PALMERTON & PARRISH, INC.

GEOTECHNICAL & MATERIALS ENGINEERS
MATERIALS TESTING LABORATORIES
ENVIRONMENTAL SERVICES

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July 28, 2015

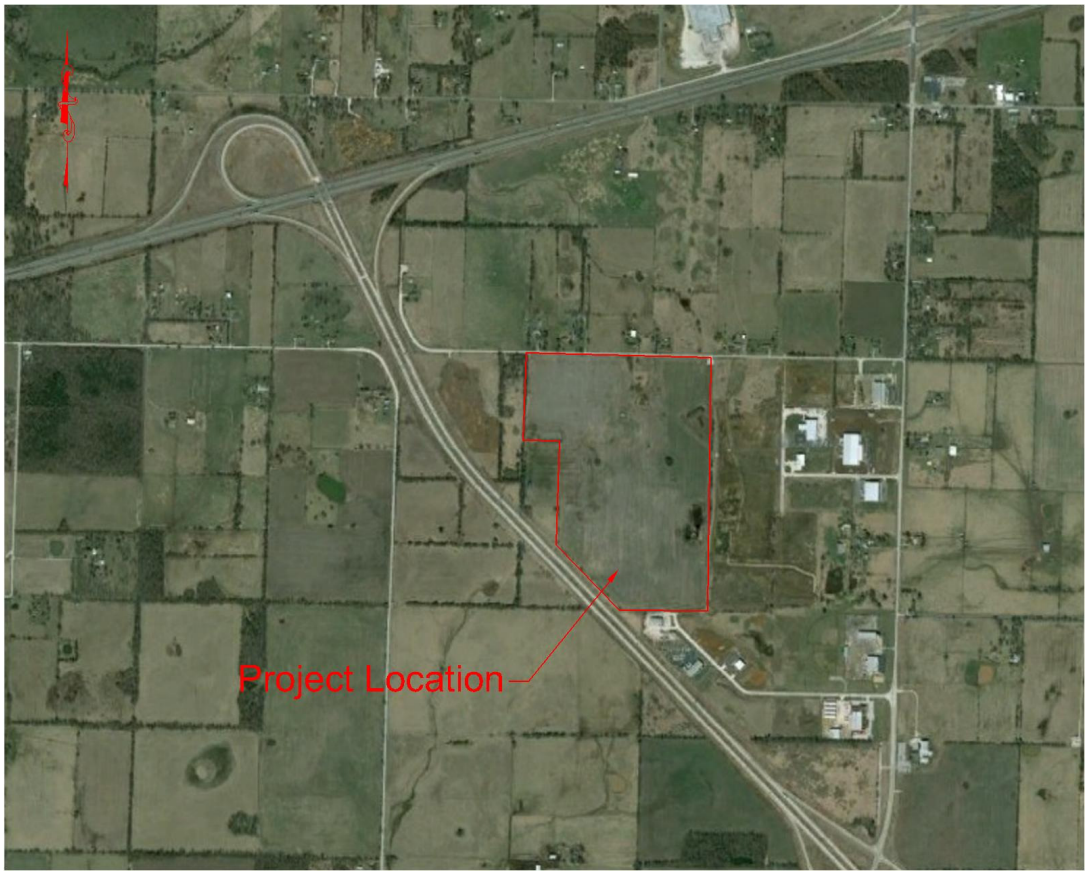
Drury Properties, Inc.
P.O. Box 1326
Springfield, MO 65801

Attn: Mr. Mitch Drury
Mitch@DruryProperties.com

Re: Preliminary Geotechnical Investigation – New Development
7136 West Farm Road 144
Greene County, Missouri
PPI Project Number: 229620

Dear Mr. Drury:

This letter report was prepared to summarize results of the Preliminary Geotechnical Investigation performed at the site proposed for development consisting of 99.3 acres located at 7136 West Farm Road 144 in Greene County, Missouri. This Investigation was authorized by a letter proposal dated June 30, 2015 and signed by Mr. Mitch Drury, representing Drury Properties, Inc. The area of the proposed development is presented below:



10000 Hwy 160
Walnut Shade, MO 65771
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5616 S. 122nd East Ave., Ste. I
Tulsa, OK 74146
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Joplin, MO 64801
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Executive Summary

A Preliminary Geotechnical Investigation was performed at 7136 West Farm Road 144 in Greene County, Missouri. Important geotechnical considerations for proposed development of the subject property is summarized below. However, users of the information contained in the report must review the entire report for specific details pertinent to preliminary development considerations.

- There are five (5) closed contour features on the subject property, all of which have been influenced by past man-made development. These features are labeled and identified on Figure 1. Closed Contour Areas 1 and 5 are probably the result of road grading and not karst related. Ground disturbances have also occurred in the areas of Closed Contour Areas 2, 3 and 4. Although the presence of a small karst feature in these areas is possible, it is considered unlikely in Areas 2 and 4 (but with greater potential for karst activity at Area 3). During the design plan approval process, the City may require a formal sinkhole report for these closed contour features in accordance with Chapter 96 of City Ordinances.
- Subsurface conditions were investigated by drilling a total of four (4) soil sample borings selected at locations based on the major soils present on the subject property according to the USDA Soils Map, seen on Figure 2.
- Results of the field investigation indicate that bedrock depths vary from 9 ft. to greater than 15 ft.
- Shallow spread footings should generally provide satisfactory support for light to moderately loaded commercial buildings on the property.
- Significate shrink/swell behavior from higher plasticity clays classifying as CH in accordance with the USCS is not anticipated. See pg. 7 of this report for details.
- All work performed on the property was conducted in a limited manner to minimize damage to corn crops present on the subject property at the time of this investigation.
- This is a preliminary investigation and this report is limited to generalized recommendations for development. An additional investigation will be required for each structure to provide specific recommendations.

Project Description

As previously mentioned, the 99.3 acres located at 7136 West Farm Road 144 in Greene County, Missouri is proposed for new development. Anticipated new development may include structures 1 to 2 stories in height with light to moderate loads bearing on shallow foundations. New pavement is also anticipated at the project site and may be subjected to light to moderate wheel loadings. Minimal depths of cut and/or fill are anticipated across this site.

The subject property is currently open agricultural land planted in corn. The property boundary is currently covered in brush with semi mature trees. There are five (5) areas of depression on the subject property that have closed contours that are possibly karst features. These features are shown on Figure 1: LiDAR Site Location Plan. The purpose of this investigation was to characterize the existing subsurface conditions of the subject property and provide preliminary recommendations for new development.

Work Performed

Subsurface conditions on the subject property were investigated by drilling a total of four (4) sample borings and subsequent laboratory testing. Boring locations were selected and staked in the field by PPI based upon the USDA soil groups on the subject property. According to the USDA, four (4) major soil groups exceeding 15 acres are present on the subject property. USDA soils map with boring locations can been seen in Figure 2. Approximate boring locations are shown on Figure 2: Boring Location Plan.

Please note that boring locations were limited to the perimeter of the subject property to avoid damaging crops present during the time of the work performed.

Boring 1 was discontinued in natural overburden soils at a depth of 15 ft. below the existing ground surface. Boring 2, 3 and 4 were discontinued in limestone at depth ranging from 9.7 to 14.5 ft. below the existing ground surface. The Missouri One-Call System was notified prior to the investigations to assist in locating buried public utilities. Logs of the borings showing descriptions of soil and rock units encountered, as well as results of field and laboratory tests and a “Key to Symbols” are presented in Appendix I.

Borings were drilled July 17, 2015 using 4.5-inch O.D. continuous flight augers powered by an ATV mounted BK-51 drill-rig. Soil samples were collected at 2.5 to 5-ft. centers during drilling. Soil sample types included split spoon samples collected while performing the Standard Penetration Test (SPT) in general accordance with ASTM D1586 and. Please refer to Appendix II for general notes regarding boring logs and additional soil sampling information.

A site visit was performed by Joshua D. Elson G.R.I.T., PPI Staff Geologist, on July 28, 2015. The purpose of the site visit was to conduct a brief reconnaissance of closed contours existing on the property and discussed in the Conclusions and Recommendations section below.

Laboratory Test Results

Collected samples were sealed and transported to the laboratory for further evaluation and visual examination. Laboratory soil testing included the following:

- Moisture Content (ASTM D2216);
- Unconfined Compressive Strength (ASTM D2166);
- Atterberg Limits (ASTM D4318);and

- Pocket Penetrometers.

Laboratory test results are shown on each boring log in Appendix I and are summarized in the following table.

Boring	Depth (ft.)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Moisture Content (%)	USCS Symbol	Cohesion (psf)	Dry Unit Wt. (pcf)
1	1 to 2.5	-	-	-	21.6	CL	2246	100.7
1	3.5 to 5	43	14	29	19.2	CL	-	-
1	8.5 to 10	-	-	-	46.8	CH	3359	75.8
3	8.5 to 10	59	23	36	38.3	CH	-	-
4	1.5 to 2.8	49	20	29	26.2	CL-CH	-	-

Generalized Subsurface Conditions

Based upon subsurface conditions encountered within the borings drilled at the project site, generalized subsurface conditions are summarized in the table below. Soil stratification lines on the boring logs indicate approximate boundary lines between different types of soil and rock units based upon observations made during drilling. In-situ transitions between soil and some rock types are typically gradual.

Description	Borings	Approx. Depth to Bottom of Stratum	Material Encountered	Moisture	Consistency/ Density
Stratum 1	All	0.5 to 1.5 ft.	Topsoil, Grass Covered	Moist	Soft
Stratum 2	All	1.5 to 7.0 ft.	Lean Clay w/Varying Amounts of Chert	Moist	Medium Stiff to Stiff
Stratum 3	2 & 4	4.8 to 5.0 ft.	Lean to Fat Clay w/Varying Amounts of Chert	Moist	Medium Stiff to Very Stiff
Stratum 4	All	9.0 to 11.0 ft. or Boring Completion In Boring 1	Fat Clay w/Varying Amounts of Chert	Moist	Stiff to Very Stiff
Stratum 5	2,3 & 4	Boring Completion	Limestone	-	Moderately Hard

Deeper lean clays encountered in Boring 3 are possible in-wash materials typically associated with active karst features.

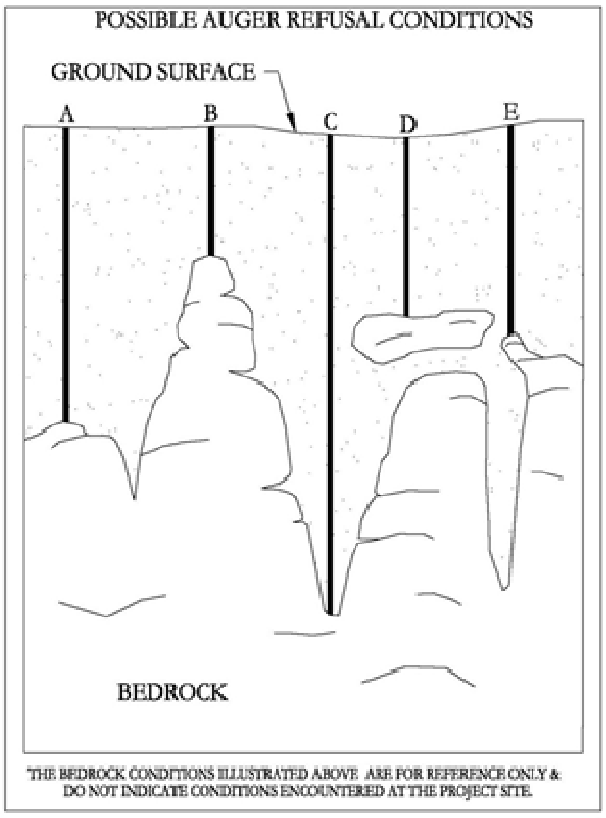
Limestone Bedrock

Approximate depth to limestone have been summarized and provided in the table below.

Boring	Approximate Depth to Limestone (ft.)
1	Deeper than 15.0
2	9.0
3	11.0
4	9.3

Auger Refusal

Auger refusal is defined as the depth below the ground surface at which a boring can no longer be advanced with the soil drilling technique being used. Auger refusal is subjective and is based upon the type of drilling equipment and types of augers being used, as well as the effort exerted by the driller. Several different auger refusal conditions are possible in the general site area. These conditions are represented graphically in the adjacent figure: (A) on the upper surface of continuous bedrock, (B) on rock "pinnacles", (C) in widened joints that may extend well below the surrounding bedrock surface, (D) slabs of unweathered rock suspended in the residual soil matrix, or "floaters", or (E) on the upper surface of discontinuous



Groundwater

Shallow groundwater was observed within borings 3 and 4 at 5.5 and 6 ft. below ground surface, respectively, on the date drilled. Groundwater levels should be expected to fluctuate with changes in site grading, precipitation, and regional groundwater levels. Groundwater may be encountered at shallower depths during wetter periods.

Geology

The general site area is underlain at depth by the Mississippian Age Burlington Limestone Formation. This unit characteristically consists of coarse grained gray limestone which is nearly pure calcium carbonate. Isolated chert nodules and discontinuous chert layers are present throughout the formation. The upper surface of this limestone unit is generally irregular due to the effects of differential vertical weathering and solution activity. Limestone pinnacles, some of which are 10 to 15 ft high are common in the general area. In upland areas, overburden soils are usually composed of red clay and chert and are residual having developed from physical and chemical weathering of the parent limestone. The chert fragments were interbedded with the limestone, but are much more resistant to weathering and retain rock-like properties. The contact between comparatively unweathered bedrock and the residual soils is usually abrupt.

The general site area is located within the Ozarks Physiographic Region of Missouri which is characterized by rugged to rolling hill terrain, meandering streams and karst topography. Karst topography forms over areas of carbonate bedrock where groundwater has solutionally enlarged openings to form a subsurface drainage system. Springs, caves, losing streams and sinkholes are common in karst areas. Sinkholes are defined as a depression in the landscape with an internal drainage system.

Closed Contours

LiDAR data was obtained from the University of Missouri MSDIS website to generate an elevation map of the subject property with 1 ft. contour intervals. Upon further review, five (5) closed contour areas were identified on the subject property. Two (2) of these features may be a result of past roadway construction. Three (3) of these features may be the results of past construction of farm ponds. Specifically, Closed Contour Area 2 can be seen in a historical aerial photo dated 1990 from Google Earth holding water. These features are labeled and identified on Figure 1: LiDAR Site Location Plan and discussed in the section below.

Site Reconnaissance

A site visit was performed by Joshua D. Elson, PPI Staff Geologist, on July 28, 2015. The purpose of this site visit was to evaluate Closed Contour Areas 2, 3 and 4. Each of these areas appeared to have a constructed berm to serve as areas for water detention. Extremely thick vegetation at the time of the site visit made observing the ground surface extremely difficult. Small pools of standing water was observed in Closed Contour Areas 3 and 4. No sinkhole eyes were observed during the site visit.

Conclusions & Recommendations

Closed Contour Areas 2, 3 and 4 are the most apparent and appear to be possible manmade depressions with constructed berms to detain water, most likely for past use of watering livestock. As previously mentioned, Closed Contour Area 2 can be seen in a historical aerial photo taken in 1990 holding water. Closed Contour Areas 3 and 4 are the largest in aerial extent and are confined along the eastern property boundary. Boring 3 is located at the southern end of Closed Contour Area 3 and has the presence of deeper lean clays and retains the possibility of being related to a karst feature. Closed Contour Areas 1 and 5 appear to be manmade depressions created during roadway development which should not affect land development.

It can probably be shown that all Closed Contour Areas on the subject property were developed due to man-made processes which should not affect land development. However, additional investigation would be required to better characterize these areas, specifically areas 2, 3 & 4 which retain the possibility of including karst features. Closed Contour Areas 3 & 4 receive the majority of storm water run-off from the topographic high on the west side of the property. Avoiding development in these areas, if possible, is recommended. Please refer to *Greene County Design Standards: Section 107 – Sinkholes and Karst Features* for general standards and restrictions regarding development in areas containing karst features.

Subgrade Recommendations

The majority of the site has slight rolling topography but it is anticipated that minimal to moderate depths of cut and fill may be required across this site. The initial site preparation should include the following:

- Complete removal of all trees and underbrush present at the project site;
- Removal of vegetative matter and topsoil stripping. Topsoil stripping on the order of 16-inches should be anticipated. However, thicker topsoil zones may be encountered in other areas not investigated by borings;
- Topsoil should be stockpiled outside of areas to receive controlled fill and may be re-used in lawn or landscape areas only; and

Subgrade preparation should include proof-rolling areas to receive controlled fill prior to fill placement in order to assure a stable subgrade. Proof-rolling consists essentially of rolling the ground surface with a loaded tandem axle dump truck or similar heavy rubber tired construction equipment and noting any areas which rut or deflect during rolling. All soft subgrade areas identified during proof-rolling should be undercut and replaced with compacted fill as outlined below. Proof-rolling, undercutting and replacement should be monitored by a qualified representative of PPI. The depth and areal extent of undercutting will be largely dependent upon the time of year and related soil moisture conditions. **If construction is initiated during or following wetter periods, the requirement for undercutting soft surficial soils below normal topsoil stripping should be anticipated and reflected in contract documents.** As previously mentioned, surficial clays at the project site are moisture sensitive and may pose difficulties regarding subgrade stability and proper compaction.

After evaluation by proof-rolling and approval, the subgrade should be scarified to a depth of at least 8-inches in depth, adjusted to within the optimum moisture content and compacted to specified densities as outlined below. Placement of controlled fill or aggregate base may then proceed.

Expansive Soils

The fat clays were encountered within borings drilled exhibited varying (but often appreciable) percentages of chert fragments. High plasticity clays in the site area typically exhibit low potential for shrink/swell behavior due to relatively high soil moisture content relative to the plastic limit; low dry unit weight; and dilution effect of the chert. However, CH clays should be maintained with 0 to 4% above optimum and allowed to dry and not be allowed to dry and desiccate prior to placement of slabs, pavement or footings.

General Fill Material Types

Fill Type[1]	USCS Classification	Acceptable Location for Placement
Low Volume Change Engineered Fill[2]	CL, GC or SC (LL < 50)	All locations and elevations
On-Site Natural Soils[3]	CH, , GC or CL	All locations and elevations[3]
Potential Borrow Material[3]	CL, SC, CH or GC	All locations and elevations[3]
Rock Fill[4]	GW	All locations and elevations

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris and contain maximum rock size of 4 to 6 in. Frozen material should not be used and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to its use.
2. Low plasticity cohesive soil or granular soil having at least 15% low plasticity fines and preferably containing significant gravel content.
3. CH clays with a Liquid Limit above 50 are considered suitable for use as controlled fill, only if the percentage of rock fragments exceeds 35% or if placed 2 ft. below foundations, floor slabs or pavements.
4. Rock fill should consist of 4 to 6 inch top size rock fill with no particles greater than 8 in. Rock material should be placed in horizontal layers having a thickness of approximately the maximum size of the large rock comprising the lift and compacted with a minimum of three (3) passes with a heavy self- propelled vibratory roller. Rock fill should not be dumped into place, but should be distributed in horizontal lifts by blading and dozing in such a manner as to ensure proper placement into final position. Finer material including rock fines and limited soil fines should be worked into the rock voids during this blading operation. Excessive soil and rock fine particles preventing interlock of cobble and boulder sized rock should be prohibited. The testing of rock fill quality should include the requirements that a representative of the Geotechnical Engineer be present daily, but not necessarily continuous during the placement of the fill to observe the placement of rock fill in order to determine fill quality and to observe that the contractors work sequence is in compliance with this specification. Progress reports indicative of the quality of the fill should be made at regular intervals to the Owner. If improper placement procedures are observed during the placement of the fill the Geotechnical Engineer should inform the Contractor, and no additional fill should be permitted on the affected area until the condition causing the low densities has been corrected and the fill has been reworked to obtain sufficient density.

Compaction Requirements

Item	Description
Subgrade Scarification Depth	At least 8 inches
Fill Lift Thickness	8-inch (loose)
Compaction Requirements[1]	95% Standard Proctor Density (ASTM D-698)
Moisture Content	• ± 2% optimum moisture for CL, GC or SC Soil Types • 0 to 4% above optimum for CH Soil Types.

1. We recommend that engineered fill (including scarified compacted subgrade) be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved. One (1) field density test for each 2500 and 5000 sq. ft. of fill lift, but no less than 3 tests per lift, is recommended in building and pavement areas, respectively.

Foundation Considerations

Again, this is a preliminary report and it is understood supplemental investigations will be performed upon final development plans. It is anticipated that proposed structures may be 1 to 2 stories in height with light to moderate foundation loads. Based upon the limited borings drilled at this site, it is anticipated that structures may be designed using allowable bearing pressures ranging from 2,000 to 4,000 psf. Footing support upon controlled fill or competent natural foundation soils should generally be permissible. For frost protection, all exterior footings will need to be supported at least 2.5 ft. below final exterior grade. **Again, these recommendations are preliminary and each structure will require an additional investigation to provide specific foundation recommendations.**

Seismic Considerations

Code Used	Site Classification
2012 International Building Code (IBC)[1]	C
1. In general accordance with the *2012 International Building Code*, Section 1613	

Report Limitations

This letter report has been prepared in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area. Palmerton & Parrish, Inc. observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. Palmerton & Parrish's findings and conclusions must be considered not as scientific certainties, but as opinions based on our professional judgment concerning the significance of the data gathered during the course of this investigation. Other than this, no warranty is implied or intended**.**

Closure

Should you have any questions or need additional information please feel free to call our office.

PALMERTON & PARRISH, INC.
By:

Joshua D. Elson, G.R.I.T.
Geologist

PALMERTON & PARRISH, INC.
By:

Brad R. Parrish, P.E.
President

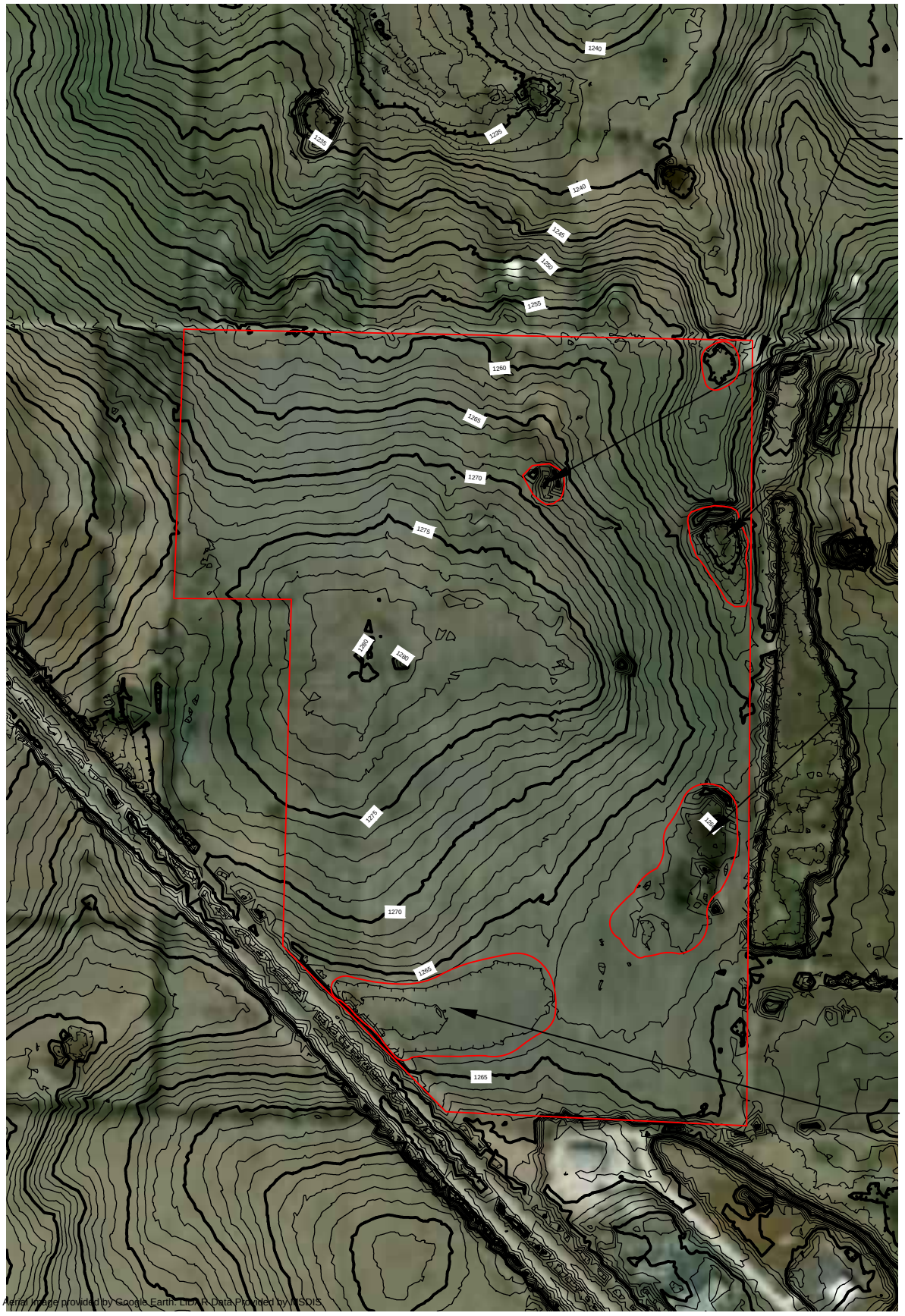
STATE OF MISSOURI
BRAD R. PARRISH
NUMBER E-20224
REGISTERED PROFESSIONAL ENGINEER

JDE:SMR:BRP:jde

Attachments:

Figure 1	LiDAR Site Location Plan
Figure 2	USDA Soils Map & Boring Location Plan
Appendix I	Boring Logs & Key to Symbols
Appendix II	General Notes

FIGURES



S:_MASTER PROJECT FILE\2015\D\Drury Properties-229620-7136 W FR 144-Sub\LIDAR Data.dwg

LEGEND

Site Location

SCALE
1" = 500'

Project: 7134 W Farm Road 144 - Republic, Missouri
Client: Drury Properties

LiDAR Site Location Plan

DATE: July, 28 2015

Project Number: 229620

PALMERTON & PARRISH, INC.
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MATERIALS TESTING LABORATORIES / ENVIRONMENTAL SERVICES

FIGURE 1

S:_MASTER PROJECT FILE\2015\D\Drury Properties-229620-7136 W FR 144-Sub\LIDAR Data.dwg

LEGEND

Boring Location

SCALE
1" = 300'

Project: 7134 W Farm Road 144 - Republic, Missouri
Client: Drury Properties

USDA Soils Map & Boring Location Plan

DATE: July 28, 2015

Project Number: 229620

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FIGURE 2

APPENDIX I

BORING LOGS & KEY TO SYMBOLS

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Springfield, MO 65803
Telephone: 417-864-6000

GEOTECHNICAL TEST PIT LOG

BORING NUMBER 1

CLIENT Drury Properties
PROJECT NAME New Development
PROJECT NO. 229620
PROJECT LOCATION Greene Co., MO
DATE STARTED 7/17/15 **COMPLETED** 7/17/15
SURFACE ELEVATION _____ **BENCHMARK EL.** _____
DRILLER RD **DRILL RIG** BK-51 MB
GROUND WATER LEVELS
HAMMER TYPE Cathead
AT TIME OF DRILLING None
LOGGED BY AJ **CHECKED BY** _____
AT END OF DRILLING _____
NOTES _____

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
0.0	CFA - 4.5" O.D.		TOPSOIL, Grass Covered				
			1.3 ft LEAN CLAY, Gray, Medium Stiff, Moist (CL)	SPT 1		3-5-11 (16)	4.5
			2.0 ft LEAN CLAY, Trace Chert, Mottled Red, Brown, and Gray, Stiff, Moist (CL)				
2.5			3.5 ft LEAN CLAY, Red and Gray, Verystiff, Moist (CL)	SPT 2		6-19-21 (40)	4.5
			4.8 ft FAT CLAY, with Chert, Red, Very Stiff, Moist (CH)				
5.0				SPT 3		26-50/4"	1.5
			- Chert Layer from 7-7.5'				
7.5				SPT 4		9-7-9 (16)	4
10.0			- Trace Chert below 11'				
12.5				SPT 5		4-4-6 (10)	3.25
			15.0 ft				
15.0			Bottom of borehole at 15.0 feet.				

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

ELEVATION (ft)

4168 W. Kearney
Springfield, MO 65803
Telephone: 417-864-6000

GEOTECHNICAL TEST PIT LOG

BORING NUMBER 2

CLIENT Drury Properties
PROJECT NAME New Development
PROJECT NO. 229620
PROJECT LOCATION Greene Co., MO
DATE STARTED 7/17/15 **COMPLETED** 7/17/15
SURFACE ELEVATION _____ **BENCHMARK EL.** _____
DRILLER RD **DRILL RIG** BK-51 MB
GROUND WATER LEVELS
HAMMER TYPE Cathead
AT TIME OF DRILLING None
LOGGED BY AJ **CHECKED BY** _____
AT END OF DRILLING _____
NOTES _____

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 / N VALUE 20 40 60 80 / PL MC LL 20 40 60 80 / SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL, Grass Covered						
			0.5 ft LEAN CLAY, with Chert Cobbles, Dark Brown, Stiff, Moist (CL)						
			1.5 ft LEAN TO FAT CLAY, with Weathered Chert, Red Tan, Very Stiff, Moist (CH)	SPT 1		13-11-31 (42)	3.5		
2.5									
				SPT 2		11-9-19 (28)	1.5		
5.0			5.0 ft FAT CLAY, with Chert, Red, Medium Stiff, Moist (CH)						
			- Chert Layer from 6.3-6.5'	SPT 3		5-3-2 (5)	1.5		
7.5									
			9.0 ft LIMESTONE, Weathered	SPT 4		12-50/4"	0.25		
10.0			10.5 ft						

Bottom of borehole at 10.5 feet.

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Springfield, MO 65803
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GEOTECHNICAL TEST PIT LOG

BORING NUMBER 3

CLIENT Drury Properties
PROJECT NAME New Development
PROJECT NO. 229620
PROJECT LOCATION Greene Co., MO
DATE STARTED 7/17/15 **COMPLETED** 7/17/15
SURFACE ELEVATION _____ **BENCHMARK EL.** _____
DRILLER RD **DRILL RIG** BK-51 MB
GROUND WATER LEVELS
HAMMER TYPE Cathead
AT TIME OF DRILLING 5.5 ft
LOGGED BY AJ **CHECKED BY** _____
AT END OF DRILLING 4.5 ft
NOTES _____

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 / N VALUE 20 40 60 80 / PL MC LL 20 40 60 80 / SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL, Grass Covered						
			1.0 ft						
			LEAN CLAY, Grass Covered, with Chert Cobbles, Brown, Medium Stiff, Moist (CL)						
2.5			- Trace Chert below 2.5'	SPT 1		5-3-5 (8)	2.75		
			▼						
5.0			▽ 5.5 ft						
			LEAN CLAY, with Chert Gravel, Dark Brown, Medium Stiff, Moist to Wet (CL)						
			7.0 ft						
7.5			FAT CLAY, Trace Chert, Red Brown, Medium Stiff, Moist to Wet (CH)	SPT 2		9-3-3 (6)	0.25		
			8.5 ft						
			FAT CLAY, with Chert Gravel and Cobbles, Red Brown, Stiff, Moist to Wet (CH)	SPT 3		8-7-9 (16)	0		
10.0			11.0 ft						
			LIMESTONE, Highly Weathered, Soft						
12.5				SPT 4		16-21-37 (58)	0		
			14.4 ft 14.5 ft						
			LIMESTONE, Moderately Hard						
			Bottom of borehole at 14.5 feet.						

4168 W. Kearney
Springfield, MO 65803
Telephone: 417-864-6000

GEOTECHNICAL TEST PIT LOG

BORING NUMBER 4

CLIENT Drury Properties
PROJECT NAME New Development
PROJECT NO. 229620
PROJECT LOCATION Greene Co., MO
DATE STARTED 7/17/15 **COMPLETED** 7/17/15
SURFACE ELEVATION _____ **BENCHMARK EL.** _____
DRILLER RD **DRILL RIG** BK-51 MB
GROUND WATER LEVELS
HAMMER TYPE Cathead
AT TIME OF DRILLING 6 ft
LOGGED BY AJ **CHECKED BY** _____
AT END OF DRILLING 5 ft
NOTES _____

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL, Grass Covered					
			1.3 ft					
			LEAN CLAY, Mottled Gray, Red, and Tan, Medium Stiff, Moist (CL)	SPT 1		3-3-3 (6)	2.5	
2.5			3.0 ft					
			LEAN TO FAT CLAY, Trace Chert, Red Brown, Stiff, Moist, (CL-CH)	SPT 2		1-11-11 (22)	1.5	
5.0			5.0 ft					
			FAT CLAY, with Weathered Chert, Red Brown, Stiff, Moist to Wet (CH)					
			6.5 ft					
			FAT CLAY, Trace Chert, Red, Stiff, Moist to Wet (CH)	SPT 3		6-4-5 (9)	1.75	
7.5								
				SPT 4		11-50/0"	1.5	
			9.3 ft					
			LIMESTONE, Slightly Weathered					
			9.7 ft					

Bottom of borehole at 9.7 feet.

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

APPENDIX II

GENERAL NOTES

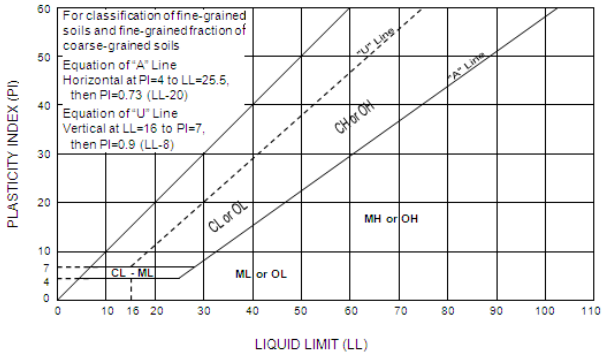
PALMERTON & PARRISH, INC.

GENERAL NOTES

SOIL PROPERTIES & DESCRIPTIONS

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu)	Pocket Penetrometer Strength	N-Value
	(psf)	(tsf)	(blows/ft)
Very Soft	<500	<0.25	0-1
Soft	500-1000	0.25-0.50	2-4
Medium Stiff	1001-2000	0.50-1.00	5-8
Stiff	2001-4000	1.00-2.00	9-15
Very Stiff	4001-8000	2.00-4.00	16-30
Hard	>8000	>4.00	31-60
Very Hard			>60



Group Symbol	Group Name
CL –	Lean Clay
ML –	Silt
OL –	Organic Clay or Silt
CH –	Fat Clay
MH –	Elastic Silt
OH –	Organic Clay or Silt
PT –	Peat
CL-CH –	Lean to Fat Clay

Plasticity		Moisture	
Description	Liquid Limit (LL)	Descriptive Term	Guide
Lean	<45%	Dry	No indication of water
Lean to Fat	45-49%	Moist	Indication of water
Fat	≥50%	Wet	Visible water

Fine Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms: SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT	PRIMARY CONSTITUENT
Sandy,gravelly, abundant cobbles, abundant boulders	>30-50]
with sand, with gravel, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered sand, scattered gravel, scattered cobbles, scattered boulders	5-15]
a trace sand, a trace gravel, a few cobbles, a few boulders	<5]
The relationship of clay and silt constituents is based on plasticity and normally determined by performing index tests. Refined classifications are based on Atterberg Limits tests and the Plasticity Chart.	

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	N-VALUE
Very Loose	0-4
Loose	5-10
Medium Dense	11-24
Dense	25-50
Very Dense	≥51

MOISTURE CONDITION	
Descriptive Term	Guide
Dry	No indication of water
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table.

**GRAIN SIZE IDENTIFICATION		
Name	Size Limits	Familiar Example
Boulder	12 in. or more	Larger than basketball
Cobbles	3 in. to 12 in.	Grapefruit
Coarse Gravel	¾-in. to 3 in.	Orange or lemon
Fine Gravel	No. 4 sieve to ¾-in.	Grape or pea
Coarse Sand	No. 10 sieve to No. 4 sieve	Rock salt
Medium Sand	No. 40 sieve to No. 10 sieve	Sugar, table salt
Fine Sand*	No. 200 sieve to No. 40 sieve	Powdered sugar
Fines	Less than No. 200 sieve	
*Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 in.		

Coarse Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms: GRAVEL, SAND, COBBLES, BOULDERS	PRIMARY CONSTITUENT
Sandy,gravelly, abundant cobbles, abundant boulders	>30-50]
with gravel, with sand, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered gravel, scattered sand, scattered cobbles, scattered boulders	5-15]
a trace gravel, a trace sand, a few cobbles, a few boulders	<5]
Silty (MH & ML)*, clayey (CL & CH)*	<15]
(with silt, with clay)*	5-15] – secondary fine grained constituents
(trace silt, trace clay)*	<5]
*Index tests and/or plasticity tests are performed to determine whether the term "silt" or "clay" is used.	

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

PALMERTON & PARRISH, INC.

GENERAL NOTES

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)	
Description of Rock Quality	*RQD (%)
Very Poor	< 25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

*RQD is defined as the total length of sound core pieces 4 in. or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

SCALE OF RELATIVE ROCK HARDNESS		
Term	Field Identification	Approx. Unconfined Compressive Strength (tsf)
Extremely Soft	Can be indented by thumbnail	2.6-10
Very Soft	Can be peeled by pocket knife	10-50
Soft	Can be peeled with difficulty by pocket knife	50-260
Medium Hard	Can be grooved 2 mm deep by firm pressure of knife	260-520
Moderately Hard	Requires one hammer blow to fracture	520-1040
Hard	Can be scratched with knife or pick only with difficulty	1040-2610
Very Hard	Cannot be scratched by knife or sharp pick	>2610

DEGREE OF WEATHERING	
Slightly Weathered	Rock generally fresh, joints stained and discoloration extends into rock up to 25mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered	Rock mass is decomposed 50% or less, significant portions of rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS)		
Description	Diameter (mm)	Field Identification
Very Coarse Grained	>4.76	
Coarse Grained	2.0-4.76	Individual grains can easily be distinguished by eye.
Medium Grained	0.42-2.0	Individual grains can be distinguished by eye.
Fine Grained	0.074-0.42	Individual grains can be distinguished by eye with difficulty.
Very Fine Grained	<0.074	Individual grains cannot be distinguished by unaided eye.

VOIDS	
Pit	Voids barely seen with naked eye to 6mm (¼-in)
Vug	Voids 6 to 50mm (¼ to 2 in) in diameter
Cavity	50 to 6000mm (2 to 24 in) in diameter
Cave	>600mm

BEDDING THICKNESS	
Very Thick Bedded	> 3' thick
Thick Bedded	1' to 3' thick
Medium Bedded	4" to 1' thick
Thin Bedded	1¼" to 4" thick
Very Thin Bedded	½" to 1¼" thick
Thickly Laminated	⅛" to ½" thick
Thinly Laminated	⅛" or less (paper thin)

DRILLING NOTES

Drilling and Sampling Symbols

NQ – Rock Core (2-in. diameter)
HQ – Rock Core (3 in. diameter)
HSA – Hollow Stem Auger
CFA – Continuous Flight (Solid Stem) Auger
SS – Split Spoon Sampler
ST – Shelby Tube
WB – Wash Bore or Mud Rotary
TP – Test-Pit
HA – Hand Auger

Soil Sample Types

Shelby Tube Samples: Relatively undisturbed soil samples were obtained from the borings using thin wall (Shelby) tube samplers pushed hydraulically into the soil in advance of drilling. This sampling, which is considered to be undisturbed, was performed in accordance with the requirements of ASTM D 1587. This type of sample is considered best for the testing of "in-situ" soil properties such as natural density and strength characteristics. The use of this sampling method is basically restricted to soil containing little to no chert fragments and to softer shale deposits.

Split Spoon Samples: The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The "N" value corresponds to the number of blows required to drive the last 1 foot of an 18-in. long, 2-in. O.D. split-barrel sampler with a 140 lb. hammer falling a distance of 30 in. The Standard Penetration Test is carried out according to ASTM D-1586.

Water Level Measurements

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, shallow groundwater may indicate a perched condition. Caution is merited when interpreting short-term water level readings from open bore holes. Accurate water levels are best determined from piezometers.

Automatic Hammer

Palmerton and Parrish's CME's are equipped with automatic hammers. The conventional method used to obtain disturbed soil samples used a safety hammer operated by company personnel with a cat head and rope. However, use of an automatic hammer allows a greater mechanical efficiency to be achieved in the field while performing a Standard Penetration resistance test based upon automatic hammer efficiencies calibrated using dynamic testing techniques.

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987