheets, the various maps and the report are provided in Adobe Portable Document Format (pdf). The main project database is provided in both a Microsoft Access database file format and Microsoft Excel file format. Some of the ArcGIS shape files created specifically for this project are also provided in ESRI shape file format.

3.0 CERTIFICATION

ProSource has prepared this Geological Assessment Report for the exclusive use of the University of Minnesota, and its agents, for specific application to the UMore Park site located in Rosemount and Empire Township, Minnesota.

I certify that the hydrogeologic portions of this document and all attachments were prepared under my direction or supervision under a system designed to assure that qualified personnel gathered and evaluated the information submitted. Based on my inquiry of the persons or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. Furthermore, I certify that I am knowledgeable in the field of hydrogeology.

Name and Title:	Signature:	Date Signed:
Wade A. Carlson, P.G. – President		
J. D. Lehr, P.G. – Geologist		
Aric Olsen - Hydrogeologist		

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