MEMORANDUM

Missouri Department of Transportation
Construction and Materials
Geotechnical Section

TO: Richard Benett – tr

CC: Richard Bennett - tr
Kevin Eggmeyer – cd-tr
Patricia Lemongelli –cd-co

FROM: George H. Davis, CPG, R.G. G.D.
Central District Geologist – acting
Central Office Geologist

DATE: January 14, 2015

SUBJECT: Materials
Geotechnical Section
Foundation Investigation for
Flat Radio Tower
Job No. R 35G

Attached are logs of borings for a planned radio tower to be built approximately 3.7 miles west-northwest of the town of Flat in Phelps County approximately 300' off Route M. A general location map for this tower is attached as Figure 1. The existing MoDOT radio tower at this site is due for replacement. The planned new tower is to be located immediately adjacent to the existing radio tower. Locations of soil borings completed are listed in Table 1 along with their UTM coordinates. Map locations of the borings are shown in Figure 2.

Table 1. Locations of borings completed

Boring	Easting	Northing	Remarks
T-14-46	1792236.5	700650.6	North side tower bldg
T-14-47	1792189.9	700773.0	N guy location
T-14-48	1792367.1	700598.5	SE guy location
T-14-49	1792176.3	700508.8	SW guy location
Auger boring	1792271.0	700611.0	SE side tower bldg

Shallow foundations at this site may be designed using an allowable bearing of 6 ksf. Shallow foundations shall be embedded a minimum of 20inches below finished grade for frost protection. Spread footings Shall have a minimum width of three feet while strip footings shall have a minimum width of 2 feet. An angle of internal friction of 25 degrees may be utilized in determining sliding resistance.

The values in the following table may be used for drilled shaft design at the site. The bearing resistance of the soil to a depth of 5.0 feet shall be ignored. The use of permanent casing is not anticipated.

Table 2. Values for Drilled Shaft Design

Depth (ft.) From	To	Unit Weight pcf	Allowable Side Friction, ksf	Allowable End Bearing, ksf	External Friction Angle $\phi°$
0	5.0	Ignore	Ignore	Ignore	Ignore
5.0	15.0	121.8	0.7	6.0	25.0

The results of electrochemical testing indicates the shallow soil has a minimum resistivity of 1710 Ω (ohms)/ cm as determined by AASHTO T-288 and a soil pH of 4.1 as determined by AASHTO T-289

Attachments
ghd

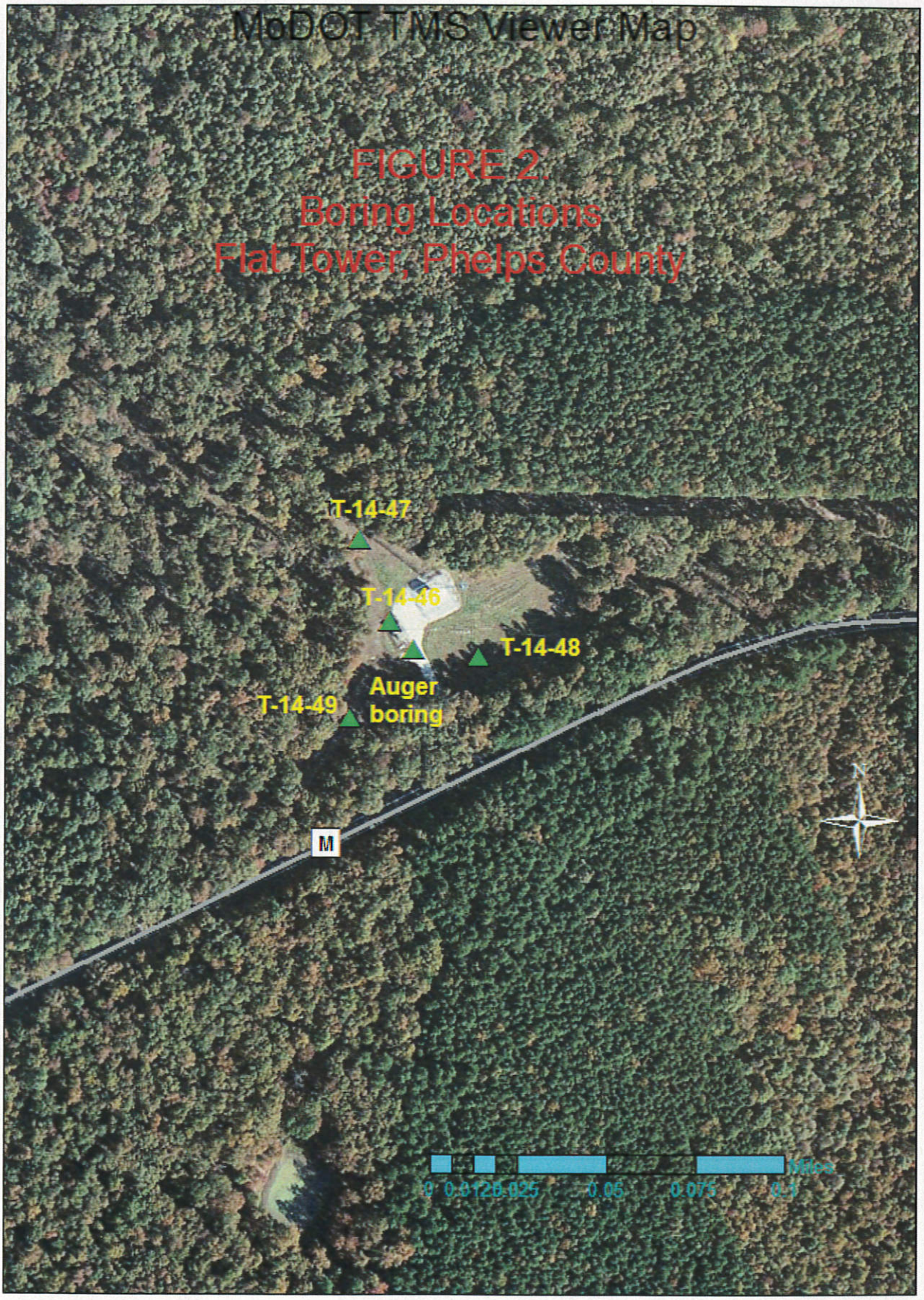
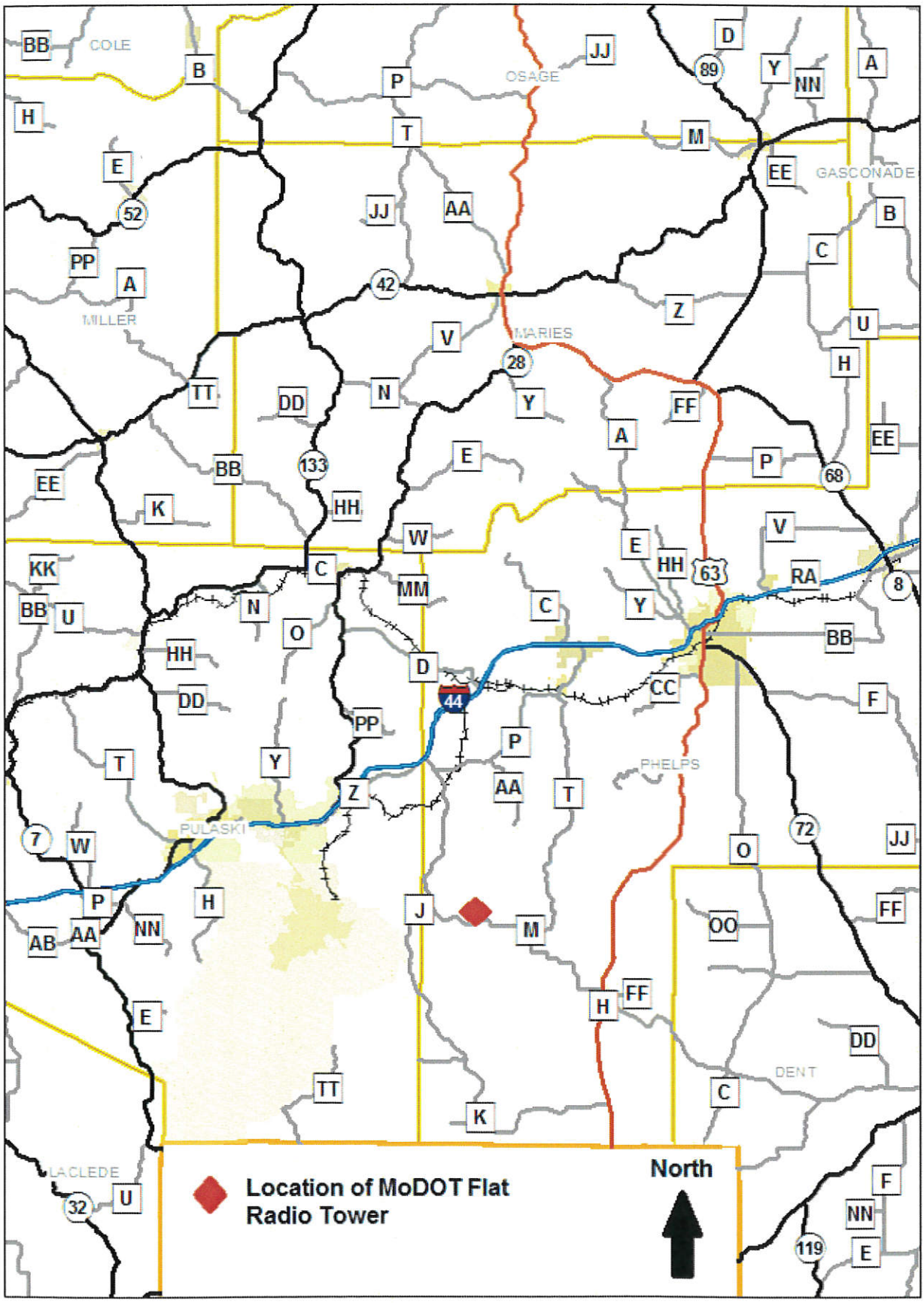

MoDOT TMS Viewer Map
FIGURE 2.
Boring Locations
Flat Tower, Phelps County
T-14-47
T-14-46
T-14-48
Auger
boring
T-14-49
M
N
0 0.0125 0.025 0.05 0.075 0.1
Miles

Figure 1. General Location of MoDOT Flat Tower



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BORING NO. T-14-46
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Job No.: R35G-Fi2240
Design: Fi2240
Bent:
Station:
Offset:
Elevation: 1187.1
Requested Station:
Requested Offset:
Requested Elevation:
Drill No.: G-9577

County: Phelps
Skew:
Logged By: Kevin Moore
Northing: 700650.6
Easting: 1792236.5
Requested Northing:
Requested Easting:
Equipment: CME 45 ,Auger Cuttings, Split-Spoon Sampler, Shelby Tube, NX
Location Note:
Hammer Efficiency: 84%

Route: M
Location: Flat
Operator: Raymond Murray
Date of Work: 12/23/14-12/23/14
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 Strength Data	Field Tests	Index Tests
0		0-5.5' Dark reddish brown and gray, FAT CLAY scattered fine sand, with coarse gravel, and coarse sand, stiff, moist, poorly graded	1185		100 87		Qu Test Results UCS = 7.46 ksf MC = 32.9% γ_{moist} = 119.5 pcf	PP = 7.00 tsf Torvane = 0.40 tsf	MC = 23.4%
5					60	5-7-10 (24)		PP = 6.00 tsf	MC = 32.7% LL = 82 PL = 37
		5.5-18.2' Dark reddish brown and gray, FAT CLAY scattered fine sand, with coarse gravel, and coarse sand, moist, poorly graded, Interbedded with small lens of rock.	1180		100			PP = 6.50 tsf Torvane = 1.35 tsf	MC = 32.5%
10					80	36-18-15 (46)		PP = 9.00 tsf	MC = 35.1% LL = 76 PL = 29
					100			PP = 7.50 tsf Torvane = 1.35 tsf	MC = 25.8% LL = 78 PL = 32
			1175		27	21-15-44 (83)			MC = 29.2%
					100	4-11-13 (34)		PP = 9.00 tsf	MC = 27.1% LL = 58 PL = 29
15					32		Qu Test Results UCS = 3.44 ksf MC = 26.4% γ_{moist} = 108.2 pcf	PP = 3.00 tsf	MC = 18.9%
			1170		47	17-18-19 (52)		PP = 7.00 tsf	MC = 32.0%
20		18.2-31.2' Dolomite, gray and tan, thin bedded, hard to very soft, highly weathered, very fine grained, Interbedded with clay seams 18.2' Auger refusal @ 18.2'.			40 (12)				
			1165		13 (0)				
25									
			1160		15 (0)				
30									
		Bottom of borehole at 31.2 feet.							

N_{60} = (Em/60)Nm N_{60} - 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 Central **Coordinate Proj. Factor:** 1.0000000

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.

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BORING NO. T-14-47
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Job No.: R35G-Fi2240 **County:** Phelps **Route:** M
Design: Fi2240 **Skew:** **Location:** Flat
Bent: **Logged By:** Kevin Moore **Operator:** Raymond Murray
Station: **Northing:** 700773 **Date of Work:** 12/23/14-12/23/14
Offset: **Easting:** 1792189.9 **Depth to Water:**
Elevation: 1185.5 **Requested Northing:** **Depth Hole Open:**
Requested Station: **Requested Easting:** **Time Change:**
Requested Offset: **Equipment:** CME 45 ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: G-9577 **Hammer Efficiency:** 84% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Strength Data	Field Tests	Index Tests
0		0-10' Dark reddish brown and gray, GRAVELLY FAT CLAY, medium stiff to very stiff, moist	1185						
5			1180	X	87	6-11-17 (39)		PP = 6.50 tsf	MC = 27.5% LL = 63 PL = 32
10		10-15.9' Dark reddish brown and gray, SANDY FAT CLAY with coarse gravel, and cobbles, hard to very hard, moist, poorly graded, Interbedded with lenses of weathered limestone. 10' chert lens.	1175	X	67	33-23-44 (94)		PP = 9.00 tsf	MC = 19.3%
15			1170	X	80	7-44			MC = 23.4% LL = 62 PL = 34
		15.9' Refusal on rock, hard, probably dolomite. Bottom of borehole at 15.9 feet.							

N_{60} = (Em/60)Nm N_{60} - 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 Central **Coordinate Proj. Factor:** 1.0000000
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BORING NO. T-14-49
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Job No.: R35G-Fi2240	**County:** Phelps	**Route:** M
Design: Fi2240	**Skew:**	**Location:** Flat
Bent:	**Logged By:** George Davis	**Operator:** Raymond Murray
Station:	**Northing:** 700508.8	**Date of Work:** 12/30/14-12/30/14
Offset:	**Easting:** 1792176.3	**Depth to Water:**
Elevation: 1185.4	**Requested Northing:**	**Depth Hole Open:**
Requested Station:	**Requested Easting:**	**Time Change:**
Requested Offset:	**Equipment:** CME 45 ,Split-Spoon Sampler	
Requested Elevation:	**Location Note:**	
Drill No.: G-9577	**Hammer Efficiency:** 84%	**Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Strength Data	Field Tests	Index Tests
0		0-3.7' Brown, LEAN CLAY, medium stiff, moist	1185						
5		3.7-19.9' Reddish brown and gray, FAT CLAY with fine to coarse gravel, very hard, moist	1180	X	100	4-6-10 (22)			
10			1175	X	100	6-25-27 (73)			
15			1170	X	100	7-21-30 (71)			
20		19.9-22.1' Cherty Dolomite, soft, moderately weathered	1165	X	100	32-20-13 (46)			
		Bottom of borehole at 22.1 feet.							

N_{60} = (Em/60)Nm N_{60} - 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 Central **Coordinate Proj. Factor:** 1.0000000

Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

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BORING NO. T-14-48
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Job No.: R35G-Fi2240 **County:** Phelps **Route:** M
Design: Fi2240 **Skew:** **Location:** Flat
Bent: **Logged By:** George Davis **Operator:** Raymond Murray
Station: **Northing:** 700598.5 **Date of Work:** 12/30/14-12/30/14
Offset: **Easting:** 1792367.1 **Depth to Water:**
Elevation: 1188.1 **Requested Northing:** **Depth Hole Open:**
Requested Station: **Requested Easting:** **Time Change:**
Requested Offset: **Equipment:** CME 45 ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: G-9577 **Hammer Efficiency:** 84% **Drilling Method:** Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Strength Data	Field Tests	Index Tests
0		0-3.1' Brown, LEAN CLAY trace chert gravel, stiff, dry	1185						
5		3.1-6.9' Reddish brown, FAT CLAY with fine to coarse gravel, hard, moist		X	100	4-7-10 (24)			
10		6.9-10.8' Reddish brown, FAT CLAY with fine to coarse gravel, few cobbles, hard, moist	1180	X	45	2-30/0.4', 10/0'			
		10.8-12' Cherty Dolomite, soft to medium hard, moderately weathered, cut with hollow stem augers	1175						
15		12-16.8' Reddish brown, FAT CLAY with cobbles, hard, moist		X	100	5-12-15 (38)			
		16.8-17.8' Cherty Dolomite, very hard, slightly weathered							
		Bottom of borehole at 17.8 feet.							

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

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Boring Data

Job No.: R35G-Fi2240 **County:** Phelps **Route:** M
Design: Fi2240 **Skew:** **Location:** Flat
Bent: **Logged By:** Kevin Moore **Operator:** Raymond Murray
Station: **Northing:** 700611 **Date of Work:** 12/23/14-12/23/14
Offset: **Easting:** 1792271 **Depth to Water:**
Elevation: 1188.7 **Requested Northing:** **Depth Hole Open:**
Requested Station: **Requested Easting:** **Time Change:**
Requested Offset: **Equipment:** CME 45 , Continuous Flight Auger
Requested Elevation: **Location Note:**

Depth (ft)	Graphic		Description	Elevation (ft)
0			0-13.9' Dark reddish brown and gray, FAT CLAY with cobbles, and coarse gravel, and sand, stiff to very stiff, moist to dry, poorly graded	1185
5				1180
10				1175
			13.9' Auger refual on rock, probably dolomite. Bottom of borehole at 13.9 feet.	

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000000
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