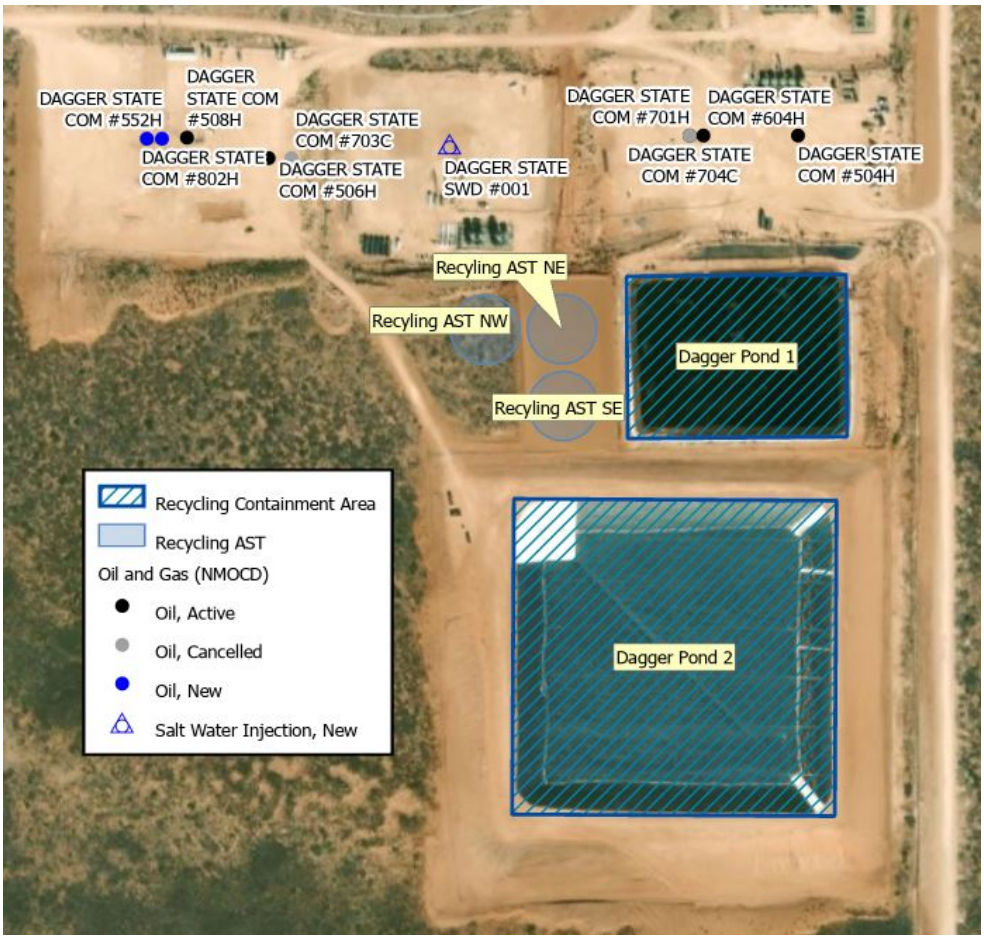
July, 2020

Volume 2 C-147 Registration Package for Dagger Recycling Facility -

Above-Ground Steel Tank Containments #1(NE), #2(NW) and #3(SE) Section 30, T21-S, R33-E, Lea County



Prepared for:

Advance Energy Partners Hat Mesa, LLC

11490 Westheimer Rd. STE 950

Houston, TX 77077 Lea County

Prepared by:
R.T. Hicks Consultants, Ltd.
901 Rio Grande NW F-142
Albuquerque, New Mexico

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745
Artesia ▲ Carlsbad ▲ Durango ▲ Midland

July 29, 2020

Ms. Susan Lucas Kamat
NMOCD
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-Mail Susan.LucasKamat@state.nm.us

RE: Advance Energy Partners Hat Mesa, LLC Dagger Recycling Facility Flow-Through ASTs
Section 30, T21-S, R33-E, Lea County

Dear Ms. Kamat Lucas:

On behalf of Advance Energy Partners Hat Mesa, R.T. Hicks Consultants submits the attached modification to the Dagger 2 permit application (RF Pending). This modification identifies three existing AST containments associated with the Dagger 2 Recycling Facility. The package follows the order of Form 147 to allow for an easier review.

Submitted is Volume 2 as an amendment to the previously submitted C 147 package for the Dagger 2 In Ground Containment (RF Pending)

The following elements of the submission are germane to your review:

a. A C 147 modification with information specific to the AST containments.
b. Schematic of liner application.
c. Engineering drawings of the AST containments stamped by a Registered Engineer.
d. SOP and liner specifications.
e. Design, operational and closure plans for the AST containments.
f. Variances applicable to the Dagger AST containments with Technical Memorandums supporting engineering variances.
g. Stamped letters from Ron Frobel PE discussing the applicability of engineering variances to a wide variety of site conditions for AST Containments; CV included.
h. C 148 monthly reports (note that AST #1 has not been used)

The liner system meets or exceeds what is defined in the rule and will provide equal or better protection of fresh water, public health and the environment. The primary liner is a dual 40 mil LLDPE that is supported by an engineer signed variance for a 40 mil LLDPE primary and secondary system. The secondary liner (60 mil HDPE) is notably more robust than the 30 mil LLDPEr advised in the rule. The 60-mil HDPE liner has a *hydraulic conductivity no greater 1 x 10-9 cm/sec and it meets or exceeds the EPA SW-846 method 9090A or subsequent relevant publications*. (See liner specifications and letter from Solmax). Therefore, a variance for use of the 60-mil HDPE liner is not required. The required leak detection system includes 200 mil Geonet that is placed between the primary liner system and the secondary liner, as defined in the rule, and extends beyond the tank bottom, readily allowing observance of any leakage through the two 40 mil primary liners and allow for removal of any seepage.

At present, Advance plans to construct a secondary containment around the ASTs as shown in Figures 1 and 2, following the Form C-147. The 60-mil secondary liner will either be attached to a vertical steel wall (as is common with tank batteries) or anchored to a berm with rule defined slope,

the inside grade will be no steeper than two horizontal feet to one vertical foot (2H: 1V) and the outside grade no steeper than three horizontal feet to one vertical foot (3H: IV). Please refer to schematics, modified C 147 and associated variances.

I have personally evaluated the applicability of all non-engineering variances to the text of Rule 34 listed below. In my opinion, these variances, all of which have been previously approved by OCD, are applicable to the location of the Dagger 2 Recycling facility and all containments in the Permian Basin of New Mexico:

- Alternative chloride testing method
- Slope and Anchor Trench
- Freeboard

We urge OCD to carefully evaluate the freeboard variance arguments in the discussion by Mr. Frobel. The denial of this variance request for the Quail Ranch Air Gap AST was surprising to us and if this variance is also denied, we would appreciate an explanation of OCD logic

In compliance with 19.15.34.10 of the Rule, this submission this modification is transmitted to the State Land Office who is the owner of the surface.

If you have any questions or concerns regarding this registration or the attached C-147, please contact me. As always, we appreciate your work ethic and attention to detail.

Sincerely,
R.T. Hicks Consultants

Randall T. Hicks PG
Principal

Copy: Advance Energy Partners Hat Mesa, David Harwell
New Mexico State Land Office, Ryan Mann

C-147

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources
Department
Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-147
Revised April 3, 2017

Recycling Facility and/or Recycling Containment

Type of Facility: ☒ Recycling Facility ☒ Recycling Containment*****

Type of action: ☒ Permit ☒ Registration
☒ Modification/addition of AST information ☐ Extension
☐ Closure ☐ Other (explain)

*** At the time C-147 is submitted to the division for a Recycling Containment, a copy shall be provided to the surface owner.**

Be advised that approval of this request does not relieve the operator of liability should operations result in pollution of surface water, ground water or the environment. Nor does approval relieve the operator of its responsibility to comply with any other applicable governmental authority's rules, regulations or ordinances.

1.

Operator: : Advance Energy Partners, LLC OGRID #: 372417

Address: 11490 Westheimer Rd. STE 950, Houston, TX 77077

Facility or well name (include API# if associated with a well): Dagger 2 Recycling Facility: AST #1, #2 and #3

OCD Permit Number: _____(For new facilities the permit number will be assigned by the district office)

U/L or Qtr/Qtr _____ Section 30 Township 21S Range 33E County: Lea

Surface Owner: ☐ Federal ☒ State ☐ Private ☐ Tribal Trust or Indian Allotment

2.

☒ **Recycling Facility**: **Dagger Recycling facility**

Location of (if applicable): Latitude 32.448103° Longitude -103.607381° NAD83 (Approximate)

Proposed Use: ☒ Drilling* ☒ Completion* ☒ Production* ☒ Plugging *

****The re-use of produced water may NOT be used until fresh water zones are cased and cemented***

☐ Other, ***requires permit for other uses. Describe use, process, testing, volume of produced water and ensure there will be no adverse impact on groundwater or surface water.***

☒ Fluid Storage

☒ Above ground tanks ☒ Recycling containment ☐ Activity permitted under 19.15.17 NMAC explain type_____

☐ Activity permitted under 19.15.36 NMAC explain type:_____ ☐ Other explain _____

☐ For multiple or additional recycling containments, attach design and location information of each containment

☐ **Closure Report (required within 60 days of closure completion)**: ☐ Recycling Facility Closure Completion Date:_____

3.

☒ **Recycling Containment**: **AST #1** **(NE Tank)** Associated with Dagger 2 Containment (RF Pending)_

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable) Latitude 32.4488580° Longitude -103.6066425° NAD83 (Approximate)

☒ For multiple or additional recycling containments, attach design and location information of each containment: **all are adjacent to Dagger 1 and Dagger 2 in ground containments**

☒ Lined ☐ Liner type: Thickness __Secondary 60 mil HDPE_Primary dual 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other

_____

☐ String-Reinforced

Liner Seams: ☒ Welded ☐ Factory ☐ Other _ Volume: 40,000 bbl Dimensions: (Inside dimensions) Diameter 153 ft; Height 12 ft 4 in

☐ Recycling Containment Closure Completion Date:_____

3.

☒ **Recycling Containment: AST #2 (NW Tank)** Associated with Dagger 2 Containment (RF Pending)

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable) Latitude 32.4488108° Longitude -103.6072052° NAD83 (Approximate)

☒ For multiple or additional recycling containments, attach design and location information of each containment: **all are adjacent to Dagger 1 and Dagger 2 in ground containments**

☒ Lined ☐ Liner type: Thickness __Secondary 60_mil HDPE_ Primary Dual 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other

_____

☐ String-Reinforced

Liner Seams: ☒ Welded ☐ Factory ☐ Other _ Volume: 40,000 bbl Dimensions: (Inside dimensions) Diameter 153 ft; Height 12 ft 4 in

☐ Recycling Containment Closure Completion Date:_____

3.

☒ **Recycling Containment: AST #3 (SE Tank)** Associated with Dagger 2 Containment (RF Pending)

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable) Latitude 32.4483441° Longitude -103.6066551° NAD83 (Approximate)

☒ For multiple or additional recycling containments, attach design and location information of each containment: **all are adjacent to Dagger 1 and Dagger 2 in ground containments**

☒ Lined ☐ Liner type: Thickness __Secondary 60_mil HDPE_ Primary Dual 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other

_____

☐ String-Reinforced

Liner Seams: ☒ Welded ☐ Factory ☐ Other _ Volume: 40,000 bbl Dimensions: (Inside dimensions) Diameter 153 ft; Height 12 ft 4 in

☐ Recycling Containment Closure Completion Date:_____

4.

Bonding:

☒ Covered under bonding pursuant to 19.15.8 NMAC per 19.15.34.15(A)(2) NMAC **(These containments are limited to only the wells owned or operated by the owners of the containment.)**

☐ Bonding in accordance with 19.15.34.15(A)(1). Amount of bond _____ **(work on these facilities cannot commence until bonding amounts are approved)**

☐ Attach closure cost estimate and documentation on how the closure cost was calculated.

5.

Fencing:

☒ Four foot height, four strands of barbed wire evenly spaced between one and four feet

☐ Alternate. Please specify_____

6.

Signs:

☒ 12"x 24", 2" lettering, providing Operator's name, site location, and emergency telephone numbers

☐ Signed in compliance with 19.15.16.8 NMAC

7.

Variances:

Justifications and/or demonstrations that the proposed variance will afford reasonable protection against contamination of fresh water, human health, and the environment.

Check the below box only if a variance is requested:

☒ Variance(s): Requests must be submitted to the appropriate division district for consideration of approval. If a Variance is requested, include the variance information on a separate page and attach it to the C-147 as part of the application.

If a Variance is requested, it must be approved prior to implementation.

8.
Siting Criteria for Recycling Containment

Instructions: The applicant must provide attachments that demonstrate compliance for each siting criteria below as part of the application. Potential examples of the siting attachment source material are provided below under each criteria.

General siting See Dagger 2 Registration/Permit C-147 (RF Pending)

Ground water is less than 50 feet below the bottom of the Recycling Containment. NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells FIGURES 1-2	☐ Yes ☒ No ☐ NA
Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended. - Written confirmation or verification from the municipality; written approval obtained from the municipality FIGURE 3	☐ Yes ☒ No ☐ NA
Within the area overlying a subsurface mine. - Written confirmation or verification or map from the NM EMNRD-Mining and Minerals Division FIGURE 4	☐ Yes ☒ No
Within an unstable area. - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; topographic map FIGURE 5	☐ Yes ☒ No
Within a 100-year floodplain. FEMA map FIGURE 6	☐ Yes ☒ No
Within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; visual inspection (certification) of the proposed site FIGURE 7	☐ Yes ☒ No
Within 1000 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; aerial photo; satellite image FIGURE 8	☐ Yes ☒ No
Within 500 horizontal feet of a spring or a fresh water well used for domestic or stock watering purposes, in existence at the time of initial application. FIGURES 1 and 7 - NM Office of the State Engineer - iWATERS database search; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 500 feet of a wetland. FIGURE 9 - US Fish and Wildlife Wetland Identification map; topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No

9.
Recycling Facility and/or Containment Checklist:
Instructions: Each of the following items must be attached to the application. Indicate, by a check mark in the box, that the documents are attached.

- ☒ Design Plan - based upon the appropriate requirements.
- ☒ Operating and Maintenance Plan - based upon the appropriate requirements.
- ☒ Closure Plan - based upon the appropriate requirements.
- ☒ Site Specific Groundwater Data -
- ☒ Siting Criteria Compliance Demonstrations –
- ☒ **Certify that notice of the C-147 (only) has been sent to the surface owner(s)**

10.
Operator Application Certification:
I hereby certify that the information and attachments submitted with this application are true, accurate and complete to the best of my knowledge and belief.

Name (Print): David Harwell Title: Vice President Engineering/Operations

Signature: David Harwell Date: 7/29/2020

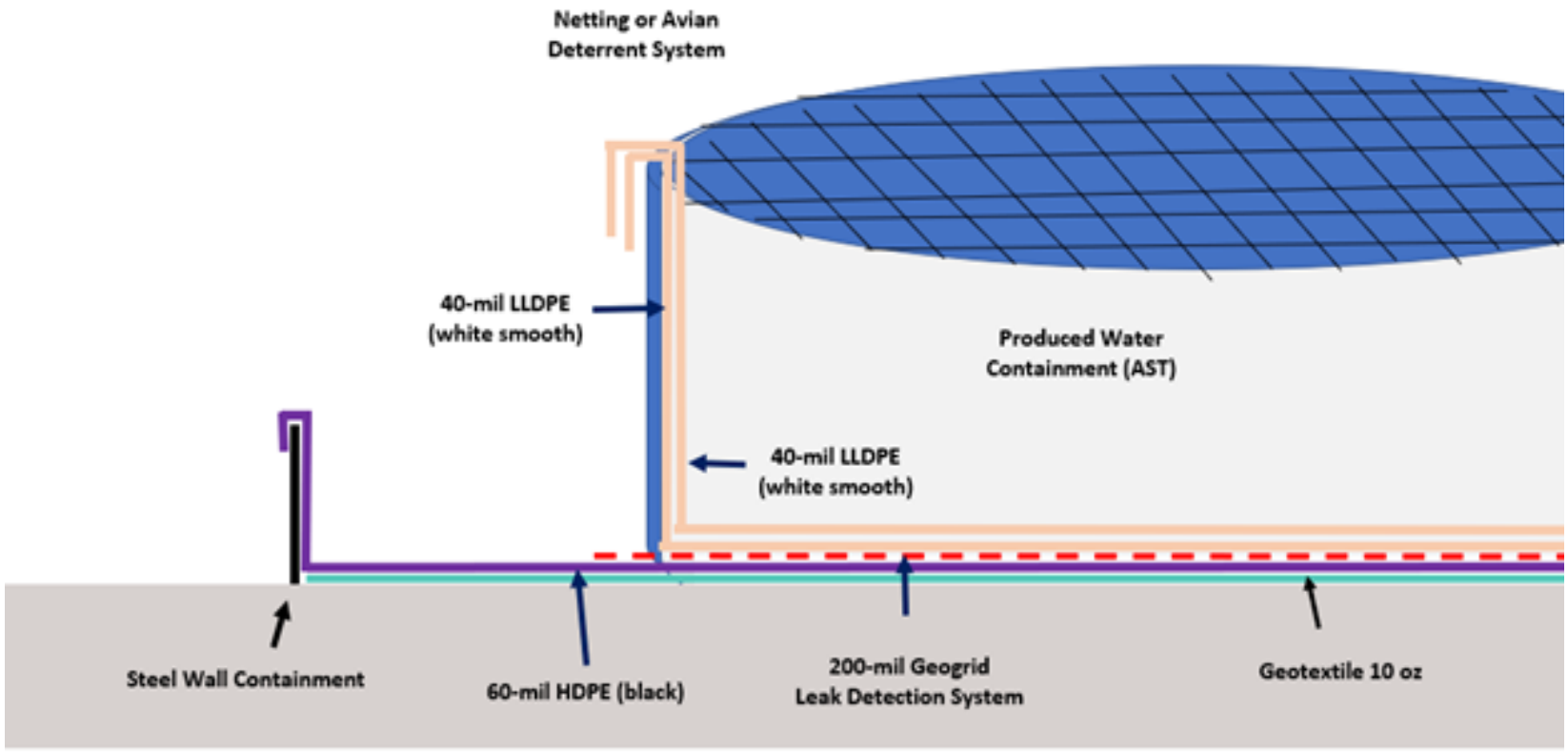
e-mail address DHarwell@advanceenergypartners.com Telephone: 832-672-4604

11.
OCD Representative Signature: _____ **Approval Date:** _____

Title: _____ **OCD Permit Number:**_____

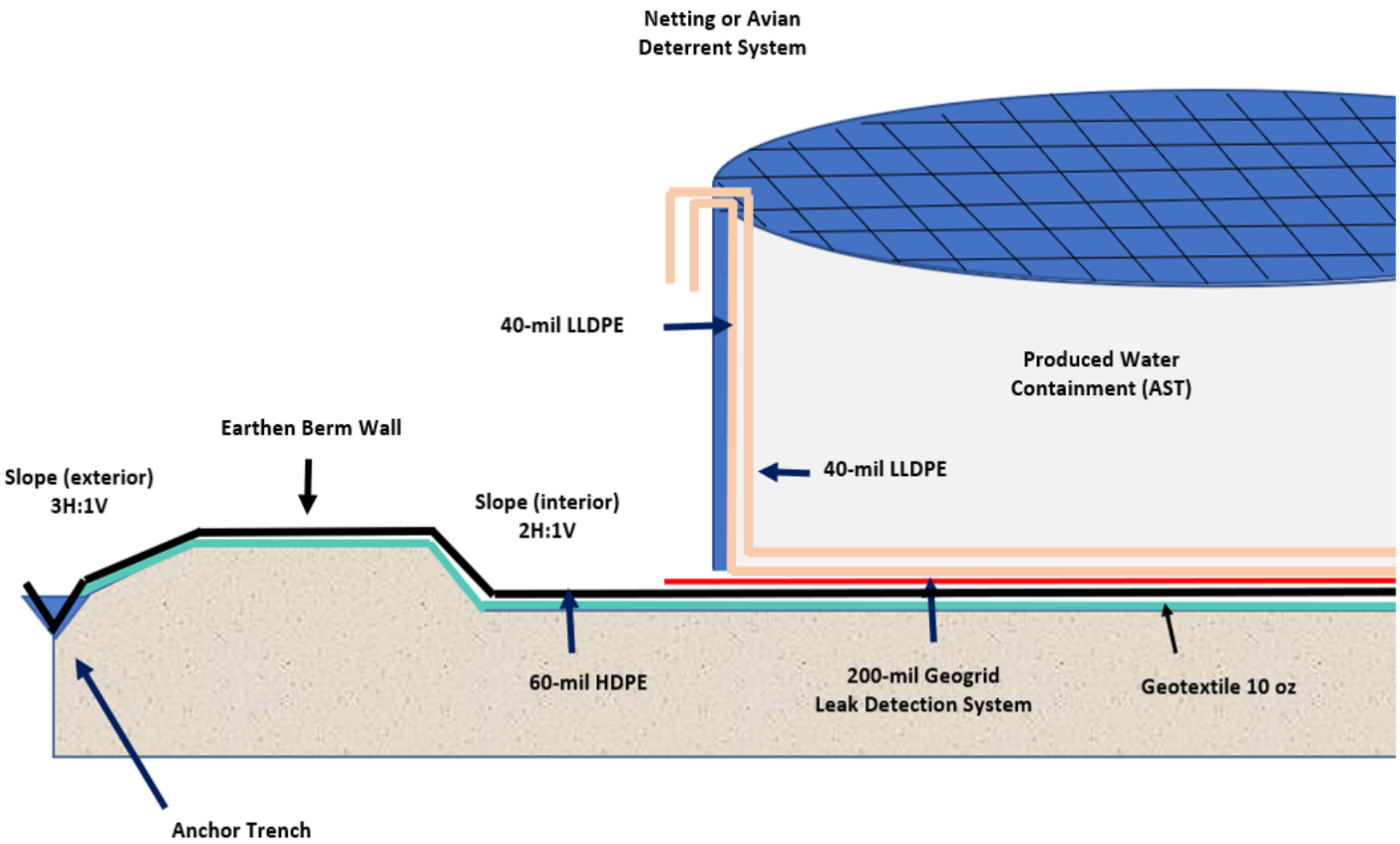
☐ OCD Conditions _____

☐ Additional OCD Conditions on Attachment



Not to Scale

R.T. HICKS CONSULTANTS, LTD. 901 Rio Grande Blvd NW Suite F142 Albuquerque, NM 87104 Office Ph: 505.266.5004	AST Schematic	Plate 1
	Dagger Pond 2 Recycling Facility	July 2020



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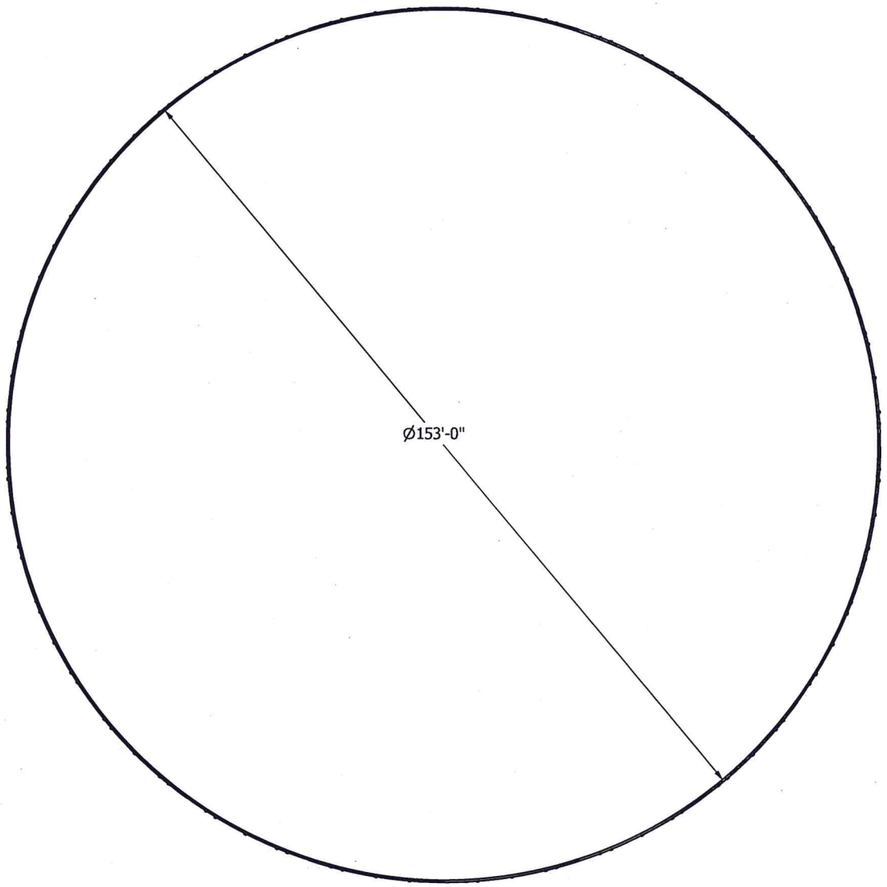
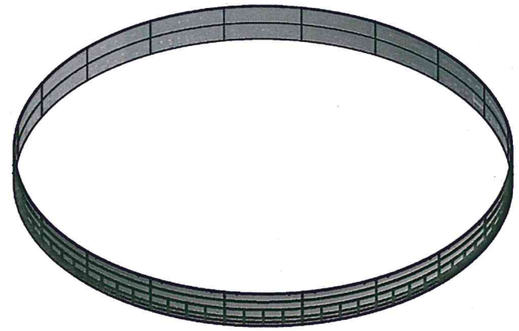
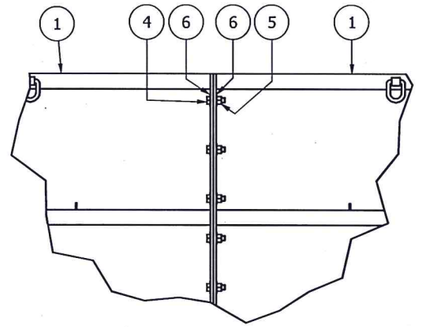
R.T. HICKS CONSULTANTS, LTD. 901 Rio Grande Blvd NW Suite F142 Albuquerque, NM 87104 Office Ph: 505.266.5004	AST Schematic	Plate 2
	Dagger Pond 2 Recycling Facility	July 2020

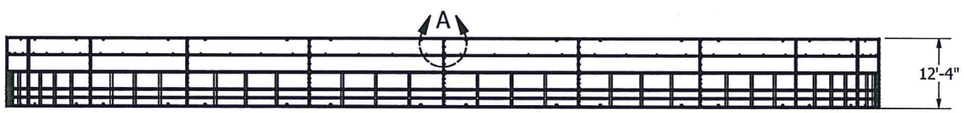
RECYCLING CONTAINMENT DESIGN DRAWINGS







DETAIL A



COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
CHARLES R. GOSS
No. 40569-E

9 Sept 2013

ITEM	QTY	PART NUMBER	DESCRIPTION	REV
7	96	4X4X4 LUMBER	4" x 4" x 48" Lumber (NOT SHOWN)	-
6	600	WASH-200-1-1/4	1-1/4" ASTM F436 Galvanized Structural Washer	-
5	300	NUT-200-1-1/4-7	1-1/4"-7 ASTM A563 Gr DH Galvanized Hex Nut	-
4	300	BOLT-1-1/4-4331	1-1/4"-7 x 4" ASTM A490 Structural Bolt	-
3	20	ETC-106	.063" X 8" X 168" RUBBER SHEET (NOT SHOWN)	-
2	4	MWC-SA-008	Shipping Support	-
1	20	MWC-SA-002	CORRAL WALL SECTION	A

PARTS LIST

NEXT ASSY | USED ON
APPLICATION
THIRD ANGLE PROJECTION

INTERPRET DIMENSIONS AND TOLERANCES IAW ASME Y14.5-2009 UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES (MM)
FRACTIONAL ± 1/8(6.4)
.XX = ±.25(6.4)
.XXX = ±.125(3.2)
.XXXX = ±.060(1.5)
ANGULAR ± 1°
125

MATERIAL
THICKNESS: NA | WEIGHT: N/A

DRAWN BY: mspeciale
DATE: 6/4/2012
CHECKED BY: dbodenshatz
DATE: 11/23/2012
APPROVED: mspeciale
DATE: 11/23/2012

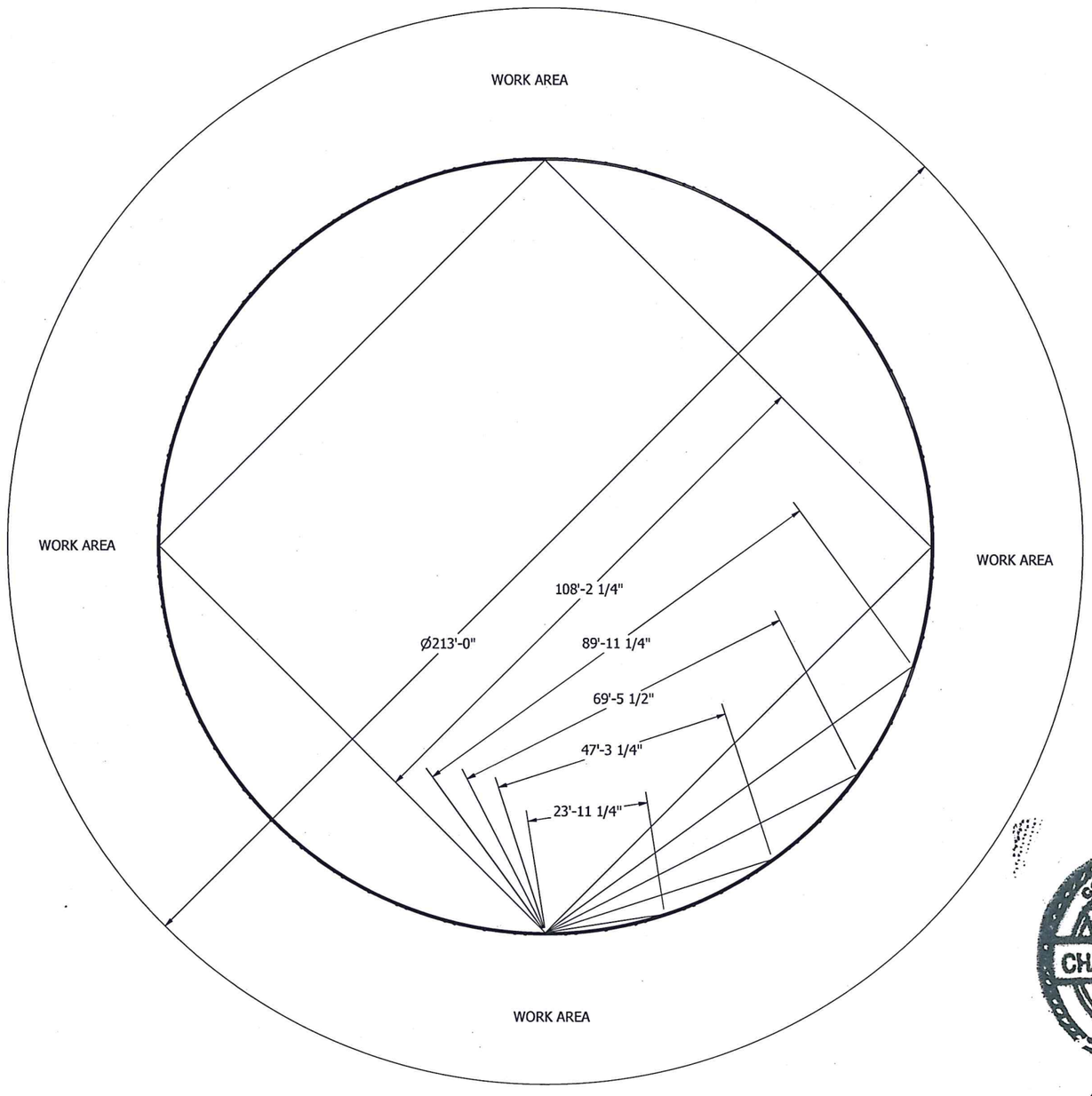
ETC
Environmental Tank & Container
JOHNSTOWN, PA
855-382-8265
www.etctank.com

TITLE: 40,000 BBL MOBILE WATER CORRAL, BOLT-UP DESIGN

SIZE: C | PRT. NO.: MWC-A-002 | REV: -
SCALE: DO NOT SCALE | DWG. NO.: MWC-A-002 | SHEET 1 OF 2
LOCATION: C:_Vault\ETCVault_Corrals\MWC-A-002.iam

NOTES:

1. MINIMUM OF 30 FEET OF WORK AREA AROUND CORRAL SUGGESTED
2. OVER ALL SITE MUST BE LEVEL TO +/- .50 INCH
3. RING AREA WHERE CORRAL PANELS WILL BE SETUP MUST BE LEVEL TO +/- .25 INCH
4. SOIL REPORT MUST MEET ASTM D-698A, 90% OR GREATER
5. BUILD A 12" X 12" SAND INSIDE CORNER RELIEF BEFORE INSTALLING LINER
6. MUST USE 1"-1/4"-7 X 4" GRADE A490 STRUCTURAL BOLTS
7. PANELS MUST HAVE ALL CONNECTING BOLTS TIGHTENED AND LINER FULLY SECURED BEFORE ADDING WATER
8. TOTAL VOLUME OF 1,696,200 GALLONS



COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
CHARLES R. GOSS
NO. 40569-E

9 Sept 2013

NEXT ASSY / USED ON	
APPLICATION	
THIRD ANGLE PROJECTION	
INTERPRET DIMENSIONS AND TOLERANCES IAW ASME Y14.5-2009 UNLESS OTHERWISE SPECIFIED	DIMENSIONS ARE IN INCHES (MM)
FRACTIONAL ± 1/4(6.4)	
.XX = ±.25(6.4)	
.XXX = ±.125(3.2)	
.XXXX = ±.060(1.5)	
ANGULAR ± 1°	
125	
MATERIAL	
THICKNESS: NA	WEIGHT: N/A
DRAWN BY: mspeciale	DATE: 6/4/2012
CHECKED BY: dbodenshatz	DATE: 11/23/2012
APPROVED: mspeciale	DATE: 11/23/2012
LOCATION: C:_Vault\ETCVault_Corrals\MWC-A-002.iam	

ETC
Environmental Tank & Container
JOHNSTOWN, PA
855-382-8265
www.etctank.com

TITLE: 40,000 BBL MOBILE WATER CORRAL, BOLT-UP DESIGN

SIZE	PRT. NO.	REV
C	MWC-A-002	-
SCALE: DO NOT SCALE	DWG. NO. MWC-A-002	SHEET 2 OF 2

Policy Template

APPROVALS

*All approvals are maintained and controlled By **OPERATIONS MANAGEMENT***

*Please refer to the **SOP MANUAL** for the current controlled revision and approval records.*

REVISION HISTORY

AUTHOR	*REVISED SECTION/PARAGRAPH*	*REV*	*RELEASED*
Jeff Anderson	**INITIAL RELEASE**	02	

Draft and Archived/Obsolete revisions are not to be used.

Table of Contents

1. PURPOSE

This procedure is being implemented to standardize the process for installing Epic 360 Tanks and to ensure the quality from a standardized plan.

2. SCOPE

This procedure applies to the installations of 10,000bbl, 22,000bbl, 40,000bbl, and 60,000bbl Epic Tanks

3. DEFINITIONS

- Epic 360 Tank – Above ground tank used for water containment. Permanent or temporary structure used in industrial processes where large volumes of water are needed.
- Secondary Containment – Usually a "steel wall" type of containment that surrounds the perimeter of the Epic tank and serves as safeguard if leaks were to occur.

4. RESPONSIBILITIES

- SOP process owner –On-Site Epic Supervisor designated by management
- On-site Epic Supervisor – Ensure that SOP is strictly followed as the source for correct assembly and installation of Epic Tanks and their secondary containments.
- Crew Leader – Follow direction given by the On-Site Supervisor and managing their crew in a safe and productive manner
- Crew – Labor portion of the assembly/installation process
- Safety Coordinator – Ensuring that safety standards are being followed by the On-Site Supervisor, Crew Leader, and Crew. This is attained through audits and evaluation.
- Quality Director – Performs a post-completion inspection and ensures that the tank was built to customer specifications.
- Regulatory/Document Coordinator – Compile and file appropriate inspections and quality control documentation.

5. POLICY

Procedure for installing Epic 360 Tanks.

5.1 Prepare Surface Area

- Assure ground surface is within 1" of level grade. This is checked by the On-Site Epic Supervisor.
- If level, find the center of tank location and mark ground with paint. Determine radius of tank and mark ground for footprint of the tank.
- Obtain textile and appropriate liner, as determined by customer or internal specifications.

5.2 Ground Cover Installation

- Determine whether the tank requires a secondary containment to achieve 110% containment, spill containment, or tank only installation.

- Apply textile to the entire footprint of the tank, including secondary tank if applicable. Re-mark the painted footprint on top of the textile to serve as a guide for the wall panel placement.
- Apply liner material over the textile extending it 15 feet past the edge of the tank footprint.
- Fold the liner back toward the center of the tank footprint allowing sufficient space to place the wall panels.

5.3 Tank Wall Assembly

- Panels weight 8,600 lbs. each. A 10,000--11,000 lb Telehandler or greater must be used when handling and installing these panels. Use **Extreme Caution** when performing this process.
- Wall Assembly cannot take place if winds exceed 15 mph.
- Hold a safety meeting to determine who the signal person will be. The designated signal person will be the **ONLY** person to give direction to the Telehandler operator. However, anyone can give the **STOP** signal.
- Using rate and certified lift chains, attach two (2) hooks to the top of the wall panel.
- Attach tag lines to the bottom of the wall panel to assist in guiding the panel during installation.
- Equipment operator will place the wall panel in its designated location. While still supported by chains and the telehandler, install six (6) braces on the wall panel – three (3) braces on the inside of the wall and three (3) on the outside of the wall. Once the braces are installed, the lift chains can be removed.
- Install second wall panel following the same process. Once the second wall panel is in place, bolt the panels together. Be sure to leave the braces in place until at least half of the panels are installed.
- Repeat this process until the entire circumference is complete.

5.4 Tank Liner Installation

- The On-Site Supervisor and Safety Coordinator will determine if entry into the tank would be considered "confined space entry". If designated as such, a confined space permit will be obtained and only those designated personnel will be permitted to enter.
- Liner install cannot take place if winds are over 10-15 mph.
- Attach pull line to the edge of the liner and pull line over top of the wall panels.
- Secure liner to the top of the wall panels using the (3) clamps per panel. While clamping, inspect the liner to ensure it is not in a "stressed" condition and be sure to leave enough slack so that the liner can conform to the walls once the tank is filled with water.
- Trim any excess liner material from the outer edge of the tank wall

5.5 Final Installation

- The tank is now ready for the necessary access ladders and discharge hoses to be installed.
- Remove all excess material from the property and dispose of appropriately.

5.6 Final Inspection

- The Quality Director will inspect the completed build to ensure that it was built to the customer specifications.

6. APPLICABLE REFERENCES

- Epic Tank Supervisor

TECHNICAL DATA SHEET

LLDPE Series, 40 mils

White Reflective, Smooth

2801 Boul. Marie-Victorin Varennes, Quebec Canada J3X 1P7
Tel: (450) 929-1234 Sales: (450) 929-2544 Toll free in North America:1-800-571-3904 www.Solmax.com www.solmax.com

PROPERTY	TEST METHOD	FREQUENCY[1]	UNIT Imperial	
SPECIFICATIONS				
Thickness (min. avg.)	ASTM D5199	Every roll	mils	40.0
Thickness (min.)	ASTM D5199	Every roll	mils	36.0
Melt Index - 190/2.16 (max.)	ASTM D1238	1/Batch	g/10 min	1.0
Sheet Density (8)	ASTM D792	Every 10 rolls	g/cc	≤ 0.939
Carbon Black Content	ASTM D4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D5596	Every 10 rolls	Category	Cat. 1 & Cat. 2
OIT - standard (avg.)	ASTM D3895	1/Batch	min	100
Tensile Properties (min. avg) (2)	ASTM D6693	Every 2 rolls		
Strength at Break			ppi	168
Elongation at Break			%	800
2% Modulus (max.)	ASTM D5323	Per formulation	ppi	2400
Tear Resistance (min. avg.)	ASTM D1004	Every 5 rolls	lbf	22
Puncture Resistance (min. avg.)	ASTM D4833	Every 5 rolls	lbf	62
Dimensional Stability	ASTM D1204	Certified	%	± 2
Multi-Axial Tensile (min.)	ASTM D5617	Per formulation	%	30
Oven Aging - % retained after 90 days	ASTM D5721	Per formulation (5)		
STD OIT (min. avg.)	ASTM D3895		%	35
HP OIT (min. avg.)	ASTM D5885		%	60
UV Resistance - % retained after 1600 hr	ASTM D7238	Per formulation (5)		
HP-OIT (min. avg.)	ASTM D5885		%	35
Low Temperature Brittleness	ASTM D746	Certified	°F	- 106
SUPPLY SPECIFICATIONS (Roll dimensions may vary ±1%)				
Color (one side) (4)		-		White

NOTES

1. Testing frequency based on standard roll dimension and one batch is approximately 180,000 lbs (or one railcar).
2. Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
4. Smooth edge may not have the same consistent shade of color as the membrane itself. The colored layer may cause the carbon black content results to be higher than 3%.
5. Certified by core (black) formulation on geomembrane roll or molded plaque.
8. Correlation table is available for ASTM D792 vs ASTM D1505. Both methods give the same results.

* All values are nominal test results, except when specified as minimum or maximum.
* The information contained herein is provided for reference purposes only and is not intended as a warranty of guarantee. Final determination of suitability for use contemplated is the sole responsability of the user. SOLMAX assumes no liability in connection with the use of this information.

Solmax is not a design professional and has not performed any design services to determine if Solmax's goods comply with any project plans or specifications, or with the application or use of Solmax's goods to any particular system, project, purpose, installation or specification.

LIST OF GEOMEMBRANE ROLLS

SOLMAX

Solmax, 2801 Boul. Marie-Victorin, Varennes, Qc, Canada, J3X 1P7
Tél.: 1-450-929-1234 • Fax.: 1-450-929-2547 • www.solmax.com

SOLMAX APPROVED Quality Assurance

Project Name : PO 3292-2 - Odessa, TX

Project Number : 3292-2

Reference Number : 111550

Packing Slip Number : 224726

Roll Number	Product Code	Resin Lot Number	Manufactured Date	Resin Melt Index 190/2.16 g/10 min D1238	Resin Density g/cc D1505	OIT Spec Result min D3895	HPOIT Spec Result min D5885	ESCR SP-NCTL Spec Roll Tested hours D5397
LLDPE 40 mils White Reflective Smooth								
5-35524	1008348-56350-1	CJB810750	23-mars-18	0.32	0.919	*100* > 120		N/A
5-35539	1008348-56350-1	CJB810750	24-mars-18	0.32	0.919	*100* > 120		N/A
5-35540	1008348-56350-1	CJB810750	24-mars-18	0.32	0.919	*100* > 120		N/A
5-35542	1008348-56350-1	CJB810500	24-mars-18	0.36	0.919	*100* > 120		N/A
5-35543	1008348-56350-1	CJB810500	24-mars-18	0.36	0.919	*100* > 120		N/A
5-35550	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A
5-35551	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A
5-35552	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A
5-35553	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A
5-35554	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A
5-35556	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A
5-35557	1008348-56350-1	CJB810500	25-mars-18	0.36	0.919	*100* > 120		N/A

Quantity (rolls) : **12**

Solmax is not a design professional and has not performed any design services to determine if Solmax's goods comply with any project plans or specifications, or with the application or use of Solmax's goods to any particular system, project, purpose, installation or specification.

SOLMAX

MANUFACTURING QUALITY CONTROL

Test Results - Rolls

Solmax, 2801 Boul. Marie-Victorin, Varennes, Qc, Canada, J3X 1P7
Tél.: 1-450-929-1234 • Fax.: 1-450-929-2547 • www.solmax.com

Project Name PO 3292-2 - Odessa, TX

Reference Number : 111550

Project Number : 3292-2

Packing Slip Number : 224726

SOLMAX APPROVED Quality Assurance

Product 1008348-56350-1

LLDPE 40 mils White Reflective Smooth

CE Certificate = LL-40-SS-WB

Properties		Thickness ave / min.	Geo-membrane Density	Carbon Black Content	Carbon Black Dispersion	Tensile Yield Strength	Tensile Yield Elong.	Tensile Break Strength	Tensile Break Elong.	Tear Resist.	Puncture Resist.	Dimension. Stability	Asperity Height in / out
Unit		mils	g/cc	%	Cat. 1 and 2	ppi	%	ppi	%	lbs	lbs	%	mils
Test Method		D5199	D1505/D792	D4218 / D1603	D5596	D6693				D1004	D4833	D1204	
Frequency		Each roll		1/2 ro	1/10 ro	1/2 ro				1/5 ro	1/5 ro	Certied	N/A
Specification		40.0 / 36.0	≤ 0.939	2.0 - 3.0	Cat. 1 _ Cat. 2			168	800	22	62	± 2	
5-35524	MD	40.6 / 39	0.937	2.68	10 /10 Views			211	873	25.7	92.9		/
	XD							214	980	27.1			
5-35539	MD	40.1 / 39	0.937	2.25	10 /10 Views			211	864	25.6	90.4		/
	XD							197	915	26.9			
5-35540	MD	40.4 / 39	0.937	2.25	10 /10 Views			211	864	25.1	88.9		/
	XD							197	915	27.3			
5-35542	MD	40.6 / 39	0.937	2.39	10 /10 Views			210	860	25.1	88.9		/
	XD							206	939	27.3			
5-35543	MD	40.6 / 39	0.937	2.23	10 /10 Views			213	866	25.1	88.9		/
	XD							209	942	27.3			
5-35550	MD	41.4 / 40	0.936	2.59	10 /10 Views			221	913	25.9	88.6		/
	XD							217	1011	27.7			
5-35551	MD	40.7 / 39	0.936	2.68	10 /10 Views			215	878	25.9	88.6		/
	XD							222	1031	27.7			
5-35552	MD	40.9 / 39	0.936	2.68	10 /10 Views			215	878	25.9	88.6		/
	XD							222	1031	27.7			
5-35553	MD	40.8 / 39	0.937	2.83	10 /10 Views			218	894	25.0	90.9		/
	XD							220	1028	27.2			
5-35554	MD	40.9 / 40	0.937	2.83	10 /10 Views			218	894	25.0	90.9		/
	XD							220	1028	27.2			
5-35556	MD	40.6 / 39	0.937	2.59	10 /10 Views			210	855	25.0	90.9		/
	XD							216	1021	27.2			
5-35557	MD	40.8 / 40	0.937	2.51	10 /10 Views			225	926	25.0	90.9		/
	XD							216	1001	27.2			

CoA Date: 02/13/2018

Certificate of Analysis

Shipped To: SOLMAX
2801 BOUL MARIE-VICTORIN
VARENNES QC J3X 1P7
CANADA

Recipient: Marcotte
Fax:

Delivery #: 89611704
PO #: 116755-0
Weight: 188300.000 LB
Ship Date: 02/13/2018
Package: BULK
Mode: Hopper Car
Car #: CPCX815050
Seal No: 110664

Product:
MARLEX 7104 POLYETHYLENE in Bulk
Additive levels have been tested and meet minimum the specification for this lot.
As a result, Standard OIT (by ASTM D 3895) is greater than 120 minutes (nominal value, not tested on every lot).

Lot Number: CJB810500

Property	Test Method	Value	Unit
Melt Index	ASTM D1238	0.36	g/10min
Density	D1505	0.919	g/cm3

The data set forth herein have been carefully compiled by Chevron Phillips Chemical Company LP (CPChem).
However, there is no warranty of any kind, either expressed or implied, applicable to its use, and the user assumes all risk and liability in connection therewith.

KEVIN AYRES
QUALITY ASSURANCE SUPERINTENDENT

For CoA questions contact Melissa Alexander at +-832-813-4244

CoA Date: 02/14/2018

Certificate of Analysis

Shipped To: SOLMAX
2801 BOUL MARIE-VICTORIN
VARENNES QC J3X 1P7
CANADA

Recipient: Marcotte
Fax:

Delivery #: 89612650
PO #: 116787-0
Weight: 196150.000 LB
Ship Date: 02/14/2018
Package: BULK
Mode: Hopper Car
Car #: NAHX620433
Seal No: 122023

Product:
MARLEX 7104 POLYETHYLENE in Bulk
Additive levels have been tested and meet minimum the specification for this lot.
As a result, Standard OIT (by ASTM D 3895) is greater than 120 minutes (nominal value, not tested on every lot).

Lot Number: CJB810750

Property	Test Method	Value	Unit
Melt Index	ASTM D1238	0.32	g/10min
Density	D1505	0.919	g/cm3

The data set forth herein have been carefully compiled by Chevron Phillips Chemical Company LP (CPChem).
However, there is no warranty of any kind, either expressed or implied, applicable to its use, and the user assumes all risk and liability in connection therewith.

KEVIN AYRES
QUALITY ASSURANCE SUPERINTENDENT

For CoA questions contact Melissa Alexander at +-832-813-4244

TECHNICAL DATA SHEET

HDPE Series, 60 mils

Black, Smooth

2801 Boul. Marie-Victorin Varennes, Quebec Canada J3X 1P7
Tel: (450) 929-1234 Sales: (450) 929-2544 Toll free in North America:1-800-571-3904 www.Solmax.com www.solmax.com

PROPERTY	TEST METHOD	FREQUENCY[1]	UNIT Imperial	
SPECIFICATIONS				
Thickness (min. avg.)	ASTM D5199	Every roll	mils	60.0
Thickness (min.)	ASTM D5199	Every roll	mils	54.0
Melt Index - 190/2.16 (max.)	ASTM D1238	1/Batch	g/10 min	1.0
Sheet Density (8)	ASTM D792	Every 10 rolls	g/cc	≥ 0.940
Carbon Black Content	ASTM D4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D5596	Every 10 rolls	Category	Cat. 1 & Cat. 2
OIT - standard (avg.)	ASTM D3895	1/Batch	min	100
Tensile Properties (min. avg) (2)	ASTM D6693	Every 2 rolls		
Strength at Yield			ppi	132
Elongation at Yield			%	13
Strength at Break			ppi	243
Elongation at Break			%	700
Tear Resistance (min. avg.)	ASTM D1004	Every 5 rolls	lbf	42
Puncture Resistance (min. avg.)	ASTM D4833	Every 5 rolls	lbf	120
Dimensional Stability	ASTM D1204	Certified	%	± 2
Stress Crack Resistance (SP-NCTL)	ASTM D5397	1/Batch	hr	500
Oven Aging - % retained after 90 days	ASTM D5721	Per formulation		
HP OIT (min. avg.)	ASTM D5885		%	80
UV Res. - % retained after 1600 hr	ASTM D7238	Per formulation		
HP-OIT (min. avg.)	ASTM D5885		%	50
Low Temperature Brittleness	ASTM D746	Certified	°F	- 106
SUPPLY SPECIFICATIONS (Roll dimensions may vary ±1%)				

NOTES

1. Testing frequency based on standard roll dimension and one batch is approximately 180,000 lbs (or one railcar).
2. Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
8. Correlation table is available for ASTM D792 vs ASTM D1505. Both methods give the same results.

* All values are nominal test results, except when specified as minimum or maximum.
* The information contained herein is provided for reference purposes only and is not intended as a warranty of guarantee. Final determination of suitability for use contemplated is the sole responsability of the user. SOLMAX assumes no liability in connection with the use of this information.

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SOLMAX

Mustang Extreme Environmental Services

July 22, 2020

Attn: Alex Skousen | Operations Manager
Re: Hydraulic Conductivity – Solmax HDPE 60 mil

Dear Mr. Skousen:

Solmax International Inc. hereby certifies that the HDPE geomembrane 60 mil, black smooth, has a hydraulic conductivity (ATMD E 96) lower than 1 x 10^{-12} cm/s.

Hoping the above information will be satisfactory.

Sincerely,

Mauricio Ossa
Global Technical Engineering Manager

T +1 800 435-2008

GSE ENVIRONMENTAL, LLC | A SOLMAX COMPANY
19103 GUNDLE ROAD, HOUSTON, TX 77073, USA

SOLMAX.COM

PERMEABILITY FOR SOLMAX GEOMEMBRANES

Due to its chemical structure, polyethylene is an (essentially) impermeable substance. The material is made up of very long molecules. There does exist, however, molecular voids (sometimes referred to as “free space”) among the individual polyethylene chains. The existence of these spaces is recognized when we say polyethylene is essentially impermeable. Permeation may exist when, for instance, the pressure behind the permeant is very high or the permeant’s molecular size is very small. However, the degree of permeation exhibited is difficult to determine using currently available test procedures. As a result, test results frequently reflect the inaccuracy of the procedure rather than the permeation of the material. Testing of Solmax HDPE performed by an independent laboratory produced the following results.

Test	ASTM Method	Results
Methane Permeability	D 1434	2×10^{-8} cm^2/s @ 1 atm
Water Vapor Permeability	E96	1.5×10^{-13} cm/s (note 1)

Table 1

It must be emphasized that different chemicals will permeate at different rates due to differences in molecular shape, polarity and phase (gas or liquid).

For example, the relatively small water molecule (atomic weight 18) will more easily permeate the polyethylene matrix as compared to a large molecule such as cyclohexanol (atomic weight 94).

The molecules’ polarity must also be considered (recall the adage “like dissolves like”).

Polyethylene is a non-polar molecule, therefore other non-polar molecules will permeate the matrix better. Examples of these molecules are hydrocarbons — especially those such as octane, pentane and hexene. The permeation of these are therefore greater than for polar molecules such as water.

REFERENCES

[1] Calculation based on the density of liquid water.

A Final Report:

Laboratory Testing of 30 mil Smooth HDPE Geomembrane for Waste Containment EPA Method 9090A

April 2014

Submitted to:

Solmax
2801 Marie-Victorin, Varennes (Québec)
Canada, J3X1P7
Attn: **Marie Andree Fortin**

Submitted by:

TRI/Environmental, Inc.
9063 Bee Caves Rd.
Austin, Texas 78733

From: Mauricio Ossa
To: laura@rthicksconsult.com; "Alex Skousen"; Patty Beaubien
Subject: RE: 60mil black smooth nominal
Date: Thursday, July 23, 2020 2:01:49 PM
Attachments: image001.png
image002.png
image003.png
image017.png
image018.png
image019.png
image020.png
image021.png
image022.png
image023.png
image024.png
image025.png
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image029.png
image786314.png
image985911.png
image974542.png
image503124.png
image173458.png
image891381.png
image267522.png
image403234.png
image943227.png
image529420.png

Yes, you are correct.

Regards

MAURICIO OSSA
Responsable de liingenierie technique mondiale | Global Technical Engineering Manager

+1 281 230 5887
+1 713 806 5662
mossa@solmax.com

SOLMAX

19103 Gundle Road, Houston, Texas, 77073, USA

SOLMAX.COM

From: laura@rthicksconsult.com <laura@rthicksconsult.com>
Sent: Thursday, July 23, 2020 2:54 PM
To: Mauricio Ossa <mossa@solmax.com>; 'Alex Skousen' <askousen@mustangextreme.com>; Patty Beaubien <pbeaubien@solmax.com>
Subject: RE: 60mil black smooth nominal

Can we assume that the 60 mil HDPE would have similar if not better results?

Laura Parker
R T Hicks Consultants
Durango Office
505-270-8647

From: Mauricio Ossa <mossa@solmax.com>
Sent: Thursday, July 23, 2020 1:07 PM
To: laura@rthicksconsult.com; 'Alex Skousen' <askousen@mustangextreme.com>; Patty Beaubien <pbeaubien@solmax.com>
Subject: RE: 60mil black smooth nominal

Hi Laura,

Attached is the only EPA 9090 report I have available, that could suit the project.

Regards

MAURICIO OSSA
Responsable de liingenierie technique mondiale | Global Technical Engineering Manager
+1 281 230 5887
+1 713 806 5662
mossa@solmax.com

SOLMAX

19103 Gundle Road, Houston, Texas, 77073, USA

SOLMAX.COM

From: laura@rthicksconsult.com <laura@rthicksconsult.com>
Sent: Thursday, July 23, 2020 1:40 PM
To: 'Alex Skousen' <askousen@mustangextreme.com>; Mauricio Ossa <mossa@solmax.com>; Patty Beaubien <pbeaubien@solmax.com>
Subject: RE: 60mil black smooth nominal

The setting is an AST used to contain flow through produced water from a fracking operation. Is this

the information that is needed?

Laura Parker
R T Hicks Consultants
Durango Office
505-270-8647

From: Alex Skousen <askousen@mustangextreme.com>
Sent: Thursday, July 23, 2020 11:34 AM
To: Mauricio Ossa <mossa@solmax.com>; Patty Beaubien <pbeaubien@solmax.com>
Cc: Laura Parker <laura@rthicksconsult.com>
Subject: RE: 60mil black smooth nominal

Thanks Mauricio,

I have copied Laura with Hicks Consulting on this email to answer the questions regarding the EPA9090.

From: Mauricio Ossa <mossa@solmax.com>
Sent: Thursday, July 23, 2020 12:26 PM
To: Alex Skousen <askousen@mustangextreme.com>; Patty Beaubien <pbeaubien@solmax.com>
Subject: RE: 60mil black smooth nominal

Hi Alex,

I thought I had forwarded Patty's email to the new Technical Manager. I'm not longer in charge of technical services.

However, it was my mistake. I will send you the info during the morning.

Regarding the statement "hydraulic conductivity no greater than 1 x 10-9 cm/sec"; it is fine. I can send you the info in a few minutes. However, EPA9090 analysis is specific to the site and to the specific leachate. Sometimes the owners/engineers accept EPA9090 reports when they are for leachate that is somehow similar to the one they have in their site. What kind of leachate will be in contact with the liner?

Regards

MAURICIO OSSA
Responsable de liingenierie technique mondiale | Global Technical Engineering Manager
+1 281 230 5887
+1 713 806 5662
mossa@solmax.com

SOLMAX

19103 Gundle Road, Houston, Texas, 77073, USA

SOLMAX.COM

From: Alex Skousen <askousen@mustangextreme.com>
Sent: Thursday, July 23, 2020 10:48 AM
To: Patty Beaubien <pbeaubien@solmax.com>; Mauricio Ossa <mossa@solmax.com>
Subject: RE: 60mil black smooth nominal

Hey Mauricio,

Do you have an update for the below request? I have a vendor needing the info so they can get permitting for a containment we built them. The New Mexico is holding them up until they get the information.

Thanks!

From: Patty Beaubien <pbeaubien@solmax.com>
Sent: Monday, July 20, 2020 9:36 AM
To: Mauricio Ossa <mossa@solmax.com>
Cc: Alex Skousen <askousen@mustangextreme.com>
Subject: FW: 60mil black smooth nominal

Mauricio,

Can you please help with the request below.

Thank you,

PATTY BEAUBIEN
Sales Manager
+1 281 723 7617
pbeaubien@solmax.com

SOLMAX

19103 Gundle Road, Houston, Texas, 77073, USA

SOLMAX.COM

From: Alex Skousen <askousen@mustangextreme.com>
Sent: Monday, July 20, 2020 9:31 AM
To: Patty Beaubien <pbeaubien@solmax.com>
Subject: 60mil black smooth nominal

Hey Patty,

I am trying to get some tanks we put up permitted for a customer. We put down 60mil black smooth from Solmax as a secondary containment liner. They need something saying that material has a "hydraulic conductivity no greater than 1 x 10-9 cm/sec. Liner compatibility needs to meet or exceed EPA SW-846 method 9090A or subsequent relevant publications"

Could you help me out with this??

Thanks,

Alex Skousen| Operations Manager
askousen@mustangextreme.com
C: 432.653.3739
O: 432.684.1159
www.mustangextreme.com

April 30, 2014

Marie Andree Fortin
Solmax
2801 Marie-Victorin, Varennes (Québec)
Canada, J3X1P7

Dear Marie:

TRI/Environmental, Inc. (TRI) is pleased to present this Final Report for a geomembrane chemical compatibility study performed in general accordance with EPA Method 9090A.

TRI is very pleased to be of service to Solmax. Please call me if you have any questions or require any additional information.

Respectfully submitted,

Jarrett A. Nelson
Laboratory Director
Geosynthetic Services Division

FOREWORD

The testing reported herein is based upon accepted industry practice as well as the test method listed. TRI/Environmental Inc. (TRI) neither accepts responsibility for nor makes claim as to the final use and purpose of the materials tested.

Tests were performed under laboratory conditions and not under actual usage conditions. TRI can give no conclusions as to the serviceability, life expectancy or general durability of the products tested when used in a lining and/or leachate collection system.

1.0 INTRODUCTION

This report describes the work performed by TRI/Environmental, Inc. (TRI) to determine the chemical compatibility of one geomembrane product with one waste leachate. The product selected for testing was a high density polyethylene (HDPE) geomembrane. The objective was to determine the resistance of the geomembrane to changes caused by exposure to leachate. Changes in physical and mechanical properties were measured after exposure to the leachate at 23°C and 50°C for 30, 60, 90 and 120 days following the exposure regimen specified in United States Environmental Protection Agency (EPA) Method 9090A.

All materials were received and tested under TRI log number E2386-18-02. Methods, results and discussion are provided in the sections which follow. Test results are provided in the Tables of Results which accompany this report.

2.0 METHODS

2.1 Materials

Table 1 describes the product selected for evaluation in this chemical compatibility study.

Table 1. List of geomembranes evaluated in chemical compatibility study

Geosynthetic	Source
30 mil smooth HDPE geomembrane Roll Number: 2-68814-A	Solmax

2.2 Leachate

The waste leachate used was provided by Solmax. Leachate analysis provided in the appendix.

2.3 Exposure Conditions

Geomembrane coupons were exposed to the waste leachate following the specifications of EPA Method 9090A as they relate to exposure to waste fluids. The tanks used for these exposures were maintained at 23 2°C and 50 2°C throughout the 120-day exposure period. Tanks were constructed from glass or stainless steel, fitted with stirrers and heated with a circulating hot water heat exchanger system. The 50°C tanks were sealed with a lid, and a reflux condenser was installed to minimize loss of volatile leachate components.

2.4 Testing Procedures

The following table lists tests performed on the HDPE geomembrane product.

Table 3. Tests performed on HDPE geomembrane

Test or Physical Property	Method	Number of replicate specimens
Dimensions and weight	EPA 9090A	3
Hardness	ASTM D 2240 D scale	3
Volatiles and Extractables	EPA SW 870, Appendix III	2
Specific Gravity	ASTM D 792	3
Tensile Properties	ASTM D 638	3
5% Secant Modulus	ASTM D 882	3
Hydrostatic Resistance	ASTM D 751 Method A	3
Tear Strength	ASTM D 1004	3
Puncture Resistance	ASTM D 4833	3

Note that tensile properties were determined in accordance with ASTM D638 procedures as modified by GRI GM-13, which gives specific methods for testing HDPE geomembranes. The tensile tests were performed on a screw-type tensile testing machine. The Type IV die was used. Load measurements were made by a strain-gage bridge load cell. Elongation was determined by crosshead movement as recorded by Bluehill 2 Instron data acquisition software. The rate of grip separation was 2 inches per minute. Gauge length ratios of 1.3 inches for yield values, and 2.0 inches for break values were used to calculate elongation from grip movement. The parameters reported for ASTM D638 testing included: tensile stress at yield, tensile strength at break, elongation at yield and elongation at break.

3.0 RESULTS AND DISCUSSION

Test results are presented in the Tables of Test Results (raw data) and selected graphical presentations are presented in Appendix A.

In considering these results, it must be determined through engineering judgment whether observed differences in the value of test results measured before and after immersion are due to product variability, unidentified factors relating to the test procedure, or leachate interaction with the products. Any significant chemical interaction with leachate would be expected to result in degradation trends which are consistent across the various properties being evaluated, and not isolated to one set of test results only.

Also of critical importance is the issue of product variability. With HDPE geomembranes, a range of physical and mechanical index test values covering 5% or more of the average is not uncommon. This can be traced to variability inherent in the product, and the randomness associated with the onset of failure under the specified testing conditions. However, in chemical compatibility testing the statistical sampling of a broad range of manufactured product is not possible. Therefore, the small size of the sample population tested at each time point must be taken into consideration. The criteria to be applied in evaluating data measured before and after leachate immersion should be that property changes, if observed, are consistent and so great that product variability and experimental factors can be ruled out.

In this report, standard deviations (STD) are reported for most measurements involving three or more replicate specimens. In statistics, the standard deviation is defined as root of the mean squared deviations of individual test results about the mean value. The standard deviation is a quantitative measure of variability within a group of measurements.

One related measure of variability observed within a sample set, relative to the magnitude of the mean value itself, is the *coefficient of variation or variance* (COV). The coefficient of variance is defined as the standard deviation divided by the mean associated with a group of specimens, and may be expressed as a percentage. The COV provides an indication of what proportion of the mean value may be attributable to random experimental factors or product variability. It is useful to consider apparent changes in property values against the criterion of COV since observed changes which fall below the COV may not be significant. This approach was used in preparing the tables below.

The term *range* refers to the difference between the extreme highest and lowest points within a group of measured values. Considering range as a percentage of the mean values provides another measure of variability within a dataset.

In the table below, the high and low extremes for percentage change in some of the measured mean values are listed. These may be compared against COV and range as a percentage of mean from the baseline sample group. The high and low percentage changes are the extremes from data measured at 30, 60, 90 and 120 days.

Baseline COV and Range of Percent Change Results

Test	Baseline COV (%)	Baseline Range as % of Mean	High Observed % Change	Low Observed % Change
Stress at yield (MD)	2	4	5	-4
Stress at break (MD)	9	23	9	-7
Elongation at yield (MD)	4.6	13.0	7.8	-7.8
Elongation at break (MD)	8	23	6	-5
5% Secant modulus (MD)	4	13	4	-7
Tear strength (MD)	1	3	25	4
Puncture resistance	1	3	6	-1
Hydrostatic resistance	2	7	6	-3
Hardness	1	3	1	-3

4.0 SUMMARY

While changes in certain measured mechanical properties were noted, they were not observed to be consistent throughout the exposure periods. The effects of product variability and experimental factors could not be ruled out as causes for observed changes. The data, considered together, do not suggest that observed changes were caused by the test exposures.

TRI/Environmental, Inc. is pleased to have been selected to participate in this project. We trust that the information provided in this report meets your requirements for technical documentation of this chemical compatibility study. Please do not hesitate to call if we can provide any further information (1-800-880-8378).

Respectfully submitted,

Jarrett A. Nelson

Jarrett A. Nelson
Laboratory Director
Geosynthetic Services Division

APPENDIX A:

EPA METHOD 9090A TEST RESULTS

30 mil Smooth HDPE Geomembrane TEST RESULTS

Roll # 2-68814-A

Dimensions

TRI LOG NUMBER: E2386-18-02

GEOMEMBRANE TEST RESULTS

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS

TRI Client: Solmax

Chemical: Leachate

Report Date: April 2014

Exposure Time and Temperature

Test Parameters	Temp.	30 Day Baseline	30 Day Exposed	30 Day % Change	60 Day Baseline	60 Day Exposed	60 Day % Change	90 Day Baseline	90 Day Exposed	90 Day % Change	120 Day Baseline	120 Day Exposed	120 Day % Change
30 mil smooth HDPE geomembrane: Roll # 2-68814-A													
Thickness (mils)	23C	28	28	1.3	28	28	0.4	27	28	3.8	28	28	1.0
	50C	28	27	-2.8	29	29	-1.4	28	28	1.0	28	28	-1.5
Length (inches)	23C	9.98	9.98	-0.04	9.98	9.98	-0.03	9.99	9.99	-0.01	9.98	9.98	0.01
	50C	9.98	9.97	-0.03	9.97	9.97	-0.05	9.98	9.98	-0.05	9.99	9.98	-0.08
Width (inches)	23C	7.98	7.98	-0.01	7.98	7.98	-0.02	7.98	7.98	-0.02	7.97	7.98	0.02
	50C	7.96	7.97	0.05	7.98	7.98	-0.03	7.98	7.98	-0.03	7.98	7.97	-0.06
Mass (g)	23C	34.20	33.68	-1.52	34.42	34.40	-0.06	34.07	34.04	-0.09	34.09	34.08	-0.03
	50C	34.11	34.10	-0.03	35.14	35.15	0.03	34.03	33.84	-0.56	33.98	33.99	0.03

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EPA METHOD 9090A TEST RESULTS

30 mil Smooth HDPE Geomembrane TEST RESULTS

Roll # 2-68814-A

TRI LOG NUMBER: E2386-18-02

NOTE ON TEST RESULTS

This section includes generated test data provided in both tabular and graphical form. Each graph is represented by a series of "I" beam plots. Each "I" beam represents a single test population and illustrates the high and low value as the end points, and the mean as a central box on the beam. The initial "I" beam represents the baseline or unexposed test specimens.

GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Exposure Time and Temperature									
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Tensile Properties:									
Tensile Stress @ Yield (psi)	2609	2629	2626	2474	2675	2647	2660	2563	2727
ASTM D638	2569	2607	2614	2487	2427	2846	2922	2751	2690
Machine Direction	2645	2666	2652	2574	2664	2609	2699	2698	2697
	2580								
	2665								
	2650								
Average	2620	2634	2631	2512	2589	2701	2760	2671	2705
STD	40	30	19	54	140	127	141	97	20
Coefficient of Variation	2	1	1	2	5	5	5	4	1
% Change		1	0	-4	-1	3	5	2	3
Tensile Strength @ Break (psi)	5587	5248	5632	5223	4975	4830	5155	4814	5229
ASTM D638	5325	5231	5455	4588	4577	5315	5245	4503	4929
Machine Direction	4627	4609	5142	4133	5110	4784	4924	4827	5013
	4457								
	5016								
	4845								
Average	4976	5029	5410	4648	4887	4976	5108	4715	5057
STD	425	364	248	547	277	294	166	183	155
Coefficient of Variation	9	7	5	12	6	6	3	4	3
% Change		1	9	-7	-2	0	3	-5	2
Elongation @ Yield (%)	17.5	18.5	18.5	18.0	18.7	17.8	18.5	18.0	19.8
ASTM D638	17.5	17.9	19.2	17.4	19.5	16.9	12.7	17.1	18.8
Machine Direction	19.0	18.0	19.6	19.0	19.2	16.4	17.9	18.8	18.4
	17.4								
	16.7								
	18.4								
Average	17.8	18.1	19.1	18.1	19.1	17.0	16.4	18.0	19.0
STD	0.8	0.3	0.6	0.8	0.4	0.7	3.2	0.9	0.7
Coefficient of Variation	4.6	1.8	2.9	4.5	2.1	4.2	19.5	4.7	3.8
% Change		2.2	7.6	2.2	7.8	-4.0	-7.8	1.2	7.0

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

		Exposure Time and Temperature							
	Baseline	30 Day		60 Day		90 Day		120 Day	
Test Parameters		23C	50C	23C	50C	23C	50C	23C	50C
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Tensile Properties:									
Elongation @ Break (%)	834	788	809	835	793	711	756	744	748
ASTM D638	800	769	816	746	724	759	873	695	726
Machine Direction	719	713	769	628	759	715	721	704	744
	664								
	753								
	728								
Average	749	756	798	736	758	728	783	714	739
STD	61	39	26	104	34	26	79	26	11
Coefficient of Variation	8	5	3	14	5	4	10	4	2
% Change		1	6	-2	1	-3	5	-5	-1
Set after Break (%)	720	690	710	740	730	640	710	680	760
ASTM D638	710	670	720	670	660	670	760	600	650
Machine Direction	660	640	680	620	650	650	630	640	800
	610								
	680								
	670								
Average	675	667	703	677	680	653	700	640	737
STD	39	25	21	60	44	15	66	40	78
Coefficient of Variation	6	4	3	9	6	2	9	6	11
% Change		-1	4	0	1	-3	4	-5	9
Stress @ 100% Elongation (psi)	2467	2480	2565	2340	2483	2465	2440	2354	2645
ASTM D638	2499	2356	2425	2287	2371	2692	2127	2570	2594
Machine Direction	2550	2442	2539	2497	2579	2355	2455	2656	2421
	2506								
	2562								
	2500								
Average	2514	2426	2510	2375	2478	2504	2341	2527	2553
STD	35	64	74	109	104	172	185	156	117
Coefficient of Variation	1	3	3	5	4	7	8	6	5
% Change		-4	0	-6	-1	0	-7	1	2

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

Test Parameters	Baseline	Exposure Time and Temperature: 30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Tensile Properties:									
Stress @ 200% Elongation (psi)	2505	2487	2362	2224	2315	2469	2514	2509	2635
ASTM D638	2394	2450	2474	2353	2300	2430	2194	2349	2533
Machine Direction	2466	2479	2533	2365	2382	2471	2523	2480	2521
	2411								
	2489								
	2478								
Average	2457	2472	2456	2314	2332	2457	2410	2446	2563
STD	45	19	87	78	44	23	187	85	63
Coefficient of Variation	2	1	4	3	2	1	8	3	2
% Change		1	0	-6	-5	0	-2	0	4
Tensile Stress @ Yield (psi)	2880	2894	2888	3016	2855	2945	3051	2883	2917
ASTM D638	2865	3052	2866	2723	3000	2966	3006	2822	3108
Transverse Direction	2925	3042	2997	2717	2827	2899	2709	2996	2868
	2890								
	2822								
	2852								
Average	2872	2996	2917	2819	2894	2937	2922	2900	2964
STD	35	88	70	171	93	34	186	88	127
Coefficient of Variation	1	3	2	6	3	1	6	3	4
% Change		4	2	-2	1	2	2	1	3
Tensile Strength @ Break (psi)	5280	5163	4976	4666	5468	5484	5348	5288	5417
ASTM D638	5490	5615	5367	5000	5310	5061	5221	4713	5291
Transverse Direction	5597	5387	5147	5140	4017	4583	4650	5355	4526
	5189								
	5701								
	4711								
Average	5328	5388	5163	4935	4932	5043	5073	5119	5078
STD	358	226	196	244	796	451	372	353	482
Coefficient of Variation	7	4	4	5	16	9	7	7	9
% Change		1	-3	-7	-7	-5	-5	-4	-5

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

		Exposure Time and Temperature							
	Baseline	30 Day		60 Day		90 Day		120 Day	
Test Parameters		23C	50C	23C	50C	23C	50C	23C	50C
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Tensile Properties:									
Elongation @ Yield (%)	13.4	13.4	13.4	13.8	14.1	12.3	13.2	12.3	14.0
ASTM D638	12.3	13.3	12.9	14.1	14.5	12.2	12.2	12.4	13.7
Transverse Direction	12.7	14.4	13.4	14.8	14.1	13.2	16.3	14.1	14.1
	12.2								
	12.4								
	13.4								
Average	12.7	13.7	13.2	14.2	14.2	12.6	13.9	12.9	13.9
STD	1	0.6	0.3	0.5	0.2	0.6	2.1	1.0	0.2
Coefficient of Variation	4	4.4	2.2	3.6	1.6	4.4	15.4	7.8	1.5
% Change		7.6	3.9	11.8	11.8	-1.3	9.2	1.6	9.4
Elongation @ Break (%)	871	829	806	808	928	871	836	861	863
ASTM D638	905	875	893	851	868	831	840	784	850
Transverse Direction	899	828	823	930	710	760	698	864	750
	856								
	906								
	786								
Average	871	844	840	863	835	821	791	836	821
STD	46	27	46	62	112	56	81	45	62
Coefficient of Variation	5	3	5	7	13	7	10	5	8
% Change		-3	-3	-1	-4	-6	-9	-4	-6
Set after Break (%)	740	740	710	750	750	770	750	740	810
ASTM D638	770	760	760	750	750	720	750	720	750
Transverse Direction	750	720	720	770	670	710	640	730	750
	770								
	780								
	720								
Average	755	740	730	757	723	733	713	730	770
STD	23	20	26	12	46	32	64	10	35
Coefficient of Variation	3	3	4	2	6	4	9	1	4
% Change		-2	-3	0	-4	-3	-6	-3	2

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

Test Parameters	Baseline	Exposure Time and Temperature: 30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Tensile Properties:									
Stress @ 100% Elongation (psi)	2006	2092	2048	2114	2154	2172	2248	2145	2164
ASTM D638	2141	2312	2168	1972	2057	2121	2176	2091	2178
Transverse Direction	2109	2152	2171	2018	2000	2094	2442	2233	2141
	2123								
	2100								
	2140								
Average	2103	2185	2129	2035	2070	2129	2289	2156	2161
STD	50	114	70	72	78	40	138	72	19
Coefficient of Variation	2	5	3	4	4	2	6	3	1
% Change		4	1	-3	-2	1	9	3	3
Stress @ 200% Elongation (psi)	2032	2151	2201	2143	2159	2200	2283	2201	2271
ASTM D638	2174	2341	2255	2014	1994	2192	2203	2101	2234
Transverse Direction	2191	2216	2216	2031	2090	2116	2543	2229	2186
	2178								
	2100								
	2140								
Average	2136	2236	2224	2063	2081	2169	2343	2177	2230
STD	61	97	28	70	83	46	178	67	43
Coefficient of Variation	3	4	1	3	4	2	8	3	2
% Change		5	4	-3	-3	2	10	2	4
Modulus of Elasticity:									
ASTM D882 (psi)	34027	39368	38433	34990	34265	37649	37903	37629	38223
Machine Direction	38797	38124	37289	34924	34868	39656	40307	38251	38033
5% Secant	37697	38024	37306	35081	33681	37461	37416	37920	39117
	37241								
	36618								
	37227								
Average	36935	38505	37676	34998	34271	38255	38542	37933	38458
STD	1599	749	656	79	594	1217	1548	311	579
Coefficient of Variation	4	2	2	0	2	3	4	1	2
% Change		4	2	-5	-7	4	4	3	4

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

Test Parameters	Baseline	30 Day		60 Day		90 Day		120 Day	
		Exposure Time and Temperature							
		23C	50C	23C	50C	23C	50C	23C	50C
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Modulus of Elasticity:									
ASTM D882 (psi)	45534	44555	45126	44123	41881	44208	44836	44472	43648
Transverse Direction	47268	45303	45664	41153	42007	43980	43383	44991	44658
5% Secant	45007	44497	46519	42511	40431	44571	44780	43919	43652
	44577								
	46169								
	46120								
Average	45779	44785	45770	42596	41440	44253	44333	44461	43986
STD	958	450	702	1487	876	298	823	536	582
Coefficient of Variation	2	1	2	3	2	1	2	1	1
% Change		-2	0	-7	-9	-3	-3	-3	-4
Indentation Hardness:									
Reading	58	58	60	58	58	58	59	59	59
ASTM D2240	60	59	60	58	59	57	59	59	60
(with TYPE D DUROMETER)	60	59	59	57	59	59	59	59	60
	60								
	59								
	59								
Average	59	59	60	58	59	58	59	59	60
STD	1	1	1	1	1	1	0	0	1
Coefficient of Variation	1	1	1	1	1	2	0	0	1
% Change		-1	1	-3	-1	-2	-1	-1	1
Density:									
ASTM D1505	0.947	0.948	0.948	0.949	0.950	0.948	0.949	0.947	0.948
	0.948	0.948	0.948	0.949	0.950	0.948	0.948	0.947	0.948
	0.948	0.948	0.948	0.949	0.950	0.948	0.948	0.947	0.948
	0.948								
	0.948								
	0.948								
Average	0.948	0.948	0.948	0.949	0.950	0.948	0.948	0.947	0.948
STD	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
Coefficient of Variation	0.043	0.000	0.000	0.000	0.000	0.000	0.061	0.000	0.000
% Change		0.018	0.018	0.123	0.229	0.018	0.053	-0.088	0.018

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

Test Parameters	Baseline	Exposure Time and Temperature: 30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Puncture Resistance:									
Load @ Rupture (lbs)	79	78	83	79	79	86	85	87	86
ASTM D4833	79	78	83	84	80	84	83	85	80
	80	80	81	83	80	82	81	79	81
	80								
	80								
	78								
Average	80	79	82	82	79	84	83	84	82
STD	1	1	1	3	1	2	2	4	3
Coefficient of Variation	1	1	1	3	1	2	3	5	4
% Change		-1	3	3	0	6	4	5	4
Tear Resistance:									
ASTM D1004	23	24	24	29	26	26	26	26	26
(lbs)	22	23	25	27	28	27	27	27	27
Machine Direction	22	23	24	28	25	27	24	25	26
	23								
	22								
	22								
Average	22	23	24	28	26	27	26	26	26
STD	0	0	1	1	2	1	1	1	1
Coefficient of Variation	1	1	3	3	6	2	5	4	2
% Change		4	8	25	18	18	14	16	16
Tear Resistance:									
ASTM D1004	21	23	25	26	26	26	24	24	25
(lbs)	24	22	24	25	27	24	25	24	22
Transverse Direction	22	22	24	25	25	25	24	25	23
	21								
	21								
	22								
Average	22	22	24	25	26	25	25	25	23
STD	1	0	1	0	1	1	1	1	1
Coefficient of Variation	5	1	3	2	4	3	3	3	6
% Change		3	12	17	20	15	14	13	8

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GEOMEMBRANE TEST RESULTS
TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
TRI Client: Solmax
Chemical: Leachate

Report Date: April 2014

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
30 mil smooth HDPE geomembrane: Roll # 2-68814-A									
Hydrostatic Resistance:									
ASTM D751	220	215	230	230	235	250	220	230	235
(psi)	230	215	225	225	235	245	220	230	235
	230	230	230	225	230	230	235	225	220
	225								
	225								
	235								
Average	228	220	228	227	233	242	225	228	230
STD	5	9	3	3	3	10	9	3	9
Coefficient of Variation	2	4	1	1	1	4	4	1	4
% Change		-3	0	0	3	6	-1	0	1
Volatiles and Extractables:									
Machine Diameter Change (%)	0.37	-0.22	-0.15	-0.20	-0.10	-0.70	-0.40	-0.37	-0.25
SW 870 - Appendix III-D	0.00	-0.10	-0.22	-0.05	-0.25	-0.57	-0.20	-0.15	-0.10
	-0.42								
	-0.30								
Average	-0.09	-0.16	-0.19	-0.13	-0.18	-0.64	-0.30	-0.26	-0.18
STD	0.35	0.08	0.05	0.11	0.11	0.09	0.14	0.16	0.11
Transverse Diameter Change (%)	-0.02	-0.07	-0.03	0.00	0.10	0.42	0.07	-0.12	0.00
SW 870 - Appendix III-D	-0.12	0.20	0.07	0.27	0.07	-0.05	0.00	0.02	0.02
	0.30								
	-0.05								
Average	0.03	0.07	0.02	0.14	0.09	0.19	0.04	-0.05	0.01
STD	0.19	0.19	0.07	0.19	0.02	0.33	0.05	0.10	0.01
% Volatiles	0.05	0.08	0.10	0.01	0.04	0.01	0.01	0.03	0.10
SW 870 - Appendix III-D	0.13	0.08	0.09	0.06	0.01	0.01	0.00	0.04	0.10
	0.09								
	0.09								
Average	0.09	0.08	0.10	0.04	0.03	0.01	0.01	0.04	0.03
STD	0.03	0.00	0.01	0.04	0.02	0.00	0.01	0.01	0.01
% Extractables	0.43	0.59	0.50	0.41	0.32	0.60	0.64	0.29	0.10
SW 870 - Appendix III-D	0.16	0.60	0.21	0.39	0.35	0.47	0.44	0.25	0.10
	0.23								
	0.20								
Average	0.26	0.60	0.36	0.40	0.34	0.54	0.54	0.27	0.23
STD	0.12	0.01	0.21	0.01	0.02	0.09	0.14	0.03	0.22

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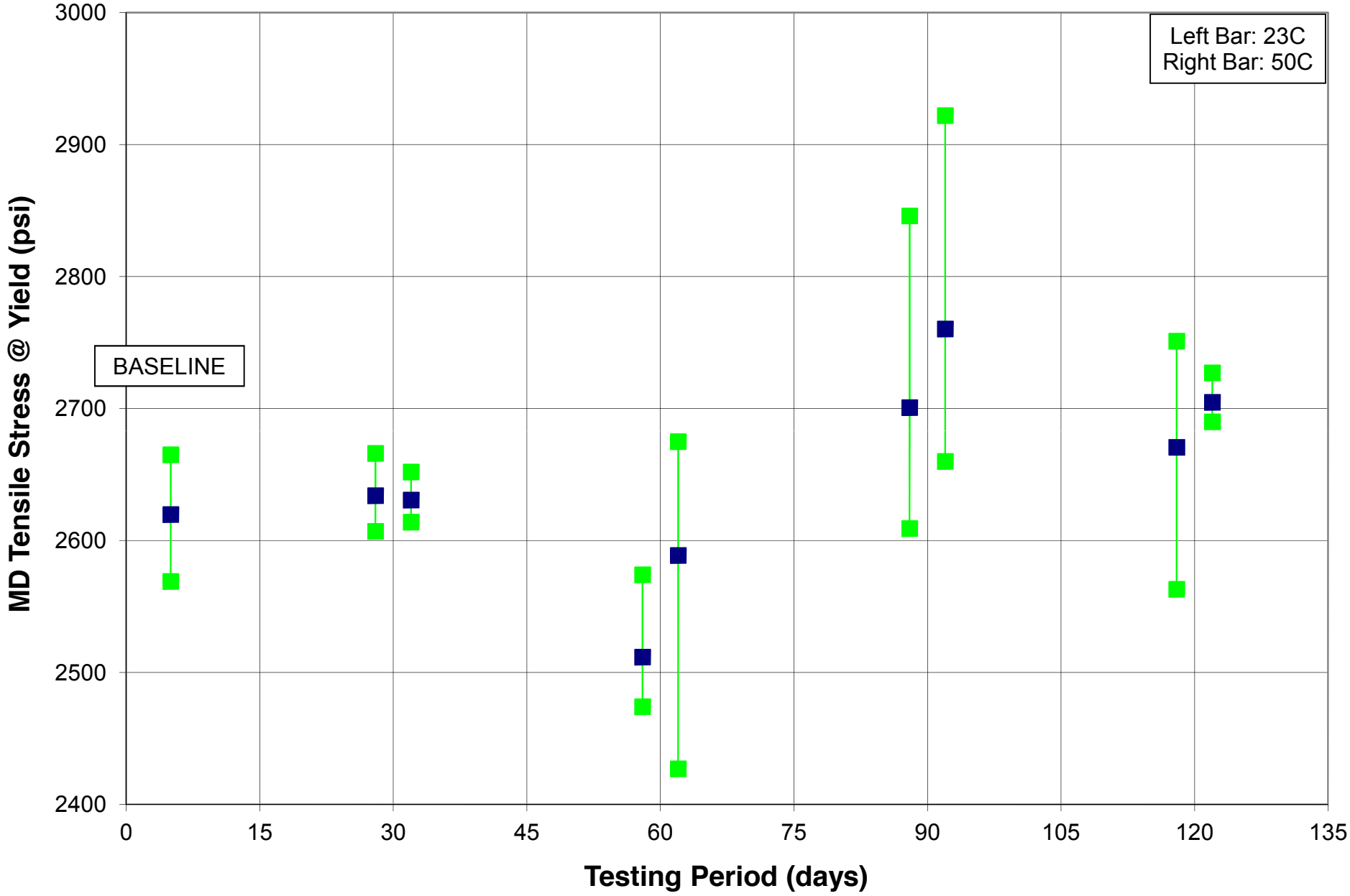
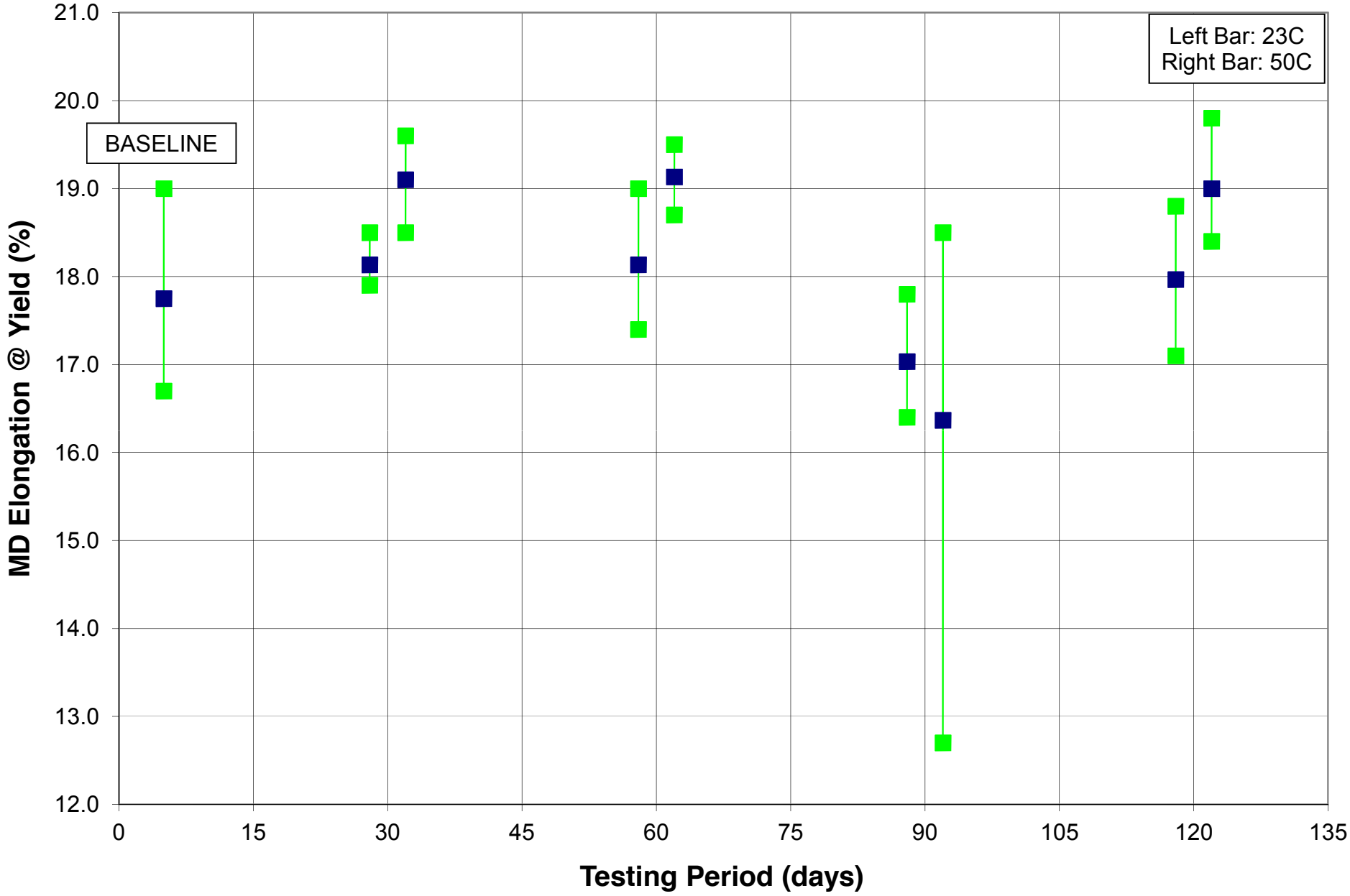
Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



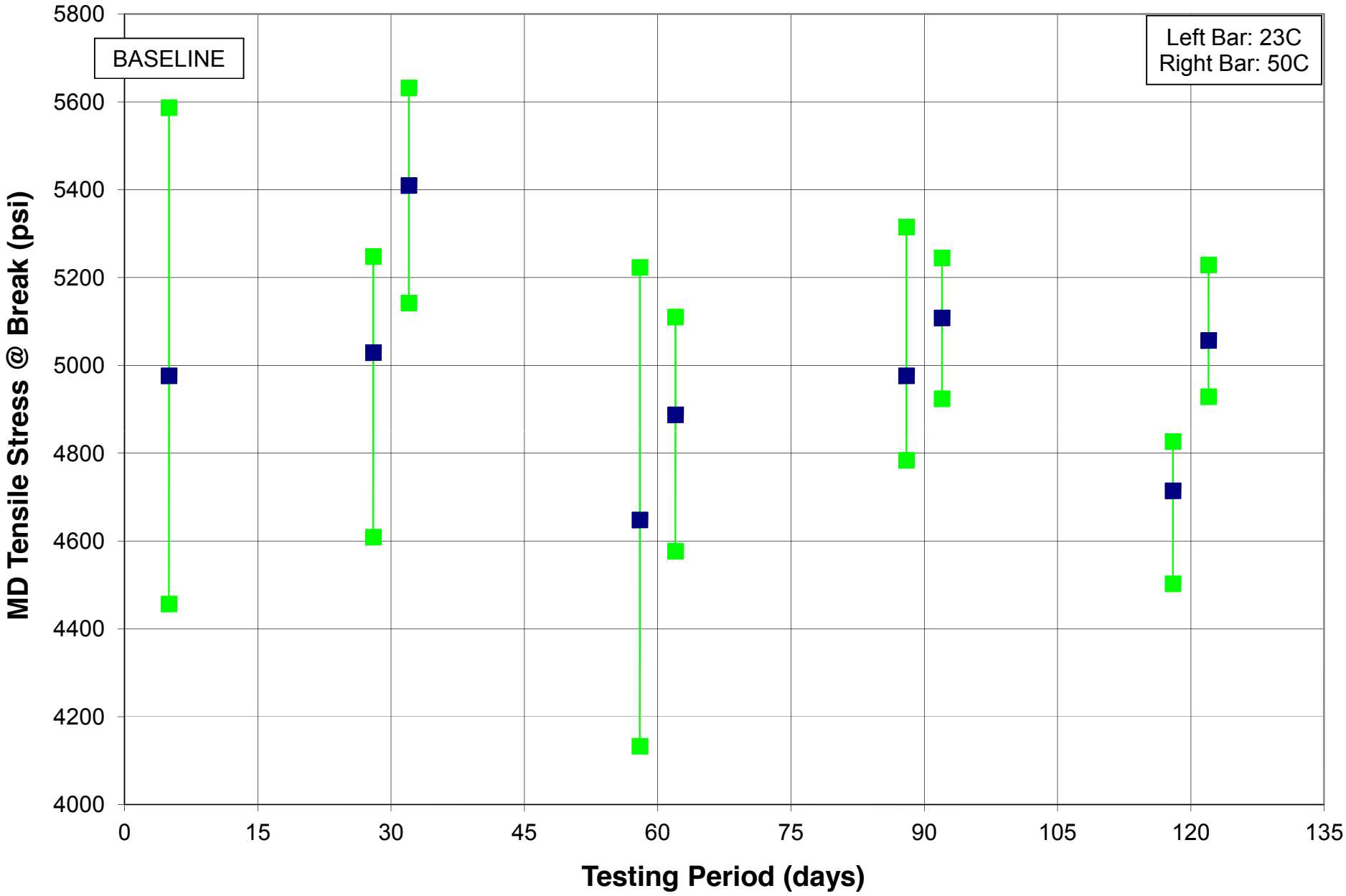
9063 Bee Caves Road / Austin, TX 78733 / 512-263-2101 / FAX 263-2558 / 800-880-TEST

Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



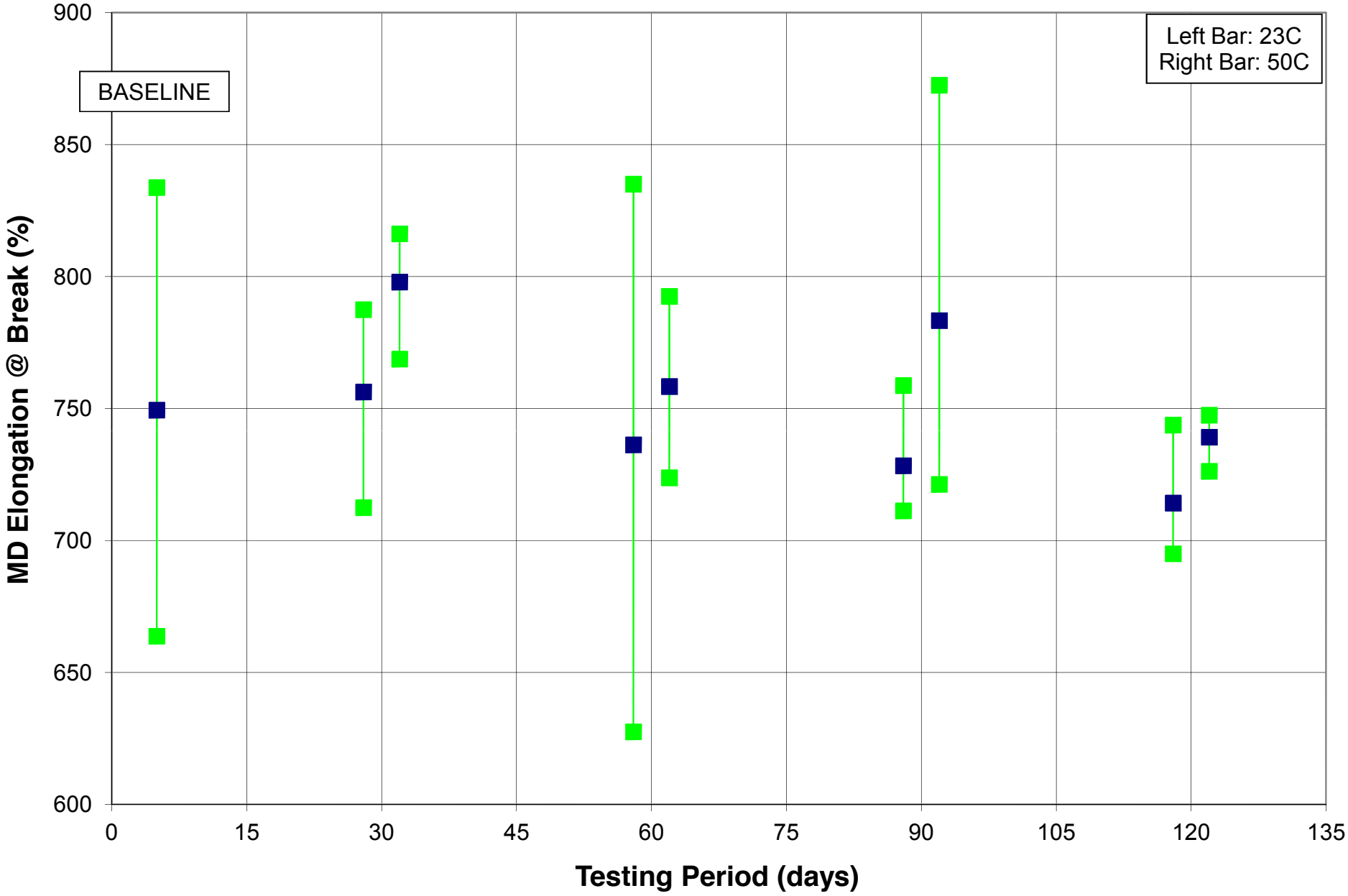
9063 Bee Caves Road / Austin, TX 78733 / 512-263-2101 / FAX 263-2558 / 800-880-TEST

Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



9063 Bee Caves Road / Austin, TX 78733 / 512-263-2101 / FAX 263-2558 / 800-880-TEST

Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



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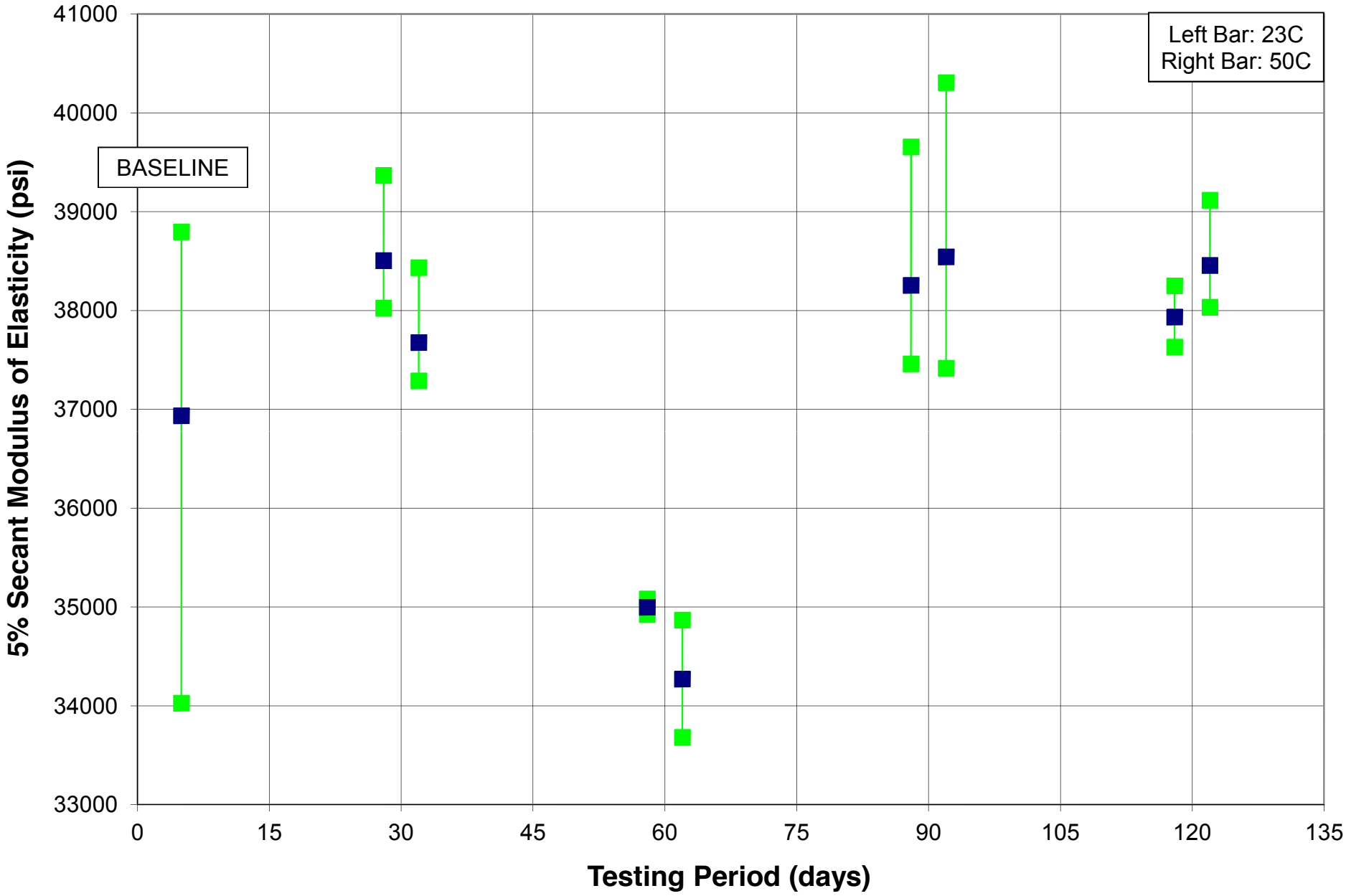
Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



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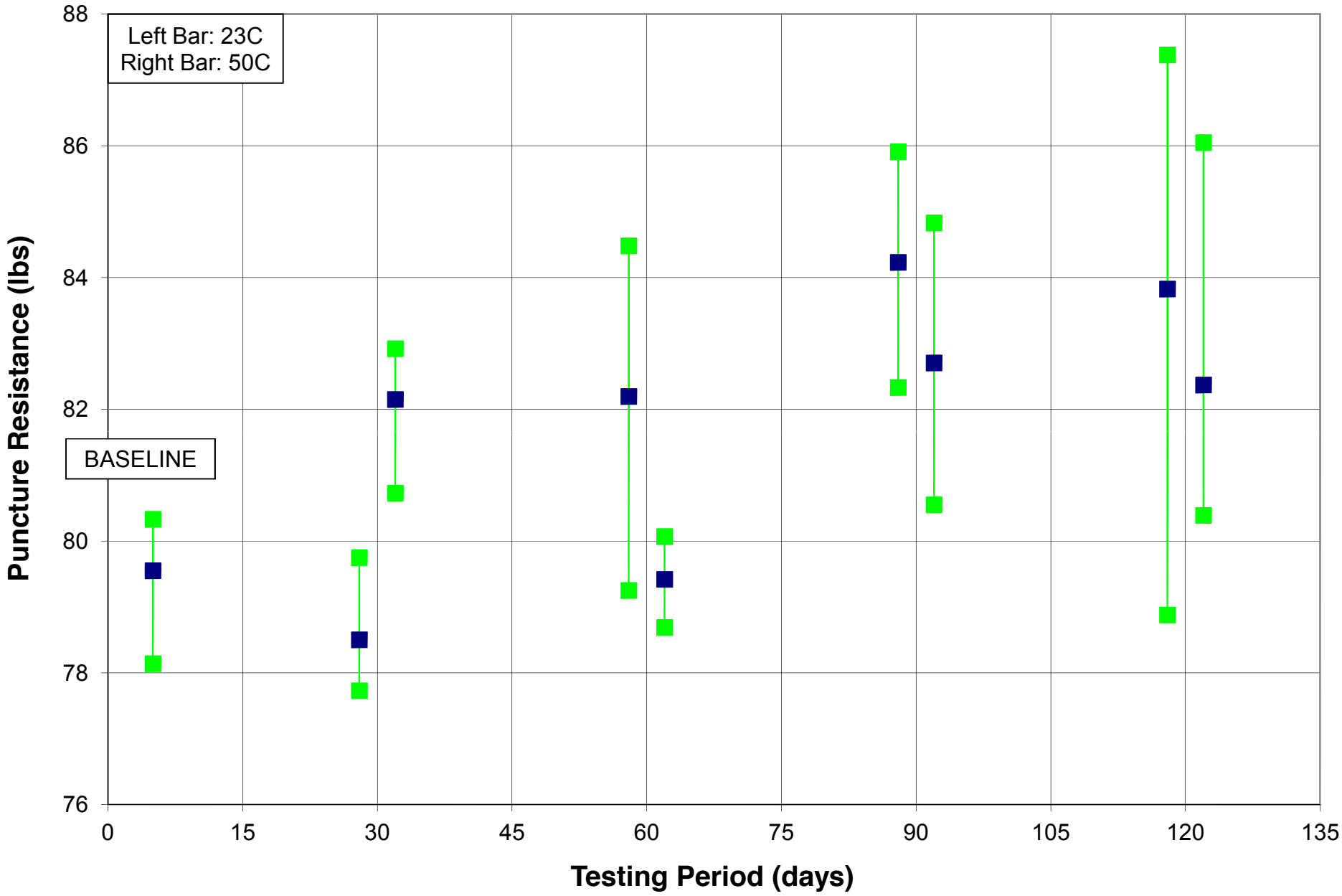
Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



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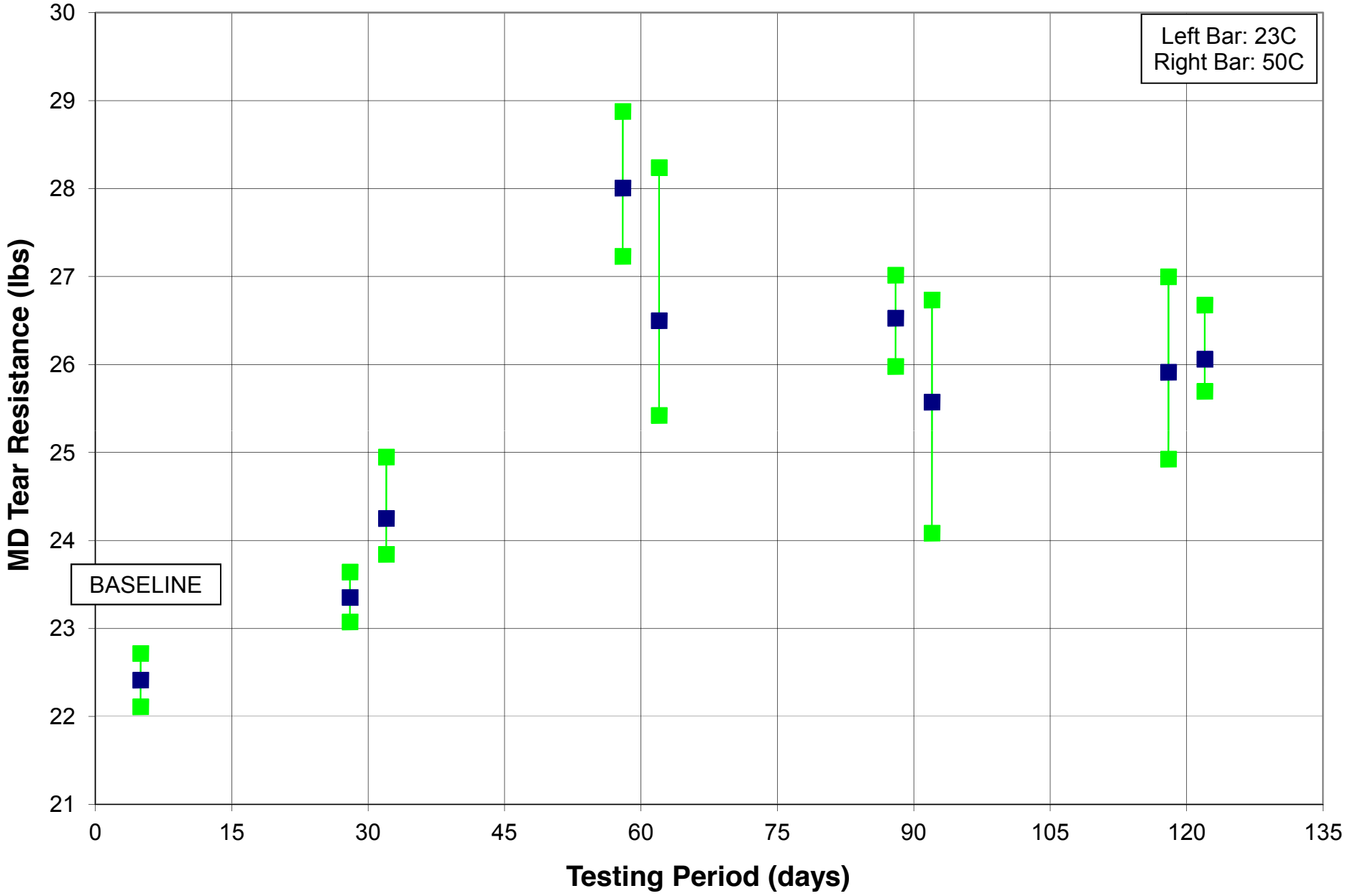
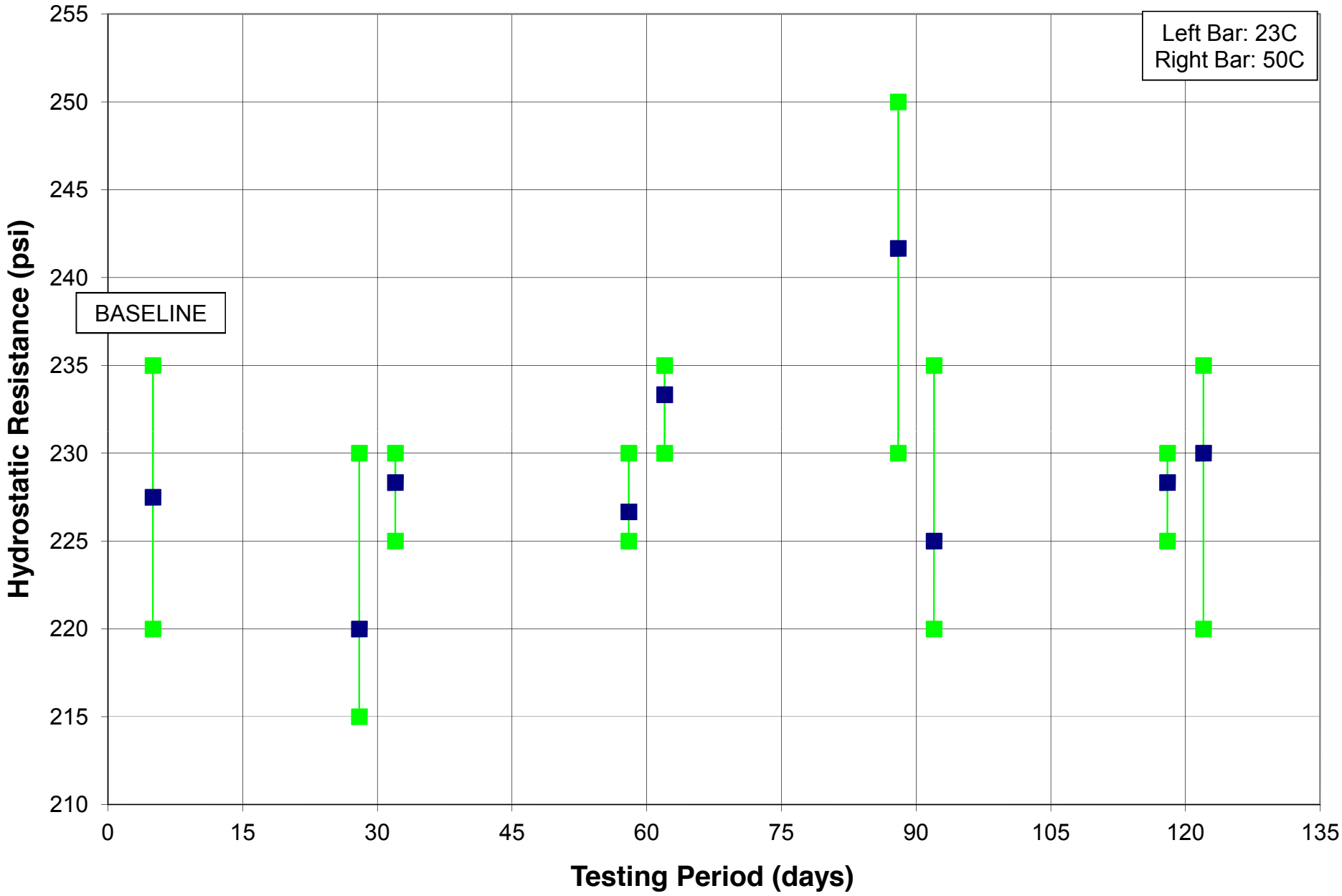
Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



9063 Bee Caves Road / Austin, TX 78733 / 512-263-2101 / FAX 263-2558 / 800-880-TEST

Solmax - EPA METHOD 9090A
30 mil smooth HDPE vs Leachate



9063 Bee Caves Road / Austin, TX 78733 / 512-263-2101 / FAX 263-2558 / 800-880-TEST

EPA METHOD 9090A TEST RESULTS

Leachate Analysis

TRI LOG NUMBER: E2386-18-02

DHL Analytical, Inc.

Date: *01-May-14*

CLIENT:	TRI Environmental, Inc.	**Client Sample ID:**	Waste Leachate
Project:	E2386-18-02 Waste Leachate	**Lab ID:**	1404217-01
Project No:		**Collection Date:**	03/05/14
Lab Order:	1404217	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TOTAL MERCURY: AQUEOUS		**SW7470A**					Analyst: **SM**
Mercury	ND	0.000400	0.00100	C	mg/L	1	04/24/14 11:50 AM
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SW**
Antimony	0.00843	0.00400	0.0125	J	mg/L	1	04/23/14 05:41 PM
Arsenic	ND	0.0100	0.0250		mg/L	1	04/23/14 05:41 PM
Barium	481	1.50	5.00		mg/L	100	04/24/14 01:05 PM
Beryllium	ND	0.00150	0.00500		mg/L	1	04/23/14 05:41 PM
Cadmium	0.0114	0.00150	0.00500		mg/L	1	04/23/14 05:41 PM
Chromium	ND	0.0100	0.0250		mg/L	1	04/23/14 05:41 PM
Cobalt	ND	0.0150	0.0500		mg/L	1	04/23/14 05:41 PM
Copper	ND	0.0100	0.0500		mg/L	1	04/23/14 05:41 PM
Lead	ND	0.00150	0.00500		mg/L	1	04/23/14 05:41 PM
Nickel	0.0235	0.0150	0.0500	J	mg/L	1	04/23/14 05:41 PM
Selenium	ND	0.0100	0.0250		mg/L	1	04/23/14 05:41 PM
Silver	ND	0.00500	0.0100		mg/L	1	04/23/14 05:41 PM
Thallium	ND	0.00250	0.00750		mg/L	1	04/23/14 05:41 PM
Vanadium	0.00532	0.00250	0.00500		mg/L	1	04/23/14 05:41 PM
Zinc	0.296	0.0100	0.0250		mg/L	1	04/23/14 05:41 PM
SEMIVOLATILES BY GC/MS - WATER		**SW8270D**					Analyst: **KL**
1,2,4-Trichlorobenzene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
1,2-Dichlorobenzene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
1,3-Dichlorobenzene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
1,4-Dichlorobenzene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,4,5-Trichlorophenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,4,6-Trichlorophenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,4-Dichlorophenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,4-Dimethylphenol	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,4-Dinitrophenol	ND	0.00500	0.0200	C	mg/L	1	04/22/14 09:39 PM
2,4-Dinitrotoluene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,6-Dichlorophenol	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
2,6-Dinitrotoluene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2-Chloronaphthalene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2-Chlorophenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2-Methylnaphthalene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2-Methylphenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2-Nitroaniline	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
2-Nitrophenol	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
3,3´-Dichlorobenzidine	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits
N	Parameter not NELAC certified		

DHL Analytical, Inc.

Date: *01-May-14*

CLIENT:	TRI Environmental, Inc.	**Client Sample ID:**	Waste Leachate
Project:	E2386-18-02 Waste Leachate	**Lab ID:**	1404217-01
Project No:		**Collection Date:**	03/05/14
Lab Order:	1404217	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
SEMIVOLATILES BY GC/MS - WATER		**SW8270D**					Analyst: **KL**
3-Nitroaniline	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
4,6-Dinitro-2-methylphenol	ND	0.00250	0.0100	C	mg/L	1	04/22/14 09:39 PM
4-Bromophenyl phenyl ether	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
4-Chloro-3-methylphenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
4-Chloroaniline	ND	0.00250	0.0100	C	mg/L	1	04/22/14 09:39 PM
4-Chlorophenyl phenyl ether	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
4-Methylphenol	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
4-Nitroaniline	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
4-Nitrophenol	ND	0.00500	0.0200	C	mg/L	1	04/22/14 09:39 PM
Acenaphthene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Acenaphthylene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Aniline	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Anthracene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Benzo[a]anthracene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Benzo[a]pyrene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Benzo[b]fluoranthene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Benzo[g,h,i]perylene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Benzo[k]fluoranthene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Benzyl alcohol	ND	0.00250	0.0100	C	mg/L	1	04/22/14 09:39 PM
Bis(2-chloroethoxy)methane	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Bis(2-chloroethyl)ether	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Bis(2-chloroisopropyl)ether	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Bis(2-ethylhexyl)phthalate	ND	0.00500	0.0150	C	mg/L	1	04/22/14 09:39 PM
Butyl benzyl phthalate	ND	0.0100	0.0300	C	mg/L	1	04/22/14 09:39 PM
Carbazole	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Chrysene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Dibenz[a,h]anthracene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Dibenzofuran	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Diethyl phthalate	ND	0.0100	0.0300	C	mg/L	1	04/22/14 09:39 PM
Dimethyl phthalate	ND	0.0100	0.0300	C	mg/L	1	04/22/14 09:39 PM
Di-n-butyl phthalate	ND	0.0100	0.0300	C	mg/L	1	04/22/14 09:39 PM
Di-n-octyl phthalate	ND	0.0100	0.0300	C	mg/L	1	04/22/14 09:39 PM
Fluoranthene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Fluorene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Hexachlorobenzene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Hexachlorobutadiene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Hexachlorocyclopentadiene	ND	0.00250	0.0100	C	mg/L	1	04/22/14 09:39 PM
Hexachloroethane	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits
N	Parameter not NELAC certified		

DHL Analytical, Inc.

Date: *01-May-14*

CLIENT:	TRI Environmental, Inc.	**Client Sample ID:**	Waste Leachate
Project:	E2386-18-02 Waste Leachate	**Lab ID:**	1404217-01
Project No:		**Collection Date:**	03/05/14
Lab Order:	1404217	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
SEMIVOLATILES BY GC/MS - WATER		**SW8270D**					Analyst: **KL**
Indeno[1,2,3-cd]pyrene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Isophorone	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Naphthalene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Nitrobenzene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
N-Nitrosodiethylamine	ND	0.00500	0.0150	C	mg/L	1	04/22/14 09:39 PM
N-Nitrosodi-n-propylamine	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
N-Nitrosodiphenylamine	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Pentachlorophenol	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Phenanthrene	ND	0.00100	0.00400	C	mg/L	1	04/22/14 09:39 PM
Phenol	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Pyrene	ND	0.00200	0.00400	C	mg/L	1	04/22/14 09:39 PM
Surr: 2,4,6-Tribromophenol	88.2	0	42-124		%REC	1	04/22/14 09:39 PM
Surr: 2-Fluorobiphenyl	81.0	0	48-120		%REC	1	04/22/14 09:39 PM
Surr: 2-Fluorophenol	66.2	0	20-120		%REC	1	04/22/14 09:39 PM
Surr: 4-Terphenyl-d14	80.2	0	51-135		%REC	1	04/22/14 09:39 PM
Surr: Nitrobenzene-d5	83.2	0	41-120		%REC	1	04/22/14 09:39 PM
Surr: Phenol-d5	50.8	0	20-120		%REC	1	04/22/14 09:39 PM
8260 WATER VOLATILES BY GC/MS		**SW8260C**					Analyst: **DEW**
1,1,1,2-Tetrachloroethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,1,1-Trichloroethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,1,2,2-Tetrachloroethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,1,2-Trichloroethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,1-Dichloroethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,1-Dichloroethene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,1-Dichloropropene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,2,3-Trichlorobenzene	ND	0.0300	0.100	C	mg/L	20	04/18/14 10:54 PM
1,2,3-Trichloropropane	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,2,4-Trichlorobenzene	ND	0.0300	0.100	C	mg/L	20	04/18/14 10:54 PM
1,2,4-Trimethylbenzene	ND	0.0300	0.100	C	mg/L	20	04/18/14 10:54 PM
1,2-Dibromo-3-chloropropane	ND	0.0600	0.200	C	mg/L	20	04/18/14 10:54 PM
1,2-Dibromoethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,2-Dichlorobenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,2-Dichloroethane	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,2-Dichloropropane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,3,5-Trimethylbenzene	ND	0.0300	0.100	C	mg/L	20	04/18/14 10:54 PM
1,3-Dichlorobenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,3-Dichloropropane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
1,4-Dichlorobenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits
N	Parameter not NELAC certified		

DHL Analytical, Inc.

Date: *01-May-14*

CLIENT:	TRI Environmental, Inc.	**Client Sample ID:**	Waste Leachate
Project:	E2386-18-02 Waste Leachate	**Lab ID:**	1404217-01
Project No:		**Collection Date:**	03/05/14
Lab Order:	1404217	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
8260 WATER VOLATILES BY GC/MS		**SW8260C**					Analyst: **DEW**
2,2-Dichloropropane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
2-Butanone	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
2-Chlorotoluene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
2-Hexanone	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
4-Chlorotoluene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
4-Methyl-2-pentanone	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
Acetone	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
Benzene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Bromobenzene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Bromochloromethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Bromodichloromethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Bromoform	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Bromomethane	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Carbon disulfide	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
Carbon tetrachloride	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Chlorobenzene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Chloroethane	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Chloroform	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Chloromethane	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
cis-1,2-Dichloroethene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
cis-1,3-Dichloropropene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Dibromochloromethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Dibromomethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Dichlorodifluoromethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Ethylbenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Hexachlorobutadiene	ND	0.0200	0.0600	C	mg/L	20	04/18/14 10:54 PM
Iodomethane	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
Isopropylbenzene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
m,p-Xylene	ND	0.0120	0.0400	C	mg/L	20	04/18/14 10:54 PM
Methyl tert-butyl ether	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Methylene chloride	ND	0.0500	0.0500	C	mg/L	20	04/18/14 10:54 PM
Naphthalene	ND	0.100	0.300	C	mg/L	20	04/18/14 10:54 PM
n-Butylbenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
n-Propylbenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
o-Xylene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
p-Isopropyltoluene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
sec-Butylbenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Styrene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits
N	Parameter not NELAC certified		

DHL Analytical, Inc.

Date: *01-May-14*

CLIENT:	TRI Environmental, Inc.	**Client Sample ID:**	Waste Leachate
Project:	E2386-18-02 Waste Leachate	**Lab ID:**	1404217-01
Project No:		**Collection Date:**	03/05/14
Lab Order:	1404217	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
8260 WATER VOLATILES BY GC/MS		**SW8260C**					Analyst: **DEW**
tert-Butylbenzene	ND	0.00600	0.0200	C	mg/L	20	04/18/14 10:54 PM
Tetrachloroethene	ND	0.0120	0.0400	C	mg/L	20	04/18/14 10:54 PM
Toluene	ND	0.0120	0.0400	C	mg/L	20	04/18/14 10:54 PM
trans-1,2-Dichloroethene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
trans-1,3-Dichloropropene	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Trichloroethene	ND	0.0120	0.0400	C	mg/L	20	04/18/14 10:54 PM
Trichlorofluoromethane	ND	0.00400	0.0200	C	mg/L	20	04/18/14 10:54 PM
Vinyl chloride	ND	0.00200	0.0200	C	mg/L	20	04/18/14 10:54 PM
Surr: 1,2-Dichloroethane-d4	102	0	72-119		%REC	20	04/18/14 10:54 PM
Surr: 4-Bromofluorobenzene	98.8	0	76-119		%REC	20	04/18/14 10:54 PM
Surr: Dibromofluoromethane	101	0	85-115		%REC	20	04/18/14 10:54 PM
Surr: Toluene-d8	99.1	0	81-120		%REC	20	04/18/14 10:54 PM
PH		**M4500-H+ B**					Analyst: **LM**
pH	4.91	0	0		pH Units@16.2°C	1	04/18/14 11:20 AM

Qualifiers:					
	*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
	C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
	E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
	MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
	RL	Reporting Limit	S	Spike Recovery outside control limits
	N	Parameter not NELAC certified		

SKAPS TRANSNET™

HDPE GEONET TN 220

SKAPS TRANSNET™ geonet consists of SKAPS Geonet made from HDPE resin.

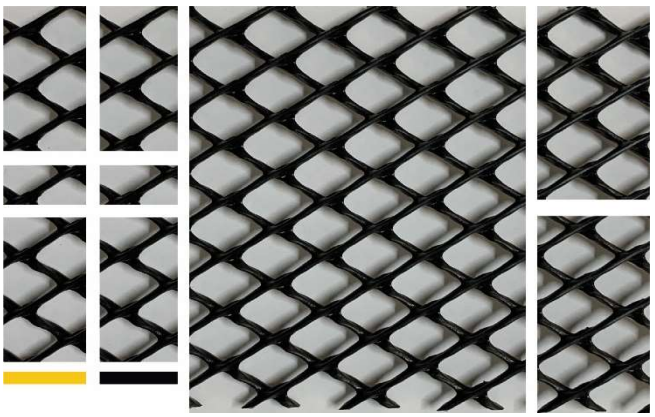
PROPERTY	TEST METHOD	UNIT	VALUE	QUALIFIER
Thickness	ASTM D 5199	mil	200	MAV(3)
Carbon Black	ASTM D 4218	%	2.0	MAV
Tensile Strength	ASTM D 7179	lb/in	45	MAV
Melt Flow	ASTM D 1238(2)	g/10 min	1.0	Maximum
Density	ASTM D 1505	g/cm^3	0.94	MAV
Transmissivity(1)	ASTM D 4716	gal/min/ft (m^2/sec)	9.67 (2.0 x 10^{-3})	MAV

Notes:

(1) Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10,000 psf between steel plates after 15 minutes. Values may vary with individual labs.

(2) Condition 190/2.16

(3) Minimum average value



This information is provided for reference purposes only and is not intended as a warranty or guarantee.

SKAPS assumes no liability in connection with the use of this information.

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www.skaps.com

DESIGN/CONSTRUCTION PLAN
O&M PLAN
CLOSURE PLAN

General

Examination of the engineering drawings and the SOP for set-up (Appendix Engineering Drawings, Liner Specifications, Set Up) plus the history of solid performance of these AST Containments demonstrates that the AST Containment is designed and will be assembled to ensure the confinement of produced water, to prevent releases and to prevent overtopping due to wave action or rainfall. As the AST Containments are generally less than 190 feet in diameter, wave action is not a meaningful consideration.

19.15.34.12 A
(1) The operator shall design and construct a recycling containment to ensure the confinement of produced water, to prevent releases and to prevent overtopping due to wave action or rainfall.

These AST Containments are constructed of 8-12 foot high steel panels and are netted or employ the Mega Blaster Pro avian deterrent system to prevent ingress of migratory birds. AST Containments will be enclosed by a 4-strand barbed wire fence. Thus, complies with the Rule to fence or enclose a recycling containment in a manner that deters unauthorized wildlife and human access and shall maintain the fences in good repair.

19.15.34.12 D
(1) The operator shall fence or enclose a recycling containment in a manner that deters unauthorized wildlife and human access and shall maintain the fences in good repair. The operator shall ensure that all gates associated with the fence are closed and locked when responsible personnel are not onsite.

The operator shall post an upright sign no less than 12 inches by 24 inches with lettering not less than two inches in height in conspicuous places surrounding the containment. The operator shall post the sign in a manner and location such that a person can easily read the legend. The sign shall provide the following information: the operator's name, the location of the site by quarter-quarter or unit letter, section, township and range, and emergency telephone numbers.

19.15.34.12 C
Signs. The operator shall post an upright sign no less than 12 inches by 24 inches with lettering not less than two inches in height in a conspicuous place on the fence surrounding the containment. The operator shall post the sign in a manner and location such that a person can easily read the legend. The sign shall provide the following information: the operator's name, the location of the site by quarter-quarter or unit letter, section, township and range, and emergency telephone numbers.

Site Preparation

Foundation for AST Containment

Preparation of the soils on site is required to form a dependable base for the AST Containment in accordance with the SOP. If the location of the AST Containment is on an existing pad, the operator has stripped and stockpiled the topsoil for use as the final cover or fill at the time of closure. If the pad is new construction, the operator will strip and stockpile the soil for reclamation upon cessation of site activities.

19.15.34.12 B
Stockpiling of topsoil. Prior to constructing containment, the operator shall strip and stockpile the topsoil for use as the final cover or fill at the time of closure.

The foundation soils must be roller compacted smooth and free of loose aggregate over ½ inch. Compaction characteristics must meet or exceed 95% of Standard Proctor Density in accordance with ASTM D 698.

19.15.34.12 A
(2) A recycling containment shall have a properly constructed foundation and interior slopes consisting of a firm, unyielding base, smooth and free of rocks, debris, sharp edges or irregularities to prevent the liner's rupture or tear. Geotextile is required under the liner when needed to reduce localized stress-strain or protuberances that otherwise may compromise the liner's integrity. The operator shall construct the containment in a levee with an inside grade no steeper than two horizontal feet to one vertical foot (2H:1V). The levee shall have an outside grade no steeper than three horizontal feet to one vertical foot (3H:1V). The top of the levee shall be wide enough to install an anchor trench and provide adequate room for inspection and maintenance.

Examination of the SOP shows that the AST Containment contractor will conform to the following mandates of the Rule:

- the AST Containment will have a properly constructed compacted earth foundation and interior slopes (vertical steel) consisting of a firm, unyielding base, smooth and free of rocks, debris, sharp edges or irregularities to prevent the liner's rupture or tear.
- Geotextile will be placed under the liner where needed to reduce localized stress-strain or protuberances that otherwise may compromise the liner's integrity.
- If the AST Containment contractor constructs the containment in a levee, the inside grade is no steeper than two horizontal feet to one vertical foot (2H: 1V) and the outside grade no steeper than three horizontal feet to one vertical foot (3H: IV). The vertical steel walls of the AST Containment are the *subject of a requested variance*.

19.15.34.12 A
(6) At a point of discharge into or suction from the recycling containment, the operator shall insure that the liner is protected from excessive hydrostatic force or mechanical damage. External discharge or suction lines shall not penetrate the liner.

The Operator will ensure that at a point of discharge into or suction from the recycling containment, the liner is protected from excessive hydrostatic force or mechanical damage and external discharge or suction lines shall not penetrate the liner.

Liner and Leak Detection Materials

The liner and geotextile specifications show that all primary (upper) liners in a recycling containment shall be geomembrane liners composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. All primary liners shall be *an equivalent liner [to that stated in Rule 34] approved by OCD pursuant to a variance.* The liner system is presented in an earlier section of this submission.

19.15.34.12 A
(4) All primary (upper) liners in a recycling containment shall be geomembrane liners composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. All primary liners shall be 30-mil flexible PVC, 45-mil LLDPE string reinforced or 60-mil HDPE liners. Secondary liners shall be 30-mil LLDPE string reinforced or equivalent with a hydraulic conductivity no greater than 1 x 10-9 cm/sec. Liner compatibility shall meet or exceed the EPA SW-846 method 9090A or subsequent relevant publications.

All secondary liners shall be *an equivalent liner [to that stated in Rule 34] approved by OCD pursuant to a*

variance. The liner system is presented in an earlier section of this submission.

Liner compatibility shall meet or exceed the EPA SW-846 method 9090A or subsequent relevant publications.

The AST Containment will have a leak detection system between the upper and lower geomembrane liners that shall consist of 200-mil geonet to facilitate drainage.

Install Secondary Liner, Leak Detection System and Secondary Containment

All AST containments holding produced water will have a primary (upper) liner and a secondary (lower) liner with a leak detection system appropriate to the site's conditions. The rule states that the edges of all secondary liners shall be anchored in the bottom of a compacted earth-filled trench. The anchor trench shall be at least 18 inches deep. *The lack of an anchor trench with an AST Containment is also the subject of requested variance.*

19.15.34.12 A
(3) Each recycling containment shall incorporate, at a minimum, a primary (upper) liner and a secondary (lower) liner with a leak detection system appropriate to the site's conditions. The edges of all liners shall be anchored in the bottom of a compacted earth-filled trench. The anchor trench shall be at least 18 inches deep.

The AST Containment Contractor will cause the recycling containment will have a leak detection system between the upper and lower geomembrane liners that shall consist of 200-mil geonet to facilitate drainage. The leak detection system shall consist of a properly designed drainage and collection and removal system placed above the lower geomembrane liner in depressions and sloped to facilitate the earliest possible leak detection.

19.15.34.12 A
(7) The operator of a recycling containment shall place a leak detection system between the upper and lower geomembrane liners that shall consist of 200-mil geonet or two feet of compacted soil with a saturated hydraulic conductivity of 1 x 10-5 cm/sec or greater to facilitate drainage. The leak detection system shall consist of a properly designed drainage and collection and removal system placed above the lower geomembrane liner in depressions and sloped to facilitate the earliest possible leak detection.

The presence of the secondary containment levee or pre-fabricated secondary containment meets the OCD Rule mandate that a recycling containment shall design the containment to prevent run-on of surface water. The containment shall be surrounded by a berm, ditch or other diversion to prevent run-on of surface water.

19.15.34.12 A
(8) The operator of a recycling containment shall design the containment to prevent run-on of surface water. The containment shall be surrounded by a berm, ditch or other diversion to prevent run-on of surface water.

AST Containment Setup

As with the secondary liner, AST Containment contractor will minimize liner seams and orient them up and down, as much as possible, not across, a slope. Factory welded seams shall be used where possible. AST Containment contractor will employ field seams in

19.15.34.12 A
(5) The operator of a recycling containment shall minimize liner seams and orient them up and down, not across, a slope of the levee. Factory welded seams shall be used where possible. The

geosynthetic material that are thermally seamed. Prior to field seaming, AST Containment contractor shall overlap liners four to six inches and minimize the number of field seams and corners and irregularly shaped areas. There shall be no horizontal seams within five feet of the AST Containment bottom. Qualified personnel shall perform field welding and testing.

operator shall ensure field seams in geosynthetic material are thermally seamed. Prior to field seaming, the operator shall overlap liners four to six inches. The operator shall minimize the number of field seams and corners and irregularly shaped areas. There shall be no horizontal seams within five feet of the slope's toe. Qualified personnel shall perform field welding and testing.

Fluid Injection/Withdrawal Flow Diverter

The injection or withdrawal of fluids from the containment shall be accomplished through a header, diverter or other hardware that prevents damage to the liner by erosion, fluid jets or impact from installation and removal of hoses or pipes.

19.15.34.13 B
(3) The injection or withdrawal of fluids from the containment shall be accomplished through a header, diverter or other hardware that prevents damage to the liner by erosion, fluid jets or impact from installation and removal of hoses or pipes.

General Specifications

This plan provides additional protocols to cause the proposed recycling containments (AST Containments) to conform to NMOCD Rules.

The operator will maintain and operate the recycling containments and facility in accordance with the following plan to contain liquids and maintain the integrity of the liner to prevent contamination of fresh water and protect public health and the environment.

- The operator will use the treated produced water in the containments for drilling, completion (stimulation), producing or processing oil or gas or both. If other uses are planned, the operator will notify the OCD though the submission of a modified C-147.
- For all exploration and production operations that use produced water, the operator will conduct these activities in a manner consistent with hydrogen sulfide gas provisions in 19.15.11 NMAC or NORM provisions in 19.15.35 NMAC, as applicable.
- The operator will address all releases from the recycling and re-use of produced water in accordance with 19.15.29 NMAC.
- The operator will not discharge into or store any hazardous waste in the recycling containments, but they may hold fluids such was freshwater, brackish water, recycled and treated water, water generated by oil or gas processing facilities, or other waters that are gathered for well drilling or completion. The recycling facility will not be used for the disposal of produced water. The operator will maintain the containments free of miscellaneous solid waste or debris.
- The operator will verify that no oil is on the surface of the contained fluid. If oil is observed, the oil shall be removed using an absorbent boom or other device and properly disposed at an approved facility. An absorbent boom or other device will be maintained on site.
- The operator will install and use a header and diverter described in the design/construction plan in order to prevent damage to the liner by erosion, fluid

19.15.34.10 B
Recycling containments may hold produced water for use in connection with drilling, completion, producing or processing oil or gas or both.

19.15.34.8 A
(5) All operations in which produced water is used shall be conducted in a manner consistent with hydrogen sulfide gas provisions in 19.15.11 NMAC or NORM provisions in 19.15.35 NMAC, as applicable.

19.15.34.8 A
(6) All releases from the recycling and re-use of produced water shall be handled in accordance with 19.15.29 NMAC.

19.15.34.10 B
Recycling containments may hold produced water for use in connection with drilling, completion, producing or processing oil or gas or both. Such fluids may include fresh water, brackish water, recycled and treated water, fluids added to water to facilitate well drilling or completion, water produced with oil and gas, flowback from operations, water generated by an oil or gas processing facility or other waters that are gathered for well drilling or completion but may not include any hazardous waste.

19.15.34.9 G
Recycling facilities may not be used for the disposal of produced water.

19.15.34.13 B
(1) The operator shall remove any visible layer of oil from the surface of the recycling containment
(7) The operator shall install, or maintain on site, an oil absorbent boom or other device to contain an unanticipated release.

19.15.34.13 B
(3) The injection or withdrawal of fluids from the containment shall be accomplished through a header, diverter or other hardware that prevents damage to the liner by erosion, fluid jets or impact from installation and removal of hoses or pipes.

jets or impact from installation and removal of hoses or pipes during injection or withdrawal of liquids.

- *Pursuant to a requested variance*, the operator will maintain at least 2-feet of freeboard in each AST containment. Under extenuating circumstances, which will be noted on the inspection log as described below, the operator may temporarily exceed the freeboard mandate.

19.15.34.13 B
(2) The operator shall maintain at least three feet of freeboard at each containment.

- If the liner develops a leak or if any penetration of the liner occurs above the liquid's surface, then the operator will repair the damage or initiate replacement of the liner within 48 hours of discovery or will seek a variance from the division district office within this time period.

19.5.34.13 B
(4) If the containment's primary liner is compromised above the fluid's surface, the operator shall repair the damage or initiate replacement of the primary liner within 48 hours of discovery or seek an extension of time from the division district office.

- If visible inspection suggests that the liner developed a leak or if any penetration of the liner occurs below the liquid's surface, then the operator will remove all liquid above the damage or leak line within 48 hours of discovery. The operator will also notify the district division office within this same 48 hours of the discovery and repair the damage or replace the liner.

(5) If the primary liner is compromised below the fluid's surface, the operator shall remove all fluid above the damage or leak within 48 hours of discovery, notify the division district office and repair the damage or replace the primary liner.

- In the event of a leak due to a hole in the liner, the following steps will be followed:
    1. If the source of the fluid is uncertain, comparative field tests may need to be performed on both the water in the containment and that which may have been released (e.g. pH, conductance, and chloride).
    2. If the fluid is found to be coming from the containment, determine the location from which the leak is originating.
    3. Mark the point where the water is coming out of the tank.
    4. Locate the puncture or hole in the liner.
    5. Empty the containment to the point of damage in liner.
    6. Clean area of liner that needs to be repaired.
    7. Cut out piece of material (patch or tape) to overlay liner.

8. Either weld the patch to the injured area in the liner or apply tape over the rupture.
9. Make sure rupture is completely covered.
10. Monitor as needed.

The operator will inspect and remove, as necessary, surface water run-on accumulated in the secondary containment

Monitoring, Inspections, and Reporting

The containment will contain enough produced water to prevent any shifting of the liner. Weekly inspections shall occur when there is 1-foot depth or more of produced water in the containment. Monthly inspections shall occur when there is less than 1-foot depth of produced water in the containment, as well as when the ASTs are emptied and prior to refilling. An inspection log will be maintained by the operator and will be made available to the division upon request. Inspection will include: freeboard monitoring, leak detection, identifying potential hazards that may have developed, change in site conditions or if the contents of the containment change from the initial use.
An "Inspection Form" meeting the requirements according to NMAC 19.15.34 is to be filled out during these routine inspections. The form also provides a list of observations that will enable early detection of uneven tank panel settlement, soil settlement, liner damage, insufficient liner slack, or leaks. The form is reproduced at the end of this section.

Weekly inspections consist of:

- Reading and recording the fluid height of staff gauges and freeboard
- Recording any evidence of visible oil on surface
- Visually inspecting the containments exposed liners
- Checking the leak detection system for any evidence of a loss of integrity of the primary liner
- Inspect any diversion ditches and berms around the containment to check for erosion and collection of surface water run-on.
- Inspect the leak detection system for evidence of damage or malfunction and monitor for leakage.

- Inspect netting (may not be used if Mega Blaster Pro avian deterrent is used) for damage or dead wildlife, including migratory birds. Operator shall report the discovery of a dead animal to the appropriate wildlife agency and to the district within 30 days of discovery. Further prevention measures may be required.

19.15.34.12 E
Netting. The operator shall ensure that a recycling containment is screened, netted or otherwise protective of wildlife, including migratory birds. The operator shall on a monthly basis inspect for and, within 30 days of discovery, report the discovery of dead migratory birds or other wildlife to the appropriate wildlife agency and to the division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.

Additional monitoring to identify hazards that may have developed, changes in site conditions, tank use, and to enable early detection of structural issues such as uneven tank panel settlement, soil settlement, liner damage, insufficient liner slack or leaks. If changes are noted the AST contractor should be notified

- If observed conditions indicate a potential tank failure is imminent, the vicinity will be immediately cleared and the AST will be drained.

Monthly, the operator will:

- Report to the division, the total volume of water received for recycling, with the amount of fresh water received listed separately, and the total volume of water leaving the facility for disposition by use on form C-148.
- Record sources and disposition of all recycled water.

Cessation of Operations

If less than 20% of the total fluid capacity is utilized every six months, beginning from the first withdraw, operation of the facility has ceased and the division district office will be notified. The division district may grant an extension not to exceed six months to determine the cessation of operations.

19.15.34.13 C
A recycling containment shall be deemed to have ceased operations if less than 20% of the total fluid capacity is used every six months following the first withdrawal of produced water for use. The operator must report cessation of operations to the appropriate division district office. The appropriate division district office may grant an extension to this determination of cessation of operations not to exceed six months.

The operator will remove all fluids from the recycling facility within 60 days of cessation of operations. An extension, not to exceed 2 months, may be granted by the district division for the removal of fluids from the facility.

19.15.34.14 A
Once the operator has ceased operations, the operator shall remove all fluids within 60 days and close the containment within six months from the date the operator ceases operations from the containment for use. The division district office may grant an extension for the removal of all fluids not to exceed two months.

The breakdown of the containments follows the reverse order of the setup steps presented in the set-up manual.

Inspection Form

Date: _____

Dagger Recycling Facility AST #1 (NE Tank)

(weekly inspection when fluids are present, monthly otherwise)

Tank ID: _____

Fluid Level: _____ Tank contents: _____

Inspection Task	Results		Remarks, Observations, and/or Remedial Actions
Visible Oil on Surface	☐ None Observed	☐ Yes, Describe Action	
	An absorbent boom or similar device is located on site to remove visible oil from surface.		
At least 2 ft of freeboard	☐ Yes	☐ No, Measure Freeboard	
Evidence of surface water run-on	☐ None Observed	☐ Yes, Describe	
	Check for excessive erosion of perimeter berms.		
Birds or wildlife in net or screen	☐ None Observed	☐ Yes, Describe	
	Within 30 days of discovery, report dead birds or wildlife to the appropriate agency (USFWS, NMDGF) and to NMOCD District II.		
Damage to netting or screen	☐ None Observed	☐ Yes, Describe	
Rupture of Liner	☐ None Observed	☐ Yes, Describe	
	If rupture is above fluid level, repair within 48 hours. If below fluid level, remove fluid above within 48 hours, notify NMOCD District II, and repair.		
Clips or clamps properly securing liner	☐ Yes	☐ No, Describe	
If low level, enough liner slack on panel wall	☐ Yes	☐ No, Describe	
Uneven gaps between panels	☐ None Observed	☐ Yes, Describe	

Signs of tank settlement	☐ None Observed	☐ Yes, Describe	
Erosion of soil surrounding tank (10 ft radius)	☐ None Observed	☐ Yes, Describe	
Running water on the ground	☐ None Observed	☐ Yes, Describe	
Unusual ponding of fluid inside berm	☐ None Observed	☐ Yes, Describe	
		Field test (pH, Cl-, conductance, etc.) ponded fluid and compare to fluid in tank. If tank is determined as the source, locate and repair rupture within 48 hours. Notify NMOCD District II and repair.	
Rust or corrosion on panels, stairs, or hardware	☐ None Observed	☐ Yes, Describe	
Damage to any hardware	☐ None Observed	☐ Yes, Describe	

Additional Observations or Actions: _____

_____

_____

_____

_____

_____

_____

_____

Inspected by: _____

Inspection Form

Date: _____

Dagger Recycling Facility AST #2 (NW Tank)

(weekly inspection when fluids are present, monthly otherwise)

Tank ID: _____

Fluid Level: _____ Tank contents: _____

Inspection Task	Results		Remarks, Observations, and/or Remedial Actions
Visible Oil on Surface	☐ None Observed	☐ Yes, Describe Action	
	An absorbent boom or similar device is located on site to remove visible oil from surface.		
At least 2 ft of freeboard	☐ Yes	☐ No, Measure Freeboard	
Evidence of surface water run-on	☐ None Observed	☐ Yes, Describe	
	Check for excessive erosion of perimeter berms.		
Birds or wildlife in net or screen	☐ None Observed	☐ Yes, Describe	
	Within 30 days of discovery, report dead birds or wildlife to the appropriate agency (USFWS, NMDGF) and to NMOCD District II.		
Damage to netting or screen	☐ None Observed	☐ Yes, Describe	
Rupture of Liner	☐ None Observed	☐ Yes, Describe	
	If rupture is above fluid level, repair within 48 hours. If below fluid level, remove fluid above within 48 hours, notify NMOCD District II, and repair.		
Clips or clamps properly securing liner	☐ Yes	☐ No, Describe	
If low level, enough liner slack on panel wall	☐ Yes	☐ No, Describe	
Uneven gaps between panels	☐ None Observed	☐ Yes, Describe	

Signs of tank settlement	☐ None Observed	☐ Yes, Describe	
Erosion of soil surrounding tank (10 ft radius)	☐ None Observed	☐ Yes, Describe	
Running water on the ground	☐ None Observed	☐ Yes, Describe	
Unusual ponding of fluid inside berm	☐ None Observed	☐ Yes, Describe	
		Field test (pH, Cl-, conductance, etc.) ponded fluid and compare to fluid in tank. If tank is determined as the source, locate and repair rupture within 48 hours. Notify NMOCD District II and repair.	
Rust or corrosion on panels, stairs, or hardware	☐ None Observed	☐ Yes, Describe	
Damage to any hardware	☐ None Observed	☐ Yes, Describe	

Additional Observations or Actions: _____

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_____

_____

_____

_____

Inspected by: _____

Inspection Form

Date: _____

Dagger Recycling Facility AST #3 (SE Tank)

(weekly inspection when fluids are present, monthly otherwise)

Tank ID: _____

Fluid Level: _____ Tank contents: _____

Inspection Task	Results		Remarks, Observations, and/or Remedial Actions
Visible Oil on Surface	☐ None Observed	☐ Yes, Describe Action	
	An absorbent boom or similar device is located on site to remove visible oil from surface.		
At least 2 ft of freeboard	☐ Yes	☐ No, Measure Freeboard	
Evidence of surface water run-on	☐ None Observed	☐ Yes, Describe	
	Check for excessive erosion of perimeter berms.		
Birds or wildlife in net or screen	☐ None Observed	☐ Yes, Describe	
	Within 30 days of discovery, report dead birds or wildlife to the appropriate agency (USFWS, NMDGF) and to NMOCD District II.		
Damage to netting or screen	☐ None Observed	☐ Yes, Describe	
Rupture of Liner	☐ None Observed	☐ Yes, Describe	
	If rupture is above fluid level, repair within 48 hours. If below fluid level, remove fluid above within 48 hours, notify NMOCD District II, and repair.		
Clips or clamps properly securing liner	☐ Yes	☐ No, Describe	
If low level, enough liner slack on panel wall	☐ Yes	☐ No, Describe	
Uneven gaps between panels	☐ None Observed	☐ Yes, Describe	

Signs of tank settlement	☐ None Observed	☐ Yes, Describe	
Erosion of soil surrounding tank (10 ft radius)	☐ None Observed	☐ Yes, Describe	
Running water on the ground	☐ None Observed	☐ Yes, Describe	
Unusual ponding of fluid inside berm	☐ None Observed	☐ Yes, Describe	
		Field test (pH, Cl-, conductance, etc.) ponded fluid and compare to fluid in tank. If tank is determined as the source, locate and repair rupture within 48 hours. Notify NMOCD District II and repair.	
Rust or corrosion on panels, stairs, or hardware	☐ None Observed	☐ Yes, Describe	
Damage to any hardware	☐ None Observed	☐ Yes, Describe	

Additional Observations or Actions: _____

_____

_____

_____

_____

_____

_____

_____

Inspected by: _____

Closure Plan

The containments are expected to contain a small volume of solids, the majority of which will be windblown sand and dust with some mineral precipitates from the water.

The operator will notify the division district (phone or email) before initiating closure of the containments and/or facility.

Excavation and Removal Closure Plan – Protocols and Procedures

1. Residual fluids in the containments will be sent to disposal at a division-approved facility.
2. The operator will remove all solid contents and transfer those materials to the following division-approved facility:
3. If possible, geomembrane textiles and liners that exhibit good integrity may be recycled for use as an under liner of tank batteries or other use as approved by OCD.
4. Disassemble the recycling containment infrastructure according to manufacturer's recommendations
5. After the disassemble of the containments and removal of the contents and liners, soils beneath the tanks will be tested as follows
    a. Collect a five-point (minimum) composite from beneath the liner to include any obviously stained or wet soils, or any other evidence of impact from the containments for laboratory analyses for the constituents listed in Table I of 19.15.34.14 NMAC.
    b. If any concentration is higher than the parameters listed in Table I, additional delineation may be required, and closure activities will not proceed without Division approval.
    c. If all constituents' concentrations are less than or equal to the parameters listed in Table I, then the operator will backfill the facility as necessary using non-waste containing, uncontaminated, earthen material and proceed to reclaim the surface to pre-existing conditions.

19.15.34.14 B
The operator shall close a recycling containment by first removing all fluids, contents and synthetic liners and transferring these materials to a division approved facility.

19.15.34.14 C
The operator shall test the soils beneath the containment for contamination with a five-point composite sample which includes stained or wet soils, if any, and that sample shall be analyzed for the constituents listed in Table I below.
(1) If any contaminant concentration is higher than the parameters listed in Table I, the division may require additional delineation upon review of the results and the operator must receive approval before proceeding with closure.
(2) If all contaminant concentrations are less than or equal to the parameters listed in Table I, then the operator can proceed to backfill with non-waste containing, uncontaminated, earthen material.

19.15.34.14 D
Within 60 days of closure completion, the operator shall submit a closure report on form C-147, including required attachments, to document all closure activities including sampling results and the details on any backfilling, capping or covering, where applicable. The closure report shall certify that all information in the report and attachments is correct and that the operator has complied with all applicable closure requirements and conditions specified in division rules or directives.

Closure Documentation

Within 60 days of closure completion, the operator will submit a closure report (Form C-147) to the District Division, with necessary attachments to document all closure activities are complete, including sampling results and details regarding backfilling and capping as necessary.

In the closure report, the operator will certify that all information in the report and attachments is correct and that the operator has complied with all applicable closure requirements and conditions specified in the closure plan.

19.15.34.14 E
Once the operator has closed the recycling containment, the operator shall reclaim the containment's location to a safe and stable condition that blends with the surrounding undisturbed area. Topsoils and subsoils shall be replaced to their original relative positions and contoured so as to achieve erosion control, long-term stability and preservation of surface water flow patterns. The disturbed area shall then be reseeded in the first favorable growing season following closure of a recycling containment. The operator shall substantially restore the impacted surface area to the condition that existed prior to the construction of the recycling containment.

Reclamation and Re-vegetation

The operator will reclaim the surface to safe and stable pre-existing conditions that blends with the surrounding undisturbed area. "Pre-existing conditions" may include a caliche well pad that existed prior to the construction of the recycling containment and that supports active oil and gas operations.

Areas not reclaimed as described herein due to their use in production or drilling operations will be stabilized and maintained to minimize dust and erosion.

For all areas disturbed by the closure process that will not be used for production operations or future drilling, the operator will substantially restore the surface to the condition that existed prior to the construction of the recycling containment:

1. Replace topsoils and subsoils to their original relative positions
2. Contour so as to achieve erosion control, long-term stability and preservation of surface water flow patterns
3. Reseed in the first favorable growing season following closure

19.15.34.14 G
The re-vegetation and reclamation obligations imposed by federal, state trust land or tribal agencies on lands managed by those agencies shall supersede these provisions and govern the obligations of any operator subject to those provisions, provided that the other requirements provide equal or better protection of fresh water, human health and the environment.

Federal, state trust land, or tribal lands may impose alternate reclamation and re-vegetation obligations that provide equal or better protection of fresh water, human health, and the environment. Re-vegetation and reclamation plans imposed by the surface owner will be outlined in communications with the OCD.

19.15.34.14 F
Reclamation of all disturbed areas no longer in use shall be considered complete when all ground surface disturbing activities at the site have been completed, and a uniform vegetative cover has been established that reflects a life-form ratio of plus or minus fifty percent (50%) of pre-disturbance levels and a total percent plant cover of at least seventy percent (70%) of pre-disturbance levels, excluding noxious weeds.

The operator will notify the division when the site meets the surface owner's requirements or exhibits a uniform vegetative cover that reflects a life-form ratio of plus or minus fifty percent (50%) of pre-disturbance levels and a total percent plant cover of at least seventy percent (70%) of pre-disturbance levels, excluding noxious weeds. The operator will notify the Division when reclamation and re-vegetation is complete.

Variance Requests for Recycling Facility AST Containments

- **Variance for Alternative Testing Methods**
- **Two-Foot Freeboard**
- **Side Slope and Anchor Trench**
- **Variances For AST Modular Recycling Storage Containment Liners**
- **Applicability of Variances for Modular AST Containments in the Permian Basin of New Mexico**

Variances for Alternative Testing Methods

Request for OCD Approval of Alternative Test Methods to Analyze Concentrations of TPH and Chloride

The prescriptive mandates of the Rule that are the subject of this request are the following subsections of NMAC 19.15.17.13 [emphasis added], 19.15.34.14 and 19.15.29. 12 D

> **19.15.17.13 CLOSURE AND SITE RECLAMATION REQUIREMENTS:**
> **D.(5)** The operator shall collect, at a minimum, a five point composite of the contents of the temporary pit or drying pad/tank associated with a closed-loop system to demonstrate that, after the waste is solidified or stabilized with soil or other non-waste material at a ratio of no more than 3:1 soil or other non-waste material to waste, the concentration of any contaminant in the stabilized waste is not higher than the parameters listed in Table II of 19.15.17.13 NMAC.

The referenced Table II, which is reproduced in part below, notes the Method with asterisk signifying: "*Or other test methods approved by the division".

Table II
Closure Criteria for Burial Trenches and Waste Left in Place in Temporary Pits

Depth below bottom of pit to groundwater less than 10,000 mg/l TDS	Constituent	Method*	Limit**
25-50 feet	Chloride	EPA Method 300.0	20,000 mg/kg
	TPH	EPA SW-846 Method 418.1	100 mg/kg

> **19.15.34.14 CLOSURE AND SITE RECLAMATION REQUIREMENTS FOR RECYCLING CONTAINMENTS:**
> **C.** The operator shall test the soils beneath the containment for contamination with a five-point composite sample which includes stained or wet soils, if any, and that sample shall be analyzed for the constituents listed in Table I below.
> **(1)** If any contaminant concentration is higher than the parameters listed in Table I, the division may require additional delineation upon review of the results and the operator must receive approval before proceeding with closure.

The referenced Table I, which is reproduced in part below, notes the Method with asterisk signifying: "*Or other test methods approved by the division".

Table I
Closure Criteria for Recycling Containments

Depth below bottom of containment to groundwater less than 10,000 mg/l TDS	Constituent	Method*	Limit**
51 feet - 100 feet	Chloride	EPA 300.0	10,000 mg/kg
	TPH (GRO+DRO+MRO)	EPA SW-846 Method 8015M	2,500 mg/kg

After sampling solids of more than 50 drilling pits in the Permian Basin, we have observed and reported to OCD on numerous occasions significant problems with non-petroleum drilling additives (e.g. starch) interfering with the laboratory method 418.1. It is not surprising that in many instances we found no correlation between the laboratory results using 418.1 and the results using Method 8015.

We request approval of Method 8015 (GRO + DRO + MRO) for Method 418.1.

> **19.15.29.12 D. CLOSURE REQUIREMENTS.** The responsible party must take the following action for any major or minor release containing liquids.
> **(1)** The responsible party must test the remediated areas for contamination with representative five-point composite samples from the walls and base, and individual grab samples from any wet or discolored areas. The samples must be analyzed for the constituents listed in Table I of 19.15.29.12 NMAC or constituents from other applicable remediation standards.

The referenced Table I, is reproduced in part below.

Table I
Closure Criteria for Soils Impacted by a Release

Minimum depth below any point within the horizontal boundary of the release to ground water less than 10,000 mg/l TDS	Constituent	Method*	Limit**
≤ 50 feet	Chloride***	EPA 300.0 or SM4500 Cl B	600 mg/kg
	TPH (GRO+DRO+MRO)	EPA SW-846 Method 8015M	100 mg/kg
	BTEX	EPA SW-846 Method 8021B or 8260B	50 mg/kg
	Benzene	EPA SW-846 Method 8021B or 8260B	10 mg/kg

We request approval of EPA 300.0 or SM4500 for the analysis of chloride.

Demonstration that OCD Approval Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

The purpose of TPH analyses in the Pit Rule is to measure total petroleum hydrocarbons not all non-polar compounds, such as starch or cellulose that can interfere with Method 418.1. While Method 418.1 may provide some useful data for transportation of crude oil or condensate spills to disposal, the addition of non-polar organic materials in drilling fluids, especially for horizontal wells, renders Method 418.1 highly problematic to determine compliance with the Rule. Using Method 8015 for TPH (GRO+DRO+MRO) provides a better measurement of what we believe the Commission intended operators to measure.

In hearings before the Oil Conservation Commission technical arguments were presented regarding the use of SM4500 in lieu of EPA 300.00 for chloride analysis for Rule 29. The Division and the Commission agreed that these two methods provide equal or better protection of fresh water, public health and the environment.

Freeboard Variance Request for Above Ground Steel Tank Modular Recycling Storage Containments

STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR FREEBOARD FOR MODULAR STEEL AST CONTAINMENT

Statement Explaining Why the Applicant Seeks a Variance

The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of NMAC 19.15.34.13

> **19.15.34.13 OPERATIONAL REQUIREMENTS FOR RECYCLING CONTAINMENTS:**
> **B.** The operator shall maintain and operate a recycling containment in accordance with the following requirements.
> **(2)** The operator *shall maintain at least three feet of freeboard at each containment*.

The applicant requests variance to allow for a freeboard of 2 feet as opposed to the prescribed 3 feet in the setting of an above ground steel tank modular system.

Rule 34 did not take into consideration above ground steel tank modular containment systems. With respect to lined earthen impoundments that may hold 25-acre feet of produced water, a 3-foot freeboard stipulation makes sense. For example, wave action and other factors could focus stress on the upper portion of the levee or the liner system in these large impoundments. The smaller diameter steel tank (modular impoundment) does not share the same characteristics as these large earthen pits.
We believe 3-feet of freeboard is not necessary – especially during active hydraulic stimulation of wells when maximum storage volume provides the highest value. Moreover, meeting the 3-foot freeboard requirement at all times significantly reduces the storage capacity of a single modular impoundment – negatively impacting the economics of using produced water in lieu of fresh water for E&P activities.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

The attached technical memorandum by Ron Frobel, PE, describes how the proposed 2-foot freeboard limit in the permit application for the modular impoundment provides the same protection afforded by the 3-foot freeboard mandate for a large earthen pit. The attached equations and supporting email from Mr. Jason Henderson, PE, shows that a 2-foot freeboard limit on the steel impoundment meets the manufacturer's design criteria.

R.K. FROBEL & ASSOCIATES
Consulting Engineers

Freeboard Requirements for Above Ground Steel Tank Modular Recycling Storage Containments

NMAC 19.15.34.13 B (2)

Liquid impoundments such as fresh water or process water containments are usually built within an excavation or with raised earthen embankments. For a liquid impoundment with an exposed liner system, the slope soils and construction dictate slope inclination and very detailed slope stability analysis may be required to determine if slope failure within the embankment will occur once loaded with impounded water. Freeboard or the vertical height between the maximum water surface elevation and the top of slope is important for earthen impoundments. Specified freeboard requirements take into consideration high precipitation events and prevent wave run-up on slopes that result in over-topping and potential saturation of embankments. This is particularly important on large earthen impoundments. Detailed design considerations including freeboard requirements for lined earthen impoundments can be found in "Designing with Geosynthetics" by R.M Koerner as well as other publications on reservoir design.

A modular impoundment, on the other hand, consists of a professionally designed steel tank ring with vertical walls. There is no slope to consider as the segmental steel sections are set vertical. Design of steel tanks as regards hydrostatic loading, wind loading, seismic loads, etc. are thoroughly referenced with detailed procedures in the design code - American Petroleum Institute (API) 650-98 "Welded Steel Tanks for Oil Storage". *There are requirements for operational freeboard to prevent over-topping but due to the relatively small surface area and fetch of cylindrical tanks, wave heights are much less than large earthen impoundments. Thus, freeboard is usually within the range of 0.5 to 2 ft.* I have reviewed the Tank Design Calculation Summary and regarding the structural stability of the tank walls, a freeboard of 0.5 ft was assumed. Thus, the variance request of 2.0 ft for a Modular Impoundment is well within the Tank Design requirements.

In summary, it is my professional opinion that the design freeboard of 2.0 ft will provide requisite storage volume and prevent overtopping due to wind and wave action, potential seismic events and high precipitation.

If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

COLORADO REGISTERED RONALD KENNETH FROBEL 15742 PROFESSIONAL ENGINEER

References:

NMAC 19.15.34.13 OPERATIONAL REQUIREMENTS FOR RECYCLING CONTAINMENTS

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Ph 303-679-0285 Fx 303-679-8955 geosynthetics@msn.com

American Petroleum Institute (API) 650-98 “Welded Steel Tanks for Oil Storage”

Koerner, R.M., 2005 “Designing With Geosynthetics” Prentice Hall Publishers

Attachments:

R. K. Frobel C.V.

The modular impoundment is designed for use with fluids that are 8.34 pounds/gallon (62.4 pounds per cubic foot) or lighter. Exceeding this specification for fluid weight at full tank capacity (12') could lead to failure at the connection plate(s).

Assuming a freeboard of 0.5 ft (minimum modular impoundment freeboard requirement) the Hyrdo Pressure (p) of water is 718 pounds per square foot (psf), where

$$p = Design\ Density\ X\ Height$$

$$= 62.4\ PCF * 11.5\ ft$$

$$(design\ density = 8.34\ \frac{lb}{gal}\ X\ 7.48\ \frac{ft^3}{gal})$$

The density of the conditioned produced water is 9.3 pounds/gallon. Assuming a freeboard of 3-ft (19.15.17.12.F(3) NMAC) , the Hyrdo Pressure (p) of conditioned produced water is 626 psf, where

$$p = Design\ Density\ X\ Height$$

$$= 69.64\ PCF * 9\ ft$$

$$(design\ density = 9.3\ \frac{lb}{gal}\ X\ 7.48\ \frac{ft^3}{gal})$$

Using conditioned produced water with the Pit Rule freeboard requirements of 3-feet results in a Hydro Pressure 92 psf less than the engineered design.

The operator asks the District Division to allow for a 2-foot freeboard, which yields a Hydro Pressure (p) of 696.4 psf, where

$$p = Design\ Density\ X\ Height$$

$$= 69.64\ PCF * 10\ ft$$

$$(design\ density = 9.3\ \frac{lb}{gal}\ X\ 7.48\ \frac{ft^3}{gal})$$

Slope and Anchor Variance Request for Above Ground Steel Tank Modular Recycling Storage Containments

STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR SLOPE AND ANCHOR FOR MODULAR STEEL AST CONTAINMENT

Statement Explaining Why the Applicant Seeks a Variance

The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of NMAC 19.15.34.12.

NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT:

A. An operator shall design and construct a recycling containment in accordance with the following specifications.

(2) A recycling containment shall have a properly constructed foundation and interior slopes consisting of a firm, unyielding base, smooth and free of rocks, debris, sharp edges or irregularities to prevent the liner's rupture or tear. Geotextile is required under the liner when needed to reduce localized stress-strain or protuberances that otherwise may compromise the liner's integrity. *The operator shall construct the containment in a levee with an inside grade no steeper than two horizontal feet to one vertical foot (2H:1V). The levee shall have an outside grade no steeper than three horizontal feet to one vertical foot (3H:1V).* The top of the levee shall be wide enough to install an anchor trench and provide adequate room for inspection and maintenance.

(3) Each recycling containment shall incorporate, at a minimum, a primary (upper) liner and a secondary (lower) liner with a leak detection system appropriate to the site's conditions. *The edges of all liners shall be anchored in the bottom of a compacted earth-filled trench. The anchor trench shall be at least 18 inches deep*.

The applicant requests a variance to prescribed slope and anchor in the setting of above ground modular steel containments.

With respect to storage of produced water for use in lieu of fresh water, Rule 34 is written for earthen, lined pits, not free-standing modular impoundments that employ liners as their primary fluid containment system. A modular impoundment consists of a professionally designed steel tank ring with vertical walls. There is no slope to consider as the segmental steel sections are set vertical.

There is no anchor trench as envisioned by the Rule, liners are anchored to the top of the steel walls with clips, no anchor trench is required.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

The following technical memorandum provides supportive data to demonstrate equal or better protection of fresh water, public health and the environment by providing the requisite containment and protection.

R.K. FROBEL & ASSOCIATES
Consulting Engineers

Technical Memorandum: Slope and Anchor Trench Variance for Above Ground Steel Modular Containments

NMAC 19.15.34.12 A (2), (3)

Side Slope

The design of soil side slope (inclination) is a geotechnical engineering design consideration. Liquid impoundments such as fresh water or process water containments are usually built within an excavation or with raised earthen embankments. For a liquid impoundment with an exposed liner system, the slope soils and construction dictate slope inclination and very detailed slope stability analysis may be required to determine if slope failure within the embankment will occur once loaded with impounded water. Slope failure may also occur during construction or when the impoundment is empty. A maximum slope is usually specified and is dependent on soil type and cohesive strength, saturated or unsaturated conditions, etc. Detailed analysis for slope stability can be found in "Designing with Geosynthetics" by R.M Koerner as well as many geotechnical books.

A modular impoundment, on the other hand, consists of a professionally designed steel tank ring with vertical walls. *There is no slope to consider as the segmental steel sections are set vertical.* Design of steel tanks, in regard to hydrostatic loading, wind loading, seismic loads, etc. are thoroughly referenced with detailed procedures in the design code - American Petroleum Institute (API) 650-98 "Welded Steel Tanks for Oil Storage". *There are no requirements for maximum slope inclination other than perhaps 90 degrees or vertical wall.*

Anchor Trench

All earthen impoundments with a geomembrane lining system require some form of top of slope anchor, the most common of which is an excavated and backfilled anchor trench usually set back at least 3 ft from the top of slope. Again, there are detailed procedures for anchor trench design in "Designing with Geosynthetics" by R.M Koerner.

A Modular Impoundment requires mechanical anchoring of the geomembrane at the top of the vertical steel wall using standard liner clips that prevent the geomembrane or geomembrane layers from slipping down the side wall. These are detailed in the Tank Installation Manual. *There are no requirements for an "anchor trench" as this is not an in-ground impoundment.*

In summary, based on the design and specifications of a modular steel impoundment, there is no requirement for a maximum interior slope angle of 2H:1V due to the fact that this impoundment is a steel tank with vertical walls. Additionally, there is no requirement for an anchor trench as the geomembrane is attached to the top of the Modular Impoundment vertical walls with large steel clips. This provides the requisite protection of fresh water, public health and the environment for many years.

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If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

References:

NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT

American Petroleum Institute (API) 650-98 "Welded Steel Tanks for Oil Storage"

Koerner, R.M., 2005 "Designing With Geosynthetics" Prentice Hall Publishers

Attachments:

R. K. Frobel C.V.

Variances for Above Ground Steel Tank Modular Recycling Storage Containment Liners

STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR 40 MIL NON-REINFORCED LLDPE GEOMEMBRANE AS AN ALTERNATIVE PRIMARY AND SECONDARY LINER FOR MODULAR STEEL AST CONTAINMENT

The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of 19.15.34.12

NMAC 19.15.34.12 A DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT

(4) All primary (upper) liners in a recycling containment shall be geomembrane liners composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. *All primary liners shall be 30-mil flexible PVC, 45-mil LLDPE string reinforced or 60-mil HDPE liners. Secondary liners shall be 30-mil LLDPE string reinforced or equivalent with a hydraulic conductivity no greater than 1 x 10-9 cm/sec*. Liner compatibility shall meet or exceed the EPA SW-846 method 9090A or subsequent relevant publications.

The applicant proposes one layer of 40-mil LLDPE as a primary liner and a secondary liner comprised of one layer of 40-mil LLDPE material.

Rule 34 did not consider Above Ground Steel Storage Tanks that employ liners as a primary and secondary containment method.

This material is more readily available than the prescribed liners in the Rule and provides superior flexibility and conformity characteristics. Due to the vertical steel walls, 60-mil HDPE, 45 or 30-mil LLDPE string reinforced liners and 30-mil PCV liners are not sufficiently flexible for use in these modular containments.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

The following technical documents provide supportive data to demonstrate equal or better protection of fresh water, public health and the environment by providing the requisite containment and protection. Technical comparison of the proposed material is compared to what is advised through Rule 34 is discussed. A second memorandum provides clarification that the engineering requirements for site preparation, which ensures functionality of the liner system, is crosscutting to varied locations within the Permian Basin. Stamped plans from design engineer confirm applicability of this liner system to this specific site.

R.K. FROBEL & ASSOCIATES
Consulting Engineers

Technical Memorandum: 40-mil LLDPE as Alternative Primary/Secondary Liner System for Modular Steel AST Recycling Containment

NMAC 19.15.34.12 A (4)

In consideration of the Primary lining application (modular AST impoundment), size of the AST and depth, design details for modular tanks as well as estimated length of up to five years of service time, it is my professional opinion that a 40 mil LLDPE geomembrane will provide the requisite barrier against processed water loss. It should be noted that the 40 mil LLDPE exceeds the OCD mandate for a Secondary lining system. *The two proposed 40 mil LLDPE liners will function equal to or better than 45 mil String Reinforced LLDPE, 30 mil PVC, or 60 mil HDPE liners as a primary liner and 30 mil LLDPE string reinforced as a secondary liner system. Additionally, the 40 mil LLDPE in a two-layer system will provide requisite protection for the environment that is equal to or better than the above primary and secondary liner systems referenced in OCD rule 34.* The following are discussion points that will exhibit the attributes of a 40 mil LLDPE lining system:

The nature and formulation of LLDPE resin is very similar to HDPE. The major difference is that LLDPE is lower density, lower crystallinity (more flexible and less chemical resistant). However, LLDPE will resist aging and degradation and remain intact for many years in exposed conditions. The LLDPE resin is virtually the same for non-reinforced 40 mil LLDPE and string reinforced 45 mil LLDPE geomembranes and both will provide requisite containment and be equally protective for this application.

Flexibility Requirements. Non-reinforced LLDPE geomembranes are less stiff and far more flexible than string reinforced geomembranes as well as 60 mil HDPE and in this regard are preferred for installations in vertical wall tanks such as this proposed installation. LLDPE provides a very flexible sheet that enables it to be fabricated into large panels, folded for shipping and installed on vertical walls transitioned to flat bottom. Non-reinforced LLDPE sheet will conform better than a string reinforced LLDPE to the tank dimensions under hydrostatic loading and will exhibit less wrinkling and creasing during and after installation.

Thermal Fusion Seaming Requirements. Thermal seaming and QC seam test requirements for geomembranes are product specific and usually prescribed by the sheet manufacturer. Both dual wedge and single wedge thermal fusion welding is commonly used on LLDPE and QC testing by air channel (ASTM D 5820) or High Pressure Air Lance (ASTM D 4437) is fully acceptable and recognized as industry standards. In this regard, either non-reinforced LLDPE or string-reinforced LLDPE will be acceptable as far as QC and thermal fusion seaming methods are concerned.

Potential for Leakage through the Primary and Secondary Liners. Leakage through geomembrane liners is directly a function of the height of liquid head above any hole or imperfection. The geonet drainage media between the primary and secondary LLDPE

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geomembranes at the base of the AST in this application provides immediate drainage to a low point or outside the Modular AST Impoundment and thus no hydrostatic head or driving gradient is available to push leakage water through a hole in the Secondary LLDPE liner .

Leakage through any Primary geomembrane is driven by size of hole and depth and will be detected by the increase of water in the drainage system and the volume being pumped out of the secondary containment. In this regard and for this variance, the Primary consists of 40 mil LLDPE geomembrane which will perform equal to or better than a single layer of string reinforced LLDPE for potential leakage. Thus, if a leak occurs through the top layer, it will be effectively contained by the second layer of 40 mil LLDPE geomembrane. If required, location of holes in the Primary can be found by Electrical Leak Location Survey (ELLS) using a towed electrode (ASTM D 7007). Holes found can then be repaired and thus water seepage into the leakage collection and drainage system will be kept to a minimum. Dependent on OCR requirements for Action Leakage Rate (ALR), the leakage volumes may only be monitored. For example, a typical ALR is < 20 gpad whereas a rapid and large leak (RLL) may be > 100 gpad.
Most states specify maximum ALR values for waste and process water impoundments usually in the range of 100 to 500 gpad. However, New Mexico does not specify an ALR for waste or process water impoundments (GRI Paper No. 15).

Both non-reinforced LLDPE and string reinforced LLDPE can be prefabricated into large panels and thus both types offer the following for Containment:

- Prefabrication in factory-controlled conditions into very large panels (up to 30,000 sf) results in ease of installation, less thermal fusion field seams and less on site QC and CQA. (It should be noted that HDPE cannot be prefabricated into panels and requires considerably more on-site welding and QC).

- Large prefabricated panels will provide better control of thermal fusion welding in a factory environment that will improve the liner system integrity for the long term. Ease of installation of large prefabricated custom size panels results in a greater reduction of installation time and associated installation and QC costs

- The Non-reinforced LLDPE geomembrane provides superior lay flat characteristics and conformability which allows for more intimate contact with the underlying soil, geonet, or geotextile and tank walls as well as overlying materials thus providing better flow characteristics for drainage of water. String reinforced LLDPE exhibits more wrinkling and when overlaid or in contact with a geonet drain, wrinkles tend to form pockets and dams affecting drainage of any leakage water to the exterior of the Modular AST Impoundment.

- Both types of LLDPE geomembrane are easily repaired using the same thermal fusion bonding method without the need for special surface grinding/preparation for extrusion welding as is typically used in repair of HDPE geomembranes.

However, string reinforced LLDPE requires that all cut edges with exposed scrim must be encapsulated with extrusion bead. No encapsulation is required on non-reinforced LLDPE.

In summary, it is my professional opinion that the two layers of 40 mil non-reinforced LLDPE geomembranes will provide a Primary/Secondary liner system that is equal to or better than 45 mil string reinforced LLDPE, 30 mil PVC, 60 mil HDPE (primary liner) and 35 mil LLDPEr (secondary liner). Additionally, the two layers of 40 mil LLDPE will provide a superior installation and function better than liners referenced in the OCD rule. The two layers of 40 mil non- reinforced LLDPE will provide the requisite protection of fresh water, public health and the environment for at least 5 years in the frack water environment.

If you have any questions on the above technical memorandum or require further information, give me a call at 720-289-0300 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

References:

NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT

Geosynthetic Research Institute (GRI) Published Standards and Papers 2018

ASTM Standards 2018

Attachments:

R. K. Frobel C.V.

Aplicability off Variances for Modular AST Containments in the Permian Basin offNew Mexico

R.K. FROBEL & ASSOCIATES
Consulting Engineers

Technical Memorandum: Applicability of Variances for Modular AST Containments in the Permian Basin of New Mexico

NMAC 19.15.34.12 A (2)

I have reviewed the most recent historical variances for AST Containments in the document titled "Variances for C-147 Registration Packages Permian Basin of New Mexico" (January 2020) and examined the applicable design drawings and permits for the following modular AST containments located in the Permian Basin of New Mexico.

- C-147 Registration Package for Myox Above Ground Storage Tank Section 32, T25S, R28E, Eddy County (January 20, 2020)
- C-147 Registration Package for Fez Recycling Containment and Recycling Facility Area (100+ acres) Section 8, T25-S, R35-E, Lea County, Volume 2 – Above-Ground Storage Tank Containments
- Hackberry 16 Recycling Containments and Recycling Facility Section 16, T19S, R31E, Eddy County

Locations of the modular containments range from west of the Pecos River to slightly west of Jal, NM. All locations exhibit different surface and subsurface geology, different topography and are of various sizes and volumes. *However, in regard to structural integrity of the base soils that support the AST and in particular the geomembrane containment system, the specification requirements are the same*. The foundation soils must be roller compacted smooth and free of loose aggregate over ½ inch. Compaction characteristics must meet or exceed 95% of Standard Proctor Density in accordance with ASTM D 698. This specification requirement is specific and causes the general or earthworks contractor to meet this standard regardless of the site- specific geology or topography. Provided that the design drawings and associated specifications call out the minimum requirements for subsoils compaction (i.e., 95% Standard Proctor Density – ASTM D 698), the design engineer or owners representative will carry out soils testing on the foundation materials to provide certainty to the AST containment owner that the earthworks contractor has met these obligations.

Thus, provided that the contractor meets the minimum specified requirements for foundation soils preparation and density, the location, geology or depth to groundwater will make no difference in regard to geomembrane liner equivalency as demonstrated by the AST variances presented in this volume and are considered valid for meeting NMOCD Rule 34 requirements for all locations within the Permian Basin of New Mexico.

If you have any questions on the above technical memorandum or require further information, give me a call at 720-289-0300 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

References:

NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT

ASTM Standards 2019

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TITLE: Principal and Owner

PROFESSIONAL AFFILIATIONS:

American Society for Testing and Materials (ASTM) -
Founding member of Committee D 35 on Geosynthetics
Chairman ASTM D35 Subcommittee on Geomembranes 1985-2000
ASTM Award of Merit Recipient/ASTM Fellow - 1992
ASTM D18 Soil and Rock - Special Service Award - 2000
Transportation Research Board (TRB) of The National Academies
Appointed Member A2K07 Geosynthetics 2000 - 2003
National Society of Professional Engineers (NSPE) - Member
American Society of Civil Engineers (ASCE) - Member
Colorado Section - ASCE - Member
International Society of Soil Mechanics and Foundation Engineers
(ISSMFE) - Member
International Geosynthetics Society (IGS) - Member
North American Geosynthetics Society (NAGS) - Member
International Standards Organization (ISO) - Member TC 221
Team Leader - USA Delegation Geosynthetics 1985 - 2001
European Committee for Standardization (CEN) - USA Observer
EPA Advisory Committee on Geosynthetics (Past Member)
Association of State Dam Safety Officials (ASDSO) – Member
U. S. Committee on Irrigation and Drainage (USCID) - Member
Technical Advisory Committee - Geosynthetics Magazine
Editorial Board - Geotextiles and Geomembranes Journal
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U.S. Naval Reserve Officer (Inactive)
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ACADEMIC BACKGROUND:

University of Arizona: M.S. - Civil Engineering - 1975
University of Arizona: B. S. - Civil Engineering – 1969
Wentworth Institute of Technology: A.S. Architecture – 1966

PROFESSIONAL EXPERIENCE:

R. K. Frobel & Associates - Consulting Engineers
Evergreen, Colorado, Principal and Owner, 1988 - Present

Chemie Linz AG and Polyfelt Ges.m.b.H., Linz, Austria
U. S. Technical Manager Geosynthetics, 1985 - 1988

U.S. Bureau of Reclamation, Engineering and Research Center
Denver, Colorado, Technical Specialist in Construction Materials Research and Application, 1978 - 1985

Water Resources Research Center (WRRC), University of Arizona
Tucson, AZ, Associate Research Engineer, 1975 - 1978

Engineering Experiment Station, University of Arizona
Tucson, AZ, Research Assistant, 1974 - 1975

United States Navy, Commissioned Naval Officer, 1970 - 1973

REPRESENTATIVE EXPERIENCE:

R.K. Frobel & Associates: Civil engineering firm specializing in the fields of geotechnical, geo-environmental and geosynthetics. Expertise is provided to full service civil/geotechnical engineering firms, federal agencies, municipalities or owners on a direct contract, joint venture or sub-consultant basis. Responsibilities are primarily devoted to specialized technical assistance in design and application for foreign and domestic projects such as the following:
Forensics investigations into geotechnical and geosynthetics failures; providing expert report and testimony on failure analysis; providing design and peer review on landfill lining and cover system design, mine waste reclamation, water treatment facilities, hydro-technical canal, dam, reservoir and mining projects, floating reservoir covers; oil and gas waste containment; design of manufacturers technical literature and manuals; development and presentation of technical seminars; new product development and testing; MQA/CQA program design and implementation.

Polyfelt Ges.m.b.H., Linz, Austria and Denver Colorado: As U.S. technical manager, primary responsibilities included technical development for the Polyfelt line of geosynthetics for the U.S. civil engineering market as well as worldwide applications.

U.S. Bureau of Reclamation, Denver, Colorado: As technical specialist, responsibilities included directing laboratory research, design and development investigations into geosynthetics and construction materials for use on large western water projects such as dams, canals, power plants and other civil structures. Included were material research, selection and testing, specification writing, large scale pilot test programs, MQA/CQA program design and supervision of site installations. Prime author or contributor to several USBR technical publications incorporating geosynthetics.

University of Arizona, Tucson, Arizona: As research engineer at the Water Resources Research Center, responsibilities included research, design and development of engineering materials and methods for use in construction of major water projects including potable water reservoirs, canals and distribution systems. Prime author or contributor to several WRRC technical publications.

Northeast Utilities, Hartford, Connecticut: As field engineer for construction at Northeast Utilities, responsibilities included liason for many construction projects including additions to power plants, construction of substations, erection of fuel oil pipelines and fuel oil storage tanks. Responsibilities also included detailed review, inspection and reporting on numerous construction projects.

U.S. Navy: Commissioned Naval Officer – Nuclear Program

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