February 2, 2017
Revised June 28, 2017

EnSite USA, Inc.
109 Fieldview Drive
Versailles, KY, 40383
Attn: Jacob Shams, P.E.

Re: Revised Report for Karst Topography Review Services
6493 – Eastern Panhandle Expansion Project
Potomac River Crossing, Preliminary Investigation
Fulton County, Pennsylvania; Washington County, Maryland; and
Morgan County, West Virginia.
PSI Project Number 0512713-2

Dear Mr. Shams:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your consultant for the referenced project. Authorization to perform services was provided through PSI Proposal No. 0512-182348 dated June 13, 2016. The proposal was executed by Mr. Shams, P.E. representing EnSite USA, Inc.

This report was prepared to provide the public and Federal Energy Regulatory Commission (FERC) with information regarding the potential for Karst conditions along the Eastern Panhandle Expansion Project.

Project Description

PSI understands that the proposed project will consist of installation of natural gas transmission pipeline below portions of Fulton County, Pennsylvania; Washington County, Maryland; and Morgan County, West Virginia.

The Eastern Panhandle Expansion Project will consist of 3.37 miles of new greenfield 8-inch-diameter pipeline; three valves and two new tie-in assemblies. Two thirds of the pipeline will have ground cover of at-least 3 feet below the surface and about one third will be installed using Horizontal Directional Drilling (HDD) to lay the pipeline under the Potomac River and Interstate I-68.

EnSite USA is providing engineering services for Columbia Pipeline Partners for the proposed pipeline and requested that PSI perform an assessment of the potential for the presence of karstic limestone bedrock along the alignment.

Purpose and Scope Of Work

The purpose of this study was to obtain supplemental subsurface information in the area of the proposed natural gas transmission pipeline footprint in order to assess the potential for karst feature development. The following subsurface information was collected:

- Approximate bedrock depth and conditions at test borings performed along the proposed pipeline alignment
- Karst potential along the alignment based on a review of published geologic reports.

The following services were performed in order to achieve the objectives as outlined above:

- PSI reviewed readily available published topographic, geologic and soils information. This published information was obtained from the sources listed in the Bibliography, provided in the end of this report.

- PSI executed a limited subsurface exploration program consisting of drilling eight test borings, designated as PSI Borings GO-1, GO-2R, GO-3R, GO-4, GO-5, GO-6, GO-7 and GO-10 using a track mounted drill rig. The approximate locations of the test borings are shown on the Boring Location Plan in the Appendix B.

- Water level observations were made during the boring operations and are recorded on the boring logs in the Appendix C. Seasonal variations could influence the groundwater levels at the site; therefore, water levels could be different from those observed during the subsurface exploration.

- PSI prepared the geotechnical report, which summarizes the subsurface conditions encountered in the areas of potential Karst concern.

KARST TOPOGRAPHY

Karst is a special type of landscape that is formed by the dissolution of soluble carbonate rocks including limestone.

The development of karst occurs whenever acidic water starts to break down the surface of bedrock near its cracks, or bedding planes. Over geologic time, even very mildly acidic water can contribute to this weathering and dissolution of the bedrock. As the bedrock (typically limestone or dolostone) continues to degrade, its cracks tend to get bigger. As time goes on, these fractures will become wider, and eventually an internal drainage system of some sort may start to form underneath. If this underground drainage system does form, it will speed up the development of karst formations there because more water will be able to flow through the region.

The project site is located within a region which is prone to solution activity within the soluble carbonate bedrock. Karst is characterized by underground drainage systems with sinkholes and caves. Sinkhole development may result from raveling or movement of soil fines from the soil overburden by infiltrating water flowing downward to the poor-quality bedrock media where the rock mass has partially dissolved in the geologic past creating solution channels, clay-filled joints, and voids. Thus, a sinkhole may consist of a relatively localized weathered feature or a larger feature resulting from a collapse within a void formed in the overburden during migration of the soil fines. Solution activity could also be present along bedrock fracture zones or along geologic contacts. The mechanism of sinkhole development is illustrated schematically in Appendix D of this report. The following discussion outlines the findings of the study of the geology and subsurface exploration along the pipeline alignment as they relate to the potential for karst activity.

SITE AND SUBSURFACE CONDITIONS

SITE LOCATION AND DESCRIPTION

The project site is located in Fulton County, Pennsylvania; Washington County, Maryland; and Morgan County, West Virginia. The proposed Potomac river crossing has a steep eastern river bank and rolling hill terrain along the rest of the pipeline footprint. From the electronic plans provided, the elevations across the site range from about EL 402 to 691 feet.

SUBSURFACE CONDITIONS

LOCAL GEOLOGY

The Eastern Panhandle Expansion Project site is located in Ridge and Valley Province between South Mountain in Washington County and Dans Mountain in western Allegany County which contains strongly folded and faulted sedimentary rocks. The Potomac river flows in a valley called the Great Valley and is formed on Cambrian and Ordovician limestone and dolomite. Some of the valleys in this region are underlain by Silurian and Devonian limestones.

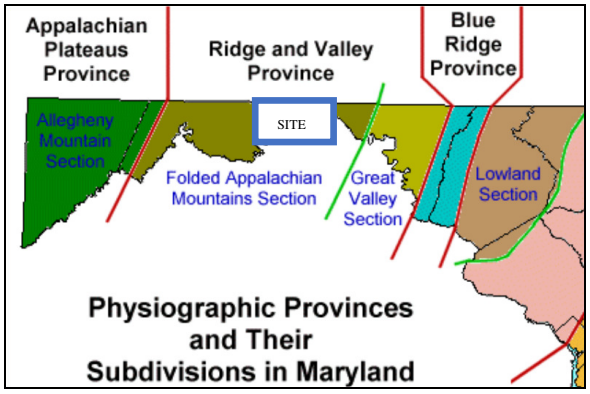

Figure 1. Physiographic Provinces and their Subdivisions in Maryland, Source: Maryland Geological Survey http://www.mgs.md.gov/geology/

A review of the Pennsylvania (PA), Maryland (MD) and West Virginia (WV) Geologic Maps, compiled by the United States Department of Interior Geologic Survey (USGS) indicates that the project site is underlain by the Marcellus Formation and Needmore Shale; Oriskany Sandstone and Helderberg Group; Wills Creek Shale and Bloomsburg Formation and Bloomsburg and Mifflintown Formations of the Ridge and Valley Physiographic Province of WV, MD and PA and are from the Silurian and Devonian Period.

Marcellus Formation and Needmore Shale, Devonian
Marcellus Formation (part of Millboro Shale) is predominantly gray-black to black thinly laminated non-calcareous pyritic shale. Contains one or more thin-bedded limestones, including the Purcell Member of Pennsylvania. *Needmore Shale* (part of Onesquethaw ("Onondaga") Group): predominantly dark grey or green, calcitic, mostly non-fissile shale. Gives strong "kick" on gamma ray logs. Tioga Bentonite near the top. Includes the black Beaver Dam Shale Member. Grades westward into the Huntersville Chert.

Oriskany Sandstone and Helderberg Group, Devonian
Oriskany Sandstone consists of White to brown coarse to fine grained, partly calcareous sandstone, locally pebbly or conglomeratic, and ridge-forming. May be white, nearly pure silica, and a source of glass sand, as at Berkeley Springs, Morgan County. *Helderburg Group* consists of mostly cherty limestone, with some sandstone and shale. Group contains several named stratigraphic units, including the Keyser Formation, which is partly Silurian and includes the Clifton Forge Sandstone and Big Mountain Shale Members.

Wills Creek Shale and Bloomsburg Formation, Silurian
Wills Creek Shale is olive to yellowish-gray, thin-bedded mudstone, calcareous shale, argillaceous limestone, and sandstone; thickness 450 feet in west, increases to 600 feet in east; *Bloomsburg Formation* is bright red, hematitic, thin to thick bedded sandstone and shale; some dark sandstone and green shale; *Cedar Creek Limestone Member* is dark gray, fine to medium grained argillaceous limestone, occurs in middle part of formation; total thickness 20 feet in west, increases to 200 feet in east.

Bloomsburg and Mifflintown Formations, Silurian
Bloomsburg and Mifflintown Formations - Includes, in descending order, the *Bloomsburg Formation* (Sb) and the *Mifflintown Formation* are interbedded dark-gray shale and medium-gray fossiliferous limestone;

Weathering in these formations is moderate to highly weathered to depths of 5 ft to 23 ft. Joints have a platy pattern, are steeply dipping, well developed, open and highly fractured. The interface between the bedrock and the soil mantle is pinnacled in most places. Some solution-channel openings as voids and caves can be expected in these formations and investigations for possible incipient sinkholes and sinkhole collapse areas are necessary.

Map showing the distribution of carbonate rocks in Pennsylvania. In Fulton County, folded carbonate rocks at the surface are shown along the eastern border of the county and at the center of the southern border. In the area of the proposed pipeline and tie-in facility we did not find mapped areas of karst activity nor did we observe exposed karst features at the surface.

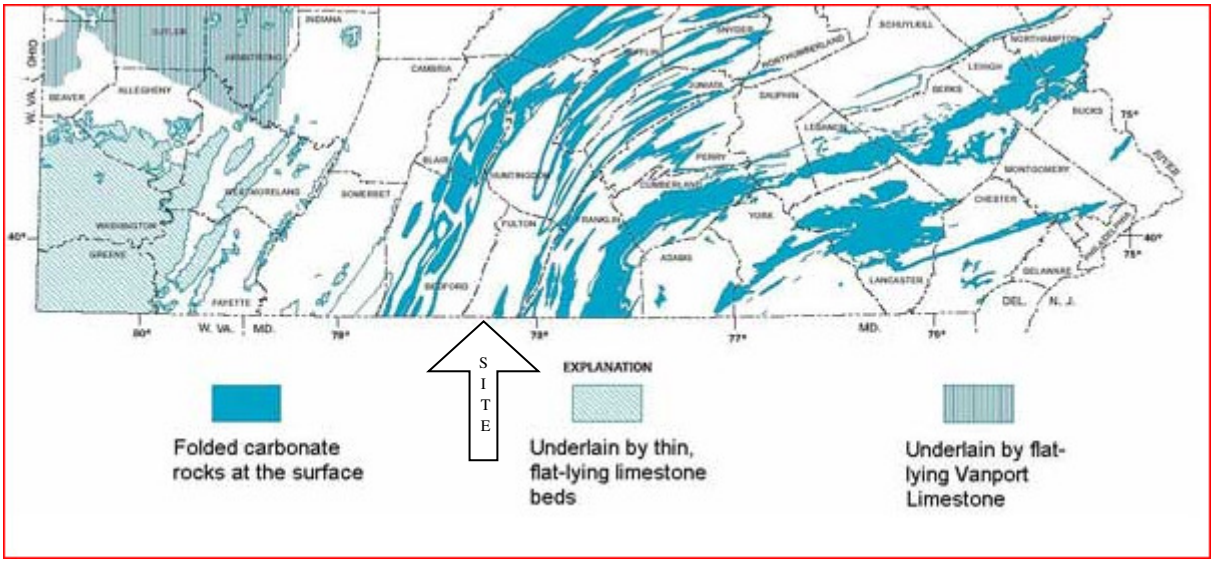

Figure 2. Pennsylvania Karst Map, Source: USGS, 2003 Pennsylvania Karst Map
https://pubs.usgs.gov/of/2003/of03-471/graphics/reese/fig1.jpg

Map showing the distribution of carbonate rocks in Maryland. Those most associated with collapse sinkholes are the Hagerstown Valley (HV), the Frederick Valley (FV), and the Wakefield Valley (WV). To a lesser degree, collapse sinkholes are found in Green Spring Valley (gs), Worthington Valley (wo), and Long Green Valley (lg). In the area of the proposed pipeline and in Washington County mapping does not indicate karst activity.

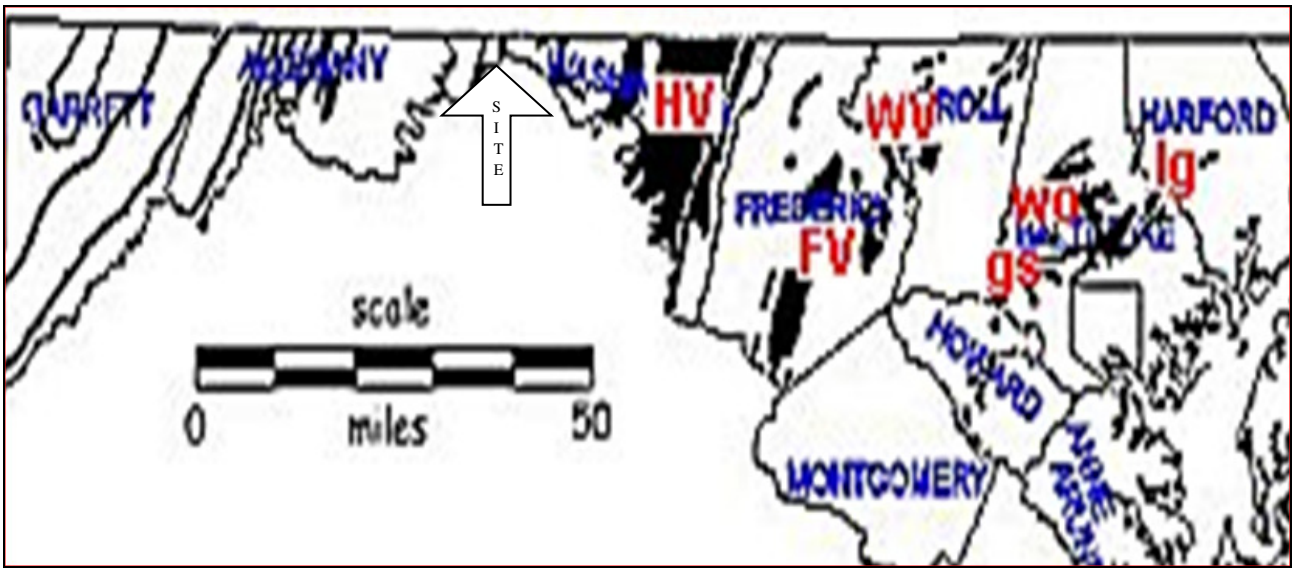

Figure 3. Maryland Sinkhole Map, Source: InspectAPedia®, Maryland Sinkhole Map
http://inspectapedia.com/vision/Maryland_Karst.jpg

Map showing the distribution of carbonate rocks in Morgan County, West Virginia. The most prevalent carbonate rock outcrops are shown along the eastern 1/3 of West Virginia. In Morgan County, karst areas are shown to the south of the project site. In the area of the proposed pipeline and Point-of-Delivery facility in Morgan County mapping does not indicate karst activity. The map shows the distribution of caverns (blue triangles) in Berkeley, Jefferson and Hampshire Counties.

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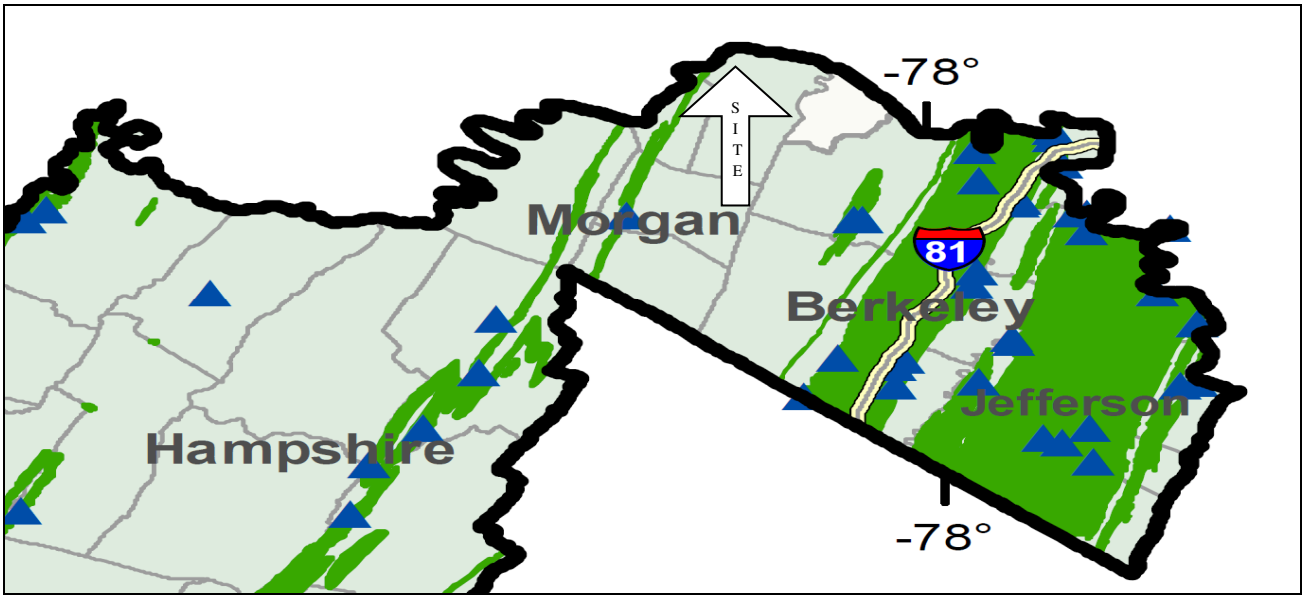

Figure 4. West Virginia Tax Districts with Karst Terrain, Source: Davies, William E., Caverns of West Virginia, (Volume 19A):
http://www.wvgs.wvnet.edu/wvges2/publications/PubCat_Details.aspx?PubCatID

Summary of Field Exploration and Laboratory Testing

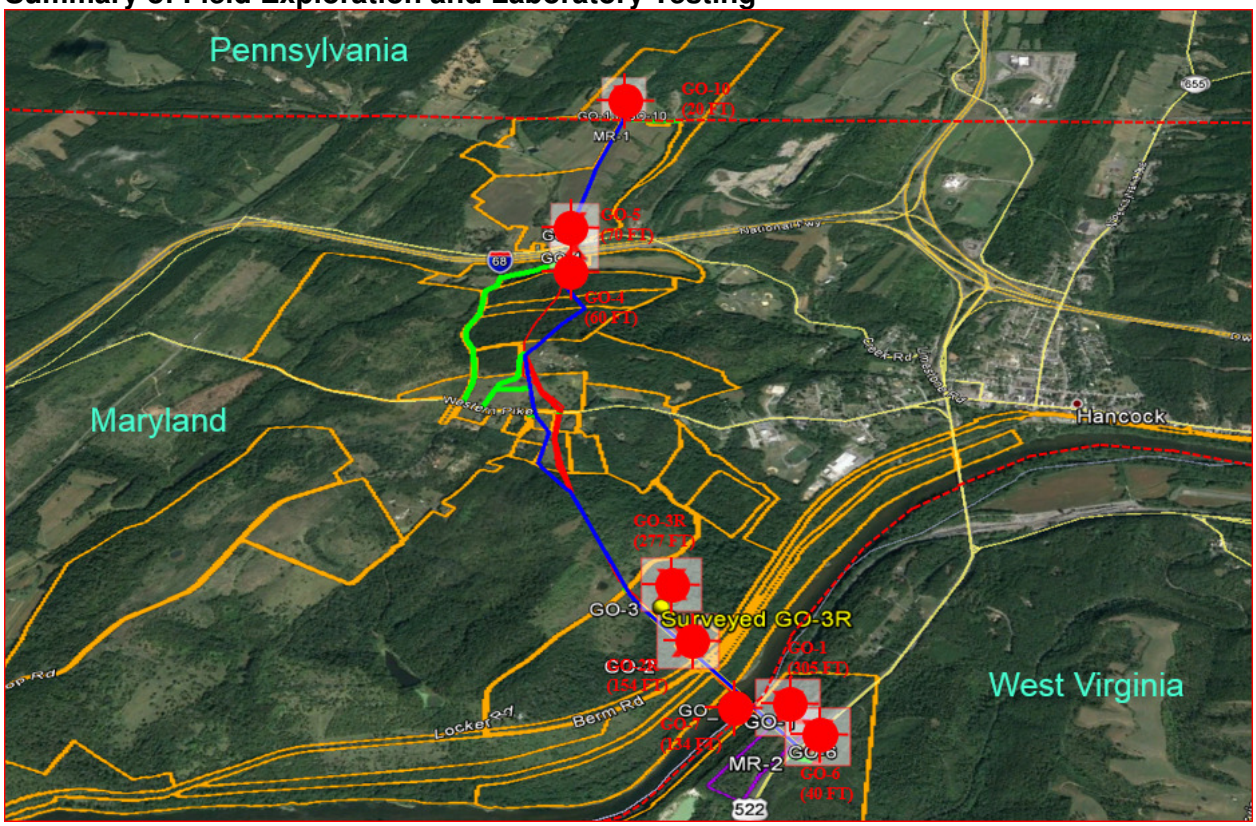

Figure 5. Boring Plan, Source: Google Earth 2016

Eight borings were completed with a track-mounted drill rig in conformance with ASTM standards. Hollow stem augers were used to advance the boreholes through the upper overburden soils. Four borings were completed for the Potomac River crossing (GO-1, GO-7, GO-2R and GO-3R), two borings for the Interstate I-68 crossing (GO-4 and GO-5), one for the proposed Tie-in-Facility (GO-10) and one for the proposed Point-of-Delivery Facility (GO-6). Standard Penetration Testing (SPT) and split-spoon sampling of overburden soils was performed at 2.5 foot intervals for the first 10 feet and at 5-foot intervals thereafter to the auger refusal depths to evaluate the strength and relative consistency of the soils encountered. Below auger refusal depth, rock coring was performed using NQ coring equipment. All recovered soil and rock samples were visually classified by a PSI geotechnical engineer and a graphical log developed for each boring.

The boring logs included in the Appendix indicate depths and visual descriptions of overburden soil, underlying rock materials encountered, soil SPT test results, rock core recovery and quality designation values, and groundwater depth, where encountered. The total length of recovered rock core, divided by the length of the run, is referred to as rock core recovery and is expressed as a percentage. The Rock Quality Designation (RQD) is a measure of the rock mass quality and is defined as the total length of sound, intact rock core pieces 4 inches or more in length divided by the length of the rock core run, also expressed as a percentage. The rock core recovery and RQD values are indicated on the boring logs included with this report.

The borings generally encountered five to twenty-three feet of overburden soil materials over the weathered rock and sound rock. The overburden deposits thicken toward the Potomac

river. Boring depths and bedrock depth at which auger refusal was encountered are summarized in Table 1 below.

Table 1 – Summary of Boring Depths

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of Top of Weathered Rock	Approximate Depth/Elevation of Auger Refusal
GO-1	305	624	23 feet, EL ±601MSL	24 feet, EL ±600MSL
GO-2R	154	411	20 feet, EL ±391MSL	24 feet, EL ±387MSL
GO-3R	277	591	9 feet, EL ±582MSL	23 feet, EL ±568MSL
GO-4	60	435	6.5 feet, EL ±428.5 MSL	10 feet, EL ±425 MSL
GO-5	70	447	8.5 feet, EL ±438.5 MSL	13.5 feet, EL ±433.5 MSL
GO-6	40	590	19 feet, EL ±571MSL	30 feet, EL ±560MSL
GO-7	100	402	6 feet, EL ±396	6 feet, EL ±396MSL
GO-10	20	581	5 feet, EL ±576MSL	20 feet, EL ±561MSL

Weathered rock (WR) was encountered in all borings and is sufficiently dense or hard to result in SPT N-values of at least 100 bpf. Boring B-10 was terminated in weathered rock. Auger refusal **was** encountered in all test borings.

Rock discontinuities as voids as well as clay and sand seams which were encountered are summarized in Table 2 below.

Table 2 – Summary of Borings with Voids, Sand and Clay Seams

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of recorded VOIDS Depth/Elevation (Feet)	Approximate Depth/Elevation of recorded Sand Seams Depth/Elevation (Feet)	Material Washed Away During Coring Depth/Elevation (Feet)
GO-1	305	624	N/A	10-foot sand seam from 264feet, EL ±360MSL to 274feet, EL ±350MSL	N/A
GO-2R	154	411	1-inch void at 51.3 feet, EL ±359.7MSL 1-inch void at 53.1 feet, EL ±357.9MSL 7-inch void at 53.4 feet, EL ±357.6MSL	29-inch sand seam from 131.6 feet, EL ±279.4MSL to 134feet, EL ±277MSL 8-inch sand seam at 136 feet, EL ±275MSL 6-inch sand seam at 138.5 feet, EL ±272.5MSL	N/A
GO-3R	277	591	N/A	N/A	N/A
GO-4	60	435	N/A	N/A	N/A
GO-5	70	447	N/A	N/A	N/A
GO-6	40	590	N/A	N/A	N/A
GO-7	100	402	9-inch void at 58.2 feet, EL ±343.8MSL	N/A	17-inch clay seam from 72.6 feet, EL±329.4MSL to 74feet, EL ±328MSL 18-inch clay seam from 107feet, EL ±295MSL to 108.5feet, EL ±293.5MSL
GO-10	20	581	N/A	N/A	N/A

Groundwater Conditions

Groundwater was encountered only in one of eight borings while drilling operations were performed, at GO-6 at depth of approximately 29.5 feet below ground surface. The mud rotary and rock coring drilling processes introduced water into the boreholes, so the levels measured after drilling did not reflect the level of the saturated zone at the site. Borings were backfilled on completion for safety reasons; therefore, 24-hour water levels were not measured.

The rock coring process includes circulating water through the drilling rods to lubricate the core bit and to wash the cuttings up to the surface where the circulating water enters a small tank and the cuttings are allowed to settle out. The drilling crew did not observe excess return water that could indicate the presence of a confined aquifer containing groundwater under positive pressure, a so-called flowing artesian condition.

Conclusions

The results of the geologic literature review indicate that the rock formations along the project alignment are not mapped as having karst features. The borings did not encounter a soft soil, indicative of an active weathering zone just above the bedrock, which is a characteristic of sites with active karst feature development. In addition, the limestone encountered in the rock cores was interbedded with shale. Karst features are more likely to develop in massive limestone deposits than in more thinly bedded limestone that is interbedded with shale. Although some voids were observed in the rock cores, they were typically small and well above the expected depth of the pipeline.

Should there be any questions, please do not hesitate to contact our office at (703) 698-9300. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you on this and future projects.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

Lubomir D. Peytchev, P.E.
Senior Geotechnical Engineer

Karl Suter, P.E.
Chief Engineer/Principal Consultant

Appendix:

Appendix A: Important Information About Your Geotechnical Report
Appendix B: Figure 1A: Site Vicinity Map and Figure 1B: Boring Location Plan
Appendix C: Boring Logs and Profiles
Appendix D: The mechanism of sinkhole development

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APPENDIX A: IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

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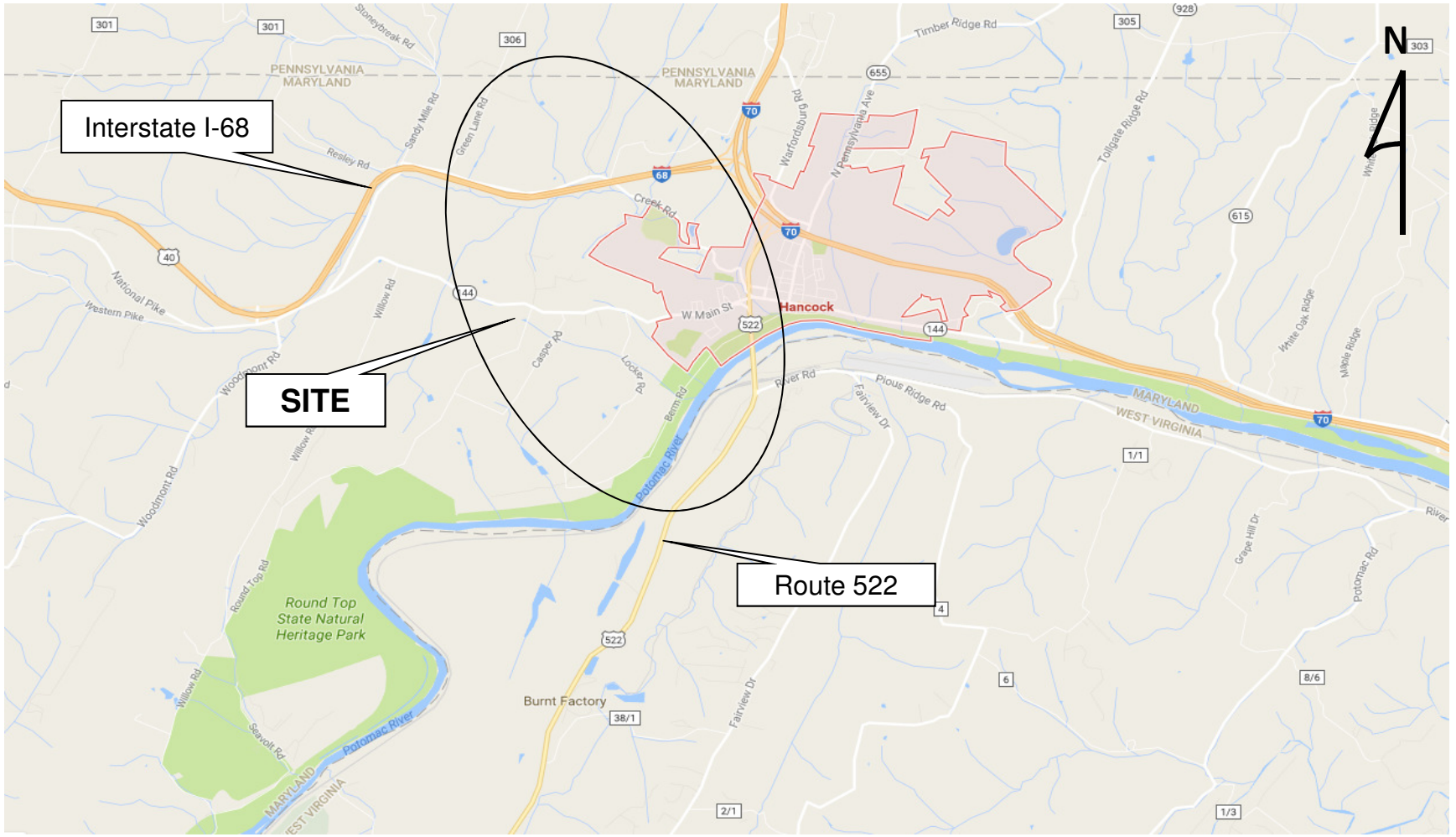
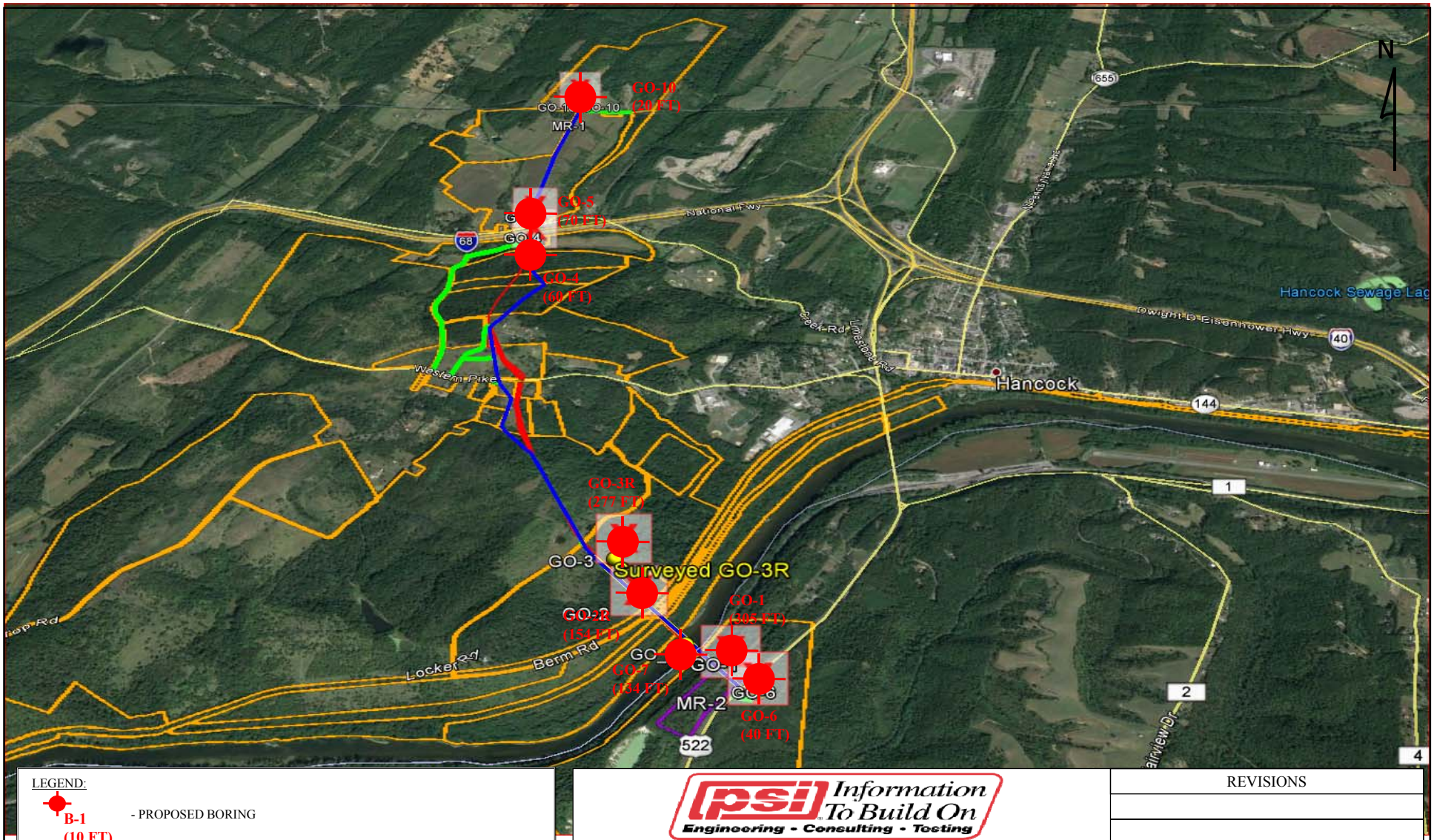
APPENDIX B – VICINITY MAP AND BORING LOCATION PLAN

Map Source: Google



		REVISIONS
psi Information To Build On — Engineering • Consulting • Testing		
Site Vicinity Map (Figure 1A) **6493- Eastern Panhandle Expansion Potomac River Crossing**		
Morgan County, WV		January 11, 2017
L.D.P.	Not Drawn To Scale	0512713-2



LEGEND:

B-1 (10 FT) - PROPOSED BORING - BORING DEPTH

NOTES:
1. ALL BORINGS WERE ADVANCED WITH HOLLOW-STEM AUGERS.
2. SPT SAMPLING WAS PERFORMED IN ALL BORINGS.
3. BORING DEPTHS ARE AS SHOWN
4. BORING SPOILS WERE USED TO BACKFILL THE BORE HOLES.

psi Information To Build On
Engineering - Consulting - Testing

REVISIONS

BORING LOCATION PLAN (FIGURE 1B)
6493- EASTERN PANHANDLE EXPANSION POTOMAC RIVER CROSSING

FULTON COUNTY, PA; WASHINGTON COUNTY, MD; AND MORGAN COUNTY, WV;		January 27, 2017
L.D.P.	N.T.S.	0512713-2

APPENDIX C: BORING LOGS

BORING GO-1

DATE STARTED:	6/29/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/7/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	311.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	624 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.6803639°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.1952222°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0	1	18	Approximately 3 inches of Topsoil	Top Soil	1-6-5 N=11	14	LL = 55 PL = 27 Fines=97.4%
		2	18	Soft to stiff, moist, light brown, **FAT CLAY (USCS CH)** some gravel, roots. **Alluvium**	CH	2-6-8 N=14	21	
620	5	3	18	Stiff to very stiff, moist, brown, red, trace gray, **SILT (USCS ML)** some gravel. **Residuum**	ML	6-8-10 N=18	23	
615	10	4	16	Stiff to very stiff, moist, dark brown, brown, **SILT (USCS ML)** some gravel, trace shale fragments **Residuum**	ML	2-5-6 N=11	25	LL = 39 PL = 27 Fines=99.8%
			24				26	LL = 45 PL = 29 Fines=99.6%
610	15	5	18			7-14-16 N=30	21	
			24	Medium stiff to stiff, very moist, dark brown, olive brown, black **lean CLAY (USCS CL)** some gravel, shale fragments, wood chips. **Residuum**			21	LL = 44 PL = 26 Fines=90.0%
605	20	6	12		CL	1-4-2 N=6	25	
600	25	7	0	Weathered Rock, gray, dark gray, soft SHALE and hard LIMESTONE	WEATHERED SHALE	50/0"		
		8	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 25 to 45 degrees, (RQD from 45% to 100 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=89 Rec=100%		
595	30	9	60			RQD=90 Rec=100%		
590	35	10	60			RQD=100 Rec=100%		
585	40	11	60		Shale and Limestone	RQD=78 Rec=100%		
580	45	12	60			RQD=88 Rec=100%		
575	50	13	60			RQD=90 Rec=100%		
570	55	14	52			RQD=45 Rec=87%		
565	60							

Continued Next Page

Professional Service Industries, Inc.
2930 Eskridge Rd
Fairfax, VA 22031
Telephone: (703) 698-9300

PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	6/29/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/7/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	311.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	624 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.6803639°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.1952222°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-1

Water			
	While Drilling	Dry	feet
	Upon Completion	Dry	feet
	Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	60										
560	65			15	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 25 to 45 degrees, (RQD from 45% to 100 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=83 Rec=100%			
				16	60			RQD=95 Rec=100%			
555	70						Shale and Limestone				
				17	60			RQD=92 Rec=100%			
550	75										
				18	60			RQD=97 Rec=100%			
545	80					Slightly weathered, medium bedded to thin bedded, black, dark gray, trace white , fine grained to medium grained, soft SHALE, trace coal seams, dip of 20 to 60 degrees, (RQD from 47% to 95 %), Devonian [Marcellus Formation and Needmore Shale]					
				19	60			RQD=94 Rec=100%			
540	85										
				20	60			RQD=95 Rec=100%			
535	90										
				21	60			RQD=95 Rec=100%			
530	95										
				22	60			RQD=88 Rec=100%			
525	100						Shale				
				23	60			RQD=67 Rec=100%			
520	105										
				24	60			RQD=50 Rec=100%			
515	110										
				25	60			RQD=47 Rec=100%			
510	115										
				26	60			RQD=64 Rec=100%			
505	120										

Continued Next Page

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PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	6/29/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/7/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	311.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	624 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.6803639°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.1952222°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-1

Water			
	While Drilling	Dry	feet
	Upon Completion	Dry	feet
	Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	120										
500	125			27	60	Slightly weathered, medium bedded to thin bedded, black, dark gray, trace white , fine grained to medium grained, soft SHALE, trace coal seams, dip of 20 to 60 degrees, (RQD from 47% to 95 %), Devonian [Marcellus Formation and Needmore Shale]	Shale	RQD=53 Rec=100%			
				28	60			RQD=59 Rec=100%			
495	130			29	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 25 to 50 degrees, (RQD from 55% to 100 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=100 Rec=100%			
490	135			30	60			RQD=96 Rec=100%			
485	140			31	60			RQD=93 Rec=100%			
480	145			32	58			RQD=95 Rec=97%			
475	150			33	60			RQD=98 Rec=100%			
470	155			34	60		Shale and Limestone	RQD=91 Rec=100%			
465	160			35	59			RQD=96 Rec=98%			
460	165			36	60			RQD=100 Rec=100%			
455	170			37	60			RQD=73 Rec=100%			
450	175			38	54			RQD=75 Rec=90%			
445	180										

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PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	6/29/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/7/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	311.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	624 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.6803639°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.1952222°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-1

Water			
	While Drilling	Dry	feet
	Upon Completion	Dry	feet
	Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
440	180			39	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 25 to 50 degrees, (RQD from 55% to 100 %), Devonian [Marcellus Formation and Needmore Shale]	Shale and Limestone	RQD=75 Rec=100%			
	185			40	60			RQD=83 Rec=100%			
435	190			41	60			RQD=55 Rec=100%			
430	195			42	60			RQD=63 Rec=100%			
425	200			43	60	Interbedded, slightly weathered, medium bedded to thin bedded, red, fine grained, soft SHALE and hard LIMESTONE, dip of 25 to 45 degrees, (RQD from 88% to 93 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=88 Rec=100%			
420	205			44	60			RQD=88 Rec=100%			
415	210			45	60		Shale and Limestone	RQD=93 Rec=100%			
410	215			46	60			RQD=88 Rec=100%			
405	220			47	60			RQD=93 Rec=100%			
400	225			48	56	Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, trace red, yellow, fine grained to medium grained, soft SANDSTONE and soft SHALE, dip of 10 to 25 degrees, (RQD from 46% to 75 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=51 Rec=93%			
395	230			49	60		SANDSTONE	RQD=70 Rec=100%			
390	235			50	60			RQD=65 Rec=100%			
385	240										

Continued Next Page

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Telephone: (703) 698-9300

PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

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BORING GO-1

DATE STARTED:	6/29/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/7/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	311.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	624 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.6803639°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.1952222°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	240			51	60	Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, trace red, yellow, fine grained to medium grained, soft SANDSTONE and soft SHALE, dip of 10 to 25 degrees, (RQD from 46% to 75 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=75 Rec=100%			
380	245			52	58			RQD=68 Rec=97%			
375	250			53	57		SANDSTONE	RQD=85 Rec=95%			
370	255			54	57			RQD=83 Rec=95%			
365	260			55	60			RQD=46 Rec=100%			
360	265			56	26	Loose wet brown poorly-graded **SAND (USCS SP)** trace limestone floaters, Devonian [Marcellus Formation and Needmore Shale]	SP	RQD=0 Rec=43%			
355	270			57	8			RQD=0 Rec=13%			
350	275			58	52	Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained to medium grained, medium hard SANDSTONE and sand seams, dip of 10 to 35 degrees, (RQD from 13% to 30 %), Devonian [Marcellus Formation and Needmore Shale]		RQD=13 Rec=87%			
345	280			59	52		SANDSTONE	RQD=30 Rec=87%			
340	285			60	49			RQD=25 Rec=82%			
335	290			61	60	Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained, medium hard LIMESTONE - CHERTY and sand seams, dip of 45 degrees, (RQD from 58% to 100 %), Devonian [Marcellus Formation and Needmore Shale]	LIMESTONE - CHERTY	RQD=58 Rec=100%			
330	295			62	60			RQD=62 Rec=100%			
325	300										

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PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

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BORING GO-1

DATE STARTED:	6/29/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/7/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	311.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	624 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.6803639°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.1952222°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	300										
				63	60		LIMESTONE - CHERTY	RQD=78 Rec=100%			
320				64	12			RQD=100 Rec=100%			
	305					Bottom of test boring at 305 feet					
315											
	310										

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PROJECT NO.: 0512719-1
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LOCATION: Washington County, Hancock, MD

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BORING GO-2R

DATE STARTED:	7/7/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/11/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	154.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	411 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.683456°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.19904°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
410	0	1	16	Approximately 3 inches of Topsoil	Top Soil	2-2-3 N=5	21	LL = 38 PL = 22 Fines=75.1%
		1	24	Medium stiff, moist, brown, dark brown, **lean CLAY (USCS CL)** some gravel, roots. **Alluvium**	CL		19	
		2	18			3-3-4 N=7	30	LL = 63 PL = 25
405	5	3	18	Medium stiff to stiff, moist, mottled brown **FAT CLAY (USCS CH)** some sand. **Alluvium**	CH	3-4-6 N=10	27	LL = 59 PL = 23 Fines=89.3%
		4	24	Stiff, moist, mottled brown, **lean CLAY (USCS CL)** trace sand. **Alluvium**		2-3-8 N=11	20	LL = 33
400	10		18		CL		18	PL = 18 Fines=90.8%
		5	14	Medium stiff, moist, mottled brown **sandy lean CLAY (USCS CL)** trace gravel. **Alluvium**	CL	2-2-3 N=5	17	Fines=55.8%
395	15							
		6	12	Stiff, moist, mottled brown, **lean CLAY (USCS CL)** trace shale fragments, sand, gravel. **Residuum**	CL	18-11-7 N=18	14	
390	20			Weathered Rock, gray, dark gray, soft SHALE and hard LIMESTONE, Silurian [Wills Creek Shale and Bloomsburg Formation]	WEATHERED SHALE			
		7	2	Interbedded, slightly weathered, medium bedded to thin bedded, gray, light gray, trace brown, fine grained to medium grained, medium hard SHALE and hard LIMESTONE, dip from 30 to 40 degrees, (RQD from 35 to 95 %) Silurian [Wills Creek Shale and Bloomsburg Formation]		4-48-50/2"		
385	25	8	54			RQD=35 Rec=90%		
380	30	9	60			RQD=40 Rec=100%		
375	35	10	60		Shale and Limestone	RQD=95 Rec=100%		
370	40	11	60			RQD=52 Rec=100%		
365	45	12	60			RQD=82 Rec=100%		
360	50	13	53		Shale and Limestone	RQD=70 Rec=88%		
355	55	14	57			RQD=93 Rec=95%		
	60							

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PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

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DATE STARTED:	7/7/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	7/11/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	154.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	411 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.683456°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.19904°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-2R

Water		
While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
350	60			15	60	Interbedded, slightly weathered, medium bedded to thin bedded, brown and gray, fine grained to medium grained, medium hard SHALE and hard LIMESTONE, dip from 30 to 40 degrees, (RQD from 42 to 93 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=78 Rec=100%			
345	65			16	57			RQD=52 Rec=95%			
340	70			17	60	Void from 51.3' to 51.4' Void from 53.1' to 53.2'		RQD=42 Rec=100%			
335	75			18	60	Void from 53.4' to 54' Interbedded, slightly weathered, medium bedded to thin bedded, gray, trace brown, fine grained to medium grained, medium hard SHALE and hard LIMESTONE, dip from 30 to 45 degrees, (RQD from 66 to 98 %) Silurian [Wills Creek Shale and Bloomsburg Formation]		RQD=98 Rec=100%			
330	80			19	60			RQD=72 Rec=100%			
325	85			20	60		Shale and Limestone	RQD=85 Rec=100%			
320	90			21	59			RQD=83 Rec=98%			
315	95			22	57			RQD=70 Rec=95%			
310	100			23	60			RQD=66 Rec=100%			
305	105			24	51	Interbedded, slightly weathered, medium bedded to thin bedded, gray, trace yellow and brown, fine grained to medium grained, medium hard SHALE and hard LIMESTONE, dip from 30 to 45 degrees, (RQD from 17 to 95 %) Silurian [Wills Creek Shale and Bloomsburg Formation]		RQD=62 Rec=85%			
300	110			25	49		Shale and Limestone	RQD=18 Rec=82%			
295	115			26	60	Sand seam from 131.6' to 134' Sand seam from 136' to 136.7' Sand seam from 138.5' to 139'		RQD=73 Rec=100%			
	120					*Continued Next Page*					

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PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

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DATE COMPLETED:	7/11/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	154.0 ft	**DRILL RIG:**	CME 55 LC
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	411 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.683456°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.19904°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-2R

Water		
While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
290	120			27	56	Interbedded, slightly weathered, medium bedded to thin bedded, gray, trace yellow and brown, fine grained to medium grained, medium hard SHALE and hard LIMESTONE, dip from 30 to 45 degrees, (RQD from 17 to 95 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=85 Rec=93%			
285	125			28	60			RQD=95 Rec=100%			
280	130			29	33	Sand seam from 131.6' to 134' Sand seam from 136' to 136.7'		RQD=23 Rec=55%			
275	135			30	52	Sand seam from 138.5' to 139'		RQD=58 Rec=87%			
270	140			31	60			RQD=60 Rec=100%			
265	145			32	52			RQD=17 Rec=87%			
260	150			33	60			RQD=75 Rec=100%			
						Bottom of test boring at 154 feet.					

Professional Service Industries, Inc.
2930 Eskridge Rd
Fairfax, VA 22031
Telephone: (703) 698-9300

PROJECT NO.: 0512719-1
PROJECT: Eastern Panhandle Expansion
LOCATION: Washington County, Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-3R

DATE STARTED:	12/15/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/21/16	**DRILLER:** Kevin Kersh	**LOGGED BY:** Gunner Ingram
COMPLETION DEPTH	277.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	591 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.686351°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.20148°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture PL LL (0 25 50) STRENGTH, tsf Qu Qp (0 2.0 4.0)	Additional Remarks
590	0			1	8	Approximately 3 inches of Topsoil	Top Soil	2-3-5 N=8	10		
				2	9	Medium stiff, moist, red, **lean CLAY (USCS CL)** some gravel, roots.	CL	8-14-18 N=32	7 6		LL = 26 PL = 17 Fines=21.3%
585	5			3	9	Dense to very dense, moist, red **silty GRAVEL (USCS GM)** some sand. **Residuum**	GM	14-50/0"	6 4 9	>>	Fines=27.3%
580	10			4	10	Weathered Rock, SHALE and LIMESTONE, sampled as very hard, moist, red **silty GRAVEL (USCS GM) with sand**		23-50/4"		>>	
575	15			5	5		GM	50/5"		>>	
	20			6	2			50/2"		>>	
570				7	22	Interbedded, slightly weathered, medium bedded to thin bedded, red, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 70 degrees, (RQD from 20 to 76 %), Silurian [Wills Creek Shale and Bloomsburg Formation]		RQD=29 Rec=92%			
565	25			8	33			RQD=25 Rec=55%			
560	30			9	58			RQD=53 Rec=97%			
555	35			10	60			RQD=60 Rec=100%			
550	40			11	60		Shale and Limestone	RQD=75 Rec=100%			
545	45			12	60			RQD=76 Rec=100%			
540	50			13	57			RQD=58 Rec=95%			
535	55			14	60			RQD=65 Rec=100%			
	60			15	48			RQD=20			

Continued Next Page

Professional Service Industries, Inc.
2930 Eskridge Rd
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Telephone: (703) 698-9300

PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	12/15/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/21/16	**DRILLER:** Kevin Kersh	**LOGGED BY:** Gunner Ingram
COMPLETION DEPTH	277.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	591 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.686351°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.20148°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-3R

Water			
	While Drilling	Dry	feet
	Upon Completion	Dry	feet
	Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
530	60							Rec=80%			
				16	34	Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 40 to 50 degrees, (RQD from 7 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]		RQD=7 Rec=57%			
525	65										
				17	60			RQD=70 Rec=100%			
520	70										
				18	55			RQD=77 Rec=92%			
515	75										
				19	60			RQD=77 Rec=100%			
510	80										
				20	60		Shale and Limestone	RQD=73 Rec=100%			
505	85										
				21	60			RQD=83 Rec=100%			
500	90										
				22	60			RQD=93 Rec=100%			
495	95										
				23	60			RQD=100 Rec=100%			
490	100										
				24	60			RQD=77 Rec=100%			
485	105										
				25	51	Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 60 degrees, (RQD from 7 to 75 %), Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=40 Rec=85%			
480	110										
				26	60			RQD=70 Rec=100%			
475	115										
				27	32			RQD=37			
	120					*Continued Next Page*					

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PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	12/15/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/21/16	**DRILLER:** Kevin Kersh	**LOGGED BY:** Gunner Ingram
COMPLETION DEPTH	277.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	591 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.686351°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.20148°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev
REMARKS:			

BORING GO-3R

Water		
While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
470	120										
				28	43	Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 60 degrees, (RQD from 7 to 75 %), Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	Rec=53% RQD=27 Rec=72%			
465	125										
				29	60			RQD=75 Rec=100%			
460	130										
				30	36			RQD=7 Rec=60%			
455	135										
				31	57	Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 60 degrees, (RQD from 67 to 97 %), Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=67 Rec=95%			
450	140										
				32	60			RQD=97 Rec=100%			
445	145										
				33	60			RQD=95 Rec=100%			
440	150										
				34	60	Interbedded, slightly weathered, medium bedded to thin bedded, green, red, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=100 Rec=100%			
435	155										
				35	60			RQD=97 Rec=100%			
430	160										
				36	57	Interbedded, slightly weathered, medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=92 Rec=95%			
425	165										
				37	60			RQD=75 Rec=100%			
420	170										
				38	60			RQD=77 Rec=100%			
415	175										
				39	60			RQD=83			
	180					*Continued Next Page*					

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PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	12/15/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/21/16	**DRILLER:** Kevin Kersh	**LOGGED BY:** Gunner Ingram
COMPLETION DEPTH	277.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	591 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.686351°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.20148°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-3R

Water			
	While Drilling	Dry	feet
	Upon Completion	Dry	feet
	Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
410	180					Interbedded, slightly weathered, medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]		Rec=100%			
405	185			40	44			RQD=30 Rec=73%			
400	190			41	60			RQD=93 Rec=100%			
395	195			42	60			RQD=100 Rec=100%			
390	200			43	60		Shale and Limestone	RQD=97 Rec=100%			
385	205			44	60			RQD=98 Rec=100%			
380	210			45	60			RQD=100 Rec=100%			
375	215			46	56			RQD=92 Rec=93%			
370	220			47	56	Interbedded, slightly weathered, medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 45 to 65 degrees, (RQD from 50 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]		RQD=86 Rec=93%			
365	225			48	60			RQD=95 Rec=100%			
360	230			49	60		Shale and Limestone	RQD=95 Rec=100%			
355	235			50	60			RQD=100 Rec=100%			
	240			51	60			RQD=95			

Continued Next Page

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PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-3R

DATE STARTED:	12/15/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/21/16	**DRILLER:** Kevin Kersh	**LOGGED BY:** Gunner Ingram
COMPLETION DEPTH	277.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	591 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.686351°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.20148°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
350	240					Interbedded, slightly weathered, medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 45 to 65 degrees, (RQD from 50 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]		Rec=100%			
345	245			52	60			RQD=90 Rec=100%			
340	250			53	60			RQD=97 Rec=100%			
335	255			54	52			RQD=100 Rec=87%			
330	260			55	58		Shale and Limestone	RQD=50 Rec=97%			
325	265			56	60			RQD=80 Rec=100%			
320	270			57	60			RQD=78 Rec=100%			
315	275			58	60			RQD=83 Rec=100%			
						Bottom of test boring at 277 feet					

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PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-4

DATE STARTED:	6/23/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	6/23/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	60.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	435 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.7099278°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.2084611°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev
REMARKS:			

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0	1	18	Approximately 3 inches of Topsoil Soft to medium stiff, moist, brown, sandy **lean CLAY (USCS CL)** some gravel, roots. **Alluvium**	Top Soil CL	1-3-4 N=7	19	LL = 35 PL = 21 Fines=77.9%
		2	18	Dense to medium dense, moist, brown, olive brown, dark brown **clayey SAND (USCS SC)** some gravel, trace shale fragments. **Residuum**	SC	11-18-16 N=34	9	
430	5	3	18			4-10-11 N=21	9	LL = 29 PL = 17 Fines=20.1%
		4	3	Weathered Rock, gray, dark gray, soft SHALE and hard LIMESTONE, Silurian [Wills Creek Shale and Bloomsburg Formation]	WEATHERED SHALE	50/3"	4	>>
		5	12			RQD=0 Rec=37%		
425	10	6	50	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 35 degrees, (RQD = 10 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=10 Rec=83%		
420	15	7	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 66 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=66 Rec=100%		
415	20	8	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 80 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=80 Rec=100%		
410	25	9	60			RQD=80 Rec=100%		
405	30	10	60	Interbedded, slightly weathered, medium bedded to thin bedded, red, trace white and gray , fine grained to medium grained, hard LIMESTONE and soft SHALE, dip of 40 degrees, (RQD of 75 % and 66 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=75 Rec=100%		
400	35	11	58			RQD=66 Rec=97%		
395	40			*Continued Next Page*				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
Moisture ✕ 0 25 50 PL ◪ LL ✚
STRENGTH, tsf
Qu ▲ Qp ✳ 0 2.0 4.0

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PROJECT NO.: 0512719-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: I-68 HDD Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-4

DATE STARTED:	6/23/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	6/23/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	60.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	435 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.7099278°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.2084611°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	40										
				12	60	Interbedded, slightly weathered, medium bedded to thin bedded, red, trace white and gray , fine grained to medium grained, hard LIMESTONE and soft SHALE, dip of 40 degrees, (RQD = 80 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=80 Rec=100%			
390	45			13	50	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 0 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=0 Rec=83%			
385	50			14	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 45 degrees, (RQD = 86 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=86 Rec=100%			
380	55			15	59			RQD=86 Rec=98%			
375	60					Bottom of test boring at 60 feet					

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Telephone: (703) 698-9300

PROJECT NO.: 0512719-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: I-68 HDD Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-5

DATE STARTED:	6/22/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	6/22/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	70.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	447 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.7117556°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.2086167°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	0					Approximately 3 inches of Topsoil	Top Soil				
445				1	6	Dense to medium dense, moist, brown, sandy **clayey SAND (USCS SC)** some gravel, roots. **Alluvium**	SC	1-31-18 N=49	22	× ◪ ✚	LL = 45 PL = 26 Fines=29.4%
				2	4			17-18-9 N=27	41	×	
	5			3	18	Medium dense, moist, brown, olive brown, dark brown **clayey SAND (USCS SC)** some gravel, traceshale fragments. **Residuum**	SC	3-7-10 N=17	21	× ◪ ✚	LL = 41 PL = 25 Fines=23.9%
440				4	5	Weathered Rock, gray, dark gray, soft SHALE and hard LIMESTONE, Silurian [Wills Creek Shale and Bloomsburg Formation]	WEATHERED SHALE	50/5"	4	× >>◎	
	10			5	3			50/3"	5	× >>◎	
435				6	18	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 55 degrees, (RQD = 80 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=61 Rec=100%	3	×	
	15										
430				7	60			RQD=80 Rec=100%			
	20			8	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 48 degrees, (RQD = 68 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=68 Rec=100%			
425											
	25			9	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 95 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=95 Rec=100%			
420											
	30			10	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 57 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=57 Rec=100%			
415											
	35			11	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 93 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=93 Rec=100%			
410											
	40					*Continued Next Page*					

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Telephone: (703) 698-9300

PROJECT NO.: 0512719-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: I-68 HDD Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-5

DATE STARTED:	6/22/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	6/22/16	**DRILLER:** Tom Chew	**LOGGED BY:** J. Thonnfend
COMPLETION DEPTH	70.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	447 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.7117556°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.2086167°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	40										
405				12	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 43 degrees, (RQD = 83 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=83 Rec=100%			
	45										
400				13	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 38 degrees, (RQD = 97 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=97 Rec=100%			
	50										
395				14	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 40 degrees, (RQD = 67 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=67 Rec=100%			
	55										
390				15	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 50 degrees, (RQD = 90 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=90 Rec=100%			
	60										
385				16	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray , fine grained to medium grained, soft SHALE and hard LIMESTONE, dip of 53 degrees, (RQD = 93 %) Silurian [Wills Creek Shale and Bloomsburg Formation]	Shale and Limestone	RQD=93 Rec=100%			
	65										
380				17	60			RQD=93 Rec=100%			
	70					Bottom of test boring at 70 feet					

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PROJECT NO.: 0512719-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: I-68 HDD Crossing
Washington County
Hancock, MD

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BORING GO-6

DATE STARTED:	12/14/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/14/16	**DRILLER:** Kevin Kersh	**LOGGED BY:** Gunner Ingram
COMPLETION DEPTH	40.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	590 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.678878°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.194106°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev
REMARKS:			

Water

While Drilling	29.5 feet
Upon Completion	N/A feet
Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0	1	10	Approximately 4 inches of Topsoil	Top Soil	2-3-6 N=9	16	LL = 37 PL = 25
				Loose to medium dense, moist, brown, **silty SAND (USCS SM)** with shale fragments, gravel, roots.	SM			
		2	18	Medium dense to very dense mottled brown **silty SAND (USCS SM)** with gravel, shale fragments **Residuum**		7-6-13 N=19	19	
585	5	3	12			10-13-17 N=30	19	LL = 41 PL = 27 Fines=34.5%
		4	18		SM	19-36-48 N=84	14	>>
580	10							
		5	10			25-50/4"	13	>>
575	15						13	
		6	4	Weathered Rock, SHALE and LIMESTONE, sampled as very hard, moist, dark gray, black **silty GRAVEL (USCS GM) with sand**		50/4"		>>
570	20							
		7	4		GM	50/4"	5	>> LL = 26 PL = 19 Fines=13.3%
565	25							
		8	4			50/4"	7	>>
560	30			Interbedded, weathered, medium bedded to thin bedded, gray, dark gray , black fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 30 to 45 degrees, (RQD from 25% to 0 %), Devonian [Marcellus Formation and Needmore Shale]				
		9	60		Shale and Limestone	RQD=25 Rec=100%		
555	35							
		10	42			RQD=0 Rec=70%		
550	40			Bottom of test boring at 40 feet				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

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PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-7

DATE STARTED:	1/17/17
DATE COMPLETED:	1/20/17
COMPLETION DEPTH	134.0 ft
BENCHMARK:	N/A
ELEVATION:	402 ft
LATITUDE:	39.681887°
LONGITUDE:	78.197553°
STATION:	N/A
OFFSET:	N/A
REMARKS:	

DRILL COMPANY:	Connelly Drilling, Inc.
DRILLER:	Howie Roberts
LOGGED BY:	Rob Stickley
DRILL RIG:	Diedrich D-50
DRILLING METHOD:	Rock Coring
SAMPLING METHOD:	1.874-in Core Standard
HAMMER TYPE:	N/A
EFFICIENCY	N/A
REVIEWED BY:	Lubomir Peytchev

Water		
	While Drilling	0 feet
	Upon Completion	0 feet
	Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	0					Potomac River, approximately 6 feet of WATER					
400							Water				
	5										
395				1	18	Medium dense to very dense, wet, white, red, brown, gray and black **Sand, Gravel and Cobbles (Alluvium)**		RQD=0 Rec=50%			
	10						Cobble Stones				
390				2	14			RQD=0 Rec=23%			
	15					Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, trace brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 68% to 100 %), Devonian [Oriskany Sandstone and Helderberg Group]					
385				3	58			RQD=88 Rec=96%			
	20										
380				4	60			RQD=100 Rec=100%			
	25						SHALE				
375				5	56			RQD=86 Rec=94%			
	30										
370				6	60			RQD=68 Rec=100%			
	35					Interbedded, weathered, medium bedded to thin bedded, brown, gray, dark gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60 degrees, clay seams (RQD of 0 %), Devonian [Oriskany Sandstone and Helderberg Group]					
365				7	36		SHALE	RQD=0 Rec=60%			
	40					Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 24% to 86 %), Devonian [Oriskany Sandstone and Helderberg Group]					
360				8	60			RQD=86 Rec=100%			
	45						SHALE				
355				9	58			RQD=72 Rec=96%			
	50										

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PROJECT NO.:	0512713-1
PROJECT:	6493-Eastern Panhandle Expansion
LOCATION:	Potomac River Crossing
	Washington County
	Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	1/17/17	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	1/20/17	**DRILLER:**	Howie Roberts **LOGGED BY:** Rob Stickley
COMPLETION DEPTH	134.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Rock Coring
ELEVATION:	402 ft	**SAMPLING METHOD:**	1.874-in Core Standard
LATITUDE:	39.681887°	**HAMMER TYPE:**	N/A
LONGITUDE:	78.197553°	**EFFICIENCY**	N/A
STATION:	N/A **OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

BORING GO-7

Water		
	While Drilling	0 feet
	Upon Completion	0 feet
	Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
350	50			10	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 24% to 86 %), Devonian [Oriskany Sandstone and Helderberg Group]		RQD=24 Rec=100%			
345	55			11	50		SHALE	RQD=64 Rec=84%			
340	60			12	52	Void approximately from 58.2' to 59'		RQD=30 Rec=86%			
335	65			13	60	Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, trace brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 50 degrees, (RQD from 24% to 92 %), Devonian [Oriskany Sandstone and Helderberg Group]		RQD=70 Rec=100%			
330	70			14	43	Clay seam approximately from 72.6' to 74'		RQD=60 Rec=72%			
325	75			15	56			RQD=60 Rec=94%			
320	80			16	60		SHALE	RQD=74 Rec=100%			
315	85			17	60			RQD=92 Rec=100%			
310	90			18	60			RQD=82 Rec=100%			
305	95			19	58			RQD=24 Rec=96%			
	100					*Continued Next Page*					

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PROJECT NO.: 0512713-1
PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING GO-7

DATE STARTED:	1/17/17	**DRILL COMPANY:** Connelly Drilling, Inc.
DATE COMPLETED:	1/20/17	**DRILLER:** Howie Roberts **LOGGED BY:** Rob Stickley
COMPLETION DEPTH	134.0 ft	**DRILL RIG:** Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:** Rock Coring
ELEVATION:	402 ft	**SAMPLING METHOD:** 1.874-in Core Standard
LATITUDE:	39.681887°	**HAMMER TYPE:** N/A
LONGITUDE:	78.197553°	**EFFICIENCY** N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:** Lubomir Peytchev

REMARKS:

Water

While Drilling	0 feet
Upon Completion	0 feet
Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 / 25 / 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 / 2.0 / 4.0)	Additional Remarks
300	100			20	58		SHALE	RQD=50 Rec=96%			
295	105			21	48	Interbedded, weathered, medium bedded to thin bedded, brown, dark gray, gray, dark brown, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, clay seams (RQD of 0 %), Devonian [Oriskany Sandstone and Helderberg Group]	SHALE	RQD=0 Rec=80%			
290	110			22	60	Clay seam approximately from 107' to 108.5' Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, trace brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 40 to 60 degrees, (RQD from 28% to 72 %), Devonian [Oriskany Sandstone and Helderberg Group]		RQD=34 Rec=100%			
285	115			23	60			RQD=46 Rec=100%			
280	120			24	60		SHALE	RQD=28 Rec=100%			
275	125			25	60			RQD=44 Rec=100%			
270	130			26	60			RQD=72 Rec=100%			
						Bottom of test boring at 134 feet					

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PROJECT: 6493-Eastern Panhandle Expansion
LOCATION: Potomac River Crossing
Washington County
Hancock, MD

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BORING GO-10

DATE STARTED:	12/21/16	**DRILL COMPANY:**	Connelly Drilling, Inc.
DATE COMPLETED:	12/21/16	**DRILLER:** Josh Lewis	**LOGGED BY:** Philip Daute
COMPLETION DEPTH	20.0 ft	**DRILL RIG:**	CME 550 ATV
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	581 ft	**SAMPLING METHOD:**	2-in SS1.874-in Core Standard
LATITUDE:	39.723074°	**HAMMER TYPE:**	Automatic
LONGITUDE:	78.206551°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	Lubomir Peytchev

REMARKS:

Water

While Drilling	Dry	feet
Upon Completion	Dry	feet
Delay	N/A	feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
580	0			1	18	Approximately 4 inches of Topsoil Stiff, moist, light brown **sandy SILT (USCS ML)** some gravel, roots.	Top Soil/ ML	3-6-8 N=14	16		
				2	14	Medium dense, moist, light brown **silty GRAVEL (USCS GM)** with sand, trace shale fragments. **Residuum**	GM	3-8-14 N=22	19		LL = 39 PL = 26 Fines=19.3%
575	5			3	2	Weathered Rock, SHALE and LIMESTONE, sampled as very hard, moist, red, dark brown **silty GRAVEL (USCS GM) with sand**, Silurian [Bloomsburg and Mufflintown Formation]		50/2"	2	× >>◎	
				4	10			7-50/5"	9	× >>◎	LL = 31 PL = 19 Fines=15.7%
570	10						WEATHERED SHALE				
				5	3			50/3"	9	× >>◎	
565	15										
				6	2			50/2"	4	× >>◎	
	20					Bottom of test boring at 20 feet					

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GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
RC: Rock Core
TC: Texas Cone
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
Q_u: Unconfined compressive strength, TSF
Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼,▽,▼ Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	N - Blows/foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

GRAIN-SIZE TERMINOLOGY

Component	Size Range
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.005 mm to 0.075 mm
Clay:	<0.005 mm

PARTICLE SHAPE

Description	Criteria
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% Dry Weight
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

Q_U - TSF	N - Blows/foot	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

MOISTURE CONDITION DESCRIPTION

Description	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term	% Dry Weight
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

Component	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

DEGREE OF WEATHERING

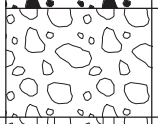
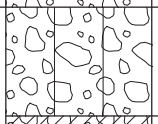
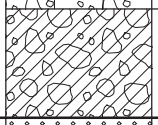
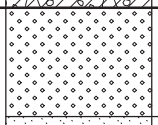
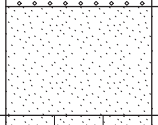
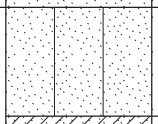
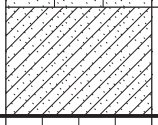
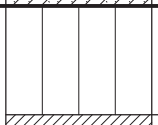
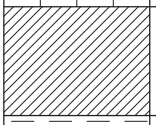
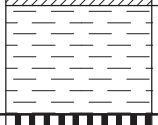
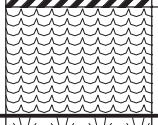
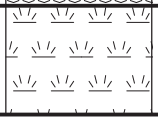
Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.

Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.

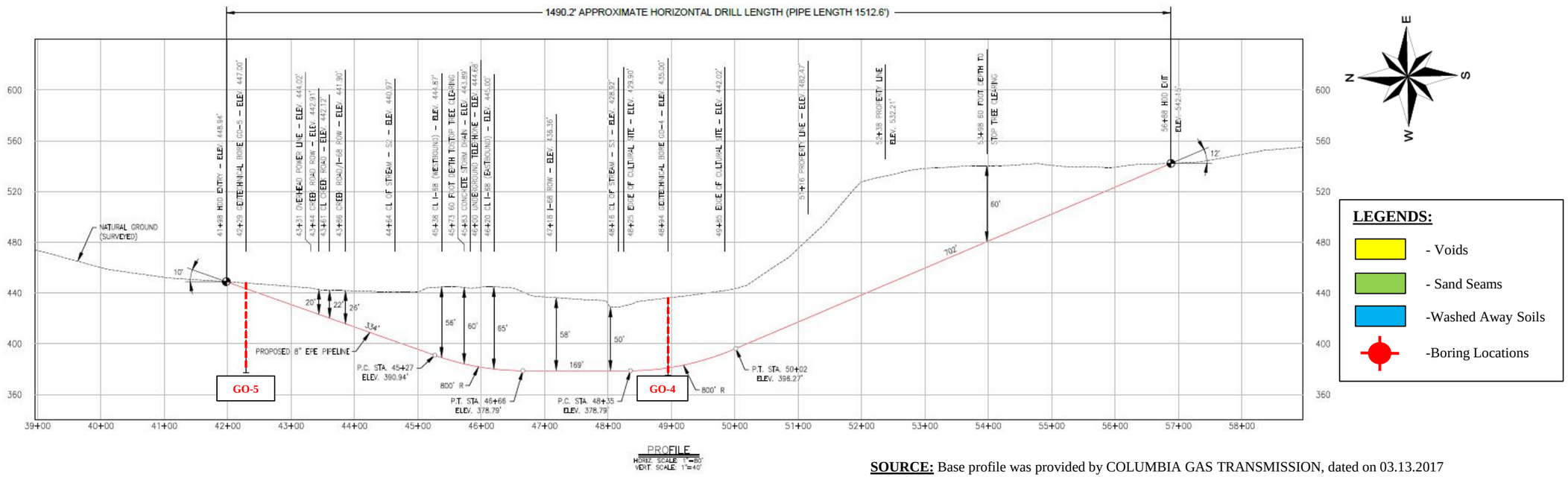
Highly Weathered: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	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
				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
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

PLAN
SCALE: 1"=80'



PROFILE
HORIZ. SCALE: 1"=80'
VERT. SCALE: 1"=40'

LEGENDS:

- Voids
- Sand Seams
- -Washed Away Soils
- -Boring Locations

SOURCE: Base profile was provided by COLUMBIA GAS TRANSMISSION, dated on 03.13.2017

Boring	Approximate Depth/Elevation of recorded VOIDS *Depth/Elevation (ft)*	Approximate Depth/Elevation of recorded SAND SEAMS *Depth/Elevation (ft)*	Material Washed Away During Coring *Depth/Elevation (ft)*
GO - 4	N/A	N/A	N/A
GO – 5	N/A	N/A	N/A

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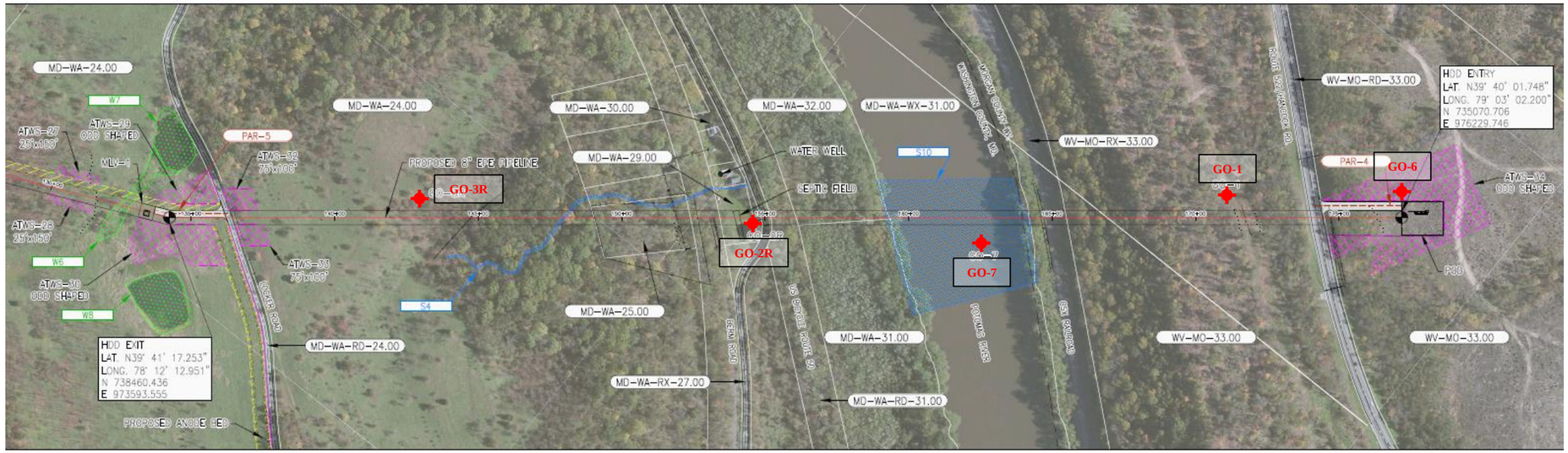
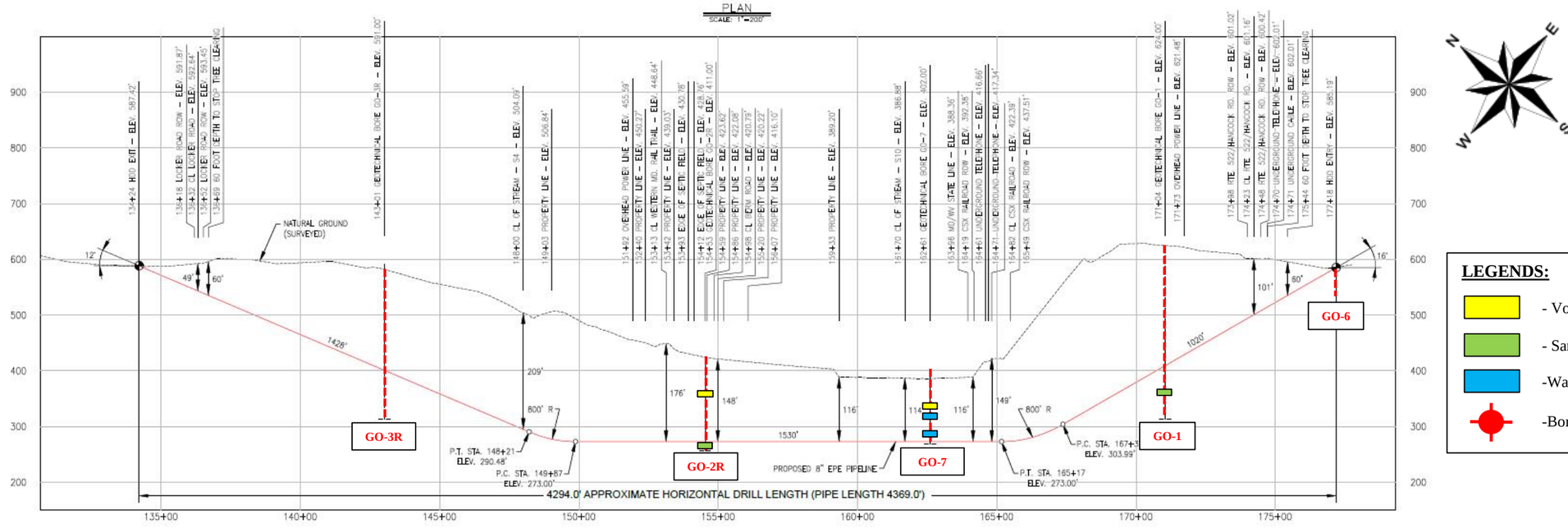
REVISIONS

PROFILE
6493 – EASTERN PAN HANDLE EXPANSION INTERSTATE 68 CROSSING

Washington County, MD – Morgan County, WV		June 15, 2017
E.Q.S.	N.T.S.	0512713





LEGENDS:

- Voids
- Sand Seams
- -Washed Away Soils
- -Boring Locations

Boring	Approximate Depth/Elevation of recorded VOIDS *Depth/Elevation (ft)*	Approximate Depth/Elevation of recorded SAND SEAMS *Depth/Elevation (ft)*	Material Washed Away During Coring *Depth/Elevation (ft)*
GO - 1	N/A	10.0' / 360 to 350 MSL	N/A
GO – 2R	0.1' / 359.7 MSL 0.1' / 357.9 MSL 0.6' / 357.6 MSL	2.4' / 279.4 to 277 MSL 0.7' / 275 MSL 0.5' / 272.5 MSL	N/A
GO – 3R	N/A	N/A	N/A
GO – 6	N/A	N/A	N/A
GO – 7	0.8' / 343.8 MSL	N/A	1.4' / 329.4 to 328 MSL 1.5'/ 295 to 293.5 MSL

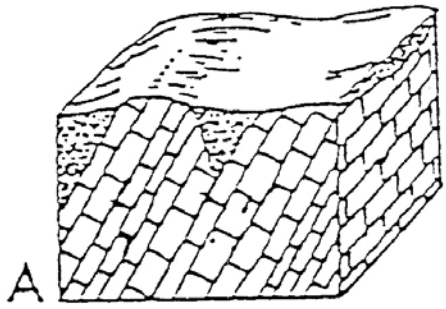
SOURCE: Base profile was provided by COLUMBIA GAS TRANSMISSION, dated on 03.13.2017

		REVISIONS
PROFILE 6493 – EASTERN PANHANDLE EXPANSION POTOMAC RIVER CROSSING		
Washington County, MD – Morgan County, WV		June 15, 2017
E.Q.S.	N.T.S.	0512713

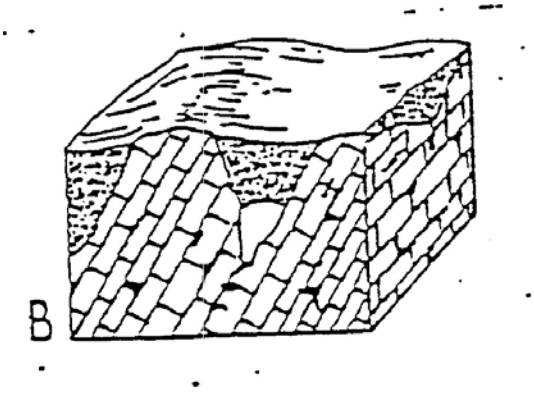
APPENDIX D: THE MECHANISM OF SINKHOLE DEVELOPMENT

THE MECHANISM OF SINKHOLE DEVELOPMENT

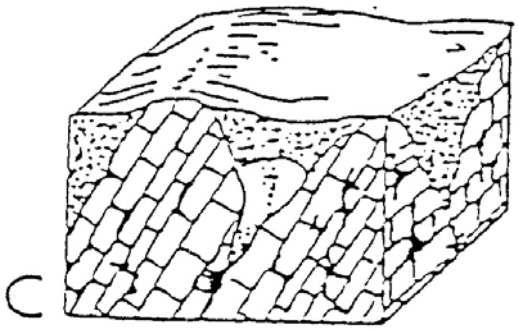
Limestone areas represent a potentially serious foundation problem. The solubility of these carbonate rocks often makes small fractures become larger channelways, intersecting fractures become huge chambers and the normally smooth soil-bedrock interface becomes pinnacled with almost unbelievable relief. Usually, these fractures are hidden from view beneath a gently rolling landscape with exceptionally rich looking soils.



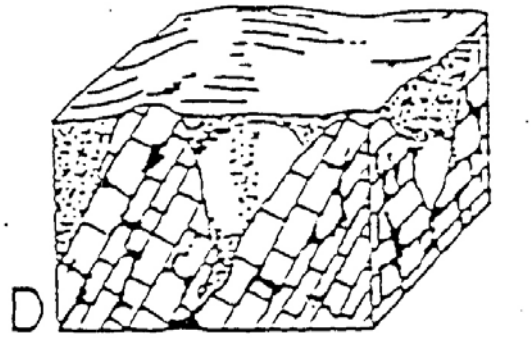
The character of the carbonate bedrock surface is usually pinnacled and covered with thick, weathered mantle. As this mantle dries out during periods of drought or lowering of the water table by man's activities, volume shrinkage due to compaction takes place.



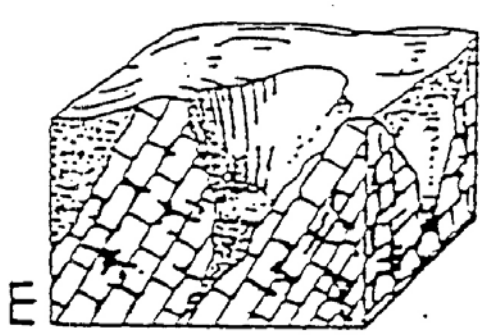
This compaction is irregular and may be expressed at the surface by the typical rolling topography of carbonate terrains. However, an open void may develop in this overlying debris and the roof of the void assumes the shape of an arch. The weight of the compacted soil would then be carried along the arch-bridge and absorbed by the soil abutments adjacent to the carbonate rock pinnacles.



At the same time, the dried-out debris is slowly migrating downward into the existing openings, widened by solution, in the carbonate bedrock. A wide range of soil particle sizes encourages a sporadic but continuous process of roof spalling into the voids. This debris is then carried to great depths within the bedrock probably along interconnecting solution channels that have opened along joints, faults, and bedding planes in the limestone.



As the spalling continues and the debris moves downward, the open chambers gradually grow upward. At that point in time when the arch-bridge cannot hold the weight of the overlying materials, sudden collapse of the surface occurs, and a sinkhole is born.



The appearance of most sinkholes after a torrential rainfall is probably due to the sudden influx of water which adds weight to the overlying materials, flushes out much of the debris at the bottom of the voids, and softens the dried arch-bridge, causing collapse.

No simple solution is available for the detection of potential sinkholes or for determining the exact soil-bedrock interface. A combination of conventional soil borings and rock probes, fracture trace analyses, and electrical resistivity studies have proven successful in analyzing this precarious phenomenon.