



MEMORANDUM

Missouri Department of Transportation Construction - Materials Central Laboratory

TO: Jacky Traw-se/gs

CC/ATT: Kevin Plott-se/cm
Corbin Carlton-se/cm
Paul Huskey-se/gs
James Bradford-se/mt

FROM: Ricardo N. Todd
Sr. Geotechnical Specialist

DATE: October 6, 2016

SUBJECT: Materials
Geotechnical Section
Foundation Investigation for
Structure No. FI2451
Route 19, Shannon County

As requested in a letter dated August 25, 2016, from Materials Inspector Corbin Carlton, a foundation investigation has been conducted for a new cold storage building at the Winona Maintenance Facility. The layout of the bore holes for the proposed structure is shown in Figure 1.

Existing Conditions

The soil encountered at the four (4) borings primarily included base material that extended to a depth of approximately 0.5 feet. The soil beneath the base material consists of about 5.1 feet of brown fat clay, which classifies as CH by ASTM classification methods and beneath this material consists 16.5 feet of tannish red lean clay, which classifies as CH by ASTM classification methods. The pocket penetrometer readings of the soil generally indicate a stiff to very stiff soil.

Free ground water was not observed in the borings upon completion. Further information on the subsurface materials encountered and their properties is presented on the attached boring logs.

Recommendations

The following recommendations are made based upon information provided regarding the proposed building and conditions observed during the foundation investigation:

- Remove any asphalt pavement, concrete pavement, foundations and any other existing surface or subsurface features from the proposed construction area. After making any

grading excavation and before any fill placement, proof roll all cut and fill areas with a fully loaded tandem axle dump truck. Any areas exhibiting pumping or rutting should be undercut and backfilled with compacted granular fill. Prior to placement of any new fill, scarify the surface of any areas to be filled.

- It is recommended that any new fill material be lean clay or better. However, use of granular fill material is preferred if feasible. Fill should be compacted to 95% of standard Proctor maximum dry density. Non-granular fill material should be compacted at or within 3% of optimum moisture content. All fill and cut areas should be constructed to slope and drain away from the proposed building.
- An allowable bearing pressure of 2500 psf or less may be used for the design of shallow foundations constructed on or in properly compacted fill or natural soils at this site. Shallow foundations shall be embedded a minimum of 20 inches below finished grade for frost protection. Individual spread footings shall have a minimum width of 2.5 feet while strip footings shall have a minimum width of 1.5 feet.

Figure 1 Foundation Investigation Route 19



R35G - FI2451

INDUSTRIAL DR

1:600 = 1" = 50'

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

**Missouri Department of Transportation
Construction and Materials**

BORING NO. O-16-70
Page 1 of 1

Job No.: R35G-FI2451
 Design: FI2451
 Bent: SW
 Station: _____
 Offset: _____
 Elevation: 1057.2
 Requested Station: _____
 Requested Offset: _____
 Requested Elevation: _____
 Drill No.: G-9667

County: Shannon
 Skew: _____
 Logged By: Ricardo Todd
 Northing: 434343.1
 Easting: 579990.4
 Requested Northing: _____
 Requested Easting: _____
 Equipment: Acker Renegade ,Split-Spoon Sampler
 Location Note: _____
 Hammer Efficiency: 82%

Route: 19
 Location: Winona
 Operator: Raymond Murray
 Date of Work: 09/12/16-09/12/16
 Depth to Water: _____
 Depth Hole Open: _____
 Time Change: _____
 Drilling Method: Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N ₆₀)	Shear Data	Field Tests	Index Tests
0									
0.0-5.4'		0.0-5.4' Red, GRAVELLY FAT CLAY, stiff, moist	1055						
5				X	33	3-3-4 (10)		PP = 1.00 tsf	LL = 52 PL = 21
5.4-14.3'		5.4-14.3' Tan, GRAVELLY LEAN CLAY, stiff, moist	1050	X	67	3-7-13 (28)			MC = 18.5% γ _{sat} = 132 pcf ⁽¹⁾
10				X	105	22-49/0.5'			
15				X	75	15-28-49/0.3'			
			1045	X	38	11-49/0.2'			
		14.3-16.5' Limestone, highly weathered			100	49/0.1'			
		Bottom of borehole at 16.5 feet.							

LETTER BOREHOLE - MODOT 20150728.GDT - 10/6/16 16:00 - J:\SG\GINT\PROJECT FILES\R35G-FI2451.GPJ

N₆₀ = (Em/60)Nm N₆₀ - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
 (1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 Coordinate Zone: Missouri East Coordinate Proj. Factor: _____
 Coordinate Datum: NAD 83 (CONUS) Coordinate Units: U.S. Survey Feet

* Persons using this information are cautioned that the materials shown are determined by the equipment noted and accuracy of the "log of materials" is limited thereby and by judgement of the operator. THIS INFORMATION IS FOR DESIGN PURPOSES ONLY.

**Missouri Department of Transportation
Construction and Materials**

BORING NO. O-16-71
Page 1 of 1

Job No.: R35G-FI2451
 Design: FI2451
 Bent: NW
 Station: _____
 Offset: _____
 Elevation: 1056.9
 Requested Station: _____
 Requested Offset: _____
 Requested Elevation: _____
 Drill No.: G-9667

County: Shannon
 Skew: _____
 Logged By: Ricardo Todd
 Northing: 434393
 Easting: 579989.4
 Requested Northing: _____
 Requested Easting: _____
 Equipment: Acker Renegade ,Split-Spoon Sampler
 Location Note: _____
 Hammer Efficiency: 82%

Route: 19
 Location: Winona
 Operator: Raymond Murray
 Date of Work: 09/12/16-09/12/16
 Depth to Water: _____
 Depth Hole Open: _____
 Time Change: _____
 Drilling Method: Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N ₆₀)	Shear Data	Field Tests	Index Tests
0									
0.0-7.6'		0.0-7.6' Red, FAT CLAY scattered gravel, medium stiff to very stiff, moist	1055						
5				X	67	3-3-2 (7)		PP = 1.00 tsf	MC = 24.2% γ _{sat} = 126 pcf ⁽¹⁾
				X	67	2-4-4 (11)		PP = 1.50 tsf	MC = 23.2% γ _{sat} = 127 pcf ⁽¹⁾ LL = 54 PL = 20
7.6-16.5'		7.6-16.5' Red, GRAVELLY LEAN CLAY, stiff, moist	1050						
10				X	67	2-3-9 (17)			MC = 18.4% γ _{sat} = 132 pcf ⁽¹⁾
				X	67	3-3-6 (13)		PP = 1.00 tsf	MC = 18.0% γ _{sat} = 133 pcf ⁽¹⁾ LL = 32 PL = 16
15				X	60	16-49/0.3'			
				X	67	6-20-33 (75)			MC = 19.9% γ _{sat} = 131 pcf ⁽¹⁾
		Bottom of borehole at 16.5 feet.							

LETTER BOREHOLE - MODOT 20150728.GDT - 10/6/16 16:00 - J:\SG\GINT\PROJECT FILES\R35G-FI2451.GPJ

N₆₀ = (Em/60)N_m N₆₀ - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; N_m - Observed N-value
 (1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 Coordinate Zone: Missouri East Coordinate Proj. Factor: _____
 Coordinate Datum: NAD 83 (CONUS) Coordinate Units: U.S. Survey Feet

* Persons using this information are cautioned that the materials shown are determined by the equipment noted and accuracy of the "log of materials" is limited thereby and by judgement of the operator. THIS INFORMATION IS FOR DESIGN PURPOSES ONLY.

**Missouri Department of Transportation
Construction and Materials**

BORING NO. O-16-72
Page 1 of 1

Job No.: R35G-FI2451
 Design: FI2451
 Bent: NE
 Station: _____
 Offset: _____
 Elevation: 1057.2
 Requested Station: _____
 Requested Offset: _____
 Requested Elevation: _____
 Drill No.: G-9667

County: Shannon
 Skew: _____
 Logged By: Ricardo Todd
 Northing: 434395.9
 Easting: 580139.4
 Requested Northing: _____
 Requested Easting: _____
 Equipment: Acker Renegade ,Split-Spoon Sampler
 Location Note: _____
 Hammer Efficiency: 82%

Route: 19
 Location: Winona
 Operator: Raymond Murray
 Date of Work: 09/12/16-09/12/16
 Depth to Water: _____
 Depth Hole Open: _____
 Time Change: _____
 Drilling Method: Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N ₆₀)	Shear Data	Field Tests	Index Tests
0									
0.0-8.5'		0.0-8.5' Red, FAT CLAY scattered gravel, stiff, moist	1055	X	67	6-4-7 (16)		PP = 1.50 tsf	MC = 26.3% γ _{sat} = 124 pcf ⁽¹⁾
5			1050	X	67	2-6-4 (14)		PP = 1.25 tsf	MC = 22.9% γ _{sat} = 127 pcf ⁽¹⁾ LL = 39 PL = 23
8.5-16.5'		8.5-16.5' Red, GRAVELLY LEAN CLAY scattered cobbles, very stiff, moist		X		3-4-49/0.3'			
10			1045	X	67	3-36-22 (82)		PP = 7.00 tsf	MC = 21.5% γ _{sat} = 129 pcf ⁽¹⁾
15				X	34	3-36-49/0.5'			
				X	75	8-49/0.2'			
		Bottom of borehole at 16.5 feet.							

LETTER BOREHOLE - MODOT 20150728.GDT - 10/6/16 16:00 - J:\SG\GINT\PROJECT FILES\R35G-FI2451.GPJ

N₆₀ = (Em/60)Nm N₆₀ - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
 (1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 Coordinate Zone: Missouri East Coordinate Proj. Factor: _____
 Coordinate Datum: NAD 83 (CONUS) Coordinate Units: U.S. Survey Feet

* Persons using this information are cautioned that the materials shown are determined by the equipment noted and accuracy of the "log of materials" is limited thereby and by judgement of the operator. THIS INFORMATION IS FOR DESIGN PURPOSES ONLY.

**Missouri Department of Transportation
Construction and Materials**

BORING NO. O-16-73
Page 1 of 1

Job No.: R35G-FI2451
 Design: FI2451
 Bent: SE
 Station: _____
 Offset: _____
 Elevation: 1057.3
 Requested Station: _____
 Requested Offset: _____
 Requested Elevation: _____
 Drill No.: G-9667

County: Shannon
 Skew: _____
 Logged By: Ricardo Todd
 Northing: 434345.9
 Easting: 580140.3
 Requested Northing: _____
 Requested Easting: _____
 Equipment: Acker Renegade ,Split-Spoon Sampler
 Location Note: _____
 Hammer Efficiency: 82%

Route: 19
 Location: Winona
 Operator: Raymond Murray
 Date of Work: 09/12/16-09/12/16
 Depth to Water: _____
 Depth Hole Open: _____
 Time Change: _____
 Drilling Method: Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N ₆₀)	Shear Data	Field Tests	Index Tests
0									
0-5		0.0-5.1' Brown, FAT CLAY scattered gravel, loose to dense, moist	1055	X	67	9-3-4 (10)		PP = 1.25 tsf	MC = 16.8% γ _{sat} = 134 pcf ⁽¹⁾ LL = 23 PL = 14
5-16.5		5.1-16.5' Red, GRAVELLY LEAN CLAY, stiff, moist	1050	X	67	4-12-12 (34)			MC = 25.0% γ _{sat} = 125 pcf ⁽¹⁾
10				X	52	6-49/0.5'			
10-15			1045	X	67	5-23-19 (60)			
15				X	67	9-22-32 (77)			
15				X	67	12-49/0.3'			
		Bottom of borehole at 16.5 feet.							

LETTER BOREHOLE - MODOT 20150728.GDT - 10/6/16 16:00 - J:\SG\GINT\PROJECT FILES\R35G-FI2451.GPJ

N₆₀ = (Em/60)N_m N₆₀ - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; N_m - Observed N-value
 (1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 Coordinate Zone: Missouri East Coordinate Proj. Factor: _____
 Coordinate Datum: NAD 83 (CONUS) Coordinate Units: U.S. Survey Feet

* Persons using this information are cautioned that the materials shown are determined by the equipment noted and accuracy of the "log of materials" is limited thereby and by judgement of the operator. THIS INFORMATION IS FOR DESIGN PURPOSES ONLY.



Missouri Department of Transportation
1617 Mo. Blvd.
Jefferson City, Mo. 65109

KEY TO SYMBOLS

CLIENT _____

PROJECT NAME Cold Storage

PROJECT NUMBER R35G-FI2451

PROJECT LOCATION Winona

LITHOLOGIC SYMBOLS (Unified Soil Classification System)



CH: USCS High Plasticity Clay



CHG: USCS High Plasticity Gravelly Clay



CLG: USCS Low Plasticity Gravelly Clay



CLS: USCS Low Plasticity Sandy Clay

HI-WEA LIMESTONE

SAMPLER SYMBOLS



Split-Spoon Sampler

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

- LL - LIQUID LIMIT (%)
- PI - PLASTIC INDEX (%)
- W - MOISTURE CONTENT (%)
- DD - DRY DENSITY (PCF)
- NP - NON PLASTIC
- 200 - PERCENT PASSING NO. 200 SIEVE
- PP - POCKET PENETROMETER (TSF)
- Qu - UNCONFINED COMPRESSIVE STRENGTH (PSF)

- TV - TORVANE
- PID - PHOTOIONIZATION DETECTOR
- UC - UNCONFINED COMPRESSION
- ppm - PARTS PER MILLION

Water Level at Time of Drilling

Water Level at End of Drilling

Water Level after Drilling