# SOILS INVESTIGATION
# PROPOSED FUNERAL HOME
# BECK AND 11 MILE ROADS
# NOVI, MICHIGAN

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3-1-17
@ 9am

L.J. GRIFFIN FUNERAL HOME
7707 MIDDLEBELT ROAD
WESTLAND, MICHIGAN 48185

FEBRUARY 27, 2017
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

February 27, 2017

L.J. Griffin Funeral Home
7707 Middlebelt Road
Westland, Michigan 48185

Job No. 17-041

Attention: Mr. David Griffin

Subject: Soils Investigation
Proposed Funeral Home
Beck and 11 Mile Roads
Novi, Michigan

Dear Mr. Griffin:

In accordance with your request, we have performed a Soils Investigation at the subject project.

Four (4) Soil Test Borings, designated as 1 through 4, were performed at the locations staked by your surveyors. The approximate locations of the borings are shown on the Soil Boring Location Plan which accompanies this report. Borings 1, 2 and 4 were drilled in the planned building location and were advanced to a depth of twenty feet six inches (20'6") below the existing ground surface at these boring locations. Boring 3 was drilled in the planned parking lot area and was advanced to a depth of ten feet six inches (10'6"). Surface elevations shown on the logs of Borings 1, 2 and 4 were on the surveyor stakes. No elevation was written on the stake for Boring 3.

Soil descriptions, groundwater observations and the results of field and laboratory tests are to be found on the accompanying Logs of Soil Test Borings and summary sheet of Sieve Analysis results.

Boring 1 encountered one foot six inches (1'6") of possible fill soils followed by stiff to extremely stiff brown to blue silty clay which were found throughout the remainder of this boring. Borings 2, 3 and 4 encountered two feet (2') of fill and possible fill soils, one foot six inches (1'6") to six feet six inches (6'6") of stiff to extremely stiff brown to variegated silty clay, one foot (1') to two feet four inches (2'4") of medium compact to extremely compact brown silty sand to silty sand and gravel, followed by very stiff to extremely stiff brown to blue silty clay. The fill and possible fill soils found in the borings consist of topsoil and stiff brown and discolored brown silty clay.

Soil descriptions and depths shown on the boring logs are approximate indications of change from one soil type to another and are not intended to represent an area of exact geological change or stratification. Also, the site shows signs of modification which could indicate fill and soil conditions different from those encountered at the boring locations.

Water was encountered in the borings at depths ranging from four feet (4') to fourteen feet (14') below the existing ground surface. Water was measured upon completion of the drilling operation in the borings at depths ranging from six feet (6') to nineteen feet (19'). It should be noted that short-term groundwater observations may not provide a reliable indication of the depth of the water table. In clay soils, this is due to the slow rate of infiltration of water into the borehole 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 level fluctuations may 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.

Standard Penetration Tests made during sampling indicate that the native soils at the site have fair to very good strengths and densities. Tests taken at a depth of two feet six inches (2'6") gave results ranging from (8) to twelve (12) blows per foot. The five foot (5') test values varied from sixteen (16) to thirty-three (33) blows per foot. At a depth of seven feet six inches (7'6"), the results ranged from fourteen (14) to twenty (20) blows per six inches (6"). At ten feet (10') and below, penetration indices varied from nineteen (19) blows per foot to twenty-nine (29) blows per nine inches (9").

It is understood that a one- to two-story slab-on-grade funeral home building with parking lot and drives will be constructed at the site. It is assumed that the structure will transmit moderate loads to the supporting soils and pavements will support mostly automobile traffic with occasional trucks.

Based on the project information provided and the results of field and laboratory tests, it is believed that the new structure could be supported by conventional spread or strip footings. All exterior footings should be constructed at, or below, a minimum frost penetration depth of three feet six inches (3'6") below finished grade. All interior and exterior load-bearing footings should extend through non-engineered fill soils, soils containing a significant amount of organic substances, or excessively weak soils. All strip footings should be continuously reinforced in order to minimize the noticeable effects of differential settlement.

Footings constructed at the following boring locations could be proportioned for the design soil pressures shown in the table below:

| Boring | Depth | Soil Pressure (psf) |
|---|---|---|
| 1 | 1'6" to 4'0" | 3500 |
| | 4'6" to 12'0" | 4000 |
| 2 | 2'0" to 4'0" | 3000 |
| | 4'6" to 12'0" | 4000 |
| 4 | 2'0" to 4'6" | 2500 |
| | 5'0" to 12'0" | 4000 |

Higher design soil pressures are available at various depths in the individual borings and could be detailed, if desired.

It should be noted that footing excavations may be near, or below, the level at which water was encountered in Borings 2 and 3. Depending upon the depth of the footings relative to the existing ground surface and the actual conditions at the time of construction, it may be necessary to depress the water table in these locations to allow for footings to be constructed. Water seepage in sands above clay in the vicinity of Boring 3 should be manageable with construction pumping and sumps. However, this is not known for certain. If large volumes of water or saturated granular soils are encountered, special dewatering techniques may be required. Wet sand soils were encountered in Boring 2. It is sometimes possible to construct strip footings a foot or so below the water table in coarse granular soils using a rapid sequence of excavation and placement of concrete. If this is not possible, it may be necessary to use special dewatering techniques to depress the water table. A potential exists during any dewatering operation that nearby existing structures or utilities could be affected by the dewatering and could settle, especially if the nearby buildings are supported on shallow frost depth footings. Therefore, extreme caution should be practiced during any dewatering operation if nearby houses, buildings, structures or nearby utilities are sensitive to settlement. Extreme care must be taken to minimize any removal of soil fines during any dewatering operation to not cause ground loss.

Fill and possible fill soils were found in the borings. If the possibility of more than normal differential movement can be tolerated, slab-on-grade floors or floor-supporting backfill could be placed at, or near, the present grade. Any topsoil, soft, loose, highly organic or obviously objectionable material should be removed and the subgrade thoroughly proof-compacted with heavy, rubber-tired equipment. If, during the proof-compaction operation, areas are found where the soils yield excessively, the yielding materials should be scarified, dried and re-compacted or removed and replaced with engineered fill. Where fill or backfill is required to raise the subgrade for concrete floors, it is suggested that clean, well-graded granular soils be used. If clay material is utilized, it should be placed within two percent (2%) of its optimum moisture content. The fill should be deposited in horizontal lifts not to exceed nine inches (9") in thickness with each lift being compacted uniformly to a minimum density of ninety-five percent (95%) of its maximum value as determined by the Modified Proctor Test (A.A.S.H.T.O. T-180 or A.S.T.M. D-1557).

If the possibility of more than normal differential movement cannot be tolerated, then all existing fill soils should be removed and replaced with engineered fill meeting the requirements outlined above or the floor slab should be structurally supported.

It appears that the subgrade soils consist of clay soils. We would expect the clay soils to have California Bearing Ratios (CBRs) on the order of three percent (3%) and a modulus of subgrade reaction of about one hundred pounds per cubic inch (100 pci). It appears these soils may have a high percentage of silt-size particles which would indicate they could tend to have a severe frost heave potential.

Based on the above estimated CBR value, we have made the following pavement analysis. The site soils appear to be susceptible to frost heave. Consequently, it is suggested that in areas of

automobile and light truck traffic, three inches (3") of asphalt with eight inches (8") of high quality, well-graded granular base course be used. In the areas subject to a considerable amount of truck traffic, it is recommended that the asphalt thickness be increased by a minimum of one and one-half inches (1½"). In the areas to be paved, the site should be prepared in a manner similar to that recommended above. In addition, the subgrade is compacted to at least ninety-five percent (95%) of its maximum dry density as determined by the Modified Proctor Test. It is recommended as a minimum that stub drains be provided at the storm sewer catch basins to provide some drainage for the pavement base. Edge drains should be installed in shallow groundwater areas and in irrigated landscaped areas. The subgrade should be properly sloped to allow drainage of surface water. Eight inches (8") of concrete pavement should be used in the dumpster area and other intensive truck wheel load areas.

Experience indicates that the actual subsoil conditions at the site could vary from those found at the soil borings made at specific locations. It is, therefore, essential that McDowell & Associates be notified of any variation of soil conditions to determine their effects on the recommendations presented in this report. The evaluations and recommendations presented in this report have been formulated on the basis of reported or assumed data relating to the proposed project. Any significant change in this data in the final design plans should be brought to our attention for review and evaluation with respect to the prevailing subsoil conditions.

It is recommended that the services of McDowell & Associates be engaged to observe the soils in the footing excavations prior to concreting in order to test the soils for the required bearing capacities. Testing should also be performed to check that suitable materials are being used for controlled fills and that they are properly placed and compacted.

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

Very truly yours,

McDOWELL & ASSOCIATES

Daniel A. Kaniarz, M.S., P.E.

DAK/jb

McDOWELL & ASSOCIATES
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LOG OF SOIL BORING NO. 1

PROJECT Soils Investigation - Proposed Funeral Home

LOCATION Beck and 11 Mile Roads
Novi, Michigan

JOB NO. 17-041

SURFACE ELEV. 965.1 DATE 2-21-17

| Sample & Type | Depth | Legend | SOIL DESCRIPTION | Penetration Blows for 6" | Moisture % | Natural Wt. P.C.F. | Dry Den Wt. P.C.F. | Unc. Comp. Strength PSF. | Str. % |
|---|---|---|---|---|---|---|---|---|---|
| | | | Moist dark brown clayey TOPSOIL | | | | | | |
| | 1 | | 1'0" Moist discolored brown silty CLAY with trace of | | | | | | |
| | | | 1'6" topsoil, possible fill | | | | | | |
| A | 2 | | | 3 | | | | | |
| UL | | | Stiff moist brown sandy CLAY with moist brown | 7 | 11.7 | 132 | | | |
| | 3 | | silty sand seams | 5 | | | * | (3500) | |
| | | | | | | | | | |
| | 4 | | 4'0" | | | | | | |
| B | | | | 9 | | | | | |
| UL | 5 | | | 15 | 13.5 | 136 | | | |
| | | | Extremely stiff moist brown silty CLAY with sand | 16 | | | * | (9000+) | |
| | 6 | | and pebbles | | | | | | |
| | | | | | | | | | |
| C | 7 | | 7'0" | 9 | | | | | |
| UL | | | | 16 | | | | | |
| | 8 | | | 10 / 3" | | | | | |
| | | | | | | | | | |
| | 9 | | Extremely stiff moist variegated silty CLAY with | | | | | | |
| D | | | sand and pebbles | 6 | | | | | |
| UL | 10 | | | 12 | | | | | |
| | | | | 18 | | | | | |
| | 11 | | 11'0" | | | | | | |
| | | | | | | | | | |
| | 12 | | | | | | | | |
| | | | | | | | | | |
| | 13 | | | | | | | | |
| | | | | | | | | | |
| | 14 | | | | | | | | |
| E | | | | 6 | | | | | |
| UL | 15 | | Very stiff moist blue silty CLAY with sand and | 7 | | | | | |
| | | | pebbles and moist to wet gray silty sand seams | 11 | | | | | |
| | 16 | | | | | | | | |
| | | | | | | | | | |
| | 17 | | | | | | | | |
| | | | | | | | | | |
| | 18 | | | | | | | | |
| | | | | | | | | | |
| | 19 | | 19'0" | | | | | | |
| F | | | | 7 | | | | | |
| UL | 20 | | Very stiff moist blue silty CLAY with sand and | 8 | | | | | |
| | | | pebbles and wet gray silty sand seams | 11 | | | | | |
| | 21 | | 20'6" | | | | | | |
| | | | | | | | | | |
| | 22 | | | | | | | | |
| | | | | | | | | | |
| | 23 | | | | | | | | |
| | | | | | | | | | |
| | 24 | | | | | | | | |
| | | | | | | | | | |
| | 25 | | | | | | | | |

TYPE OF SAMPLE
O. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30". Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

| | | | | |
|---|---|---|---|---|
| G.W. ENCOUNTERED AT | 14 | FT | 0 | INS |
| G.W. ENCOUNTERED AT | | FT. | | INS |
| G.W. AFTER COMPLETION | 19 | FT. | 0 | INS |
| G.W. AFTER HRS. | | FT. | | INS. |
| G.W. VOLUMES | Medium | | | |

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LOG OF SOIL BORING NO. 2

PROJECT Soils Investigation - Proposed Funeral Home

JOB NO. 17-041

LOCATION Beck and 11 Mile Roads

SURFACE ELEV. 866.8 DATE 2-21-17

Novi, Michigan

| Sample & Type | Depth | Legend | SOIL DESCRIPTION | Penetration Blows for 6" | Moisture % | Natural Wet P.C.F. | Dry Den W/ P.C.F. | Unc. Comp. Strength PSF. | Silt % |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | | Moist discolored brown silty CLAY with traces of topsoil and vegetation, fill | | | | | | |
| A | 2 | | 2'0" | 2 | | | | | |
| UL | | | | 3 | 23.6 | 110 | | | |
| | 3 | | Stiff moist brown silty CLAY with sand and pebbles and moist brown sand seams | 7 | | | | (3000) | |
| | 4 | | | | | | | | |
| B | | | 4'2" | 12 | | | | | |
| UL | 5 | | | 15 | 11.9 | 136 | | | |
| | | | Extremely compact wet brown silty SAND with trace of gravel | --- | | | | | |
| | 6 | | | | | | | | |
| | | | 6'6" | | | | | | |
| C | 7 | | | 8 | | | | | |
| UL | | | Extremely stiff moist variegated silty CLAY with sand and pebbles | 16 | | | | | |
| | 8 | | | 10/3" | | | | | |
| | | | 8'6" | | | | | | |
| | 9 | | | | | | | | |
| D | | | | 10 | | | | | |
| UL | 10 | | | 17 | | | | | |
| | | | | 12/3" | | | | | |
| | 11 | | | | | | | | |
| | | | | | | | | | |
| | 12 | | | | | | | | |
| | | | | | | | | | |
| | 13 | | | | | | | | |
| | | | | | | | | | |
| | 14 | | Extremely stiff moist blue silty CLAY with sand and pebbles, occasional stones and very moist to wet gray silty sand seams | | | | | | |
| E | | | | 10 | | | | | |
| UL | 15 | | | 13 | | | | | |
| | | | | 18 | | | | | |
| | 16 | | | | | | | | |
| | | | | | | | | | |
| | 17 | | | | | | | | |
| | | | | | | | | | |
| | 18 | | | | | | | | |
| | | | | | | | | | |
| | 19 | | | | | | | | |
| F | | | | 8 | | | | | |
| UL | 20 | | | 13 | | | | | |
| | | | | 18 | | | | | |
| | 21 | | 20'6" | | | | | | |
| | | | | | | | | | |
| | 22 | | | | | | | | |
| | | | | | | | | | |
| | 23 | | | | | | | | |
| | | | | | | | | | |
| | 24 | | | | | | | | |
| | | | | | | | | | |
| | 25 | | | | | | | | |

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

| | | | | |
|---|---|---|---|---|
| G.W. ENCOUNTERED AT | 4 | FT. | 2 | INS. |
| G.W. ENCOUNTERED AT | 14 | FT. | 8 | INS. |
| G.W. AFTER COMPLETION | 15 | FT. | 0 | INS. |
| G.W. AFTER HRS. | | FT. | | INS. |
| G.W. VOLUMES | Heavy | | | |

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LOG OF SOIL BORING NO. 3

PROJECT Soils Investigation - Proposed Funeral Home

LOCATION Beck and 11 Mile Roads

JOB NO. 17-041

SURFACE ELEV. _____ DATE 2-21-17

Novi, Michigan

| Sample & Type | Depth | Legend | SOIL DESCRIPTION | Penetration Blows for 6" | Moisture % | Natural Wt. P.C.F. | Dry Den. Wt. P.C.F. | Unc. Comp. Strength PSF. | Str. % |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | | Moist discolored brown sandy CLAY with some topsoil and vegetation, fill | | | | | | |
| A UL | 2 | | 2'0" | 2 | | | | | |
| | 3 | | Stiff moist variegated sandy CLAY with pebbles | 4 | 14.3 | 121 | | | |
| | 4 | | 3'6" | 4 | | | * | (2500) | |
| B UL | 5 | | Medium compact moist to wet brown silty SAND & GRAVEL with trace of clay and moist brown clay seams | 3 | | | | | |
| | 6 | | 5'0" | 4 | 20.3 | 127 | | | |
| C UL | 7 | | Extremely stiff moist brown silty CLAY with sand and pebbles | 12 | | | * | (7000) | |
| | 8 | | | 14 | | | | | |
| | 9 | | 9'0" | 14 | | | | | |
| D UL | 10 | | Very stiff moist blue silty CLAY with sand and pebbles, occasional stones and moist gray silt seams | --- | | | | | |
| | 11 | | 10'6" | 8 | | | | | |
| | 12 | | | 8 | | | | | |
| | 13 | | | 15 | | | | | |
| | 14 | | | | | | | | |
| | 15 | | | | | | | | |
| | 16 | | | | | | | | |
| | 17 | | | | | | | | |
| | 18 | | | | | | | | |
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| | 22 | | | | | | | | |
| | 23 | | | | | | | | |
| | 24 | | | | | | | | |
| | 25 | | | | | | | | |

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30" Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

| | | | | |
|---|---|---|---|---|
| G.W. ENCOUNTERED AT | 4 | FT | 0 | INS. |
| G.W. ENCOUNTERED AT | | FT. | | INS. |
| G.W. AFTER COMPLETION | 5 | FT. | 0 | INS. |
| G.W. AFTER HRS. | | FT. | | INS. |

G.W. VOLUMES Heavy

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LOG OF SOIL BORING NO. 4

PROJECT Soils Investigation - Proposed Funeral Home

JOB NO. 17-041

LOCATION Beck and 11 Mile Roads

SURFACE ELEV. 967.9 DATE 2-21-17

Novi, Michigan

| Sample & Type | Depth | Legend | SOIL DESCRIPTION | Penetration Blows for 6" | Moisture % | Natural Wt. P.C.F. | Dry Den. Wt. P.C.F. | Unc. Comp. Strength PSF. | Gr. % |
|---|---|---|---|---|---|---|---|---|---|
| | | | Moist dark brown clayey TOPSOIL with sand and | | | | | | |
| | 1 | | pebbles and vegetation, fill | | | | | | |
| | | | 1'0" Moist discolored brown silty CLAY with topsoil | | | | | | |
| A | 2 | | and sand and pebbles, fill | 2 | | | | | |
| UL | | | 2'0" | 4 | 13.2 | 130 | | | |
| | 3 | | | 4 | | | * | (2500) | |
| | | | Stiff moist brown silty CLAY with sand and | | | | | | |
| | 4 | | pebbles | | | | | | |
| B | | | | 8 | | | | | |
| UL | 5 | | 4'6" | 14 | 13.4 | 131 | | | |
| | | | | 19 | | | * | (9000+) | |
| | 6 | | | | | | | | |
| | | | Extremely stiff moist variegated silty CLAY with | | | | | | |
| C | 7 | | sand and pebbles | 13 | | | | | |
| UL | | | | 20 | | | | | |
| | 8 | | | --- | | | | | |
| | | | 8'6" | | | | | | |
| | 9 | | Extremely compact wet brown silty fine to medium | | | | | | |
| D | | | SAND | 8 | | | | | |
| UL | 10 | | 9'6" | 13 | | | | | |
| | | | | 16 | | | | | |
| | 11 | | | | | | | | |
| | | | Extremely stiff moist blue silty CLAY with sand | | | | | | |
| | 12 | | and pebbles and occasional stones | | | | | | |
| | | | | | | | | | |
| | 13 | | | | | | | | |
| | | | | | | | | | |
| | 14 | | 14'0" | | | | | | |
| E | | | | 6 | | | | | |
| UL | 15 | | | 9 | | | | | |
| | | | | 10 | | | | | |
| | 16 | | | | | | | | |
| | | | Very stiff moist blue silty CLAY with sand and | | | | | | |
| | 17 | | pebbles and wet gray silty sand seams | | | | | | |
| | | | | | | | | | |
| | 18 | | | | | | | | |
| | | | | | | | | | |
| | 19 | | 19'0" | | | | | | |
| F | | | Extremely stiff moist blue silty CLAY with sand | 9 | | | | | |
| UL | 20 | | and pebbles and moist gray silty sand seams | 12 | | | | | |
| | | | | 18 | | | | | |
| | 21 | | 20'6" | | | | | | |
| | | | | | | | | | |
| | 22 | | | | | | | | |
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| | 23 | | | | | | | | |
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| | 24 | | | | | | | | |
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| | 25 | | | | | | | | |

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

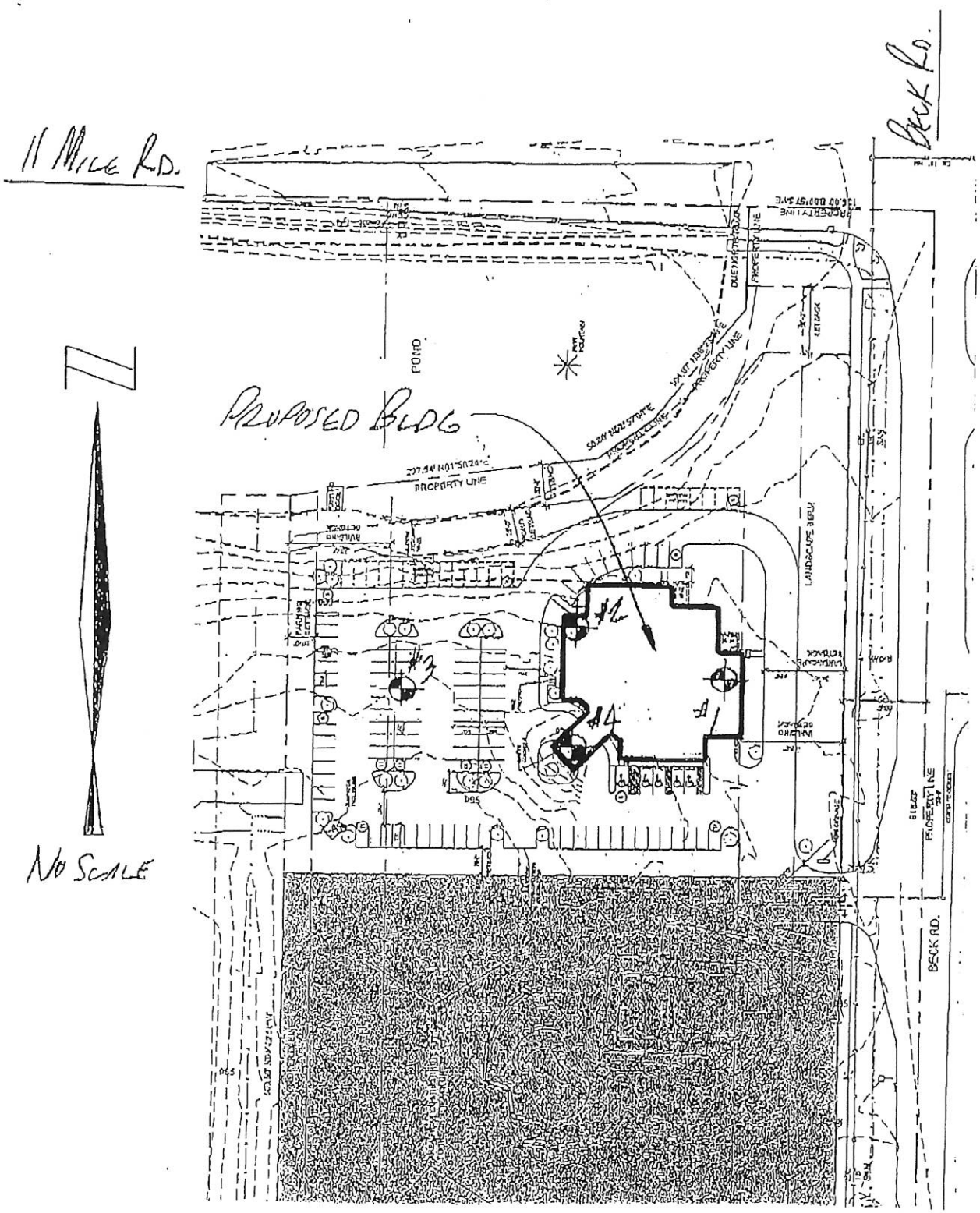
| | | | | |
|---|---|---|---|---|
| G.W. ENCOUNTERED AT | 8 | FT. | 6 | INS. |
| G.W. ENCOUNTERED AT | 14 | FT. | 2 | INS. |
| G.W. AFTER COMPLETION | 19 | FT. | 0 | INS. |
| G.W. AFTER HRS. | | FT. | | INS. |

G.W. VOLUMES Medium

Job No. 17-041

## SIEVE ANALYSIS

| Boring | Sample | % Passing #4 Sieve | % Passing #10 Sieve | % Passing #40 Sieve | % Passing #100 Sieve | % Passing #200 Sieve |
|---|---|---|---|---|---|---|
| 2 | B | 89.6 | 77.3 | 44.3 | 27.2 | 20.8 |




Soil Boring Location Plan

#17-041