DETAILED GEOTECHNICAL INVESTIGATION REPORT

for

PATTESON FARM COURT
Lovettsville, Virginia

prepared for

Mr. Amit Bery
Ironwood Real Estate Holdings, LLC
4812 Rhett Lane
Fairfax, Virginia

prepared by

CLENDENIN ENVIRONMENTAL & GEOTECHNIC CONSULTANTS, INC.
P.O. Drawer 6070
Leesburg, Virginia 20178-7406

date

May 3, 2016
16003. ENG

May 3, 2016
16003.ENG

Mr. Amit Bery
Ironwood Real Estates Holdings, LLC
4512 Rhett Lane
Fairfax, VA 22030

Subject: Detailed Geotechnical Investigation Report
Patteson Farm Court
Lovettsville, Virginia

Dear Mr. Bery:

Clendenin Environmental & Geotechnic Consultants, Inc. **(CCRG)** is pleased to submit this Detailed Geotechnical Investigation Report for construction of Patteson Farm Court, Lovettsville, Virginia. The site location plan is included as Figure 1. The work was performed in accordance with our proposal dated March 30, 2016 and agreement dated April 5, 2016. The report contains the results of our field exploration, recommendations for roadway construction and an evaluation of slope stability issues.

Also, we have prepared an addendum to this report to provide recommendations for construction of proposed houses in Patteson Farm and the storm water pond adjacent to Patteson Farm Court. The addendum is attached to this report as Appendix C.

We appreciate the opportunity to provide services during the construction phase of the project, and look forward to our continued association with you.

Please call us at (703) 771-8816 if you have any questions.

Sincerely,

CLENDENIN ENVIRONMENTAL & GEOTECHNIC CONSULTANTS, INC.

Nimal N. Jayaratne, PE
Senior Project Engineer

Bruce E. Clendenin, CPG
President

COMMONWEALTH OF VIRGINIA
NIMAL N. JAYARATNE
Lic. No. 20036
PROFESSIONAL ENGINEER
5/3/16

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1.0 EXECUTIVE SUMMARY

The soil borings along the proposed roadway mostly encountered low to medium plastic SILT underlain by silty SAND within the upper 10 ft. below ground level. The SILT thickness varies from 3 ft. to greater than 10 ft. below ground level. The borings indicated that depth to bedrock is greater than 10 ft. However, according to the soil boring information, isolated shallow rock zones and/or large boulders may exist in the overburden.

According to the site grading plan provided by GeoEnv Engineers on March 30, 2016, the maximum longitudinal design slope along the roadway will be 7.29% and the design slopes of the lateral cuts and fills will be 1(V):3(H). These slopes are considered safe against global failure for the type of material encountered along the roadway.

The maximum cut and fill along the roadway will be 12.5 ft. and 7 ft. respectively. These cuts are unlikely to encounter intact bedrock but may encounter hard decomposed rock at depths greater than 10 ft. below ground level. Also, isolated shallow rock zones and/or large boulders may be encountered. It may be possible to remove decomposed rock with ripping. However, blasting will be required to remove large boulders and shallow bedrock, if encountered.

The cut areas mostly belong to Class II Purcellville/Tankerville group (20C/20D) and Class I Purcellville Silt Loam (23B). Most of the fill areas also belong to the same soil types except for an approximately 250-foot deep fill section where Class IV Mongle Loam (10B) and Class III Middleburg Silt Loam (17B) are likely to exist.

Generally, the overburden silty and sandy cut soils are suitable as fill. However, additional laboratory testing is recommended to check that the soils satisfy the requirements outlined in Section 8.3 of this report, especially for SILT, because of its lightweight. We recommend that a sample of SILT be collected and tested for density early in the project to check for suitability.

A California Bearing Ratio **(CBR)** value of 6.0 is recommended for preliminary pavement thickness determinations with onsite silty and sandy soils. However, the final pavement design should be based on the CBR tests conducted on actual subgrade soils.

Ground water was not observed in any of the borings and in the long-term ground water monitoring well except in the boring conducted in the low area at the beginning of roadway. Therefore, contractors should be prepared for temporary dewatering systems, especially, during roadway excavations in the low areas and culvert excavations.

2.0 PROJECT DESCRIPTION

The proposed Patteson Farm Court is located off Quarter Branch Road (Rt. 663) in Loudoun County near Lovettsville as shown in Figure 1. The approximately 1600-foot public roadway between St. 10+00 and St. 26+00 will be constructed to serve thirteen housing lots with sizes varying from 1.5 to 8 acres. The roadway easement currently consists of grass fields with a thin tree line between St 19+00 and 20+00. This report is prepared to address any slope stability issues existing at the site and provide recommendations for construction considerations such as controlled fill placement.

According to the Site Grading Plan electronically provided by GeoEnv Engineers on March 30, 2016, the roadway section is steepest between Stations 14+75 and 18+00 with a longitudinal slope at 7.29%. Roadway section between St. 10+50 and 14+75 slopes at 6.27% and between Stations 24+00 and 26+00 slopes at 6.21%. The longitudinal slopes are less than 2% in all other road sections. The lateral cut and fill slopes along the roadway will be at 1(V):3(H).

The road will be constructed on cut between St. 10+00 and 16+00 and between St. 24+25 and 26+00. A maximum cut of 12.5 ft. occurs at St. 14+50. The section between St. 16+00 and 24+25 will be constructed on fill. The deepest fill of 7 ft. occurs at approximately St. 17+50. Also, approximately 3 ft. of cut is anticipated in the cul-de-sac area at the end of the roadway. Three culverts will be constructed as a part of the roadway development.

3.0 SITE GEOLOGY

The site is located in the Blue Ridge Physiographic Province. The bedrock of this region is a complex crystalline formation that has been faulted and contorted by past tectonic movements. The rock has weathered to residual soils which form the mantle for the hillside and hilltops. The degree and depth of rock weathering vary extensively, depending on the local character of the rock, the crack pattern, the ground water conditions, and local surface erosion. According to the USGS geologic map of Loudoun County dated 1992, the site geologic formation belongs to Leucocratic Metagranite consisting of white to pink, medium to medium-fine grained, massive to moderately foliated plagioclase-quartz-microcline granite gneiss. The geologic map is included as Figure 2.

According to the Loudoun County Soil Survey maps dated 2000, following soil groups exist along the roadway alignment.

Mongle Loam (10B) – Class IV – consisting of very deep, somewhat poorly drained brown and mottled brown and gray loamy to silty soils developed in alluvium and local colluvium from mixed acid and basic rock. This soil has very poor potential for local development with prolonged high water table. The depth to bedrock is generally greater than 5 ft.

Middleburg Silt Loam (17B) – Class III- consisting of very deep, well drained yellowish-brown to brown loamy soils with intermittent seasonal water tables and developed in recent colluvium of soils derived from mixed acid and basic rocks. This soils has a poor potential for general development with short duration water tables. The depth to hard bedrock in this soil group is generally greater than 5 feet.

Purcellville/Tankerville group (20C) (20D) – Class II - consisting of a complex of very deep, well drained yellowish red silty Purcellville and moderately deep, well drained yellowish brown loamy soils developed in residuum weathered from mixed granite gneiss and metadiabase rock. This soils has a fair potential for general development. The depth to hard bedrock is generally greater than 6 feet in Purcellville and greater than 30 inches in Tankerville.

Purcellville Silt Loam (23B) – Class I - consisting of very deep, well drained yellowish-red silty to loamy soils developed in residuum weathered from mixed granite gneiss. This soils has a good potential for general development. The depth to bedrock in this soil group is generally greater than 6 feet.

The cut areas of the roadway mostly belong to Purcellville/Tankerville group (20C/20D) and Purcellville Silt Loam (23B). Most of the fill areas also belong to the same soil types except in the deep fill area between St.17+50 and St. 20+00 where Mongle Loam (10B) and Middleburg Silt Loam (17B) are likely to exist. The soils map is included as Figure 3.

4.0 SUBSURFACE EXPLORATION

Subsurface conditions along the roadway were evaluated from 9 soil borings B-1 through B-8 conducted on November 8, 2006 by Connelly and Associates, Inc. using a Diedrich D-50 Turbo drill rig. The soil boring locations were surveyed and field staked by William H. Gordon Associates, Inc. prior to drilling. Borings were conducted at 250-foot intervals with the borings in the sloping areas at 150-foot intervals. The approximate locations of the borings are shown in Figure 4.

All the soil borings were drilled to 10 ft. below ground level, except for borings B-3, B-5 and B-7 which were terminated at 14, 5 and 9 feet below ground level, respectively. In accordance with ASTM D-1586, split-spoon sampling with Standard Penetration Testing **(SPT)** was conducted at 2.5-foot intervals in all the borings to obtain representative samples for laboratory analyses and visual classification. Soil boring B-6 was offset approximately ten feet west of the original B-6 and re-drilled as B-6(2) due to shallow auger refusal. One temporary ground water observation well was installed in boring B-2.

Our field geologist was present full-time during drilling operation to direct the field crew, log all recovered soil samples, and observe groundwater and rock conditions. The recovered soil samples were transported to our laboratory for classification. Two representative samples were analyzed for Atterberg limits and particle size distribution. The results are summarized in Section 7.0 and in boring logs.

The final logs of the borings with our engineering classification of the recovered soil samples are included in Appendix A. The Finished Grade **(FG)** levels shown on the logs were estimated from the site grading contours and should be considered very approximate. The boring details are summarized below:

Boring No.	Station No.	Surveyed El. (ft.)	Approx. Finished Grade El. (ft.)	Cut(-)/Fill(+)
B-1	10+50	482.86	480.25	-2.61
B-2	13+00	499.26	495.50	-3.76

B-3	14+50	512.90	501.50	-11.4
B-4	16+00	497.45	497.25	-0.20
B-5	18+50	478.97	483.00	+4.03
B-6	21+00	483.64	484.00	+0.36
B-6(2)*	21+00	±483.64	484.00	+0.36
B-7	23+50	484.42	486.75	+2.33
B-8	25+93	498.77	496.50	-2.27

* Boring location not surveyed

5.0 SUBSURFACE CONDITIONS

In general, soil borings encountered lean CLAY and SILT underlain by silty SAND down to boring termination depth. The borings did not encounter auger refusal defined as bedrock in any of the borings within the exploration depth except in boring B-6. The shallow auger refusal encountered in boring B-6 at approximately 3 ft. below ground level may be due to possible presence of shallow bedrock or a boulder. No rock outcrops were observed along the roadway alignment. Based on the SPT N-values, it appears that borings B-1, B-3 and B-7 may have encountered decomposed rock at approximately 10-foot depth. The subsurface startigraphy along different sections of the roadway as interpreted from the boring logs is summarized below.

Station 10+00 – 16+00 (Cut Section)

This section of roadway requires up to 12.5 ft. of cut. All the borings except boring B-1 conducted in this section encountered SILT (SOIL 2) in the upper 5 to 10 ft. underlain by silty SAND (SOIL 3) down to the boring termination depth of 10 ft. The boring B-1, conducted at the beginning of the roadway encountered lean CLAY (SOIL 1) in the upper 5 ft. underlain by SILT (SOIL 2) down to the boring termination depth of 10 ft.

Station 16+00 – 24+25 (Fill Section)

This section of the roadway requires up to 2 ft. of fill. All the borings except boring B-6 conducted in this section encountered SILT (SOIL 2) in the upper 3 to 10 ft. underlain by silty SAND (SOIL 3) down to boring termination depth. The boring B-6 conducted at St. 21+00 in this section encountered shallow auger refusal at 3 ft. below ground level possibly due to presence of a boulder.

<u>Station 24+25 – 26+00 (Cut Section)</u>

The boring B-8 conducted in this section encountered silty SAND (SOIL 3) down to boring termination depth.

A longitudinal profile of the roadway showing different soil types at the boring locations is included as Figure 5.

6.0 GROUND WATER

Ground water was not encountered in any of the borings, except in B-1 at 3 feet below ground level, during our soil boring investigation. Also, ground water was not observed in the long- term ground water observation well installed in boring B-2 when measured on November 10, 2006.

However, fluctuations in the ground water level may also occur due to variations in climatic conditions, construction activity such as blasting, surface runoff and other site-specific activities. The ground water levels at the time of construction may, therefore, differ from those observed during our field exploration.

7.0 LABORATORY TESTING

Soil samples collected during the soil boring investigation were visually classified by field staff and checked by our geotechnical engineer. Analytical testing was then performed on two selected samples. The samples were analyzed for Atterberg Limits and passing a #200 sieve for soil classification. A summary of laboratory test results is provided below with the Unified Soil Classification System **(USCS)** symbols and. The results are also shown on the boring logs. Detailed laboratory test results are included in Appendix B. The moisture content tests were conducted on all soil samples and the results are shown on the boring logs. A plasticity chart is included as Figure 6.

Boring Number	**Sample Number**	**Depth (ft)**	**Moisture Content (%)**	**Atterberg Limits**			**Percent Passing #200**	**USCS Symbol**
				Liquid Limit	**Plastic Limit**	**Plasticity Index**		
B-3	S-2	3.5-5.0	7.9	30	23	7	45.2	SM
B-4	S-1	1.0-2.5	25.0	36	29	7	78.1	ML

8.0 DISCUSSION AND RECOMMENDATIONS

8.1 Site Preparation

All topsoil, vegetation, debris and surface soil containing organic material, should be removed from the construction area. During stripping and rough grading, positive drainage should be maintained to prevent the accumulation of water.

8.2 Cut Areas

Cuts more than 10 ft. below ground level are anticipated along the roadway alignment near boring B-3 at approximately St. 14+50. These cuts are likely to encounter hard decomposed rock. Based on the soil boring information, isolated shallow rock zones and/or large boulders may also exist in the overburden. Ripping with heavy earth moving equipment may remove the hard decomposed rock in deep cut areas near St. 14+50. Blasting will be required to remove large boulders and/or bedrock, if encountered.

The soils in the cut areas are likely to encounter low to medium plastic SILT and silty SAND that are suitable as controlled fill. However, we recommend that additional laboratory testing including proctor compaction tests be conducted on cut soils especially for SILT, because of its lightweight. We recommend that a sample of SILT be collected and tested for density early in the project to check for suitability.

All cut areas should be proofrolled to detect any unstable areas prior to fine grading and gravel placement for the subgrade. Unstable soft wet zones should be scarified, air-dried and re-compacted. If drying is not economical, then the soils should be over-excavated to stable natural soils and replaced with controlled fill as required. Geotextile fabrics may be used for further stabilization in areas where proofrolling is unsuccessful.

Proofrolling should be performed with at least two passes of a loaded 10-wheel tandem axle truck or other similar approved construction equipment after a suitable period of dry weather. The exposed subgrade and proofrolling operation should be observed and documented under the direction and supervision of a registered professional engineer/design professional licensed in the State of Virginia.

We did not encounter CH type high plastic CLAY or MH type elastic SILT in any of the soil borings. However, if encountered, those soils should be undercut 2 feet below the final subgrade level and backfilled with compacted controlled fill.

8.3 Fill Areas

According to the site grading plan, fills up to 7 ft. will be required for roadway construction. Prior to placement of fill, the area should be stripped of any vegetation, debris, unsatisfactory soil materials, obstructions, and any other deleterious materials. The ground surface should then be proofrolled as described in Section 8.2.

The fill materials should contain less than 2 percent by weight of vegetation, organic materials or other deleterious matter. The contractor must be submit the fill materials to the registered professional engineer of the testing agency two weeks prior to use to allow laboratory testing to be completed. The samples should be tested to determine the maximum dry density, optimum moisture content, natural moisture content, gradation and plasticity of the soil. These tests are needed to determine if the fill material is acceptable and for quality control during compaction. According to the soil boring information and laboratory test data the onsite cut soils of SOIL 2 and SOIL 3 are generally suitable as controlled fill.

The fill should be placed in lifts not more than an 8-inch loose thickness for material compacted by heavy compaction equipment, and not more than a 6-inch loose thickness for material compacted by hand-operated tampers or light compaction equipment. Each lift shall be compacted, tested and approved prior to placing subsequent fill lifts to above specifications. Moisture contents should be within ±20% of the optimum moisture content. This provision may require the contractor to dry the soils during periods of wet weather or wet the soils during the hot summer months.

Before compaction, moisten or aerate each layer, as necessary to obtain required compaction. Compact each layer to the required percentage of the fill's maximum dry density. Fill material should not be placed on surfaces that are muddy, frozen, or contain more than 2 percent organic and other deleterious material, or have not been approved by testing and/or proofrolling.

We recommend that the fill surface be sloped to achieve sufficient drainage and to prevent water from ponding on the fill. If precipitation is expected while fill construction is temporarily halted, the surface should be rolled with smooth drum roller to seal the surface and improve surface runoff. If the surface soils become excessively wet or frozen, fill operations should be halted and the project geotechnical engineer/design professional should be consulted for guidance.

The fill placement and compaction be observed and documented by the project geotechnical engineer/design professional. Particular attention should be given to compaction along slopes and around the culvert and utility line pipes. We recommend that the controlled fill materials placed in the upper 2 ft. beneath the roadway subgrade be compacted to the 95% of the laboratory Maximum Dry Density **(MDD)** as determined from Standard Proctor method, ASTM D-698. The top 6-inches of the roadway areas that will be paved with asphalt should be compacted to 100% of the MDD. The fill placed below 24 inches of the roadway subgrade should be compacted to minimum 90% of MDD. Also, all culvert and utility line backfills should be compacted to 95% of MDD.

We recommend that a CBR value of 6.0 be used with onsite silty and sandy soils for preliminary pavement thickness determinations where required. However, the final pavement design should be based on the CBR tests conducted on actual subgrade soils.

Satisfactory soil materials are defined as those complying with ASTM D-2487 soil classification groups GW, GP, GM, SM, SW, SP, SC, ML and CL. Fine grained soils with a dry in-place density greater than 105 pcf, Liquid Limit **(LL)** less than 40 and Plasticity Index **(PI)** less than 20 area acceptable to use as controlled fill. Gravel fill materials should have a maximum density of not less than 115 pcf.

8.4 Culvert Construction

Three box culverts will be constructed along the roadway. Based on the soil boring data, culvert excavations are unlikely to encounter intact bedrock but may encounter hard decomposed rock requiring ripping if placed at depths greater than 10 ft. below ground level. Groundwater may be encountered during culvert construction depending on the seasonal groundwater conditions and the excavation depths. Ground water was observed at 3 ft. below ground level in boring B-1 conducted near culvert at St. 10+50 during our investigation.

All temporary excavations for the culverts should be sloped no steeper than 1(H):1(V) during construction. Steeper slopes up to 1(H):2(V) may be allowed in decomposed rock and rock materials. Slopes in excavations greater than 4 feet deep in soil materials should be braced adequately according to OSHA regulations. Equipment and excavated soils should be placed no closer than 10 feet from the top edge of any trench excavation. If rock/decomposed rock is encountered at the final pipe elevation, the subgrade should be undercut and replaced with suitable bedding material. Pipe backfill material should be free of rock or gravel more than 1.5 inches in its greatest dimension within 12 inches of the pipe.

8.5 Construction Dewatering

Ground water was not observed in any of the borings and in the long-term ground water monitoring well except in boring B-1 located in the low area at the beginning of roadway. Therefore, contractors should be prepared for temporary dewatering systems, especially, during roadway excavations in the low areas and culvert excavations as discussed in Section 8.4. Dewatering is effectively accomplished by sump pumps and pits.

Fluctuations in the ground water level may also occur due to variations in climatic conditions, construction activity such as blasting, surface runoff and other site-specific activities. Blasting generally increases the ground water flow. Also, perched ground water can flow along the shallow rock surface during the wet periods of the year. The ground water conditions at the time of construction may, therefore, differ from those observed during our field exploration.

8.6 Slope Stability Issues

According to the Site Grading Plan, the maximum longitudinal design slope of the roadway is 7.29% and the design slopes of lateral cuts and fills will be 1(V):3(H). Considering the presence of silty and sandy materials in the cut sections and assuming that soils from the cut sections will be used as controlled fill in the fill sections, these slopes are considered safe against global failure.

Prevention of infiltration of water into the roadway subgrade is essential for long-term performance of the pavement. Both the subgrade and pavement should have a minimum lateral slope of one-quarter inch per foot to promote surface drainage. Also, surface drains along the roadway edges, especially on the cut sides, are recommended to intercept lateral drainage and discharge away from the roadway area. The water, if not intercepted, may infiltrate into the subgrade and will make the pavement unstable.

8.7 Construction Monitoring

We recommend that CCRG be retained to monitor the construction activities and verify that the field conditions are consistent with the findings of this investigation. If significant variations are encountered, or if the roadway design is altered, we should be notified immediately.

CCRG will provide personnel full-time to monitor, test and approve subgrades and fill layers before, during, and after fill placement. We will perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2922 (nuclear method), and laboratory CBR tests (VTM-8 or ASTM D-1883) as required. At least one field density test will be taken for each lift placed to verify the required soil compaction has been achieved. A daily field report will be submitted for each day's work summarizing the compaction test results, observations, and comments on the contractor's activities.

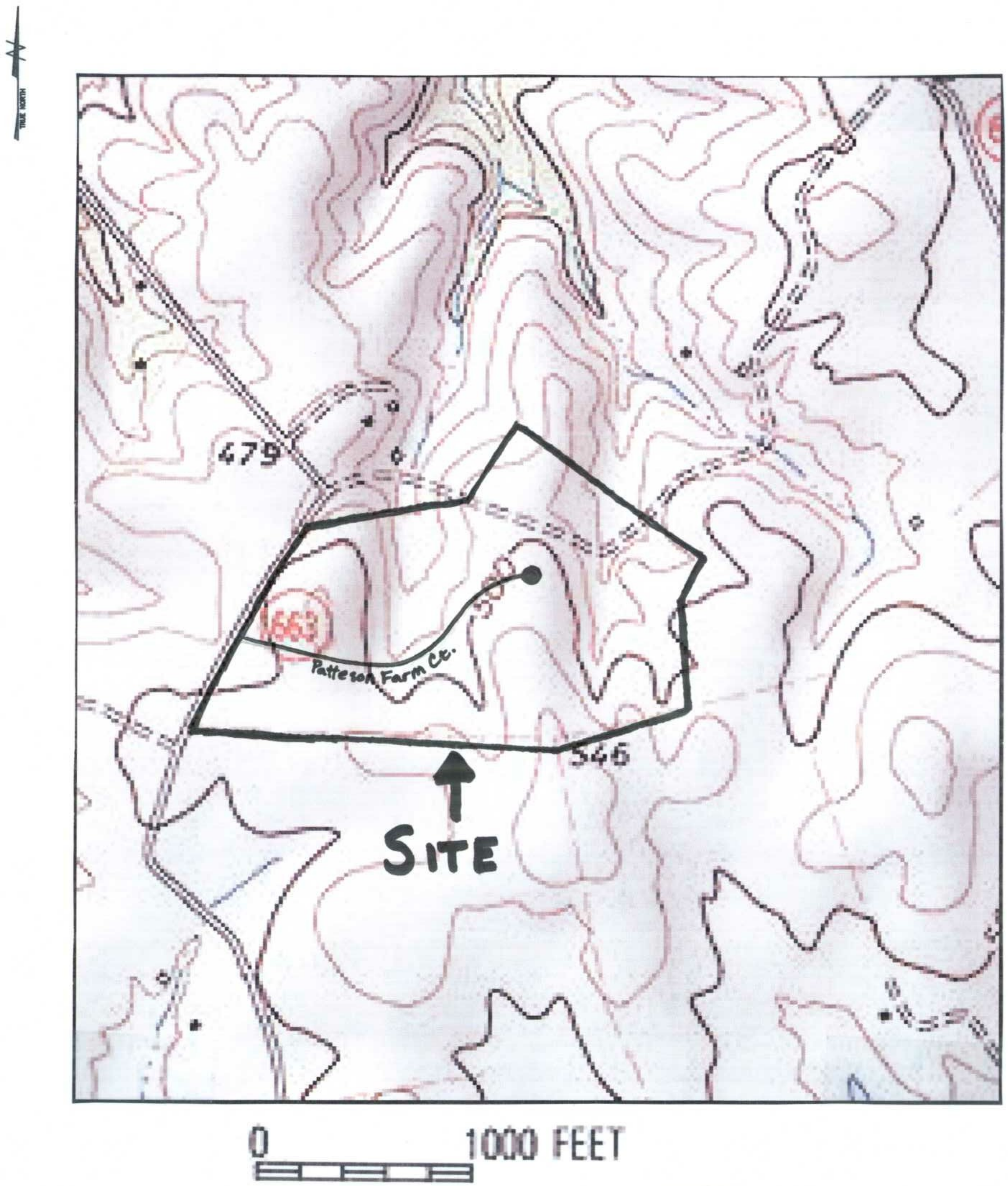
9.0 LIMITATIONS

The work on the project has been carried out in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is applicable to this work.

Subsurface conditions may vary from those encountered at the soil boring locations. The boring logs represent only the conditions at the boring locations when the sampling occurred. Stratigraphic boundaries on the logs represent interpolation of the vertical variations between strata and may not indicate the complete stratigraphy at the site. Classifications of the recovered soil samples are based on recognized standards.

The interpretations and recommendations in this report are based solely on the information available at the time this report was prepared and the Site Grading Plan electronically provided by GeoEnv Engineers on March 30, 2016. In the event that the project designs and site grading are altered, the conclusions and recommendations presented herein should not be considered valid unless we have been given the opportunity to review the changes.

FIGURES



CCRG
Clendenin Consulting & Remediation Group

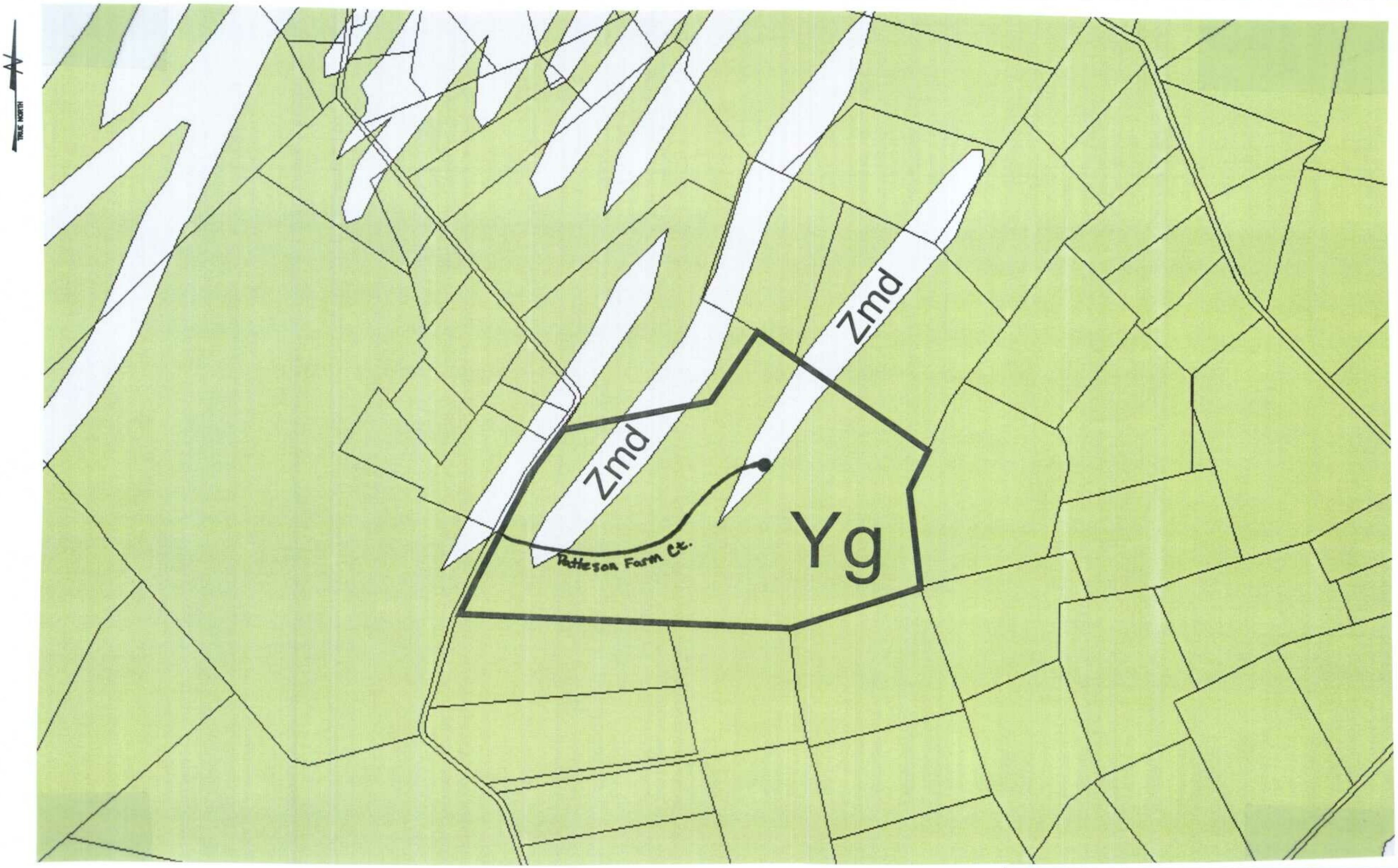
Patteson Farm Ct

Site Map

Lovetsville, VA

Date: 11/16/2006	Scale: See Scale
Drawn by: EMR	Approved by: NJ
Project #: 06028	Figure: 1

Base map created with USGS Topographic Maps TOPO! 2003 National Geographic Software



Legend:

Yg- Leucocratic Metagranite
Zmd- Metadiabase

Note: Base map created using ArcExplorer GIS program

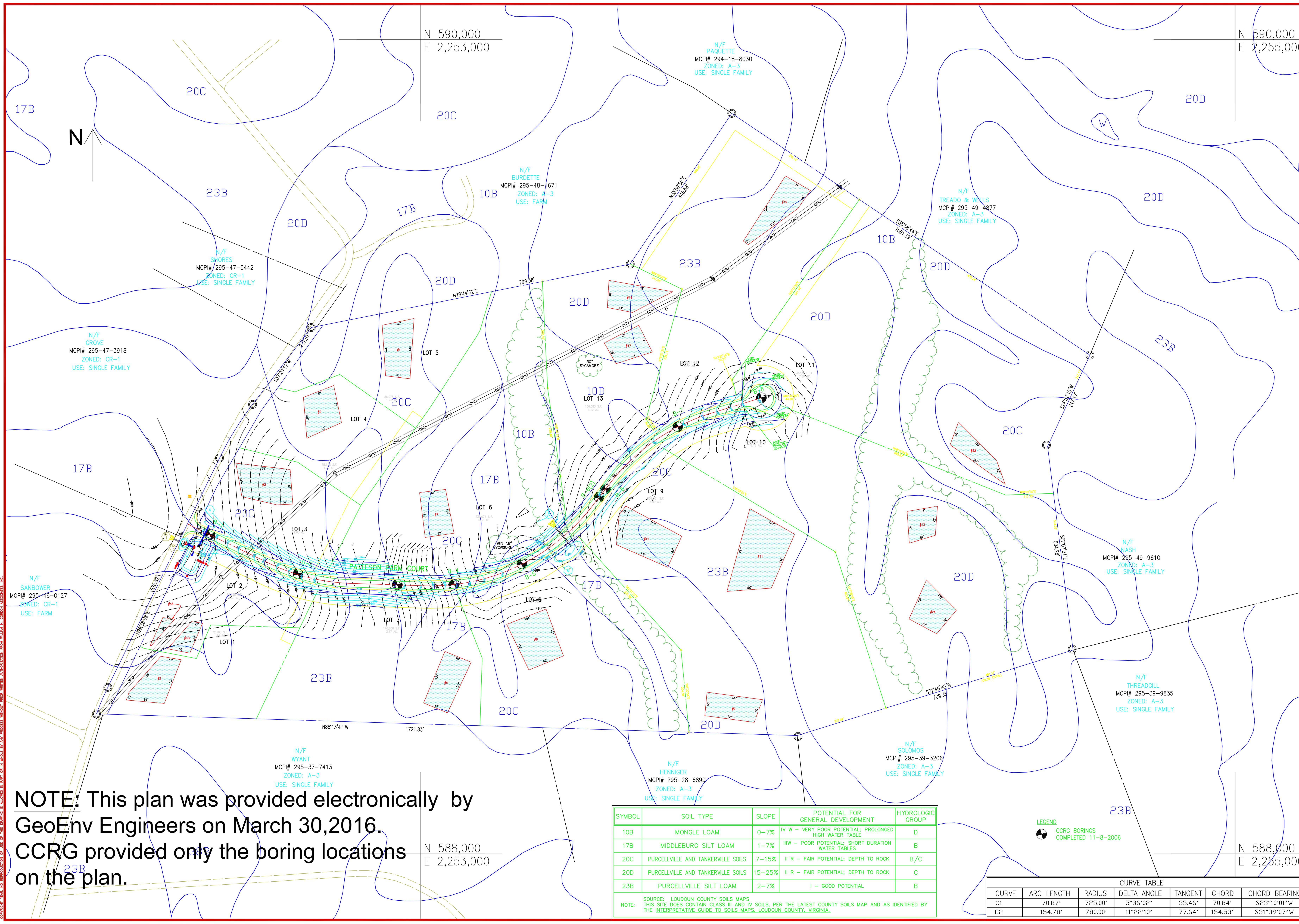
CCRG
Clendenin Consulting & Remediation Group

Patteson Farm Court

Geology Map

Lovetsville, VA

Date: 11/16/2006	Scale: 1" = +/- 630'
Drawn by: EMR	Approved by: NJ
Project #: 06028	Figure: 2



SYMBOL	SOIL TYPE	SLOPE	POTENTIAL FOR GENERAL DEVELOPMENT	HYDROLOGIC GROUP
10B	MONGLE LOAM	0–7%	IV W – VERY POOR POTENTIAL; PROLONGED HIGH WATER TABLE	D
17B	MIDDLEBURG SILT LOAM	1–7%	IIIW – POOR POTENTIAL; SHORT DURATION WATER TABLES	B
20C	PURCELLVILLE AND TANKERVILLE SOILS	7–15%	II R – FAIR POTENTIAL; DEPTH TO ROCK	B/C
20D	PURCELLVILLE AND TANKERVILLE SOILS	15–25%	II R – FAIR POTENTIAL; DEPTH TO ROCK	C
23B	PURCELLVILLE SILT LOAM	2–7%	I – GOOD POTENTIAL	B
NOTE:	SOURCE: LOUDOUN COUNTY SOILS MAPS THIS SITE DOES CONTAIN CLASS III AND IV SOILS, PER THE LATEST COUNTY SOILS MAP AND AS IDENTIFIED BY THE INTERPRETATIVE GUIDE TO SOILS MAPS, LOUDOUN COUNTY, VIRGINIA.			

CURVE TABLE

CURVE	ARC LENGTH	RADIUS	DELTA ANGLE	TANGENT	CHORD	CHORD BEARING
C1	70.87'	725.00'	5°36'02"	35.46'	70.84'	S23°10'01"W
C2	154.78'	780.00'	11°22'10"	77.64'	154.53'	S31°39'07"W

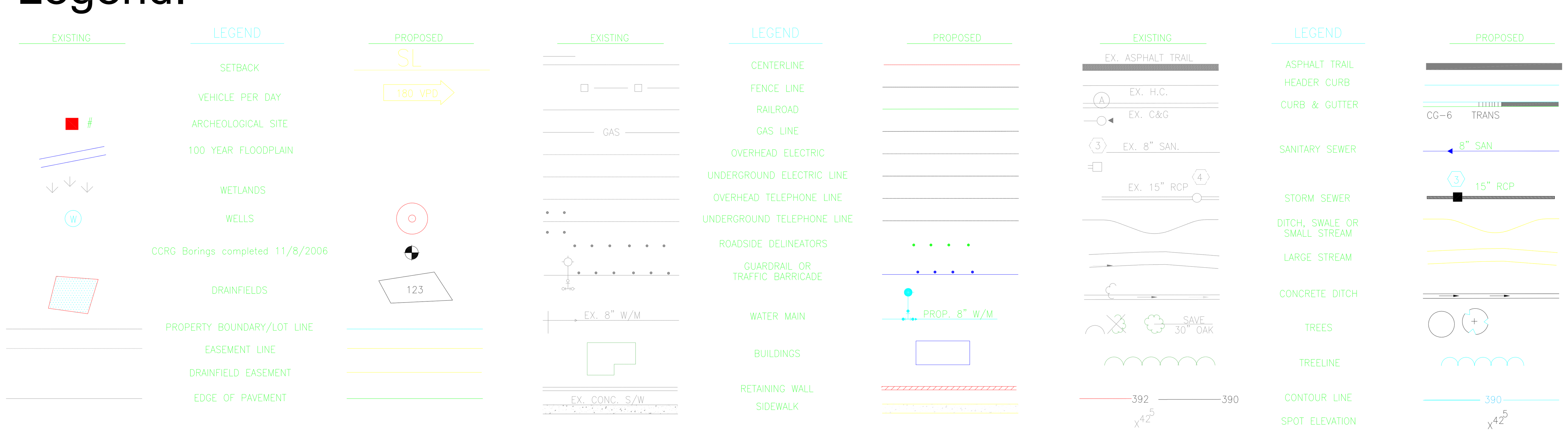
SOILS MAP

PATTESON FARM

FIGURE 3

Scale 1" = 100'

Legend:



Note:
CCRG provided only the boring locations on this plan. GeoEnv Engineers provided all other information.

Note: Base plan provided electronically by GeoEnv Engineers on March 30, 2016

CCRG
Clendenin Consulting & Remediation Group

Patteson Farm

Boring Location Plan

Lovettsville, VA

Date: 04/7/2016	Scale: 1" = 60'
Drawn by: EMR	Approved by: NJ
Project #: 06028	Figure: 4

Legend:

SOIL 1 -- Clay (CL)
SOIL 2 -- Silt (ML)
SOIL 3 -- Sand (SM)
DRx -- Decomposed Rock

Note: CCRG provided only the boring and soil information on this plan.
Profile provided electronically by GeoEnv Engineers on March 30, 2016.

CCRG Clendenin Consulting & Remediation Group

Patteson Farm Court

Longitudinal Profile

Lovettsville, VA

Date: 04/7/2016	Scale: As shown
Drawn by: EMR	Approved by: NJ
Project #: 06028	Figure: 5

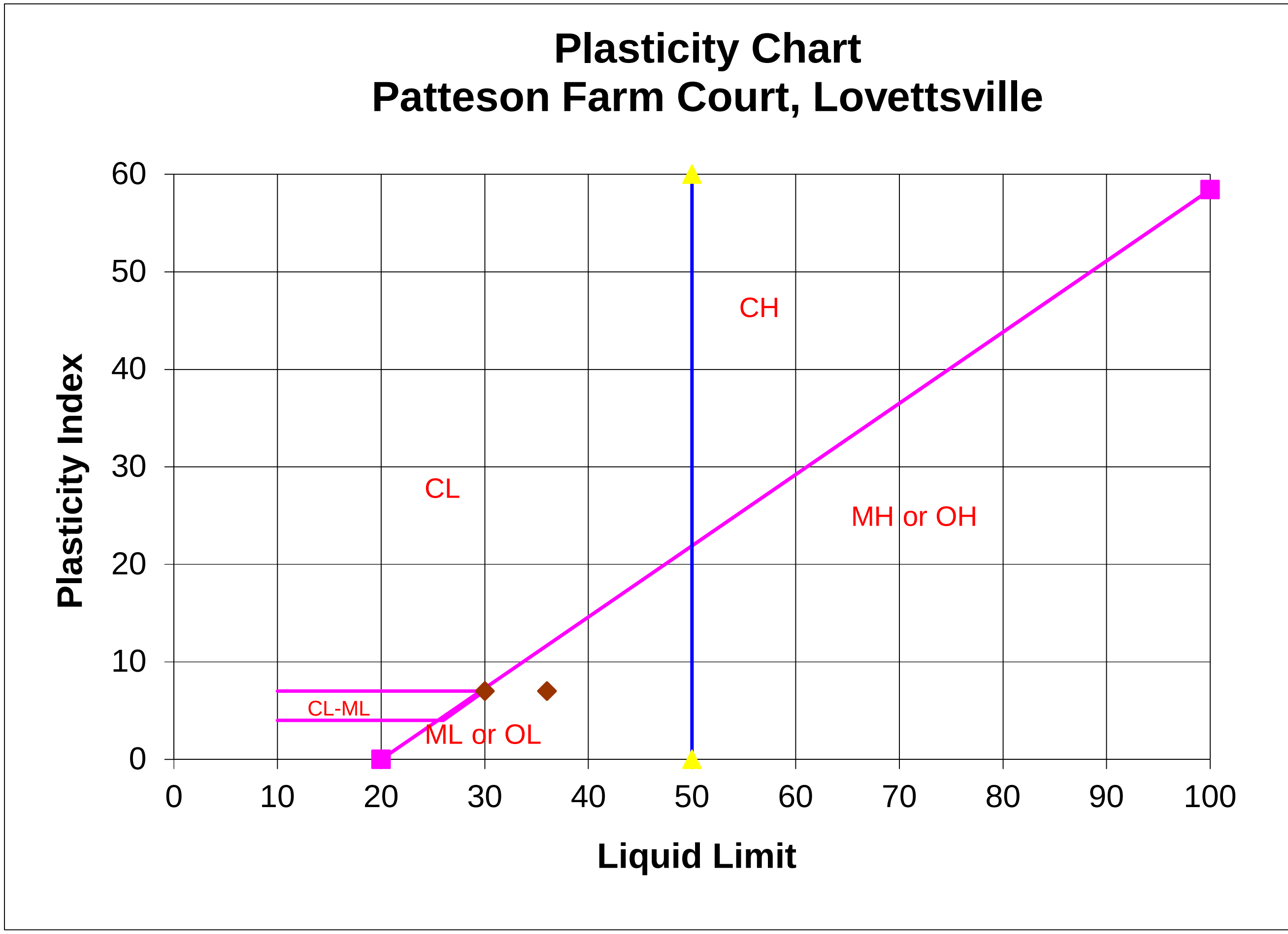

Plasticity Chart
Patteson Farm Court, Lovettsville
Plasticity Index
Liquid Limit
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
CH
CL
MH or OH
CL-ML
ML or OL

Figure 6

APPENDIX A

IDENTIFICATION OF SOIL SAMPLES

Material descriptions on the logs indicate the visual identification of the soils recovered from the explorations and are based on the following criteria. Major soil components are designated by capital letters and minor components are described by terms indicating the percentage by weight of each component. Soil descriptions are determined visually, except where laboratory test data is available.

MAJOR components, used as a noun, constitute more than 50% of sample, have the following size designation. If no component is greater than 50%, the dominant component is capitalized.

MINOR components, have following percentage designation.

Component		Size or Sieve
BOULDERS		Plus 12 inch
COBBLES		3 to 12 inches
GRAVEL	- coarse	3/4 to 3 inches
	- fine	No.4 to 3/4 inches
SAND	- coarse	No.10 to No.4
	- medium	No.10 to No.40
	- fine	No.200 to No.40
Silt or Clay		Minus No.200 (fine grained soil)

Adjective	Percent
"and"	35 to 50
"some"	20 to 35
"little"	10 to 20
"trace"	0 to 20

Fine grain soils	Plasticity terms for designating components
SILT	non plastic, fine grained
SILT, trace clay	Slight plasticity
Clayey SILT	low plasticity
Silty CLAY	medium plasticity
CLAY	high and very high plasticity

CONSISTENCY of cohesive soils is based on N-value, or estimate of unconfined compressive strength by laboratory tests or field pocket penetrometer.

N-Value	Qu*	Consistency
0 to 2	0 to 0.25	very soft
2 to 4	0.25 to 0.50	soft
4 to 8	0.50 to 1.00	firm
8 to 15	1.00 to 2.00	stiff
15 to 30	2.00 to 4.00	very stiff
30 plus	4 plus	hard

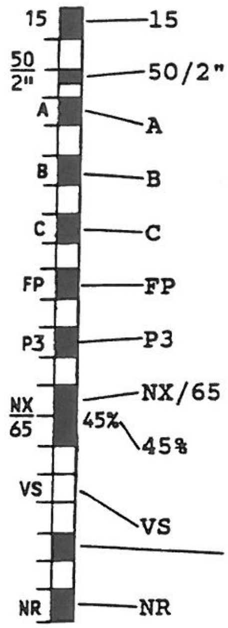
PLASTICITY of cohesive soils, or fines of granular soils is based on laboratory tests.

Plasticity Index	Soil Plasticity
0	none
1 to 5	slight
6 to 10	low
11 to 20	medium
20 to 40	high
over 40	very high

* Unconfined Strength (tsf), or estimate of unconfined strength, based on pocket penetrometer Qp (tsf).

Test and sample identification

Field Work



15 - N-value, number of blows in Standard Penetration Test

50/2" - Number of blows in SPT for number of inches

A - Auger sample

B - Bag sample

C - Denison or Pitcher type, core barrel sampler

FP - Fixed position shelby tube sampler

P3 - Push thin wall Shelby Tube sampler

NX/65 - NX size rock core (2-1/8 inch diameter 65% of core recovered)

45% - Rock quality designation where: (Total core pieces +4 inch/core run) - does not include breaks by drilling

VS - Vane shear test

- Sample recovered

NR - Sample not recovered

Laboratory work

C - Consolidation test	K - Permeability
DS - Direct Shear	T - Triaxial Compression
G - Specific Gravity	U - Unconfined Compression
M - Mechanical Analysis	X - Special test

Glossary of Terms

Unified Soil Classification Symbols, when shown, are based on Laboratory tests.

FILL - Man placed material, often contains foreign material.

Possible Fill - Soils without visually detectable foreign materia, suspect with respect to origin.

Top Soil - Soil with considerable amount of organic material that supports plant growth.

Residual Soil - Fully weathered soil.

Transition - Weathered, but containing relict joints and characteristics of both soil and rock.

Decomposed Rock - Partially weathered rock.

Rock Fragments - Angular pieces of rock in soil material, not transported gravel, and separate from a rock vein.

Parting - 0 to 1/16" thickness.

Seam - 1/16" to 1/2" thickness.

Layer - 1/2" to 12" thickness.

Stratum - Grater than 12" thickness.

Pocket - Small, erratic deposit, usually less than 1 foot.

Lens - Lenticular deposit.

Occasional - One or less per foot of thickness.

Frequent - More than one per foot of thickness.

Varved Clay - Alternating seams of layers of sand or silt, with clay.

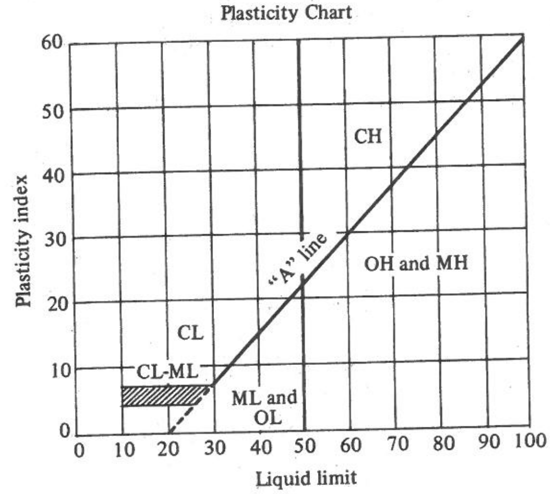
Moisture - From sample appearance: dry, moist, or wet.

Standard Penetration Test (SPT) - The number of blows required to drive 1.5 inch diameter split spoon sampler a distance of 12 inches using a 140 pound hammer dropped 30 inches.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			*Group Symbols*	*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent: GW, GP, SW, SP; More than 12 per cent: GM, GC, SM, SC; 5 to 12 per cent: *Borderline* cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a] d / u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a] d / u	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	Plasticity Chart		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt	Peat and other highly organic soils			

Plasticity Chart



[a]Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.
[b]Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

(From Table 2.16, *Foundation Engineering Handbook*, Winterkorn and Fang – 1975)

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 482 GROUND 482.86	MATERIAL DESCRIPTION	MOISTURE CONTENT %	LL	PL	PID	Pass. %200
		4		FG	Topsoil 0-0.3" Soft brown lean CLAY (CL) tr. to some sand, mois	21.4				
2.5										
		4	▽			29.5				
5.0					SOIL 1					
		21			Very stiff to very hard greenish and orange brown SILT (MI	18.7				
7.5										
		79/11"			SOIL 2	17.3				
					Boring terminated at 10'					
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)		TIME (hrs)		DATE
START	0	@	8:26	ON	11/8/2006
FINAL	10	@	8:46	ON	11/8/2006
WATER	3	@	12:10	ON	11/8/2006
WATER		@		ON	
WATER		@		ON	

LOG OF BORING B-1

Location: See Figure 4

PAGE 1 OF 1

CLENDENIN CONSULTING & REMEDIATION GROUP

06028
Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 495.5 GROUND 499.26	MATERIAL DESCRIPTION	MOISTURE CONTENT %	LL	PL	PID	Pass. %200
					Stiff brown SILT (ML), trace to little sand, moist					
2.5		12				33.3				
5.0		12		FG	SOIL 2	29.8				
					Dense greenish brown silty SAND (SM), quartz roc fragments, moist					
7.5		41				7.5				
10.0		59			SOIL 3	15				
					Boring terminated at 10' Installed temporary monitoring wel					
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)		TIME (hrs)		DATE
START	0	@	8:55	ON	11/8/2006
FINAL	10	@	9:14	ON	11/8/2006
WATER	Dry	@		ON	11/10/2006
WATER		@		ON	
WATER		@		ON	

LOG OF BORING B-2

Location: See Figure 4

PAGE 1 OF 1

CLENDENIN CONSULTING & REMEDIATION GROUP

06028

Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 501.5 GROUND 512.89	MATERIAL DESCRIPTION	MOISTURE CONTENT %	LL	PL	PID	Pass. %200
					Hard orange brown SILT (ML), some sand, mois					
2.5		33			SOIL 2	12.1				
					Dense greenish brown silty SAND (SM), mois					
5.0		56				7.9	30	23	7	45.2
7.5		49			---same--- decomposed rock fragment:	7.4				
					SOIL 3					
		50/2"			DECOMPOSED ROCK sampled as very dense greenish brown silty SAND (SM).	8.8				
10.0										
				FG						
12.5										
		50/3"			DRx	7.3				
15.0					Splt spoon refusal at 14'					
17.5										
20.0										
22.5										

	DEPTH(ft)	TIME (hrs)	DATE
START	0 @	9:22	ON 11/8/2006
FINAL	14 @	9:50	ON 11/8/2006
WATER	@		ON
WATER	@		ON
WATER	@		ON

LOG OF BORING B-3

Location: See Figure 4

PAGE 1 OF 1

CLENDENIN CONSULTING & REMEDIATION GROUP

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Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 497 GROUND 497.45	MATERIAL DESCRIPTION	MOISTURE CONTENT %	LL	PL	PID	Pass. %200
				FG	Stiff to very stiff orange brown SILT (ML), mois					
2.5		11				25	36	29	7	78.1
5.0		17				11.6				
7.5		35			---same--- some sanc	11.2				
10.0		24			---same--- greenish brown decomposed rock fragment SOIL 2	19.2				
					Boring terminated at 10'					
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)		TIME (hrs)		DATE
START	0	@	9:55	ON	11/8/2006
FINAL	10	@	10:12	ON	11/8/2006
WATER		@		ON	
WATER		@		ON	
WATER		@		ON	

LOG OF BORING B-4

Location: See Figure 4

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CLENDENIN CONSULTING & REMEDIATION GROUP

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Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 483 GROUND 478.97	MATERIAL DESCRIPTION	MOISTURE CONTENT %	REMARKS LL	PL	PID	Pass. %200
					Stiff to very stiff orange brown SILT (ML), some roc fragments.					
2.5		11				22.6				
5.0		17			---same--- greenish brown decomposed rock fragments SOIL 2	19.1				
					Boring terminated at 5'					
7.5										
10.0										
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)	TIME (hrs)	DATE
START	0	@ 10:16	ON 11/8/2006
FINAL	5	@ 10:37	ON 11/8/2006
WATER		@	ON
WATER		@	ON
WATER		@	ON

LOG OF BORING B-5

Location: See Figure 4

CLENDENIN CONSULTING & REMEDIATION GROUP

06028

Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 483.8 GROUND 483.64	MATERIAL DESCRIPTION	MOISTURE CONTENT %	LL	PL	PID	Pass. %200
2.5		59			Very dense greenish brown silty SAND (SM), mois SOIL 3	13.6				
5.0					Auger refusal at 3' (Possible boulder)					
7.5										
10.0										
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)	TIME (hrs)	DATE
START	0 @	10:44	ON 11/8/2006
FINAL	3 @	10:51	ON 11/8/2006
WATER	@		ON
WATER	@		ON
WATER	@		ON

LOG OF BORING B-6

Location: See Figure 4

PAGE 1 OF 1

CLENDENIN CONSULTING & REMEDIATION GROUP

06028

Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 483.8 GROUND ± 483.64	MATERIAL DESCRIPTION	MOISTURE CONTENT %	LL	PL	PID	Pass. %200
2.5		23			Very stiff greenish brown SILT (ML), trace sand, moist SOIL 2	13.3				
5.0		30			Firm to dense mottled dark brown and orange brown silty SAND (SM), moist.	14				
7.5		22			---same--- quartz rock fragments	7.4				
10.0		44			---same--- decomposed rock fragments SOIL 3	6.2				
12.5					Boring terminated at 10'					
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)		TIME (hrs)		DATE
START	0	@	11:43	ON	11/8/2006
FINAL	10	@	11:58	ON	11/8/2006
WATER		@		ON	
WATER		@		ON	
WATER		@		ON	

LOG OF BORING B-6 (2)

Location: See Figure 4

CLENDENIN CONSULTING & REMEDIATION GROUP

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Patteson Farm Court Geotechnical Investigation

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 487 GROUND 484.42	MATERIAL DESCRIPTION	MOISTURE CONTENT %	REMARKS LL	PL	PID	Pass. %200
2.5		30			Very stiff greenish brown SILT (ML), trace to ilttle sand moist. SOIL 2		12			
5.0		24			Firm to very dense greenish brown silty SAND (SM and demposed rock fragments		8			
7.5		11					7			
		50/6"			SOIL 3		4			
10.0					Boring terminated at 9'					
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)	TIME (hrs)	DATE
START	0 @	10:55	ON 11/8/2006
FINAL	9 @	11:11	ON 11/8/2006
WATER	@		ON
WATER	@		ON
WATER	@		ON

LOG OF BORING B-7

Location: See Figure 4

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CLENDENIN CONSULTING & REMEDIATION GROUP

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Patteson Farm Court Geotechnical Investigatio

Depth in Feet	Sample Recovery	N VALUE (blows/ 12 in.)	Ground Water	ELEV. FINAL GRADE ± 498.5 GROUND 498.71	MATERIAL DESCRIPTION	MOISTURE CONTENT %	REMARKS LL	PL	PID	Pass. %200
2.5		11			Firm to dense orange brown and gray brown sil SAND (SM), some clay and demposed rock fragments moist	22.5				
5.0		24 (NR)				NA				
7.5		33				7.5				
10.0		34			---same--- greenish browr SOIL 3	14.6				
					Boring terminated at 1C					
12.5										
15.0										
17.5										
20.0										
22.5										

	DEPTH(ft)		TIME (hrs)		DATE
START	0	@	11:17	ON	11/8/2006
FINAL	10	@	11:36	ON	11/8/2006
WATER		@		ON	
WATER		@		ON	
WATER		@		ON	

LOG OF BORING B-8

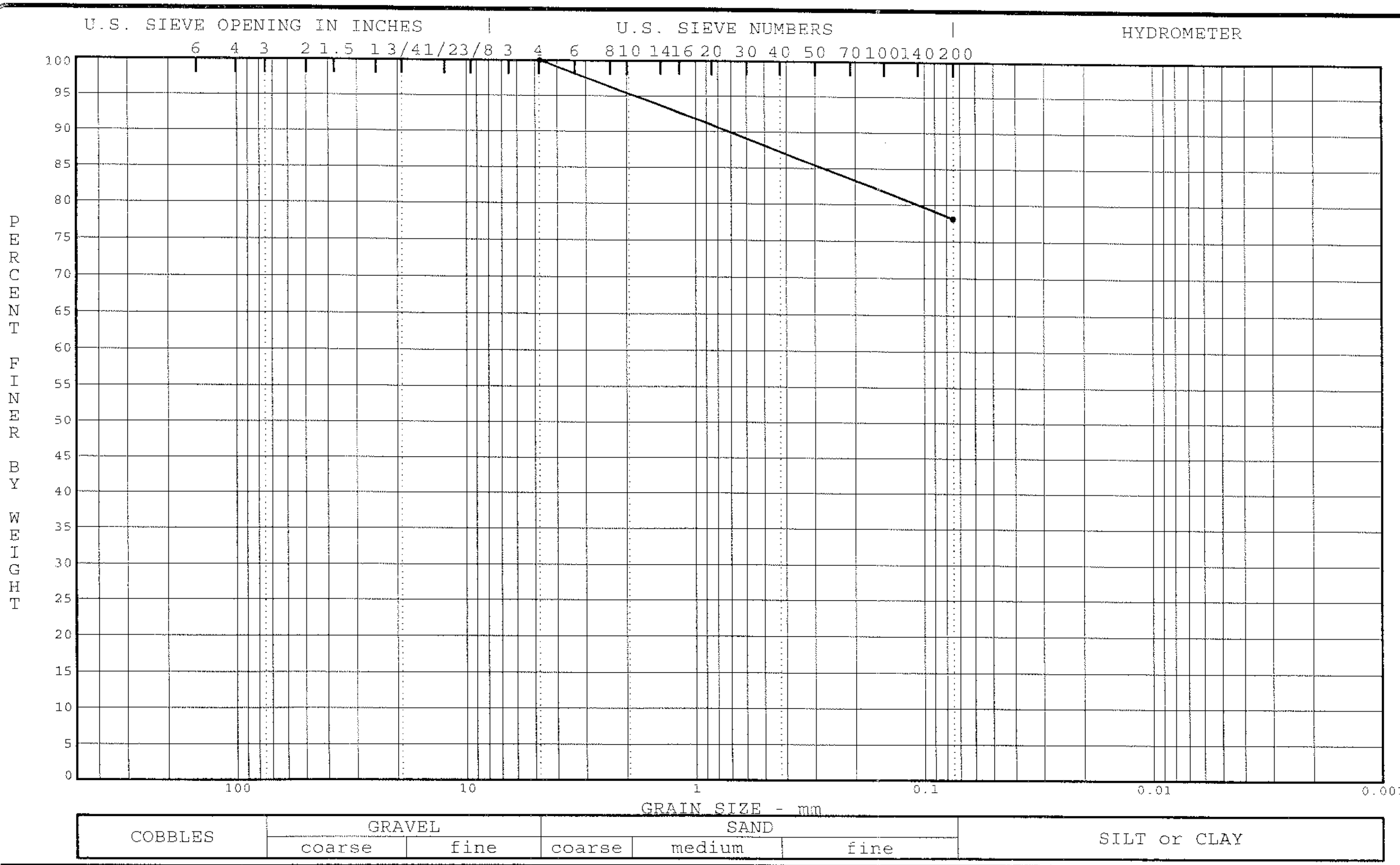
Location: See Figure 4

PAGE 1 OF 1

CLENDENIN CONSULTING & REMEDIATION GROUP

06028
Patteson Farm Court Geotechnical Investigatio

APPENDIX B



Sample ID: S-1	Description	%Gravel	%Sand	%Silt %Clay	MC%	LL	PL	PI	USCS
B-4, from 1.0 feet	Yellowish brown SILT with SAND	0.0	21.9	78.1		36	29	7	ML
to 2.5 feet									AASHTO
									A-4 (6)

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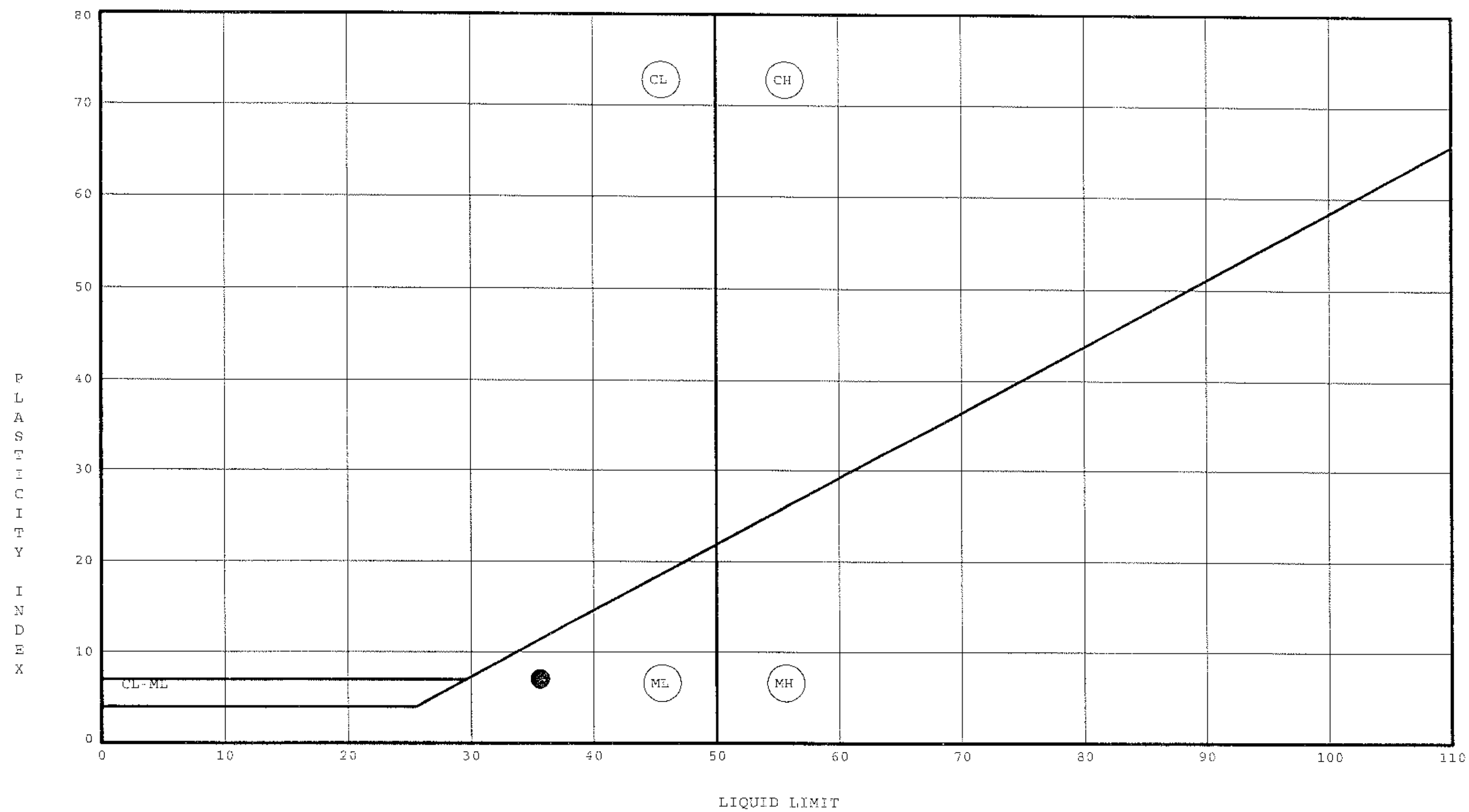
Patterson Farm Court
Lovettsville, Virginia
CCTG. Pr. No. 06028
Project No. 10705-1-0

LAB-SVE NEW 06028 GPJ B-4 2 11/16/06



Sample ID: S-1	Description	%Gravel	%Sand	%Silt %Clay	MC%	LL	PL	PI	USCS
B-4, from 1.0 feet	Yellowish brown SILT with SAND	0.0	21.9	78.1		36	29	7	ML
to 2.5 feet									AASHTO
									A-4 (6)

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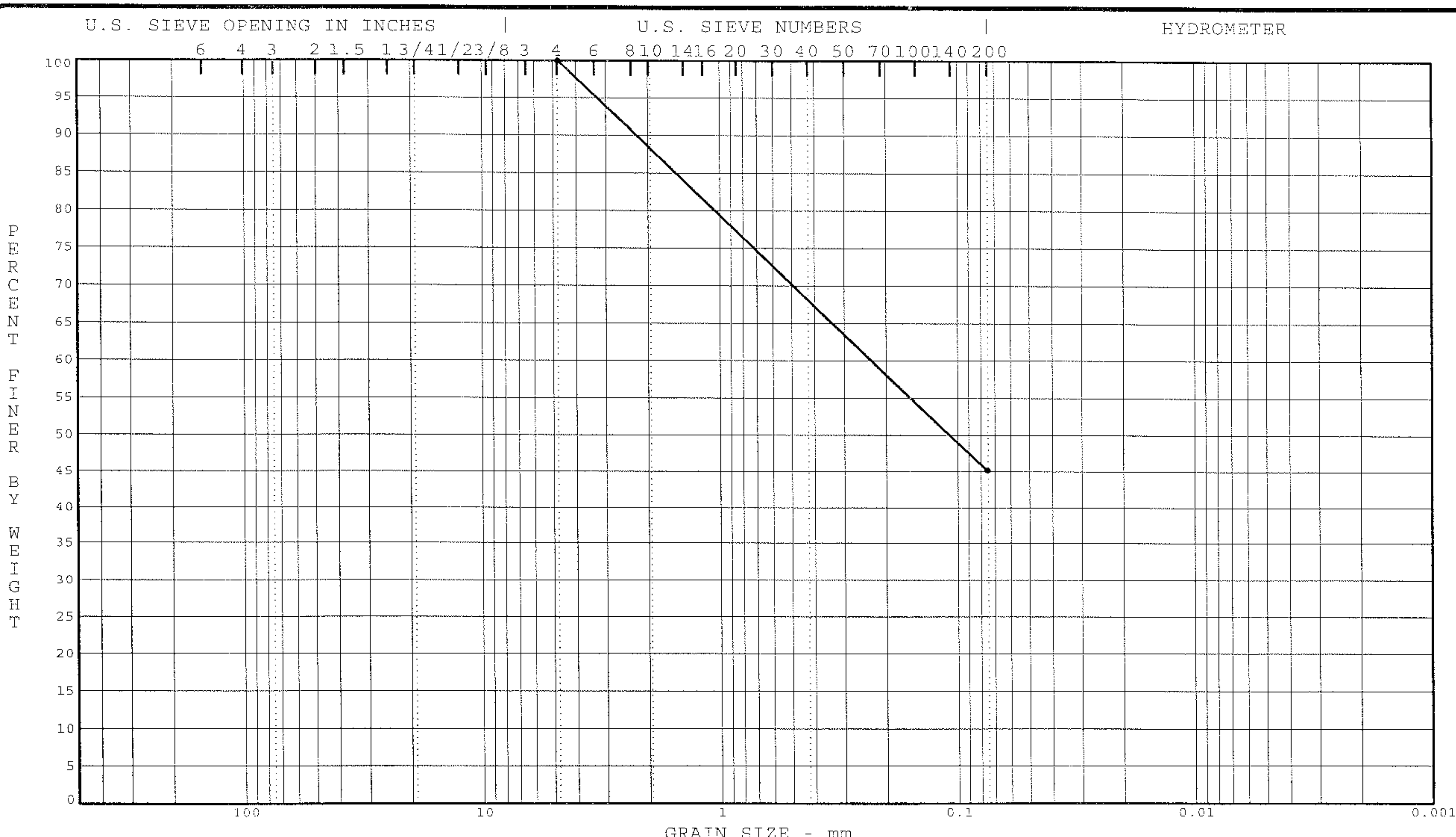
Lovettsville, Virginia
CCTG. Pr. No. 06028
Project No. 10705-1-0

LAB-ATT NEW 06028.GPJ B-4 2 11/16/06



COBBLES	GRAVEL		SAND			SILT or CLAY
	coarse	fine	coarse	medium	fine	

Sample ID: S-2	Description	%Gravel	%Sand	%Silt %Clay	MC%	LL	PL	PI	USCS
B-3, from 3.5 feet	Yellowish brown SILTY SAND	0.0	54.8	45.2		30	23	7	SM
to 5.0 feet									AASHTO
									A-4 (1)

PHR+A
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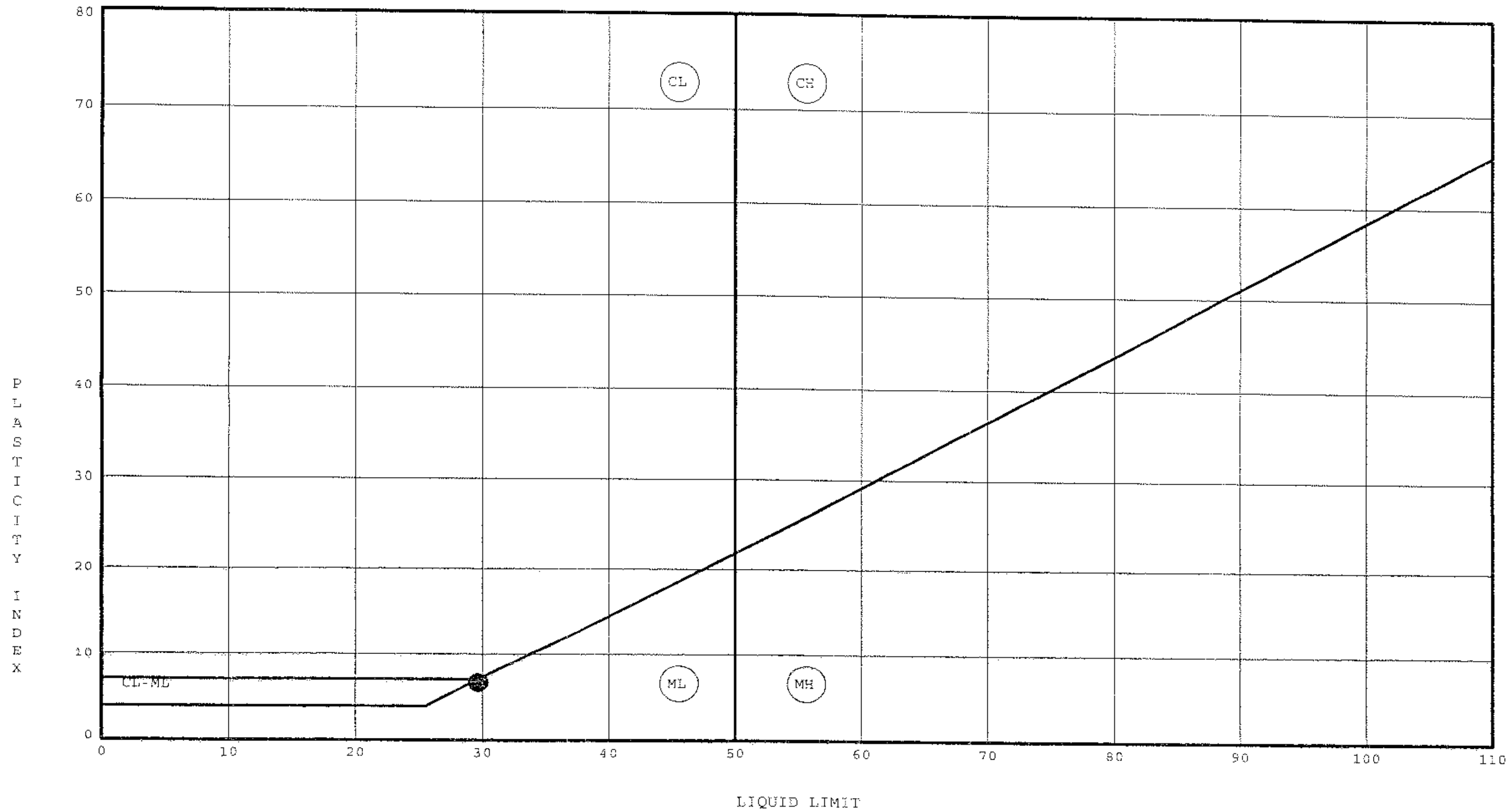
Project No. 10705-1-0



Sample ID: S-2	Description	%Gravel	%Sand	%Silt %Clay	MC%	LL	PL	PI	USCS
-3, from 3.5 feet	Yellowish brown SILTY SAND	0.0	54.8	45.2		30	23	7	SM
o 5.0 feet									AASHTO
									A-4 (1)

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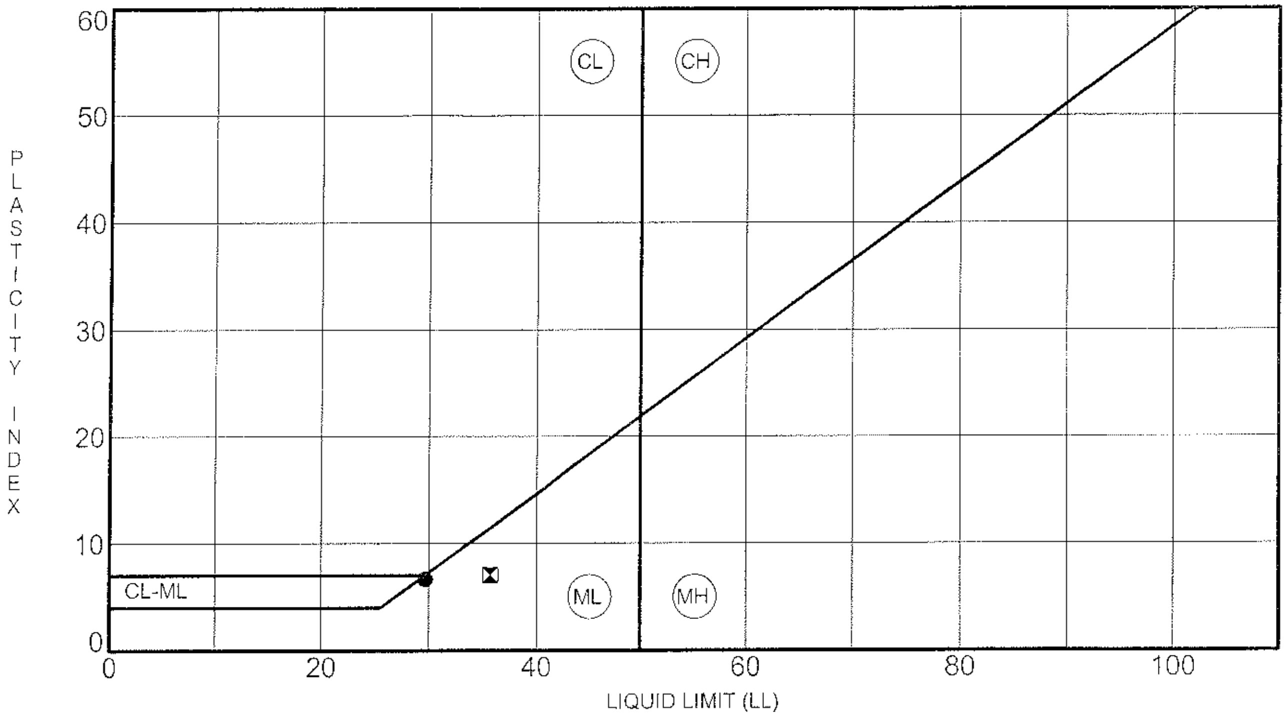

	Specimen Identification		LL	PL	PI	Fines	Classification
●	B- 3	4.5	30	23	7	45.2	SILTY SAND SM
⧗	B- 4	2.0	36	29	7	78.1	SILT with SAND ML

COMMONWEALTH OF VIRGINIA
MARWAN SALEH IFTAIHA
No. 0402 036287
PROFESSIONAL ENGINEER
11.16.06

ATTERBERG LIMITS' RESULTS

PHR+A
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Project No. 10705-1-0

APPENDIX C

CCRG
Clendenin Consulting & Remediation Group

May 3, 2016
16003.ENG

Mr. Amit Bery
Ironwood Real Estates Holdings, LLC
4512 Rhett Lane
Fairfax, VA 22030

Subject: Addendum to Detailed Geotechnical Investigation Report
Patteson Farm Court
Lovettsville, Virginia

Dear Mr. Bery:

Clendenin Environmental & Geotechnic Consultants, Inc. **(CCRG)** is pleased to submit this addendum to our Detailed Geotechnical Investigation Report dated April 19, 2016 for construction of Patteson Farm Court, Lovettsville, Virginia. This addendum was prepared to provide recommendations for construction of proposed houses and the storm water pond adjacent to Patteson Farm Court. The Site Grading Plan provided electronically by GeoEnv Engineers on March 30, 2016 showing the proposed house locations and the storm water pond is included as Figure 1. The pond details are shown in Figure 2.

1.0 SUBSURFACE CONDITIONS

According to the Loudoun County soil survey map included as Figure 3, in the original report, the building areas consist of soils similar to those along Patteson Farm court. The pond area consists of Middleburg Silt Loam (17B). The soil type descriptions are provided in Section 3.0 of our original report.

The soil borings conducted along the proposed roadway mostly encountered low to medium plastic SILT underlain by silty SAND within the upper 10 ft. below ground level. The SILT thickness varies from 3 ft. to greater than 10 ft. below ground level. The borings indicated that depth to bedrock is greater than 10 ft. but decomposed rock is likely to encounter generally at depths as shallow as 7 ft. below ground level. According to the soil boring information, isolated shallow rock zones and/or large boulders may also exist in the overburden.

The soil boring B-1 (El. 482.86 ft.) conducted adjacent to the pond encountered soft brown lean CLAY in the upper 5 ft. underlain by very stiff greenish and orange brown SILT down to the boring terminated depth of 10 ft. below ground level. The high SPT-N value of 79 blows per 11 inches at 8.5-10 ft. below ground level indicates possible presence of decomposed rock at that depth.

Clendenin Environmental & Geotechnic Consultants, Inc.
Clendenin Environmental & Geotechnic Consultants, Inc.
116 - I Edwards Ferry Road • Leesburg, Virginia 20176 • tel:703/771-8816 • fax:703/771-8825
www.clendeninconsulting.com

2.0 RECOMMENDATIONS

2.1 Site Preparation

Exposed soil sub grade in building and pond areas where controlled fill is proposed, should be proofrolled with a loaded 10-wheel truck to identify any soft and unstable zones. Any soft unstable zones should be first, scarified, air dried and re-compacted. If drying is not economical, then the soils should be over-excavated to stable natural soils and replaced with controlled fill as required.

Proofrolling should be performed with at least two passes of a loaded 10-wheel tandem axle truck or other similar approved construction equipment after a suitable period of dry weather. The exposed subgrade and proofrolling operation should be observed and documented under the direction and supervision of a registered professional geotechnical engineer licensed in the Commonwealth of Virginia.

The professional geotechnical engineer should visit the areas where proofrolling cannot be used to check for soft and unstable zones. Depending on the exact field situation, he may approve those zone(s) visually or use field-testing equipment to gather additional data to approve or disapprove the zone(s).

2.2 Excavation and Fill Considerations

According to the site grading plan, the houses will be constructed with basements. However, the Finished Floor Levels **(FFL)** and Basement Floor Levels **(BFL)** of the houses are currently not available. Considering the bedrock depth greater than 10 ft. below ground level in all the borings except in boring B-6, the basement excavations may not encounter hard bedrock if excavations are limited to the upper 10-foot depth. However, decomposed rock will likely be encountered at depths generally greater than 7 ft. below ground level. Also, isolated shallow rock zones and/or large boulders may also exist in the upper soil zones. Ripping with heavy earth moving equipment can possibly remove hard decomposed rock. Blasting will be required to remove large boulders and/or bedrock, if encountered.

All permanent excavations in the residual soil should not be steeper than 1(V):3(H). However, the excavations in the competent rock may be steepened up to 2(V):1(H) depending on the rock quality. Shallow temporary excavations deeper than 4 feet should comply with OSHA bracing regulations or sloped appropriately as approved by the geotechnical engineer. Temporary excavations in rock/decomposed rock should not be steeper than 2(V): 1(H). All other temporary excavations should have side slopes not steeper than 1(V):1(H) unless approved by the geotechnical engineer. All excavated slopes should be inspected and approved by the geotechnical engineer.

2.3 Re-use of Excavated Material

The SOIL 2 (ML) and SOIL 3 (SM) excavated from the site are generally suitable as controlled fill. Also, the decomposed rock materials removed from the basement and utility line excavations, mostly from depths greater than 7 ft. below ground level, should be suitable for use as controlled fill. However, all excavated material should satisfy the controlled fill requirements described in Section 2.7.

2.4 Foundations

Continuous and isolated footings should generally be at least 16 inches and 24 inches in width respectively. The minimum widths are recommended to provide a margin of safety against a local or punching shear failure of the foundation soils. In all cases, footings should be designed in accordance with the building code for the allowable net bearing capacity.

Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open and exposed to moisture. Therefore, concrete for foundations should be placed the same day the excavations are made. If the bearing soils are softened by water intrusion, the softened soils must be removed from the bottom of the excavation immediately prior to placement of concrete. If softened soils are not removed, settlement can occur. Proper surface drainage should be provided around the excavation areas to prevent surface water from flowing into the excavations. We recommend that the footing excavations be inspected and approved in accordance with the Loudoun County requirements.

We recommend that the footing excavations be observed and approved by a field technician under the direction and supervision of a registered professional engineer/design professional licensed in the State of Virginia. The technician should check foundation surfaces immediately prior to placement of concrete and compare field observations back to this report. If differences are observed, they should be brought to the attention of registered professional engineer/design professional for appropriate recommendations. Foundation bearing surfaces should be free of loose soil, mud, ponded water, frozen soil and debris prior to inspection.

Shallow spread footings and/or wall footings are recommended for the houses. It is likely that house foundations will be constructed on natural soil or compacted controlled fill. We recommend a net bearing capacity of 2500 psf for footings placed on onsite natural soils or compacted controlled fill consisting of onsite ML and SM type soils.

We did not encounter any CH type and MH type soils in any of the soil borings. However, if high plastic CH type CLAY is encountered at the footing subgrade level or within 6 feet below the outside finished grade at the footing location should be undercut and capped with a minimum 2 feet of compacted controlled fill in accordance with Loudoun County requirements. A minimum 2-foot separation should always be provided between the footing subgrade and the high plastic CH type CLAY layer.

Any over-excavations in building areas due to rock blasting should be backfilled with lean concrete or controlled fill up to footing subgrade level. For design purposes, we recommend a design net bearing capacity of 6000 psf on lean concrete. The net bearing capacity is defined as the ultimate pressure per unit area of the foundation that can be supported by the soil/rock in excess of the pressure caused by surrounding soil at the footing subgrade level.

Up to an inch of total settlement is anticipated in footings placed in natural soils generally existing at the site. The total settlement will be in the order of one-half inch or less for footings placed on controlled fill. The differential settlements are anticipated to be one-half of the total settlements. Up to an inch of differential settlement is anticipated within a unit if the structure is placed partially on rock/decomposed rock and partially on controlled fill or natural soil. All structures are designed by the structural engineer to compensate for these differential settlements.

Controlled structural fill should extend horizontally beyond the building limits to provide support for footings bearing on controlled fill. The horizontal limit of fill beyond the footing should be 5 feet plus the thickness of fill below the floor slab at the edge of footing.

All exterior footings placed on natural soil or controlled fill should be founded at least 30 inches below finished exterior grade to protect against frost heave and to provide protective embedment. Interior footings may be founded at nominal depths unless the completed foundation subgrade will be exposed to freezing weather or to severe evaporation during construction.

2.5 Grade Slab Construction

The proposed houses will include concrete slabs supported on grade and bearing on approved residual soils, rock/decomposed rock and/or controlled compacted fill. We recommend at least 2 feet of over-excavation if rock is encountered at the BFL/FFL and backfilling with compacted controlled fill for placement of utility lines.

Any high plastic CH type CLAY encountered at the grade slab subgrade level should be undercut 2 feet and backfilled with compacted controlled fill. The final subgrade of the grade slab should be proofrolled to identify visible soft and unstable zones. Any soft unstable zones should be undercut and replaced with compacted controlled fill as required.

A minimum 4-inch thick No. 57 porous stone layer covered with a 6-mil thick impermeable membrane should be placed in all areas beneath the grade slab. The floor slab should be reinforced with a welded wire mesh. The porous stone with the impermeable membrane will serve as a working mat for the placement of slab and as a moisture barrier to reduce the possibility of dampness. A drainage system must be provided beneath the grade slabs of the houses with basements to prevent accumulation of moisture vapor and provide drainage beneath the slab.

2.6 Below Grade Walls

We recommend that the below grade basement walls be designed to withstand an equivalent lateral fluid pressure of 60 psf per foot of wall height. The earth pressure parameters assume a drained backfill with no hydrostatic pressure against the wall and a flat surface at the wall top. Adequate permanent back wall drainage should be provided behind all below grade walls to drain the backfill and minimize the potential for hydrostatic pressure against the wall.

A typical back wall drainage system is shown in Figure 3. The discharge from the back wall drainage system should be daylighted in a sump pit or at least 20 feet away from the exterior footing line with positive drainage away from the house. The sump pump discharge must also be daylighted at least 20 feet away from the exterior footing line of the house. Water that is discharged against or close to a foundation can result in softening of the soils supporting the foundations and possible settlement.

The wall backfill soils should have minimum 40% retained on No. 4 sieve with a maximum size of 4 inches and Liquid Limit **(LL)** and Plasticity Index **(PI)** less than 40 and 15 respectively. The onsite soils of SOIL 2 (ML) and SOIL3 (SM) are generally suitable for wall backfill according to the available limited laboratory test results. This must be confirmed by additional laboratory testing.

The backfill directly behind the walls should be compacted with light, hand held compactors. Heavy compactors and grading equipment should not be allowed to operate within 8 feet of the walls during backfilling to avoid developing excessive temporary or long term lateral soil pressures. The compaction should satisfy the requirements in Section 2.7.

2.7 Controlled Fill

All controlled fill should satisfy the requirements in Section 8.3 of our original report. Additional compaction requirements are provided below:

Structural Fill:
Compact each lift to at least 98% of the laboratory Maximum Dry Density **(MDD)** as determined by Standard Proctor Method ASTM D-698 or VTM-1 beneath all building areas.

Below Grade Wall Backfill:
95% of MDD by ASTM-698 or VTM-1

Landscaped Areas:
No requirement.

Storm water Management Pond Dam:
See Section 2.8.8.

2.8 STORM WATER MANAGEMENT POND

2.8.1 Pond Design Parameters

According to GeoEnv Engineers, the pond will be a dry pond with following design parameters. The pond details provided by GeoEnv Engineers are shown in Figure 2.

Pond type	-	Dry
Dam top elevation	-	481.05 ft.
Pond bottom elevation	-	476.10 ft.
100-year water surface elevation	-	479.05 ft.
Maximum U/S dam height	-	4.95 ft.
Maximum D/S dam height	-	5.05 ft.
Outlet pipe inlet elevation	-	476.00 ft.
Outlet pipe diameter	-	15" (dia)
Outlet pipe type	-	RCP

2.8.2 Site Preparation

The dam foundation area should be cleared, grubbed and stripped of all vegetation, topsoil, organic matter, excessively soft soil and other deleterious material to a minimum distance of 5 feet beyond the toe of the embankment slopes. The exposed dam foundation area should then be proofrolled.

Proofrolling should be performed with at least two passes of a loaded 10 wheel tandem axle truck or other similar approved construction equipment after a suitable period of dry weather. The proofrolling operation should be observed and documented as discussed in Section 2.1. Excessively soft, wet and organic soils or old fill material encountered during the proof rolling operation should be removed and replaced with approved compacted fill. The registered professional engineer/design professional overseeing the project should approve the excavation bottom before backfilling begins. Details of controlled fill placement are discussed in Section 2.8.8 of this report.

Up to 6 ft. of excavation is anticipated in the pond bed area. This excavation will unlikely require ripping, blasting and/or hoe ramming. However, deeper excavations may encounter hard decomposed rock requiring heavy excavators and/or ripping tools.

2.8.3 Embankment Design

An embankment with homogeneous fill consisting of lean CLAY (CL) and/or SILT (ML) is recommended considering the availability of those soils in the development area. The CL and ML type soils excavated from the pond bed area may be used if they satisfy the controlled fill requirements discussed in Section 2.8.8. The design upstream (U/S) and downstream (D/S) slopes of 1 on 3 for the dam are generally stable for the recommended fill soil types and the design dam heights.

The dam will likely be founded on the hard SILT stratum below the upper CLAY stratum. The bearing stratum of the dam foundation should be approved by the registered professional engineer/design professional before fill placement for the embankment. With hard SILT, the settlement of the dam bearing stratum will be negligible. However, normal settlement of the embankment fill, under its own weight is anticipated and should be accounted for in the design and construction.

2.8.4 Cut-off Trench and Toe-drain

Since the dam will likely be founded on relatively permeable SILT, an impervious cut-off trench is recommended along the dam center line to limit seepage below the dam foundation level. The trench should be excavated a minimum 4 ft. below the dam foundation level and at least 4 ft. wide at the base with side slopes 1(H):1(V). The trench should be backfilled with compacted clayey soils classified as SC, CH or CL with PI not less than 15 and passing #200 sieve not less than 30%.

Based on available soil boring information, these soil types may not exist at the site and may have to be imported. However, additional laboratory testing is recommended to check whether clayey soils excavated from the upper 6 ft. of the pond area satisfy these requirements. The registered professional engineer/design professional should approve the trench excavation before fill placement.

A toe drain is not recommended for the dam. However, if seepage is observed during routine maintenance of the dam, a toe drain should be provided to ensure dam safety after evaluating the condition of dam.

2.8.5 Erosion Protection

Considering an effective fetch of less than 500 feet, a riprap protection is not required on the upstream slope of the dams. However, minimum erosion protection measures such as vegetative cover should be provided on both upstream and downstream slopes of the dams.

2.8.6 Impervious Clay Liner for Pond Bed

Since the pond is designed as a dry pond and is not expected to hold water, a clay liner is not required on the pond bed.

2.8.7 Pipe Outlet Structures

Considering that the maximum hydraulic head is less than 3 ft. and the pond is designed as a dry pond with a short drawdown period for temporary storage, anti-seep collars are not required for the discharge pipe but may be provided as an additional seepage prevention measure. Also, since the discharge pipe will be placed on hard SILT stratum, we do not recommend concrete cradle/bedding for the outlet pipe. Gravel bedding is not permitted.

Watertight rubber gaskets should be provided at all joints along the pipe. The soil around the pipe should be compacted to 95% of Standard Proctor maximum dry density to a minimum distance of 12 inches from the exterior surfaces of the pipe. Hand-held compaction equipment will be required to achieve the required compaction. We recommend VDOT Class II rip-rap with woven geotextile fabric underlay equivalent to AMOCO 2016 along the pipe discharge channel.

The pond riser structures should be founded on the SILT stratum or on compacted controlled fill with a net bearing capacity of 2500 psf. Any high plastic CH type CLAY encountered at the foundation subgrade level should be undercut to the underlying SILT or decomposed rock stratum and backfilled with compacted controlled fill. Also, a minimum 6-inch thick "mud mat" consisting of lean concrete is recommended for the riser foundation.

2.8.8 Fill Placement

- The limits of clearing and stripping along the dam foundation and abutment areas should extend at least 5 feet beyond the toe of the embankment slopes.

- Prior to the placement of fill, the dam foundation area should be stripped of all vegetation, root mat, topsoil, loose fill and any other soft or deleterious material and undercut where required.

- Exposed foundation subgrade should be proofrolled using a loaded 10-wheel dump truck or similar construction equipment that will not cause disturbance or deterioration of the subgrade. Excessively soft, organic or excessively wet soils or old fill materials encountered during the proofrolling operation should be removed and replaced with approved compacted fill. The dam foundation should be inspected and approved by the registered professional engineer/design professional before fill placement.

- All foundations for outlet pipes and riser structures should be inspected and approved by the registered professional engineer for the project.

- At least two weeks before fill operations begin, representative samples of the proposed fill material should be collected and tested to determine the maximum dry density, optimum moisture content, natural moisture content, Atterberg limits and gradation of borrow soil.

- Fill material should be free of topsoil, organic and contaminated soil and rock fragments having the largest dimension greater than 4 inches. Material suitable for the body of the dam should include soils classified as CLAY (CL) and/or SILT (ML) considering availability of those types of soils at the site. The ML type soils should have PI not less than 10. CH and MH type materials are not recommended for dam construction. The materials excavated from the pond bed areas are suitable for dam construction provided that they satisfy above requirements. Additional, laboratory testing is recommended on onsite soils due to the observed low PI values of tested samples. Material suitable for the cut-off trench should satisfy the requirements discussed in Section 2.8.4.

- All fill placed for construction of the dam should be placed in loose 6 to 8 inch layers compacted to a density not less than 95% of the maximum dry density as determined by Standard Proctor compaction method (ASTM D698). The compacted soil moisture content should be within 2 percentage points of optimum as determined by the Standard Proctor compaction method.

2.8.9 Dam Maintenance

Our recommendations for the SWM pond in this report are valid subject to proper maintenance of the dam as outlined below.

A qualified registered professional engineer should visually inspect the dam at least once a year. The inspection should include the following important items with recommendations to remediate any observed adverse conditions.

- Seepage along the downstream toe area and on the downstream face. If seepage is apparent, drainage blankets and/or toe drains should be provided to ensure safety of the dam.

- Signs of possible slope failure.

- Excessive upstream slope erosion due to wave action.

- Any land subsidence on the dam surfaces.

- Excessive surface erosion along the spill tail and outlet pipe discharge channel.

- Any disturbance to dam material due to construction/excavation activities in the dam area.

- Animal burrow holes.

In order to keep the dam in good condition, the following routine maintenance work should be performed

- Trees should not be allowed to grow on the dam.
- No excavation/construction work, which disturbs the dam material, should be conducted without prior approval from a qualified registered professional engineer.
- No excavation/construction work should be conducted within 10 feet of the downstream toe of the dam.
- Any surface erosion along the exposed slopes of the dam should be backfilled immediately with compacted controlled fill and properly vegetated.
- Any loss of vegetation on the exposed dam slopes should be replaced immediately.
- Outlet pipe inlet and the discharge channels should be clear of obstructions at all times.

We appreciate the opportunity to provide services during the construction phase of the project, and look forward to our continued association with you.

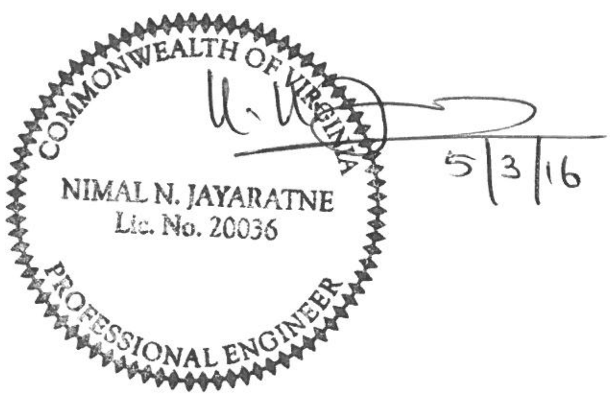
Please call us at (703) 771-8816 if you have any questions.

Sincerely,

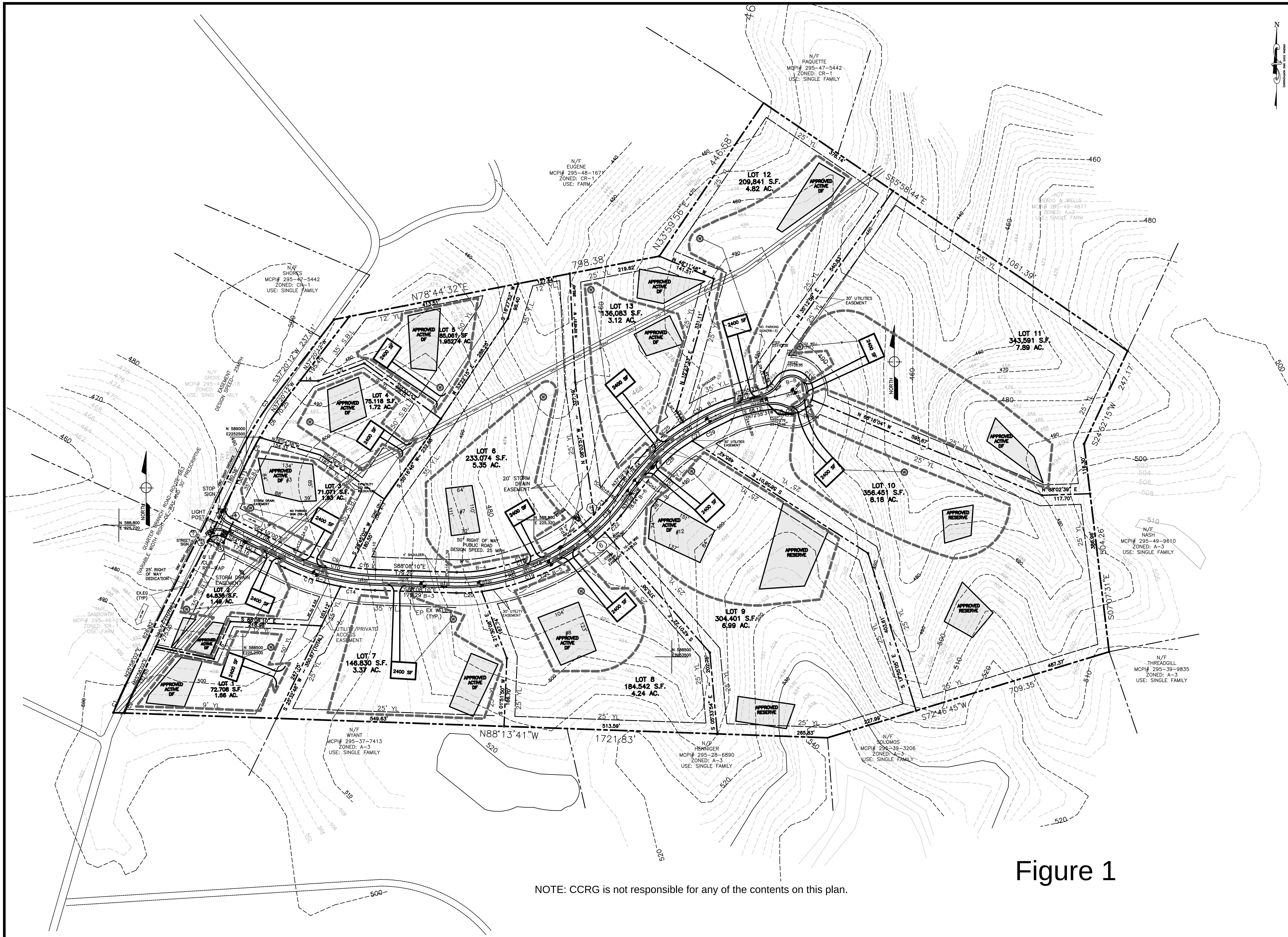
CLENDENIN ENVIRONMENTAL & GEOTECHNIC CONSULTANTS, INC.

Nimal N. Jayaratne, PE
Senior Project Engineer

Bruce E. Clendenin, CPG
President



Attachments: Figure 1 – Subdivision Plan
Figure 2 – SWM Pond Details
Figure 3 – Backwall Drainage



NOTE: CCRG is not responsible for any of the contents on this plan.

Figure 1

GeoEnv Engineers
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www.geoenvl.com

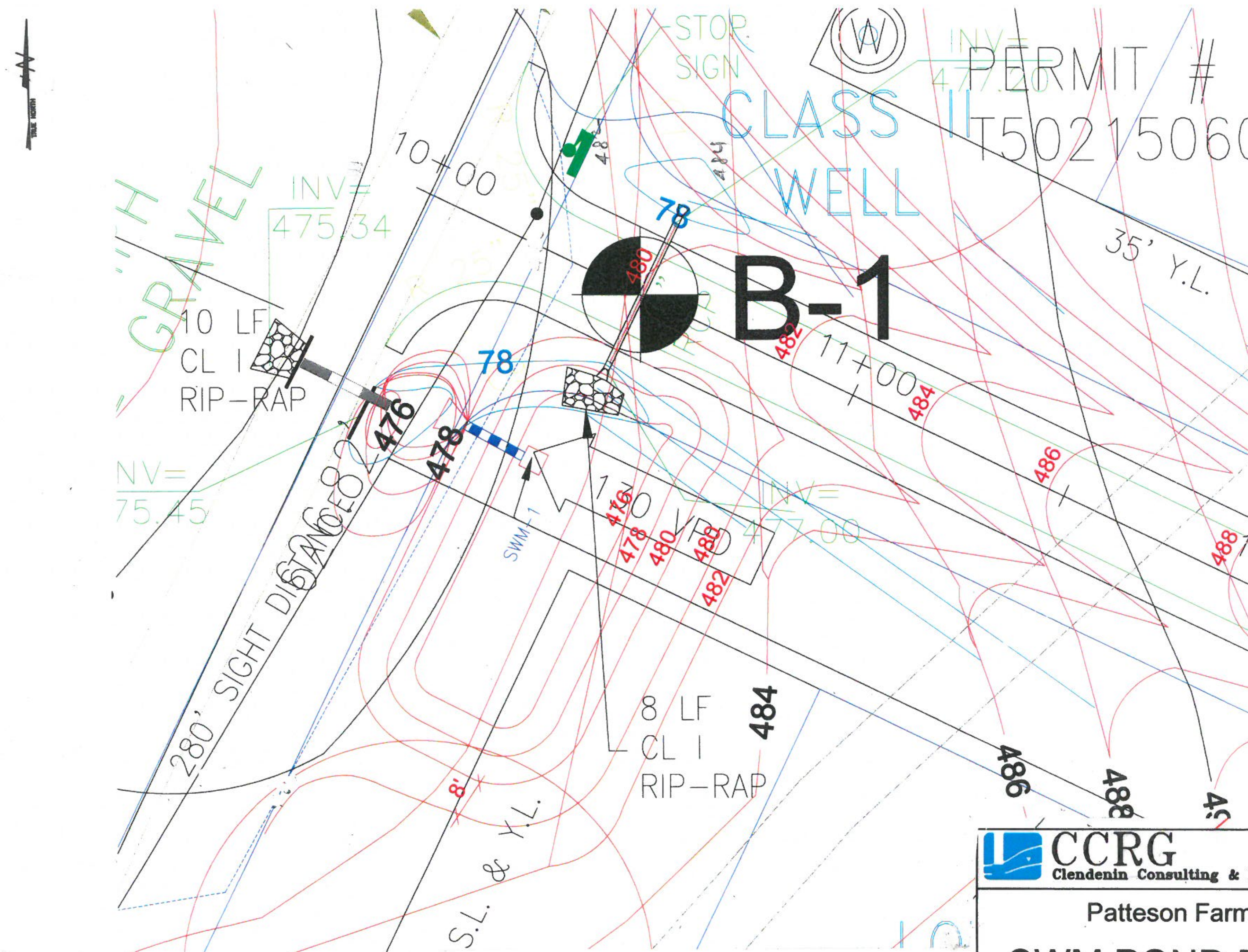
REVISION BLOCK

NO.	DESCRIPTION	DATE
	REVISION APPROVED BY OFFICE OF SITE DEVELOPMENT SERVICES	

PROFESSIONAL SEAL — DATE:

SUBDIVISION PLAN
PATTESON FARM
40396 QUARTER BRANCH ROAD
LOVESTSVILLE, VA 20180 COUNTY: LOUDOUN COUNTY, VIRGINIA

PIN#	
DATE:	FEB.2016
PREPARED BY:	R.I
CHECKED BY:	H.M.TEHRANI
PROJECT #	
SCALE: 1"=100'	
SHEET 3A OF 15	



Base plan electronically provided by GeoEnv Engineers on 3/30/16.

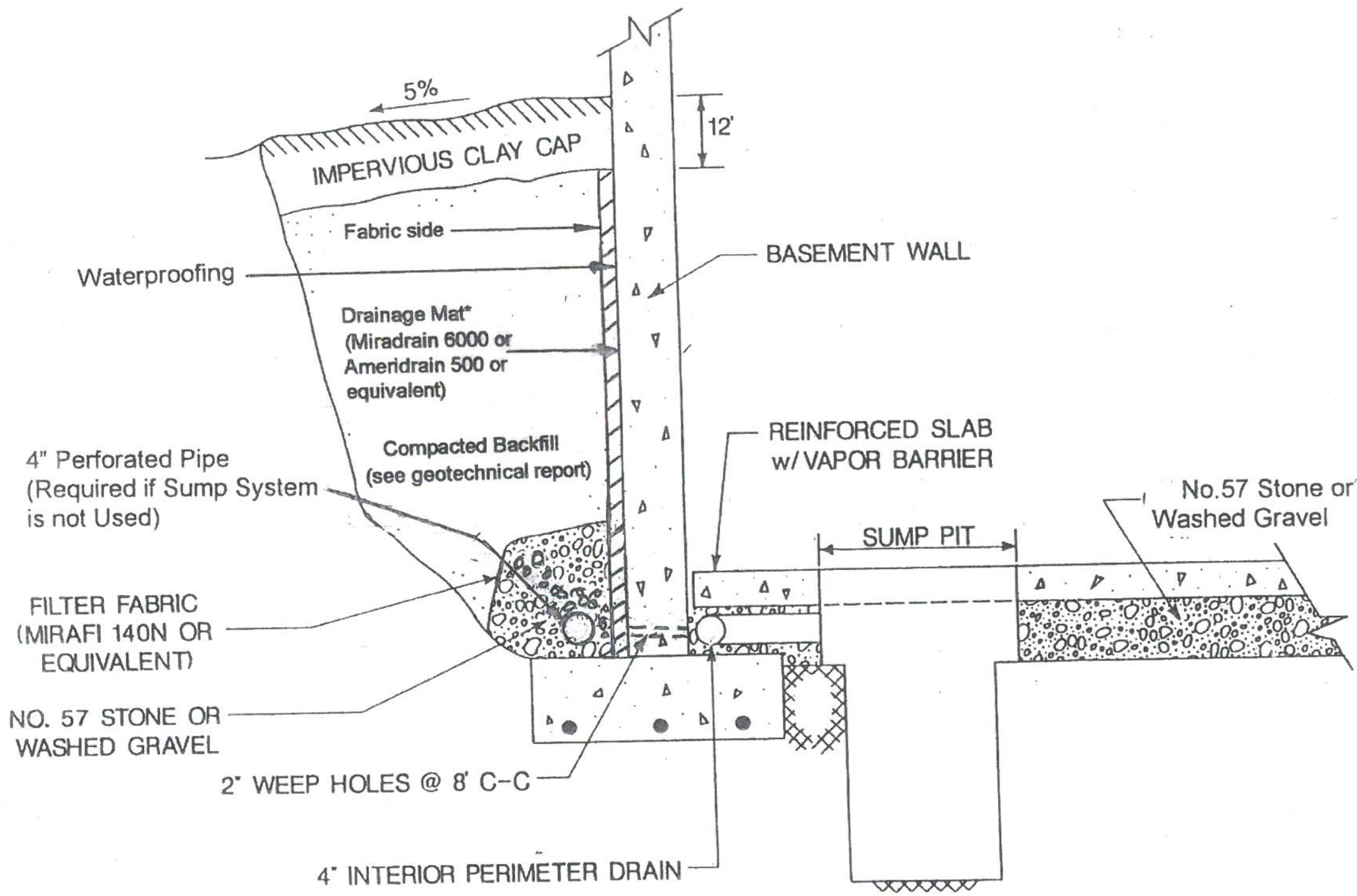
CCRG Clendenin Consulting & Remediation Group

Patteson Farm

SWM POND DETAIL

Lovettsville, VA

Date: 4/15/206	Scale: 1" = 30'
Drawn by: EMR	Approved by: NJJ
Project #: 16003	Figure: 2



*Alternatively, a 12-inch thick #57 stone drainage zone wrapped with filter fabric (Amoco 4551 or equivalent) may be provided.

CCRG
Clendenin Consulting & Remediation Group

Patteson Farm

Typical Backwall Drainage

Town of Herndon, VA

Date: April 6, 2016	Scale: not to scale
Drawn by: JWM	Approved by: NJ
Project #: 16002	Figure: 3