Prepared for

Prince William Sound
Regional Citizens' Advisory Council
3709 Spenard Road, Suite 100
Anchorage, Alaska 99503

SECONDARY CONTAINMENT LINER INTEGRITY EVALUATION

Valdez Marine Terminal
Valdez, Alaska

Prepared by

Geosyntec consultants
engineers | scientists | innovators

1111 Broadway, 6th Floor
Oakland, California 94607

Project Number: WG2487

October 2018

The opinions expressed in this PWSRCAC-commissioned
report are not necessarily those of PWSRCAC

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Jay L. Griffin, P.E.
Project Engineer

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1. INTRODUCTION

This report provides recommendations by Geosyntec Consultants, Inc. (Geosyntec) for evaluating the integrity of the secondary containment systems for the East Tank Farm at the Valdez Marine Terminal (VMT) located in Valdez, Alaska. The VMT is operated by the Alyeska Pipeline Service Company (APSC) and is designed to store and load crude oil transported to the facility via the Trans-Alaska Pipeline System. This report was prepared for Prince William Sound Regional Citizens' Advisory Council (PWSRCAC), a non-profit corporation aimed at promoting the environmentally safe operation of the VMT, in accordance with Professional Services Agreement 5052.18.01 between PWSRCAC and Geosyntec.

1.1 Purpose and Scope of Services

Geosyntec's services focused on the evaluation of non-destructive methods to assess the condition of the liner for the secondary containment systems at the VMT. To prepare the evaluation, Geosyntec performed a site visit on 20 June 2018, reviewed available documents related to the VMT, and assembled information on potential non-destructive testing methods.

Beginning in 2013, APSC contracted Golder Associates (Golder) to perform investigations of the secondary containment systems at the VMT. The Terminal Operations and Environmental Monitoring (TOEM) Committee (part of the PWSRCAC) reviewed Golder's reports, which included visual observations of the liners, and found that the integrity of the liner in the East Tank Farm was questionable and potentially not meeting the design intent. Therefore, the TOEM Committee initiated this project with Geosyntec to investigate non-destructive methods that could be used to better evaluate the current overall condition of secondary containment liners at the VMT.

1.2 Document Review

PWSRCAC and APSC provided Geosyntec with numerous documents related to the secondary containment systems for the East and West Tank Farms at the site:

- Site Assessment and Spill Reports by American North/EMCON, Inc. from the early 1990s;
- Well Location Map by EMCON from 1999;
- Liner Integrity Evaluation Report by Golder from 2013;
- Water Quality Monitoring Reports from SLR from 2014;
- Inspection and Testing Reports by Golder from 2015, 2016, 2017, and 2018;

- Construction Drawings for Industrial Waste Water System (IWWS) Repairs by APSC from 2014, 2016 and 2017;
- Construction Drawings for East Tank Farm Liner Upgrades by APSC from 1990;
- Construction Drawings for Bioventing System by APSC from 1993;
- Secondary Containment Integrity Management Report by APSC from 2016;
- Slope Stability Piezometer Report by Carsten from 2017; and
- Report on Evaluation of Secondary Containment Liners by Golder and APSC (undated).

Information from the above documents was used to inform the evaluation and recommendations included in this report.

2. BACKGROUND

The VMT marks the end of the Trans-Alaska Pipeline System and is located in the northeast corner of Prince William Sound as presented in Figure 1. Crude oil can be stored at the VMT in the East Tank Farm that includes 14 in-service above ground storage tanks that can each store over 500,000 barrels of crude oil. The West Tank Farm is currently not operational and consists of four storage tanks of the same size. The storage tanks at both tank farms are located within secondary containment systems lined with a combination of geosynthetic and asphalt liners intended to comply with Title 18, Chapter 75.075 of the Alaska Administrative Code (18 AAC 75.075) regulating oil spill containment structures. 18 AAC 75.075 requires that the liners for secondary containment systems include components which are resistant to damage from weather, "sufficiently impermeable," and resistant to operational damage.

This section focuses on design information for the secondary containment systems that is pertinent to non-destructively evaluating the integrity of the liners. More detailed background information on the secondary containment systems at the VMT and previous investigations of those secondary containment systems can be found in reports authored by Golder for APSC [Golder, 2013, 2015, 2016, 2017, 2018]. The background and design information presented in this section is based on Geosyntec's review of documents provided by PWSRCAC and APSC, observations made during the site visit on 20 June 2018, and communications with PWSRCAC and APSC personnel.

2.1 Secondary Containment Cells

The East Tank Farm is separated into seven secondary containment cells that each include two crude oil tanks. The secondary containment cells are defined on their perimeters by earthen dikes and/or concrete containment walls or shotcrete installed over bedrock cuts.

To comply with 18 AAC 75.075, the floor of the containment cells and the earthen dikes are lined with a combination of the following liners:

- Catalytically Blown Asphalt (CBA);
- Chlorosulfonated polyethylene (CSPE) Hypalon® geomembrane (Hypalon); and
- Ethylene Interpolymer Alloy (EIA) XR-5® geomembrane (XR-5).

The three liner materials are intended to be “sufficiently impermeable” barriers to fluids, including crude oil.

Other storage tanks at the facility, such as diesel storage tanks and ballast water storage tanks, also include secondary containment units; however, those secondary containment units were not included in this report.

2.1.1 CBA Liner

During the construction of the tank farms in the late 1970s, the CBA liner was installed on the floors of the secondary containment cells. The minimum specified thickness of the CBA liner was 5/16 of an inch and it was spray-applied directly onto subgrade (not applied to a carrier geotextile) [Golder, 2013]. PWSRCAC provided Geosyntec with a sample of the CBA liner obtained from a previous APSC investigation; the CBA material resembled roofing tar and did not appear to contain aggregates or air voids (as would be expected for hot mix asphalt for paving), which is consistent with the description of the material in Golder [2015]. Photographs of the CBA sample are included in Figure 2.

Golder performed permeability testing on approximately 25 undamaged samples of the CBA liner from 2014 to 2017 and results of the testing indicate that the CBA liner samples meet the “sufficiently impermeable” requirement of 18 AAC 75.075 more than 35 years after installation [Golder, 2015, 2016, 2017, 2018]. Geosyntec believes that the permeability testing serves as evidence that an intact CBA liner is a stable and durable material that can adequately serve as a barrier layer for secondary containment cells.

During construction, approximately 3 inches of bedding material (3/8-inch minus soil) was placed overlying the CBA liner to act as a separation/bedding layer to protect the liner from damage during placement of the 2 to 5-foot thick gravel fill cover [Golder, 2015]. The gravel fill cover contains particles up to 5-inches in diameter that could damage the CBA if placed directly overlying the CBA. APSC confirmed that the bedding layer was placed during the original construction and Golder [2015] described the material as a silty sand with some 3/8-inch minus gravel when encountered during excavations. Figure 3 provides a generic cross-section of the floor of the secondary containment cells.

2.1.2 Hypalon Liner

Original construction of the secondary containment cells included Hypalon geomembrane on the earthen dikes and at connections to structures penetrating the CBA liner (piping and foundations). Hypalon geomembrane provides excellent resistance to ultraviolet (UV) degradation and retains flexibility under freeze-thaw conditions, making it a good choice for exposed secondary containment cells; however, Hypalon is less compatible with fats, oils, or hydrocarbons (e.g. crude oil) than other liner materials. In 1992, APSC initiated a project to replace the existing exposed Hypalon liner in the secondary containment cells with XR-5 geomembrane.

2.1.3 XR-5 Liner

XR-5 has excellent resistance to UV degradation, retains flexibility under freeze-thaw conditions, and has good compatibility with a wide variety of chemicals and hydrocarbons. It is regularly used in the oil and gas industry in cold regions.

In 1992, XR-5 was placed over the exposed Hypalon geomembrane on the earthen dike portions of the secondary containment cells. Generally, a nonwoven geotextile was placed over the Hypalon geomembrane prior to installation of the XR-5 material. The XR-5 geomembrane was overlapped from the dike slopes onto the existing CBA liner and "seamed" with a 2-foot wide Volclay® panel (bentonite clay) and ¼-inch of hot roofing asphalt, as shown in Figure 3.

2.2 <u>Other Tank Farm Features</u>

The secondary containment cells include various features that could impact evaluation of the integrity of the in-place liners.

2.2.1 Foundations

Concrete foundations that bear below the CBA liner on the containment cell floors include:

- Ring walls for the two crude oil storage tanks;
- Foundations for vertical members that support above-ground crude oil and fire suppression piping; and
- Foundations for concrete inter-cell containment walls.

Based on discussions with APSC personnel, Geosyntec understands that concrete foundations were generally constructed prior to application of the CBA liner and the CBA liner was continued onto the top of the concrete foundations. Hypalon geomembrane was secured to the foundations with a batten bar, overlapped with the CBA liner, and sealed with a tar adhesive. Geosyntec's understanding of the generic foundation connection is presented in Figure 4. In general, the batten bar and Hypalon geomembrane connections have not been replaced since the original construction.

Additionally, electrical grounding straps were placed equidistant around each tank concrete ring wall and presumably are buried in the cover material, but do not penetrate the CBA.

2.2.2 Industrial Waste Water System and Fire Suppression Piping

The IWWS includes four to five catch basins, two manholes, and two draw sumps (one for each tank) in each secondary containment cell. Originally, the IWWS was connected with cast iron bell and spigot piping leading out of each containment cell through the dikes into the facility's ballast water treatment system. The IWWS was upgraded over the last four years to replace the original concrete catch basins with high density polyethylene (HDPE) catch basins and line the cast iron piping with smaller diameter HDPE piping. An XR-5 geomembrane is attached to the catch basins, manholes, and draw sumps using stainless steel band clamps or batten bars and overlaps the surrounding CBA liner. The overlaps were sealed with Voclay® panels and hot roofing tar. Geosyntec's understanding of the connection details related to the IWWS and other liner repairs are presented in Figures 3 and 5, both from APSC-provided drawings. The liner repairs are detailed in the Golder reports [Golder, 2015, 2016, 2017, 2018].

Some tank fire suppression piping, adjacent to the tanks, is located below the CBA liner and includes penetrations through the liner sealed with a Hypalon pipe boot and connected to the surrounding CBA liner with an overlap, likely sealed with tar.

2.2.3 Environmental Investigation and Monitoring Features

As part of the original construction, a network of ten piezometers were installed in the East Tank Farm to monitor groundwater levels for slope stability monitoring. The piezometers penetrate the CBA liner and were fitted with a Hypalon pipe boot, similar to the fire suppression piping.

Environmental remediation activities in the East Tank Farm since original construction have included:

- 139 borings were drilled in the 1990s, for characterization of soil and groundwater contamination, using a hollow-stem auger drill rig to bedrock. APSC reported that the borings were backfilled with bentonite chips and neat grout and penetrations through the CBA liner have since been mostly (if not all) located, exposed, and patched;

- Installation of a bioventing system installed in Cells 1, 3, 4, 5 and 7 to treat hydrocarbon impacts to soil and water. The system consisted of injection points, recovery wells, and monitoring points along with associated piping. Drawings provided by APSC suggest that the CBA liner was penetrated for the bioventing systems and it is unknown if proper XR-5 or Hypalon boots were constructed for the CBA penetrations. APSC has reported that most of the bioventing system features have been removed. It is unknown whether penetrations of the CBA liner were properly patched upon system removal. The bioventing system generally consisted of the following:

    - Installation of 6-inch diameter PVC groundwater recovery wells with attached discharge piping running to an IWWS catch basin. During Geosyntec's site visit, recovery wells were observed in Cells #5 and #7 along with associated electrical conduit for the downhole pump running to the cell concrete wall. The quantity of recovery wells installed is unknown. Recovery pumps are currently installed in four recovery wells [SLR, 2014]. These wells have also been used for collection of groundwater samples and referred to as monitoring wells.

    - Installation of 2-inch diameter PVC injection points with attached Schedule 80 PVC air ducting to blower unit housed in a shipping container. A document provided by ASPC lists a total of 17 "vent" wells present in 1994; nearly all have been decommissioned.

    - Installation of subsurface thermocouple strings. The quantity of monitoring points is unknown.

Geosyntec understands that environmental remediation activities have not occurred at the West Tank Farm.

2.2.4 Additional Features

In addition to the documented features discussed previously, there are likely other features present in the cover material that could have an impact on non-destructive testing.

One example is 4-inch diameter "drain tiles" that have been observed during various excavation activities at the site, as reported by APSC. The drain tiles are not identified on design drawings and there is little information regarding their installation. APSC personnel described the drain tiles as coiled rib style lines with a "sock"-like cover (possibly corrugated pipe wrapped in filter geotextile) that traverse the cells, beneath the surface, in random sweeping arcs and connect to a catch basins on the northern side of each cell. It is assumed that the drain tiles were installed to facilitate drainage of meteoric water that percolates through the cover material and builds up on the CBA liner. It is unclear whether the drain tiles are present in all the cells.

3. LINER INTEGRITY EVALUATION METHODS

Non-destructive evaluation of buried liners relies on the indirect interpretation of subsurface data to determine the location of holes or defects in the liner. Like any subsurface characterization method, non-destructive methods are inexact and often require calibration or correlation with visual evidence. Even in perfect conditions, holes or defects can be missed when utilizing non-destructive methods.

For the purpose of this project, Geosyntec evaluated commercially available, non-destructive methods that could potentially be utilized for evaluating the buried CBA liner at the VMT. The following sections describe each method and assess its potential for use at the VMT.

3.1 Electronic Leak Location Testing

Electronic Leak Location (ELL) is commonly used in the waste containment and mining industries to locate defects in geomembranes after installation. Several ASTM International Standards exist for ELL that can be performed on exposed geomembranes or on geomembranes covered with soil or water. The ASTM International Standard that would apply to ELL at the VMT is *ASTM D7007 – Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials*.

ELL relies on the concept that the liner material acts as an insulator and does not easily conduct electricity and the materials above and below the liner (generally soil) act as a good conductor of electricity. To perform an ELL survey, a high voltage is applied to the cover material using a power source that is grounded to the subgrade below the liner. An ELL surveyor can then walk in a grid pattern over the cover material with a dipole instrument to measure voltage. Recorded voltage anomalies indicate areas where the cover material is in direct contact with the subgrade completing the electrical "circuit" and indicating a defect in the liner. Figure 6 presents a schematic of ELL from ASTM D7007.

Because ELL depends on the liner acting as an insulator between the conductive overlying material and subgrade, any conductive path between the two materials needs to be isolated. This would include penetrations in the liner related to foundations and the IWWS and any soil to soil connections with the cover soil and the subgrade at the edges of the liner (ramps). These conductive pathways can mask nearby leaks and interfere with the ELL survey.

The accuracy of an ELL survey depends on the thickness of cover material above the liner. Typically, leaks as small as ¼-inch in diameter can be detected through approximately 2-feet of cover soil. Thicker cover soil above the liner generally means that leaks need to be larger to detect; the minimum leak size that can be detected with cover soil thicker than 2-feet will vary based on site specific conditions and should be confirmed in the field for the VMT. ELL is only applicable for detecting actual leaks in the liner and would not be able to identify cracking (not full thickness) in the CBA liner that does not result in a leak.

To conduct an ELL survey, the cover material needs to be moist to ensure good electrical conductivity; however, wet conditions (during or immediately after a rain or snow event) can provide a conductive pathway between the cover material in the test area and materials outside the test area, which can mask nearby leaks and interfere with the ELL survey. For example, a saturating rain or surface covering snow event would create a highly conductive pathway between the area being tested with ELL technology and materials outside the area being tested, potentially causing "short circuiting" of the electrical current through the more conductive saturated soils or snow layer, which would cause a false positive or interference with the test.

Geosyntec considers ELL technically feasible for use at the VMT, but it would need to be proven in the field prior to being implemented at full-scale. ELL would require isolation of electrically conductive foundations and IWWS penetrations through the CBA liner and any piping or infrastructure buried in the cover material. Isolation would be accomplished through carefully removing cover material around foundations (i.e. not to damage the liner and not to undermine or otherwise destabilize the structural integrity of the foundation system) or penetrations to prevent current applied to the cover material from using those penetrations as a conductive pathway. The variable thickness of the cover material may also present problems related to resolution of the ELL survey and the size of defect that can be detected.

3.2 Geophysical Methods

In the engineering industry, geophysical methods can be used to obtain information about the subsurface without disturbing the ground surface. Geophysical methods can be used to detect buried structures (such as utilities), identify subsurface soil changes, and locate groundwater, among other innovative applications. In the waste containment and mining industries, geophysical methods are not typically used for leak detection of liner systems; however, Geosyntec considered two potential geophysical methods for evaluation of the secondary containment liner.

3.2.1 Ground Penetrating Radar

Ground Penetrating Radar (GPR) is designed primarily to image shallow soil and ground structures using electromagnetic waves and has been increasingly applied for geological, geotechnical, environmental, and archaeological investigations since the 1980s. Reflections and diffractions of electromagnetic waves occur at boundaries between subsurface materials that have different electrical properties. To conduct a GPR survey, electromagnetic waves are emitted from an antenna and travel down through the subsurface until they hit an object that has different electrical properties than the surrounding medium. The waves are scattered from the object and detected by a receiving antenna at the surface.

It is possible that GPR could detect the interface between the cover material and the CBA liner and anomalies in the GPR results could signify large defects (i.e. large areas where no CBA was placed), but it is unlikely that GPR could identify smaller defects or cracking in the CBA.

In “Evaluation of Buried Secondary Containment Liners,” Anderson (Golder), Lai (APSC), and Tart (Golder), documented secondary containment liner assessments at pump stations along the Trans-Alaska Pipeline System. Their assessment concluded that results from GPR were “ambiguous and undefined.” Results from GPR at the VMT could be different from those documented in the pump station assessment because the CBA liner is generally much thicker than the reinforced chlorinated polyethylene (CPER) liners used at the pump stations. However, it is Geosyntec’s opinion that GPR results would be similar between the pump station and the VMT.

Because of the expected lack of resolution of GPR for detecting defects in the buried CBA liner and previous documented experience by Anderson, Lai, and Tart, Geosyntec does not recommend GPR for reliably locating defects in the liner system at the VMT.

3.2.2 Electromagnetic

Electromagnetic (EM) instruments are sensitive to variations in the electrical properties of subsurface materials and can be utilized to locate buried tanks and pipelines, delineate landfill boundaries, map conductive soil and groundwater contamination, and characterize geologic structure. The method is based on the measurement of the change in mutual impedance between a pair of coils on or above the ground surface. In the secondary containment cells, EM would likely suffer from interference from tanks and other above ground or below ground structures. Because of potentially significant interference from buried structures and tanks, Geosyntec does not recommend EM for reliably locating defects in the liner system at the VMT.

3.3 Tracer Gas Testing

The concept of injecting a tracer gas into a system to detect leaks is used in the commercial development, aerospace, power generation, medical, and automotive industries for building vapor barrier systems and mechanical equipment and piping.

Smoke testing is commonly used for vapor barrier systems installed below buildings. After installation of the vapor barrier system a glycerin-based smoke is pumped under the barrier layer and leaks can be identified where smoke is clearly escaping the system. Another tracer method used primarily for piping and mechanical equipment is Helium Leak Testing (HLT) where helium gas is injected into the system being tested and leaks are detected with a helium sensor.

Geosyntec is not aware of examples where tracer testing such as HLT or smoke testing have been used on large scale projects with a buried liner. However, the cover material overlying the CBA liner is relatively permeable and tracer testing may be able to identify leaks in limited areas. The most ideal potential application for tracer testing is around liner penetrations where a limited quantity of cover material could be excavated to expose the penetration for easy detection of the tracer.

Tracer testing would require creating a temporary penetration in the CBA liner to inject tracer smoke or gas beneath the liner, which would require patching upon completion of the testing.

Geosyntec considers tracer testing technically feasible for use at the VMT, but it would need to be proven in the field prior to being implemented at full-scale.

3.4 Visual Inspection of Exposed Liner

Visual inspection of the existing CBA, Hypalon, and XR-5 liners by an experienced engineer or technician is a very good method for identifying defects. Because the majority of the liners at the VMT are buried, visual inspection would require excavation of a significant amount of cover material and is considered infeasible by Geosyntec. Also, excavation and replacement of the cover material would likely cause additional damage to the liners from heavy equipment which is inherent in earthwork excavation above a liner for any project.

3.5 Costs

Geosyntec anticipates that an ELL survey at the VMT could cost approximately $12,000 to $15,000 per acre. The estimated costs only include equipment and personnel required to perform the ELL surveys and analysis of the ELL data. The costs do not include engineering planning, support, and reporting for the ELL surveys and they assume that the surveys can be conducted without significant weather or logistics delays. The estimated costs do not include any earthwork or isolation of specific foundation elements or liner penetrations.

Because Geosyntec is not aware of projects similar to the VMT where tracer gas testing has been performed, estimates of cost would need to be assessed after field testing. For planning purposes, Geosyntec believes that the costs to include equipment and personnel required to perform the tracer gas survey would be similar to the costs of equipment and personnel to perform an ELL survey.

4. RECOMMENDATIONS

Based on the information provided by PWSRCAC, a site visit, and knowledge of commercially available leak detection methods, Geosyntec does not recommend that PWSRCAC or APSC proceed with a full-scale, non-destructive liner evaluation program. However, Geosyntec does consider ELL and tracer gas testing as technically feasible methods if certain site conditions are controlled and the methods are verified at the site prior to full-scale implementation. Our recommendation is to conduct a site-specific field pilot test program of both methods.

Geosyntec recommends that an engineer develop a pilot study program with two main objectives:

- Prove (or disprove) that ELL and/or tracer gas testing can identify the types of defects of primary concern to APSC and PWSRCAC under site-specific conditions; and
- Assess the practicality of the non-destructive test methods for full-scale implementation related to time, cost, and resources and determine best practices for full-scale implementation.

To assess if the non-destructive evaluation methods work to the satisfaction of APSC and PWSRCAC, the pilot study should include at least two separate areas, each approximately 100 feet by 100 feet. One pilot study location should be in an area free of liner penetrations or other subsurface utilities and the other location should include one or more liner penetrations. Both areas should include several intentional holes located by survey and covered with cover material to test how well the non-destructive methods locate the known holes. Defects in penetrations could also be intentionally created to assess the non-destructive methods considered. All defects would need to be repaired in accordance with previous repair design documents.

Potential vendors for the non-destructive evaluation methods discussed are included in Appendix A.

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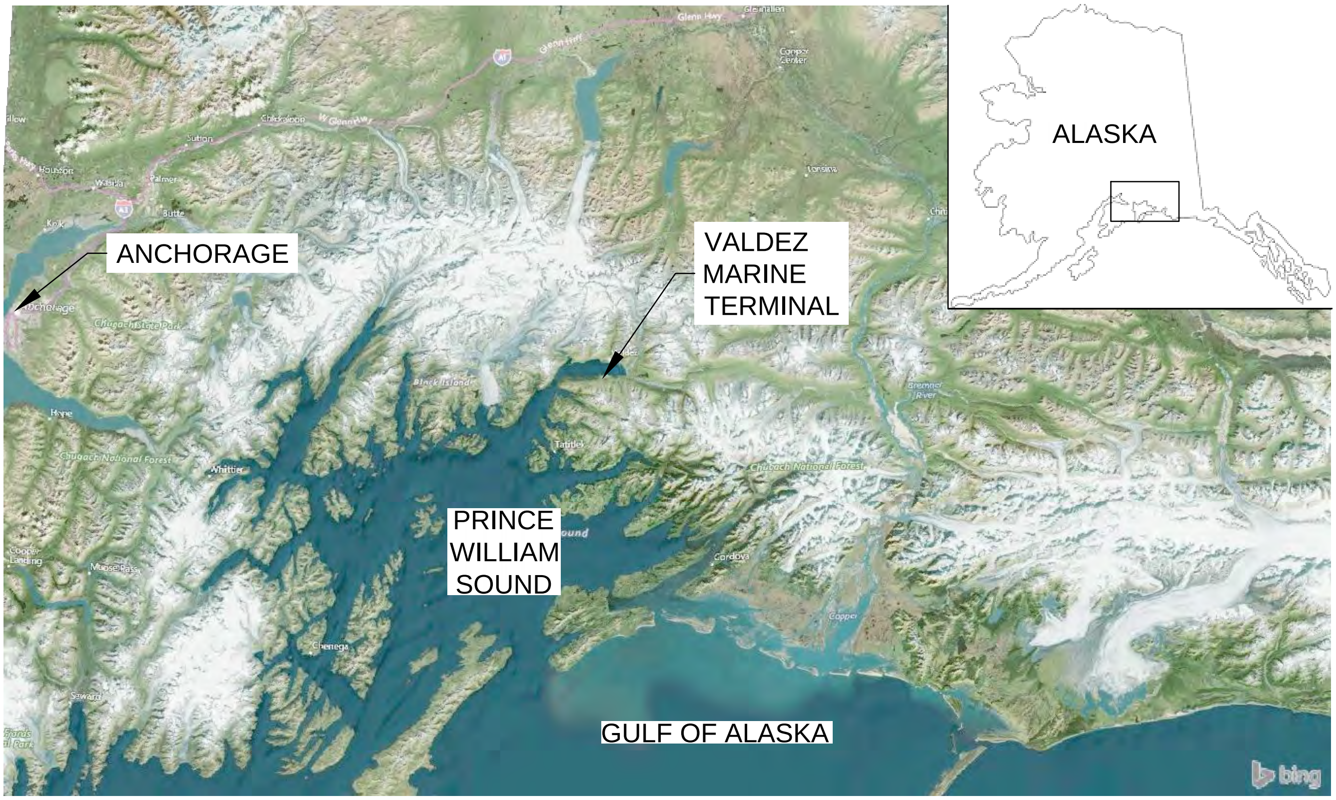
FIGURES



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SITE LOCATION MAP
LINER INTEGRITY EVALUATION
VALDEZ MARINE TERMINAL
VALDEZ, ALASKA

Geosyntec consultants

PROJECT NO: WG2487	OCTOBER 2018	FIGURE 1

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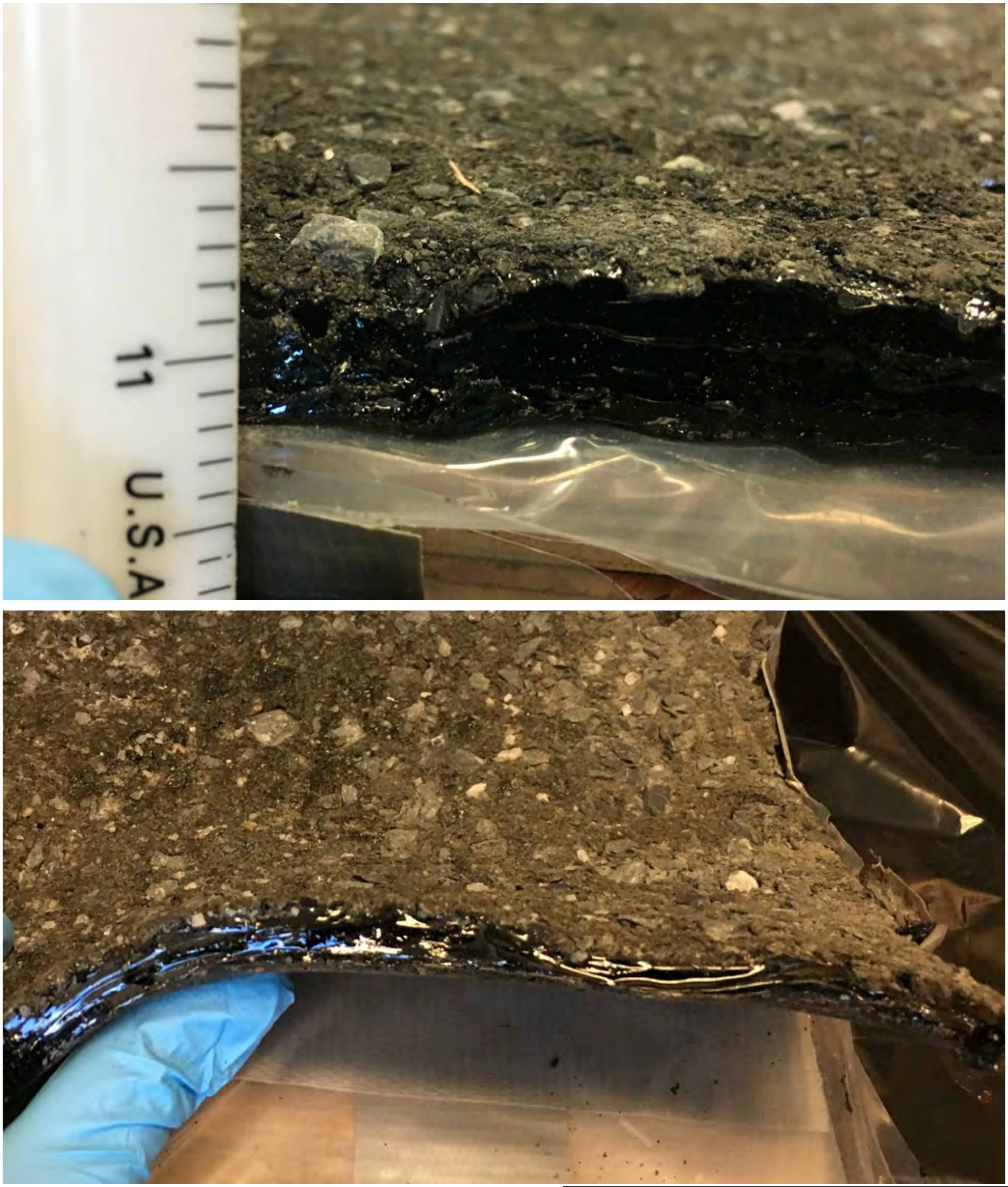

NOTE: SCALE IN UPPER PICTURE MARKS 0.1 INCHES

CBA LINER PHOTOGRAPHS
LINER INTEGRITY EVALUATION
VALDEZ MARINE TERMINAL
VALDEZ, ALASKA

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FIGURE 2

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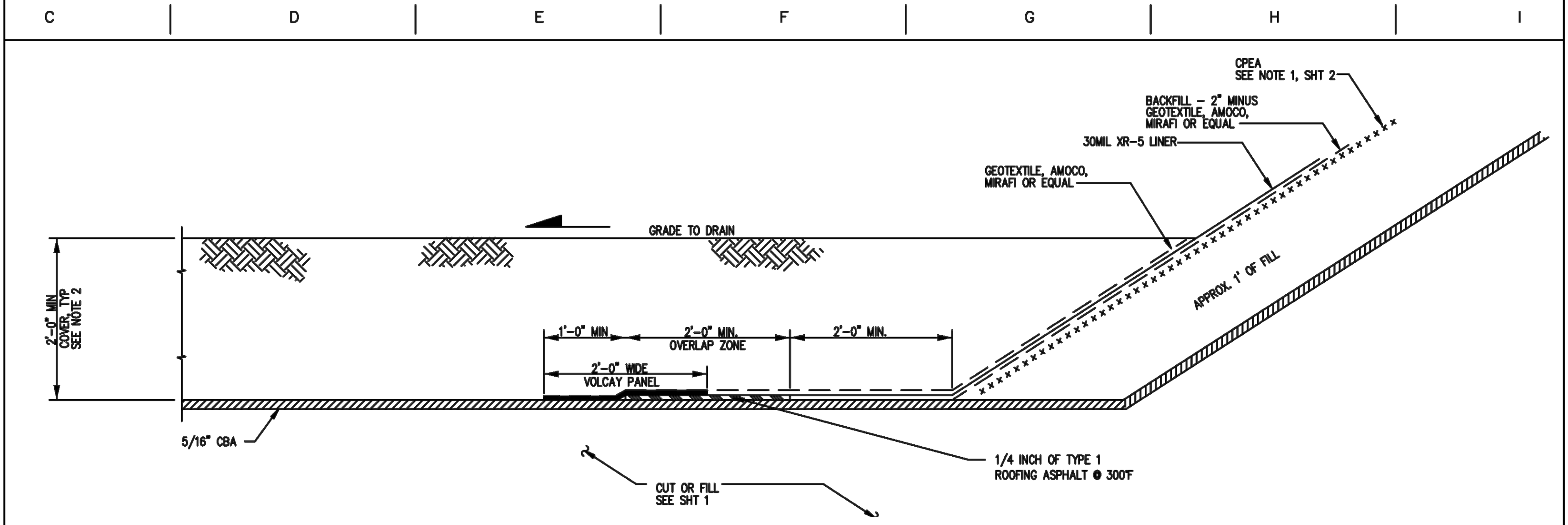

SOURCE: ALYESKA PIPELINE SERVICE CO., 1990. "EAST TANK FARM, DIKE LINER, GENERAL DETAILS," DRAWING NO. D-54-C21, 23 APRIL 1990.

GENERIC CBA CONNECTION DETAIL
LINER INTEGRITY EVALUATION
VALDEZ MARINE TERMINAL
VALDEZ, ALASKA

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FIGURE 3

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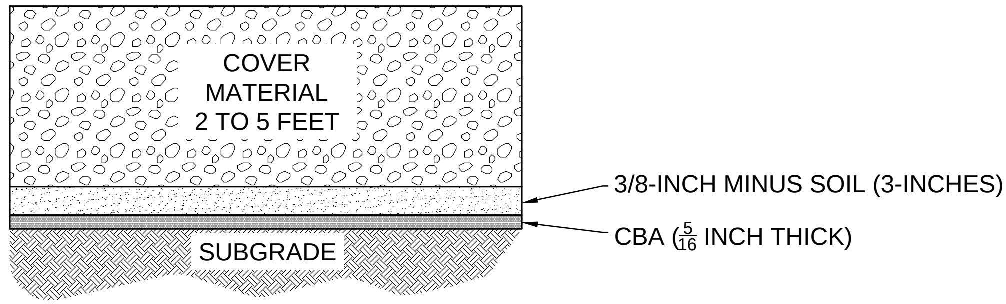

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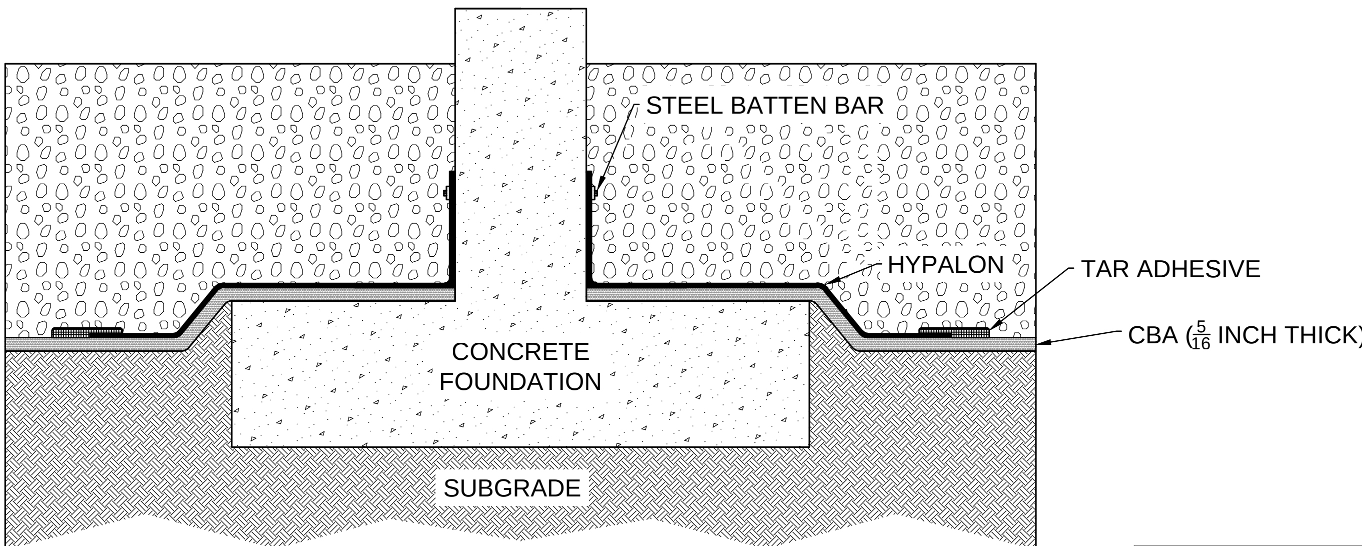

-- / -- GENERIC CBA-FOUNDATION CONNECTION

NOT TO SCALE

DETAILS RE-CREATED BASED ON GEOSYNTEC'S UNDERSTANDING OF THE CBA TERMINATION CONNECTIONS. ACTUAL CONNECTION DETAILS AND DESIGN DRAWINGS MAY VARY.

GENERIC CBA DETAILS
LINER INTEGRITY EVALUATION
VALDEZ MARINE TERMINAL
VALDEZ, ALASKA

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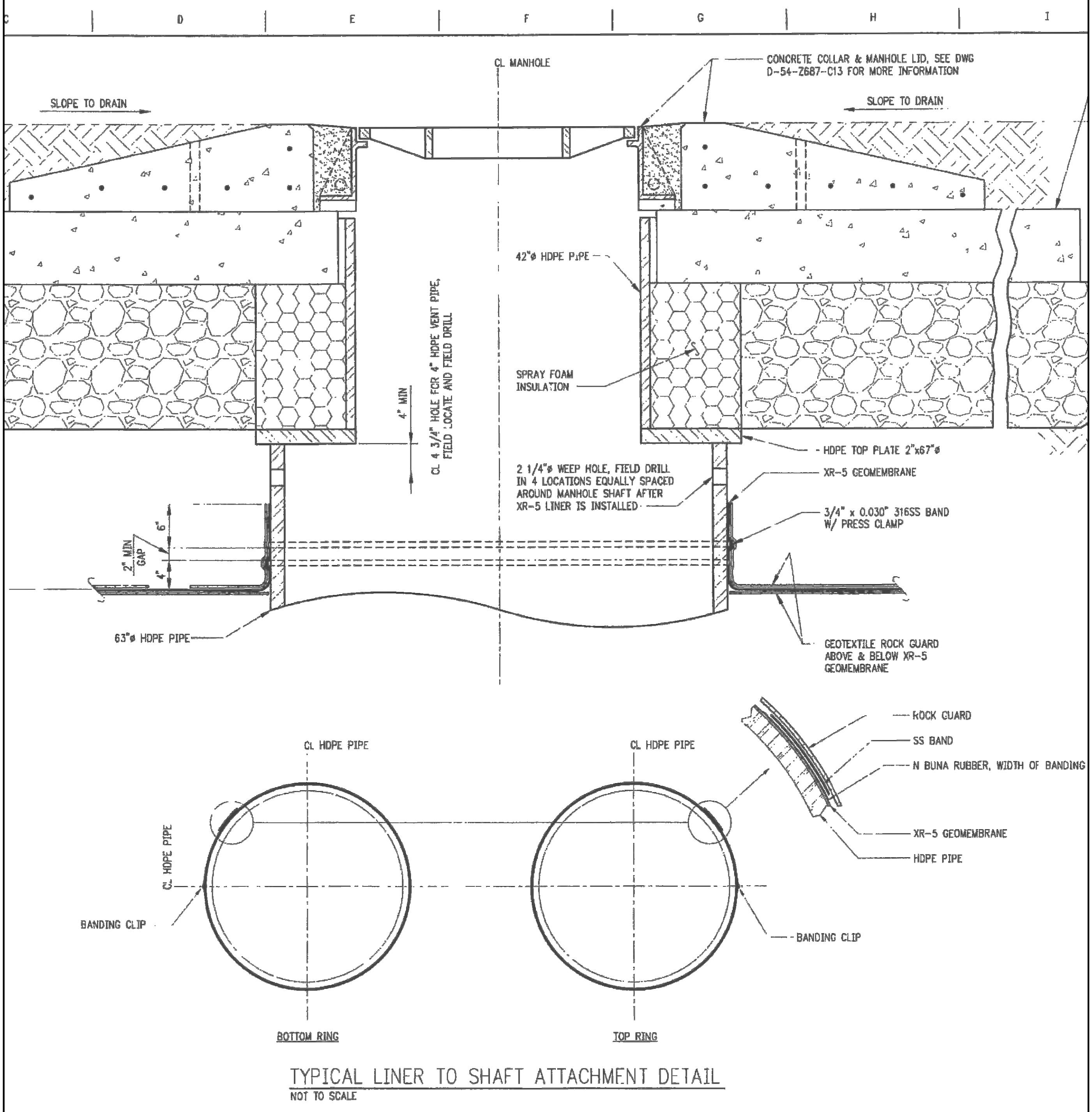
FIGURE 4



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IWWS CONNECTION DETAIL
LINER INTEGRITY EVALUATION
VALDEZ MARINE TERMINAL
VALDEZ, ALASKA

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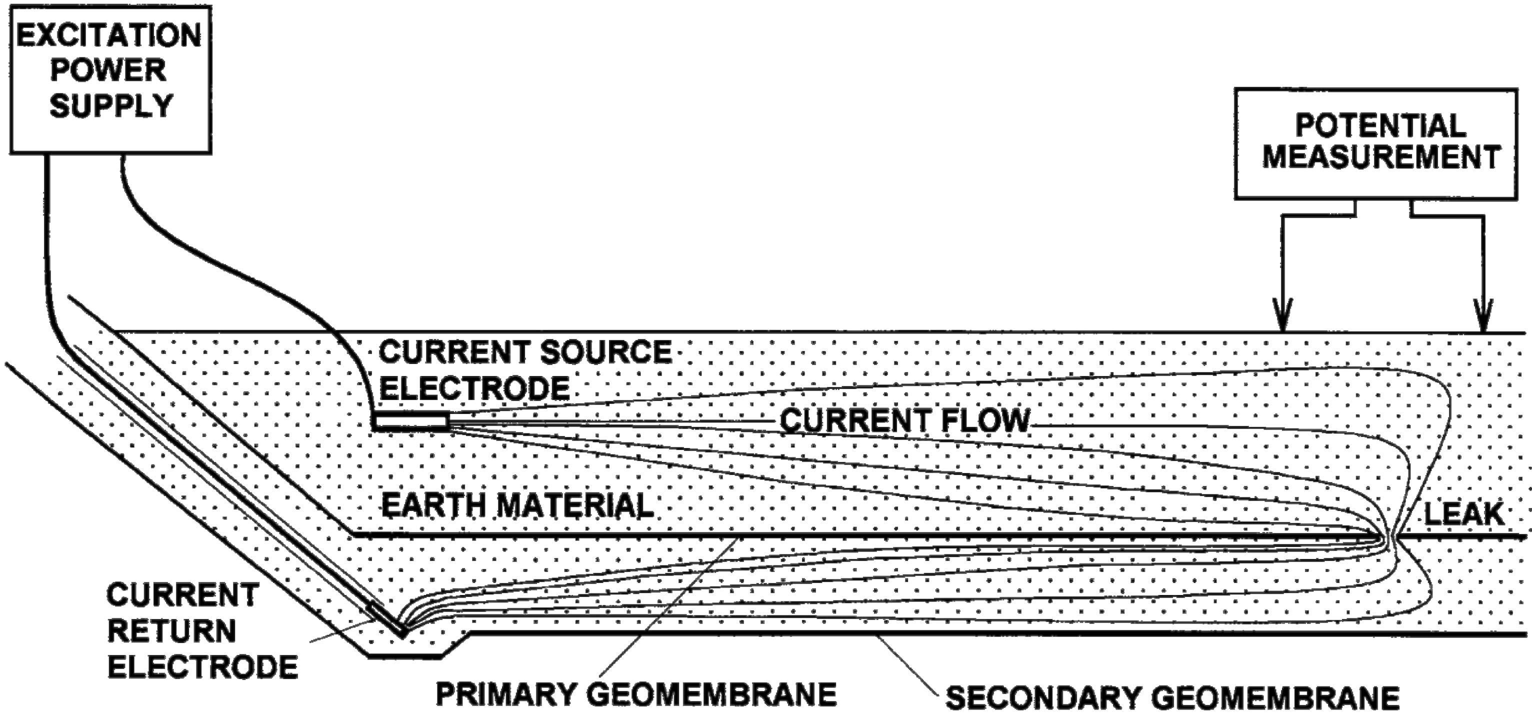
FIGURE 5

PROJECT NO: WG2487 | OCTOBER 2018

SOURCE: ALYESKA PIPELINE SERVICE CO., 2014. "VALDEZ MARINE TERMINAL, VMT IWWS LIFECYCLE REPAIRS (2014), TYPICAL LINER TO SHAFT ATTACHMENT DETAIL," DRAWING D-54-Z687-C2, 14 FEB 2014.



SOURCE: ASTM STANDARD D7007

ELECTRIC LEAK LOCATION SURVEY
LINER INTEGRITY EVALUATION
VALDEZ MARINE TERMINAL
VALDEZ, ALASKA

Geosyntec consultants

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FIGURE 6

APPENDIX A

Vendor Information

Appendix A – Vendor Information

The following table includes potential vendors that could perform ELL and/or geophysical services at the VMT:

Vendor	Services
HydroGeophysics www.hgiworld.com Located in Washington, California, Arizona	ELL and geophysics
Leak Location Services, Inc. www.llsi.com Located in San Antonio, Texas	ELL
Logic Geophysical and Analytics LLC. www.logicgeophysics.com Located in Anchorage, Alaska	Geophysics

Geosyntec is not aware of a project similar to VMT where tracer gas testing has been implemented to identify defects in a liner system and cannot recommend vendors suited to perform that work. At this time, Geosyntec would anticipate working with a geophysics vendor to develop a work plan and pilot testing program for tracer gas testing.

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