

PRELIMINARY HYDROGEOLOGICAL STUDY
PORTIONS OF SECTIONS 8, 9, 16 AND 17
GENOA TOWNSHIP, LIVINGSTON COUNTY, MICHIGAN

VERSA REAL ESTATE
25900 WEST ELEVEN MILE ROAD
SUITE 250
SOUTHFIELD, MICHIGAN 48034

NOVEMBER 28, 2016
BY
McDOWELL & ASSOCIATES

McDowell & Associates

Geotechnical, Environmental & Hydrogeological Services • Materials Testing & Inspection

21355 Hatcher Avenue • Ferndale, MI 48220

Phone: (248) 399-2066 • Fax: (248) 399-2157

www.mcdowasc.com

November 28, 2016

Versa Real Estate
25900 West Eleven Mile Road
Suite 250
Southfield, Michigan 48034

Job No. 16-376

Attention: Nicole Jeffries, P.E.

Subject: Preliminary Hydrogeological Study
Portions of Sections 8, 9, 16 and 17
Genoa Township, Livingston County, Michigan

Dear Ms. Jeffries:

In accordance with your request, we have made a preliminary hydrogeological study at the subject project.

Field Work & Laboratory Testing

Sixteen test pits, designated as TP-1 through TP-16, were excavated at the subject property. The approximate test pit locations are shown on the Test Pit Location Plan which accompanies this report. The test pits were excavated to depths ranging from about seven feet (7') to thirteen feet six inches (13'6") below the existing ground surface.

It should be noted that the test pits were backfilled with uncompact material. If future structures are to be constructed so that floor slabs or footings are to be supported by the uncompact fill from the test pits, the test pit location should be re-excavated and filled with compacted material. Therefore, it is suggested to have the test pit locations surveyed and their locations placed on any development plans.

Five (5) grab samples from the test pits were tested for moisture content, unit weight and permeability. Permeabilities were measured using brass liners filled with lab compacted soils from the grab samples. Soil descriptions and groundwater observations are to be found on the Logs of Test Pits and the results of laboratory tests are to be found on the Lab Results and Sieve Analysis sheets.

The test pits encountered about five inches (5") to one foot three inches (1'3") of dark brown to black topsoil at the surface. Test Pits TP-1, TP-2, TP-4, TP-7, TP-10 and TP-12 through TP-15 encountered primarily clay type soils below the topsoil with occasional layers of sand having a maximum thickness of about one foot nine inches (1'9"). Test Pits TP-3, TP-5, TP-6, TP-8, TP-9, TP-11 and TP-16 were terminated in granular type soils and often had layers of granular type soils throughout their profiles.

Soil descriptions and depths shown on the test pit logs are approximate indications of change from one soil type to another and are not intended to represent an area of exact geologic change or stratification. Due to their manner(s) of deposition, the transition from one soil type to the next may be gradual rather than abrupt. Therefore, it is expected that the subsurface conditions may be different from those found by the test pits at locations between or beyond the actual test pit locations.

Groundwater Conditions

Groundwater was encountered in Test Pits TP-4, TP-9 through TP-11 and TP-13 through TP-16 at depths ranging from about three feet (3') to nine feet (9') below the existing ground surface. Groundwater inflow volumes were described as ranging from very light to heavy at various depths in these tests pits. Groundwater was not encountered in Test Pits TP-1 through TP-3, TP-5 through TP-8 and TP-12. It should be noted that short-term groundwater observations may not provide a reliable indication of the depth of the water table. In fine grained soils, this is due to the slow rate of infiltration of water into the excavation as well as the potential for water to become trapped in overlying layers of granular soils during periods of heavy rainfall. Water levels in granular soils fluctuate with seasonal and climatic changes as well as the amount of rainfall in the area immediately prior to the measurements. It should be expected that groundwater fluctuations could occur on a seasonal basis and that seams of water-bearing sands or silts could be found within the various clay strata at the site.

Site Geology

The USDA Soil Survey for Livingston County was reviewed. The survey shows clay type soils covering most of the site with some areas described as sandy loam or loamy sand. Sand type soils are shown near the southeast and southwest corners of the site. A copy of the soil survey, from the USDA website, is attached.

The DEQ Water Well Records were also reviewed. The well records show a potential for shallow granular deposits near the southeast and southwest corners of the site. Due to heavily wooded areas, test pits were not performed at these locations. Other well logs in a close vicinity to the site indicate the potential for sand type soil deposits slightly below the extent of the test pits at depths of roughly fifteen feet (15') to twenty five feet (25')

Lab Results

Falling Head Permeability Tests were performed on five (5) re-compacted soil samples. The tests resulted in coefficients of permeability ranging from 1.0×10^{-6} cm/s to 1.2×10^{-2} cm/s or about 0.001 in/hr to 17 in/hr. It should be noted that field infiltration rates may vary from lab permeability results performed on re-compacted samples.

Conclusions

Sixteen (16) test pits were excavated at specific locations in order to locate sand beds for potential storm/waste water discharge. Considering current elevations and grading, most of the test pit locations do not appear to be favorable for infiltration due to the presence of clay type soils, shallow groundwater, layer thickness of granular type soils and low permeability of some granular type soils. Test Pits TP-3, TP-5 and TP-8 show some potential for low level infiltration and may be suitable for individual septic fields. Only Test Pit TP-6 appears to have somewhat favorable conditions for a regional infiltration sand bed disposal system. It is recommended that soil test borings be done in the areas of TP-6 to better explore both the vertical and horizontal extent of favorable sandy soils.

If we can be of any further service, please feel free to call.

Very truly yours,

McDOWELL & ASSOCIATES



David Quintal, M.S., E.I.T.
Geotechnical Engineer



John H. Lamb, III, P.E.
Manager of Geotechnical Engineering
and Hydrogeological Services

DQ:/

Attachments: Logs of Test Pits (4 pp)
 Test Pit Location Plan (1 pp)
 Lab Results (1 p)
 Sieve Analysis (1 p)
 Soil Survey (3 pp)

LOGS OF TEST PITS

Test Pit 1

0'0" to 0'8" Moist dark brown silty to clayey TOPSOIL
0'8" to 13'0" Moist brown silty CLAY with trace of clay and occasional stone

- No groundwater was encountered

Test Pit 2

0'0" to 0'8" Moist dark brown silty sandy TOPSOIL
0'8" to 3'0" Moist brown silty sandy CLAY with trace of gravel
3'0" to 13'0" Moist brown silty CLAY with sand and occasional cobbles

- No groundwater was encountered

Test Pit 3

0'0" to 0'10" Moist dark brown clayey TOPSOIL
0'10" to 9'3" Moist brown silty CLAY with sand to silty sandy CLAY with occasional cobbles
9'3" to 13'6" Moist brown silty fine to medium SAND to sandy SILT with traces of clay and gravel

- No groundwater was encountered

Test Pit 4

0'0" to 1'3" Moist dark brown silty TOPSOIL with sand
1'3" to 9'3" Moist brown to variegated silty CLAY with sand, pebbles, occasional cobbles and occasional wet silty sand seams from 6' to 8'
9'3" to 11'0" Wet brown silty fine SAND
11'0" to 12'0" Moist variegated silty CLAY with sand and pebbles

- Very light groundwater was encountered at 6'
- Light groundwater was encountered at 9'3"

Test Pit 5

0'0" to 0'7" Moist dark brown silty TOPSOIL with sand
0'7" to 1'10" Moist brown silty SAND with trace of clay
1'10" to 7'0" Moist brown silty CLAY with sand and trace of gravel
7'0" to 13'0" Moist brown silty fine to medium SAND with little gravel and trace of clay

- No groundwater was encountered

Test Pit 6

0'0" to 1'0" Moist dark brown sandy silty TOPSOIL
1'0" to 1'10" Moist brown silty SAND with trace of clay
1'10" to 3'6" Moist brown silty CLAY with sand
6'6" to 10'0" Moist brown silty fine SAND with trace of gravel and clay
10'0" to 13'0" Moist brown fine to medium SAND with trace of silt and gravel

- No groundwater was encountered

Test Pit 7

0'0" to 0'10" Moist dark brown silty TOPSOIL with sand and clay
0'10" to 13'0" Moist brown silty CLAY with trace of sand, pebbles and occasional stone

- No groundwater was encountered

Test Pit 8

0'0" to 0'8" Moist dark brown silty sandy TOPSOIL
0'8" to 2'9" Moist brown silty SAND with stones, cobbles and a boulder
2'9" to 6'0" Moist brown silty sandy CLAY with stones
6'0" to 13'0" Moist brown gravelly SAND with little silt, trace of clay, frequent cobbles and clayey sand layers

- No groundwater was encountered

Test Pit 9

0'0" to 0'5" Moist dark brown silty sandy TOPSOIL
0'5" to 4'6" Moist to wet brown silty fine to medium SAND
4'6" to 6'0" Wet gray to blue clayey SAND to sandy CLAY with silt
6'0" to 7'0" Wet gray to brown SAND & GRAVEL with trace of silt

- Light to medium groundwater was encountered at 4'
- Heavy groundwater was encountered at 6'
- Groundwater at 3' after a few hours

Test Pit 10

0'0" to 0'7" Moist dark brown silty TOPSOIL
0'7" to 2'0" Moist brown silty SAND with occasional trace of clay
2'0" to 10'0" Moist brown to variegated silty CLAY with trace of sand and wet silty sand and gravel layers below 8'
10'0" to 12'0" Moist blue silty CLAY with trace of sand and pebbles

- Medium groundwater was encountered at 8'
- Pocket Penetrometer reading at 6' was approximately 3000 psf

Test Pit 11

0'0" to 0'6" Moist dark brown silty TOPSOIL with sand and clay
0'6" to 2'0" Moist brown silty SAND with occasional trace of clay
2'0" to 6'0" Moist brown silty CLAY with trace of sand and gravel
6'0" to 9'0" Wet silty SAND & GRAVEL with trace of clay

- Light groundwater was encountered at 6'
- Heavy groundwater was encountered at 6'10"

Test Pit 12

0'0" to 1'0" Moist dark brown clayey TOPSOIL
1'0" to 9'8" Moist brown to variegated silty CLAY with sand, pebbles and occasional cobbles
9'8" to 12'0" Moist blue silty CLAY with trace of sand and pebbles

- No groundwater was encountered

Test Pit 13

0'0" to 0'5" Moist dark brown silty sandy TOPSOIL
 0'5" to 1'5" Moist brown silty SAND with occasional trace of clay and gravel
 1'5" to 9'0" Moist brown silty CLAY with sand and clayey sand seams
 9'0" to 11'0" Moist blue sandy CLAY with wet sand seams

- Light groundwater was encountered at 9'

Test Pit 14

0'0" to 1'0" Moist black sandy TOPSOIL with silt and clay
 1'0" to 1'10" Moist brown silty SAND with occasional trace of clay
 1'10" to 3'0" Moist variegated sandy silty CLAY
 3'0" to 8'0" Moist blue silty sandy CLAY with wet silt and silty sand seams

- Very light groundwater was encountered at 3'
- Medium groundwater was encountered at 7'6"

Test Pit 15

0'0" to 0'8" Moist dark brown silty sandy TOPSOIL
 0'8" to 2'0" Moist brown silty SAND with occasional trace of clay
 2'0" to 8'0" Moist brown to variegated silty CLAY with sand and pebbles and a wet silty sand seam at 7'6"
 8'0" to 11'0" Moist blue silty CLAY with sand and pebbles

- Light groundwater was encountered at 7'6"
- Pocket Penetrometer reading at 8' was approximately 2000 psf

Test Pit 16

0'0" to 0'6" Moist dark brown silty sandy TOPSOIL with clay
 0'6" to 1'10" Moist brown silty SAND with occasional trace of clay
 1'10" to 3'0" Moist brown silty sandy CLAY with pebbles
 3'0" to 6'6" Moist variegated silty CLAY with sand and pebbles
 6'6" to 8'10" Moist brown silty CLAY with sand and pebbles
 8'10" to 11'0" Moist to wet blue clayey SILT with silty clay seams and wet silty sand seams
 11'0" to 12'0" Wet gray silty SAND with occasional trace of clay

- Light groundwater was encountered at 9'
- Medium to heavy groundwater was encountered at 11'6"
- Pocket Penetrometer reading at 5' was approximately 6500 psf



LEGEND



Test Pit Location by McDowell & Associates
(16 Locations, TP-1 through TP-16)



McDowell & Associates
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (248) 399-2066
Fax: (248) 399-2157

Test Pit Location Plan
Job No. 16-376

LAB RESULTS

<u>Test Pit</u>	<u>Approximate Depth (ft)</u>	<u>Moisture Content (%)</u>	<u>Permeability Coefficient, K (cm/s)</u>
TP-3	10	12.9	1.0×10^{-6}
TP-5	8	10.6	7.3×10^{-6}
TP-6	4	5.9	1.1×10^{-2}
TP-6	11	7.4	1.2×10^{-2}
TP-8	8	10.1	6.8×10^{-5}

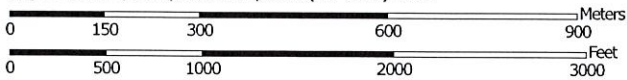
SIEVE ANALYSIS

<u>Test Pit</u>	<u>Approximate Depth (ft)</u>	<u>% Passing #4 Sieve</u>	<u>% Passing #10 Sieve</u>	<u>%Passing #40 Sieve</u>	<u>% Passing #100 Sieve</u>	<u>% Passing #200 Sieve</u>
TP-3	10	90.0	87.1	79.7	50.0	37.5
TP-5	8	90.7	85.0	70.1	39.0	28.3
TP-6	4	76.0	58.3	29.2	7.6	5.2
TP-6	11	96.7	93.9	54.9	8.1	5.3
TP-8	8	93.5	86.6	68.4	26.8	18.6

Soil Map—Livingston County, Michigan



Map Scale: 1:11,500 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

- Area of Interest (AOI)
 - Area of Interest (AOI)
- Soils
 - Soil Map Unit Polygons
 - Soil Map Unit Lines
 - Soil Map Unit Points
- Special Point Features
 - Blowout
 - Borrow Pit
 - Clay Spot
 - Closed Depression
 - Gravel Pit
 - Gravelly Spot
 - Landfill
 - Lava Flow
 - Marsh or swamp
 - Mine or Quarry
 - Miscellaneous Water
 - Perennial Water
 - Rock Outcrop
 - Saline Spot
 - Sandy Spot
 - Severely Eroded Spot
 - Sinkhole
 - Slide or Slip
 - Sodic Spot
- Water Features
 - Streams and Canals
- Transportation
 - Rails
 - Interstate Highways
 - US Routes
 - Major Roads
 - Local Roads
- Background
 - Aerial Photography
- Other
 - Spill Area
 - Stony Spot
 - Very Stony Spot
 - Wet Spot
 - Other
 - Special Line Features

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000. Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Livingston County, Michigan
 Survey Area Data: Version 14, Sep 21, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 18, 2011—Mar 21, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Livingston County, Michigan (MI093)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BiB	Boyer-Oshtemo loamy sands, 2 to 6 percent slopes	10.0	1.6%
BuA	Brady loamy sand, 0 to 2 percent slopes	4.6	0.7%
BwA	Bronson loamy sand, 0 to 2 percent slopes	28.1	4.6%
By	Brookston loam, 0 to 2 percent slopes	8.8	1.4%
Cc	Carlisle muck, 0 to 2 percent slopes	56.2	9.2%
CvA	Conover loam, 0 to 2 percent slopes	14.8	2.4%
FoB	Fox sandy loam, 2 to 6 percent slopes	52.2	8.6%
FoC	Fox sandy loam, 6 to 12 percent slopes	2.3	0.4%
FrD	Fox-Boyer complex, 12 to 18 percent slopes	8.3	1.4%
Gd	Gilford sandy loam, 0 to 2 percent slopes, gravelly subsoil	15.1	2.5%
HmC	Hillsdale-Miami loams, 6 to 12 percent slopes	0.3	0.0%
MiB	Metamora sandy loam, 0 to 4 percent slopes	2.7	0.4%
MnB	Metea loamy sand, 2 to 6 percent slopes	10.2	1.7%
MoA	Miami loam, 0 to 2 percent slopes	1.2	0.2%
MoB	Miami loam, 2 to 6 percent slopes	241.9	39.6%
MoC	Miami loam, 6 to 12 percent slopes	67.3	11.0%
MoD	Miami loam, 12 to 18 percent slopes	21.3	3.5%
MoE	Miami loam, 18 to 25 percent slopes	26.5	4.3%
OmB	Owosso-Miami sandy loams, 2 to 6 percent slopes	30.9	5.1%
Wh	Washtenaw silt loam	7.2	1.2%
Totals for Area of Interest		610.2	100.0%