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MATERIALS SURVEY OF OUTAGAMIE COUNTY

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Materials Survey of Outagamie County

Introduction

The purpose of this report is to give a general description of the types of geologic materials occuring in Outagamie County. The area adjacent to the Fox River Valley is emphasized. For convenience the county is divided into 14 provinces (fig. 1). They are defined by topography and the nature of the materials as seen in drill holes, natural exposures, road cuts, sand and gravel pits, and quarries. Each province is summarized in the text of the report. For details of the materials in various places refer to Appendix # 1 (drill holes), Appendix # 2 (sand and gravel pits, and quarries), and Appendix # 3 (road cut observations).

Each materials province presents unique problems in addition to the acquisition of materials, such as those encountered in excavations and in foundations for bridges and other structures. However, except for the included information on general topography and materials present, no attempt is made to discuss them.

The study is financed by funds from the State Highway Commission, under the auspices of the State Geological Survey. Field studies and preparation of this report were accomplished in the period from June 12 to September 9, 1961. All previous materials reports for the county, available drilling logs in the files of the Soils Laboratory of the State Highway Commission, and pertinent published literature (see selected bibliography) were examined. Mapping in the field and office was accomplished on topographic maps or planimetric maps, and aerial photographs. A Mobile Drill, B-36, power auger was made available for one month by the State Highway Commission. No field assistants were provided.

Bedrock Geology

Outagamie County is underlain by Pre-Cambrian crystalline rocks and by Upper Cambrian and Middle Ordovician sedimentary rocks. Pre-Cambrian exposures are non-existent and Cambrian and Ordovician exposures are limited and scattered. The bedrock is generally overlain by 1 to 512 feet of lake deposits and (or) glacial drift.

Figure 2 is a bedrock map of Outagamie County. It shows outcrop areas, known contacts, and hidden contacts. It also gives a fairly detailed stratigraphic column. In the appendices (pages 15) representative detailed quarry and outcrop sections can be found.

Pre-Cambrian

Pre-Cambrian rocks are identified in well logs from the northwest corner of the county. They are pink, gray, and red granites

Upper Cambrian

Upper Cambrian rocks are identified in well logs and in outcrops. They rest unconformably on the Pre-Cambrian, strike northeast-southwest, and dip to the southeast. The sequence of Cambrian rocks is at least 458 feet thick and is primarily sandstone. In the county three formations are identified; the Dresbach, Franconia, and Trempealeau. Of these the Franconia and Trempealeau outcrop just east of New London. The exposed rocks include 4 feet of buff, sandy, silty dolomite and more than 20 feet of greenish gray, red, white, or yellow sandstone which is fine-to medium-grained, crossbedded, and glauconitic and dolomitic in part.

Middle Ordovician

The Prairie du Chien group (Lower Magnesian) consists of the Oneota dolomite, New Richmond sandstone, and Shakopee dolomite, but is not subdivided in this report. It rests unconformably on the Upper Cambrian, strikes northeast-

southwest, and dips to the southeast. It outcrops along the prominent escarpment which forms the south and east boundries of the flat northwest quarter of the county. It is characteristically a hard, gray to brown dolomite with chert, green shale, oolites, and occasional sandy zones. Its thickness and bedding are irregular; numerous dome structures are attributed to algal reefs.

St. Peter sandstone outcrops at the base of escarpments formed by the Black River group, or is buried by glacial and recent deposits in low swampy areas having a general northeast-southwest trend. It is a poorly consolidated sandstone with well rounded fine- to coarse-grained components.

Black River and Galena groups (Platteville and Trenton) are not subdivided in this report. This unit outcrops in small scarps across the central portion of the county and is exposed in isolated patches and in stream beds in the eastern portion of the county. The Fox River flows over this unit throughout the county and Duck Creek exposes it in numerous places. This unit may have dips contrary to the normal southeasterly dip. These secondary dips are thought to be due to deformation caused by overridding glaciers. As seen in outcrops, the fresh surface is a greenish to blue-gray dolomite, and the weathered surface is buff. The rock is a soft to hard dolomite with shaly beds and partings.

Glacial Geology

General

Deposits of three glacial substages of the Wisconsin stage are represented in Outagamie County. The oldest or Rockian advance left deposits buried by the last two, Cary and Valders which are best represented and are most important from an economic standpoint.

Figure 3, a glacial map of Outagamie County, separates the various types of deposits of the Cary and Valders substages. It also gives a fairly detailed stratigraphic column. In the appendices (pages [illegible]) representative detailed sections are given.

The major axis of advance of glacial ice into the county during the Cary and Valders substages and probably during the Rockian was southwestward up the Fox River Valley. This valley was controlled by the Niagaran escarpment along the southeast side and by rising bedrock elevations to the northwest along the northwest side. In times of glaciation the ice first moved into this valley from Green Bay, attained its greatest thickness and width (southeast-northeast), and retreated from the valley last. This advance of ice upslope and retreat downslope controlled in many ways the kinds of unconsolidated deposits in the county.

Glacial deposits in the county consist of lake deposits and glacial drift. Lakes were formed in front of ice advancing upslope and behind ice retreating locally downslope. Their deposits are found over much of the county and consist of silt or clay in the deep portions of the lakes, fine- to medium-grained sand in shallow waters, and beach sand and gravel along the edges of the lakes. The glacial drift includes both stratified and unstratified materials.

Stratified deposits are found in such features as kames, deltas, crevasse fillings, and eskers. Unstratified deposits include ground moraine, end and lateral moraines, and drumlins. The mapping of these deposits was based on composition, color, structure, and topographic expression. Field methods of separating the drifts of different ages are not yet definitive, and in this reconnaissance it was commonly not possible to determine the history of many deposits.

Rockian substage

The Rockian advance of the Wisconsin glaciation according to dates outside the county, occurred approximately 30,000 years ago. In Outagamie County a dense, reddish brown, sandy till which has been found below some Cary kame gravels and is recorded in drill holes (appendix 1) is correlated with the Rockian. These deposits are not separated in figure 3. No deposits of construction aggregates are known to be of Rockian age in the county, in marked contrast with counties in southern Wisconsin.

Cary substage

The Cary substage occurred perhaps 12,500 to 16,000 years ago, according to data from outside Wisconsin. The Cary till is silty, stoney, buff, gray, or pinkish. Associated with the Cary till are numerous kame and kame complexes of coarse gravel, gravel, and sand. During Cary times, the main outline of Duck Creek Ridge (Duck Creek esker of Thwaites 1943) was formed. Many marginal lakes were formed and deposits of gravel, sand, silt, and clay were laid down during advance and retreat of Cary ice. These lakes were either small and of local extent or were broad expanses of water such as Early Lake Oshkosh (Thwaites 1943).

Two Creek interstadial

The Two Creeks interstadial occurred from 11,000 to 12,500 years ago

according to many dates from Two Creeks and from the area of Green Bay, [illegible] Outagamie County several gravel pits expose peat and organic layers of the Two Creeks organic bed. It is a 3 to 4 inch organic bed with some tree trunks present. Above the organic zone is Valders till and (or) pond silts and clays, and below are silts and clays lying on Cary kame gravel. This bed has been identified in wells and drill holes as distinct organic zones or natural gas zones. The organic bed, however, is discontinous.

Valders substage

It is estimated that the Valders substage occurred from 9,500 to 11,000 years ago. The Valders is represented in the county by a clayey red till with 5 to 10 percent stone content. The till attained its red color as the Valders ice moved across the upper Great Lakes region and reworked the previously deposited lake clays (Murray, 1953). Associated with the till are sand and gravel deposits laid down in front of the advancing glacier. When the Valders ice retreated, marginal lakes were again formed. The major lake, Lake Oshkosh (Thwaites, 1943), occupied approximately the same basin as Early Lake Oshkosh.

Recent Deposits

After the Valders glaciation, the present drainage was established. The rivers in the county started eroding and redepositing the material they passed over. The alluvium they deposited consists mainly of clay, silt and fine sand. The wind also reworked the glacial and lacustrine deposits and formed sand dunes. In the poorly drained areas where streams and wind were not active, swamp deposits were formed. The highlands received no deposits but were deeply eroded in some areas.

Material provinces

Province # 1

Province 1 occurs in scattered areas of the western part of the county. The province has relief of 50 feet or more along northeast-southwest trending ridges and upland areas. The Prairie du Chien Dolomite outcrops or lies below a thin cover of sand or Valders clayey till in the northeast and the Cary stonier till in the southwest. The dolomite is generally good quality with occassional cherty zones, oolitic zones, and glauconitic shaly partings. This province offers good sites for quarry development. See drill hole 49 and quarries 28 and 76.

Province # 2

This province occurs in scattered areas of the eastern part of the county. It has relief of 50 feet or more along northeast-southwest trending ridges and uplands. The Black River - Galena Dolomite outcrops or lies below a thin cover of Valders red-clayey till or lake sands. The dolomite is poor to fair quality. It contains a few beds of hard dolomite and numerous beds of soft dolomite with many shaly partings. A thin sandstone bed may be present. The quality of the stone varies from area to area. This province offers sites for quarry development. See drill hole 29 and quarries 62, 87, and 88.

Province # 3

This province occurs in several areas of the county. The most notable is the northeast-southwest trending Duck Creek ridge in the southeastern part of the county. It is a dominant topographic feature rising from 20-50 feet above the surrounding country. Topographically it is broken into three segments each containing characteristic materials. At the southwest end, this ridge typically shows 1 to 8 feet of Valders red-clayey till overlying

interstratified sands and silts with lenses of gravel. The central segment of the ridge shows a similar sequence only with a more complex interstratification of sand, silt, gravel, and wedges of clay. Several 15-20 foot thick isolated patches of Valders till cap the ridge. On the east side of Duck Creek, the northeast segment is predominantly a clean, well rounded and sorted sand with some lenses and beds of ¼ to 1 inch diameter gravel. On the west side of the Creek, this segment is predominantly 5-15 foot thick Valders till over lake silts and sands with two pit locations of overridden Cary kame gravels. This ridge offers possibilities for development of fine aggregates but little likelihood of coarse aggregates.

The other two areas of occurrence of Province 3 are east of Seymour. These two areas lie in gently rolling uplands surrounded by a featureless plain. These areas show 0-5 feet of Valders red-clayey till overlying interstratified sand and silt with intraformational coarse gravel and pea gravel. These areas offer some possibilities of development of fine aggregates and limited coarse aggregates. See drill holes 6, 7, 8, 9, 15, 18, 19, 26 and 27 and pits 66 and 71.

Province # 4

Province 4 occurs in the vicinity of Binghamton and Medina. It is a province of prominant knobs and kettles or rolling upland areas. Coarse gravels are found in this province in Cary kame complexes. The material grades from sand size to coarse cobble and boulder size, coarse material being dominant. Some pockets of clay and silt occur in the gravels, and clay and silt locally serve as a binding agent. The gravel is generally 5-20 feet thick, it bottoms on Prairie du Chien Dolomite or on the hard, dense, brown Rockian till. The

gravel generally appears at the surface. This province can provide considerable coarse aggregate. See pits 22, S-4 and 92.

Province # 5

Province 5, two miles east of New London, is a broad, gently rolling upland region. Trempealeau and Franconia sandstone outcrop or lie below 20 feet of loose sand. These sandstones have beds of clean, white sandstone, yellow sandstone, and grayish green glauconitic very fine-grained sandstone. They are generally well sorted and well rounded. This province offers good sites for sand pit or quarry development if very fine aggregates are needed. See drill hole 33 and pit S-9.

Province # 6

Province 6, in the vicinity of New London and Stephensville, is characterized by gently rolling topography. It consists of lake beaches and other shore features containing medium-grained sand with frequent lenses and thin beds of 1 to 2 inch gravel. The sand and gravel generally appear at the surface. This province offers good prospects for fine aggregates. See drill holes 34, 35, 36, 37, 39, and 47 and pits 40, S-28, and 37.

Province # 7

This province occurs in the vicinity of New London and in the northwest corner of the county. Occasional dune hills rise above the flat plains. This province is characterized by surface deposits of fine, well sorted and well rounded, wind blown sands overlying fine-grained lake sands and silts. The lake deposits lie on top of hard, dense, clayey till of Cary age with 5-10 percent stone. Generally the washed aggregates in this province are too fine for road construction. See drill holes 31, 32, and 38.

Province # 8

Province 8 extends north from Appleton through the vicinity of Mackville and Black Creek up to the North County Line. It is characterized by a prominent upland with relief of 50 feet or more. The upland is pocketed by numerous knobs and kettles. The material is Cary, stoney, buff to pinkish till. Patches of Valders red till overlie the Cary. Small pockets of washed material also occur. There is little possibility of developing large quantities of fine or coarse aggregates in this province. See drill holes 21, 46, and 56.

Province # 9

Province 9 lies north of the Duck Creek ridge and east of the north-south extension of County Trunk Highway KK. It is a relatively flat plain. The material is the Valders, red-clayey till. It may be absent or 15 feet or more thick. Beneath the till are lake sands, silts, and clays or Galena Dolomite. There is one locality where the Valders has overridden Cary kame gravels. There is a possibility that more localities like this may exist; however there was no time to explore all features that suggested possible new deposits. There also is a possibility of isolated resistent patches of Galena Dolomite being near the surface. The recommended area to look for buried gravel and bedrock is in the triangle outlined by County Trunk Highway C, State Trunk Highway 54, and the Duck Creek ridge. See drill holes 10, 11, 12, 20, 22, 24, 28, 42, 43, and 44 and pit 65.

Province # 10

Province 10, southeast of the Duck Creek ridge, is characterized by gently rolling topography dissected by streams flowing into the Fox River. The material is lake sand, silt, and clay. It may be overlain by 1 to 20 feet of Valders red-clayey till. The possibility of finding coarse aggregates is

remote. Fine-grained aggregates may occur along the flank of the Duck Creek ridge. Local resistent patches of Galena Dolomite may be near the surface. See drill holes 4, 5, 13, 16, and 17.

Province # 11

Province 11, in the vicinity of Binghamton and Stephensville, is characterized by rolling topography. The Cary stoney till is absent or present in thicknesses of 1 to 20 feet. It lies on Prairie du Chien Dolomite. The valleys have lake deposits on top of the Cary, and the uplands have Valders red till on top of the Cary. Some of the Cary till near Provinces 4 and 6 may contain small local pockets of washed material. See drill holes 14, 36, and 55.

Province # 12

Province 12, in the vicinity of Mortonville and Medina, has relief of 50 feet or more. Numerous drumlins trend east-west. The stoney buff to pink Cary till is absent or present in thickness of 30 feet or more. In the valleys, lake deposits lie on top of the Cary till, and on the hills, Valders till caps the Cary. There also are patches of wind blown sand in some areas. Local pockets of washed material occur; however, the possibility of developing large quantities of fine or coarse aggregate is remote. See drill holes 40, 41, 50, 51, 52, 53, and 55.

Province # 13

Province 13 is a broad area in the northwest corner of the County. It is characterized by plains with very low relief. Materials include recent alluvium, marsh deposits, lake deposits, and in some cases clay till. The water table is at or close to the surface. All materials are too fine for construction aggregates, and the high water table makes development of any deposit difficult.

See drill holes 45 and 48.

Province # 14

Province 14 is a special sand province found in the eastern half of the county. Topographically it consists of northeast-southwest trending ridges in the relatively flat Provinces 9 and 10. They are esker ridges (Thwaites, 1943) with thicknesses of 5 to 38 feet. The sand is too fine-grained for most construction aggregate. See drill holes 1, 2, 3, 23, 25 and 30.

Conclusions

Fourteen materials provinces are distinguished in Outagamie County. Most of these provinces have pits or quarries which have been described in previous Outagamie County reports. No new deposits of large size were found in this investigation. It is suggested that additional quarry sites for Prairie du Chien dolomite be located in Province 1 and for the Black River-Galena dolomite in Province 2. Province 5 contains large quantities of friable fine-grained Cambrian sandstone. Gravel deposits are limited in Outagamie County; the most favorable province is 4, but some gravel can be obtained in province 3. Very fine grained sand was found in provinces 6, 7, and 14. Provinces 8, 9, 10, 11, 12, and 13 in general will provide only fill.

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APPENDIX 1

Drill Holes

Drill Hole 1
Location: NW¼, SE¼, Sec. 5, T. 21N., R. 19E.
Elevation 684 ft.

1½ ft.	Sandy soil
3½ ft.	Fine to medium sand, one foot zone of clay at 5½ feet
1½ ft.	Fine, silty sand
1 ft.	Clayey, silty sand
2½ ft.	Silty sand, water saturated
2 ft.	Medium grained, well sorted sand
24 ft.	Fine to medium sand

Elevation 650 ft.

Drill Hole 2
Location: NE¼, SE¼, Sec. 28, T. 22N., R. 19E.
Elevation 676 ft.

1 ft.	Silty, sandy soil
6 ft.	Fine, silty sand
1 ft.	Reddish clay, very dense
7 ft.	Fine sand
6 ft.	Fine sand, water table at base
4 ft.	Fine silty sand, some pebbles present

Elevation 651 ft.

Drill Hole 3
Location: SE¼, SW¼, Sec. 24, T. 23N., R. 18E.
Elevation 800 ft.

1 ft.	Sandy soil
27 ft.	Fine sand
10 ft.	Very fine sand

Elevation 762 ft.

Drill Hole 4
Location: NE¼, NW¼, Sec. 35, T. 22N., R. 18E.
Elevation 720 ft.

1 ft.	Clay soil
12 ft.	Stony red till (Valders)
10 ft.	Brown to purple clay (Lake clays)

Elevation 697 ft.

Drill Hole 5
Location: SE¼, NE¼, Sec. 4, T. 22N., R. 19E.
Elevation 720 ft. Road cut

1 ft.	Sandy soil
3 ft.	Silt and fine sand
	Drill hole
2 ft.	Silt (local pond deposit)
1 ft.	Red clay
1 ft.	Blue gray clay
2 ft.	Stony red till
5 ft.	Dense red clay
14 ft.	Lake silts, water saturated, angular fragments of dolomite present suggesting nearness to bedrock

Elevation 692 ft.

Drill Hole 6
Location: NE¼, SW¼, Sec. 16, T. 23N., R. 19E.
Elevation 700 ft.
1 ft. Sandy soil
7 ft. Silt
12 ft. Fine, well sorted sand
5 ft. Coarse sand
12 ft. Coarse sand, some gravelly zones
½ ft. Dense reddish brown clay (Cary or Rockian?)
Elevation 762½ ft.

Drill Hole 7
Location: NE¼, NW¼, Sec. 17, T. 23N., R. 19E.
Elevation 760 ft.
4 ft. Red clay till, some stones (Valders)
7 ft. Silty clay, water saturated
1 ft. Dense grayish brown clay (Cary)
Elevation 748 ft.

Drill Hole 8
Location: NW¼, SW¼, Sec. 31, T. 23N., R. 19E.
Elevation 740 ft.
1½ ft. Clay soil
4 ft. Red clay till (Valders)
3 ft. Silty clay
4½ ft. Red clay till, some pebbles
8½ ft. Silty brown clay, very dense, some stones (Cary?)
Elevation 718½ ft.

Drill Hole 9
Location: SW¼, NW¼, Sec. 25, T. 24N., R. 18E.
Elevation 832 ft.
2 ft. Coarse gravel
1 ft. Coarse sandy gravel
4 ft. Gravelly sand
6 ft. Coarse gravel, somewhat silty, estimated 30-35% of the material brought up by auger was over ¼" in size
Elevation 819 ft.

Drill Hole 10
Location: SW¼, SW¼, Sec. 24, T. 24N., R. 18E.
Elevation 820 ft.
4 ft. Stony red clay till
Elevation 816 ft.

Drill Hole 11
Location: SE¼, SE¼, Sec. 21, T. 23N., R. 18E.
Elevation 811 ft.
6 ft. Stony red clay till
Elevation 807 ft.

Drill Hole 12
Location: NW¼, NE¼, Sec. 24, T. 23N., R. 18E.
Elevation 765 ft.
12½ ft. Red Clay till (Valders)
Elevation 752½ ft.

Drill Hole 13
Location: SW¼, SW¼, Sec. 28, T. 22N., R. 18E.
Elevation 752 ft.
1 ft. Clay soil
11½ ft. Red brown clay, some stones
Elevation 739½ ft.

Drill Hole 14
Location: SE¼, SE¼, Sec. 35, T. 22N., R. 17E.
Elevation 830 ft.
1 ft. Clay soil
18½ ft. Red brown clay, some stones
Elevation 811½ ft.

Drill Hole 15
Location: SE¼, NE¼, Sec. 21, T. 22N., R. 18E.
Elevation 754 ft.
1 ft. Sandy silty soil
3 ft. Fine sand
½ ft. Red clay
13 ft. Lake silts, brownish gray
Elevation 736½ ft.

Drill Hole 16
Location: SE¼, SW¼, Sec. 3, T. 21N., R. 18E.
Elevation 720 ft.
1 ft. Clay soil
13½ ft. Red clay till, some stones (Valders)
Elevation 706½ ft.

Drill Hole 17
Location: NW¼, NE¼, Sec. 19, T. 22N., R. 19E.
Elevation 720 ft.
1 ft. Clay soil
11 ft. Red brown stony clay
Elevation 708 ft.

Drill Hole 18
Location: NW¼, NE¼, Sec. [illegible] T. [illegible] R. [illegible]E.
Elevation 830 ft.
[illegible]
[illegible]
[illegible]
1 ft. Silty sand
2½ ft. Silty gravel
Elevation 822½ ft.

Drill Hole 19
Location: NW¼, NW¼, Sec. 29, T. 23N., R. 19E.
Elevation 720 ft.

3 ft. Silty sand
3 ft. Silt with several thin clay beds
1 ft. Silty sand
17 ft. Fine, well sorted sand
18 ft. Interbedded silty sand, sand, gravel, and pea gravel Also a stony buff to red clay at the base (Cary or Rockian?)

Elevation 678 ft.

Drill Hole 20
Location: NE¼, NE¼, Sec. 31, T. 23N., R. 18E.
Elevation 810 ft.

11 ft. Red clay till, some stones (Valders)
1½ ft. Water saturated silt

Elevation 797½ ft.

Drill Hole 21
Location: NW¼, NW¼, Sec. 32, T. 24N., R. 17E.
Elevation 790 ft.

11 ft. Red clay till, some stones
1½ ft. Brown clay till, very few stones

Elevation 777½ ft.

Drill Hole 22
Location: NE¼, SE¼, Sec. 1, T. 23N., R. 17E.
Elevation 800 ft.

10 ft. Red clay till, some stones (Valders)
2 ft. Brown clay (lake deposit)
2 ft. Greenish brown clay
1 ft. Gray silty sandy clay
1 ft. Black silt, gives a methane odor (organic zone) (Two Creeks bed)
½ ft. Brown silt, water saturated

Elevation 783½ ft.

Drill Hole 23
Location: SW¼, SE¼, Sec. 4, T. 24N., R. 19E.
Elevation 770 ft.

5 ft. Silty very sandy gravel
7½ ft. Red clay till, some stones (Valders)

Elevation 757½ ft.

Drill Hole 24
Location: NE¼, NE¼, Sec. 1, T. 23N., R. 18E.
Elevation 760 ft.

7 ft. Red clay till, some stones (Valders)

Elevation 753 ft.

Drill Hole 25
Location: SE¼, SW¼, Sec. 36, T. 24N., R. 17E.
Elevation 780 ft.
2 ft. Silty sand
5 ft. Silt
7 ft. Fine silty sand, water saturated
4 ft. Medium grained sand, water saturated
1 ft. Gray clay, couple little pieces of wood included
2 ft. Silty stony red brown clay (Cary)
1½ ft. Hard very dense, stony, red-brown clay
Elevation 757½ ft.

Drill Hole 26
Location: SE¼, SE¼, Sec. 35, T. 23N., R. 18E.
Elevation 750 ft.
5 ft. Red clay till, some stones (Valders)
3½ ft. Silty sand
Elevation 741½ ft.

Drill Hole 27
Location: SE¼, NE¼, Sec. 9, T. 23N., R. 19E.
Elevation 740 ft. Top of gravel pit face
8 ft. Red clay till, stones 10% (Valders)
8 ft. Interbedded medium to coarse grained sand and pea gravel (sand predominating), stones and pebbles range from ¼ to 4 inches in diameter, red clay till balls are present
Drill hole
4 ft. Pea gravel, pebbles range from ¼ to ½ inches in diameter
16 ft. Interbedded water saturated silty clay and sand which bottomed in a hard dense stony brown clay to hard to penetrate
Elevation 704 ft.

Drill Hole 28
Location: NW¼, NW¼, Sec. 8, T. 24N., R. 18E.
Elevation 885 ft.
6½ ft. Red clay till, stones present
Elevation 878½ ft.

Drill Hole 29
Location: NE¼, SW¼, Sec. 18, T. 24N., R. 18E.
Elevation 890 ft.
7 ft. Red clay till, stones present
Elevation 883 ft.

Drill Hole 30
Location: NW¼, NE¼, Sec. 8, T. 22N., R. 15E.
Elevation 810 ft.
5 ft. Red clay till, stones present
5 ft. Well sorted and well rounded sand
5 ft. Silt
2½ ft. Fine well sorted and well rounded sand
Elevation 792½ ft.

Drill Hole 31
Location: SW¼, NE¼, Sec. 16, T. 22N., R. 15E.
5 ft. Sandy reddish brown clay
7½ ft. Hard dense brown clay till, some stones present

Drill Hole 32
Location: SE¼, NE¼, Sec. 15, T. 22N., R. 15E.
17 ft. Fine well sorted and well rounded sand
9½ ft. Brown clay till, some stones present

Drill Hole 33
Location: SW¼,, NE¼, Sec. 3, T. 22N., R. 15E.
3 ft. Sandy soil, numerous stones
Drill stopped by bedrock

Drill Hole 34
Location: NW¼, NW¼, Sec. 15, T. 22N., R. 16E.
Road cut
10 ft. Fine sand
Drill hole
6 ft. Fine well sorted and rounded sand
4 ft. Fairly coarse sandy silty gravel

Drill Hole 35
Location: NE¼, SW¼, Sec. 11, T. 22N., R. 16E.
2½ ft. Fine sandy soil
9 ft. Fine well sorted and rounded sand
2 ft. Silt, water saturated
4 ft. Hard dense brown clay, somewhat silty and stony

Drill Hole 36
Location: SW¼, SE¼, Sec. 34, T. 23N., R. 16E.
7 ft. Brown stony clay till
2 ft. Silt and clay bound gravel

Drill Hole 37
Location: NE¼, NE¼, Sec. 18, T. 23N., R. 15E.
1 ft. Brown sandy soil
1 ft. Gravelly sand
2 ft. Sandy gravel, pebbles up to ½ inches in diameter
3 ft. Coarse gravel, pebbles up to 4 inches in diameter

Drill Hole 38
Location: NW¼, NE¼, Sec. 8, T. 24N., R. 16E.
10 ft. Fine well sorted and rounded sand
7½ ft. Interbedded sand, silt, and clay

Drill Hole 39
Location: SW¼, SE¼, Sec. 6, T. 23N., R. 15E.
8 ft. Fine well sorted and rounded sand
18 ft. Hard compacted silt

Drill Hole 40
Location: SE¼, NE¼, Sec. 25, T. 22N., R. 14E.
3 ft. Fine well sorted and rounded sand
3½ ft. Red brown compacted clay till, some stones

Drill Hole 41
Location: NE¼, NE¼, Sec. 1, T. 21N., R. 15E.
4 ft. Fine well sorted rounded sand
8½ ft. Hard pinkish to brownish stony clay till

Drill Hole 42
Location: NE¼, SE¼, Sec. 20, T. 24N., R. 19E.
5 ft. Red lake clays (wet and plastic)
1 ft. Silt, water saturated
4 ft. Red clay till, somewhat stony (Valders)

Drill Hole 43
Location: NE¼, N[illegible]¼, Sec. 11, T. 23N., R. 18E.
Elevation 765 ft.
6 ft. Red clay till, stony and plastic
2 ft. Silty and stony red clay till
Elevation 757 ft.

Drill Hole 44
Location: [illegible]¼, SW¼, Sec. 26, T. 23N., R. 18E.
Elevation 755 ft.
3 ft. Silty red lake clay
3 ft. Silt
½ ft. Fine silty sand, some stones present
2 ft. Stony, buff to grayish, silty clay till (Cary)
Elevation 742½ ft.

Drill Hole 45
Location: SE¼, SE¼, Sec. 30, T. 24N., R. 18E.
Elevation 785 ft.
2 ft. Fine silty sand
3 ft. Sandy silt, water saturated
9 ft. Lenses of silt and stony silty clay bottoming in hard stony brown clay
Elevation 771 ft.

Drill Hole 46
Location: SE¼, NW¼, Sec. 27, T. 24N., R. 17E.
Elevation 875 ft.
10 ft. Red clay till, stones present (Valders)
7 ft. Buff to grayish stony clay till (Cary)
3 ft. Silty stony gray clay till
2½ ft. Hard stony red clay till

Drill Hole 47
Location: NE¼, NW¼, Sec. 29, T. 23N., R. 17E.
Elevation 810 ft.
14 ft. Fine well sorted and rounded sand
3 ft. Gravelly silty sand
Hole bottomed on bedrock
Elevation 793 ft.

Drill Hole 48
Location: SE¼, SW¼, Sec. 17, T. 24N., R. 17E.
Elevation 785 ft.
2 ft. Silt
5 ft. Fine well sorted and rounded sand, water saturated
10 ft. Gray to buff lake clays, some sand lenses
Elevation 768 ft.

Drill Hole 49
Location: SE¼, NE¼, Sec. 17, T. 23N., R. 17E.
Elevation 805 ft.
Road cut
4 ft. Red clay till (Valders)
Drill hole
3 ft. Red clay till
Hole bottomed on bedrock (Prairie du Chien)
Elevation 798 ft.

Drill Hole 50
Location: SW¼, SW¼, Sec. 17, T. 21N., R. 16E.
3 ft. Red clay, 5-10% stone content (Valders)
4½ ft. Silty, very stony, buff clay till (Cary)

Drill Hole 51
Location: NE¼, SE¼, Sec. 20, T. 21N., R. 16E.
12½ ft. Red clay till (Valders)

Drill Hole 52
Location: NE¼, SW¼, Sec. 28, T. 21N., R. 16E.
6 ft. Silty stony buff colored clay till
1 ft. Silt
2 ft. Sandy silt
1 ft. Silty sand
1 ft. Medium grained well sorted and rounded sand
4 ft. Coarse sand, some ¼ to 1 inch diameter gravel
12½ ft. Silty stony till with some lenses of silt, sand, and clay

Drill Hole 53
Location: NE¼, SE¼, Sec. 9, T. 21N., R. 15E.
Road cut
5 ft. Red clay till
Drill hole
3 ft. Buff stony clay till

Drill Hole 54
Location: SW¼, NW¼, Sec. 21, T. 22N., R. 16E.
11 ft. Red clay till, some stones present
11½ ft. Gravelly sand (Early Lake Oshkosh beach gravel)

Drill Hole 55
Location: SW¼, NE¼, Sec. 25, T. 22N., R. 16E.
7 ft. Stony red brown clay (lake clay?)

Drill Hole 56
Location: NW¼, SW¼, Sec. 25, T. 22N., R. 17E.
Elevation 850 ft.
5 ft. Red clay till (Valders)
2 ft. Silty, sandy, and stony till
6 ft. Buff to pinkish stony clay till (Cary)
3 ft. Grayish to buff stony till

Appendix 2
Quarries and Gravel and Sand Pits

Location: SE¼, SE¼, Sec. 17, T. 24N, R. 17E.
Section: Quarry # 28 Prairie du Chien dolomite

1 ft. Soil and rock rubble
3 ft. Brownish weathered dolomite with numerous small solution cavities, grades into 1 ft. of brown flaggy dolomite at the base
1 ft. Cherty dolomite, bottom 3 inches quite high in chert
1 ft. Flaggy dolomite, beds are 3 inches thick
9 ft. Hard gray brown dolomite, beds average 6 inches in thickness
Quarry floor is a dome structure

Location: NW¼, SW¼, Sec. 30, T. 22N., R. 15E.
Section: Quarry # 76 Prairie du Chien dolomite

1 ft. Sandy soil and rock rubble
3 ft. Weathered brownish dolomite
10 ft. Hard brownish dolomite, beds vary from 2 to 4 inches in thickness
5 ft. Hard greenish gray dolomite, thin 1 to 3 inch beds, a few green glauconitic shale partings, a dominant zone of shale at the base
2 ft. Massive hard dolomite, algal structures present
10 ft. Massive to thinly bedded, greenish to brownish dolomite, some shale partings

Location: NW¼, NW¼, Sec. 21, T. 22N., R. 18E.
Section: Quarry # 62 Black River-Galena dolomite

1 ft. Clayey soil
3 ft. Thinly bedded shaly buff colored dolomite
7 ft. Greenish gray dolomite, less shaly, some biohermal algal structures.
1 ft. Grayish to white sandst ne, local unconformity indicated
10 ft. Hard bluish gray dolomite
Quarry bottoms on a thin ripple marked sandstone

Location: NE¼, SW¼, Sec. 16, T. 22N., R. 18E.
Section: Quarry # 87 Black River-Galena dolomite

1 ft. Clayey soil and rock rubble
5 ft. Slightly weathered buff colored dolomite, beds 2 to 6 inches thick
16 ft. Hard dolomite, some beds have shaly partings

Location: NW¼, NE¼, Sec. 36, T. 24N., R. 18E.
Section: Quarry # 88 Black River-Galena dolomite

1 ft. Sandy clay soil and rock rubble
5 ft. Weathered dolomite, buff colored on weathered surface, gray on fresh
1 ft. Soft blue gray shaly dolomite
3 ft. Thinly bedded grayish dolomite
1 ft. Soft blue gray shaly dolomite
8 ft. Soft dolomite with numerous shaly partings

Location: NW¼, SW¼, Sec. 31, T. 23N., R. 15E.
Section: Gravel Pit # 37
8 ft. Gravel to sandy gravel, pebbles 1 to 4 inches in diameter, grades into sand and pea gravel zones

Location: SE¼, SW¼, NE¼, Sec. 15, T. 22N., R. 15E.
Section: Gravel Pit # 40 (Section put together from exposures in three pits)
6 ft. Fine wind blown sand
7 ft. Medium lake deposited sand
3 ft. Paleosol, may overlie clay bound gravel or clay or may be absent
3 ft. Clay bound sand and gravel
8 ft. Gravel, coarse angular sand

Location: NW¼, SE¼, SW¼, NE¼, Sec. 9, T. 23N., R. 18E.
Section: Gravel Pit # 65
North end
10 to 15 ft. Red clay till (Valders)
12 to ? ft. Coarse gravel, stones range in size from 2 to 10 and 15 inches in diameter, some areas are secondarily cemented
South end
6 to 7 ft. Medium lake sand
5 to ? ft. Coarse gravel
[illegible] gravel [illegible] water table

Location: NE¼, SE¼, NW¼, Sec. 5, T. 21N., R. 19E.
Section: Gravel Pit # 86
10 ft. Red clay till, variable in thickness (Valders)
15 ft. Sand and silt, 3 to 4 ft. lenses of gravel

Location: SW¼, SW¼, Sec. 32, T. 22N., R. 18E.
Section: Gravel Pit # 71
Northwest face
18 ft. Interstratified crossbedded sands and fine gravel, some clay till is found near the top
Northeast face
12 ft. Dirty clay bound gravel, poorly sorted, some sandy lenses
10 ft. Fine well stratified pond or lake sands
South face
3 ft. Red clay till
10 ft. Dirty poorly sorted gravel, some sand lenses
10 ft. Fine well stratified pond or lake sands and silts

Location: NE¼, NW¼, Sec. 20, T. 21N., R. 16E.
Section: Gravel Pit # 81
2½ ft. Red stony clay soil
5 ft. Fine to medium grained sand, some lenses of clay
12 ft. Clay bound gravel, coarse to pea gravel

Location: SE¼, SW¼, Sec. 12, T. 22N., R. 16E.
Section: Gravel Pit # 92

15 ft. Coarse gravel, 6 to 10 inch diameter stones, some finer material does occur
Pit floor is composed of a hard red brown till

Location: NE¼, SE¼, Sec. 19, T. 23N., R. 19E.
Section: Gravel Pit

1 ft. Clay soil
1 ft. Lake clays and silts
10 ft. Red clay till, stony, some lake sediments at base
2 to 6 in. Organic material (Two Creeks forest bed)
1 ft. Red clay
15 ft. Poorly sorted coarse gravel - water table about 20 ft. of gravel

Location: NW¼, NE¼, Sec. 31, T. 23N., R. 17E.
Section: Sand Pit # 4

Sect. 1
4 ft. Thin beds of sand, 1 inch gravel, and ¼ inch gravel
1 ft. Gravel, 1 to 2 inches in diameter
1.5 ft. Pea gravel
3 ft. Clay bound gravel

Sect. 2
1.5 ft. Gravelly sand
1.5 ft. Gravel, 6 inch cobbles to ¼ inch pebbles
4 ft. Fine sand
Numerous 1 to 3 foot diameter stones are present

Location: S½, NE¼, NE¼, SW¼, Sec. 3, T. 22N., R. 15E.
Section: Sand Pit # 9

20 ft. Fine well sorted and well rounded wind deposited sand
4 ft. Fine well sorted and well rounded lake deposited sand
11 ft. Red clay, pebbles present, appears to be a mud flow
2 ft. Lake sands and silts
5 ft. Weathered Franconia sandstone

Section may be present between Franconia sandstone and overlying lake sands

2 ft. Weathered silty sandy dolomite
2 ft. Greenish to grayish glauconitic sandstone
7 ft. Fine to medium sandstone

Location: SW¼, SE¼, Sec. 11, T. 22N., R. 16E.
Section: Sand Pit # 28

20 ft. Fine to medium grained well sorted and rounded sand with numerous lenses of medium sized gravel

Appendix 3
Road Cuts and Natural Exposures

1. Location: NE¼, SE¼, Sec. 21, T. 21N., R. 15E.
   15 ft. Buff to pinkish stony till, stone content 20% (Cary)
   Cut is in an east west trending drumlin

2. Location: SW¼, SW¼, Sec. 31, T. 22N., R. 15E.
   5 to 10 ft. Fine wind blown sand, overlies Prairie du Chien dolomite
   10 ft. Buff colored weathered dolomite (Prairie du Chien)
   Estimated thickness is 25 to 30 ft.

3. Location: NW¼, SW¼, Sec. 34, T. 22N., R. 15E.
   6 ft. Fine well sorted and rounded dune sand

4. Location: SW¼, NW¼, Sec. 18, T. 21N., R. 15E.
   10 ft. Buff colored weathered dolomite (Prairie du Chien)
   Exposed in a NE–SW trending scarp

5. Location: NW¼, NW¼, Sec. 28, T. 22N., R. 15E.
   10 ft. Massive light gray dolomite
   4 ft. Thin and irregularly bedded dolomite, reddish brown, oolitic in places
   4 ft. Massive light gray to brown dolomite, some sandy lenses
   6 ft. Massive dolomitic sandstone

6. Location: NE¼, NE¼, Sec. 6, T. 24N., R. 16E.
   8 ft. Fine well sorted and rounded sand, dune sand

7. Location: NW¼, NW¼, Sec. 33, T. 22, R. 16E.
   8 ft. Buff to pinkish stony clay till, stone content 20% (Cary)
   Exposed in a east–west trending drumlin

8. Location: NE¼, SE¼, Sec. 16, T. 22N., R. 16E.
   6 ft. Buff to pinkish stony clay till, stone content 20% (Cary)

9. Location: SE¼, SE¼, Sec. 10, T. 24N., R. 17E.
   12 ft. Buff colored stony silty clay till, some gravel, sand, and silt beds and lenses are present, 1 to 2 foot diameter boulders are present, stone content 20% (Cary)

10. Location: SE¼, NW¼, Sec. 27, T. 24N., R. 17E.
    2 ft. Silt, local pond deposit
    7 ft. Red clay till, somewhat stony (Valders)

11. Location: NE¼, NE¼, Sec. 30, T. 24N., R. 18E.
    6 ft. Red clay till (Valders)
    Bedrock is believed near the surface

12. Location: NW¼, NW¼, Sec. 6, T. 23N., R. 15E.

5 ft. 6 inch beds of fairly hard dolomite, some shaly partings (Black River Dolomite)

Estimated thickness is 30 ft.