

## Part 2 – Technical Requirements

Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area, and/or manure storage facility(ies)

<b>NRCB USE ONLY</b>	Application number <b>RA23022</b>	Legal land description <b>NW 15-42-16 W4M</b>
<input checked="" type="checkbox"/> Approval <input type="checkbox"/> Registration <input type="checkbox"/> Authorization <input type="checkbox"/> Amendment		

### APPLICATION DISCLOSURE

This information is collected under the authority of the *Agricultural Operation Practices Act (AOPA)*, and is subject to the provisions of the *Freedom of Information and Protection of Privacy Act*. This information is public unless the NRCB grants a written request that certain sections remain private.

**Any construction prior to obtaining an NRCB permit is an offence and is subject to enforcement action, including prosecution.**

I, the applicant, or applicant’s agent, have read and understand the statements above, and I acknowledge that the information provided in this application is true to the best of my knowledge.

\_\_\_\_\_  
Date of signing

Emily Jocelyn Low -- P. Eng. - APEGA  
Digitally signed by Emily Jocelyn Low – P. Eng. - APEGA  
Date: 2024.04.10 15:30:07 -06'00'

\_\_\_\_\_  
Signature

Envirowest Engineering

Corporate name (if applicable)

Print name

AO Note: Mitchel Kroetsch signed the part 1, and gave Envirowest Engineering permission to act as his agent for application purposes.

### GENERAL INFORMATION REQUIREMENTS

**Proposed facilities:** list all proposed confined feeding operation facilities and their dimensions. Indicate whether any of the proposed facilities are additions to existing facilities. (attach additional pages if needed)

Proposed facilities	Dimensions (m) (length, width, and depth)
Feedlot pens and alleys	208 m x 502 m
Catch Basin 1	53 m x 44 m x 3.5 m
Catch Basin 2	46 m x 36 m x 3.5 m

**Existing facilities:** list ALL existing confined feeding operation facilities and their dimensions

Existing facilities	Dimensions (m) (length, width, and depth)	NRCB USE ONLY
N/A		

<b>NRCB USE ONLY</b>  New proposed CFO; no existing facilities
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If a new facility is replacing an old facility, please explain what will happen to the old facility and when.  N/A

Construction completion date for proposed facilities Spring 2024

**Additional information**

**Livestock numbers:** Complete only if livestock numbers are different from what was identified in the Part 1 application. Note: if livestock numbers increase in your Part 2 application, a new Part 1 application must be submitted which may result in a loss of priority for minimum distance separation (MDS).

Livestock category and type (Available in the Schedule 2 of the Part 2 Matters Regulation)	Permitted number	Proposed increase or decrease in number (if applicable)	Total
Feeders		2500	2500
Finishers		2500	2500

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### DECLARATION AND ACKNOWLEDGMENT OF APPLICANT CONCERNING WATER ACT LICENCE

issued by Alberta Environment and Protected Areas (EPA) for a confined feeding operation (CFO)

*Date and sign one of the following four options*

#### **OPTION 1: Applying through the NRCB for both the AOPA permit and the Water Act licence**

I **DO** want my water licence application coupled to my AOPA permit application.

Signed this \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
*Signature of Applicant or Agent*

#### **OPTION 2: Processing the AOPA permit and Water Act licence separately**

1. I (we) acknowledge that the CFO will need a new water licence from EPA under the *Water Act* for the development or activity proposed in this AOPA application.
2. I (we) request that the NRCB process the AOPA application **independently of** EPA's processing of the CFO's application for a water licence.
3. In making this request, I (we) recognize that, if this AOPA application is granted by the NRCB, the NRCB's decision will not be considered by EPA as improving or enhancing the CFO's eligibility for a water licence under the *Water Act*.
4. I (we) acknowledge that any construction or actions to populate the CFO with livestock pursuant to an AOPA permit in the absence of a *Water Act* licence will **not** be relevant to EPA's consideration of whether to grant the *Water Act* licence application.
5. I (we) acknowledge that any such construction or livestock populating will be at the CFO's sole risk if the *Water Act* licence application is denied or if the operation of the CFO is otherwise deemed to be in violation of the *Water Act*. This risk includes being required to depopulate the CFO and/or to cease further construction, or to remove "works" or "undertakings" (as defined in the *Water Act*).
6. **AS RELEVANT:** I (we) acknowledge that the CFO is located in the South Saskatchewan River Basin and that, pursuant to the *Bow, Oldman and South Saskatchewan River Basin Water Allocation Order* [Alta. Reg. 171/2007], this basin is currently closed to new surface water allocations.
7. **Provide:** Water licence application number(s) In process

Signed this \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

Emily Jocelyn Low -- P. Eng. -  
APEGA

Digitally signed by Emily Jocelyn Low -- P. Eng. -  
APEGA  
Date: 2024.03.21 17:03:44 -06'00'

\_\_\_\_\_  
*Signature of Applicant or Agent*

#### **OPTION 3: Additional water licence not required**

1. I (we) declare that the CFO will not need a new licence from EPA under the *Water Act* for the development or activity proposed in this AOPA application.
2. **Provide:** Water license number(s) or water conveyance agreement details \_\_\_\_\_

Signed this \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
*Signature of Applicant or Agent*

## Part 2 – Technical Requirements

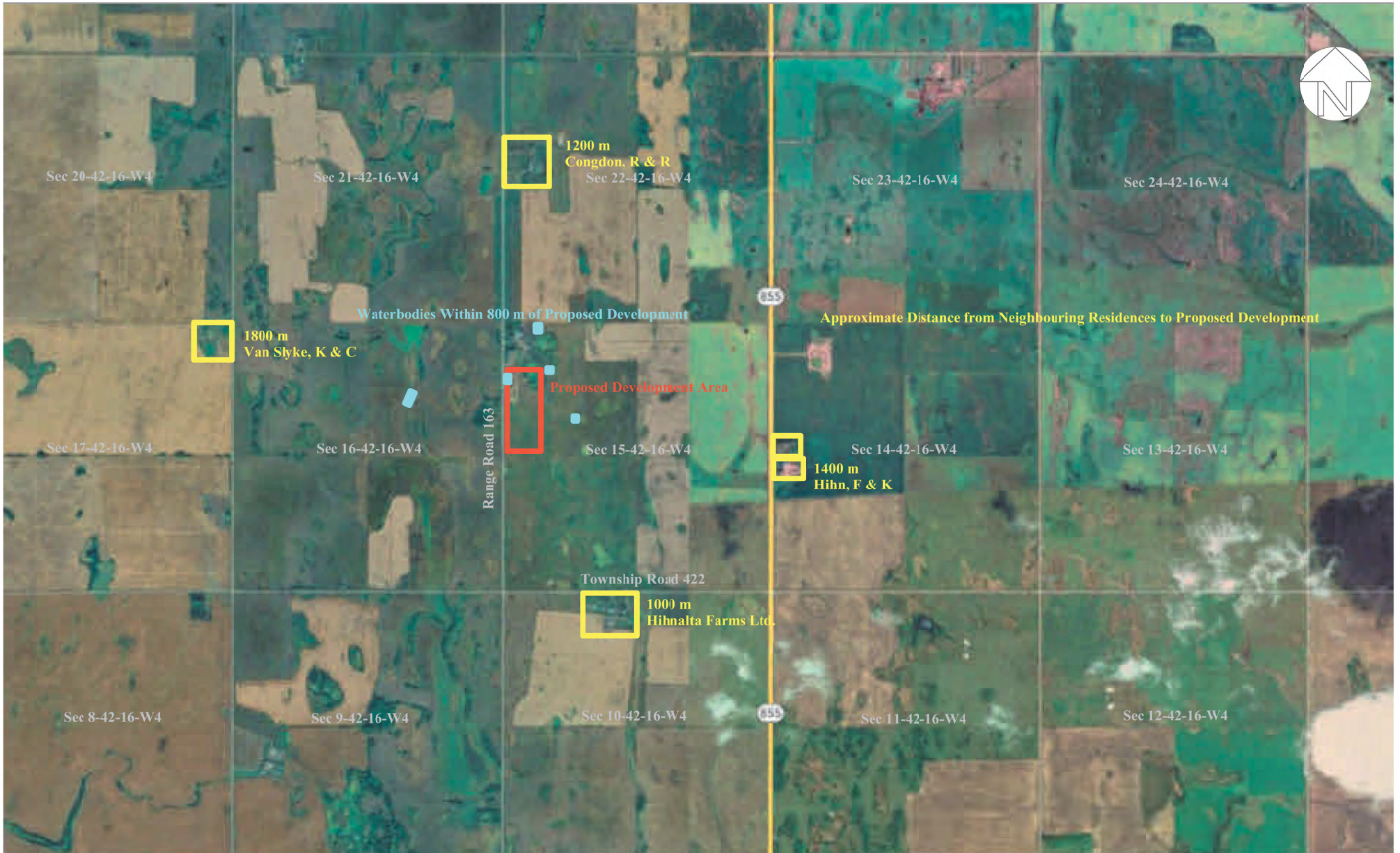
Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area, and/or manure storage facility(ies)

### **OPTION 4: Uncertain if *Water Act* licence is needed; acknowledgement of risk (for existing CFOs only)**

1. At this time, I (we) do not know whether a new water licence is needed from EPA under the *Water Act* for the development or activity proposed in this AOPA application.
2. If a new *Water Act* licence is needed, I (we) request that the NRCB process the AOPA application **independently of** EPA's processing of the CFO's application for a water licence.
3. In making this request, I (we) recognize that, if this AOPA application is granted by the NRCB, the NRCB's decision will not be considered by EPA as improving or enhancing the CFO's eligibility for a water licence under the *Water Act*.
4. I (we) acknowledge that any construction or actions to populate the CFO with additional livestock pursuant to an AOPA permit in the absence of a *Water Act* licence will **not** be relevant to EPA's consideration of whether to grant my *Water Act* licence application, if a new water licence is needed.
5. I (we) acknowledge that any such construction or livestock increase will be at the CFO's sole risk if the *Water Act* licence application is denied or if the operation of the CFO is otherwise deemed to be in violation of the *Water Act*. This risk includes being required to depopulate the CFO and/or to cease further construction, or to remove "works" or "undertakings" (as defined in the *Water Act*).
6. **AS RELEVANT:** I (we) acknowledge that the CFO is located in the South Saskatchewan River Basin and that, pursuant to the *Bow, Oldman and South Saskatchewan River Basin Water Allocation Order* [Alta. Reg. 171/2007], this basin is currently closed to new surface water allocations.
7. **Provide:** Water license number(s) or water conveyance agreement details \_\_\_\_\_

Signed this \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_,

\_\_\_\_\_  
*Signature of Applicant or Agent*



**Title:**

Detailed Site Layout Plan  
 Part II Technical Requirements  
 Mitchel Kroetsch  
 NW-15-042-16-W4M  
 Flagstaff County, Alberta

**Project No:**

2304-43021

**Date:**

March 12, 2024

**Scale:**

**Prepared By:**

L. Predy

**Image Source:**

Google Earth Pro (2022)

**Figure No.:**

**1.0**

Page 5 of 92



**Title:**

Detailed Site Layout Plan  
Part II Technical Requirements  
Mitchel Kroetsch  
NW-15-042-16-W4M  
Flagstaff County, Alberta

**Project No:**

2304-43021

**Date:**

March 12, 2024

**Scale:**

**Prepared By:**

L. Predy

**Image Source:**

Google Earth Pro (2022)

**Figure No.:**

2.0

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→ SURFACE WATER WILL BE DIRECTED TO EACH RESPECTIVE CATCH BASIN THROUGH SURFACE GRADING AT APPROXIMATELY 0.5% AND CULVERTS WHERE NEEDED

⊕ 23BH04

CB 2

Area 2

Approximate PL ROW

Proposed Solid Manure Storage Area

⊕ 23BH05

CB 1

Area 1

⊕ 23BH03

⊕ 23BH01

⊕ 23BH02

SW CORNER OF CONSTRUCTION AREA APPROXIMATELY 30 M FROM CENTER OF ROAD



**Title:** Borehole Locations and Proposed Surface Water Flow Site and Soil Assessment  
NW-15-42-16 W4M  
Flagstaff County, Alberta

**Project No:** 2304-43021

**Date:** March 21, 2024

**Figure No.:**

**Scale:** 1:3500

**Prepared By:** E. Low

**2.0**

**Image Source:**

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Google Earth Pro (2022)

# Part 2 – Technical Requirements

Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area, and/or manure storage facility(ies)

## GENERAL ENVIRONMENTAL INFORMATION

*(complete this section for the worst case of the existing facility which is the closest to water bodies or water wells and for each of the proposed facilities)*

Facility description / name *(as indicated on site plan)*

Existing: \_\_\_\_\_

Proposed 1: Feedlot Pens + Catch Basin 1

Proposed 2: Catch Basin 2

Proposed 3: \_\_\_\_\_

Facility and environmental risk information		Facilities				NRCB USE ONLY	
		Existing	Proposed 1	Proposed 2	Proposed 3	Meets requirements	Comments
Flood plain information	What is the elevation of the floor of the lowest manure storage or collection facility above the 1:25 year flood plain or the highest known flood level?	<input type="checkbox"/> >1 m <input type="checkbox"/> ≤ 1 m	<input checked="" type="checkbox"/> >1 m <input type="checkbox"/> ≤ 1 m	<input checked="" type="checkbox"/> >1 m <input type="checkbox"/> ≤ 1 m	<input type="checkbox"/> > 1 m <input type="checkbox"/> ≤ 1 m	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES with exemption	Confirmed
	How many springs are within 100 m of the manure storage facility or manure collection area?		0	0		<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES with exemption	No springs observed during site visit
Surface water information	How many water wells are within 100 m of the manure storage facility or manure collection area?		0	0		<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES with exemption	No water wells observed within 100 m of proposed facilities New well >100 m from proposed.
	What is the shortest distance from the manure collection or storage facility to a surface water body? (e.g., lake, creek, slough, seasonal)		Existing dugout is within	60		<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES with exemption	39 m to dugout from pens; ephemeral creek >1100 m east
Groundwater information	What is the depth to the water table?		> 6.0 m	> 6.0 m		<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES with exemption	Confirmed
	What is the depth to the groundwater resource/aquifer you draw water from?		64-73	64-73		<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES with exemption	UGR identified at 60.06 m in WW 105363

**Additional information (attach supporting information, e.g. borehole logs, records, etc. you consider relevant to your application)**

There is an existing dugout within the west boundary of the proposed pen construction area. This dugout will be filled in.



## Part 2 – Technical Requirements

Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area, and/or manure storage facility(ies)

### DISTANCE OF ANY MANURE STORAGE FACILITY (EXISTING OR PROPOSED) TO NEIGHBOURING RESIDENCES

Neighbour name(s)	Legal land description	Distance (m)	NRCB USE ONLY				
			Zoning (LUB) category	MDS category (1-4)	Distance (m)	Waiver attached (if required)	Meets regulations
Hihnalta Farms Ltd.	NW-10-42-16-W4	1000	Ag	1	1000 m		Yes
R & R Congdon	NW-22-42-16-W4	1200	Ag	1	1100 m		Yes
F & K Hihn	NW-14-42-16-W4	1400	Ag	1	1485 m		Yes
F & K Hihn	SW-14-42-16-W4	1400	Ag	1	1430 m		Yes
K & C Van Slyke	NE-17-42-16-W4	1800	Ag	1	1780 m		Yes

### LAND BASE FOR MANURE AND COMPOST APPLICATION (complete only if an increase in livestock or manure production will occur)

Name of land owner(s)*	Legal land description	Usable area** (ha)	Soil zone ***	NRCB USE ONLY	
				Usable area (ha)	Agreement attached (if required)
See attached					
Total					

\* If you are **not** the registered landowner, you must attach copies of land use agreements signed by all landowners.

\*\* Available manure spreading area (excluding setback areas from residences, common bodies of water, water wells, etc. as identified in Agdex 096-5 [Manure Spreading Regulations](#))

\*\*\* Brown, dark brown, black, grey wooded, or irrigated

**Additional information (attach any additional information as required)**

<b>Name of Landowners</b>	<b>Land Location</b>	<b>Acres</b>	<b>Soil Zone</b>
Barbara and Colin Kroetsch	SW-3-43-16-W4	117	Black
Barbara and Colin Kroetsch	SE-31-43-16-W4	110	Black
Barbara and Colin Kroetsch	SW-31-43-16-W4	148	Black
Barbara and Colin Kroetsch	NE-24-43-17-W4	130	Black
Betty and Debbie Henderson	E½-29-41-16-W4	264	Black
Betty and Debbie Henderson	SW-29-41-16-W4	150	Black
Betty and Debbie Henderson	SE-30-41-16-W4	150	Black
Lorraine J Henderson	NE-26-41-16-W4	155	Black
Lorraine J Henderson	NE-27-41-16-W4	143	Black
Lorraine J Henderson	SW-6-42-15-W4	147	Black

AO Note: The applicant has provided 1,514 ac of land with black soil





# LANDOWNER CONSENT

For the purpose of manure spreading

Date: January 10, 2024

Lorraine J Henderson of Forestburg Alberta  
(Name) (Town/City)

Do hereby give consent for Mitchel Kroetsch to spread feedlot manure on the following lands:

Legal Land Description	Acres Available
NE 26 041 16 4	155
NE 27 041 16 4	143
SW 6 042 15 4	147
	AO: 445 ac

This agreement shall remain in effect continuously for 5 years.  
(Number)

Land Owner Lorraine Henderson  
(Print name)



(Signature)

Feedlot Owner Mitchel Kroetsch  
(Print name)



(Signature)

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## NRCB USE ONLY

### MINIMUM DISTANCE SEPARATION

Methods used to determine distance (if applicable): Aerial photography

Margin of error (if applicable): +/- 5 m

Requirements (m): Category 1: 624 m Category 2: 831 m Category 3: 1039 m Category 4: 1663 m

Technology factor:  YES  NO

Expansion factor:  YES  NO

MDS related concerns from directly affected parties or referral agencies:  YES  NO

### LAND BASE FOR MANURE AND COMPOST APPLICATION

Land base required: 791 ac black soil

Land base listed: 1514 ac

Area not suitable: already accounted for

Available area 1514 ac

Requirement met:  YES  NO

Land spreading agreements required:  YES  NO

Manure management plan:  YES  NO

If yes, plan is attached:

### PLANS

Submitted and attached construction plans:  YES  NO

Submitted aerial photos:  YES  NO

Submitted photos:  YES  NO

### GRANDFATHERING

Already completed:  YES  NO  N/A

If already completed, see \_\_\_\_\_

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**NRCB USE ONLY**  
**WATER WELL AND SURFACE WATER INFORMATION**

Well IDs: 105363 296831 New 2024 well

Surface water related concerns from directly affected parties or referral agencies:  YES  NO  
 Groundwater related concerns from directly affected parties or referral agencies:  YES  NO

**Water wells**  N/A  
 If applicable, exemption for 100 m distance requirements applied:  YES  NO Condition required:  YES  NO

**Surface water**  N/A  
 If applicable, exemption for 30 m distance requirements applied:  YES  NO Condition required:  YES  NO

**Water Well Exemption Screening Tool**  N/A

Water Well ID	Preliminary Screening Score	Secondary Screening Score	Facility

**Groundwater or surface water related comments:**

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**NRCB USE ONLY**

**ALL SIGNATURES IN FILE**  YES  NO

**DATES OF APPROVAL OFFICER SITE VISITS**

April 24, 2024	

**CORRESPONDENCE WITH MUNICIPALITIES AND REFERRAL AGENCIES**

Date deeming letters sent: May 1, 2024

Municipality: Flagstaff County

letter sent     response received     written/email     verbal     no comments received

**Alberta Health Services:**     N/A (responses with health related concerns were forwarded to AHS)

letter sent     response received     written/email     verbal     no comments received

**Alberta Environment and Parks:**     N/A

letter sent     response received     written/email     verbal     no comments received

**Alberta Transportation:**     N/A

letter sent     response received     written/email     verbal     no comments received

**Alberta Regulatory Services:**     N/A

letter sent     response received     written/email     verbal     no comments received

**Other:** Nova Chemicals Corp, TC Energy, Signalta Resources Ltd     N/A

letter sent     response received     written/email     verbal     no comments received

**Other:** Phoenix Gas Co-op, Calpine Canada Resources Ltd     N/A

letter sent     response received     written/email     verbal     no comments received



# Part 2 – Technical Requirements

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**NRCB USE ONLY**  
**ENVIRONMENTAL RISK SCREENING INFORMATION**

ERST for **proposed** facilities

Facility	Groundwater score	Surface water score	File number
Feedlot pens	Low	Low	RA23022
Catch basin 1	Low	Low	RA23022
Catch basin 2	Low	Low	RA23022

ERST for **existing** facilities

Facility	Groundwater score	Surface water score	File number
No existing CFO facilities			

ERST related comments:



# Water Well Drilling Report

[View in Imperial](#) [Export to Excel](#)

GIC Well ID 105363  
GoA Well Tag No.  
Drilling Company Well ID  
Date Report Received 1982/09/01

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GOWN ID

Well Identification and Location										Measurement in Metric	
<b>Owner Name</b> KROETCH, COLIN		<b>Address</b> HEISLER		<b>Town</b>		<b>Province</b>		<b>Country</b>		<b>Postal Code</b>	
<b>Location</b>	<b>1/4 or LSD</b>	<b>SEC</b>	<b>TWP</b>	<b>RGE</b>	<b>W of MER</b>	<b>Lot</b>	<b>Block</b>	<b>Plan</b>	<b>Additional Description</b>		
	NW	15	42	16	4						
<b>Measured from Boundary of</b>				<b>GPS Coordinates in Decimal Degrees (NAD 83)</b>							
_____ m from _____				Latitude <u>52.619687</u> Longitude <u>-112.229984</u>				Elevation: _____ m			
_____ m from _____				How Location Obtained _____				How Elevation Obtained _____			
				Map				Not Obtained			

Drilling Information	
<b>Method of Drilling</b> Rotary	<b>Type of Work</b> New Well
<b>Proposed Well Use</b> Domestic	

Formation Log			Measurement in Metric
Depth from ground level (m)	Water Bearing	Lithology Description	
3.05		Brown Clay	
4.57		Coal	
41.15		Gray Shale	
41.76		Coal	
60.05		Gray Shale	
64.31		Blue Sand	

Yield Test Summary			Measurement in Metric
<b>Recommended Pump Rate</b> <u>27.28</u> L/min			
<b>Test Date</b>	<b>Water Removal Rate (L/min)</b>	<b>Static Water Level (m)</b>	
1982/06/21	27.28	23.16	

Well Completion				Measurement in Metric
<b>Total Depth Drilled</b>	<b>Finished Well Depth</b>	<b>Start Date</b>	<b>End Date</b>	
64.31 m		1982/06/18	1982/06/21	
<b>Borehole</b>				
<b>Diameter (cm)</b>	<b>From (m)</b>	<b>To (m)</b>		
0.00	0.00	64.31		
<b>Surface Casing (if applicable)</b>		<b>Well Casing/Liner</b>		
Steel				
<b>Size OD :</b>	<u>11.43</u> cm	<b>Size OD :</b>	<u>0.00</u> cm	
<b>Wall Thickness :</b>	<u>0.396</u> cm	<b>Wall Thickness :</b>	<u>0.000</u> cm	
<b>Bottom at :</b>	<u>61.26</u> m	<b>Top at :</b>	<u>0.00</u> m	
		<b>Bottom at :</b>	<u>0.00</u> m	
<b>Perforations</b>				
<b>From (m)</b>	<b>To (m)</b>	<b>Diameter or Slot Width (cm)</b>	<b>Slot Length (cm)</b>	<b>Hole or Slot Interval (cm)</b>
Perforated by _____				
<b>Annular Seal</b> Driven				
Placed from <u>0.00</u> m to <u>61.26</u> m				
Amount _____				
Other Seals				
<b>Type</b>		<b>At (m)</b>		
<b>Screen Type</b> Stainless Steel				
Size OD : <u>7.95</u> cm				
<b>From (m)</b>	<b>To (m)</b>	<b>Slot Size (cm)</b>		
61.57	64.31	0.018		
Attachment <u>Attached To Riser</u>				
<b>Top Fittings</b> Neoprene (Figure <u>K</u> )		<b>Bottom Fittings</b> Bail _____		
<b>Pack</b>				
<b>Type</b> <u>Natural</u>		<b>Grain Size</b> _____		
Amount _____				

Contractor Certification	
<b>Name of Journeyman responsible for drilling/construction of well</b> UNKNOWN NA DRILLER	<b>Certification No</b> 1
<b>Company Name</b> LOSNESS DRILLING (1975) LTD.	<b>Copy of Well report provided to owner</b> <b>Date approval holder signed</b>



# Water Well Drilling Report

[View in Imperial](#) [Export to Excel](#)

GIC Well ID 105363  
GoA Well Tag No.  
Drilling Company Well ID  
Date Report Received 1982/09/01

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GOWN ID

Well Identification and Location										Measurement in Metric	
<b>Owner Name</b> KROETCH, COLIN		<b>Address</b> HEISLER			<b>Town</b>		<b>Province</b>		<b>Country</b>		<b>Postal Code</b>
<b>Location</b>	<i>1/4 or LSD</i> NW	<i>SEC</i> 15	<i>TWP</i> 42	<i>RGE</i> 16	<i>W of MER</i> 4	<i>Lot</i>	<i>Block</i>	<i>Plan</i>	<i>Additional Description</i>		
<b>Measured from Boundary of</b>				<b>GPS Coordinates in Decimal Degrees (NAD 83)</b>							
_____ m from _____				Latitude <u>52.619687</u> Longitude <u>-112.229984</u>				Elevation: _____ m			
_____ m from _____				How Location Obtained _____				How Elevation Obtained _____			
				Map _____				Not Obtained			

Additional Information										Measurement in Metric
Distance From Top of Casing to Ground Level _____ cm										
Is Artesian Flow _____					Is Flow Control Installed _____					
Rate _____ L/min					Describe _____					
Recommended Pump Rate _____ 27.28 L/min					Pump Installed Yes _____					Depth _____ m
Recommended Pump Intake Depth (From TOC) _____ 59.74 m					Type SUB _____					Make _____ H.P. 5
										Model (Output Rating) _____
Did you Encounter Saline Water (>4000 ppm TDS) _____					Depth _____ m		Well Disinfected Upon Completion _____			
Remedial Action Taken _____					Gas _____ Depth _____ m		Geophysical Log Taken _____			
										Submitted to ESRD _____
										Sample Collected for Potability _____ Submitted to ESRD _____
Additional Comments on Well _____										

Yield Test			Taken From Ground Level	Measurement in Metric
			Depth to water level	
Test Date 1982/06/21	Start Time 12:00 AM	Static Water Level 23.16 m		
			Pumping (m)	Recovery (m)
			Elapsed Time Minutes:Sec	
<b>Method of Water Removal</b>				
Type <u>Bailer &amp; Pump</u>				
Removal Rate <u>27.28 L/min</u>				
Depth Withdrawn From <u>54.25 m</u>				
If water removal period was < 2 hours, explain why _____				

Water Diverted for Drilling		
Water Source	Amount Taken _____ L	Diversion Date & Time

Contractor Certification	
Name of Journeyman responsible for drilling/construction of well UNKNOWN NA DRILLER	Certification No 1
Company Name LOSNESS DRILLING (1975) LTD.	Copy of Well report provided to owner _____ Date approval holder signed _____



# Water Well Drilling Report

**View in Imperial** **Export to Excel**

GIC Well ID 296831  
GoA Well Tag No.  
Drilling Company Well ID  
Date Report Received 2001/08/16

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GOWN ID

Well Identification and Location										Measurement in Metric	
<b>Owner Name</b> KROETCH, COLIN		<b>Address</b> HEISLER		<b>Town</b>		<b>Province</b>		<b>Country</b>		<b>Postal Code</b> T0B 2A0	
<b>Location</b>	<i>1/4 or LSD</i>	<i>SEC</i>	<i>TWP</i>	<i>RGE</i>	<i>W of MER</i>	<i>Lot</i>	<i>Block</i>	<i>Plan</i>	<i>Additional Description</i>		
	13	15	42	16	4						
<b>Measured from Boundary of</b>				<b>GPS Coordinates in Decimal Degrees (NAD 83)</b>							
396.24 m from North				Latitude 52.619742		Longitude -112.233001		Elevation _____ m			
198.12 m from West				How Location Obtained				How Elevation Obtained			
				Map				Not Obtained			

Drilling Information	
<b>Method of Drilling</b> Rotary	<b>Type of Work</b> New Well
<b>Proposed Well Use</b> Domestic	

Formation Log			Measurement in Metric
Depth from ground level (m)	Water Bearing	Lithology Description	
3.35		Brown Clay & Boulders	
17.07		Gray Clay	
22.56		Light Gray Shale	
41.15		Gray Shale	
43.59		Brown Shale & Coal	
61.87		Brown Shale	
71.32		Blue Sandstone	
72.54		Gray Shale	
73.15		Rocks	

Yield Test Summary			Measurement in Metric
<b>Recommended Pump Rate</b>			45.46 L/min
Test Date	Water Removal Rate (L/min)	Static Water Level (m)	
2001/07/20	68.19	26.46	

Well Completion				Measurement in Metric
<b>Total Depth Drilled</b>	<b>Finished Well Depth</b>	<b>Start Date</b>	<b>End Date</b>	
73.15 m		2001/07/17	2001/07/20	
<b>Borehole</b>				
<b>Diameter (cm)</b>	<b>From (m)</b>	<b>To (m)</b>		
0.00	0.00	73.15		
<b>Surface Casing (if applicable)</b>		<b>Well Casing/Liner</b>		
Plastic				
<b>Size OD :</b>	12.70 cm	<b>Size OD :</b>	0.00 cm	
<b>Wall Thickness :</b>	0.953 cm	<b>Wall Thickness :</b>	0.000 cm	
<b>Bottom at :</b>	68.28 m	<b>Top at :</b>	0.00 m	
		<b>Bottom at :</b>	0.00 m	
<b>Perforations</b>				
From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)
Perforated by				
<b>Annular Seal</b> Bentonite Chips/Tablets				
Placed from 0.00 m to 64.01 m				
Amount _____				
Other Seals				
Type		At (m)		
<b>Screen Type</b> Stainless Steel				
Size OD : 12.70 cm				
From (m)	To (m)	Slot Size (cm)		
68.28	71.32	0.038		
Attachment Attached To Casing				
Top Fittings Packer		Bottom Fittings Plug		
<b>Pack</b>				
Type Artificial		Grain Size 10-20		
Amount 12.00 Bags				

Contractor Certification	
Name of Journeyman responsible for drilling/construction of well UNKNOWN NA DRILLER	Certification No 1
Company Name LOSNESS DRILLING (1975) LTD.	Copy of Well report provided to owner Date approval holder signed



# Water Well Drilling Report

[View in Imperial](#) [Export to Excel](#)

GIC Well ID 296831  
GoA Well Tag No.  
Drilling Company Well ID  
Date Report Received 2001/08/16

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GOWN ID

Well Identification and Location										Measurement in Metric		
<b>Owner Name</b> KROCTCH, COLIN		<b>Address</b> HEISLER			<b>Town</b>		<b>Province</b>		<b>Country</b>		<b>Postal Code</b> T0B 2A0	
<b>Location</b>	<i>1/4 or LSD</i> 13	<i>SEC</i> 15	<i>TWP</i> 42	<i>RGE</i> 16	<i>W of MER</i> 4	<i>Lot</i>	<i>Block</i>	<i>Plan</i>	<i>Additional Description</i>			
<b>Measured from Boundary of</b>					<b>GPS Coordinates in Decimal Degrees (NAD 83)</b>							
396.24 m from North					Latitude 52.619742		Longitude -112.233001		Elevation _____ m			
198.12 m from West					How Location Obtained					How Elevation Obtained		
					Map					Not Obtained		

Additional Information										Measurement in Metric	
<b>Distance From Top of Casing to Ground Level</b> _____ cm											
<b>Is Artesian Flow</b> _____					<b>Is Flow Control Installed</b> _____						
Rate _____ L/min					Describe _____						
<b>Recommended Pump Rate</b> _____ 45.46 L/min					<b>Pump Installed</b> Yes _____		<b>Depth</b> _____ m				
<b>Recommended Pump Intake Depth (From TOC)</b> _____ 67.06 m					<b>Type</b> SUB _____		<b>Make</b> GOULDS _____		<b>H.P.</b> 1 _____		
										<b>Model (Output Rating)</b> _____	
<b>Did you Encounter Saline Water (&gt;4000 ppm TDS)</b> _____					<b>Depth</b> _____ m		<b>Well Disinfected Upon Completion</b> _____				
<b>Remedial Action Taken</b>					<b>Gas</b> _____		<b>Depth</b> _____ m		<b>Geophysical Log Taken</b> _____		
										<b>Submitted to ESRD</b> _____	
										<b>Sample Collected for Potability</b> _____	
										<b>Submitted to ESRD</b> _____	
<b>Additional Comments on Well</b>											
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 1.5'. HARDNESS 2 GRAINS, IRON .05 PPM, PH 7.3. WELL CHLORINATED. WATER HAULED FROM LOSNESS SHOP 4000 GALS IN 3 DAYS.											

Yield Test			Taken From Ground Level	Measurement in Metric
<b>Test Date</b> 2001/07/20	<b>Start Time</b> 12:00 AM	<b>Static Water Level</b> 26.46 m	<b>Depth to water level</b>	
<b>Method of Water Removal</b>			<b>Pumping (m)</b>	<b>Elapsed Time</b> Minutes:Sec
Type <b>Pump</b> _____				<b>Recovery (m)</b>
Removal Rate _____ 68.19 L/min			26.47	0:00
Depth Withdrawn From _____ 67.06 m			31.93	1:00
			35.21	2:00
			37.57	3:00
			39.25	4:00
			40.48	5:00
			41.46	6:00
			42.16	7:00
			42.64	8:00
			43.03	9:00
			43.32	10:00
			43.75	12:00
			44.06	14:00
			44.30	16:00
			44.53	20:00
			44.82	25:00
			44.97	30:00
			45.26	35:00
			45.38	40:00
			45.60	50:00
			45.80	60:00
			45.98	75:00
			46.01	90:00
			46.05	105:00
			46.09	120:00

Water Diverted for Drilling		
<b>Water Source</b>	<b>Amount Taken</b> L	<b>Diversion Date &amp; Time</b>

Contractor Certification		
<b>Name of Journeyman responsible for drilling/construction of well</b> UNKNOWN NA DRILLER	<b>Certification No</b> 1	
<b>Company Name</b> LOSNESS DRILLING (1975) LTD.	<b>Copy of Well report provided to owner</b>	<b>Date approval holder signed</b>

# Part 2 – Technical Requirements

Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area and/or manure storage facility(ies)

## RUNOFF CONTROL CATCH BASIN: Synthetic liner

(complete a copy of this section for **EACH** proposed manure storage facility with a synthetic liner)

Facility description / name (as indicated on site plan)

1. Catch Basin 1
2. Catch Basin 2

### Determination of minimum required catch basin volume

Provide a plan and show how you calculated the area contributing to runoff for each catch basin  
See attached Envirowest Engineering Report (March, 2024)

### Catch basin capacity

	Length (m)	Width (m)	Depth (m)	Depth below ground level (m)	Slope run:rise			NRCB USE ONLY Calculated storage capacity (excl. 0.5 m freeboard) (m <sup>3</sup> )
					Inside end walls	Inside side walls	Outside walls	
1.	53	44	3.5	3.5	3:1	3:1	4:1	4017 cubic metres
2.	46	36	3.5	3.5	3:1	3:1	4:1	2529 cubic metres
TOTAL CAPACITY								6,546 cubic metres

AO Note: p. 6 of Envirowest's report proposes a total depth of 3.5 m, with all of it below grade. They also propose to construct above ground berms to redirect run-on, although this is not reflected in total depth.

### Synthetic liner details

Synthetic liner	Thickness and type of liner material 40 mil HDPE	Provide liner material details (as required)
<small>Catch Basin – Design and management requirements can be found in Technical Guideline Agdex 096-101</small>		<b>NRCB USE ONLY</b>  Requirements met: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO Condition required: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO

### Liner protection

Describe how the inside walls, bottom and outside walls are protected from erosion

A liner thickness of 40 mil of HDPE will be used to protect from erosion on the bottom and inside walls. The exterior walls (where applicable) will be soil covered.

Describe how the physical integrity of the liner will be maintained from damage

Barriers will be placed around the catch basin to avoid any physical damage to the liner.

### NRCB USE ONLY

Requirements met:  YES  NO  
Condition required:  YES  NO

# Part 2 – Technical Requirements

Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area and/or manure storage facility(ies)

## SOLID MANURE, COMPOST, & COMPOSTING MATERIALS: Barns, feedlots, & storage facilities - Naturally occurring protective layer

*(complete a copy of this section for EACH barn, feedlot, and storage facility for solid manure, composting materials, or compost with a naturally occurring protective layer for the liner)*

Facility description / name *(as indicated on site plan)*

1. Solid Manure Storage Area (AO note, this is the feedlot pen area)
2. \_\_\_\_\_

### Manure storage capacity

	Length (m)	Width (m)	Depth below ground level (m)	NRCB USE ONLY Estimated storage capacity (m <sup>3</sup> )
1.	502	208	0.4	more than 9 months
2.				
TOTAL CAPACITY				more than 9 months

I plan to use a short-term solid manure storage (STMS) as part of my manure storage and handling plan for this CFO. (The AOPA requirements for STMS are set out in the NRCB [Short-Term Solid Manure Storage Requirements Fact Sheet](#).)

### Surface water control systems

Describe the run-on and runoff control system

The south portion of the solid manure storage area, Area 1 (as shown on Figure 2.0), will be contoured so as to direct impacted runoff to Catch Basin 1. Area 2 will be contoured so as to direct impacted runoff to Catch Basin 2. Redirection and the construction of berms around the Catch Basins will prevent unimpacted runoff from entering.

### Naturally occurring protective layer details

Thickness of naturally occurring protective layer	Provide details (as required) A minimum of 0.4 m thickness is required to provide a sufficient protective barrier.		
	2.3 - 3.0 (m)		
Soil texture	53 % sand	17 % silt	29 % clay
Hydraulic conductivity - naturally occurring protective layer	Depth and type of soil tested 1.75 - 2.6 mbgs Sandy Clay Loam	Hydraulic conductivity (cm/s) 2.163 x 10 <sup>-7</sup> cm/s	Describe test standard used Slug test using AQTESOLV Bouwer-Rice method for

Additional information *(attach copies of soil test reports)*

#### NRCB USE ONLY

Requirements met:  YES  NO  
 Condition required:  YES  NO  
 Report attached:  YES  NO

AO note: Envirowest has stated that a minimum of 0.4 m thickness is required to provide a sufficient protective layer. The NRCB's Technical Guideline Agdex 096-61 "Determining Equivalent Protective Layers and Constructed Liners" states that a naturally occurring protective layer that is thinner than the regulation, but meets the hydraulic conductivity requirements, must have a minimum of 0.5 m thick protective soil cover to ensure its structural integrity. Envirowest's report states that the layer will be a minimum of 0.5 m thick. The soil investigation report shows that the layer was 2.3 to 3.0 m thick, generally at surface. However, along the south portion, there is approximately 0.8 m of overburden. The protective layer meets the minimum 0.5 m thickness

Last updated February 26, 2021

## Part 2 – Technical Requirements

Application under the *Agricultural Operation Practices Act* for a confined feeding operation, manure collection area and/or manure storage facility(ies)

NRCB USE ONLY	
RUNOFF CONTROL CATCH BASIN CAPACITY SUMMARY (if applicable)	
<b>Facility 1</b>	
Name / description Catch basin 1	Capacity 4017 cubic metres
<b>Facility 2</b>	
Name / description Catch basin 2	Capacity 2529 cubic metres
<b>Facility 3</b>	
Name / description	Capacity
<b>Facility 4</b>	
Name / description	Capacity
<b>TOTAL CAPACITY</b>	<b>6546 cubic metres</b>
<b>RUNOFF VOLUME FROM CONTRIBUTING AREAS</b>	<b>3809 cubic metres</b>
<b>MEETS AOPA RUNOFF CONTROL VOLUME REQUIREMENTS</b>	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO



# Enviro

## L I N E R **6000**

### TECHNICAL DATA & SPECIFICATIONS



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## SECTION 1

# PRODUCT OVERVIEW

“Enviro Liner® 6000 is a specialized fortified polyolefin alloy that is designed for extended life in most geomembrane applications. Fortified geomembranes are manufactured with special prime grade resins that are stabilized with advanced UV stabilizers and antioxidant additives. This provides the geomembrane with superior physical, mechanical, and endurance properties.”

Enviro Liner® 6000 is fortified with the latest in Ultra Violet/Anti Oxidant (UV/AO) stabilization packages that provides exceptional UV resistance. It is designed for long term exposed applications and very good chemical resistance. It is an excellent product choice for applications such as landfill caps, secondary containment of hydrocarbons, frac produced water, tailings dams, and waste water containment. Enviro Liner® 6000 series is manufactured by Layfield in North America and is available in thicknesses of 20, 30, 40, 50, 60 and 80 mils (0.5, 0.75, 1.0, 1.25, 1.5, 2.0 mm).

Every step in the production of an Enviro Liner® 6000 geomembrane is completed to our ISO 9000 quality management system. The Enviro Liner® 6000 series has been tested for various key performance properties and the results of these tests have been documented in this booklet. Both standard and extended warranties are available on approved applications for our Enviro Liner® 6000 series in thicknesses of 30, 40, 50, 60 and 80 mil (0.75, 1.0, 1.25, 1.5, 2.0 mm).



Figure 1. Layfield's headquarters and manufacturing facility in Vancouver, Canada.

Key performance advantages of Enviro Liner® 6000 include superior UV resistance, multiaxial properties, flexibility and chemical resistance. Enviro Liner® 6000 is NSF 61 certified allowing it to be used in drinking water applications. It also complies with the Australia water standard AS/NZS 4020 and is fish grade approved.



Figure 2. Layfield's Line 9, a wide width geomembrane manufacturing line.

Enviro Liner® 6000 is an excellent choice as a high performance geomembrane barrier in a variety of markets and applications. These include water & wastewater treatment, mining, oil & gas, waste management, agriculture, aquaculture and commercial vapor management. Enviro Liner® 6000 can be used in both primary and secondary geomembrane containment applications and for floating covers.



## SECTION 2

# PRODUCT SPECIFICATIONS

Table 1. Enviro Liner 6000 Specifications

	Performance Properties	ASTM	EL 6030	EL 6040	EL 6050	EL 6060	EL 6080	
Index	Thickness	D 5199	30 mils 0.75 mm	40 mils 1.0 mm	50 mils 1.25 mm	60 mils 1.5 mm	80 mils 2.0 mm	
	Strength at Break (min. avg)	D 66693	141 ppi 25 N/mm	180 ppi 31.5 N/mm	220 ppi 38.5 N/mm	255 ppi 44.5 N/mm	304 ppi 53 N/mm	
	Elongation at Break (min. avg) Gauge Length - 2"(50mm)	D 6693	800%	800%	800%	800%	800%	
	Trapezoidal Tear Resistance (typical)	D 751	63 lbs 280 N	90 lbs 400 N	108 lbs 480 N	132 lbs 590 N	176 lbs 780 N	
	Puncture Resistance (min. avg)	D 4833	53 lbs 236 N	67 lbs 298 N	75 lbs 333 N	90 lbs 400 N	112 lbs 500 N	
Performance	Hydrostatic Burst Strength	D 751	828 kPa 120 psi	1148 kPa 166 psi	1482 kPa 215 psi	1863 kPa 270 psi		
	Axi-Symmetric Break Strain <sup>1</sup>	D 5617	50%	50%	80%	80%	50%	
	Critical Cone Height <sup>1</sup> (Large Scale Puncture Test)	D 5514	2.0 inches 50 mm	2.0 inches 50 mm	2.0 inches 50 mm	2.0 inches 50 mm		
	Dynamic Puncture Test			306 psi 2117 kPa		560 psi 3881 kPa		
	Ozone Resistance 100 pphm @ 40°C, 168 hrs.	D 1149	No Cracks Observed					
	Flexibility Cycles Without Cracking <sup>5</sup>	D 6182	8000					
	Stress Crack Under Constant Load	D 5397	> 1000 hrs					
	Solvent Vapour Permeability <sup>1,3</sup>	D 814	Fuel C (Toluene/Octane) < 4 grams/m <sup>2</sup> .hr Diesel Fuel < 0.4 grams/m <sup>2</sup> .hr					
	Methane Permeability <sup>1,4</sup>	D 1434	2.40 x 10 <sup>-5</sup> m <sup>3</sup> /m <sup>2</sup> .day, atm					
	Water Vapor Transmission <sup>1,2</sup>	F 1249	3 x 10 <sup>-13</sup> cm/sec					
Endurance	Oxidative Induction Time (OIT)	D 3895	> 200 mins					
	High Pressure Oxidative Induction Time (HPOIT)	D 5885	> 2000 mins					
	Oven Aging at 85°C <sup>1</sup> % OIT retained after 90 days % HPOIT retained after 90 days	D 5721 D 3895/D5885	>70% >90%					
	Brine Resistance @ 90°C <sup>1</sup> % HPOIT retained	D 1693 1000 hrs	>90%					
	UV Resistance <sup>1</sup> % HPOIT retained after 1600 Hours	GRI GM13/17	>80%					
	UV Resistance Strength Retained (Black) <sup>1,2</sup>	D 4329 40,000 hrs	>90%					
	Coefficient of Liner Thermal Expansion <sup>1,3</sup>	D 696	1.4 x 10 <sup>-4</sup> m/m/°C 7.8 x 10 <sup>-5</sup> ft/ft/°F					

Notes: <sup>1</sup> Performance Properties once per formulation (as tested values) | <sup>2</sup> Tested on 30 mil | <sup>3</sup> Tested on 40 mil | <sup>4</sup> Tested on 60 mil. | <sup>5</sup> Measured on 30 mil thickness.

## SECTION 3

# MATERIAL PROPERTIES

## Definitions for Material Properties

### Index Properties

Index properties characterize a geomembrane in its manufactured state. These properties are tested to ensure quality control during manufacturing of a geomembrane. Index properties define a geomembrane's characteristics and physical properties. Examples of index properties include:

- Thickness
- Density
- Tensile Strength at break
- Elongation at break
- Trapezoidal tear
- Puncture resistance



Figure 3. Layfield Testing Lab, Vancouver, Canada

### Performance Properties

These are the properties that are tested to simulate important field conditions. They provide a more accurate indication of how a geomembrane will perform in the field. Examples of performance properties include:

- Hydrostatic Burst Strength
- Axi-Symmetric Strain
- Large Scale Puncture Test
- Dynamic Puncture test
- Barrier Properties/ Chemical Resistance
- Geomembrane Flexibility
- Multi-Axial Stress Strain Test
- Improved Surface Friction Properties
- Potable Water Certifications

### Endurance Properties

These are the properties that are tested to establish the long-term aging performance of a geomembrane. These properties provide an indication of longevity. Examples of endurance properties include:

- Weathering Resistance
- High Pressure Oxidative Induction Test
- Brine Resistance Testing

## INDEX PROPERTIES

### Tensile Strength

The Enviro Liner® 6000 formulation yielded higher tensile strength compared to HDPE without compromising the flexibility of the geomembrane. The improved formulation increased the tensile strength by almost 15% compared to our Enviro Liner® 4000 series which is manufactured in accordance with GRI GM 17. Enviro Liner® 6000 consistently yields higher tensile strengths compared to equivalent thickness of standard HDPE and LLDPE geomembranes. The 30 mil (0.75 mm) Enviro Liner® 6030 yields a tensile strength of 141 ppi (25 N/mm).

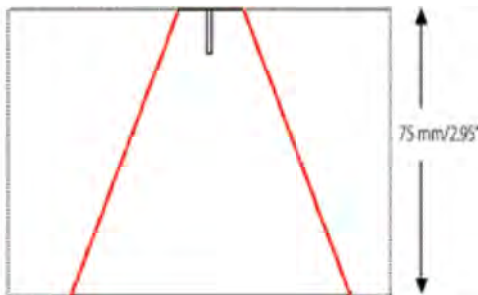


Figure 4a. Schematic of Trapezoidal tear specimen (ASTM D751)

### Tear Strength

Tear strength is an important property of geomembranes. Small scale tear tests taken from the film industry such as ASTM D1004 do not model field tearing conditions. In order to more closely model field conditions Enviro Liner® materials are tested using the trapezoidal tear test which is part of the ASTM D751 test methods.

The major difference between the two tests is the length of test specimen exposed to tear propagation across the specimen as shown in the figures below. For both ASTM D1004 and ASTM D751 the specimen is held between the grips of a tensiometer and pulled to see the resistance of material to tear propagation. In the trapezoidal tear test a small slit is made on the one of the edges as shown in the picture below.

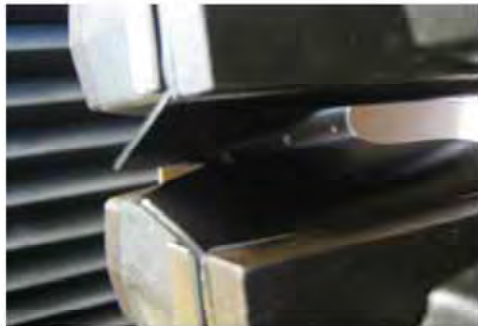


Figure 4b. Trapezoidal Tear Test on Enviro Liner® 6040

The specimen is placed between the jaws so that narrow side of the trapezoid forms a straight line with the edge of the clamp and the angled sides of trapezoid are lined up with the clamp. Since the ASTM D751 uses a wider specimen it provides a more accurate estimate of field behavior.

### Standard Puncture Test (ASTM D4833)

Standard puncture tests such as ASTM D4833 show increased puncture resistance as the tensile strength of the material increases. This test involves pushing an 8 mm diameter metal rod through a 45 mm diameter geomembrane. Figure 5 shows the metal rod and specimen mounting area on the test equipment. The ASTM D4833 is regarded as a quality control test rather than a performance test. This test does not simulate actual conditions of a geomembrane in service. Large scale puncture testing was developed to better simulate field conditions.



Figure 5. Standard Puncture Test Equipment



## PERFORMANCE PROPERTIES

### Barrier Properties/Chemical Resistance

Enviro Liner® 6000 materials are resistant to a wide range of chemicals. Enviro Liner® 6000 is resistant to most inorganic chemicals and a large number of organic chemicals. The hydrocarbon resistance of Enviro Liner® 6000 is very good and hence is suitable for a large number of oilfield applications where oil resistance is important. Enviro Liner® 6000 can be used for crude oil, drilling sumps, frac/produced water, and produced sand storage as well as ecology pits and secondary containment. Another important application is containment of brine solution in large ponds for storage of natural gas. Layfield has performed extensive brine testing at accelerated conditions to determine performance of the material to saturated salt solutions at elevated temperatures.

Enviro Liner® 6000 is suitable for secondary containment of combustible liquids and primary containment of mine tailings, potable and waste water applications. Please refer to Section 8 for a complete list of major applications.

In several occasions we encounter unique, proprietary, or mixed chemicals that need to be contained with geomembranes. With only a few hundred chemical tests available for reference and many thousands of chemicals in use there will inevitably be chemicals for which we will not have geomembrane compatibility test data. To address this issue, Layfield has developed a test container that can be shipped to the client's location pre-loaded with a variety of geomembrane samples. The client pours their liquid chemical into the container and exposes the geomembrane samples for 7 to 30 days (depending on the application). After chemical exposure the chemical is drained and the container and geomembrane samples are cleaned. The cleaned container is returned to Layfield for evaluation and testing. Layfield will then report on the compatibility of the geomembrane. Ask your Layfield representative for more details of this testing.

### Solvent Vapor Permeability

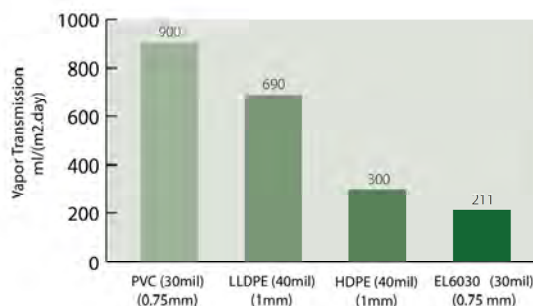
Solvent Vapor Permeability is a measure of the rate at which chemicals diffuse through the geomembrane over a period of time. In critical containment applications this is a key property. Enviro Liner® is tested against common industry chemicals to substantiate its use as a secondary containment liner. The tests were designed to measure the solvent vapor permeability and the ASTM D814 method was used as a procedural guide.

Chemical	EL6030 in grams/m <sup>2</sup> hr	EL6040 in grams/m <sup>2</sup> hr
ASTM Fuel C	≤ 10	≤ 10
ASTM IRM 902	≤ 10	≤ 10
Ethanol	≤ 10	≤ 10
Methanol	≤ 10	≤ 10

Table 2. Solvent Vapor Permeability Rates for Enviro Liner®

### Methane Permeability

Layfield tested methane permeability in accordance with ASTM D1434, (Procedure V). The permeability of polymers to gases is mainly a function of sheet density and the molecular structure of the polymer. Our Enviro Liner® shows excellent resistance against methane and shows lower values when compared to geomembrane products like High Density Polyethylene (HDPE) 40 mil (1.0 mm), Poly Vinyl Chloride (PVC) 30 mil (0.75 mm) and Linear Low Density Polyethylene (LLDPE) 40 mil (1.0 mm). Values for HDPE 40 mil (1.0 mm), PVC 30 mil (0.75 mm) and LLDPE 40 mil (1.0 mm) were extracted



Graph 1. Methane Permeability Rates for Various geomembranes

## SECTION 3 B

# PERFORMANCE PROPERTIES

## Water Vapor Permeability

Water vapor permeability with geomembranes operates in a completely different manner than water permeability in clay liners. The movement of water in clay is actually as a liquid between the particles of clay while the movement of water vapor in a geomembrane is actually molecule-by-molecule between the molecules of the plastic. This makes comparison between the two systems difficult. We are often asked if our geomembrane meets the requirements of  $1 \times 10^{-7}$  cm/sec which is the speed of movement of water through a clay. Our Enviro Liner® 6000 material was tested using ASTM F1249, which is a standard test method for "Water Vapor Transmission Rate through Plastic Film and Sheeting". This test determines the rate of water vapor transmission through flexible barrier materials. Our Enviro Liner® 6000 yielded a permeation rate of  $3 \times 10^{-13}$  cm/sec which is over one million times lower than a typical clay liner at  $1 \times 10^{-7}$  cm/sec, and about a ten thousand times lower than a geosynthetic clay liners at  $1 \times 10^{-9}$  cm/sec.

## Puncture Resistance

### Large Scale Puncture Test

There are two large scale puncture performance tests that have been performed on Enviro Liner®. These are the Truncated Cone Puncture and the Dynamic Puncture tests.

The Truncated Cone Puncture (ASTM D5514) test simulates the relative puncture resistance of a geomembrane when subjected to gradually increasing loads over a relatively large area of the specimen. The test equipment is a pressure vessel that is designed to deliver a hydrostatic pressure of up to 100 psi (690 kPa). The truncated cones are designed to simulate rocks in the field and are tapered to a 45 degree angle on top to give a sharp edge. The hydrostatic pressure is increased in the vessel until geomembrane rupture is observed.

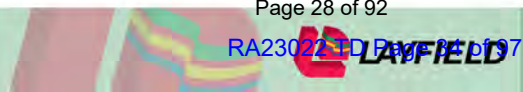


Figure 6. Truncated cones used for testing on subgrade

A modification of this test is to determine the Critical Cone Height (CCH) of a geomembrane. The CCH is a height of cone above the subgrade where an increase in pressure will not puncture the geomembrane. Typically a geomembrane would be able to resist puncture from a rock of a similar size up to 100 psi (690 kPa, about 230 ft, or 70 m of water volume). In our recent tests the CCH was found to be low for stiffer material like HDPE, with values around 35 mm/1.37". The more flexible Enviro Liner® showed higher CCH values around 50 mm (2"). Previous studies on geomembranes using large scale testing have suggested that stiffer materials tend to fail at smaller cone heights. In previous studies HDPE demonstrated cone heights as low as 10 mm/0.4". A technical report on the truncated cone testing is now available. Please contact Layfield for a copy.

The second large scale puncture test is the Dynamic Puncture Test. This test was developed by an engineering firm specializing in Heap Leach Mining and is used to validate geomembranes for use in Heap Leach projects.

The Dynamic Puncture test measures the resistance of a geomembrane to fill materials at very high confining loads. Layfield has worked closely with an industry accredited geosynthetics laboratory to measure puncture resistance of Enviro Liner® 6040 (1.0 mm) and 6060 (1.5mm) at 306 PSI (2,117 kPa), 460 PSI (3,176 kPa), and 560 PSI (3,881 kPa). We also measured Enviro Liner® 6040 (1.00mm) with a 200 g/m<sup>2</sup> geotextile. This test is very relevant to the simulation of load conditions in heap leach mining applications. A steel pressure vessel with an inside dimension of 305 mm x 305 mm and a height of 153 mm and capable of applying vertical pressures of up to 4,000 kPa was used for testing. A subgrade material was placed in the lower half of the test cell at a specified dry density and moisture content to simulate the field conditions. The



## SECTION 3 B

# PERFORMANCE PROPERTIES

geomembrane specimen was placed on this prepared soil and then covered with an overliner (select fill) material. The select fill for the overliner material was taken from an actual heap leach project and is representative of this type of application. The pressure was applied in increments of 70 kPa per minute until a pressure of 3881 kPa was reached. It was then held constant for 48 hours. A visual inspection was done after removal of the geomembrane sample. The sample was then placed in a vacuum box to observe punctures.

### Flexibility

The flexibility of geomembranes is important for installation and handling in the field. To date geomembrane flexibility has been a subjective term as different people have different perceptions on material flexibility. One material may appear to be more flexible than another based on handling. As a geomembrane manufacturer and fabricator, the challenge for us was to measure the point where a material fatigues upon exposure to constant flexing. Results from this test would compare material flexibility with other materials commonly used as geomembranes. One way of doing this was to determine the fatigue behavior in geomembrane materials when exposed to cyclic loading. Plastics, as well as other materials, subjected to cyclic loading, will fail at stress levels well below their tensile or compressive strengths. To determine geomembrane flexibility, Layfield researched available test standards that measured material flexibility; we found ASTM D6182 test that we could use to closely simulate the cyclic loading in a geomembrane. ASTM D6182 is "Standard Test Method for Flexibility and Adhesion of Finish on Leather". In this test a specimen is flexed and an endpoint is determined by rating the degree of damage after a fixed number of flexes. The specimens are subjected to flexing at 100 cycles per minute.

Applications where flexibility is desirable in a geomembrane:

- Interim and permanent Landfill Cap
- Floating Covers
- Tanks and Pond Liners
- Baffle walls in municipal clear wells
- Geomembranes exposed to a high Degree of soil deformation
- Prefabricated Products
- Flexible Membrane Liners
- Floating Covers
- Baffle Curtains

Material	Thickness (mils/mm)	# of Flex Cycles before material deterioration
Enviro Liner <sup>®</sup> 6030 (Polyolefin Alloy)	30 / 0.75	8,000
Reinforced Polypropylene (TPO)	36 / 0.91	4,000
High Density Polyethylene (HDPE)	60 / 1.50	3,000
Chlorosulfonated Polyethylene (CSPE)	36 / 0.91	2,500
Reinforced Polyethylene (RPE)	20 / 0.5	2,000

Table 3. Flex cycles for various geomembranes before material deterioration



Figure 7. Specimens mounted and tested on the flexibility test equipment

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## SECTION 3 B

# PERFORMANCE PROPERTIES

### Multi-axial Stress-Strain Test

This test measures the out of plane response of a geomembrane to a force that is applied perpendicular to the initial plane of geomembrane sample. Test results showed a substantially improved strain values for our Enviro Liner® 6000. This property is desirable in landfill cap applications where large concentration of gases can develop against the liner and push it upwards.



Figure 8a. Multi-Axial Strain Tester



Figure 8b. Inflated Enviro Liner® 6030 Cap

In 2007, Layfield installed an interim landfill cap utilizing Enviro Liner® 6030 geomembrane to prevent infiltration and the runoff entering the landfill which would potentially increase the amount of leachate that has to be treated before disposal. Subsidence and settlement of waste can occur as the waste decomposes over the period of time leaving the liner to withstand the out-of-plane deformations beneath the cover. Figure 8b. shows Enviro Liner® 6030 exposed to full landfill gas swells. (Simpson et al, 2009)

### Improved Surface Friction Properties

Surface friction properties of a liner material can be improved during manufacturing by using a process called texturing. Enviro Liner® can be textured on one or both sides to improve the interface friction properties. A smooth geomembrane with lower interface friction will have poor interaction with the soil cover and increases the concern of slope stability. When installing geomembranes on steep side slopes, the geomembrane should prevent sloughing of backfill material off of the slopes. Layfield tested our textured liner at an accredited geosynthetics laboratory to determine the interface friction angles between the soil and geomembrane. The data clearly shows that surface texturing can significantly improve the interface shear between the geomembrane and soil. Another advantage of having a textured surface is having a safe work environment. Smooth liners can get slippery due to precipitation, frost and ice build-up. Smooth geomembranes when wet act like a slide and can cause serious injury and can drastically reduce the output in such environments. Using a textured surface can increase installation safety in certain applications.

Textured Enviro Liner® 6000		
Interface	ASTM	Friction Angle
Clay	D 5321	30 degrees
Sand		30 degrees
Non Woven Geotextile		28 degrees

Table 4. Interface friction properties of textured Enviro Liner 6000 to soils & geotextile



Figure 9. Textured Enviro Liner® 6140

# PERFORMANCE PROPERTIES

### Low Temperature Behavior

Enviro Liner® 6000 retains its flexibility at low temperatures and does not become stiff even at temperatures as low as -40°C/-40°F. This feature is particularly important as it enables the geomembrane to be installed during extreme weather conditions. The practical handling temperature for our Enviro Liner® 6000 is -25°C/-13°F which means we can install Enviro Liner® 6000 in extreme environments. For more information on low temperature behavior, please refer our cold temperature handling guide which is available on our website.

### Potable Water Certifications

Enviro Liner® 6000 has been tested and certified by NSF International (NSF) under their standard NSF 61 Drinking Water System Components. NSF International tests Layfield geomembranes annually to maintain their certification. Each year a sample of geomembrane is sent for testing. The testing includes a water extraction test where the geomembrane is soaked in water and then the water is analyzed for trace chemicals. Our Enviro Liner® 6000 regularly passes the extraction test with all 173 chemicals being below the detection limit or at most a few close to the detection limit.

Enviro Liner® 6000 was also tested by the Australian Water Quality Centre in accordance with AS/NZS 4020:2005 standard for contact with drinking water. The AS/NZS 4020:2005 standard requires that the product not affect the taste or appearance of water; not support the growth of microorganisms; and not release cytotoxic or mutagenic compounds or metals when immersed in, or exposed to, test water in accordance with extraction procedures as outlined for each of the tests.



Figure 10. Enviro Liner® 6040 defined sump floating cover for a potable water reservoir in Australia

## SECTION 3 C

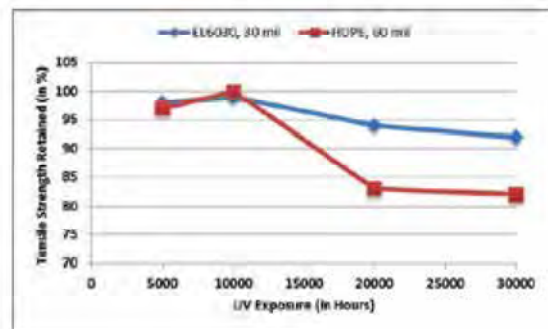
# ENDURANCE PROPERTIES

## Weathering Resistance

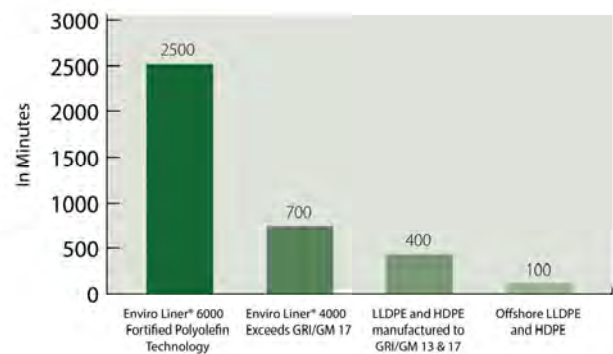
Enviro Liner® 6000 geomembranes have an advanced UV stabilization package in their formulation. In 2009 we presented a research paper titled "Long-Term Weathering Stability and Warranty Implications for Thin Film Geomembranes". (Mills et al, 2009). This paper describes our testing methodology and compares our EnviroLiner® with HDPE 60 mil under similar test conditions. This extended long-term UV test tested a sample of our 0.75 mm (30 mil) black polyolefin material and a 1.5mm (60 mil) HDPE material out to 30,000 hours. The exposure for these samples was 10 hours of UV light at 60°C followed by a 2-hour condensation cycle at 50°C. UVB bulbs were used with an irradiance of 0.80 W/m2/nm (at 313 nm). Recent laboratory studies on the degradation of exposed polyethylene geomembranes in Texas weather conditions have shown significant improvements in the service life of geomembrane liners that contain high loading of anti-oxidants (Islam, 2011). Layfield in the past has carried out similar tests and reported the advantages of fortifying a geomembrane.

In our study, our Enviro Liner® 6000 fortified geomembrane showed excellent resistance to UV weathering after 30,000 hours. The results showed that our Enviro Liner® 6000 series retained almost 90% of strength after 30,000 hours of UV exposure.

In order to ensure that our Enviro Liner® 6000 geomembranes maintain their high UV resistance we test every production lot for UV stabilizer and antioxidant levels. The level of antioxidants is determined using the test method ASTM D3895 for Oxidative Induction Time of Polyolefins (OIT). Standard geomembranes have an OIT value of 100 minutes while the minimum for Enviro Liner® 6000 geomembranes is double that at 200 minutes. UV stabilizers use a slightly different test method ASTM D5885 which is High Pressure Oxidative Induction Time of Polyolefins (HPOIT). This test uses lower temperatures but higher pressures to target the performance of UV additives. Standard geomembranes have an HPOIT value of 400 minutes. Our Enviro Liner® 6000 has a minimum HPOIT value of 2,000 minutes. For this reason, polymer scientists describe Enviro Liner® 6000 as a fortified geomembrane (Schiers, 2009).



Graph 2. Accelerated Weathering Results



Graph 3. High Pressure Oxidative Induction Time (HPOIT)

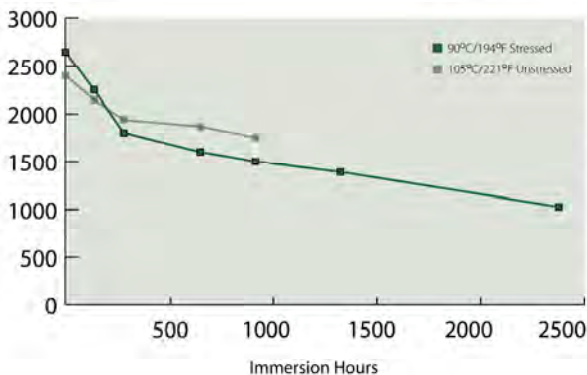


Figure 11. Exposed Landfill cap 3,000,000 ft<sup>2</sup> / 280,000 m<sup>2</sup> Enviro Liner 6030 (30 mil)

## ENDURANCE PROPERTIES

### Resistance to Brine Solution

There are a number of developing geomembrane applications where hot salt water needs to be contained over the long term. One application is hydraulic fracturing (fracking) where the flow back water that comes up from underground is high in saline concentration. Brine can include reservoir water, injected water, and chemicals added during the production and treatment process. Brine containment may also be needed to contain highly saline “produced water” or “formation water” extracted along with oil and gas during exploration and production. A second brine containment application is the bypass water from reverse osmosis (RO) water treatment systems. Both of these applications create high salt content water which needs to be stored. Salt water storage applications become more critical when the salt water needs to be stored for an extended period of time. Determining long term performance requires accelerated test methods.



Graph 4. Salt Solution Immersion Test Results for Enviro Liner® 6040

To investigate these hot salt water containments we used two test methods. One of these methods used stressed specimens at a single temperature while the other method used unstressed specimens at multiple temperatures. The stressed specimen method immerses the samples in a hot salt solution in a bent strip arrangement. After immersion the bent strips are removed and the antioxidant levels are measured with the HPOIT test. For the unstressed condition, the specimens were cut with a die and immersed as is in the hot salt solution.

In both the stressed and unstressed test, a salt solution with the following composition was used:

100 g/L NaCl	Sodium Chloride
62 g/L NaHCO <sub>3</sub>	Sodium Bicarbonate
50 g/L NaCO <sub>3</sub>	Sodium Carbonate

The samples in this test were placed in stressed condition in a hot brine solution with samples taken after 150 hours, 300 hours, 600 hours, 1200 hours, and 2400 hours of immersion time (the actual time may vary but these are the targeted immersion times). At the end of each of these immersion periods the samples were visually inspected to see if any cracking had occurred. Then the samples were sent for antioxidant testing. After 2400 hours of immersion time the Enviro Liner® 6000 material maintained an HPOIT test result of greater than 1000 minutes. In the stressed specimen test the Enviro Liner® 6040 material started with a typical high value of HPOIT. After an initial loss of antioxidant the HPOIT slowed significantly. After 2400 hours of immersion in a stressed state, the material retained over 1000 minutes of HPOIT.

The unstressed specimen test did not show the same antioxidant loss but did show some small tensile strength changes over 1000 hours of immersion. The tensile changes were not clear enough to establish a trend. Other physical measurements of the unstressed specimens did not show any significant changes. This testing indicates that Enviro Liner® 6000 will retain antioxidant stability which will result in long term UV and chemical resistance. Please request a full technical report on this testing from your Layfield Representative.

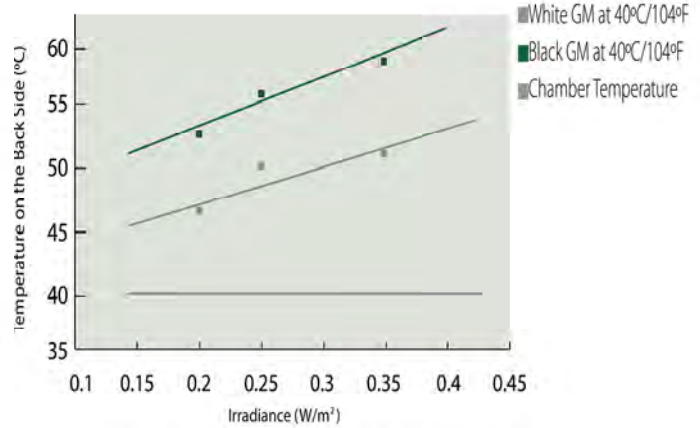
## ENDURANCE PROPERTIES

### Effects of Solar Irradiance

Exposure to solar radiation has been shown to increase the surface temperature of black colored geomembranes resulting in thermal expansion of the material. Liner materials that show higher coefficient of liner thermal expansion are prone to dimensional change during service. Geomembranes with light colors have lower surface temperatures when they are exposed to sunlight. Previous research shows how the geomembrane surface temperature between white and black can be very significant over a period of time.

Layfield carried out a study to simulate the effect of solar irradiance were specimens were exposed to UV light in a climatic chamber. Layfield used ASTM D4355 as a procedural guide to set up the test. Both black and white geomembrane specimens were exposed to Xenon arc lamps emitting an irradiance of 0.19 W/m<sup>2</sup>nm, 340 nm while the chamber temperature was set to 40 °C/104 °F. By comparison an irradiance of 0.11 W/m<sup>2</sup>nm is equivalent to a UV index of 7 which would be typical of a sunny day in Southern Ontario, Canada in July. It was concluded that the white surface resulted in 46% reduction in surface temperature compared to the black surface. Enviro Liner® 6000 is manufactured with our state-of-the art multi layer co-extrusion technology. Layfield offers our geomembranes in black, white and tan skin colors. Light skin colors ensure lower geomembrane surface temperature and have the following benefits:

1. Lower expansion/contraction
2. Greater Resistance to long term degradation
3. Increased protection of soil subgrade from desiccation
4. Prevent heat build up under floating covers



Graph 5. Effect of Solar Irradiance on Surface Temperature.



Figure 12. White Surfaced Floating Cover-Enviro Liner® 6030 evaporation control cover for a winery in Australia





## SECTION 4

# COMPARATIVE PHYSICAL PROPERTIES

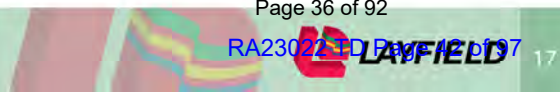
Table 5. Comparative Physical Properties of Geomembranes

Properties	ASTM	EL6020	LLDPE 20 <sup>1</sup>	EL6030	LLDPE 30 <sup>1</sup>	HDPE 30 <sup>2</sup>	EL6040	LLDPE 40 <sup>1</sup>	HDPE 40 <sup>2</sup>	EL6060	HDPE 60 <sup>60</sup>
Thickness (Nominal)	D 5199	20 mils 0.50 mm	20 mils 0.50 mm	30 mils 0.75 mm	30 mils 0.75 mm	30 mils 0.75 mm	40 mils 1.0 mm	40 mils 1.0 mm	40 mils 1.0 mm	60 mils 1.5 mm	60 mils 1.5 mm
Tensile Strength at Break	D 6693	95 ppi 16.5 N/mm	71 ppi 13 N/mm	141 ppi 25 N/mm	114 ppi 20 N/mm	114 ppi 20 N/mm	180 ppi 31.50 N/mm	152 ppi 27 N/mm	152 ppi 27 N/mm	255 ppi 44.5N/mm	228 ppi 40 N/mm
Elongation	D 638	1000%	800%	1000%	800%	700%	1000%	800%	700%	1000%	700%
Critical Cone Height	D 5514		N/A	2.0 in 50 mm	N/A	N/A	2.0 in 50 mm	N/A	N/A	2.0 in 50 mm	1.4 in 35 mm
UV Resistance Strength Retained @ 30,000 hrs	D 4329	N/A	N/A	90%	N/A	N/A	90%	N/A	N/A	90%	N/A
Axi-Symmetric Break Resistance Strain	D 5617	50%	30%	50%	30%	N/A	80%	30%	N/A	80%	N/A
High Pressure Oxidative Induction Time	D 5885	2000 min	400 min	2000 min	400 min	400 min	2000 min	400 min	400 min	2000 min	400 min
Oxidative Induction Time	D 3895	N/A	N/A	200 min	N/A	N/A	200 min	N/A	N/A	200 min	N/A
Stress Crack Under Constant Load	D 5397	> 1000 hrs	N/A	> 1000 hrs	N/A	300 hrs	> 1000 hrs	N/A	300 hrs	> 1000 hrs	300 hrs
Flexibility, Number of Cycles	D 6182	N/A	N/A	8000	N/A	N/A	N/A	N/A	N/A	N/A	3000
Certifications (Potable Water)		NSF 61 AS/NZ 4020	N/A	NSF 61 AS/NZ 4020	N/A	N/A	NSF 61 AS/NZ 4020	N/A	N/A	NSF 61 AS/NZ 4020	N/A
Fish Safe	Daphnia Magna LC50	Yes	N/A	Yes	N/A	N/A	Yes	N/A	N/A	Yes	N/A

Notes:

<sup>1</sup> In accordance with GRI GM 17 specification; Test Method, Test Properties for LLDPE Smooth and Textured Geomembrane.

<sup>2</sup> In accordance with GRI GM 13 specification; Test Method, Test Properties for HDPE Smooth and Textured Geomembrane.



## PREFABRICATED GEOMEMBRANES

Prefabricated geomembrane liners are usually made of flexible liner materials that are thermally welded together to form large geomembrane panels that can be deployed very quickly in the field. On prefabricated panels all of the seams are manufactured in a controlled environment. Installation of prefabricated panels reduces the number of field seams and significantly improves overall efficiency and economics.

Field assembled geomembranes are typically stiffer and are not designed to be prefabricated in a factory environment. Field assembled geomembranes are designed to be assembled in the field and are subject to the variability of the weather.

Our Enviro Liner® 6000 series has been formulated to overcome flexibility issues related with field fabricated geomembranes such as HDPE. HDPE's very crystalline structure makes it stiffer and produces lower elongation at yield compared to Enviro Liner® 6000, which is flexible with exceptional elongation behavior. For the same reason we do not fabricate HDPE into large panels as it is too stiff to fold and roll.

Even in the field, HDPE liners have to be laid smooth on the ground with no creases; backfilling over the creases may cause permanent deformation in those areas with significant loss in strength leading to geomembrane failure. Prefabricated panels also minimize field welding increasing quality control and reducing dependence on weather elements. Prefabricated panels are welded in a controlled environment compared to seam fabrication in field, ensuring high seam integrity.

Another important benefit of using prefabricated liners is described in the figures below. Figure 13a. shows panel layout using roll stock material assembled in field. Figure 13b. involves prefabricated panels made from more flexible materials like Enviro Liner® 6000. In this example, the containment area is approximately 350' (106.7 m) wide x 500' (152.4 m) long x 10' (3 m) deep with a 4 (horizontal) to 1 (vertical) slope.

The following observations and conclusions can be derived from these two typical panel layouts in Figure 13a & b:

- Prefabricated geomembranes require fewer panels: approximately eight Enviro Liner® 6030x (30 mil) (0.75 mm) panels versus approximately sixty-five HDPE (60mil) (1.5 mm) panels
- Prefabricated panels require approximately 80% less field seams: approximately 1550 linear feet/475 linear meters of onsite seams for Enviro Liner 6030x (30 mil)(0.75 mm) versus approximately 8000 linear feet/2438.4 linear meters of onsite seams for HDPE (60 mil) (1.5 mm)

Other considerations of prefabricated panels:

- Prefabricated panels are manufactured in a controlled environment
- Less dependency on weather elements during construction
- Shorter on-site time
- Panels can be prefabricated between 20,000 ft<sup>2</sup> /1,860m<sup>2</sup> to 100,000 ft<sup>2</sup>/9,290m<sup>2</sup>
- Smaller jobs can be supplied in one prefabricated panel

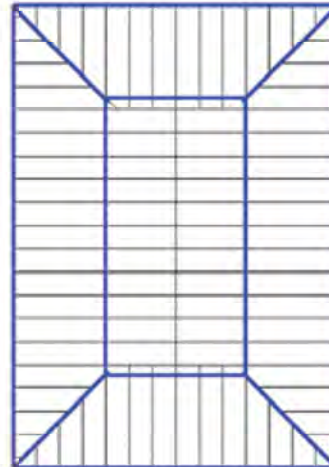


Figure 13a. Schematic showing layout of panels for field assembled liners

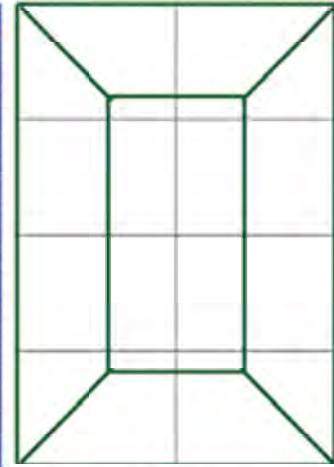


Figure 13b. Schematic showing layout of panels for shop fabricated liners



Figure 14. 7000 lbs (3200 ks) one-piece prefabricated Enviro Liner® 6030

## SECTION 6

# GEOMEMBRANES THICKNESS

At Layfield we strongly believe that the thickness of materials should be a function of the containment design taking into consideration site specific conditions. There are a number of thickness standards that are often quoted. One of the most quoted standards is the USEPA RCRA Subtitle D for landfills\*. That document requires a minimum material thickness of 30 mil (0.75mm) for the base liners of landfills. The Natural Resources Conservation Service (NRCS) has Conservation Practice Standard 521A that requires a minimum thickness of 40 mil (1.00 mm) for waste water and 30 mil (0.75 mm) for clear water ponds (unsupported materials). In the 6th edition of Designing with Geosynthetics (Table 5.13) Robert Koerner ties thickness to survivability in the designations: Low 25 mil (0.63mm), Medium 30 mil (0.75mm), High 35 mil (0.88mm), and Very High 40 mil (1.0 mm). Therefore, the actual standard for the thickness of geomembranes is clearly between 30 mil (0.75mm) and 40 mil (1.0 mm).

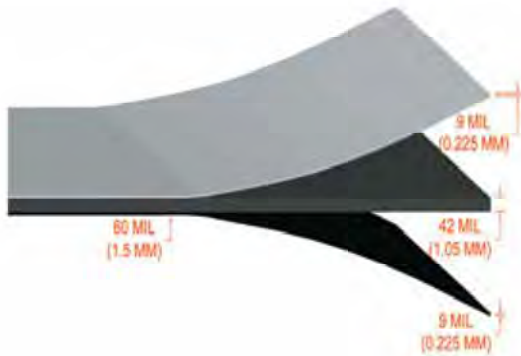


Figure 15. Multi Layer co-extrusion

One important aspect to consider is that thickness is not a key property of a geomembrane. The performance properties of a geomembrane need to be examined against the requirements of the project. For example Enviro Liner® 6000 has better UV resistance than other materials twice its thickness. Selecting the thinner material in this case can help you retain UV resistance while adding other properties such as flexibility and the increased speed of installation of a prefabricated liner. With a number of commodity grade liner materials, 60 mil (1.50 mm) and 80 mil (2.00 mm) thick products actually have worse yield, elongation and critical cone height puncture properties compared to more flexible 30 mil (0.75 mil) and 40 mil (1.00 mm) Enviro Liner® 6000 products.

\* The full document name is: Code of Federal Regulations, Title 40, Chapter 1, Subchapter 1, §258.40, Subpart D of Resource Conservation and Recovery Act.

## WARRANTY

### Ultra Violet Weathering Warranty

Enviro Liner® 6000 geomembranes have been specially formulated for outstanding UV resistance. Layfield has developed a proprietary UV stabilization package for the Enviro Liner® 6000 series which allows a 30 mil (0.75 mm) Enviro Liner® 6030 to resist degradation as well as a 60 mil (1.5 mm) geomembrane stabilized with carbon black alone. This is a major advancement in flexible membrane liner technology as it allows the more flexible and durable Enviro Liner® formulation to be considered in exposed applications where a thicker material, such as HDPE 60 or 80 mil (1.5 & 2.0 mm), may have needed to be specified in the past. An extended exposed service life weathering warranty of up to 25 years on approved applications is available for the Enviro Liner® 6000 series in a 40 mil (1.0 mm), 60 mil (1.5 mm) and 80 mil (2.0 mm) thickness. Our warranty is backed by natural and accelerated weathering tests. For further details please ask your Layfield representative for the technical paper "Long Term Weathering Stability and Warranty Implications for Thin Film Geomembranes"

### Warranty Terms

1. Enviro Liner® 6000 will be free from manufacturing defects and, if properly installed and maintained, shall withstand normal weathering for the term of the warranty.

Materials	Standard Weathering Warranty	Extended Weathering Warranty (on approved applications)
Enviro Liner® 6000 Black 40, 50, 60, 80 mil	10 years	25 years
Enviro Liner® 6000 White 40, 50, 60, 80 mil	10 years	20 years

Table 6. Enviro Liner® 6000 Weathering Warranties

2. The warranty does not cover any damage to the liner, or defects in the liner, resulting from conditions beyond the reasonable control of Layfield, including misuse, abuse, fire, acts of God, abnormal weather conditions of all types, improper installation or maintenance, excessive stress from any source, improper handling during transportation, unloading, storage or installation, floating debris, damage due to machinery, damage from exposure to chemicals harmful to the liner, foreign objects or animals. In addition, the maximum temperature of the effluent is not to exceed 40° C and the pH of the effluent is to be maintained between 5 and 9. In water treatment applications including reverse osmosis the Langelier Saturation Index must not be negative (below 0.0).

3. A failure of a geomembrane is considered to be a breach (holes or cracks) or if the tensile strength falls below a level of 50% of the original specification.

4. As a condition of the warranty, the liner will be installed following Layfield recommended procedures.

5. A claim for breach of warranty needs to be presented to Layfield in writing within 30 days of the discovery of the possible defect. Layfield will then have the opportunity to inspect and determine the cause of the possible defect and take appropriate steps to repair or replace the Liner if a defect exists.

\*For the complete warranty terms and conditions please contact your nearest Layfield representative.

## APPLICATIONS



Figure 16. Double Lined secondary containment system lined with Enviro Liner® 6030

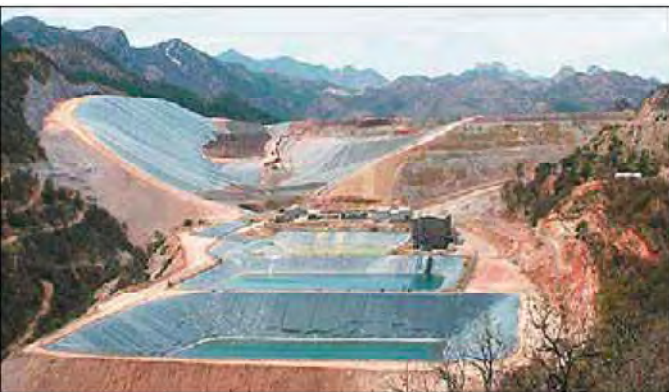


Figure 17. Heap Leaching Pads and Ponds



Figure 18. Enviro Liner® 6040 Floating cover and liner for a potable water reservoir

### Major Applications

Exposed Applications: 25 year weathering warranty available on approved applications

#### Oil and Gas

- Frac/ Flowback Water
- Brine/ Produced Water
- Oilfield Pit Liners
- Tank liners
- Remediation liners and covers
- Secondary containment of hydrocarbons and chemicals
- Evaporation floating covers

#### Mining

- Heap leach pads and ponds
- Tailings ponds
- Raincoat covers
- Dam face waterproofing
- Remediation liners and covers

#### Water and Wastewater

- Potable water
- Municipal utilities
- Waste water treatment ponds
- Sewage Lagoons
- Manure Lagoons
- Industrial waste water
- Stormwater Management Ponds
- Aquaculture
- Decorative Ponds
- Irrigation Canal Liners

#### Solid Waste Containment

- Hazardous Waste
- Landfill caps ( temporary and permanent)
- Landfill liners
- Soil remediation liners
- Sludge dewatering

#### Floating Covers

- Algae control
- Evaporation control
- Prevent waterfowl from landing
- Insulated covers
- Odor control
- Biogas covers

#### Recreational

- Decorative Ponds
- Golf Course Ponds
- Surf Park Facilities

# APPLICATIONS

### Oil and Gas

Enviro Liner® 6000 is used extensively in the Oil & Gas sector for environmental containment. The product's excellent chemical resistance, long term UV stability, mechanical strengths and flexibility make it an ideal choice in multiple upstream, midstream and downstream applications. In upstream applications Enviro Liner® 6000's ability to withstand brine and produced water makes it well suited for reserve pits and frac tank liners. It is also commonly used in a multitude of secondary containment applications from hydrocarbons, crude oil, gas liquids, and condensates. A quickly emerging application in warmer and windier climates is as a floating cover for evaporation control for water and fluids used for hydraulic fracturing.

For water storage and waste water treatment applications, Enviro Liner® 6000 provides excellent UV resistance and high levels of anti-oxidant protection, which makes it a very good choice for exposed applications such as brine ponds. The product's ability to be prefabricated in a custom large size factory panels allows it to be mobilized for fast turnarounds, helping reduce construction costs. In midstream transportation applications, Enviro Liner® 6000 is commonly used for secondary containment applications for temporary storage and transfer facilities for crude oil, liquid bitumen, diluents and many other industry chemicals. It is also an excellent choice for brine water storage ponds. In downstream applications Enviro Liner® 6000 is commonly specified for secondary containment of liquid hydrocarbons for petro chemical facilities, refineries and above ground bulk storage.



Figure 19. Enviro Liner® 6040 lining a Brine Storage Pond in Ontario, Canada



Figure 20. Enviro Liner® 6030 Frac Tank Liner, West Texas.



Figure 21. Enviro Liner® Frac Fluid Evaporation control cover, Texas.



Figure 22. Secondary containment system in Alberta, Canada

## APPLICATIONS

### Mining Applications

#### Heap Leaching

A geomembrane is a vital component for heap leach pad construction in mining applications. The geomembrane system contains the heap leaching fluids which allows the target mineral to be recovered through a chemical extraction process. The geomembrane also ensures that the environment is protected by preventing the release of the heap leaching chemicals. When selecting a geomembrane for heap leach pad construction it is important to consider both the mechanical and chemical properties of the material. We have discussed chemical resistance of Enviro Liner® 6000 in detail in previous sections of this booklet. In this section, we emphasize the importance of puncture resistance and interface friction properties of Enviro Liner® 6000 in the challenging application of heap leaching.

#### Dynamic Puncture Tests and its relevance to Heap Leach Applications

A typical heap leaching process involves placing the geomembrane on a prepared subgrade and then placing a select fill material (in this example called the “over liner” material) on top of the liner for protection. Once the over liner layer is in place the ore is placed on the heap leach pad to the required operating height.

The gradation for the over liner material used in this example is shown in Table 7 and is a combination of soil fines and crushed rock. The over liner material is screened from crushed materials on site and contains ≤ 5% of soil fines to encourage drainage of the heap leach chemicals. The select fill (over liner) material in this test was from an actual heap leach project. The over liner material is designed to protect the geomembrane from the pressure of the heap leach ore which in a heap leach pad can reach up to 100 meters (300') high. Evaluating whether a geomembrane will be able to withstand these types of ore pressures is done with the Dynamic Puncture test.

The Dynamic Puncture test replicates the high pressures in a heap leach pad using a steel vessel and a hydraulic press. The steel pressure vessel has an inside dimension of 305 mm x 305 mm and a height of 153 mm and is capable of applying vertical pressures of up to 4,000 kPa (580 psi - shown in Figure 22) . Pressure is typically applied in increments of 70 kPa every minute up to a pressure of 3881 kPa (equivalent to 200 m of ore). The pressure was then held constant for 48 hours. Enviro Liner® 6000 performed very well in this Dynamic Puncture Test and the results are shown in Table 8.

Sieve Size		% Passing	
Metric	English	Soil Liner	Over Liner
75 mm	3"	100	100
38 mm	1.5"	75-100	100
25 mm	1"	65-100	84
13 mm	1/2"	55-95	46
4.75 mm	# 4	45-85	19
0.45 mm	# 40	25-65	12
0.075 mm	# 200	15-50	3

Table 7. Soil Liners and Over Liner Gradation

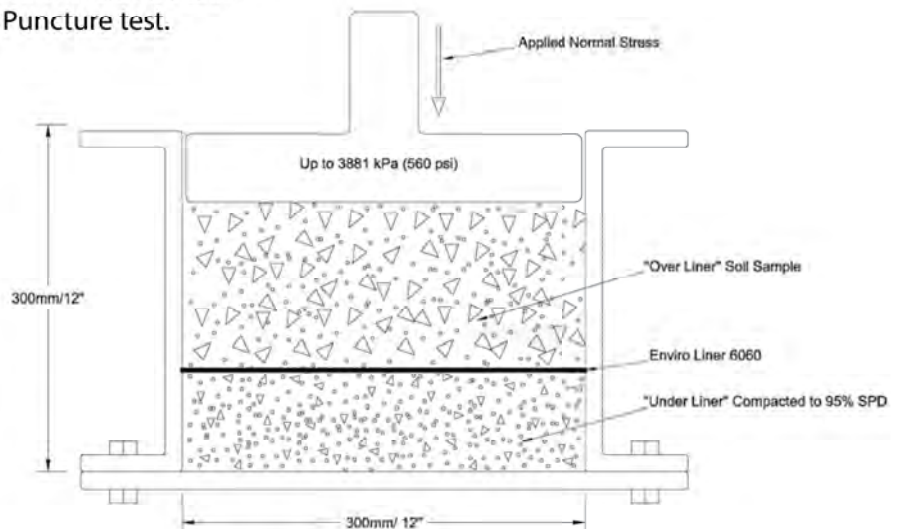


Figure 23. Mining schematic showing placement of geomembrane



## APPLICATIONS

Material	Ore Height/Equivalent Loads		
	120 m (393') 2117 kPa(306 PSI)	180 m (590') 3176 kPa (460 PSI)	220m(721') 3881 kPa (560PSI)
Enviro Liner® 6040 (40 mil) (1.00 mm)	No perforations, minor yielding	Minor Perforations	Not Tested
Enviro Liner® 6040 (40 mil) (1.00 mm) and 6 oz/yd geotextile	Not tested most likely will pass	Tested , Passed no perforations or yielding	Not tested will likely pass due to protection geotextile
Enviro Liner® 6060 (60 mil) (1.5 mm)	No Perforations	No Perforations	No Perforations

Table 8. Results of Dynamic Puncture Test

### Interface Friction Test and its relevance to Heap Leach Applications

Another important aspect of heap leach construction is the stability of the heap leach pads. This requires that the friction angle between the over liner and the geomembrane is clearly understood. Since most interface friction tests with geosynthetics are done at low normal stresses, the values are not always appropriate to heap leaching applications. Once again using a lab specializing in heap leach studies the Layfield Enviro Liner® 6000 was tested for interface friction values at high normal stresses with two soil types. The two soil types used in this testing were the select fill material (over liner) that was used in the Dynamic Puncture test and a fill material representative of the prepared subgrade of the heap leach pad (called the soil liner material). The soil liner material has a high fines content while the over liner material has a very low fines content. Soil gradations for both materials are shown. Below is the table showing the results of friction angle testing for the smooth and textured Enviro Liner® 6000.

Friction Angles with "Over Liner"				
Horizontal Displacement	Enviro Liner® 6060 (60mil) (1.5 mm)	Enviro Liner® 6160 (60 mil)(1.5 mm)	Enviro Liner® 6040 (40 mil) (1.00 mm)	Enviro Liner® 6140 (40 mil) (1.00 mm)
2.5 cm displacement	24.5 degrees	24.8 degree	23.7 degree	23.3 degree
7.0 cm displacement	23.9 degrees	26.8 degree	20.0 degree	24.4 degree

Table 9. Friction Angles with Over Liner

Friction Angles with "Soil Liner"		
Horizontal Displacement	Enviro Liner® 6160 (60mil) (1.5 mm)	Enviro Liner® 6140 (40 mil) (1.00 mm)
2.5 cm displacement	21.1 degree	22.5 degree
7.0 cm displacement	19.1 degree	21.6 degree

Table 10. Friction Angles with Soil Liner

#### Test Conditions:

Normal Loads: 100 kPa (2000 PSF), 200 kPa (4000 PSF), 400 kPa (8000 PSF) and 800 kPa (16,000 PSF)

Asperity Height of the Geomembrane: 12 mils, 0.012" (0.305 mm)

Soil Gradation: Soil Liner and Over Liner

## APPLICATIONS

### Water and Waste Water Applications

Enviro Liner® 6000 is a potable water grade geomembrane that is certified to the National Sanitation Foundation Standard 61 (NSF 61) and the Australian water standard AS/NZ 4020 for compatibility with drinking water. Enviro Liner® 6000 has excellent long-term resistance to chlorines and other disinfectants (in typical concentrations for potable water) and is commonly specified in potable water applications. In wastewater applications, Enviro Liner® 6000 can contain many variants of waste water from municipal sewage to agricultural manure and commercial waste water. Enviro Liner® 6000 is heavily fortified with advanced stabilizers and a proprietary UV inhibitor / antioxidant additive package that makes it very suitable for exposed long-term floating cover applications. In drinking water applications, Enviro Liner® 6000 can help protect the water from contamination from external sources.



Figure 24. Enviro Liner® 6030 evaporation control cover for a winery in Australia

Enviro Liner® 6000 can also be used to fabricate evaporation control covers in a number of agricultural and industrial applications. In wastewater applications, Enviro Liner® 6000 floating covers help prevent odors, collect biogas, and prevent the build-up of algae. Enviro Liner® 6000 has a High Pressure Oxidative Induction Time (HPOIT) level of more than 2,000 minutes which allow us to offer a longer term extended UV weathering warranties on approved applications. Enviro Liner® 6000 can also be placed with the white side exposed to

help reduce the surface temperature of the geomembrane which results in lower expansion/contraction cycles and prevents heat build-up under floating covers.



Figure 25. Reclaimed water storage reservoir floating cover fabricated with Enviro Liner® 6060, Corona California

Enviro Liner® 6000 has high multi axial stress strain values. This property is desirable for biogas collection covers or other applications where large concentrations of gases can develop against the liner and push it upwards. Another important property of Enviro Liner® 6000 is its flexibility. Enviro Liner® 6000 can be thermally welded together to fabricate very large panels, thus reducing the number of field seams in large municipal water and wastewater projects.

## SECTION 9 INSTALLATION SPECIFICATIONS

### Subgrade Preparation

1. Ensure subgrade is compacted and surface finished to not impair installed geomembrane.
2. Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade.
3. A smooth drum rolled surface is preferable.
4. Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.
5. If a suitable sub-grade is not available then a cushion layer of 100 mm (4 inches) of clean sand LP8 non woven geotextile shall be placed prior to liner placement.
6. Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.
7. Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
8. All concrete surfaces to which the liner will attach shall have "smooth trowel" finish. All the corners should have radius to a minimum 25mm (1 inch) as per the drawing.
9. Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.
10. A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.



Figure 26. Approved subgrade for an oilsands project in Northern, Alberta

### Geomembrane Installation

1. Installation of the geomembrane shall be performed in a logical sequence.
2. Place panels according to the drawings, the panel layout, and the label on each panel.
3. Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.

## SECTION 9

# INSTALLATION SPECIFICATIONS

4. Weather Conditions at Time of Installation:
  - Site welding may proceed at any temperature providing a suitable qualification weld can be prepared at site conditions using the operator, equipment, and materials intended for the project.
  - Installation of geomembrane in winds above 20 km/h (12 mph) can proceed only if the installer can demonstrate that the liner will not be at risk of damage.
  - Do not install the geomembrane during precipitation or in the presence of excessive moisture.
  - Do not install in weather conditions that may be detrimental to the function of the geomembrane.
  
5. Ensure personnel working on geomembrane do not use damaging footwear.
  
6. Protect completed panels from damage; handle carefully to avoid damaging the liner.
  
7. Equipment and methods used to unroll liner panels should not damage the prepared subgrade.
  
8. Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.
  
9. Qualification Seams:
  - A qualification seam will be run prior to any field seams.
  - A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.
  - Machine conditions, and operator used for welding must be the same as those used for the qualification weld.
  - Qualification seam must be tested in shear and peel, and meet the specified requirements for the material as stated in the materials section.
  - A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.
  
10. Field Seams:
  - Field seams will be sampled for testing in a way that does not compromise the installed liner
  - One sample to be tested for every 150 m (500 ft) of field seam.
  - Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner
  - Samples to be approximately 100 mm (4 inches) long to permit testing of one shear and two peel specimens (ASTM D6392).
  - Test samples immediately after seaming.
  - Record date, location and pass/fail description.
  - A written record will be maintained for all field seam tests.
  - All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).



Figure 27. Installation of double lined secondary containment system lined with EnviroLiner® 6030

## INSTALLATION SPECIFICATIONS

### Enviro Liner® 6000 series REVOC® Floating Cover Specification Summary

#### Product Description



Figure 28. Floating cover being inflated during inspection

REVOC® Defined Sump Covers are manufactured using our fortified Enviro Liner® 6000. These covers use floats and weights to create rainwater collection sumps in the cover and to accommodate changes in water level. The REVOC® Defined Sump system is ideal for larger floating cover applications. A defined sump system can be fairly simple, or can be exceptionally complex depending on site conditions. REVOC® Defined Sump Covers are used for all floating cover applications including potable water storage, odor control, evaporation control and contamination/dilution protection. A REVOC® defined sump cover is the most versatile cover system and can be used in any floating cover application especially large ponds, or ponds with an irregular shape. Layfield's REVOC® Defined Sump Cover design,

installation techniques, and inspection/maintenance protocols fully meet the requirements of local regulations, such as the AWWA M25 Lining and Floating Cover Guidelines and AWWA California-Nevada Reservoir Floating Cover Guidelines. Layfield designs, installs, and maintains all types of floating covers.

#### Installation

All REVOC® Defined Sump Covers made with Enviro Liner® 6000 must be installed by a Layfield crew operating under a clearly defined contract. Much of the installation of a REVOC® Defined Sump Cover is accomplished by skilled technicians in the field. The layout and fitting of a defined sump cover system requires significant field skill and experience. REVOC® Defined Sump Covers are almost always installed in a dry pond. After the pond liner is complete and inspected the cover panels are placed and welded to fit into the containment. The layout and installation of sumps is done on site according to the final cover geometry. Our skilled installers locate where each sump should be on the cover and then attach the floats and weights around the sump as required. Final installation of fittings such as hatches, walkways, steps, vents, sumps, and pumps complete the cover installation.

#### Maintenance

Floating Covers, including pumps and auxiliary equipment, should be inspected at least once per year for damage, stress, or any other detrimental condition. Layfield provides complete floating cover maintenance services including cleaning, repairs, and disinfection of potable water covers.



## REPAIR AND MAINTENANCE

### Enviro Liner® Welding Gun:

The Enviro Liner® Welding Gun is a portable welder designed to make permanent repairs to Enviro Liner® products, including Enviro Liner® 6000. The Enviro Liner® Welding Gun is a low cost, manually operated, extrusion welder for small repairs in thermoplastic geomembranes. The Enviro Liner® Welding Gun will repair all Enviro Liner® brand geomembranes. The Enviro Liner® Welding Gun will also repair other polyolefin materials if compatible welding sticks are available.

Following items are required to perform a repair with this welding gun:

- The Welding Gun itself
- Power source (grounded)
- Welding Sticks (compatible with the geomembrane)
- Enviro Liner® welding tape (for tacking weld)
- Repair material (left over materials from site or order new material)



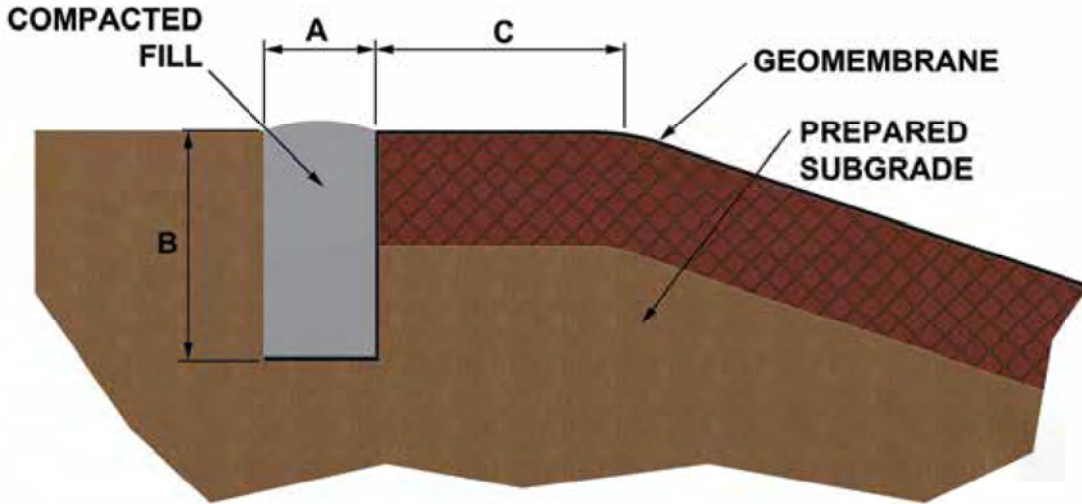
Figure 29. Enviro Liner Welding Gun

### Maintenance

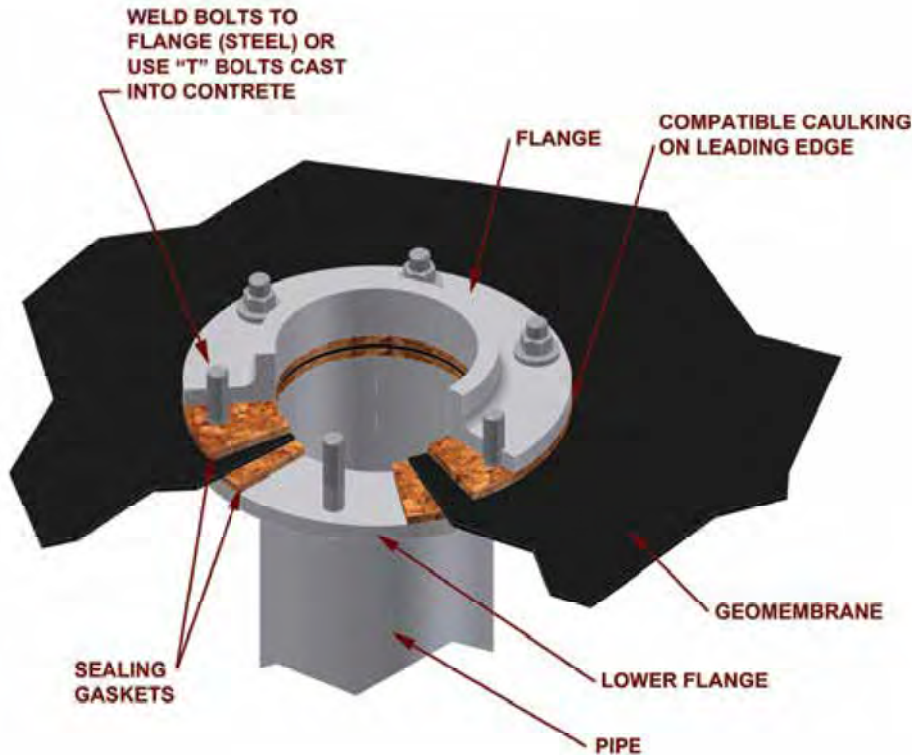
1. Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.
2. Identify any sign of foreign matter contamination.
3. Repair all through-thickness defects.
4. Defective Seams: Cap strip or replace.
5. Small Holes: Repair by extrusion welding using a bead of extruded material over hole. Patch if hole is larger than 6 mm (1/4 inch).
6. Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.
7. Repair blisters, large cuts and undispersed raw materials with patch.
8. Secure Patches by Extrusion Welding (Enviro Liner® Welding Gun) or Hot Air Welding:
  - Extrusion Welding
    - Clean area to be patched.
    - Tack patch in place with hot air welding or with double sided tape.
    - Prepare patch area by roughening with a wire brush.
    - Extrude all the way around patch.
    - More than one extrusion bead can be laid side-by-side on Enviro Liner® 6000 materials. A maximum of three extrusion beads can be laid side-by side on Enviro Liner® 6000
  - Hot Air Welding
    - Hand hot air welding is permitted for patching Enviro Liner® 6000
    - Clean area to be patched.
    - Hand weld the patch with a hot air gun and suitable roller.
9. Patches: Round or oval, of same geomembrane. Extend minimum 75 mm (3 inches)
10. Beyond the edge of the defect.
11. Verification of Repairs: All repairs to be non-destructively tested using:
  - Air Lance Test, ASTM D4437 Method 7.2
  - Vacuum Box Test ASTM D5641
12. Redo failed repairs and re-test.
13. Keep records of all repairs and the test results.

## TYPICAL DRAWINGS

### Anchor Trench



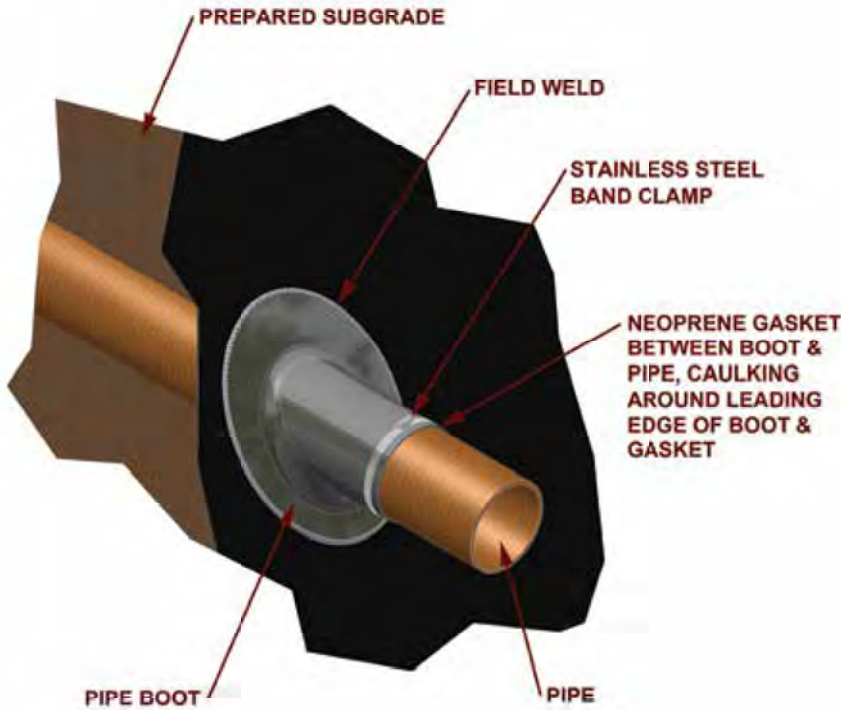
### Pipe Flange



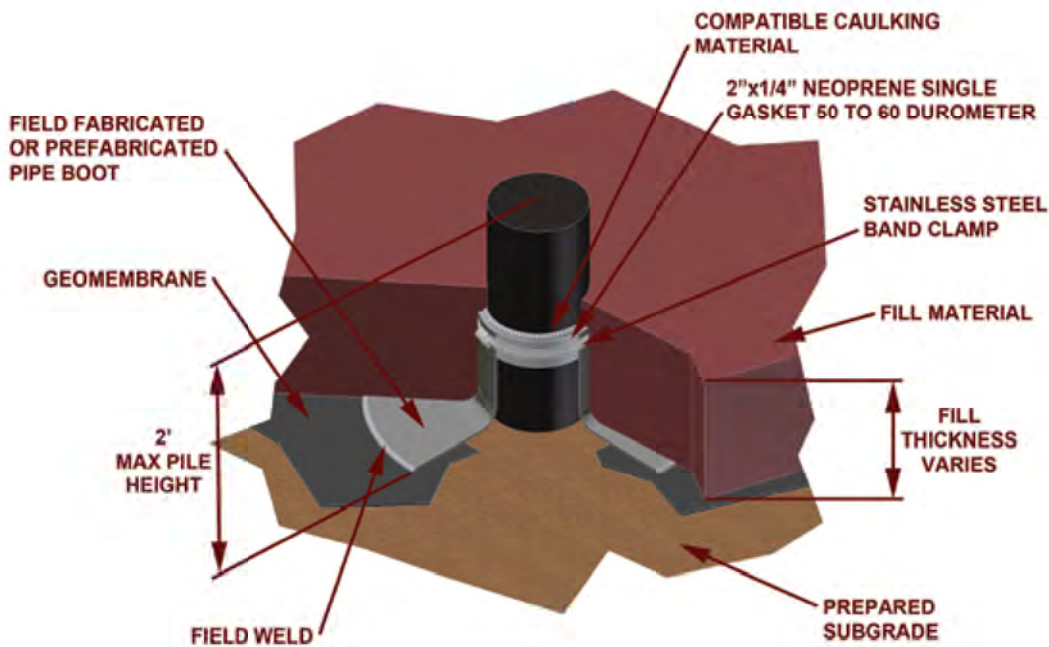


## TYPICAL DRAWINGS

### Pipe Boot

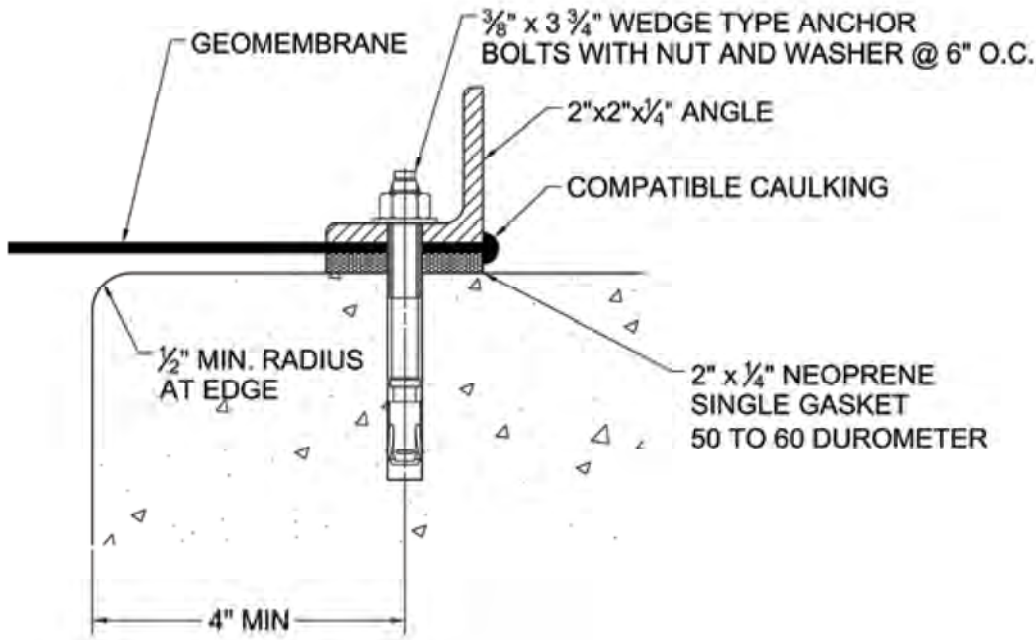


### Piling Support

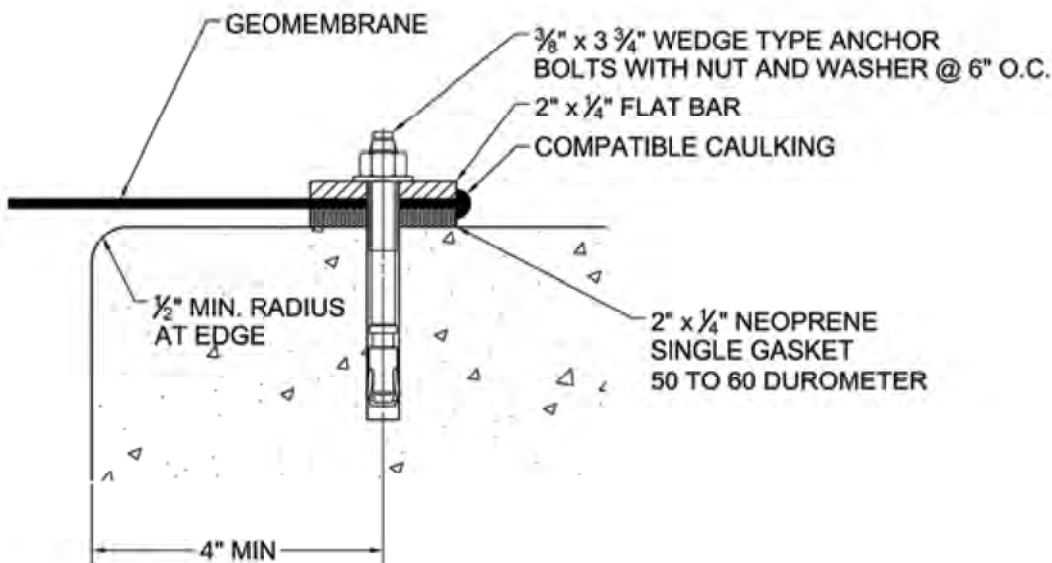


**TYPICAL DRAWINGS**

**Mechanical Attachment to Concrete – Angle Bar Detail**

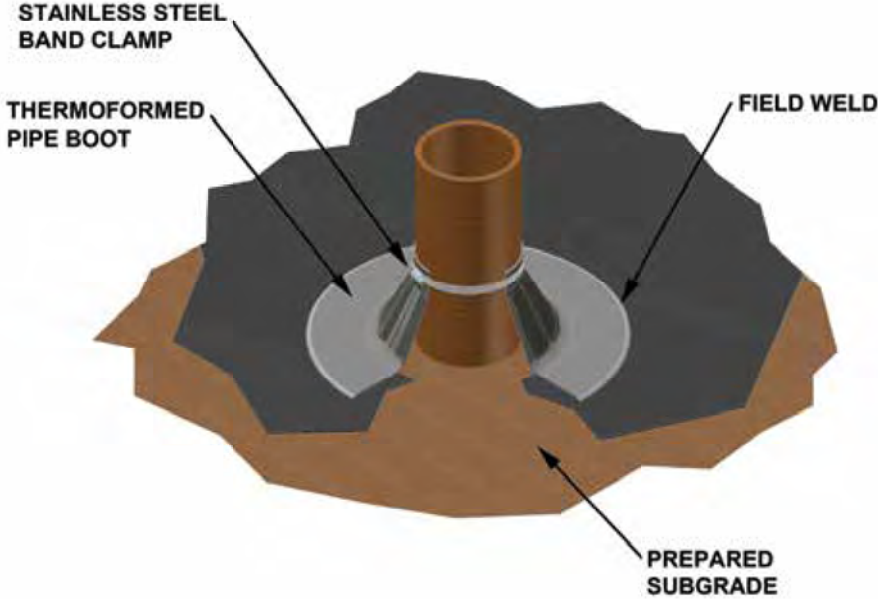


**Mechanical Attachment to Concrete – Flat Bar Detail**

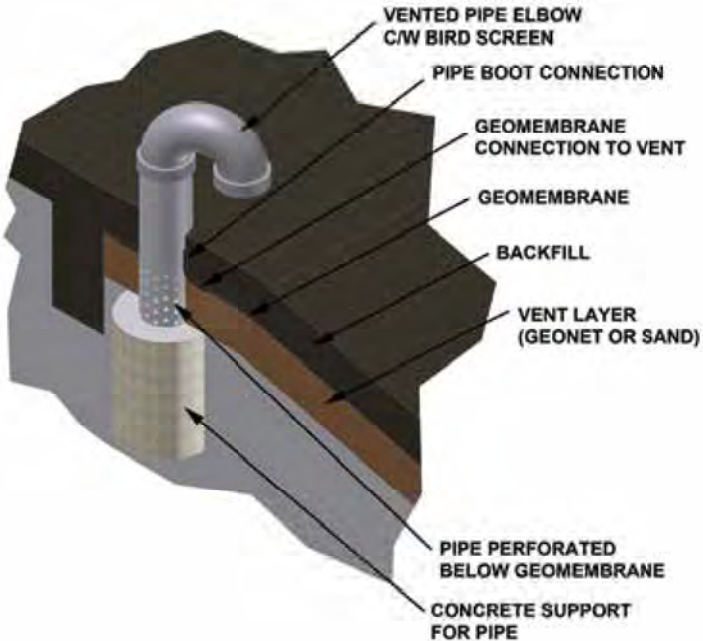


## TYPICAL DRAWINGS

### Thermoformed Boot

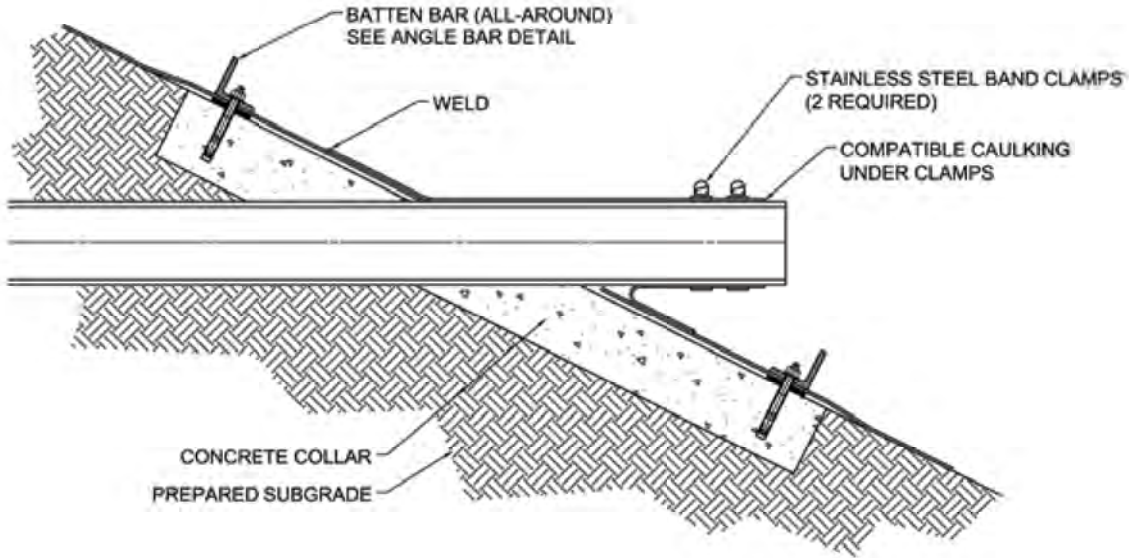


### Vent Detail



## TYPICAL DRAWINGS

### Pipe Penetration on Slope



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Please Note :

If you have any further questions please call your Layfield representative. Layfield product information is provided free of charge for your consideration. The comments offered are for discussion purposes only. While this information is based on Layfield's experience, this information may not be relied upon for any specific application as the nature of applications and site conditions are beyond Layfield's control. It is the user's responsibility to satisfy themselves as to the suitability of this information and to determine the suitability of this information for their specific application. Layfield shall not be liable for any loss or damages whatsoever that may occur from the use of this information. No warranty against patent infringement is offered or implied.

# Enviro LINER® 6000





## **SITE AND SOIL ASSESSMENT**

Mitchel Kroetsch  
NW-15-42-16-W4M

Flagstaff County, Alberta



**Site and Soil Assessment**

NW-15-42-16-W4M  
Flagstaff County, Alberta

Prepared For: Mitchel Kroetsch

Prepared By: Envirowest Engineering  
Box 4248, Ponoka, AB, T4J 1R6  
(403) 783-8229

Report Date: March 21, 2024

Project Number: 2304-43021

**Private and Confidential**





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- C. Certificates of Analysis



## **1.0 Introduction and Scope of Work**

Envirowest Engineering (Envirowest) was retained by Mitchel Kroetsch to conduct a Site and Soil Assessment for the proposed construction of a solid manure storage facility and two catch basins for a proposed 5000 head feedlot, composed of 2500 finishers and 2500 feeders.

The assessment was completed to determine conditions beneath the proposed construction areas and assess soil properties for construction of the proposed facilities. The operation, herein referred to as “the Site,” is located on NW-15-42-16-W4M in Flagstaff County, as shown on Figure 1.0.

The assessment has been completed in accordance with the standards and regulations associated with the amended Agricultural Operation Practices Act (2022) and associated regulations which govern all new and modified confined feeding operations.

### **Scope of Work**

Five investigative boreholes were drilled using a truck-mounted rotary auger and completed to depths between 3.0 and 6.0 metres below ground surface (mbgs) on May 2, 2023. The boreholes were completed in the areas proposed for solid manure storage and a catch basin. One borehole was completed as a groundwater monitoring well to allow for in-situ hydraulic conductivity testing, which was completed on May 30, 2023.

Soil samples were collected from the strata beneath the proposed solid manure storage and catch basin locations and submitted to an accredited third-party laboratory for analysis of soil properties.



## 2.0 Assessment Results

The results of the soil analysis completed by a third-party accredited laboratory are presented in Table 1 below. The soil sample locations are presented on Figure 2.0. Borehole logs and well completion details can be found in Appendix B.

**Table 1: Soil Properties Results**

Parameter	23BH01-01	23BH03-01	23BH05-01
Sample Depth (m)	1.2	2.1	1.75 – 2.6
Particle Size (%clay)	33	34	29
Particle Size (%sand)	39	37	53
Particle Size (%silt)	27	28	17
Texture Class	Clay Loam	Clay Loam	Sandy Clay Loam
Hydraulic Conductivity (field)	-	-	$2.16 \times 10^{-7}$ cm/s

The monitoring well installed at borehole 23BH05 (23MW01) was sufficiently hydrated prior to completing the in-situ hydraulic conductivity testing. The in-situ hydraulic conductivity test was completed on May 30, 2023. The monitoring well was placed to assess the material below surface, and was screened from 2.1 to 3.0 meters below ground surface (mbgs) with bentonite filling the annulus below the screen from 3.0 to 4.5 mbgs.

The initial depth to water was measured in the well. A volume of water was then removed from the well and the change in depth measured over time to assess hydraulic conductivity of the clay strata. It is assumed (as per AGDEX 096-01) that all flow occurs under saturated conditions. The depth was measured every 30 seconds for 10 minutes and every 5 minutes for thirty minutes. The results of the test were analyzed as a slug test using AQTESOLV Bouwer-Rice method for unconfined wells. The results of the assessment were an in-situ hydraulic conductivity of  $2.16 \times 10^{-7}$  cm/sec in monitoring well 23MW01.

A saturated water table was not encountered during the assessment to a maximum depth of 6.0 mbgs.



### 3.0 Liner Assessments

#### 3.1 Natural Barrier Assessment (Solid Manure Storage)

Based on the information obtained it was determined that the native clay within the proposed area of construction for solid manure storage was found to range in thickness from 2.3 to 3.0 meters, generally at surface. Along the south portion of Area 1 contains approximately 0.8 meters of overburden. The proposed solid manure storage area is approximately 208 m x 502 m, as shown on Figure 2.0. The layout and dimensions are shown on Figure 3.0.

Minimum Required Liner Depth for a natural barrier for solid manure storage:

$$\frac{2 \text{ m}}{1 \times 10^{-6} \text{ cm/sec}} = \frac{X \text{ m}}{2.16 \times 10^{-7} \text{ cm/sec}}$$

$$X = 0.4 \text{ m}$$

A minimum of **0.5** meters of native clay is required to be present to provide a sufficient protective barrier and structural stability through erosion such as use during operations and freeze/thaw cycles. It is found that there is sufficient protection across the proposed solid manure storage area.

#### 3.2 Natural Barrier Assessment (Catch Basins)

Based on the information obtained it was determined that the native clay within the proposed area of construction was found to range in thickness from 2.3 to 3.0 meters, generally at surface. The catch basin designs are shown on Figure 2.0.

Minimum Required Liner Thickness for Catch Basin:

$$\frac{5 \text{ m}}{1 \times 10^{-6} \text{ cm/sec}} = \frac{X \text{ m}}{2.16 \times 10^{-7} \text{ cm/sec}}$$

$$X = 1.1 \text{ m}$$

A minimum of 1.1 meters of native clay is required to provide a sufficient protective liner. It is found that there is sufficient protection across the assessed and at the proposed catch basin locations.



#### **4.0 Conclusions**

The following conclusions are based on the discussed scope of construction.

##### **Solid Manure Storage Area**

The native soils were determined to present properties that will provide sufficient protection for a solid manure storage area as a natural barrier. Contouring of the proposed solid manure storage area to direct surface water flow to the catch basins should be done with caution so as to not remove this protective barrier. This is discussed further in Section 5.0.

##### **Catch Basins**

The native soils in the area of the proposed catch basins were found to provide sufficient protection for use as a natural barrier however, it is not found to be feasible to construct a catch basin using a natural barrier. The minimum depth of clay within the area is 2.3 mbgs, the required liner depth is 1.1 meters with 0.5 meters of freeboard (1.6 meters). This allows for a catch basin volume depth of 0.7 meters. As it will be required to have culverts to facilitate redirection of impacted run off, it is recommended to use a synthetic liner for both catch basins.



## **5.0 Design and Construction Considerations**

### **5.1 Solid Manure Storage**

The south portion of Area 1 (solid manure storage) may be cut to be regraded, should this occur do not remove more than 1.7 meters of clay below the overburden (approximately 2.5 meters) (as measured from the south boundary of the pens). This is to maintain the minimum protective barrier as well as 0.5% slope towards the catch basin.

Regrading and fill of Area 2 should be completed to maintain 0.5% slope towards catch basin 2. This can be achieved through an overall slope or slope within the pens with redirection of runoff towards catch basin 2.

A Figure presenting the elevations and proposed site plan is attached.

### **5.2 Catch Basin Sizing – Catch Basin 1**

#### **Surface Run-off Area**

The proposed area of contributing run-off for Catch Basin 1 (referred to as Area 1, as shown on Figure 2.0), is conservatively 64,896 m<sup>2</sup>. The size of the catch basin is recommended to have a total storage capacity of 3,890 m<sup>3</sup>, based on Killam precipitation data.

Area 1 is required to be contoured to direct ‘impacted’ runoff towards the catch basin. Unimpacted runoff should be prevented from entering the catch basin through berms or surface contouring.

The storage capacity required for Catch Basin 1 is 3,890 m<sup>3</sup> and will have the following specifications:

- To provide the required capacity, the catch basin should be 53 m in length x 44 m in width. The overall depth has been designed as 3.5 m. The overall capacity of the catch basin will be 5,112 m<sup>3</sup>, which accounts for the required 0.5 m of freeboard, and provides a storage capacity of 4,017 m<sup>3</sup>. The sizing is based on an inside end and side wall slope of 3:1 (run/rise).
- The bottom of the liner must be not less than 1.0 m above the top of the shallow groundwater level at the time of construction.
- The overall depth of 3.5 m will be achieved through a below grade depth of 3.5 m. Above-grade dykes may be needed to redirect unimpacted surface flow. The outside dyke walls should be completed to a slope of 4:1. The crest of the dyke should be sloped slightly outward to direct rainfall away from the storage facility.



### 5.3 Catch Basin Sizing – Catch Basin 2

#### Surface Run-off Area

The proposed area of contributing run-off for Catch Basin 2 (referred to as Area 2, as shown on Figure 2.0), is conservatively 39,520 m<sup>2</sup>. The size of the catch basin is recommended to have a total storage capacity of 2,461 m<sup>3</sup>, based on Killam precipitation data.

Area 2 is required to be contoured to direct ‘impacted’ runoff towards the catch basin. Unimpacted runoff should be prevented from entering the catch basin through berms or redirection.

The storage capacity required for Catch Basin 2 is 2,461 m<sup>3</sup> and will have the following specifications:

- To provide the required capacity, the catch basin should be 46 m in length x 36 m in width. The overall depth has been designed as 3.5 m. The overall capacity of the catch basin will be 3,297 m<sup>3</sup>, which accounts for the required 0.5 m of freeboard, and provides a storage capacity of 2,529 m<sup>3</sup>. The sizing is based on an inside end and side wall slope of 3:1 (run/rise).
- The bottom of the liner must be not less than 1.0 m above the shallow groundwater level at the time of construction.
- The overall depth of 3.5 m will be achieved through a below grade depth of 3.5 m. Above-grade dykes may be needed to redirect unimpacted surface flow. The outside dyke walls should be completed to a slope of 4:1. The crest of the dyke should be sloped slightly outward to direct rainfall away from the storage facility.



## Catch Basin Construction

Two types of synthetic liner which are readily available in the market and are suitable for such an installation are polyvinyl chloride (PVC) and high density polyethylene (HDPE). Both materials are resistant to degradation from animal manures. The suitability of these materials in this application will be somewhat dependent on the intended operation of the facility. Operational practices for the catch basin will need to be considered to determine the potential for mechanical damage to the liner. Some suppliers also offer specially blended materials for such an installation. The use and suitability of these materials should be discussed directly with the supplier.

PVC is a flexible material which is more easily installed and repaired than liners constructed of polyethylene material. Seams in PVC liners can be completed in the field without special equipment. These liners require a soil covering, generally 30 cm thick, to protect them from degradation from ultraviolet light, cold temperatures and mechanical damage. This presence of such a soil cover can be troublesome on the sidewalls due to gravitational sloughing and liquid drawdown. Additional care is required during installation to avoid liner damage during construction of the backfill layer.

Liners constructed of HDPE are more rigid and more resistant to damage. Both seams completed in the field and repairs to the liner require the use of special equipment to “weld” the material. The material is not degraded by ultraviolet light and does not require a soil backfill.

Should damage occur to the liner after installation, repair can be time consuming and costly, particularly with respect to HDPE liners. The liner construction should consider areas of high risk (areas of manure removal and agitation) to reduce the potential for damage. There are various methods for securing these higher risk areas such as double liner installation or concrete filled geofabrics which allow equipment to enter and exit the lagoon with less risk of damage.

Liner material is available in a range of thicknesses from 20 mil to 100 mil (1 mil= 0.001 inches or 1 mm = 39 mils). The selection of liner thickness should consider material availability, cost, durability and operational procedures. Thicker liners are less prone to damage but are more costly.

Based on the liquid level fluctuation in the catch basin and the exposure to degradation, a HDPE liner is recommended as no soil covering is required. A thickness of 40 mil is suggested to reduce the potential for liner damage.





On site preparation is required for the installation of a synthetic liner. The sub-grade must be compacted and stable. It should be smooth and uniform, must be free of sharp fragments, stones, roots or other material which could damage the liner and should not have any rapid changes in elevation. Care is required during the installation of synthetic liners to ensure damage does not result from vehicular activity or improper installation. Supervision by the supplier is recommended.

Applicable material and workmanship warranties should be discussed prior to installation.

To improve the sub-grade preparation and to again reduce the risk of liner damage, a geotextile may be installed under the geomembrane liner. The placement of this textile over the sub-grade provides a clean working area for field seams, provides added puncture resistance when loads are applied, improves the geomembrane to soil interface and can allow for the lateral and upward escape of subsurface water and gases that rise up beneath the geomembrane during its service life.

Upward moving water is caused by high groundwater levels. Upward moving gases are caused by biodegradation of organic material in the subsurface soils and from rising water table levels which expel the air from the soil voids. Vapour “strips” can be placed to allow for trapped vapours to be released from beneath the liner.

Following installation of the liner, each seam and repair area should be tested to ensure a complete seal has been achieved. The supplier/installer should provide an installation report detailing the testing of the material, the seams and any required repairs.



## 6.0 Closure

Envirowest Engineering is pleased to submit the report to Mitchel Kroetsch. The information and conclusions contained in this report are for their sole use. No other party is to rely upon the information contained within the report without the express written authorization of Envirowest Engineering.

Envirowest Engineering is not responsible for any damages that may be suffered as the result of any unauthorized use of, or reliance on, this report. Envirowest Engineering has performed the work and made the findings and conclusions set out in the report in a manner consistent with the level of care and skill normally exercised by members of the environmental engineer profession practicing under similar conditions at the time the work was performed. Envirowest Engineering accepts no responsibility for any deficiency, misstatement or inaccuracy in this report resulting from misinformation from any individuals or parties that provided information as part of this report.

We trust that this report meets your present needs. Please feel free to contact the undersigned with any questions or should you require additional information.

Respectfully submitted,



March 21, 2024

**Prepared by:**

Emily J. Low, P.Eng.  
Envirowest Engineering

**Reviewed by:**

Leah Predy, P.Ag.  
Envirowest Engineering

<b>PERMIT TO PRACTICE</b>	
<b>2206165 ALBERTA LTD.</b>	
RM SIGNATURE:	_____
RM APEGA ID #:	110373
DATE:	March 21, 2024
<b>PERMIT NUMBER: P014810</b>	
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)	

2206165 Alberta Ltd. o/a Envirowest Engineering  
Association of Professional Engineers and Geoscientists of Alberta  
Permit to Practice No. P14810



## 7.0 Qualifications of Assessors

Ms. Emily Low, B.Sc., P.Eng, is an Environmental Engineer with Envirowest Engineering and has approximately 15 years of environmental assessment, monitoring, and remediation experience in the agricultural, industrial, real estate and development, and oil and gas sectors. Ms. Low has a Bachelor of Science in Chemical Engineering from the University of Alberta and is a certified Professional Engineer in Alberta (Association of Professional Engineers and Geoscientists of Alberta).

Leah Predy, B.A., B.Sc., P.Ag., is a Professional Agrologist with Envirowest Engineering and has approximately 5 years of experience in the environmental field, both in field data collection and report preparation for environmental assessments, monitoring, and remediation, as well as agricultural projects. Prior to her employment with Envirowest Engineering, Leah had five years of experience managing rangelands and navigating legislation and regulations as a Rangeland Agrologist with the Government of Alberta. She is a Professional Agrologist in Alberta (Alberta Institute of Agrologists).



## 8.0 References

GOA (Government of Alberta). (November 2022). Agricultural Operation Practices Act and Regulations. Edmonton, AB: Author.

GOA (Government of Alberta). (December 2020). Agricultural Operation Practices Act: Standards and Administration Regulation. Edmonton, AB: Author.

## **Environmental Assessment Report – General Conditions**

### **1.0 Use of Report**

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of Envirowest Engineering's (Envirowest's) client. Envirowest does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Envirowest's client (hereunder referred to as the "Client") or an approved agent of the Client. Any unauthorized use of or reliance on the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Envirowest. The Client agrees that it shall use the report for its own internal purposes and it shall not provide the report to another party other than an approved agent.

### **2.0 Limitation of Report**

This report is based solely on the conditions that existed on site at the time of Envirowest's investigation. The Client, and any other parties using this report with the express written consent of the Client and Envirowest, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The Client, and any other party using this report with the express written consent of the Client and Envirowest, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The Client acknowledges that Envirowest is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the site, the decisions on which are the sole responsibility of the Client.

### **3.0 Information Provided to Envirowest by Others**

During the performance of the work and the preparation of this report, Envirowest may have relied on information provided by persons other than the Client. While Envirowest endeavours to verify the accuracy of such information when instructed to do so by the Client, Envirowest accepts no responsibility for the accuracy or the reliability of such information that may affect the report.

#### **4.0 Limitation of Liability**

The Client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising from the presence of those materials. In consideration of these risks, and in consideration of Envirowest providing the services requested, the Client agrees that Envirowest's liability shall be limited as follows:

- (1) With respect to any claims brought against Envirowest by the Client for damages of any kind whatsoever, including without limitation, incidental, consequential, exemplary or punitive, for any reason whatsoever arising out of the provision or failure to provide services hereunder the amount of such claim and the extent of Envirowest's liability shall be limited to the amount of fees paid by the Client to Envirowest under this Agreement.
- (2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the Client agrees to indemnify, defend, and hold harmless Envirowest from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by Envirowest.

#### **5.0 Disclosure of Information by Client**

The Client agrees to fully cooperate with Envirowest with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client acknowledges that in order for Envirowest to properly provide the service, Envirowest requires and shall rely upon the full disclosure and accuracy of any and all such information.

#### **6.0 Standard of Care**

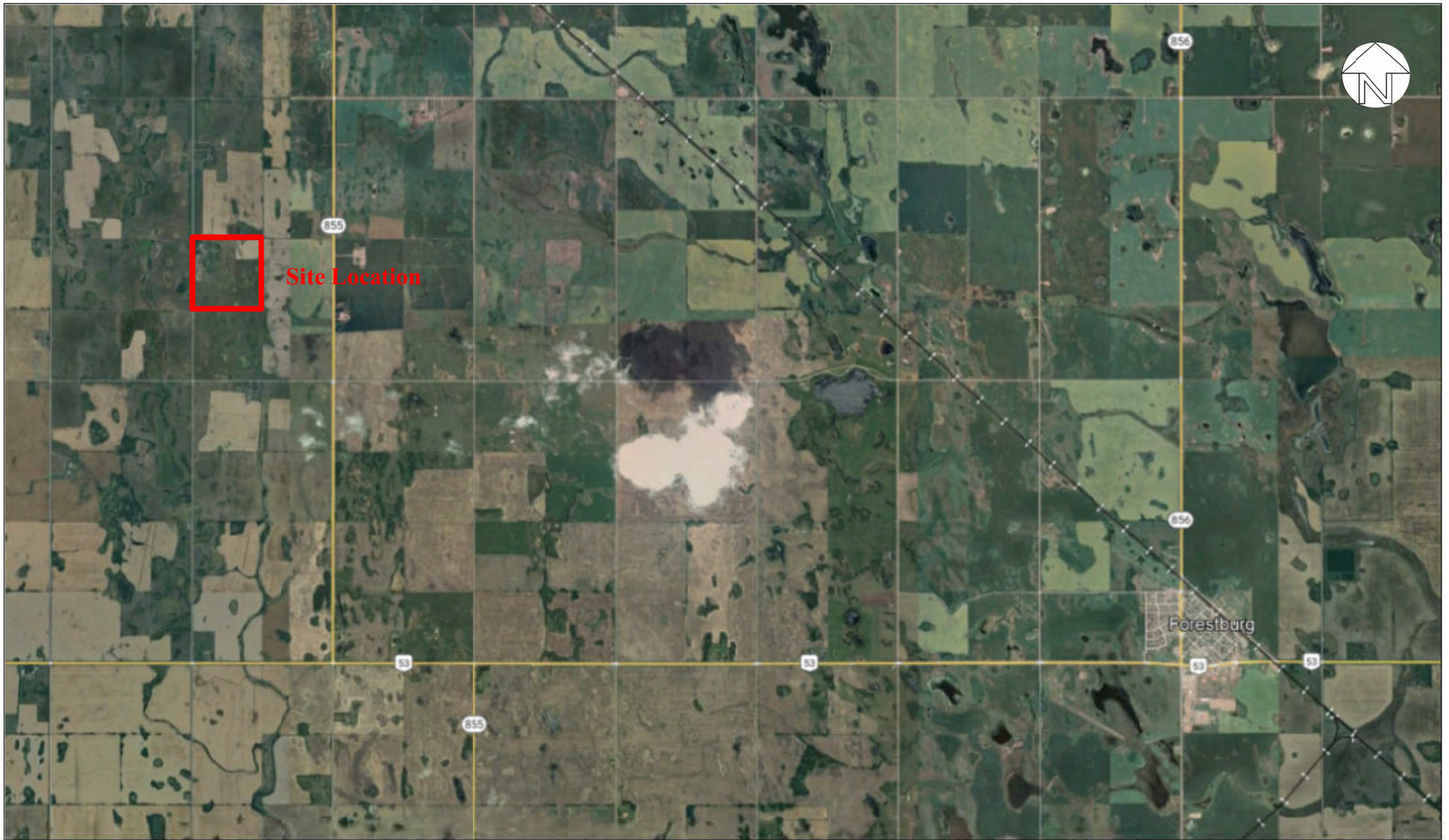
Services performed by Envirowest for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering and scientific judgment have been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

#### **7.0 Ownership of Instruments of Service**

The Client acknowledges that all reports, plans, and data generated by Envirowest during the performance of the work and other documents prepared by Envirowest are considered its professional work product and shall remain the copyright property of Envirowest.

**Appendix A**

**Figures**



**Title:** Location of Subject Site  
 Site and Soil Assessment  
 NW-15-42-16-W4M  
 Flagstaff County, Alberta

**Project No:** 2304-43021

**Date:** January 3, 2024

**Prepared by:** L. Predy

**Drawing No:** 1.0  
 Page 75 of 92





→ SURFACE WATER WILL BE DIRECTED TO EACH RESPECTIVE CATCH BASIN THROUGH SURFACE GRADING AT APPROXIMATELY 0.5% AND CULVERTS WHERE NEEDED

⊕ 23BH04

CB 2

Area 2

Approximate PL ROW

Proposed Solid Manure Storage Area

⊕ 23BH05

CB 1

Area 1

⊕ 23BH03

⊕ 23BH01

⊕ 23BH02

SW CORNER OF CONSTRUCTION AREA APPROXIMATELY 30 M FROM CENTER OF ROAD



**Title:** Borehole Locations and Proposed Surface Water Flow Site and Soil Assessment  
NW-15-42-16 W4M  
Flagstaff County, Alberta

**Project No:** 2304-43021

**Date:** March 21, 2024

**Figure No.:**

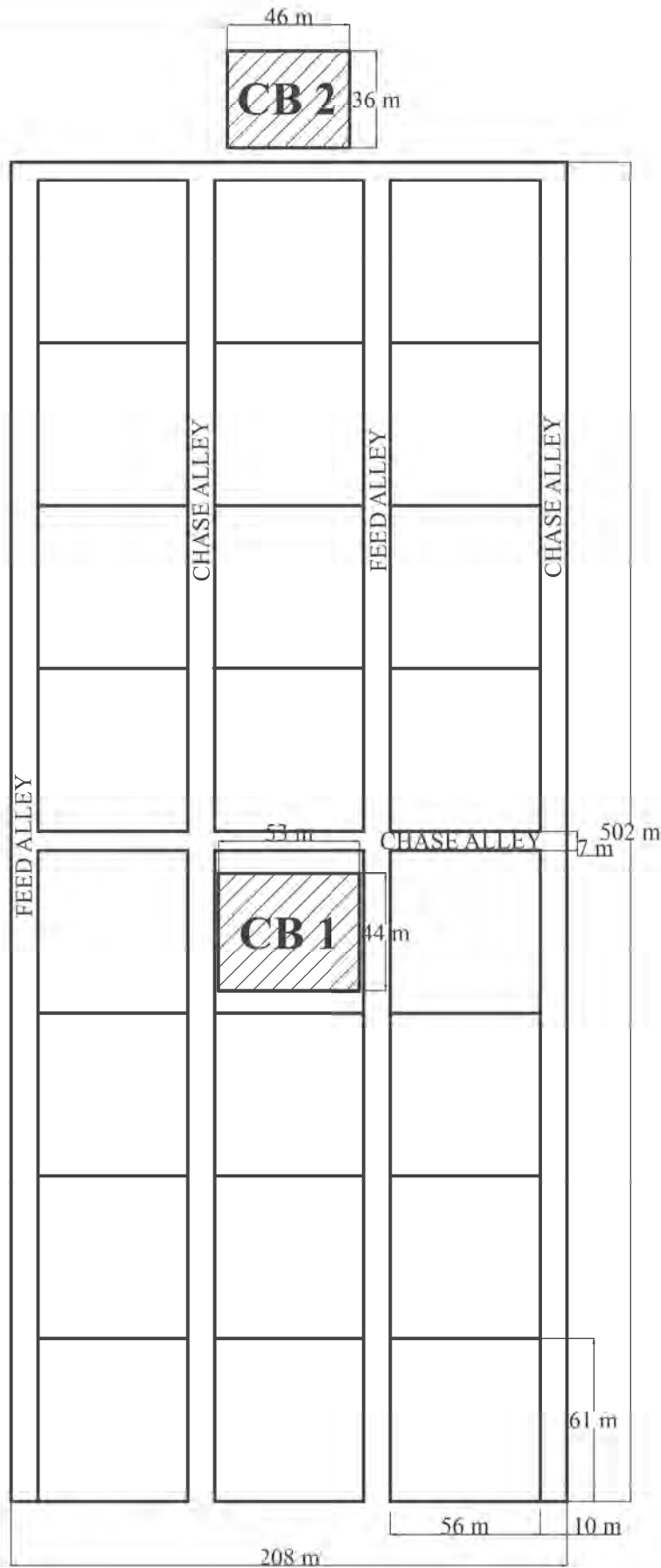
**Scale:** 1:3500

**Prepared By:** E. Low

**2.0**

**Image Source:**

Page 76 of 92  
Google Earth Pro (2022)



**Title:**  
Site Plan  
Site and Soil Assessment  
NW-15-42-16 W4M  
Flagstaff County, Alberta

**Project No:**  
2304-43021

**Date:**  
March 21, 2024

**Figure No.:**

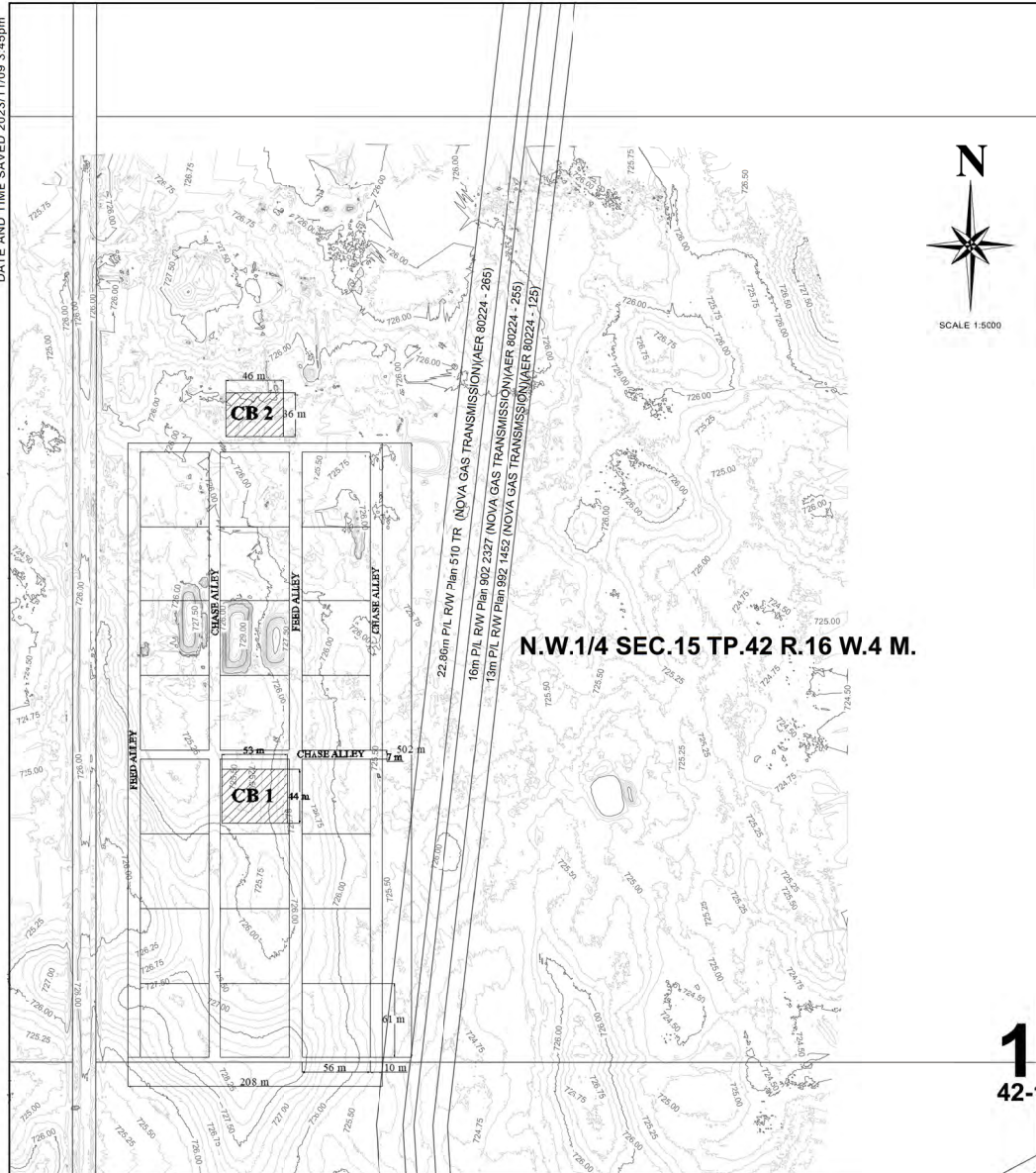
**Scale:**

**Prepared By:**  
E. Low

**3.0**

**Image Source:**

Page 77 of 92



**N.W.1/4 SEC.15 TP.42 R.16 W.4 M.**

**15**  
42-16-4



**PLAN showing  
DETAIL of CONTOUR MAP**

WITHIN NW SEC. 15 TWP. 042 RGE. 16 W4M

**NOTE:**  
CONTOURS WERE DERIVED FROM A DIGITAL SURFACE MODEL CREATED THROUGH PHOTOGRAMMETRY. IN AREAS OF HIGH VEGETATION, TREES OR BUILDINGS, SURFACE MODEL DATA HAS BEEN REMOVED AND RECREATED BY INTERPOLATING VALUES BASED ON SURROUNDING ELEVATIONS.

**NOTE:**  
THE RIGHT OF WAYS WERE TAKEN FROM CADASTRAL MAPPING AND SHOULD BE USED FOR REFERENCE ONLY.

**CAUTION:**  
NO UNDERGROUND AND ABOVE GROUND FACILITIES HAVE BEEN LOCATED AND SHOWN.



**NOTE:**  
LAST FIELD UPDATE WAS DONE ON  
OCTOBER 27, 2023

NO.	DATE	REVISION/ISSUED	REFERENCE DRAWINGS	DRAWING NO.
1	2023/10/27	INITIAL SURVEY		

	PROJECT	NW-15-042-16 W4M	FILE NO.	<b>EE0001FB</b>
	AREA	FORESTBURG	DRAW	

**COMMENTS:**

**UPDATING:**  
PLEASE MARK ANY CHANGES/ERRORS/OMISSIONS ON THE DRAWING. BRIEFLY DESCRIBE IN THE SPACE PROVIDED THE NATURE OF THE CHANGE. PLEASE EMAIL THE ENTIRE DRAWING TO [mcElhanney@mcElhanney.com](mailto:mcElhanney@mcElhanney.com). YOUR COOPERATION IS APPRECIATED AND WILL ENSURE A SAFER WORKPLACE.



**Appendix B**  
**Borehole Logs**





# LOG OF BORING 23BH01

(Page 1 of 1)

Site and Soil Assessment  
 NW-15-42-16-W4  
 Flagstaff County, Alberta  
 Project Number: 2304-43021

Driller: : Evergreen Drilling  
 Drilling Method: : Truck Mounted Auger  
 Drill Date : May 2, 2023  
 Logged By: : Emily Low, P.Eng.

Depth in Meters	Gastech Reading (ppm)	VOC Reading	GRAPHIC	DESCRIPTION	Well: Elev.:	Water Level
0.0				SAND, trace clay, light brown, dry		
0.3						
0.5						
0.8				SANDY CLAY, olive brown, compact, damp		
1.0						
1.3						
1.5						
1.8						
2.0						
2.3						
2.5						
2.8						
3.0						
3.3				dark brown		
3.5				SAND, grey , compact		
3.8						
4.0						
4.3						
4.5						

03-21-2024 Z:\Operations\Client Data\43021 Mitchell Kroetsch\23BH01.bor



# LOG OF BORING 23BH02

(Page 1 of 1)

Site and Soil Assessment  
 NW-15-42-16-W4  
 Flagstaff County, Alberta  
 Project Number: 2304-43021

Driller: : Evergreen Drilling  
 Drilling Method: : Truck Mounted Auger  
 Drill Date : May 2, 2023  
 Logged By: : Emily Low, P.Eng.

Depth in Meters	Gastech Reading (ppm)	VOC Reading	GRAPHIC	DESCRIPTION	Well: Elev.:	Water Level
0.0				SAND, trace clay, light brown, dry		
0.3						
0.5						
0.8				SANDY CLAY, olive brown, compact, damp		
1.0						
1.3						
1.5						
1.8						
2.0						
2.3						
2.5						
2.8						
3.0						
3.3				SAND, grey, damp		
3.5						
3.8						
4.0						
4.3						
4.5						
4.8						
5.0						
5.3						
5.5						
5.8						
6.0						

03-21-2024 Z:\Operations\Client Data\43021 Mitchell Kroetsch\23BH02.bor



# LOG OF BORING 23BH03

(Page 1 of 1)

Site and Soil Assessment  
 NW-15-42-16-W4  
 Flagstaff County, Alberta  
 Project Number: 2304-43021

Driller: : Evergreen Drilling  
 Drilling Method: : Truck Mounted Auger  
 Drill Date : May 2, 2023  
 Logged By: : Emily Low, P.Eng.

Depth in Meters	Gastech Reading (ppm)	VOC Reading	GRAPHIC	DESCRIPTION	Well: Elev.:	Water Level
0.0				SANDY CLAY, olive brown, compact, damp		
0.3						
0.5						
0.8						
1.0						
1.3						
1.5						
1.8						
2.0						
2.3						
2.5						
2.8						
3.0				SAND, grey, damp		
3.3						
3.5						
3.8						
4.0						
4.3						
4.5						

03-21-2024 Z:\Operations\Client\_Data\43021 Mitchell Kroetsch\23BH03.bor



# LOG OF BORING 23BH04

(Page 1 of 1)

Site and Soil Assessment  
 NW-15-42-16-W4  
 Flagstaff County, Alberta  
 Project Number: 2304-43021

Driller: : Evergreen Drilling  
 Drilling Method: : Truck Mounted Auger  
 Drill Date : May 2, 2023  
 Logged By: : Emily Low, P.Eng.

Depth in Meters	Gastech Reading (ppm)	VOC Reading	GRAPHIC	DESCRIPTION	Well: Elev.:	Water Level
0.0				SANDY CLAY, olive brown, compact, damp		
0.3						
0.5						
0.8						
1.0						
1.3						
1.5						
1.8						
2.0						
2.3						
2.5				SAND, grey, damp		
2.8						
3.0						

03-21-2024 Z:\Operations\Client\_Data\43021 Mitchell Kroetsch\23BH04.bor





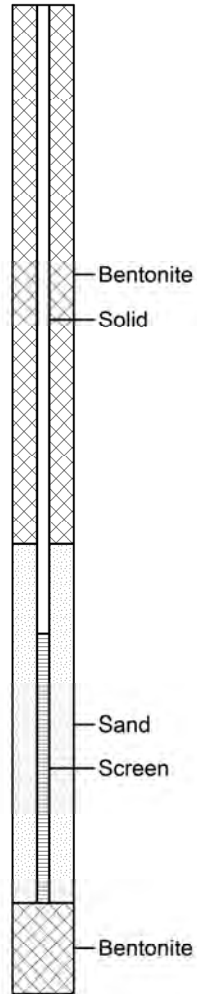
# LOG OF BORING 23BH05

(Page 1 of 1)

Site and Soil Assessment  
 NW-15-42-16-W4  
 Flagstaff County, Alberta  
 Project Number: 2304-43021

Driller: : Evergreen Drilling  
 Drilling Method: : Truck Mounted Auger  
 Drill Date : May 2, 2023  
 Logged By: : Emily Low, P.Eng.

Depth in Meters	Gastech Reading (ppm)	VOC Reading	GRAPHIC	DESCRIPTION	Well: 23MW01 Elev.:	Water Level
0.0				SANDY CLAY, olive brown, compact, damp		
0.3						
0.5						
0.8						
1.0						
1.3						
1.5						
1.8						
2.0						
2.3						
2.5						
2.8						
3.0						
3.3						
3.5						
3.8						
4.0						
4.3						
4.5						



03-21-2024 Z:\Operations\Client\_Data\43021 Mitchell Kroetsch\23BH05.bor

**Appendix C**  
**Certificates of Analysis**



**CLIENT NAME: ENVIROWEST**  
**BOX 4248, 5118-50th STREET**  
**PONOKA, AB T4J1R6**  
**(403) 783-8229**

**ATTENTION TO: Emily Low**  
**PROJECT: 43021**  
**AGAT WORK ORDER: 23R060845**

**SOIL ANALYSIS REVIEWED BY: Thomas Yoo, Report Writer**  
**DATE REPORTED: Aug 26, 2023**  
**PAGES (INCLUDING COVER): 6**  
**VERSION\*: 1**

Should you require any information regarding this analysis please contact your client services representative at (403) 735-2005

\*Notes

**Disclaimer:**

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be dispensed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.



## Certificate of Analysis

AGAT WORK ORDER: 23R060845

PROJECT: 43021

2910 12TH STREET NE  
 CALGARY, ALBERTA  
 CANADA T2E 7P7  
 TEL (403)735-2005  
 FAX (403)735-2771  
<http://www.agatlabs.com>

CLIENT NAME: ENVIROWEST

ATTENTION TO: Emily Low

SAMPLING SITE:

SAMPLED BY:

### Particle Size - Texture

DATE RECEIVED: 2023-08-22

DATE REPORTED: 2023-08-26

Parameter	Unit	SAMPLE DESCRIPTION:			
		G / S	RDL		
		23BH03-01	22BH01-01	22BH05-01	
		Soil	Soil	Soil	
		2023-05-02	2023-05-02	2023-05-02	
		5233994	5233995	5233996	
Particle Size Distribution (Sand)	%	2	37	39	53
Particle Size Distribution (Silt)	%	2	28	27	17
Particle Size Distribution (Clay)	%	2	34	33	29
Soil Texture			Clay Loam	Clay Loam	Sandy Clay Loam

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

5233994-5233996 Soil Texture is a calculated parameter. The calculated parameter is non-accredited. The parameters that are components of the calculation are accredited.  
 % Silt is a calculated parameter. The calculated value is determined by subtracting the percent sand and clay values from 100 percent.

Analysis performed at AGAT Calgary (unless marked by \*)

Certified By:



## Quality Assurance

 CLIENT NAME: ENVIROWEST  
 PROJECT: 43021  
 SAMPLING SITE:

 AGAT WORK ORDER: 23R060845  
 ATTENTION TO: Emily Low  
 SAMPLED BY:

### Soil Analysis

RPT Date: Aug 26, 2023			DUPLICATE				Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Measured Value		Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits		
								Lower	Upper		Lower	Upper		Lower	Upper	

**Particle Size - Texture**

Particle Size Distribution (Sand)	5235130	25	25	0.2%	< 2	108%	80%	120%
Particle Size Distribution (Silt)	5235130	39	39	0.0%	< 2	93%	80%	120%
Particle Size Distribution (Clay)	5235130	35	35	0.1%	< 2	95%	80%	120%

Comments: Duplicate NA: results are less than 5X the RDL and RDP will not be calculated.

 Certified By: 

## Method Summary

CLIENT NAME: ENVIROWEST

PROJECT: 43021

SAMPLING SITE:

AGAT WORK ORDER: 23R060845

ATTENTION TO: Emily Low

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
<b>Soil Analysis</b>			
Particle Size Distribution (Sand)	SOIL 0520; SOIL 0110; SOIL 0120	JONES 2001	HYDROMETER
Particle Size Distribution (Silt)	SOIL 0520; SOIL 0110; SOIL 0120	JONES 2001	HYDROMETER
Particle Size Distribution (Clay)	SOIL 0520; SOIL 0110; SOIL 0120	JONES 2001	HYDROMETER





# AGAT Laboratories

## SAMPLE INTEGRITY RECEIPT FORM

### RECEIVING BASICS - Shipping

Company/Consultant: Envirowest

Courier: Jerry Prepaid Collect

Waybill# \_\_\_\_\_

Branch: EDM GP FN FM RD VAN LYD FSJ EST SASK Other: \_\_\_\_\_

If multiple sites were submitted at once: Yes ~~No~~ *S.C. [Signature]*

Custody Seal Intact: Yes No NA

TAT: <24hr 24-48hr 48-72hr Reg Other \_\_\_\_\_

Cooler Quantity: 1 small

### TIME SENSITIVE ISSUES - Shipping

ALREADY EXCEEDED HOLD TIME? Yes No

Inorganic Tests (Please Circle): Mibi , BOD , Nitrate/Nitrite , Turbidity , Color , Microtox , Ortho PO4 , Tedlar Bag , Residual Chlorine , Chlorophyll\* , Chloroamines\*

Earliest Expiry: \_\_\_\_\_

Hydrocarbons: Earliest Expiry \_\_\_\_\_

### SAMPLE INTEGRITY - Shipping

Hazardous Samples: YES NO Precaution Taken: \_\_\_\_\_

Legal Samples: Yes No

International Samples: Yes No

Tape Sealed: Yes No

Coolant Used: Icepack Bagged Ice Free Ice Free Water None

Temperature (Bottles/Jars only) N/A if only Soil Bags Received

### FROZEN (Please Circle if samples received Frozen)

1 (Bottle/Jar) NA + \_\_\_ + \_\_\_ = \_\_\_ °C    2 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C

3 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C    4 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C

5 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C    6 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C

7 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C    8 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C

9 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C    10 (Bottle/Jar) \_\_\_ + \_\_\_ + \_\_\_ = \_\_\_ °C

(If more than 10 coolers are received use another sheet of paper and attach)

### LOGISTICS USE ONLY

Workorder No: 23R060845

Samples Damaged: Yes No If YES why?

No Bubble Wrap Frozen Courier

Other: \_\_\_\_\_

Account Project Manager: \_\_\_\_\_ have they been notified of the above issues: Yes No

Whom spoken to: \_\_\_\_\_ Date/Time: \_\_\_\_\_

CPM Initial \_\_\_\_\_

General Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\* Subcontracted Analysis (See CPM)



Data Set: Z:\Operations\Client Data\43021 Mitchel Kroetsch\SlugTest.aqt  
 Date: 08/21/23  
 Time: 10:37:44

**PROJECT INFORMATION**

Company: Envirowest Engineering  
 Client: Kroetsch  
 Project: 2304-43021  
 Test Date: May 30, 2023  
 Test Well: 23MW01(23BH05)

**AQUIFER DATA**

Saturated Thickness: 2.7 m  
 Anisotropy Ratio (Kz/Kr): 1.

**SLUG TEST WELL DATA**

Test Well: New Well

X Location: 0. m  
 Y Location: 0. m

Initial Displacement: 0.445 m  
 Static Water Column Height: 1.2 m  
 Casing Radius: 0.0255 m  
 Well Radius: 0.075 m  
 Well Skin Radius: 0.075 m  
 Screen Length: 1.2 m  
 Total Well Penetration Depth: 2.4 m

No. of Observations: 25

Observation Data			
Time (min)	Displacement (m)	Time (min)	Displacement (m)
0.	0.445	6.5	0.445
0.5	0.445	7.	0.445
1.	0.445	7.5	0.445
1.5	0.445	8.	0.445
2.	0.445	8.5	0.445
2.5	0.445	9.	0.445
3.	0.445	9.5	0.445
3.5	0.445	10.	0.445
4.	0.445	15.	0.445
4.5	0.445	20.	0.445
5.	0.445	25.	0.445
5.5	0.445	30.	0.445
6.	0.445		

**SOLUTION**

Slug Test  
 Aquifer Model: Unconfined  
 Solution Method: Bouwer-Rice  
 ln(Re/rw): 2.119

**VISUAL ESTIMATION RESULTS**

**Estimated Parameters**

Parameter	Estimate	
K	2.163E-7	cm/sec
y0	0.4448	m

$T = K \cdot b = 5.841E-5 \text{ cm}^2/\text{sec}$