March 30, 2018

Allan Batka
United States Environmental Protection Agency, Region 5
77 W. Jackson Blvd.
Chicago, IL 60604-359

Subject: Replacement Forms for UIC Class I Non Hazardous Permit Application for Proposed Wells BDW-1 through BDW-5

Dear Sir:

On the behalf of Buckeye Terminals, LLC, please find the following signed originals EPA Form 7520-6 for proposed brine disposal wells BDW-1 through BDW-5 to be installed at Buckeye Terminals, LLC, Woodhaven Terminal in Wayne County, Michigan.

The well latitudes and longitudes have been changed to match the correct well locations. Please replace the forms signed on December 15th, 2017 with the enclosed forms signed on March 23rd, 2018.

Kind regards,

Brandon Schulte

BMS/bms
Encl.
cc: Brian Ball, Buckeye Partners L.P.

WSP USA
Suite 200
16200 Park Row
Houston, TX 77084

Tel.: +1 281 589-5900
Fax: +1 281 759-5164
wsp.com

OMB No. 2040-0042 Approval Expires 11/30/2014

United States Environmental Protection Agency

EPA

Underground Injection Control Permit Application

(Collected under the authority of the Safe Drinking Water Act. Sections 1421, 1422, 40 CFR 144)

I. EPA ID Number

		T/A	C
U			

Read Attached Instructions Before Starting

For Official Use Only

Application approved mo day year	Date received mo day year	Permit Number	Well ID	FINDS Number

II. Owner Name and Address

Owner Name: Buckeye Terminals, LLC

Street Address: One Greenway Plaza | Phone Number: (832) 214-6026

City: Houston | State: TX | ZIP CODE: 77046

III. Operator Name and Address

Owner Name: Buckeye Terminals, LLC

Street Address: 20755 West Road | Phone Number:

City: Woodhaven | State: MI | ZIP CODE: 48483

IV. Commercial Facility

- [ ] Yes
- [x] No

V. Ownership

- [x] Private
- [ ] Federal
- [ ] Other

VI. Legal Contact

- [x] Owner
- [ ] Operator

VII. SIC Codes

4226

VIII. Well Status *(Mark "x")*

- [ ] A. Operating — Date Started mo day year:
- [ ] B. Modification/Conversion
- [x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

- [x] A. Individual
- [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-1

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
42	8	19.8	83	13	58.5	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

- [ ] Yes
- [x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A--U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

XIV. Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

A. Name and Title *(Type or Print)*: Carl A. Ostach, VP Domestic Field Operations

B. Phone No. *(Area Code and No.)*: (610) 904-4262

C. Signature: Carl A. Ostach

D. Date Signed: 3/23/18

EPA Form 7520-6 (Rev. 12-11)

OMB No. 2040-0042 Approval Expires 11/30/2014

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- [x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

- [x] A. Individual
- [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-2

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Min	Sec	Longitude Deg	Min	Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
42	8	19.4	83	13	58.4	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

- [ ] Yes
- [x] No

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- [ ] B. Modification/Conversion
- [x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

- [x] A. Individual
- [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-3

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
42	8	9.2	83	13	56.7	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

- [ ] Yes
- [x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

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- [ ] A. Operating — Date Started mo day year:
- [ ] B. Modification/Conversion
- [x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

- [x] A. Individual
- [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-4

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

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42	8	9.8	83	13	56.9	22	04S	10E	NE				

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- [ ] Yes
- [x] No

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VI. Legal Contact

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- [ ] B. Modification/Conversion
- [x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

- [x] A. Individual
- [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-5

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
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XI. Location of Well(s) or Approximate Center of Field or Project

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C. Signature: Carl A. Ostach

D. Date Signed: 3/23/18

EPA Form 7520-6 (Rev. 12-11)

BUCKEYE TERMINALS, LLC

CLASS I NON-HAZARDOUS PERMIT APPLICATION FOR PROPOSED BDW-1 THROUGH BDW-5

WOODHAVEN TERMINAL, WAYNE COUNTY, MICHIGAN

DECEMBER 15, 2017

CLASS I NON-HAZARDOUS PERMIT APPLICATION FOR PROPOSED BDW-1 THROUGH BDW-5

WOODHAVEN TERMINAL, WAYNE COUNTY, MICHIGAN

BUCKEYE TERMINALS, LLC

PROJECT NO.: 192065A
DATE: DECEMBER 2017

WSP USA
SUITE 200
16200 PARK ROW
HOUSTON, TX 77084

TEL.: +1 281 589-5900
FAX: +1 281 759-5164
WSP.COM

December 15, 2017

Stephen Jann, UIC Branch Chief
United States Environmental Protection Agency, Region 5
77 W. Jackson Blvd.
Chicago, IL 60604-359

Subject: Submission of Class I UIC Non-Hazardous Permit Application for Proposed Wells BDW-1 through BDW-5 and Class III Area Permit for Proposed Wells CW-1 through CW-4

Dear Sir:

On the behalf of Buckeye Terminals, LLC, please find the following permit applications for proposed Class 1 non-hazardous injection wells (BDW-1 through BDW-5) and Class III area permit application for proposed cavern wells (CW-1 through CW-4) to be installed at Buckeye Terminals, LLC, Woodhaven Terminal in Wayne County, Michigan. The following is included with this transmittal letter.

- (2) Prints of Class I Non-Hazardous Permit Application for Proposed BDW-1 Through BDW-5
- (2) Prints of Class III Area Permit Application for Proposed Caverns Wells CW-1 through CW-4
- (2) USB Drives Containing PDF Files of Abovementioned Permit Applications, Complete with Bookmarks and Hyperlinks

Kind regards,

Brandon Schulte

BMS/bms
Encl.
cc: Brian Ball, Buckeye Partners L.P.

WSP USA
Suite 200
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SIGNATURES

PREPARED BY

Graciela E. Moore, P.G.
Senior Geologist

REVIEWED BY

Brandon Schulte, P.E.
Mgr. Permitting & Well Integrity

PRODUCTION TEAM

CLIENT

Senior Manager	Grant McHardy
Vice President	Brian Ball

WSP

Senior Geologist	Graciela Moore, P.G.
Mgr. Permitting & Well Integrity	Brandon Schulte, P.E.
Drilling Engineer	Tim Jones

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C DRILLING FLUID PROGRAM (SEE ATTACHMENT L)

D WASTE ANALYSIS PLAN (SEE ATTACHMENT P)

E EPA PLUGGING AND ABANDONMENT PLAN - EPA FORM 7540-14 (SEE ATTACHMENT Q)

ACRONYMS

AB-LOC	Abandoned Location
AOR	Area of Review
bbls	barrels
bgs	below ground surface
BHA	Bottom Hole Assembly
BOP	Blowout Preventer
BWOC	Percent of material added to cement
BWOW	Percent of a material added to a cement slurry based on the weight of water
CESQG	Conditionally Exempt Small Quantity Generator
cf/sk	cubic foot per sack
D&A	Dry and Abandoned
EIS	Emissions Inventory System
EPA	Environmental Protection Agency - Region 5
gal/sk	gallons per sack
gpm	gallons per minute
GSTG	Liquified Petroleum Gas Storage - Active
LCM	Solid material introduced into a mud system
md	millidarcy
MD	measured depth
MDEQ	Michigan Department of Environmental Quality
mg/L	milligram per liter
MIT	Mechanical Integrity Test
NPDES	National Pollutant Discharge Elimination System
PPF	pounds per foot
ppg	pounds per gallon
psi	pound per square inch
psi/ft	pound per square inch per foot
psig	pounds per square inch gauge
RCRA	Resource Conservation and Recovery Act
SWDOP	Liquified Petroleum Gas Storage - Plugging Approved
SWPPP	Stormwater Pollution Prevention Plan

TD	Total Depth
TDS	Total Dissolved Solids
TSDF	Hazardous Waste Treatment, Storage, or Disposal Facilities
TVD	Total Vertical Depth
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water

APPLICATION INTRODUCTION

Buckeye Terminals, LLC ("Buckeye") is seeking permit application approval from the Environmental Protection Agency - Region 5 (EPA) Underground Injection Control (UIC) for non-hazardous Class I injection wells (brine disposal wells) to be installed at Buckeye Woodhaven Terminal in Wayne County, Michigan. The five proposed non-hazardous injection wells are to be used for disposal of brine associated with the development and maintenance of below-ground salt cavern hydrocarbon storage wells.

Buckeye Terminals, LLC currently operates a terminal at Woodhaven that uses surface tanks to store gasoline, diesel fuel, and ethanol. Approximately 990,000 barrels (bbls) of tank storage is present at the Woodhaven Terminal. An additional four solution-mined salt cavern hydrocarbon storage wells are proposed for the facility. The salt cavern wells permit application, US EPA UIC Class III Permit Application, is provided in a separate application document. The salt caverns will be developed in the Salina B salt formation by injecting fresh water and producing brine. The five proposed non-hazardous injection wells are to dispose of produced brine during cavern development and any excess brines created through normal cavern operation.

The proposed wells will operate under the UIC program 40 CFR 146.

Enclosed in this permit application are copies of EPA Form 7520-6 completed for each proposed well along with associated attachments. Attachments are keyed to the letter designations indicated in the instructions for EPA Form 7520-6. To ease agency review, the application has been prepared to the format outlined in the EPA Region 5 Permit Application Checklist for Class I Injection Wells in Michigan/Indiana (completed checklist included in Appendix A).

OMB No. 2040-0042 Approval Expires 11/30/2014

EPA

United States Environmental Protection Agency

Underground Injection Control Permit Application

(Collected under the authority of the Safe Drinking Water Act. Sections 1421, 1422, 40 CFR 144)

I. EPA ID Number

	T/A	C
U		

Read Attached Instructions Before Starting

For Official Use Only

Application approved mo day year	Date received mo day year	Permit Number	Well ID	FINDS Number

II. Owner Name and Address

Owner Name: Buckeye Terminals, LLC

Street Address: One Greenway Plaza

Phone Number: (832) 214-6026

City: Houston State: TX ZIP CODE: 77046

III. Operator Name and Address

Owner Name: Buckeye Terminals, LLC

Street Address: 20755 West Road

Phone Number:

City: Woodhaven State: MI ZIP CODE: 48483

IV. Commercial Facility

[x] Yes
[ ] No

V. Ownership

[x] Private
[ ] Federal
[ ] Other

VI. Legal Contact

[x] Owner
[ ] Operator

VII. SIC Codes

4226

VIII. Well Status *(Mark "x")*

[ ] A. Operating — Date Started mo day year:

[ ] B. Modification/Conversion

[x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

[x] A. Individual [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-1

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
2	1	30	12	57	39	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

[ ] Yes
[x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A--U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

XIV. Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

A. Name and Title *(Type or Print)*: Carl A. Ostach, VP Domestic Field Operations

B. Phone No. *(Area Code and No.)*: (610) 904-4262

C. Signature: Carl A. Ostach

D. Date Signed: 12/15/17

EPA Form 7520-6 (Rev. 12-11)

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City: Houston | State: TX | ZIP CODE: 77046

III. Operator Name and Address

Owner Name: Buckeye Terminals, LLC

Street Address: 20755 West Road

Phone Number:

City: Woodhaven | State: MI | ZIP CODE: 48483

IV. Commercial Facility

[x] Yes
[ ] No

V. Ownership

[x] Private
[ ] Federal
[ ] Other

VI. Legal Contact

[x] Owner
[ ] Operator

VII. SIC Codes

4226

VIII. Well Status *(Mark "x")*

[ ] A. Operating — Date Started mo day year:

[ ] B. Modification/Conversion

[x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

[x] A. Individual [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-2

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (If area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
2	I	28	12	57	39	22	04S	10E	NW				

XII. Indian Lands (Mark 'x')

[ ] Yes
[x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

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Underground Injection Control Permit Application

(Collected under the authority of the Safe Drinking Water Act. Sections 1421, 1422, 40 CFR 144)

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		T/A	C
U			

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III. Operator Name and Address

Owner Name: Buckeye Terminals, LLC

Street Address: 20755 West Road

Phone Number:

City: Woodhaven State: MI ZIP CODE: 48483

IV. Commercial Facility

[x] Yes
[ ] No

V. Ownership

[x] Private
[ ] Federal
[ ] Other

VI. Legal Contact

[x] Owner
[ ] Operator

VII. SIC Codes

4226

VIII. Well Status *(Mark "x")*

[ ] A. Operating — Date Started mo day year:

[ ] B. Modification/Conversion

[x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

[x] A. Individual [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-3

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
2	2	8.3	12	57	13	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

[ ] Yes
[x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A--U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

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I. EPA ID Number

		T/A	C
U			

Read Attached Instructions Before Starting

For Official Use Only

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Street Address: One Greenway Plaza | Phone Number: (832) 214-6026

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Owner Name: Buckeye Terminals, LLC

Street Address: 20755 West Road | Phone Number:

City: Woodhaven | State: MI | ZIP CODE: 48483

IV. Commercial Facility

[x] Yes
[ ] No

V. Ownership

[x] Private
[ ] Federal
[ ] Other

VI. Legal Contact

[x] Owner
[ ] Operator

VII. SIC Codes

4226

VIII. Well Status *(Mark "x")*

[ ] A. Operating — Date Started mo day year:

[ ] B. Modification/Conversion

[x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

[x] A. Individual [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
0	1	BDW-4

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
2	1	27	12	57	43	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

[ ] Yes
[x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A--U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

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B. Phone No. *(Area Code and No.)*: (610) 904-4262

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D. Date Signed: 12/15/17

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Underground Injection Control Permit Application

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I. EPA ID Number

		T/A	C
U			

Read Attached Instructions Before Starting

For Official Use Only

Application approved mo day year	Date received mo day year	Permit Number	Well ID	FINDS Number

II. Owner Name and Address

Owner Name			
Buckeye Terminals, LLC			
Street Address		Phone Number	
One Greenway Plaza		(832) 214-6026	
City	State	ZIP CODE	
Houston	TX	77046	

III. Operator Name and Address

Owner Name		
Buckeye Terminals, LLC		
Street Address		Phone Number
20755 West Road		
City	State	ZIP CODE
Woodhaven	MI	48483

IV. Commercial Facility

- [x] Yes
- [ ] No

V. Ownership

- [x] Private
- [ ] Federal
- [ ] Other

VI. Legal Contact

- [x] Owner
- [ ] Operator

VII. SIC Codes

4226

VIII. Well Status *(Mark "x")*

[ ] A. Operating	Date Started mo day year	[ ] B. Modification/Conversion	[x] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

[x] A. Individual	[ ] B. Area	Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
		0	1	BDW-5

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
I	I		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
2	1	24	12	57	43	22	04S	10E	NE				

XII. Indian Lands (Mark 'x')

- [ ] Yes
- [x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A--U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

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A. Name and Title *(Type or Print)*	B. Phone No. *(Area Code and No.)*
Carl A. Ostach, VP Domestic Field Operations	(610) 904-4262
C. Signature: Carl A. Ostach	D. Date Signed: 12/15/17

EPA Form 7520-6 (Rev. 12-11)

A. AREA OF REVIEW

Buckeye Terminals, LLC Woodhaven Terminal is located in south-central Wayne County, Michigan, approximately 15 miles southwest of the city of Detroit. Five injection wells are proposed to be installed at this terminal.

The Area of Review (AOR) is the area surrounding an injection well that is set at a minimum fixed radius of 2 miles for non-hazardous wells. Well data available from public records within the AOR are tabulated in Table A-1 (non-freshwater) and Table A-2 (freshwater). Twenty-three (23) non-freshwater wells and eight freshwater wells were identified within the AOR. The non-freshwater wells include:

- Active liquefied petroleum gas storage – 8 wells;
- Gas storage (plugging approved) - 8 wells;
- Brine disposal - 1 well;
- Dry and abandoned - 4 wells; and
- Abandoned locations – 2 wells.

The above wells include active storage caverns at the site operated by Marathon Oil Co. (five storage caverns, one disposal well, and three brine recovery wells). The storage caverns at the site formerly operated by Phillips Petroleum Co. (two caverns and one brine disposal well) and Mobil Oil Co. (four caverns and two brine disposal wells), but have since been plugged and abandoned.

Two of the wells reviewed within the AOR penetrate the top of the confining zone, Utica-Trenton, which is projected to occur at a depth of approximately 2,060 feet below ground surface (bgs). Well API # 21163004199000 is listed as dry and abandoned. Well API #21163001468000 is a salt water disposal well operated by Marathon Pipe Line LLC (original operator Marathon Oil Co). A geophysical log recorded downhole in Well API #21163001468000 is shown on the cross section provided on Figures F-4 and F-5 in Attachment F. As demonstrated in Attachment C, no corrective action is necessary for this site.

Surrounding wells, with the exception of shallow monitoring wells and borings, are shown on the map provided in Attachment B.

List of Tables in Attachment A

Table A-1 Non-Freshwater (Oil and Gas) Wells in Area of Review

Table A-2 Freshwater Wells in 2-Mile Area of Review

TABLE A-1
NON-FRESHWATER (OIL AND GAS) WELLS IN AREA OF REVIEW
BUCKEYE TERMINAL, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

Map ID	API	Township-Range-Section	Footage	Lease Name	Well Num	Current Operator	Status and Type	Drill Date	Depth (feet)
1	2116324850	4S 10E 10	487 FNL 1065 FEL CONGRESS SECTION	PHILLIPS PETROLEUM CO	1	PHILLIPS PETRLM CO	D&A	1963-08-14	1315
2	2116300135	4S 10E 10	735 FNL 1065 FEL CONGRESS SECTION	PHILLIPS PETROLEUM COMPANY	BD-2	PHILLIPS PETRLM CO	AB-LOC		
3	2116324851	4S 10E 10	992 FNL 1065 FEL CONGRESS SECTION	PHILLIPS PETROLEUM CO	2	PHILLIPS PETRLM CO	D&A	1963-09-03	1315
4	2116327160	4S 10E 22	525 FNL 143 FEL CONGRESS SECTION	MARATHON OIL LPG	1	MARATHON PIPELINE CO	GSTG	1968-04-11	1156
5	2116323775	4S 10E 22	1470 FNL 120 FEL CONGRESS SECTION	SOCONY-MOBIL OIL	3-A	MOBIL OIL CORP	SWDOP	1961-12-14	1158
6	2116323776	4S 10E 22	1570 FNL 120 FEL CONGRESS SECTION	SOCONY-MOBIL OIL	3-B	MOBIL OIL CORP	SWDOP	1961-12-29	1150
7	2116323673	4S 10E 22	1500 FNL 660 FEL CONGRESS SECTION	FEE	1	MOBIL OIL CORP	SWDOP	1961-10-17	1162
8	2116323774	4S 10E 22	1800 FNL 660 FEL CONGRESS SECTION	SOCONY-MOBIL	2	MOBIL OIL CORP	SWDOP	1962-02-01	1148
9	2116300145	4S 10E 22	1918 FNL 356 FEL CONGRESS QTR	MOBIL OIL CORPORATION	BD2	MOBIL OIL CORP	SWDOP	1967-11-01	365
10	2116323777	4S 10E 22	1870 FNL 120 FEL CONGRESS SECTION	SOCONY-MOBIL	4-A	MOBIL OIL CORP	SWDOP	1962-01-09	1147
11	2116300133	4S 10E 22	1895 FNL 120 FEL CONGRESS SECTION	SOCONY-MOBIL OIL	BD-1	MOBIL OIL CORP	SWDOP	1962-01-18	330
12	2116323778	4S 10E 22	1970 FNL 12 FEL CONGRESS SECTION	SOCONY-MOBIL OIL	4-B	MOBIL OIL CORP	SWDOP	1962-01-24	1162
13	2116300146	4S 10E 22	561 FNL 342 FEL CONGRESS QTR	FEE	BD-1	MARATHON PIPELINE CO	Brine Disposal	12/12/1968	3745
14	2116327161	4S 10E 22	525 FNL 629 FEL CONGRESS QTR	MARATHON OIL LPG	2	MARATHON PIPELINE CO	GSTG	1968-03-12	1154
15	2116328435	4S 10E 22	1580 FSL 204 FEL CONGRESS SECTION	MARATHON OIL CO	BR-1	MARATHON PIPELINE CO	GSTG	1971-07-08	1150
16	2116327162	4S 10E 22	781 FNL 341 FEL CONGRESS QTR	MARATHON OIL LPG	4	MARATHON PIPELINE CO	GSTG	1968-02-14	1154
17	2116331007	4S 10E 22	1186 FNL 670 FEL CONGRESS QTR	MARATHON OIL COMPANY BR	BR-2	MARATHON PIPELINE CO	AB-LOC		
18	2116327980	4S 10E 22	781 FNL 1314 FEL CONGRESS QTR	MARATHON OIL LPG	6	MARATHON PIPELINE CO	GSTG	1970-05-27	1165
19	2116332882	4S 10E 22	1165 FNL 709 FEL CONGRESS QTR	MARATHON OIL CO	2	MARATHON PIPELINE CO	GSTG	1979-07-11	1158
20	2116332883	4S 10E 22	1135 FNL 1158 FEL CONGRESS QTR	MARATHON OIL CO	BR-3	MARATHON PIPELINE CO	GSTG	1979-06-13	1130
21	2116327528	4S 10E 22	785 FNL 823 FEL CONGRESS QTR	FEE	5	MARATHON PIPELINE CO	GSTG	1969-01-31	1155
22	2116357361	4S 10E 22	990 FSL 1070 FEL CONGRESS SECTION	WOODHAVEN WELL	3	MARATHON PIPELINE CO	D&A	2005-12-01	1244
23	21163004199	4S 10E 35		W.E. ELLIS	1	W E ELLIS	D&A	4/11/1927	3055

Note:
D&A = Dry and Abandoned
AB-LOC = Abandoned Location
GSTG - Liquified Petroleum Gas Storage - Active
SWDOP - Gas Storage - Plugging Approved

TABLE A-2
FRESHWATER WELLS WITHIN 2-MILE AREA OF REVIEW
BUCKEYE TERMINAL, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

WELLID	USE	OWNER NAME	COUNTY	DEPTH (feet)	DATE	SECTION	TOWNSHIP	RANGE	EASTING	NORTHING
82000001604	OTHER	MARATHON OIL*	Wayne	1156	5/3/68	22	04S	10E	-83.226748	42.13917558
82000001605	OTHER	SOCONY MOBIL OIL CO.	Wayne	1162	11/18/61	22	04S	10E	42.136549	-83.2285466
82000001606	OTHER	MOBIL OIL CO.	Wayne	365	11/14/67	22	04S	10E	-83.227492	42.13530271
82000001607	OTHER	MARATHON OIL CO.*	Wayne	1155	2/19/69	22	04S	10E	-83.229152	42.13851764
82000001608	OTHER	SOCONY MOBIL OIL CO.	Wayne	1158	12/22/61	22	04S	10E	42.136654	-83.2265824
82000001609	OTHER	MARATHON OIL CO.*	Wayne	1153	3/7/68	22	04S	10E	-83.227232	42.13866968
82000001610	OTHER	SOCONY MOBIL OIL CO.	Wayne	1149	1/3/62	22	04S	10E	42.136247	-83.2264726
82000001611	OTHER	MARATHON OIL CO.*	Wayne	1142	4/18/72	22	04S	10E	-83.226853	42.13621126

NOTES:

Source: Michigan Department of Environmental Quality - Wellogic Systems

Datum: NAD27

* - Cavern Well

B. MAPS OF WELLS (AREA OF REVIEW)

B.1 MAPS

Figure B-1 was prepared using a compilation of USGS 7 ½ minute series topographic quadrangle maps: Flat Rock NE, MI; Wyandotte, MI, ON; Flat Rock, MI; and Rockwood, MI. This figure shows the proposed injection well locations, the property boundary, the AOR for the proposed injection wells, surface features, and one listed Hazardous Waste Treatment, Storage, or Disposal Facilities (TSDF) (see Attachment B.3). There are no known faults within the AOR.

Figure B-2 illustrates the property boundary, the AOR boundary, freshwater and non-freshwater penetrations, and cross section line locations for regional cross sections provided in Attachment F.

B.2 ADJACENT LANDOWNERS

Table B-1 is a list of property landowners that are within ¼ mile radius of the proposed injection well locations (Figure B-3).

B.3 HAZARDOUS WASTE TREATMENT, STORAGE, OR DISPOSAL FACILITIES (TSDF)

A search of the TSDF in the vicinity of the Woodhaven Terminal was conducting using the EPA Enforcement and Compliance History Online Facility Search (2017). One TSDF is located within the AOR as shown on Figure B-1:

1 Solutia Inc. (Resource Conservation and Recovery Act [RCRA] ID: MID009708678)
5045 W. Jefferson Ave.
Trenton, MI
Current Compliance Status: Noncompliance
Designation: Conditionally Exempt Small Quantity Generator (CESQG)

B.4 PROTOCOL FOR IDENTIFYING WELLS

B.4.1 NON-FRESHWATER RECORDS

Records for oil and gas wells in the state of Michigan are maintained by the Mineral Wells Division of the Michigan Department of Environmental Quality (MDEQ), which is the primary regulatory agency that enforces compliance with oil and gas rules and regulations. Well permits, completions, and pluggings filed with this agency are maintained by county, township, range and section number.

Information on non-freshwater wells located in the AOR was reviewed. Well data available from public records within the AOR for non-freshwater wells are tabulated in Table A-1. Twenty-three (23) non-freshwater wells were identified within the AOR. The non-freshwater wells include:

- Active liquefied petroleum gas storage – 8 wells;
- Gas storage (plugging approved) - 8 wells;

- Brine disposal - 1 well;
- Dry and abandoned - 4 wells; and
- Abandoned locations – 2 wells.

The above wells include active storage caverns near the site formerly operated by Marathon Oil Co. (five storage caverns, one disposal well, and three brine recovery wells). The storage caverns near the site operated by Phillips Petroleum Co. (two caverns and one brine disposal well) and Mobil Oil Co. (four caverns and two brine disposal wells) were previously operated, but have since been plugged and abandoned. The locations of these wells are indicated on Figure B-2.

Two of the wells within the AOR penetrate the top of the confining zone, Utica-Trenton, which is projected to occur at a depth of approximately 2,060 feet bgs. Well API # 21163004199000 is listed as dry and abandoned. Well API # 21163001468000 is a salt water disposal well approved to be plugged, operated by Marathon Oil Co. A geophysical log recorded downhole at Well API # 21163001468000 is shown on the cross section provided in Figures F-4 and F-5 in Attachment D. As demonstrated in Attachment C, no corrective action is necessary for this site.

B.4.2 FRESHWATER RECORDS

Water well records available for the State of Michigan are maintained by the MDEQ – Water Bureau. The filing system used is referenced by section, township, and range. Well data available from public records for freshwater wells within the AOR are tabulated in Table A-2. Eight freshwater wells are listed and indicated on Figure B-1.

List of Tables in Attachment B

Table B-1 Adjacent Landowners List

List of Figures in Attachment B

Figure B-1 Topographic Map of Area of Review

Figure B-2 Area of Review Map

Figure B-3 Property Owner Map

TABLE B-1

ADJACENT LANDOWNERS LIST
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

1. BUCKEYE TERMINAL, LLC
   20089 WEST ROAD
   WOODHAVEN, MI 48183

2. FORD MOTOR CO- TAX DEPT.
   VAN HORN
   WOODHAVEN, MI 48183

3. WOLVERNINE PROPERTIES
   WEST ROAD
   WOODHAVEN, MI 48183

4. WORLD OF BEER
   20970 WEST ROAD
   WOODHAVEN, MI 48183

5. BAGGER DAVES BURGER
   20980 WEST ROAD
   WOODHAVEN, MI 48183

6. TST EXPEDITED SERVICES
   20985 WEST ROAD
   WOODHAVEN, MI 48183

7. WOODHAVEN VILLAGE SQUARE
   23420 ALLEN ROAD
   WOODHAVEN, MI 48183

8. MCINERNEY'S WOODHAVEN CHRYSLER
   23940 ALLEN ROAD
   WOODHAVEN, MI 48183

9. BUCKEYE PIPE LINE CO.
   24002 ALLEN ROAD
   WOODHAVEN, MI 48183

10. MARATHON ASHLAND PETROLEUM CO.
    24400 ALLEN ROAD
    WOODHAVEN, MI 48183

11. MEIJER INC.
    22600 ALLEN ROAD
    WOODHAVEN, MI 48183

12. CITY OF WOODHAVEN
    21869 WEST ROAD
    WOODHAVEN, MI 48183

13. FORD MOTOR CO. - TAX DEPT.
    24189 ALLEN ROAD
    WOODHAVEN, MI 48183

14. ALLEN WOOD PROPERTIES
    23979 ALLEN ROAD
    WOODHAVEN, MI 48183

15. MORETTI LAND CO.
    23933 ALLEN ROAD
    WOODHAVEN, MI 48183

16. MORETTI FOUNDATION
    23933 ALLEN ROAD
    WOODHAVEN, MI 48183

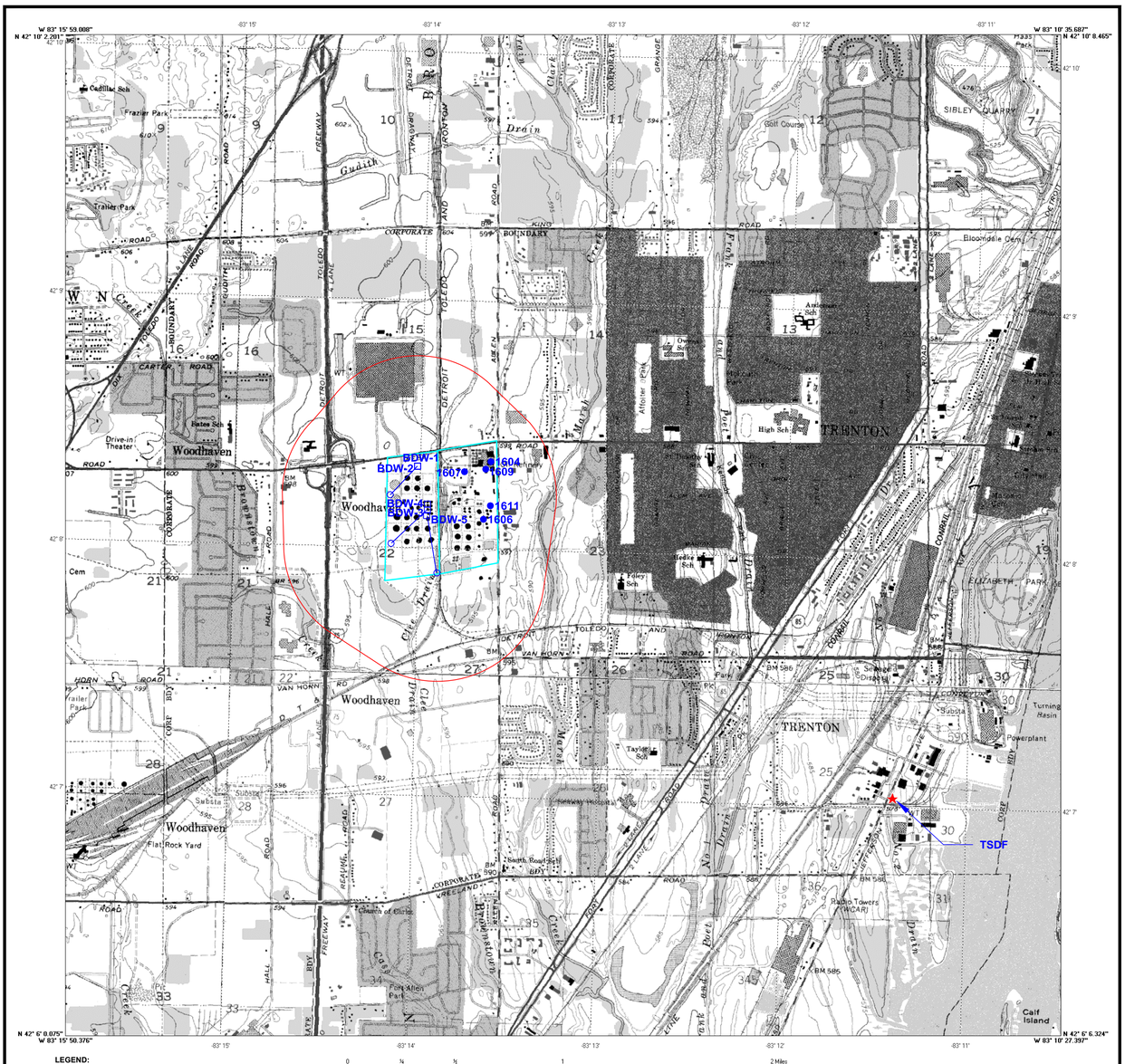
17. DBT PROPERTIES LLC
    23901 ALLEN ROAD
    WOODHAVEN, MI 48183

18. MARATHON ASHLAND PETROLEUM
    ALLEN ROAD
    WOODHAVEN, MI 48183

19. RODGERS HOLDINGS LLC
    23755 ALLEN RD
    WOODHAVEN, MI 48183

20. FORD MOTOR COMPANY-TAX DEPT
    ALLEN RD
    WOODHAVEN, MI 48183

21. FLYING J, IHOP AND SUBWAY
    21055 WEST ROAD
    WOODHAVEN, MI 48183



LEGEND:

- FRESHWATER WELLS
- PROPOSED BRINE SOLUTION WELLS SURFACE HOLE LOCATIONS
- BOTTOMHOLE LOCATIONS
- 1/4-MILE COMBINED RADIUS AROUND WELLS
- PROPERTY BOUNDARY

0 ¼ ½ 1 2 Miles

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 10,000 Feet

1,000 Meters 500 0 ½ 1 2 Kilometers

ROAD CLASSIFICATION

Heavy-duty — Light-duty

Medium-duty — Unimproved dirt

Interstate Route — U.S. Route

UTM GRID AND 1980 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

MICHIGAN

QUADRANGLE LOCATION

NOTE: A search of the TSDF in the vicinity of the Buckeye Woodhaven Terminal was conducted using the EPA Enforcement and Compliance History Online Facility Search (2017). One TSDF is located within the AOR as shown on Figure B-xx:

1. Solutia Inc. (RCRA ID: MID009708678)
   5045 W. Jefferson Ave.
   Trenton, MI
   Current Compliance Status: Noncompliance

Designation: Conditionally Exempt Small Quantity Generator (CESQG)

Maps Compiled from USGS Quads:
Flat Rock NE, MI
Wyandotte, MI,ON
Flat Rock, MI
Rockwood, MI

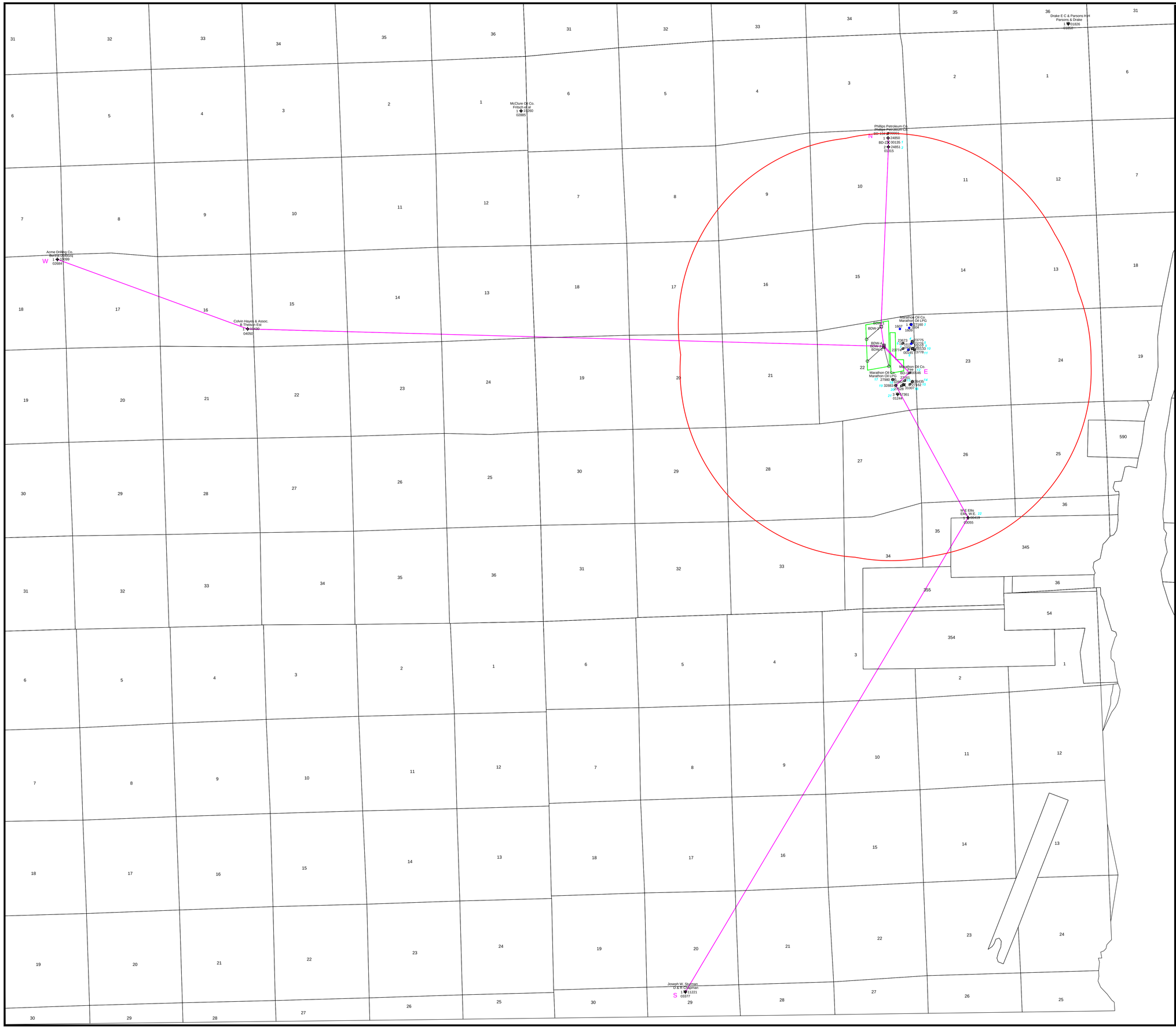
WSP USA Inc.
16200 Park Row Ste. 200
Houston, TX 77084
TEL: (281) 589-5900

FIGURE B-1

BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

TOPOGRAPHIC MAP OF AREA OF REVIEW

DATE: 11/14/17	CHECKED BY:		JOB NO.:192065A-Rev-2
DRAWN BY: WDO	APPROVED BY:		DWG NO.:



LEGEND

- DRY HOLE
- DRY HOLE - OIL
- DRY HOLE - OIL & GAS
- GAS STORAGE
- SALTWATER DISPOSAL - INJECTION
- ABANDONED LOCATION
- PROPOSED SURFACE LOCATION
- BOTTOMHOLE LOCATION
- COMBINED 2-MILE AREA OF REVIEW
- LINES OF CROSS SECTION
- BUCKEYE PROPERTY BOUNDARY

Map ID Number — API Number
Well Number — 00 — 00
Total Depth of Well — 1238

SCALE (IN FEET)

0 — 2000 — 4000

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Houston, Texas 77084
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FIGURE B-2

BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

AREA OF REVIEW MAP

DATE: 11/09/17	CHECKED BY:	JOB NO: 192065A-Rev-2
DRAWN BY: WDD	APPROVED BY:	DWG NO:

Source: http://wayne.maps.arcgis.com/apps/Viewer/index.html?appid=4e75960fbf28455c9acf115e97a3c7c0

Combined 1/4-Mile Area around the Buckeye Facilities.

25 See Table B-1 Adjacent Landowers List

WSP USA Inc. 16200 Park Row Suite. 200 Houston, TX 77084 TEL: (281) 589-5900	**BUCKEYE TERMINALS, LLC** **WOODHAVEN TERMINAL** **WAYNE COUNTY, MICHIGAN**	
PROPERTY OWNERS MAP		Job No. 192065A–Rev 2

Design: WDD	Drawn: WDD	Checked: GM	Date: 12/13/17	Scale: NTS	Figure No. B–3

C. CORRECTIVE ACTION PLAN AND WELL DATA

The AOR, as discussed in Attachment A, is set at a minimum fixed radius of 2-miles for non-hazardous Class 1 wells. Well data available from public records within the AOR are tabulated in Table A-1 (non-freshwater) and Table A-2 (freshwater). Twenty-three (23) non-freshwater wells and eight freshwater wells were identified within the AOR. Surrounding wells, with the exception of shallow monitoring wells and borings, are show on the map provided in Attachment B.

The available records for the two wells within the AOR that penetrate the top of the confining zone, Utica-Trenton, which is projected to occur at a depth of approximately 2,060 feet bgs, were reviewed (Table C-1), but do not penetrate the injection zone (Figure F-5). Well API # 21163004199000 (W.E. Ellis) is listed as dry and abandoned. The drillers log was the only record available for review for this well (Appendix B). Since this well was drilled in 1927, records are limited. MDEQ has made most records from 1965 through 1999 available as mandated by state legislation. Although some historic records (those submitted before the 1965) are also available, it was not a requirement for the well drilling contractor to submit well records.

Well API # 21163001468000 is a salt water disposal well operated by Marathon Pipe Line LLC (original operator Marathon Oil Co). According to the well construction and the plugging and abandonment plan, the well was constructed to be protective of the USDW and to withstand injection pressure from outside pressures. The top of the plug was set at 2,439 and the surface. Available records for this well are included in Appendix B.

No wells appear to have been improperly completed or plugged and abandoned that might act to transmit fluids into the lowermost underground source of drinking water (USDW). Therefore, no corrective action is necessary for this site.

Table C-1 Wells Within the AOR Penetrating the Top of the Confining Zone

	API # 21163004199000 PERMIT #419 W.E. ELLIS	API # 21163001468000 PERMIT #416 MARATHON OIL COMPANY
Date of Construction	April 11, 1927	December 12, 1968
Total Depth (feet)	3,055	3,745
Well Construction	Vertical	Vertical
Cement Records	Unavailable	Unavailable
Plugging Records	Unavailable	Unavailable
Distance from Nearest Proposed Well	Approximately 9,680 feet	Approximately 1,260 eet

D. MAPS AND CROSS SECTIONS OF USDWS

Figure D-1 illustrates a stratigraphic column for Michigan (MDEQ, 2000). Figure D-2 illustrates regional cross sections across Wayne County showing the sedimentary rocks below the glacial overburden discussed further below.

D.1 DOMESTIC WATER USE

The aquifer most commonly used for domestic water is generally found in the glacial drift zone (Figure D-2). In Wayne County, the glacial deposits range in thickness from 20 to 400 feet (Mozola, 1969). In the vicinity of the site, this zone is estimated to be 70 feet thick. The glacial drift zone in the Detroit area occurs under both water table and artesian conditions. It is composed of irregular beds of sand, silt, gravel, and clay (Wisler et al., 1952). Groundwater flow is generally in the east to southeast direction, toward the Michigan River (Gillespie and Dumouchelle, 1988). Based on the February 2005 Wellogic database, approximately 67 percent of the wells in Wayne County produce water from this zone (USGS, 2007).

D.2 LOWERMOST USDW

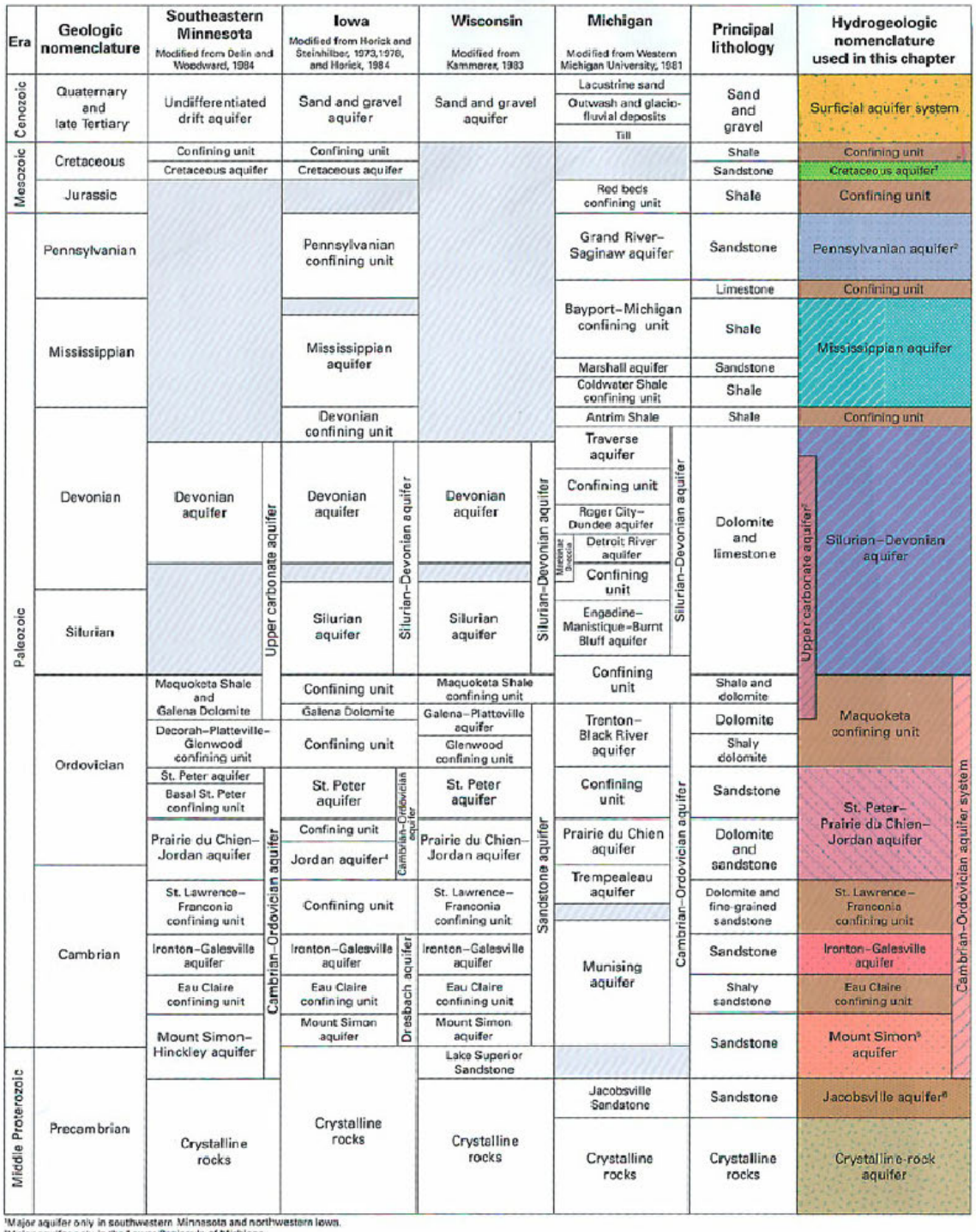
A USDW is defined as an aquifer or its portion which either supplies any public water system or contains a sufficient quantity of groundwater to supply a public water system. Potential USDWs are aquifers that can yield producible quantities of water that have a total dissolved solids (TDS) concentration less than 10,000 milligrams per liter (mg/L). If an aquifer is not currently supplying drinking water for human consumption, it must contain fewer than 10,000 mg/L TDS and not be an exempted aquifer to be considered a USDW.

The base of the USDW within the AOR, based on logs of wells within the vicinity of the site, is estimated to be at 350 feet bgs at the base of the Sylvania Sand. This is illustrated on Figure D-2 and on cross sections in Attachment F. Underlying the USDW is 3,100 feet of limestone, shale, dolomite, and salt formations protecting the USDW from the proposed injection interval including the 1,410-foot thick confining zone (discussed further in Attachment F).

List of Figures in Attachment D

Figure D-1 Stratigraphic Column of Michigan

Figure D-2 Regional Cross Sections of Sedimentary Formations in Wayne County



[1]Major aquifer only in southwestern Minnesota and northwestern Iowa.
[2]Major aquifer only in the Lower Peninsula of Michigan.
[3]Major aquifer only in southeastern Minnesota.
[4]Includes lower part of the Prairie du Chien Group and the Jordan Sandstone.
[5]Major aquifer includes the Hinckley Sandstone of Precambrian age in southeastern Minnesota.
[6]Major aquifer only in part of the Upper Peninsula of Michigan.

Figure 8. The numerous aquifers and confining units that have been named in the four States of Segment 9 are grouped into the sequence of hydrogeologic units shown in the column on the right. The gray area represents missing rocks.

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BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

STRATIGRAPHIC COLUMN OF MICHIGAN

Job No. 192065A

Design:	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale:	Figure No. D–1

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Houston, TX 77084
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BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

REGIONAL CROSS SECTIONS OF SEDIMENTARY FORMATIONS IN WAYNE COUNTY

Job No. 192065A

Design:	Drawn:	Checked:	Date:	Scale:	Drawing No.
WDD	WDD	GM	06/01/2017	NTS	D–2

E. DOES NOT APPLY TO CLASS I WELLS

F. MAPS AND CROSS SECTIONS OF GEOLOGIC STRUCTURE OF AREA

F.1 REGIONAL GEOLOGY

The site is located in the southeastern part of the Michigan Basin and the Algonquin Arch (Figure F-1). The Precambrian basement rock in this area is part of the Grenville Province. The basin was filled with sedimentary layers dipping and thickening inward toward the center of the basin. In addition to including most of the state of Michigan, the basin includes parts of Wisconsin, Illinois, Indiana, Ohio, and Ontario, Canada. A general regional cross section of the Michigan Basin from Lake Michigan to Lake Erie is provided in Figure F-2. Formations outcropping along the margins of the basin are the older rocks which are overlain by younger formations toward the center of the basin. The basin structure originated by slow tectonic movements within the crust.

Sedimentary rocks predominately deposited during the Paleozoic Era form the stratigraphy of the region. Figure F-3 illustrates the stratigraphy of Michigan. The general lithology consists of sandstone in basal Mt. Simon and Eau Claire Formations overlain by dolomite, limestone, and shale up to the Salina Group, which consists of dolomite, anhydrites and interbedded salts. Overlying the Salina Group are Devonian aged dolomites, sandstones, and limestones.

F.2 LOCAL GEOLOGY

The local geologic information for the site was determined based on the construction of cross sections from West to East and North to South across the area (Figure F-4 and Figure F-5). Data from open hole logging was used to provide a generalized site geology.

The deepest formation observed in the area is the Precambrian granite of the basement rock of the Central Stable Region or Canadian Shield. Overlying the granite, as seen in the nearby Marathon Oil Co. BD-1 (API 21163001468000) is the Granite Wash at 3,745 feet KB. The Granite Wash is composed of eroded granitic materials.

The Eau Claire Formation and Mt. Simon Sandstone unconformably overlie the Granite Wash. The Mt. Simon Sandstone is characterized as having sub-rounded to rounded quartz grains, grading from medium to very coarse grains. The sandstone is observed to thicken southward. The base of the unit contains a higher content of feldspar grains. Figure F-6 and Figure F-7 illustrate the thickness and structure of the Mt. Simon across Michigan. The Mt. Simon interfingers with the Eau Claire Formation which consists of a basal sandstone that is commonly included in the Mt. Simon. The upper section consists of thinly bedded dolomite and siltstone. Figure F-8 illustrates the structure of the Eau Claire (EPA, 1981). These combined sands are further discussed in Attachment F.4.

The Trenton/Black River Group overlies the Eau Claire. The limestone is estimated to be 1,090 feet thick at the site and is observed to be a sequence of dense, brown to gray, micritic limestone. The formation includes widespread cherty zones. The Trenton Group (Figure F-9) has been dolomitized in some areas.

The Utica Shale overlies the Trenton Group and is estimated to be 340 feet thick in this area (Figure F-10). The shale consists of a hard, dark gray to greenish-black, calcareous shale that is homogeneous. A distinctive contact exists between the Trenton and Utica Shale, unlike the gradational contact with the overlying Cincinnatian Series (EPA, 1981). The Utica Shale and Trenton/Black River Group are further discussed in Attachment F.3.

The Cincinnatian Series, overlying the Utica Shale, consists of a sequence of interbedded shales and carbonates that is estimated to be 350 feet thick in the vicinity of the site.

The Clinton Shale is considered part of the Middle Silurian age deposits (Niagaran Series) situated between the Cincinnatian and the Upper Niagaran Series. This deposit is composed of interbedded shale and dolomite. The Niagaran Series of the Middle Silurian overlies the Clinton Shale in this area (Figure F-11). This series includes basal dolomitic shale (Clinton Shale) and consists of mostly dolomites in the outcrop areas. The Niagaran is estimated to be 390 feet thick in this area.

The Salina Group of the upper Silurian overlies the Niagaran. The Salina Group is a thick sequence of anhydrite, salt and shale in the basin. The Salina is estimated to be 640 feet thick in the area and includes a sequence of evaporite units starting at the base of the foundation with the A-1 Carbonate (Figure F-12 through Figure F-15). Multiple Silurian-aged, salt-bearing deposits occur within the basin; however, only the B Evaporite (salt) unit of the Salina Group underlies the area of this study with suitable thickness for storage cavern development (Figure F-3).

The Bass Island Formation overlies the Salina Group and consists of fine-grained cherty dolomite. Figure F-16 illustrates the thickness of this formation across Michigan.

The Bois Blanc overlying the Bass Island Formation may be present at the site. The formation is cherty limestone with some dolomite. The Sylvania Sandstone overlies the Bois Blanc Formation and consists of well-rounded and sorted, fine to medium quartz grains. The combined lithofacies thickness of the Bois Blanc and Sylvania is illustrated on Figure F-17.

The Detroit River Formation, consisting of limestone with chert, anhydrite and gypsum, typically overlies the Sylvania Sandstone; however, it is not anticipated to be observed at the site. Instead, the Dundee Formation is expected to overlie the Sylvania Sandstone in this area. The Dundee Formation is an alternating sequence of shales and limestones, often combined with the Traverse Group. Figure F-18 and Figure F-19 illustrate the thickness of the lithofacies and the structure of the Dundee Formation.

The upper 70 feet at the site consists of the overlying glacial drift. The drift consists of clay and silt in this area (EPA, 1981).

F.3 CONFINING ZONE

The confining zone for a Class I injection well is defined as “a geologic formation, group of formations, or part of a formation that is capable of limiting fluid movement above an injection zone.” The deepest well within the AOR for which geologic information is available is Marathon Oil Co. BD-1 (API 21163001468000) in the Granite Wash at 3,745 feet KB.

The confining zone at the Woodhaven Terminal includes the combined formations of the Utica Shale, Trenton Limestone, and the Black River/Trenton Dolomite. These formations were discussed in Sections F.1 and F.2. The thickness of confining zone, overlying the proposed injection zone (Attachment F.4), is estimated to be 1,410 feet.

F.4 INJECTION ZONE

The injection zone for a Class I injection well is defined as “a geological formation, group of formations, or part of a formation receiving fluids through a well." For the subsurface strata to accept fluid, the interval must have sufficient height, permeability, and regional extent to prevent pressure increases from injection that could initiate or propagate fractures. The rate and volume at which fluid can be injected into an injection reservoir are a function of its depth, pore volume, pore pressure, fluid properties, height, permeability, and fracture closure pressure.

The injection zone at the Woodhaven Terminal will include the Eau Claire Formation and the Mt. Simon Sandstone. The combined sands are anticipated to be approximately 300 feet thick at a depth of approximately 3,400 feet MSL. The average porosity of the Eau Claire in the area was found to range from 2.5-11%. The Mt. Simon in the area has a porosity range from 8-18%. The combined sands have been proven to be effective reservoirs for injection at other sites in the area.

The following table summarizes the injection zone requested for this permit:

Table F-1 Injection Zone

FORMATION NAME	INTERVAL TOP (ESTIMATED FEET BGS)	INTERVAL BOTTOM (ESTIMATED FEET BGS)	ESTIMATED NET THICKNESS (FEET)
Eau Claire	3,470	3,510	40
Mt. Simon	3,510	3,730	220

F.5 STRUCTURE AND SEISMIC ACTIVITY

The thickness of the Cambrian System, the Mt. Simon Formation, and the Eau Claire Formation are found in previously listed figures. Figure F-20 indicates the lack of seismic risk in the area. In addition, the cross sections provided as Figures F-4 and F-5 do not indicate faulting in the area.

The Mt. Simon Formation is dipping to the northwest dip into the basin. Regional dip in the Mt. Simon Sandstone and the Eau Claire Formation injection interval is approximately one degree to the northwest (EPA, 1981).

The U.S. Geological Survey Earthquake Data Base (National Earthquake Information Center) was used to locate any significant earthquake events occurring within 100 miles of the Woodhaven Terminal. Twelve (12) earthquake events were recorded within the 100 mile search radius (Figure F-21). The closest earthquake to occur near the site was approximately 8 miles away on the Canadian side of Lake Erie. The event was a magnitude 2.5 on March 2010 at a depth of 18 km (11.2 miles) (USGS, 2017).

The lack of seismic activity coupled with the lack of faulting within the vicinity of the site reinforces the choice of this site for a brine disposal wells.

List of Figures in Attachment F

Figure F-1 Geologic Map of Michigan

Figure F-2 Generalized Regional Cross-Section of Michigan Basin

Figure F-3 Stratigraphic Nomenclature for Michigan

Figure F-4 West-East Cross-Section

Figure F-5 North-South Cross-Section

Figure F-6 Thickness of the Mt. Simon

Figure F-7 Structure Map of the Mt. Simon

Figure F-8 Structure Map of the Eau Claire

Figure F-9 Structure Map of the Ordovician Trenton Group

Figure F-10 Thickness of the Utica Shale

Figure F-11 Thickness-Facies of the Niagaran Group

Figure F-12 Thickness of the A-1 Carbonate

Figure F-13 Thickness of the A-2 Evaporite

Figure F-14 Thickness of the A-3 Carbonate

Figure F-15 Thickness of the B Evaporite

Figure F-16 Thickness of the Bass Island Group

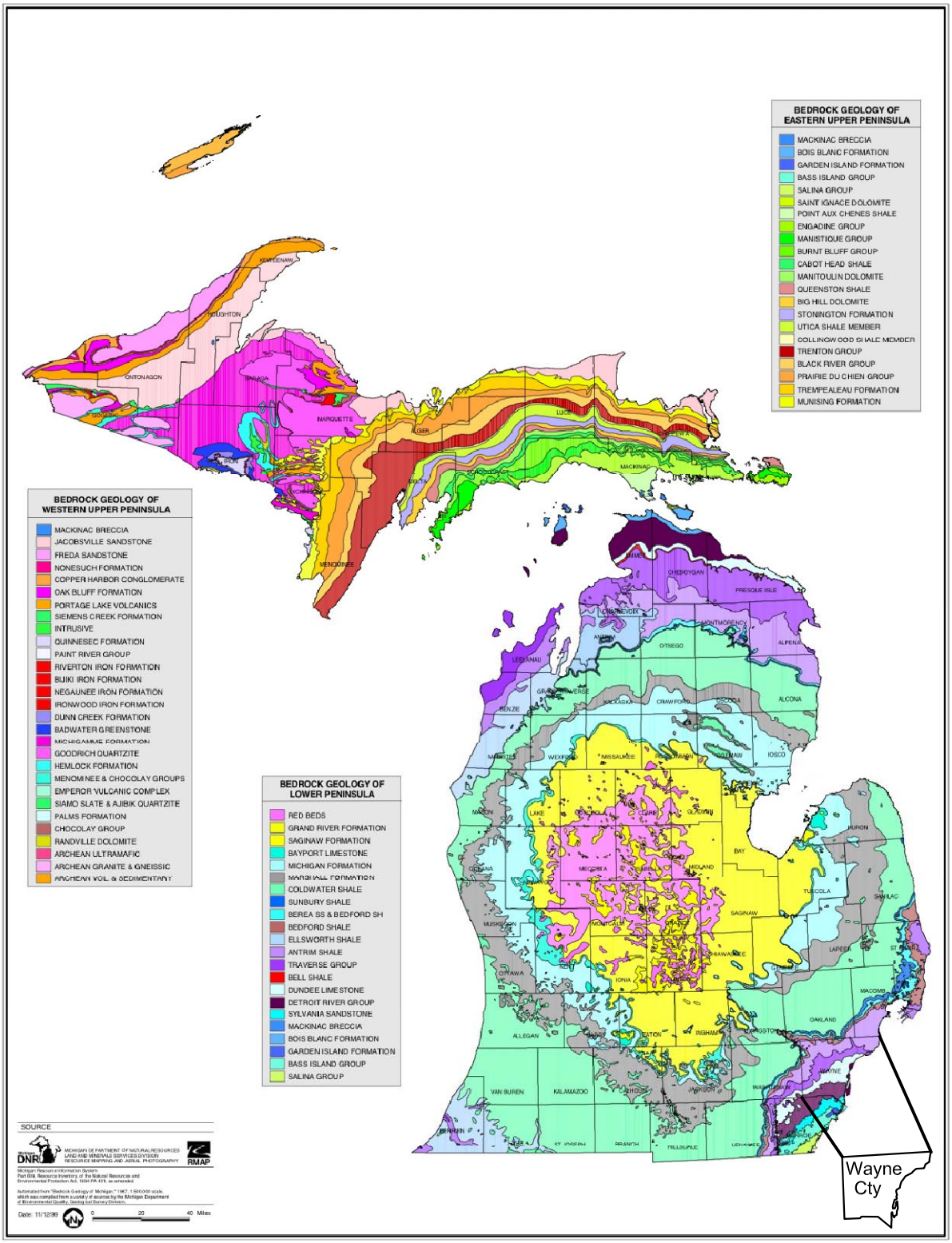
Figure F-17 Thickness Lithofacies of the Bios Blac/Sylvania

Figure F-18 Thickness Lithofacies of the Dundee Formation

Figure F-19 Structure Map of the Dundee Formation

Figure F-20 Seismic Risk Map

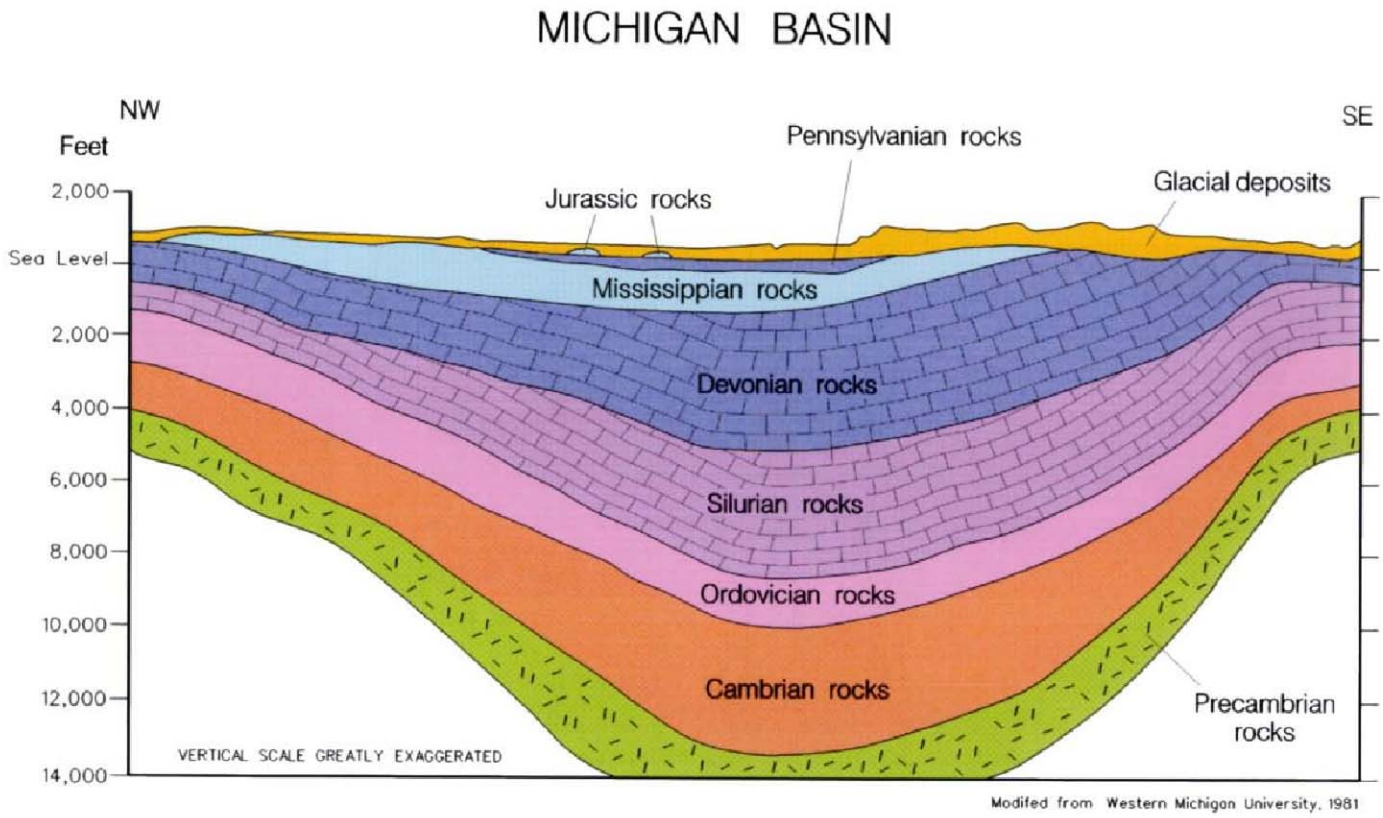
Figure F-21 Historical Earthquakes



Source: Michigan DNR, 1987

WSP USA Inc. 16200 Park Row Suite 200 Houston, TX 77084 TEL: (281) 589-5900	**BUCKEYE TERMINALS, LLC** **WOODHAVEN TERMINAL** **WAYNE COUNTY, MICHIGAN**	
GEOLOGIC MAP OF MICHIGAN		Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F–1



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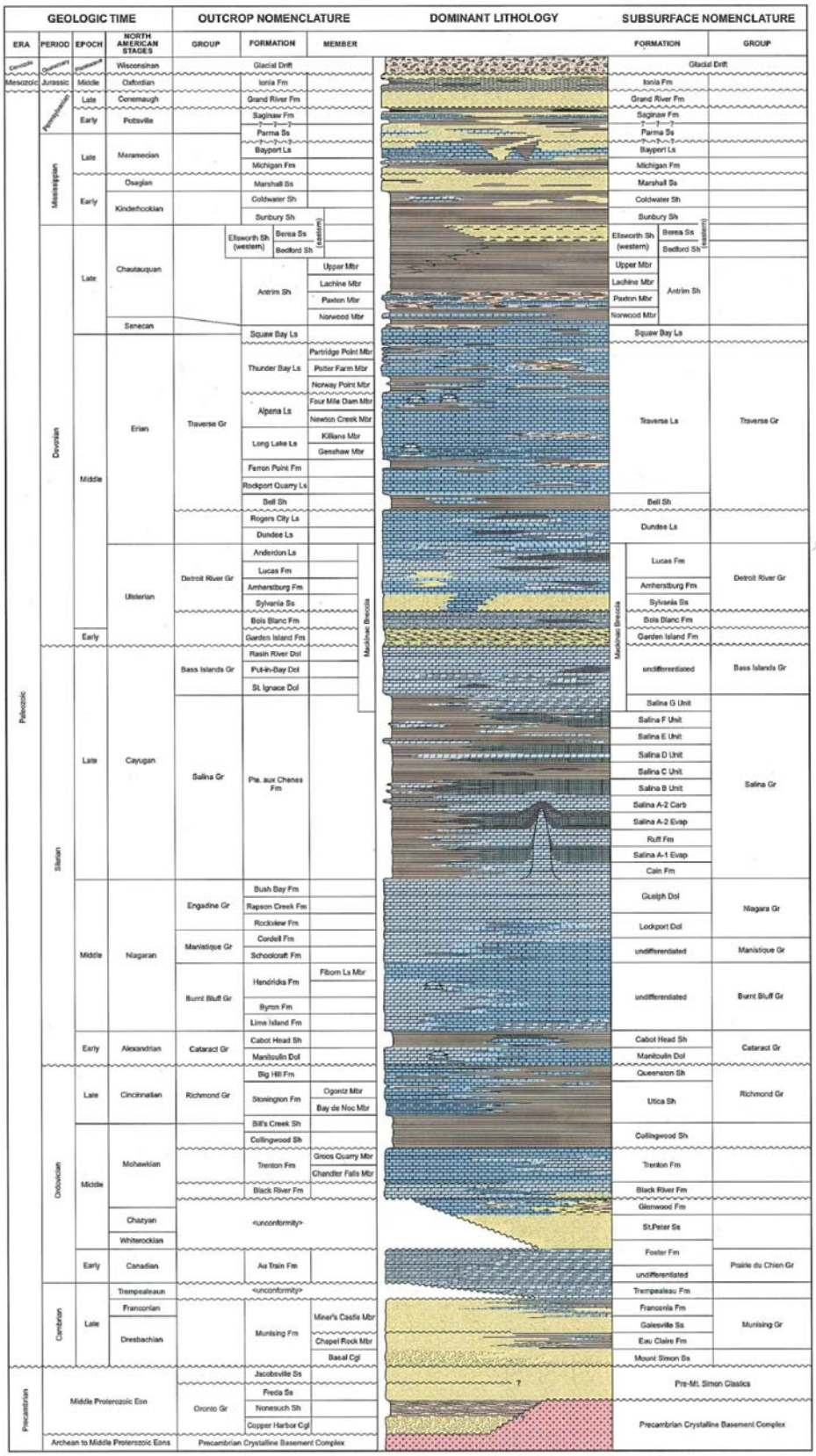
WAYNE COUNTY, MICHIGAN

GENERALIZED REGIONAL CROSS-SECTION OF MICHIGAN BASIN

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-2



STRATIGRAPHIC NOMENCLATURE FOR MICHIGAN

Michigan Dept. of Environmental Quality
Geological Survey Division
Harold Fitch, State Geologist
and
Michigan Basin Geological Society

Stratigraphic Nomenclature Project Committee:
Dr. Paul A. Catacosinos, Co-chairman
Mr. Mark S. Wollensak, Co-chairman

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Mr. Robert F. Reynolds
Dr. David B.Westjohn
Mr. Mark S. Wollensak

2000

Acknowledgements

This work is the product of the combined efforts of the geological communities of Michigan and the surrounding states and provinces. Below are given just a representative few of the contributors:

Academia: Dr. Aureal T. Cross, Michigan State University; Dr. Robert H. Dott, Jr., University of Wisconsin; Mr. William D. Everham, Ph.D. Candidate, Michigan Technological University.

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Industry: Mr. Donald J. Bailey, Consultant; Mr. Jimmy R. Myles, Scot Energy; Mr. Dan E. Pfeiffer, Pfeiffer Exploration Services.

A complete listing of all contributors will be found in the Stratigraphic Lexicon for Michigan, of which this column is an integral part.

RELATED TERM CORRELATION

STRATIGRAPHIC POSITION	RELATED TERMS
Ionia Fm	Jurassic Red Beds
Michigan Fm	Clare Dolomite, Brown Lime, Stray Dolomite, Stray Sandstone, Stray-Stray Sandstone, Stray-Stray-Stray Sandstone, Triple Gyp
Coldwater Sh	Coldwater Red Rock, Speckled Dolomite, Wier Sand
Antrim Sh	Charlton Black Shale Member, Elbrim, Chester Black Shale Member, Upper Black Shale, Light Antrim, Lower Black, Lower Antrim Middle Antrim, Middle Gray Antrim, Dark Antrim, Middle Gray Shale, Unit 1A, Unit 1B, Unit 1C, Crappo Creek Grey Shale Member
Dundee Ls	Reed City Member/Dolomite/Anhydrite
Lucas Fm	Freer Sandstone, Horner Member, Iatzi Member, Massive Salt/Anhydrite, Sour Zone, Big Anhydrite, Richfield Zone/Member/Sandstone, Big Salt
Amherstburg Fm	Filer Sandstone, Matinum Member, Stark Lime
St. Ignace Dolomite	Salina H Unit
Salina B Unit	Big Salt, B Salt
Ruff Formation	Salina A-1 Carbonate, Rabbit Ears Anhydrite,
Cain Fm	Salina A-0 Carbonate
Guelph Dolomite	Brown Niagara, Niagaran Reef, Pinnacle Reef, Engadine Dolomite
Lockport Dolomite	Gray Niagara, White Niagara
Burnt Bluff Gr	Clinton Formation
Trenton Fm	Cap Dolomite
Black River Fm	Van Wert Zone, Sneaky Peek, Black River Shale
Glenwood Fm	Goodwell Unit, Zone of Unconformity
St. Peter Sandstone	Bruggers Sandstone, Jordan Sandstone, Knox Sandstone, Massive Sand
Prairie du Chien Gr	Foster Formation, New Richmond Sandstone, Lower Knox Carbonate, St. Lawrence Formation, T-PDC, Oneota Dolomite, Brazos Shale
Trempealeau Fm	Lodi Formation
Galesville Ss	Dresbach Sandstone
Pre-Mt. Simon Clastics	Precambrian "Red Beds"

LEGEND

Source: Michigan DEQ, 2000

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STRATIGRAPHIC NOMENCLATURE FOR MICHIGAN

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-3

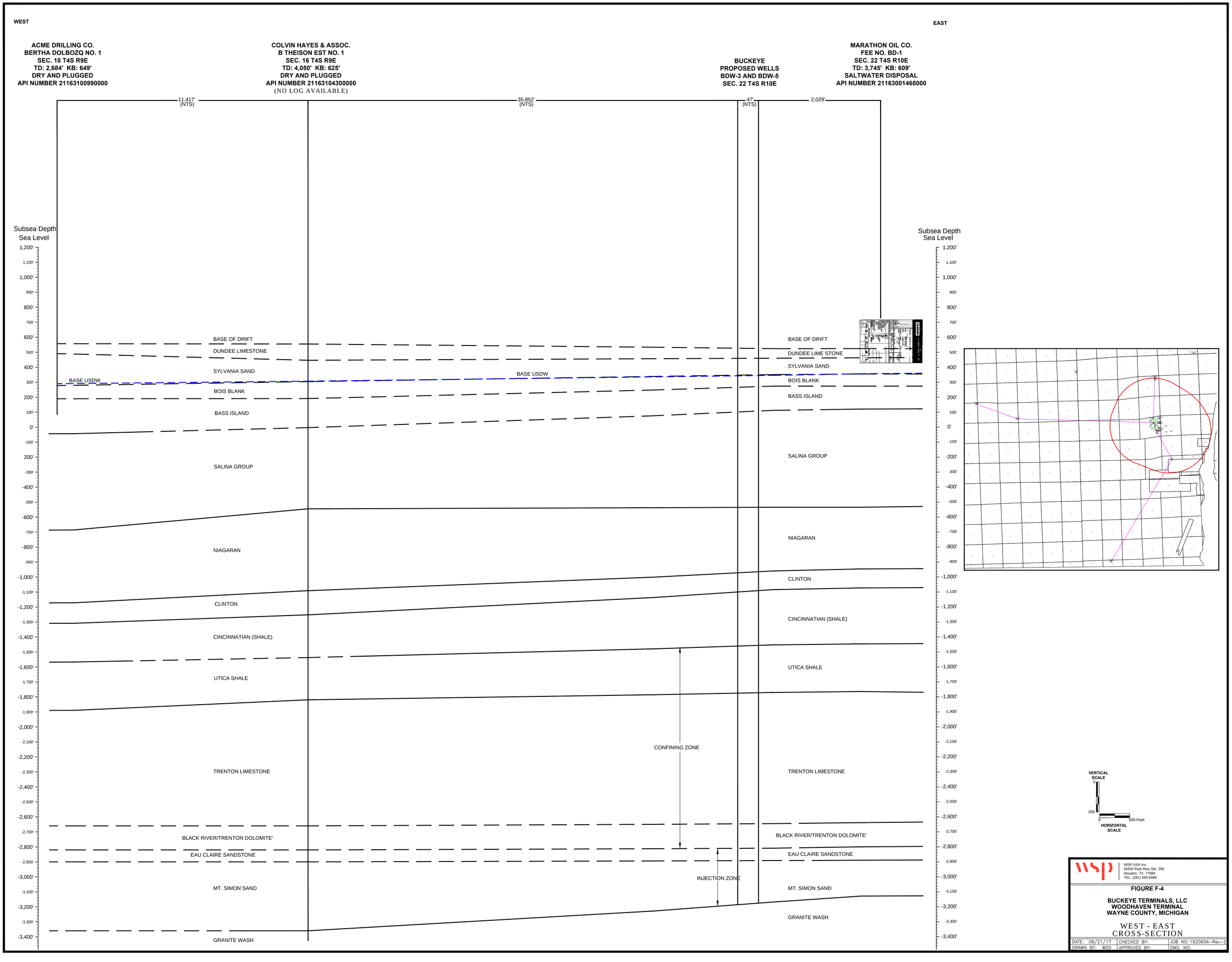

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FIGURE F-4

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WEST - EAST
CROSS-SECTION

DATE: 08/21/17	CHECKED BY:	JOB NO: 192065A-Rev-2
DRAWN BY: WDD	APPROVED BY:	DWG. NO:

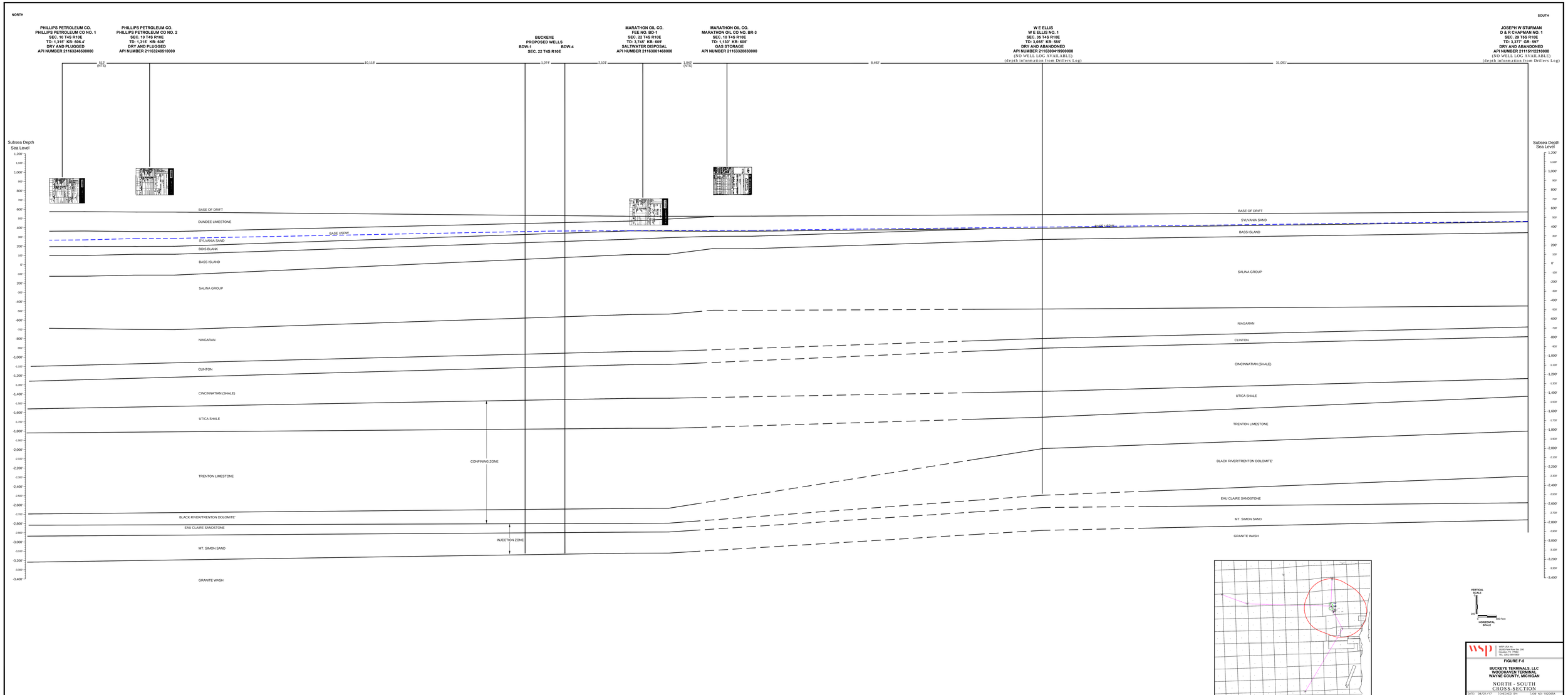
NORTH
SOUTH
PHILLIPS PETROLEUM CO.
PHILLIPS PETROLEUM CO NO. 1
SEC. 10 T4S R10E
TD: 1,315' KB: 606.4'
DRY AND PLUGGED
API NUMBER 21163248500000
PHILLIPS PETROLEUM CO.
PHILLIPS PETROLEUM CO NO. 2
SEC. 10 T4S R10E
TD: 1,315' KB: 606'
DRY AND PLUGGED
API NUMBER 21163248510000
BUCKEYE
PROPOSED WELLS
BDW-1
BDW-4
SEC. 22 T4S R10E
MARATHON OIL CO.
FEE NO. BD-1
SEC. 22 T4S R10E
TD: 3,740' KB: 609'
SALTWATER DISPOSAL
API NUMBER 21163001468000
MARATHON OIL CO.
MARATHON OIL CO NO. BR-3
SEC. 10 T4S R10E
TD: 1,130' KB: 605'
GAS STORAGE
API NUMBER 21163288030000
W E ELLIS
W E ELLIS NO. 1
SEC. 35 T4S R10E
TD: 3,055' KB: 585'
DRY AND ABANDONED
API NUMBER 21163044190000
(NO WELL LOG AVAILABLE)
(depth information from Drillers Log)
JOSEPH W STURMAN
D & R CHAPMAN NO. 1
SEC. 29 T5S R10E
TD: 3,377' GR: 597'
DRY AND ABANDONED
API NUMBER 21115112210000
(NO WELL LOG AVAILABLE)
(depth information from Drillers Log)
512'
(NTS)
10,118'
1,074'
7,101'
1,042'
(NTS)
8,492'
33,095'
Subsea Depth
Sea Level
BASE OF DRIFT
DUNDEE LIMESTONE
BASE USDW
SYLVANIA SAND
BOIS BLANK
BASS ISLAND
SALINA GROUP
NIAGARAN
CLINTON
CINCINNATIAN (SHALE)
UTICA SHALE
TRENTON LIMESTONE
BLACK RIVER/TRENTON DOLOMITE'
EAU CLAIRE SANDSTONE
MT. SIMON SAND
GRANITE WASH
CONFINING ZONE
INJECTION ZONE
VERTICAL SCALE
200'
HORIZONTAL SCALE
500' FAR
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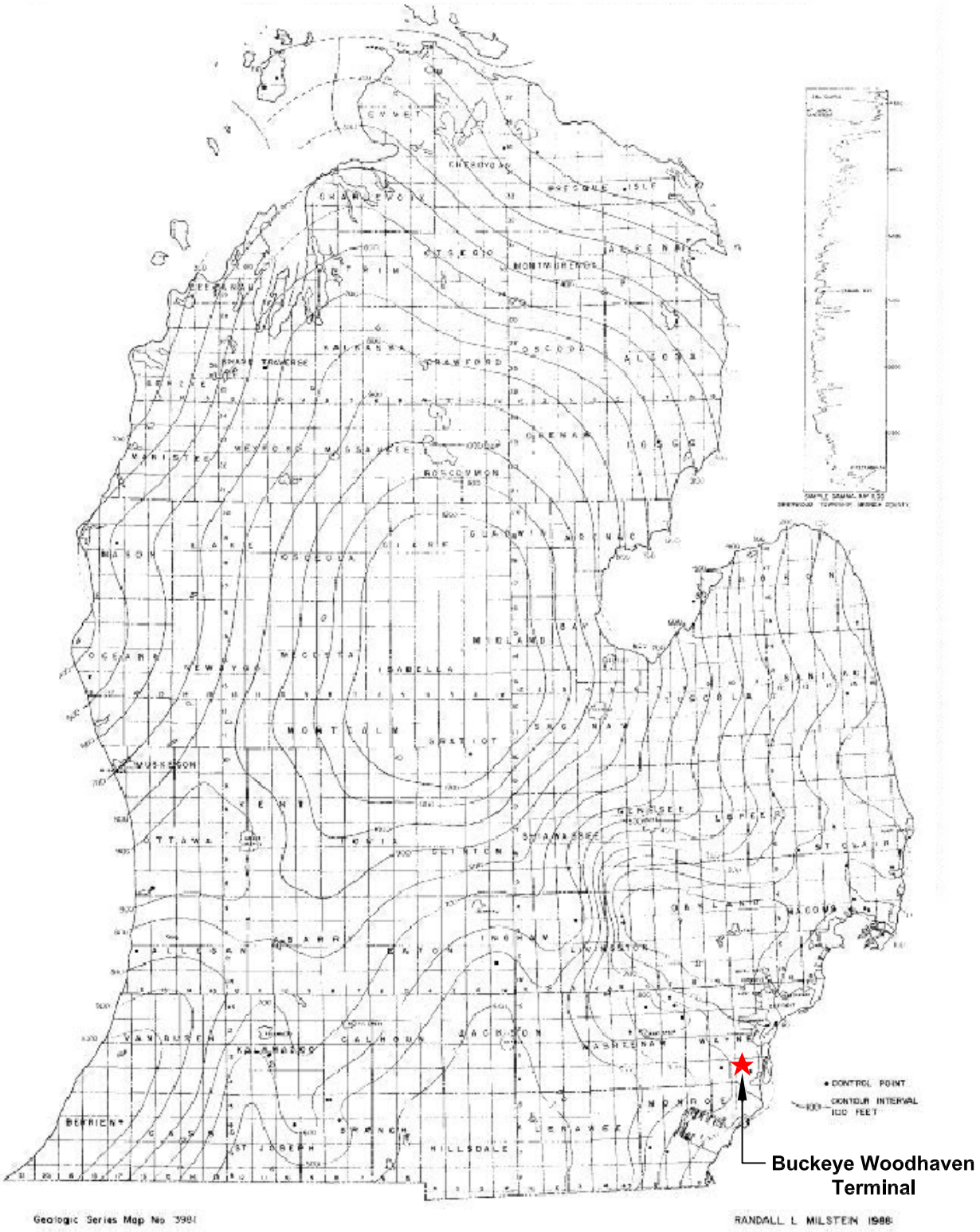
FIGURE F-5
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN
NORTH - SOUTH
CROSS-SECTION
DATE: 08/27/21
CHECKED BY:
JOB NO. 18G0004
DRAWN BY: BCC
APPROVED BY:
FIG. NO.



Source: Milstein, 1988

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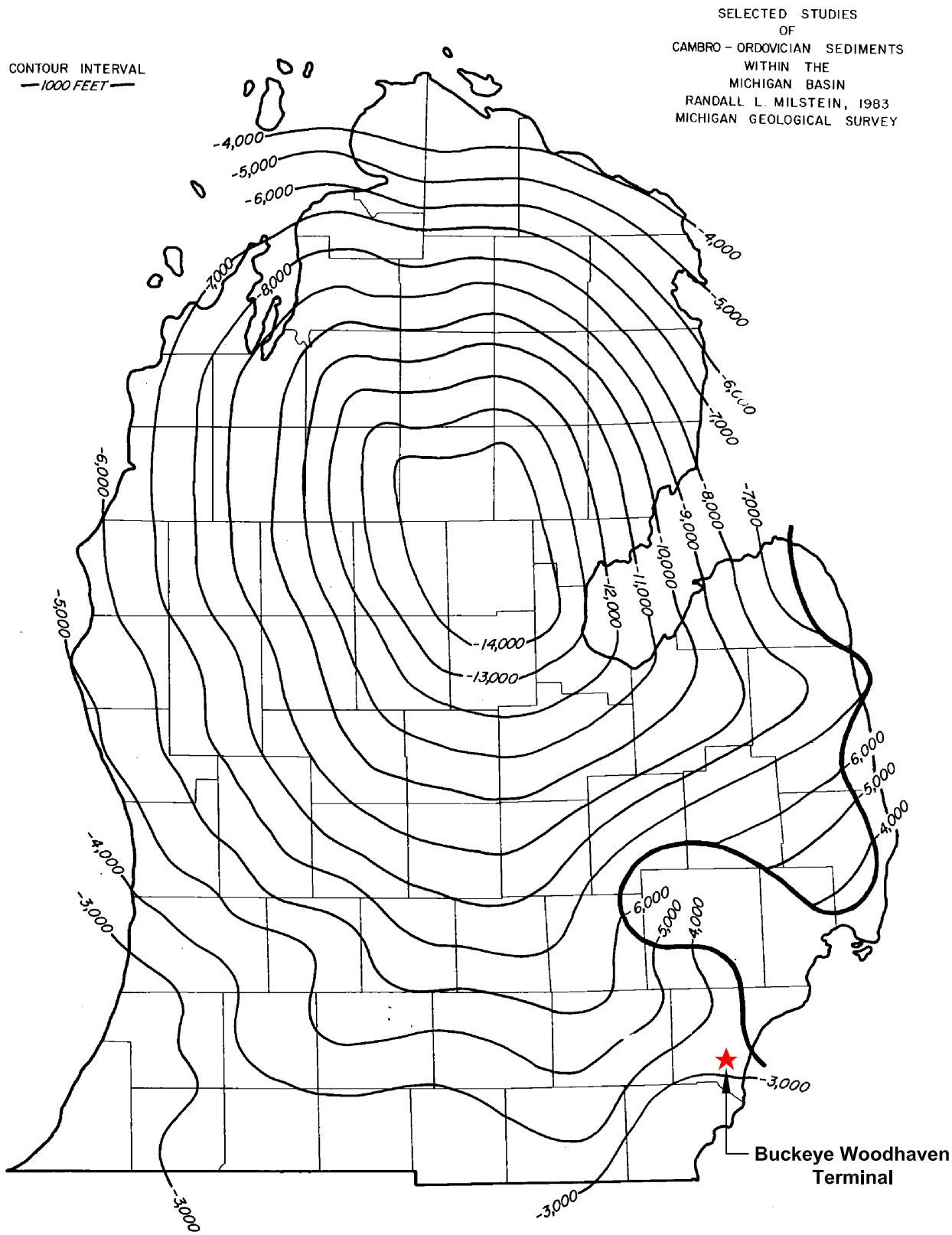
WAYNE COUNTY, MICHIGAN

THICKNESS OF THE MT. SIMON

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F–6



Source: Michigan Geological Survey, 1983

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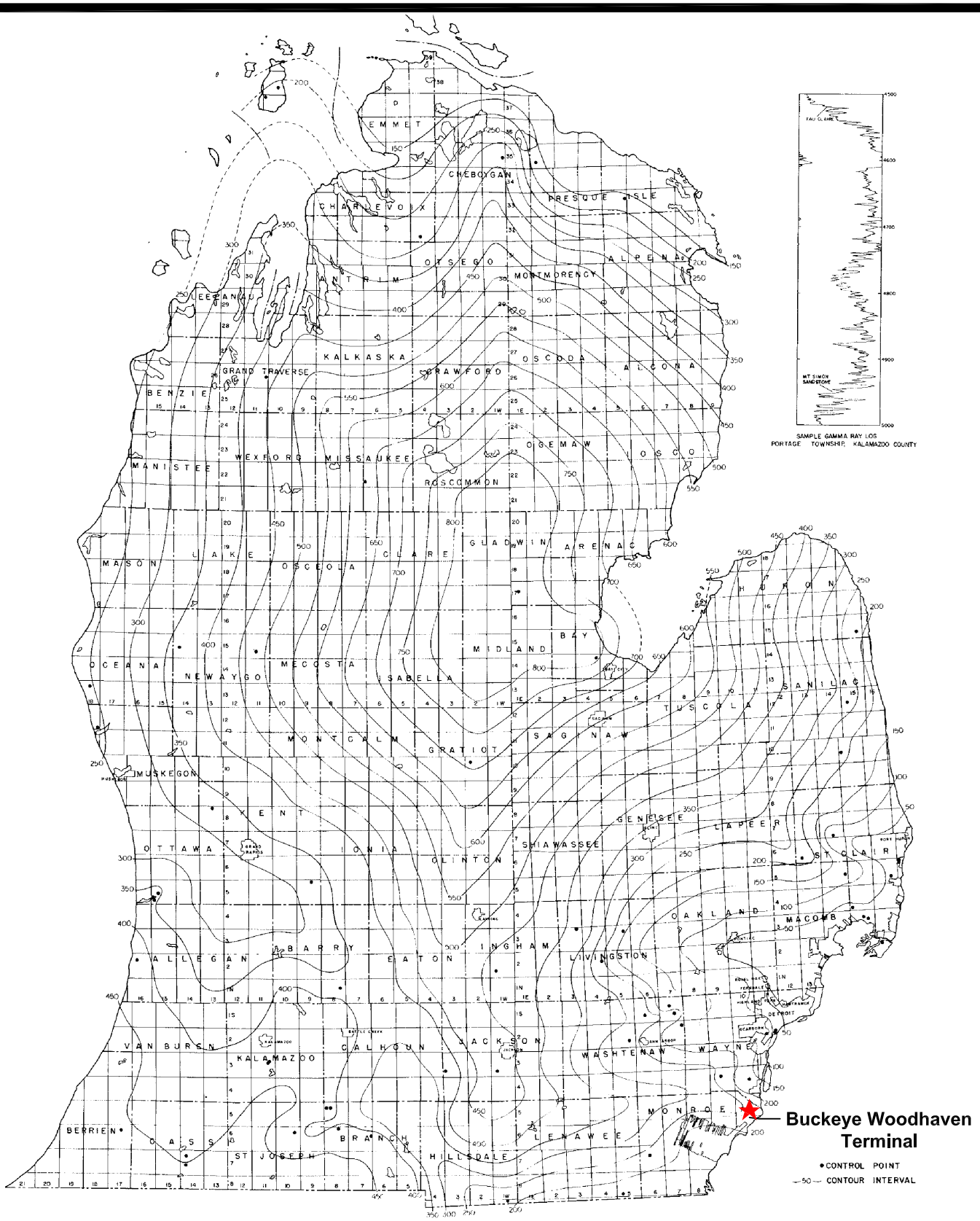
STRUCTURE ON THE MT. SIMON

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-7



Source: Milstein, 1988

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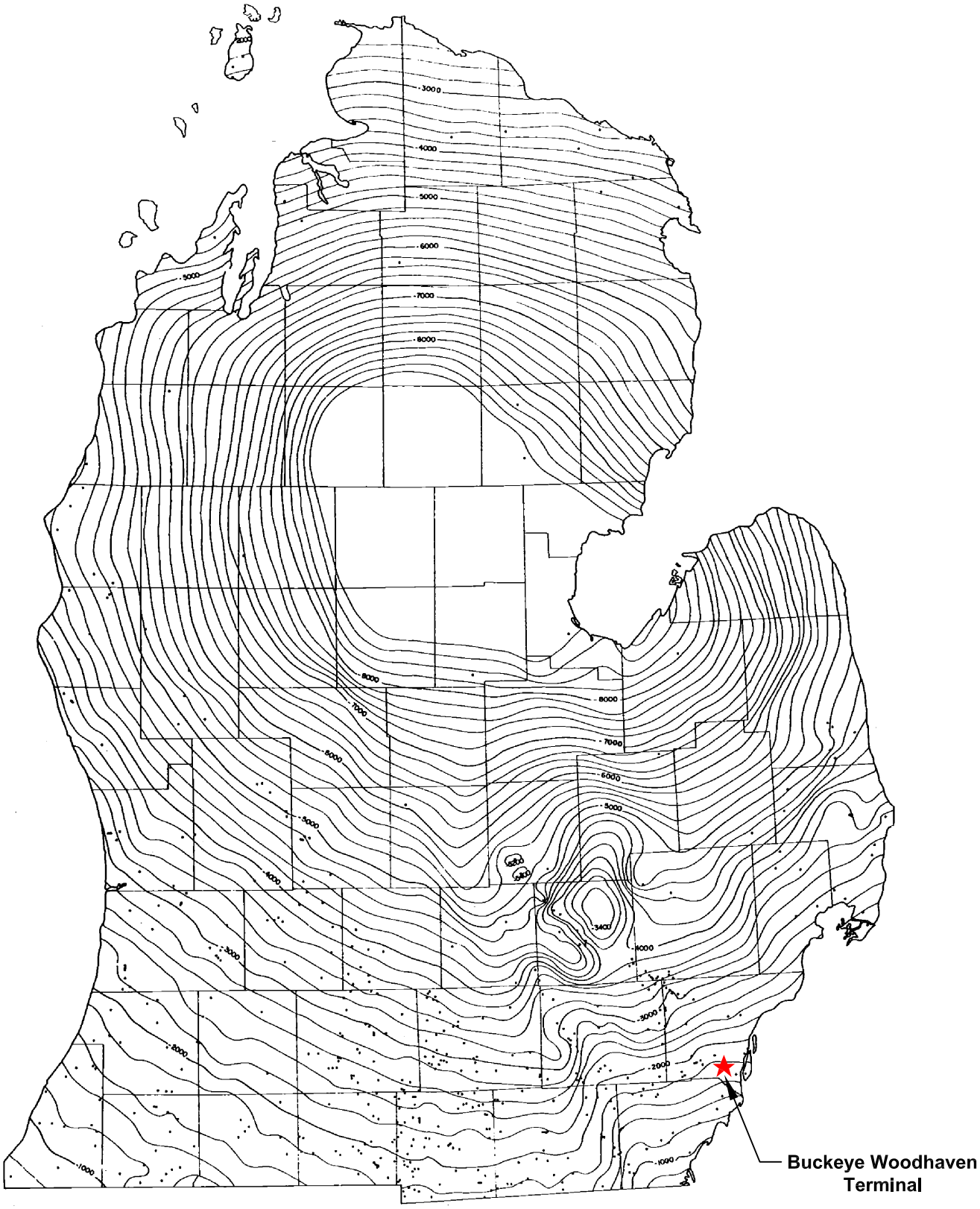
STRUCTURE ON THE EAU CLAIRE		Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F–8



Source: Michigan Basin Geological Society, 1969

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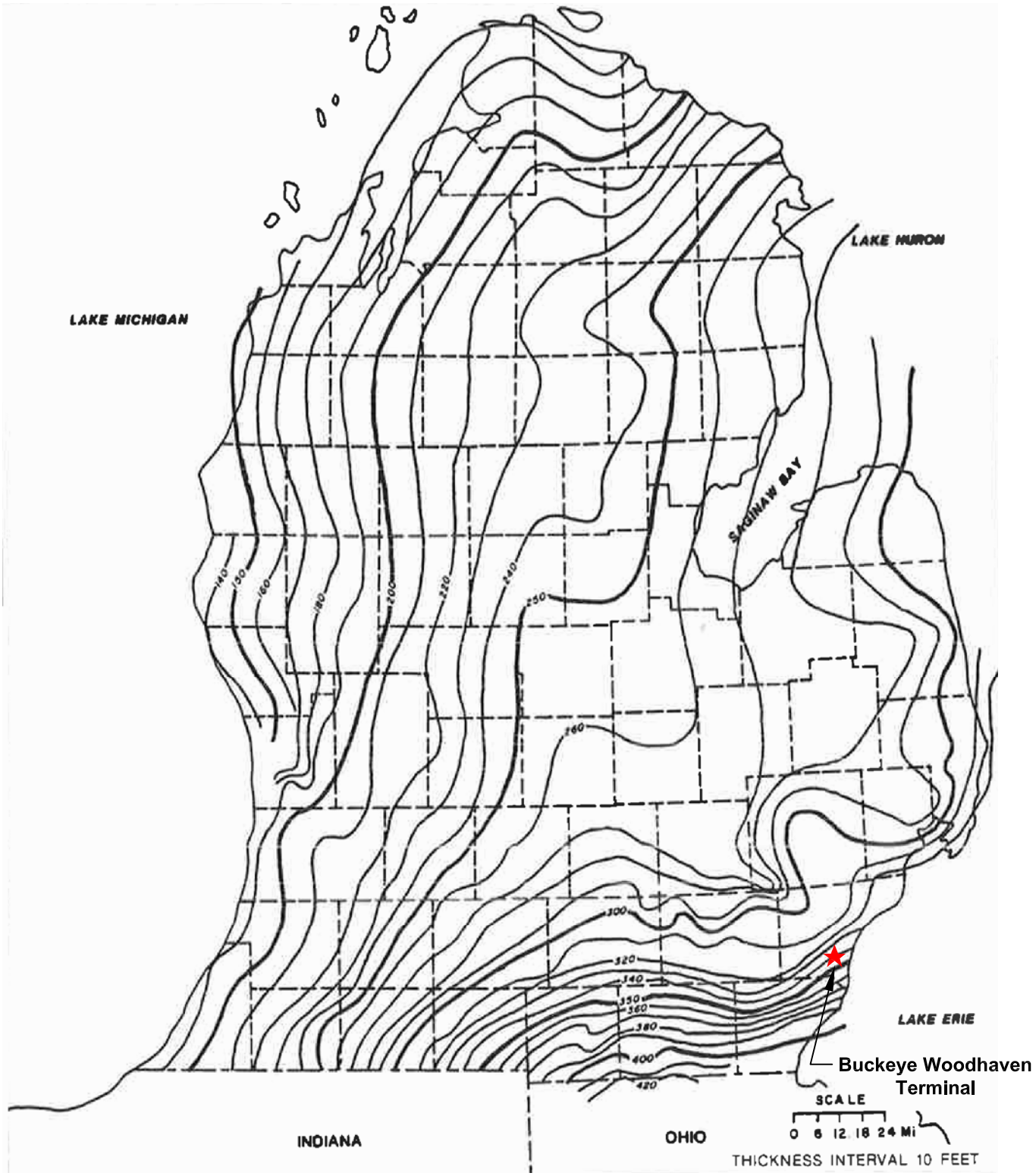
STRUCTURE MAP OF THE ORDOVICIAN TRENTON GROUP

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-9



Source: Michigan Basin Geological Society, 1969

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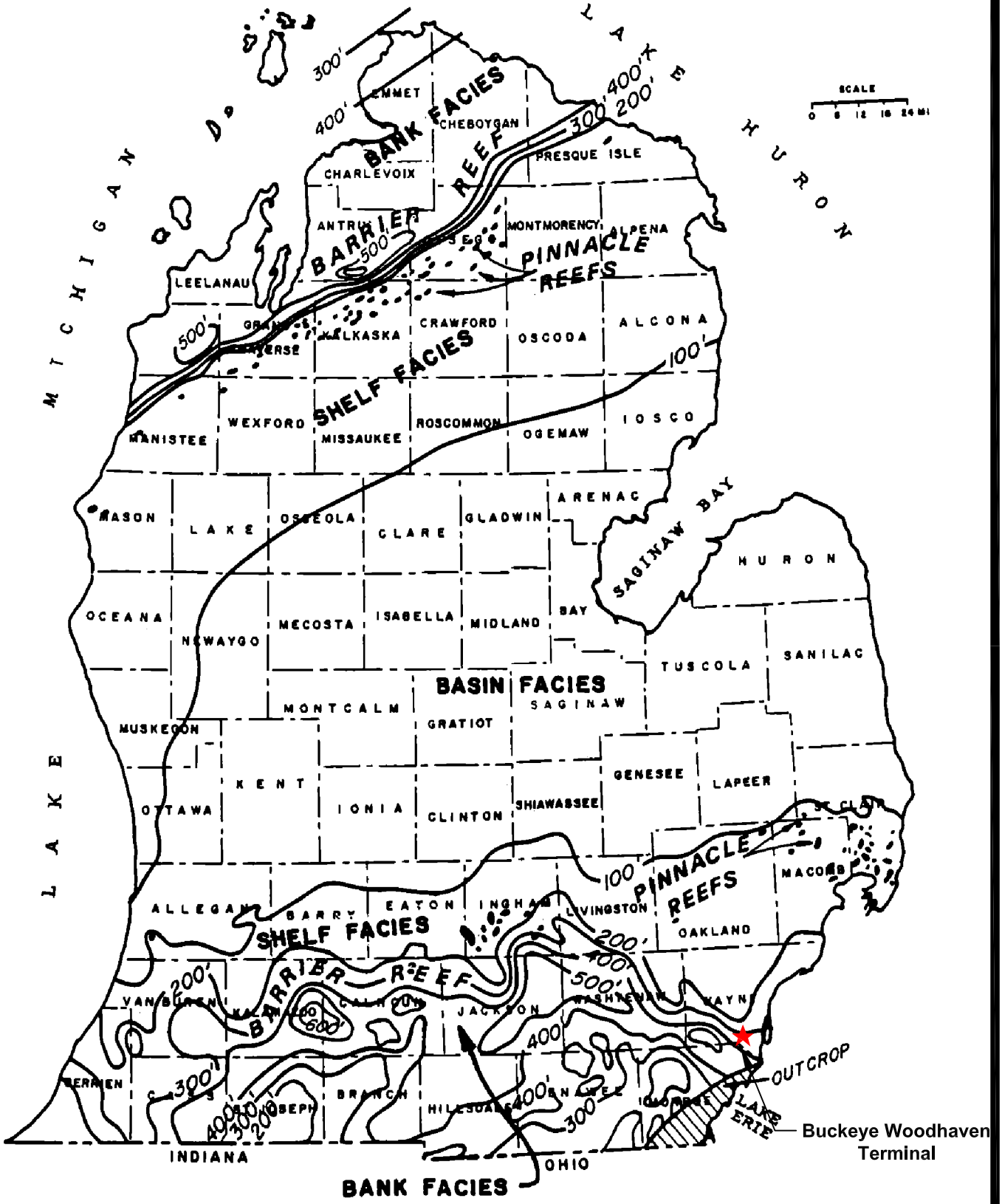
THICKNESS OF UTICA SHALE

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-10



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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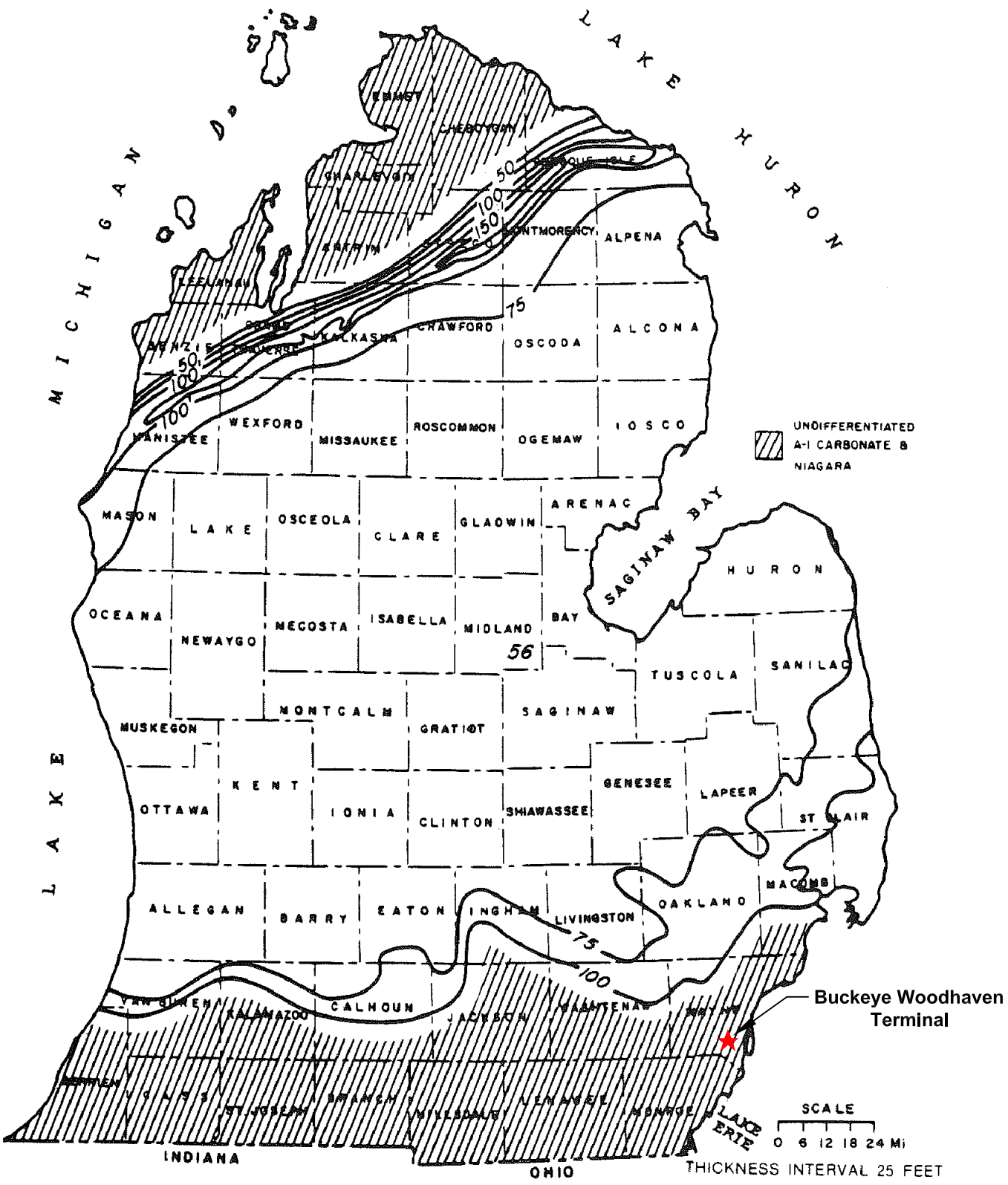
THICKNESS-FACIES OF THE NIAGARAN GROUP

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-11



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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THICKNESS OF THE A-1 CARBONATE

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-12

Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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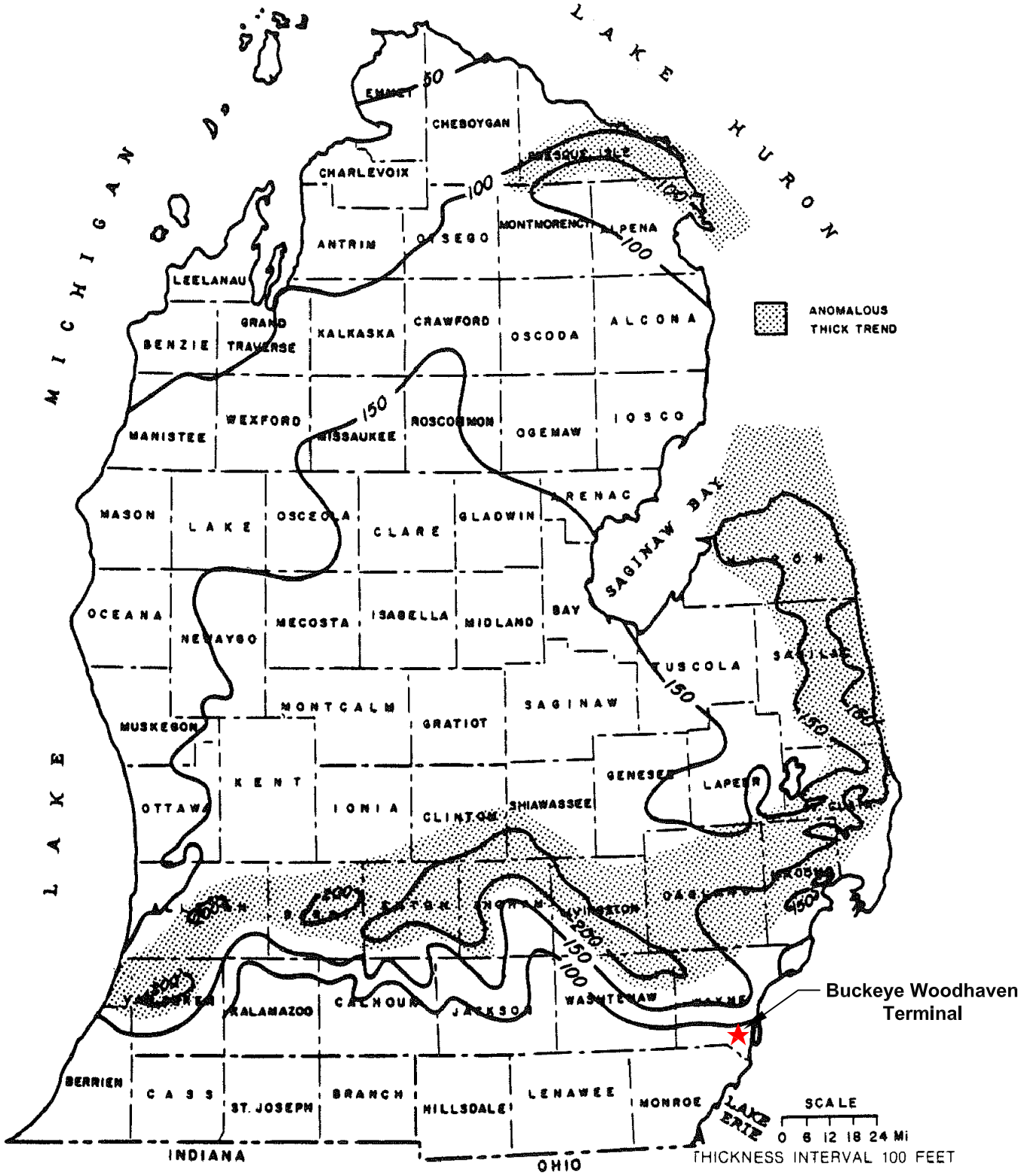
THICKNESS OF THE A-2 EVAPORITE

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F–13



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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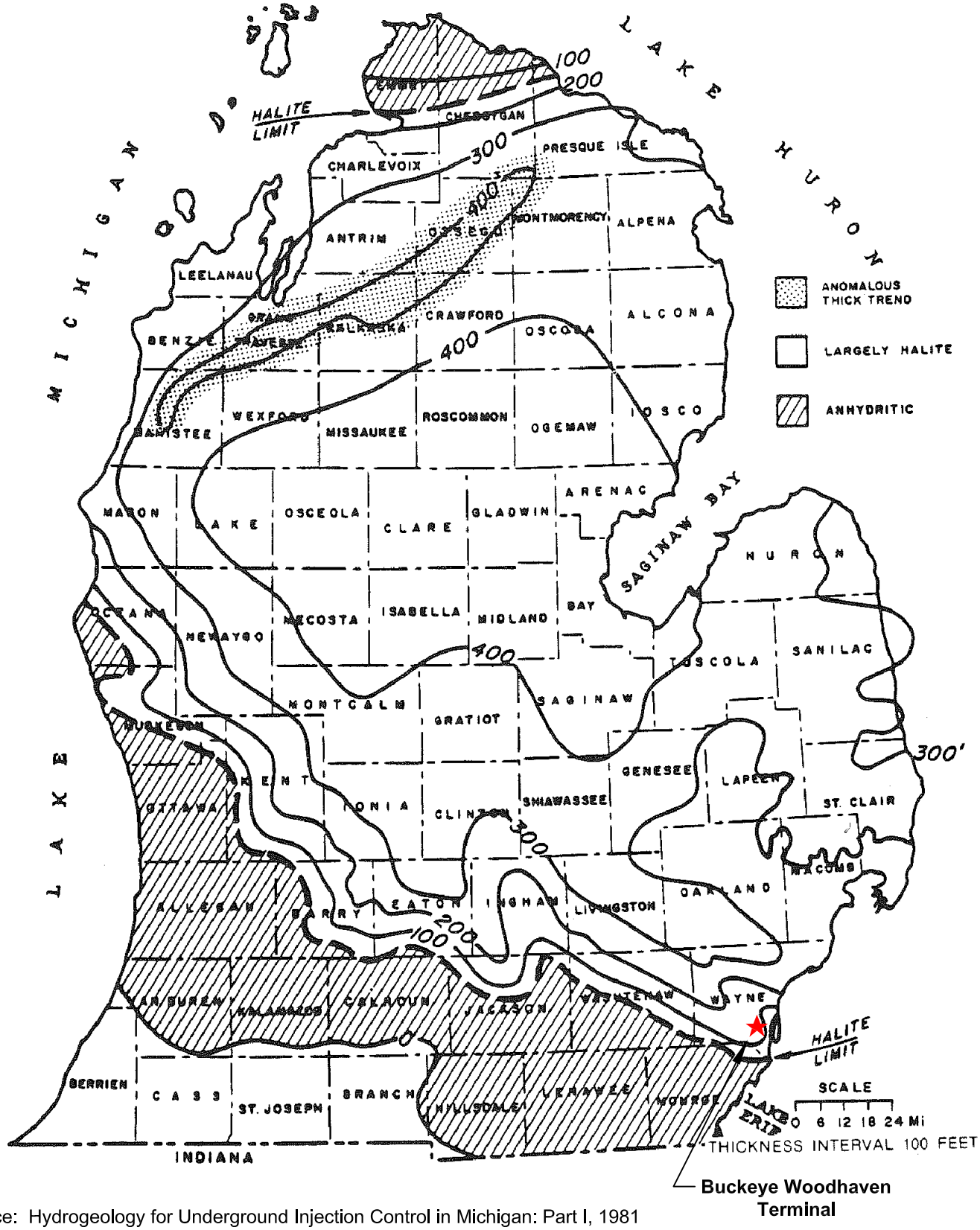
THICKNESS OF THE A-3 CARBONATE

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-14



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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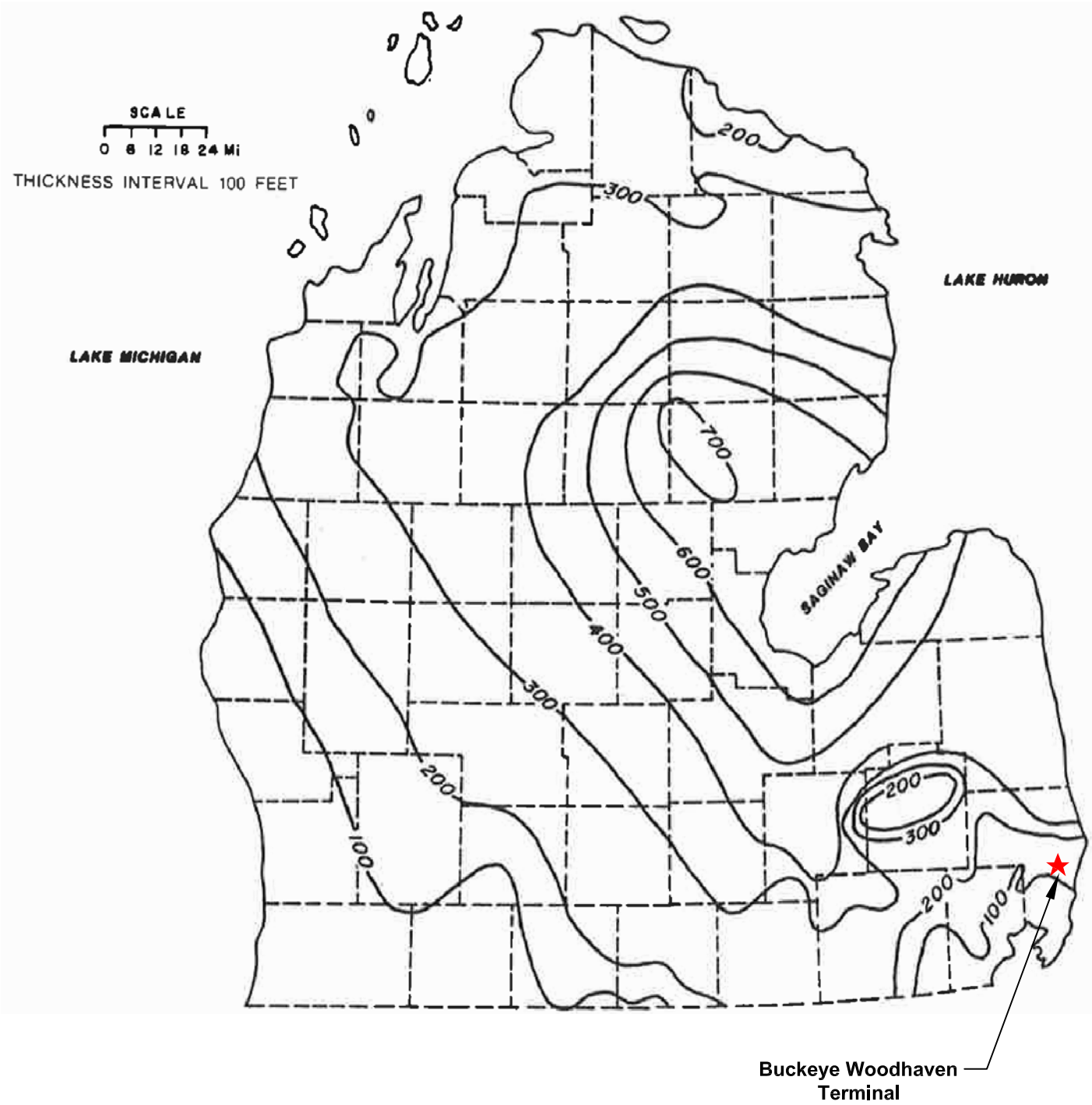
THICKNESS OF THE B EVAPORITE

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-15



Source: Nurmi, 1972

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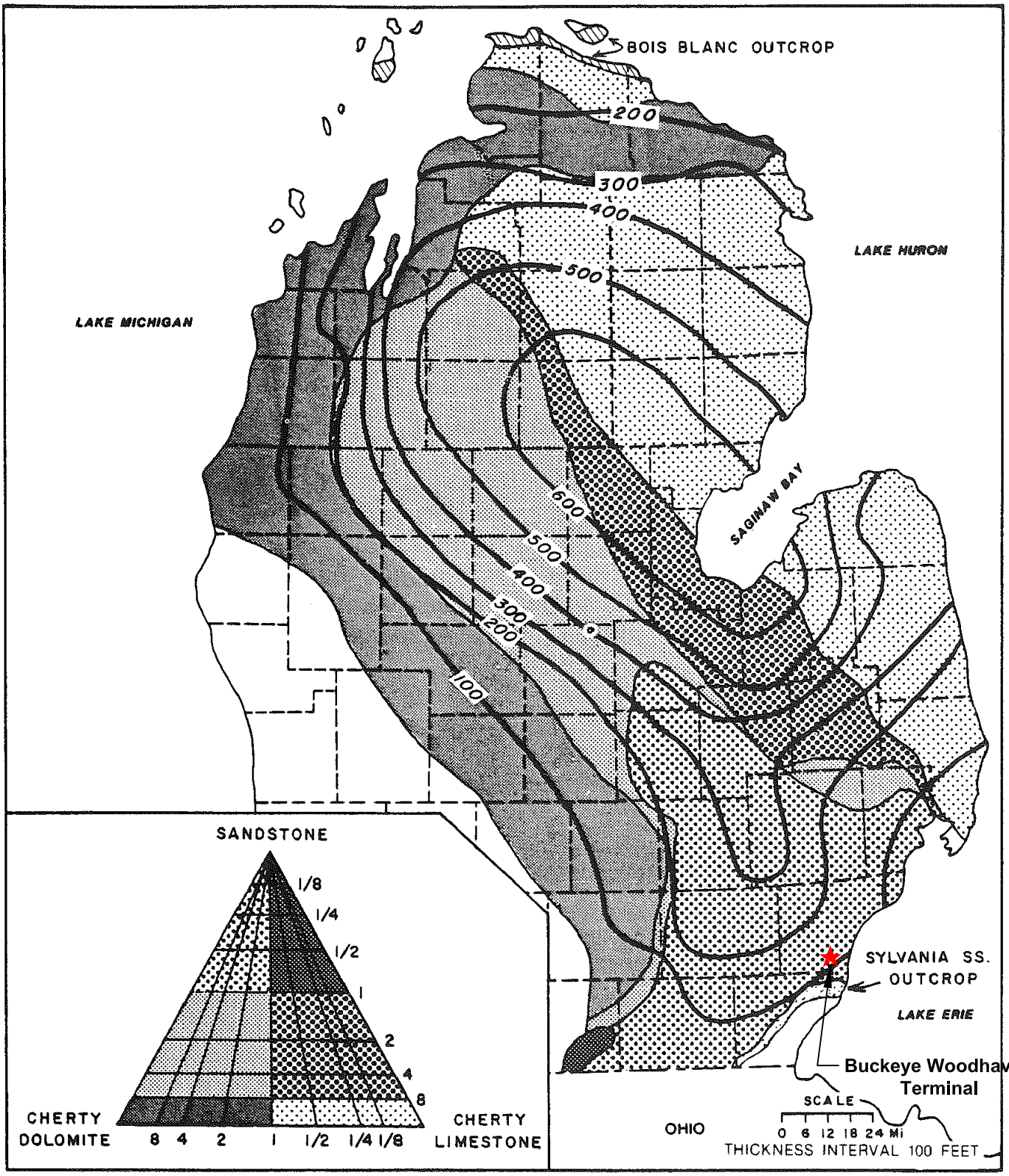
THICKNESS OF THE BASS ISLAND GROUP

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-16



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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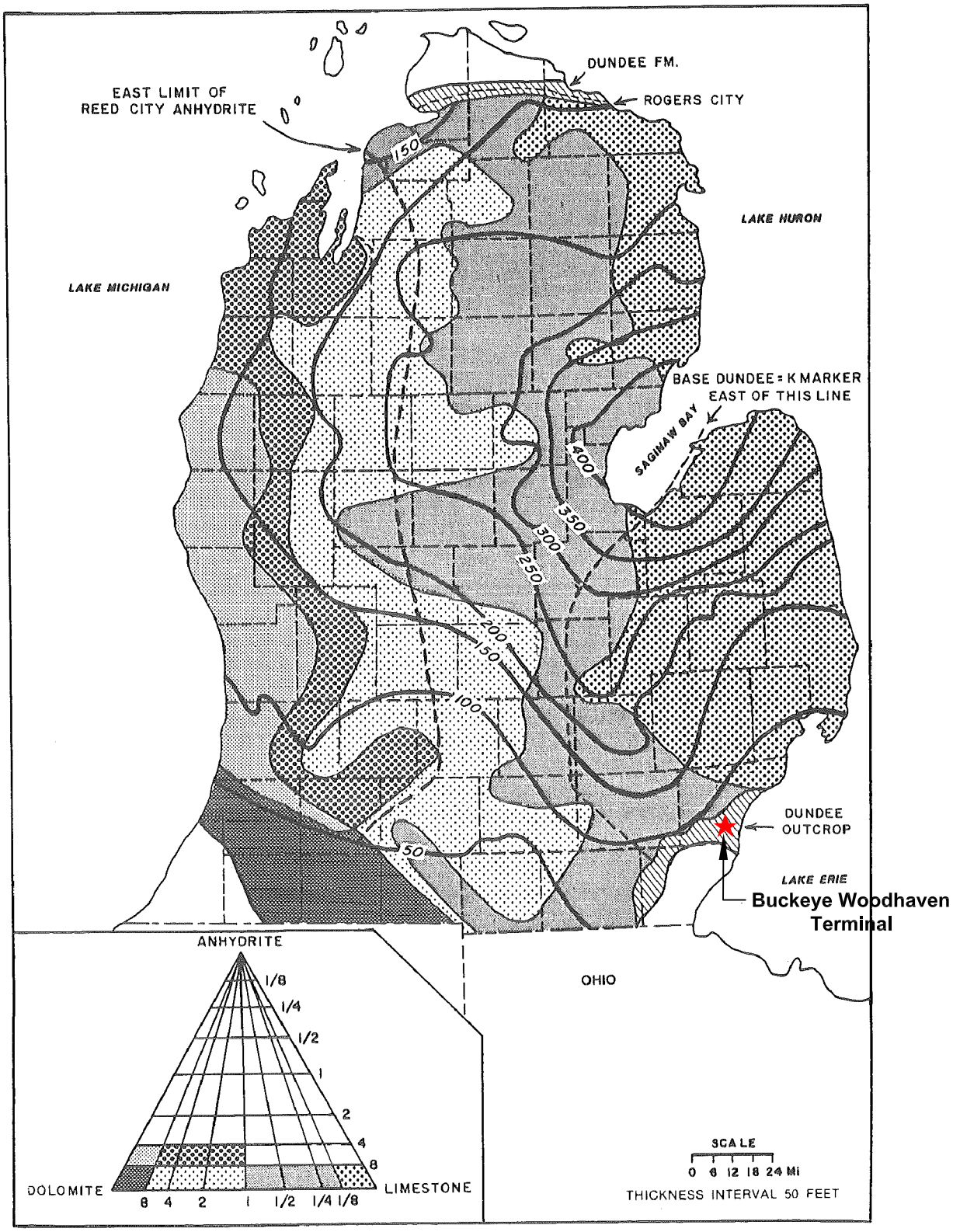
THICKNESS LITHOFACIES OF THE BOIS BLANC/SYLVANIA

Job No. 192065A					
Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-17



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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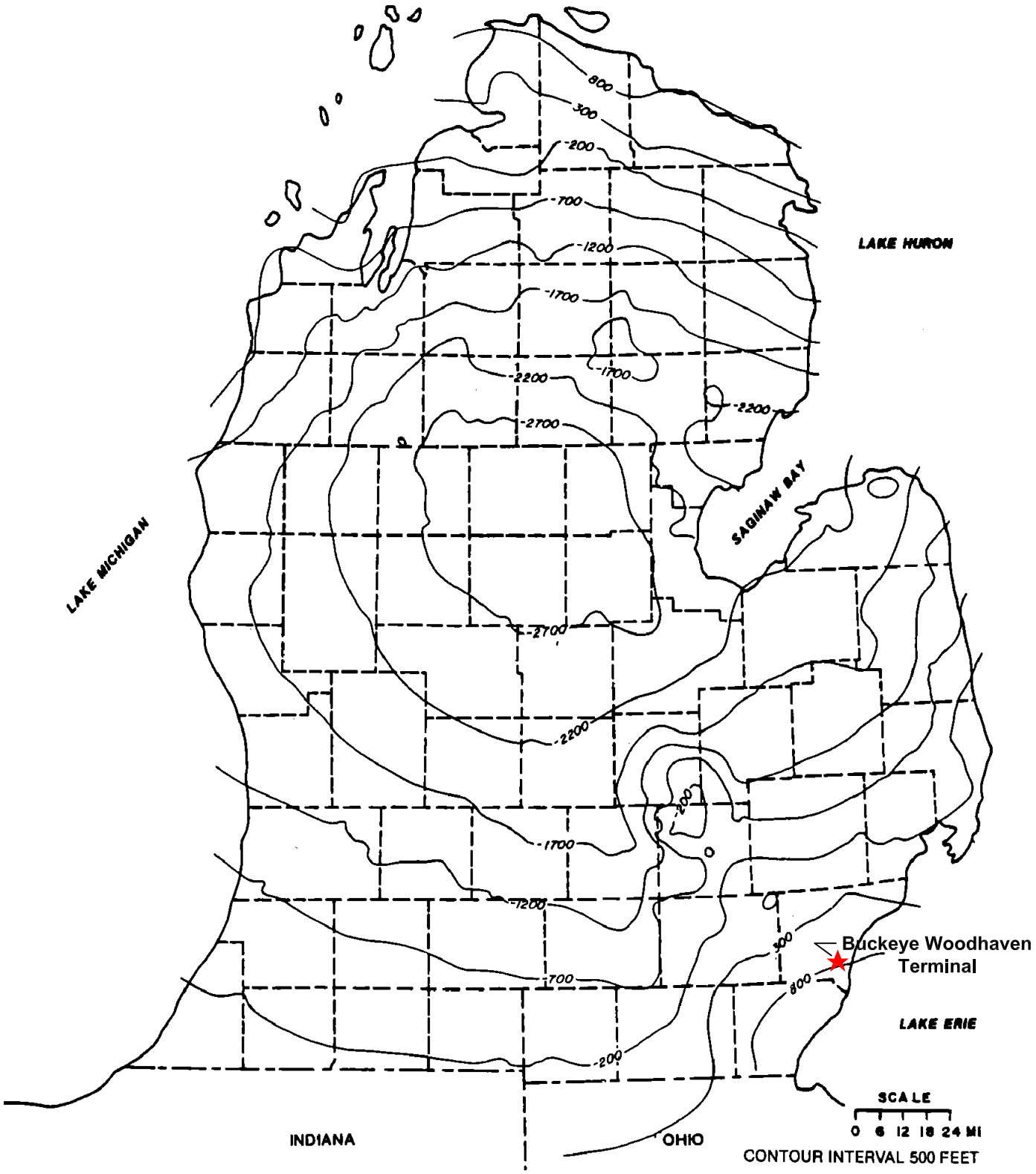
THICKNESS LITHOFACIES OF THE DUNDEE FORMATION

Job No. 192065A					
Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F–18



Source: Hydrogeology for Underground Injection Control in Michigan: Part I, 1981

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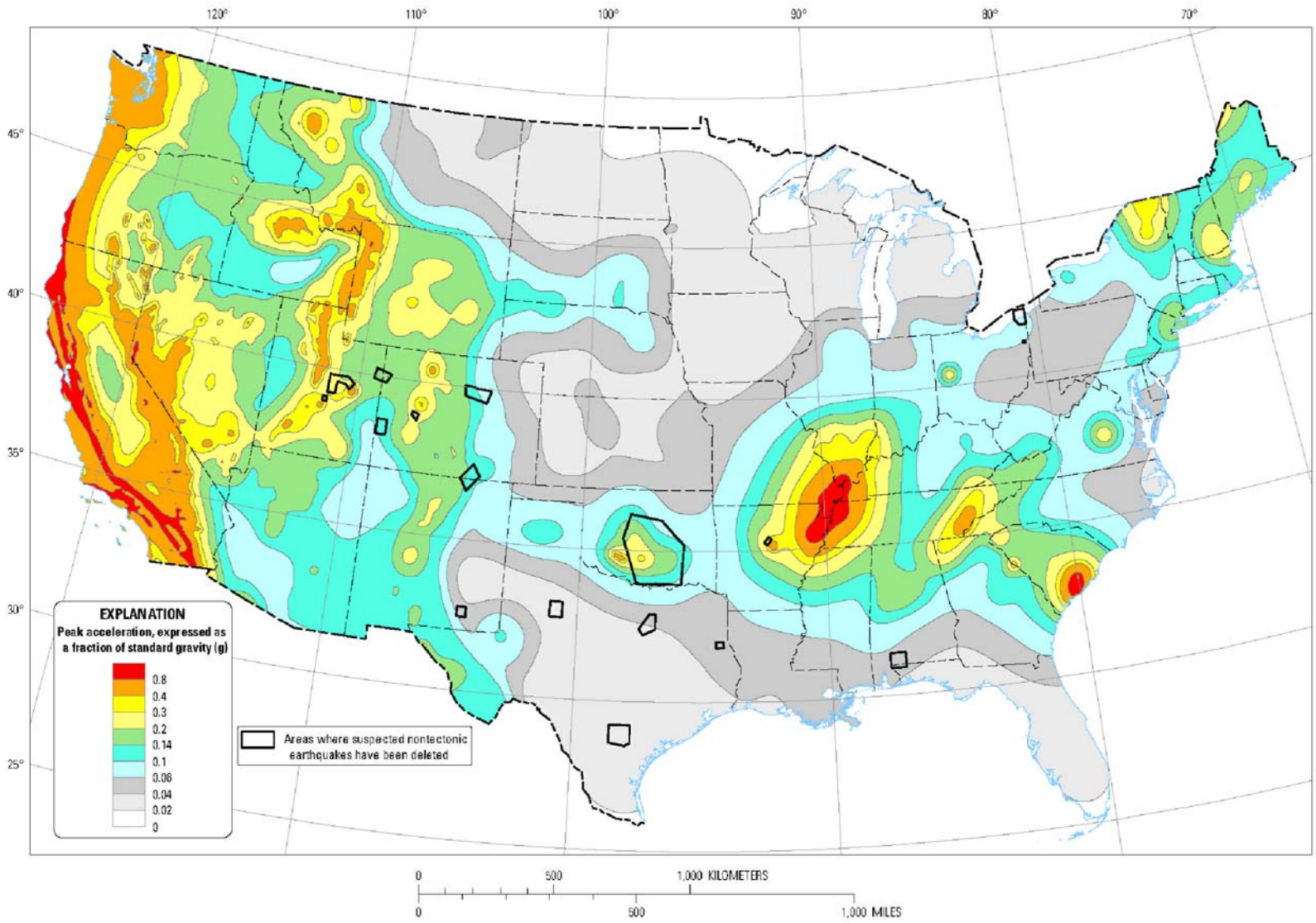
STRUCTURE MAP OF THE DUNDEE FORMATION

Job No. 192065A

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. F-19



Two-percent probability of exceedance in 50 years map of peak ground acceleration

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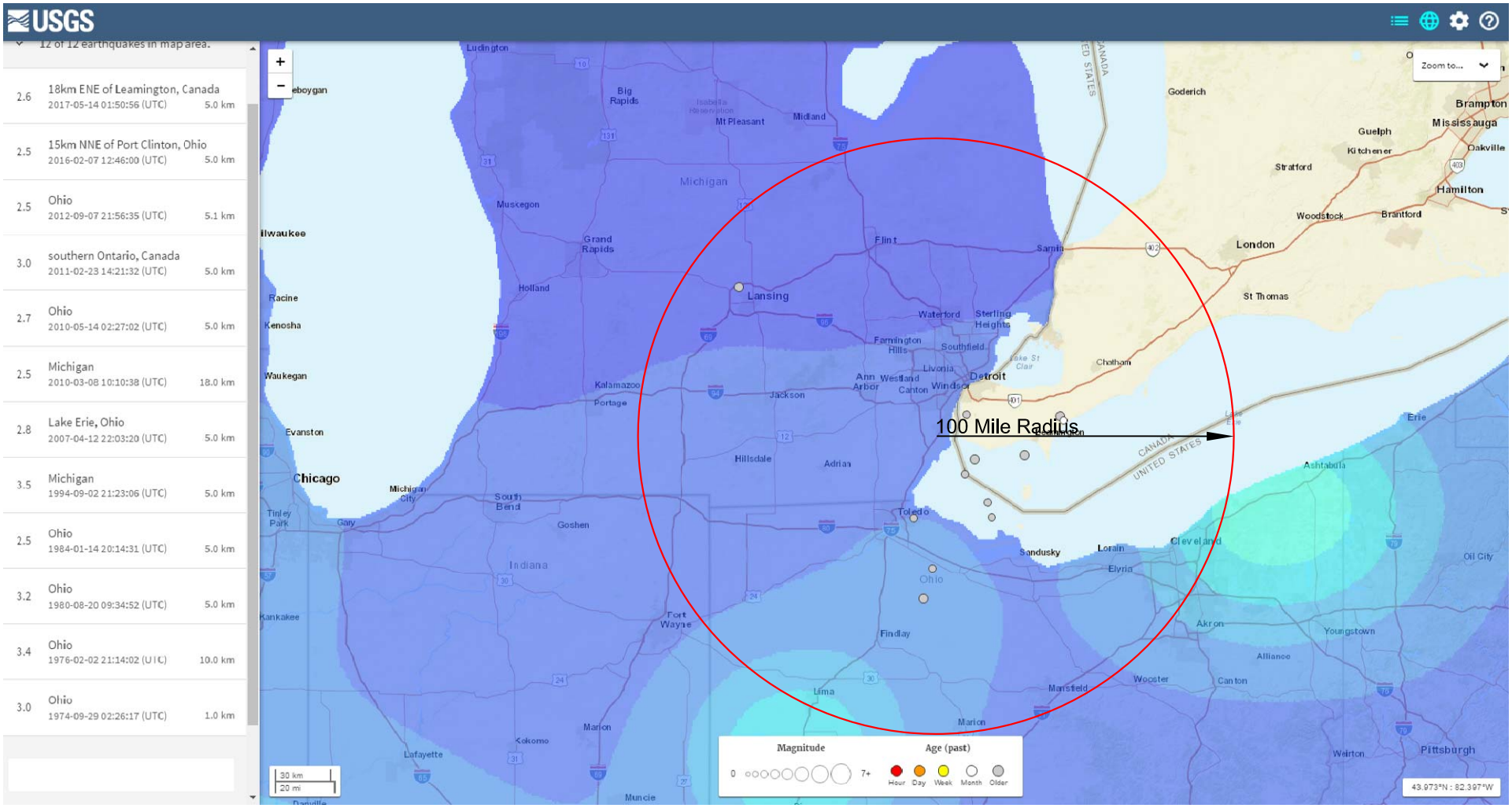
SEISMIC RISK MAP

Job No. 192065A

Design:	Drawn:	Checked:	Date:	Scale:	Drawing No.
WDD	WDD	GM	08/21/17	NTS	F–20



Date and Time	Latitude	Longitude	Depth	Magnitude	Place	Type
2017-05-14T01:50:56.250Z	42.136	-82.41	5	2.6	18km ENE of Leamington, Canada	earthquake
2016-02-07T12:46:00.000Z	41.6503	-82.8969	5	2.5	15km NNE of Port Clinton, Ohio	earthquake
2012-09-07T21:56:35.100Z	41.864	-83.076	5.1	2.5	Ohio	earthquake
2011-02-23T14:21:32.420Z	42.157	-82.43	5	3	southern Ontario, Canada	earthquake
2010-05-14T02:27:02.150Z	41.39	-83.3	5	2.7	Ohio	earthquake
2010-03-08T10:10:38.560Z	42.163	-83.07	18	2.5	Michigan	earthquake
2007-04-12T22:03:20.450Z	41.722	-82.924	5	2.8	Lake Erie, Ohio	earthquake
1994-09-02T21:23:06.520Z	42.798	-84.604	5	3.5	Michigan	earthquake
1984-01-14T20:14:31.290Z	41.645	-83.427	5	2.5	Ohio	earthquake
1980-08-20T09:34:52.300Z	41.941	-83.01	5	3.2	Ohio	earthquake
1976-02-02T21:14:02.000Z	41.96	-82.67	10	3.4	Ohio	earthquake
1974-09-29T02:26:17.100Z	41.238	-83.361	1	3	Ohio	earthquake

Note: Colors indicate US Hazard Risk, see Figure F-20 showing low risk

Source: USGS, 2017

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HISTORICAL EARTHQUAKES

Job No.	192065A

Design:	WDD	Drawn:	WDD	Checked:	GM	Date:	08/21/17	Scale:	NTS	Drawing No.	F–21

G. DOES NOT APPLY TO CLASS I WELLS

H. OPERATING DATA

H.1 INJECTION RATE AND VOLUME

The estimated average injection rate is: 165 gallons per minute (gpm) for each well.

The estimated average injection volume is: 7,128,000 gallons per month (30 days) per well for each well.

The requested maximum injection rate is: 215 gpm for each well.

The requested maximum injection volume is: 9,288,000 gallons per month (30 days) for each well.

The estimated average injection rate is based on measured injection rates in nearby wells injecting into the Mt. Simon Formation.

H.2 INJECTION PRESSURES

Based on the following calculations, the requested maximum surface pressure (MASIP) for variable specific gravities are as follows:

[(0.80 pound per square inch per foot [psi/ft] – (0.433 psi/ft x specific gravity)) x depth] – 14.7 pounds per square inch gauge (psig)

[(0.80 psi/ft – (0.433 psi/ft x 1.00)) x 3,470] – 14.7 psi = 1,259 psig

Where: Specific Gravity = 1.00

Depth to top of the Mt. Simon Formation = 3,470 feet

Fracture Gradient = 0.80 psi/ft

[(0.80 psi/ft – (0.433 psi/ft x 1.21)) x 3,470] – 14.7 psi = 943 psig

Where: Specific Gravity = 1.21

Depth to top of the Mt. Simon Formation = 3,470 feet

Fracture Gradient = 0.80 psi/ft

A table of MASIP as a function of Specific Gravity is provided in Table H-1.

Table H-1 MASIP as a Function of Injectate Specific Gravity

INJECTATE SPECIFIC GRAFIVTY	MASIP (PSIG)
1.00	1259
1.05	1184
1.10	1109
1.15	1033
1.20	958
1.21	943

H.3 WASTE

H.3.1 SOURCE

The proposed injectate will consist of brine from the solution mining of the Salina Formation to create storage caverns. The specific gravity of the brine is expected to range from 1.00 to 1.21. The injectate pH will be approximately 7.24 at 70 F°.

H.3.2 WASTE ANALYSIS

A typical Wastewater analysis is provided in Table H-2 and as Table 1-1 in Appendix D, the Waste Analysis Plan discussed in Attachment P.

H.3.3 CORROSION MONITORING

The corrosivity of the wastewater injectate will be monitored with corrosion coupons placed in the injectate stream. Well component materials will be selected using standard engineering specifications for specific functions with a balance between engineering serviceability and economics.

Table H-2 Estimated Wastestream Analysis for Proposed Monitored Parameters

PARAMETER	UNITS	READING
pH		7.24
Resistivity	ohm-meter	0.046
Temperature	°F	70
ANIONS		
Chlorides	mg/L	193,000
Sulfates	mg/L	2,989
Sulfides	mg/L	ND < 1
Carbonates	mg/L	ND < 10
Bicarbonates	mg/L	150
CATIONS		
Sodium	mg/L	112,500
Calcium	mg/L	1,940
Magnesium	mg/L	199
Barium	mg/L	ND < 1
Iron (total)	mg/L	ND < 1

Notes:

Mg/L – milligram per liter
ND – not detected

I. FORMATION TESTING PROGRAM

I.1 PROCEDURES TO VERIFY DEPTH OF THE LOWERMOST USDW, IF NEEDED

The base of the USDW within the AOR is estimated to be at 350 feet bgs at the base of the Sylvania Sand.

At each proposed well, the surface hole will be drilled to 470 feet (120 feet below the base of the USDW) to allow for geophysical logging to be conducted across the base of the USDW. The logging to be conducted is discussed further in Attachment L. The resistivity of the formation water will be calculated using the resistivity and porosity values recorded on the logs.

No open-hole testing is planned to sample the lowermost USDW during the installation of the wells.

I.2 PROCEDURES TO OBTAIN EXTRAPOLATED FORMATION PRESSURE

The following procedures are to obtain extrapolated formation pressure in porous and permeable zones within approximately 500 feet of the top of the injection zone.

As discussed in Attachments L and M, a series of drill stem tests may be conducted during drilling. The intervals to be tested will be determined from data collected while drilling. The open-hole drill stem tests will provide preliminary reservoir information regarding permeability-thickness product and bottom hole pressure.

The open-hole testing, combined with the open-hole geophysical log interpretations, will determine the primary injection zone to be targeted during well completion. Casing will be set at the top of the selected injection zone and cemented as described in Attachments L and M. Injection and pressure falloff testing will be conducted as detailed in Steps 10 through 12 of the Completion Procedure discussed in Attachment L.

The original formation pressure obtained from the pressure falloff testing will be used to calculate the formation pressures in porous zones within 50 feet of the top of the injection zone. The specific gravity of the fluid will be measured from samples of the formation fluid recovered in Steps 5 and 6 of the Completion Procedure discussed in Attachment L.

The following equation will be used to extrapolate pressure to a well depth within 500 feet from the top of the injection zone:

$$P_D=P_L-0.433\ \gamma^f(L-D)]$$

Where:

P_D = Extrapolated formation pressure at depth D feet bgs, psia

P_L = Formation pressure measured at depth L feet bgs, psia

γ^f = Specific gravity of formation fluid sample recovered from the injection interval

L = Depth bgs of pressure measurement taken in the injection interval

D = Depth bgs of calculated pressure in injection interval

I.3 SAMPLING AND ANALYSIS PROCEDURES FOR FORMATION FLUID

When the primary injection interval is determined, the first aquifer overlying the confining zone will be sampled utilizing a wireline conveyed repeat formation tester while conducting the open-hole geophysical logging. A standard water analysis of the formation fluid (Section L.2) will be conducted to determine physical and chemical properties.

I.4 COLLECTION AND ANALYSIS OF CORES

As previously discussed, the primary injection zone will be determined during drilling of the wells. Consequently, the confining and injection zone will be sampled by sidewall coring after the geophysical logging. Full-hole cores will be obtained in specific intervals during the drilling of future wells as needed.

Physical core analysis will include lithologic descriptions. Rock density, porosity, and air permeability will be determined on selected core samples. In addition, permeability to both waste and brine will be determined on selected plug samples taken from obtained core. Both horizontal and vertical permeability will be measured. Brine and waste permeability measurements will be run utilizing methods with a high range of accuracy (10^3 to 10^{-6} millidarcy [md]).

Testing for mechanical rock properties will include determinations of Young's Modulus, Poisson's Ratio, tensile strength, and bulk compressibility. Selected samples from each core will be tested. Injectate compatibility testing will be conducted with fluids and matrix material derived from the injection zone.

I.5 FRACTURE CLOSURE PRESSURE DETERMINATION

Fracture closure pressure will be determined during the step-rate test of the injection zone discussed in Attachment L. This data will be collected in support of the geophysical calculations of the mechanical properties of the formation.

I.6 PROCEDURES FOR INJECTIVITY/FALL-OFF TESTING

Injection/fall-off test procedures are included Attachment L. The testing will be performed in accordance with EPA Region 5 Guidelines for Reservoir Testing (Regional Guidance #6). The rate and volume of fluid to be injected will be determined from preliminary injection testing results.

J. STIMULATION PROCEDURE

The need for any type of stimulation program will be determined after the well has been drilled and tested; however, it is not anticipated to be needed. Should the results of the injectivity testing program performed after the well has been constructed indicate stimulation is necessary to achieve the desired injection rate, the well will be chemically enhanced to reduce formation skin damage. The injection interval may be treated with a hydrochloric acid pre-treat, a mud acid main treat, and a hydrochloric acid post-treat.

This operation will consist of placing the acid across the entire injection interval in sequence allowing the acid to soak and then flow back out of the well after post flush. The exact volume, make-up and placement technique of the acid will be developed after the necessary performance data from the proposed injection wells have been collected and analyzed.

Below is an estimated stimulation program to be verified. All chemicals involved in this stimulation activity will need to be stored and handled in accord with site and industry safe working practice and regulatory working practice. A plan will be developed and approved by all parties involved prior to bringing chemicals on site, after requirement has been defined. The EPA will be notified prior to any acid stimulation of the injection formation. It should be noted that during acid stimulation, the annulus pressure may not be maintained at a 100 psi differential over the injection pressure.

Pre-Flush:

5,000 gallon 10% Hydrochloric Acid

250 gallon Well Stimulator

10 gallon Inhibitor

10 gallon Iron Reducing Agent

10 gallon Non-Emulsifying Agent

10 gallon Perm Clay Stabilizer

Main Flush:

18,000 gallon 12% Hydrochloric/3% Hydrofluoric (Mud Acid)

36 gallon Inhibitor

180 gallon Well Stimulator

36 gallon Iron Reducing Agent

36 gallon Non-Emulsifying Agent

36 gallon Perm Clay Stabilizer

Post Flush:

2,000 gallon 10% Hydrochloric Acid

20 gallon Well Stimulator

4 gallon Inhibitor

4 gallon Iron Reducing Agent

4 gallon Non-Emulsifying Agent

4 gallon Perm Clay Stabilizer

K. INJECTION PROCEDURE

K.1 WASTE STREAM FLOW

A simplified schematic showing the plant outline indicating the proposed waste stream flow is provided as Figure K-1.

K.2 DESCRIPTION OF FACILITIES

The cavern solution mining system will be composed of two smaller connected systems: 1) the water injection system; and 2) the brine disposal system. The brine disposal system incorporates solids separation, a booster pump to pressurize the brine, a fine particle filtration system, brine disposal pumps, a disposal well, and a well annulus monitoring system. This leaching system will not be a part of the facility until future cavern development starts.

Brine will be injected into the wells with multiple, variable speed positive displacement injection pumps connected in parallel. A sample tap will be located on the injectate flow line before the injection pumps.

Figure K-2 provides a simplified schematic diagram showing the flow of the injectate through storage, filtration and pumps to the injection well.

K.3 DESCRIPTION OF INJECTION PUMPS

The facility is proposing to utilize two centrifugal injection pumps with a rating of 350 horsepower and operating pressure of 2000 psi.

K.4 DESCRIPTION OF ANNULUS PRESSURE MAINTENANCE SYSTEM

The annulus pressure maintenance system at each wellhead will consist of a 200-250 gallon, nitrogen pressurized pot that is filled with inhibited fluid and connected to the annulus of 4-½-inch injection tubing and 9-⅝-inch protection casing. The annulus pot will have a sight glass to allow the fluid level to be monitored visually as well as an electronic transmission that will be monitored continuously at the main computer terminal.

The annulus pressure will be maintained at least 100 psi above the maximum wellhead injection pressure. An analog pressure gauge will be connected to the well annulus and a pressure transducer will also be connected to the well annulus that transmits a signal to a digital converter. The digital output of the annulus pressure will be transmitted to a computer for continuous monitoring of the annulus pressure.

A female coupling will be connected below the analog annulus pressure gauge to allow for independent determination of annulus pressure. A schematic diagram of the anticipated well head and annulus maintenance system has been included as Figure K-3.

K.5 DESCRIPTION OF ALARM AND SHUT-OFF SYSTEM

Continuous measurements of injection pressure and annulus pressure will be monitored by a shut-down system. The injectate specific gravity will be measured daily during cavern leaching operation. The injectate specific gravity will be measured weekly during cavern hydrocarbon storage operation when the wells will transition to intermittent use and the injectate brine will be fully saturated or nearly fully saturated. The system will shut down the injection pumps if the wellhead injection pressure exceeds a predetermined MASIP determined by calculations based on the most recent measured specific gravity or if the annulus pressure drops below a predetermined minimum allowable annulus pressure. All instrumentation will be enclosed in weatherproof housing located near the deep well.

In accordance with regulations, the annulus pressure will be kept at a minimum of 100 psi over the injection pressure and the annulus pressure will have a maximum of 150 psi above the maximum calculated MASIP. The alarm and shutdown will occur when the annulus pressure drops below 100 psi above this MASIP. The specific gravity variable injection pressure and annulus pressures will be monitored continuously with analog and digital gauges on the wells. Pressure transducers and flow measurement will be tied in with the well's main computer terminal to compute the MASIP as well as flow rate.

All personnel will be trained in the operation of the well, including fluid quality, alarms, shutdowns, and notification procedures. Operators will be in continual attendance during well operation. In the event that an alarm sounds, facility personnel will notify a trained operator who will investigate and correct the problem. If upon investigation, it is determined that a well lacks mechanical integrity, or if continued monitoring otherwise indicates that the well may be lacking mechanical integrity, then Buckeye Terminals, LLC will:

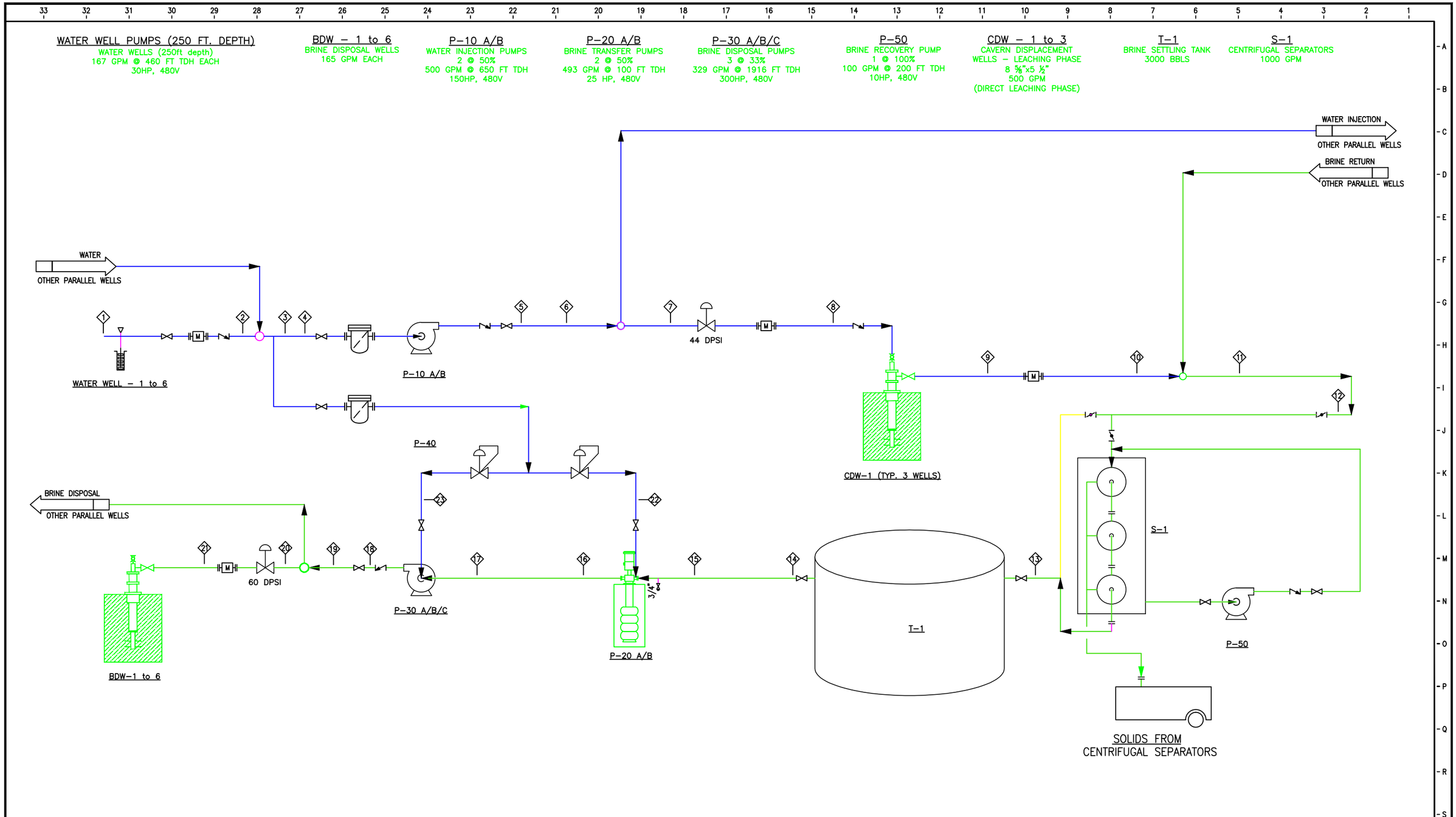
1. cease injection of waste fluids (unless authorized by the executive director (MDEQ) to continue or resume injection;
2. take the steps necessary to determine the presence or absence of a leak; and
3. notify the MDEQ within 24 hours after the alarm or shutdown occurs.

List of Figures in Attachment K

Figure K-1 Process Flow Diagram

Figure K-2 Conceptual Process Flow Diagram

Figure K-3 Proposed Wellhead and Annulus Pressure System Schematic



PRELIMINARY

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THIS DRAWING PREPARED FOR:

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GENERAL NOTES

REFERENCE DRAWINGS

REV. No.	REVISIONS	REVISED BY	REVISED DATE	CHECKED BY	CHECKED DATE	APPROVED BY	APPROVED DATE
A	ISSUED FOR REVIEW	RMM	4/3/14	HK	4/3/14	AJ	4/3/14
B	ISSUED FOR CLIENT REVIEW	RMM	04/30/14	HK	04/30/14	AJ	04/30/14

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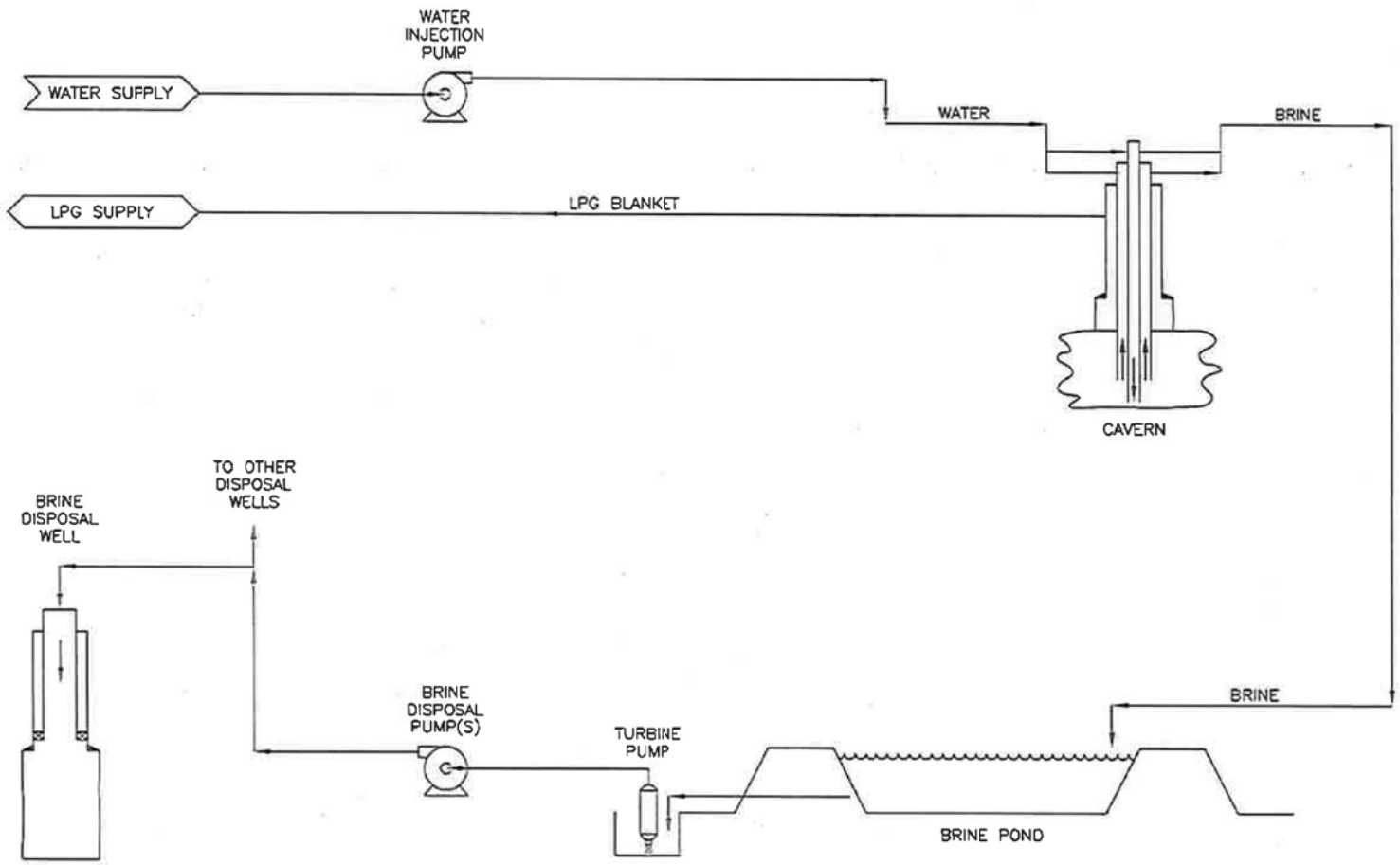
SIMPLIFIED SCHEMATIC OF PROPOSED WASTE STREAM FLOW
LEACH PLANT
WOODHAVEN
BUCKEYE TERMINALS, LLC

DESIGN BY: HK DATE: 4/21/14	DRAWN BY: RMM DATE: 4/21/14	SCALE: NONE	
CHECKED BY: HK DATE: 4/21/14	APPROVED BY: HK DATE: 4/21/14	PROJECT No: 192065A	
FILE NAME: FIGURE K–1	DRAWING No.	LATEST REVISION: B	



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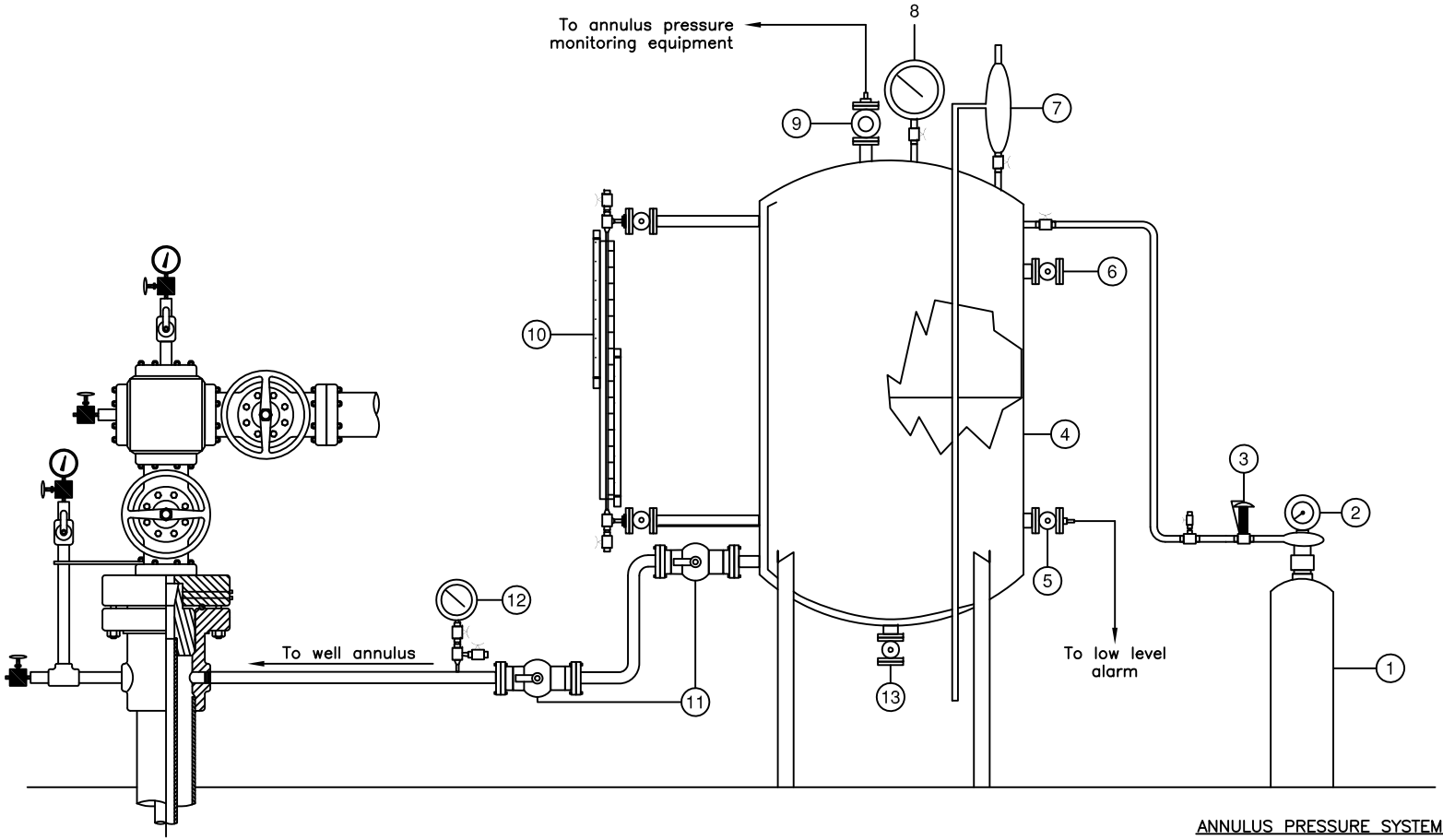
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

SIMPLIFIED SCHEMATIC DIAGRAM OF INJECTATE FLOW

Job No. 192065A					
Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Drawing No. K–2



ANNULUS PRESSURE SYSTEM DETAILS

1. Nitrogen supply tank
2. Nitrogen supply tank pressure gauge
3. Nitrogen pressure control valve
4. Annulus pressure pot
5. Annulus fluid level low alarm
6. Annulus pressure pot fill valve
7. Annulus pressure pot safety valve
8. Annulus pressure pot pressure gauge
9. Annulus pressure pot pressure measuring point
10. Annulus pressure pot sight glass
11. Annulus block valves
12. Pressure gauge
13. Annulus pressure pot drain valve

NOT TO SCALE

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BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED WELLHEAD AND ANNULUS PRESSURE SYSTEM SCHEMATIC

Job No. 192065A

Design:	Drawn:	Checked:	Date:	Scale:	Drawing No.
WDD	WDD	GM	08/21/17	NTS	K-3

L. CONSTRUCTION PROCEDURES

L.1 CONSTRUCTION PROCEDURES

The injection zone will include the Eau Claire Formation and the Mt. Simon Sandstone (approximately 3,470 to 3,730 feet bgs). The Utica shale, the Trenton Limestone, and the Trenton/Black River Dolomite constitute the confining zone (2,060 to 3,470 feet bgs).

The construction procedures below are developed to drill and test the individual zones to evaluate and maximize the potential for injection. Intermediate casing will be set below the lowermost formation that is productive of hydrocarbons in the immediate area. The injection long-string casing will be set above the selected injection interval and cemented to surface.

The estimated timetable for drilling, logging, and formation testing is provided on Table L-1.

L.1.1 DRILLING AND COMPLETION OF VERTICAL WELLS (BDW-1 AND BDW-4)

1. Clear and level the location to accommodate rotary drilling equipment. The pad will be constructed in a manner that the entire pad is covered with a liner surrounded on all sides with spill berm. It is anticipated that salt-based drilling fluid will be required; therefore, the cuttings will be processed through a closed loop mud system that will dewater cuttings and recycle fluids. Solids and fluids will be disposed of in an environmentally safe and proper way.

2. Set conductor casing by driving or augering 20-inch, 0.625-inch minimum wall thickness, conductor casing to 50 feet bgs or refusal.

3. Move in and rig up a rotary drilling rig and equipment capable of a total depth of 8,000 feet. Rotary rig has to have all inspections and certifications up to date and have documentation to prove it. Install a riser pipe on the conductor casing to contain drilling fluid while drilling the surface hole. A proposed drilling fluid program can be found in Appendix C.

4. Mix a fresh water gel drilling fluid to drill the surface hole. Drill a 17-½ inch hole to 470 feet bgs. Run deviation surveys at the base of the conductor casing and at 50-foot intervals to 470 feet. The maximum allowable deviation of the surface hole will be 0.75 degree from vertical at 470 feet.

5. Run geophysical logs on the surface hole to verify the base of the USDW (Table L-2).

6. Run 13-3/8 inch surface casing as specified in Table M-2 to the total depth of the surface hole. Cement the surface casing to ground surface as detailed in Table M-1. Should the cement fail to circulate to surface or fall back bgs, run 1-inch pipe to the top of the cement and fill the annulus to the surface with standard cement.

7. Run a temperature survey between 8 and 12 hours after the cement is in place to locate the top of the cement if it does not circulate to surface. Allow 24 hours for the cement to set before releasing the casing from the slips or elevators.

8 Cut the surface casing off at ground level and install a 13-5/8 inch, 3000-psi working pressure, weld-on casing head. Pressure test the surface casing to 1000 psig according to EPA Region 5 guidelines.

9 Run a 12-¼ inch bit and drill the cement out of the shoe joint to the base of the surface casing.

10 Rig up a 24-hour, manned, mud logging unit to collect and evaluate samples, plot drilling time, and detect hydrocarbon shows while drilling.

11 Drill a 12-1/4 inch hole to the depth of 650' with the fresh water drilling system. Conduct deviation surveys on 90-foot intervals with a maximum deviation change of 1 degree per 100 feet and a total deviation not to exceed 5 degrees from vertical at any point in the well. At 650' displace and convert the drilling fluid system to a salt-saturated system to protect the salt beds from washing out in the Salina interval. Maintain good quality salt saturated drilling fluid and a closed loop solids separation system to contain and isolate drill cuttings for disposal.

12 Drill 12-1/4" hole 150' below the to the base of the B Salt to approximately 1310' BGL. Circulate and condition hole and run geophysical logs from 1310 feet to the base of the surface casing.

13 Run 9-5/8", 36 lb/ft, J-55, intermediate casing to total depth. Run centralizers on every other casing collar from total depth to surface. Cement with salt saturated class G cement.

14 Center the casing in the wellhead and install the casing slips without moving the casing. Wait on cement a minimum of 24 hours. Cut the casing and install the "B" section of the wellhead. Nipple up blowout preventors.

15 Drill out the cement stage collar with an 8-3/4" drill bit assembly and clean out to the float collar. Run a cement bond log from total depth to the surface. Pressure test the casing to 1500 psi for 20 minutes per MDEQ and EPA requirements.

16 Drill out cement and shoe with stabilized 8-3/4" drill bit assembly and continue to drill to total depth at the base of the Mt Simon (approximately 3730 feet) as determined by sample analysis and on-site evaluation.

17 Run geophysical logs as detailed in Table L-2. Determine the optimum setting depth for the 5-1/2", 15.5#, LTC casing.

18 Fill the bottom of the well with sand to the depth of the casing shoe as determined from logs and other testing. Run 5-1/2" casing, according to the detail in Table M-2, to the desired depth. Cement the casing annulus to the surface, in one or two stages, as detailed in Table M-1.

19 Run a temperature survey between 8 and 12 hours after the cement is in place to locate the top of the cement if it does not circulate to surface. Run 1-inch pipe and fill the annulus to surface if necessary.

20 After 48 hours waiting time, run a cement bond log from the stage tool (if run) or the float collar to surface. Set the casing slips release the 5-1/2" casing. Make a final cut on the 5-1/2" casing and install an 7-1/16-inch, 3000-psi tubing head.

21 Install blowout preventers and drilling nipple. Run a 4-5/8" drilling assembly on 3-1/2" drill pipe. Pressure test the casing above the stage collar (if present) to 1500 psi according to EPA guidelines. Drill out the stage collar and pressure test the casing and the stage collar. Clean out the casing to the shoe joint.

22 Run a cement bond log along the full length of the 5-1/2" casing if not done previously. Conduct the final intermediate casing pressure test according to EPA guidelines to certify mechanical integrity.

23 Drill out the cement from the shoe joint and clean out the open hole below the casing to TD.

24 Displace the wellbore to 1% KCl water and secure the well with a cap.

25 Rig down and move out the drilling rig and equipment and restore location.

26 The well will be completed as described in the Completion section below.

L.1.2 DRILLING AND COMPLETION OF DIRECTIONAL WELL (BDW-2, BDW-3, AND BDW-5)

1 Clear and level the location to accommodate rotary drilling equipment. The pad will be constructed in a manner that the entire pad is covered with a liner surrounded on all sides with spill berm. It is anticipated that salt-based drilling fluid will be required; therefore, the cuttings will be processed through a closed loop mud system that will dewater cuttings and recycle fluids. Solids and fluids will be disposed of in an environmentally safe and proper way.

2 Set conductor casing by driving 20-inch, 0.625-inch minimum wall thickness, conductor casing to 50 feet bgs or refusal.

3 Move in and rig up a rotary drilling rig and equipment capable of a total depth of 8,000 feet. Rotary rig has to have all inspections and certifications up to date and have documentation to prove it. Install a riser pipe on the conductor casing to contain drilling fluid while drilling the surface hole. A proposed drilling fluid program can be found in Appendix C.

4 Mix a salt gel drilling fluid to drill the surface hole. Drill a 17-½ inch hole to 470 feet bgs. Run deviation surveys at the base of the conductor casing and on 50-foot intervals to 470 feet. The maximum allowable deviation of the surface hole will be 0.75 degree from vertical at 470 feet.

5 Run geophysical logs on the surface hole to verify the base of the USDW (Table L-2).

6 Run 13-3/8 inch surface casing as specified in Table M-2 to the total depth of the surface hole. Cement the surface casing to ground surface as detailed in Table M-1. Should the cement fail to circulate to surface or fall back bgs, run 1-inch pipe to the top of the cement and fill the annulus to the surface with standard cement.

7 Run a temperature survey between 8 and 12 hours after the cement is in place to locate the top of the cement if it does not circulate to surface. Allow 24 hours for the cement to set before releasing the casing from the slips or elevators.

8 Cut the surface casing off at ground level and install a 13-5/8 inch, 3000-psi working pressure, weld-on casing head. Pressure test the surface casing to 1000 psig according to EPA Region 5 guidelines.

9 Run a 12-¼ inch bit and drill the cement out of the shoe joint to the base of the surface casing.

10 Rig up a 24-hour, manned, mud logging unit to collect and evaluate samples, plot drilling time, and detect hydrocarbon shows while drilling.

11 Run a 12-¼ inch bit and stabilized drilling assembly. Drill a 12-1/4 inch hole to the depth of 650' with the fresh water drilling system. Conduct deviation surveys on 90-foot intervals with a maximum deviation change of 1

degree per 100 feet and a total deviation not to exceed 5 degrees from vertical at any point in the well. At 650' displace and convert the drilling fluid system to a salt-saturated system to protect the salt beds from washing out in the Salina interval. Maintain good quality salt saturated drilling fluid and a closed loop solids separation system to contain and isolate drill cuttings for disposal.

12 Drill 12-1/4" hole 150' below the to the base of the B Salt to approximately 1310' BGL. Circulate and condition hole and run geophysical logs from 1310 feet to the base of the surface casing.

13 Run 9-5/8", 36 lb/ft, J-55, intermediate casing to total depth. Run centralizers on every other casing collar from total depth to surface. Cement with salt saturated class G cement.

14 Center the casing in the wellhead and install the casing slips without moving the casing. Wait on cement a minimum of 24 hours. Cut the casing and install the "B" section of the wellhead. Nipple up blowout preventors.

15 Drill out the cement stage collar with an 8-3/4" drill bit assembly and clean out to the float collar. Run a cement bond log from total depth to the surface. Pressure test the casing to 1500 psi for 20 minutes per MDEQ and EPA requirements.

16 Trip out of the well and install drilling motor and mud tools to the bottom hole assembly (BHA). Maintain good quality drilling fluid and solids separation equipment to minimize the weight of the drilling fluid and minimize hole erosion and washout.

17 Start building curve section and build to final inclination (maximum 35 degree) while maintaining 3 degrees per 100 feet build rate. Once final inclination reached, hold angle from to depth of 3,730 feet total vertical depth (TVD).

18 Run geophysical logs as detailed in Table L-2. Determine the optimum setting depth for the 5-1/2", 15.5#, LTC casing.

19 Fill the bottom of the well with sand to the depth of the casing shoe as determined from logs and other testing. Run 5-1/2" casing, according to the detail in Table M-2, to the desired depth. Cement the casing annulus to the surface, in one or two stages, as detailed in Table M-1.

20 Run a temperature survey between 8 and 12 hours after the cement is in place to locate the top of the cement if it does not circulate to surface. Run 1-inch pipe and fill the annulus to surface if necessary.

21 After 48 hours waiting time, run a cement bond log from the stage tool (if run) or the float collar to surface. Set the casing slips release the 5-1/2" casing. Make a final cut on the 5-1/2" casing and install an 7-1/16-inch, 3000-psi tubing head.

22 Install blowout preventers and drilling nipple. Run a 4-5/8" drilling assembly on 3-1/2" drill pipe. Pressure test the casing above the stage collar (if present) to 1500 psi according to EPA guidelines. Drill out the stage collar and pressure test the casing and the stage collar. Clean out the casing to the shoe joint.

23 Run a cement bond log along the full length of the 5-1/2" casing if not done previously. Conduct the final intermediate casing pressure test according to EPA guidelines to certify mechanical integrity.

24 Drill out the cement from the shoe joint and clean out the open hole below the casing to TD.

25 Displace the wellbore to 1% KCl water and secure the well with a cap.

26 Rig down and move out the drilling rig and equipment and restore location.

27 The well will be completed as described in the Completion section below.

L.2 COMPLETION

1 Prepare the location for a well completion rig. Move in a completion rig and ancillary equipment and sufficient 2-7/8 inch work string to reach total depth.

2 Rig up wireline and run a baseline temperature survey. Rig down wireline.

3 Run a 5-1/2-inch test packer on the work string and set the packer approximately 100 feet above the base of the casing.

4 Swab or jet well to recover formation fluid utilizing coiled tubing if necessary. Continue sampling until a representative recovery rate is established and a representative sample of fluid can be obtained for analysis.

5 Run a bottom hole pressure recorder to obtain a stabilized (12 hr minimum) bottom hole pressure. Pull the recorder and pull the workstring and packer out of the well.

6 Conduct a baseline injection test down the casing with filtered 1% KCL water. Determine the injectivity and establish whether stimulation of the formation with acid or fracture stimulation is necessary. Run a baseline casing inspection log.

7 Run a hydraulically set, retrievable packer with a 40 foot fiberglass tailpipe assembly and set it above the base of the casing. Run 3-1/2 inch injection tubing, and fill the annulus with corrosion inhibited brine water with oxygen scavenger. Latch into the packer (Refer to Figure M-6) and land the tubing in the wellhead.

8 Notify the EPA of the pending mechanical integrity test. Allow the well to stabilize thermally and conduct a Standard Annulus Pressure Test to confirm internal mechanical integrity of the casing, tubing, packer, and wellhead.

9 Place sufficient water into frac tanks to conduct a 12-hour injection test at the rate previously established. Run a surface readout bottom hole pressure transducer and set it near the base of the casing. Conduct a step rate injection test, plotting the rate and pressure to determine the fracture pressure as required, then shut down for one hour.

10 Inject fluid for 12 hours at a constant matrix injection rate while continuing to record bottom-hole pressure. Shut the well in and conduct a pressure falloff test for a time necessary to reach radial flow as determined by the derivative plot. Design pressure falloff test to measure interefence with nearby well(s), if applicable. At the completion of the pressure falloff, remove the pressure recorders from the well(s).

11 Begin injection into the well and run a radioactive tracer survey according to the guidelines of Region 5 for external mechanical integrity. Develop a fluid distribution profile from the moving surveys.

12 Rig down completion equipment and install the wellhead to secure the well while obtaining final permits for injection.

L.3 PROPOSED OPEN-HOLE AND CASED-HOLE LOGS

The proposed logging program is detailed in Table L-2. Multiple logging runs in the open hole may be required to evaluate the potential intervals available for injection. Mechanical integrity testing logs (cement bond logs, radioactive tracer log, and temperature, or noise or oxygen activation logs) are required prior to injection of brine.

The well(s) will be tested to demonstrate mechanical integrity as required by the guidelines of Region 5. Cement bond logs will be run on each casing string after the cement has cured. Each casing string will be pressure tested prior to drilling any new hole below the shoe joint.

A baseline casing inspection log will be run on the final casing string from total casing depth to surface. A baseline temperature survey will be conducted on the final casing and open-hole interval prior to the injection of significant volumes of water to provide a basis of comparison to future temperature surveys that may be run for demonstration of mechanical integrity.

After the injection tubing and packer have been installed, a radioactive tracer survey will be conducted to demonstrate external mechanical integrity of the cemented casing and the containment of injected fluid.

All tests will be conducted according to the most current edition of EPA Region 5 guidelines for mechanical integrity testing.

L.4 PROPOSED BUFFER FLUID AND VOLUME

After recovering samples of the formation water in the intended injection interval, compatibility tests will be run with samples of the intended waste stream. The samples will be tested at simulated bottom hole conditions to determine if precipitates form under those conditions. If the results are favorable, then no buffer fluid will be needed. If the results are in doubt, a volume of buffer fluid will be determined, based on the compatibility results to minimize direct contact of the connate water and the injectate.

List of Tables in Attachment L

Table L-1 Estimated Timetable for Field Operations (Drilling, Logging, and Testing)

Table L-2 Proposed Logging Program

TABLE L-1

ESTIMATED TIMETABLE FOR FIELD OPERATIONS (DRILLING, LOGGING, AND TESTING)
BUCKEYE TERMINAL, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

(Timeline is for Each Well)

	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Days	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112
	Task																
1	Build Location, Drive Conductor and Rig Up																
2	Drill, Log, Case and Cement Surface Casing to 450' (13-3/8' Casing 17-1/2" Hole)																
3	Intermediate String Casing to 1,310'TVD / (9-5/8" Casing 12-1/4" Hole)																
4	Drill, Log Case and Cement Long String Casing to 3,490'TVD / (5-1/2" Casing 8-3/4" Hole)																
5	Drill and Log 8-3/4" Open Hole to 3730' TVD																
6	Set 9-5/8" X 4-1/2" Packer at 3470' TVD, 4-1/2" Injection String and Install Wellhead																
7	Run Injection Testing and MIT																

NOTES:
TVD - Total Vertical Depth
MD - Measured Depth
MIT - Mechnical Integrety Test

Table L-2 Proposed Down-Hole Logging and Mechanical Integrity Testing Program

BOREHOLE/CASING DESCRIPTIONS AND INTERVALS	PROPOSED OPEN HOLE LOGS	PROPOSED CASED HOLE LOGS
Conductor Casing (20-inch to 50 feet bgs)	None	None
Surface Hole (17 ½ - inch to 450 feet) Surface Casing (13 3/8-inch)	Spontaneous Potential Gamma Ray Resistivity Comp. Neutron Density Comp. Formation Density 4-Arm Caliper	Cement Bond Variable Density Gamma Ray Temperature
Open Hole 12 ¼ - inch 450 feet to 1,310 feet bgs	Spontaneous Potential Gamma Ray Resistivity 4-Arm Caliper	Cement Bond Variable Density Gamma Ray Temperature
Open Hole 8 ¾ - inch 1,310 feet bgs to Total Vertical Depth (TVD)	Spontaneous Potential Gamma Ray Resistivity Comp. Neutron Density Comp. Formation Density Long Space Sonic Log 4-Arm Caliper	Cement Bond Variable Density Gamma Ray Temperature
Completion Logs Surface to Total Depth Including both cased and open hole intervals		Baseline Differential Temperature Survey Bottomhole Pressure Falloff Test Radioactive Tracer Survey Post-Injection Differential Temperature Survey

M. CONSTRUCTION DETAILS

M.1 PROPOSED WELL CONSTRUCTION

A schematic of each of the proposed wells is included as Figures M-1 through M-5. Installation and construction of the well(s) is described in Attachment L.

M.2 PROPOSED CEMENT DESIGN

The cement design for the casing strings is shown in Table M-1. The cement has been recommended by Franklin Well Service and modified by WSP. Cement volumes will be based on a minimum of 120% of the open-hole/casing annular volume as determined by a four-arm caliper measurement of the open hole.

M.3 PROPOSED TUBULAR AND PACKER SPECIFICATIONS

The specifications for the casing, tubing and packer are included in Table M-2. The intermediate (long string) casing has been designed for a setting depth of 3,490 feet bgs.

M.4 WELLHEAD CONSTRUCTION DETAILS

The proposed well head is shown on Figure M-6.

M.5 LOCATION OF SAMPLE TAP AND FEMALE COUPLING FOR INDEPENDENT DETERMINATION OF ANNULUS PRESSURE

A needle valve, with a ½-inch female connection, will be installed on the tubing head outlet between the injection tubing and the casing annulus for an independent pressure gauge. An independent ½-inch tap will be provided on the flowline inlet to the well for independent measurement of injection pressure (Figure K-3).

List of Tables for Attachment M

Table M-1 Specifications for Cement for All Casing Strings

Table M-2 Specifications for Casing, Tubing, and Packer

List of Figures for Attachment M

Figure M-1 Proposed BDW-1 Well Construction and Stratigraphy

Figure M-2 Proposed BDW-2 Well Construction and Stratigraphy

Figure M-3 Proposed BDW-3 Well Construction and Stratigraphy

Figure M-4 Proposed BDW-4 Well Construction and Stratigraphy

Figure M-5 Proposed BDW-5 Well Construction and Stratigraphy

Figure M-6 Proposed Wellhead Schematic

TABLE M-1

SPECIFICATIONS FOR CEMENT FOR ALL CASING STRINGS
BUCKEYE TERMINAL, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

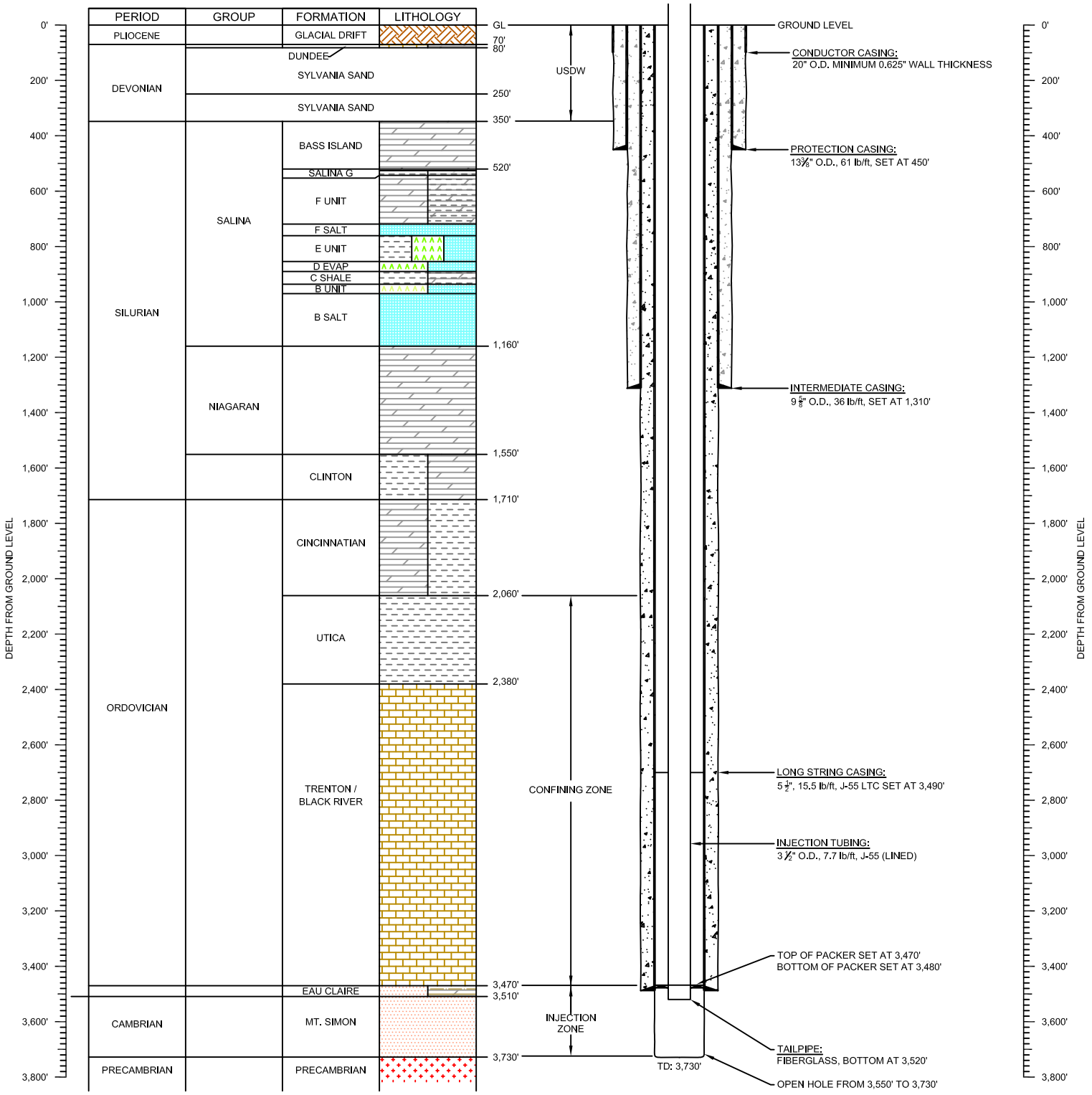
Interval	Casing Size (inch)	Hole Size (inch)	Interval (feet below ground surface)	Ideal Cement Volume x 1.2 (ft^3)	Cement Type From Haliburton Recommendation Volume to be based on 120% of caliper
Conductor	20	N/A	50	Driven	
Protection	13 3/8	17 1/2	0-470	459 cu. ft.	**Surface Casing (production)** 10 / 8 Franklin Salt System 225 sacks Class "A," + 10% (BWOC) Cal - Seal (GYPSUM) + 8% (BWOW) salt + .6% fluid loss + 5# Kol Seal (LCM) + 1/8# Poly-Flake (LCM) yield 1.7 cf/sk density 14.2 PPG water 8.0 gal/sk
Intermediate 1 (Long String)	9 5/8 (40 PPF)	12 1/4	0-1310	513 cu. Ft.	**Intermediate (long string)** 150 BBL Mud Flush **Lead** 10 / 8 Franklin Salt System 185 sacks Class "A," + 10% (BWOC) Cal-Seal (GYPSUM) + 18% (BWOW) salt + .6% fluid loss + .2% retarder + 5# Kol Seal (LCM) + 1/8# Poly-Flake (LCM) yield 1.75 cf/sk density 14.4 ppg water 7.9 gal/sk **Tail** 10 / 8 Franklin Salt System 112 sacks Class "A," + 10% (BWOC) Cal-Seal (GYPSUM) + 8% (BWOW) salt + 6% fluid loss + 5# Kol-Seal (LCM) + 1/8# Poly Flake (LCM) yield 1.7 cf/sk density 14.3 ppg water 8.0 gal/sk
Intermediate 2 (Production String)	5 1/2	8 3/4	0-3490	1083 cu. Ft.	**Intermediate (production string)** 245 BBL Mud Flush **Lead** 10 / 8 Franklin 391 sacks Class "A" cement + additives TBD yield 1.75 cf/sk density 14.5 ppg water 7.9 gal/sk **Tail** 10 / 8 Franklin 236 sacks Class "A" cement + additives TBD yield 1.7 cf/sk density 16 ppg water 8.0 gal/sk

NOTES:
BWOC - Amount in percent of material added to cement.
BWOW - Amount in percent of a material added to a cement slurry based on the weight of water.
cf/sk - cubic foot per sack
LCM - Solid material intentionally introduced into a mud system to reduce and eventually prevent the flow of drilling fluid into a weak, fractured or vugular formation.
gal/sk - gallons per sack
PPF - pounds per foot
ppg - pounds per gallon

TABLE M-2
Specifications for Casing, Tubing and Packer

Ref	Section	Outside Diameter (in)	Setting Depth (feet BGL)	Material	Collapse Resistance (psi)	Internal Yield (psi)	Tensile Strength (psi)	Maximum External Press (psi)	Maximum Internal Press (psi)	Maximum Tensile Load (lbs)	Safety Factor Collapse	Safety Factor Burst	Safety Factor Tension
	Conductor	20	50	133 ppf; 0.625" wall, N-80, STC or Welded	1600	4450	1,707,000	NA	NA				
1	Protection	13.375	470	61 ppf; J-55; STC	1,540	3,090	595,000	152	1,000	28,670	10.2	3.09	20.8
2	Intermediate	9.625	1310	36 ppf; J-55 (or K-55); STC	2,570	3,950	394,000	422	1,500	47,160	6.1	2.63	8.4
2	Long String	5.5	3490	15.5 ppf; J-55; LTC	4,040	4,810	202,000	1125	1,500	54,095	3.6	3.21	3.7
3	Injection Tubing	3.5	3,470	7.7 ppf; J-55; LTC	5,970	5,940	89,840	1861	5,000	26,719	3.2	1.19	3.4
	Injection Packer	5.5	3,470	Compression set retrievable double grip carbon steel									

1. Maximum external pressure after cementing 14.2 ppg cement with fresh water inside. Assumed gradient equal to 8.0 ppg. Maximum internal pressure during pressure test at 1000 psi.
2. Maximum external pressure after cementing 14.2 ppg cement with fresh water inside. Assumed gradient equal to 8.0 ppg. Maximum internal pressure during pressure test at 1500 psi.
3. Maximum external pressure during APT with 10.0 ppg brine and 1500 psi test pressure. Maximum internal pressure during stimulation set at 5000 psi.



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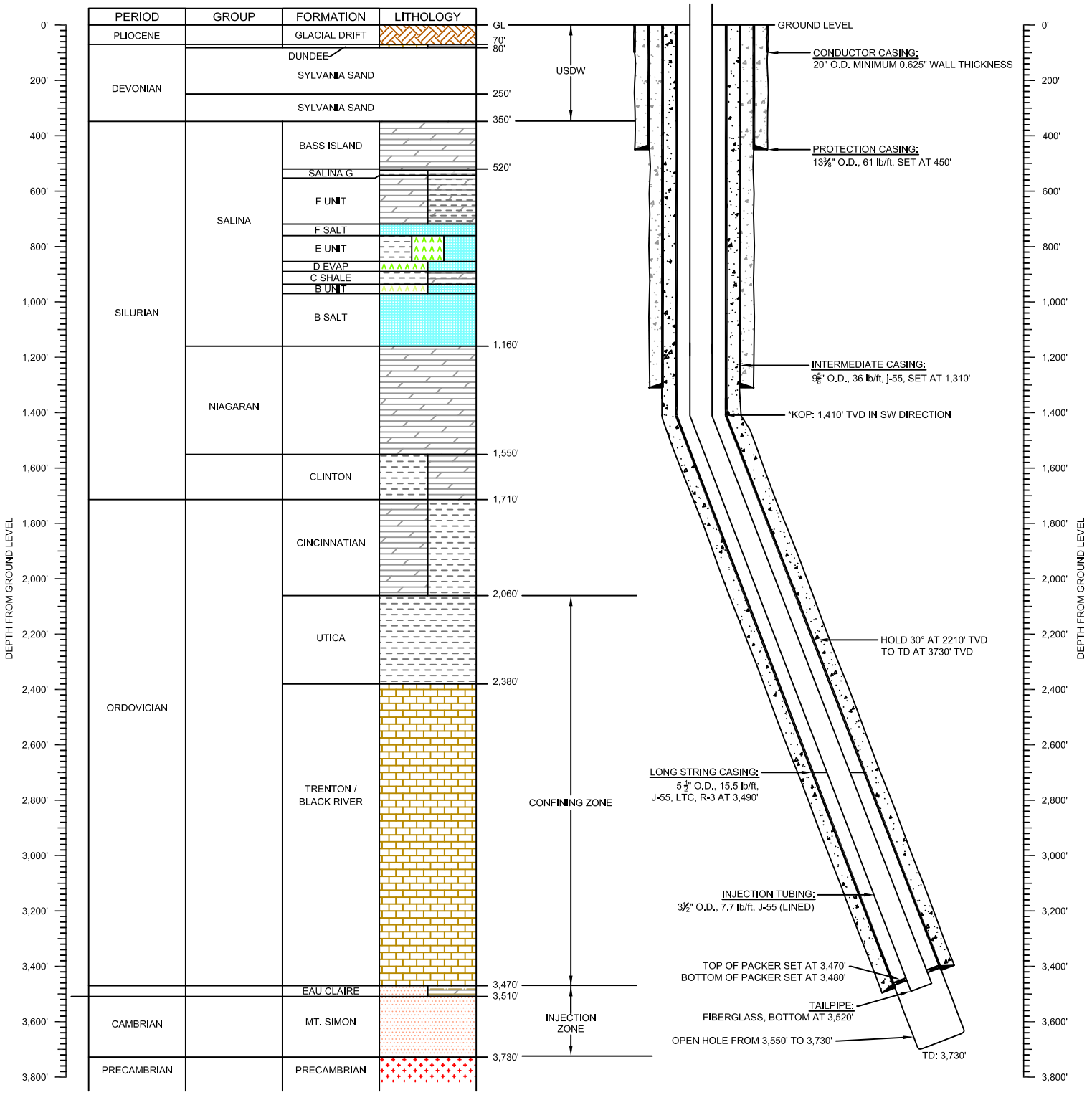
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED BDW-1 WELL CONSTRUCTION AND STRATIGRAPHY

Job No. 192065A–Rev–2

Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. M–1



NOTE: KOP will be 50 feet below bottom of salt

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BUCKEYE TERMINALS, LLC
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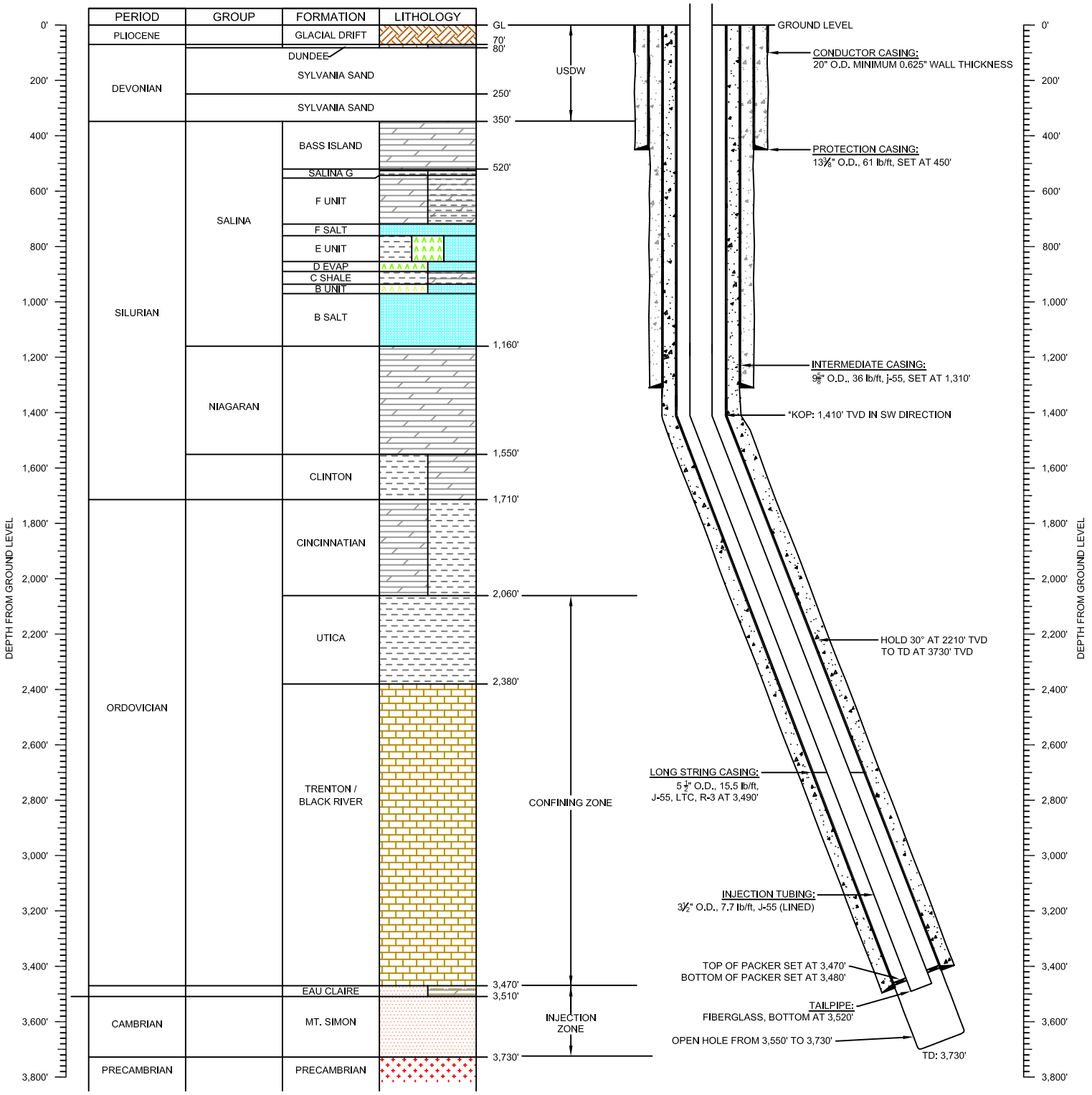
WAYNE COUNTY, MICHIGAN

PROPOSED BDW-2 WELL CONSTRUCTION AND STRATIGRAPHY

Job No. 192065A–Rev–2					
Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. M–2



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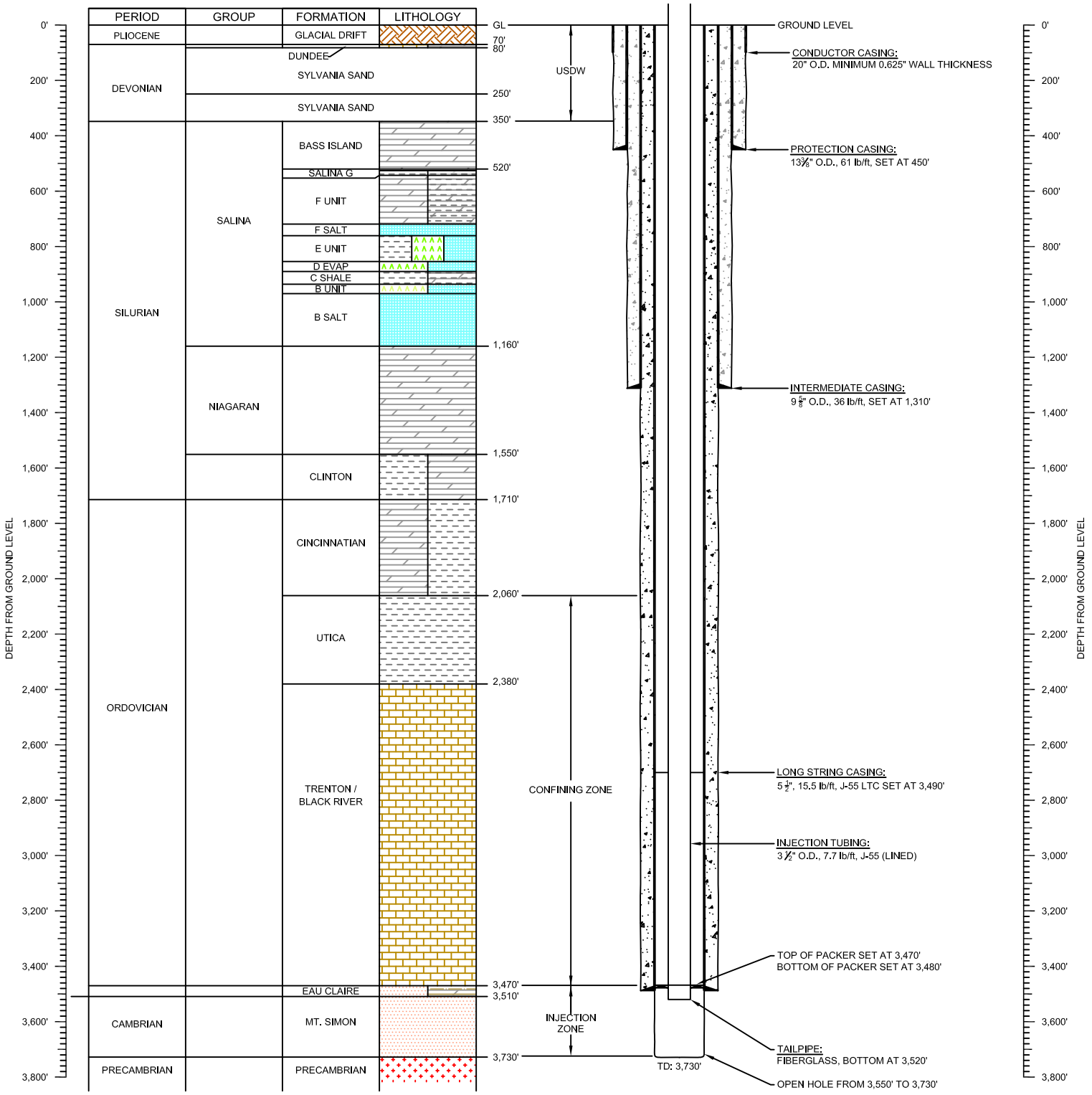
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED BDW-3 WELL CONSTRUCTION AND STRATIGRAPHY

Job No. 192065A–Rev–2					
Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. M–3



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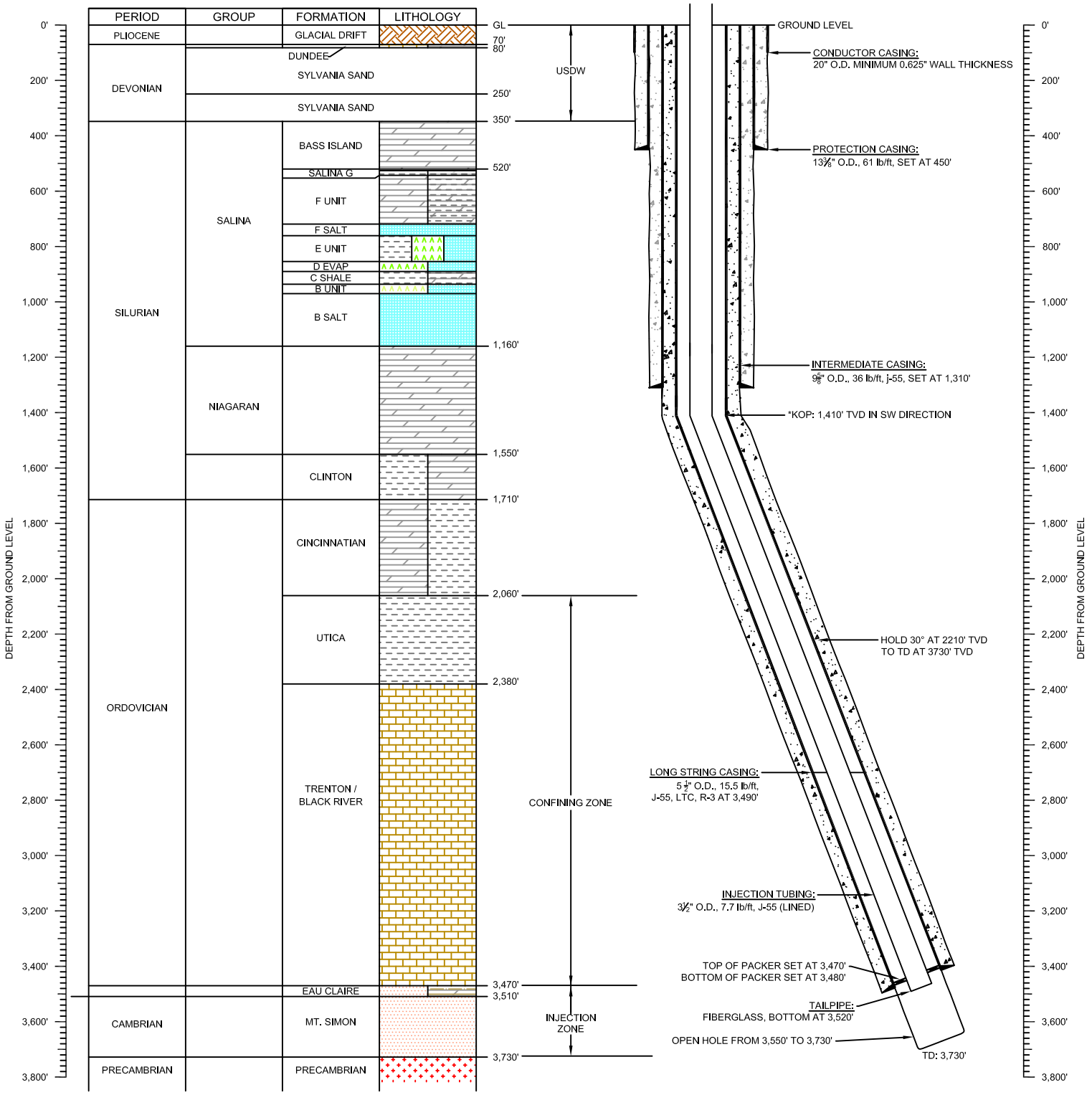
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED BDW-4 WELL CONSTRUCTION AND STRATIGRAPHY

Job No. 192065A–Rev–2

Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. M–4



NOTE: KOP will be 50 feet below bottom of salt

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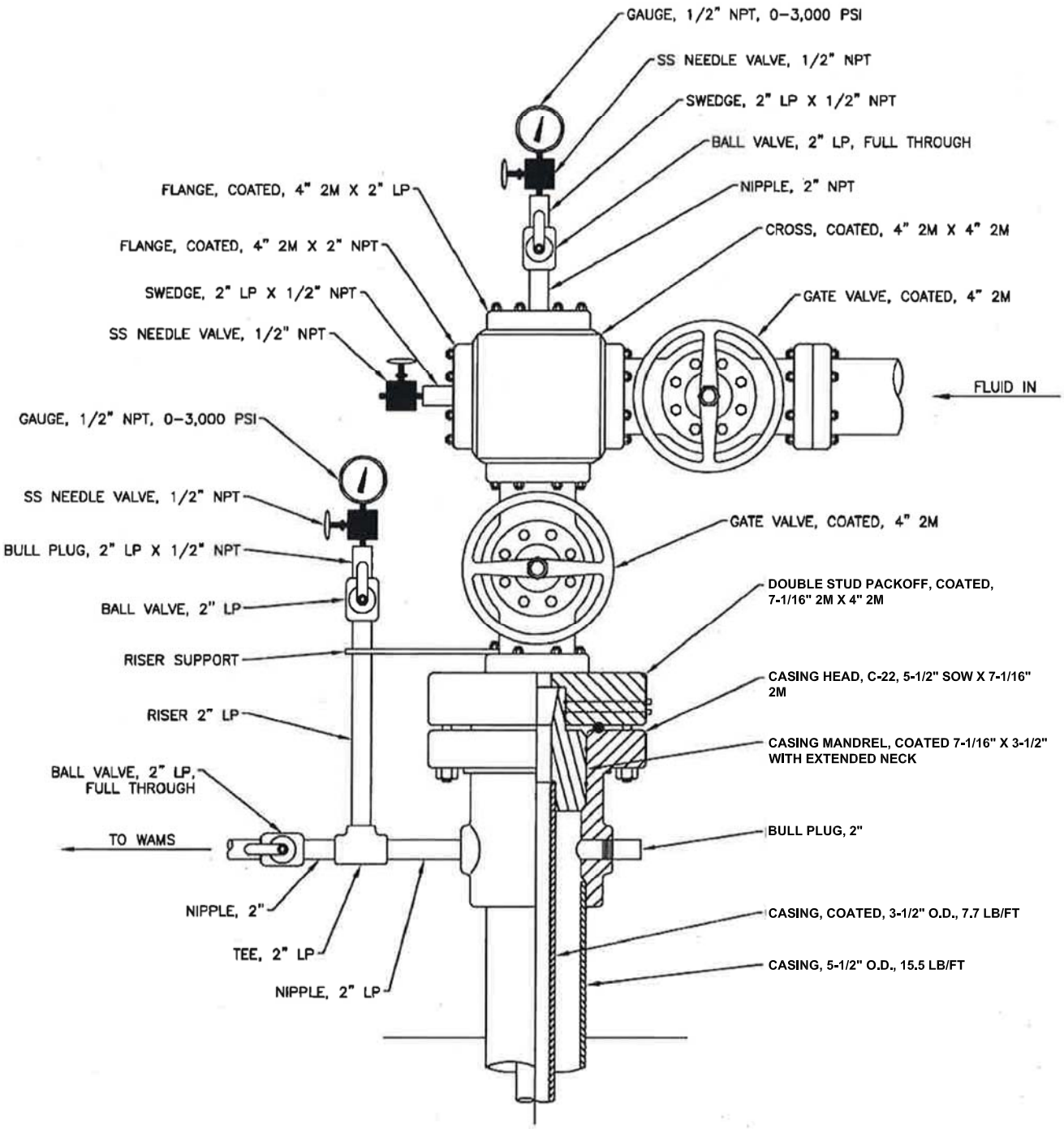
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED BDW-5 WELL CONSTRUCTION AND STRATIGRAPHY

Job No. 192065A–Rev–2					
Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. M–5



WSP USA Inc.
16200 Park Row Suite 200
Houston, TX 77084
TEL: (281) 589-5900

BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED WELLHEAD SCHEMATIC

Job No. 192065A-Rev-2

Design: CRB	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. M-6

N. DOES NOT APPLY TO CLASS I WELLS

O. PLANS FOR WELL FAILURES

The purpose of the Class I injection wells is to supply a means to dispose of brine water generated from the solution mining of caverns developed in the Salina B Formation.

In the event a failure occurs to any one of the injection wells, the well will be shut-in immediately and injectate shifted to other wells to prevent migration of fluids into any USDW. See Attachment P, Well Monitoring Program, for description of method used to monitor for well failure. If it is determined that the well has lost mechanical integrity, the necessary measures will be taken to assess the cause(s) of lost mechanical integrity, and a work plan for restoring mechanical integrity will be developed and submitted to the EPA Region 5, for approval. Once regulatory approval has been obtained, the work plan will be implemented to restore mechanical integrity to the well. When mechanical integrity of the well can be demonstrated to EPA Region 5, regulatory approval to restore operation will be obtained prior to resuming injection. A final report documenting the well work performed and mechanical tests run will be prepared and submitted to EPA Region 5.

P. MONITORING PROGRAM

P.1 WASTE ANALYSIS PLAN

The proposed Waste Analysis Plan is included as Appendix D.

P.2 MONITORING AND RECORDING SYSTEM FOR INJECTION PRESSURE, RATE, VOLUME, AND ANNULUS PRESSURE

The injection wells will be operated on-site. The operating system will be designed to control the well from a dedicated computer terminal with a continuous monitoring and recording system for injection pressure, rate, volume, and annulus pressure. The system will have the capability to interface and deliver selected data to the station archive. The system will have the capability of long term storage of process data by being archived within the plant control system electronically. The recording system will be physically located on site.

The pressure transducer for the injection pressure will be located near the wellhead. In the event the injection pressure is outside the desired pressure bounds, the computer will automatically interface with the facility control system and send an alarm to the terminal notifying the operator.

The monitoring and recording system for the injection rate will use an inline flow meter that will be located between the injection pumps and the wellhead. Associated with the flow meter will be a volume totalizer that will keep track of the total gallons of fluid injected. In the event the injection operation is outside the desired rate bounds, the computer will automatically interface with the facility control system and send an alarm to the terminal notifying the operator.

The pressure transducer for the annulus pressure will be located near the wellhead. In the event the annulus pressure is outside the desired pressure bounds, the computer will automatically interface with the facility control system and send an alarm to the terminal notifying the operator.

The injectate specific gravity will be measured at the sampling location with a salinometer or similarly accurate instrument. Measurements will be conducted daily during the cavern solution mining process as the specific gravity. The specific gravity will range from the minimum to maximum requested specific gravity during cavern development. During cavern hydrocarbon storage, injection will become intermittent and the injectate specific gravity will remain saturated or near saturated (approximately specific gravity of 1.20). Therefore, following completion of cavern solution mining, the specific gravity will be measured at the well location weekly.

P.3 SIGHT GLASS LEVEL MONITORING AND RECORDING

The top 10 feet of the well annulus will be filled with a fluid capable of resisting freezing. The seal pot system will also be filled with this same fluid to prevent freezing problems near the surface. Nitrogen will be used to pressurize the seal pot. Two pressure transducers, one at the top of the seal pot and one at the bottom of the seal pot, will be used to determine the height of the liquid in the sight glass.

The annulus pressure will be maintained 100 psi above (differential) the injection pressure. A nitrogen pressure regulator will be used to regulate the annulus pressure.

P.4 GROUNDWATER MONITORING PLAN AND QUALITY ASSURANCE PROJECT PLAN

Due to the nonhazardous nature of the injectate, neither a groundwater monitoring plan nor a Quality Assurance Project Plan will be required.

Q. PLUGGING AND ABANDONMENT PLAN

A completed EPA Plugging and Abandonment Plan (EPA Form 7540-14), including a detailed estimate of plugging and abandonment costs, has been included as Appendix E. This cost estimate may be used for each of the wells due to the expected similarity of design and construction. The form was completed by WSP, an independent firm.

The following general closure procedure will be used to permanently plug and abandon the injection wells:

1. Prepare well and location for plugging. Remove surface facilities, well annulus maintenance system and injection piping.
2. Move in and rig up workover rig and associated equipment.
3. Remove wellhead assembly and install blowout preventer (BOP).
4. Release injection packer. Pull and lay down the injection packer and injection tubing.
5. Go in the hole open end with workstring to total depth and set balanced Class "H" cement plug (15.6 pounds per gallon [ppg] slurry weight) across open hole section and 200 feet into protection casing. Pull up several stands and reverse out. Wait for cement to cure.
6. Tag top of cement and displace wellbore with appropriate weight mud (as determined from injection zone pressure) by circulating until equilibrium is achieved. Run bridge plug and set +/- 20 feet above the top of cement. Pressure test plug to 500 psig.
7. Mix and set 50 feet of Class "H"cement (15.6 ppg) on top of bridge plug. Wait for cement to cure.
8. Tag top of cement plug. Pressure test plug to 500 psi for 30 minutes.
9. Set a 200 foot balanced Class "A" cement plug (15.6 ppg) 100 feet above and below the base of the USDW. Wait for cement to cure.
10. Tag top of cement plug and pressure test to 500 psi for 30 minutes.
11. Set cement plug from +/- 250 feet to the surface and top out annular area around protection and surface casing and conductor if necessary.
12. Nipple down the blowout preventer and cut off all casing 3 feet bgs. Weld a 1/2-inch steel plate over the casings and inscribe with appropriate identifying information.
13. Rig down and move out workover rig and associated equipment.
14. Clean and level location to grade.

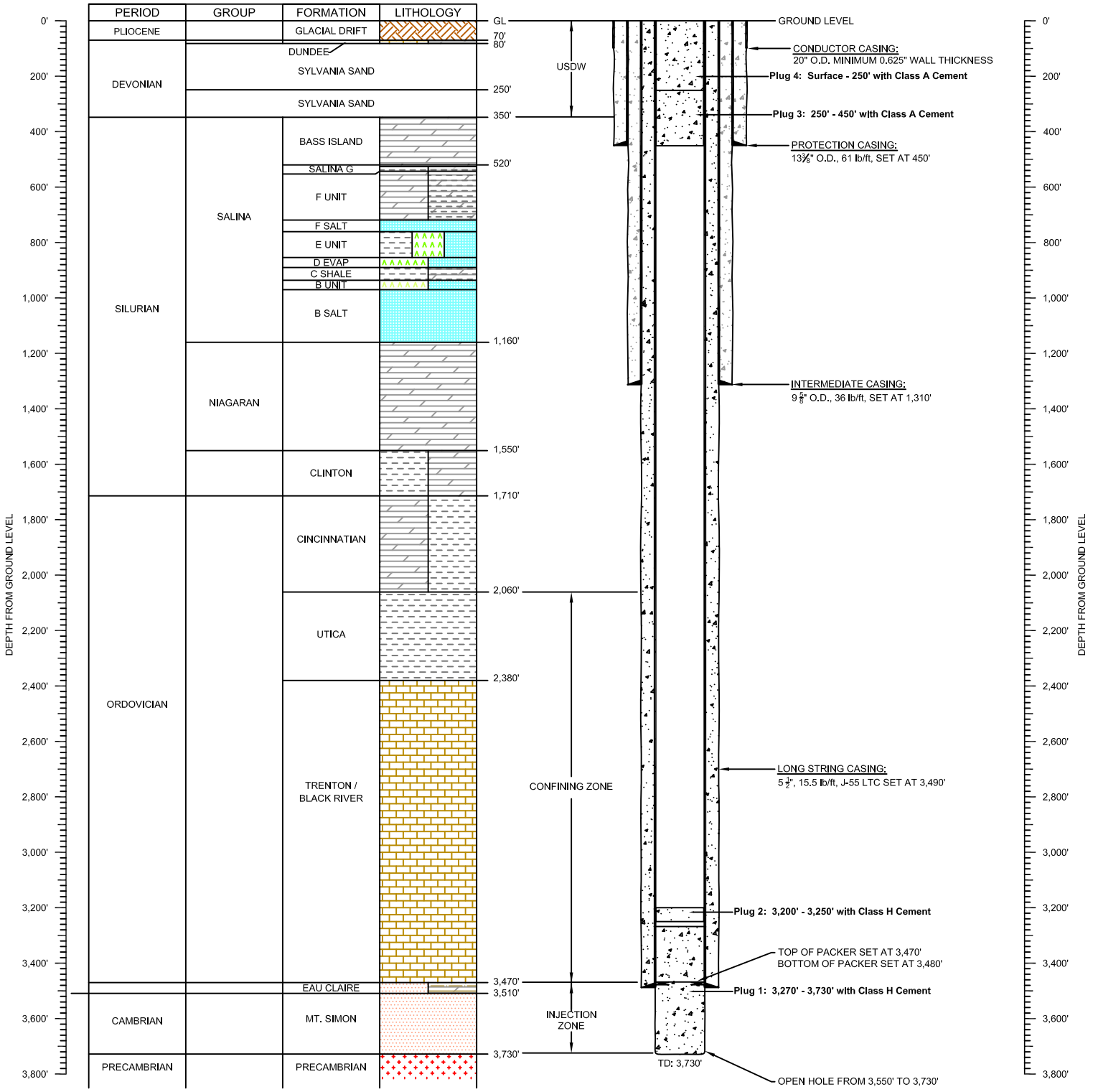
Figures Q-1 and Q-2 illustrate the proposed plugging and abandonment for both the vertical and directional wells.

Since the proposed wells will be nonhazardous, no closure or post-closure care plans are required.

List of Figures for Attachment Q

Figure Q-1 Proposed Vertical Plugging and Abandonment Schematic

Figure Q-2 Proposed Directional Plugging and Abandonment Schematic



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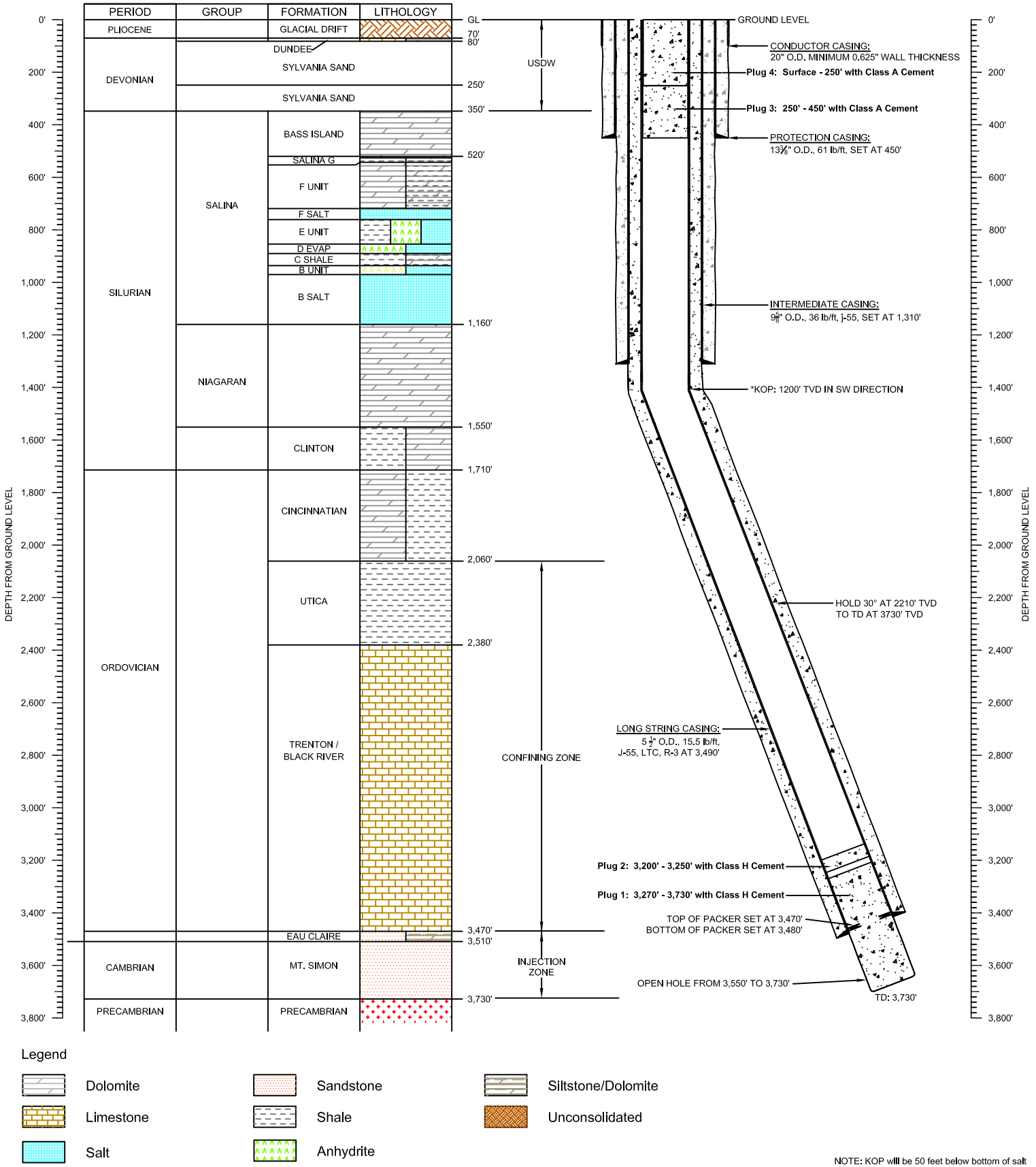
BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED VERTICAL PLUGGING & ABANDONMENT SCHEMATIC

Job No. 192065A–Rev–2

Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. Q–1



NOTE: KOP will be 50 feet below bottom of salt

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BUCKEYE TERMINALS, LLC
WOODHAVEN TERMINAL
WAYNE COUNTY, MICHIGAN

PROPOSED DIRECTIONAL PLUGGING & ABANDONMENT SCHEMATIC

Job No. 192065A–Rev–2

Design: WDD	Drawn: WDD	Checked: GM	Date: 08/21/17	Scale: NTS	Figure No. Q–2

R. NECESSARY RESOURCES

See attached documentation.

By consent of the FOIA requestor, private financial information specific to Buckeye Terminals LLC, (financial figures on Pages 111-112, and 128 pages of 2016 Form 10-K), have been determined to be not relevant to the information request, and have been partially redacted.

BUCKEYE PARTNERS, L.P.

One Greenway Plaza
Suite 600
Houston, Texas 77046
Tel (832) 615-8700
Fax (832) 615-8601

Regional Administrator
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60605-3590

I am the chief financial officer of Buckeye Partners, L.P., One Greenway Plaza Ste 600, Houston, Texas 77046. This letter is in support of this firm's use of the financial test to demonstrate financial assurance, as specified in subpart F of 40 CFR part 144.

1. This firm is the owner or operator of the following injection wells for which financial assurance for plugging and abandonment is demonstrated through the financial test specified in subpart F of 40 CFR part 144. The current plugging and abandonment cost estimate covered by the test is shown for each injection well.

Well Name	EPA Identification No.	Address	Plugging and Abandonment Cost Estimate
BDW-1	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$109,895
BDW-2	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$112,645
BDW-3	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$112,645
BDW-4	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$109,895
BDW-5	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$112,645
CW-1	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$224,050
CW-2	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$224,050
CW-3	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$224,050
CW-4	Permit Pending	20755 West Road, Woodhaven, MI, 48483	$224,050
		Total:	$1,453,925

2. This firm guarantees, through the corporate guarantee specified in subpart F of 40 CFR part 144, the plugging and abandonment of the following injection wells owned or operated by subsidiaries of this firm. The current cost estimate for plugging and abandonment so guaranteed is shown for each injection well:

NOT APPLICABLE

3. In States where EPA is not administering the financial requirements of subpart F of 40 CFR part 144, this firm, as owner or operator or guarantor, is demonstrating financial assurance for the plugging and abandonment of the following injection wells through the use of a test equivalent or substantially equivalent to the financial test specified in subpart F of 40 CFR part 144. The current plugging and abandonment cost estimate covered by such a test is shown for each injection well:

NOT APPLICABLE

4. This firm is the owner or operator of the following injection wells for which financial assurance for plugging and abandonment is not demonstrated either to EPA or a State through the financial test or any other financial assurance mechanism specified in subpart F of 40 CFR part 144 or equivalent or substantially equivalent State mechanisms. The current plugging and abandonment cost estimate not covered by such financial assurance is shown for each injection well:

None.

This firm is required to file a Form 10K with the Securities and Exchange Commission (SEC) for the latest fiscal year.

The fiscal year of this firm ends on December 2017. The figures for the following items marked with an asterisk are derived from this firm's independently audited, yearend financial statements for the latest completed fiscal year, ended 2016.

ALTERNATIVE I

1.	(a) Current plugging and abandonment cost	[redacted]
	(b) Sum of the company's financial responsibilities under 40 CFR Parts 264 and 265, Subpart H, currently met using the financial test or corporate guarantee	[redacted]
	(c) Total of lines a and b	[redacted]
*2.	Total liabilities [if any portion of the plugging and abandonment cost is included in total liabilities, you may deduct the amount of that portion from this line and add that amount to lines 3 and 4]	[redacted]
*3.	Tangible net worth	[redacted]
*4.	Net worth	[redacted]
*5.	Current assets	[redacted]
*6.	Current liabilities	[redacted]
*7.	Net working capital [line 5 minus line 6]	[redacted]
*8.	The sum of net income plus depreciation, depletion and amortization	[redacted]
*9.	Total assets in U.S. (required only if less than 90% of firm's assets are located in U.S.)	[redacted]
		Yes / **No**
10.	Is line 3 at least $10 million?	[redacted]
11.	Is line 3 at least 6 times line 1(c)?	[redacted]
12.	Is line 7 at least 6 times line 1(c)?	[redacted]
*13.	Are at least 90% of firm's assets located in the U.S.? If not, complete line 14	[redacted]
14.	Is line 9 at least 6 times line 1(c)?	[redacted]

15.	Is line 2 divided by line 4 less than 2.0?	
16.	Is line 8 divided by line 2 greater than 0.1?	
17.	Is line 5 divided by line 6 greater than 1.5?	

ALTERNATIVE II – NOT APPLICABLE – Using Alternative I for financials assurance testing

1.	(a) Current plugging and abandonment cost	
	(b) Sum of the company's financial responsibilities under 40 CFR Parts 264 and 265, Subpart H, currently met using the financial test or corporate guarantee	
	(c) Total of lines a and b	
2.	Current bond rating of most recent issuance of this firm and name of rating service	
3.	Date of issuance of bond	
4.	Date of maturity of bond	
*5.	Tangible net worth [if any portion of the plugging and abandonment cost estimate is included in ''total liabilities'' on your firm's financial statements, you may add the amount of that portion to this line]	
*6.	Total assets in U.S. (required only if less than 90% of firm's assets are located in U.S.)	

		Yes	No
7.	Is line 5 at least $10 million?		
8.	Is line 5 at least 6 times line 1(c)?		
*9.	Are at least 90% of the firm's assets located in the U.S.? If not, complete line 10		
10.	10. Is line 6 at least 6 times line 1(c)?		

I hereby certify that the wording of this letter is identical to the wording specified in 40 CFR 144.70(f) as such regulations were constituted on the date shown immediately below.

BUCKEYE PARTNERS, L.P.
By Buckeye GP LLC, its sole general partner

Keith E. St.Clair
Executive Vice President & Chief Financial Officer

December 15, 2017

Deloitte.

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INDEPENDENT ACCOUNTANTS' REPORT ON APPLYING AGREED-UPON PROCEDURES

The Board of Directors of Buckeye GP LLC and the
Partners of Buckeye Partners, L.P.

We have performed the procedures included in the Code of Federal Regulations (CFR) Title 40, Part 144 Section 63 (40 CFR 144.63) which were agreed to by the Environmental Protection Agency and Buckeye Partners, L.P., related to Buckeye Partners, L.P.'s compliance with the financial test option as of December 31, 2016, included in the accompanying letter dated December 15, 2017, from Keith E. St.Clair of Buckeye Partners, L.P. Buckeye Partners, L.P.'s management is responsible for its compliance with those requirements. The sufficiency of these procedures is solely the responsibility of those parties specified in this report. Consequently, we make no representations regarding the sufficiency of the procedures enumerated below either for the purpose for which this report has been requested or for any other purpose.

The procedures that we performed and related findings are as follows:

1. We compared the amounts included in items "Total Liabilities", "Current Assets", and "Current Liabilities" under the caption Alternative I in the letter referred to above with the corresponding amounts in the audited financial statements of Buckeye Partners, L.P. as of and for the year ended December 31, 2016, on which we have issued our report dated February 24, 2017, and noted that such amounts were in agreement, after rounding.

2. We recomputed from, or reconciled to, the financial statements referred to in procedure 1 the information included in items "Tangible Net Worth", "Net Worth", "Net Working Capital", "The Sum of Income Plus Depreciation, Depletion and Amortization", and "Total Assets in U.S." under the caption Alternative I in the letter referred to above and noted no differences, after rounding.

This agreed-upon procedures engagement was conducted in accordance with attestation standards established by the American Institute of Certified Public Accountants. We were not engaged to and did not conduct an examination or review, the objective of which would be the expression of an opinion or conclusion, respectively, on compliance with the financial test option in the accompanying letter dated December 15, 2017. Accordingly, we do not express such an opinion or conclusion. Had we performed additional procedures, other matters might have come to our attention that would have been reported to you.

This report is intended solely for the information and use of the board of directors and management of Buckeye Partners, L.P. and the Environmental Protection Agency and is not intended to be, and should not be, used by anyone other than the specified parties.

Deloitte + Touche LLP

December 15, 2017

2016 ANNUAL REPORT

BUCKEYE PARTNERS, L.P.

EXPANDED GLOBAL PRESENCE

ABOUT US

BUCKEYE PARTNERS, L.P. (NYSE: BPL) is a publicly traded master limited partnership and owns and operates a diversified network of integrated assets providing midstream logistic solutions, primarily consisting of the transportation, storage, and marketing of liquid petroleum products.

ORGANIZATIONAL OVERVIEW

DOMESTIC PIPELINES & TERMINALS

- ~6,000 miles of pipeline with ~110 delivery locations
- Over 115 liquid petroleum product terminals
- ~56 million barrels of liquid petroleum product storage capacity
- Stable fee-based cash flows derived from throughput volumes, tariffs and terminalling and storage fees
- Primarily demand-pull system; limiting impact of supply disruptions
- Operates and/or maintains third-party pipelines and performs certain engineering and construction management services for its customers

GLOBAL MARINE TERMINALS

- Seven liquid petroleum product terminals in: the Caribbean, including The Bahamas, St. Lucia and Puerto Rico; New York Harbor, including Perth Amboy, Port Reading and Raritan Bay; and South Texas
- ~62 million barrels of liquid petroleum product storage capacity
- Deep water capability to handle ULCCs and VLCCs in The Bahamas and St. Lucia
- Ship, barge, truck rack, rail and pipeline transportation in the New York Harbor
- Condensate splitters and connectivity through truck rack, pipeline, and marine handling capabilities in South Texas
- Revenue supported by take or pay contracts
- 50% equity interest in VTTI B.V., which owns and operates 14 terminals located in key global energy hubs, including Northwest Europe, the United Arab Emirates and Singapore

MERCHANT SERVICES

- Markets liquid petroleum products in areas served by Domestic Pipelines & Terminals and Global Marine Terminals

Vessel dock at the Buckeye Perth Amboy facility in New Jersey

DEAR UNITHOLDERS:

I AM PLEASED TO REPORT THAT 2016 WAS AN EXCEPTIONAL YEAR for Buckeye and our unitholders. Our strong financial and operational performance for the year continues to prove the value of Buckeye's culture, growth strategy and diversified asset base. We successfully completed a number of capital investment projects across Buckeye as well as executing on a significant strategic investment in an international growth platform that I am confident will deliver strong results to our unitholders. In addition to improving our position as a global enterprise, we surpassed $1 billion of Adjusted EBITDA[1] for the first time in our illustrious 130-year history.

Clark C. Smith
Chairman, President and Chief Executive Officer

Safely Through the Storm

Buckeye is fully committed to the safety of our employees, contractors and the communities in which we operate. Our employees were able to demonstrate that commitment when Hurricane Matthew delivered a direct hit to our Buckeye Bahamas Hub facility on the Grand Bahama Island in October 2016. Buckeye's preparation before the storm and our response and recovery in the aftermath of the storm were nothing short of outstanding.

Prior to the storm landfall, our teams worked diligently to ensure that all of our operations were secure and that our facilities were fully prepared for its impact. Our teams relied on their extensive training and existing safety processes as they readied for landfall. Through past incidents, Buckeye has repeatedly

Rail unloading rack at the Buckeye Port Reading facility in New Jersey

demonstrated that this advanced preparation allows us to withstand incidents with minimal impact. Most importantly, we are happy and thankful to report that all of our employees and their families in Matthew's path survived the storm with no injuries.

Financial and Operational Excellence

2016 was an outstanding year for Buckeye as we grew Adjusted EBITDA[1] by almost 20 percent to a record $1.03 billion. This strong performance allowed us to continue to grow distributions to our unitholders as we declared distributions of $4.875 for the year, representing over four percent growth from the prior year. All three of our business segments contributed to this record performance. Our Domestic Pipelines & Terminals segment has grown consistently through the contribution from numerous capital projects that our commercial and operating teams have successfully delivered. Tariff increases, favorable tariff mix and growing terminal throughput and storage revenues also contributed to this growth. Global Marine Terminals benefited from strong storage demand driving higher utilization and storage rates as well as new capital projects that brought storage capacity back in service. In addition, we completed the build out and are now operating all assets at our South Texas hub. Merchant Services had a record year as it benefited from continued discipline in inventory management and favorable business conditions. This segment also contributed a record level of revenues to the Buckeye umbrella, fulfilling its mission to drive higher utilization of our pipeline and terminal assets.

2016 WAS AN OUTSTANDING YEAR FOR BUCKEYE AS WE GREW ADJUSTED EBITDA BY ALMOST 20 PERCENT TO A RECORD $1.03 BILLION.

Business Strategy for Growth and Diversification

Buckeye has continually emphasized our goal of diversifying our business across new products and services as well as new geographic locations. We have achieved great success in executing that strategy. We have invested over $8 billion since 2010 in strategic acquisitions and high return growth capital projects. We have significantly expanded our portfolio of domestic terminals. We also entered into the marine terminal business while meeting our objective of increasing our geographic scale by acquiring terminals in the Caribbean, Corpus Christi, and New York Harbor as well as our global expansion with the 50% investment in VTTI B.V.

We also diversified our product handling capabilities through the liquid petroleum gas ("LPG") storage and condensate splitter operations in South Texas and propane storage caverns in the Midwest. We created and significantly expanded our Chicago Complex, adding crude oil and diluent storage and handling along with propylene, ethanol and other service capabilities across the Complex. We were prudent in executing this strategy, minimizing investment risk where possible with long-term contracts. We managed our balance sheet and conservatively financed these investments with an appropriate mix of equity and debt.

The success of this diversification strategy has been demonstrated by the tremendous growth and stability we have achieved over this time. Our Adjusted EBITDA has increased by almost 170% since embarking on this strategy in 2010. At the same time, we have also improved our coverage and strengthened our balance sheet, maintaining our investment grade credit rating while continuing to grow distributions to our unitholders. Our strategy has allowed us to excel despite the many challenges in the energy markets over the past 18 to 24 months.

We continue to expect this strategy to drive growth for our unitholders. Importantly, we remain focused on targeting strategic midstream activities with the appropriate size and scale to be impactful to Buckeye and its investors. We prefer assets that offer platforms for future growth, driven by favorable macroeconomic and competitive factors. We look for growth opportunities that meet our objectives of safe and efficient operations, all within a culture emphasizing accountability and integrity. We focus on assets that offer fee-based cash flow backed by contracts with creditworthy counterparties as well as minimal commodity price exposure. Lastly, we look for accretive opportunities meeting our internal cost of capital hurdle rates that improve coverage and strengthen our balance sheet.

To put it simply, we want to be best in class in the eyes of our customers, the communities we serve, our regulators and our investors. These are the core principles that we believe differentiate Buckeye and continue to contribute to our success.

Investing Globally

We announced in 2016 a significant investment in one of the largest independent global marine terminal businesses in the world. In January 2017, we acquired a 50 percent interest in VTTI B.V., which boasts approximately 57 million barrels of petroleum product storage across 14 terminals located in 13 countries on five continents. The majority of this capacity is located in key global energy hubs, including the Amsterdam-Rotterdam-Antwerp hub in Northwest Europe, the Fujairah terminal in the United Arab Emirates in the Middle East and in Johor, Malaysia near the Port of Singapore. VTTI's terminals offer world-class storage and marine terminalling services primarily for refined products as well as crude oil and LPGs.

Importantly, we believe this transaction delivers on all of the key objectives of our growth strategy enumerated above. Our investment establishes for Buckeye an immediate worldwide geographically diverse presence. VTTI has been a very successful high growth business, growing through both acquisition in the very fragmented international terminal market as well as greenfield development. We expect this growth to continue and look forward to working with the outstanding management teams at both VTTI as well as Vitol, our new partner and one of the world's largest global traders of crude and petroleum products.

VTTI terminal located in Johor, Malaysia near the Port of Singapore

Capitalizing on Opportunities

Buckeye made substantial progress on our Michigan Ohio pipeline and terminal expansion project during the year. We completed construction and began transportation of product on the first phase of this project, which provides incremental capacity for our customers to move refined products from advantaged Midwestern supply sources eastward to the Pittsburgh and other Western Pennsylvania markets. This project, which is supported by 10-year transportation agreements with major shippers, is expected to continue to ramp up in early 2017 with the full run-rate contribution being achieved in the second quarter.

We also announced the successful completion of an open season for the second phase of this project. The second phase is expected to further expand Buckeye's ability to move competitively priced refined products from Midwestern refineries to Pittsburgh as well as destinations in central Pennsylvania through the partial reversal of our Laurel Pipeline. We are proceeding with engineering activities and have initiated the regulatory approval and permitting process for this project, which we currently plan to complete in late 2018.

In addition, we benefited from a number of capital investment projects that were completed during the year. We constructed or refurbished significant additional storage capacity across our domestic and international terminals. We also increased our butane blending and vapor recovery capabilities and completed a number of additional improvements and debottlenecks across our system during the year that we expect to benefit us in 2017 and beyond.

Opportunity Set Remains Vast

As we look forward to 2017, we continue to see numerous opportunities as well as business challenges to execute on our strategy. The pipeline of potential investments, both acquisitions and internal capital projects, is more robust now than it has ever been. Beyond our Michigan Ohio and VTTI opportunities, we are continuing to make progress on infrastructure upgrades expected to enhance our competitive positon among our New York Harbor terminals. We are assessing further opportunities to invest in our Chicago Complex to support the growing needs of major Midwestern refinery customers. In addition, we announced recently that we are exploring two pipeline opportunities to move crude oil and natural gas liquids from the prolific Permian basin. We have received positive feedback from potential shippers on these two greenfield pipeline construction projects, which would capitalize on our existing infrastructure and rights-of-way in and around Corpus Christi. I expect to continue to update our unitholders on the progress our commercial and development teams are making on these very important initiatives.

Finally, we continue to focus on maximizing the performance of our legacy businesses, as we believe our exceptional employees will continue to deliver safe and strong performance for our unitholders. We look forward to another outstanding year and I thank you for your investment and your confidence in our ability to continue to deliver outstanding results.

Clark C. Smith
Chairman, President and Chief Executive Officer

[1]See definition of Non-GAAP measures and reconciliations to Non-GAAP measures at the end of this report.

BUCKEYE PARTNERS, L.P.

2016
FORM 10-K

By consent of the FOIA requestor, private financial information specific to Buckeye Terminals LLC, (financial figures on Pages 111-112, and 128 pages of 2016 Form 10-K), have been determined to be not relevant to the information request, and have been partially redacted.

BUCKEYE PARTNERS, L.P.

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Suite 600
Houston, TX 77046
www.buckeye.com

S. AQUIFER EXEMPTIONS

This application does not request an aquifer exemption.

T. EXISTING PERMITS

Buckeye Terminals, LLC holds the permits listed in Table T-1.

Table T-1 Existing EPA Permits for Buckeye Terminals, LLC Woodhaven Terminal

MEDIUM	PERMIT TYPE	PERMIT ID	EXPIRATION DATE
Federal Permits			
Air	Emissions Inventory System (EIS)	EIS #7305611	NA
Waste	RCRA - Notification of Waste Activity Active CESQG	MIR000039974	NA
State Permits			
Air	MDEQ Permit to Install No. 21-14A, Wayne County	State Registration Number B2158	December 7, 2017
Water	Michigan DEQ, EPA Region 5, CWA, National Pollutant Discharge Elimination System (NPDES) Certificate of Coverage under General Permit	MIG670085	April 2018
Water	Stormwater Pollution Prevention Plan (SWPPP)	MIS320020	April 2018

U. DESCRIPTION OF BUSINESS

Buckeye Terminals, LLC is an affiliate of Buckeye Partners, L.P., a publicly traded master limited partnership that owns and operates a diversified network of integrated assets providing midstream logistic solutions, primarily consisting of the transportation, storage, and marketing of liquid petroleum products. Buckeye Terminals, LLC is one of the largest independent terminalling and storage operators in the United States in terms of capacity available for service. Buckeye Terminals, LLC, through its affiliates, also uses its service expertise to operate and/or maintain third-party pipelines and perform certain engineering and construction services for its customers.

Buckeye Terminals, LLC's terminal network comprises more than 120 liquid petroleum products terminals with aggregate storage capacity of over 115 million barrels across its portfolio of pipelines, inland terminals and an integrated network of marine terminals located primarily in the East Coast and Gulf Coast regions of the United States and in the Caribbean.

Buckeye Terminals, LLC has 115 active terminals that provide bulk storage and throughput services with respect to liquid petroleum products and renewable fuels, including ethanol, and have an aggregate storage capacity of over 55 million barrels. In addition, three of the terminals provide crude oil services, including train loading/unloading, storage and throughput.

The Woodhaven Terminal located at 20755 West Road, Woodhaven, Michigan, currently uses surface tanks to store gasoline, diesel fuel, and ethanol. Approximately 990,000 bbls of tank storage is present at the Woodhaven Terminal.

Applicable SIC Code: 4226 Special Warehousing and Storage

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APPENDIX

A EPA CHECKLIST

MICHIGAN/INDIANA PERMIT APPLICATION CHECKLIST FOR CLASS I INJECTION WELLS		
UIC Permit Application Form Attachment Number		**Comment**
A.	**Area of Review**	
	Minimum of 2 miles for non-hazardous wells.	AoR is 2 miles as discussed in Attachment A and shown in Figures A-1 and A-2.
B.	**Maps of Wells / Area of Review**	
B.1	Each major intake and discharge structures for liquid waste	See Figure B-1.
B.2	Each hazardous waste treatment, storage, or disposal facility	Discussed in Attachment B, Section B.3 and shown in Figure B-1.
B.3	Number, name and location of all producing wells	Discussed in Attachment B, Section B.4.1 and shown in Figure B-2.
B.4	Number, name and location of all injection wells of all classes	Discussed in Attachment B, Section B.4.1 and shown in Figure B-2.
B.5	Number, name and location of all abandoned wells, plugged wells, and dry holes	Discussed in Attachment B, Section B.4.1 and shown in Figure B-2.
B.6	Known or suspected faults	Discussed in Attachment B, Section B.1. There are no known faults.
B.7	Location of all water wells of public record or otherwise known to the applicant, within the AOR or within a quarter mile of the facility property boundary, whichever is greater	Discussed in Attachment B, Section B.4.2 and shown in Figure B-1.
B.8	Bodies of water, springs, surface and subsurface mines and quarries, residences, and roads within the AOR, or within a quarter mile of the facility property boundary, whichever is greater	See Figure B-1.
B.9	List of names and addresses of all owners of record of land within a quarter mile of the facility boundary, unless waived by the Director.	Listed in Table B-1 and shown in Figure B-3.
B.10	A description of the methods used to locate wells in the AOR.	Discussed in Attachment B, Section B.4.
C.	**Corrective Action Plan and Well Data**	
C.1	Corrective action plan for inadequately plugged wells in the AOR which penetrate the top of the confining zone	Discussed in Attachment C.
C.2	Well construction, date of construction and total depth	Summarized in Table C-1 on p. C-1. Available well records in Appendix B.
C.3	Well operator/owner	Summarized in Table C-1 on p. C-1. Available well records in Appendix B.
C.4	Cement records	Unavailable for Wells Listed in Attachment C
C.5	Plugging records	Unavailable for Wells Listed in Attachment C
C.6	Distance from proposed injection well	Listed in Table C-1 on p. C-1.
D.	**Maps and Cross Sections of USDWs**	
D.1	Stratigraphic column of site which indicates all USDWs	See Figure D-1.
D.2	Data substantiating the depth of the lowermost USDW, if available	Disscussed in Attachment D and Figures F-4 and F-5.
F.	**Maps and Cross Sections of Geologic Structure of Area**	
F.1	Cross sections and structure contour maps adequate to describe the regional geology of the area, including especially any faults	See Figures F-1 through F-3; F-6 through F-19
F.2	Cross sections of site-specific geology, including any faulting in the AOR	See Figures F-4 and F-5.
F.3	Geologic description of confining zone (including lateral extent, lithologies, thicknesses, permeabilities, porosities, extent of natural or induced fractures, etc.)	Discussed in Attachment F Sections F.2 and F.3.
F.4	Geologic description of injection zone (including depth, lateral extent, lithology, thickness, permeability, porosity, presence of natural or induced fractures, etc.)	Discussed in Attachment F Sections F.2 and F.4.
F.5	Page-sized (8 1/2" x 11") diagram showing well construction and corresponding site stratigraphy.	See Figures M-1, M-2, M-3, M-4, and M-5.
G.	**Does not apply to Class 1 Wells**	
H.	**Operating Data**	
H.1	Estimated average and maximum injection rate and volume	Discussed in Attachment H, Section H.1.
H.2	Estimated average and maximum injection pressures	Discussed in Attachment H, Section H.2, and tabulated in Table H-1.
H.3	Source(s) of waste (brief description of industrial process(es) which produce the waste)	Discussed in Attachment H, Section H.3.1.
H.4	A representative waste analysis (including all major constituents and, for hazardous wastes, all hazardous constituents and characteristics)	Shown in Attachment H, Table H-2.
H.5	Plans for corrosion monitoring, if the waste is corrosive	Discussed in Attachment H, Section H.3.3.
I.	**Formation Testing Program**	
I.1	Procedures to verify depth of lowermost USDW, if needed	Discussed in Attachment I Section I.1, Attachment L, Section L.1.1 Step 5, Section L.1.2 Step 5, and Table L-2.
I.2	Procedures to obtain extrapolated formation pressure in porous and permeable zones within approximately 500 feet of the top of the injection zone (non-hazardous wells) or injection interval (hazardous wells)	Discussed in Attachment I, Section I.2 and Attachment L, Section L.2 Steps 10 through 12.
I.3	Sampling and analysis procedures for formation fluid of 1. the first aquifer overlying confining zone (hazardous and non-hazardous waste wells), 2. the injection zone (non-hazardous waste wells) or injection interval (hazardous waste wells), and 3. the containment interval (hazardous waste wells only)	1. Attachment I, Section I.3. 2. Attachment I, Section I.3 and Attachment L, Section L.2 Step 4. 3. Does not apply.

MICHIGAN/INDIANA PERMIT APPLICATION CHECKLIST FOR CLASS I INJECTION WELLS		
UIC Permit Application Form Attachment Number		**Comment**
I.4	Cores and laboratory core testing for confining and injection zones (For non-hazardous waste wells, a minimum of one 30-foot core of the confining zone and one 30-foot core of the injection zone are required. For hazardous waste wells where injection of restricted wastes is proposed, one or more cores of the containment interval will also be necessary)	Discussed in Attachment I, Section I.4.
I.5	Determination of fracture closure pressure of injection zone (nonhazardous wells) or injection interval (hazardous wells)	Discussed in Attachment I Section I.5 and Attachment L Section L.2 Step 9.
I.6	Injectivity/fall-off testing of injection zone/interval, including interference testing if multiple wells are proposed	Discussed in Attachment I Section I.6 and Attachment L Section L.2 Steps 9 and 10.
J.	**Stimulation Program**	
	Class I wells are not recommended in areas where fracture stimulation will be necessary. If it is proposed, procedures should be included in the permit application which show how the operator proposes to confine fractures to the injection formation. If acid or other type of stimulation is proposed, procedures should also be included in the permit application under this section.	Discussed in Attachment J. Fracture stimulation is not proposed. An "acid wash" will be performed as necessary.
K.	**Injection Procedures**	
K.1	Plant plan showing flow line of waste stream(s) to be injected	Provided in Figure K-2.
K.2	Description of filters, storage tanks (including capacity), and any teatment processes and facilities, including location on plant plan	Discussed in Attachment K Section K.2 and shown in in Figure K-2.
K.3	Description of injection pumps, including rate capacity	Discussed in Attachment K Section K.3 and shown in Figure K-2.
K.4	Description of annulus pressure maintenance system	Discussed in Attachment K Section K.4 and shown in Figure F-3.
K.5	Description of alarm and shut-off system	Discussed in Attachment K Section K.5.
L.	**Construction Procedures**	
L.1	Detailed well construction procedures	Provided in Attachment L Sections L.1 and L.2.
L.2	Estimated time table for drilling, logging and formation testing	Provided in Table L-1.
L.3	Proposed open-hole and cased hole logs	Provided in Table L-2.
L.4	Proposed mechanical integrity testing (cement bond logs, radioactive tracer log, and temperature, noise or oxygen activation log are required prior to injection of waste)	Discussed in Attachment L Section L.2, Steps 9 through 11.
L.5	Proposed buffer fluid and volume, if any	Discussed in Attachment L Section L.4.
M.	**Construction Details**	
M.1	Proposed construction of well, including total depth, completion type, casing sizes, types, weights, and setting depths	Discussed in Attachment M Section M.1 and shown in Figures M-1 through M-5.
M.2	Proposed cement type and amount for all casing (All casings should be cemented to surface.)	Discussed in Attachment M Section M.2 and provided in Table M-1.
M.3	Tubing and packer specifications, including size, type, and setting depths	Discussed in Attachment M Section M.3 and provided in Table M-2.
M.4	Well head construction details	Provided in Figure M-6.
M.5	Location of sample tap and female coupling for independent determination of annulus pressure	Discussed in Attachment M Section M.5.
N.	**Does not apply to Class 1 Wells**	
O.	**Plans for Well Failures**	
O.1	Actions that will be taken if mechanical integrity of well is lost	Discussed in Attachment O.
O.2	Storage or alternate treatment or disposal of waste in the case of emergency shut-in.	Discussed in Attachment O. Injectate will be routed to other wells.
P.	**Monitoring Program**	
P.1	Waste Analysis Plan (see guidelines)	Provided in Appendix D.
P.2	Description of monitoring and recording system for injection pressure, rate, and volume, and for annulus pressure	Discussed in Attachment P Section P.2.
P.3	Description of sight glass level monitoring and recording, if a seal pot system of annulus pressure maintenance is proposed	Discussed in Attachment P Section P.3.
P.4	Groundwater monitoring plan and Quality Assurance Project Plan (In most cases, this will be necessary for new wells injecting restricted hazardous wastes. Region 5's two guidances on groundwater monitoring should be followed.)	Discussed in Attachment P Section P.4. Neither a Groundwater Monitoring Plan nor a Quality Assurance Project Plan is required.
Q.	**Plugging and Abandonment Plan**	
Q.1	Signed plugging and abandonment form, showing amount and type of cement, placement method, and estimated cost. (Region 5 requires a cement plug to extend from the base of the lowermost casing to the surface.)	Provided in Attachment Q and Appendix E.
Q.2	Signed estimate of plugging and abandonment costs (and post-closure costs, if applicable) by an independent firm	Provided in Appendix E.

MICHIGAN/INDIANA PERMIT APPLICATION CHECKLIST FOR CLASS I INJECTION WELLS		
	UIC Permit Application Form Attachment Number	**Comment**
Q.3	Closure plan, including plans to acquire a representative fluid sample from the first aquifer overlying the injection zone (Only necessary for wells which inject restricted hazardous wastes)	Not Applicable.
Q.4	Post-closure plan, which covers the requirements of 40 CFR 146.72 (Only necessary for hazardous waste wells)	Not Applicable.
R.	**Necessary Resources**	
	Signed mechanism of financial assurance sufficient to cover closure (and post-closure, if applicable) of well. (Applicants for both hazardous and non-hazardous waste wells should use 40 CFR 144, Subpart F as a guideline)	To be provided in a separate submission.
S.	**Aquifer Exemptions**	
	Region 5 does not encourage applications for aquifer exemptions for Class I wells. If application is made, 40 CFR 146.4 may be used as a guideline.	This application does not request an aquifer exemption.
T.	**Existing Permits**	
	Briefly describe activities which require the applicant to obtain permits under the RCRA, UIC, NPDES, or PSD programs. List all permits or construction approvals received or applied for at the facility where the well will be located, under any of the following programs:	
T.1	Hazardous Waste Management under RCRA	Provided in Table T-1.
T.2	UIC program under SDWA	Not Applicable.
T.3	NPDES program under CWA	Not Applicable.
T.4	Prevention of Significant Deterioration (PSD) program under the Clear Air Act	Provided in Table T-1.
T.5	Nonattainment program under the Clean Air Act	Provided in Table T-1.
T.6	Dredge and fill permits under section 404 of CWA	Not Applicable.
T.7	Other relevant environmental permits, including State permits.	Provided in Table T-1.
U.	**Description of Business**	
U.1	Briefly describe the nature of the business and list up to four SIC codes which best reflect the principal products or services provided by the facility.	Discussed in Attachment U.
	Prior Releases	
	For existing wells, list the highest injection pressure in use in this well since construction and the approximate dates of injection near that pressure	Not Applicable.
	List of prior releases of waste through injection wells at this facility to intervals other than that proposed in this permit application	Not Applicable.
	IF THE PERMIT APPLICATION IS FOR HAZARDOUS WASTE INJECTION, THE APPLICANT MUST ALSO INCLUDE THE FOLLOWING:	Not Applicable.

MICHIGAN/INDIANA
PERMIT APPLICATION CHECKLIST FOR CLASS I INJECTION WELLS

(Keyed to subsections of the Underground Injection Control permit application form)

A. AREA OF REVIEW

In Region 5, the Area of Review (AOR) is a set at a minimum fixed radius of 2 miles for non-hazardous wells; or the larger of the calculated Cone of Influence or a 2 mile radius, for hazardous wells.

For hazardous waste wells, the following information is needed to calculate the Cone of Influence:

__ Depth of top of proposed injection interval

__ Known or estimated pre-injection pressure at top of injection interval

__ Known or estimated specific gravity of formation fluid at top of injection interval

__ Depth of bottom of lowermost aquifer which qualifies as an Underground Source of Drinking Water (USDW)

__ Hydrostatic head (or static water level) of lowermost USDW

__ Expected or modeled maximum pressure buildup in the injection interval

B. MAPS OF WELLS/AREA OF REVIEW

Topographic map of AOR or area extending at least 1 mile beyond property boundaries, whichever is greater, showing the following: (Only items of public record are required.)

__ Each major intake and discharge structures for liquid waste

__ Each hazardous waste treatment, storage, or disposal facility

__ Number, name and location of all producing wells

__ Number, name and location of all injection wells of all classes

__ Number, name and location of all abandoned wells, plugged wells, and dry holes

__ Known or suspected faults

__ Location of all water wells of public record or otherwise known to the applicant, within the AOR or within a quarter mile of the facility property boundary, whichever is greater

__ Bodies of water, springs, surface and subsurface mines and quarries, residences, and roads within the AOR, or within a quarter mile of the facility property boundary, whichever is greater

The following information is also required:

__ List of names and addresses of all owners of record of land within a quarter mile of the facility boundary, unless waived by the Director.

__ A description of the methods used to locate wells in the AOR.

C. CORRECTIVE ACTION PLAN AND WELL DATA

__ Corrective action plan for inadequately plugged wells in the AOR which penetrate the top of the confining zone

The following information should be submitted for all wells in the AOR which penetrate the top of the confining zone:

__ Well construction, date of construction and total depth

__ Well operator/owner

__ Cement records

__ Plugging records

__ Distance from proposed injection well

D. MAPS AND CROSS SECTIONS OF USDWs

__ Stratigraphic column of site which indicates all USDWs

__ Data substantiating the depth of the lowermost USDW, if available

E. DOES NOT APPLY TO CLASS I WELLS

F. MAPS AND CROSS SECTIONS OF GEOLOGIC STRUCTURE OF AREA

__ Cross sections and structure contour maps adequate to describe the regional geology of the area, including especially any faults

__ Cross sections of site-specific geology, including any faulting in the AOR

__ Geologic description of confining zone (including lateral extent, lithologies, thicknesses, permeabilities, porosities, extent of natural or induced fractures, etc.)

__ Geologic description of injection zone (including depth, lateral extent, lithology, thickness, permeability, porosity, presence of natural or induced fractures, etc.)

__ Page-sized (8 1/2" x 11") diagram showing well construction and corresponding site stratigraphy

G. DOES NOT APPLY TO CLASS I WELLS

H. OPERATING DATA

__ Estimated average and maximum injection rate and volume

__ Estimated average and maximum injection pressures

__ Source(s) of waste (brief description of industrial process(es) which produce the waste)

__ A representative waste analysis (including all major constituents and, for hazardous wastes, all hazardous constituents and characteristics)

__ Plans for corrosion monitoring, if the waste is corrosive

I. FORMATION TESTING PROGRAM

__ Procedures to verify depth of lowermost USDW, if needed

__ Procedures to obtain extrapolated formation pressure in porous and permeable zones within approximately 500 feet of the top of the injection zone (non-hazardous wells) or injection interval (hazardous wells)

__ Sampling and analysis procedures for formation fluid of 1. the first aquifer overlying confining zone (hazardous and non-hazardous waste wells), 2. the injection zone (non-hazardous waste wells) or injection interval (hazardous waste wells), and 3. the containment interval (hazardous waste wells only)

__ Cores and laboratory core testing for confining and injection zones (For non-hazardous waste wells, a minimum of one 30-foot core of the confining zone and one 30-foot core of the injection zone are required. For hazardous waste wells where injection of restricted wastes is proposed, one or more cores of the containment interval will also be necessary)

__ Determination of fracture closure pressure of injection zone (nonhazardous wells) or injection interval (hazardous wells)

__ Injectivity/fall-off testing of injection zone/interval, including interference testing if multiple wells are proposed

J. STIMULATION PROGRAM

Class I wells are not recommended in areas where fracture stimulation will be necessary. If it is proposed, procedures should be included in the permit application which show how the operator proposes to confine fractures to the injection formation. If acid or other type of stimulation is proposed, procedures should also be included in the permit application under this section.

K. INJECTION PROCEDURES

__ Plant plan showing flow line of waste stream(s) to be injected

__ Description of filters, storage tanks (including capacity), and any pretreatment processes and facilities, including location on plant plan

__ Description of injection pumps, including rate capacity

__ Description of annulus pressure maintenance system

__ Description of alarm and shut-off system

L. CONSTRUCTION PROCEDURES

__ Detailed well construction procedures

__ Estimated time table for drilling, logging and formation testing

__ Proposed open-hole and cased hole logs

__ Proposed mechanical integrity testing (cement bond logs, radioactive tracer log, and temperature, noise or oxygen activation log are required prior to injection of waste)

__ Proposed buffer fluid and volume, if any

M. CONSTRUCTION DETAILS

The following information should be included in well schematics and/or tables:

__ Proposed construction of well, including total depth, completion type, casing sizes, types, weights, and setting depths

__ Proposed cement type and amount for all casing (All casings should be cemented to surface.)

__ Tubing and packer specifications, including size, type, and setting depths

__ Well head construction details

__ Location of sample tap and female coupling for independent determination of annulus pressure

N. DOES NOT APPLY TO CLASS I WELLS

O. PLANS FOR WELL FAILURES

The applicant should submit contingency plans for 1. actions that will be taken if mechanical integrity of well is lost and 2. storage or alternate treatment or disposal of waste in the case of emergency shut-in.

P. MONITORING PROGRAM

__ Waste Analysis Plan (see guidelines)

__ Description of monitoring and recording system for injection pressure, rate, and volume, and for annulus pressure

__ Description of sight glass level monitoring and recording, if a seal pot system of annulus pressure maintenance is proposed

__ Groundwater monitoring plan and Quality Assurance Project Plan (In most cases, this will be necessary for new wells injecting restricted hazardous wastes. Region 5's two guidances on groundwater monitoring should be followed.)

Q. PLUGGING AND ABANDONMENT PLAN

__ Signed plugging and abandonment form, showing amount and type of cement, placement method, and estimated cost. (Region 5 requires a cement plug to extend from the base of the lowermost casing to the surface.)

__ Signed estimate of plugging and abandonment costs (and post-closure costs, if applicable) by an independent firm

__ Closure plan, including plans to acquire a representative fluid sample from the first aquifer overlying the injection zone (Only necessary for wells which inject restricted hazardous wastes)

__ Post-closure plan, which covers the requirements of 40 CFR 146.72 (Only necessary for hazardous waste wells)

R. NECESSARY RESOURCES

__ Signed mechanism of financial assurance sufficient to cover closure (and post-closure, if applicable) of well. (Applicants for both hazardous and non-hazardous waste wells should use 40 CFR 144, Subpart F as a guideline)

S. AQUIFER EXEMPTIONS

Region 5 does not encourage applications for aquifer exemptions for Class I wells. If application

is made, 40 CFR 146.4 may be used as a guideline.

T. EXISTING EPA PERMITS

Briefly describe activities which require the applicant to obtain permits under the RCRA, UIC, NPDES, or PSD programs. List all permits or construction approvals received or applied for at the facility where the well will be located, under any of the following programs:

1. Hazardous Waste Management under RCRA
2. UIC program under SDWA
3. NPDES program under CWA
4. Prevention of Significant Deterioration (PSD) perogram under the Clear Air Act
5. Nonattainment program under the Clean Air Act
6. Dredge and fill permits under section 404 of CWA
7. Other relevant environmental permits, including State permits.

U. DESCRIPTION OF BUSINESS

Briefly describe the nature of the business and list up to four SIC codes which best reflect the principal products or services provided by the facility.

PRIOR RELEASES

__ For existing wells, list the highest injection pressure in use in this well since construction and the approximate dates of injection near that pressure

__ List of prior releases of waste through injection wells at this facility to intervals other than that proposed in this permit application

IF THE PERMIT APPLICATION IS FOR HAZARDOUS WASTE INJECTION, THE APPLICANT MUST ALSO INCLUDE THE FOLLOWING:

__ All applicable RCRA waste codes for listed and characteristic wastes proposed for injection in this well

__ All applicable Land Disposal Restriction deadlines or "ban dates"

__ Proposed schedule for submittal of exemption petition, if waste is restricted from land disposal

__ Additional testing proposed to support the exemption petition

__ Future plans for waste minimization and a certified statement which meets the requirements of 40 CFR 146.70(d)

APPENDIX

B WELL RECORDS

(SEE ATTACHMENT C)

(C)

35-4S-10E
Brownstown Twp., (Wayne Co.)

TD 2820 in Black River Dry

W. E. Ellis

Location: NE¼ NE¼ section 35, T 4S, R 10E
Brownstown Twp., on the Miller Road, 2 miles southwest of Trenton, about 700' south of road.

Elevation: About 585 feet above sea level

Record by: W. Osgood & R. B. Newcombe from samples furnished by J. F. Miller, & Driller's log. Spudded in April 11, 1927.
Driller: Frank C. Cheers

	Thickness (Feet)	Depth (Feet)
PLEISTOCENE:		
Drift:		
Surface deposits	20	20
DEVONIAN:		
Detroit River:		
Dolomite, light buff	70	90
" , gray	15	105
" , light buff	11	116
" , dark brown, bituminous	20	136
" , buff, light	44	180
Sylvania:	(160)	
Sandstone, gray, cemented by dolomite	10	190
" , white (hole full water 215)	70	260
" , gray (dolomite cem.)	20	280
Sandstone	10	290
SILURIAN:	(110)	
Bass Island-Salina:		
Dolomite, gray, cherty	10	300
" , sandy	10	310
" , gray to buff, cherty (much chert 310-60)	140	450
" " " "	90	540
Dolomite, gray	10	550
" , buff	10	560
" , gray with some gypsum	20	580
" , light buff	25	605
" , gray	15	620
" , dark gray to black with some anhydrite	110	730
" , brown	20	750
" , dark gray with anhydrite	30	780
" , buff	10	790
" , gray	30	820
" , buff	10	840
" , gray & brown	30	870
" "	130	1000
" , brown & anhydrite	80	1080
" , gray	30	[illegible]
" , light gray & anhydrite	30	1140
" , light buff(water enough to drill with at 1195, more 1280)	110	1250
Dolomite, brown	30	[illegible]
" , gray & brown	90	1370
" , gray (6 bailers of water)	20	[illegible]
	(1100)	

	Thickness (Feet)	Depth (Feet)
Guelph:		
Dolomite, white or bluish white	10	1400
Dolomite, milky white, crystalline	10	1410
Dolomite, light brown, iron stained	20	1430
Dolomite, iron stained	30	1460
Dolomite, light blue	30	1490
Dolomite, blue to gray	10	1500
	(110)	
Lockport:		
Dolomite, light buff (Lithographic)	10	1510
Dolomite, gray and greenish gray shale	10	1520
	(20)	
Cataract:		
Cabot Head:		
Shale, purple and green and dolomite	20	1540
Shale, soft greenish gray	40	1580
Dolomite, gray and purple shales (iron stained)	10	1590
	(70)	
Manitoulin:		
Dolomite, gray to buff (Iron stained)	10	1600
Dolomite, gray to greenish gray, shaly	10	1610
Dolomite, light gray to buff, hard crystalline	20	1630
	(40)	
ORDOVICIAN:		
Cincinnatian:		
Shale, greenish gray to purple	10	1640
Shale, greenish gray	10	1650
Shale, light red	10	1660
Shale, greenish gray to purple	30	1690
Shale, soft red	70	1760
Shale, light red	10	1770
Shale, purple and green (purple predominating)	10	1780
Shale, purple and green (green predominating)	10	1790
Shale, soft light gray	10	1800
Dolomite, gray, shaly	10	1810
Shale, light to dark gray and shaly dolomite	30	1840
Shale, purple with some green	20	1860
Shale, greenish gray with some purple	20	1880
Shale, light greenish gray	10	1890
Shale, hard gray	250	2140
Shale, gray, hard	60	2200
Shale, brownish, gray (Utica?)	40	2240
Gray, brownish, shale & dolomite (some Pyrite)	10	2250
	(620)	
Trenton-Black River:		
Limestone, buff dolomitic and blue-gray shale (Steel line measurement shows top of Trenton - 2660')	30	2280
Limestone, brown (some blue shale)	20	2300
Limestone, light gray	10	2310
Limestone, buff & light gray with some blue shale (fossils)	36	2346
(show of oil and gas at 2344, oil at 2342-2352. After standing overnight made about 2 quarts of oil.)		
Dolomite, buff	8	2354
Limestone, wh[illegible]ff, cherty	16	2370

	Thickness (Feet)	Depth (Feet)
Trenton-Black River: (Contd.):		
Limestone, light gray	20	2390
Limestone, dark gray to buff	30	2420
Limestone, light gray	10	2430
Limestone, buff to dark gray (fossils)	20	2450
Limestone, buff, fossiliferous and dark blue gray shale	20	2470
Limestone, buff	50	2520
Shale, dark gray (some buff limestone)	20	2540
Limestone, buff (fossils)	40	2580
Limestone, dark gray (some shale)	60	2640
Limestone, light buff, fine grained, nearly lithographic limestone	180 (570+)	2820
TOTAL DEPTH		2820

Casing record:
10" 147'
8 1/4" 610'
6 5/8" (2) 1798'

7-13-56-C

Muskegon Twp. (Muskegon County)

Reed Oil Company

Heinz #6 Permit #419

Drilling Contractor: J. B. Reed

Location: NW¼ of SE¼ of section 8, T.10N.,R.16W.
1795 feet from south and 2100 feet from east line of quarter section.

Elevation: 587 feet above sea level.

Record by: O. F. Poindexter from driller's log.

	Thickness (Feet)	Depth (Feet)
PLEISTOCENE:		
Drift:		
Drift	199	199
MISSISSIPPIAN:		
Lower Marshall:		
Lime (sandstone and shale ?)	71	270
Coldwater:		
Shale	239	509
Limestone	49	558
Blue shale	230	788
Red limestone	22	810
Bedford:		
Green shale	522	1332
MISSISSIPPIAN-DEVONIAN:		
Antrim:		
Brown shale	165	1497
DEVONIAN:		
Traverse:		
Gray limestone	99	1596
No record (gas 1596-1606; oil 1606-1610)	14	1610
Limestone	250	1860
Shale and limestone	120	1980
Dundee:		
Limestone (oil and gas)	10	1990

587
199
388

Casing record:
10" 202'
8¼" 290'
6-5/8" 1980'

Commenced: 10-10-29
Completed: 11-4-29
Initial Production: 100 bbls. oil

Permit No 146 Source: Geowebface DEQ

- API Number:21163001468000
- Permit Number:146
- Lease Name:MARATHON OIL CO. (WOODHAVEN)
- Well #:BD1
- Status:Active
- Total Depth:3752
- Producing Formation:Null
- Latitude:42.131838
- Longitude:-83.227123
- Place:Woodhaven
- County:Wayne
- TRS:04S10E22
- Map-click Lat:42.13187
- Map-click Lon:-83.22718

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA)
UNDERGROUND INJECTION CONTROL MINOR PERMIT MODIFICATION: CLASS II

Permit Number: MI-163-2D-0001

Facility Name: Brine Disposal Well #1 (BD146)

Pursuant to the provisions of the Safe Drinking Water Act, as amended (42 U.S.C. 300f et seq., commonly known as the SDWA) and implementing regulations promulgated by the USEPA at Parts 124, 144, 146 and 147 of Title 40 of the Code of Federal Regulations (CFR),

Marathon Pipe Line LLC., of Findlay, Ohio

is hereby authorized to operate an injection well located in Michigan, Wayne County, T4S, R10E, Section 22, SE 1/4 Section, for injection into the Eau Claire and Mt. Simon Formations at depths between 3252 feet and 3704 feet, upon the express condition that the permittee meet the restrictions set forth herein.

The purpose of the injection is for the disposal of salt water from gas storage operations owned or operated by Marathon Pipe Line LLC in the immediate area.

All references to Title 40 of the Code of Federal Regulations are to all regulations that are in effect on the date that this permit is effective.

This permit is a minor modification of an existing permit which was signed on December 8, 1988. This permit shall become effective on NOV 4 2005 and shall remain in full force and effect during the operating life of the well, unless this permit is otherwise revoked, terminated, modified or reissued pursuant to 40 CFR 144.39, 144.40 or 144.41. This permit shall also remain in effect upon delegation of primary enforcement responsibility to the State of Michigan, unless that State chooses to adopt this permit as a State permit. This permit will be reviewed at least every five (5) years from the effective date specified above.

Signed and dated: November 4, 2005

Charles J. Elly
for
Jo Lynn Traub
Director, Water Division

This permit contains 13 pages and attachments A through C.

PART I

GENERAL PERMIT COMPLIANCE

A. EFFECT OF PERMIT

The permittee is allowed to engage in underground injection in accordance with the conditions of this permit. The underground injection activity, otherwise authorized by this permit or rule, shall not allow the movement of fluid containing any contaminant into Underground Sources of Drinking Water (USDW), if the presence of that contaminant may cause a violation of any Primary Drinking Water Regulation pursuant to Title 40 CFR Part 142 or may otherwise adversely affect the health of persons. Any underground injection activity not specifically authorized in this permit or otherwise authorized by permit or rule is prohibited. Issuance of this permit does not convey property rights of any sort or any exclusive privilege; nor does it authorize any injury to persons or property, any invasion of other private rights, or any infringement of State or local law or regulations. Compliance with the terms of this permit does not constitute a defense to any action brought under Section 1431 of the Safe Drinking Water Act (SDWA), or any other law governing protection of public health or the environment, for any imminent and substantial endangerment to human health or the environment.

B. PERMIT ACTIONS

This permit may be modified, revoked and reissued, or terminated for cause as specified in Title 40 CFR §144.39, §144.40, and §144.41. The filing of a request for a permit modification, revocation and reissuance, termination, or the notification of planned changes or anticipated noncompliance on the part of the permittee does not stay the applicability or enforceability of any permit condition.

C. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances and to the remainder of this permit shall not be affected thereby.

D. CONFIDENTIALITY

In accordance with Title 40 CFR Part 2 and §144.5, any information submitted to USEPA pursuant to this permit may be claimed as confidential by the submitter. Any such claim must be asserted at the time of submission by stamping the words "confidential business information" on each page containing such information. If no claim is made at the time of submission, USEPA may make the information available to the public without further notice.

If a claim is asserted, the validity of the claim will be assessed in accordance with the procedures in Title 40 CFR Part 2 (Public Information). Claims of confidentiality for the following information will be denied:

1) The name and address of the permittee; and,

2) Information which deals with the existence, absence or level of contaminants in drinking water.

E. DUTIES AND REQUIREMENTS

1. Duty to Comply - The permittee shall comply with all conditions of this permit, except to the extent and for the duration such noncompliance is authorized by an emergency permit. Any permit noncompliance constitutes a violation of the SDWA and is grounds for enforcement action, permit termination, revocation and reissuance or modification.

2. Penalties for Violations of Permit Conditions - Any person who operates this well in violation of permit conditions is subject to civil penalties, fines, and other enforcement action under the SDWA and may be subject to such actions under the Resource Conservation and Recovery Act. Any person who willfully violates a permit condition may be subject to criminal prosecution.

3. Need to Halt or Reduce Activity not a Defense - It shall not be a defense for a permittee in an enforcement action to state that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

4. Duty to Mitigate - The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

5. Proper Operation and Maintenance - The permittee shall at all times properly operate and maintain all facilities. Proper operation and maintenance includes effective performance and adequate funding, including appropriate quality assurance procedures.

6. Duty to Provide Information - The permittee shall furnish to the Director, within thirty (30) days, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required by this permit to be retained.

7. Inspection and Entry - The permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by law to:

   (a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this permit;

   (b) Have access to and copy, at reasonable times, any records that must be retained under the conditions of this permit;

   (c) Inspect, at reasonable times, any facilities, equipment (including monitoring equipment), practices, or operations, regulated or required under this permit; and,

   (d) Sample or monitor the injected fluids, at reasonable times, for the purposes of assuring permit compliance, or as otherwise authorized by the SDWA, at any location.

8. Records

   (a) The permittee shall retain records of all monitoring information, including all calibration and maintenance records and copies of all reports required by this permit, for a period of at least three (3) years from the date of the sample, measurement or report. The permittee shall also maintain records of all data required to complete this permit application and any supplemental information submitted under Title 40 CFR §144.27, §144.28 and §144.31. These periods may be extended by the Director at any time by written notice to the permittee.

   (b) The permittee shall retain records concerning the nature and composition of all injected fluids until three (3) years after the completion of plugging and abandonment in accordance with the plugging and abandonment plan, contained in Part III(B) of this permit. At the conclusion of the retention period, if the Director so requests, the permittee shall deliver the records to the Director.

   (c) Records of monitoring information shall include:

      (i) The date, exact place, and the time of sampling or measurements;

      (ii) The individual(s) who performed the sampling or measurements;

      (iii) A precise description of both sampling methodology and the handling of samples;

      (iv) The date(s) analyses were performed;

      (v) The individual(s) who performed the analyses;

(vi) The analytical techniques or methods used; and,

(vii) The results of such analyses.

9. Notification Requirements

(a) Planned Changes - The permittee shall notify the Director at least thirty (30) days prior to any planned physical alterations or additions to the permitted facility, or changes in the injection fluids. An analysis of new injection fluids shall be submitted to the Director in accordance with Parts II(B)(2) and II(B)(3) of this permit.

(b) Anticipated Noncompliance - The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

(c) Transfer of Permits - This permit is not transferrable to any person except after notice is sent to the Director and the requirements of Title 40 CFR §144.38 have been met. The Director may require modification or revocation of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under the SDWA.

(d) Compliance Schedules - Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than thirty (30) days following each schedule date.

(e) Twenty-Four (24) Hour Reporting

(i) The permittee shall report to the Director any noncompliance which may endanger health or the environment. This information shall be provided orally within twenty-four (24) hours from the time the permittee becomes aware of the circumstances, and shall include the following information:

(a) Any monitoring or other information which indicates that any contaminant may cause an endangerment to an underground source of drinking water; or,

(b) Any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between underground sources of drinking water.

(ii) A written submission shall also be provided as soon as possible but no later than five (5) days from the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

(f) Other Noncompliance - The permittee shall report all other instances of noncompliance. The reports shall contain the information listed in Part I(E)(9)(e)(ii) of this permit.

(g) Other Information - If or when the permittee becomes aware that he/she failed to submit any relevant facts in the permit application, or submitted incorrect information in a permit application or in any report to the Director, the permittee shall promptly submit such facts or corrected information.

(h) Report on Permit Review - Within thirty (30) days of receipt, the permittee shall report to the Director that he/she has read and is personally familiar with all terms and conditions of this permit.

10. Commencing Injection - The permittee shall not recommence injection until any remedial procedures described in Parts I(E)(16) and III(C) of this permit are complete, and;

(a) The permittee has submitted a report on the remedial work to the Director; and,

(b) The Director has inspected or otherwise reviewed the remedial work and notified the permittee in writing that he/she is in compliance with the conditions of this permit; or,

(c) The permittee has not received, with thirteen (13) days of the date of the Director's receipt of the report required above, notice from the Director of his/her intent to inspect or otherwise review the new injection well, in which case prior inspection or review is waived and the permittee may commence injection.

11. Signatory Requirements - All reports or other information requested by the Director shall be signed and certified according to Title 40 CFR §144.32.

12. Notice of Plugging and Abandonment - The permittee shall notify the Director at least forty-five (45) days before conversion or abandonment of the well.

13. Plugging and Abandonment - The permittee shall plug and abandon the well as provided in the plugging and abandonment plan contained in Part III(B) of this permit. After a cessation of operation of two (2) years, the owner or operator shall plug and abandon the well in accordance with the plan provided in Part III(B) of this permit unless the operator fulfills the other requirements under Title 40 CFR §144.52(a)(6). The permittee shall notify the Director of plugging and abandonment in accordance with the reporting procedures in Part II(B)(3)(d) of this permit.

14. Financial Responsibility - The permittee shall maintain financial responsibility and resources to plug and abandon the underground injection well in accordance with Title 40 CFR §144.52(a)(7) as provided in Attachment R of the administrative record corresponding to this permit action which is hereby incorporated by reference as if it appeared fully set forth herein. The permittee shall not substitute an alternative demonstration of financial responsibility from that which the Director has approved, unless the permittee has previously submitted evidence of that alternative demonstration to the Director and the Director has notified the permittee in writing that the alternative demonstration of financial responsibility is acceptable. The financial responsibility mechanism shall be updated periodically, upon request of the Director.

15. Insolvency

    (a) In the event of the bankruptcy of the trustee or issuing institution of the financial mechanism, or a suspension or revocation of the authority of the trustee institution to act as trustee or the institution issuing the financial mechanism to issue such an instrument, the permittee must submit an alternative demonstration of financial responsibility acceptable to the Director within sixty (60) days after such event.

    (b) An owner or operator must also notify the Director by certified mail of the commencement of voluntary or involuntary proceedings under Title 11 (Bankruptcy), U. S. Code, naming the owner or operator as debtor, within ten (10) business days after the commencement of the proceeding. A guarantor of a corporate guarantee

must make such a notification if the permittee is named as debtor, as required under the terms of the guarantee.

16. Remedial Action

(a) The permittee shall shut in the injection well whenever he/she or USEPA determines that operation thereof may be causing upward fluid migration through the wellbore of any improperly plugged or unplugged well in the area of review and shall take such steps as he/she can to properly plug the offending well(s). Any operation of the well which may cause upward fluid migration from an improperly plugged or unplugged well will be considered a violation of this permit. If the permittee or USEPA determines that the casing of the permitted well is leaking, the permittee will immediately shut in the well until such time as appropriate repairs can be effected and a mechanical integrity demonstration provided to the Director.

(b) The permittee shall not recommence injection until any and all remedial action has been taken in accordance with the plan contained in Part III(C) of this permit and the requirements in Part I(E)(10) of this permit have been met.

17. Mechanical Integrity

(a) The permittee must establish and shall maintain mechanical integrity of this well, in accordance with Title 40 CFR §146.8.

(b) A demonstration of mechanical integrity, in accordance with Title 40 CFR §146.8, shall be performed at least every five (5) years from the date of the last approved demonstration. The permittee shall notify the Director of his/her intent to demonstrate mechanical integrity at least thirty (30) days prior to such demonstration.

(c) The permittee shall demonstrate the mechanical integrity of the well by pressure testing whenever: (i) the tubing is removed from the well or replaced; (ii) the packer is reset; or, (iii) a loss of mechanical integrity occurs during operation.

(d) The Director may, by written notice, require the permittee to demonstrate mechanical integrity at any time.

(e) The permittee shall cause all gauges used in mechanical integrity demonstrations to be calibrated prior to the demonstration. For continuous annulus monitoring, gauges shall be calibrated on an annual basis.

(f) The permittee shall cease injection if a loss of mechanical integrity during a test, or a loss of mechanical integrity, as defined by Title 40 CFR §146.8, becomes evident during operation. Operations shall not be resumed until the Director gives approval to recommence injection.

(g) The permittee shall notify the Director of the loss of mechanical integrity, in accordance with the reporting procedures in Parts II(B)(3)(d) and I(E)(9)(e) of this permit.

18. Restriction on Injected Substances - The permittee shall be restricted to the injection of oil field brines or those fluids used in the enhancement of oil and gas production, and further, no fluids other than those from sources noted in the administrative record and approved by the Director shall be injected.

PART II

WELL SPECIFIC CONDITIONS FOR UIC PERMITS

A. CONSTRUCTION REQUIREMENTS

1. Siting - Notwithstanding any other provision of this permit, the injection well shall inject only into a formation which is separated from any USDW by a confining zone that is free of known open faults or fractures within the area of the review.

2. Casing and Cementing - Injection wells shall be cased and cemented to prevent the movement of fluids into or between USDWs. Specifics on the casing and cement to be used in the construction of the well shall be as contained in Attachments L and M of the administrative record corresponding to this permit action which are hereby incorporated by reference as if they appeared fully set forth herein.

3. Tubing and Packer Specifications - Injection shall only take place through tubing with a packer set in the long string casing at a depth no higher than immediately above the injection zone. Tubing and packer specifications shall be as represented in engineering drawings contained in Attachments L and M of the administrative record corresponding to this permit action which are hereby incorporated by reference as if they appeared fully set forth herein. Any proposed changes shall be submitted by the applicant for the approval of the Director before installation.

4. Wellhead Specifications - For every injection well, the operator shall provide a female fitting, with a cutoff valve, to the tubing at the wellhead, so that the amount of injection pressure being used may be measured by a representative of the USEPA by attaching a gauge having a male fitting.

B. OPERATING, MONITORING AND REPORTING REQUIREMENTS

1. Operating Requirements

(a) Injection Pressure Limitation

(i) Beginning on the effective date of this permit, the permittee is authorized to operate the injection well, subject to the limitations and monitoring requirements set forth herein. The injection pressure and injected fluid shall be limited and monitored as specified in Part III(A) of this permit.

(ii) Injection at a pressure which initiates fractures in the confining zone or causes the movement of injection or formation fluids into or between USDWs is prohibited.

(iii) Injection between the outermost casing protecting USDWs and the well bore is prohibited.

(iv) The annulus between the tubing and the long string casing shall be filled with a liquid designed to inhibit corrosion. The annulus liquid will be monitored in accordance with Parts II(B)(2)(d) and II(B)(3)(b) of this permit. Any specific annulus requirements are contained in Part III(A) of this permit.

2. Monitoring Requirements

(a) Samples and measurements, taken for the purpose of monitoring, shall be representative of the monitored activity. Grab samples shall be used to obtain a representative sample of the fluid to be analyzed. Part III(A) of this permit describes the sampling location and required parameters for injection fluid analysis. The permittee shall identify the types of tests and methods used to generate the monitoring data. The monitoring program shall conform to the one described in Part III(A) of this permit.

(b) Analytical Methods - Monitoring of the nature of injected fluids shall comply with applicable analytical methods cited and described in Table I of Title 40 CFR §136.3 or in Appendix III of Title 40 CFR Part 261 or by other methods that have been approved by the Director.

(c) Injection Fluid Analysis - The nature of the injection fluids shall be monitored as specified in Part III(A) of this permit. An initial analysis of the injection fluid is contained in Attachment H of the administrative record corresponding to this permit action which is hereby incorporated by reference as if it appeared fully set forth herein.

(d) Injection Pressure, Annulus Pressure, Annulus Liquid Loss, Flow Rate and Cumulative Volume - Injection pressure, annulus pressure, flow rate and cumulative volume shall be recorded at least weekly. Annulus liquid loss shall be recorded at least quarterly. This loss shall be reported as the volume of liquid added to the annulus to keep it filled in accordance with Part II(B)(1)(iv). All gauges used in monitoring shall be calibrated in accordance with Part I(E)(17)(e) of this permit.

3. Reporting Requirements - Copies of the monitoring results and all other reports shall be submitted to the Director at the following address:

U.S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, Illinois 60604
Attn: UIC Section, Enforcement Team (5WD-TUB-9)

(a) Monthly Reports - Monitoring results obtained during each week shall be recorded on a form which has been signed and certified according to Title 40 CFR §144.32. Forms shall be submitted at the end of each month and shall be postmarked no later than the 10th day of the month following the sampling period. The first report shall be sent no later than the 10th day of the month following the month in which injection commences. This report shall include the weekly measurements of injection pressure, annulus pressure, flow rate and cumulative volume as required in Part III(A) of this permit.

(b) Quarterly Reports - Monitoring results obtained each quarter shall include the measurement of annulus liquid loss as required in Part III(A) of this permit. Reports shall be submitted at the end of each quarter and shall be postmarked no later than the 10th day of the first month of the following quarter.

(c) Annual Reports - Monitoring results obtained each year shall include the measurements of injected fluid characteristics as required in Part III(A) of this permit. Reports shall be submitted at the end of each year and shall be postmarked no later than the 10th day of the first month of the following year.

(d) Reports on Well Tests, Workovers, and Plugging and Abandonment - The applicant shall provide the Director with the following reports and test results within sixty (60) days of completion of the activity:

(i) Mechanical integrity tests;

(ii) Logging or other test data;

(iii) Well workovers (Using EPA Form 7520-12); and,

(iv) Plugging and abandonment.

PART III

SPECIAL CONDITIONS

These special conditions include, but are not limited to plans for maintaining correct operating procedures, monitoring conditions and reporting, as required by Title 40 CFR Parts 144 and 146. These plans are described in detail in the permittee's application for a permit, and the permittee is required to adhere to these plans as approved by the Director as follows:

A. OPERATING, MONITORING AND REPORTING REQUIREMENTS (ATTACHED)

B. PLUGGING AND ABANDONMENT PLAN (ATTACHED)

C. REMEDIAL ACTION PLAN (ATTACHED)

D. ADDITIONAL REQUIREMENTS (ATTACHED)

OPERATING, MONITORING AND REPORTING REQUIREMENTS

Characteristic	LIMITATION	MINIMUM MONITORING REG. Freq.	Type	MINIMUM REPORTING REQUIREMENTS
*Injection Pressure	869 psig (MAXIMUM)	weekly		monthly
Annulus Pressure		weekly		monthly
Flow Rate		weekly		monthly
Cumulative Volume		weekly		monthly
Annulus Liquid Loss		weekly		quarterly
**Chemical Composition of Injected Fluid		annually	grab	annually

SAMPLING LOCATION:

*The limitation on wellhead pressure serves to prevent confining-formation fracturing. This limitation was calculated using the following formula: [{0.8 - (0.433 psi/ft)(specific gravity)} x depth] - 14.7 psi. The maximum wellhead pressure is dependent upon depth and specific gravity of the injected fluid. The Eau Claire Formation at 3252 feet was used as the depth and a specific gravity of 1.22 was used for the injected fluid.

**Chemical composition analysis shall include, but not be limited to, the following: Sodium, Calcium, Magnesium, Barium, Total Iron, Chloride, Sulfate, Carbonate, Bicarbonate, Sulfide, Total Dissolved Solids, pH, Resistivity (ohm-meters @ 75°F), and Specific Gravity.

Form Approved OMB No. 2040-0042

EPA

United States Environmental Protection Agency
Washington, DC 20460

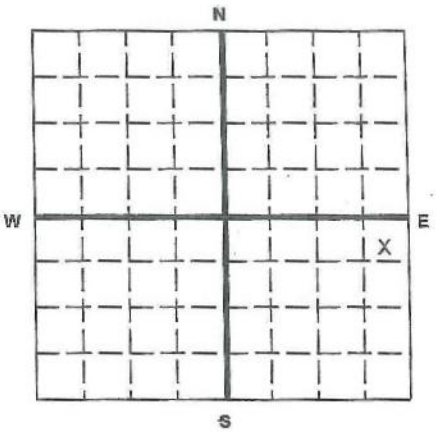
PLUGGING AND ABANDONMENT PLAN

MI-163-2D-0001
Page B-1 of 2

Name and Address of Facility
Marathon Pipe Line LLC - Woodhaven Station
24400 Allen Road
Woodhaven, MI 48183

Name and Address of Owner/Operator
Marathon Pipe Line LLC
539 South Main Street
Findlay, OH 45840

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
MI	Wayne	MI-163-2D-001

Surface Location Description
___ 1/4 of NE 1/4 of NE 1/4 of SE 1/4 of Section 22 Township 4S Range 10E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location 591 ft. frm (N/S) N Line of quarter section
and 342 ft. from (E/W) E Line of quarter section.

TYPE OF AUTHORIZATION
- [ ] Individual Permit
- [ ] Area Permit
- [X] Rule

Number of Wells 1

Lease Name

WELL ACTIVITY
- [ ] CLASS I
- [X] CLASS II
  - [X] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
16"	65	83	83	22"
10-3/4"	40.5	422	422	13-3/4"
5-1/2"	14	3745	3745	7-7/8"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [X] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	5-1/2"	5-1/2"					
Depth to Bottom of Tubing or Drill Pipe (ft	3300	380					
Sacks of Cement To Be Used (each plug)	100	194					
Slurry Volume To Be Pumped (cu. ft.)	118	228.92					
Calculated Top of Plug (ft.)	2439	Surface					
Measured Top of Plug (if tagged ft.)	N/A	N/A					
Slurry Wt. (Lb./Gal.)	15.6	15.6					
Type Cement or Other Material (Class III)	Class A	Class A					

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3334	3700		

Estimated Cost to Plug Wells
$36,492.00

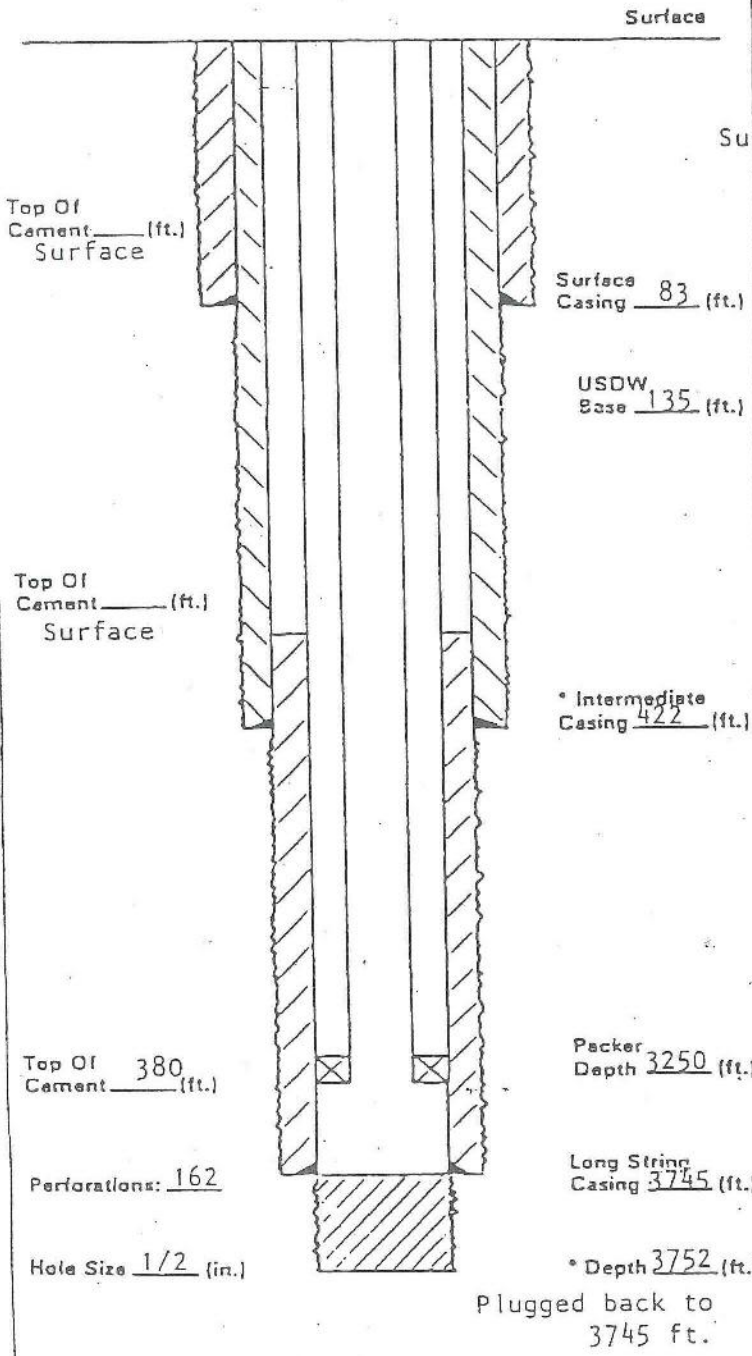
Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Mr. Donald P. Bozell, President Marathon Pipe Line, LLC	DPBozell	10/20/05

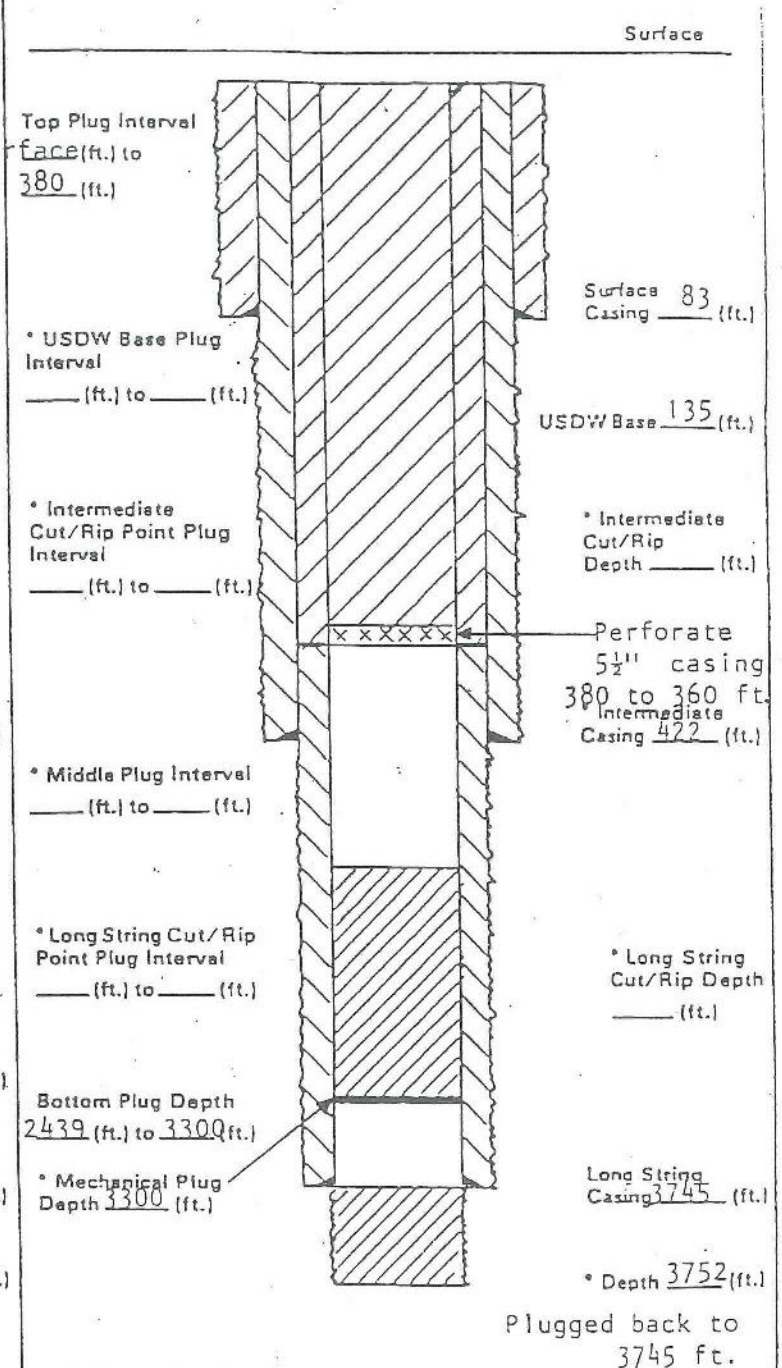
EPA Form 7520-14

ORIGINAL WELL CONSTRUCTION DURING OPERATION



** Add Any Additional Information
* May Not Apply

PLUGGING AND ABANDONMENT CONSTRUCTION



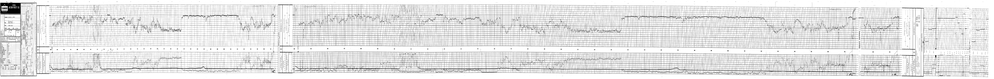
** Add Any Additional Information
* May Not Apply

LIST OF ALL OPEN AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED

Specify Open Hole/Perforations/Varied Casing	From	To	Formation Name
162 perforations	3334	3700	Eau Claire - Mt. Simon

REMEDIAL ACTION PLAN

No remedial action is required at this time.



BD146

Birdwell

Gamma · Perforating

FILING NO.	
COMPANY	Marathon O. C. Co
WELL	Baird Disposal #1
FIELD	
COUNTY	Wayne
STATE	Mich
LOCATION	N/2 SE/4
SEC	22
TWP	4S
RGE	10E
OTHER SERVICES	
ELEVATIONS: KB	605.4
DF	596
PERMANENT DATUM	Ground Level
ELEV	596
LOG MEASURED FROM	K.B.
DRILLING MEASURED FROM	K.B.

DATE	1-2-69
RUN NO.	
TYPE LOG	Gamma CCL
DEPTH-DRILLER	3710
DEPTH-LOGGER	3710
BOTTOM LOGGED INTERVAL	3708
TOP LOGGED INTERVAL	1400
TYPE FLUID IN HOLE	Water
LEVEL	
OPR. RIG TIME	
TRUCK NO.	2253
LOCATION	Jackson
RECORDED BY	
WITNESSED BY	

BORE HOLE RECORD			CASING RECORD		
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1	13 3/4				Surf	83
	8 3/4				Surf	
	7 7/8			4½	Surf	3695

FIELD PRINT

EQUIPMENT DATA

CORRELATION GAMMA-RAY		
RUN NO.	One	One
TOOL MODEL NO.		
DIAM.	3 7/8	3 5/8
SPEED FT./MIN.	40	
T. C. SEC.	1	

WELL DATA	TYPE	FROM	TO	
PERFORATIONS	Select-a-Jet (4½")	3620	3700	1 Hole/2'

BRIDGE PLUG		
TYPE	C.I. ☐	MAG. ☐
SIZE NO.	DEPTH SET	
TYPE	C.I. ☐	MAG. ☐
SIZE NO.	DEPTH SET	

REMARKS: NA Means not available.

APPENDIX

C DRILLING FLUID PROGRAM

(SEE ATTACHMENT L)

PROPOSED DRILLING FLUID PROGRAM

PHASE # 1

Interval:	**Surface**
Fluid Type:	**Spud Mud**
Estimated "Drilling Days":	**2**
Well Depth:	**0 – 470'**
Hole Size:	**17 1/2**
Products:	**Caustic Soda, Aqua Gel, Soda Ash, Lime, X Tend II**

Fluid Properties:

Viscosity:	**60 – 80 sec./1000cc**
Density:	**9.4 or less**
PV:	**>10**
YP:	**>16**
Gels 10 sec./10 min.:	**>10**

Discussion:

Use caustic Soda, Soda Ash, Lime, Gel & X-Tend II for this interval, build a system with viscosity in the 60-80 sec./1000cc range to ensure well bore stability for casing and reduce "wash out." Operate using reduced volume in system to reduce cost, add Caustic Soda (& Soda Ash, if necessary) to water before adding gel. Add Hypochlorite to surface make up water before mixing any other product. Mix gel, as needed, to attain 38-40 sec./1000cc funnel viscosity before adding any extender or PHPA. We recommend using Extender and PHPA to raise viscosity above 40 while drilling and use the Lime when closer to surface TD. If lime is added too early (need more gel added to the system), it must be treated out before adding more gel or the new gel will not yield (raise viscosity).

PHASE # 2

Interval:	**Fresh Water**
Fluid Type:	**Fresh Water**
Estimated "Drilling Days":	**1**
Well Depth:	**471– 530'**
Bit Size:	**12 1/4**
Products:	**Aqua Gel, Soda Ash, Lime, X Tend II**

Fluid Properties:

Viscosity:	**27 – 29 sec./1000cc**
Density:	**8.6 or less**
PV:	**>4**
YP:	**1**
Gels 10 sec./10 min.:	**No control**

Discussion:

Drill this interval on fresh water sweeping the well bore with a high viscosity gel pill every 150 ft., or as the hole dictated. If possible, salvage as much of the pill as possible back to the tank to re-use for subsequent sweeps.

Stop drilling with fresh water just before topping the F Salt formation. Dump and clean the tanks, then refill them with saturated 10/2 ppg brine water. Displace the fresh water out of the hole into the reserve with the saturated brine before drilling the F Salt.

Use good drilling practices and do not surge or swab well bore with the drill string or pump.

PHASE # 3

Interval:	**Saturated Brine**
Fluid Type:	**0**
Estimated "Drilling Days":	**3**
Well Depth:	**530'– 1310'**
Bit Size:	**12 1/4**
Products:	**HEC-HV, Salt Gel**

Fluid Properties:

Viscosity:	**29 – 29 sec. /1000cc**
Density:	**10.2 – 10.4**
PV:	**>6**
YP:	**1-3**
Gels 10 sec./10 min.:	**No control**

Discussion:

Continue drilling to total depth with the saturated brine water. The hole will be swept as needed with a salt gel/polymer high viscosity pill to ensure a clean hole. Sweep the hole several times at TD, to ensure a clean hole before tripping out for log

One may consider mixing starch at the Glenwood formation to help protect the disposal zone and better ensure a gauge hole diameter through the cap rock. This cost is not included in this cost estimate.

KEEP THE HOLE FULL ON ALL TRIPS and MONITOR THE HOLE WHEN ON THE BANK.

PHASE #4

Interval:	**Fresh Water**
Fluid Type:	**Fresh Water**

Estimated "Drilling Days":	**9**
Well Depth:	**1310– 3730'**
Bit Size:	**8 3/4**
Products:	**Aqua Gel, Soda Ash, Lime, X Tend II**

Fluid Properties:

Viscosity:	**27 – 29 sec./1000cc**
Density:	**8.9 or less**
PV:	**>4**
YP:	**1**
Gels 10 sec./10 min.:	**No control**

Discussion:

Drill this interval on fresh water sweeping the well bore with a high viscosity gel pill every 150 ft., or as the hole dictated. If possible, salvage as much of the pill as possible back to the tank to re-use for subsequent sweeps.

Use good drilling practices and do not surge or swab well bore with the drill string or pump.

KEEP THE HOLE FULL ON ALL TRIPS and MONITOR THE HOLE WHEN ON THE BANK.

APPENDIX

D WASTE ANALYSIS PLAN

(SEE ATTACHMENT P)

BUCKEYE TERMINALS, LLC

WASTE ANALYSIS PLAN

CLASS I UIC PERMIT APPLICATION FOR PROPOSED BDW-1 THROUGH BDW-5

SEPTEMBER 12, 2017

WASTE ANALYSIS PLAN

CLASS I UIC PERMIT APPLICATION FOR PROPOSED BDW-1 THROUGH BDW-5

BUCKEYE TERMINALS, LLC

PROJECT NO.: 192065A
DATE: SEPTEMBER 2017

WSP USA

WSP.COM

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1 INTRODUCTION

1.1 PURPOSE

Buckeye Terminals, LCC (Buckeye) is applying for a permit to install and operate five non-commercial Class I nonhazardous injection wells for the disposal of salt water brine associated with the creation of storage caverns and the operation of the Woodhaven Terminal in Woodhaven, MI. The brine disposal wells will be operated under the United States Environmental Protection Agency (EPA) Underground Injection Control (UIC) program and follow federal rules and regulations as defined in 40 CFR 146.

The requirements of 40 CFR Section 146.13(b)(1) specify that any operator of a Class I underground injection well monitor and analyze the fluids injected into the well such that:

> *"The analysis of the injected fluids {shall be monitored} with sufficient frequency to yield representative data of their characteristics."*

Additionally, 40 CFR Section 146.68(a)(1) specifies that:

> *"The owner or operator shall develop and follow an approved written waste analysis plan that describes the procedures to be carried out to obtain a detailed chemical and physical analysis of a representative sample of the waste, including the quality assurance procedures used."*

This Waste Analysis Plan (WAP) fulfills the applicable requirements of the permit application process as stated in various 40 CFR sections. This document was prepared following guidance as illustrated in the EPA Region 5 UIC Section Regional Guidance #8 issued January 21, 1994, entitled *Preparing a Waste Analysis Plan at Class I Injection Well Facilities*.

1.2 WASTE DESCRIPTION AND GENERATION

Anticipated wastewater consists of brine associated with the solution mining of salt caverns utilized to store liquefied petroleum gas (LPG). The wastewater will be non-hazardous. Values of the expected wastestream, based on typical characteristics of solution mining wastewater, are shown in Table 1-1.

Should Buckeye decide to change the chemical and/or physical characteristics to operate commercial wells, they will submit a minor permit modification request to EPA summarizing information for each new proposed waste source for approval prior to acceptance. EPA will review pre-approval waste characterization data and approve waste sources on a case-by-case basis, assigning specific analytical requirements and frequencies for subsequent sampling and testing. As a commercial operation, Buckeye would maintain a listing of all approved Class I waste sources and Class II produced brine sources. Buckeye would require any off-site waste generator to certify the non-hazardous nature of each waste stream proposed for shipment to the disposal well site.

1.3 WASTE STORAGE, TRANSPORTATION AND DISPOSAL

The wastewater generated will be filtered prior to the injection pumping system and the injection wells.

A summary of recorded data will be provided per applicable permit requirements. Daily volumes will be recorded and the total monthly volume will be calculated based on the data maintained in site records. Total monthly volume will be provided in monthly well reports.

1.4 OPERATING DATA

Estimated average injection rate while in operation: 165 gallons per minute (gpm) for each well. Estimated injection pressures while in operation: 800-1180 pounds per square inch gauge (psig).

Table 1-1 Estimated Wastestream Chemical and Physical Characteristics

PARAMETER	UNITS	READING
pH		7.24
Resistivity	ohm-meter	0.046
Temperature	°F	70
ANIONS		
Chlorides	mg/L	193,000
Sulfates	mg/L	2,989
Sulfides	mg/L	ND < 1
Carbonates	mg/L	ND < 10
Bicarbonates	mg/L	150
CATIONS		
Sodium	mg/L	112,500
Calcium	mg/L	1,940
Magnesium	mg/L	199
Barium	mg/L	ND < 1
Iron (total)	mg/L	ND < 1

1.5 EXTERNAL TRANSPORT AND DISPOSAL PROCEDURES

Buckeye does not anticipate any wastewater leaving the property. Wastewater will be disposed of in the injection wells or the brine pond. In the event of well failure, wastewater will be diverted from the cavern well, via pipeline, to an alternate on-site injection well or the onsite brine pond. If, for some reason, the alternate locations are unavalabe for disposal, the facility will discontinue fresh water injection into the caverns to stop the generation of waste until the injection well is repaired or the brine pond is available.

1.6 PROJECT RESPONSIBILITY

Buckeye's Terminal Manager will have the primary responsibility to ensure all WAP conditions are met. The Terminal Manager and Environmental Engineer are responsible for coordination and selection of the subcontracted laboratory used to support the analyses associated with this WAP.

A Michigan Department of Environmental Quality qualified laboratory will be performing the analytical requirements of the WAP. It is the primary responsibility of the laboratory to ensure that all of the laboratory quality assurance (QA) functions are fulfilled.

2 SAMPLING ACTIVITIES

The following parameters will be analyzed for one or more of the following reasons:

- required to show that the waste is characteristically non-hazardous per 40 CFR 261
- required per the EPA Region 5 guidance document
- required for optimal injection well system performance

2.1 SAMPLING PARAMETERS

Table 2-1 summarizes the proposed sampling parameters, analytical methods, and sampling frequency. For quality control purposes, field duplicate samples will be collected, at a minimum annually, in an effort to document the effectiveness of the sample techniques and the analytical system. Four hazardous characteristics: (1) corrosivity, (2) reactivity, (3) ignitability, and (4) toxicity will be tested on a monthly basis to demonstrate that no characteristically hazardous waste is present in the wastestream.

Table 2-1 Sampling Parameters for Buckeye Woodhaven Terminal Injection System

PARAMETER	METHOD	SAMPLING FREQUENCY
pH	EPA 150.1	Daily
Eh	EPA 120.1	Daily
Specific Conductance		Daily
Specific Gravity		Daily
Temperature		Daily
Total Dissolved Solids (TDS)	EPA 160.1	Monthly
Total Organic Carbon (TOC)	SW846-9060	Monthly
Cations Sodium Potassium	 EPA 273.1 EPA 258.1	Monthly
Calcium	215.1	Monthly
Magnesium	EPA 242.2	Monthly
Barium	EPA 208.1	Monthly
Iron (total)	EPA 236.1	Monthly
Anions Chlorides Sulfates Carbonates Bicarbonates Sulfides	 SM4500B EPA 375.4 EPA 310.1 EPA 310.1 EPA 376.2	Monthly

2.2 SAMPLING FREQUENCY JUSTIFICATION

The sampling frequency presented in this WAP was based on process knowledge of the operational conditions and anticipated waste stream. As the waste stream is non-hazardous, the sampling frequency proposed is a reasonable monitor of the waste stream. The frequency specified will provide the necessary monitoring to insure identification of any potential fluctuations in the stream. Additionally, this WAP allows for supplemental, or modified, sampling when system anomalies are suspected.

2.3 SAMPLING LOCATION

Buckeye has identified a primary sampling location from which wastewater injectate will be collected. The primary sampling point, a manual spigot proposed to be located at the discharge point of the final filtration unit, will be used for specified sampling events. This spigot will be located on the wastewater main discharge line, such that no other piping is connected to the main prior to the wellhead.

2.4 SAMPLING PROTOCOL

The sampling protocols include the collection of operational data at the wellhead and the collection of samples at the appropriate sample points.

2.4.1 SAMPLING PROTOCOL (ANALYTICAL)

The sample will be obtained at the primary sample point by carefully opening the spigot valve to allow the sample to flush to the local sump drain for one minute. After the flush period, appropriate sample containers will be filled with the final filtered wastewater (annually, a second set of containers will be filled as a field duplicate).

Each sample container will be labeled with the:

- sample ID (Example: BDW-1 or post-treatment discharge)
- date of collection
- time of collection
- bottle sequence (example: 1 of 3)
- sampler initials

A Chain-of-Custody (COC) will be initiated that includes:

- sample ID (injection well)
- date of collection
- time of collection
- analyses to be performed
- pertinent sampling notes
- sampler signature

2.5 SAMPLING PERSONNEL

Only those individuals who are thoroughly familiar with the safety and operational characteristics of the injection well system and the requirements of this document will perform or assist in sampling. The sampling staff will possess site familiar training in the proper sampling protocols specified in this WAP. Additionally, they will possess site knowledge to perform the sampling tasks safely. Personnel will be primarily responsible for the operation, maintenance and corrective action documentation of the injection well system.

Sampling personnel will be primarily responsible for coordinating sampling activities with the lab, performing sampling as outlined in Section 2.4, preparing and completing all required sample labels and COC, and securing transportation of samples to the laboratory for analysis.

2.6 CHAIN-OF-CUSTODY

The following COC procedures have been developed to insure that all samples collected remain intact and representative, until all analytical procedures are conducted. These procedures include both field and laboratory custody requirements.

2.6.1 FIELD CUSTODY PROCEDURES

Sample containers are labeled as indicated in Section 2.4 immediately after collection. A COC is initiated in the field at the time of collection. After signature, the COC induplicate form is removed and retained by Buckeye terminal personnel. The samples and COC are sent by the field sampling technician to the chosen laboratory.

Upon receipt of the sample at the laboratory, the COC is signed as received by the sample custodian, the sample information is recorded in a computer log and the sample is released to the laboratory for testing.

2.6.2 LABORATORY CUSTODY PROCEDURES

The chosen laboratory will utilize strict procedures for sample custody. The QA/QC document in Appendix A illustrates sample guidelines. These guidelines are established to maintain the custody of samples in the laboratory and the legal validity of results generated. The sample custody procedure outlines the general procedures utilized in the processing of all samples received. The following is to be considered a minimum requirement. Once a qualified laboratory is chosen, specific details covering sample receipt, login, storage, internal sample transfer, storage, analysis, and disposal will be provided.

2.6.3 SAMPLE CUSTODY PROCEDURE

This procedure is designed to outline the general processes used to initiate and maintain sample custody for samples received at the laboratory. These procedures have been instituted to insure that proper sample custody has been established upon receipt and that this custody is maintained during the entire analytical process.

GENERAL PROCEDURE:

When a sample cooler is received, a sample login is immediately initiated. The cooler is inspected externally to determine if any obvious leakage has occurred. The cooler seals are broken and the COC is removed. The cooler contents are inspected for obvious damage or leaks. A thermometer is used to measure the temperature of the samples, and the receipt temperature is recorded on the COC. Upon completion of inspection, the COC is checked against the bottles received. The COC is reviewed and signed.

All samples received at the laboratory are logged into a computerized laboratory data management system, which assigns a unique laboratory sample number to each sample. Each container for a given sample is issued a unique container identification number.

Login personnel determine which analysis is required for a given sample from the information provided on the COC. The COC information is entered into the laboratory data management system.

The sample COC, check list, and any other shipping paperwork are placed into a project file, which is then given to the applicable laboratory project manager who verifies the receipt of the sample, COC information, and analyses logged into the database system.

Labels are generated for each sample container. These labels are durable, water resistant, and printed with indelible ink. The labels include the following information:

- sample number
- client name
- client sample ID
- date received
- date collected
- preservative
- required tests from that container

The sample number serves as the container identification number. Where multiple containers are received for a given container type, they are further identified with a container identification in the format of (1 of 3). This sample number and container number format provides a link between sample analysis and the container used.

Samples are placed in a cooler (maintained at approximately 4°C). Access to the cooler and samples are limited to the technical staff of the laboratory. Sample security is maintained through secured limited access areas.

2.7 BOTTLES AND PRESERVATIVES

All samples will be collected in appropriate laboratory supplied sample containers. Depending on the analysis involved, chemical preservatives may or may not be necessary. Samples will be transported on ice and stored refrigerated at 4 +/- 2 deg C.

2.8 SAMPLE TRANSPORT

All samples will be packaged in a cooler with sufficient ice and packing material. Caution will be taken during handling and transport of the samples to ensure that the sample containers are not damaged.

3 ANALYSIS INFORMATION

3.1 ANALYTICAL PROCEDURES

Analytical methods are listed in Section 2.1 of the WAP. It is understood that these are the base parameters, and circumstances may necessitate the need for additional testing. Detailed aspects of the analytical parameters, including typical lower quantitation limits, analytical method references, units of reporting, and holding times will be provided once a qualified laboratory is selected.

3.2 PARAMETER AND QUANTITATION LIMIT JUSTIFICATION

The parameters selected for analysis under the WAP are representative of those necessary to monitor and characterize the wastestream. These parameters are analyzed to determine compliance with the UIC permit, and to insure that the waste stream characteristics are consistent.

The parameters selected for analysis under this WAP are consistent with the requirements of the UIC permit. The provision for waste recharacterization, provided in this WAP, eliminates the need for additional routine analysis.

The quantitation limits reflect realistic levels of detection that can be reasonably reproduced to insure permit compliance, and to allow for the obvious effects of the sample matrix. These limits should be achievable for the analysis indicated, however, when not obtainable, adequate documentation for matrix interference will be provided.

3.3 WASTE RECHARACTERIZATION

In the event that a significant change is suspected or detected in the waste stream, a provision for waste recharacterization will be implemented. A sampling/resampling of the wastestream will be performed and analyzed for all parameters specified in Section 2.1. This sample will be drawn from the primary sampling point as described in Section 2.3.

4 QUALITY ASSURANCE/QUALITY CONTROL

4.1 FIELD QA/QC

The following general procedures will be followed by sampling personnel.

4.1.1 EQUIPMENT BLANKS

Samples for this WAP are drawn from a free flowing spigot, therefore all sampling equipment and containers are dedicated. Equipment blanks will not be required.

4.1.2 TRIP BLANKS

A trip blank will be prepared by the laboratory using preserved containers (as applicable) and filled with reagent grade water. The trip blank will follow the sample containers to the site and through the entire collection and transportation process.

4.1.3 FIELD DUPLICATES

Field duplicates are representative samples taken at the same time of normal sampling using similar sampling techniques. The field duplicates are identified in a generic fashion to limit laboratory knowledge of the sample source. Field duplicates will be analyzed for all parameters. Field duplicates will be analyzed at a frequency equivalent to at least one (1) per calendar year. Additional field duplicates may be required to investigate specific parameters or analytical processes.

4.2 LABORATORY QA/QC

This section presents the general QA/QC requirements applicable to the analysis of environmental samples, as well as the methods for assessing data quality. The purpose of the QA/QC program is to produce data of known quality that is legally defensible, satisfies applicable data quality objectives (DQOs), and meet or exceed the requirements of the WAP.

Performance of all analytical methods is monitored to assess the accuracy and precision of the procedure. Specific quality control checks are designed to provide the necessary information for method assignment.

The following general elements apply to the chemical analyses performed in the laboratory. Note that a specified laboratory QA/QC program will be provided once a qualified laboratory is selected.

4.2.1 ELEMENTS OF QUALITY CONTROL - CHEMICAL

A preparation batch is a group of samples that are carried through an applicable preparation technique (e.g. digestion, distillation, or extraction) at the same time using the same reagents and conditions. An analytical batch is a batch of samples that are analyzed using the same instrument and conditions within the same time period. The identity of each batch is unambiguously recorded as a unique (Batch ID) so that a reviewer can identify the QC samples associated with a group of samples. The type of QC samples that may be utilized and their use are identified below. Specifics regarding the requirements of these QC samples are detailed in the individual standard operating procedures.

4.2.2 CALIBRATION

Instruments and support equipment are calibrated in accordance with the referenced analytical methods. Details of calibration procedures are contained in the laboratory SOPs. For the analyses selected, all target analytes are included in the initial and continuing calibrations regardless of their need in a given environmental sample.

If the calibration acceptance criteria are not met, the operating curve may be narrowed either by eliminating the low point or high point of the curve (providing all project criteria are still met.) For multi-analyte calibrations, specific analytes may be eliminated from the low or high points. Otherwise, the entire calibration curve is repeated. Elimination of any of the inner levels of the calibration in order to meet QC acceptance criteria is allowed provided that all analytes are eliminated in that level and the required minimum number of calibrated levels remain.

4.2.3 SURROGATES (SURR)

Surrogates are used to evaluate accuracy, method performance, and extraction efficiency in organic procedures. Surrogates shall be added to environmental samples, quality control samples, and blanks.

4.2.4 INITIAL CALIBRATION VERIFICATION (ICV)

A second source standard containing all target analytes is analyzed after each initial curve, to verify the validity of the calibration. This standard must be from a separate source or lot number from that used for calibration. Unless specified in the reference method, the ICV is at a concentration near the midpoint of the calibration range.

If the acceptance criteria are not met for the ICV, corrective action steps will include the following. When deemed appropriate, the analyst may take lesser corrective action.

- perform corrective action (e.g. prepare new standard, rinse system, etc.)
- analyze another calibration verification. If acceptance criteria are not met in this second consecutive (immediate) calibration verification, then perform one of the following. Either,
- demonstrate performance after corrective action with two consecutive successful calibration verifications, or
- a new initial instrument calibration must be performed.

The acceptance criteria must be met before samples can be analyzed. However, sample data associated with unacceptable calibration verification may be reported if the verification indicates high bias and the samples indicate non-detectable concentration, or if the project DQOs are met and an appropriate qualifier is reported.

4.2.5 INITIAL CALIBRATION BLANK (ICB)

A reagent blank is analyzed after the ICV and prior to the analysis of environmental samples. A blank may also be analyzed after high concentration samples to demonstrate that carryover contamination does not exist.

Samples associated with an ICB indicating high bias may be reported if the samples indicate non-detectable concentration, or if the project DQOs are met and an appropriate qualifier is reported.

4.2.6 INTERFERENCE CHECK SAMPLE (ICS)

Interference check samples are used in inductively coupled plasma analyses to verify background and inter-element correction factors. Samples associated with an ICS indicating high bias may be reported if the samples indicate non-detectable concentration, or if the project DQOs are met and an appropriate qualifier is reported.

4.2.7 METHOD BLANK (MB)

The method blank goes through all applicable preparation steps and is used to document non-contamination of the entire analytical process. The MB is considered a batch control parameter. Samples associated with a MB indicating high bias are re-prepared and analyzed. The only exceptions are samples that indicate a non-detectable concentration despite the MB result, or where the project DQOs are met and an appropriate qualifier is reported.

4.2.8 LABORATORY CONTROL SAMPLE (LCS)

The LCS is prepared with analyte-free water or, where available, a purchased solid matrix spiked with representative analytes. The LCS shall be spiked with a second source standard at a level near or below the midpoint of the calibration curve for each analyte. This QC sample shall be carried through the entire preparatory and analytical procedure to document the accuracy of the entire analytical process.

The LCS is considered a batch control parameter. Samples associated with a LCS that fails to meet the acceptance criteria for recovery are re-prepared and analyzed. The only exceptions are samples that indicate a non-detectable concentration when the LCS indicates high bias, or where the project DQOs are met and an appropriate qualifier is reported.

4.2.9 MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

A matrix spike and matrix spike duplicate are separate aliquots of sample spiked with known concentrations of analyte using a second source standard. The spiking occurs prior to sample preparation and analysis. Samples used for the MS/MSD are chosen at random. This allows for the evaluation of all sample matrices over time. The MS and MSD shall be spiked at a level less than or equal to the midpoint of the calibration curve.

The MS/MSD are matrix-specific quality control samples and are used to assess the bias for accuracy and precision of a method in a given sample matrix. The MS/MSD accuracy recovery is not solely used to assess batch control.

Samples having an indigenous concentration greater than or equal to 4 times the spiked amount are considered not applicable for spike analysis at that level. Where the sample chosen for MS/MSD analysis is one of a group of samples submitted from a site with homogeneous character and the MS/MSD require that the sample is re-prepared and analyzed, all samples from that Sample Delivery Group should be re-analyzed under similar conditions. If the acceptance criteria are not met in two separately prepared analyses, the failure is considered matrix specific for that sample and the results yielding better recovery are reported with an appropriate qualifier.

4.2.10 DUPLICATE (DUP)

Applicable to analyses where MS/MSD are not, duplicate samples are analyzed using identical recovery techniques and treated in an identical manner. Duplicate sample results are used to assess the precision of the entire analytical process. Samples used for the DUP are chosen at random. This allows for the evaluation of all sample matrices over time.

The DUP is a matrix-specific quality control sample and is used to assess the bias of a method due to a given sample matrix. The DUP is not used to solely assess batch control. If the acceptance criteria (%RPD) are not met, the sample and its duplicate must be re-prepared and analyzed. Relative Percent Difference is calculated only where the two values are greater than or equal to 5 times the PQL. If the values are below 5 times the PQL, the acceptance criteria are " 1 PQL of each other.

Where the sample chosen for duplicate analysis is one of a group of samples submitted from a site with homogeneous character and the DUP requires that the sample is re-prepared and analyzed, all samples from that Sample Delivery Group should be re-analyzed under similar conditions. If the acceptance criteria are not met in two separately prepared analyses, the failure is considered matrix specific for that sample and the results yielding better recovery are reported with an appropriate qualifier.

4.2.11 POST-DIGESTION SPIKES (PDS)

A PDS is applicable only to digested metals analyses and those general chemistry (wet chemistry) analyses that include a preparation step (e.g. cyanide, nitrogen - ammonia, and phenolics). A post-digestion spike may be analyzed to assist in the assessment of matrix interference when the MS and MSD fail to meet the accuracy acceptance criteria. In addition, a PDS can be used as a troubleshooting tool. The spiking solution is added to a sample aliquot just prior to analysis thereby evaluating the matrix effect on the analysis process only and not the preparation portion. Samples having an indigenous concentration greater than or equal to 4 times the spiked amount are considered not applicable for spike analysis at that level.

If the MS/MDS fail to meet the accuracy acceptance criteria and the PDS is within the acceptance criteria, matrix interference should be suspected. If the MS/MSD and PDS fail to meet the accuracy acceptance criteria, matrix interference is probable and the sample, MS/MSD, and PDS should be reprepared and analyzed. A smaller sample size should be considered as means to negate the apparent matrix interference.

4.2.12 SERIAL DILUTION (SD)

As a troubleshooting tool, it may be necessary to analyze a serial dilution of a sample. The results of a 1:5 serial dilution should agree with each other within 5% (unless stated otherwise in the reference method). These criteria are for evaluating the matrix effect in a new or unusual matrix and not for comparing results for a sample diluted because it was above the calibration range of the instrument.

4.2.13 CONTINUING CALIBRATION VERIFICATION (CCV)

A second source standard containing all target analytes is analyzed to verify that the calibration curve remains valid. This standard must be from a separate source or lot number from that used for calibration. Unless specified in the reference method, the ICV is at a concentration equivalent to the midpoint of the calibration range.

If the acceptance criteria are not met for the CCV corrective action steps include the following. When deemed appropriate, the analyst may take lesser corrective action.

- perform corrective action (e.g. prepare new standard, rinse system, etc.)
- analyze another calibration verification. If acceptance criteria are not met in this second consecutive (immediate) calibration verification, then perform one of the following. Either,
- demonstrate performance after corrective action with two consecutive successful calibration verifications, or
- a new initial instrument calibration must be performed.

Sample data associated with unacceptable calibration verification may be reported if the verification indicates high bias and the samples indicate non-detectable concentration, or if the project DQOs are met and an appropriate qualifier is reported.

4.2.14 CONTINUING CALIBRATION BLANK (CCB)

A reagent blank is analyzed after the CCV. A blank may also be analyzed after high concentration samples to demonstrate that carryover contamination does not exist.

Samples associated with a CCB indicating high bias may be reported if the samples indicate non-detectable concentration, or if the project DQOs are met and an appropriate qualifier is reported.

4.2.15 CONTROL CHARTS/TABULATIONS

Control chart-type data are retained by the laboratory for all quality control sample types. Where allowed by the reference method, laboratory generated acceptance limits may be statistically prepared for Surrogate recovery, LCS recovery, MS recovery for accuracy, and MSD/DUP recovery for precision. Statistical outliers are removed and a minimum of the 50 most recent data points is used to update the limits. When used, lab generated acceptance limits are updated on a minimum annual basis. Control limits are established at the average plus-and-minus three standard deviations (X " 30 n-1) unless otherwise required in the reference method.

4.2.16 SUBSAMPLING

When removing a portion of an environmental sample, appropriate care and technique is used in order to obtain a representative sub-sample. For water samples this includes thoroughly shaking the sample container in order to mix any solids. It is appropriate to shake filtered groundwater samples as any particulate in the filtrate is from the original sample. For solid and semi-solid samples this includes stirring the sample in order to homogenize any stratified layers within the sample container. These techniques do not apply to removing an aliquot for the analysis of total organic halides (TOX), or total organic carbon (TOC).

4.2.17 SAMPLE CONTAINERS

Most containers are purchased certified clean from a commercial vendor. These containers are ready for use and require no additional monitoring prior to use. Containers that are purchased without certification will be verified clean prior to shipment.

4.3 CALIBRATION PROCEDURES - LABORATORY ANALYSES

All analytical calibration procedures utilized at the laboratory have been developed to meet or exceed the requirements specified in SW-846, (current) edition, and EPA 600/4-79/020. These procedures are strictly adhered to at all times.

4.3.1 ACCURACY AND TRACEABILITY OF CALIBRATION STANDARDS

All standards and reagents are tracked from their initial preparation through their use in the preparation and analytical batches. Standards purchased from an outside vendor are, where available, traceable to the National Institute of Standards Technology (NIST). A Certificate of Analysis, or similar document of traceability, is kept in the appropriate standards preparation log. Purchased standards may be used at their prepared and labeled concentration without further verification.

Standards preparation and reagent preparation logbooks are maintained throughout the laboratory. Each logbook is labeled with the laboratory name, unique name/purpose of the logbook, logbook number, the Astart date@ and the Aend date.@

Each stock standard, subsequent dilution, and prepared reagent is given a unique tracking number. When preparing dilutions of a standard the following information is included in the standards log:

- standard source lot number
- standard name
- expiration date
- initials of the preparer
- date prepared
- detailed information of the volume/mass used
- final volume prepared

— diluent
— prepared concentration

The expiration date of a prepared standard is that date on which the stock solution expires. In mixes where there is more than one expiration date for the stock solutions, the earliest date is chosen as the expiration date for the entire mix. Each container is labeled with standard or reagent name, concentration, tracking number, and the expiration date. Containers too small for a label with the required information are labeled with a minimum of the logbook reference number and expiration date. Expired standards are discarded and are not used for the generation of analytical data. Standards are prepared using glassware and delivering devices of known and acceptable accuracy.

4.4 DATA REDUCTION, REVIEW, REPORTING - FIELD ANALYSES

Data reduction for field analyses involves the direct recording of values from various meters and instruments. All results generated from field analyses consist of values read directly from continuous monitoring meters. Therefore, no calculations are required in producing the final reported results.

All field analysis raw data is reviewed by Buckeye personnel for accuracy and completeness. Particular attention is paid to the maximum and minimum values recorded, as these values are compared to permit limits for compliance purposes.

4.5 DATA REDUCTION, REVIEW, REPORTING - LABORATORY DATA

Data reduction involves the handling of raw sample data including, but not limited to, detector response, electrode potential readings, titrant volumes, and gravimetric measurements to achieve final sample concentrations. Automated systems are used for calculation and reduction wherever feasible.

4.5.1 DATA REVIEW

A two-tier technical review of all data is performed and documented.

1ST LEVEL TECHNICAL REVIEW

The laboratory technician performing an analysis reviews all of their own data and is responsible for ensuring that the calculations were properly performed and the quality control requirements were met. A data review checklist is initiated by the technician to document this review. The data review checklist is then given to a peer knowledgeable with the current requirements of that analytical procedure, a senior technician, unit supervisor, or the QA/QC director.

2ND LEVEL TECHNICAL REVIEW

A peer, senior technician, unit supervisor, or the QA/QC director reviews the data by repeating the verification performed by the laboratory technician. This step is documented through use of the data review checklist.

Acceptable data is then available for review in the laboratory data management system. This is performed through the AQA Validation© function of the database. Anyone able to perform the 1st Level or 2nd Level Technical review can Avalidate© the data in the database. This step approves the data for release.

4.5.2 PROJECT MANAGER REVIEW

Before the data is released , a project manager will review all final reports for consistency and completeness to ensure that the data meet the overall data quality objectives of the project. This review is intended to verify that those analyses requested on the COC have been performed, the sample information is accurate, and the appropriate data qualifiers have been added.

4.5.3 QUALITY ASSURANCE REVIEW

In addition to the tiered review process, the quality assurance department will periodically perform data audits. These audits, required as part of the laboratory quality systems audit program, can be performed for the generation of reports that include quality control data, and as a troubleshooting measure. Batches that are reviewed are chosen on random basis and recreate the calculations of all samples in a given batch.

4.5.4 REPORTING

For each sampling event/sample delivery group, the laboratory will prepare an analytical report. The analytical report, accompanied by a cover letter will generally contain the following elements.

- Laboratory name, address, and phone number
- Title of Analytical Results
- Date reported
- Client name (with address on the cover letter)
- Client project ID
- Work Order and Sample Number
- Client sample identification and description
- Client defined matrix
- Collection date and received date
- Analyte
- Result (at client requested reporting limits and units)
- Reporting limit
- Units
- Applicable data qualifiers and dilution factor
- Date of analysis
- Analytical method reference
- Date of sample preparation
- Analyst initials
- Page numbering

The original chain-of-custody form and the login checklist will be returned with each report. Any deviations from the requirements of the laboratory sample acceptance policy will be noted in the final report on either the cover letter or the login checklist.

REPORT ARCHIVE

Analytical reports generated as part of the injection well waste analysis sampling will be archived by the laboratory. Individual reports will be maintained in the work order file organized by work order number. In addition to the final report archive, the chosen laboratory will maintain a complete Data Level IV QC data package for each sampling event associated

with this Waste Analysis Plan. The QC documentation will be maintained by the laboratory and made available to Buckeye upon request.

4.6 INTERNAL LABORATORY AUDITS

The purpose of auditing is to identify whether the lab is generating scientifically sound and defensible data, and that daily operating systems meet the requirements of this quality assurance plan. It is the responsibility of the laboratory QA Director to perform periodic performance audits and system audits.

4.6.1 PERFORMANCE AUDITS

Performance audits are conducted periodically throughout the year. Performance audits include proficiency testing samples and detailed data reviews. Findings from these audits are used to evaluate the defensibility and data quality produced by the analytical system. Randomly selected samples from various test methods are evaluated in this process. Deficiencies from these audits are discussed with the analyst. Copies of the reports from these audits are forwarded to the unit supervisors and summarized for upper management in the annual system audit report.

4.6.2 SYSTEM AUDITS

A systems audit is performed on a minimum annual basis. The systems audit is a comprehensive review of the overall quality and measurement system. The purpose of these audits is to confirm compliance with the requirements of the Quality Assurance Plan, and to assess the applicability of the quality system to other certification and regulatory programs. Systems audits identify the presence of the necessary organization, facility, and quality systems needed to provide evidence of the laboratory=s capability and competence. Copies of the reports from these audits are forwarded to upper management.

4.7 LABORATORY CORRECTIVE ACTION PROCEDURES

Corrective action is necessary whenever deviations from requirements of the quality system occur. System corrective action is described in this section.

4.7.1 SYSTEM CORRECTIVE ACTION

The QA department typically initiates corrective action. This type of action is usually initiated due to poor performance audit results, poor system audit results, or unacceptable results on performance testing samples. Either the unit supervisor or their designee is responsible for investigating the problem and determining the corrective action needed. When the source of the problem has been identified and corrective action suggested, a written record is completed, evaluated and, if appropriate, approved by the unit supervisor and QA department. Documentation of each corrective action is kept on file. The forms used are numbered and monitored by the QA department to ensure that out of control events and actions are documented, and that the corrective actions are appropriate, effective, and complete.

Regardless of the source or projected impact on the system failure, the following systematic approach is used in developing a suitable corrective action. The emphasis of the corrective action is to prevent the problem from reoccurring.

- Define the problem
- Establish the root cause of the problem
- Determine the needed action to resolve the problem and eliminate the root cause
- Assign responsibility for implementing corrective action
- Verify the corrective action has been implemented and has eliminated the problem

5 SAFETY

5.1 SAFETY GUIDELINES

Sampling activities at the Buckeye Woodhaven terminal will be conducted with the proper personal protective equipment (PPE). Sampling activity will generally be conducted using Level D PPE. The following is a list of specific items to be used by field personnel as defined by Safety Level D:

- Hard Hat
- Safety Glasses with side shields
- Safety shoes
- Heavy work clothes covering legs, shoulders and arms
- Safety gloves appropriate for sampling activities

Caution must be exercised at all times when performing sampling activities. In and around the area of the injection well system various mechanical hazards exist.

APPENDIX

A SAMPLE GUIDELINES

TRACE ANALYTICAL LABORATORIES, INC.

2241 Black Creek Road, Muskegon, Michigan 49444-2673

LABORATORY OPERATIONS AND QUALITY ASSURANCE MANUAL

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(231) 773-5998, extension 237
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Major Organizational Units Covered by this Manual:

- ***Sample Receiving Department***
- ***Organics Laboratory***
- ***Metals Laboratory***
- ***Wet Chemistry Laboratory***
- ***Extractions Laboratory***
- ***Mobile Laboratory***
- ***Reporting and Record Keeping Department***

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Appendix I: Resumes of Key Personnel

Appendix II: Sample Containers and Preservatives

Appendix III: Method and Reference Source

Appendix IV: Major Equipment List

Appendix V: Laboratory Layout

Appendix VI: Laboratory Organizational Chart

Appendix VII: List of methods under which Trace performs NELAC accredited analyses

Mission Statement

TRACE Analytical Laboratories, Inc. believes that providing accurate, timely and cost effective analytical data is the most important service that we as an organization can provide our clients. Working in partnerships, TRACE Analytical Laboratories, Inc. strives to serve our clients to the best of our abilities and provide a healthy, safe and productive work environment for our team members.

To that end, it shall be the purpose of TRACE Analytical Laboratories to implement internal programs, procedures, and policies that strengthen, augment and develop a sound environmental laboratory and meet the requirements outlined in the TNI Standard, the ISO/IEC 17025:2005 International Standard, the Department of Defense Quality Systems Manual, and guidelines developed by both regulatory agencies and private industries.

Disclaimer

The mention of trade names, commercial products or suppliers in this manual does not constitute any endorsement or recommendation for use by TRACE Analytical Laboratories, Inc.

Administrative Approval

TRACE ANALYTICAL LABORATORIES, INC.

Laboratory Operations and Quality Assurance Manual

Effective Date: 5-28-14

Concurrences and Approvals:

Name: Gina Roe
Title: Laboratory Manager
Signature:

Name: Alyson Yagiela
Title: QA/QC Manager
Signature:

Statement of Qualifications

OVERVIEW

TRACE Analytical Laboratories, Inc. (Trace) was founded in 1989. TRACE is a Veteran Owned Small Business full service environmental laboratory, providing a complete range of environmental analyses and sampling services for our clients. These services include organic and inorganic analyses of water, soil, air, and hazardous waste. All of our routine services conform to strict methodologies. These methods come from sources such as the US EPA, ASTM, AOAC, NIOSH, and Standard Methods.

TRACE has state-of-the-art analytical instrumentation using proven technology. Part of the Quality Assurance (QA) Program is obtaining, maintaining, and calibrating equipment and instrumentation that is required to accurately and efficiently carry out analysis of samples as prescribed in analytical test methods. TRACE purchases or prepares appropriate reagents and standards for analyses. Whenever possible these reagents and standards will be American Chemical Society (ACS) grade, spectroquality, or traceable to NIST standards. TRACE collects and receives samples under strict chain-of-custody procedures and adheres to proper sample collection and preservation techniques. The main goal of this QA Program is to provide our clients with the highest quality analytical results.

TRACE has substantial experience with servicing the analytical needs of clients in private industry, environmental consulting, federal agencies, and both state and local governmental units and is an entity that can be held legally responsible. Our laboratory continually supports regulatory programs like CERCLA/SARA, RCRA, Clean Air Act, Safe Drinking Water Act, NPDES and the Clean Water Act. TRACE is accredited in accordance with the National Environmental Laboratory Accreditation Program (NELAP)/TNI (The NELAC Institute), the Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), and ISO/IEC 17025:2005. TRACE is also a Contract Laboratory for the Michigan Department of Environmental Quality and is certified by the State of Michigan for Drinking Water analysis.

TRACE's Project Managers work closely with their clients and laboratory personnel to ensure all details and project specifications are accurately performed. The Project Managers can assist in project planning, including the preparation of Quality Assurance Project Plans (QAPPs). Working with clients at the onset of a project assures the results are more conclusive and cost-effective.

TRACE is comprised of experienced professionals with degrees in chemistry, biology, and environmental science. Our team has specialized training in laboratory operations and experience in the industrial workplace. Their expertise guarantees our clients the range and depth of scientific disciplines, technical specialties, practical experience, and analytical services needed to meet the objectives of today's complex industrial and environmental demands.

Professional resumes for TRACE's key personnel are included in Appendix I.

Laboratory Identification

EPA Laboratory ID:	MI00106
DoD-ELAP Accreditation Number:	1031
New Jersey NELAP Certification ID Number:	MI008
State Of Michigan Laboratory ID:	8001

Please contact the QA/QC Manager at Trace for current versions of certifications.

How to Contact Trace

Mailing Address:

TRACE Analytical Laboratories, Inc.
2241 Black Creek Road
Muskegon, MI 49444-2673

When sending requests for quotation through regular mail, please add 'Quotation Request' to the address listed above.

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Web Site:	www.trace-labs.com
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SECTION 1: Introduction

Purpose:

The purpose of this manual is to document the Laboratory Operations and Quality Assurance (QA) Program employed by TRACE.

A well-defined system of quality control practices is an important part of providing quality data for our clients. The data produced by TRACE are well defined and defensible.

This manual, with the practices and policies contained in it, are not to be viewed as all-inclusive. Rather, they are to be used as a foundation by TRACE to build upon. The underlying principal for quality assurance is one of continued process improvement of laboratory operations.

The management of TRACE is committed to the continual improvement of its Laboratory Operations and QA Program. While it is the responsibility of the management to put these programs and policies into effect, it is also the responsibility of the entire TRACE team to follow these programs and policies and to make suggestions for the improvement of these programs.

This manual is intended to assist our clients with basic information of laboratory operations. It is also intended to be a resource for our clients so that their projects requiring analytical services will be built upon a strong foundation of quality.

Safety:

Safety is a primary focus at TRACE.

Safety takes precedence over all other laboratory operations.

The management at TRACE provides a safe working environment for its staff. TRACE staff includes individuals who are trained as Hazardous Materials Specialists. In addition, several staff members have first aid training to assist with health and safety issues.

A health and safety session is a required part of new employee orientation. As part of their training, employees are introduced to the specialized health and safety procedures in our Standard Operating Procedures (SOPs). As part of the OSHA 'Worker-Right-To-Know' Act, TRACE maintains an inventory of the chemicals, reagents, acids and solvents used in the course of its operations. Maintained with this inventory are the Material Safety Data Sheets (MSDS) for these materials. These references are available for use by the staff. Should a client have need for information on a particular material, TRACE can provide the information upon request. TRACE also maintains a library of reference materials to assist with this part of the health and safety program.

TRACE provides safety devices such as protective gloves, laboratory coats, eye protection and first aid stations for its staff.

Each individual must also be responsible for his or her health and safety. They must also be aware of others who may be impacted by their actions. If they are unsure about the potential hazard to themselves and/or others, they must ask their Area Manager for assistance.

TRACE will work with our clients to ensure that the laboratory will do what is practicable to assure the safety of materials sent by the laboratory to its clients. Further, TRACE will seek to determine if a client's project poses a health and safety risk and will work with that client to minimize that risk.

Specific safety issues for the laboratory are addressed in general terms in this manual by laboratory area and in the laboratory safety manual. Analytical and field sampling SOPs also have more specific information on safety concerns for specific procedures.

Data Integrity:

Data integrity is a primary focus at TRACE.

Integrity is defined as 'the state of being unimpaired' as well as 'the adherence to moral and ethical principles'.

Data integrity depends on the ability to define and defend the entire analytical process and to prove that the data has been 'unimpaired' and analysis has been performed in accordance with the appropriate procedures and practices.

The ability to define and defend the entire analytical process and the integrity of the data that are produced is dependent upon the documentation of activities and actions. This manual will explain the documentation procedures employed by TRACE in order to produce data that is 'unimpaired.'

This documentation starts with project initiation by the client, project activities by the client and TRACE, and post project activities by TRACE.

All TRACE laboratory employees undergo data integrity training during initial orientation and on an annual basis and must sign that they have attended and understand TRACE's Data Integrity Policy. This training places an emphasis on proper documentation. TRACE's management reviews the data integrity policy annually and it is revised as necessary. It is important for all TRACE employees to understand that while TRACE's goal is to provide the highest quality of data, there are instances where data may be partially deficient and still useful to the client. Employee concerns regarding data integrity may be brought to the attention of either the Laboratory Manager or the QA/QC Manager in confidence. All investigations of data integrity issues will be kept confidential until they are completed and fully documented. The Laboratory Manager monitors data integrity as part of routine data review. Management will document and notify clients immediately if any issues arise that may have impacted client data.

This manual is designed to assist both our clients and TRACE personnel in the production of high quality data, which is usable and defensible.

Ethics:

It is the policy of Trace to provide accurate and reliable data in accordance with client and regulatory requirements. It is against Trace policy to improperly manipulate or falsify data or to engage in any other unethical conduct.

Any employee who knowingly manipulates and/or falsifies data or documents, or engages in any unethical conduct is subject to immediate release from employment.

Employees will be informed of their data integrity and ethics responsibilities at the time of hire and annually thereafter. Employees will be required to sign an Ethics and Data Integrity Agreement stating that they understand the Ethics and Data Integrity Policy and their responsibilities as a TRACE employee.

SECTION 2: Quality Policy Statement and Objectives

Quality Policy Statement:

TRACE is a full service, independent, commercial testing laboratory that is accredited in accordance with the National Environmental Laboratory Accreditation Program (NELAP), the Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), and ISO/IEC 17025:2005. TRACE provides analytical services to residential, industrial, engineering, and consulting clients, as well as local, state, and federal agencies, including the Department of Defense. Trace is a Contract Laboratory for the Michigan Department of Natural Resources and Environment, and is Drinking Water Certified by the State of Michigan.

TRACE was established in 1989 to specialize in environmental testing, particularly the analysis of water, wastewater, soil, drinking water, air, and hazardous waste. TRACE management is committed to good professional practice and continual improvement while providing quality analytical testing to its clients.

Any sample collected by, or submitted to, Trace for analysis may have significant implications to the environment or the health and safety of individuals. The importance of this information is such that it may be considered as court evidence or as the basis for conducting environmental remediation.

Therefore, it is the objective of Trace to follow a strict QA Program to maintain the reliability and defensibility of all generated data. TRACE management is committed to ensuring compliance with the standards set forth by their accrediting bodies, including TNI (The NELAC Institute) Standard and The DoD Quality Systems Manual for Environmental Laboratories. This document is provided to serve as a framework for fulfilling that objective.

TRACE recognizes that a good QA Program is not static but must be revised as new ideas and procedures become available. Above all, this document must serve as a reference to our employees to describe quality procedures and practices that must be followed during day-to-day operations. Management continually works to ensure that all personnel understand the importance of their work and how it contributes overall to the quality objectives set forth by management.

This QA Manual is made available upon request. However, to maintain the dynamic nature of the QA Program at TRACE, portions of this manual may change without client notification.

Quality Objectives:

- Obtain and maintain certifications and accreditations to demonstrate laboratory competence and allow tests covered by these programs to be performed.

- Maintain an organization of qualified and trained personnel who are knowledgeable in and follow the procedures and policies stated in the QA Program.

- Maintain adequate facilities (site and instrumentation) to allow personnel to perform accurate and valid chemical tests in a safe environment, and take appropriate precautions when tests are performed at sites other than the permanent laboratory.

- Ensure that personnel are not influenced or pressured by internal or external entities to the point that it may affect the quality of their work.

- Obtain, maintain, and calibrate equipment and instrumentation required to accurately and efficiently carry out chemical tests as prescribed in test methods.

- Collect and receive samples under strict chain-of-custody procedures and adhere to proper sample collection and preservation techniques.

- Ensure that the client's confidential information and proprietary rights are protected during sample receipt, analysis, reporting, data storage, and sample disposal.

- Ensure that personnel are not involved in conflicts of interest or other activities that may diminish client confidence in our competence, impartiality, judgment or integrity.

- Purchase, use, or prepare appropriate reagents and standards. When possible these will be ACS grade, spectroquality, or traceable to NIST standards.

- Use, adapt, or develop "rugged" analytical methods. Whenever available, EPA, ASTM, AOAC, NIOSH, Standard Methods or other recognized and accepted methods will be used.

- Establish levels for quality of laboratory data (accuracy and precision) whenever these are not specified by the analytical methods or a regulatory body.

- Maintain clear, complete and accurate records of all laboratory data and issue accurate reports thereof to clients.

- Perform quality control checks on instruments, methods and analysts to rapidly detect errors and prevent recurrence of errors. This will be accomplished through use of standards, blanks, replicated and spiked samples to check accuracy, precision, and matrix effects.

- Corrective actions will be taken and documented whenever a process is outside of the specified control limits.

- Monitor competence of personnel and adequacy of the Quality Control (QC) Program through intra-laboratory and inter-laboratory efforts.

- Maintain a complete, up-to-date QA Manual that describes the QA Program in sufficient detail to ensure that all personnel have a clear understanding of their responsibilities within the QA Program.

- Make the QA Manual available and adhered to by all employees. The manual will be available to laboratory auditors and clients upon request.

- Ensure that laboratory practices are in agreement with the contents of the QA Program as stated in the manual.

- Audit the QA Program periodically to assure compliance. Audits will consist of system audits, data audits, and performance evaluation samples.

- When work is subcontracted to other laboratories, be responsible to the client for the subcontractor's work. Subcontract laboratories used for Department of Defense work must have an established and documented laboratory quality system that complies with DoD ELAP requirements, and must get project-specific approval by the specific DoD Component before any samples are analyzed.

SECTION 3: Organization and Responsibilities of Quality Control Staff

Statement of Purpose:

It is the policy of management that the assurance of analytical quality is the responsibility of all TRACE employees. TRACE Management is committed to good professional practice and the quality of testing performed for our customers. We believe that the production of accurate analytical data is the most important service we can offer to our clients. To that end, the following job descriptions and associated responsibilities are included in the TRACE QA Program.

President:

The President is responsible for the overall management of the company. The duties of the President encompass tasks necessary to ensure production control, financial management, product quality, sales and marketing success, and administrative support functions. The President shall have overall authority in the management of the QA Program and will make sure that all aspects of the program comply with current and appropriate regulatory requirements, methodologies, and protocols. The President will have absolute authority to make any additions, deletions, or changes to the program as deemed necessary.

Senior Vice President:

The Senior Vice President is responsible for the overall management of the company in conjunction with the President. Ultimate decisions about financial and personnel matters are a primary function. In addition, the Senior Vice President is available to the staff as a technical advisor and chemical consultant.

Laboratory Manager:

The Laboratory Manager shall oversee all aspects of laboratory operations. The Laboratory Manager shall work with the QA/QC Manager to insure that analysts and technicians follow current and appropriate regulatory requirements, methodologies, protocols, and compliance with the TNI Standard and the DoD QSM.

If the Laboratory Manager is absent for a period of time exceeding 15 consecutive calendar days he/she shall designate another full-time staff member meeting the qualifications of the Laboratory Manager to temporarily perform this function. If this absence exceeds 35 consecutive calendar days, the primary TNI accrediting authority must be notified in writing. If this absence exceeds 65 consecutive calendar days, the DoD-ELAP accrediting authority must be notified in writing. TRACE requires that the Laboratory Manager possess a Bachelor's degree and recommends that they have relevant laboratory experience.

QA/QC Manager:

The QA/QC Manager will make sure that all aspects of the program comply with current and appropriate regulatory requirements, methodologies, and protocols. The QA/QC Manager will coordinate and manage the QA Program on a daily basis. The QA/QC Manager must have functions independent from laboratory operations for which he/she has QA/QC oversight and must be able to evaluate the data objectively and perform assessments without outside influence. He/she shall ensure compliance with the TNI standard and the DoD QSM. The QA/QC Manager shall keep members of the quality assurance group informed on issues relating to the laboratory QA Program. The QA/QC Manager reports to the company President.

Laboratory management must appoint a deputy QA/QC Manager in the absence of the QA/QC Manager, to perform this function. TRACE requires that the QA/QC Manager possess a Bachelor's degree, must have a general knowledge of the methods for which any data review is performed, and recommends that they have relevant experience.

Laboratory Area Managers, Analysts, and Technicians:

All analysts and technicians are responsible to prepare and analyze the required quality control samples. Upon completion of each test, the laboratory area managers will compare results to the quality control limits that have been established for that test. TRACE recommends that all technicians possess a high school diploma and that analysts have completed at least 2 years of higher education.

Laboratory Area Managers, Laboratory Manager, and QA/QC Manager will ensure that all analytical and operational activities of the laboratory are properly documented.

Laboratory Area Managers and the Laboratory Manager are responsible for the supervision of the personnel in their respective departments and documentation of the quality of all data reported from their respective departments.

If a Laboratory Area Manager is absent for a period of time exceeding 15 consecutive calendar days he/she shall designate another full-time staff member meeting the qualifications of the Laboratory Area Manager to temporarily perform this function. If this absence exceeds 35 consecutive calendar days, the primary TNI accrediting authority must be notified in writing. If this absence exceeds 65 consecutive calendar days, the DoD-ELAP accrediting authority must be notified in writing. TRACE recommends that any Laboratory Area Manager possess a Bachelor's degree and requires that they are experienced in the fields of accreditation.

Sample Receiving Personnel:

Sample Receiving Personnel will assure that all samples are logged into the laboratory accurately and completely and will ensure that samples received at TRACE represent those indicated on the accompanying chain-of-custody. They will check all sample paperwork for accuracy, obtain required signatures, complete the log-in checklist, and make sure that samples and required analytical tests are properly identified. TRACE recommends that sample receiving personnel possess a high school diploma or equivalent.

Project Managers:

Project Managers will double-check all sample paperwork for accuracy, required signatures, and completed log-in checklist(s), and will make sure that samples and required analytical tests are properly identified. The Project Managers are responsible for accurately obtaining this information, entering it into the Laboratory Information Management System (LIMS), and communicating client needs to the laboratory.

Project Managers are responsible for promptly notifying clients, in writing, of any event that jeopardizes the integrity of data in any report, and documenting this in the project file. TRACE recommends that Project Managers possess a Bachelor's degree.

SECTION 4: Quotation Review and Contract Review

Quotation Review:

Requests for quotation may be sent to the following address:

Request for Quotation
c/o Trace Analytical Laboratories, Inc.
2241 Black Creek Road
Muskegon, MI 49444-2673

Each request for quotation received by TRACE will be reviewed by one of, or a combination of the following:

- Sales Team
- Project Manager
- Laboratory Manager

The review will determine if the project is within the capabilities of TRACE and ensure that all requested requirements can be met. After reviewing the request for quotation, a written response for the requested quotation will be provided.

Contract Review:

Contracts for review should be sent to the attention of the SalesTeam, Project Manager, or QA/QC Manager.

Each contract received by TRACE will be reviewed by the appropriate team of individuals. This review will be conducted to determine whether or not the contract differs from the original project quotation. Such a review will also be made to determine if the project is within the capabilities of TRACE and to ensure that all contractual requirements can be met. After reviewing the contract, any requirements differing from the original project quotation will be noted and discussed verbally or in writing with the client. Any changes to a contract will undergo the same review process as the original contract and the client will be notified.

Subcontract laboratories used for Department of Defense Environmental Restoration work must be DoD ELAP accredited, and must get project-specific approval by the specific DoD Component before any samples are analyzed.

Subcontract laboratories used for NELAP work must be NELAP accredited and comply with the TNI Standard, and must get project-specific approval by the client before any samples are analyzed.

A register of our subcontractors is currently maintained by our Invoicing Specialist. Prior to any NELAP or DoD work, a review of any subcontractors certifications will be performed.

SECTION 5: Document Control, Record Keeping, and Computers and Electronic Data Related Requirements

Data generated by TRACE could potentially be legal evidence. Therefore, it is imperative that integrity and confidentiality are maintained, including all records pertaining to national security concerns. All records will be permanent, complete and retrievable. To this end, all records will be written in ink. All changes will be accomplished by drawing a single line through the error, initialing, dating, and writing the correct information nearby. All records are maintained for a minimum of 7 years and can be retrieved by TRACE staff if the Project Manager is notified within that timeframe. In the event that the company transfers ownership or closes, all clients will be notified for further instructions on the maintenance of their records. All records will be retained for 7 years and in cooperation with the appropriate regulatory and state legal requirements. If any documents are to be retained for knowledge or legal purposes, they are to be noted as such. Documents, logs, and records include the items listed in this section:

Quality Assurance Manual:

The QA/QC Manager is responsible for the preparation, maintenance, and updating of the QA Manual. The master copy of the QA Manual is maintained in the QA/QC Manager's office. Any changes will require the signatures of the Laboratory Manager, QA/QC Manager, President, and Senior Vice President. Changes in the QA Manual due to changes in the company's practices and procedures will be made to ensure that the contents of the QA Manual accurately reflect laboratory operations. The updated text will be noted in blue. Because the QA Manual is considered a controlled document, one hard copy is stored in the QA/QC Manager's office, and the only other controlled copy is a pdf file which is available to all analysts on the company network.

Standard Operating Procedures:

Standard Operating Procedures (SOPs) are required for all analytical procedures, log-in and custody procedures, and corrective action protocols. Although detailed analytical methods are available from the EPA, ASTM, Standard Methods, and other sources, each laboratory is responsible for developing, writing and implementing its own procedures.

Each SOP is given a unique number, which is specific to an area of laboratory operations. SOPs are reviewed and updated on an annual basis. The updated text in each SOP is noted in blue. Because SOPs are considered a controlled document, one hard copy is stored in the QA/QC Manager's office, and the only other controlled copy is a pdf file which is available to all analysts on the company network. The employees utilizing the SOPs are required to sign off that they have read and understand the most current version of each SOP they use. Obsolete copies of SOPs are retained, but are removed from all points of use and are watermarked as "obsolete".

SOPs are approved by the Laboratory Manager and QA/QC Manager.

Reports of Analysis:

Reports of analysis are generated electronically through our LIMS software as PDF documents that cannot be altered. Hard copies are not generated unless required by the client. All verbal results are considered preliminary and do not necessarily reflect appropriate review. If a change needs to be made to a client report after it has been issued, an amended version will be created and sent to the client. The amended report will be indicated as such with the reason for the amendment within the cover page of the report.

Reports are confidential client information. The content of reports and other client data will not be divulged except upon request of the client, subpoena, or during state certification inspections which make certain data reviewable under statute (*e.g.*, drinking water data).

If it becomes necessary to remove reports of analysis from the premises for legal proceedings, duplicates will be prepared and placed in the files pending return of the original documents for those clients requiring hard-copy reports.

Electronic reports are kept for a minimum of seven years and then destroyed except for specific client requests, government consent orders, or other legal requirements of record retention.

Laboratory Logbooks:

Laboratory logbooks are kept in the individual laboratories. A separate logbook is used for each type of analysis. Each logbook contains the date of analysis, analyst's initials, batch ID, observations, and may also contain raw data, and calculations for that analysis. Completed logbooks are stored in the QA/QC Manager's Office. Laboratory logbooks are to be kept for a minimum of seven years after completion. Logbooks, which are no longer referred to by the laboratory are removed to a locked storage location off site. Unused portions of logbooks are marked out with a line, dated, and initialed.

Laboratory Data Worksheets:

Benchsheets are used to summarize data for word processing and to record data and data qualifiers from tests that do not supply hard copy or electronic output. Worksheets may also have places for calculations, formulae, etc. All observations will be recorded in laboratory notebooks or worksheets. Completed worksheets are to be forwarded to the Laboratory Area Manager for report assembly and are stored with the reports of analysis. Retention policies are the same as for the reports of analysis.

Equipment Logbooks:

Equipment logbooks are kept to record instrument condition and maintenance experience. Logbooks will be kept by the instrument or in a nearby drawer or cabinet. These records will be kept for a minimum of seven years after the last entry or after disposal of the equipment.

Chain-of-Custody Documents:

Chain-of-custody (C-O-C) documents are used to record the source and transfer of samples between the client and TRACE. The completed C-O-C forms are retained with the copy of the report of analysis. Retention policies are the same as for the reports of analysis.

Hard-Copy Instrument Output:

Instrument output for the organics laboratory such as quantitation reports, spectra, and chromatograms are marked with the sample identity and forwarded with the analytical benchsheets for storage with the retained copy of the reports of analysis. Hard-copy output such as instrument calibration, instrument tuning, blank data, and batch quality control data is retained and filed by the analyst. Instrument output for the metals laboratory consists of multiple samples and clients per page. For this reason, output is retained and filed by the analyst. The instrument hard-copy output for the inorganic laboratory is forwarded with the analytical benchsheets when appropriate, while other output must be retained and filed by the analyst. Retention policies for instrument output are the same as for the reports of analysis.

Client Correspondence:

All client correspondence related to a specific job is recorded on the client correspondence log on the front of each file folder. Any facsimile or e-mail correspondence to a client is to be retained with the related project. Retention policies are the same as for the reports of analysis.

Sample Run Logbooks:

Sample run logbooks are utilized when all the pertinent information cannot be captured on hard-copy instrument output. In these cases, the information must be recorded in a controlled logbook and every sample, standard and quality control check that is analyzed in a sequence is entered into a sample run logbook to document the date of analysis, the analyst's name, batch information, dilutions made, and other pertinent information. Each laboratory has sample run logbooks designed specifically for the analytical method being used. For example, the GC/MS logbook for volatiles includes calibration and instrument tuning requirements as well as a column to enter analytical run times. Several inorganic logbooks include sections that show both the preparative and analytical steps.

The information from the sample run logbooks can be used to check compliance with analytical protocols and as a diagnostic tool for troubleshooting analytical problems. For example, checking the sample run log can be done to ensure that the compounds identified in a sample are not the result of contamination from a previous run.

Sample run logbooks are comb-bound with pages sequentially numbered. When a sample run logbook is completed it is given to the QA/QC Manager for storage.

Retention policies for these logbooks are the same as for the reports of analysis.

Standards:

Every standard, whether prepared for calibration or spiking, is either entered into a standards logbook or into LIMS. These contain all necessary information about the standard including stock standard number, concentration, date prepared, vendor and lot number, purity, expiration date, and storage area. The organic laboratory uses the following format for the standards logbook. The front side of each page contains all relevant information about the stock standards, while the backside contains information about the working standards.

Every stock standard made, whether it is a single compound or a mixture of compounds and/or stock standards, gets a new stock standard number. A new number is required every time a stock is made or combined, even when making up the same stock standard again, with the exception of those made daily where the lot number has not changed. The identification numbers are assigned in one of two ways. The first is alphanumeric, beginning with a prefix that describes the lab area and type of standard, followed by the logbook number and page number where the stock standard preparation information can be found, and ending in zero (when dilutions of the stock standard are made, the zero changes to 1, 2, 3, etc, as appropriate). Additional instructions are found on the inside of each logbook, where applicable. The other option is to have LIMS assign a unique number based on the year, month, and day, followed by a sequential number

Standards logbooks are comb-bound with pages sequentially numbered. Retention policies for these logbooks are the same as for the reports of analysis.

Data Validation Checklists:

Data validation checklists are provided for those clients who require them. Data validation checklists consist of two parts: Analyst Review and Manager Review. Upon completion of their analyses, the analyst will fill out the appropriate Analyst Review checklist, making sure to sign and date it.

The checklist is method specific but typically includes items such as verification that method blank QC criteria have been met; all quantitation is within the calibration curve or linear dynamic range limit; the Initial Calibration Verification (ICV) and Continuing Calibration Verifications (CCVs) have passed QC criteria; Laboratory Control Sample (LCS) data have been checked against QC criteria; and samples have been analyzed within holding time.

The Laboratory Area Manager will fill out a Manager Review checklist after an Analyst Review has been completed. The analytical method or specific analysis will be filled out at the top of the form and the checklist is signed and dated at the bottom. The Manager Review includes items such as verification that analyst initials are on the benchsheet; analysis in the file matches request on the C-O-C; qualitative and quantitative results have been checked; transcriptions are correct; quality control issues are explained on the benchsheet; and so on.

The data validation checklists are kept with the reports of analysis.

QA/QC Data:

The raw quality control data, which validates the sample results, are retained by the laboratory in a manner allowing for easy retrieval. The method of storage depends on the nature of the raw data. Some instruments integrate calibration data, QA/QC data and sample data together on a page so that separating one from another would require dividing the page itself. In this case, all the data, (QA/QC included) is filed by the analyst according to the method and the date of analysis. Other instruments give each standard or sample a printout of its own so that there are no shared pages. In this case, the QA/QC data that are associated with particular samples (*e.g.*, surrogate data from chromatograms or Matrix Spike/Matrix Spike Duplicate-MS/MSD data) are maintained in the client's project file from which the particular samples come. The other QA/QC data, which are associated with a complete batch or run of samples and not with any one sample in particular (*e.g.*, laboratory control sample data or calibration verification data) are filed by the analyst by date analyzed.

Program Compliance Records:

All records related to compliance with the State of Michigan, Department of Defense, National Environmental Laboratory Accreditation Program, or any other agency or organization will be made available to certifying, validating, or accrediting authorities.

Computers and Electronic Data Related Requirements:

The Laboratory Information Management System (LIMS) is manufactured by Promium, and the software program is titled Element. The LIMS is on the company network, which is password protected. In addition, access to the LIMS itself is password protected. Only authorized users can access the LIMS. The LIMS is able to monitor log-on failures and break-in attempts. System operating privileges are controlled by the LIMS administrator.

As the laboratory receives samples, they are entered into the LIMS and provided with a barcode label. The samples are then scanned, initiating an internal chain-of-custody, and released to the designated storage area or directly to an analyst. The analyst retrieves a sample from storage and scans it into his/her custody. The analysis is performed and the sample is scanned back to storage or to disposal.

The analyst builds an analytical batch, analyzes the samples and then posts the results with the associated quality control (as controlled by the batch rule) into LIMS. The Laboratory Area Manager then reviews the data before being released for reporting.

The LIMS automatically uses the user's name and password to identify any entries made by that person. The system is equipped with an audit trail function, which tracks changes to a database. The audit trail function records:

- The original data and the modified data
- The identity of the person who made the change
- The dates of the original and modified data

The LIMS database and all electronic data on the company network are continuously backed up to prevent the loss of data on a separate server that is co-located with an off-site service. All electronic data/instrument data not located on the company network, is backed up once a month. This back up is stored on site in a fire resistant storage cabinet.

Instructions for the proper use of the LIMS are provided by Promium, and can be accessed through LIMS. To access instructions, an employee must first gain access to the company network using their network user name and password, and then gain access to the LIMS using their LIMS user name and password, which are assigned by the system administrator. Each user belongs to a 'user class' which allows/restricts their privileges within the LIMS. Examples are the ability to make changes to data once it has been saved and the ability to schedule work.

Once access to LIMS has been attained, the "Help" category is selected from the top drop down menus. This provides the user seven choices for help windows:

- Help Topics

- New User Tutorial
- Data Tool Tutorial
- Promium (Internet)
- SW-846 Methods (Internet)
- About Element
- Revision History

Help Topics:

Help Topics provides instructions on the LIMS in the following categories:

- Introduction
- Quick Start
- File/Login
- Print
- Sample Control
- Laboratory
- Project Management
- QA Admin
- Database Admin
- Help
- Index

Specific instructions in the above categories can be accessed by:

- Clicking on the Chapter in the Contents drop-down
- Clicking on the specific topic in the Index drop-down
- Using the Search drop-down

New User Tutorial:

The New User Tutorial is a pdf version of the Element DataSystem Tutorial. This is a step-by-step introduction to Element, and is an excellent resource for the first time user.

DataTool™ Tutorial:

DataTool™ allows electronic data entry form the analytical instrument to the Element DataSystem™ database. DataTool™ Tutorial takes the user step-by-step through the data transfer operation.

Promium (Internet):

The Promium (Internet) is a link to the Promium Web site.

SW-846 Methods (Internet):

The SW-846 Methods (Internet) is a link to the Environmental Protection Agency SW-846 Analytical Methods.

About Element:

About Element provides software system information.

Revision History:

Revision History provides revision information on the current and previous revisions.

SECTION 6: Control of Supplies

In order to ensure that purchased supplies, reagents, and consumables comply with method specifications or requirements, these materials are specified for purchase by an analyst responsible for knowing the method requirements. When the items are received, the purchasing agent checks the packing slip against the items received, and against the order to ensure what was received is what was ordered. The purchasing agent then signs and dates the packing slip.

Reagent Grade Chemical, Acids and Reagents:

Chemical reagents, solvents, gases, etc. are available in many grades of purity. In order to produce high quality, reproducible data, it is necessary to obtain materials of the appropriate quality required for the analyses to be performed. It is also important to ensure that the quality of reagents used for specific procedures is consistent over time.

It is the policy of TRACE to use only reagent grade, ACS grade, or better quality materials for the preparation of analytical standards and reagents. Where necessary, TRACE will order and utilize chemicals, acids, and reagents that have been assayed for purity.

Labels on all material will be inspected upon receipt to determine whether the reagent quality meets the specifications for the analytical method and to determine whether the material has adequate shelf life.

High Purity Solvents:

Solvents used for gas chromatography, high performance liquid chromatography and mass spectrometry are of the highest purity available, HPLC or Pesticide Residue grade. It is also the policy of TRACE to frequently run a solvent blank during an analysis sequence. The use of such blanks is beneficial to detect the presence of trace impurities, which may have been introduced from the solvents. Solvent blanks are normally run once a day, or more often as interference or suspect samples dictate.

Purchased Analytical Standards:

It is often beneficial to purchase analytical reference standards at prepared concentrations. TRACE purchases such standards for atomic absorption, ICP spectroscopy, HPLC, gas chromatography, wet chemistry, and mass spectrometry. Records are maintained which document the composition and purity of purchased standards. The following sources have been found to provide analytical standards of acceptable quality.

Metals Analysis: Atomic Absorption and ICP and ICP-MS Standards:

Standards are purchased from Fisher, Accustandard, Inorganic Ventures, SPEX Industries, Inc. and other suppliers.

HPLC, Gas Chromatography and Mass Spectroscopy Standards:

Standards are purchased from Supelco Chromatography Supplies, Accustandard, NSI, or Absolute Standards.

Wet Chemistry:

Standards are purchased from Fisher, Accustandard, or Hach Chemicals.

Microbiological Analysis:

Media purchased from vendors will be of a quality that is acceptable under the guidelines of the EPA approved drinking water certification program administered by the State of Michigan. Dilution water is DI water that is nutrient enriched and sterilized at 15 psi for 30 minutes.

Storage of Reagents:

Reagents, standards and solvents will always be stored in accordance with manufacturer's instructions. Incompatible materials, *e.g.*, organics and peroxides or perchlorates, will not be stored together. Acids and bases will be stored in appropriate cabinets. Flammable materials will be stored in flammable solvent storage cabinets.

Deionized Water:

The reagent used in the largest quantity in the laboratory is deionized water. Deionized water at TRACE is used by all of the laboratories and the field-sampling department. The water is prepared using deionization following reverse osmosis. The ion exchange tanks are supplied by Kohley's Eco-Water Systems and are located in the back storage area.

Deionized water is tested monthly for conductivity, heterotrophic plate count, and residual chlorine. The deionized water is continually monitored for resistivity and the deionization cartridges are changed when the conductivity is > 0.056 μmho/cm. Deionized water is checked annually for bacteriological suitability and for Lead, Cadmium, Chromium, Copper, Nickel, and Zinc.

SECTION 7: Equipment Calibration and Maintenance

Equipment Calibration and Maintenance:

To provide high quality data, it is essential that all laboratory and field equipment be in satisfactory operating condition. (For a list of major equipment, see Appendix IV) To this end, TRACE performs routine equipment calibration and maintenance. This includes the following:

Gas Chromatographs:

Analysis done by gas chromatography will follow SW-846 protocols except in those cases where 40 CFR Part 136 methods or drinking water methods are warranted. The instrument will be calibrated using a minimum of a five-point calibration curves for all analytes. Continuing calibrations utilizing a midpoint standard are performed after every ten samples to check the validity of the multi-point curve. The value of the continuing calibration standard must agree within plus or minus 15% of the initial value or appropriate corrective action is taken, which may include recalibrating the instrument. The calibration standards are commercially available certified standards and are spiked with internal standards. All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained. Reference standards are used for no other purpose other than instrument calibration and calibration verification.

Gas Chromatographs/Mass Spectrometers:

Prior to calibration, the instruments used for gas chromatography/mass spectrometry (GC/MS) analyses are hardware tuned by analysis of p-bromofluorobenzene (BFB) for volatile analyses and decafluorotriphenyl phosphine (DFTPP) for semi-volatile analyses. The instrument tune will be verified every twelve hours of operation.

Once the tuning criteria for these reference compounds are met, the instrument is initially calibrated using a minimum of a five-point calibration curve. Continuing calibration is verified as specified in the method being used. Under SW-846 protocols, the Continuing Calibration Compounds (CCCs) and System Performance Check Compounds (SPCCs) are checked every twelve hours. Under 40 CFR Part 136 protocols, the continuing calibration is checked daily. The calibration standards are commercially available certified standards and are spiked with internal standards.
All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained. Reference standards are used for no other purpose other than instrument calibration and calibration verification.

Analytical Balances:

The analytical balances are checked for proper leveling at the beginning of each day. The accuracy of the calibration is then checked with a 100-milligram, one 1-gram, a 10-gram and a 100-gram class “S” weight. The class “S” weights must weigh ±0.0002g. All calibrations are recorded in the balance calibration logbook.

The calibration weights are compared annually to reference mass standards that are directly traceable to the NIST. The calibration weights are used for no other purpose other than to verify the calibration of the balances.

Top Loading Balances:

The top loading balances are checked for proper leveling at the beginning of each day. The accuracy of the calibration is then checked with a ten (10) gram and either a two hundred (200) gram or five hundred (500) gram class “S” weight. The class “S” weights must weigh ± 0.02g. All calibrations are recorded in the balance calibration logbook.

The calibration weights are compared annually to reference mass standards that are directly traceable to the NIST. The calibration weights are used for no other purpose other than to verify the calibration of the balances.

The balances are also maintained and calibrated annually by an outside firm. Calibration labels are placed on each balance during the annual inspection.

pH Meter Calibration:

The pH meters are calibrated against two (2) reference standards prior to each use. A third reference standard is analyzed to verify the accuracy of the calibration. All calibrations are recorded in the pH logbook.

Incubators:

The temperatures of the laboratory incubators are checked twice daily. Bacteriological incubators are maintained at 35 ± 0.5 ºC and BOD incubators are maintained at 20 ± 1.0 ºC. All temperatures are recorded in the incubator temperature logbook.

Refrigeration Units:

The temperature of each walk-in cooler, refrigerator and freezer is checked at the beginning of each day. The coolers and refrigerators are maintained at 0 to 6 ºC, freezers are maintained at -10 to -20 ºC. All temperatures are recorded in the refrigerator/freezer temperature logbooks.

Atomic Absorption Spectrophotometers:

TRACE employs an Atomic Absorption (AA) spectrophotometer using cold vapor (for mercury analysis) and an Atomic Fluorescence Spectrometer (for low-level mercury). These are calibrated daily with a blank and at least the number of standards required by the protocol of the method being applied. First-order regression is used to generate a calibration equation, which computes analyte concentration as a function of absorbance. Initial and continuing calibration checks are analyzed to verify the validity of the curve.

The instrument operator responds to the failure of a calibration check by investigating and addressing any problem as necessary and recalibrating, thus assuring that all data is generated with a valid calibration curve.

All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained.

Inductively Coupled Plasma (ICP) Atomic Emission Spectrophotometers:

The ICP atomic emission spectrophotometer is calibrated daily with a blank and standard, unless client protocols call for a different procedure (*i.e*. the USACE requires the use of a blank and three standards.) One concentration is measured as a function of the intensity of light emitted by the element of interest at whatever discreet wavelength is being monitored. The calibration is verified by initial and continuing calibration checks and spectral interference checks. The instrument operator responds to the failure of a calibration check by investigating and addressing any problem as necessary and recalibrating, thus assuring that all data is generated with a valid calibration curve. The failure of a spectral interference check is remedied by monitoring a different wavelength free from interference or by adjusting background correction points.

All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained.

Inductively Coupled Plasma Mass Spectrometer (ICP-MS):

Calibration of the ICP-MS consists of a calibration curve that has one blank and three calibration standards. Calibration is done on a daily basis for each element that is to be analyzed. Additionally, during the analysis of environmental samples an Initial Calibration Verification (ICV) and an Initial Calibration Blank (ICB) are run to verify calibration of the instrument. A Continuing Calibration Verification (CCV) is also run after every 10 samples along with a Continuing Calibration Blank (CCB).

A Linear Dynamic Range (LDR) is determined at least once a year or more often if the analyst believes that the response of the instrument has changed due to a change in instrument hardware or in instrument operating conditions. The LDR is determined by calibrating the instrument for the analyte of interest, and then analyzing successively higher standards in excess of the calibration standard concentration. The highest standard that can be analyzed which also has a recovery of 90% or greater is defined as the LDR limit. Sample concentrations that exceed 90% of the LDR limit must be diluted and reanalyzed.

All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained.

Lachat QuikChem ® 8500:

The Lachat QuikChem® 8500 is calibrated with a blank and five to nine standards, depending on the analyte that is being analyzed. A standard curve is prepared by plotting instrument response against the concentration values. Continuing calibration is checked by running a mid-range standard every ten samples.

All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained.

Konelab Aqua 20:

The Konelab Aqua 20 is calibrated with a blank and 5 or 6 standards, depending on the analyte to be analyzed. A standard curve is prepared by plotting instrument response against the concentration values. Instrument QC is monitored using ICV, CCVs, CCBs, and second source

standards, as appropriate, depending on the method being used. Batch QC is monitored using LCSs and MS/MSDs.

All standard solutions are traceable to NIST or other reliable standards and certificates of analysis for these standards are maintained.

UV/VIS Spectrophotometers:

Calibrations for the Milton Roy Spectronic 21 spectrophotometer and the Spectronic Instruments Spectronic Genesys 5 spectrophotometer in the Wet Chemistry Laboratory are verified annually. This can be done either using cell standards or with potassium dichromate standards.

Laboratory Thermometers:

All laboratory thermometers will be checked for calibration upon initial usage. All liquid-in-glass thermometers are calibrated annually thereafter against the NIST thermometer and digital thermometers are calibrated on a quarterly basis. The calibration check will be recorded in the thermometer logbook and on a calibration label on each thermometer. The Thermometer Calibration Certificate is maintained with the NIST thermometer. The NIST thermometer is used for no other purpose other than to calibrate laboratory thermometers.

Preventative Maintenance and Preventative Action:

As part of the QA/QC program, a routine preventative maintenance program is conducted by TRACE to minimize the occurrence of instrument failure and other system malfunctions. TRACE staff performs preventative maintenance and repairs, or coordinates with a vendor for the repair of all instruments. All laboratory instruments are maintained in accordance with manufacturer's specifications and the requirements of the specific method employed. This maintenance is carried out on a regular basis and is documented in the laboratory equipment logbook for each instrument. Emergency repair or scheduled manufacturer’s maintenance is provided by factory or vendor representatives. For many of the instruments, a supply of spare parts is kept on hand to expedite repairs.

Equipment or instrumentation that has been damaged, gives suspect results, or is otherwise considered defective is taken out of service, identified as defective, and when possible removed from the area of use. In addition, the effect that the damage or defect may have had on previous analyses is investigated, as appropriate.

TRACE employs the use of preventative actions as a proactive approach for improvements and prevention of nonconformities. When a potential nonconformity is identified, an action plan is implemented and evaluated for effectiveness. Refer to SOP 10-29.

Glassware:

Volumetric glassware used in the laboratory must be of “Class A” tolerances. Graduated cylinders and pipettes will be checked by the laboratory before being placed into service to make sure their tolerances are within the limits specified by the manufacturer. This check will be conducted by weighing the glassware on an analytical or top loading balance, filling the piece of glassware to the highest calibration mark with deionized water, and then weighing again on the balance. Ten measurements are made, and the precision and accuracy must meet the appropriate agency’s requirements.

All glassware will be rinsed by the analyst after its use and before being placed in the glassware washing areas. There should be a double rinse with the last solvent contained by that piece of glassware. Glassware containing chemicals, reagents, or samples will not be left so that these materials become dried onto the surface.
Glassware is cleaned using Liquinox and/or Detergent 8 when washed by hand. Glassware washed using the laboratory dishwasher is cleaned using NeoDisher LaboClean FLA and NeoDisher 2. Glassware is inspected prior to use. If it is not clean, it is not used. Glassware that can not be cleaned is discarded to prevent possible contamination of sample analysis.

Volumetric Dispensing Devices (auto-pipettes)

Auto-pipettes are checked for precision and accuracy initially, and quarterly thereafter by weighing ten replicate measurements of water, calculating the volume of each, and determining standard deviation and percent accuracy. The relative standard deviation must be $\leq$ 1 and accuracy must be +/- 2% of the nominal volume.

Auto-pipettes that do not meet the requirements stated above are removed from service and cleaned, repaired or discarded.

SECTION 8: Sample Collection

Monitoring Well Sampling:

All monitoring well samples will be collected according to EPA guidelines (EPA Report No. 600/4-82-029, The Handbook for Sampling and Sample Preservation of Water and Wastewater and USEPA Ground Water Issue Document EPA/540/S-95/504, April 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.). Submersible sampling pumps, deep well jet pumps, or hand bailers will be used as necessary; however, no sample will be collected until the monitoring well has been evacuated to five (5) times the volume of water that is standing in the casing or when stabilization readings indicate a stable aquifer.

Composite Wastewater Sampling:

All composite wastewater samples will be collected according to EPA guidelines (EPA Report No. 600/4-82-029, The Handbook for Sampling and Sample Preservation of Water and Wastewater). Automatic interval sampling devices will be used where allowable.

Drum Sampling:

Drum samples are obtained by the use of a coliwassa sampler or other type of drum thief, which retrieves a cross-section of the entire drum.

Wipe Sampling:

Wipe samples are recommended for non-porous surfaces only. The area to be sampled is marked by the use of a disposal template, usually at least 100 square centimeters in area. The area within the template is wiped with a 2 by 2-inch sterile gauze pad or a piece of filter paper moistened with the appropriate reagent.

PCB Wipe Sampling:

To sample and test for PCBs, a gauze pad is moistened with hexane, wiped across the proposed area, then placed in a 4-oz. glass container with a Teflon-lined lid. The bottle is then labeled completely with the client sample ID, and the time and date of the sampling event. Nitrile gloves are used to hold the gauze during sampling and are disposed of after each sample to avoid cross-contamination.

Metals Wipe Sampling:

Wipe sampling to test for metals follows the same procedures as above except using a pre-moistened Ghost Wipe.

Sampling for Low Level Metals Analysis

Sampling for Low Level metals analysis is performed according to the guidelines set forth in US EPA Method 1669: *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria*. This method requires the use of techniques designed to prevent contamination of samples by environmental factors, field technicians and other sources of contamination.

SECTION 9: Sample Receipt and Storage

How samples are delivered to TRACE

Samples can be delivered to the laboratory in several ways:

Client drop off:

Clients may drop off samples at the laboratory between the hours of 8:00 a.m. and 5:00 p.m., Monday through Friday. Holiday and Saturday deliveries are available if special arrangements have been made with the Project Manager.

Upon sample delivery, the client will be requested to initiate a TRACE Chain-of-Custody (C-O-C) record. The sample receiving department will document the apparent condition of samples on the C-O-C record (e.g., whether samples were refrigerated upon receipt, contained headspace, etc.) and complete the sample login checklist.

Samples should be kept on ice from the time sampled to delivery to the laboratory. Proper and full documentation is required, including the information found in the “Chain-of-Custody Documentation” section of this manual.

Commercial Delivery Service:

Samples may be sent to the laboratory by commercial carrier. It is important that the proper precautions are taken when sending via commercial delivery service:

- Sample temperatures must be kept between just above 0 and 6 ºC.
- Make sure that coolers do not leak.
- Make sure that samples are shipped with the correct documentation and packaging, so that US DOT (US Department of Transportation), and the USDA (US Department of Agriculture) rules and regulations governing sample shipments are met.
- Call TRACE Analytical before shipping of any samples for Saturday or holiday delivery.

The sample receiving department will document the apparent condition of samples on the C-O-C record (*e.g.*, whether samples were refrigerated upon receipt, contained headspace, etc.) and complete the sample login checklist.

TRACE Analytical Laboratories, Inc., Courier Service:

TRACE is able to provide sample courier service to its clients. It is the courier's responsibility to collect all the pertinent paperwork from the client so that sample IDs, analyses requested, and sample preservation information will be readily apparent to laboratory personnel. The courier, upon return to the laboratory, will complete the C-O-C record to document the transfer of the samples.

The sample receiving department will document the apparent condition of samples on the C-O-C record (*e.g.*, whether samples were refrigerated upon receipt, contained headspace, etc.) and complete the sample login checklist.

TRACE Analytical Laboratories, Inc., Field Sampling Department:

It is the responsibility of the Field Sampling Department to properly label samples when collected and to initiate C-O-C records. Samples are to be placed in coolers packed with ice in order to bring the temperature to between just above 0 and 6º C as rapidly as possible.

Samples are to be kept on ice until delivery to the laboratory. Sample delivery should be accomplished as soon as possible.

Sample labels will contain the sample type, client name, site, sample identification, date and time of collection, preservatives used, test to be performed, and the name or initials of the person collecting the sample. This information must also be recorded on the C-O-C.

Upon delivery of samples to the laboratory, the field sampler transfers custody of the samples to the sample receiving department by completing the C-O-C.

The sample receiving department will document the apparent condition of samples on the C-O-C record (*e.g.*, whether samples were refrigerated upon receipt, contained headspace, etc.) and complete the sample login checklist.

Sample receiving by TRACE Analytical Laboratories, Inc.:

All samples received will be processed by the following procedures:

Chain-of-Custody Documentation:

The client or TRACE personnel will fill out a C-O-C record for all samples submitted to the laboratory. A copy of the completed C-O-C record will be given to the client while the original form will be placed in the client's project folder. The following information will be provided on the form:

- Sample identification names or numbers (*e.g.*, Well #1)
- Date and time of sample collection and analyses required for each sample
- Name of individual collecting samples and name of client submitting samples
- Address of client/telephone number/fax number/email address
- Client project number, where applicable
- TRACE quote number and/or client purchase order number
- Signature of individual delivering samples to the laboratory
- Signatures of any other individuals who took charge of the samples either during collection, transportation, or storage
- Date and time of delivery to the laboratory, signature of laboratory personnel accepting samples
- TRACE identification number
- Matrix and number of containers per sample
- Preservation and sample pH (where appropriate) and confirmation of field filtration
- Cooler temperature
- Turnaround time requested

Sample Login Checklist:

All coolers and samples will be checked using the Sample Login Checklist. Each cooler must have its own checklist. The following information is documented on this checklist:

Shipping Information

Date received
Client Name
Project Number
Project Name
TRACE personnel who logged in the submittal
Number of coolers
Cooler numbers
Bill of lading or tracking number
Use of custody seals
Type of packing used in the cooler

Method(s) of delivery

TRACE personnel
Client drop off
Commercial courier

Chain-of-Custody documentation

Sample condition
Appropriate paper work present
Special notations if needed

Coolant and Temperature documentation

The type of coolant used
Date and time the cooler temperature is taken.
Temperatures of temperature blank (if applicable)

Methanol Preserved Soil Samples:

Soil samples that are to be analyzed for Volatile Organic Compounds (VOCs) and are field preserved with methanol should be recorded on the Field Worksheet for Methanol Preserved Soils. This document must be sent to the laboratory.

For Methanol preserved samples that are shipped to TRACE:

The U.S. Department of Transportation, Title 49 of the Code of Federal Regulations regulates the shipping of methanol. The DOT number for methanol is: **UN 1230**. The amount of methanol used in sample preservation falls under the exemption for small quantities. The following requirements must be observed when shipping methanol preserved samples:

- The maximum amount of methanol per sample vial is to be no greater than 30 mls.
- The sample container cannot be completely filled with methanol.
- Each cooler may have no more than 500 mls of methanol
- Each cooler must be identified as containing less than 500 mls of methanol
- Each cooler must have a total weight of less than 64 pounds

Violations of the items listed above can result in fines or other punitive measures by the US Department of Transportation.

TRACE Identification Numbers:

Each new project will be assigned a TRACE project number upon entry into the Laboratory Information Management System (LIMS). This number will be entered on the client project folder, raw data sheets, C-O-C record, and on the individual sample bottle labels

Each individual sample will be given its own TRACE identification number.

Quality Control Check of Sample Receiving:

Each set of samples and the corresponding C-O-C and sample login checklist is double-checked by a second person to confirm that the login procedure is accurate. The second person will initial the C-O-C.

A new file folder will be obtained for each project and the following information will be recorded on the tab:

- Client name
- TRACE identification number
- File due date

File folders may be color coded to identify specific clients, analysis or turnaround times.

The TRACE identification number will be recorded on the C-O-C and entered into the LIMS system. It will be verified that the appropriate TRACE identification numbers have been recorded on the individual sample bottle labels and that all temperature-sensitive samples have been placed in the refrigerated storage room. All samples requiring volatile organic analysis are to be placed in segregated refrigerated storage.

Sample Custody, Security, Disposal and Subcontracted analysis:

Sample Custody:

It is important to minimize the number of people who physically handle samples in order to simplify record keeping. The traceability of sample custody is of vital importance for samples analyzed by TRACE Analytical Laboratories, Inc. According to the USEPA Contract Laboratory Program, Statement of Work, a sample is in your custody if:

- It is in your possession, or
- It is in your view after being in your possession, or
- It was in your possession and you locked it up, or
- It is in a designated secure area. (Secure areas shall be accessible only to authorized personnel)

All samples received by TRACE are maintained under custody at all times.

Sample Security:

All samples are stored in the laboratory, which is designated as a secure area. Security is maintained by locking all exterior entries into the laboratory and with keypad locks on all interior entryways.

No unauthorized personnel are allowed in the secure area unless escorted by authorized personnel. All non-TRACE employees are required to use the sign-in logbook (located in the lobby area) when entering and leaving the secured areas of the building.

Public areas at TRACE are designated as the front office areas, sample receiving and connecting hallways. These areas are accessible only during normal business hours.

Sample Disposal:

Samples are kept for a period of sixty (60) days after the final report for a project has been released. If samples are to be retained by TRACE for a longer period of time, then the client must indicate this when a project is initiated.

TRACE, in the disposal of samples, maintains documentation of disposal in LIMS. Manifests for the disposal of hazardous waste samples are maintained as well. At no time is client confidentiality to be compromised when samples are disposed.

Control of subcontracted analyses:

TRACE will occasionally utilize other laboratories for conducting specific analyses. These laboratories are selected on the basis of their ability to meet certain subcontract requirements, applicable certifications, establishment of a formal QA/QC program, and data integrity reputation.

Trace will inform clients when analyses are subcontracted to another laboratory. Trace will ensure that the subcontracted laboratory has any validations/certifications required by the client. Transfer of samples to a subcontract laboratory will be performed under a chain-of-custody. This information will be filed in the project file.

Trace is responsible to the client for the quality and timeliness of subcontracted work.

SECTION 10: Sample Container and Preservation

Sample Containers:

When collecting samples, the proper containers should be used to ship samples to the laboratory. Some environmental contaminates can interact with certain materials and compromise sample integrity. Data quality could be affected as well. In addition, the proper amount of sample needs to be collected in order to ensure that analyses can be performed correctly. Tables in Appendix II list the proper containers and sample amounts needed for analysis.

Sample Preservation:

Proper sample preservation is critical to maintaining sample integrity. Preservation should not be overlooked when collecting environmental samples. Samples that are not properly preserved will have data that are qualified. The tables in Appendix II give the proper preservation techniques for environmental analyses.

SECTION 11: Analytical Methods and Standard Operating Procedures

Analytical Methods:

When properly used, analytical methods should provide reliable information about the composition and nature of the sample being tested. In order for this information to be of value, the methods used should:

- Give evidence of the presence of the analyte
- Be able to separate the analyte from any interferences
- Be consistent with the level of analyte expected
- Be consistent with the sample matrix
- Have the required accuracy and precision
- Have the required lower limit of detection
- Be "rugged", *i.e.*, not sensitive to minor changes in variables, analysts, or laboratory
- Meet the regulatory requirements pertaining to the sample

Sources of Analytical Methods:

The methods used at TRACE are for the purpose of evaluating samples to determine their environmental significance, their potential impact on the health and well-being of individuals, or the operability or condition of equipment or a process. All of these purposes have the potential for significant economic or legal impact. Therefore, it is important to select published methods that have been widely tested, used and accepted. Wherever possible, the methods should be "standard" methods, *i.e.*, methods promulgated by a regulatory agency or other scientifically recognized organizations.

A list of the primary sources used for obtaining analytical methods employed at TRACE can be found in Appendix III.

A list of all methods under which Trace performs NELAC accredited analyses can be found in Appendix VII.

A list of the methods and Standard Operating Procedures (SOP's) used in the analysis of drinking water can be found in Appendix III.

Standard Operating Procedures:

TRACE develops in-house SOP's using the published methods as a reference. SOP's provide the analysts with detailed instruction on safety, sample preparation, analysis, quality control, and reporting. Any deviation from a SOP must first be approved by the Laboratory Area Manager and the QA/QC Manager.

SECTION 12: Data Validation, Reporting and Client Feedback

Routine Procedures for Data Validation:

All analytical data is thoroughly reviewed prior to report generation. The data review includes checks on data generation and reduction, and is performed as a three level review.

Level 1: Analyst Review

Level 1 is a technical data review performed by the analyst according to a prescribed set of guidelines. The review is designed to ensure the following:

- The sample preparation and analysis information are correct and complete
- The appropriate SOP's were followed
- The QC samples and blanks were analyzed and results are within established control limits
- The documentation is complete and any qualifications are recorded

Level 2: Technical Review

Level 2 is a technical review performed by the appropriate Laboratory Area Manager according to a prescribed set of guidelines. The review is designed to ensure the following:

- The appropriate SOP's were followed
- Calibration data is accurate and appropriate
- QC sample results are within established guidelines
- Qualitative identifications and quantitative results are correct
- Documentation is complete and the data is ready for incorporation into the final report

Level 3: Administrative Data Review

Level 3 is an administrative data review, which can be performed by the QA/QC Manager or the Laboratory Manager. The Level 3 review provides an overview of the entire data package. The review is designed to ensure the following:

- The completion and documentation of the Level 1 and 2 data reviews
- The performance of a primary proof reading by administrative support staff and a secondary proof reading by managerial staff of the compiled results
- Assurance that all qualifications and narrations are included in the compiled reports and are correct
- The data package is complete and ready for submittal to the client

Department of Defense Data Package Reviews:

The Quality Manager will review at least 10% of all Department of Defense data packages for technical completeness, accuracy, and DoD-QSM compliance. This review is part of the oversight program and does not have to be completed in “real time”.

Validation Checks:

In the event of client or regulatory question of data, the following validation checks may be made:

- Method - check to be sure the method was appropriate and performed properly
- Calculations - check all calculations for data in question
- Standards and Titrants - check to determine if expiration dates were exceeded or standards were contaminated or prepared improperly
- Instruments - check instrument function and calibration data
- Transcription Error – check data for errors, dilution factors, etc.

Repeat Analysis - if the above investigation identifies any problems or fails to confirm the data, it may be necessary to repeat the analysis in question.

Data Reporting:

Specific data reporting responsibilities for analysts are provided in the SOP’s.

For reports that are not generated through the LIMS, the analyst’s bench sheets and raw data are reviewed by the Laboratory Area Manager and released to reporting.

For LIMS reports, the Laboratory Area Manager performs a batch review of the data in LIMS and the Project Manager, with assistance from administrative assistants, performs a work order review of the data before it is released to reporting.

After issuance of a report, the report must remain unchanged. If it is necessary to make changes to a report after it has been issued, it must be done so in the form of a further document, which is identified as a supplement to the original report.

Client Feedback:

TRACE actively seeks customer feedback in the form of client surveys, but any form of client feedback is addressed, however received. This is useful for TRACE’s management to better understand our clients’ needs and concerns and to make improvements to our overall operation. All customer correspondence with regard to complaints should be handled by the Project Manager. When necessary, these individuals can consult with the Laboratory Manager, Laboratory Area Managers, or QA/QC Manager to resolve and document complaints through the use of a non-conformance memo or other appropriate means. All correspondence must be documented on the client correspondence log or in the project file. Refer to section 14 for feedback on non-conforming work.

SECTION 13: Quality Control

There are a number of quality control tools employed by TRACE, in order to ensure that data are of satisfactory quality and within prescribed requirements for accuracy and precision. These tools and the minimum frequency of use are described below.

Blanks:

Blanks are artificial samples that are used to determine whether there has been contamination of samples, equipment or reagents. Analysis of a minimum of one blank sample per batch is required. There are several types of blank samples that may be analyzed. The types of blank samples to be employed for a particular project or analytical method may vary.

Field Blanks:

A sample of reagent water or sampling medium (*e.g.*, filter or absorption tube) that has been taken to the sampling site and exposed to the ambient air without exposing the material to sampling conditions. These samples will be used to determine the amount of background contamination that could arise from the sample being collected at the particular site.

Trip Blanks:

A sample of reagent water that accompanies a sampling crew to the sampling site and is carried back unopened to the laboratory under the same storage conditions as the actual samples. The purpose of these samples is to assess the potential for cross-contamination of volatile organics during sample shipment. A minimum of one trip blank per sampling event or per cooler is required by TRACE. Clients are encouraged to submit trip blanks as well.

Refrigeration Blanks:

A sample of reagent water or sampling medium (*e.g.*, filter or absorption tube, etc.) that is used to determine if there has been contamination of a cooler or refrigeration unit. These samples will be used to determine the amount of cross contamination that could arise from the samples being collected at the particular site.

Temperature Blanks:

Reagent water or other medium that is used to determine if the samples are being kept at the proper temperature during shipment.

Rinsate or Equipment Blanks:

A sample of clean water or solvent that is used to rinse equipment before or between samples to determine the potential for contamination from sampling equipment. The number of rinsate blanks to be submitted should be determined by the sampling crew based upon potential for cross-contamination at the site and whether disposable sampling equipment is being used, *i.e.*, no reuse of sampling equipment.

Reagent or Method Blanks:

A sample of reagent water or analytical medium (buffers, solvents, water with preservatives added, etc.) that is carried through the entire analytical process including sample preparation (extraction, digestion) and analysis. Frequency of these samples is a minimum of one per twenty or one per batch, whichever is more frequent.

Instrument Blanks:

A sample of reagent water or solvent that is analyzed between samples to assess the potential for cross-contamination in an analytical instrument or procedure. This sample is not carried through the sample preparation portion of the analytical method. The frequency of analysis of instrument blanks is variable and will be best determined by the analyst. For example, if a highly contaminated sample has been analyzed, instrument blanks will be analyzed until the analytical equipment fails to show any evidence of contamination. If a large number of samples that have no detectable contamination are analyzed, the necessity for instrument blanks is greatly reduced.

Spiked Samples:

Spiked samples are samples to which a known quantity of reagent or analyte has been added. Spiked samples are then analyzed to determine the performance of a method or analyst, or the stability of an analyte in the sample matrix. There are several types of spiked samples. These are usually analyzed at a minimum frequency of one spike per twenty samples or one per batch.

Laboratory Control Samples (BS):

Samples prepared by adding a known amount of analyte(s) to deionized reagent water, which are carried though the entire analytical procedure to assess the precision and accuracy of the procedure independent of sample matrix influence. Laboratory Control Samples (BS's) will be run with every batch of samples. Results will be within calculated control limits or those specified in the method.

Matrix Spike and Matrix Spike Duplicates (MS/MSD):

Samples that have a separate aliquot spiked with a predetermined quantity of analyte(s). The results of the MS/MSD's are used to assess the precision and accuracy of the analytical procedure when analyzing real world matrices. Results will be within calculated control limits or those specified in the method.

Duplicate Samples:

Samples are analyzed in duplicate to verify the precision of the analytical procedure.

Duplicates:

One sample prepared and analyzed twice in the laboratory. Duplicate analytical results are utilized to assess the precision of the analytical procedure.

Field Duplicates:

Replicate samples collected in the field or duplicate samples submitted by a client. These samples are analyzed and the results compared to assess the precision of the

entire sampling and analytical process. Duplicate analysis of one sample in the laboratory only tests the precision of the analytical procedure.

Surrogates:

Surrogate compounds are materials not usually expected to be found in environmental samples but are expected to behave similarly to an analyte of interest in the analytical process. Surrogates are often isotopic forms of environmentally significant materials.

These materials are added to a sample aliquot and carried through sample preparation and analysis. A satisfactory recovery of these materials demonstrates that the analytical process is in control.

Surrogate recoveries are calculated as follows:

$$SurrogateRecovery\ \% = \left(\frac{amount\ found}{amount spiked}\right) x100\%$$

Surrogates are added to all quantitative organic analyses.

Calibration:

All equipment, methods and procedures are to be calibrated prior to conducting analyses.

Calibration Standard:

A standard containing a known quantity of an analyte, which is used in conjunction with standards of other concentrations to determine instrument response (a standard curve). The number of calibration standards to be used is method dependent. The most common number of standards used to generate a response curve is five.

Calibration Check:

A standard containing a known quantity of an analyte, which has been purchased or prepared from a different source than the standards used to calibrate the equipment or method. These are used to verify the instrument calibration. These standards are not carried through the sample preparation portion of the analytical procedure. The normal frequency of analysis is defined in the appropriate SOP's. Some methods also require a calibration check prepared from the same source as the calibration standards.

Laboratory Water Quality:

The laboratory water quality is monitored on a regular basis. See SOP 10-21 for details.

Method Detection Limits (MDL) and Practical Quantitation Limits (PQL):

TRACE conducts MDL studies where applicable. In addition, MDL studies are performed each time there is a change in the test method that affects how the test is performed, or when a change in instrumentation occurs that affects the sensitivity of the analysis. At least seven reagent water samples and seven reagent soil samples are spiked at a concentration that is estimated to be the lowest level that can be reliably quantified. All processing steps of the

analytical method are included in the MDL determination. All procedures are documented, including the matrix, and all supporting data is retained.

The calculated MDL value is compared to the spike amount. The U.S.A.C.E. requires that the calculated MDL value be compared to the mean recovery of the spikes. If the calculated value is larger than the spiked amount, the MDL study is not valid and the procedure is repeated at a higher spike concentration. If the calculated MDL is between 100% and 20% of the spiked amount, the study is considered valid. If the calculated MDL is less than 20% of the spiked amount, the study should be repeated at a lower spike concentration.

MDL's refer to the minimum concentration of an analyte that can be detected above instrument background noise. On the other hand, Practical Quantitation Limits (PQL's) refer to a minimum concentration of an analyte that can be measured within specified limits of precision and accuracy. PQL's are generally 5-10 times the MDL, but no lower than 3 times the MDL. PQL's are established for each method and they must be above the detection limit.

Most methods do not have a frequency requirement for MDL studies. In these instances, annual or quarterly LOD and/or LOQ verifications are performed as dictated by our accrediting bodies. Those methods that require routine MDL studies will be noted in each individual SOP.

Limit of Detection (LOD) and Limit of Quantitation (LOQ) Verification:

TRACE conducts annual LOD and/or LOQ verifications for analytes certified through NELAC as required by The NELAC Institute Standard. The LODs and LOQs of DoD-ELAP accredited analytes are verified quarterly as required by the DoD Quality Systems Manual for Environmental Laboratories. Although these are referred to as LOD and LOQ in the laboratory, our LIMS system refers to these samples as MRL and SRM respectively due to naming limitations.

Employee Training and Initial Demonstration of Competency:

New employees are required to complete a number of tasks as part of their initial orientation. This includes QA/QC training, Data Integrity Training, Safety Training, a review of TRACE's Client Confidentiality Policy, and a review of TRACE's QA Manual. Prior to conducting the analysis of any client samples, all new analysts and technicians (trainees) receive training from the appropriate Laboratory Manager and must complete an Initial Demonstration of Competency (IDC). At a minimum, training will consist of a thorough study of the appropriate SOP's, instruction from the Laboratory Manager and performance of the analytical procedure(s) in tandem with the Laboratory Manager and/or Senior Analyst.

When, in the opinion of the Laboratory Manager, the trainee is capable of successfully conducting the analytical procedure, the trainee is required to complete the IDC, which consists of analyzing four BS's of identical concentration. The trainee must demonstrate the ability to obtain satisfactory precision and accuracy for the given procedure. The IDC data is reviewed by the Laboratory Manager and compared to the established control limits. If all values are determined to be in control, then the trainee is deemed capable to conduct the analytical procedure.

The results of the IDC will be documented in the employee's training file.

Additionally, the IDC may include satisfactory completion of a MDL study if the procedure will be utilized for drinking water samples, and generation of a curve with a correlation coefficient of >0.995 for procedures utilizing a curve for analyte quantification.

A demonstration of capability must be completed each time there is a significant change in equipment, personnel, or test method. Additionally, each analyst is required to conduct an on-going demonstration of capability on an annual basis. This is discussed in detail in Standard Operating Procedure 10-8.

Performance Evaluation Samples:

TRACE participates in several performance evaluation studies, including the USEPA Water Pollution (WP), Water Supply (WS), and Soil studies. These programs ensure that laboratory performance is checked and validated by an independent source on a regular basis. Once all analyses have been reviewed by the Laboratory Manager, or designee, the QA/QC Manager prints a final report of all results. The results are then entered online and submitted to the PT provider for evaluation. All records resulting from PT evaluations will be retained according to TRACE's record retention policy outlined in Section 5. Trace will comply with all TNI and DoD-ELAP requirements with regard to proficiency test studies.

SECTION 14: Corrective Actions

Corrective actions are required for two classes of problems: analytical or equipment problems and noncompliance problems. Analytical or equipment problems may occur during sample preparation, laboratory instrumental analysis, or data review. Non-compliance issues include, but are not limited to, sampling methodologies, sample containers, holding times, and sample preservation. This also includes any issues resulting from client feedback. In instances where a Corrective Action Report is necessary, the analysts and management will work together to determine the root-cause of the problem and determine corrective action. After an established timeframe, the QA/QC Manager will determine the effectiveness of the corrective action and determine if further action is needed.

The QA/QC Manager is responsible for informing management of deficiencies in the quality program and following up on corrective actions.

Analytical or Equipment Problems:

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action is dependent on the analysis and the event. Laboratory personnel are alerted that corrective actions are necessary if:

- BS and matrix spike data are outside the acceptable windows for precision and accuracy.
- Blanks contain target analytes above acceptable levels.
- Undesirable trends are detected in spike recoveries or relative percent difference between duplicates.
- Surrogates or internal standards fail QC criteria.
- There are unusual changes in detection limits.
- Deficiencies are detected by the QA/QC Manager during internal or external audits or from the results of performance evaluation samples.
- Inquiries concerning data quality are received from clients.

Resolutions:

Analytical Problems:

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, and instrument sensitivity. If the problem persists or cannot be identified, the matter is referred to the appropriate Laboratory Area Manager for further investigation. This investigation may involve the preparation of new samples, standards, reagents, and quality control spikes to determine the exact nature of the problem.

Once the problem is resolved, all samples affected by the problem must be reanalyzed.

If the problem is not resolved, a Corrective Action Report is completed with assistance from the analyst, Laboratory Area Manager, and QA/QC Manager. If client data is affected by the non-conformance, the Project Manager is informed. The affected data is qualified using the suitable qualifier from TRACE's Narrative list.

Inaccurate Procedures or Processes:

If it is determined that the problem causing the inaccuracy could have been prevented by following normal procedures or processes, actions will be taken by the QA/QC Manager or appropriate laboratory manager to inform or educate the analyst in an effort to prevent further occurrences of the problem.

Should the inaccuracy be due to an error, inconsistency, or ambiguity in a written procedure, the QA/QC Manager or Laboratory Manager will take all steps necessary to correct the problem. This corrective action may include rewriting the SOP.

Known departures from policies and procedures must be cleared by the Laboratory Manager and Project Manager. It is the Project Manager's responsibility to notify the client immediately to discuss these departures. Any known departures will be noted in the final report with a data qualifier.

Data Error:

Should an error be discovered in reported data, it is the policy of TRACE to immediately notify the client of the error by the most expeditious means. The analyses are repeated if necessary and the corrected results are reported as soon as possible. An amended written report will be prepared and will indicate the changed data and the reason for the change.

Resolution of Non-compliance Problems:

For non-compliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. At a minimum, a Corrective Action Report will be completed and the client notified immediately by the Project Manager for further instructions.

SECTION 15: Internal Quality Control Audits and Management Reviews

Internal quality control audits will be conducted at a minimum of once a year. The audits are conducted by the QA/QC Manager and President. The purpose of these audits is to verify that all aspects of the QA program, including data integrity, are functioning properly and that the overall quality program is effective. Two types of audits are used; system audits and technical audits.

System audits review the quality system, including information such as:

- Published methods
- Standard Operating Procedures
- Training files
- Quality control charts
- Quality control data
- Corrective action procedures and documentation

Technical audits are in depth reviews of data, with emphasis on data integrity issues. Technical audits involve a review of the following:

- Logbooks (Run logs and Standard prep. logs)
- Quantitation Reports
- Bench sheets
- Raw data
- Client reports
- Data review documentation
- Client correspondence
- Chain-of-Custody

Audit findings must be documented, and corrective actions established to address the findings. At the time that the corrective action is established, a mechanism must be defined to monitor the issue and ensure that the corrective action has been effective.

Management meetings will typically be held bi-weekly to discuss issues such as:

- The use of appropriate policies, procedures and standard operating procedures
- Employee reports/concerns/issues
- Internal audit findings
- Corrective/preventive actions
- External audit/review/assessment findings
- Proficiency test results
- Work schedules
- Client complaints/comments/concerns
- Quality control issues, resources, training, etc.

The President, Laboratory Manager, QA/QC Manager, Project Managers, and any Technical Managers will attend the bi-weekly meetings.

QA/QC issue discussions will be documented on the Bi-weekly Quality Control Management Review form. Action items and the person(s) responsible for the action will be defined. Action items will be tracked in subsequent meetings, and closure will be documented.

In addition to the bi-weekly management meetings, a meeting of all employees is held weekly. This serves as an opportunity to discuss workload and any issues that arise on a weekly basis.

Appendix I

Resumes of Key Personnel

R. BRUCE PELLETIER, President

The Company President is responsible for the overall operation, planning, organizing, and directing of the laboratory and management staff. Key areas of responsibility are corporate image, client relations, company leadership, employee relations, quality assurance, and financial management.

RESPONSIBILITIES

- Assists with budget development, cash flow management, tax planning, financial strategies and organization of overall financial functions.
- Sets corporate goals and makes recommendations for plans to achieve these goals.
- Works with staff to develop and maintain a strong professional image for the company with respect to its clients, competitors, employees, and the community.
- Provides technical information and advice to clients regarding their projects or proposed projects.
- Oversees and assists with repairs, maintenance and installation of instrumentation. Also oversees facility maintenance.
- Coordinates changes within the laboratory to comply with changing regulatory requirements.
- Assists laboratory staff in writing, reviewing, and implementing SOP's.
- Serves as project coordinator for special or unusual analytical projects that differ from those commonly conducted by the laboratory.
- Reviews proposed projects containing requests for air analyses to determine if the work is within the capabilities of the laboratory.
- Supervises method development and method validation procedures for air quality analyses.
- Trains and qualifies chemists and technicians to analyze air samples in a manner consistent with good quality control practices and procedures.

PROFESSIONAL EXPERIENCE

January 1990 - Present: TRACE Analytical Laboratories, Inc., Muskegon, MI
President and Co-Owner
Air Quality Supervisor, and Special Projects Coordinator.

January 1984 - December 1990: Koch Chemical Company, Inc., Whitehall, MI
Senior Analytical Chemist and Quality Control Director
Supervised a staff of one chemist and three technicians. Responsible for the day to day operations of the FDA approved Product Testing Laboratory. Primary responsibilities included the analyses of incoming raw materials to validate stated purity, analyses of pharmaceutical intermediates to determine reaction completeness, and final product testing to formulate Certificates of Analysis for the final finished products. Additional responsibilities included instrument repair and maintenance, writing and implementation of SOP's. Instrumentation used and maintained for this position included gas chromatographs, high pressure liquid chromatographs, infrared spectrophotometers, visible and UV wavelength scanning spectrophotometers, automatic titrators, refractometers, melting point apparatus, fractional distillation equipment, and precision analytical balances.

May 1977 - December 1983: Aquatic Systems, Inc., Ludington, MI
Laboratory Director
Responsible for the daily operation of the environmental laboratory. Responsibilities included scheduling, instrument repair and maintenance; writing and implementation of SOP's, project management, data review, and the training of laboratory staff. This was a working position that also required the analysis of client samples for wet chemistry, metal, volatile and semi-volatile organic parameters. Instrumentation used and maintained under this position included gas chromatographs, high pressure liquid chromatographs, atomic absorption spectrophotometers, visible and UV wavelength spectrophotometers, infrared spectrophotometers, and precision analytical balances.

September 1975 - May 1977: Central Michigan University, Mt. Pleasant, MI,
University Instructor for the Biology Department
Responsible for teaching General Biology and Determinative Bacteriology classes under a graduate teaching assistantship. This position required the formulation and presentation of course lectures and laboratory sections. An additional requirement was the advanced preparation of bacteriological culture media and glassware.

October 1975 - May 1977: Three Lakes Association, Inc., Antrim County, MI,
Water Quality Specialist
Responsible to formulate and implement a comprehensive water sampling and analysis program to determine and document the water quality of Torch, Clam, and Bellaire Lakes of Antrim County. Tests conducted on these lakes included bottom dredging and identification of invertebrates, bottom coring for lake aging and sediment profiling, transparency measurements, total phosphorus, ammonia nitrogen, nitrate nitrogen, total organics, and chlorophyll analyses. Additional responsibilities included maintaining all sampling and analytical equipment and to provide written annual reports of all findings to the lake association.

EDUCATION

- **B.S., Aquatic Biology**, Michigan State University,
  Minor in Chemistry

- **M.S., Limnological Studies**, Central Michigan University,

PROFESSIONAL ORGANIZATIONS/CERTIFICATIONS

- American Chemical Society

- Society of American Military Engineers

- Handling Hazardous Materials & Hazardous Materials Operations

- Hazardous Materials-First Responder Operations

WILLIAM SCHROEDER, Ph.D., Senior Vice President

The Senior Vice President is responsible for the overall management of the company in conjunction with the PresidentUltimate decisions about financial and personnel matters are a primary function. In addition, the Senior Vice President is available to the staff as a technical advisor and chemical consultant. Finally, the Senior Vice President serves as the company representative in community activities and contacts with corporate, political, and environmental entities.

PROFESSIONAL EXPERIENCE

September 1989 – Present: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Co-Owner and Senior Vice President.

1985 - 1989: Baxter International, Muskegon, MI,
Vice President and General Manager of the Burdick and Jackson Division
This position had complete profit and loss responsibilities for a manufacturing operation engaged in the production of highly purified solvents designed for use in sophisticated analytical techniques. Additional responsibilities included the coordination of activities with other corporate interests.

1983 - 1985: American Hospital Supply Corporation, Muskegon, MI,
Vice President and General Manager of the Burdick and Jackson Division
This position had complete profit and loss responsibility for a manufacturing operation engaged in the production of highly purified reagents and the coordination of division sales efforts with corporate national programs.

1978 - 1983: Hofmann LaRoche International, Muskegon, MI,
President of the Burdick and Jackson Division
This position had full profit and loss responsibilities for a manufacturing and research operation designed to broaden the manufacturing interest of the parent company; specifically to develop procedures for the manufacture of chemical intermediates as well as the continuing operation of the purified solvent program.

1974 - 1978: Hofmann LaRoche International, Muskegon, MI,
V.P. Research for the Burdick and Jackson Division
This position was responsible for the development of new procedures for the purification of solvents and the innovative synthesis of organic intermediates for the preparation of new pharmaceuticals.

1965 - 1974: Burdick and Jackson Laboratories, Muskegon, MI,
Vice President of Research and Co-Owner
Responsible for the development of procedures for the preparation of highly purified solvents and the production of intermediates and final drug products for the pharmaceutical industry. These drug products required the inspection of the operation and approval of procedures by the Food and Drug Administration. The development of analytical procedures for testing the purity of both the solvent and drug products was also a requirement.

1958 - 1965: The Upjohn Company, Kalamazoo, MI,
Research Associate
This position was responsible for the research and development of new antibiotics and anti-cancer drugs. A significant result of this activity was the cooperative effort that brought to market the antibiotic Lincocin and its derivatives. This antibiotic has unique properties for the control of deep-seated bone infections.

EDUCATION

- **Ph.D., Organic Chemistry,** Purdue University
- **B.S., Chemistry,** Purdue University

PROFESSIONAL ORGANIZATIONS/CERTIFICATIONS

- American Chemical Society
- Association of Official Analytical Chemists
- Research Associate: Grand Valley State University

GINA ROE, Laboratory Manager

The Laboratory Manager is responsible for all aspects of environmental chemistry as related to clients and projects. The Laboratory Manager is also responsible for the day to day operations of the laboratory.

RESPONSIBILITIES

- Production - Responsible for the overall production of the laboratory, including development of new methods, and scheduling of workloads
- Performance - Insures that the laboratory is meeting requirements regarding quality, procedures, volume, and turnaround. Schedules and reviews analyst certifications, MDL studies and SOP writing. Monitors on-time performance. Conducts annual review of employees.
- Data Validation - Accountable for the data released from the laboratory. Reviews analytical data prior to submission to data reporting, evaluates PE results, and implements corrective actions.
- Budget - Responsible for the development and maintenance of an operating budget.
- Training - Insures that employees are properly trained to meet the requirements of their positions.
- Client Interface - Serves as the in-house representative on all projects requiring technical expertise.
- Planning - Plans for future growth of the laboratory.

PROFESSIONAL EXPERIENCE

July 2010-Present: Trace Analytical Laboratories, Inc., Muskegon, MI, Laboratory Manager

October 2005 – July 2010: Trace Analytical Laboratories, Inc., Muskegon, MI, Project Manager

February 1997 – October 2005: Trace Analytical Laboratories, Inc., Muskegon, MI, Senior Analyst
Responsible for GC/MS volatiles and other organic analyses.

February 1990 – February 1997: Trace Analytical Laboratories, Inc., Muskegon, MI, Analyst
Responsible for Organic, Inorganic, and Metals analysis.

September 1986 – May 1987: Muskegon Community College.
Interim Laboratory Director
Responsible for laboratory set-up for student use, and ordering of supplies.

EDUCATION

- **A.A.S**., Chemistry, Muskegon Community College
- **B.S.**, **Natural Resource Management**, Grand Valley State University

JON MINK, Technical Systems/Project Manager

The Technical Systems/Project Manger is responsible for mobile analytical services, sampling services, equipment repair and maintenance, waste management and disposal, LIMS/computer systems management and special project management.

RESPONSIBILITIES

- Evaluate the ability of the laboratory to perform new methods with existing equipment and personnel.
- Determine project requirements with clients, as pertaining to instrumental and staff capabilities. As necessary develop and implement new analytical methodologies as required by client project needs.
- Set up and oversee laboratory equipment maintenance and preventative maintenance schedules.
- Conduct major repairs of analytical equipment with help from the manufacturers technical support staff. If necessary schedule on-site or off-site repair.
- Develop, implement, and oversee a plan for the management and disposal of laboratory and sample waste.
- Work with clients to determine sampling requirements.
- Manage LIMS/Computer systems.
- Building maintenance.

PROFESSIONAL EXPERIENCE

September 1995 – Present: TRACE Analytical Laboratories, Inc., Muskegon, MI, Technical Systems Manager/Project Manager

July 1993 – September 1995: TRACE Analytical Laboratories, Inc., Muskegon, MI, Project Manager
The Project Manager was responsible for the management of the mobile analytical services. Duties also included special project management. Included were the selection, set-up, and maintenance of instrumentation.

July 1992 - July 1993: TRACE Analytical Laboratories, Inc., Muskegon, MI, Application Specialist
Responsible for determining the laboratories abilities to meet specific, non-standard, client analytical requests. Also responsible for the implementation of new EPA analytical methods not currently being performed by the laboratory.

July 1991 - July 1992: TRACE Analytical Laboratories, Inc., Muskegon, MI, Client Services / Safety Manager
Corresponded with clients regarding analytical requirements. Included in this was the determination of proper sample techniques, volumes, containers, preservatives, and hold times. Also worked closely with the laboratory to determine the availability of analytical results and priority sample treatment. Other duties included ordering of supplies needed by the laboratory for day to day operations, and the development of the laboratory safety plan.

September 1990 - July 1991: TRACE Analytical Laboratories, Inc., Muskegon, MI, Analyst
Performed analyses in all areas of the laboratory. Set-up new equipment for analytical determinations, investigated and implemented new methodologies. Also responsible for field sampling.

January 1984 - September 1988: University of California at San Diego, School of Medicine Pathology Department. La Jolla, California,
Lab Assistant II
Worked with a principal investigator doing research on cholestasis and choleuresis as an electron microscopist and research assistant. Duties included small animal surgeries, tissue harvesting, tissue processing for light microscopy and transmission electron microscopy, electron micrograph development and printing, student assistant supervision, paper writing for journal publication, and laboratory purchasing.

EDUCATION

- **B.A., Microbiology**, University of California, San Diego, Revelle campus
  minors in Physiological Psychology and Chemistry

PROFESSIONAL ORGANIZATIONS/CERTIFICATIONS

- Hazardous Materials Specialist
- Firefighter I & II
- Confined Space Rescue Technician
- Member Muskegon County Hazmat Team
- Member Michigan Regional Response Team for Western Michigan District

ALYSON YAGIELA, QA/QC Manager

The QA/QC Manager will make sure that all aspects of the program comply with current and appropriate regulatory requirements, methodologies, and protocols, will coordinate and manage the quality assurance program on a daily basis, and shall keep members of the quality assurance group informed on issues relating to the laboratory quality assurance program.

RESPONSIBILITIES

- Conducts internal and coordinates external laboratory audits.
- Coordinates efforts for state and federal certifications.
- Coordinates changes within the laboratory to comply with changing regulatory requirements.
- Assists laboratory staff in writing, reviewing, and implementing SOP's.
- Maintains Quality Control calculation programs.
- Updates and edits Quality Control Program manual.
- Assists with project quotation preview and review.

PROFESSIONAL EXPERIENCE

May 2011 – Present: TRACE Analytical Laboratories, Inc., Muskegon, MI
QA/QC Manager

February 2007 – May 2011: Mead Johnson Nutrition, Zeeland, MI
Quality Control Laboratory Analyst
Held multiple roles within the QA/QC labs, including the collection, preparation, and analysis of infant formula samples. Worked to update SOPs and analytical methods, which required strict adherence to FDA regulations.

September 2005 – February 2007: Aerotek Scientific, Mead Johnson Nutrition, Zeeland, MI
Quality Assurance Technician
Laboratory sample preparation and analysis using microbial determination methods while complying with FDA regulations.

May 2002 – May 2004: Michigan State University, East Lansing, MI
Master's Degree Candidate / Research Assistantship
Master's thesis research studied the effects of nutrient enrichment on consumers in lacustrine wetlands using stable isotopes. Assisted with Muskegon River Watershed Assessment Project sampling and algal identification.

May 2001 – August 2001: Boston University, Woods Hole, MA
REU – Research Fellow
Worked on a sandplain restoration project and designed/implemented research project to study nitrogen concentrations at the seepage face of Edgartown Great Pond.

September 2000 – April 2001: University of Michigan, Ann Arbor, MI
Assistant-in-Research
Studied historical trends in diatom assemblages and effects on the diets of fish and zooplankton.

May 2000 – August 2000: National Oceanic and Atmospheric Administration, Muskegon, MI
Research Fellow
Studied zooplankton size and population distributions in Lake Michigan.

EDUCATION

- **B.S., Resource Ecology & Management**, The University of Michigan
- **M.S., Zoology**, Michigan State University

Appendix II

Sample Containers and Preservatives

SAMPLE REQUIREMENTS - WATER SAMPLES				
Test Parameter	**Method**	**Container**	**Preservative**	**Hold Time**
Acidity	305.1	250 mL Plastic	Cool to <6°C	14 days
Alkalinity	SM 2320B	250 mL Plastic	Cool to <6°C	14 days
Ammonia-Nitrogen	350.1	250 mL Plastic	H2SO4, Cool to <6°C	28 days
BOD	SM 5210B	1 Liter Plastic	Cool to <6°C	48 Hours
COD	410.1	250 mL Plastic	H2SO4, Cool to <6°C	28 days
Cyanide	335.4	125 mL Plastic	NaOH, Cool to <6°C	14 days
Chloride	300	125 mL Plastic	Cool to <6°C	28 days
Chlorine	SM 4500 Cl G	500 mL Plastic	Cool to <6°C	Immediate
Fluoride	300	250 mL Plastic	Cool to <6°C	28 days
Hardness	130.2	250 mL Plastic	HNO3, Cool to <6°C	6 months
Herbicides	8151	(2) 1 Liter Ambers	Cool to <6°C	14 days/40 days
Hexavalent Chromium	SM 3500 Cr B	250 mL Plastic	Cool to <6°C	Immediate
Mercury	245.1	250 mL Plastic	HNO3, Cool to <6°C	28 days
Low Level Mercury	1631	Call Trace	BrCl or HCl, Cool to <6°C	90 days
Metals	200/60x0/7000	500 mL Plastic	HNO3, Cool to <6°C	6 months
Nitrate	300	250 mL Plastic	Cool to <6°C	48 Hours
Nitrate-Nitrite	300	250 mL Plastic	H2SO4, Cool to <6°C	28 days
Nitrite	300	250 mL Plastic	Cool to <6°C	48 Hours
Nitrogen, Total Kjeldahl	351.2	250 ml Plastic	H2SO4, Cool to <6°C	28 days
Oil & Grease	1664	1 Liter Amber	HCl, Cool to <6°C	28 days
Oxygen, Dissolved	SM 4500 O C	Call Trace	Call Trace	8 hours
PCBs	8081	(2) 1 Liter Ambers	Cool to <6°C	1 year/1 year
Pesticides	8081	(2) 1 Liter Ambers	Cool to <6°C	7 days/40 days
pH	SM 4500 H+ B	125 mL Plastic	Cool to <6°C	24 hours
Phenols (Total)	420.1	2 oz Amber	H2SO4, Cool to <6°C	28 days
Phosphorus, Ortho	365.1	125 mL Plastic	Filter, Cool to <6°C	48 Hours
Phosphorus, Total	365.1	250 mL Plastic	H2SO4, Cool to <6°C	28 days
PNAs	8270	(2) I Liter Ambers	Cool to <6°C	7 days/40 days
Semivolatile Organics (BNA)	8270	(2) 1 Liter Ambers	Cool to <6°C	7 days/40 days
Solids	SM 2540 B	250 mL Plastic	Cool to <6°C	7 days
Solids, Settleable	160.5	1 Liter Plastic	Cool to <6°C	48 Hours
Sulfate	300	250 mL Plastic	Cool to <6°C	28 days
Sulfide	SM 4500 S2 F	Call Trace	Call Trace	7 days
Sulfite	SM4500SO3B	BOD bottle	EDTA	Immediate
Surfactants (MBAS)	SM 5540 C	500 mL Plastic	Cool to <6°C	48 Hours
Total Organic Carbon	SM 5310 D	250 mL Plastic	H2SO4, Cool to <6°C	28 days
TPH	418.1	1 Liter Amber	H2SO4, Cool to <6°C	14 days

SAMPLE REQUIREMENTS - WATER SAMPLES (continued)				
Test Parameter	**Method**	**Container**	**Preservative**	**Hold Time**
TOX/AOX	9020	250 mL Amber	H2SO4	28 days
Volatile Organics	8021/8260	(3) 40 mL VOAs	HCl, Cool to <6°C	14 days
Water Content	Karl Fischer	125 mL Plastic	Cool to <6°C	7 days

SAMPLE REQUIREMENTS - SOLID SAMPLES				
Test Parameter	**Method**	**Container**	**Preservative**	**Hold Time**
Cyanide	335.2	4 ounce glass jar	Cool to 4°C	14 days
Flash Point	1010	4 ounce glass jar	Cool to 4°C	ASAP
Herbicides	8150	4 ounce glass jar	Cool to 4°C	14 days/40 days
Hexavalent Chromium	7196	4 ounce glass jar	Cool to 4°C	24 hrs after leach
Mercury	7471	4 ounce glass jar	Cool to 4°C	28 days
Metals	6010/7000	4 ounce glass jar	Cool to 4°C	6 months
Oil & Grease	413.1	4 ounce glass jar	Cool to 4°C	28 days
Paint Filter	9095	4 ounce glass jar	Cool to 4°C	7 days
PCBs	8081	4 ounce glass jar	Cool to 4°C	14 days/40 days
Pesticides	8081	4 ounce glass jar	Cool to 4°C	14 days/40 days
pH	9045	4 ounce glass jar	Cool to 4°C	24 hours
Phosphorus, Total	365.2	4 ounce glass jar	Cool to 4°C	28 days
PNAs	8270	4 ounce glass jar	Cool to 4°C	14 days/40 days
Reactivity	SW 846, Ch. 7	4 ounce glass jar	Cool to 4°C	7 days
Semivolatile Organics (BNA)	8270	4 ounce glass jar	Cool to 4°C	14 days/40 days
Sulfate	375.4	4 ounce glass jar	Cool to 4°C	28 days
TCLP/SPLP	1311/1312	(5) 4 ounce glass jars	Cool to 4°C	14 days
Total Organic Carbon	415.1	4 ounce glass jar	Cool to 4°C	28 days
TPH	418.1	4 ounce glass jar	Cool to 4°C	14 days
Volatile Organics	8021/8260	Methanol/Encor™	Cool to 4°C	48 Hrs/14 days

Appendix III

Method and Reference Sources

Standard Methods For the Examination of Water and Wastewater, A.D. Eaton, et. al, editors, American Water Works Assoc., On-Line.

Methods for Chemical Analysis of Water and Wastes, J.F. Kopp and G.D. McKerr, USEPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-79-020, revised March 1983.

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Official Methods of Analysis, 15th Edition, Kenneth Helrich, ed., Association of Official Analytical Chemists, Arlington, VA, 1990, 1990. (or earlier editions).

Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, published annually.

NIOSH Manual of Analytical Methods, Second and Third Editions, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institutes for Occupational Safety and Health, Division of Physical Sciences and Engineering, Cincinnati, OH, 1981,1984, and updates.

Methods of Soil Analysis, Second Edition, Arnold Klute, Editor, American Society of Agronomy, Inc., Soil Society of America, Inc., Madison, WI, 1986.

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Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH, August 1993.

Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH, June 1991.

Methods for the Determination of Metals in Environmental Samples Supplement, EPA/600/R-94-111, PB95-125472, Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH, May 1994.

Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH, December 1988 (Revised July 1991).

Plumb, R. H., Jr. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples, Technical Report EPA/CE-81-1

Drinking Water Methods and Standard Operating Procedures

Analyte	Analytical Method	TAL SOP #	SOP Title
Total and *E*. Coli	SM 9223B	100-42	The Determination of Total Coliform and *E*. Coli by Presence-Absence
Heterotrophic Plate Count	SM 9215B	100-47	Heterotrophic Plate Count
Barium, Beryllium, Chromium, Copper, Nickel, and Sodium	EPA 200.7	110-2	Analysis of Metals by Inductively Coupled Plasma Atomic Emission Spectroscopy: Method 200.7
Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, and Thallium	EPA 200.8	110-11	Analysis of Metals by Inductively Coupled Plasma Mass Spectroscopy: Method 200.8
Mercury	EPA 245.1	110-7	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry: Method 245.1
Cyanide	EPA 335.4	100-1	The Determination of Total and Amenable Cyanide by Semi-Automated Colorimetry
Nitrite	SM 4500-NO_2-B	100-8	The Determination of Nitrite-Nitrogen by Spectrophotometric Analysis
Fluoride, Nitrate, Nitrite, and Sulfate	EPA 300.0	100-19	The Determination of Inorganic Anions by Ion Chromatography

Appendix IV
Major Equipment List

Wet Chemistry Department

- Lachat QuikChem ® 8500 Instrument with XYZ Sampler (S/N: 101200001292)
- Konelab Aqua 20 (S/N: S2519233)
- Mettler DL-21 auto-titrator with probes for Alkalinity and Chloride analyses (S/N: M06782)
- Kontes Midi Cyanide Distillation Unit
- Dionex DX500 Ion Chromatograph system (S/N: 97030284)
- Dionex ICS-1500 Ion Chromatograph system (S/N: 06120697)
- Perkin Elmer 1650 FT-IR Fouier transformed infra-red spectrophotometer
- Milton Roy Spectronic 21 spectrophotometer (S/N: 3151186012)
- Spectronic Instruments Spectronic Genesys 5 spectrophotometer (S/N: 3V89193004)
- Tekmar Dohrmann Pheonix 8000 TOC Analyzer (S/N: US01170011)
- O.I. Model FS 3000 Available Cyanide Instrument with a Model 5027 sampler (S/N: 351804496)
- Orion Model 830A dissolved oxygen meter
- YSI Model 500 dissolved oxygen meter (S/N: 04B0563)
- Orion Model 122 conductivity meter (S/N: 33294058)
- Euroglass 1200 AOX Analyzer (S/N: 2001.079)
- Pensky-Martens TS-74745 AP-9 flash point tester
- Petrotest Auto Flashpoint Tester (S/N: 0741032203)
- O.I. Analytical CNSolution 3100 Cyanide Analyzer (S/N: 302831499)
- Meile Professional Laboratory Dishwasher G7883 CD

Aquacounter AQV-300 Volumetric Karl Fischer Titrator (S/N: P421008-7)

Metals Department

- Perkin-Elmer NexION 300X Inductively Coupled Plasma Mass Spectrometer (S/N: 81XN3081201)
- Jobin-Yvon Ultima 2 Incuductively Coupled Plasma Atomic Absorption Spectrophotometer with AS421 Autosampler (S/N: 12015684NE)
- Varian 720-ES ICP-OES with Varian SPS 3 Autosampler (S/N: EL06033903)
- CETAC M-6100 Mercury Analyzer with ASX-130 autosampler (S/N: 010901QTA)
- CETAC M-800 Low Level Mercury Analyzer, Atomic Fluorescence Spectrometer (S/N: 061302QMB)
- MARSX Digestion Microwave (S/N: XM3209)
- Hanna Instruments HI 93703 Turbidity Meter (S/N: 453093)

Organics Department

Extractions

- CEM Corporation MARSX Extraction Microwave with 40-position turntable (S/N: MD3921)
- Horizon Technology SPE-1000XL Plus SS Hexane Extractable Materials Analyzer (S/N: 00-007)

GC/MS Volatiles

- Hewlett-Packard 5890 Series II Gas Chromatograph with Electronic Pressure Control and a 5971A Mass Selective Detector coupled with a Tekmar LSC-2000 Purge and Trap Concentrator and an Archon Water / Soil Autosampler. Instrument S/N: 3609A00855. Instrument Name: TRIXIE.
- Hewlett-Packard 5890 Series II Gas Chromatograph with Electronic Pressure Control and a 5972A Mass Selective Detector coupled with a Tekmar LSC-2000 Purge and Trap Concentrator and an Archon (EST Model 8100) water and soil autosampling system. Instrument S/N: 3307A00304. Instrument Name: CASSIE.
- Hewlett-Packard 5890 Series II Gas Chromatograph with 5972 Mass Selective Detector coupled with a Tekmar LSC-2000 Purge and Trap Concentrator and a CENTURION water and soil autosampling system. MS Instrument S/N: 3341A00932. Instrument Name: JACOB.
- Hewlett-Packard GCD Series Gas Chromatograph with Electronic Pressure Control and an EID coupled with a Tekmar LSC-2000 Purge and Trap Concentrator and a CENTURION water and soil autosampling system. Instrument S/N: LR 47359C. Instrument Name: OTIS.

GC Volatiles

- Varian 3300 Gas Chromatograph with O.I. 430 Photo Ionization Detector coupled with a Tekmar LSC-2000 Purge and Trap Concentrator equipped with a Dynatech PTA-30 W/S water and soil autosampling system. Instrument S/N: 4026. Instrument Name: MYRTLE.

- Varian 3400 Gas Chromatograph with dual Varian Flame Ionization Detectors. Instrument S/N: 2066. Instrument Name: HOMER.

- Varian 3400 Gas Chromatograph with Varian Flame Ionization Detectors (S/N: 3520)

GC/MS SemiVolatiles

- Hewlett-Packard 5890 Series II Gas Chromatograph with Electronic Pressure Control equipped with 5971 Mass Selective Detector and 7673A Automatic Injector. Instrument Name: BETA.

- Hewlett-Packard-GCD Series II Gas Chromatograph with Electronic Pressure Control equipped with 5972 Mass Selective Detector and 7673 Automatic Injector. Instrument S/N: US00063331. Instrument Name: STUD.

- Hewlett-Packard Series II Gas Chromatograph with Electronic Pressure Control equipped with 6890 Mass Selective Detector and 6890 Series Injector. Instrument Name: HAWG.

- Hewlett-Packard 5890 Seried II Gas Chromatograph with 5971A Mass Selective Detector and an HP 7673 Controller and Injector. MS S/N: 3188A03554 GC S/N: 3310A47628. Instrument Name: EDWARD

GC SemiVolatiles

- Hewlett-Packard 5890A Gas Chromatograph with dual Split/Splitless injectors and dual Flame Ionization Detectors equipped with a 7673A Automatic Injector. Instrument S/N: 2843A19951. Instrument Name: FRANK.

- Hewlett-Packard 5890A Gas Chromatograph with dual Split/Splitless injectors, an Electron Capture Detector and a 7673A Automatic Injector. Instrument S/N: 2443A04016. Instrument Name: NORTON.

- Hewlett-Packard 5890A Gas Chromatograph with a Universal Injector and a Flame Ionization Detector and an Electron Capture Detector equipped with a 7673A Automatic Injector. Instrument S/N: 87082702. Instrument Name: BACCHUS.

- Varian 3400 Gas Chromatograph with Electron Capture Detector and a Universal Injector equipped with a 8200 autosampler. Instrument S/N: 6552. Instrument Name: DOLLY.

- Varian 3400 Gas Chromatograph with Electron Capture Detector and a Split/Splitless Injector equipped with an 8100 autosampler. Instrument S/N: 8119. Instrument Name: STOSH.

- Varian 3400 Gas Chromatograph with Flame Ionization Detector. Instrument S/N: 15921. Instrument Name: GUS.

- Agilent HPLC 1050 with Diode Array Detector. Instrument S/N: 2840A00296. Instrument Name: ODIN.

- Waters HPLC with Supelco UV/VIS Detector. Instrument S/N: 590-003253. Instrument Name: THOR.

- Agilent 6890 Gas Chromatograph (S/N: US00026897) with Electron Capture Detector (S/N: U2188) equipped with a 7683 autosampler injector and tray. Instrument Name: FREYA.

Mobile Laboratory

- 16 foot custom designed trailer with high purity gas manifolds, refrigerator, air conditioning, heating and sink.

- Mettler BD 202 Balance

- Two (2) 5000 Watt Honda generators

- Hewlett-Packard-MSD Series II Gas Chromatograph with Electronic Pressure Control upgraded to a 5972 Mass Selective Detector coupled with a Tekmar LSC-2000 Purge and Trap Concentrator and a Dynatech PTA-30 autosampling system

Air Quality Department

- Olympus BH-2 (BHSP) Polarized Light Microscope

- Olympus CH-2 (BHSP) Phased Contrast Microscope

- Four (4) SKC personal air sampling pumps

- DC-Lite DryCal calibrator

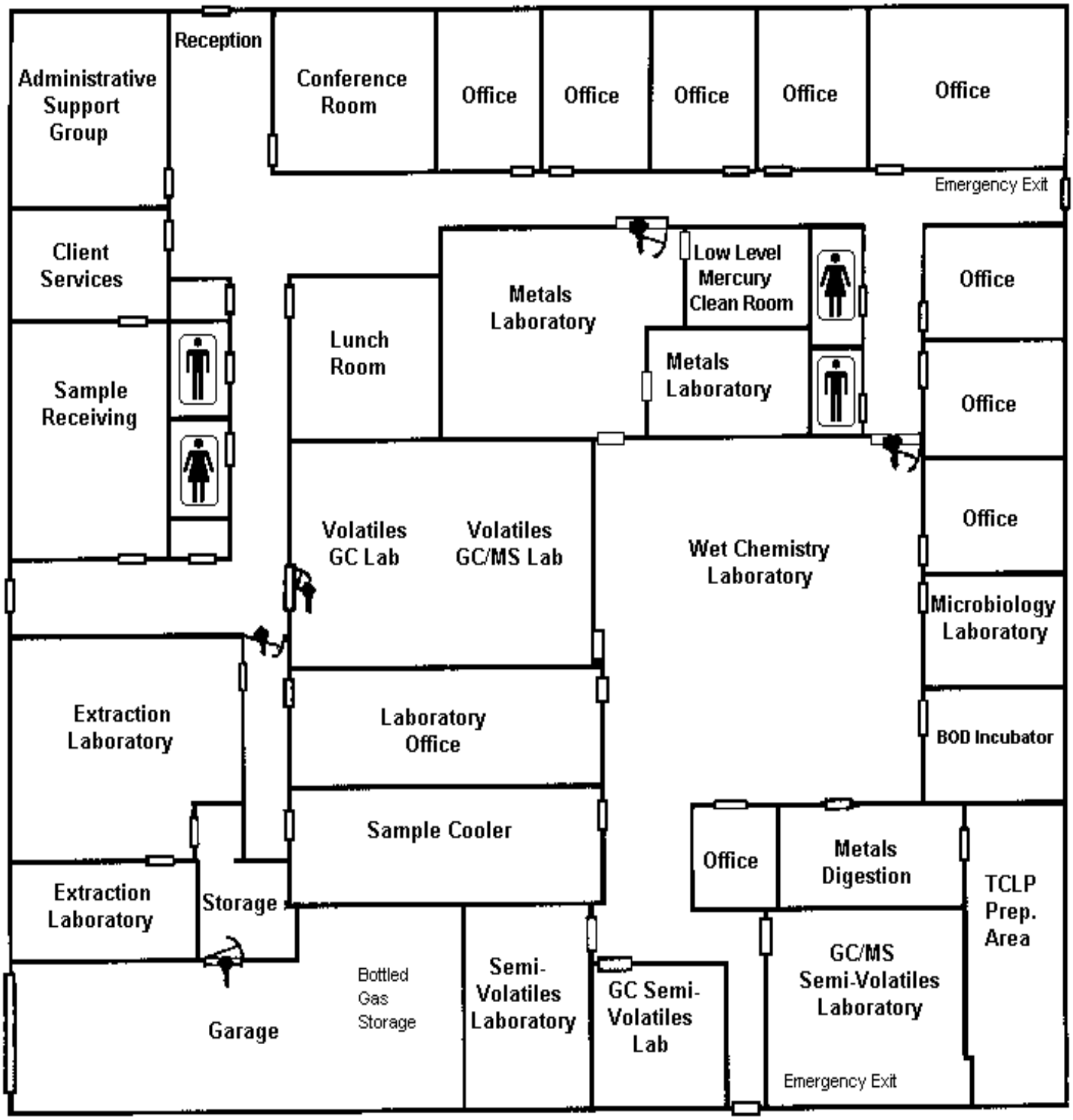
- High Volume air sampling pump

- Bacharach electronic gas analyzer for carbon monoxide

- Bacharach electronic gases meter

Appendix V

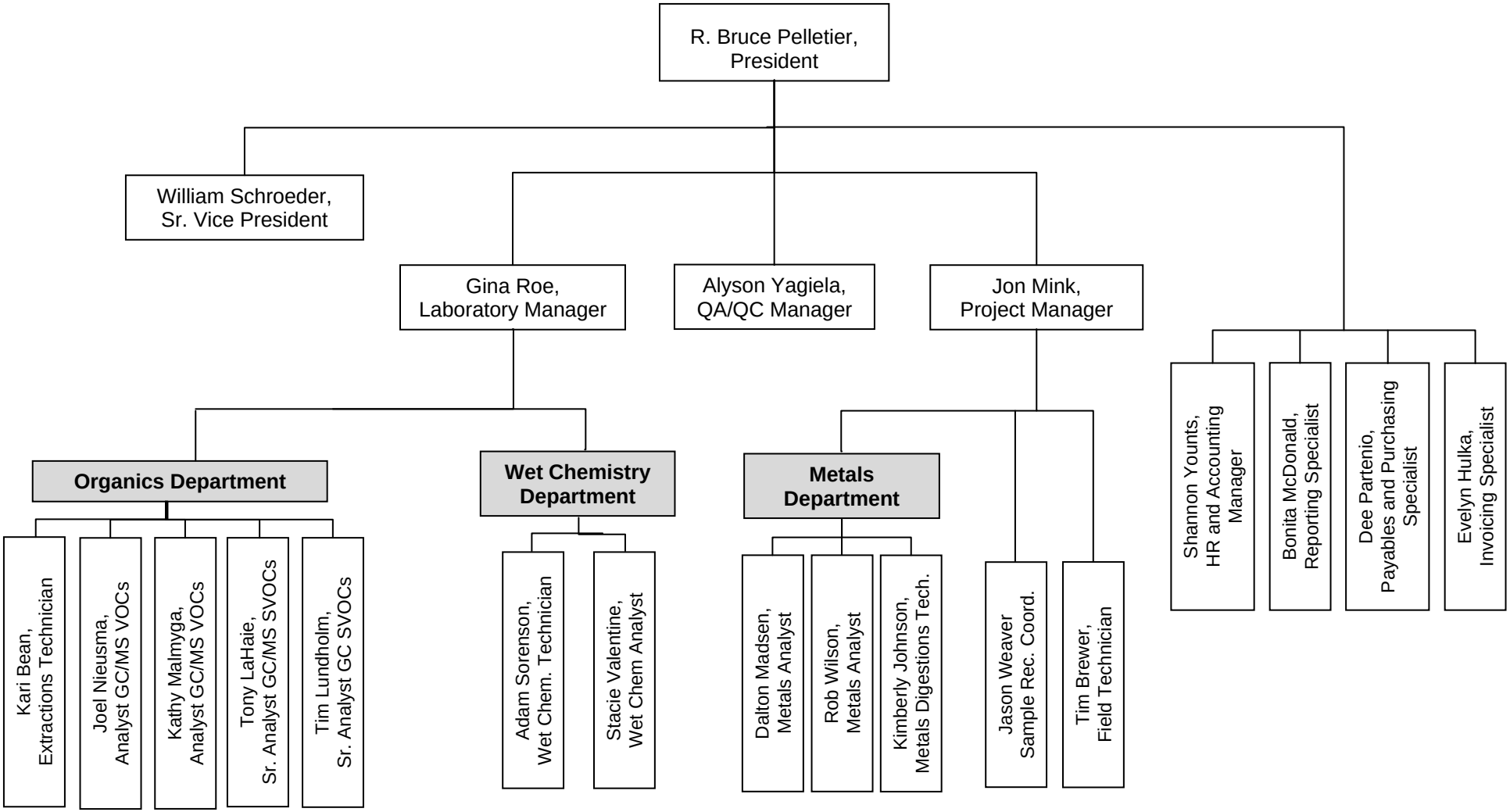
Laboratory Layout



Appendix VI

Organization Chart

May 2014



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Trace Analytical Laboratories, Inc.
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Statement of Qualifications

PJLA Testing
Accreditation# 1031

OVERVIEW

TRACE Analytical Laboratories, Inc. was founded in 1989 by Dr. William Schroeder, a veteran of service in the U.S. Navy that holds a doctorate in chemistry. TRACE is a full service Veteran Owned Small Business environmental laboratory, providing a complete range of environmental analyses and sampling services for our clients. These services include organic and inorganic analyses of water, soil, air, and hazardous waste. All of our routine services conform to strict methodologies from sources such as the US EPA, ASTM, AOAC, NIOSH, and Standard Methods.

TRACE has state-of-the-art analytical instrumentation using proven technology. Part of the Quality Assurance program is obtaining, maintaining, and calibrating equipment and instrumentation that is required to accurately and efficiently carry out analysis of samples as prescribed in analytical test methods. TRACE purchases or prepares appropriate reagents and standards for analyses. Whenever possible these reagents and standards will be ACS grade, spectroquality, or traceable to NIST standards. TRACE collects and receives samples under strict chain-of-custody procedures and adheres to proper sample collection and preservation techniques. The ability to define and defend the analytical process is one of TRACE'S primary Quality Assurance program objectives.

TRACE has substantial experience with servicing the analytical needs of a diverse client base. TRACE is accredited in accordance with the National Environmental Laboratory Accreditation Program (NELAP), the Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), and ISO/IEC 17025:2005. This gives TRACE the ability to provide analytical services to residential, industrial, engineering, and consulting clients, as well as local, state, and federal agencies, including the Department of Defense. TRACE is a Contract Laboratory for the Michigan Department of Natural Resources and Environment, and is Drinking Water Certified by the State of Michigan. Our laboratory continually supports regulatory programs such as CERCLA/SARA, RCRA, Clean Air Act, Safe Drinking Water Act, NPDES and the Clean Water Act.

TRACE's Client Services/Project Management Department works closely with clients and laboratory personnel to ensure all details and project specifications are accurately performed. The Client Services/Project Management Department can assist in project planning, including the preparation of Quality Assurance Project Plans (QAPPs). Working with clients at the onset of a project assures the results are more conclusive and cost-effective.

Personnel:

TRACE Analytical Laboratories, Inc., is comprised of experienced professionals with degrees in chemistry, biology, and environmental science. Our team has specialized training in laboratory operations and experience in the industrial workplace. Their expertise guarantees our clients the range and depth of scientific disciplines, technical specialties, practical experience, and analytical services needed to meet the objectives of today's complex industrial and environmental demands.

Professional resumes for TRACE's key personnel are included in Appendix I.

Laboratory Identification

EPA Laboratory ID:	MI00106
DoD-ELAP Accreditation Number:	1031
New Jersey NELAP Certification ID Number:	MI008
Pennsylvania NELAP Certification ID Number:	68-04471
State Of Michigan Laboratory ID:	8001

How to Contact Trace

Mailing Address:

TRACE Analytical Laboratories, Inc.
2241 Black Creek Road
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Telephone:	(231) 773-5998
Toll Free:	(800) 733-5998
Fax:	(231) 773-6537
Web Site:	www.trace-labs.com
General Email Delivery:	info@trace-labs.com

Appendix I

Resumes of Key Personnel

Trace Analytical Laboratories, Inc.

R. BRUCE PELLETIER, President

The Company President is responsible for the overall operation, planning, organizing, and directing of the laboratory and management staff. Key areas of responsibility are corporate image, client relations, company leadership, employee relations, quality assurance, and financial management.

RESPONSIBILITIES

- Assists with budget development, cash flow management, tax planning, financial strategies and organization of overall financial functions.
- Sets corporate goals and makes recommendations for plans to achieve these goals.
- Works with staff to develop and maintain a strong professional image for the company with respect to its clients, competitors, employees, and the community.
- Provides technical information and advice to clients regarding their projects or proposed projects.
- Oversees and assists with repairs, maintenance and installation of instrumentation. Also oversees facility maintenance.
- Coordinates changes within the laboratory to comply with changing regulatory requirements.
- Assists laboratory staff in writing, reviewing, and implementing SOP's.
- Serves as project coordinator for special or unusual analytical projects that differ from those commonly conducted by the laboratory.
- Reviews proposed projects containing requests for air analyses to determine if the work is within the capabilities of the laboratory.
- Supervises method development and method validation procedures for air quality analyses.
- Trains and qualifies chemists and technicians to analyze air samples in a manner consistent with good quality control practices and procedures.

PROFESSIONAL EXPERIENCE

January 1990 - Present: TRACE Analytical Laboratories, Inc., Muskegon, MI
President and Co-Owner
Air Quality Supervisor, and Special Projects Coordinator.

January 1984 - December 1990: Koch Chemical Company, Inc., Whitehall, MI
Senior Analytical Chemist and Quality Control Director
Supervised a staff of one chemist and three technicians. Responsible for the day to day operations of the FDA approved Product Testing Laboratory. Primary responsibilities included the analyses of incoming raw materials to validate stated purity, analyses of pharmaceutical intermediates to determine reaction completeness, and final product testing to formulate Certificates of Analysis for the final finished products. Additional responsibilities included instrument repair and maintenance, writing and implementation of SOP's. Instrumentation used and maintained for this position included gas chromatographs, high pressure liquid chromatographs, infrared spectrophotometers, visible and UV wavelength scanning spectrophotometers, automatic titrators, refractometers, melting point apparatus, fractional distillation equipment, and precision analytical balances.

May 1977 - December 1983: Aquatic Systems, Inc., Ludington, MI
Laboratory Director
Responsible for the daily operation of the environmental laboratory. Responsibilities included scheduling, instrument repair and maintenance; writing and implementation of SOP's, project management, data review, and the training of laboratory staff. This was a working position that also required the analysis of client samples for wet chemistry, metal, volatile and semi-volatile organic parameters. Instrumentation used and maintained under this position included gas chromatographs,

high pressure liquid chromatographs, atomic absorption spectrophotometers, visible and UV wavelength spectrophotometers, infrared spectrophotometers, and precision analytical balances.

September 1975 - May 1977: Central Michigan University, Mt. Pleasant, MI,
University Instructor for the Biology Department
Responsible for teaching General Biology and Determinative Bacteriology classes under a graduate teaching assistantship. This position required the formulation and presentation of course lectures and laboratory sections. An additional requirement was the advanced preparation of bacteriological culture media and glassware.

October 1975 - May 1977: Three Lakes Association, Inc., Antrim County, MI,
Water Quality Specialist
Responsible to formulate and implement a comprehensive water sampling and analysis program to determine and document the water quality of Torch, Clam, and Bellaire Lakes of Antrim County. Tests conducted on these lakes included bottom dredging and identification of invertebrates, bottom coring for lake aging and sediment profiling, transparency measurements, total phosphorus, ammonia nitrogen, nitrate nitrogen, total organics, and chlorophyll analyses. Additional responsibilities included maintaining all sampling and analytical equipment and to provide written annual reports of all findings to the lake association.

EDUCATION

- **B.S., Aquatic Biology**, Michigan State University,
  Minor in Chemistry

- **M.S., Limnological Studies**, Central Michigan University,

PROFESSIONAL ORGANIZATIONS/CERTIFICATIONS

- American Chemical Society

- Society of American Military Engineers

- Handling Hazardous Materials & Hazardous Materials Operations

- Hazardous Materials-First Responder Operations

Trace Analytical Laboratories, Inc.

WILLIAM SCHROEDER, Ph.D., Senior Vice President

The Senior Vice President is responsible for the overall management of the company in conjunction with the President and Vice President of Business Operations. Ultimate decisions about financial and personnel matters are a primary function. In addition, the Senior Vice President is available to the staff as a technical advisor and chemical consultant. Finally, the Senior Vice President serves as the company representative in community activities and contacts with corporate, political, and environmental entities.

PROFESSIONAL EXPERIENCE

September 1989 – Present: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Co-Owner and Senior Vice President.

1985 - 1989: Baxter International, Muskegon, MI,
Vice President and General Manager of the Burdick and Jackson Division
This position had complete profit and loss responsibilities for a manufacturing operation engaged in the production of highly purified solvents designed for use in sophisticated analytical techniques. Additional responsibilities included the coordination of activities with other corporate interests.

1983 - 1985: American Hospital Supply Corporation, Muskegon, MI,
Vice President and General Manager of the Burdick and Jackson Division
This position had complete profit and loss responsibility for a manufacturing operation engaged in the production of highly purified reagents and the coordination of division sales efforts with corporate national programs.

1978 - 1983: Hofmann LaRoche International, Muskegon, MI,
President of the Burdick and Jackson Division
This position had full profit and loss responsibilities for a manufacturing and research operation designed to broaden the manufacturing interest of the parent company; specifically to develop procedures for the manufacture of chemical intermediates as well as the continuing operation of the purified solvent program.

1974 - 1978: Hofmann LaRoche International, Muskegon, MI,
V.P. Research for the Burdick and Jackson Division
This position was responsible for the development of new procedures for the purification of solvents and the innovative synthesis of organic intermediates for the preparation of new pharmaceuticals.

1965 - 1974: Burdick and Jackson Laboratories, Muskegon, MI,
Vice President of Research and Co-Owner
Responsible for the development of procedures for the preparation of highly purified solvents and the production of intermediates and final drug products for the pharmaceutical industry. These drug products required the inspection of the operation and approval of procedures by the Food and Drug Administration. The development of analytical procedures for testing the purity of both the solvent and drug products was also a requirement.

1958 - 1965: The Upjohn Company, Kalamazoo, MI,
Research Associate
This position was responsible for the research and development of new antibiotics and anti-cancer drugs. A significant result of this activity was the cooperative effort that brought to market the antibiotic Lincocin and its derivatives. This antibiotic has unique properties for the control of deep-seated bone infections.

Trace Analytical Laboratories, Inc.

EDUCATION

- **Ph.D., Organic Chemistry,** Purdue University
- **B.S., Chemistry,** Purdue University

PROFESSIONAL ORGANIZATIONS/CERTIFICATIONS

- American Chemical Society
- Association of Official Analytical Chemists
- Research Associate: Grand Valley State University

Trace Analytical Laboratories, Inc.

GINA ROE, Laboratory Manager

The Laboratory Manager is responsible for all aspects of environmental chemistry as related to clients and projects. The Laboratory Manager is also responsible for the day to day operations of the laboratory.

RESPONSIBILITIES

- Production - Responsible for the overall production of the laboratory, including development of new methods, and scheduling of workloads
- Performance - Insures that the laboratory is meeting requirements regarding quality, procedures, volume, and turnaround. Schedules and reviews analyst certifications, MDL studies and SOP writing. Monitors on-time performance. Conducts annual review of employees.
- Data Validation - Accountable for the data released from the laboratory. Reviews analytical data prior to submission to data reporting, evaluates PE results, and implements corrective actions.
- Budget - Responsible for the development and maintenance of an operating budget.
- Training - Insures that employees are properly trained to meet the requirements of their positions.
- Client Interface - Serves as the in-house representative on all projects requiring technical expertise.
- Planning - Plans for future growth of the laboratory.

PROFESSIONAL EXPERIENCE

July 2010-Present: Trace Analytical Laboratories, Inc., Muskegon, MI, Laboratory Manager

October 2005 – July 2010: Trace Analytical Laboratories, Inc., Muskegon, MI,
Project Manager

February 1997 – October 2005: Trace Analytical Laboratories, Inc., Muskegon, MI,
Senior Analyst
Responsible for GC/MS volatiles and other organic analyses.

February 1990 – February 1997: Trace Analytical Laboratories, Inc., Muskegon, MI,
Analyst
Responsible for Organic, Inorganic, and Metals analysis.

September 1986 – May 1987: Muskegon Community College.
Interim Laboratory Director
Responsible for laboratory set-up for student use, and ordering of supplies.

EDUCATION

- A.A.S., Chemistry, Muskegon Community College

- B.S., Natural Resource Management, Grand Valley State University

Trace Analytical Laboratories, Inc.

JON MINK, Senior Project Manager / Technical Systems Manager

The Project Manager is a liaison between the laboratory and the customers. Also serving as the Technical Systems Manager, responsibilities include sampling services, equipment repair and maintenance, waste management and disposal, LIMS/computer systems management.

RESPONSIBILITIES

- Oversee clients' needs including sampling, sample tracking, and reporting
- Notify clients of exceedances or discrepancies in data
- Supervise and assist field personnel
- Evaluate the ability of the laboratory to perform new methods with existing equipment and personnel.
- Determine project requirements with clients, as pertaining to instrumental and staff capabilities. As necessary develop and implement new analytical methodologies as required by client project needs.
- Set up and oversee laboratory equipment maintenance and preventative maintenance schedules
- Conduct major repairs of analytical equipment with help from the manufacturers technical support staff. If necessary schedule on-site or off-site repair
- Develop, implement, and oversee a plan for the management and disposal of laboratory and sample waste
- Manage LIMS/Computer systems
- Building maintenance

PROFESSIONAL EXPERIENCE

September 1995 – Present: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Project Manager / Technical Systems Manager

July 1993 – September 1995: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Project Manager
The Project Manager was responsible for the management of the mobile analytical services. Duties also included special project management. Included were the selection, set-up, and maintenance of instrumentation.

July 1992 - July 1993: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Application Specialist
Responsible for determining the laboratories abilities to meet specific, non-standard, client analytical requests. Also responsible for the implementation of new EPA analytical methods not currently being performed by the laboratory.

July 1991 - July 1992: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Client Services / Safety Manager
Spoke with clients regarding analytical requirements. Included in this was the determination of proper sample techniques, volumes, containers, preservatives, and hold times. Also worked closely with the laboratory to determine the availability of analytical results and priority sample treatment. Other duties included ordering of supplies needed by the laboratory for day to day operations, and the development of the laboratory safety plan.

Trace Analytical Laboratories, Inc.

September 1990 - July 1991: TRACE Analytical Laboratories, Inc., Muskegon, MI,
Analyst
Performed analyses in all areas of the laboratory. Set-up new equipment for analytical determinations, investigated and implemented new methodologies. Also responsible for field sampling.

January 1984 - September 1988: University of California at San Diego, School of Medicine Pathology Department. La Jolla, California,
Lab Assistant II
Worked with a principal investigator doing research on cholestasis and choleuresis as an electron microscopist and research assistant. Duties included small animal surgeries, tissue harvesting, tissue processing for light microscopy and transmission electron microscopy, electron micrograph development and printing, student assistant supervision, paper writing for journal publication, and laboratory purchasing.

EDUCATION

- **B.A., Microbiology**, University of California, San Diego, Revelle campus
  minors in Physiological Psychology and Chemistry

PROFESSIONAL ORGANIZATIONS/CERTIFICATIONS

- Hazardous Materials Specialist
- Firefighter I & II
- Member Muskegon County Hazmat Team
- Member Muskegon County Urban Search and Rescue Team
- Member Michigan Regional Response Team for Western Michigan District

Trace Analytical Laboratories, Inc.

ALYSON YAGIELA, QA/QC Manager

The QA/QC Manager will make sure that all aspects of the program comply with current and appropriate regulatory requirements, methodologies, and protocols, will coordinate and manage the quality assurance program on a daily basis, and shall keep members of the quality assurance group informed on issues relating to the laboratory quality assurance program.

RESPONSIBILITIES

- Conducts internal and coordinates external laboratory audits.
- Coordinates efforts for state and federal certifications.
- Coordinates changes within the laboratory to comply with changing regulatory requirements.
- Assists laboratory staff in writing, reviewing, and implementing SOP's.
- Maintains Quality Control calculation programs.
- Updates and edits Quality Control Program manual.
- Assists with project quotation preview and review.

PROFESSIONAL EXPERIENCE

May 2011 – Present: TRACE Analytical Laboratories, Inc., Muskegon, MI
QA/QC Manager

February 2007 – May 2011: Mead Johnson Nutrition, Zeeland, MI
Quality Control Laboratory Analyst
Held multiple roles within the QA/QC labs, including the collection, preparation, and analysis of infant formula samples. Worked to update SOPs and analytical methods, which required strict adherence to FDA regulations.

September 2005 – February 2007: Aerotek Scientific, Mead Johnson Nutrition, Zeeland, MI
Quality Assurance Technician
Laboratory sample preparation and analysis using microbial determination methods while complying with FDA regulations.

May 2002 – May 2004: Michigan State University, East Lansing, MI
Master's Degree Candidate / Research Assistantship
Master's thesis research studied the effects of nutrient enrichment on consumers in lacustrine wetlands using stable isotopes. Assisted with Muskegon River Watershed Assessment Project sampling and algal identification.

May 2001 – August 2001: Boston University, Woods Hole, MA
REU – Research Fellow
Worked on a sandplain restoration project and designed/implemented research project to study nitrogen concentrations at the seepage face of Edgartown Great Pond.

September 2000 – April 2001: University of Michigan, Ann Arbor, MI
Assistant-in-Research
Studied historical trends in diatom assemblages and effects on the diets of fish and zooplankton.

May 2000 – August 2000: National Oceanic and Atmospheric Administration, Muskegon, MI
Research Fellow

Studied zooplankton size and population distributions in Lake Michigan.

EDUCATION

- B.S., Resource Ecology & Management, The University of Michigan
- M.S., Zoology, Michigan State University

the science of compliance

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Statement of Qualifications

Accredited in accordance with nelac

PJLA Testing
Accreditation# 1031

OVERVIEW

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TRACE has state-of-the-art analytical instrumentation using proven technology. Part of the Quality Assurance program is obtaining, maintaining, and calibrating equipment and instrumentation that is required to accurately and efficiently carry out analysis of samples as prescribed in analytical test methods. TRACE purchases or prepares appropriate reagents and standards for analyses. Whenever possible these reagents and standards will be ACS grade, spectroquality, or traceable to NIST standards. TRACE collects and receives samples under strict chain-of-custody procedures and adheres to proper sample collection and preservation techniques. The ability to define and defend the analytical process is one of TRACE'S primary Quality Assurance program objectives.

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Appendix VII

List of methods under which Trace performs NELAC accredited analyses

Analyte/Analyte Group	Matrix	Analytical Method(s)
pH	Aqueous	SM 4500 H^+ B, SW 846 9040B, SW 846 9045C
Temperature	Aqueous	EPA 170.1
Turbidity	Aqueous	EPA 180.1
Non-Filterable Residue (TSS)	Aqueous	SM 2540 D
Total Dissolved Solids (TDS)	Aqueous	SM 2540 C
Residue (Total)	Aqueous	SM 2540 B
Calcium Hardness as $CaCO_3$	Aqueous	SM 2340 B
Total Hardness as $CaCO_3$	Aqueous	SM 2340 B
BOD/CBOD	Aqueous	SM 5210 B
COD	Aqueous	EPA 410.4
TOC	Aqueous/Solid	SM 5310 C / Walkley-Black
Ammonia as N	Aqueous	EPA 350.1
Ions by Ion Chromatography	Aqueous/Solid	EPA 300.0, SW 846 9056
Sulfides	Aqueous/Solid	SW 846 9030B, SM 4500 S^{2-} F & D
Ortho-phosphate as P	Aqueous	EPA 365.1
Total Kjeldahl Nitrogen	Aqueous	EPA 351.2
Total phosphorous	Aqueous	SW 846 6010B, EPA 365.2
Cyanide, total	Aqueous	EPA 335.4, EPA 9012A
Phenolics, total	Aqueous	EPA 420.2, SW 846 9065
Grease & Oil	Aqueous	EPA 1664
Alkalinity as $CaCO_3$	Aqueous	SM 2320 B
Conductivity	Aqueous	EPA 120.1
Total Residual Chlorine	Aqueous	SM 4500 Cl^- G
Ignitibility	Aqueous/Waste	SW 846 1010
Metals	Aqueous/Solid	SW 846 6010B, EPA 200.7
Metals	Aqueous/Solid	SW 846 6020, EPA 200.8
Mercury	Aqueous/Solid	SW 846 7470A/7471A
Low-Level Mercury	Aqueous	EPA 1631
Calcium, Magnesium, Potassium, Sodium	Aqueous/Solid	SW 846 6010B, EPA 200.7
Potassium, Sodium	Aqueous	SW 846 6020, EPA 200.8
Hexavalent Chromium	Aqueous/Solid	SM 3500 Cr B, SW 846 7196
Volatiles	Aqueous/Solid	SW 846 8260B, EPA 624
PCBs	Aqueous/Solid/Oil	SW 846 8082
Pesticides	Aqueous/Solid	SW 846 8081A
Herbicides	Aqueous	SW 846 8151A
Semi-Volatiles (BNAs)	Aqueous/Solid	SW 846 8270C, EPA 625
Explosives Residue	Aqueous/Solid	SW 846 8330B
Polynuclear Aromatic Hydrocarbons	Aqueous/Sold	SW 846 8310
TCLP	Aqueous/Solid/Waste	SW 846 1311
SPLP	Aqueous/Solid/Waste	SW 846 1312
Paint Filter	Solid	SW 846 9095A

APPENDIX

E EPA PLUGGING AND ABANDONMENT PLAN - EPA FORM 7540-14 (SEE ATTACHMENT Q)

September 5, 2017

Mr. Grant McHardy
Buckeye Partners, LP
One Greenway Plaza, Suite 600
Houston, TX 77046

Re: Plugging and Abandonment Costs
Proposed Class I Injection Wells BDW 1 through 5

Dear Mr. McHardy:

As required, WSP has completed an estimate for the plugging and abandonment procedures and associated costs for the closure of Buckeye Partners, LP Woodhaven Terminal Wells BDW 1 through 5. Field Plugging procedures provided with this application were used as a basis for this estimate. This estimate reflects current rates applicable to the Midwest for oilfield services including workover rigs, oilfied supplies and cementing equipment. A summary of the major cost elements is provided below. Complete cost estimates are provided as attachments.

WELL NO.	P&A ESTIMATE
BDW-1	$109,895
BDW-2	$112,645
BDW-3	$112,645
BDW-4	$109,895
BDW-5	$112,645
Total	$557,725

Kind regards,

Brandon Schulte
Mgr. Permitting & Well Integrity

Enclosures

WSP USA
Suite 200
16200 Park Row
Houston, TX 77084

Tel.: +1 281 589-5900
Fax: +1 281 759-5164
wsp.com

BUDGET COST ESTIMATE

Client Name:	Buckeye Parterns, LP
Project Name:	P&A Cost Estimate Per Well (Wells 1 & 4)
Date:	09/05/2017
Project No.:	192065A
Estimate By:	Brandon Schulte
Reviewed By:	

Rev. 0

01	**MANAGEMENT COST**		
01	LABOR - OFFICE		$6,260
02	LABOR - FIELD		$4,800
03	EXPENSES		$2,200
04	MISCELLANEOUS		$0
05	SPECIAL LABOR & SERVICES		$0
06	SPECIAL EXPENSES		$0
	SUBTOTAL - 01 MANAGEMENT COST		**$13,260**
02	**SERVICES AND RENTALS**		
01	LOCATION		$0
02	RIG MOBILIZATION/DEMOBILIZATION		$0
03	DRILLING RIG		$0
04	FUEL		$0
05	DRILLING WATER		$0
06	DRILLING FLUIDS & SOLIDS CONTROL		$0
07	BITS, HOLE OPENERS, AND UNDERREAMERS		$0
08	RENTAL TOOLS, FISHING TOOLS AND SERVICES		$10,600
09	DIRECTIONAL DRILLING		$0
10	CEMENT, CEMENT SERVICES, HARDWARE		$22,500
11	LOGGING, PERFORATING & WIRELINE SERVICES		$0
12	CORING & CORE ANALYSIS		$0
13	WORKOVER RIG		$25,000
14	MUDLOGGING, RESERVOIR TESTING & ANALYSIS, ETC.		$0
15	STIMULATION, NITROGEN, PUMP TRUCKS		$0
16	CASING CREWS & TOOLS, EXT. TESTERS, SPEAR SERVICES		$5,500
17	WELDING		$1,250
18	TESTING , INSPECTION, & REPAIR SERVICES		$0
19	TRANSPORTATION		$5,000
20	HAULING, VACUUM TRUCKS & DISPOSAL		$0
21	MISCELLANEOUS MATERIALS & SUPPLIES		$0
22	MISCELLANEOUS SERVICES & EQUIPMENT		$10,500
23	SITE COMMUNICATIONS		$0
24	HEALTH, SAFETY & ENVIRONMENTAL		$0
25	CONSULTANTS AND SPECIAL SERVICES		$0
	SUBTOTAL - 02 SUBCONTRACTS, SERVICES, RENTALS		**$80,350**
03	**MATERIALS**		
01	CASING		$0
02	WELLHEAD EQUIPMENT		$0
03	COMPLETION EQUIPMENT		$7,500
	SUBTOTAL - 03 MATERIALS		**$7,500**
04	**TAXES**		
01	SALES TAX - LOCAL & STATE - INCLUDED IN LINE ITEMS		
02	CONTRACTOR'S TAX	**0%**	$0
	SUBTOTAL - 04 TAXES		**$0**
05	**PROJECT CONTINGENCIES**		
01	SERVICES	**0%**	$0
02	MATERIALS	**0%**	$0
	SUBTOTAL - 05 PROJECT CONTINGENCIES		**$0**
06	**PROJECT MANAGEMENT FEES**		
01	SERVICES	**10%**	$8,035
02	MATERIALS	**10%**	$750
	SUBTOTAL - 06 PROJECT MANAGEMENT FEES		**$8,785**
	TOTAL COST ESTIMATE		**$109,895**

BUDGET COST ESTIMATE

Client Name:	Buckeye Parterns, LP
Project Name:	P&A Cost Estimate Per Well (Wells 2, 3, & 5)
Date:	09/05/2017
Project No.:	192065A
Estimate By:	Brandon Schulte
Reviewed By:	

Rev. 0

01	**MANAGEMENT COST**		
01	LABOR - OFFICE		$6,260
02	LABOR - FIELD		$4,800
03	EXPENSES		$2,200
04	MISCELLANEOUS		$0
05	SPECIAL LABOR & SERVICES		$0
06	SPECIAL EXPENSES		$0
	SUBTOTAL - 01 MANAGEMENT COST		**$13,260**
02	**SERVICES AND RENTALS**		
01	LOCATION		$0
02	RIG MOBILIZATION/DEMOBILIZATION		$0
03	DRILLING RIG		$0
04	FUEL		$0
05	DRILLING WATER		$0
06	DRILLING FLUIDS & SOLIDS CONTROL		$0
07	BITS, HOLE OPENERS, AND UNDERREAMERS		$0
08	RENTAL TOOLS, FISHING TOOLS AND SERVICES		$10,600
09	DIRECTIONAL DRILLING		$0
10	CEMENT, CEMENT SERVICES, HARDWARE		$25,000
11	LOGGING, PERFORATING & WIRELINE SERVICES		$0
12	CORING & CORE ANALYSIS		$0
13	WORKOVER RIG		$25,000
14	MUDLOGGING, RESERVOIR TESTING & ANALYSIS, ETC.		$0
15	STIMULATION, NITROGEN, PUMP TRUCKS		$0
16	CASING CREWS & TOOLS, EXT. TESTERS, SPEAR SERVICES		$5,500
17	WELDING		$1,250
18	TESTING , INSPECTION, & REPAIR SERVICES		$0
19	TRANSPORTATION		$5,000
20	HAULING, VACUUM TRUCKS & DISPOSAL		$0
21	MISCELLANEOUS MATERIALS & SUPPLIES		$0
22	MISCELLANEOUS SERVICES & EQUIPMENT		$10,500
23	SITE COMMUNICATIONS		$0
24	HEALTH, SAFETY & ENVIRONMENTAL		$0
25	CONSULTANTS AND SPECIAL SERVICES		$0
	SUBTOTAL - 02 SUBCONTRACTS, SERVICES, RENTALS		**$82,850**
03	**MATERIALS**		
01	CASING		$0
02	WELLHEAD EQUIPMENT		$0
03	COMPLETION EQUIPMENT		$7,500
	SUBTOTAL - 03 MATERIALS		**$7,500**
04	**TAXES**		
01	SALES TAX - LOCAL & STATE - INCLUDED IN LINE ITEMS		
02	CONTRACTOR'S TAX	**0%**	$0
	SUBTOTAL - 04 TAXES		**$0**
05	**PROJECT CONTINGENCIES**		
01	SERVICES	**0%**	$0
02	MATERIALS	**0%**	$0
	SUBTOTAL - 05 PROJECT CONTINGENCIES		**$0**
06	**PROJECT MANAGEMENT FEES**		
01	SERVICES	**10%**	$8,285
02	MATERIALS	**10%**	$750
	SUBTOTAL - 06 PROJECT MANAGEMENT FEES		**$9,035**
	TOTAL COST ESTIMATE		**$112,645**

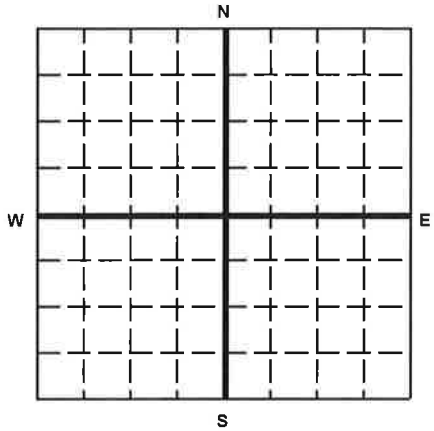
OMB No. 2040-0042 Approval Expires 12/31/2018

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Buckeye Woodhaven Terminal Woodhaven, MI	Buckeye Terminals, LLC

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Michigan	Wayne	

Surface Location Description

nw 1/4 of NE 1/4 of nw 1/4 of NE 1/4 of Section 22 Township 04S Range 10E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION

- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name

WELL ACTIVITY

- [x] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number BDW-1

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20	133		50	Driven
13 3/8	61		470	17 1/2
9 5/8	40		1310	12 1/4
5 1/2	15.5		3490	8 3/4

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8 3/4	4.95 (ID)	4.95 (ID)	4.95 (ID)			
Depth to Bottom of Tubing or Drill Pipe (ft	3730	3250	450	250			
Sacks of Cement To Be Used (each plug)	132	6.2	25	31.1			
Slurry Volume To Be Pumped (cu. ft.)	156	7.4	29.4	36.8			
Calculated Top of Plug (ft.)	3270	3200	250	0			
Measured Top of Plug (If tagged ft.)	3270	3200	250	0			
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6	15.6			
Type Cement or Other Material (Class III)	H	H	H	H			

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3730	3490		

Estimated Cost to Plug Wells

$109,895

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Carl A. Ostach, VP Domestic Field Operations	Carl A. Ostach	12/15/17

Paperwork Reduction Act Notice

The public reporting and record keeping burden for this collection of information is estimated to average 4.5 hours for operators of Class I hazardous wells, 1.5 hours for operators of Class I non-hazardous wells, 3 hours for operators of Class II wells, and 1.5 hours for operators of Class III wells.
Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to the collection of information; search data sources; complete and review the collection of information; and, transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9 and 48 CFR Chapter 15.
Please send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques to Director, Office of Environmental Information, Collection Strategies Division, U.S. Environmental Protection Agency (2822), Ariel Rios Building, 1200 Pennsylvania Ave., NW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW., Washington, DC 20503, Attention: Desk Officer for EPA. Please include the EPA ICR number and OMB control number in any correspondence.

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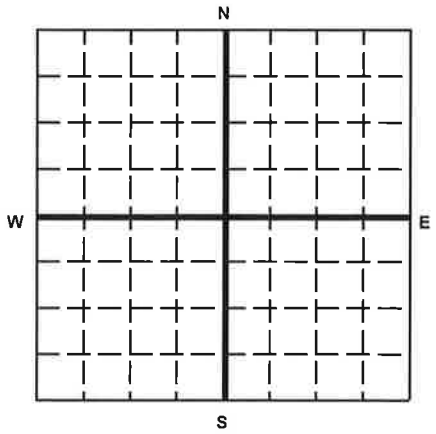
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Buckeye Woodhaven Terminal Woodhaven, MI	Buckeye Terminals, LLC

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Michigan	Wayne	

Surface Location Description

nw 1/4 of NE 1/4 of nw 1/4 of NE 1/4 of Section 22 Township 04S Range 10E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ___ ft. frm (N/S) ___ Line of quarter section and ___ ft. from (E/W) ___ Line of quarter section.

TYPE OF AUTHORIZATION

- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name

WELL ACTIVITY

- [x] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number BDW-2

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20	133		50	Driven
13 3/8	61		470	17 1/2
9 5/8	40		1310	12 1/4
5 1/2	15.5		3490	8 3/4

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8 3/4	4.95 (ID)	4.95 (ID)	4.95 (ID)			
Depth to Bottom of Tubing or Drill Pipe (ft	3730	3250	450	250			
Sacks of Cement To Be Used (each plug)	152	7.2	25	31.1			
Slurry Volume To Be Pumped (cu. ft.)	180	8.5	29.4	36.8			
Calculated Top of Plug (ft.)	3270	3200	250	0			
Measured Top of Plug (If tagged ft.)	3270	3200	250	0			
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6	15.6			
Type Cement or Other Material (Class III)	H	H	H	H			

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3730	3490		

Estimated Cost to Plug Wells

$112,645

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Carl A. Ostach, VP Domestic Field Operations	Carl A. Ostach	12/15/17

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Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

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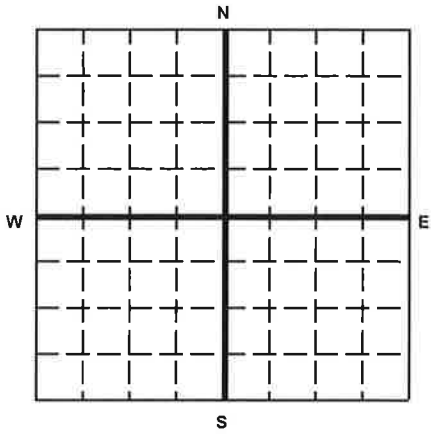

State	County	Permit Number
Michigan	Wayne	

Surface Location Description

NE 1/4 of NE 1/4 of sw 1/4 of NE 1/4 of Section 22 Township 04S Range 10E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION

- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name

WELL ACTIVITY

- [x] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number BDW-3

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20	133		50	Driven
13 3/8	61		470	17 1/2
9 5/8	40		1310	12 1/4
5 1/2	15.5		3490	8 3/4

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8 3/4	4.95 (ID)	4.95 (ID)	4.95 (ID)			
Depth to Bottom of Tubing or Drill Pipe (ft	3730	3250	450	250			
Sacks of Cement To Be Used (each plug)	152	7.2	25	31.1			
Slurry Volume To Be Pumped (cu. ft.)	180	8.5	29.4	36.8			
Calculated Top of Plug (ft.)	3270	3200	250	0			
Measured Top of Plug (if tagged ft.)	3270	3200	250	0			
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6	15.6			
Type Cement or Other Material (Class III)	H	H	H	H			

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3730	3490		

Estimated Cost to Plug Wells

$112,645

Certification

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Name and Official Title *(Please type or print)*	Signature	Date Signed
Carl A. Ostach, VP Domestic Field Operations	Carl A. Ostach	12/15/17

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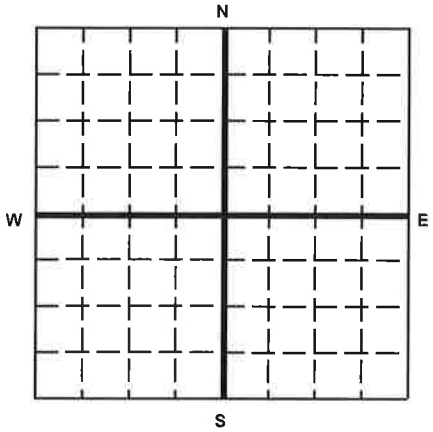
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Buckeye Woodhaven Terminal
Woodhaven, MI

Name and Address of Owner/Operator
Buckeye Terminals, LLC

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Michigan	Wayne	

Surface Location Description
NE 1/4 of NE 1/4 of S 1/4 of NE 1/4 of Section 22 Township 04S Range 10E

Locate well in two directions from nearest lines of quarter section and drilling unit
Surface Location ____ ft. frm (N/S) ____ Line of quarter section
and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name

WELL ACTIVITY
- [x] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number BDW-4

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20	133		50	Driven
13 3/8	61		470	17 1/2
9 5/8	40		1310	12 1/4
5 1/2	15.5		3490	8 3/4

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8 3/4	4.95 (ID)	4.95 (ID)	4.95 (ID)			
Depth to Bottom of Tubing or Drill Pipe (ft	3730	3250	450	250			
Sacks of Cement To Be Used (each plug)	132	6.2	25	31.1			
Slurry Volume To Be Pumped (cu. ft.)	156	7.4	29.4	36.8			
Calculated Top of Plug (ft.)	3270	3200	250	0			
Measured Top of Plug (if tagged ft.)	3270	3200	250	0			
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6	15.6			
Type Cement or Other Material (Class III)	H	H	H	H			

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3730	3490		

Estimated Cost to Plug Wells
$109,895

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Carl A. Ostach, VP Domestic Field Operations	Carl A. Ostach	12/15/17

Paperwork Reduction Act Notice

The public reporting and record keeping burden for this collection of information is estimated to average 4.5 hours for operators of Class I hazardous wells, 1.5 hours for operators of Class I non-hazardous wells, 3 hours for operators of Class II wells, and 1.5 hours for operators of Class III wells.
Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to the collection of information; search data sources; complete and review the collection of information; and, transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9 and 48 CFR Chapter 15.
Please send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques to Director, Office of Environmental Information, Collection Strategies Division, U.S. Environmental Protection Agency (2822), Ariel Rios Building, 1200 Pennsylvania Ave., NW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW., Washington, DC 20503, Attention: Desk Officer for EPA. Please include the EPA ICR number and OMB control number in any correspondence.

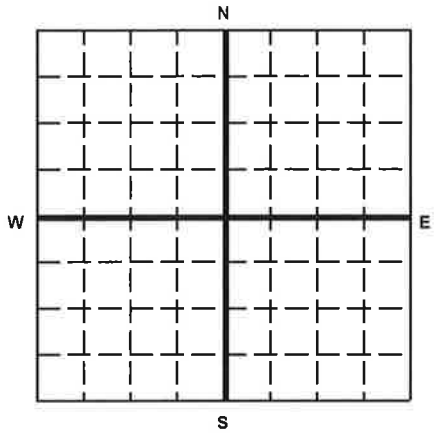
OMB No. 2040-0042 Approval Expires 12/31/2018

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Buckeye Woodhaven Terminal Woodhaven, MI	Buckeye Terminals, LLC

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Michigan	Wayne	

Surface Location Description

NE 1/4 of NE 1/4 of sw 1/4 of NE 1/4 of Section 22 Township 04S Range 10E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION

- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name

WELL ACTIVITY

- [x] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number BDW-5

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20	133		50	Driven
13 3/8	61		470	17 1/2
9 5/8	40		1310	12 1/4
5 1/2	15.5		3490	8 3/4

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8 3/4	4.95 (ID)	4.95 (ID)	4.95 (ID)			
Depth to Bottom of Tubing or Drill Pipe (ft	3730	3250	450	250			
Sacks of Cement To Be Used (each plug)	152	7.2	25	31.1			
Slurry Volume To Be Pumped (cu. ft.)	180	8.5	29.4	36.8			
Calculated Top of Plug (ft.)	3270	3200	250	0			
Measured Top of Plug (if tagged ft.)	3270	3200	250	0			
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6	15.6			
Type Cement or Other Material (Class III)	H	H	H	H			

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (If any)

From	To	From	To
3730	3490		

Estimated Cost to Plug Wells

$112,645

Certification

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