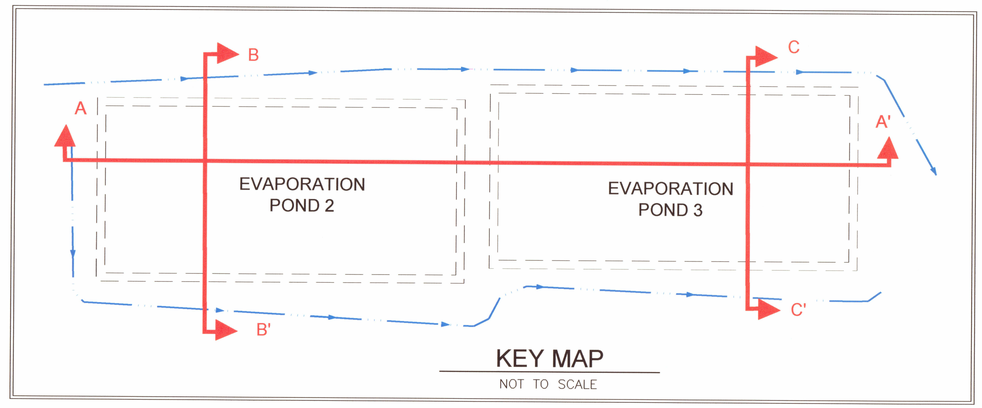
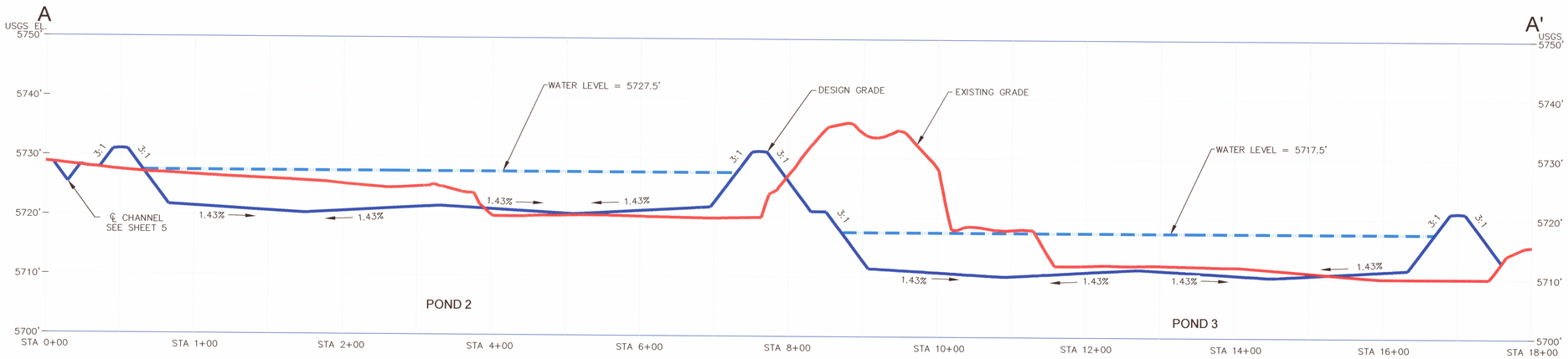
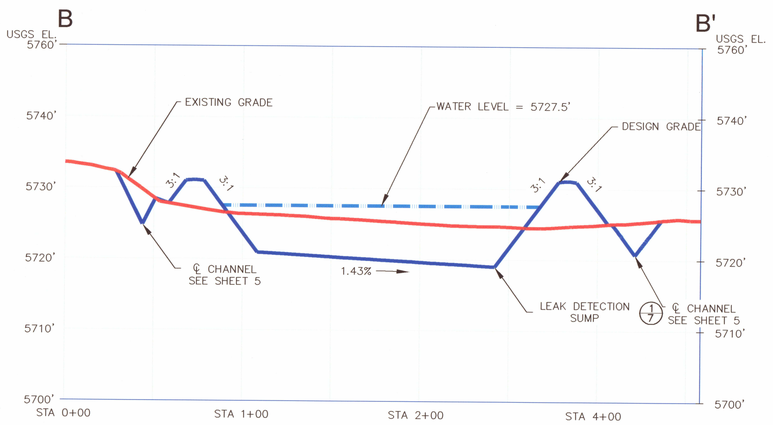


KEY MAP

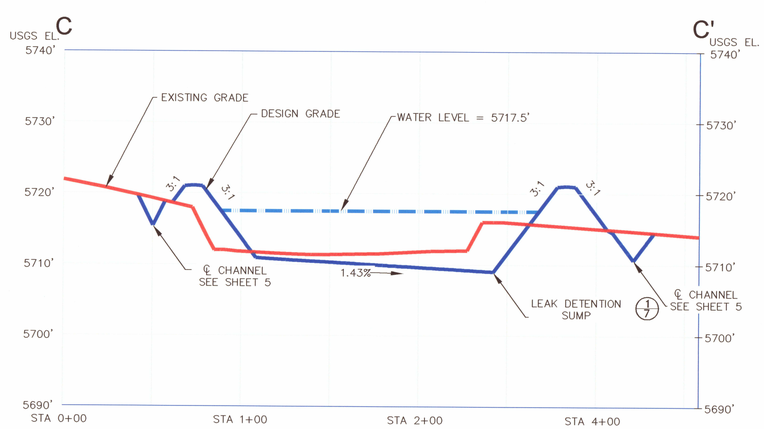
NOT TO SCALE



1/4 EVAPORATION PONDS 2 & 3



2/4 EVAPORATION POND 2



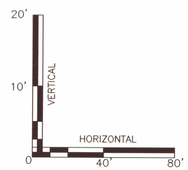
3/4 EVAPORATION POND 3

LEGEND

EXISTING GRADE

DESIGN GRADE

WATER LEVEL



CROSS SECTION
SCALE

I. KEITH GORDON, P.E.
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I. KEITH GORDON NEW MEXICO 10984 REGISTERED PROFESSIONAL ENGINEER 6/10/09

CROSS SECTIONS

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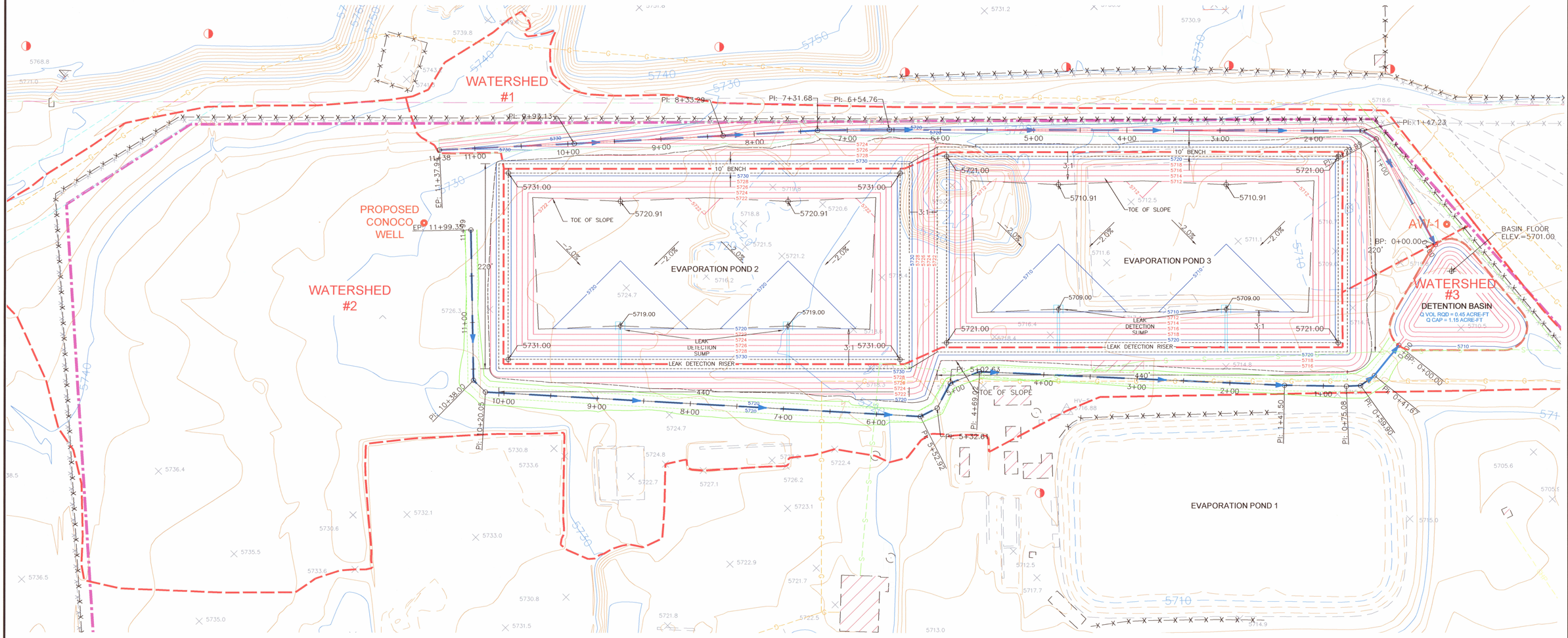
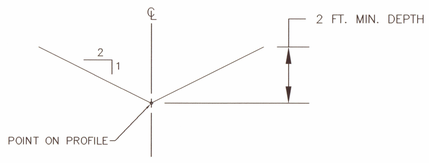
DATE: 11/21/08	CAD: 04 XSECS.dwg	PROJECT #: 520.01.01
DRAWN BY: GEI	REVIEWED BY: MRH	SHEET 4 of 8
APPROVED BY: IKG	gei@gordonenvironmental.com	



WATERSHED	AREA (ACRES)	CURVE NUMBER	$P_{25-YR\ 24-HR}$ (INCHES)	Q_{25} (CFS)	Q_{25} VOLUME (ACRE-FT)
#1	1.93	77	2.1	1.93	0.08
#2	7.52	77	2.1	6.62	0.32
#3	0.28	—	—	—	0.05
				TOTAL VOLUME	0.45
25 YEAR 24 HOUR POINT PRECIPITATION FREQUENCY ESTIMATED FROM NOAA ATLAS					



NORTH CHANNEL TYPICAL SECTION

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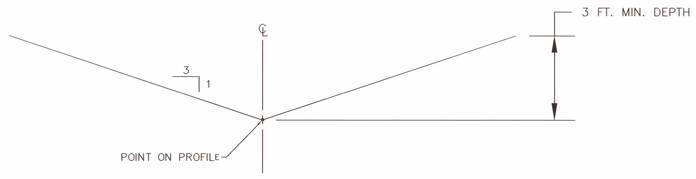


SOUTH CHANNEL TYPICAL SECTION

NOT TO SCALE

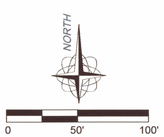
LEGEND

- SITE BOUNDARY
- DRAINAGE DIVIDE
- 2' CONTOUR (EXISTING)
- 5700 10' CONTOUR (EXISTING)
- 2' DEPRESSION CONTOUR (EXISTING)
- 5700 10' DEPRESSION CONTOUR (EXISTING)
- 5720 10' MAJOR CONTOUR
- 5716 2' MINOR CONTOUR
- 5705.6× SPOT ELEVATIONS (EXISTING)
- 5711.04 SPOT ELEVATION (DESIGN)
- CHANNEL FLOW LINE
- CUT LIMIT
- FILL LIMIT
- GAS LINE (EXISTING)
- SEWER LINE (EXISTING)
- GAS LINE (EXISTING)
- UTILITY EASEMENT
- UNPAVED ROADWAY (EXISTING)
- FENCE (EXISTING)
- AW-1 ASSESSMENT WELL
- TANKS
- LIGHT POLE (EXISTING)
- STRUCTURE
- SURVEY CONTROL POINT AND ELEVATION

NOTES:

1. LOCATION OF SITE UTILITIES IS APPROXIMATE. LOCATIONS OF SITE UTILITIES WILL BE FIELD VERIFIED PRIOR TO CONSTRUCTION.
2. NOT FOR CONSTRUCTION

All reports, drawings, specifications, computer files, field data, notes and other documents and instruments prepared by the Engineer as instruments of service shall remain the property of the Engineer. The Engineer shall retain all common law, statutory and other reserved rights, including the copyright thereto.



Drawing:\\server01\public\acad 2003\520.01.01\PERMIT PLAN SET\05 DRAINAGE.dwg
Date/Time:Jun. 08, 2009-13:22:05

I. KEITH GORDON, P.E.
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DRAINAGE PLAN

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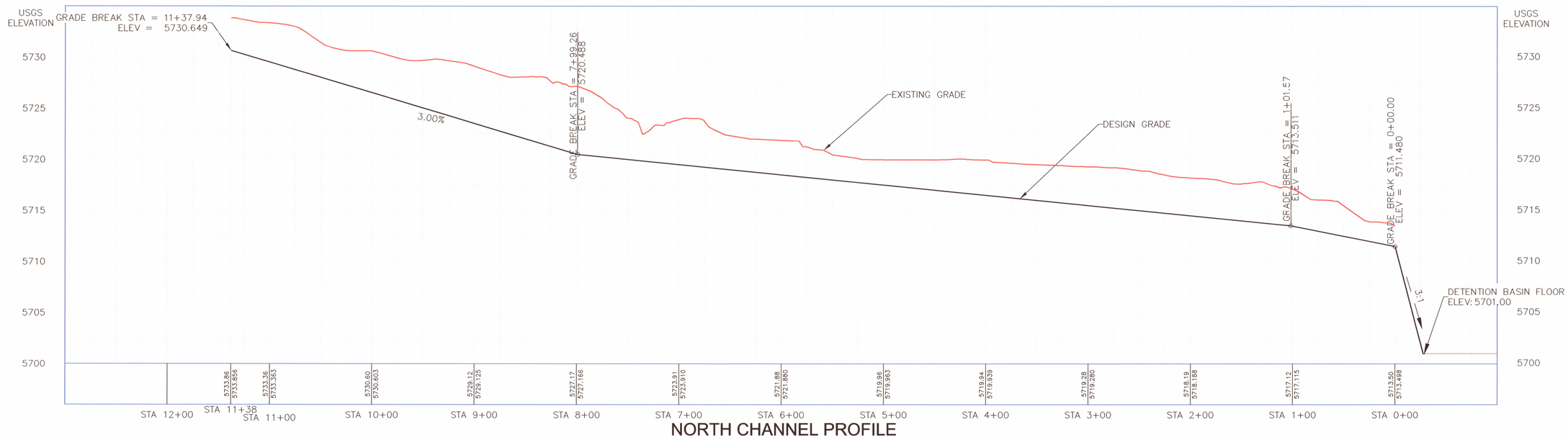
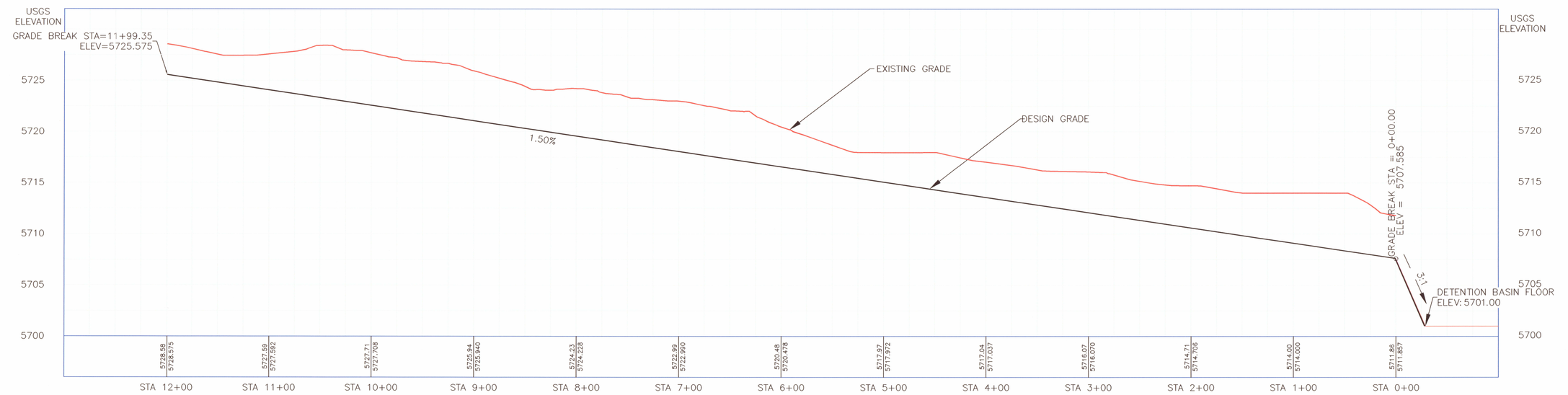
DATE: 11/24/08	CAD: 05 DRAINAGE.dwg	PROJECT #: 520.01.01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 5 of 8
APPROVED BY: IKG	gei@gordonenvironmental.com	



NORTH CHANNEL PROFILE



SOUTH CHANNEL PROFILE

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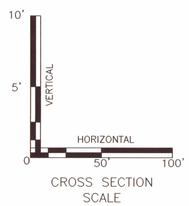

CROSS SECTION SCALE

I. KEITH GORDON
NEW MEXICO
10984
05/10/09
REGISTERED PROFESSIONAL ENGINEER

I. KEITH GORDON, P.E.
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DRAINAGE CHANNEL DETAILS

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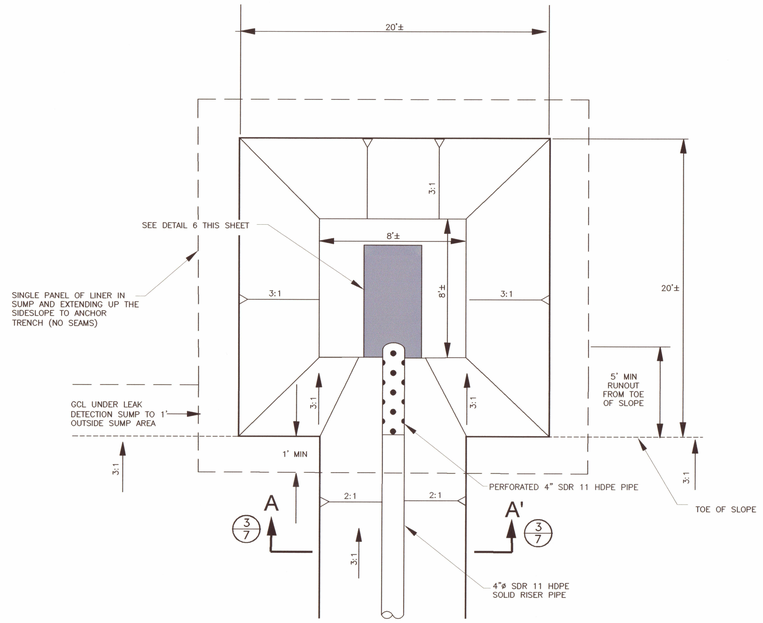
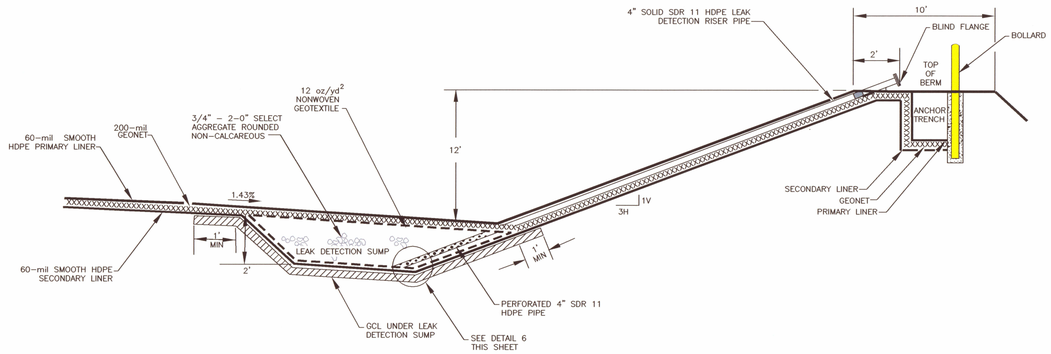
DATE: 11/24/08	CAD: 05 DRAIN DETAILS.dwg	PROJECT #: 520.01.01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 6 of 8
APPROVED BY: IKG	gei@gordonenvironmental.com	



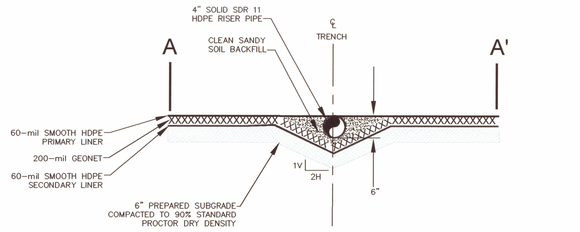
1/7 LEAK DETECTION SUMP

NOT TO SCALE



5/7 CROSS-SECTION AT LEAK DETECTION SUMP

NOT TO SCALE

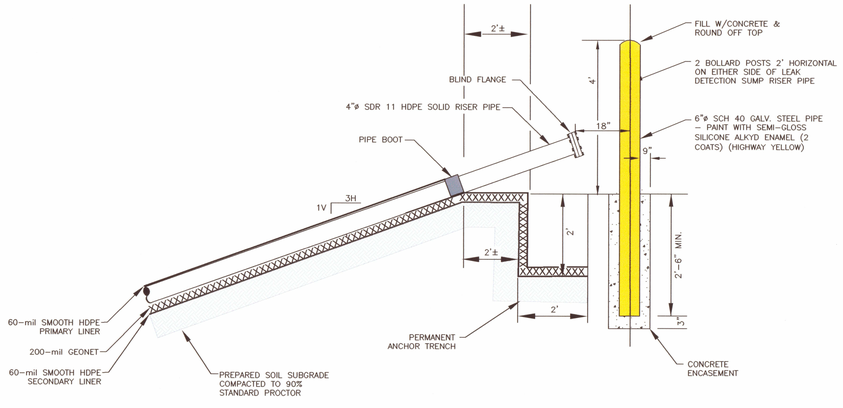


3/7 LEAK DETECTION SUMP RISER PIPE CROSS SECTION A-A'

NOT TO SCALE

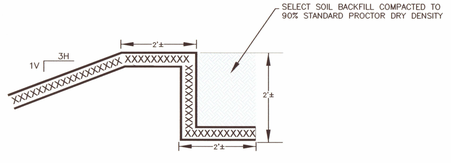
6/7 SUMP FLOOR DETAIL

NOT TO SCALE



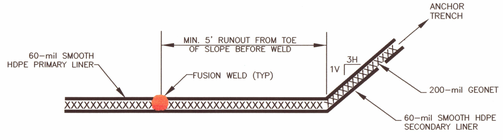
2/7 LEACHATE COLLECTION SUMP RISER PIPE

SECTION VIEW NOT TO SCALE



4/7 ANCHOR TRENCH DETAIL

NOT TO SCALE



7/7 LINER RUNOUT ON POND FLOOR

NOT TO SCALE

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Date/Time:Jun. 08, 2009-13:21:28

REVISIONS		
NO.	DATE	DESCRIPTION
1	05/13/09	ADD GCL UNDER LEAK DETECTION SUMP
2	05/13/09	ADD CLEAN SANDY SOIL BACKFILL IN LEAK DETECTION SUMP RISER PIPE TRENCH
3	05/13/09	SPECIFY SDR 11 HDPE PIPE

ENGINEERING DETAILS

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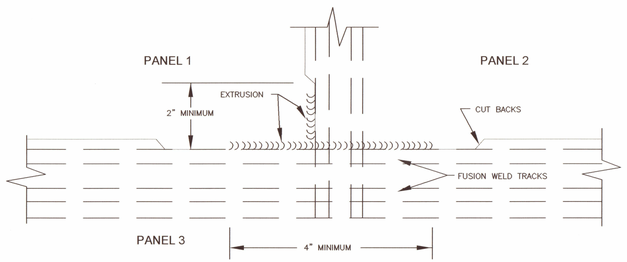
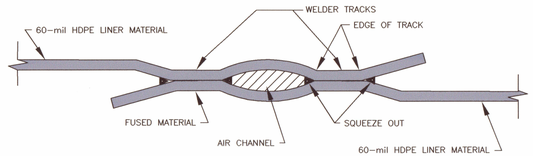
DATE: 11/21/08	CAD: 07 ENGR DET.dwg	PROJECT #: 520.01.01
DRAWN BY: JFP	REVIEWED BY: MRH	SHEET 7 of 8
APPROVED BY: IKG	gei@gordonenvironmental.com	

I. KEITH GORDON, P.E.
N.M. PROFESSIONAL ENGINEER NO. 10984

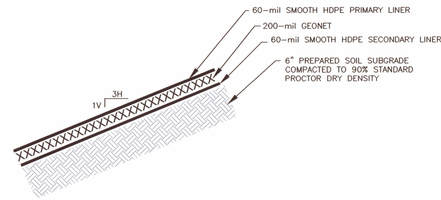


1/8 TYPICAL "T" AT BUTT SEAM
PLAN VIEW NOT TO SCALE

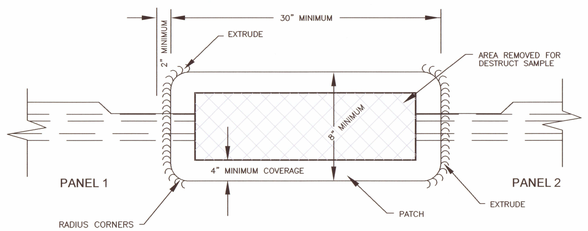


NOTES:
1. BOTH AREAS OF FUSED MATERIAL SHOULD BE VOID OF ANY SEAM LINES.
2. EDGE OF TRACKS NOT TO CUT THE LINER.
3. AIR CHANNEL SHOULD BE CLEAR.
4. BOTH WELDER TRACKS SHALL BE EQUAL WIDTHS.
5. SQUEEZE OUT SHOULD BE JUST BARELY VISIBLE IN ALL 4 LOCATIONS WHEN VIEWED IN THE TEST CROSS-SECTION.

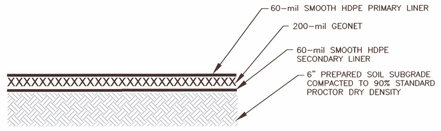
3/8 TYPICAL FUSION WELD
SECTION VIEW NOT TO SCALE



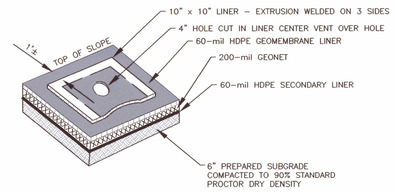
5/8 SIDEWALL LINER SYSTEM
NOT TO SCALE



TYPICAL DESTRUCT SAMPLE PATCH
60-mil LINER
2/8 PLAN VIEW NOT TO SCALE



4/8 FLOOR LINER SYSTEM
NOT TO SCALE



NOTE: WELD TOP AND SIDES OF VENT; DOWN-SIDE OF FLAP TO REMAIN OPEN

6/8 FLAP-TYPE VENT DETAIL
NOT TO SCALE

NOT FOR CONSTRUCTION
Drawing:\\server01\public\acad 2003\520.01.01\PERMIT PLAN SET\08 LINER DET.dwg
Date/Time:Jun. 08, 2009-13:21:13

I. KEITH GORDON, NEW MEXICO, 10984, REGISTERED PROFESSIONAL ENGINEER, 06/10/09

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LINER DETAILS

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DATE: 10/30/08	CAD: 08 LINER DET.dwg	PROJECT #: 520.01.01
DRAWN BY: JFP	REVIEWED BY: MRH	SHEET 8 of 8
APPROVED BY: IKG	gei@gordonenvironmental.com	

ATTACHMENT III.1.B

LINER LONGEVITY ARTICLE:

GEOSYNTHETICS MAGAZINE, OCT/NOV 2008

How long will my liner last?

| What is the remaining service life of my HDPE geomembrane?

By Ian D. Peggs, P.E., P.Eng., Ph.D.

Introduction

In his keynote lecture at the GeoAmericas-2008 conference last March, Dr. Robert Koerner (et al., 2008) of the Geosynthetic Institute (GSI) reported the ongoing Geosynthetic Research Institute (GRI) work to make the first real stab at assessing the service lives of high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), reinforced PE, ethylene propylene diene terpolymer (EPDM), and flexible polypropylene (fPP) exposed geomembranes.

The selected environment simulated that of Texas, USA, in sunny ambient temperatures between ~7°C (45°F) and 35°C (95°F). Of course, an exposed black HDPE geomembrane in the sun will achieve much higher temperatures, probably in excess of 80°C (176°F).

I do not know what the temperature would be at 150-300mm above the liner (for those still specifying this parameter), but it is quite immaterial. The only temperature of concern is the actual geomembrane temperature.

The lifetimes are shown in **Table 1**, but it must be recognized that these data are for specific manufactured products with specific formulations. The "greater than" notation indicates that laboratory exposures (incubations) are still on-going, not that some samples have failed after the indicated time period. The PE-R-1 material is a thin LLDPE, so it might be expected to be the first to reach the defined end of life; the half-life—the time to loss of 50% of uniaxial tensile properties.

It is interesting to note that HDPE-1 and LLDPE-1 are proceeding apace, but it would be expected that the LLDPE-1 would reach its half-life earlier than HDPE-1. However, this does not automatically follow. With adequate additive formulations, perhaps LLDPE could be left exposed and demonstrate more weathering resistance than some HDPEs. This demonstrates the fact that all PEs, whether HD or LLD, are not identical—they can have different long-term performances dependent on the PE resin used and the formulation of the stabilizer package. However, such differences are not evident in the conventional mechanical properties such as tensile strength/elongation, puncture and tear resistances, and so on.

The two fPPs are performing well. However, there had also been an fPP-1, one of the first PP geomembranes that did not perform well. This was due to a totally inappropriate stabilizer formulation. That particular product lasted 1.5 years in service. In

Final Inspection continued on page 44

Type	Specification	Predicted Lifetime in Texas, USA
HDPE-1	GRI-GM13	>28 years (Incubation ongoing)
LLDPEE-1	GRI-GM17	>28 years (Incubation ongoing)
EPDM-1	GRI-GM21	>20 years (Incubation ongoing)
PE-R-1	GRI-GM22	≈17 years (reached halflife)
fPP-2	GRI-GM18 (temp. susp.)	>27 years (Incubation ongoing)
fPP-3	GRI-GM18 (temp. susp.)	>17 years (Incubation ongoing)

Table 1 | Estimated exposed geomembrane lifetimes

| Ian Peggs is president of I-CORP International Inc. and is a member of *Geosynthetics* magazine's Editorial Advisory Committee.

Final Inspection continued from page 56

the QUV weatherometer, it lasted 1,800 light hours at 70°C (158°F). Therefore, the lab/field correlation is that 1,000 QUV light hours is equivalent to a 0.83yr service life under those specific environmental conditions.

At another location in Texas, Koerner/GRI found 1,000hr of QUV exposure was equivalent to 1.1 year actual field exposure. Consequently, for Texas exposures GRI is using a correlation of 1000hr QUV exposure as equivalent to Iyr of in-service exposure. Clearly, the correlation would be different in less sunny and colder environments.

The failed fPP-1 liner was replaced with a correctly stabilized fPP that, subsequently, performed well.

So how can we evaluate the condition of our exposed liners in a simple and practical manner to ensure they will continue to provide adequate service lifetimes and to get sufficient warning of impending expiration?

For each installation, a baseline needs to be established, and changes from that baseline need to be monitored.

A liner lifetime evaluation program

Rather than be taken by surprise when a liner fails or simply expires, it should be possible to monitor the condition of the liner to obtain a few years of notice for impending expiration. One can then plan for a timely replacement without the potential for accidental environmental damage and undesirable publicity. A program of periodic liner-condition assessment is proposed.

... it should be possible to monitor the condition of the liner to obtain a few years of notice for impending expiration.

While estimated correlations might be made for other locations using historical weather station sunshine and temperature data, there is no question that the best remaining lifetime assessments will be obtained using samples removed from the field installation of interest.

A lifetime in excess of 28yr, demonstrated for a recently-made HDPE geomembrane, is comparable to the present actual service periods of as long as 30-35yr. However, actual lifetimes of as low as ~15yr have also been experienced.

Do service lifetimes now exceeding 30yr mean that we might expect to see another round of stress cracking failures as exposed liners finally oxidize sufficiently on the surface to initiate stress cracking?

This would be frustrating after resolving the early 1980s problems with stress cracking failures at welds and stone protrusions when the liners contracted at low temperatures, but it is the way end-of-life will become apparent. And will that be soon or in another 5-20 years? It would be useful to know.

For baseline data, it would be useful to have some archive material to test, but that is not usually available. Manufacturers often discard retained samples after about 5 years. Perhaps facility owners should be encouraged to keep retained samples at room temperature and out of sunlight. The next best thing is to use material from the anchor trench or elsewhere that has not experienced extremes in temperature and that has not been exposed to UV radiation or to expansion/contraction stresses.

Less satisfactory options are to use the original NSF 54 specifications, the manufacturer's specifications, or the GRI-GM13 specifications at the appropriate time of liner manufacturing. The concern with using these specifications is that while aged material may meet them, there is no indication of whether the measured values have significantly decreased from the actual as-manufactured values that generally significantly exceed the specification.

A final option for the baseline would be to use the values at the time of the first liner assessment.

The first liner condition assessment would consist of a site visit during which a general visual examination would be done together with a mechanical probing of the edges of welds. A visual examination would include the black/gray shades of different panels that might indicate low carbon contents.

A closer examination should be done using a loupe (small magnifier) on suspect areas such as wrinkle peaks, the tops and edges of multiple extrusion weld beads, and the apex-down creases of round die-manufactured sheet.

The last detail is significant because the combination of oxidizing surface and exposed surface tension when the liner contracts at low temperatures and the crease is pulled flat can be one of the first locations to crack. The apex-up creases do not fail at the same time because the oxidized exposed surface is under compression (or less tension) when the crease is flattened out.

Appropriate samples for detailed laboratory testing will be removed.

It may be appropriate to do a water lance electrical integrity survey on the exposed sideslopes, but this would only be effective on single liners, and on double liners with a composite primary liner, a conductive geomembrane, or a geocomposite with a conductive geotextile on top.

A sampling and testing regime

A liner lifetime evaluation program should be simple, meaningful, and cost-effective.

While it will initially require expert polymer materials science/engineering input to analyze the test data and to define the critical parameters, it should ultimately be possible to use an expert system to automatically make predictions using the input test data.

Small samples will be taken from deep in the anchor trench and from appropriate

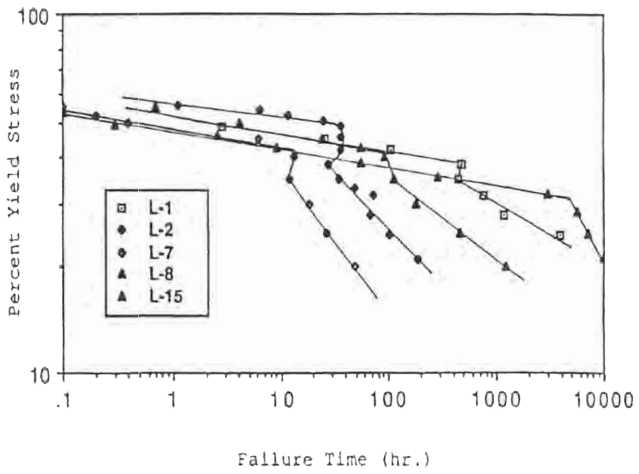

Figure 1 | Standard stress rupture curves for five HDPE geomembranes (Hsuan, et al. 1992)

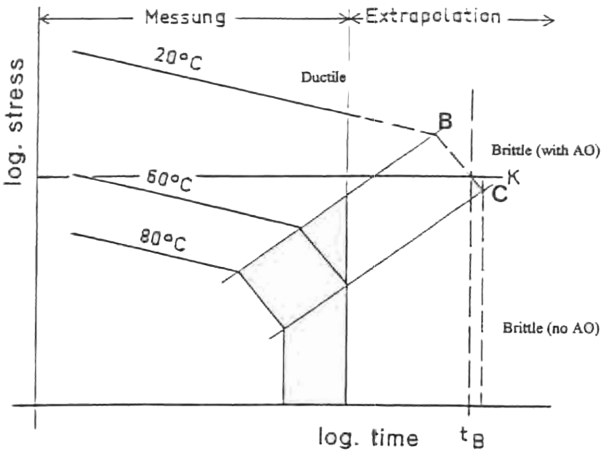

Figure 2 | Stress rupture curves showing third stage (Brittle no AO) oxidized limit. (Gaube, et al. 1985)

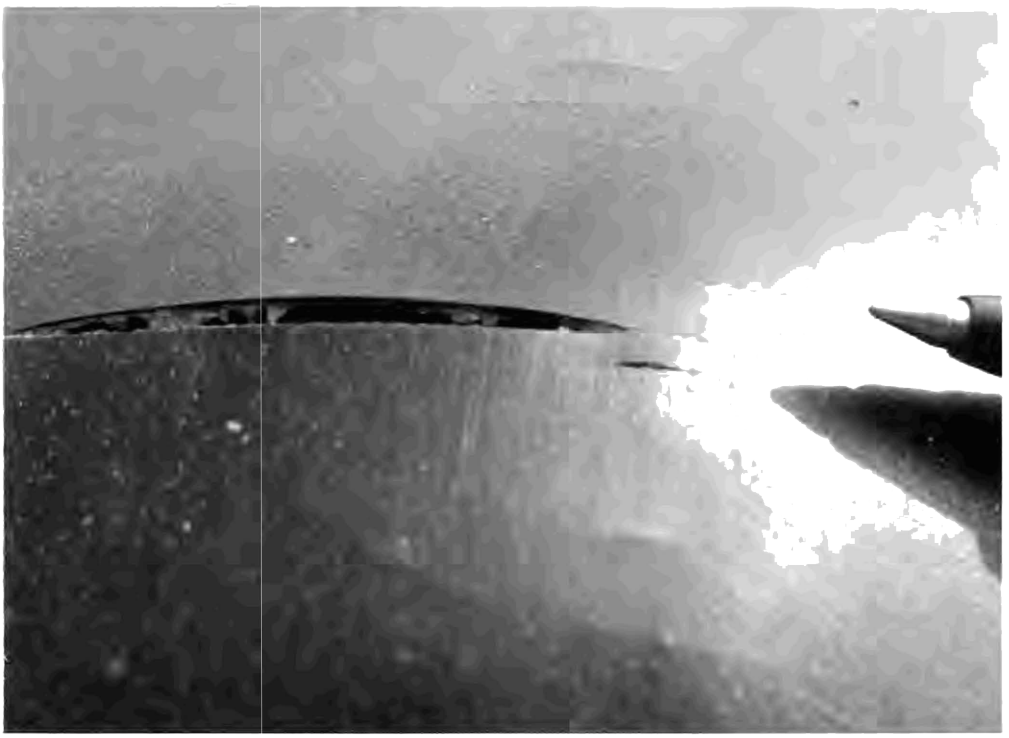

Figure 3 | Stress crack initiated by extruder die line at stone protrusion

exposed locations. Potential sites for future sample removal by the facility owner for future testing will be identified and marked by the expert during the first site visit.

The baseline sample(s) will be tested as follows:

- Single-point stress cracking resistance (SCR) on a molded plaque by ASTM D5397
- High-pressure oxidative induction time (HP-OIT) by ASTM D5885
- Fourier transform infrared spectroscopy (FTIR-ATR) on upper surface to determine carbonyl index (CI) on nonarchive samples only
- Oven aging/HP-OIT (GRI-GM13)
- UV resistance/HP-OIT (GRI-GM13)

The exposed samples will be tested as follows:

- Carbon content (ASTM D1603)
- Carbon dispersion (ASTM D5596)
- Single-point SCR on molded plaque (ASTM D5397)
- Light microscopy of exposed surface, through-thickness cross sections, and thin microsections (~15 µm thick) as necessary
- HP-OIT on 0.5-mm-thick exposed surface layers from basic sheet and from sheet at edge of extruded weld bead (ASTM D5885), preferably at a double-weld bead
- FTIR-ATR on exposed surface to determine CI
- Oven aging/HP-OIT on 0.5mm surface layer (GRI-GM13)
- UV resistance/HP-OIT on 0.5 mm surface layer (GRI-GM13)

Carbon content is done to ensure adequate basic UV protection. Carbon dispersion is done to ensure uniform surface UV protection and to evaluate agglomerates that might act as initiation sites for stress cracking.

HP-OIT is used to assess the remaining amount of stabilizer additives, both in the liner panels and in the sheet adjacent to an extrusion weld. Most stress cracking is observed at the edges of extrusion

weld beads in the lower sheet, so it is important to monitor this location.

While standard OIT (ASTM D3895 at 200°C) better assesses the relevant stabilizers effective at processing (melting) and welding temperatures, the relevant changes in effective stabilizer content during continued service, including in the weld zone, will be provided by measurement of HP-OIT. There will be no future high temperature transient where knowledge of S-OIT will be useful. It is expected that the liner adjacent to the weld bead will be more deficient in stabilizer than the panel itself. Therefore, S-OIT is not considered in this program.

Note that HP-OIT is measured on a thin surface layer because the surface layer may be oxidized while the body of the geomembrane may not. If material from the full thickness of the geomembrane is used it could show a significant value of OIT, implying that there is still stabilizer present and that oxidation is far from occurring. However, the surface layer could be fully oxidized with stress cracks already initiated and propagating. A crack will then propagate more easily through unoxidized material than would initiation and propagation occur in unoxidized material.

The fact that the HP-OIT meets a certain specification value in the as-manufactured condition provides no guarantee that thermo- and photo-oxidation protection will be provided for a long time. Stabilizers might be consumed quickly or slowly while providing protection. They may also be consumed quickly to begin with, then more slowly, or vice versa.

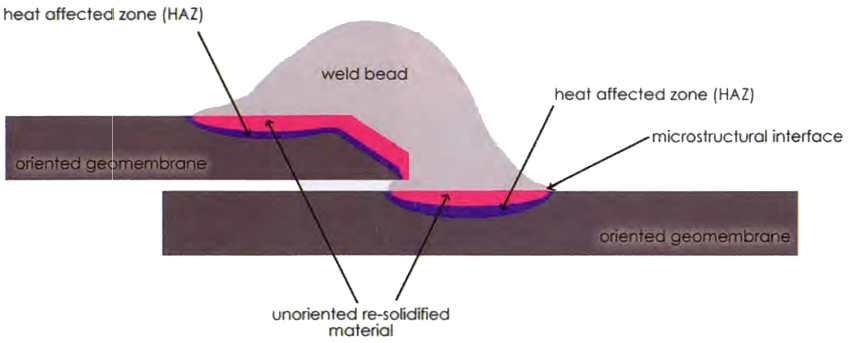

Figure 4 | Schematic of microstructure at extrusion weld

Hence, the need for continuing oven (thermal) aging and UV resistance tests. These two parameters, assessed by measuring retained HP- OIT, are critical to the assessment of remaining service life.

Oven (thermal) aging and UV resistance tests performed in this program will provide an extremely valuable data base that relates laboratory testing to in-service performance and that will further aid in more accurately projecting in-service performance from laboratory testing results.

Special considerations

Because we do not know, by OIT measurements alone, whether the surface layer is or is not oxidized (unless OIT is zero), and since we do not yet know at what level of OIT loss there might be an oxidized surface layer (the database has not yet been generated), FTIR directly on the surface of the geomembrane is performed using the attenuated total reflectance (ATR) technique to deny or confirm the presence of oxidation products (carbonyl groups).

Following the practice of Broutman, et al. (1989) and Duvall (2002) on HDPE pipes, if the ratio of the carbonyl peak at wave number 1760 cm-1 and the C-H stretching (PE) peak at wave number 1410 cm -1 is more than 0.10, there is a sufficiently oxidized surface layer that stress cracking might be initiated. For those familiar with the two slope stress rupture curve (**Figure 1**) where the brittle stress cracking region is the steeper segment below the knee, there is a third vertical part of the curve (**Figure 2**) where the material is fully oxidized and fracture occurs at the slightest stress. This is what will happen at the end of service life. But first note the times to initiation of stress cracking (the knees in the curves) in **Figure 1**—they range from ~10/hr to ~5,000/hr—clearly confirming that all HDPEs are not the same. Some are far more durable than others.

At the end of service life, at some level of OIT, there will be a critically oxidized surface layer that when stressed, such as at low temperatures by an upwards protruding stone, or by flexing due to wind uplift, will initiate a stress crack on the surface that will propagate downward through the geomembrane, as shown by the crack in **Figure 3**.

This crack, initiated at a stress concentrating surface die mark, occurred when the liner contracted at low temperatures, and tightened over an upwardly protruding stone. The straight morphology of the crack, and the ductile break at the bottom surface as the stress in the remaining ligament rose above the knee in the stress rupture curve, are typical of a stress crack. Note the shorter stress cracks initiated along other nearby die marks.

Stress cracks are preferentially initiated along the edges of welds because the adjacent geomembrane has been more depleted of stabilizers during the high temperature welding process. Thus, under further oxidizing service conditions, it will become the first location to

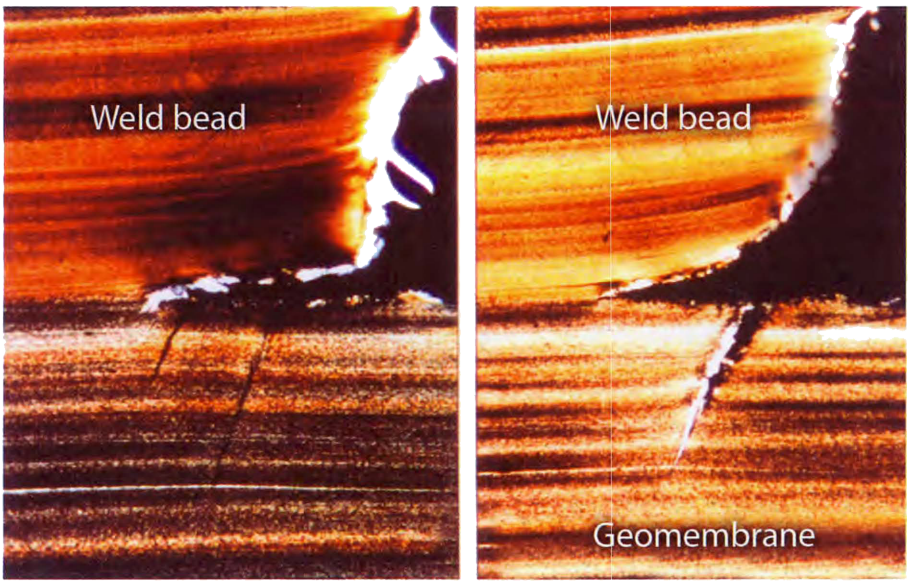

Figure 5 | Typical off-normal angle of precursor crazes (left) and stress crack (right) at edge of extrusion weld.

Type	Specification	Predicted Lifetime in Texas, USA
Side wall exposed	54	5
Side wall concrete side	81	71
Lower launder exposed	16	3
Lower launder concrete side	145	1

Table 2 | S-OIT values on solution and concrete liner surfaces (Peggs, 2008).

be oxidized to the critical level at which stress cracks will be initiated under any applied stress. In addition, the geometrical notches at grinding gouges and at the edges of the bead increase local stresses to critical levels for SC to occur.

I also believe that an internal microstructural flaw exists between the originally oriented geomembrane structure and the pool of more isotropic melted and resolidified material at the edge of the weld zone, as shown schematically in **Figure 4**. Most stress cracks occur at an off-normal angle at the edge of the weld bead that may be related to the angle of this molten-pool to oriented-structure interface (**Figure 5**). It is also known that stress increases the extraction of stabilizers from polyolefin materials.

With all of these agencies acting synergistically, it is not surprising that stress cracking often first occurs adjacent to extrusion welds.

Looking ahead

With the first field assessment test results available to us, and the extent of changes from the baseline sample known, removal of a second set of samples by the facility owner (at locations previously identified and marked by the initial surveyor), will be planned for a future time, probably in 2 or 3 years.

Why 2 or 3 years? In an extreme chemical environment, extensive reductions in S-OIT of studded HDPE concrete protection liners in mine solvent extraction facilities using kerosene/aromatic hydrocarbon/sulfuric acid process solutions at 55°C (131°F) have been observed on the solution and concrete sides of the liner (**Table 2**) within 1 year (Peggs 2008). But it is unlikely that such rapid decreases will be observed in air-exposed material.

With this second set of field samples, and with three sets of data points, practically reliable extrapolations of remaining lifetime can start to be made.

It is expected that a few years of notice for impending failures will be possible.

The key point to note in making these condition assessments is that, while all HDPE geomembranes have very similar conventional index properties, they can have widely variable photo-oxidation, thermal-oxidation, and stress-cracking resistances. Therefore, some HDPEs are more durable than others.

Thus, while one HDPE geomembrane manufactured in 1990 failed after 15 years in 2005, another HDPE geomembrane made in 1990 from a different HDPE resin (or more correctly a medium-density polyethylene [MDPE] resin), and with a better stabilizer additive package, could still have a remaining lifetime of 5, 20, or 30 years.

So, keep a close eye on those exposed liners and we'll learn a great deal more about liner performance and get notice of the end of service lifetime. And if owners can retain some archive material from new installations, so much the better.

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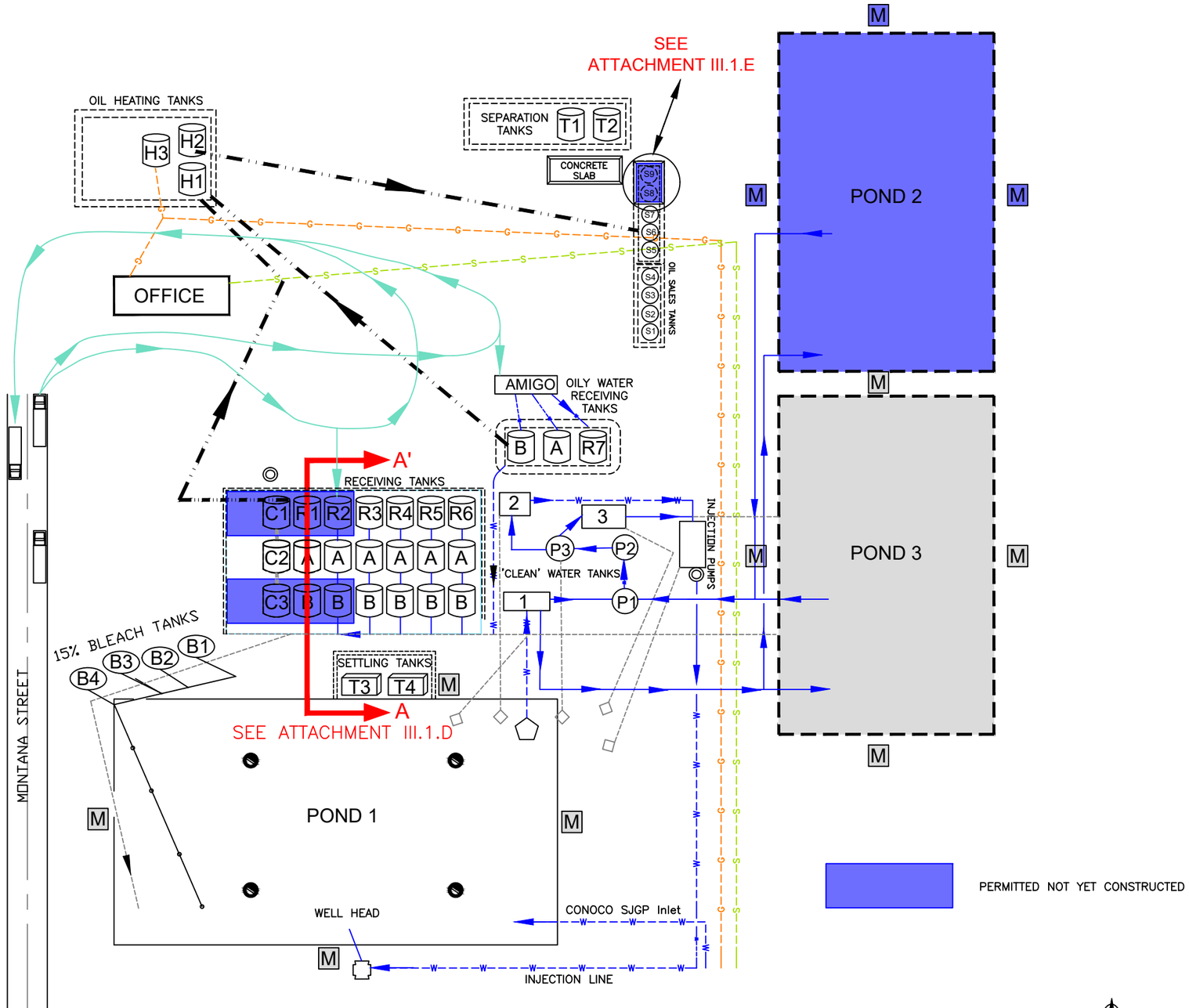
ATTACHMENT III.1.C

TYPICAL RECEIVING TANK INSTALLATION DETAILS



NOTE: ELEMENTS ARE LABELED IN ACCORDANCE WITH THE UPDATED NOMENCLATURE (11/08, ATTANCHMENT III.1.F)

SITE SCHEMATIC

SURFACE WASTE MANAGEMENT
BASIN DISPOSAL, INC.
BLOOMFIELD, NEW MEXICO

Parkhill
333 Rio Rancho Blvd. NE
Suite 400
Rio Rancho, New Mexico,
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 11/28/2022	CAD: SITE SCHEMATIC.dwg	PROJECT #: 1657.22
DRAWN BY: DMI	REVIEWED BY: MWK	ATTACHMENT III.1.C
APPROVED BY: MWK	www.parkhill.com	

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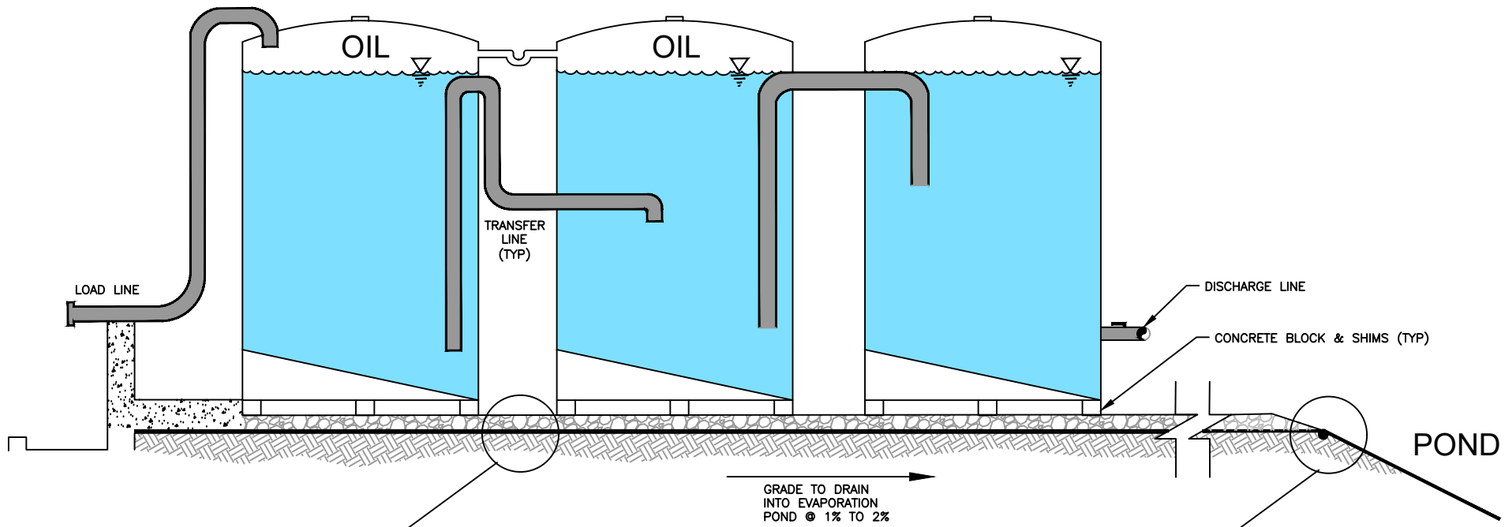
Date/Time:Nov. 28, 2022-09:54:56

ATTACHMENT III.1.D

TYPICAL RECEIVING TANK INSTALLATION DETAILS



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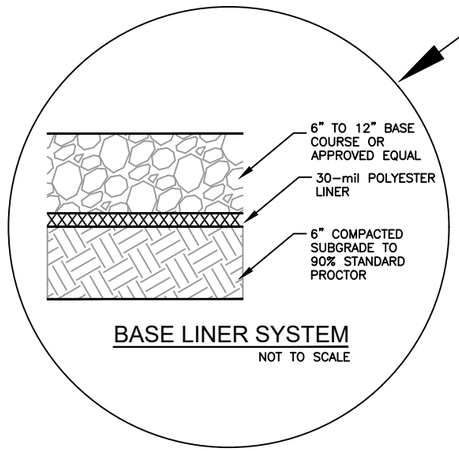

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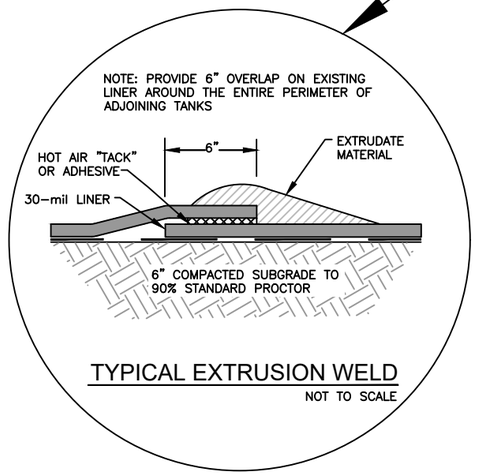

TYPICAL EXTRUSION WELD

NOT TO SCALE

TYPICAL RECEIVING TANK INSTALLATION DETAILS

SURFACE WASTE MANAGEMENT
BASIN DISPOSAL, INC.
BLOOMFIELD, NEW MEXICO

Parkhill
333 Rio Rancho Blvd. NE
Suite 400
Rio Rancho, New Mexico,
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DRAWN BY: DMI	REVIEWED BY: MWK	ATTACHMENT III.1.D
APPROVED BY: MWK	www.parkhill.com	

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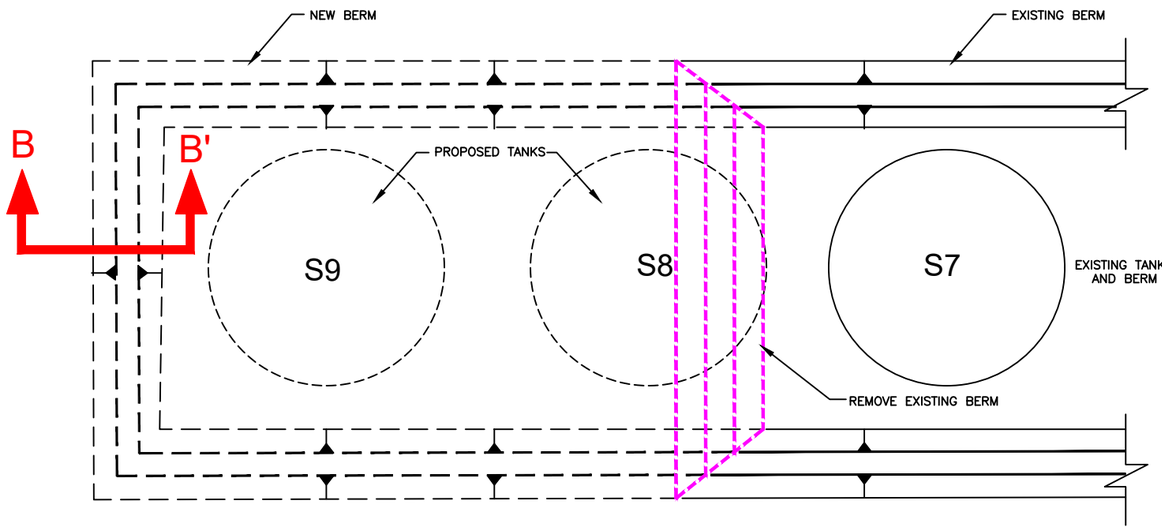
ATTACHMENT III.1.E

TYPICAL SALES TANK INSTALLATION DETAILS



PLAN VIEW
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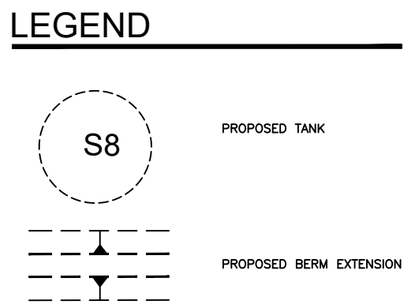

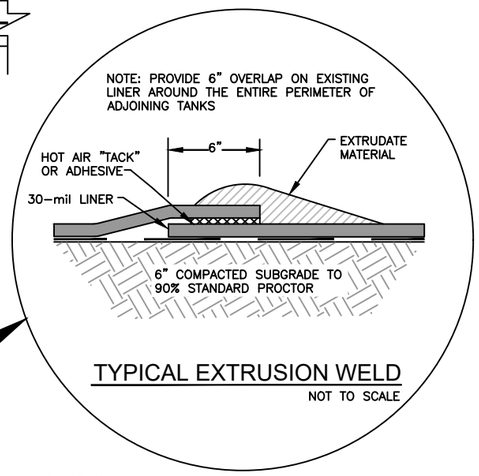

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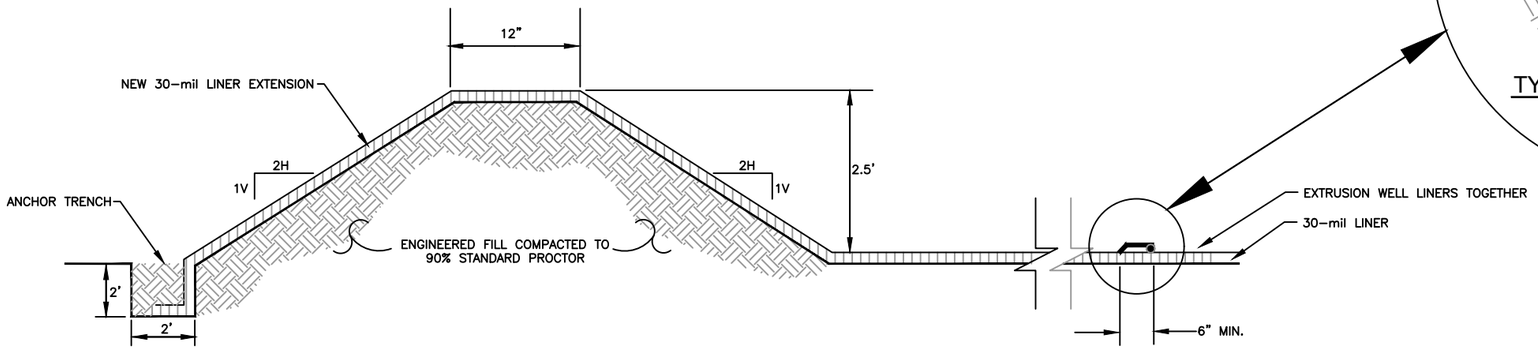

CROSS SECTION B-B'
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TYPICAL SALES TANK INSTALLATION DETAILS

SURFACE WASTE MANAGEMENT
BASIN DISPOSAL, INC.
BLOOMFIELD, NEW MEXICO

Parkhill
333 Rio Rancho Blvd. NE
Suite 400
Rio Rancho, New Mexico,
Phone: 505-867-6990
Fax: 505-867-6991

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APPROVED BY: MWK	www.parkhill.com	

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Date/Time:Jul. 07, 2022-12:11:05

ATTACHMENT III.1.F

TANK AND POND CAPACITY CALCULATIONS

ATTACHMENT III.1.F - Tank Capacity Calculations

Basin Disposal is an oil and gas produced water disposal facility. The facility is manned 24 hours per day 7 days per week.

A. Water is delivered by trucking companies into one of five sets of currently permitted Receiving Tanks:

Tank Number	Volume	Permitted
R3	400 bbls	Approved 10/11/1985
A	400 bbls	Approved 12/28/2000
B	400 bbls	Approved 12/28/2000
R4	400 bbls	Approved 10/11/1985
A	400 bbls	Approved 12/28/2000
B	400 bbls	Approved 12/28/2000
R5	400 bbls	Approved 10/11/1985
A	400 bbls	Approved 12/28/2000
B	400 bbls	Approved 12/28/2000
R6	400 bbls	Approved 10/11/1985
A	400 bbls	Approved 12/28/2000
B	400 bbls	Approved 12/28/2000
R1	400 bbls	Permitted and undeveloped
A	400 bbls	Permitted and developed (currently collecting crude oil)
B	400 bbls	Permitted and undeveloped
R2	400 bbls	Permitted and undeveloped
A	400 bbls	Permitted and developed (currently collecting crude oil)
B	400 bbls	Permitted and undeveloped
R7	400 bbls	Approved 12/28/2000
A	400 bbls	Approved 12/28/2000
B	400 bbls	Approved 12/28/2000
Amigo	500 bbls	Approved 10/11/1985

i. The Receiving tanks serve to gravity separate solids and oil from the water. Solids collect in the bottoms and oil floats to the tops of the receiving tanks.
ii. The Receiving Tanks bottoms are taken to the OCD permitted Landfarm.
iii. Receiving Tanks are set on concrete blocks within a lined bermed impermeable pad that gravity drains into the pond. The dimensions of the R7 tank containment area is 60 feet by 30 feet and is plumbed to drain into Pond #1.

B. The separated oil flows into the currently permitted Skimmed Oil Receiving Tanks:

Tank Number	Volume	Permitted
C1	400 bbls	Approved 10/11/1985 and undeveloped
C2	400 bbls	Approved 10/11/1985 and developed
C3	400 bbls	Approved 10/11/1985 and undeveloped

i. The Crude Oil Receiving Tanks are set inside a lined berm of dimensions 44 ft long by 21 ft wide by 2.5 ft tall.
ii. The Crude Oil Tanks are interconnected at the top of the tanks. This design prevents a leak in one tank causing the other tanks to empty. The volume of the lined berm is 576 bbls which exceeds the requirement for 1 1/3 times the capacity of a 400 bbl

C. The water flows into the currently permitted dual lined pond equipped with a leak detection system

Pond Number	Storage Volume	Permitted
1	109860 bbls	New Liner Approved 6/14/2004

i. Surface aeration and bleach are used to maintain water chemistry parameters:
:O_2 at or above 0.5 ppm one foot off the bottom of the pond.
:pH above 8
ii. Four H2S monitors are placed around the pond covering the four major points on the compass.
iii. The H2S monitors continually monitor the ambient air.
v. 3 Foot Freeboard per current permit, storage volume does not include freeboard
vi. Volume including freeboard is 135,179 bbls

ATTACHMENT III.1.F - Tank Capacity Calculations

Pond Number	Storage Volume	Permitted
2	73,932 bbls	Permitted and undeveloped (not constructed)
3	73,932 bbls	Permitted and developed (operational)

i. 3.5 Foot Freeboard
ii. Storage volume does not include freeboard
iii. Volume including freeboard is 122,264 bbls (15.76 acre-feet)
iv. Inside grade shall be no steeper than 3H:1V
v. Levees shall have an outside grade no steeper than 3H:1V
vi. Levees' tops shall be wide enough to install an anchor trench and provide adequate room for inspection/maintenance.
vii. Liner seams shall be minimized and oriented up and down, not across a slope
viii. Each pond shall have a:
:primary liner (60-mil HDPE liner, UV resistant)
:secondary liner (60-mil HDPE liner, UV resistant)
ix. Bottom slope shall be 2% (2 ft V for 100 ft H)
x. Wind fences shall be erected around pond
xi A spray evaporation system shall be installed.
xii Water shall be filtered through 50 um filters from Pond 1 prior to being placed in either Pond 2 or 3 to prevent solids and oils from entering Pond 2 or 3
xiii Approximate size of each pond is 200 x 420 feet x 7.6 feet deep

D. Bleach is stored in the currently permitted Chemical Tanks:

Tank Number	Volume	Permitted
B1	80 bbls	Approved Between 05/27/2003 & 04/03/2002
B2	60 bbls	Approved Between 05/27/2003 & 04/03/2002
B3	80 bbls	Approved Between 05/27/2003 & 04/03/2002
B4	80 bbls	Approved Between 05/27/2003 & 04/03/2002

i. The Chemical Tanks are set on a bermed concrete pad that drains into the pond.

E. Water from Pond 1 is:
i. Pumped through one set of currently permitted 20 um filters in Bldg 1 and then
ii. Pumped into currently permitted Positive Head Tanks

Tank Number	Volume	Permitted
P1	400 bbls	Approved 7/5/2005
P2	400 bbls	Approved 7/5/2005
P3	400 bbls	Approved 10/11/1985

F. Water from Tank P3 is:
i. Filtered though one of two sets of currently permitted 5 um filters in Bldg 2 and Bldg 3 or
ii. Returned to Pond I, if more water is in Tank P3 than being pulled through the 5 um filters

G. Sumps/hoses from the filter assemblies in Bldg 1, Bldg 2, and Bldg 3 discharge back to pond

H. Water from the 5 um filters is injected into the disposal well through one of the four currently permitted injection pumps (only two operate at any one time) at a rate of approximately 11,300 barrels per day at 1575 psi (permitted limit is 1600 psi)

I. Skimmed oil from Tanks C1-C3 is transferred to the Oil Heating Tanks (H1-H3) via an underground pipeline. In the Heating Tanks the water and oil mixture is heated so as to allow gravity separation. The water is discharged into the Amigo tank.

ATTACHMENT III.1.F - Tank Capacity Calculations

Tank Number	Volume	Permitted
H1	500 bbls	Approved 3/12/1998
H2	500 bbls	Approved 7/6/1999
H3	400 bbls	Approved 1/10/2008

i. The Oil Heating Tanks are set inside a lined berm of dimensions 62 ft long by 46 ft wide by 2.3 ft tall.
ii. The Oil Heating Tanks are not interconnected but are independently connected to the underground pipeline to the oil heating tanks. The volume of the lined berm is 1168 bbls which exceeds the requirement for 1 1/3 times the capacity of a 500 bbl tank (667 bbls).

I. Dewatered crude oil from Tanks H1-H3 is transferred to the Oil Sales Tanks via an underground pipeline for sale.

Tank Number	Volume	Permitted
S1	400 bbls	Approved 10/11/1985
S2	400 bbls	Approved 10/11/1985
S3	400 bbls	Approved 10/11/1985
S4	400 bbls	Approved 10/10/2006
S5	400 bbls	Approved 10/10/2006
S6	400 bbls	Approved 10/10/2006
S7	400 bbls	Approved 10/10/2006
S8	400 bbls	Permitted and undeveloped
S9	400 bbls	Permitted and undeveloped

i. The current Oil Sales Tanks are set inside a lined berm of dimensions 140 ft long by 22 ft wide by 2.5 ft tall. The Oil Sales Tanks are not interconnected.
ii. The volume of the lined berm is 1370 bbls which exceeds the requirement for 1 1/3 times the capacity of a 400 bbl tank (533 bbls).
iii. When the additional tanks are added the lined bermed area will be expanded to 180 ft long by 22 ft wide by 2.5 ft tall with a capacity of 1763 bbls. The tanks will not be interconnected.

J. The Separation Tanks are used to store sludge left over from the oil heating tanks. This is trucked between tanks by BDI personnel. A third party permitted vendor hauls the sludge off-site for proper disposal.

Tank Number	Volume	Permitted
T1	210 bbls	Approved 09/03/1992
T2	210 bbls	Approved 09/03/1992

i. The Separation Tanks are not interconnected and are set inside a lined berm that drains to the concrete slab. The concrete slab has a volume of 500 bbls which exceeds the requirement for 1 1/3 times the capacity of a 210 bbl tank (280 bbls).

ii. The Concrete Slab is emptied daily

D. The Settling Tanks are used to allow water and solids to separate after cleaning the Receiving Tanks to minimize the volume of waste taken to the landfarm.

Tank Number	Volume
T3	80 bbls
T4	240 bbls
T5	240 bbls

i. The water will be discharged into the pond.
ii. The solids taken to an OCD permitted Landfarm.
iii. The Settling Tanks are set on concrete blocks on top of a lined bermed impermeable pad that drains into the pond.

ATTACHMENT III.1.G

PIPE WALL THICKNESS INFORMATION

Table A-2 (cont'd)
PIPE WEIGHTS AND DIMENSIONS *(IPS)*
PE3608 *(BLACK)*

OD			SDR	Nominal ID		Minimum Wall		Weight	
Nominal	Actual							lb. per	kg. per
in.	in.	mm.		in.	mm.	in.	mm.	foot	meter
			7	2.44	61.98	0.500	12.70	2.047	3.047
			7.3	2.48	63.08	0.479	12.18	1.978	2.943
			9	2.68	67.96	0.389	9.88	1.656	2.464
			9.3	2.70	68.63	0.376	9.56	1.609	2.395
			11	2.83	71.77	0.318	8.08	1.387	2.065
3	3.500	88.90	11.5	2.85	72.51	0.304	7.73	1.333	1.984
			13.5	2.95	74.94	0.259	6.59	1.153	1.716
			15.5	3.02	76.74	0.226	5.74	1.015	1.511
			17	3.06	77.81	0.206	5.23	0.932	1.386
			21	3.15	79.93	0.167	4.23	0.764	1.136
			26	3.21	81.65	0.135	3.42	0.623	0.927
			7	3.14	79.68	0.643	16.33	3.384	5.037
			7.3	3.19	81.11	0.616	15.66	3.269	4.865
			9	3.44	87.38	0.500	12.70	2.737	4.073
			9.3	3.47	88.24	0.484	12.29	2.660	3.958
			11	3.63	92.27	0.409	10.39	2.294	3.413
4	4.500	114.30	11.5	3.67	93.23	0.391	9.94	2.204	3.280
			13.5	3.79	96.35	0.333	8.47	1.906	2.836
			15.5	3.88	98.67	0.290	7.37	1.678	2.497
			17	3.94	100.05	0.265	6.72	1.540	2.292
			21	4.05	102.76	0.214	5.44	1.262	1.879
			26	4.13	104.98	0.173	4.40	1.030	1.533
			32.5	4.21	106.84	0.138	3.52	0.831	1.237
			7	3.88	98.51	0.795	20.19	5.172	7.697
			7.3	3.95	100.27	0.762	19.36	4.996	7.435
			9	4.25	108.02	0.618	15.70	4.182	6.224
			9.3	4.29	109.09	0.598	15.19	4.065	6.049
			11	4.49	114.07	0.506	12.85	3.505	5.216
5	5.563	141.30	11.5	4.54	115.25	0.484	12.29	3.368	5.012
			13.5	4.69	119.11	0.412	10.47	2.912	4.334
			15.5	4.80	121.97	0.359	9.12	2.564	3.816
			17	4.87	123.68	0.327	8.31	2.353	3.502
			21	5.00	127.04	0.265	6.73	1.929	2.871
			26	5.11	129.78	0.214	5.43	1.574	2.343
			32.5	5.20	132.08	0.171	4.35	1.270	1.890
			7	4.62	117.31	0.946	24.04	7.336	10.917
			7.3	4.70	119.41	0.908	23.05	7.086	10.545
			9	5.06	128.64	0.736	18.70	5.932	8.827
			9.3	5.11	129.92	0.712	18.09	5.765	8.579
			11	5.35	135.84	0.602	15.30	4.971	7.398
6	6.625	168.28	11.5	5.40	137.25	0.576	14.63	4.777	7.109
			13.5	5.58	141.85	0.491	12.46	4.130	6.147
			15.5	5.72	145.26	0.427	10.86	3.637	5.413
			17	5.80	147.29	0.390	9.90	3.338	4.967
			21	5.96	151.29	0.315	8.01	2.736	4.072
			26	6.08	154.55	0.255	6.47	2.233	3.322
			32.5	6.19	157.30	0.204	5.18	1.801	2.680

See ASTM D3035, F714 and AWWA C-901/906 for OD and wall thickness tolerances.
Weights are calculated in accordance with PPI TR-7.

ATTACHMENT III.1.H

TECHNICAL DATA AND SPECIFICATIONS FOR XR-5 8130 GEOMEMBRANES

Technical Data and Specifications for XR® Geomembranes

XR-3®
XR-5®
XR-3® PW

Industrial, Municipal and Potable Water Grade Geomembranes

Seaman Corporation
1000 Venture Blvd.
Wooster, Ohio 44691
(330) 262-1111
www.xr-5.com

Seaman Corp. XR Geomembranes

Section 1 - Product Overview/Applications

- All XR Geomembrane products are classified as an Ethylene Interpolymer Alloy (EIA)
- XR-5 grade is high strength and chemically resistant for maximum resistance to high temperature, and broad chemical resistance, including acids, oils and methane
- XR-3 grade for moderate chemical resistant requirement applications such as stormwater and domestic wastewater
- NSF 61 approved XR-3 PW grade for potable water contact
- Heat weldable-thermal weldable for seams as strong as the membrane. Factory panels over 15,000 square feet (1400 sq meters) for less field seaming
- Stability is excellent, with low thermal expansion-contraction properties
- 30+ year application history

Product Application Chart

	XR-5			XR-3	XR-3 PW
	8130	**8138**	**6730**	**8228**	**8130**
High Puncture Resistance	X	X	X		X
UV Resistance	X	X	X	X	X
High Strength Applications	X	X	X		X
Floating Covers (Nonpotable)	X	X	X	X	
Diesel/Jet Fuel Containment	X	X	X		
Industrial Wastewater	X	X	X		
Stormwater	X	X	X	X	
Municipal/Domestic Wastewater	X	X	X	X	
Floating Diversion Baffles/Curtains	X		X		X
Potable Water					X
<-65 Deg F Applications	Contact Seaman Corp.				
Chemically Resistant Applications	X	X	X		

XR-5® is a registered trademark of Seaman Corporation
XR-3® is a registered trademark of Seaman Corporation
XR® is a registered trademark of Seaman Corporation

Section 2 - Physical Properties

Part 1- Material Specifications

Property	Test Method	8130 XR-5	8138 XR-5	6730 XR-5
Base Fabric Type Base Fabric Weight	ASTM D 751	Polyester 6.5 oz/yd^2 nominal (220 g/m^2 nominal)	Polyester 6.5 oz/yd^2 nominal (220 g/m^2 nominal)	Polyester 7 oz/yd^2 nominal (235 g/m^2 nominal)
Thickness	ASTM D 751	30 mils min. (0.76 mm min.)	40 mils nom. (1.0 mm nom.)	30 mils min. (0.76 mm min.)
Weight	ASTM D 751	30.0 +- 2 oz/sq yd (1017 +- 2 g/m^2)	38.0 +- 2 oz/sq yd (1288 +- 70 g/m^2)	30.0 +- 2 oz/sq yd (1017 +- 70 g/m^2)
Tear Strength	ASTM D 751 Trap Tear	40/55 lbs. min. (175/245 N min.)	40/55 lbs. min. (175/245 N min.)	
Breaking Yield Strength	ASTM D 751 Grab Tensile	550/550 lbs. min. (2,447/2,447 N min.)	550/550 lbs. min. (2,447/2,447 N min.)	600/550 lbs. min. (2,670/2,447 N min.)
Low Temperature Resistance	ASTM D 2136 4 hrs-1/8" Mandrel	Pass @ -30° F Pass @ -35° C	Pass @ -30° F Pass @ -35° C	Pass @ -30° F Pass @ -35° C
Dimensional Stability	ASTM D 1204 100° C-1 Hr.	0.5% max. each direction	0.5% max. each direction	0.5% max. each direction
Hydrostatic Resistance	ASTM D 751 Procedure A	800 psi min. (5.51 MPa min.)	800 psi min. (5.51 MPa min.)	800 psi min. (5.51 MPa min.)
Blocking Resistance	ASTM D 751 180° F	#2 Rating max.	#2 Rating max.	#2 Rating max.
Adhesion-Ply	ASTM D 413 Type A	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)
Adhesion (minimum) Heat Welded Seam	ASTM D 751 Dielectric Weld	40 lbs./2in. RF weld min. (17.5 daN/5 cm min.)	40 lbs./2in. RF weld min. (17.5 daN/5 cm min.)	15 lbs./in. RF weld min. (15 daN/5 cm min.)
Dead Load Seam Strength	ASTM D 751, 4-Hour Test	Pass 220 lbs/in @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in @ 160° F (Pass 534 N/2.54 cm @ 70° C)	Pass 220 lbs/in @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in @ 160° F (Pass 534 N/2.54 cm @ 70° C)	
Bonded Seam Strength	ASTM D 751 Procedure A, Grab Test Method	550 lbs. min. (2,450 N min.)	550 lbs. min. (2,450 N min.)	550 lbs. min. (2,560 N min.)

Abrasion Resistance	ASTM D 3389 H-18 Wheel 1 kg Load	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss
Weathering Resistance	Carbon-Arc ASTM G 153	8,000 hours min. with no appreciable changes or stiffening or cracking of coating	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min. with no appreciable change or stiffening or cracking of coating
Water Absorption	ASTM D 471, Section 12 7 Days	0.025 kg/m^2 max. @70° F/21° C 0.14 kg/m^2 max at 212° F/100° C	0.025 kg/m^2 max. @70° F/21° C 0.14 kg/m^2 max at 212° F/100° C	0.025 kg/m^2 max. @70° F/21° C 0.14 kg/m^2 max at 212° F/100° C
Wicking	ASTM D 751	1/8" max (0.3 cm max)	1/8" max. (0.3 cm max.)	1/8" max. (0.3 cm max.)
Bursting Strength	ASTM D 751 Ball Tip	750 lbs. min. (3,330 N min.)	750 lbs. min. (3,330 N min.)	750 lbs. min. (3,330 N min.)
Puncture Resistance	ASTM D 4833	275 lbs. min. 1,200 N min.	275 lbs. min. 1,200 N min.	275 lbs. min. 1,200 N min.
Coefficient of Thermal Expansion/ Contraction	ASTM D 696	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)
Environmental/Chemical Resistant Properties		See Chemical Resistance Table, Page 8	See Chemical Resistance Table, Page 8	See Chemical Resistance Table, Page 8
Puncture Resistance	FED-STD-101C Method 2031	350 lbs. (approx.)	350 lbs. (approx.)	
Cold Crack	ASTM D 2136 4 Hrs, 1/8" Mandrel	Pass at -30° F/-34° C	Pass @ -30° F/-34° C	Pass @ -30° F/-34° C

Section 2 - Physical Properties

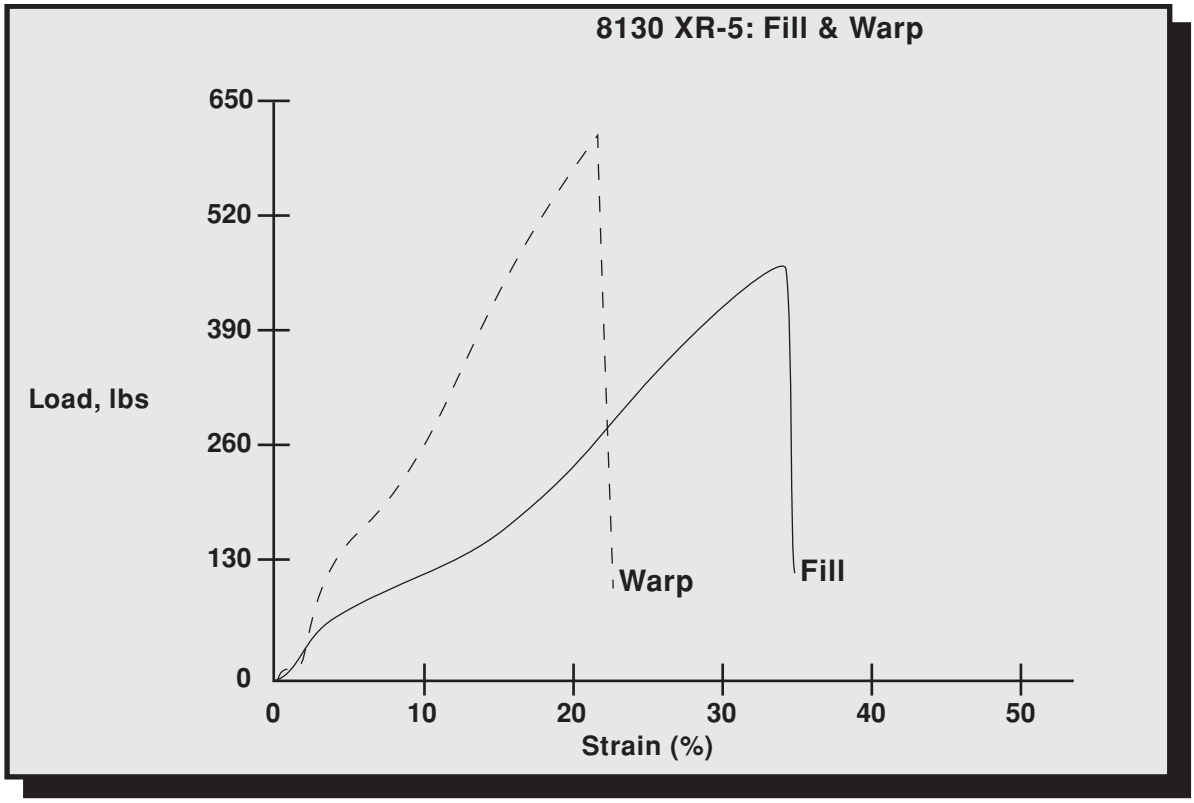
Part 1- Material Specifications (cont.)

Property	Test Method	8130 XR-3 PW	8228 XR-3
Base Fabric Type Base Fabric Weight	ASTM D 751	Polyester 6.5 oz/yd^2 nominal (220 g/m^2 nominal)	Polyester 3.0 oz/yd^2 nominal (100 g/m^2 nominal)
Thickness	ASTM D 751	30 mils min. (0.76 mm min.)	30 mils min. (0.76 mm min.)
Weight	ASTM D 751	30.0 +- 2 oz./sq. yd. (1017 +- 70 g/sq. m)	28.0 +- 2 oz./sq. yd. (950 +- 70 g/sq. m)
Tear Strength	ASTM D 751 Trap Tear	40/55 lbs. min. (175/245 N min.)	30/30 lbs. nom. (133/133 N nom.)
Breaking Yield Strength	ASTM D 751 Grab Tensile	550/550 lbs. min. (2,447/2447 N min.)	250/200 lbs. min. (1,110/890 N min.)
Low Temperature Resistance	ASTM D 2136 4hrs-1/8" Mandrel	Pass @ -30° F (Pass @ -35° C)	Pass @ -25° F (Pass @ -32° C)
Dimensional Stability	ASTM D 1204 100° C-1 hr.	0.5% max. each direction	5% max. each direction
Hydrostatic Resistance	ASTM D 751 Method A	800 psi min. (5.51 MPa min.)	300 psi min. (2.07 MPa min.)
Blocking Resistance	ASTM D 751 180° F	#2 Rating max.	#2 Rating max.
Adhesion-Ply	ASTM D 413 Type A	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	12 lbs./in. (approx.) (10 daN/5 cm approx.)
Adhesion- Heat Welded Seam	ASTM D 751 Dielectrc Weld	40 lbs./2in. min. (17.5 daN/5 cm min.)	10 lbs./in min. (9 daN/5 cm min.)
Dead Load Seam Strength	ASTM D 751, 4-Hour Test	Pass 220 lbs/in. @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in. @ 160° F (Pass 534 N/2.54 cm @ 70° C)	Pass 100 lbs/in @ 70° F (Pass 445 N @ 21° C) Pass 50 lb @ 160° F (Pass 220 N @ 70° C)
Bonded Seam Strength	ASTM D 751 Procedure A, Grab Test Method	550 lbs. min. (2,450 N min.)	250 lbs. (approx.) (1,112 N min.)

Abrasion Resistance	ASTM D 3389 H-18 Wheel 1 kg Load	2000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2000 cycles min.
Weathering Resistance	ASTM G 153	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min.
Water Absorption	ASTM D 471, Section 12 7 Days	0.025 kg/m^2 max. @ 70° F/21° C 0.14 kg/m^2 max @ 212° F/100° C	0.05 kg/m^2 max. @ 70° F/21° C (approx.) 0.28 kg/m^2 max. @ 212° F/100° C (approx.)
Wicking	ASTM D 751	1/8" max. (0.3 cm max.)	1/8" max (0.3 cm max.)
Bursting Strength	ASTM D 751 Ball Tip	750 lbs. min. (3330 N min.)	350 lbs. (approx.) (1557 N min.)
Puncture Resistance	ASTM D 4833	275 lbs. min. 1200 N min.	50 lb typ. (225 N typ.)
Coefficient of Thermal Expansion/ Contraction	ASTM D 696	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)	8 x 10^{-6} in/in/° F max. (approx.) (1.4 x 10^{-5} cm/cm/° C max. approx.)
Environmental/Chemical Resistant Properties	ASTM D 741 7-Day Total Immersion With Exposed Edges	NSF 61 approved for potable water	Crude oil 5% max. weight gain Diesel fuel 5% max. weight gain
Puncture Resistance	FTMS 101C Method 2031	350 lbs. (approx.)	205 lbs. (approx.)
Tongue Tear	ASTM D 751		50 lbs. (approx.)

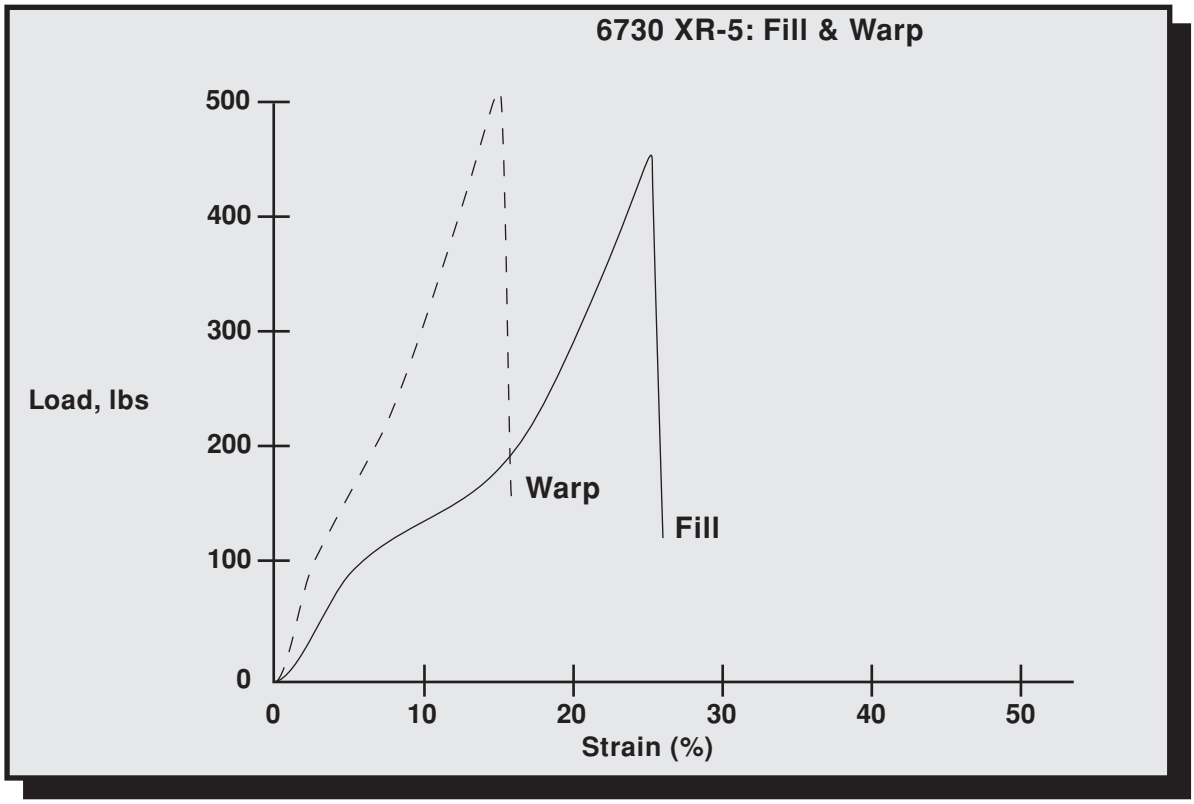
Part 2 - Elongation Properties Test

8130 XR-5



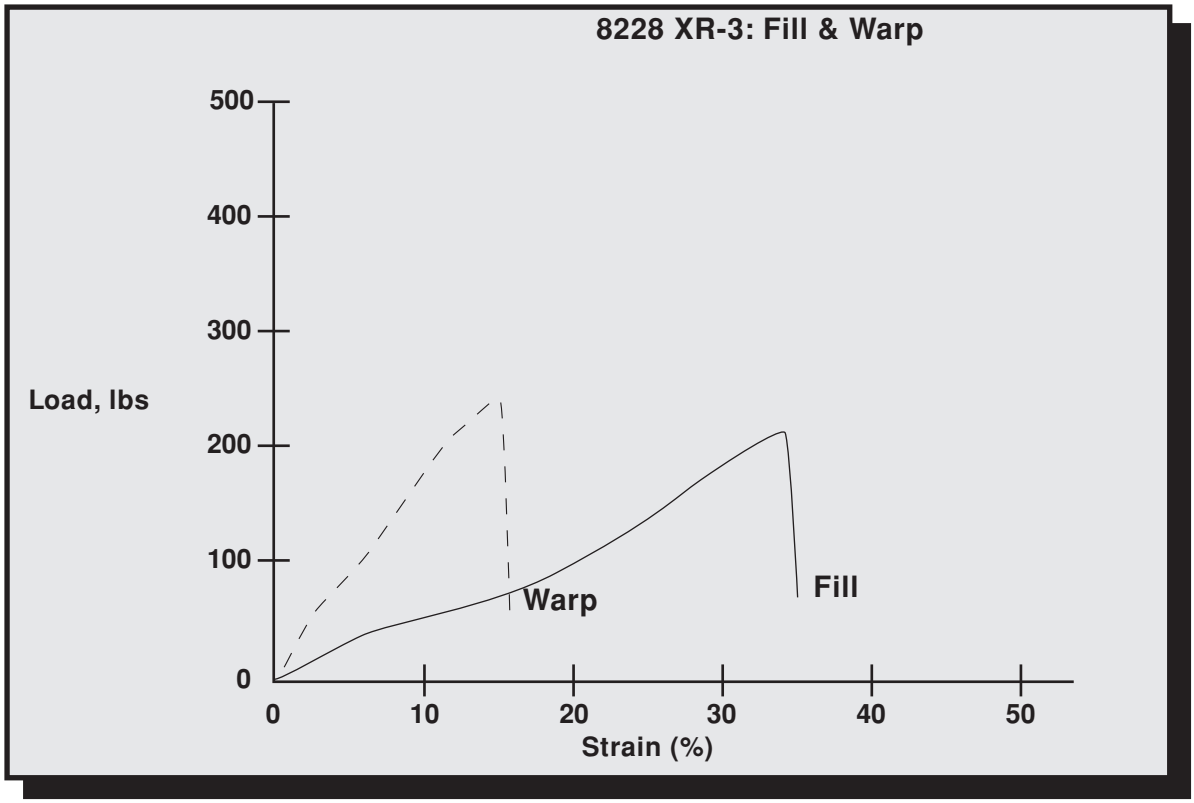
Part 2 - Elongation Properties Test

6730 XR-5



Part 2 - Elongation Properties Test

8228 XR-3



Section 3 - Chemical/Environmental Resistance

Part 1 - XR-5® Fluid Resistance Guidelines

The data below is the result of laboratory tests and is intended to serve only as a guide. No performance warranty is intended or implied. The degree of chemical attack on any material is governed by the conditions under which it is exposed. Exposure time, temperature, and size of the area of exposure usually varies considerably in application, therefore, this table is given and accepted at the user's risk. Confirmation of the validity and suitability in specific cases should be obtained. Contact a Seaman Corporation Representative for recommendation on specific applications.

When considering XR-5 for specific applications, it is suggested that a sample be tested in actual service before specification. Where impractical, tests should be devised which simulate actual service conditions as closely as possible.

EXPOSURE	RATING	EXPOSURE	RATING
AFFF	A	JP-4 Jet Fuel	A
Acetic Acid (5%)	B	JP-5 Jet Fuel	A
Acetic Acid (50%)	C	JP-8 Jet Fuel	A
Ammonium Phosphate	T	Kerosene	A
Ammonium Sulfate	T	Magnesium Chloride	T
Antifreeze (Ethylene Glycol)	A	Magnesium Hydroxide	T
Animal Oil	A	Methanol	A
Aqua Regia	X	Methyl Alcohol	A
ASTM Fuel A (100% Iso-Octane)	A	Methyl Ethyl Ketone	X
ASTM Oil #2 (Flash Pt. 240° C)	A	Mineral Spirits	A
ASTM Oil #3	A	Naphtha	A
Benzene	X	Nitric Acid (5%)	B
Calcium Chloride Solutions	T	Nitric Acid (50%)	C
Calcium Hydroxide	T	Perchloroethylene	C
20% Chlorine Solution	A	Phenol	X
Clorox	A	Phenol Formaldehyde	B
Conc. Ammonium Hydroxide	A	Phosphoric Acid (50%)	A
Corn Oil	A	Phosphoric Acid (100%)	C
Crude Oil	A	Phthalate Plasticizer	C
Diesel Fuel	A	Potassium Chloride	T
Ethanol	A	Potassium Sulphate	T
Ethyl Acetate	C	Raw Linseed Oil	A
Ethyl Alcohol	A	SAE-30 Oil	A
Fertilizer Solution	A	Salt Water (25%)	B
#2 Fuel Oil	A	Sea Water	A
#6 Fuel Oil	A	Sodium Acetate Solution	T
Furfural	X	Sodium Bisulfite Solution	T
Gasoline	B	Sodium Hydroxide (60%)	A
Glycerin	A	Sodium Phosphate	T
Hydraulic Fluid- Petroleum Based	A	Sulphuric Acid (50%)	A
Hydraulic Fluid- Phosphate Ester Based	C	Tanic Acid (50%)	A
Hydrocarbon Type II (40% Aromatic)	C	Toluene	C
Hydrochloric Acid (50%)	A	Transformer Oil	A
Hydrofluoric Acid (5%)	A	Turpentine	A
Hydrofluoric Acid (50%)	A	Urea Formaldehyde	A
Hydrofluosilicic Acid (30%)	A	UAN	A
Isopropyl Alcohol	T	Vegetable Oil	A
Ivory Soap	A	Water (200°F)	A
Jet A	A	Xylene	X
		Zinc Chloride	T

Ratings are based on visual and physical examination of samples after removal from the test chemical after the samples of Black XR-5 were immersed for 28 days at room temperature. Results represent ability of material to retain its performance properties when in contact with the indicated chemical.

Rating Key:
A – Fluid has little or no effect
B – Fluid has minor to moderate effect
C – Fluid has severe effect
T – No data - likely to be acceptable
X – No data - not likely to be acceptable

Vapor Transmission Data

Tested according to ASTM D814-55 Inverted Cup Method

Perhaps a more meaningful test is determination of the diffusion rate of the liquid through the membrane. The vapor transmission rate of Style 8130 XR-5® to various chemicals was determined by the ASTM D814-55 inverted cup method. All tests were run at room temperature and results are shown in the table.

Chemical	8130 XR-5 Black g/hr/m2
Water	**0.11**
#2 Diesel Fuel	**0.03**
Jet A	**0.11**
Kerosene	**0.15**
Hi-Test Gas	**1.78**
Ohio Crude Oil	**0.03**
Low-Test Gas	**5.25**
Raw Linseed Oil	**0.01**
Ethyl Alcohol	**0.23**
Naphtha	**0.33**
Perchlorethylene	**38.58**
Hydraulic Fluid	**0.006**
100% Phosphoric Acid	**7.78**
50% Phosphoric Acid	**0.43**
Ethanol (E-96)	**0.65**
Transformer Oil	**0.005**
Isopropyl Alcohol	**0.44**
JP4 (E-96)	**0.81**
JP8 (E-96)	**0.42**
Fuel B (E-96)	**6.28**
Fuel C (E-96)	**7.87**

Note: The tabulated values are measured Vapor Transmission Rates (VTR). Normal soil testing methods to determine permeability are impractical for synthetic membranes. An "equivalent hydraulic" permeability coefficient can be calculated but is not a direct units conversion. Contact Seaman Corporation for additional technical information.

Seam Strength

Style 8130 XR-5 Black Seam Strength After Immersion

Two pieces of Style 8130 were heat sealed together (seam width 1 inch overlap) and formed into a bag. Various oils and chemicals were placed in the bags so that the seam area was entirely covered. After 28 days at room temperature, the chemicals were removed and one inch strips were cut across the seam and the breaking strength immediately determined. Results are listed below.

Chemical	Seam Strength
None	340 Lbs. Fabric Break- No Seam Failure
Kerosene	355 Lbs. Fabric Break- No Seam Failure
Ohio Crude Oil	320 Lbs. Fabric Break- No Seam Failure
Hydraulic Fluid- Petroleum Based	385 Lbs. Fabric Break- No Seam Failure
Toluene	0 Lbs. Adhesion Failure
Naphtha	380 Lbs. Fabric Break- No Seam Failure
Perchloroethylene	390 Lbs. Fabric Break- No Seam Failure

Even though 1-inch overlap seams are used in the tests to study the accelerated effects, it is recommended that XR-5 be used with a 2-inch nominal overlap seam in actual application. In some cases where temperatures exceed 160ºF and the application demands extremely high seam load, it may be necessary to use a wider width seam.

Long Term Seam Adhesion

11 Years Immersion
ASTM D 751
Lbs./In.

Seam samples of 8130 XR-5® were dielectrically welded together and totally immersed in the liquids for 11 years. The samples were taken out, dried for 24 hours and visually observed for any signs of swelling, cracking, stiffening or degradation of the coating. The coating showed no appreciable degradation and no stiffening, swelling, cracking or peeling.

The adhesion, or resistance to separation of the coating from the base cloth, was then measured by ASTM D 751. Results show 8130 XR-5 maintains seam strength over this long period (11 years).

	Control	Crude Oil	JP-4 Jet Fuel	Diesel Fuel	Kerosene	Naphtha
8130 XR-5	20+	18	33	25	40	33*

Values in lbs./in.

*The naphtha sample was sticky.

We believe this information is the best currently available on the subject. We offer it as a suggestion in any appropriate experimentation you may care to undertake. It is subject to revision as additional knowledge and experience are gained. We make no guarantee of results and assume no obligation or liability whatsoever in connection with this information.

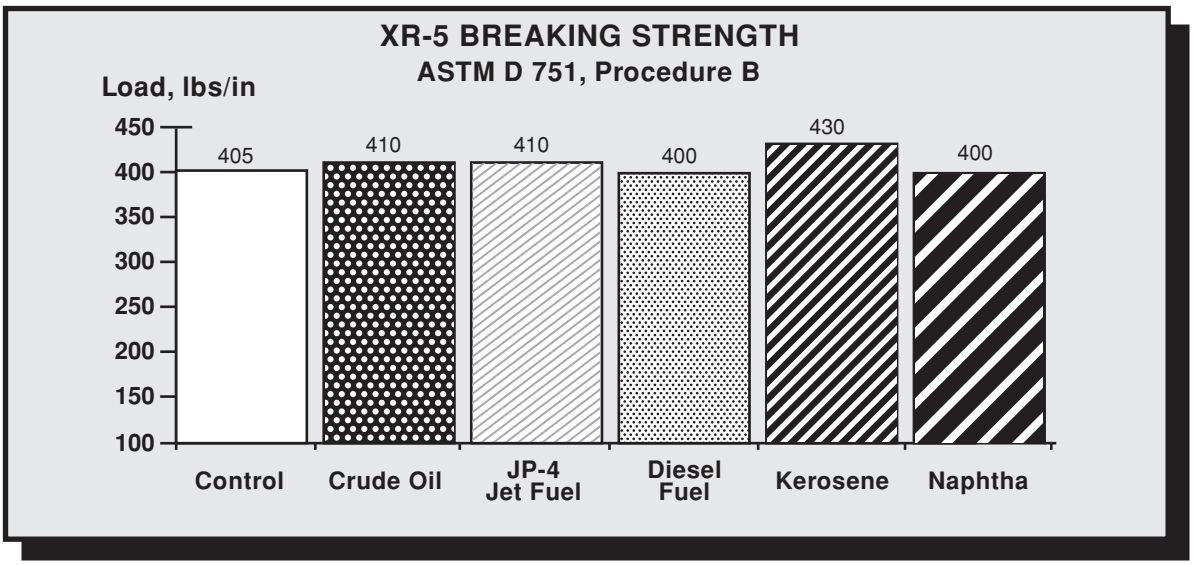
Fuel Compatibility - Long Term Immersion

Test: Samples of 8130 XR-5® Black were immersed in Diesel Fuel, JP-4 Jet Fuel, Crude Oil, Kerosene, and Naphtha for 6 1/2 years.

The samples were then taken out of the test chemicals, blotted and dried for 24 hours. The samples were observed for blistering, swelling, stiffening, cracking or delamination of the coating from the fiber.

Results: It was found in all cases that the 8130 XR-5, after immersion for six years, maintained its strength and there was no evidence of blistering, swelling, stiffening, cracking or delamination.

The strip tensile strength, or breaking strength, of the samples was measured after six years of immersion and the following are the results.



XR-3 Chemical Resistance Statement (Summary)

XR-3® is recommended for moderate chemical resistant applications such as stormwater and municipal wastewater and is not recommended for prolonged contact with pure solutions. XR-3 PW® membranes are recommended only for contact with drinking water and are resistant to low levels of chlorine found in drinking water. XR-5 has a broad range of chemical resistance which is detailed in this section.

Part 2: XR-5® Comparative Chemical Resistance

Chemical Resistance Chart
Comparative Chemical Resistance

	XR-5	HDPE	PVC	Hypalon	Polypropylene
Kerosene	A	B	C	C	C
Diesel Fuel	A	A	C	C	C
Acids (General)	A	A	A	B	A
Naphtha	A	A	C	B	C
Jet Fuels	A	A	C	B	C
Saltwater, 160° F	A	A	C	B	A
Crude Oil	A	B	C	B	C
Gasoline	B	B	C	C	C

A= Excellent B= Moderate C= Poor

Source: Manufacturer's Literature

XR-5 data based on conditions detailed in Section 3, Part 1.

Part 3: Weathering Resistance

Accelerated Weathering Test
XR-5 has been tested in the carbon arc weatherometer for over 10,000 hours of exposure and in the Xenon weatherometer for over 12,000 hours of exposure. The sample showed no loss in flexibility and no significant color change. Based on field experience of Seaman Corporation products and similar weatherometer exposure tests, XR-5 should have an outdoor weathering life significantly longer than competitive geomembranes, particularly in tropical or subtropical applications.

EMMAQUA Testing: ASTM E-838-81 was performed on a modified form of XR-5, FiberTite, used in the single-ply roofing industry. After 3 million Langleys in Arizona, no signs of degradation were noted with no evidence of cracking, blistering, swelling or adhesion delamination failure of the coating.

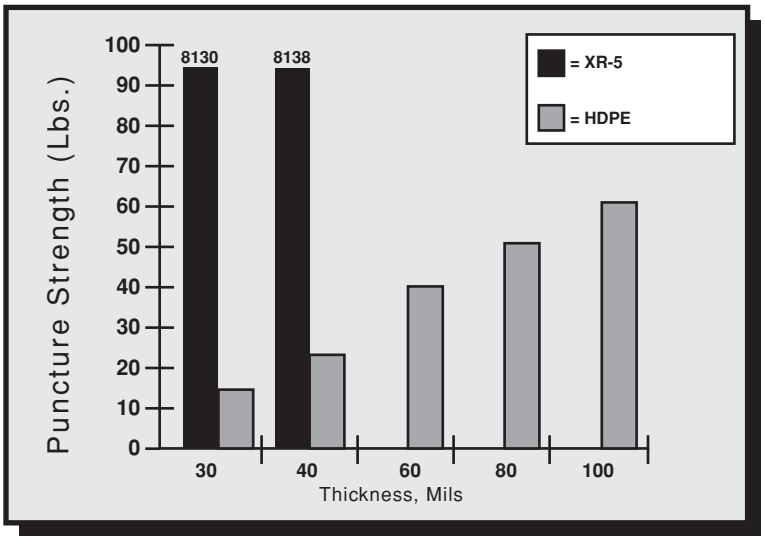
Natural Exposure
After over 17 years as a holding basin at a large oil company in the Texas desert, XR-5 showed no signs of environmental stress cracking, thermal expansion/contraction, or low yield strength problems. Temperature ranges from near zero to over 100° F.

In service approximately 17 years in a solar pond application at a research facility in Ohio, UV exposed samples, as well as immersed samples, retained over 90% of the tensile strength. Examination of the material determined there was little effect on the coating compound. The solar pond was exposed to temperatures from below zero to over 100° F.

XR5 was exposed for 12½ years in Sarasota, Florida, on a weathering rack, facing the southern direction at 45°. No significant color loss, cracking, crazing, blistering, or adhesion delamination failure of the coating was noted.

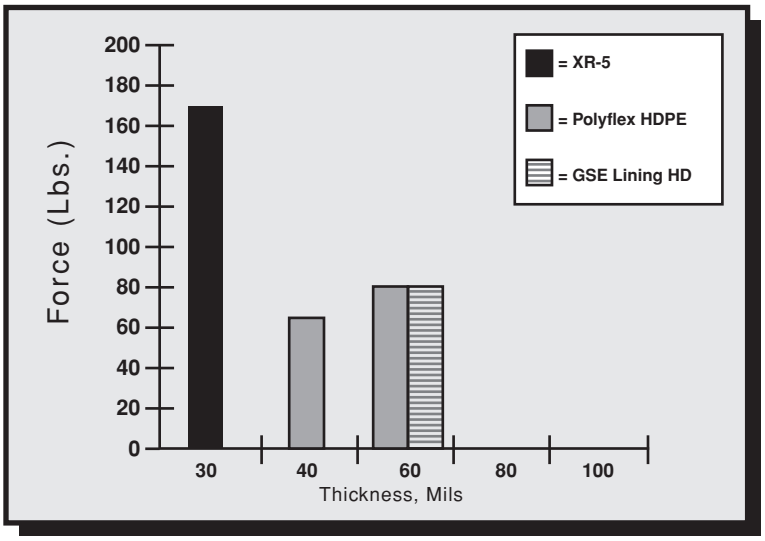
Section 4 - Comparative Physical Properties

XR-5/HDPE Comparative Properties

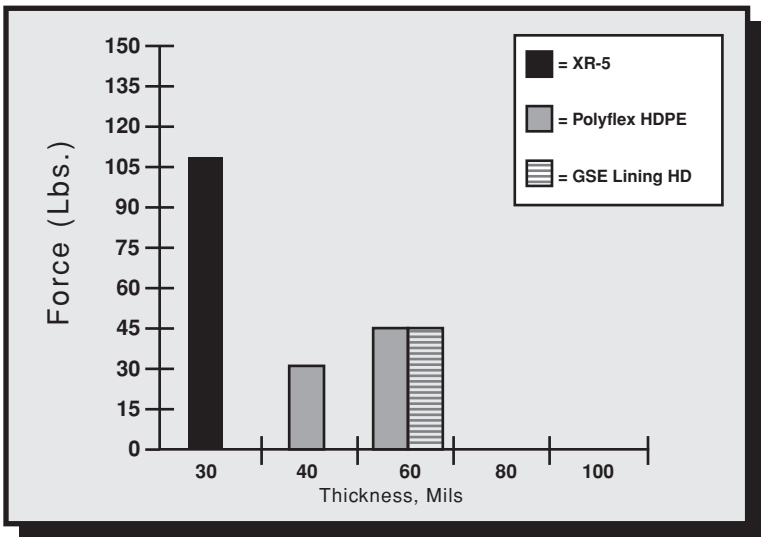


Puncture Resistance

1. ASTM D 751, Screwdriver Tip, 45° Angle (Room Temperature) Puncture Resistance, XR5 vs. HDPE



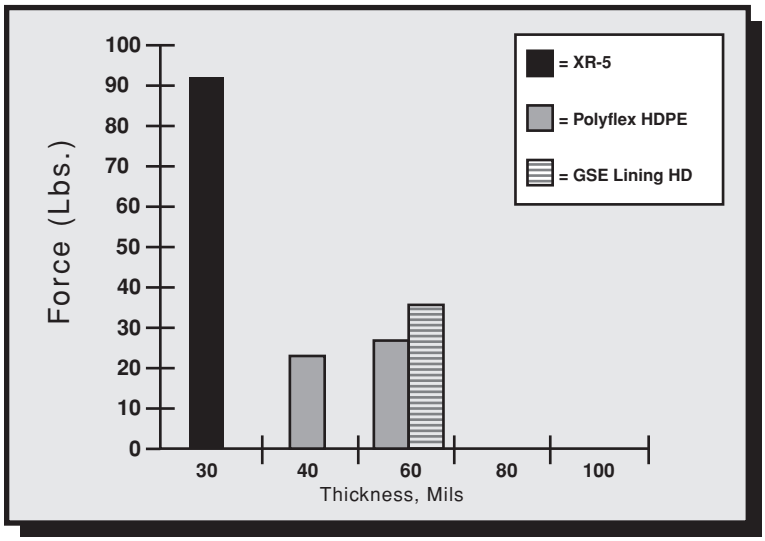
2. FED-STD-101C Method 2065 (Room Temperature)*



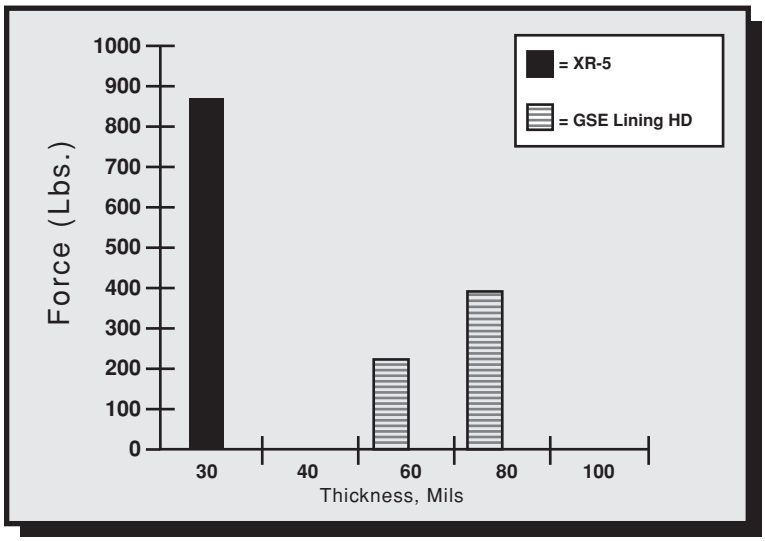
3. FED-STD-101C Method 2065 (70°C)*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

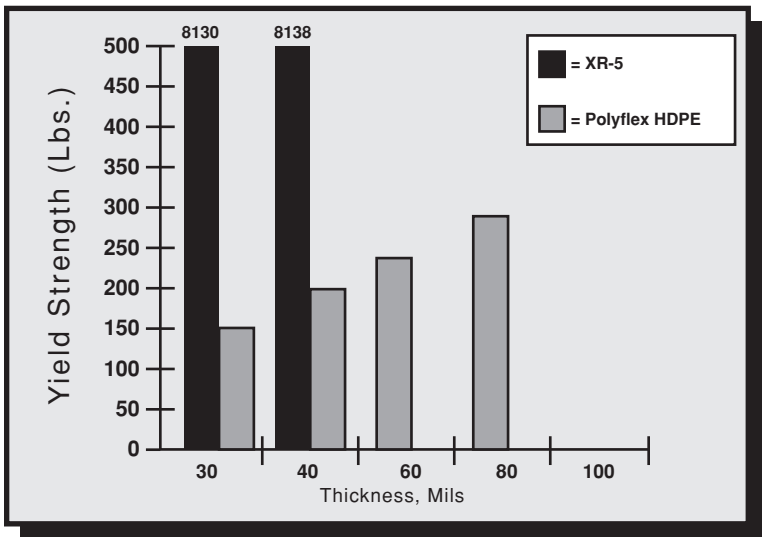
GSE is a registered trademark of GSE Lining Technology, Inc.



4. FED-STD-101C Method 2065 (100°C)*



5. ASTM D 751 Ball Burst Puncture



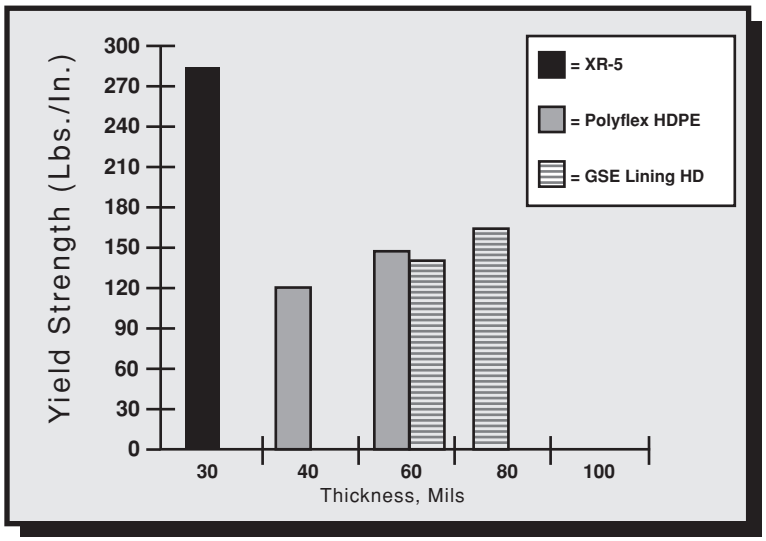
Yield Strength

1. Yield Strength, XR-5 vs. HDPE

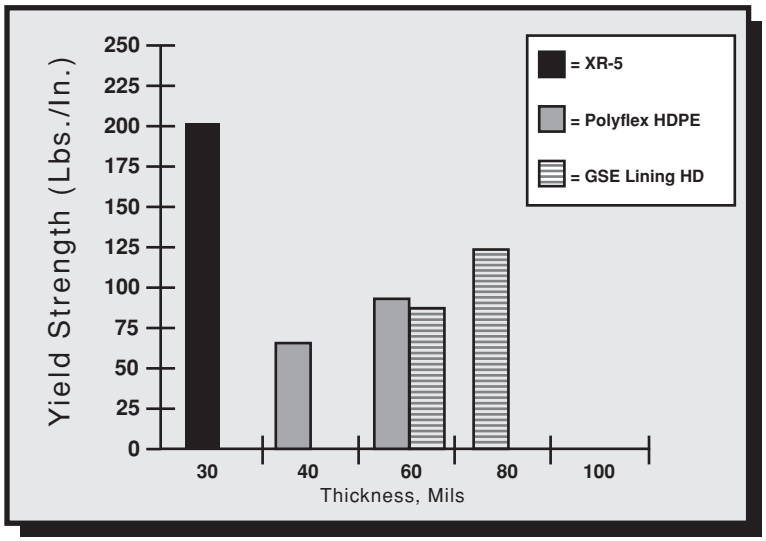
Test Method: Grab Tensile, ASTM D 751, 70° C

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

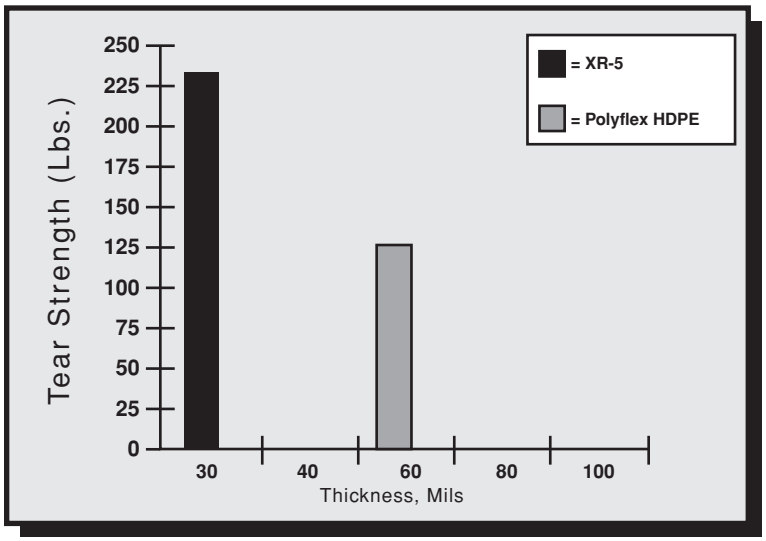
GSE is a registered trademark of GSE Lining Technology, Inc.



2. Strip Tensile, ASTM D 751, Room Temperature*



3. Strip tensile, ASTM D 751, 70ºC*

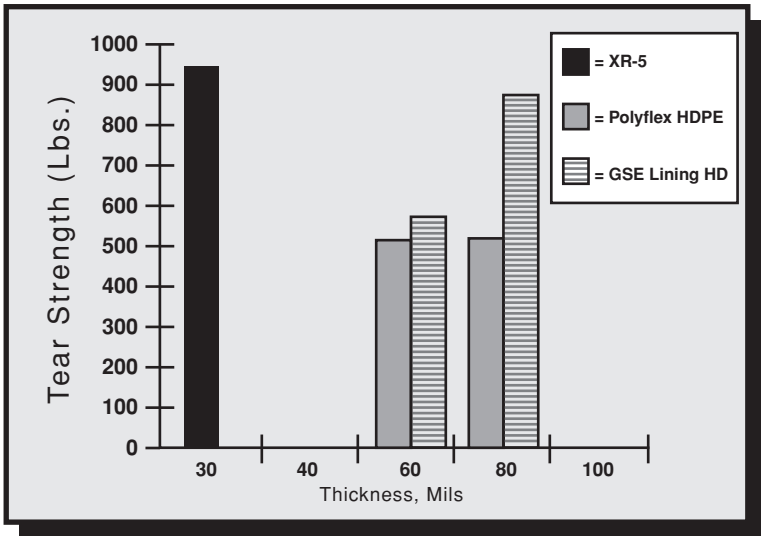


Tear Strength

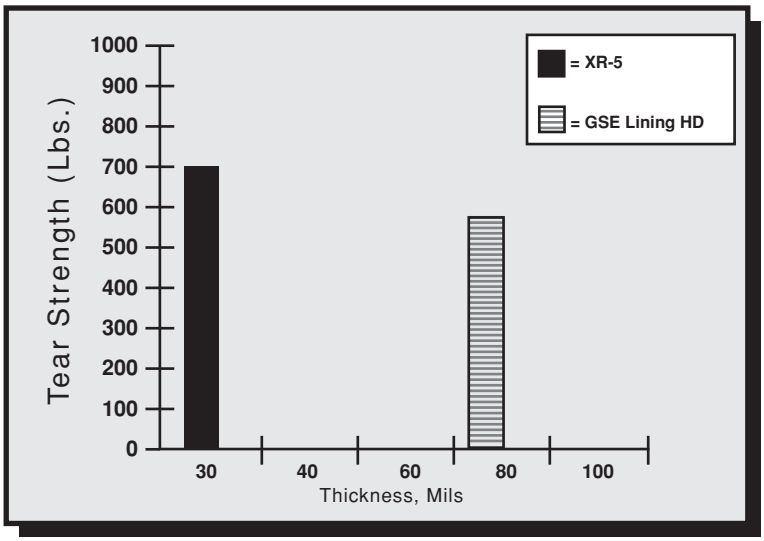
1. Tongue Tear (8" x 10" Specimens), ASTM D 751, Room Temperature*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

GSE is a registered trademark of GSE Lining Technology, Inc.



1. Graves Tear, ASTM D 624, Die C, Room Temperature*

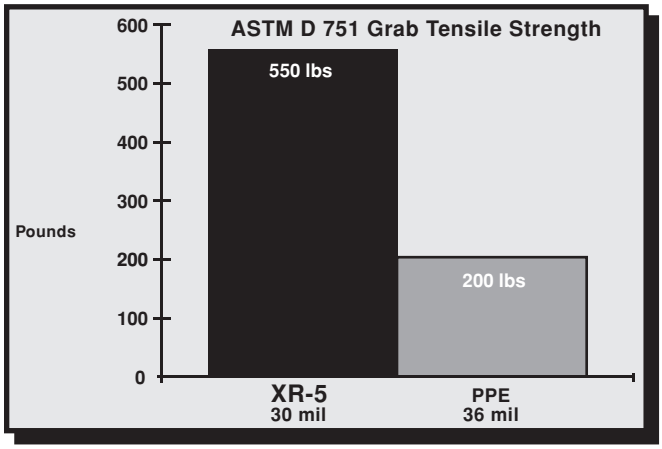


2. Graves Tear, ASTM D 624, Die C, 70°C*

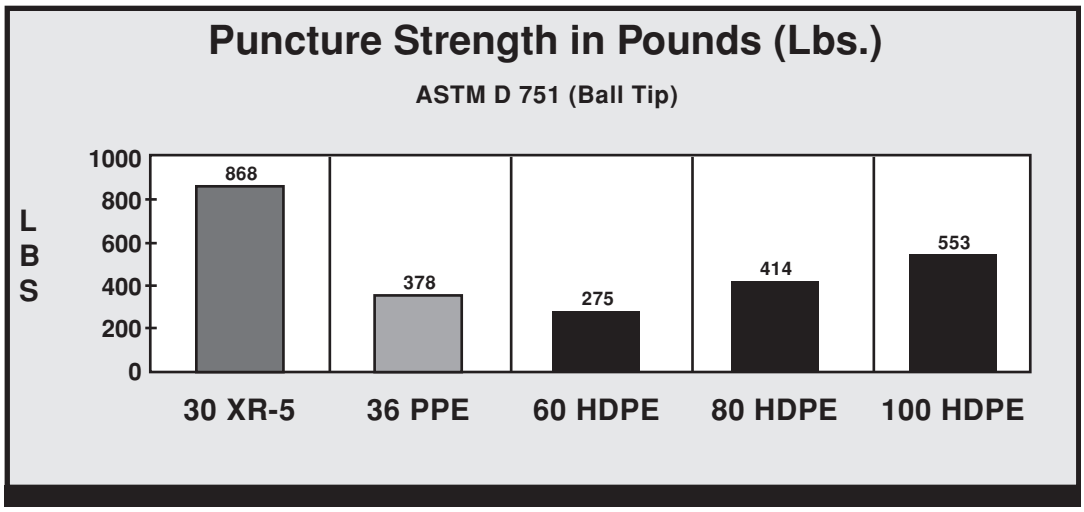
* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

GSE is a registered trademark of GSE Lining Technology, Inc.

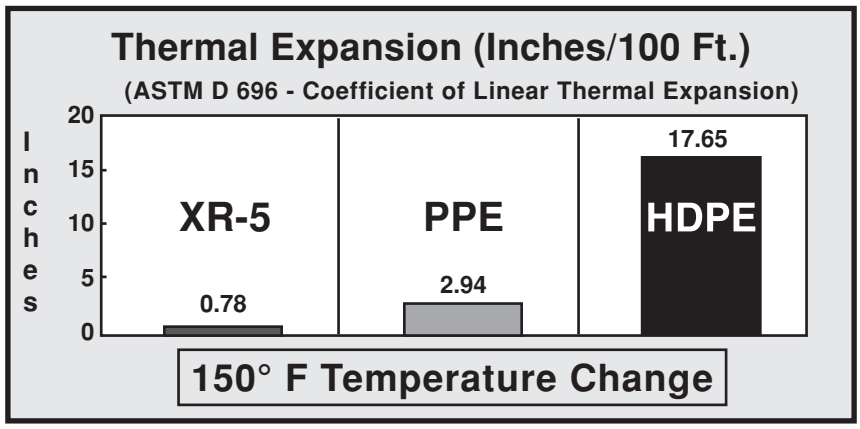
Grab Strength – XR-5® vs. Polypropylene Tensile



Puncture Strength Comparison



Coated Fabric Thermal Stability



Specification For Geomembrane Liner

(Sample specification: 8130 XR-5®. For other product specifications, go to www.xr-5.com)

General

1.01 Scope Of Work

Furnish and install flexible membrane lining in the areas shown on the drawings. All work shall be done in strict accordance with the project drawings, these specifications and membrane lining fabricator's approved shop drawings.

Geomembrane panels will be supplied sufficient to cover all areas, including appurtenances, as required in the project, and shown on the drawings. The fabricator/installer of the liner shall allow for shrinkage and wrinkling of the field panels.

1.02 Products

The lining material shall be 8130 XR-5 as manufactured by Seaman Corporation (1000 Venture Boulevard, Wooster, OH 44691; 330-262-1111), with the following physical specifications:

Base- (Type)	Polyester
Fabric Weight (ASTM D 751)	6.5 oz./sq. yd.
Finished Coated Weight (ASTM D 751)	30 ± 2 oz./sq. yd.
Trapezoid Tear (ASTM D 751)	40/55 lbs. min.
Grab Yield Tensile (ASTM D 751, Grab Method Procedure A)	550/550 lbs. min.
Elongation @ Yield (%)	20% min.
Adhesion- Heat Seam (ASTM D 751, Dielectric Weld)	40 lbs./2in. weld min.
Adhesion- Ply (ASTM D 413, Type A)	15 lbs./in. or film tearing bond
Hydrostatic Resistance (ASTM D 751, Method A)	800 psi min.
Puncture Resistance (ASTM D 4833)	275 lbs. min.
Bursting Strength (ASTM D 751 Ball Tip)	750 lbs. min.
Dead Load (ASTM D 751) Room Temperature	220 lbs. min.
(2" overlap seam, 4 hours) 160°F	120 lbs. min.
Bonded Seam Strength (ASTM D 751 Grab Test Method, Procedure A)	575 lbs. min.
Low Temperature (ASTM D 2136, 4 hours- 1/8" Mandrel)	Pass @ -30°F
Weathering Resistance ASTM G 153 Carbon Arc	8,000 hours min. With no appreciable changes or stiffening or cracking of coating
Dimensional Stability (ASTM D 1204, 212°F 1 Hour, Each Direction)	0.5% max.
Water Absorption (ASTM D 471, 7 Days)	0.025 kg/m² max. @ 70°F 0.14 kg/m² max. @ 212°F
Abrasion Resistance ASTM D 3389, H-18 Wheel, 1000 g load	2000 cycles before fabric exposure; 50 mg/100 cycles max. wgt. Loss
Coefficient of Thermal Expansion/Contraction (ASTM D 696)	8×10^{-6} in/in/° F max.

1.03 Submittals

The fabricator of panels used in this work shall prepare shop drawings with a proposed panel layout to cover the liner area shown in the project plans. Shop drawings shall indicate the direction of factory seams and shall show panel sizes consistent with the material quantity requirements of 1.01.

Details shall be included to show the termination of the panels at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring.

Placement of the lining shall not commence until the shop drawings and details have been approved by the owner, or his representative.

1.04 Factory Fabrication
The individual XR-5® liner widths shall be factory fabricated into large sheets custom designed for this project so as to minimize field seaming. The number of factory seams must exceed the number of field seams by a factor of at least 10.

A two-inch overlap seam done by heat or RF welding is recommended. The surface of the welded areas must be dry and clean. Pressure must be applied to the full width of the seam on the top and bottom surface while the welded area is still in a melt-type condition. The bottom welding surface must be flat to insure that the entire seam is welded properly. Enough heat shall be applied in the welding process that a visible bead is extruded from both edges being welded. The bead insures that the material is in a melt condition and a successful chemical bond between the two surfaces is accomplished.

Two-inch overlapped seams must withstand a minimum of 240 pounds per inch width dead load at 70° F. and 120 pounds per inch width at 160° F. as outlined in ASTM D 751. All seams must exceed 550 lbs. bonded seam strength per ASTM D 751 Bonded Seam Strength Grab Test Method, Procedure A.

1.05 Inspection And Testing Of Factory Seams
The fabricator shall monitor each linear foot of seam as it is produced. Upon discovery of any defective seam, the fabricator shall stop production of panels used in this work and shall repair the seam, and determine and rectify the cause of the defect prior to continuation of the seaming process.

The fabricator must provide a Quality Control procedure to the owner or his representative which details his method of visual inspection and periodic system checks to ensure leak-proof factory fabrication.

1.06 Certification and Test Reports
Prior to installation of the panels, the fabricator shall provide the owner, or his representative, with written certification that the factory seams were inspected in accordance with Section 1.05.

1.07 Panel Packaging and Storage
Factory fabricated panels shall be accordian-folded, or rolled, onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each factory fabricated panel shall be prominently and indelibly marked with the panel size. Panels shall be protected as necessary to prevent damage to the panel during shipment.

Panels which have been delivered to the project site shall be stored in a dry area.

1.08 Qualifications of Suppliers
The fabricator of the lining shall be experienced in the installation of flexible membrane lining, and shall provide the owner or his representative with a list of not less than five (5) projects and not less than 500,000 square feet of successfully installed XR-5 synthetic lining. The project list shall show the name, address, and telephone number of an appropriate party to contact in each case. The manufacturer of the sheet goods shall provide similar documentation with a 10 million square foot minimum, with at least 5 projects demonstrating 10+ years service life.

The installer shall provide similar documentation to that required by the fabricator.

1.09 Subgrade Preparation By Others
Lining installation shall not begin until a proper base has been prepared to accept the membrane lining. Base material shall be free from angular rocks, roots, grass and vegetation. Foreign materials and protrusions shall be removed, and all cracks and voids shall be filled and the surface made level, or uniformly sloping as indicated

on the drawings. The prepared surface shall be free from loose earth, rocks, rubble and other foreign matter. Generally, no rock or other object larger than USCS sand (SP) should remain on the subgrade in order to provide an adequate safety factor against puncture. Geotextiles may be used to compensate for irregular subgrades. The subgrade shall be uniformly compacted to ensure against settlement. The surface on which the lining is to be placed shall be maintained in a firm, clean, dry and smooth condition during lining installation.

1.10 Lining Installation
Prior to placement of the liner, the installer will indicate in writing to the owner or his representative that he believes the subgrade to be adequately prepared for the liner placement.

The lining shall be placed over the prepared surface in such a manner as to assure minimum handling. The sheets shall be of such lengths and widths and shall be placed in such a manner as to minimize field seaming.

In areas where wind is prevalent, lining installation should be started at the upwind side of the project and proceed downwind. The leading edge of the liner shall be secured at all times with sandbags or other means sufficient to hold it down during high winds.

Sandbags or rubber tires may be used as required to hold down the lining in position during installation. Materials, equipment or other items shall not be dragged across the surface of the liner, or be allowed to slide down slopes on the lining. All parties walking or working upon the lining material shall wear soft-sole shoes.

Lining sheets shall be closely fit and sealed around inlets, outlets and other projections through the lining. Lining to concrete seals shall be made with a mechanical anchor, or as shown on the drawings. All piping, structures and other projections through the lining shall be sealed with approved sealing methods.

1.11 XR-5 Field Seaming
All requirements of Section 1.04 and 1.05 apply. A visible bead should be extruded from the hot air welding process.

Field fabrication of lining material will not be allowed.

1.12 Inspection
All field seams will be tested using the Air Lance Method. A compressed air source will deliver 55 psi minimum to a 3/16 inch nozzle. The nozzle will be directed to the lip of the field seam in a near perpendicular direction to the length of the field seam. The nozzle will be held 4 inches maximum from the seam and travel at a rate not to exceed 40 feet per minute. Any loose flaps of 1/8" or greater will require a repair.

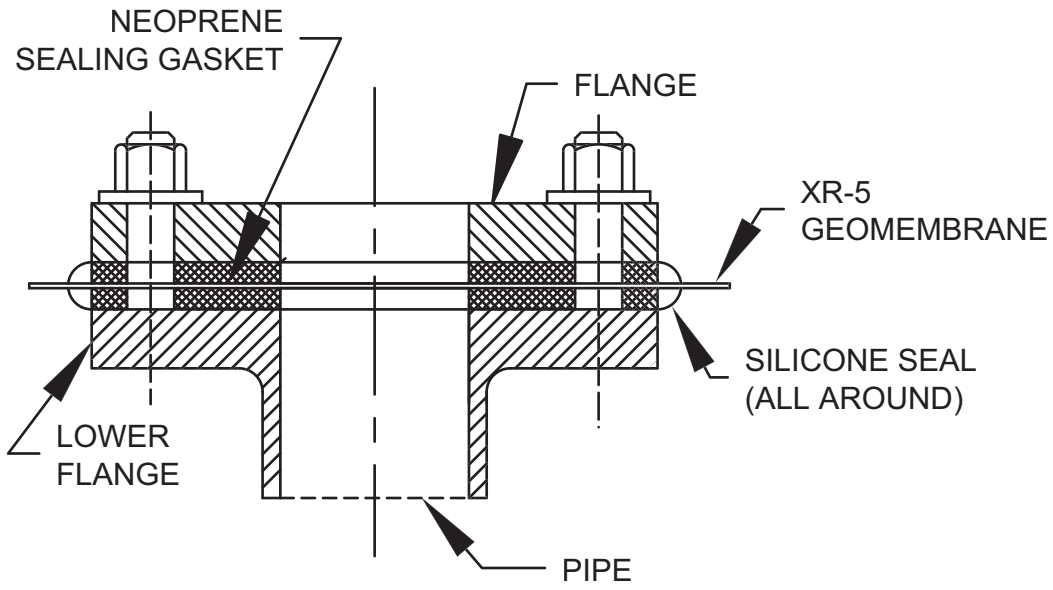
Alternatively all field seams should also be inspected utilizing the Vacuum Box Technique as described in Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber (ASTM D 5641-94 (2006)), using a 3 to 5 psi vacuum pressure. All leaks shall be repaired and tested.

All joints, on completion of work, shall be tightly bonded. Any lining surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade, shall as directed by the owner or his representative be replaced or covered, and sealed with an additional layer of lining of the proper size, in accordance with the patching procedure.

1.13 Patching
Any repairs to the lining shall be patched with the lining material. The patch material shall have rounded corners and shall extend a minimum of four inches (4") in each direction from the damaged area.

Seam repairs or seams which are questionable should be cap stripped with a 1" wide (min.) strip of the liner material. The requirements of Section 1.11 apply to this cap stripping.

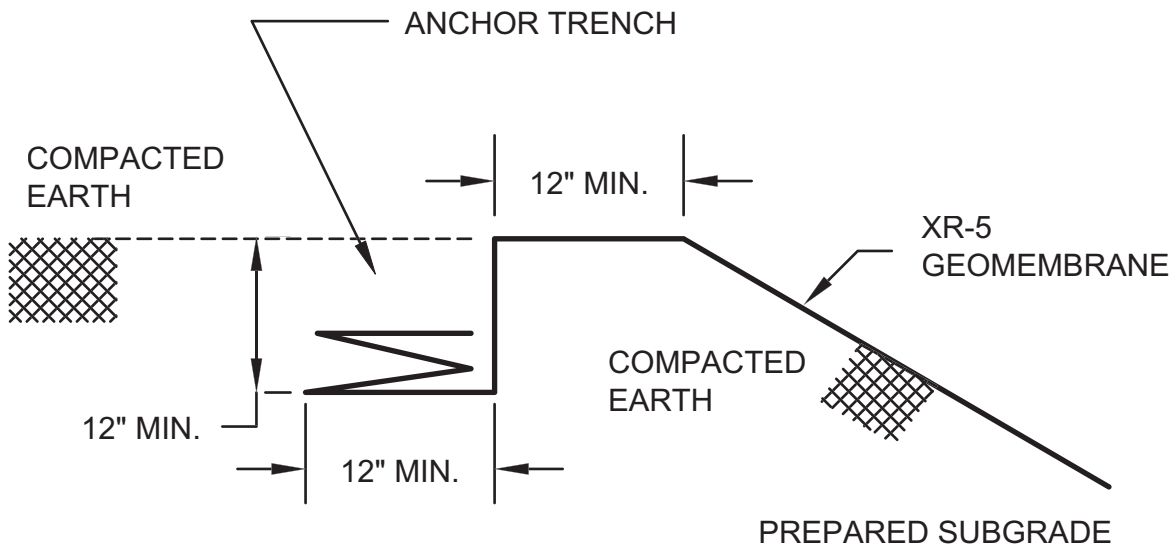
1.14 Warranty
The lining material shall be warranted on a pro-rated basis for 10 years against both weathering and chemical compatibility in accordance with Seaman Corporation warranty for XR-5® Style 8130. A test immersion will be performed by the owner and the samples evaluated by the manufacturer. Workmanship of installation shall be warranted for one year on a 100% basis.



Seaman Corporation
ENGINEERED PRODUCTS GROUP
1000 Venture Blvd.,Wooster, Ohio 44691

FLANGE CONNECTION
TO
PIPE SECTION

SCALE: NONE
SHEET 1 of 1
DRAW NO. XRD-019



Seaman Corporation

ENGINEERED PRODUCTS GROUP

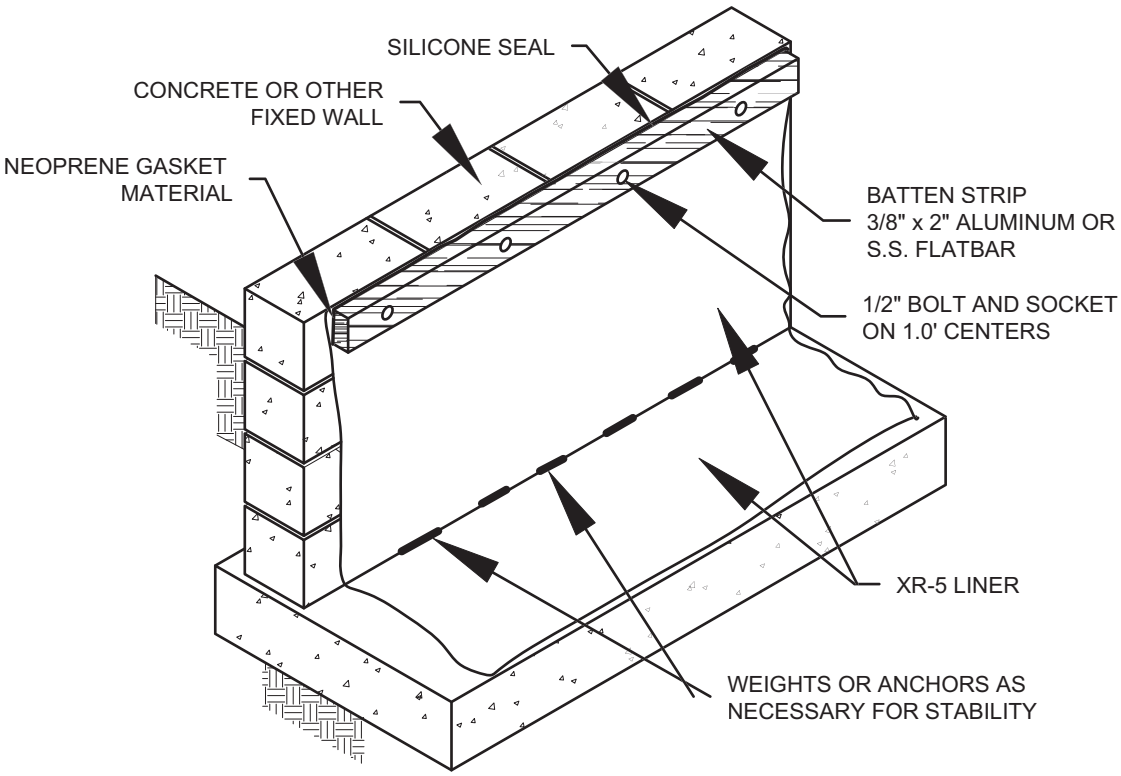
1000 Venture Blvd.,Wooster, Ohio 44691

ELEVATION VIEW
TYPICAL ANCHOR DETAILS
XR-5 LINER

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-001



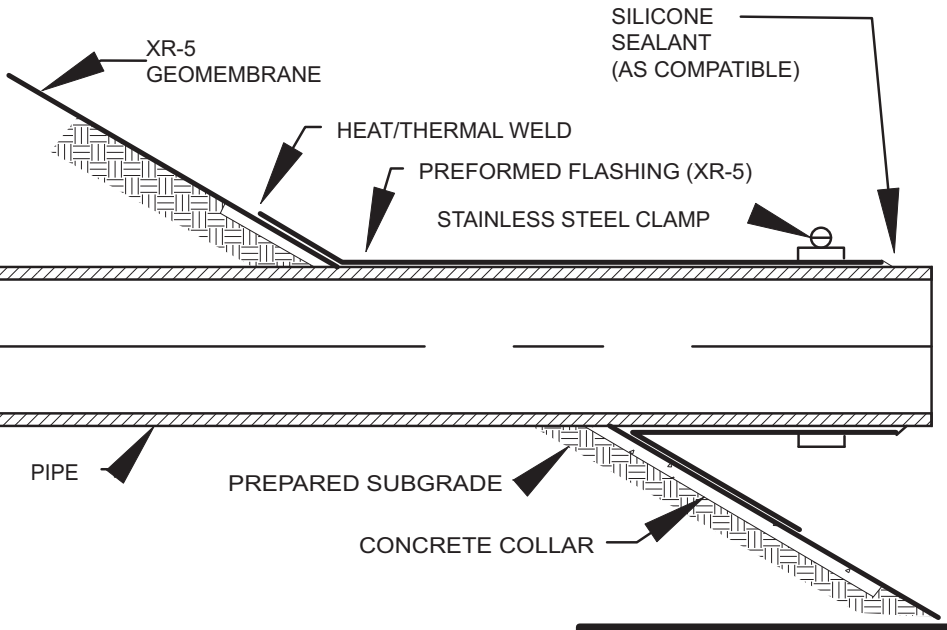
Seaman Corporation

ENGINEERED PRODUCTS GROUP

1000 Venture Blvd.,Wooster, Ohio 44691

ANCHORING DETAIL
XR-5 LINER TO FIXED WALL

SCALE: NONE	
SHEET 1 of 1	DRAW NO. XRD-023



Seaman Corporation

ENGINEERED PRODUCTS GROUP

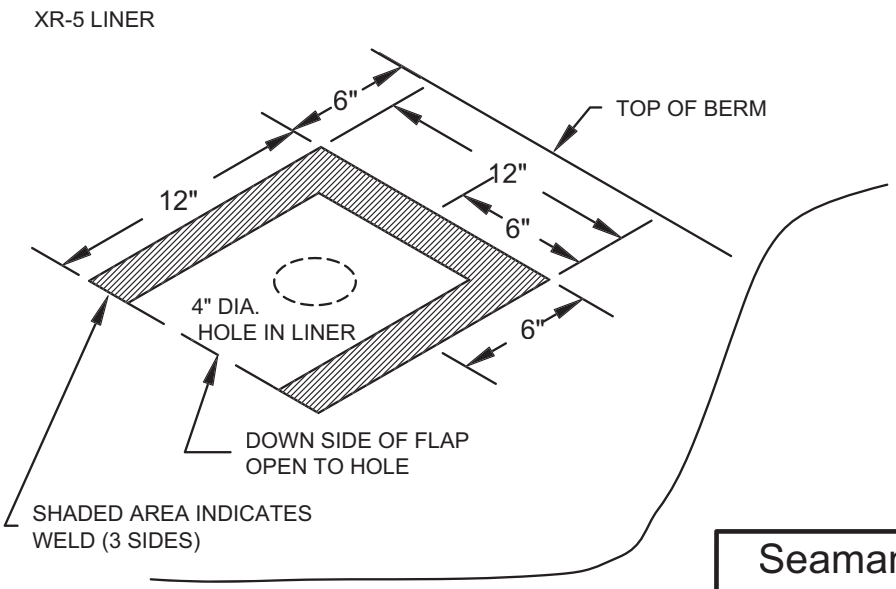
1000 Venture Blvd.,Wooster, Ohio 44691

ELEVATION VIEW
TYPICAL PIPE PUNCTURE
SEAL DETAIL XR-5 LINER

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-018



Seaman Corporation

ENGINEERED PRODUCTS GROUP

1000 Venture Blvd.,Wooster, Ohio 44691

PLAN VIEW
FLAP VENT DETAIL
XR-5 LINER

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-012

Section 6 - Warranty Information

Warranty

XR-5® is offered with Seaman Corporation standard warranty which addresses weathering and chemical compatibility for a 10-year period. A test immersion is required with subsequent testing and approval by Seaman Corporation.

Instructions for XR-5 Test Immersions and Warranty Requests

1. Completely immerse six Style 8130 XR-5 samples (8-1/2" x 11" size) in the liquid to be contained.
2. At the end of approximately thirty days, retrieve three of the samples. The samples should be rinsed with fresh water and dried.
3. Send the three samples to:

   Attn: Geomembrane Department
   Seaman Corporation
   1000 Venture Blvd.
   Wooster, OH 44691
4. Keep the other three samples immersed until further notice in case longer immersion data is required.
5. Complete and return the information form on the liner application.

8228 XR-3® and all PW Geomembranes are offered with a standard 10-year warranty for weathering. The attached information form should be completed.

XR® Membrane Application and Utilization Form

Installation Owner and Address:

Physical Location of Installation:

Expected Date of Installation:

Expected Beginning Date of Service:

Description of Application:
(Example: impoundment used to contain brine on an emergency basis.)

Physical Features of Application:
(Example: 1.3 million gallon earthen impoundment with overall top dimensions of 160′ x 160′ with 3:1 slopes and 10′ deep.)

Description of Liquid:

(Describe content of liquid including pollutants and expected temperature extremes in basin and at application point. Attach analysis of liquid chemistry, composition taken on a representative basis.)

Operational Characteristics:

(Describe the operation of the facility such as filling schedules, fluctuating liquid levels, operating temperatures, etc.)

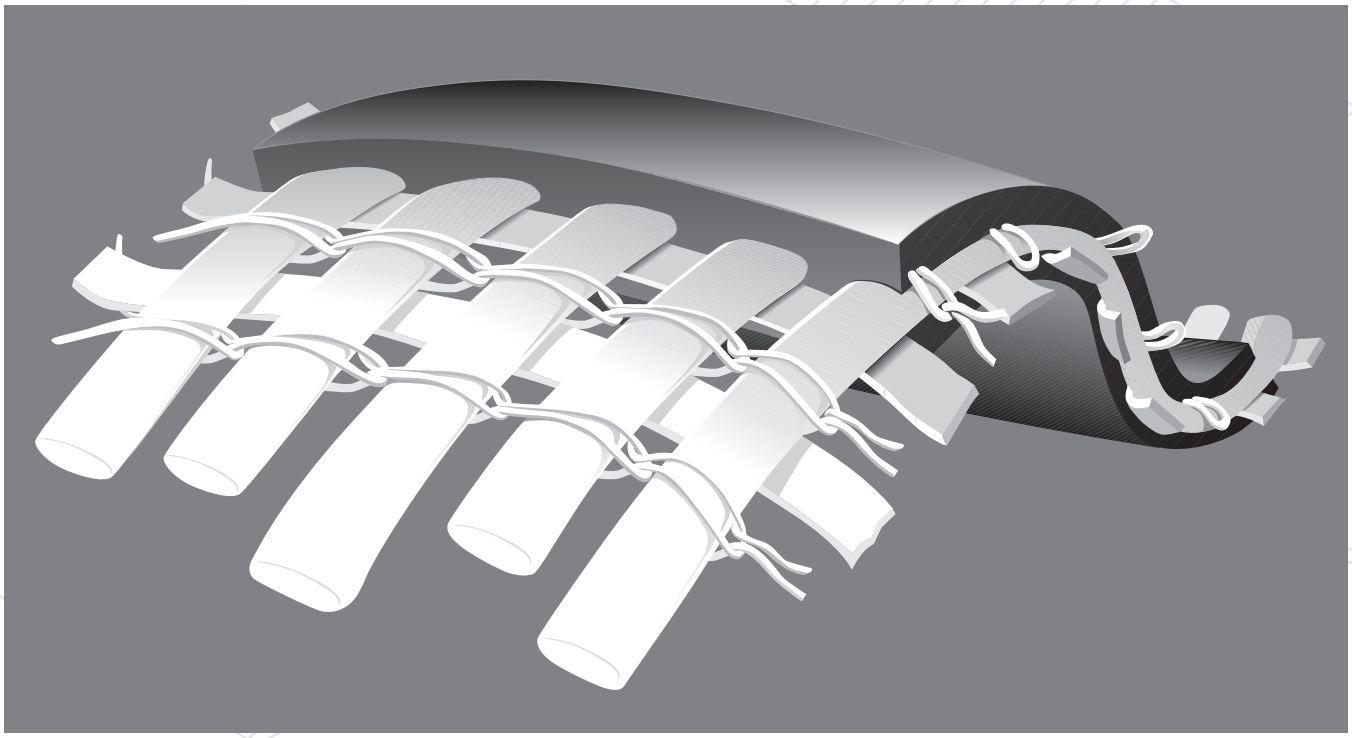
Performance Requirements, Etc:

(State any other requirements, such as rate of permeability required.)

Owner represents the information herein is complete and accurate, and understands and agrees that issuance of Seaman Corporation Warranty for XR products are conditioned upon such completeness and accuracy.

OWNER'S SIGNATURE

Reference Materials:



XR-5®: High Performance Composite Geomembrane

Seaman Corporation
1000 Venture Blvd.
Wooster, Ohio 44691
(330) 262-1111
www.xr-5.com

ATTACHMENT III.1.I
SMOOTH HDPE GEOMEMBRANE

SMOOTH HDPE GEOMEMBRANE
ENGLISH UNITS

Property	Test Method	Minimum Average Values 30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mils	ASTM D 5199					
minimum average		30	40	60	80	100
lowest individual reading		27	36	54	72	90
Sheet Density, g/cc	ASTM D 1505/D 792	0.940	0.940	0.940	0.940	0.940
Tensile Properties[1]	ASTM D 6693					
1. Yield Strength, lb/in		63	84	126	168	210
2. Break Strength, lb/in		114	152	228	304	380
3. Yield Elongation, %		12	12	12	12	12
4. Break Elongation, %		700	700	700	700	700
Tear Resistance, lb	ASTM D 1004	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	54	72	108	144	180
Stress Crack Resistance[2], hrs	ASTM D 5397 (App.)	300	300	300	300	300
Carbon Black Content[3], %	ASTM D 1603	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596			--Note 4--		
Oxidative Induction Time (OIT)						
Standard OIT, minutes	ASTM D 3895	100	100	100	100	100
Oven Aging at 85°C	ASTM D 5721					
High Pressure OIT - % retained after 90 days	ASTM D 5885	60	60	60	60	60
UV Resistance[5]	GRI GM11					
High Pressure OIT[6] - % retained after 1600 hrs	ASTM D 5885	50	50	50	50	50
Seam Properties	ASTM D 6392 (@ 2 in/min)					
1. Shear Strength, lb/in		57	80	120	160	200
2. Peel Strength, lb/in - Hot Wedge		45	60	91	121	151
- Extrusion Fillet		39	52	78	104	130
Roll Dimensions						
1. Width (feet):		23	23	23	23	23
2. Length (feet)		1000	750	500	375	300
3. Area (square feet):		23,000	17,250	11,500	8,625	6,900
4. Gross weight (pounds, approx.)		3,470	3,470	3,470	3,470	3,470

1 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; Break elongation is calculated using a gauge length of 2.0 inches.
2 The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.
3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.
5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice. REV. 11/06

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 PROJECT OBJECTIVES

The Construction Quality Assurance (CQA) Plan has been developed to document the measures that will be used to ensure that the environmental control systems will be constructed in compliance with:

- 19.15.36.17.A, B, and C (1)(2)(3)(4)(5) NMAC – Processing Design and Construction
- 19.15.36.17.D(1) NMAC – Below Grade Tanks
- The approved Permit Plans
- The Permit and any Permit Conditions
- This CQA Plan
- Industry standards and other applicable technical criteria
- The Construction Plans and Technical Specifications for each new Unit.

The sequence of development is prescribed in this Application for Permit. While operations continue in stages, will extend stormwater controls, liner systems, roadways monitoring networks, etc., in advance of need. Much of the infrastructure that is in-place and proven effective at its designated purpose will be maintained, such as the current Processing Area.

The Engineering Design is the core of project plans, as summarized in the Permit Plans. Major and/or sophisticated components (e.g., liners, leak detection, waste processing units) are then detailed on "Construction Plans" that are submitted for OCD review prior to engaging specialized Contractors.

The on-site soils are then strategically teamed with the various geosynthetic tools available to the design engineer for liners, drainage features, etc.

- Geomembranes (typically 60 mil HDPE)
- Geosynthetic Clay-Liners (GCL's)
- Geopipes
- Geotextiles
- Geogrids
- Geonets

This CQA Plan establishes the quantitative criteria that will be used in the field and laboratory to measure the quality of the installed infrastructure including but not limited to evaporation ponds, operational facilities requiring geosynthetic liner containment, and any other geosynthetic liner components as shown in approved construction plans. Specific construction elements that are addressed in this Plan includes:

1. Evaporation pond liner:
   - Inspection and compaction of the subgrade and liner foundation (6-inch)
   - Installation of the secondary containment geomembrane (60-mil smooth HDPE)
   - Installation of the geonet leak detection layer (200-mil geonet)
   - Installation of the primary containment geomembrane (60-mil smooth HDPE)
   - Installation of the leak detection sump and riser system (GCL; 4-inch SDR 11 HDPE riser pipe; 10 oz/yd^2 geotextile; course aggregate)
   - Ancillary installations as needed to complete the above (60-mil single-sided texture HDPE pond surrounds; 60-mill smooth HDPE overspray containment)
2. Process storage tank liner:
   - Inspection and compaction of the subgrade and liner foundation
   - Installation of the containment geomembrane (30-mil smooth reinforced polyester)
   - Installation of basecourse (12-inch)

This CQA Plan is a quality control plan meeting the specifications of, 19.15.36.17.B NMAC, and 19.15.36.17.D(1) NMAC. No revisions to the technical specifications should be allowed without the express approval of the Engineer. The Engineer is a registered professional engineer in New Mexico with applicable experience in soils and geosynthetics design and construction. This Plan may be updated to address changes in materials, technologies, test methods, etc. in consultation with the New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division; and more

specifically revisions will be made to the applicable geosynthetics testing standards as implemented. Additionally, the Oil Conservation Division shall be notified at least 72 hours prior to primary liner installation so the leak detection layer may be inspected.

Table III.2.1 lists the applicable testing required for each construction element. The Table identifies:
- Key property being evaluated
- The appropriate type of test procedure and method
- The sampling strategy and frequency

2.0 PROJECT ORGANIZATION

2.1 Project Organization

The Project Team shall be identified in advance of construction, and each Team member will be assigned specific responsibilities as discussed in this section.

2.2 Authority and Responsibilities

2.2.1 Owner

The Owner has the responsibility for scheduling and administration, which may include, but not be limited to:
- Contractor procurement.
- Some or all of the construction tasks (e.g., mass excavation).
- Assignments of duties of Project Team and orientation of the Project Staff to the needs and requirements of the project.
- Approval of project-specific procedures and internally prepared plans, drawings, and reports.
- Serving as the "Collection point" for Project Staff reporting project documents and activities.
- Point of collection for archived destruction test (DT) samples.

2.2.2 Site CQA Engineer

The Site CQA Engineer shares responsibilities with the Owner/Operator for addressing technical and administrative issues. The Site CQA Engineer must be present at the outset of major undertakings and at critical times during the construction. The Site CQA Engineer's staff shall be on-site continually for construction activities. The Site CQA Engineer will also be on-site, as necessary, to perform the following:
- Periodic review of submittals from the Site CQA Manager.
- Approval of any CQA Plan revisions.
- Administrative functions as necessary to staff and maintain personnel for the CQA activities.
- Periodic review and assessment of the CQA Plan as implemented to determine completeness and compliance.
- Spot-checking of field and laboratory methods and results for accuracy.
- Acceptance and approval of materials and workmanship.
- Compilation and submission of Certification Reports and other project deliverables.
- Design and certification responsibilities mandate that this site CQA Engineer must be a Professional Engineer properly registered in the State of New Mexico; who possesses demonstrated competence and experience in waste containment engineering.

2.2.3 Site CQA Manager

Responsibilties of the Site CQA Manager will include:
- Review moisture-density curves correlated to compaction specifications for the borrow source or in-situ subgrade.
- Review Field Grain Size Analyses of materials to confirm suitability.
- Perform nuclear density testing as necessary for in-place compaction confirmations.
- Conduct verification testing for thickness and placement of materials.
- Perform inspection and documentation of synthetic materials installation.
- Review of documentation from contractors as enumerated in this CQA Plan.

- Review daily CQA activities.
- Notification to appropriate personnel of nonconformance, or changes in CQA procedures.
- Completion of Project CQA audits.
- Scheduling, at regular intervals, CQA meetings with project staff and Subcontractors.
- Reporting, on a regular basis, to the Site CQA Engineer the results of reviews, inspections, and audits.
- Identifying for the Site CQA Engineer project issues, which require his direct involvement.
- Maintaining records of reviews, inspections, audits, and their results.
- Collection of Daily Field Reports from Contractor, which are to be provided no later than 24 hours after each shift has ended.
- Maintenance of calibration records of the instrumentation used on-site in the implementation of this plan.
- Other duties as directed by the Site CQA Engineer.

2.2.4 Contractor

Responsibilities of the Contractor may include:

- Management of daily field operations (labor and equipment allocation), in collaboration with Site CQA Manager.
- Submission of Daily Field Progress Reports to the Site CQA Manager.
- Implementation of tasks relative to this CQA Plan specific to his assigned construction activities per contract.
- Submittal of required as-built drawings and certificates to the Site CQA Manager.
- Submittal of required work plans to the Site CQA Engineer.

Work installed by the Contractor shall be guaranteed for at least two (2) years from date of completion. Materials shall be warranted per manufacturer standards.

The Contractor/Installer must construct this project in a workmanlike manner, in conformance with the plans and specifications. The purpose of the CQA Program is to provide independent confirmation of compliance with the plans and specifications for the Owner's benefit.

2.3 Documentation

1. Data will be gathered or developed in accordance with procedures appropriate for the intended use of the data and will be of significant or greater quality to stand up to scientific and regulatory scrutiny.
2. Data will be of known or acceptable precision, accuracy, representatives, completeness, and comparability within the limits of the project.

The quality of the measurement data can be defined in terms of the following elements:

1. Completeness - the adequacy in quantity of valid measurements to reduce the potential for misinterpretation.
2. Representativeness - the extent to which discrete measurements accurately describe the greater picture of which they are intended to represent. Good representativeness is achieved through careful, informed selection of sampling site.
3. Accuracy and Precision - the agreement between a measurement and the true value and the degree of variability in this agreement, respectively. Accuracy and precision of data collected in the investigation will depend upon the measurement standards used and the competent use of them by qualified personnel.
4. Comparability - the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability among measurements will be achieved through the use of standard procedures and standard field data sheets.
5. Traceability - the extent to which data can be substantiated by hard-copy documentation. Traceability documentation exists in two essential forms: that which links quantitation to

authoritative standards, and that which explicitly describes the history of each sample from collection to analysis.

The fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment and correction, as follows:

1. Prevention of defects in the quality through planning and design, documented instructions and procedures, and careful selection and training of skilled, qualified personnel;
2. Quality assessment through a program of regular audits and inspections to supplement continual informal review;
3. Permanent correction of conditions adverse to quality through a closed-loop corrective action system.

The Site CQA Manager shall maintain current records, on appropriate CQA forms, of quality control operations, inspections and tests performed relative to the work of suppliers and contractors. Below is an index of CQA Forms which are typically used for the Liner CQA program (**Attachment III.2.A**):

Form No.	Title
1.	Liner Quality Control Project Specifications
2.	Approval/Authorization to Proceed Form
3.	Field Observation Report
4.	Field Compaction Testing Form
5.	GCL Inventory Control Log
6.	FML Inventory Control Log
7.	Geonet Inventory Control Log
8.	Geotextile Inventory Control Log
9.	Leak Detection and Extraction Pipe Inventory Control Log
10.	FML Trial Seaming Test Log
11.	FML Seaming Log
12.	FML Seam Pressure Test Log
13.	FML Destructive Field Test Record
14.	FML Seam Vacuum Test/Repair Log
15.	GCL Deployment Log
16.	FML Deployment Log
17.	Geonet Deployment Log
18.	Geotextile Deployment Log

Photographs will also be used to document the progress and acceptability of the work and may be incorporated into the Daily Summary Report; if photographic documentation is used, each photo shall be identified with the following information:

- Date
- Time of Day
- Location/Orientation

Originals of the photographs will be retained electronically at the offices of the Site CQA Engineer. Select photographs will be submitted with Engineering Certification Reports as applicable.

3.0 CONSTRUCTION QUALITY ASSURANCE OBJECTIVES

3.1 Allowable Variations

It is the objective of this CQA Plan that test results must meet the applicable specified values in compliance with 19.15.36.17.A and B NMAC. Should a test result not achieve the specified value for a material, it must be replaced or repaired; or for operation, the operation must be repeated until it is acceptable. However, as stated by Daniel and Koerner, *"it is unrealistic to think that 100 percent of all CQA tests will be in compliance with specifications."* Variations due to isolated anomalies in material, sample disturbance, human testing errors, or other factors may result in failing tests, yet these tests are not indicative of the general quality of the construction. For this reason, the Site CQA Engineer may accept a small percentage of outliers. The total number of outliers will not exceed 1% of the sample lot size.

4.0 SITE PREPARATION

4.1 General

The following is a list of the work to be included in site preparation by the Contractor:

1. Field check utilities and groundwater monitoring well locations, as appropriate.
2. Mark survey hub markers and permanent benchmarks.
3. Strip topsoil and any other material deemed unsuitable by the Engineer, or his representative, and stockpile at designated location.
4. Strip or remove brush, and non-mowable vegetation, surface debris and similar materials from existing surface and relocate to a designated area on the site. Stumps, logs, roots, etc. will be completely removed.
5. Excavate to design grade at the direction of the Site CQA Manager.
6. The existing surfaces will be proof rolled to check stability conditions of existing surface and to provide a trafficable, reasonably smooth, working surface for construction equipment.
7. Contractor will be responsible for costs associated with repairing and/or replacement of the ground surface utilities, and appurtenant facilities damaged by the Contractor, to the satisfaction of the Owner. Any damage resulting from unauthorized intrusion upon or use of off-site areas will be completely and immediately repaired, solely at the expense of the Contractor.

The following is a list of requirements related to site grading:

1. Relocate exposed debris outside the limits of the construction area to locations as directed by Owner.
2. Remove and dispose of coarse vegetation. Vegetation removal will be accomplished in such a manner as to minimize the amount of bare soil exposed at any given time.
    a. Stripped vegetation may be stockpiled temporarily at the site, provided that it is stockpiled in a manner, which prevents movement of the material off-site due to wind, water, or other factors.
    b. Residual vegetative matter, such as stumps, will be transported to the designated on-site area or removed off-site by the Contractor under authorization by the Owner.

4.2 Survey Coordinate System

The site will be surveyed and integrated into a grid system so that locations of sample and testing points made during construction can be readily discernible by the CQA personnel. This grid system should consist of equidistant spaced parallel lines, 100-feet (ft) on center, projecting north to south and east to west within the limits of the site. In addition, permanent project benchmarks will be placed by the Owner or his representative in the vicinity of the site for correlation of lift thickness, site liner construction, etc. This grid system will be coincident with the existing and former site coordinate system for future reference. The project limits will be staked out by the Owner or his representative based on record drawings.

4.3 Subgrade Development

Subgrade development will be required prior to evaporation pond, process equipment, run-off retention pond, and other containment liner construction. The existing topography will be contoured to the subgrade elevations shown on the drawings identified by the Site CQA Manager. The subgrade will be constructed, prepared and protected in accordance with the procedures stated below.

4.3.1 Subgrade Preparation

1. Establish required lines, levels and contours. Use survey control model and/or place grade stakes as required by Contractor's methods at a minimum 100-feet on center.
2. Before grading commences, adjust monitoring wells and piezometer heights in the area to be graded in accordance with details shown on the drawings if applicable. Such adjustments will be made under direct surveillance of the Site CQA Manager. Any wells adjusted without the Site CQA Manager being present will be re-established at the Contractor's expense.
3. No subgrading will begin in a given area prior to approval of the area by the Site CQA Manager.

4.3.2 Excavating to Subgrade Elevation

1. Excavated material will be placed on-site as directed by Owner.
2. Adequate grade control during subgrade preparation/construction is imperative. Should insufficient grade control during this phase occur, the Site CQA Manager may stop work until the situation has been rectified.

4.3.3 Filling to Subgrade Elevation and Berm Construction

1. Engineer will collect samples of proposed in-situ or borrow fill material in advance of construction for determination of soil characteristics (e.g. Standard Proctor)
2. Materials will be obtained from designated in-situ areas, borrow sources, or stockpiles.
3. No fill will be used for subgrade or berm construction without approval of the Site CQA Manager.
4. Place fill material to the required elevations as shown on the drawings.
5. Place suitable fine-grained subgrade soils in 9-inch thick loose lifts, 6-inch thick compacted finshed lifts and compact to 90-percent of the maximum dry density unless otherwise specified, as determined by the Standard Proctor Compaction Test (ASTM D698).
6. Place berm material in maximum 12-inch thick loose lifts, 9-inch thick compacted finished horizontal lifts over the prepared surface. Compact to not less than 90-percent of the maximum dry density unless otherwise specified, as determined by the Standard Proctor Compaction Test (ASTM D698).
7. The surface of each lift will be scarified prior to placing the next lift, if applicable.
8. The moisture content of fill material will be adjusted in the stockpile, borrow area, and/or other approved areas to maintain uniform moisture content of fill. Uniform moisture distribution will be obtained by mixing with disc, harrow, and pulverizers or by otherwise manipulating the soil prior to compaction.
9. The final surface of subgrade and berms will be rolled smooth, free of protrusions and will contain no lumps, angular materials or large rocks. Roll the exposed surface transverse to slopes.

4.4 Final Subgrade Inspection and Protection

The final subgrade lift will conform to the following specifications:

1. The upper 6-inches shall be comprised of suitable fine-grained soils and compacted to a minimum 90-percent of the maximum dry density unless otherwise specified, as determined by the Standard Proctor Test (ASTM D698)
2. The surface of the final lift of subgrade will be free of angular material or stones greater than one-half inch in diameter.
3. The final lift will be wetted and smooth rolled. Abrupt changes of grade will be regraded.
4. Completed subgrade will be protected from traffic, erosion and damage of any kind.
5. Completed subgrade will be kept free of trash and debris.

6. Prior to placement of liner system, any areas of subgrade damaged by traffic, erosion, settlement, or another cause, will be repaired and the grades shown on the drawings will be re-established. Exposed subgrade, which has significantly dried or exhibits desiccation will be wetted and compacted prior to fill placement. Disturbed areas will be reshaped, scarified, recompacted and rolled prior to further work.
7. The condition of the subgrade will be approved by the Site CQA Manager prior to placement of any additional layers or liner system materials immediately in advance of installation.

4.5 Subgrade and Berm Testing

The following tests will be performed during construction:

1. One field compaction test will be performed at a frequency of a minimum 4 tests per acre per 6-in lift for confirmation of density of the subgrade soils and 12-in for confirmation of density of soils used in berm construction.
2. The subgrade will be required to meet an elevation tolerance of 0.20 ft±; and the sidewalls a vertical tolerance of 0.50 ft± based on a regular grid established by site survey.

5.0 ANCHOR TRENCH

1. Anchor trenchs shall be constructed as shown on the construction drawings and as specified in the CQA Plan. The anchor trench shall be backfilled and compacted by the Contractor as approved by the Site CQA Manager. Trench backfill material shall be placed and compacted by rolling with a rubber-tired wheel or mechanical tampers. Approval of compaction equipment shall be obtained from the Site CQA Manager before any compaction begins.
2. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. At no time shall construction equipment make direct contact with geosynthetic materials.
3. Anchor trench backfill shall be compacted to 90% Standard Proctor Dry Density.

6.0 GEOSYNTHETIC CLAY LINER (GCL)

6.1 GCL Properties

1. Reinforced GCL shall be installed directly in contact with the evaporation pond leak detection sump subgrade material or as otherwise specified in the construction drawings. GCL shall comply with the requirements listed in **Table III.2.2** or approved by Engineer as equivalent.
2. The primary component in the GCL is high-quality sodium bentonite (montmorillonite). The bentonite used in the manufacture of the GCL must be demonstrated to meet the testing and acceptance criteria listed in **Table III.2**. The testing shall be performed on the bentonite obtained from the finished GCL product.
3. Bentonite Sealing Compound (BSC) and Granular Bentonite (GB) shall be applied to ensure tightness at penetrations and structures. The BSC and GB shall be supplied by the manufacturer and shall be comprised of the same bentonite used in the manufacturing of the GCL. The BSC shall be a mixture of non-aqueous liquid suspension agent, which creates a paste-like texture. The suspension agents used in the manufacture of the BSC shall be non-toxic, water- soluble and shall not restrict the bentonite's ability to swell and absorb water upon hydration.
4. Longitudinal seams can also be sealed using the Winning Edge™ which eliminates the need for free bentonite on those seams.

6.2 Delivery, Storage and Handling

1. The GCL rolls shall be packaged and shipped by appropriate means to prevent damage of the geomembrane rolls. Off-loading and storage of the GCL is the responsibility of the Contractor/Installer. The Contractor shall be responsible for replacing any damaged or unacceptable material discovered upon arrival at no cost to the Owner.
2. The GCL storage area will be designated by the Site CQA Manager/Owner. No off-loading shall be performed unless the Site CQA Manager is present. Damage during off-loading shall be documented by the Site CQA Manager. Any damaged rolls must be separated from the

undamaged rolls until the proper disposition of that material has been determined by the Site CQA Manager.

3. A steel support pipe shall be inserted through the roll core. Slings or lifting chains shall be attached at the ends of the support pipe to the bucket of a front-end loader or lifting device. A spreader bar, which is used to support the pipe, must be long enough to prevent damage to the edges of the GCL during hoisting.
4. The rolls of GCL shall be stored in their original, unopened, wrapped cover in a clean, dry area, stacked no higher than three rolls high. The material shall be stored off the ground on pallets and shall be covered with a heavy, protective tarpaulin or enclosed within a storage facility. Care shall be used to keep the bentonite clean and free from debris prior to installation.
5. The installer shall be responsible for the transportation of each roll of GCL from the storage area to its proposed panel location. The contractor shall not drive upon the GCL panels with equipment exceeding 6 psi and shall be responsible for replacing any material damaged during installation until the GCL is accepted by the Site CQA Manager/Owner.

6.3 Manufacturer Quality Control Documentation

Prior to installation commencement of any GCL material, the Contractor shall provide the following information to the Site CQA Manager, certified by the manufacturer for the delivered GCL.

1. Manufacturer's certification verifying that the quality of the raw materials used to manufacture the GCL meets the Manufacturer specifications.
2. Each roll delivered to the project site shall have the following identification information:
   - Manufacturer's name
   - Product identification
   - Roll number
   - Roll dimensions
3. Quality control certificates signed by the manufacturer's quality assurance manager. Each certificate shall have roll identification number, sampling procedures, frequency and test results. At a minimum, the following results shall be provided in accordance with test requirements specified in **Table III.2.2:**
   - Free swell (ASTM D5890)
   - Fluid loss (ASTM D5891)
   - Bentonite mass/unit area (ASTM D5993)
   - Grab strength (ASTM D4632)
   - Permeability (ASTM D5887)

6.4 Conformance Testing

6.4.1 Conformance Testing – Sampling at Manufacturer's Plant

The Owner, Manufacturer and/or independent Quality Assurance Laboratory (QAL) will determine the suitability of either sampling at the Manufacturer's production plant or sampling at the delivered on-site location. Should the parties agree that the independent QAL will collect test samples from the Manufacturer's plant, the following sampling and testing criteria apply:

1. Conformance testing shall be performed by an independent Quality Assurance Laboratory (QAL) approved by the Site CQA Engineer at a minimum frequency of one (1) test per 100,000 ft^2. The sampling frequency may be increased as deemed necessary by the Site CQA Engineer. A representative of the designated QAL shall take samples at the manufacturer's plant location; across the entire roll width and shall not include the first three (3) feet. The following conformance tests shall be conducted at the QAL:
   - Mass per Unit Area (ASTM D 5993)
   - Free Swell (ASTM D 5890)
   - Fluid Loss (ASTM D 5891)
   - Hydraulic Conductivity (ASTM D 5887)
2. These conformance test shall be performed in accordance with test requirements specified in **Table III.2.2**.

3. All conformance tests shall be reviewed by the Site CQA Engineer and accepted or rejected, prior to the deployment of the GCL. All tests results shall meet, or exceed, the property values listed in **Table III.2**. In case of failing test results for any individual lot sample, the lot shall be resampled and retested. This retesting shall be at the expense of the Installer or Manufacturer. If all test values from the resamples pass the acceptable certified values listed in **Table III.2.2**.

6.4.2 Conformance Testing – Sampling On-site

The Owner, Manufacturer and/or independent Quality Assurance Laboratory (QAL) will determine the suitability of either sampling at the Manufacturer's production plant or sampling at the delivered on-site location. Should the parties agree that the independent QAL will collect test samples from delivered products, i.e., on-site sampling, the following sampling and testing criteria apply:

1. The Site CQA Manager will group the documentation of the delivered rolls into the Manufacturer's listed lot numbers. The Site CQA Manager may, at his/her discretion, subdivide the Manufacturer's listed lots into smaller lots for purposes of conformance testing.
2. Based on the requirements outlined in ASTM D4354, the Site CQA Manager will determine the number of sampling units within each lot; or at a minimum, one (1) test per one hundred thousand (100,000) square feet (ft^2) of GCL material delivered to the site.
3. The Site CQA Manager shall cut or observe the sampling (i.e. if Contractor is responsible for conformance samples) from randomly selected rolls which have been delivered to the site. Sampling Units shall be one (1) ft wide by roll width, which shall be used for field and Engineer approved Quality Assurance Laboratory (QAL) testing as described below. A measuring device and straight edge shall be used to ensure uniformity of length and width. Mass per unit area, free swell and fluid loss testing shall be performed on delivered rolls by an approved laboratory. The method used for determining specification conformance shall be in accordance with ASTM D4759.
    a. The entire sample unit will be loosely rolled, and the width of each sample shall also be measured and recorded.
    b. The sample shall then be unrolled and spread out on a clean, dry area at the site. The Site CQA Manager (or Contractor) shall randomly cut five (5) twelve (12)-inch by six (6)-inch specimens from varying places across the sample. Each specimen will be immediately packaged up in a "zip-lock" bag marked with the project name, roll number, lot number, and specimen number.
    c. The five specimens shall be sent to an independent QAL for mass per unit area, free swell (bentonite content) and fluid loss testing (ASTM D5993, ASTM D5890 and ASTM D5891, respectively).
        1) The average of the mass per unit area, free swell and fluid loss of the five specimens will be provided by the independent QAL in accordance with ASTM D4643.
        2) If any two samples from a given lot being tested for free swell falls below the specified values, the entire lot shall be rejected.
        3) If any one of the samples from a given lot being tested for free swell falls below the specified values, an additional set of samples shall be taken from the lot (the number of samples taken for the second set shall be equal to that taken from the first set). If any one of the samples from the second set fails to meet the specified criteria, the entire lot shall be rejected.
4. Conformance test results shall be reviewed by the Site CQA Manager and Site CQA Engineer. All lots shall be accepted or rejected, prior to the final placement of the GCL. All test results shall meet, or exceed, the certified values listed in **Table III.2**. In case of failing test results for any given lot sample, the lot shall be resampled and retested. This retesting shall be paid for by the Manufacturer. If all of the test values from the resamples pass the acceptable specification values listed in **Table III.2.2**, then the lot shall be accepted.

6.5 GCL Placement

1. As each roll is moved from the storage area by the Installer, the labels shall be removed by the installer and submitted to the Site CQA Manager. The rolls of GCL shall be brought to the area to be lined with a front-end loader and support pipes set up such that the GCL roll is fully supported across its length. A spreader bar or similar device shall be used to prevent the lifting chains or slings from damaging the edges. Dragging of the GCL panels over the surface shall be minimized. Travel on the GCL is permissible if low-ground pressure equipment (6 psi or less) is used. The Site CQA Manager shall be informed as to the equipment to be used and shall approve same.
2. The flexible membrane liner shall be placed over the GCL during the same day as the placement of the GCL. Only those GCL panels which can be anchored and covered the same day shall be placed in position.
3. The GCL shall not be installed in standing water or during rain. The GCL must be dry when installed and must be dry when covered.
4. In areas where wind is prevalent, GCL installation should be started at the upwind side of the project and proceed downwind. The leading edge of the GCL shall be secured at times with sandbags or other means sufficient, and approved by the Site CQA Manager, to secure it down during high winds.
5. The GCL shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. Stretching of the GCL to fit will not be allowed. The GCL shall be straightened to smooth out creases or irregularities in the runs.

6.6 Field Seams

1. Longitudinal seams shall be a minimum of 9 inches overlap on the cell floor (up to 10% slope); and 12 inches overlap for sideslopes (>10%).
2. Soil, gravel, or other debris shall be removed from the overlap area.
3. Seam overlap shall be placed such that the direction of flow is from the top sheet to the bottom sheet to form a shingle effect.
4. On slopes, runs shall be from crest to toe with the GCL machine direction running perpendicular to the base. On slopes greater than or equal to 20%, the number of seams will be minimized, and end seam overlap will be increased to a minimum of 36 inches overlap.
5. If the temperatures are higher than 85°F and humidity is low, contraction may occur soon after placement when no confining stress or soil cover is placed. In order to account for the possibility of contraction under these conditions, the seam overlap shall be increased to a minimum of twelve inches on longitudinal seams and 36 inches on end seams, or 4% of the distance to the next parallel seam, whichever is greater. Free bentonite shall be used to seal seam. Free bentonite is not necessary on longitudinal seams if the Winning Edge™ seam is used.
6. Once the first run has been laid, adjoining runs shall be laid with 9-inch minimum overlap or use of the Winning Edge™, on the longitudinal seams and 12 inches on end seams.

6.7 Field Quality Control

1. The Installer shall provide the Site CQA Manager with daily reports addressing the following:
   a. subgrade approval for areas expected to be covered by GCL
   b. the total amount and location of panels placed
   c. total amount and location of seams completed
   d. location of repairs
   e. weather conditions
2. The Installer's Superintendent and the Site CQA Manager shall provide 100% inspection of the installation to ensure compliance with the construction drawings, technical specifications, and manufacturer recommended procedures.
   a. The surface of the GCL shall be clean and free of debris at the time of inspection.
   b. The Installer and the Site CQA Manager shall record each roll number and lot number as panels are deployed and a general description of the location of each panel.

c. The Installer and the Site CQA Manager shall inspect the overlap for each panel.
d. The Installer and the Site CQA Manager shall inspect the anchoring and sealing around penetrations and structures.
e. The Installer and the Site CQA Manager shall inspect the geotextile quality, bentonite uniformity, and degree of hydration on the GCL. Areas requiring repair shall be marked and subsequently repaired in accordance with the Repair Procedures listed in this CQA Plan.
f. The Installer and the Site CQA Manager shall re-inspect areas previously marked as requiring repair.

6.8 Repair Procedures

1. Seam and non-seam areas of the GCL shall be inspected for identification of defects, holes, and any sign of contamination by foreign matter in accordance with the Field Quality Control procedures listed in this CQA Plan.
2. Any defects shall be repaired by the Installer, by placing a GCL patch with a minimum 12-inch overlap in all directions.
3. Horizontal patch seams shall be secured with adhesive glue as approved by the Site CQA Manager and manufacturer's recommendations.
4. Patches and repairs shall not be allowed on slopes greater than 5H:1V, unless they are securely anchored with an adhesive or other approved method. Alternatively, the patches can be placed under the defective liner in order to prevent slippage of the patch.
5. For any repair method, surfaces shall be clean and dry at the time of the repair.
6. Each completed repair shall be inspected in accordance with the Field Quality Control procedures listed in this CQA Plan.

6.9 GCL Acceptance

1. The GCL shall be accepted by the Site CQA Manager when the installation is complete, and documentation of installation is completed and verification of the adequacy of field seams and repairs, are complete.
2. Approval of any subsequent post-liner construction, as well as payment requests of the same, will not be granted until required documentation is provided by the Installer and approved by the Site CQA Officer.

7.0 FLEXIBLE GEOMEMBRANE LINER (FML)

1. The flexible membrane (FML) used for the evaporation ponds liner installation shall be smooth 60-mil HDPE for secondary containment and overspray containment; smooth 60-mil HDPE for primary containment; and single-sided textured 60-mil HDPE for pond separation berm caps and pond surrounds. FML used for operational facilities liner installation, i.e., process storage tanks, shall be reinforced 30-mil polyester. FML used for run-off retention pond liner installations shall be smooth 60-mil HDPE. Additional liner systems shall be as specified or shown on approved drawings.
2. The geomembrane shall be manufactured of new, prime first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures and chemically resistant to leachate.
3. The geomembrane material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
4. The sheets shall be manufactured in a minimum 15-foot seamless width. Labels on the roll shall identify the thickness, length, width and manufacturer's lot number.
5. The geomembrane rolls shall meet the minimum properties listed in **Table III.2.3** for single-sided and double sided textured 60-mil HDPE liner, **Table III.2.4** for 60-mil HDPE liner**,** and **Table III.2.5** for reinforced 30-mil polyester liner.
6. Extrudate welding rods shall be of the same compound as the geomembrane and supplied by the manufacturer and shall be delivered in the original sealed containers. Each container shall

have a label bearing the brand name, manufacturer's lot number and complete directions as to proper storage.

7.1 Manufacturer Quality Control Documentation

Prior to installation commencement of any geomembrane material, the Contractor shall provide to the Site CQA Manager the following information certified by the manufacturer for the delivered geomembrane.

1. Origin, identification and production of the resin (supplier's name, brand name and production plant).
2. Copies of quality control certificates issued by the resin supplier.
3. Manufacturer's certification verifying that the quality of the resin used to manufacture the geomembrane meets the resin specifications fingerprint properties shown in **Table III.2.3** for single-sided and double-sided textured 60-mil HDPE liner, **Tables III.2.4** for 60-mil HDPE liner, and **Table III.2.5** for the reinforced 30-mil polyester liner.
4. Each roll delivered to the project site shall have the following identification information:
   - Manufacturer's name
   - Product identification
   - Thickness
   - Roll number
   - Roll dimensions
5. Quality control certificates, signed by the manufacturer's quality assurance manager. Each certificate shall have roll identification number, sampling procedures, frequency, and test results. At a minimum, the following test results shall be provided in accordance with applicable test requirements specified in **Tables III.2.3** and **III.2.4** for the HDPE liner:
   - Thickness (smooth, ASTM D 5199; textured, ASTM D5994)
   - Density (ASTM D1505)
   - Tensile properties (ASTM D 6693 Type IV)
   - Tear properties (ASTM D 1004)
   - Carbon black content (ASTM D 4218)
   - Carbon black dispersion (ASTM D 5596)
   - Puncture Resistance (ASTM D 4833)
   - Notched constant tensile load (ASTM D 5397, Appendix)
   - Interface Friction Angle (Textured Geomembrane) [GRI - GS -7]
6. Quality control certificates, signed by the manufacturer's quality assurance manager. Each certificate shall have roll identification number, sampling procedures, frequency, and test results. At a minimum, the following test results shall be provided in accordance with applicable test requirements specified in **Table III.2.5** for the reinforced polyester liner:
   - Thickness (ASTM D751, Optical Method)
   - Weight (ASTM D751)
   - Break strength (ASTM D751 Grab Tensile Method, Procedure A)
   - Break elongation (ASTM D751)
   - Tear strength (ASTM D751)
   - Puncture Resistance (ASTM D4833)
   - Hydrostatic resistance (ASTM D751, Procedure A)
   - Bursting strength (ASTM D751, Ball Tip)

7.2 Conformance Testing

7.2.1 Conformance Testing – Sampling at Manufacturer's Plant

The Owner, Engineer, Manufacturer and/or independent Quality Assurance Laboratory (QAL) will determine the suitability of either sampling at the Manufacturer's production plant or sampling at the delivered on-site location. Should the parties agree that the independent QAL will collect test samples from the Manufacturer's plant, the following sampling and testing criteria apply:

1. Conformance testing shall be performed by an independent Quality Assurance Laboratory (QCL) approved by the Site CQA Engineer at a minimum frequency of one (1) test per 100,000 ft^2. The sampling frequency may be increased as deemed necessary by the Site CQA Engineer. A representative of the designated QAL shall take samples at the manufacturer's plant location; across the entire roll width and shall not include the first three (3) feet. The following conformance tests shall be conducted at the QAL:
   - Thickness (ASTM D 5199)
   - Density (ASTM D 1505/0792)
   - Tensile properties (ASTM D 6693)
   - Tear resistance (ASTM D 1004)
   - Carbon black content (ASTM D 4218)
   - Carbon black dispersion (ASTM D 5996)
   - Puncture resistance (ASTM D 4833)
2. These conformance test shall be performed in accordance with test requirements specified in **Tables III.2.4** and **III.2.5**.
3. All conformance tests shall be reviewed by the Site CQA Engineer and accepted or rejected, prior to the deployment of the HDPE FML. All tests results shall meet, or exceed, the property values listed in **Tables III.2.4** and **III.2.5**. In case of failing test results for any individual lot sample, the lot shall be resampled and retested. This retesting shall be at the expense of the Installer or Manufacturer. If all test values from the resamples pass the acceptable certified values listed in **Tables III.2.4** and **III.2.5**.

7.2.2 Conformance Testing – Sampling On-site

The Owner, Manufacturer and/or independent Quality Assurance Laboratory (QAL) will determine the suitability of either sampling at the Manufacturer's production plant or sampling at the delivered on-site location. Should the parties agree that the independent QAL will collect test samples from delivered products, i.e., on-site sampling, the following sampling and testing criteria apply:

1. Conformance testing shall be performed by an independent Quality Assurance Laboratory (QAL) [previously approved by the Site CQA Engineer] at a minimum of one (1) per one hundred thousand (100,000) ft^2 of each type of HDPE FML material delivered to the site; or one (1) sample per lot, whichever results in the greater number of conformance tests. As stated in the Project Technical Specifications, the Site CQA Manager or Installer shall obtain the samples from the HDPE FML roll, mark the machine direction, lot number and roll number. The minimum number of conformance samples shall meet the requirements outlined in ASTM D 4354. The following conformance tests shall be conducted at the QAL:
   - Thickness (ASTM D 5199)
   - Density (ASTM D 1505/0792)
   - Tensile properties (ASTM D 6693)
   - Tear resistance (ASTM D 1004)
   - Carbon black content (ASTM D 4218)
   - Carbon black dispersion (ASTM D 5596)
   - Puncture resistance (ASTM D 4833)
2. These conformance tests shall be performed in accordance with **Tables III.2.4,** and **III.2.5**.
3. All conformance test results shall be reviewed by the Site CQA Manager and Site CQA Engineer; and all lots shall be accepted or rejected, prior to the placement of the HDPE FML. All test results shall meet, or exceed, the property values listed in **Tables III.2.4 ,** and **III.2.5**). In case of failing test results for any individual lot sample, the lot shall be resampled and retested. This retesting shall be at the expense of the Installer or the Manufacturer. If all of the test values from the resamples pass the acceptable certified values listed in **Tables III.2.4,** and **III.2.5,** the lot shall be accepted.

7.3 Delivery, Storage and Handling

1. The geomembrane rolls shall be packaged and shipped by appropriate means to prevent damage of the geomembrane rolls. Off-loading and storage of the geomembrane is the responsibility of the Installer. The Installer shall be responsible for replacing any damaged or unacceptable material at no cost to the Owner.
2. No off-loading shall be performed unless the Site CQA Manager is present. Damage during off-loading shall be documented by the Site CQA Manager. Damaged rolls must be separated from the undamaged rolls until the proper disposition of that material has been determined collectively by the installer and Site CQA Manager.
3. The geomembrane rolls shall be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions and excessive heat that may damage the geomembrane material. The rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two rolls high.

7.4 Guarantee

1. The Contractor shall guarantee the HDPE and reinforced polyester geomembrane against defects in installation and workmanship for the period of two years commencing with the date of final acceptance by the Owner. The guarantee shall include the services of qualified service technicians and materials required for the repairs at no expense to the Owner.

7.5 Quality Assurance

1. In addition to manufacturer and installer requirements for qualifications and certification specified in submittals, the Quality Assurance consists of conformance testing of the material delivered to the site and field quality control during installation.
2. Conformance testing requirements are listed in this CQA Plan. The purpose of conformance testing is to assure that the supplied material conforms to the specifications and to the manufacturer's quality control certificates.
3. Field quality control requirements are specified in this CQA Plan. The purpose of field quality control procedures is to assure that the geomembrane has been installed in accordance with the specifications and manufacturer's recommendations.
4. Quality control forms for geomembrane installation documentation are used for field installation documentation. Sample project forms are listed below:
   - Liner Quality Control Project Specifications
   - Approval/Authorization to Proceed Form
   - Field Observation Report
   - FML Inventory Control Log
   - FML Trial Seaming Test Log
   - FML Seaming Log
   - FML Seam Pressure Test Log
   - FML Destructive Field Test Record
   - FML Seam Vacuum Test/Repair Log
   - FML Deployment Log

Photo-documentation will be also used to record the cell construction. Select photographs shall include date, time, location, and Site CQA Manager; and shall be included in the Liner Certification Report submitted to OCD.

7.6 Geomembrane Placement

1. Weather Conditions
   Geomembrane placement shall not proceed at an ambient temperature below 40 degrees F or above 104 degrees F unless otherwise authorized, in writing, by the Site CQA Manager. Geomembrane placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or excessive winds. Observation of temperature, humidity,

precipitation, and wind shall be noted on CQA forms to ensure that weather conditions are acceptable prior to geomembrane placement.

2. Method of Placement
   a. No more material than can be seamed on that same day shall be deployed.
   b. Each panel of the geomembrane shall be rolled out and installed in accordance with the approved construction drawings. The layout shall be designed to keep field joining of the HDPE geomembrane to a minimum and consistent with proper methods of HDPE geomembrane installation, seaming, etc.
   c. Geomembrane rolls shall be placed using proper spreader and rolling bars with cloth slings.
   d. The Site CQA Manager shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, as approved by the Site CQA Manager.
   e. The installer shall avoid dragging the geomembrane sheets on rough soil subgrades.
   f. Geomembranes shall be anchored as shown on the construction drawings and consistent with manufacturer's recommendations.
   g. Personnel working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in any activity that may damage the geomembrane.
   h. Vehicular traffic across the geomembrane shall not be allowed on the liner material.
   i. Damage shall be recorded and located on the as-built drawings.
   j. When tying into existing geomembrane, final excavation to previously installed liner segments shall be performed by hand to prevent damage. Damaged sections of previously installed liner at the boundary zone shall be removed and replaced. New liner segments shall be seamed only to competent segments of previously installed liner as approved by the Site CQA Manager.
   k. The geomembrane shall be kept free of debris, unnecessary tools and materials. In general, the geomembrane area shall remain neat in appearance.
   l. The method used to unroll the panels shall neither score, scratch or crimp the geomembrane, nor damage the underlying liner system components or subgrade.
   m. Adequate loading (e.g., sand bags or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind. In cases of high wind, continuous loading is recommended along edges of panels to minimize wind flow under the panels.
   n. Direct contact with the geomembrane shall be minimized; i.e., the geomembrane under traffic areas shall be protected by geotextile, extra geomembrane, or other suitable materials.
   o. Sufficient slack shall be placed in the geomembrane to compensate for the coldest temperatures envisioned so that no tensile stresses are generated in the geomembrane or in its seams either during installation or subsequently after the geomembrane is covered.
   p. The geomembrane shall have adequate slack such that it does not lift up off of the subgrade or substrate material at any location within the facility, i.e., no "trampolining" of the geomembrane shall be allowed to occur at any time.
   q. The geomembrane shall not have excessive slack to the point where creases fold over upon themselves either during placement and seaming, or when the protective soil or drainage materials are placed on the geomembrane.
   r. Permanent (fold over type) creases in the covered geomembrane shall not be permitted. Creases shall be repaired in accordance with this CQA Plan and manufacturer’s recommendations.
   s. The amount of slack to be added to the deployed and seamed geomembrane should be carefully considered and calculated, taking into account the type of geomembrane and the geomembrane's temperature during installation versus its final temperature in the completed facility.
3. Field Seams
   a. Individual panels of geomembrane shall be laid out and overlapped by a minimum of 4 inches (or three inches for extrusion fillet welding) but no more than 6 inches prior to welding. The area to be welded shall be cleaned and prepared in accordance with the quality control

welding procedures.

b. If the overlap is too wide to contain the hot wedge welding machine, "float" the liner into better position by lifting it high enough to draw air beneath it, guiding it upon the air to an improved position. Avoid dragging the liner, particularly across rough soil subgrades.
c. If overlap between the placed liners is excessive, the excess must be trimmed away. This should be done by trimming the lower sheet. If this is not possible and the upper sheet must be trimmed, use a knife with a shielded or hook blade.
d. Cutting and preparation of odd-shaped sections or small fitted pieces should be completed at least 50 feet ahead of the seaming operation, so that seaming may be conducted with the fewest interruptions.
e. Liner panel overlaps shall be shingled so the upper panel is hydraulically upgradient of lower panel.
f. Sheets which are overlapped and ready for seaming must be clean. If dirty, they must be wiped clean with dry rags.
g. The seam area must be completely free of moisture before the overlapping sheets can be properly seamed. Dry rags should be used to wipe any such moisture up from the seam surface. Air blowers may also be used.
h. Seaming is not to be performed when the soil surface beneath the liners is saturated, because the hot seaming apparatus will draw moisture into the ongoing seam. Seaming activity on frozen soil is unacceptable for the same reason.
i. Double track hot wedge fusion welder shall be used for straight welds.
j. Extrusion welder shall be used for cross seam tees, patches and repairs and penetration boots.
k. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the geomembrane material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.
l. No “fish mouths” will be allowed within the seam area. Where “fish mouths” occur, the material shall be cut, overlapped and a patch fusion weld shall be applied. Welds upon completion of the work shall be tightly bonded. Any geomembrane area showing damage due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The number of patches per 100-foot length shall not exceed five. If more than five patches per 100-foot length are necessary, then the entire 100-foot length of seam shall be removed. Further welding will cease at this time and the Site CQA Manager shall be notified.
m. Seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the as-built drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be welded together.
n. Fusion welded “T” seams (i.e., the result of the geomembrane panels placed perpendicular to each other) shall be double welded where possible. Extrusion welding shall be used for the second weld.
o. Extrudate shall be free of debris, dry and protected from damage.
p. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat-degraded extrudate. Purged extrudate shall be placed on a sacrificial sheet and disposed of.
q. No horizontal seams shall be constructed on slopes greater than or equal to 5H:1V and no horizontal seams shall be located within 5 feet of the sideslope toe.
r. Vertical panels placed on sloped surfaces shall extend 10 feet inward from the toe of slope and 3 feet from the edge of the trench.
s. In the anchor trench, seams shall extend a minimum 12 inches.
t. Factory seams, field seams and repair welds shall meet seam strength requirements specified in **Tables III.2.3, III.2.4,** and **III.2.5.**
u. For geomembrane installation in geometrically unique areas, the number of field seams shall be minimized.

v. No solvent or adhesive may be used unless the product is approved by the Site CQA Officer.

7.7 Hot Wedge Fusion Welding

The objective of hot wedge seaming is to heat two facing liner surfaces to their melting point before forcing them together and creating a permanent bond. The wedge is situated between the overlap of the two liners; it reduces the surface tension of the viscous polymer sheets and acts as a scraper and mixer, so that the nip rollers can pressure the two liners together. The result is that the two facing surfaces are bonded into one continuous molecular structure. Types of thermoplastic liners can be seamed by the hot wedge method, but temperature settings will vary according to their specific polymer components. Typical wedge temperature ranges for hot wedge seaming is specified on **Table III.2.6**.

1. The hot wedge system should be properly positioned for completing the desired single or dual (split) seam.
2. Ambient variables such as temperature, cloud cover, and wind speed may make it necessary to vary the temperatures used successfully in a variety of ambient conditions, so that the hot wedge can be more accurately adjusted if new conditions are met, or if personnel changes are necessary.
3. The drive motor should be off when positioning the welding machine to seam. Place the machine where the sheets overlap. Guide the overlapped material between the idlers and the wedge, and into the drive/nip rollers. When continuing a weld that has been abandoned mid-seam, the liners must be spread where the seam leaves off and loaded into the respective sides of the machine. Raise the machine a few inches, load the bottom sheet first, and then load the top sheet. When the nip rollers engage, and the wedge is in position, turn on the drive motor. Immediately engage the sheets when they are between the nip rollers to prevent an imminent melt-through. Move the hot wedge into position and lock it.
4. The Operator must constantly monitor the temperature controls, as well as the completed seam passing out of the machine. Occasional adjustments in temperature or speed will be necessary to maintain a consistent weld. Visual inspection and constant hand testing by the peel method (or other) is also recommended.
5. On some soils, the device tends to "bulldoze" into the ground as it travels, causing soil to enter the weld. A seam with soil trapped in its weld is unacceptable. To keep this from happening, the operator should lift the front of the machine slightly. Alternatively, a moveable base for the machine to travel on can be used. Scrap strips of geotextile or geomembrane have proven to be effective materials upon which the welder can maintain traction. It may also be necessary to change the size of the rollers in loose soils.
6. A small amount of "squeeze-out" or "flashing" is a reliable indication that proper temperatures have been achieved. The melted polymer will laterally extrude, or squeeze-out of the seam zone in properly welded seams, but not to excess. An excessive amount of extruded hot melt indicates that excessive heat or pressure, or both, was applied. Reduce the temperature and/or pressure to correct the situation.
7. The hot wedge device has just a few adjustable parts, but it is critical that they be checked after a day of seaming. The machine should be cleaned daily.

7.8 Extrusion Welding

1. The upper sheet's leading edge must be ground to a 45º bevel. It is imperative that the sheet be lifted up and away from the lower sheet during the beveling so that no deep gouges are cut in the lower sheet. Grinding should therefore be done before tack welding.
2. After beveling, the upper sheet is lowered and laid flat against the lower sheet. The horizontal surface grinding across the interface of both sheets is completed. Surface sheen in the area to be seamed must be removed. Material dust generated by grinding the liner sheets must be wiped or blown away from the seaming zone.
3. Grinding marks should run perpendicular to the seam. Though this process is slower than grinding parallel to the seam, it does not create the deep parallel grooves that significantly

decrease the thickness of the parent material that can lead to seam failure. Parallel grinding marks can also initiate stress cracking.

4. Grind marks should never be deeper than 10% of the sheet thickness. Optimally, they should be about 5% of the sheet thickness. The only purpose of grinding is the removal of oxide layers and dirt from the liner surfaces, and the roughening of their interface for extrudate.
5. Grinding marks should not extend beyond 1/4 inch of either side of the extrudate after its placement. For example, if the final extrudate bead width is 1-1/2 inches, the width of the grinding trail should not exceed 2 inches.
6. Seaming must take place no more than one (1) hour after grinding, so that surface oxide layers do not reappear where the extrudate must be placed.
7. The hand grinder should never be left running when it is not in use. If it makes contact with the liner while running it will cause serious damage.
8. A hot air gun may be used to "tack" the two sheets together, ahead of the extrusion welder. The hot air gun prepares the seam for the extrusion welder by heating the ground surface and by creating a light bond between the two sheets, securing their position. The hot air gun is not meant to create a primary seam. No heat distortion should be evident on the surface of the upper sheet.
9. The extrusion welder's barrel shall be purged of heat-degraded extrudate before starting a seam. This must be done every time the extruder is restarted after one or more minutes of inactivity. The purged extrude shall not be discharged onto the surface of previously placed liner, or onto prepared subgrade, where it would eventually form a hard lump under the liner and cause stress concentrations and possibly premature failure.
10. Molten, highly viscous extrudate is deposited along the overlapped seam. The center of the extrudate pass directly along the edge of the upper liner, at sufficient width to completely cover the edge and most of the outlying grind marks, at least to within 1/4 inch of their extremity.
11. The extrudate should be approximately twice the specified sheet thickness, measured from the top of the bottom sheet to the top or "crown" of the extrudate. Excessive "squeeze out" is acceptable, if it is equal on both sides and will not interfere with subsequent vacuum box testing. If, however, the extrudate can be pulled by its squeeze-out off the seam, the extrudate is unacceptable. The presence of squeeze-out may indicate that the extrusion die was not riding directly against the liner, that the extrudate temperature was improper for adequate flow, or that the seaming rate was too slow.
12. Where possible, inspect the underside of the lower for heat distortion. This can be done at the end of seams, and wherever samples are cut out of the seam. A slight amount of thermal "puckering" on relatively thin liners (less than 50 mil) is acceptable. It indicates that heat penetrated entirely through the sheet. However, if the underside is greatly distorted, either lower the temperature or increase the rate of seaming.
13. If the seaming process must be interrupted at mid-seam, the extrudate should trail off gradually, not terminate in a large mass of solidified extrudate. Where such welds are abandoned long enough to cool, they must be ground prior to continuing with new extrudate over the remainder of the seam. Grind where the extrudate trail-off begins. This restart procedure must be followed for patches, pipes, fittings, appurtenances and "T" and "Y" shaped items.
14. The extrudate bead should be visually inspected. Look to see that its alignment is straight, its height is appropriate, and its surface texture is uniform. No bubbles or pock marks should appear in the extrudate, which indicate the undesirable presence of air, water or debris within the extrudate rod or pelletized polymer.
15. Grind marks should not be visible more than 1/4 inch beyond the extrudate. These should be very light and not contain heavy gouges. As stated previously, grinding is considered excessive when it is deeper than 10% of the liner thickness. It is unacceptable to apply additional extrudate over the original extrusion fillet seam in an area of excessive grinding. A cap strip shall be placed over the entire portion of the seam where excessive grinding is seen.

7.9 Field Quality Control

1. Start-up Testing
   A trial weld, 10 feet long for hot wedge welding and 3 feet long for extrusion welding, from each welder/welding machine shall be run upon the beginning of each shift, every four hours thereafter and at the discretion of the Site CQA Manager, under the same conditions that exist for the geomembrane welding. The trial weld shall be marked with date, ambient temperature, welder's name, and welding machine number. A tensiometer provided by the Installer shall be required to be on-site before and during geomembrane installation for the purpose of testing samples. Specimens of weld 1-inch wide shall be cut from the trial weld and tested on site for shear and peel strength in accordance with **Tables III.2.3, III.2.4,** and **III.2.5**. No welder may start work until the trial weld has been approved by the Site CQA Manager.
2. Nondestructive Seam Testing
   a. The installer shall perform nondestructive tests on field seams over their full length. The purpose of this test is to assure continuity and integrity of the seams. Vacuum and air pressure tests shall be used for nondestructive testing. The vacuum test shall be used for extrusion welds and single-track hot wedge welds. The air pressure test shall be used for double track hot wedge welds.
   b. Vacuum Testing
      Equipment for testing single wedge fusion seams and extrusion seams shall be comprised of the following:
      1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, porthole or valve assembly and a vacuum gauge.
      2) A vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
      3) A rubber pressure/vacuum hose with fittings and connections.
      4) A plastic bucket and wide paintbrush.
      5) A soapy solution.
   c. The following procedures shall be followed by the installer:
      1) Excess sheet overlap shall be trimmed away.
      2) Clean the window, gasket surfaces and check for leaks.
      3) Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
      4) Wet a strip of geomembrane approximately 12 inches by 48 inches (length of box) with the soapy solution.
      5) Place the box over the wetted area and compress.
      6) Close the bleed valve and open the vacuum valve.
      7) Ensure that a leak-tight seal is created.
      8) For a minimum period of ten seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
      9) If no bubbles appear after ten seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 3-inch overlap and repeat the process.
      10) Areas where soap bubbles appear shall be marked and repaired in accordance with the Repair Procedures contained in this CQA Plan.
   d. If the seam cannot be tested prior to final installation, the seaming operations shall be observed by the Site CQA Manager for uniformity and completeness.
3. Air Pressure Testing (for double track fusion seams only)
   The following procedures are applicable to those processes which produce a double seam with an enclosed space. Equipment for testing double fusion seams shall be comprised of the following:
   a. An air pump equipped with pressure gauge capable of generating and sustaining a pressure of 35 psi and mounted on a cushion to protect the geomembrane.
   b. A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

c. The following procedures shall be followed by the installer:
   1) Seal one end of the seam to be tested.
   2) Insert needle or other approved pressure feed device through the sealed end of the channel created by the double wedge fusion weld.
   3) Energize the air pump to verify the unobstructed passage of air through the channel.
   4) Seal the other end of the channel.
   5) Energize the air pump to a pressure of 35 psi, close valve, and sustain pressure for at least 5 minutes.
   6) If loss of pressure exceeds 1% ±, or pressure does not stabilize, locate faulty area, repair and retest.
   7) Remove needle or other approved pressure feed device and seal.

7.10 Destructive Seam Testing

The purpose of the destructive testing is to evaluate seam strength properties. An average minimum of one test sample shall be obtained per 500 feet of performed seam length. The location of samples shall be determined by the Site CQA Manager. Selection of such locations may be prompted by suspicion of overheating, contamination, or other potential cause that may adversely impact the welds. This may result in more than one sample per 500 feet of seam length. Sampling shall be performed by the installer. Testing of field samples shall be performed by the installer in the presence of the Site CQA Manager as described below.

1. Sampling Procedures
   a. Samples shall be cut by the installer at locations chosen by the Site CQA Manager as the seaming progresses.
   b. The seams shall not be covered by another material before they have been tested and accepted by the Site CQA Manager.
   c. Upon obtaining each sample, assign a number to the sample and mark it accordingly.
   d. Record sample location on layout drawing.
   e. Record purpose of the sample, statistical routine or suspicious weld area.
   f. Record date, time, location, roll, seam number, master seamer, welding apparatus, and ambient temperature.
   g. Holes in the geomembrane resulting from destructive seam testing shall be immediately repaired in accordance with the Repair Procedures contained in this CQA Manual.
2. Size and Disposition of Samples
   a. The samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut into three pieces of equal length and distributed as follows:
      1) One portion to the Installer for field testing; 12 inches by 12 inches.
      2) One portion for the independent geosynthetic laboratory quality assurance testing; 12 inches by 12 inches.
      3) One portion to the Owner for archive storage in the Site Operating Record; 12 inches by 12 inches.
   b. The portion of the seam samples for geosynthetic laboratory quality assurance testing will be packed and shipped to an independent lab for testing by the Installer.
3. Field Testing
   a. The following shall be performed by the Installer in the presence of the Site CQA Manager for samples designated for field sampling.
      1) The Installer shall cut ten 1-inch wide replicate specimens from the sample to be tested for shear and peel strength, in accordance with the criteria set in **Tables III.2.3, III.2.4,** and **III.2.5**.
      2) Any specimen that fails through the weld or by fusion at the weld sheet interface is a non-FTB (Film Tearing Bond) break and shall be considered a failure.
      3) The Installer shall test five specimens for shear seam strength and five for peel strength. Four out of the five replicate test specimens shall pass for the seam to be acceptable. A specimen must pass both Sections 1 and 2 above to be acceptable.

4. Quality Assurance Laboratory Test
   a. The Installer shall package and ship destructive test samples designated for laboratory testing to the independent Quality Assurance Laboratory. The laboratory must be approved by the Site CQA Officer.
   b. Laboratory tests shall include shear and peel strength tests. The minimum acceptable values obtained in these tests shall be in accordance with **Tables III.2.3, III.2.4,** and **III.2.5**.
   c. At least five specimens shall be tested each for shear and peel strength. A passing test shall meet the minimum required values in at least four of the five specimens tested for each method.
   d. Any specimen that fails through the weld or by fusion at the weld sheet interface is a non-FTB (Film Tearing Bond) break and shall be considered a failure.
   e. The Independent Laboratory shall provide verbal test results to the Site CQA Manager no more than 24-hours after they receive the samples. The Site CQA Manager shall review the laboratory results as soon as they become available.
5. Procedures for Destructive Test Failure
   a. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted in the field or by the laboratory. The Installer has two options:
      1) The installer can repair the seam between any two passing test locations.
      2) The installer can retrace the welding path to an intermediate location 10 feet (on both sides) from the location of the failed test and take a sample for an additional field test. If these tests pass, then the seam shall be repaired. If the test fails, then the process is repeated to establish the zone in which the seam should be repaired. This process may only be repeated twice. After the third failed test, the entire seam must be repaired.
   b. Acceptable repaired seams shall be bound by two locations from which sample passing destructive tests have been taken. In cases where repaired seam exceeds 150 feet, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with this CQA Plan.
   c. The Installer shall document actions taken in conjunction with destructive test failures.

7.11 Repair Procedures

1. Any portion of the geomembrane exhibiting signs of defect, failing a destructive or a nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the Site CQA Manager.
2. The repair procedures available include:
   a. Defective seams shall be restarted/reseamed as described in this CQA Plan.
   b. Small holes shall be repaired by extrusion cap welding. If the hole is larger than 1/4 inch, it shall be patched with a piece of material extending six inches out from the damaged area.
   c. Tears shall be repaired by patching. The sharp end of a tear on a slope, or in an area of particular stress, must be rounded prior to patching.
   d. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.
   e. HDPE surfaces to be patched shall be abraded and cleaned no more than one hour prior to the repair. No more than 10% of the thickness shall be removed.
   f. Patches shall be round or oval in shape, made of the same geomembrane, and extend to a minimum of six inches beyond the edge of defects. Patches shall be of the same compound and thickness as the geomembrane specified. Patches shall have their top edge beveled prior to placement on the geomembrane in accordance with this CQA Plan. Patches shall be applied, and the repair made using methods discussed in the CQA Plan.
3. Restart/Reseaming Procedures - Fillet Extrusion Welds
   The Fillet Extrusion Welds process shall restart by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous

seam by at least two inches. Reseaming over an existing seam without regrinding shall not be permitted.

4. Restart/Reseaming Procedures - Hot Wedge Welds
   Over the length of the seam failure, the Installer shall either cut out the old seam, reposition the panel and reseam, or add a cap strip, as required by the Site CQA Manager.
5. For any repair method, the following provisions shall be satisfied:
   a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
   b. Surfaces shall be clean and dry at the time of the repair.
6. Repair Verification
   a. Each repair shall be numbered and logged by the installer and the Site CQA Manager. Each repair shall be nondestructively tested using the methods described in Section 7.9, Subsection 2 “Nondestructive Testing” as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the Site CQA Manager. Failed tests indicate that the repair shall be redone and retested until passing test results are achieved. The Site CQA Manager shall observe nondestructive testing of repairs. The installer shall record the number of each repair, date and test outcome.
7. Disposal of Waste Material
   Upon completion of installation, the Installer shall dispose of trash, waste material, etc., and shall leave the premises in a neat and acceptable condition.

7.12 Geomembrane Acceptance

The Installer shall retain ownership and responsibility for the geomembrane until acceptance by the Owner. The geomembrane liner shall be accepted by the Owner when the following conditions are met:

1. Installation is finished.
2. Verification in the form of a certificate of acceptance of the adequacy of field seams and repairs, including associated testing, is complete.
3. Certification by the Site CQA Manager that the geomembrane was installed in accordance with the Construction Drawings, this CQA Plan and manufacturers recommendations.
4. Certification, including "as built" drawing(s) and installation documentation, is provided by the Installer to the Site CQA Manager.

8.0 GEONET

8.1 Geonet Properties

Geonet is proposed as the leak detection layer for the evaporation pond liner systems.

1. The geonet shall be manufactured of new, prime first-quality materials designed and manufactured specifically for the purpose of planar drainage of liquid and chemically resistant to leachate.
2. Geonets are unitized sets of parallel ribs positioned in layers to form a three-dimensional structure such that liquid can be readily transmitted within their open spaces.
3. The geonet material shall meet the minimum properties listed in **Table III.2.7.**

8.2 Manufacturer Quality Control Documentation

Prior to installation commencement of any geonet material, the Contractor shall provide to the Site CQA Manager the following information certified by the manufacturer for the delivered geomembrane.

1. Origin, identification and production of the resin (supplier's name, brand name and production plant).
2. Copies of quality control certificates issued by the resin supplier.
3. Manufacturer's certification verifying that the quality of the resin used to manufacture the geonet meets the resin specifications fingerprint properties shown in **Table III.2.7.**
4. Each roll delivered to the project site shall have the following identification information:

- Manufacturer's name
- Product identification
- Thickness
- Roll number
- Roll dimensions

5. Quality control certificates signed by the manufacturer's quality assurance manager. Each certificate shall have roll identification number, sampling procedures, frequency, and test results. At a minimum, the following test results shall be provided in accordance with applicable test requirements specified in **Table III.2.7.**

8.3 Conformance Testing

1. Conformance testing shall be performed by an independent Quality Assurance Laboratory at a minimum of 1 per 100,000 ft^2. The Site CQA Manager or Installer shall obtain the samples from the roll, mark the machine direction and identification number. The number of lots and samples will be determined in accordance with ASTM D4354. The following conformance tests shall be conducted at the independent laboratory:
   - Thickness (ASTM D 5199)
   - Density (ASTM D 792 Method B)
   - Wide width tensile properties (ASTM D 7179)
   - Mass per unit area (ASTM D 5261)
   - Carbon black (ASTM D 4218)
   - Melt Index (ASTM D 1238)
2. These conformance tests shall be performed in accordance with **Table III.2.7.**
3. Conformance test results shall be reviewed by the Site CQA Officer, and lots shall be accepted or rejected prior to the placement of the geomembrane. Test results shall meet, or exceed, the property values listed in **Table III.2.7.** If the sampling results do not meet property values for any individual lot sample, the lot shall be resampled and retested. This retesting shall be paid for by the manufacturer or installer. If of the test values from the resamples pass the acceptable specification values listed in **Table III.2.7,** the lot shall be accepted.

8.4 Delivery, Storage and Handling

1. The geonet rolls shall be packaged and shipped by appropriate means to prevent damage of the geonet rolls. Off-loading and storage of the geomembrane is the responsibility of the Installer. The Installer shall be responsible for replacing any damaged or unacceptable material at no cost to the Owner.
2. No off-loading shall be performed unless the Site CQA Manager is present. Damage during off-loading shall be documented by the Site CQA Manager. Damaged rolls must be separated from the undamaged rolls until the proper disposition of that material has been determined collectively by the installer and Site CQA Manager.
3. The geonet rolls shall be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions and excessive heat that may damage the geonet material. The rolls shall be stored on a prepared surface (not wooden pallets) and shall elevated from the ground (a minimum of 3 inches) to protect the geonet from standing water.

8.5 Guarantee

1. The Contractor shall guarantee the HDPE geonet against defects in installation and workmanship for the period of two years commencing with the date of final acceptance by the Owner. The guarantee shall include the services of qualified service technicians and materials required for the repairs at no expense to the Owner.

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CONDITIONS

Action 455592

CONDITIONS

Operator: BASIN DISPOSAL INC P.O. Box 100 Aztec, NM 87410	OGRID: 1739
	Action Number: 455592
	Action Type: [C-137] Non-Fee SWMF Submittal (SWMF NON-FEE SUBMITTAL)

CONDITIONS

Created By	Condition	Condition Date
lbarr	None	4/25/2025