



July 24, 2018

Mr. Doug Scott
Project Manager
Shell Pipeline Company
777 Walker Street
Two Shell Plaza
Houston, TX 77002

RE: Carbonate Rock Analysis
Shell Pipeline Company, LP – Falcon Ethane Pipeline System
Beaver, Allegheny, and Washington Counties, Pennsylvania

Dear Mr. Scott:

AECOM Technical Services, Inc. (AECOM) is pleased to submit this carbonate rock analysis letter to Shell Pipeline Company LP (SPLC) as response to comments by the Pennsylvania Department of Environmental Protection (PADEP), dated June 1, 2018 for the Falcon Ethane Pipeline System (Project). A quotation of the comment given by the PADEP is provided below:

“Evaluate and discuss the potential for your proposed project to encounter areas underlain by a) carbonate bedrock (i.e. areas susceptible to sinkhole formation) and b) landslide prone areas, during construction. Evaluate and discuss precautions and construction methods that will be utilized during construction, where these areas will be encountered, pursuant to Section 105.14(b)(11) of the Department’s Chapter 105 rules and regulations.”

Please note that a discussion of landslide prone areas is provided in a separate report. This letter only discusses the presence of carbonate bedrock.

CARBONATE ROCK IDENTIFICATION

Forty (40) geotechnical core borings were drilled by AECOM for the Falcon project between the months of September 2016 and June 2017. The majority of these borings were drilled in order to delineate subsurface conditions that are to be encountered by proposed horizontal directional drill (HDD) crossings; the remaining borings were drilled for the civil site design of meter stations. Geotechnical information and boring logs are located in the HDD Subsurface Investigation Letter Reports for each HDD Crossing. Carbonate bedrock was encountered in twenty (20) of the borings and a summary of depth, thickness, core recovery, and rock quality designation (RQD) is provided as Table 1. Corebox photographs of the carbonate bedrock encounters listed in Table 1 are provided in Appendix A. Recovery values of carbonate bedrock were generally very high.

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KARST FEATURES

Karst features are not typical of southwestern Pennsylvania. To quote the Pennsylvania Department of Conservation and Natural Resources in *Sinkholes in Pennsylvania* (2015), “there are also some relatively thin units of limestone in western Pennsylvania that exhibit solution features in the form of widened fractures and small caves. In general, however, they are too thin to have a well-developed karst surface.” No karst features were mapped along the Project alignment on the PADEP’s web application, EMapPA. Site reconnaissance and the drilling data also confirms lack of karst development along the Project alignment in the areas of the HDD crossings.

One void was encountered in boring HOU04-03 from a depth of 35.0 to 36.5 feet. The overall unit recovery and RQD of this unit was 92% and 41%, respectively. Water was lost during coring at a depth of 35.0 feet and returned at 36.5 feet. This was the only such feature encountered during the drilling program, and this unit will not be intersected by the proposed HOU-04 HDD (the proposed HDD is 131 feet below this carbonate unit at boring HOU04-03 and this stratigraphic unit does not exist at the entry and exit HDD pathways due to topography and/or it has been removed from past strip mining).

PRECAUTIONS AND CONSTRUCTION METHODS

In the unlikely event that a karst feature is exposed during excavation for open cut pipeline installation, construction in the area will immediately cease, and a professional engineer and/or geologist will evaluate site conditions to develop a site specific mitigation plan. Potential mitigation measures to address voids may include, but are not limited to, excavation and backfill, using flowable fill, or the installation of micropiles to support pipeline loads.

In the event that a void is intercepted during an HDD installation, refer to the SPLC HDD Inadvertent Return Contingency Plan for mitigation methods.

QUALIFICATIONS

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions contained in this report were based on the applicable standards of the engineering profession at the time this report was prepared. No other warranty, express or implied is made.

The nature and extent of variations between borings may not become evident until construction. If variations appear evident, then it will be necessary to reevaluate the applicability of the information obtained with this exploration and laboratory testing program. Environmental services were beyond the scope of this report.

If you have any questions, comments, or concerns regarding this letter, please contact Steve at 412-503-4579.

Sincerely,

AECOM Technical Services



Steve Ladavat, PG
Geotechnical Lead



Lucas Turko, PE
Geotechnical Manager

Attachments:

Tables

Appendix A: Corebox Photographs



Submitted via Electronic Mail

Tables

Table 1: Limestone Unit Data							
Boring	Depth (ft)		Elevation (ft)		Layer Thickness (ft)	REC (%)	RQD (%)
	Top	Bottom	Top	Bottom			
HOU01-01	23.3	36.3	1164.7	1151.7	13.0	99	73
	44.7	51.4	1143.3	1136.6	6.7	99	49
	51.4	65.6	1136.6	1122.4	14.2	99	87
	73.0	90.5	1115.0	1097.5	17.5	100	93
HOU01-02	23.9	30.8	1180.1	1173.2	6.9	97	41
	39.8	54.8	1164.2	1149.2	15.0	99	65
	60.4	80.9	1143.6	1123.1	20.5	100	72
HOU02-01	14.0	28.7	1093.0	1078.3	14.7	96	68
	38.3	85.3	1068.7	1021.7	47.0	99	89
HOU02-02	24.1	40.1	1063.9	1047.9	16.0	96	85
	40.1	64.1	1047.9	1023.9	24.0	97	91
	88.5	89.8	999.5	998.1	1.3	100	100
	91.0	97.4	997.0	990.6	6.4	99	86
	99.3	100.1	988.7	987.9	0.8	100	100
HOU02-03	28.3	34.3	1223.7	1217.7	6.0	83	8
	76.4	86.7	1175.6	1165.3	10.3	98	53
	117.1	123.4	1134.9	1128.6	6.3	100	62
	131.8	169.3	1120.2	1082.7	37.5	94	79
	184.3	221.5	1067.7	1030.5	37.2	99	94
HOU03-01	87.0	90.9	1012.0	1008.1	3.9	100	51
	104.2	109.5	994.8	989.5	5.3	100	38
HOU03-02	25.6	30.1	1019.9	1015.4	4.5	100	60
	62.2	64.9	983.3	980.6	2.7	99	37
	74.9	77.0	970.6	968.5	2.1	100	64
HOU03-03	24.8	64.6	1175.0	1135.2	39.8	96	56
	102.5	107.7	1097.3	1092.1	5.2	100	77
	110.7	113.7	1089.1	1086.1	3.0	100	100
	114.3	120.4	1085.5	1079.4	6.1	98	49
	121.2	126.8	1078.6	1073.0	5.6	98	64
	126.8	127.5	1073.0	1072.3	0.7	100	0
	213.5	219.8	986.3	980.0	6.3	100	100
	248.3	249.3	951.5	950.5	1.0	100	50
HOU03-04	44.8	53.5	1098.2	1089.5	8.7	100	37
	55.5	75.5	1108.5	1088.5	20.0	97	42
	126.5	130.5	1037.5	1033.5	4.0	100	95
HOU03-05	--	--	--	--	--	--	--
HOU04-01	98.1	101.6	1099.9	1096.4	3.5	100	84
HOU04-02	--	--	--	--	--	--	--
HOU04-03	15.5	41.6	1251.5	1225.4	26.1	92	41
	64.1	84.8	1202.9	1182.2	20.7	100	77
	137.3	139.8	1129.7	1127.2	2.5	100	88
	156.8	168.8	1110.2	1098.2	12.0	100	71
	172.1	174.8	1094.9	1092.2	2.7	100	89

Boring	Depth (ft)		Elevation (ft)		Layer Thickness (ft)	REC (%)	RQD (%)
	Top	Bottom	Top	Bottom			
HOU04-04	62.8	80.1	1124.2	1106.9	17.3	100	61
HOU05-01	47.7	52.7	1132.3	1127.3	5.0	100	74
	65.2	67.9	1114.8	1112.1	2.7	100	100
HOU05-02	51.9	57.1	1137.1	1131.9	5.2	100	69
	73.4	78.4	1115.6	1110.6	5.0	100	46
HOU05-03	90.0	96.3	1124.0	1117.7	6.3	100	75
HOU06-01	--	--	--	--	--	--	--
HOU06-02	73.3	79.8	1118.7	1112.2	6.5	100	74
	85.5	94.5	1106.5	1097.5	9.0	98	52
HOU06-03	--	--	--	--	--	--	--
HOU07-02	--	--	--	--	--	--	--
HOU07-03	45.0	48.7	1135.0	1131.3	3.7	100	65
	62.0	65.0	1118.0	1115.0	3.0	100	93
HOU07-04	4.5	6.6	1127.5	1125.4	2.1	100	67
HOU08-01	62.4	63.4	1031.6	1030.6	1.0	100	0
	85.5	87.4	1008.5	1006.6	1.9	100	63
	117.8	123.1	976.2	970.9	5.3	100	64
HOU08-02	--	--	--	--	--	--	--
HOU09-01	--	--	--	--	--	--	--
HOU09-02	--	--	--	--	--	--	--
HOU09-03	--	--	--	--	--	--	--
HOU10-01	--	--	--	--	--	--	--
HOU10-02	74.1	76.5	722.4	720.0	2.4	100	33
HOU10-03	--	--	--	--	--	--	--
HOU11-01	--	--	--	--	--	--	--
HOU11-02	--	--	--	--	--	--	--
HOU11-03	--	--	--	--	--	--	--
HOU12-01	--	--	--	--	--	--	--
HOU12-02	--	--	--	--	--	--	--
HOU12-03	--	--	--	--	--	--	--
KB-1	--	--	--	--	--	--	--
SCIO-05-01	--	--	--	--	--	--	--
SCIO-05-02	--	--	--	--	--	--	--
MIN:					0.7	83	0
MAX:					47.0	100	100
AVERAGE:					10.1	99	66

Appendix A: Corebox Photographs



HOU01-01



HOU01-01



HOU01-01



HOU01-01



HOU01-01



HOU01-01



HOU01-01



HOU01-01



HOU01-02



HOU01-02



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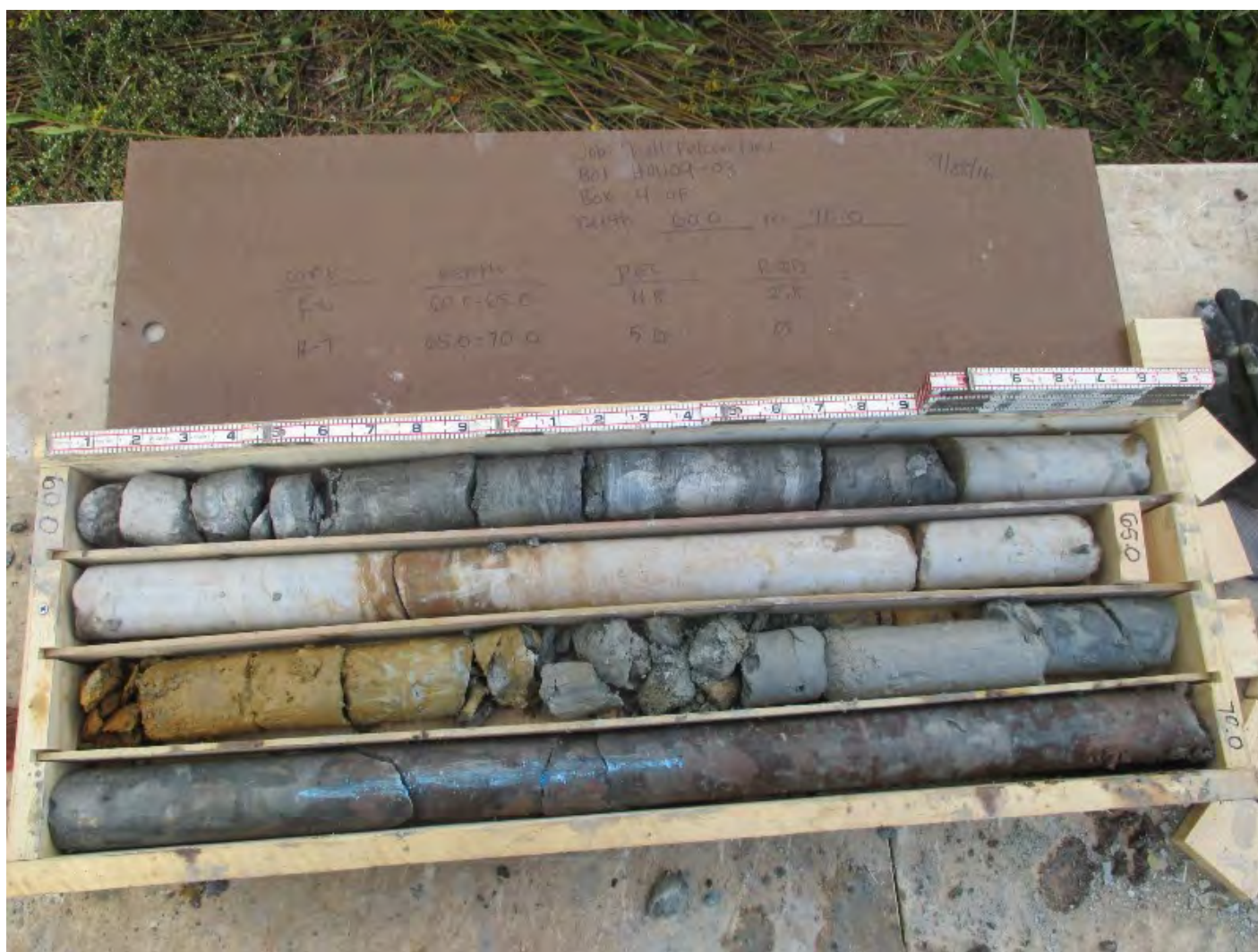
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