Todd –
Thank you for meeting with Luke and I today regarding the Liquid Transfer Unit at Twin Enviro Services in Milner, CO. Per your request, I've attached the following information regarding this unit:

- Location of the unit on the Twin property
- Photo of the two tanks that comprise the unit installed within secondary containment
- Backup calculations

Each of the two tanks weighs about 10,000 pounds empty, so the risk of floating is not considered an issue. Additionally, the tanks are approximately 35-feet long and conservatively less than 12-feet in height. With this height to base area ratio, overturn of the tanks is not considered as a potential failure and tie-downs are not required.
Design stresses on the underlying liner from the tanks (as calculated by Golder, November 2019 – see attached) is 8.2 psi, providing for a global factor of safety of 18.8. While snow is not anticipated to accumulate within the footprint of the tanks (on top nor underneath), even adding snow loads of 102 psf = 0.74 psi are inconsequential to the global factor of safety, and outside the tank footprints snow load would be well below the loading anticipated by the filled tanks. Therefore, the unit base can accommodate the snow loading.
We understood from the meeting this information is for documentation purposes to support the administrative building permit.
Please feel free to contact me or Luke with any questions or if you need additional information.
Thanks,
Rebecca Lindeman

Jardon
Engineering & Inspections LLC

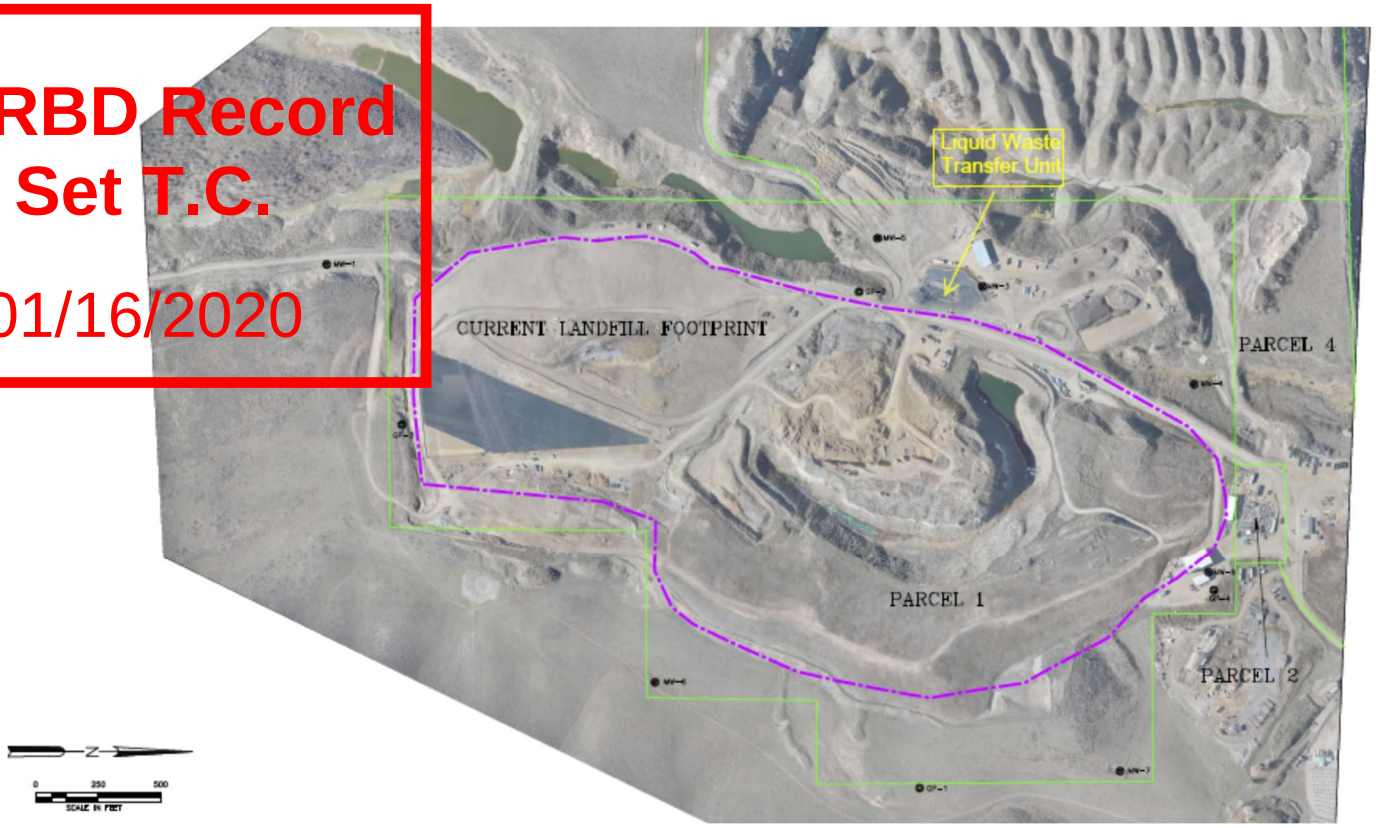
Rebecca Lindeman, P.E.

303.517.8189
Rebecca_jardon@outlook.com
PO Box 772143
Steamboat Springs, CO 80477

Liquid Unit Location – Twin Enviro Services, Milner, CO

RCRBD Record Set T.C.

01/16/2020



PJ3967-1
Fire Prevention
In: 01/23/2020
Out: 01/27/2020

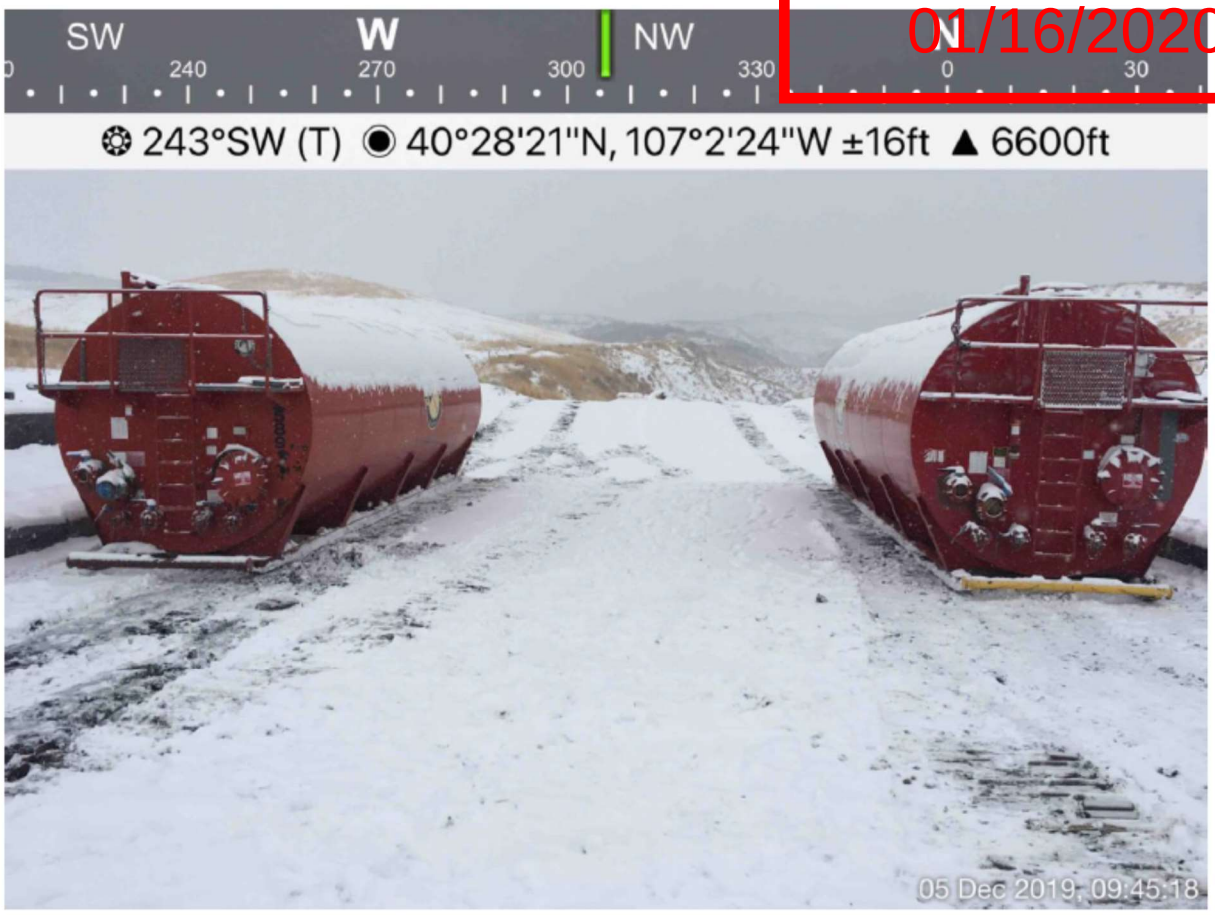
provide sign that Identify the contents.
USED COOKING OILS

Routt GIS/Addressing
OK EK 20200121

Installed Tanks Photo

RCRBD Record
Set T.C.

01/16/2020



Load Calculations (excerpts from *Liquid Waste Transfer Unit Design and Operations Plan*, Golder 2019)

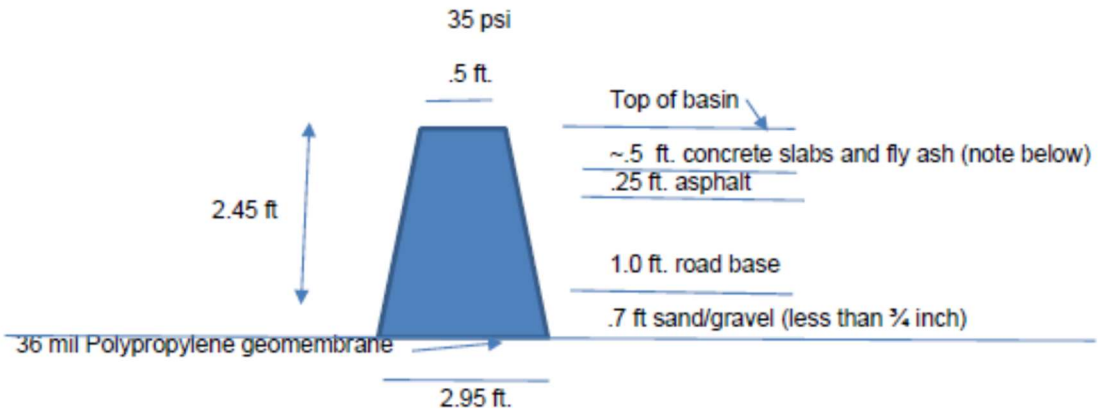
GOLDER	Subject: Milner Landfill Impacts to Liner in Old Solidification Basin from Addition of Tanks	Made by:	MEM	Job No: 1786428
		Checked by:	CDM	Date: 10/22/2019
	Analysis and References	Approved by:	MEM	Sheet No: 1 of 2

OBJECTIVE:

To show that the existing 36-mil reinforced polypropylene liner within old Solidification Basin can withstand potential puncture forces imposed by addition of two 20,000-gallon tanks that will be used for liquids transfer in former solidification basin.

METHOD:

Calculate the stress imposed by the tanks and overburden on the underlying geomembrane. Then evaluate puncture of geomembrane from granular material on top of liner. Use Koerner method of evaluating puncture.



CALCULATIONS:

From Luke Schneider at Milner, two 20,000 tanks, each sits on two steel rails about 35 ft long by 0.5 ft wide. Assume tank is completely full of fluid and stress is transferred to geomembrane at a 1 H to 2 V slope as shown to underlying geomembrane. Each tank weighs ~ 10,000 lbs. empty, so assume that total weight is 10,000 lbs., plus weight of tank full of liquid and that half of the load goes to each rail. Rails are about 7' apart for each rail, so liner will not see stress from both rails or rails supporting adjacent tank (tanks are spaced several feet apart to allow for roll-off box to be placed in-between. (Note: Ignored layers of geotextile and fence on top of geomembrane to simplify analysis. Concrete slabs are ~ 4 inches thick with additional ~ 3 inches of fly ash on top, rounded to 0.5 ft.).

Stress at top of surface of basin = 10,000 lbs. + 20,000 gal. x 8.3 lbs./gal / (35' x 0.5')/2 x 144 in.^{2} / ft.^{2} = 35 psi

Stress on top of geomembrane from tanks = 35 psi / (2.95'/.5') = 6 psi

GOLDER	Subject: Milner Landfill Impacts to Liner in Old Solidification Basin from Addition of Tanks	Made by: MEM	Job No: 1786428
		Checked by: CDM	Date: 10/22/2019
	Analysis and References	Approved by: MEM	Sheet No: 2 of 2

Approximate stress on geomembrane from overburden = 130 lb./ft^3 x 2.45 ft. x (1 ft^2/144 in^2) = 2.2 psi

Total stress on geomembrane = 6 psi + 2.2 psi = 8.2 psi

Maximum grain-size of sand/gravel on top of geomembrane is ¾ inch from Golder CQA report (2016) on repairs

Use Koerner's equation for puncture of a geotextile (page 165 3rd Edition) to estimate required puncture resistance of 36 mil PPE liner

$F_{reqd} = p' d_a^2 S_1 S_2 S_3$

Where:

p' = pressure applied to geomembrane = 8.2 psi
d_a = average diameter of puncturing aggregate, assume ¾" which is maximum size
S_1 = protrusion factor h_n/d_a, where h_n is height of protrusion, assume it is equal to d_a, so $S_1 = 1.0$
S_2 = scale factor to adjust puncture test from ASTM D 4833 from 5/16" diameter to actual diameter = $0.31/d_a$ = 0.31/.75 = 0.41
S_3= shape factor $(1 - A_p/A_c)$, where a conservative value of 0.4 for A_p/A_c will be used crushed rock so $S_3 = 0.6$

$F_{reqd} = 8.2 \times (.75)^2 \times 1.0 \times 0.41 \times 0.6 = 1.13$ lbs.

Typical minimum puncture resistance for 36 mil PPE from Lange Containment Systems using ASTM D 4833 is 85 lbs.

Using a cumulative partial factor of safety of 4.0, the global factor of safety is:

$FS = F_{allow}/F_{reqd} = 85/(4.0 \times 1.13) = 18.8$, which is acceptable

CONCLUSIONS/RESULTS:

Based on the calculation above, the 36-mil PPE liner will not be at risk from puncture from the addition of the tanks in the basins.

REFERENCES:

Koerner, Robert M. Designing with Geosynthetics, 3rd Edition. Prentice Hall, Englewood Cliffs, NJ. 1994.

Conversation with Luke Schneider at Milner to get information on tanks. September 18, 2019.

Lange Containment Systems Inc. website, Puncture Strength for 36 mi PPE using D 4833.

Golder Associates Inc. CQA Monitoring and Testing Results, Milner Landfill Solidification Repair, April 7, 2015.