PEC FIELD SERVICES

May 29, 2024

Mr. Jim Benage
City of Bel Aire
7651 E. Central Park
Bel Aire, Kansas 67226

Subject: **Report for Geotechnical Engineering Services**
Bel Aire - Woodlawn Monitoring Wells
PEC Project No.: 237363-003

Dear Mr. Benage:

Professional Engineering Consultants, PA (PEC) has completed the geotechnical engineering services for the above referenced project. The purpose of the geotechnical engineering services was to explore the subsurface conditions at the project site and provide laboratory testing results with subsurface water elevations.

The attached report presents the results of our field exploration, and our engineering interpretations with respect to the project characteristics as presented in the report. We recommend that all individuals read the entire report along with all the appendices.

This report completes our current scope of services for this project. We appreciated the opportunity to provide geotechnical engineering services for this project.

Respectfully,
FIELD SERVICES: GEOTECHNICAL ENGINEERING DIVISION
*A Department of **P**rofessional **E**ngineering **C**onsultants, P.A.*

Prepared By:

Robert W. Henthorne, PG
VP Geotechnical Engineering

Reviewed By:

BRITT D. CLUBB LICENSED 24123 05/29/2024 KANSAS PROFESSIONAL ENGINEER

Britt D. Clubb, PE
SVP Field Engineering

Geotechnical Engineering Services Report

Bel Aire - Woodlawn Monitoring Wells

East 37th St. N. to East 45th St. N. on Woodlawn Avenue
Bel Aire, Kansas

PREPARED FOR
City of Bel Aire.
Bel Aire, Kansas

PEC PROJECT NO.
237363-003

PREPARED BY
Robert W. Henthorne, PG

REVIEWED BY
Britt D. Clubb, PE
License No. 24123

DATE
May 29, 2024

TABLE OF CONTENTS

1. INTRODUCTION

1.1 GENERAL

PEC has completed the monitoring well installation and data collection for the above referenced project. All services were performed either directly by or under the direction of professional engineers or geologists licensed in the State of Kansas. This report summarizes the results of our field explorations, our conclusions and recommendations related to the geotechnical aspects of the project design and construction.

The conclusions and recommendations were based on the project information available at the time of this report and the subsurface conditions encountered in the borings at the locations and time indicated. It is possible that subsurface conditions could vary between or beyond the explored locations. If subsurface condition changes during construction, construction activity shall be ceased and PEC should be notified immediately to review and make any supplementary recommendations, if necessary.

1.2 PROJECT DESCRIPTION

The city of Bel Aire had undertaken a reconstruction project on Woodlawn Avenue from 37th Street to 45th street. The roadway has experienced failures with new pavement prior to the completion of the project. The Kansas Department of Transportation's Geotechnical and Geology Sections have done a preliminary investigation at this site. At the request of the city of Bel Aire, PEC's geotechnical group installed 12 monitoring wells and conducted lab testing of the soils along Woodlawn Avenue The wells were drilled and slotted PVC monitoring well casings were installed. The groundwater elevations were monitored on a weekly basis or within 24 hours of a rainfall event. The recorded data and graphs are shown in Appendix A.

2. SITE CONDITIONS

2.1 SITE DESCRIPTION

The general vicinity of the project site is shown on Figure 1, Site Location Map. The monitoring well locations are shown on Figure 2, Monitoring Well Location Map. All wells were installed through the existing pavement or directly behind the curb and gutter on Woodlawn Avenue

2.2 GEOLOGIC SETTING

The project soils are residual and are derived by the direct in-place weathering of the underlying Wellington Shale Formation. The soil is brown to gray-brown in color and very clay rich. Based on test results from the Kansas Department of Transportation investigation the clays have high liquid limits. Underlying the soil mantle is gray to green-gray clay rich shale of the Wellington Formation. This shale is soft in the upper 5 feet becoming firmer with depth. The shale is within a foot of the base of the pavement in several locations along Woodlawn Avenue and isolated gypsum crystals were present in borings closest to 45th street. The depth to the top of the Wellington Shale increases from north to south along Woodlawn Avenue

3. GEOTECHNICAL RECOMMENDATIONS

3.1 GENERAL

Twelve monitoring wells were installed based on the depth to shale and groundwater elevations at the time of drilling and location within the project area. The wells were monitored from March 11, 2024 through May 2, 2024. Ten depth to water measurements were taken in that period of time. The data and graphs are included in Appendix A of this report.

3.2 MONITORING WELLS

The monitoring wells showed that the groundwater elevation can be found at or above the top of the roadway in several locations. The soils along the project are residual clays that can retain moisture for extended periods of time. Several monitoring wells remained nearly full for a week or more after rainfall events. Wells that were installed along the east side of the roadway exhibited this most as the recharge area is most likely to the north and east of Woodlawn. The wells along the west side of the roadway had a shorter discharge time frame or showed little to no increase in hydrostatic elevation. The well placed near the fire station had groundwater fluctuations with each rainfall event. Monitoring wells 7 and 8 were installed south of the railroad crossing. Well 7 indicates that groundwater is still an issue south of the railroad as groundwater was found to be near the base of the roadway after each rainfall event. Well 8 was drilled near the south end of the project and groundwater stayed at an acceptable level beneath the roadway.

3.3 CONCLUSIONS

Groundwater can cause roadway problems typically when it is within 4 feet of the base of the pavement. The monitoring wells provided data that groundwater elevations are within a depth that can be detrimental to structure of a roadway. Groundwater on this project is moving along the top of the Wellington Shale. The shale was found to be within 1-foot of the base of the pavement in several locations. This shallow depth allows the groundwater elevations to be at or above the roadway. The roadway issues after construction are most likely due to the cyclic wetting and drying of the subgrade soils beneath the pavement.

Based on the findings of this study, to stabilize the roadway, the shale should be overexcavated a minimum of 24 inches below the base of the pavement section. Additionally, an underdrain system should be designed and installed to remove groundwater from beneath the roadway.

4. GENERAL NOTES AND LIMITATIONS

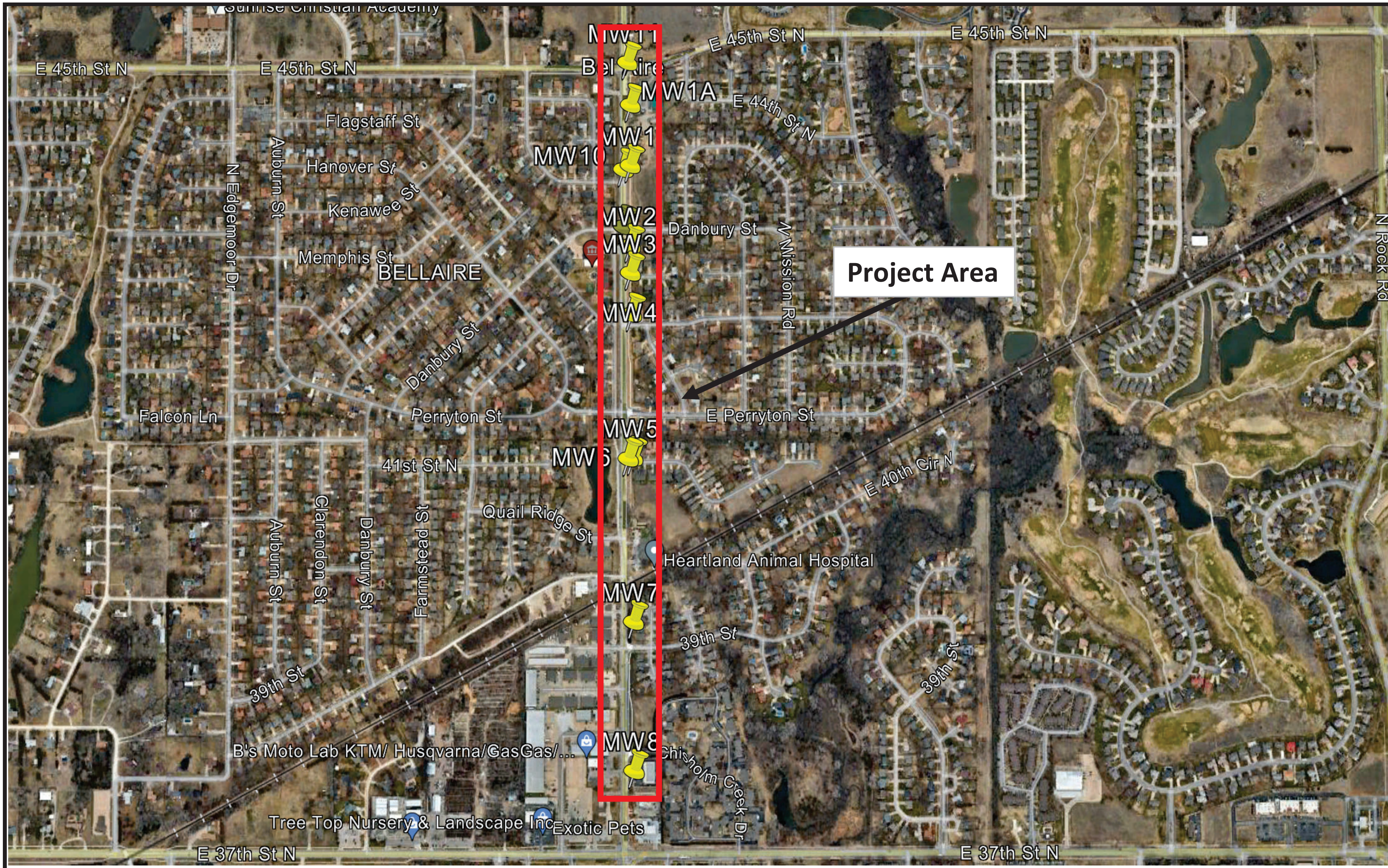
This report has been prepared in general accordance with widely accepted geotechnical engineering practices for the purpose of this project. The conclusions and recommendations presented in this report were based upon applicable standards of care in the project geographic area at the time this report was prepared. No warrantees or guarantees are intended.

We depended on project information provided to us to develop our conclusions and recommendations. If the project information described in this report is not accurate, or if it changes during course of project development, we should be notified of the changes so that we can modify our recommendations based on the additional information, if necessary.

Our conclusions were based on limited subsurface information obtained from our field explorations which consisted of periodic sampling in widely spaced, small diameter borings. Subsurface conditions may vary from those encountered in the borings and the variations may not become evident until construction. Our scope of services was intended to evaluate the soil conditions within the zone of soil influenced by the foundation system. If conditions are encountered which appear different than those described in our report, we should be notified, and our conclusion may need to be re-evaluated and adjusted.

Our Scope of Services does not address geologic conditions, such as sinkholes or soil conditions existing below the depth of the soil borings. In addition, this report should not be construed to represent subsurface conditions for the entire site.

FIGURES: Site and Well Locations

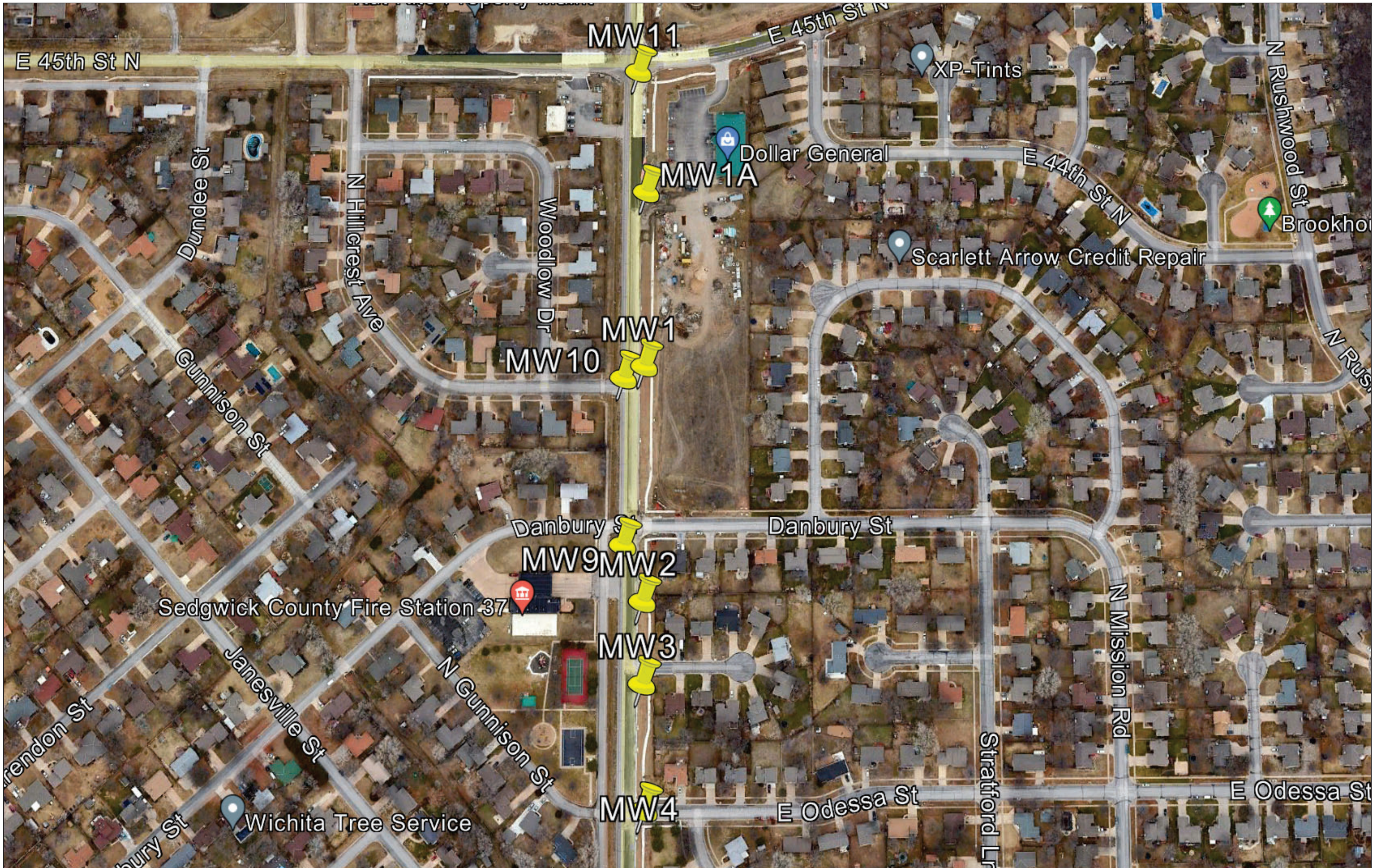


SITE LOCATION MAP

Bel Aire - Woodlawn Monitoring Wells
Bel Aire, Kansas
PEC Project No. 237363-003

PEC FIELD SERVICES

Figure 1



Standard Penetration Test Boring Approximate Location

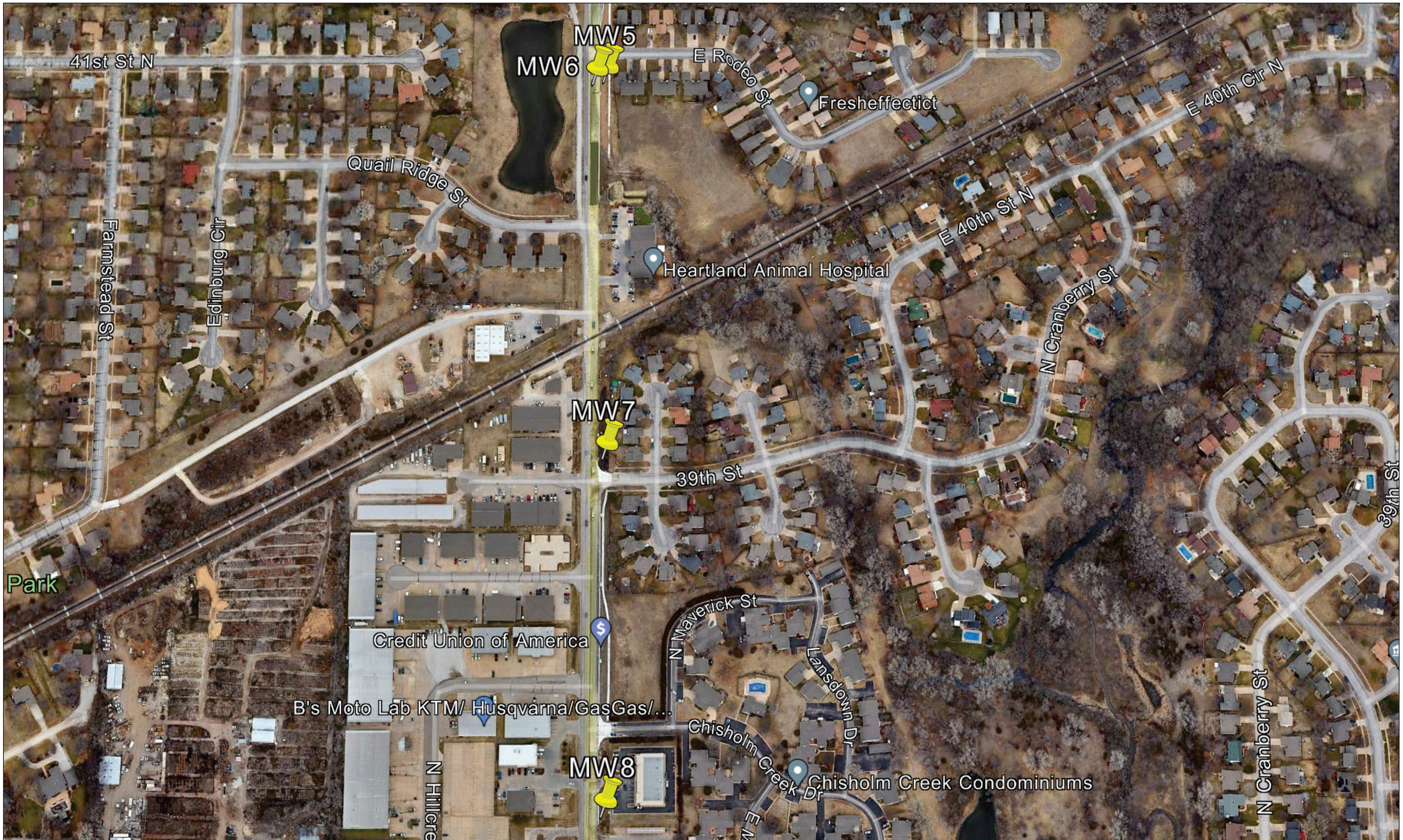
Plan provided by client for Boring location illustration only.
Not for Construction.

PEC FIELD SERVICES

BORING LOCATION PLAN

Bel Aire - Woodlawn Monitoring Wells
Bel Aire, Kansas
PEC Project No. 237363-003

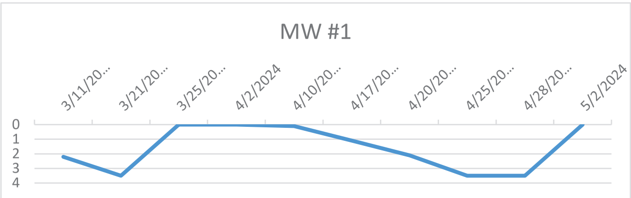
Figure 2

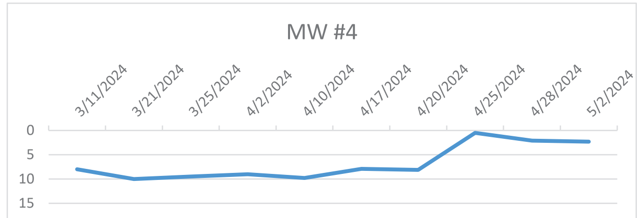


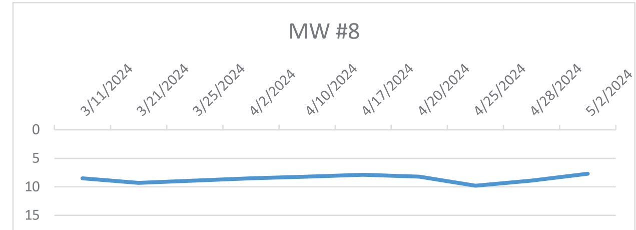
PEC FIELD SERVICES	**BORING LOCATION PLAN**
	Bel Aire - Woodlawn Monitoring Wells **Bel Aire, Kansas** **PEC Project No. 237363-003**

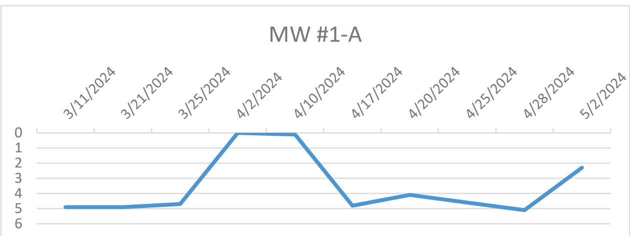
Figure 3

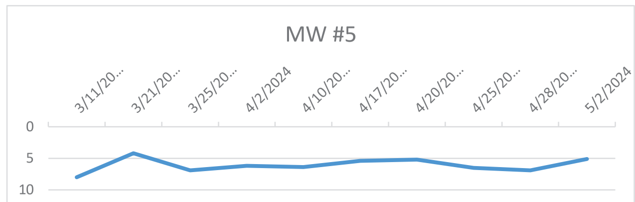
APPENDIX A: Monitoring Well Data and Graphs


MW #1
3/11/20… 3/21/20… 3/25/20… 4/2/2024 4/10/20… 4/17/20… 4/20/20… 4/25/20… 4/28/20… 5/2/2024
0 1 2 3 4


MW #4
3/11/2024 3/21/2024 3/25/2024 4/2/2024 4/10/2024 4/17/2024 4/20/2024 4/25/2024 4/28/2024 5/2/2024
0 5 10 15


MW #8
3/11/2024 3/21/2024 3/25/2024 4/2/2024 4/10/2024 4/17/2024 4/20/2024 4/25/2024 4/28/2024 5/2/2024
0 5 10 15


MW #1-A
3/11/2024 3/21/2024 3/25/2024 4/2/2024 4/10/2024 4/17/2024 4/20/2024 4/25/2024 4/28/2024 5/2/2024
0 1 2 3 4 5 6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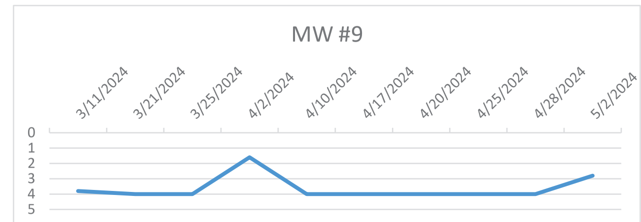
0 5 10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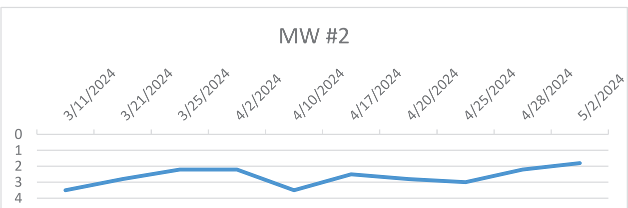
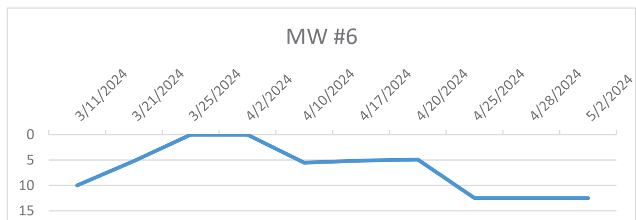
0 1 2 3 4 5


MW #2
3/11/2024 3/21/2024 3/25/2024 4/2/2024 4/10/2024 4/17/2024 4/20/2024 4/25/2024 4/28/2024 5/2/2024
0 1 2 3 4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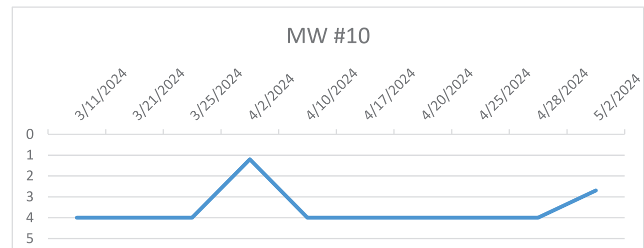
0 5 10 15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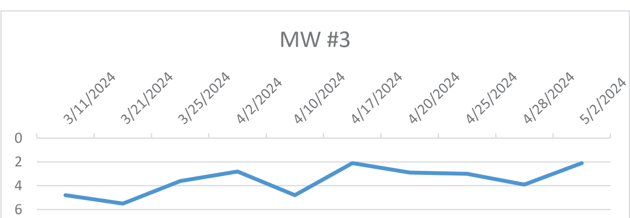
0 1 2 3 4 5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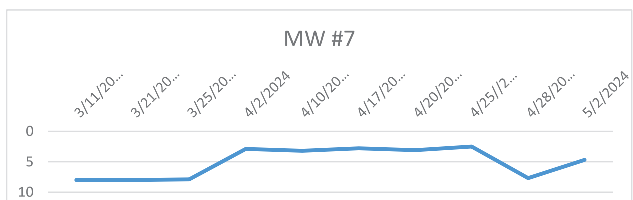
0 2 4 6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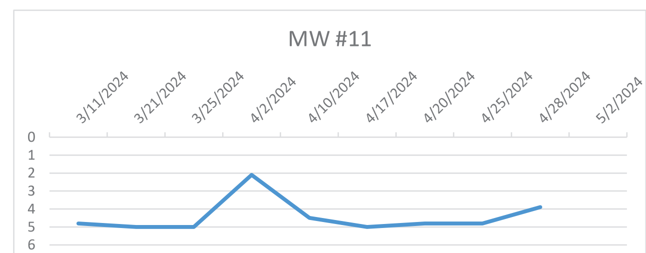
0 5 10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0 1 2 3 4 5 6

PEC
PROFESSIONAL ENGINEERING CONSULTANTS

BORING NUMBER: SB - 1

CLIENT City of Bel Aire
PROJECT NAME Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003
PROJECT LOCATION 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024
GROUND ELEVATION 1384.45' **HOLE SIZE** -
CONTRACTOR -
GROUND WATER LEVELS:
METHOD -
▽ **INITIALLY ENCOUNTERED** 2.2'
LOGGED BY BH **CHECKED BY** Bob Henthorne
▼ **AFTER 15 MIN.** N/A
NOTES -
HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Asphalt 0.6									
		Aggregate Base with Geotextile 1.0									
▽		Weathered Shale, Olive Green, Free Moisture	1380								

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BORING NUMBER: SB - 1 - A

CLIENT City of Bel Aire
PROJECT NAME Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003
PROJECT LOCATION 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024
GROUND ELEVATION 1387.84' **HOLE SIZE** -
CONTRACTOR -
GROUND WATER LEVELS:
METHOD -
INITIALLY ENCOUNTERED 3'
LOGGED BY BH **CHECKED BY** Bob Henthorne
AFTER 15 MIN. N/A
NOTES -
HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Asphalt 0.6									
		Aggregate Base with Geotextile 1.0									
		Silty Clay, with Weathered Shale 3.0	1385								
▽		Coarse Gravel, Free Water 6.0									
5											
		Weathered Shale, Soft, Free Moisture	1380								

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BORING NUMBER: SB - 2

CLIENT City of Bel Aire
PROJECT NAME Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003
PROJECT LOCATION 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024
GROUND ELEVATION 1381.88' **HOLE SIZE** -
CONTRACTOR -
GROUND WATER LEVELS:
METHOD -
▽ **INITIALLY ENCOUNTERED** 3.5'
LOGGED BY BH **CHECKED BY** Bob Henthorne
▼ **AFTER 15 MIN.** N/A
NOTES -
HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Asphalt 0.6									
		Aggregate Base plus Geotextile 1.0									
		Weathered Shale, Olive Green, Free Moisture	1380								
▽											

BORING NUMBER: SB - 3

PROFESSIONAL ENGINEERING CONSULTANTS

CLIENT	City of Bel Aire	**PROJECT NAME**	Woodlawn Monitoring Well Project
PROJECT NUMBER	237363-003	**PROJECT LOCATION**	37th to 45th street, Bel Aire Kansas
DATE STARTED	03/11/2024 **COMPLETED** 03/11/2024	**GROUND ELEVATION**	1381.06' **HOLE SIZE** -
CONTRACTOR	-	**GROUND WATER LEVELS:**	
METHOD	-	▽ **INITIALLY ENCOUNTERED**	4.8'
LOGGED BY	BH **CHECKED BY** Bob Henthorne	▼ **AFTER 15 MIN.**	N/A
NOTES	-	**HAMMER WEIGHT / DROP**	- / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Asphalt 0.6									
		Aggregate Base with Geotextile 1.0	1380								
		Silty Clay, Tan-green 2.8									
		Weathered Shale, Olive Green, Becoming Frimer at 4 ft.									
▽ 5			1375								

BORING NUMBER: SB - 4

PEC PROFESSIONAL ENGINEERING CONSULTANTS

CLIENT City of Bel Aire

PROJECT NAME Woodlawn Monitoring Well Project

PROJECT NUMBER 237363-003

PROJECT LOCATION 37th to 45th street, Bel Aire Kansas

DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024

GROUND ELEVATION 1381.38' **HOLE SIZE** -

CONTRACTOR -

GROUND WATER LEVELS:

METHOD -

▽ **INITIALLY ENCOUNTERED** 8'

LOGGED BY BH **CHECKED BY** Bob Henthorne

▼ **AFTER 15 MIN.** N/A

NOTES -

HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Silty Clay, Dark Brown									
0.6		Silty Clay, Light Brown, Free Moisture, Very Soft, Weight of Rod	1380								
5			1375								
▽ (8)											
10			1370								
13.7		Weathered Shale, Gray, Free Water									

PROFESSIONAL ENGINEERING CONSULTANTS

BORING NUMBER: SB - 5

CLIENT City of Bel Aire

PROJECT NAME Woodlawn Monitoring Well Project

PROJECT NUMBER 237363-003

PROJECT LOCATION 37th to 45th street, Bel Aire Kansas

DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024

GROUND ELEVATION 1374.33' **HOLE SIZE** -

CONTRACTOR -

GROUND WATER LEVELS:

METHOD -

▽ **INITIALLY ENCOUNTERED** 8'

LOGGED BY BH **CHECKED BY** Bob Henthorne

▼ **AFTER 15 MIN.** N/A

NOTES -

HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Silty Clay, Small Sand Pebbles									
			1370								
5											
▽											
			1365								
10											
			1360								

PEC PROFESSIONAL ENGINEERING CONSULTANTS

BORING NUMBER: SB - 6

CLIENT City of Bel Aire
PROJECT NAME Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003
PROJECT LOCATION 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024
GROUND ELEVATION 1374.33' **HOLE SIZE** -
CONTRACTOR -
GROUND WATER LEVELS:
METHOD -
▽ **INITIALLY ENCOUNTERED** 10'
LOGGED BY BH **CHECKED BY** Bob Henthorne
▼ **AFTER 15 MIN.** N/A
NOTES -
HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
0–0.6		Asphalt (0.6)									
0.6–11.5		Silty Clay, Brown, (11.5)	1370, 1365						20.8	58-41-17	
5											
10 (▽)											
11.5–		Weathered Shale, Olive Green-Gray, Free Moisture	1360								

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PROFESSIONAL ENGINEERING CONSULTANTS

BORING NUMBER: SB - 7

CLIENT City of Bel Aire

PROJECT NAME Woodlawn Monitoring Well Project

PROJECT NUMBER 237363-003

PROJECT LOCATION 37th to 45th street, Bel Aire Kansas

DATE STARTED - **COMPLETED** -

GROUND ELEVATION 1374.38' **HOLE SIZE** -

CONTRACTOR -

GROUND WATER LEVELS:

METHOD -

▽ **INITIALLY ENCOUNTERED**

LOGGED BY BH **CHECKED BY** Bob Henthorne

▼ **AFTER 15 MIN.** N/A

NOTES -

HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Fill Material, Silty Clay with Glass and other Debris									
			1370								
5											
		6.0									
		Weathered Shale, Olive Green to Gray									
			1365								

BORING NUMBER: SB - 8

PROFESSIONAL ENGINEERING CONSULTANTS

CLIENT City of Bel Aire	**PROJECT NAME** Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003	**PROJECT LOCATION** 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/11/2024 **COMPLETED** 03/11/2024	**GROUND ELEVATION** 1371.21' **HOLE SIZE** -
CONTRACTOR -	**GROUND WATER LEVELS:**
METHOD -	▽ **INITIALLY ENCOUNTERED** 8'
LOGGED BY BH **CHECKED BY** Bob Henthorne	▼ **AFTER 15 MIN.** N/A
NOTES -	**HAMMER WEIGHT / DROP** - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Silty Clay, Brown									
1.4			1370								
		Clay, Light Brown, Sandy, Soft									
5											
			1365								
7.6											
▽		Sand and Gravel, Minor amount of Clay									

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PROFESSIONAL ENGINEERING CONSULTANTS

BORING NUMBER: SB - 9

CLIENT	City of Bel Aire	**PROJECT NAME**	Woodlawn Monitoring Well Project
PROJECT NUMBER	237363-003	**PROJECT LOCATION**	37th to 45th street, Bel Aire Kansas
DATE STARTED	03/12/2024 **COMPLETED** -	**GROUND ELEVATION**	1384.41' **HOLE SIZE** -
CONTRACTOR	-	**GROUND WATER LEVELS:**	
METHOD	-	▽ **INITIALLY ENCOUNTERED**	3.8'
LOGGED BY	BH **CHECKED BY** Bob Henthorne	▼ **AFTER 15 MIN.**	N/A
NOTES	-	**HAMMER WEIGHT / DROP**	- / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Silty Clay, Brown 1.8									
		Weathered Shale, Tan to Olive Green, Soft							17.3	44-19-25	57
▽			1380								

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PROFESSIONAL ENGINEERING CONSULTANTS

BORING NUMBER: SB - 10

CLIENT City of Bel Aire
PROJECT NAME Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003
PROJECT LOCATION 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/12/2024 **COMPLETED** -
GROUND ELEVATION 1386.6' **HOLE SIZE** -
CONTRACTOR -
GROUND WATER LEVELS:
METHOD -
▽ **INITIALLY ENCOUNTERED**
LOGGED BY BH **CHECKED BY** Bob Henthorne
▼ **AFTER 15 MIN.** N/A
NOTES -
HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Silty Clay, Brown, Soft	1385								
2.0		Weathered Shale, Olive Green									

BORING NUMBER: SB - 11

PEC
PROFESSIONAL ENGINEERING CONSULTANTS

CLIENT City of Bel Aire
PROJECT NAME Woodlawn Monitoring Well Project
PROJECT NUMBER 237363-003
PROJECT LOCATION 37th to 45th street, Bel Aire Kansas
DATE STARTED 03/16/2024 **COMPLETED** 03/16/2024
GROUND ELEVATION 1391.46' **HOLE SIZE** -
CONTRACTOR -
GROUND WATER LEVELS:
METHOD -
▽ **INITIALLY ENCOUNTERED** 4.8'
LOGGED BY BH **CHECKED BY** Bob Henthorne
▼ **AFTER 15 MIN.** N/A
NOTES -
HAMMER WEIGHT / DROP - / -

Depth (Ft)	Graphic Log	Visual Classification and Remarks	Elevation (Ft)	Sample Graphic	Sample Number	REC / RQD	Blow Counts	Compressive Strength (Tsf)	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines
		Concrete Pavement 0.8									
		Aggregate Base 1.4	1390								
		Silty Clay, Brown-Gray 3.2							20.3	49-19-30	77
▽		Weathered Shale, Olive Green									

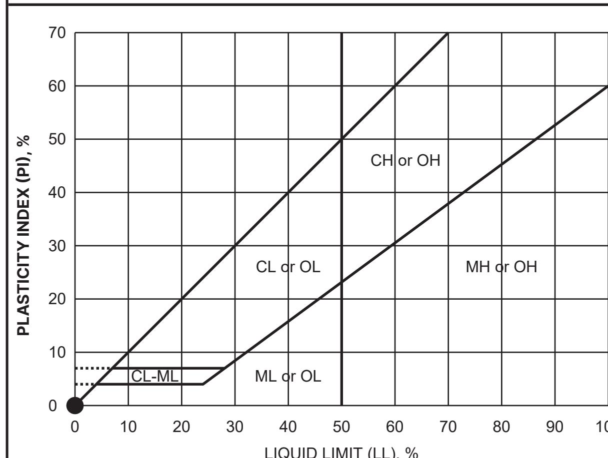
SOIL CLASSIFICATION CHART PER ASTM D 2488

PRIMARY DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly-graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly-graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly-graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction retained on No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly-graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly-graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly-graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic CLAY
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above 'A'-line)	organic CLAY
			OH (plots below 'A'-line)	organic SILT
	Highly Organic Soils		PT	Peat

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

PLASTICITY CHART



APPARENT DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

APPENDIX B: Laboratory Testing Program

Laboratory tests were performed on selected representative samples to evaluate pertinent engineering properties of the subsurface materials obtained from our borings. The results of these laboratory tests are presented on the respective boring logs in Appendix A, and are summarized in the Summary of Laboratory Results in Appendix B. The laboratory tests were performed in general accordance with the following ASTM standards:

- **Visual Classification**, ASTM D2488, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- **Moisture Content**, ASTM D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- **Atterberg Limits,** ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- **Percent finer the #200 sieve**, ASTM D1140, Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing.

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SUMMARY OF LABORATORY RESULTS

CLIENT

PROJECT NAME Bel Aire - Woodlawn Monitoring Wells

PROJECT NUMBER 237363-003

PROJECT LOCATION

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Unit Weight (pcf)	Satur-ation (%)	Void Ratio
MW-9	2.0	44	19	25	0.075	57	CL	17.3			
MW-9	6.0	58	41	17				20.8			
MW-11	1.0	49	19	30	0.075	77	CL	20.3			

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Construction | Survey | Geotechnical Engineering
350 South Washington Wichita, Ks 67202
Phone 316-262-6457 Fax 316-262-6592
www.pec1.com email: FieldServices@pec1.com

Unconfined Compressive Strength Report

Bel Aire

Woodlawn Monitoring Wells

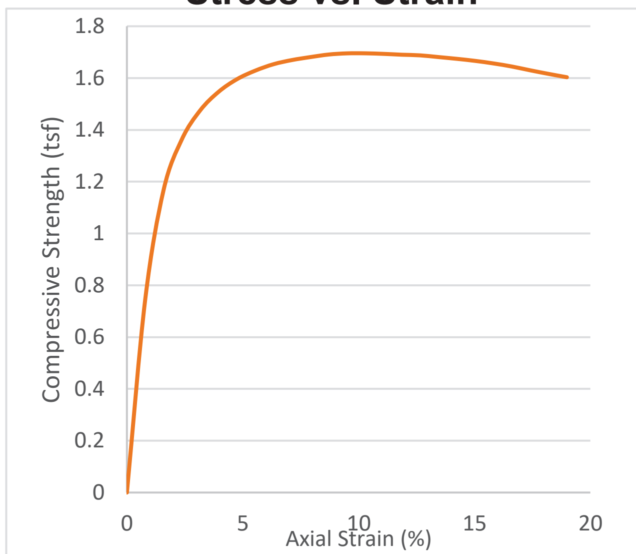
Bel Aire, Kansas

Project No. : 237363-003

Sample Details

Source	MW-9
Sample ID	2.0 - 4.0
Sampling Method	3-inch Shelby
Date Tested	4/1/2024
Material Type	CL
Unconfined Strength, tsf	1.695
Undrained Shear Strength, tsf	0.848
Failure Strain, %	10.28
Strain Rate, in./min.	2.234
Wet Density, pcf	128.36
Dry Density, pcf	109.40
Void Ratio	0.5400
Specimen Diameter, in.	2.87
Speciment Height, in.	3.16
Height/Diameter ratio	1.10

Stress vs. Strain



Sample Photograph

Comments:

- none -

Tested By: D. Riley Checked By: P. Younkin

Figure 6

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Unconfined Compressive Strength Report

Bel Aire

Woodlawn Monitoring Wells

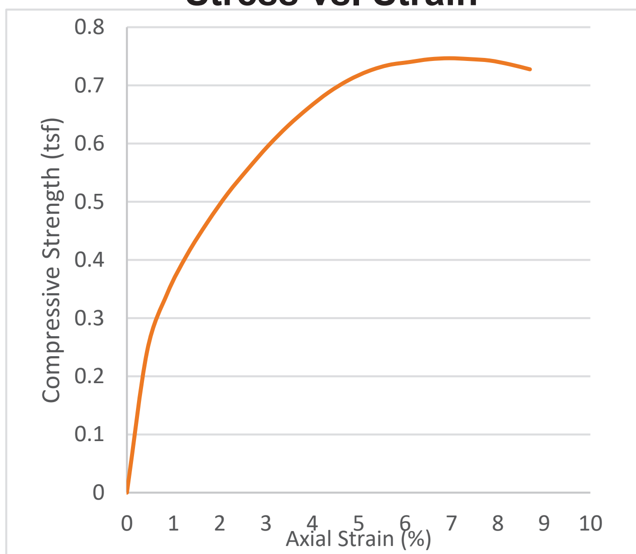
Bel Aire, Kansas

Project No. : 237363-003

Sample Details

Source	MW-9
Sample ID	6.0 - 9.0
Sampling Method	3-inch Shelby
Date Tested	4/1/2024
Material Type	Shale
Unconfined Strength, tsf	0.747
Undrained Shear Strength, tsf	0.373
Failure Strain, %	6.96
Strain Rate, in./min.	1.228
Wet Density, pcf	119.22
Dry Density, pcf	98.69
Void Ratio	0.7072
Specimen Diameter, in.	2.87
Speciment Height, in.	5.75
Height/Diameter ratio	2.00

Stress vs. Strain



Sample Photograph

Comments:

- none -

Tested By: D. Riley

Checked By: P. Younkin

Figure 6

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Unconfined Compressive Strength Report

Bel Aire

Woodlawn Monitoring Wells

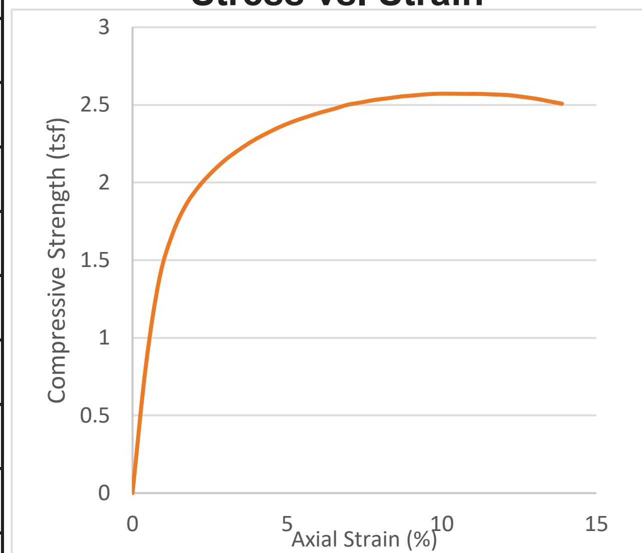
Bel Aire, Kansas

Project No. : 237363-003

Sample Details

Source	MW-11
Sample ID	1.0 - 3.0
Sampling Method	3-inch Shelby
Date Tested	4/1/2024
Material Type	CL
Unconfined Strength, tsf	2.572
Undrained Shear Strength, tsf	1.286
Failure Strain, %	9.98
Strain Rate, in./min.	1.225
Wet Density, pcf	128.19
Dry Density, pcf	106.58
Void Ratio	0.5808
Specimen Diameter, in.	2.86
Speciment Height, in.	5.76
Height/Diameter ratio	2.01

Stress vs. Strain



Sample Photograph

Comments:

- none -

Tested By: D. Riley Checked By: P. Younkin

Figure 6

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GENERAL GEOTECHNICAL NOTES

SOIL CLASSIFICATION TERMINOLOGY

Soil classification is based on ASTM D-2487 "Soil Classification for Engineering Purposes" which is based on the Unified Soil Classification System. Fine grained soils have less than 50 percent of their particles retained on the No. 200 sieve. These soils are classified as silts if they are non-plastic to slightly plastic and as clays if they classify as plastic. Coarse grained soils have more than 50 percent of their particles retained on the No. 200 sieve and are classified as sands, gravels, cobbles and boulders depending on the grain size. Minor and major constituents may be added as modifiers depending on the proportions of the soil types. Additionally, fine grained soils are described based on their consistency and coarse grained soils are delineated by their relative density. Examples: Fat clay with sand (CH) and Silty sand (SM).

WATER LEVEL MEASUREMENTS

Water level measurements presented on the test boring logs are for the times indicated. These measurements may not necessarily represent the actual groundwater levels at the site. Fine grained soils of low permeability may require measurements for extended periods to accurately reflect free water levels. Coarse grained soils will generally reflect true groundwater levels after short periods. Groundwater levels and seepage water can vary depending on time of year, climatic conditions and other factors beyond the scope of normal geotechnical explorations. Typical water level abbreviations follows:

WD - Water level during drilling
W24 - Water level 24 hours after drilling
CW - Depth to wet cave of boring
WA - Water level after drilling
W48 - Water level 48 hours after drilling
CD - Depth to dry cave of boring

SAMPLING AND DRILLING OBSERVATIONS

Drilling and sampling procedures are typically performed in accordance with ASTM standards unless otherwise noted. Typical sampling and drilling abbreviations follows:

P - Standard Penetration sampler
(1-3/8 in. ID split-spoon)
S - 3 in. diameter thin walled Shelby Tube
D - Denison Barrel Sampler
B - Bulk/grab sample
SB - Sawtooth bit barrel sampler
CF4 - 4 in. diameter continuous flight auger
CF6 - 6 in. diameter continuous flight auger
HS - 7-1/4 in. diameter hollow stem auger
NX - Diamond bit coring