

**CSID No. 3512 Avista Service Center Garage  
Operation and Maintenance Plan**

Spokane Service Center Garage  
1411 East Mission Avenue  
Spokane, Washington

for  
**Avista Corporation**

October 20, 2022



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Operation and Maintenance Plan**

Spokane Service Center Garage  
1411 East Mission Avenue  
Spokane, Washington

*for*  
**Avista Corporation**

October 20, 2022



523 East Second Avenue  
Spokane, Washington 99202  
509.363.3125

**CSID No. 3512 Avista Service Center Garage  
Operation and Maintenance Plan**

**Spokane Service Center Garage  
1411 East Mission Avenue  
Spokane, Washington**

**File No. 2522-079-06**

**October 20, 2022**

Prepared for:

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Washington State Department of Ecology

JML:BDW:tjh

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## 1.0 INTRODUCTION

This Operations and Maintenance Plan (O&M Plan) addresses general operating procedures for monitoring and maintaining the integrity of the geosynthetic liner (cap) at the former Spokane Service Center Garage fleet maintenance building (Service Center Garage) on the Avista Corporation (Avista) Spokane campus located at 1411 East Mission Avenue in Spokane, Washington. This O&M Plan was prepared to supplement the remedial action performed at the site and submitted to Washington Department of Ecology (Ecology) under CSID Number 3512.

This O&M Plan is intended to fulfill the requirements found in the Model Toxics Control Act (MTCA) WAC 173-340-400. The elements of this O&M Plan will be implemented to monitor cap conditions and provide the procedures to respond to potential damage to the protective remedial cap or emergency situations. This plan includes (1) a description of the remedial cap system and post-remediation site conditions; (2) the parties responsible for monitoring and maintaining the implemented corrective action; (3) maintenance procedures; and (4) reporting requirements. The location of the site relative to surrounding properties is depicted on Vicinity Map, Figure 1 and the locations of existing site features are depicted on Site Plan, Figure 2.

## 2.0 SITE BACKGROUND AND REMDIAL ACTION DESCRIPTION

### 2.1. Service Center Garage

The Service Center Garage building was located on the Avista Spokane campus which resides on a 19.62-acre parcel in Spokane, Washington. The site is shown on Figure 2.

The Spokane River is located approximately 400 feet east of the former Service Center Garage building. Groundwater flows from southeast to northwest, away from the Spokane River, based on several groundwater monitoring events conducted between February 2018 and January 2020. The depth to groundwater beneath the former building is about 30 feet below ground surface (bgs).

The Service Center Garage building was used from 1955 to July 2018 to service fleet vehicles. The Service Center Garage building contained sub-slab hydraulic lifts for servicing line trucks in Bay 1, Bay 2, Bay 5 and Bay 7. The high bay area contained portable hydraulic lifts that were not located beneath the floor slab.

Avista demolished the Service Center Garage building in August 2018 and moved vehicle service operations to a new facility located in the northern area of the campus. The Service Center Garage building was located adjacent to the Auditorium/Cafeteria building as shown in Figure 2. Several canopies were located west of the Service Center Garage building and were demolished after completing demolition of the Service Center Garage building to make way for the current new parking structure.

Soil assessment and remedial excavation activities were conducted between August 31 and October 3, 2018 at the Service Center Garage building. Groundwater assessment activities that bracketed the soil assessment and remedial activities were conducted at the Service Center Garage on August 17, August 20, October 10 and November 20, 2018.

Contaminants of concern for the Service Center Garage site are diesel- and oil-range petroleum hydrocarbons (DRPH and ORPH) and polycyclic aromatic hydrocarbons (PAHs) in soil and groundwater. Groundwater was additionally tested for polychlorinated biphenyls (PCBs) but they were not detected and therefore are not a contaminant of concern.

Spokane Environmental Solutions (SES) excavated and disposed approximately 3,792 tons of contaminated soil from the Service Center Garage building remedial excavation at Waste Management's Graham Road Facility near Medical Lake, Washington. Complete removal of deeper contaminated soil could not be conducted without affecting the structural integrity of nearby buildings or utility infrastructure. Contaminated soil remained within the base of the remedial excavation at depths ranging from about 15 to 24 feet bgs.

ACF West installed a linear low-density polyethylene (LLDPE) liner cap in the excavation footprint to reduce the potential for remnant contamination in soil to leach to groundwater and was constructed to divert stormwater infiltration into a drainage pipe (GeoEngineers 2019). The liner LLDPE specifications are found in Appendix B. The south section of liner was placed at a 1 percent grade draining north from 6 feet to 8½ feet bgs to the drainage pipe collection trench. The north section of liner was placed a 4 percent grade draining south to the drainage pipe collection trench. The drainage pipe conveys infiltrated water at a 1.25 percent grade to a manhole that is connected to Avista's stormwater system. The liner excavation was backfilled with imported select fill and bedding sand.

On July 26, 2019, Avista installed replacement monitoring wells MW-1A and MW-5B outside of the parking structure construction area to avoid damaging the new wells (GeoEngineers 2019a).

During construction of a new parking garage near the capped area, Avista's construction contractor damaged the northern portions of the LLDPE liner while excavating to install a water line and stormwater drainage pipes. The damage to the liner compromised the remedial action conducted in 2018 by damaging the barrier controlling infiltration to the contaminated soil. The liner damage was discovered by Avista on December 6, 2019. In January 2020, the liner was excavated using a track hoe and soil was cleared from the liner using a vactor truck and pressurized water. The liner was repaired by placing a new section of liner in the excavation and welding the new section of liner to the portion of the liner that was intact (GeoEngineers 2020). The new utilities within the excavation penetrated the liner and were booted through the liner during the repair. The repaired section of liner has a modification to the grade, but the footprint is the similar and the liner will guide infiltrated water to the drain pipe connected to Avista's stormwater system. The repaired liner design and as-built diagram are shown in Figures 3 through 5.

After construction of the new parking garage near the capped area, Avista graded the Service Center Garage capped area. A thin layer of compost was placed over the capped area and sod was installed with an irrigation system (underground sprinklers).

### **3.0 RESPONSIBLE PARTIES**

Avista will be financially responsible for maintenance and site security.

#### **3.1. Contact Information**

Table I lists the contact information for the site.

**TABLE I. IMPORTANT CONTACT INFORMATION**

<b>Name</b>	<b>Role</b>	<b>Contact</b>	<b>Phone Number</b>	<b>Additional Information</b>
Avista Corporation (Avista)	Responsible Party and Property Owner	Bryce Robbert	509.227.9722	Environmental Compliance Bryce.Robbert@avistacorp.com
GeoEngineers, Inc.	Staff Environmental Engineer	Joshua Lee, Project Manager	Office: 509.363.3125	jmlee@geoengineers.com
Washington State Department of Ecology (Ecology)	Regulatory Oversight	Ted Uecker, Site Manager	509.329.3484	Tuec461@ecy.wa.gov

#### **4.0 PROTECTION MONITORING**

Protection monitoring is required to verify that human health and the environment are protected during implementation of the remedial action. The remedial action include risks to the following receptors:

- Contractors, regulators and engineers (identified collectively as “workers”) on site during construction and maintenance activities

Workers and the public are protected through the use of health and safety monitoring and measures.

##### **4.1. Worker Health and Safety**

Remediation-related construction activities were performed in accordance with the requirements of the Washington Industrial Safety and Health Act (RCW 49.17) and the Federal Occupational Safety and Health Act (29 CFR 1910, 1926). These regulations require protection of workers from exposure to contaminants and ensuring excavations are properly shored or sloped. During the remedial action, the contractor (Contractor) and engineer (Engineer) prepared and implemented a Health and Safety Plan (HASP) covering work activities and employees. All parties are responsible for their health and safety, although visitors can adopt either the Contractor’s or Engineer’s HASP for their own use. Within contaminated areas, workers must have current hazardous waste operations and emergency response (HAZWOPER) training. Contractors working within the former Service Center Garage area will conduct earthwork associated with known or potentially contaminated materials in accordance with the Contractor’s HASP. The Contractor’s HASP shall describe the procedures and precautions required for working near potentially unstable slopes and entering excavations.

#### **5.0 MONITORING PROCEDURES AND SCHEDULE**

The Service Center Garage long-term monitoring will include:

- Cap inspections to assess the integrity of the liner, drainage pipe and cover materials; and
- The condition of the stormwater infiltration features.

The table below summarizes the site inspection schedule.

Task	Frequency	Description
Cap Inspection	Annually	Inspect the capped area, drainage pipe and stormwater infiltration basins for damage and functionality.

### 5.1. Cap Inspection

Cap inspections will be conducted annually to assess the integrity of the cap. Since the cap material is covered in soil and sod, the cover material will be inspected to maintain the integrity of the liner. During the inspections, Avista's representative will document and photograph the capped area. The site is divided into three inspection areas as shown in Figure 6. Photographs of inspection areas are found in Figures 7 and 8. Inspection areas include:

- Cap area (Inspection Area 1);
- Manhole containing the drainage pipe (Inspection Area 2); and
- Infiltration basin where drained water from the cap discharges (Inspection Area 3).

The inspection form is included in Appendix A. The representative performing the inspection will document the following conditions:

- The health of the vegetated cover including documenting areas of apparent stressed or dead vegetation;
- Blockage or damage to drainage pipe located inside of the manhole. *Note that drainage pipe function can be observed during periods of inclement weather and/or snowmelt;*
- Puddles or other depressions indicating thin cover material and poor drainage;
- Indications of excessive runoff or erosion;
- Exposed or damaged LLDPE liner or geotextile separation fabric;
- Trees or brush of sufficient size such that their roots may puncture the LLDPE liner if allowed to grow; and
- Indications of slope instability (such as sloughing material) on the capped area.

If damage to the cap or one of the above conditions is observed, the inspector will make the notifications required in Section 7.0. Damage observed will be assessed, documented and photographed. Per the requirements in the pending environmental covenant, Avista will be responsible to repair the damage and document the repair to Ecology within 30 days.

### 5.2. Site Security

The Avista Mission Campus is a secure site (fenced with security guards at access points) that limits access. The Service Center Garage capped area is located within the secure campus and potential exposure to the contaminated soil is limited to those employees or contractors working within the capped area.



## 6.0 MAINTENANCE

Cap maintenance will be conducted by Avista's authorized contractors and will be performed as needed based on the inspection observations. Maintenance activities might include:

- Repairing the fencing or gates;
- Filling in low spots and covering exposed sections of the geosynthetic liner with select fill material covered with a thin layer of compost and sod and the liner is sloped to drain toward the drainage pipe trench;
- Repairing the LLDPE liner;
- Removing large plants and shrubs from the capped area in a manner that will not cause damage to the liner;
- Filling in animal burrows with sand, gravel and topsoil;
- Re-seeding areas of sparse vegetation; and
- Cleaning excessive sediment from the drainage pipe, manhole and infiltration basins.

Required repairs will be completed and reported to Ecology within 30 days of discovery. If damage to the liner is observed or suspected, Avista's contractor will uncover the section of damaged liner in a manner to minimize additional damage. A qualified contractor will remove the damaged section of liner and weld a new section of liner onto the damaged area. Welds and other liner repairs will be tested according to industry accepted quality assurance/quality control standards such as those included in the project specifications.

Backfill material over repaired sections of liner will consist of select fill, a thin layer of compost and sod. The soil cover will be graded to match the surrounding site elevations. Infiltrated precipitation will drain toward the drainage pipe trench and discharge to Avista's stormwater infiltration basins which are managed at the site.

Large trees and shrubs will be removed from the capped area using hand tools to avoid damaging the underlying geotextile and liner.

## 7.0 REPORTING

Long term monitoring and maintenance reporting will occur as specified in the pending environmental covenant. Ecology will be notified of planned development activities, earthwork, utility installation or any other activity that might disturb the capped area or increase the risk of contaminant exposure to human health and the environment as required in the pending environmental covenant. Avista will be responsible to provide the required reports and notifications listed below to Ecology:

Report	Frequency	Description
Cap Inspection Report	Annually	Report describing the observations from the cap inspections.
Cap Damage	As Needed	Damage to the cap or infiltration basins must be reported to Ecology within 48 hours of discovery.

## 8.0 REFERENCES

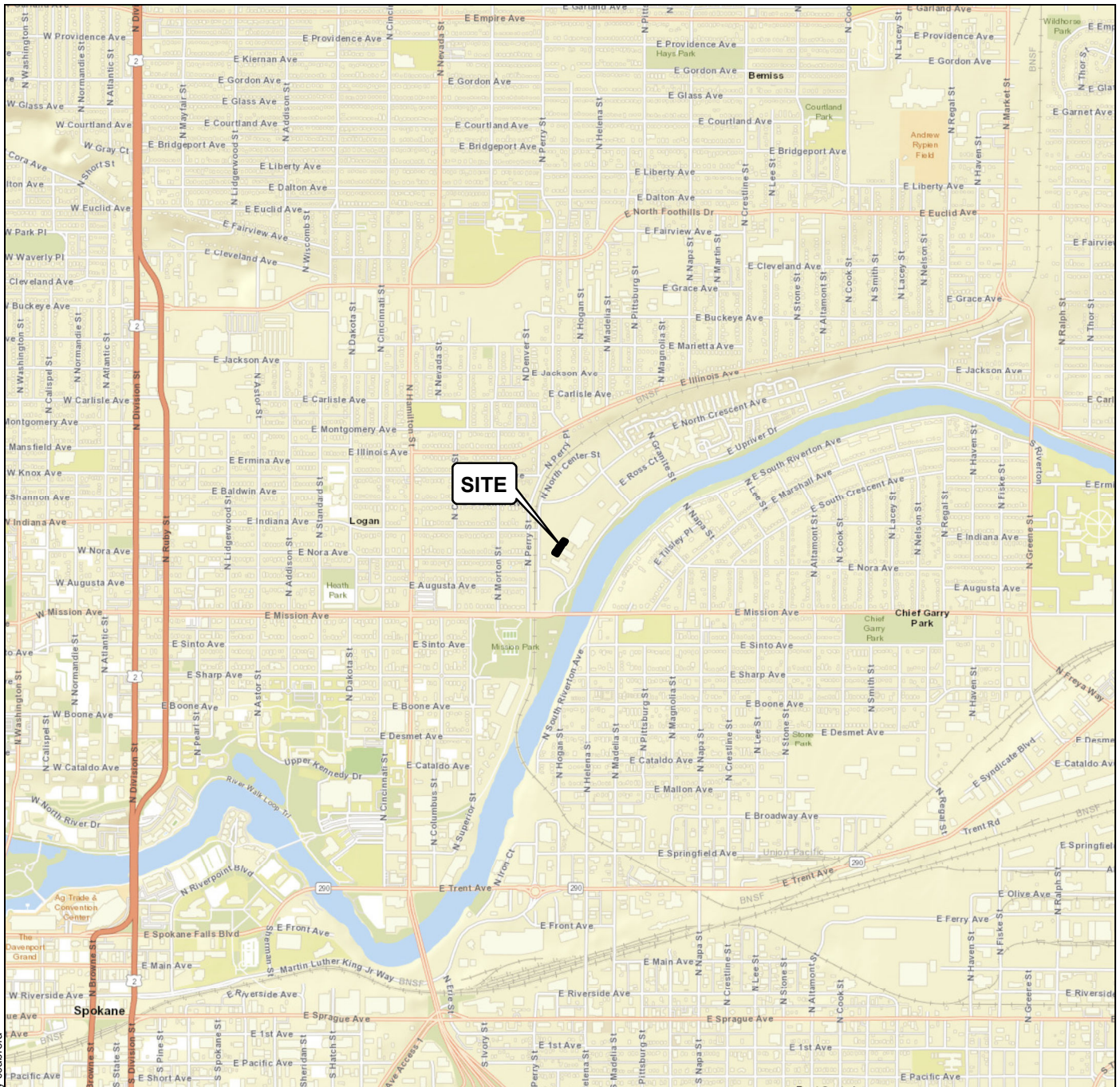
GeoEngineers, Inc. "CSID No. 3512 Revised Avista Service Center Garage Remedial Action," prepared for Avista Corporation. August 9, 2019.

GeoEngineers, Inc. "CSID No. 3512 Monitoring Well Installation and July 31, 2019 Groundwater Monitoring Report." Prepared for Avista Corporation. September 13, 2019a.

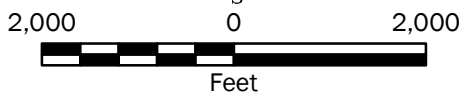
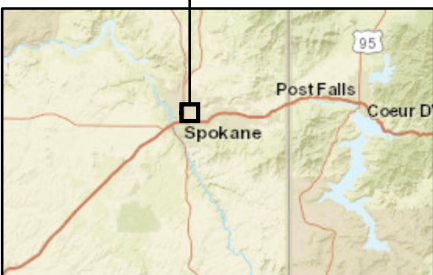
GeoEngineers, Inc. "CSID No. 3512 Avista Service Center Garage Liner Repair and Groundwater Monitoring Report," prepared for Avista Corporation. February 14, 2020.

Washington State Department of Ecology, 2007. Model Toxics Control Act (MTCA) Cleanup Regulations, Washington Administrative Code, Chapter 173-340. November 2007.





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**Notes:**

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 11N

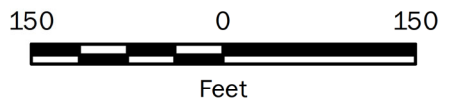
<b>Vicinity Map</b>	
Avista – Service Center Garage Spokane, Washington	
	<b>Figure 1</b>



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**Legend**

- Well ID and Approximate Location
- ⊗ Former Monitoring Well
- Approximate Area of Repaired Liner
- ▨ Approximate 2018 Remedial Excavation Area (Capped Area)
- Approximate Parking Garage Structure Location



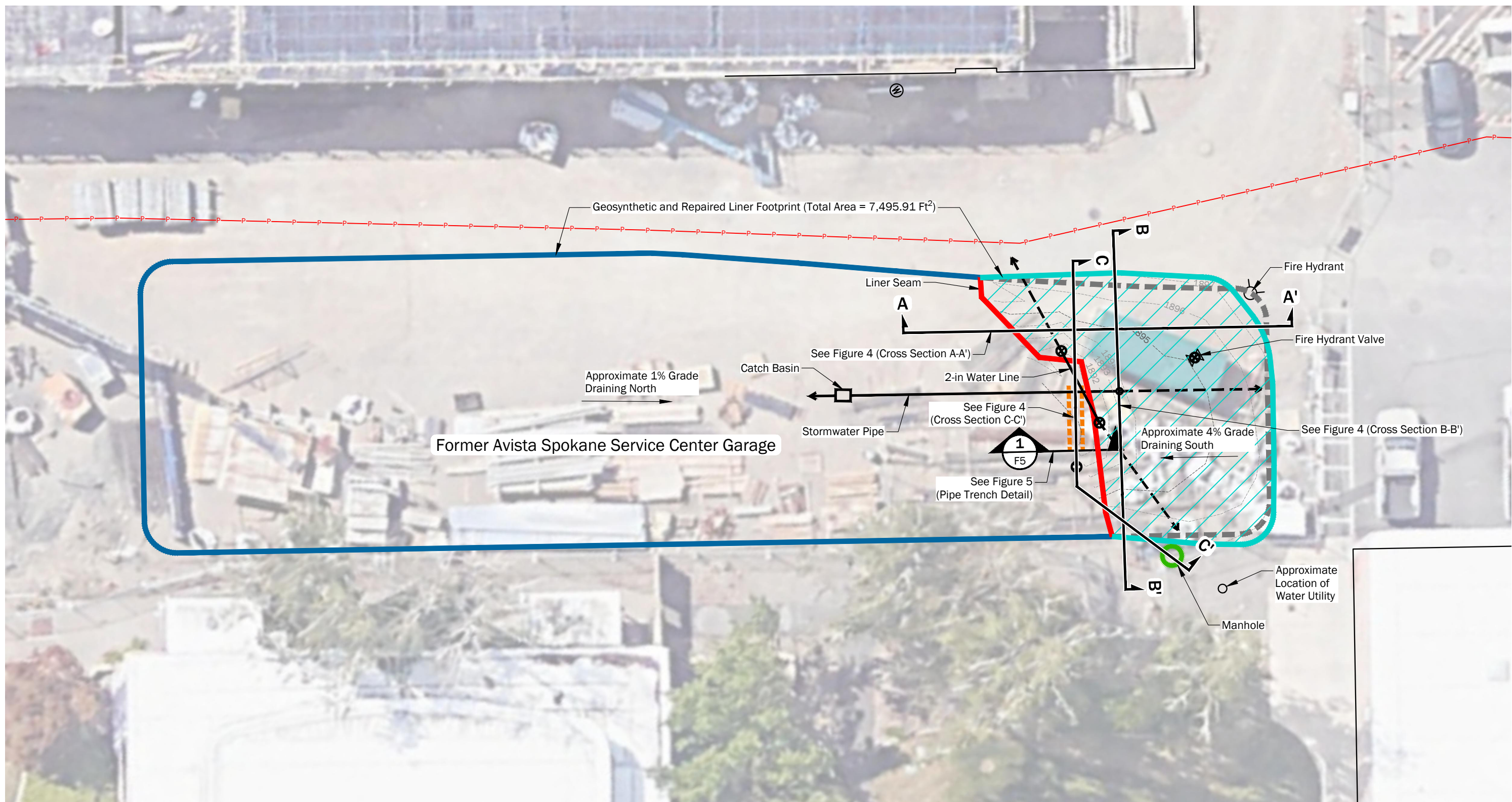
**Notes:**

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI, Spokane County GIS. Image from Google Earth.  
 Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

<b>Site Plan</b>	
Avista – Service Center Garage Spokane, Washington	
	<b>Figure 2</b>

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Former Avista Spokane Service Center Garage

Geosynthetic and Repaired Liner Footprint (Total Area = 7,495.91 Ft<sup>2</sup>)

Approximate 1% Grade Draining North

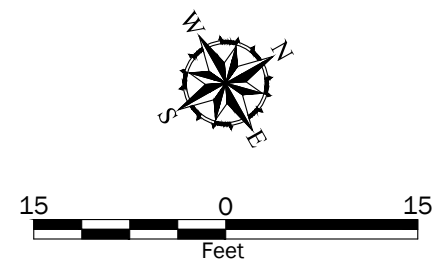
Approximate 4% Grade Draining South

**Legend**

- Geosynthetic Liner Footprint
- Old Geosynthetic Liner Footprint (Removed)
- Repaired Liner Footprint
- Approximate Location of Pipe Drain
- Liner Seam
- ⊗ Sealed/Booted Liner Penetration
- Underground Power Line
- Cross Section Location

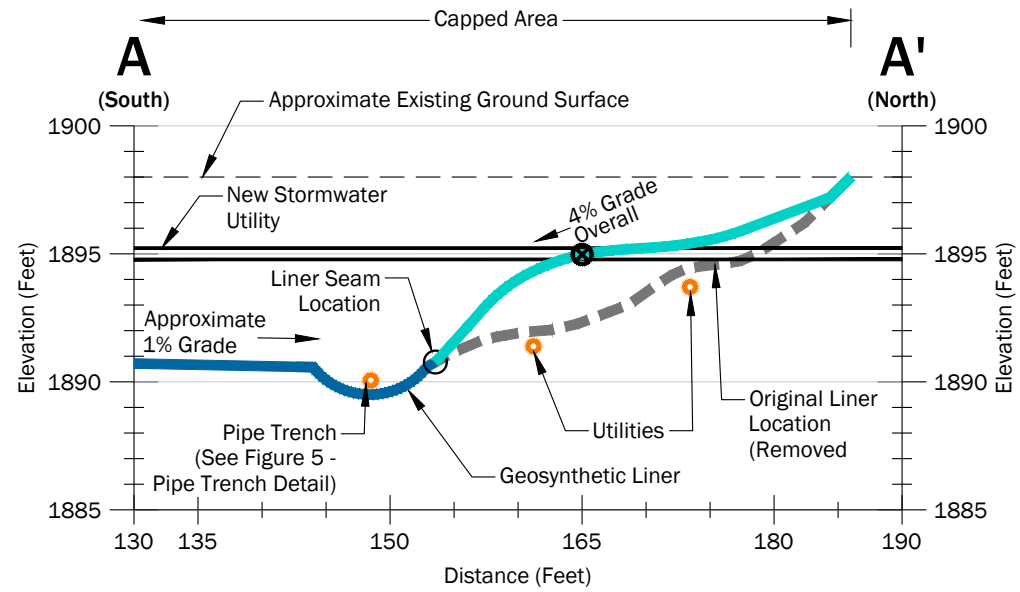
**Notes:**  
 1. The locations of all features shown are approximate.  
 2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Aerial from Orthomosaic Aerial Photo dated October 2018.  
 Vertical Datum: NAVD 88.  
 Projection: NAD83 Washington State Planes, North Zone, US Foot.

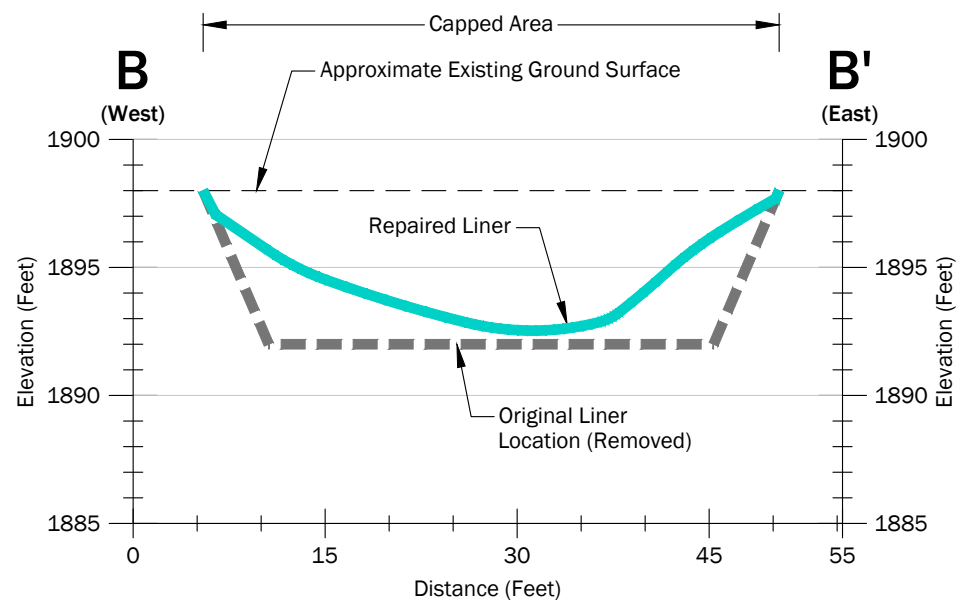


<b>Site Plan - Geosynthetic Liner</b>	
Avista - Service Center Garage Spokane, Washington	
	<b>Figure 3</b>

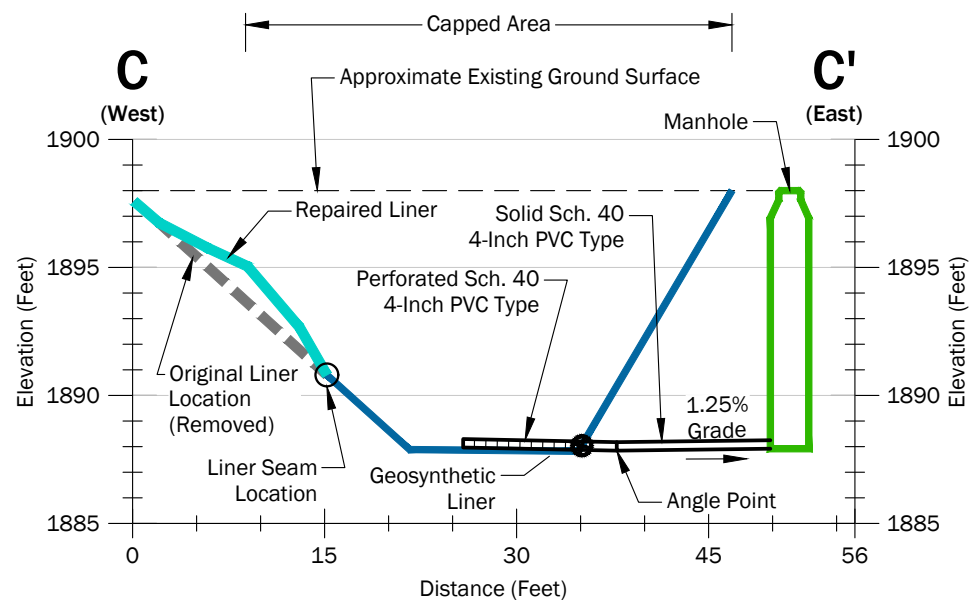
P:\25222079\CAD\06\Operation and Maintenance Plan\2522207906\_F03-F04\_Site Plan and Sections.dwg TAB:F04 Date Exported: 07/01/21 - 8:11 by syj



**CROSS SECTION A-A'**  
SCALE: F04



**CROSS SECTION B-B'**  
SCALE: F04

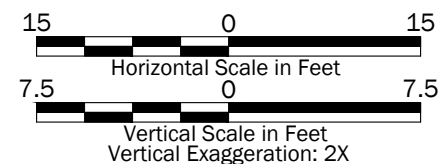


**CROSS SECTION C-C'**  
SCALE: F04

**Notes:**

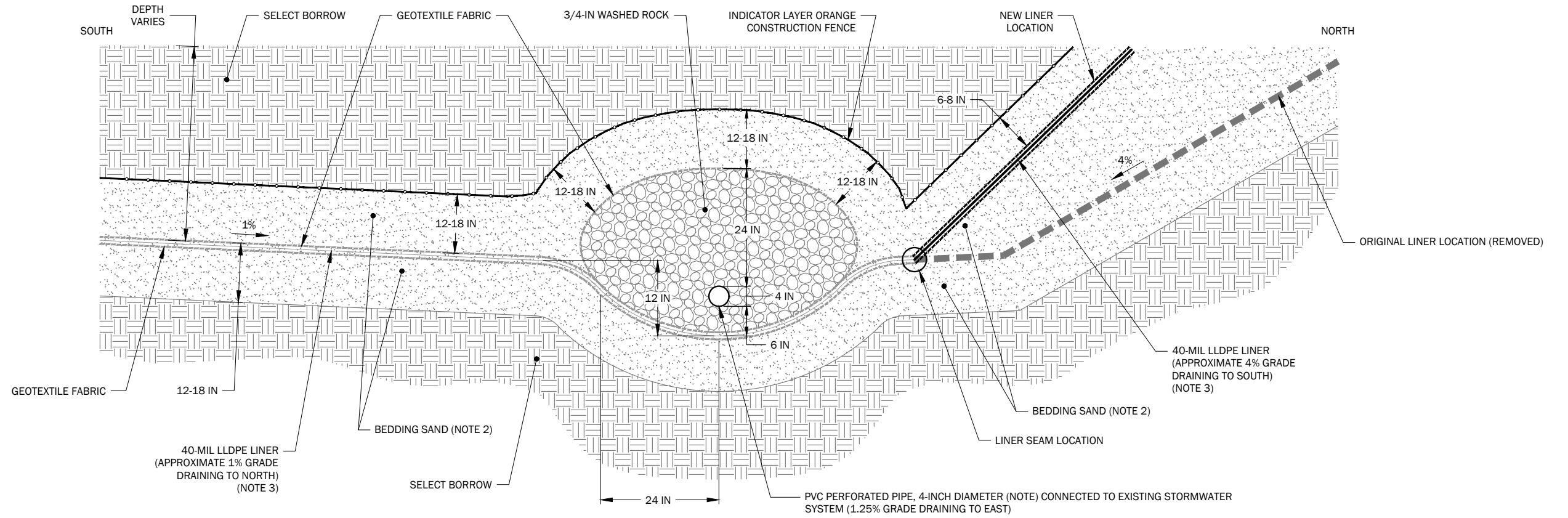
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Datum: NAVD 88, unless otherwise noted.



<b>Cross Sections A-A', B-B' and C-C'</b>	
Avista - Service Center Garage Spokane, Washington	
	<b>Figure 4</b>


P:\25222079\CAD\06\Operation and Maintenance Plan\252207906\_F05\_Pipe Trench Detail.dwg TAB:F05 Date Exported: 07/01/21 - 8:11 by syi



**NOTES:**

1. SOIL AND BACKFILL MATERIALS PLACED BENEATH THE GEOSYNTHETIC COVER WERE BE COMPACTED TO A FIRM AND UNYIELDING STATE WITH NO VISIBLE DEFLECTION.
2. BEDDING SAND CONSISTED OF MATERIAL MEETING WSDOT STANDARD SPECIFICATION 9-03.13.
3. 40-MIL LINEAR LOW-DENSITY POLYETHYLENE (LLDPE) LINER.
4. GEOTEXTILE FABRIC CONSISTED OF MIRAFI 180N.
5. IF LINER DRAIN DAMAGE IS OBSERVED, DRAIN WILL BE REPAIRED PER THIS PIPE TRENCH DETAIL.

**PIPE TRENCH DETAIL** 1  
SCALE: NOT TO SCALE F5

<b>Pipe Trench Detail</b>	
Avista - Service Center Garage Spokane, Washington	
	<b>Figure 5</b>

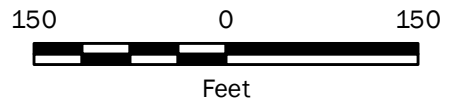




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**Legend**

- Approximate Inspection Area
- Approximate 2018 Remedial Excavation Area



**Notes:**

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI, Spokane County GIS. Image from Google Earth.  
 Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

**Site Plan and Inspection Areas**

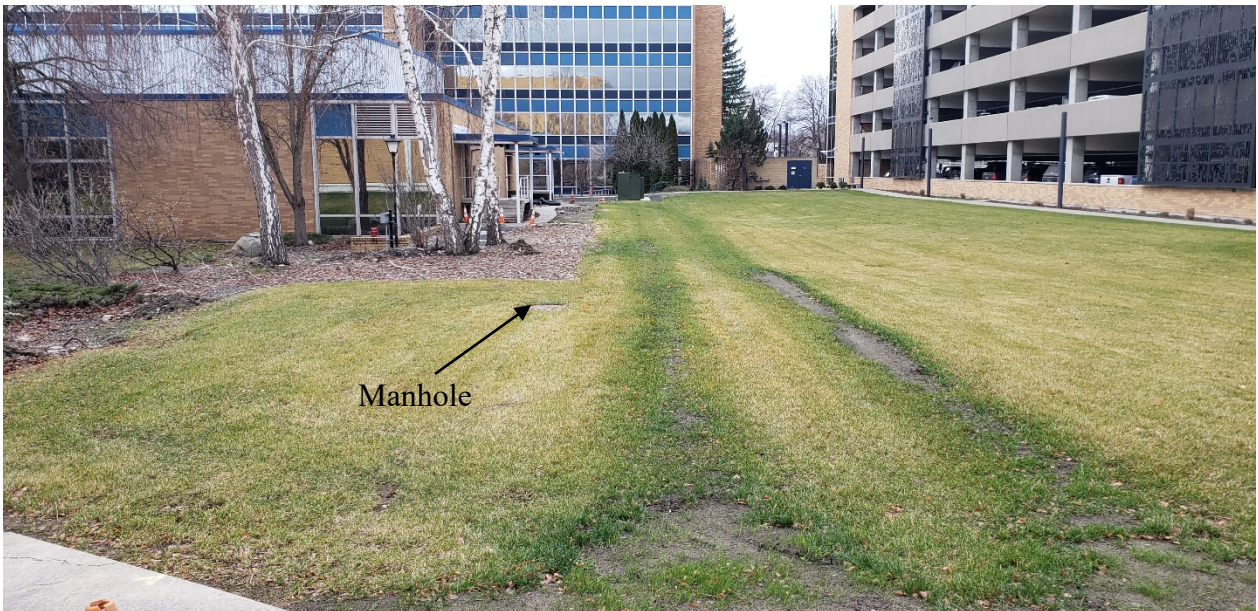
Avista – Service Center Garage  
 Spokane, Washington



**Figure 6**



Photograph 1. Photo of the cap area (Inspection Area 1), looking northeast.



Photograph 2. Photo of manhole containing the drainage pipe (Inspection Area 2), looking south.

2252-079-06 Date Exported: 12/16/2021

### Inspection Area Photos

Avista - Spokane Service Center Garage O&M Plan  
Spokane, Washington



Figure 7



**Photograph 3. Photo of the infiltration basin where drained water from the cap discharges (Inspection Area 3), looking north.**

**Inspection Area Photos**

Avista - Spokane Service Center Garage O&M Plan  
Spokane, Washington



**Figure 8**



**APPENDIX A**  
**Cap Inspection Form**

## Table A-1

### Cap Monitoring and Maintenance Field Form

CSID No. 3512 Avista Spokane Service Center Garage Site

1411 East Mission Avenue, Spokane, Washington

**Date:** \_\_\_\_\_

**Time:** \_\_\_\_\_

**Name:** \_\_\_\_\_

<b>Component</b>	<b>Condition</b>	<b>Action Needed/Notes</b>
Perimeter Fence		
Access Gates		
Geotextile		
LLDPE Liner		
Drainage Pipe Inside Manhole		
Soil Cover		
Vegetation		
Stormwater Infiltration Basin		

**APPENDIX B**  
**LLDPE Liner Specifications**

# GSE Roll Allocation

**Order** SO-085324  
**Customer** ACF West, Inc.  
**Project Name** Water Storage Pond

<b>Roll#</b>	<b>Resin Lot</b>	<b>Product Code</b>	<b>Mfg Date</b>	<b>Length</b>
104191311	18DB236	LST-040AE-BBB-B-W0	8/12/2018	800
104191314	18DB236	LST-040AE-BBB-B-W0	8/12/2018	800
104191315	18DB236	LST-040AE-BBB-B-W0	8/13/2018	800
104191316	18DB236	LST-040AE-BBB-B-W0	8/13/2018	800
104191317	18DB236	LST-040AE-BBB-B-W0	8/13/2018	800
104191318	18DB236	LST-040AE-BBB-B-W0	8/13/2018	800
104191319	18DB236	LST-040AE-BBB-B-W0	8/13/2018	800
104191414	18EB420	LST-040AE-BBB-B-W0	8/19/2018	800



# ROLL TEST DATA REPORT



Report Date: Aug/20/2018

<b>Sales Order No.</b> SO-085324	<b>Customer Name</b> ACF West, Inc.	<b>Project Location</b> Houston TX US	<b>Product Name</b> LST-040AE-BBB-B-W0	<b>BOL Number</b>
-------------------------------------	--	--	---	-------------------

Roll Number	Average Thickness ASTM D5994 (mils)	Minimum Thickness ASTM D5994 (mils)	Break Strength ASTM D6693 (ppi) MD	Break Strength ASTM D6693 (ppi) TD	Break Elongation ASTM D6693 (%) MD	Break Elongation ASTM D6693 (%) TD	Tear Resistance ASTM D1004 (lbs) MD	Tear Resistance ASTM D1004 (lbs) TD	Puncture Resistance ASTM D4833 (lbs)	Density ASTM D1505 (g/cc)	Carbon Black Content ASTM D4218 (%)	Carbon Black Dispersion ASTM D5596 (Views in Cat1-Cat2)	Asperity Height ASTM D7466 (mils) A Side
104191311	40	36	157	127	613	528	30	30	99	0.934	2.2	10	31
104191314	42	39	152	111	618	501	29	30	99	0.934	2.1	10	29
104191315	41	38	152	111	618	501	29	30	99	0.934	2.1	10	29
104191316	41	38	152	111	618	501	29	30	99	0.934	2.1	10	31
104191317	43	39	167	133	655	559	34	31	98	0.935	2.2	10	31
104191318	42	38	167	133	655	559	34	31	98	0.935	2.2	10	27
104191319	42	38	148	145	588	608	31	31	98	0.934	2.2	10	27
104191414	42	40	147	150	610	600	31	31	103	0.937	2.4	10	24

Laboratory Manager 



# Formosa Plastics

FORMOSA PLASTICS CORPORATION, TEXAS

201 FORMOSA DRIVE  
PO BOX 700  
POINT COMFORT

TX 77978

PHONE: ( 888 ) FPCUSA3

## Certificate of Analysis (CONFIDENTIAL)

CUSTOMER: GSE ENVIRONMENTAL, LLC  
UP TRACK 14732 WESTFIELD  
19103 GUNDLE ROAD  
HOUSTON TX 77070  
PRODUCT : L91507H  
RAILCAR FPAX201018

S/O NO : JT5A462  
CUSTOMER PO : 03-512910  
DATE SHIPPED: 6/29/18  
LOT NO : 18DB236  
WEIGHT (LB) : 194,600.00  
CUSTID: FT03112 SPIDE3

TEST ITEM	REFERENCE METHOD	TEST VALUE
Melt Index, g/10min	ASTM D1238	.77
Density, g/cm3	ASTM D1505	.9174

*Linda Kao*

QC SUPERVISOR: LINDA KAO



# Formosa Plastics

FORMOSA PLASTICS CORPORATION, TEXAS

201 FORMOSA DRIVE  
PO BOX 700  
POINT COMFORT

TX 77978

PHONE: ( 888 ) FPCUSA3

## Certificate of Analysis (CONFIDENTIAL)

CUSTOMER: GSE ENVIRONMENTAL, LLC  
UP TRACK 14732 WESTFIELD  
19103 GUNDLE ROAD  
HOUSTON TX 77070  
PRODUCT : L91507H  
RAILCAR FPAX940122

S/O NO : JT6A418  
CUSTOMER PO : 03-513118  
DATE SHIPPED: 7/03/18  
LOT NO : 18EB420  
WEIGHT (LB) : 181,400.00  
CUSTID: FT03112 SPIDE3

TEST ITEM	REFERENCE METHOD	TEST VALUE
Melt Index, g/10min	ASTM D1238	.89
Density, g/cm3	ASTM D1505	.9170

*Linda Kao*

QC SUPERVISOR: LINDA KAO

## Quality Assurance Laboratory Test Results

**Job Name:** ACF West/Water Storage Pond  
**Sales Order:** 85324

**Required Testing:** ASTM D 3895 -- Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry

**Frequency:** 1/200,000 lbs

**Specification:** >100 minutes

<b>Product Code</b>	<b>Resin Lot Number</b>	<b>Results</b>
LST-040AE-BBB-B-W0	18DB236	PASS
LST-040AE-BBB-B-W0	18EB420	PASS

Approved By: Lana Hickman  
Date Approved: August 20, 2018



**Sent By:** Jeff Boys

**Date:** 9-21-2018

Project # \_\_\_\_\_ - \_\_\_\_\_

**PROJECT:** **Avista Service Building**

**AGENCY:** n/a

**BID DATE:** n/a

**Containment Barrier *INSTALLED***

GSE 40 mil LLDPE Black Liner	Quantity: 10,710 SF	@ \$ .64 per SF	<b>\$6,854.40</b>
GSE 40 mil LLDPE Pipe Boot	Quantity: 1 each	@ \$135.00 each	<b>\$ 135.00</b>
Mirafi 180N Nonwoven	Quantity: 10,710 SF	@ \$ .20 per SF	<b>\$2,142.00</b>

**Includes:**

Delivery of material to the site, 2 technicians on site, 1 mobilization, on-site testing of field welds, and 1 year installation warranty.

**Excludes:**

Any taxes, earthwork and trenches, prevailing wage rates, union agreements, water testing of liner, de-watering, demolition, site specific training, mechanical attachments, soil sterilants, independent testing, concrete work, cleaning or grinding of concrete, and pipe work.

**We will need the following provided by others:**

3 laborers for ~2 hours to assist with panel deployment, sanitary facilities for ACF West Const. employees, prepared subgrade maintained in a clean, dry, unencumbered state, and immediate removal of accumulated precipitation. All anchor trenches and concrete work must be complete and all piping must be stubbed through prior to mobilization.

This proposal is based on 1 mobilization with continuous work throughout. Stand-by time for unprepared subgrade will be \$900.00 per day. Additional mobilizations will be \$800.00 each.

**F.O.B. Job Site** (One delivery per item)  
**Terms: Net 30**

**Quote good for 60 days**

Low Bidder:	Contact:	Phone #:
Submittals <input type="checkbox"/>	COI <input type="checkbox"/>	Install Date: _____ Completion Date: _____ Invoice Date: _____

# GSE UltraFlex Textured Geomembrane

GSE UltraFlex Textured is a co-extruded textured linear low density polyethylene (LLDPE) geomembrane available on one or both sides. It is manufactured from the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased frictional resistance, flexibility and elongation properties where differential or localized subgrade settlements may occur such as in a landfill closure application.



**AT THE CORE:**  
An LLDPE geomembrane that is used in applications requiring increased frictional resistance, flexibility and elongation properties, such as landfill closures and mining applications.

## Product Specifications

These product specifications meet GRI GM17

Tested Property	Test Method	Frequency	Minimum Average Value			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	40 36	60 54	80 72	100 90
Density, g/cm <sup>3</sup> (max.)	ASTM D 1505	200,000 lb	0.939	0.939	0.939	0.939
Tensile Properties (each direction)  Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lb	60 250	90 250	120 250	150 250
Tear Resistance, lb	ASTM D 1004	45,000 lb	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lb	44	66	88	110
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note <sup>(1)</sup>	Note <sup>(1)</sup>	Note <sup>(1)</sup>	Note <sup>(1)</sup>
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O <sub>2</sub> , 1 atm	200,000 lb	> 100	> 100	> 100	> 100
<b>TYPICAL ROLL DIMENSIONS</b>						
Roll Length <sup>(2)</sup> , ft	Double-Sided Textured		700	520	400	330
	Single-Sided Textured		780	540	410	330
Roll Width <sup>(2)</sup> , ft			22.5	22.5	22.5	22.5
Roll Area, ft <sup>2</sup>	Double-Sided Textured		15,750	11,700	9,000	7,425
	Single-Sided Textured		17,550	12,150	9,225	7,425

NOTES:

- <sup>(1)</sup>Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- <sup>(2)</sup>Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Textured is available in rolls weighing approximately 4,000 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- \*Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.



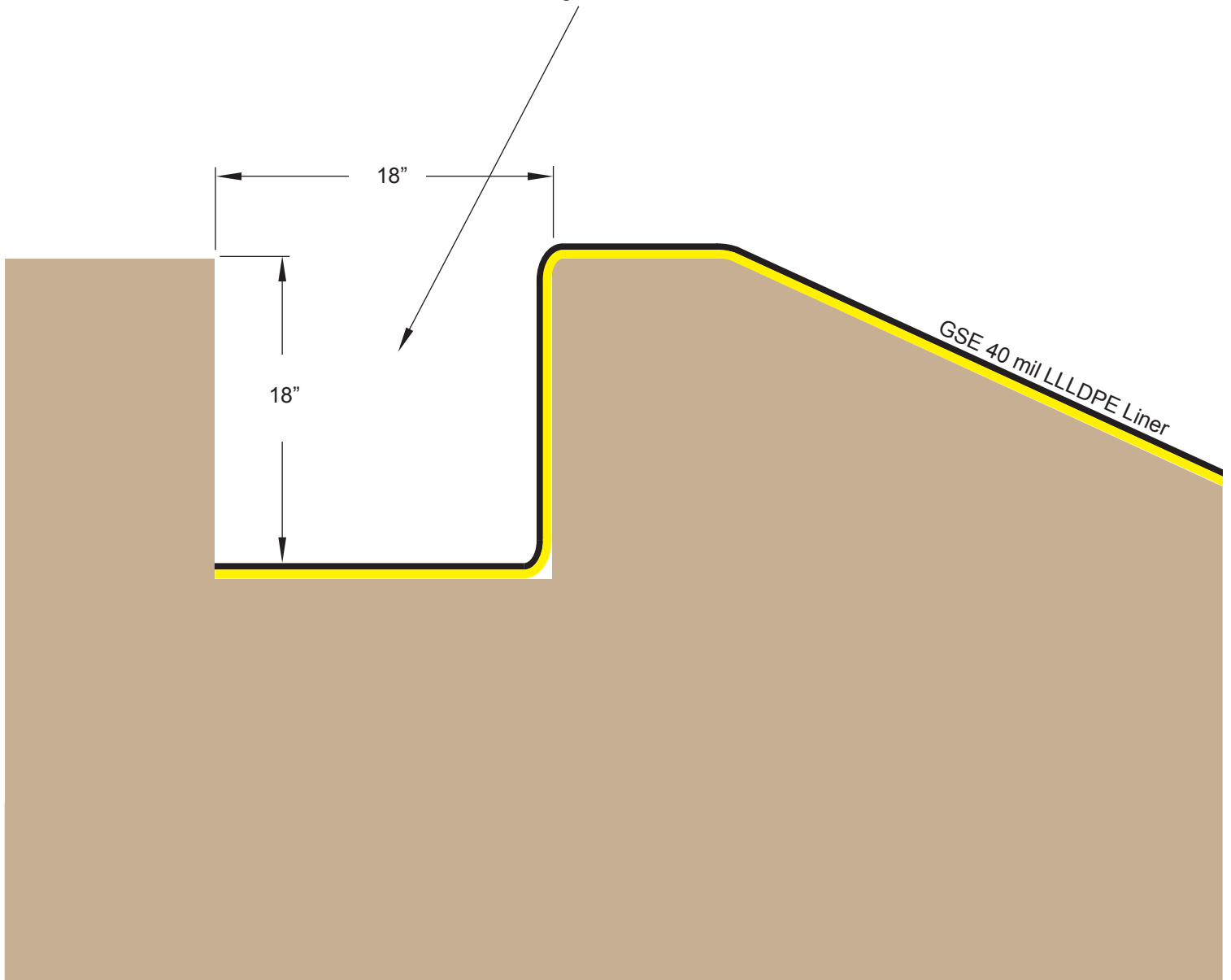
**[ DURABILITY RUNS DEEP ]** For more information on this product and others, please visit us at [GSEworld.com](http://GSEworld.com), call 800.435.2008 or contact your local sales office.



## Typical GSE LLDPE Anchor Trench Detail

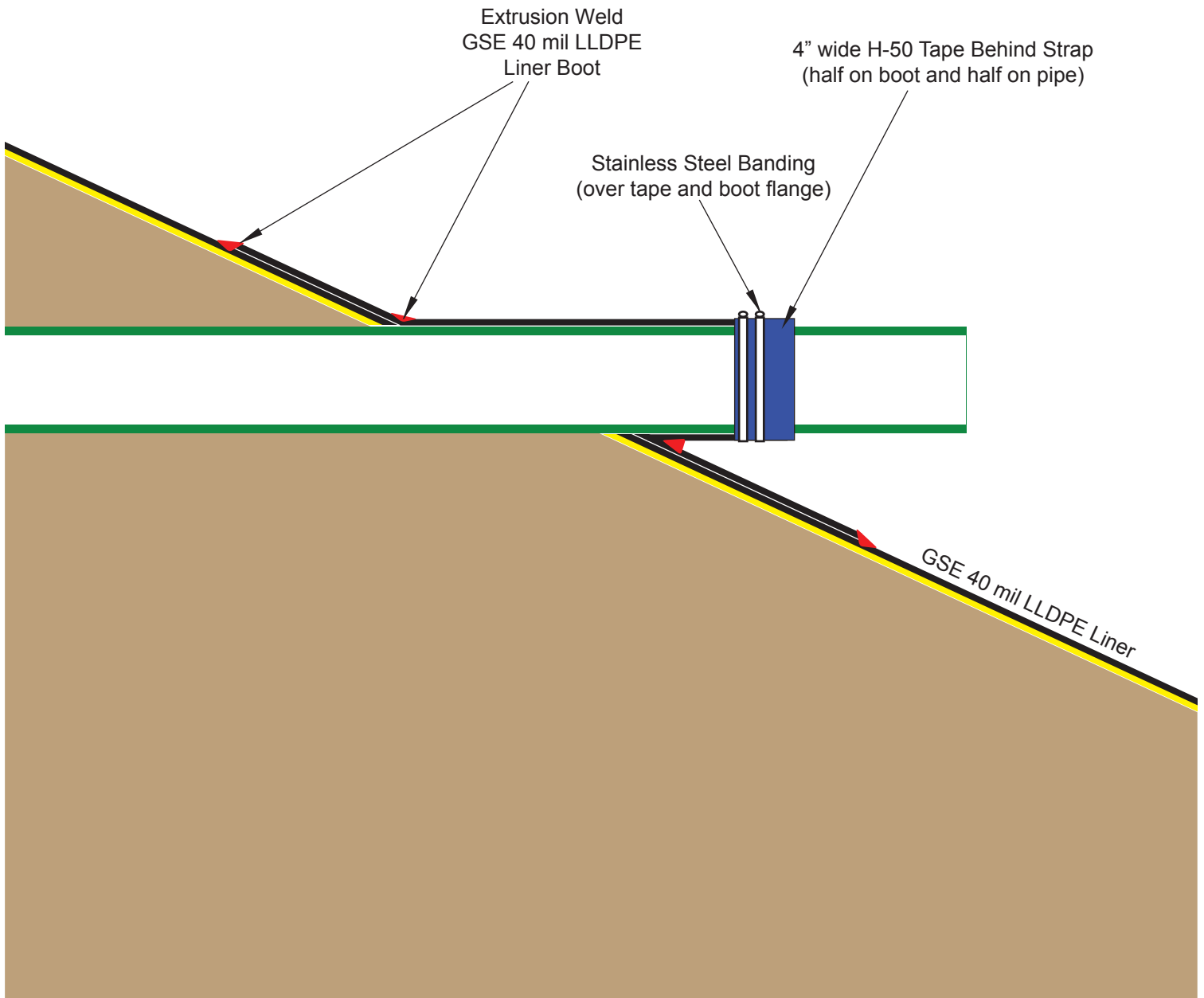
not to scale

Backfill and Compact Toe Trench  
Before Installing Cover Over Liner





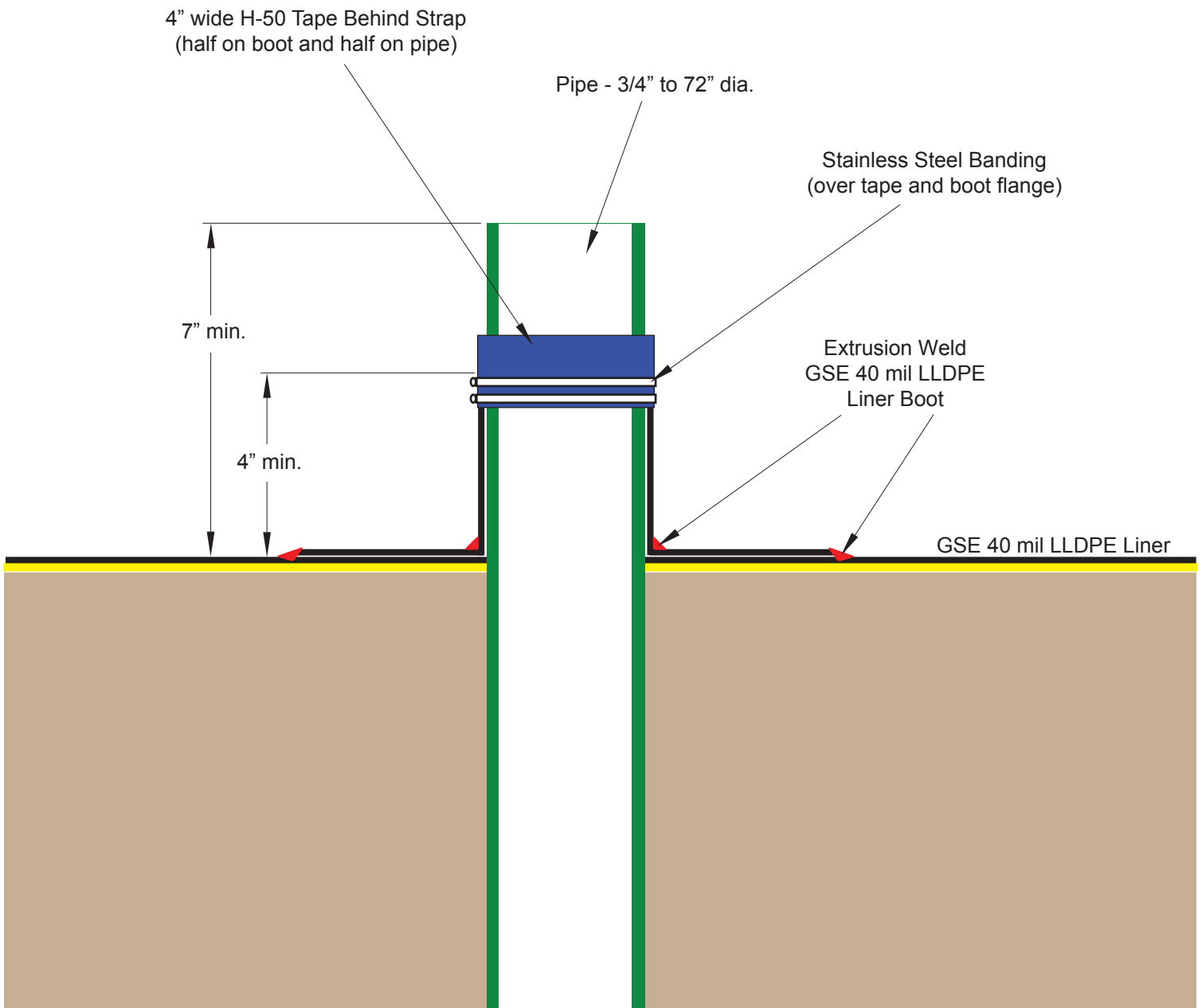
## Typical GSE LLDPE Boot Detail (Slope) not to scale







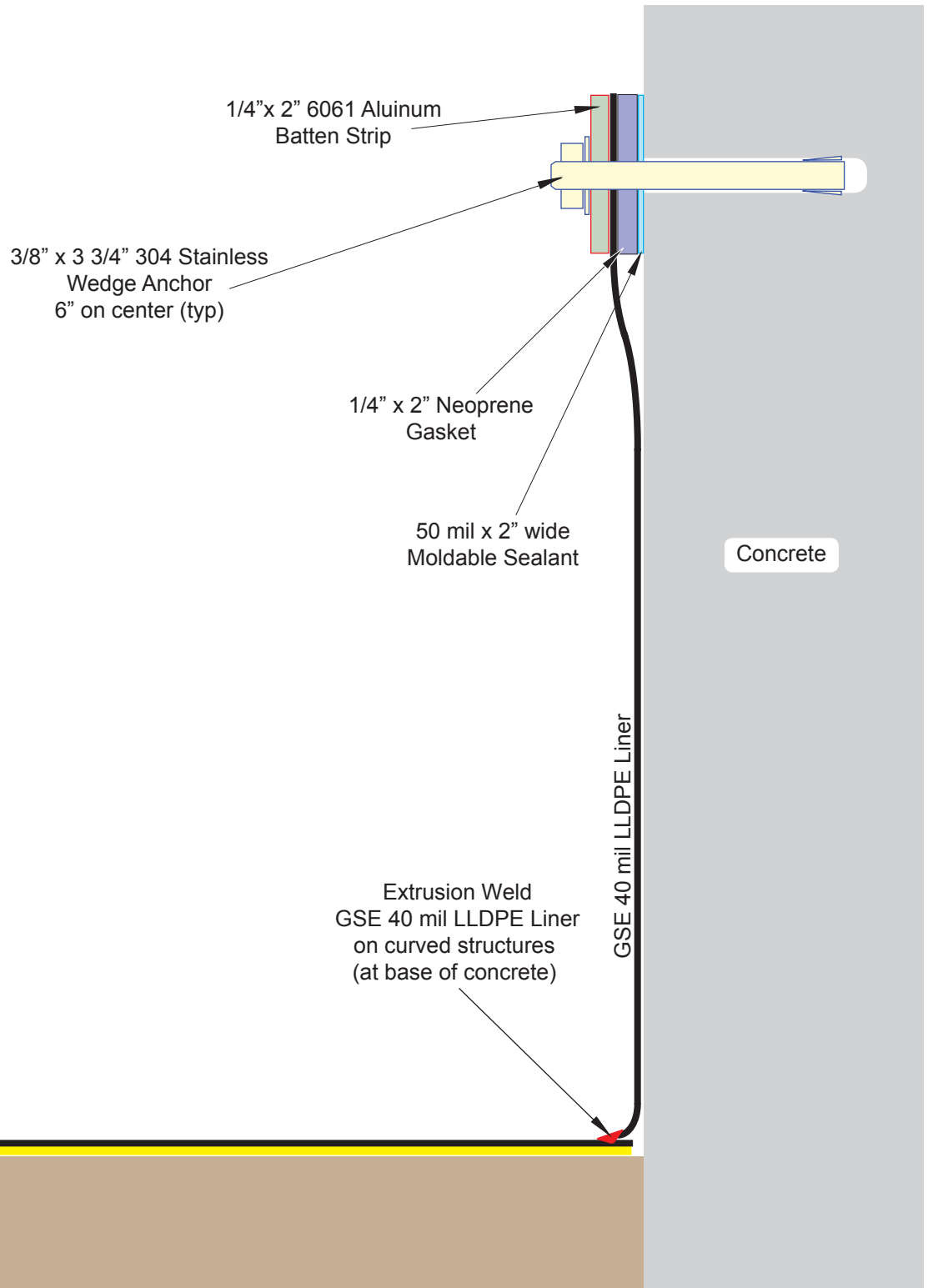
## Typical GSE LLDPE Boot Detail (90 Degree) not to scale





## GSE LLDPE Concrete Attachment Detail

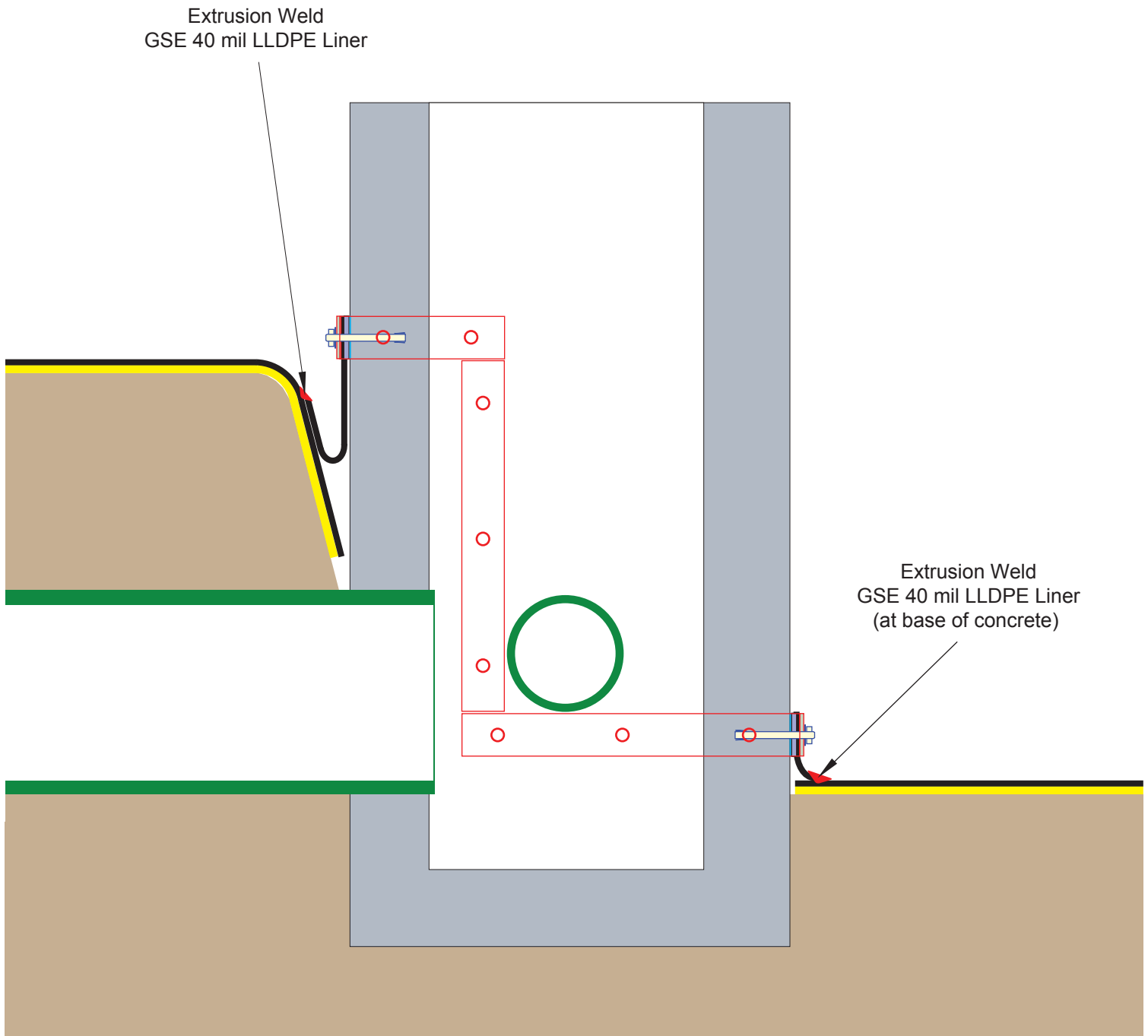
not to scale





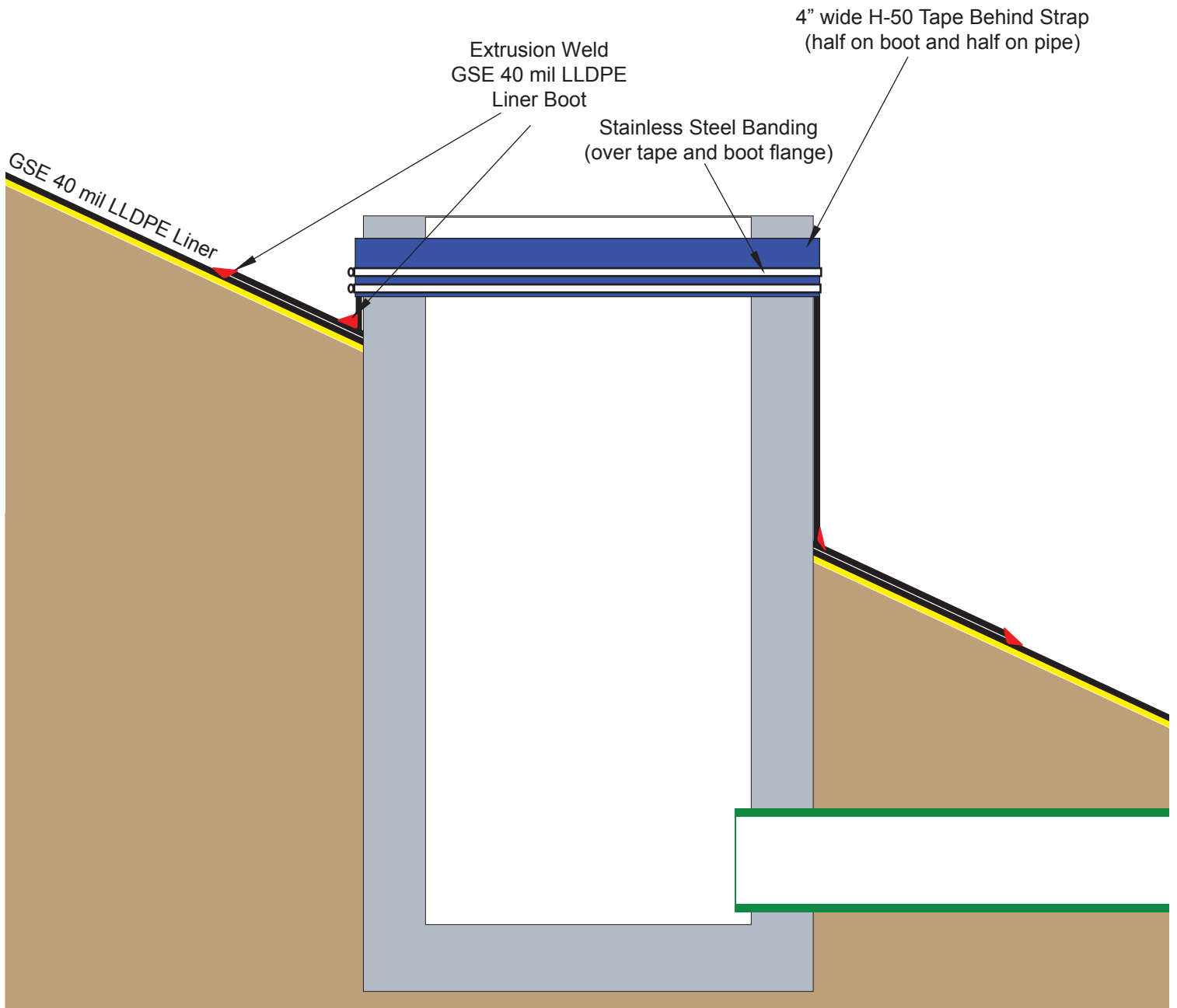
## GSE LLDPE Catch Basin Detail

not to scale





## Typical GSE LLDPE Manhole Boot Detail (Slope) not to scale





# **GEOMEMBRANE PRODUCTS**

## **INSTALLATION QUALITY ASSURANCE MANUAL**

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# Geomembrane Products

## 1.0 INTRODUCTION

This manual provides an overview of the GSE Installation Quality Assurance procedures consistent with industry accepted practices to ensure that the geomembrane products installed will perform for its intended purpose. In addition, all installation work will be performed in strict accordance per the customer's specifications. Please read the procedures below completely before you begin. If you need further clarification, contact GSE Engineering Support Staff for assistance. Remember safety first and use safe practices always on every project.

## 2.0 STANDARD TEST METHODS

- ASTM D 6392:** Standard Test Methods For Determining The Integrity Of Non-Reinforced Geomembrane Seams Produced Using Thermo Fusion Methods  
**ASTM D 5820:** Standard Practice For Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
- ASTM D 5641:** Standard Practice For Geomembrane Seam Evaluation By Vacuum Chamber
- ASTM D 6497:** Standard Guide For Mechanical Attachment of Geomembrane to Penetrations or Structures
- ASTM D 7240:** Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test)  
**GRI Standard GM13:** Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GRI Standard GM14:** Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
- GRI Standard GM17:** Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GRI Standard GM19:** Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

## 3.0 MATERIAL DELIVERY

- A. Upon arrival on site, the QA personnel will inventory all materials on the job site.
- B. Roll numbers of geomembrane will be logged on the Inventory Check List (Appendix A) and crossreferenced with the Bill of Lading for materials supplied by GSE.
- C. Copies of the Inventory Check List and signed Bill of Lading should be sent to the GSE's corporate headquarters while the QA personnel retains the original copies.
- D. Any visible damage to roll materials should be noted on the roll and Inventory Check List.

## 4.0 EARTHWORK

- A. The general contractor is responsible for preparing and maintaining the subgrade. The subgrade should be prepared and maintained per the job specifications.
- B. The site manager shall be responsible for assuring that the subgrade surface has been properly prepared for deployment of geosynthetics. After each day's deployment the Subgrade Surface Acceptance form (Appendix B) will be signed by all parties.

## 5.0 PANEL PLACEMENT

- A. Each panel will be assigned a number as described below.
  - 1. When there is one layer, panels may be designated with only a number, i.e...1, 2, 3, 4 etc.
  - 2. When two or more layers are required, use a letter and number, i.e....
    - Primary Liner P1, P2, P3, P4 etc...
    - Secondary Liner S1, S2, S3, S4 etc...
    - Tertiary Liner T1, T2, T3, T4 etc...
- B. This numbering system should be used whenever possible. Agreement to a panel numbering system should be made at the pre-construction meeting. However, it is essential that the installer, the owner representative and third party QA inspector agree.
- C. Panel numbers shall be written in large block letters in the center of each deployed panel. The roll number, date of deployment and length (gross) should be noted below the panel number. All notes should be made, so that they are easily visible from a distance. On long panels it is beneficial to write information on both ends.
- D. Panel numbers shall be logged on the Panel Placement Log (Appendix C) along with the roll number and other information necessary to complete the form.
- E. If there is a partial roll left after deployment, it is important to write the last four digits of the roll number in several locations on the roll along with the estimated length for future identification.
- F. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:
  - 1. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage. GSE Leak Location should be installed with Conductive layer facing down.
  - 2. Place temporary ballast, such as sangbags, on geomembrane that will not damage the geomembrane and to prevent wind uplift.
  - 3. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking is not permitted on the geomembrane.
  - 4. Do not allow heavy vehicular traffic directly on geomembrane. Rubber tired and tracked ATV's and equipment are acceptable if contact pressure is less than 8 psi.
    - a. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.
    - b. Prior to driving on any geomembrane layer, please check for sharp edges, embedded rocks, or other foreign objects that may protrude in the tires and tracks.
    - c. Path driven on geomembranes shall be as straight as possible with no sharp turns, sudden stops or quick starts.
    - d. Areas where driving occurs shall be continuously and thoroughly inspected throughout the deployment process by the contractor and the third party CQA.



## 6.0 TRIAL WELDS

- A. Seaming apparatus shall be allowed to warm up a minimum of 10 minutes before performing trial welds.
- B. Each seaming apparatus along with a welding technician will pass a trial weld prior to use. Trial welds to be performed in the morning and afternoon, as a minimum, as well as whenever there is a power shutdown.
- C. Fusion or wedge welds will always be performed or conducted on samples at least 6.0 ft long. Extrusion welds will be done on samples at least 3.0 ft long.

**Note: Always perform trial welds in the same conditions that exist on the job. Run the trial welds on the ground, not the installed liner. Do not use a wind break unless you are using one on the job.**

- D. Operating temperatures should be monitored while welding. The welding technician should verify that the equipment is capable of maintaining temperature while welding.
- E. Sampling Procedure
  - 1. Cut five 1.0 in wide specimens from the trial weld sample. Specimens will always be cut using a 1.0 in die cutter, so the peel values may be used for qualitative analysis.
  - 2. When cutting coupons from the trial weld samples, the inside and outside tracks on the coupon should be identified to assist in troubleshooting problems in case the weld fails. The outside track will be defined as the track, which would be peeled if pulling the overlap exposed in a typical installation, or the seam that is closest to the edge of the top sheet. The inside track is the seam closest to the edge of the bottom sheet.
- F. Cutter
  - 1. Only cut one sample at a time to avoid damaging the die cutter.
  - 2. Samples should be free of sand and grit prior to cutting sample.
  - 3. Inspect the die edge weekly for nicks, dents or signs of dullness. Dullness of the cutting edge may damage the units.
  - 4. Remove die when edge has been dulled and lightly reshape it with a medium hand file. When wear is excessive return it for a replacement die.
  - 5. When the cutting board becomes deeply scored and/or interferes with coupon cutting it should be replaced.
  - 6. To adjust the depth of the die cut into the cutting board, after replacing the cutting board or sharpening the die, 0.015 in washer shims can be added or removed between the cutting ram and the ram extension. Only add shims when cutting is difficult due to lack of depth of cut.
- G. Trial Weld Testing
  - 1. Allow coupons to cool prior to testing. Avoid separating the coupons while hot as failure of the sheet may be initiated and false readings indicated.
  - 2. In extreme heat the coupons may need to be cooled, using water or an insulated cooler prior to peel testing. Lab conditions specify 70 degrees (plus or minus 4 degrees) Fahrenheit. Coupon temperatures greater than 70 degrees may result in lowered strengths.
  - 3. Visually inspect the coupons for squeeze-out, footprint, pressure and general appearance.
  - 4. Each of the five coupons will be tested in peel on the field tensiometer at a separation rate of 2 in per minute (for HDPE). Shear tests, in addition to the peel tests, will be performed.

#### H. Pass/Fail Criteria

1. Criteria for passing trial welds will be as follows:
  - a. Seam must exhibit film tear bond (FTB). Trial welds should have no incursion into the weld.
  - b. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 1 for HDPE smooth or textured sheet (@ 2 in/min).
  - c. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 2 for LLDPE smooth or textured sheet (@ 20 in/min).
  - d. Both tracks of fusion welded samples must pass for the trial weld to be considered acceptable. If any of the five coupons fail due to seam incursion (no FTB) or low strength values, the trial weld must be performed again.
  - e. The QA personnel will give approval to proceed with welding after observing and recording all trial welds.
2. All trial weld data will be logged on the Trial Weld Log (Appendix E).
3. When logging fusion welded peel values on the Trial Weld Log indicate the values. for the outside track first, followed by the inside track.
4. Speed and temperature settings will be recorded for each machine trial weld as appropriate.

#### 7.0 GEOMEMBRANE FIELD SEAMING

- A. The seam number takes the identity of the panels on each side. The seam between panels 1 & 2 becomes seam 1/2.
- B. Welding technicians will record their initials, machine number, date and time at the start of every seam and on the Seam Log (Appendix F). The technician should also periodically mark temperatures along the seam and at the end of the seam.
- C. Approved processes for field seaming and repairing are fusion welding and extrusion welding. All welding equipment shall have accurate temperature monitoring devices installed and working to ensure proper measurement.
- D. Fusion welding shall be used for seaming panels together and is not used for patching or detail work. The site manager shall verify that:
  1. The equipment used is functioning properly.
  2. All work is performed on clean surfaces and done in a professional manner. No seaming will be performed in adverse weather conditions.
- E. Extrusion welding shall be used primarily for repairs, patching and special detail fabricating and may be used for seaming. The site manager shall verify that:
  1. Equipment used is functioning properly.
  2. Welding personnel are purging the extrusion welders of heat degraded extrudate prior to actual use.
  3. All work is performed on clean surfaces and done in a professional manner. No seaming will be performed in adverse weather conditions.

F. For seam preparation, the welding technician shall verify that:

1. Prior to seaming, the seaming area is free of moisture, dust, dirt, sand or debris of any nature.
2. The seam is overlapped properly for fusion welding.
3. The seam is overlapped or extended beyond damaged areas at least 4.0 in when extrusion welding.
4. The seam is properly heat tacked and abraded prior to extrusion welding.
5. Seams are welded with fewest number of unmatched wrinkles or "fishmouths".

G. No seaming will be performed in ambient air temperatures or adverse weather conditions that would jeopardize the integrity of the liner installation.

### 8.0 FIELD DESTRUCTIVE TESTING

A. Destructive seam tests shall be performed to evaluate bonded seam strength. The frequency of sample removal shall be one sample per 500 ft of seam, unless site specifications differ. Location of the destructive samples will be selected and marked by the QA technician or third party QA inspector. Field testing should take place as soon as possible after seam is completed.

B. Samples should be labeled in numerical order, i.e. DS-1, DS-2 etc....This should carry thru any layer and or multiple ponds, do not start numbering from 1 again. The size of samples and distribution should be approximately 12 in x 39 in (Size may vary depending on job requirements) and distributed as follows:

1. 12 in x 12 in piece given to QA technician for field testing.
2. 12 in x 12 in piece sent to the GSE's corporate headquarters for testing, if required.
3. 12 in x 12 in piece given to third party for independent testing or to archive.

**NOTE: All samples will be labeled showing test number, seam number, machine number, job number, date welded and welding tech number.**

C. The sample given to the QA technician in the field shall have ten coupons cut and be tested with a tensiometer adjusted to a pull rate as shown below. The strength of four out of five specimens should meet or exceed the values below, and the fifth specimen must meet or exceed 80% of the value below.

1. Seam must exhibit film tear bond (FTB). Welds should have < 25% incursion into the weld.
2. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 1 for HDPE smooth or textured sheet (@ 2 in/min).
3. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 2 for LLDPE smooth or textured sheet (@ 20 in/min).

D. All weld destructive test data will be logged on the Destructive Test Log (Appendix G).

E. When logging fusion welded peel values on the Destructive Test Log, indicate the values for the outside track first, followed by the inside track.

F. Test results will be noted in the Destructive Test Log as Pass (P) or Fail (F).

G. If a test fails, additional samples will be cut, approximately 10 ft on each side of the failed test, and retested. These will be labeled A (After) & B (Before). This procedure will repeat itself until a sample passes. Then the area of failed seam between the two tests that pass will be capped or reconstructed.

## 9.0 NON-DESTRUCTIVE TESTING

- A. All seams shall be non-destructively tested over their full length using an air pressure or vacuum test. The purpose of this test is to check the continuity of the seam.
- B. For air pressure testing, the following procedures are applicable to those seams welded with a double seam fusion welder.
1. The equipment used shall consist of an air tank or pump capable of producing a minimum 35 psi and a sharp needle with a pressure gauge attached to insert into the air chamber.
  2. Seal both ends of the seam by heating and squeezing them together. Insert the needle with the gauge into the air channel. Pressurize the air channel to 30 psi. Note time test starts and wait a minimum of 5 minutes to check. If pressure after five minutes has dropped less than 2 psi then the test is successful (Thickness of material may cause variance).
  3. Cut opposite seam end and listen for pressure release to verify full seam has been tested.
  4. If the test fails, follow these procedures.
    - a. While channel is under pressure walk the length of the seam listening for a leak.
    - b. While channel is under pressure apply a soapy solution to the seam edge and look for bubbles formed by air escaping.
    - c. Re-test the seam in smaller increments until the leak is found.
  5. Once the leak is found using one of the procedures above, cut out the area and retest the portions of the seams between the leak areas per 4a to 4b above. Continue this procedure until all sections of the seam pass the pressure test.
  6. Repair the leak with a patch and vacuum test.
- C. For vacuum testing, the following procedures are applicable to those seams welded with an extrusion welder.
1. The equipment used shall consist of a vacuum pumping device, a vacuum box and a foaming agent in solution.
  2. Wet a section with the foaming agent, place vacuum box over wetted area. Evacuate air from the vacuum box to a pressure suitable to affect a seal between the box and geomembrane. Observe the seam through the viewing window for the presence of soap bubbles emitting from the seam.
  3. If no bubbles are observed, move box to the next area for testing. If bubbles are observed, mark the area of the leak for repair per section 11.0 and re-test per section 9.0.
- NOTE: If vacuum testing fusion welded seams, the overlap flap must be cut off to perform the tests**
4. All non-destructive tests will be noted in the Non-Destructive Logs (Appendixes H-I).
- D. For spark testing GSE Leak Location geomembranes, ASTM D 7240 will be the procedure, unless otherwise instructed by the engineer client.

## 10.0 DEFECTS & REPAIRS

- A. All seams and non-seam areas of the geomembrane lining system shall be examined for defects.
- B. Identification of the defect should be made using the following procedures:
  - 1. For any defect in the seam or sheet that is an actual breach (hole) in the liner, installation personnel shall circle the defect and mark with the letter P along side the circle. The letter P indicates a patch is required.
  - 2. For any defect that is not an actual hole, installation personnel shall circle the defect indicating that the repair method may be only an extruded bead and that a patch is not required.
  - 3. Each suspect area that has been identified as repair shall be repaired in accordance with section 11.0 and in the non-destructively testing per section 9.0. After all work is completed, the site manager will conduct a final walk-through to confirm all repairs have been completed and debris removed. Only after this final evaluation by the site manager, the owner, and the agent shall any material be placed over the installed liner.

## 11.0 REPAIR PROCEDURES

- A. Any portion of the geomembrane lining system exhibiting a defect that has been marked for repair may be repaired with any one or combination of the following procedures:
  - 1. Patching - used to repair holes, tears, undispersed raw materials in the sheet.
  - 2. Grind and Reweld - used to repair small sections of extrusion welded seams.
  - 3. Spot Welding - Used to repair small minor, localized flaws.
  - 4. Flap Welding - Used to extrusion weld the flap of a fusion weld in lieu of a full cap.
  - 5. Capping - Used to repair failed seams.
- B. The following conditions shall apply to the above methods:
  - 1. Surfaces of the geomembrane which are to be repaired shall be prepared according to this section.
  - 2. All surfaces must be clean and dry at the time of the repair.
  - 3. All seaming equipment used in repairing procedures shall be qualified.
  - 4. All patches and caps shall extend at least 4 in beyond the edge of the defect, and all patches must have rounded corners.
  - 5. All cut out holes in liner must have rounded corners of 3.0 in minimum radius.
- C. Patches should be labeled in numerical order, i.e. RP-1, RP-2, etc... This should carry through any layer and/or multiple ponds, and do not start with the number 1 again.

## 12.0 AS-BUILT DRAWINGS

The installer shall provide the following:

- A. As-built drawings will be provided at the completion of the project.
- B. As-built drawings will include geomembrane panels and panel numbers with the last four digits of the roll number.
- C. Panel numbers and the full roll numbers will correspond with the Panel Placement Log(Appendix C).
- D. All destructive testing and repair locations will be placed on the as-built drawings.

APPENDIX A

**Inventory Check List**

Project: \_\_\_\_\_ Site Manager: \_\_\_\_\_ Date: \_\_\_\_\_  
 Project # \_\_\_\_\_ QA Technician: \_\_\_\_\_ Page: \_\_\_\_\_ of \_\_\_\_\_

Material	Roll #	Used	Material	Roll #	Used	Material	Roll #	Used	Material	Roll #	Used



APPENDIX B

**Subgrade Surface Acceptance**

Date: \_\_\_\_\_  
Project: \_\_\_\_\_ Site Manager: \_\_\_\_\_  
Project #: \_\_\_\_\_  
Location: \_\_\_\_\_ Partial: \_\_\_\_\_  
Final: \_\_\_\_\_

This document only applies to the acceptability of surface conditions for installation of geosynthetic products. GSE does not accept responsibility for compaction, elevation or moisture content, nor for the surface maintenance during deployment. Structural integrity of the subgrade and maintenance of these conditions are the responsibility of the owner or earthwork contractor.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

For GSE Lining Technology, LLC.: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

For Owner / Contractor: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Acceptance Number: \_\_\_\_\_ Area Accepted: \_\_\_\_\_ s.f Total Area Accepted to date: \_\_\_\_\_ s.f.



## APPENDIX C

### Panel Placement Log

Project Name: \_\_\_\_\_  
Location: \_\_\_\_\_ Site Supervisor: \_\_\_\_\_  
Job Number: \_\_\_\_\_ Type of Materials: \_\_\_\_\_  
Q.A. Tech.: \_\_\_\_\_ Sheet Thickness: \_\_\_\_\_

Panel Number	Roll Number	Deployment Date	Width (Feet)	Length (Feet)	Squar Feet	Squar Feet (Cumulative)	A/T 1	A/T 2



## APPENDIX D

**TABLE 1. HDPE Seam Strength Properties**

<b>Material (Mil)</b>	<b>Shear Strength (PPI)</b>	<b>Fusion Peel (PPI)</b>	<b>Extrusion Peel (PPI)</b>
40	81	65	52
60	121	98	78
80	162	130	104
100	203	162	130

**TABLE 1. LLDPE Seam Strength Properties**

<b>Material (Mil)</b>	<b>Shear Strength (PPI)</b>	<b>Fusion Peel (PPI)</b>	<b>Extrusion Peel (PPI)</b>
40	60	50	48
60	90	75	72
80	120	100	96
100	150	125	120

### Trial Weld Log

Project Name: \_\_\_\_\_  
 Location: \_\_\_\_\_  
 Job Number: \_\_\_\_\_  
 Q.A.: \_\_\_\_\_

Site Supervisor: \_\_\_\_\_  
 Type of Material: \_\_\_\_\_  
 Sheet Thickness: \_\_\_\_\_

Fusion (ppi) \_\_\_\_\_  
 Min. Peel \_\_\_\_\_  
 Min. Shear \_\_\_\_\_

Extrusion (ppi) \_\_\_\_\_  
 Min. Peel \_\_\_\_\_  
 Min. Shear \_\_\_\_\_

Trial No.	Date of Trial	Time of Trial	Technicians ID Number	Ambient Temp.	Welder Type	Wedge Mass	Speed Preheat	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Pass Fail	

APPENDIX E

## APPENDIX F

### Seam Log

Project Name: \_\_\_\_\_  
Location: \_\_\_\_\_ Site Supervisor: \_\_\_\_\_  
Job Number: \_\_\_\_\_ Type of Materials: \_\_\_\_\_  
Q.A. Tech.: \_\_\_\_\_ Sheet Thickness: \_\_\_\_\_

Seam Number	Time of Weld	Date of Weld	Type of Weld	Length of Seam	Machine Number	Technician ID Number

**Destructive Test Log**

Project Name: \_\_\_\_\_  
Location: \_\_\_\_\_  
Job Number: \_\_\_\_\_  
Q.A.: \_\_\_\_\_

Site Supervisor: \_\_\_\_\_  
Type of Material: \_\_\_\_\_  
Sheet Thickness: \_\_\_\_\_

Fusion (ppi) \_\_\_\_\_ Extrusion (ppi) \_\_\_\_\_  
Min. Peel \_\_\_\_\_ Min. Peel \_\_\_\_\_  
Min. Sheer \_\_\_\_\_ Min. Sheer \_\_\_\_\_

**APPENDIX G**

Sample Number	Date Welded	Seam Number	Technicians ID Number	Machine Type & No.	Location	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Pass/Fail

**APPENDIX H**

**Repair Log - Vacuum Test**

Project Name: \_\_\_\_\_  
 Location: \_\_\_\_\_ Site Supervisor: \_\_\_\_\_  
 Job Number: \_\_\_\_\_ Type of Materials: \_\_\_\_\_  
 Q.A. Tech.: \_\_\_\_\_ Sheet Thickness: \_\_\_\_\_

Repair Number	Weld Date	Machine Number	Tech ID	Location	Test Date	Tech ID	Pass/Fail



APPENDIX I

Non-Destructive Log - Air Test

Project Name: \_\_\_\_\_  
 Location: \_\_\_\_\_ Site Supervisor: \_\_\_\_\_  
 Job Number: \_\_\_\_\_ Type of Materials: \_\_\_\_\_  
 Q.A. Tech.: \_\_\_\_\_ Sheet Thickness: \_\_\_\_\_

Seam Number	Test Date	Technician ID Number	Air Pressure Test		Test Result (P or F)	Location
			psi start	psi finish		

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

For more information on this product and others, please visit us at [GSEworld.com](http://GSEworld.com), call 800.435.2008 or contact your local sales office.

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