

R. K. FROBEL & ASSOCIATES
Consulting Engineers

Mr. A. M. O'Hare
Maralex Resources, Inc.
P. O. Box 338
Ignacio, CO 81137

October 1, 2014

RE: Technical Memorandum
Primary 40 mil HDPE Geomembrane
Roan Creek Evaporation Pond, De Beque, CO

The Roan Creek Evaporation Pond is approximately 65,000 sf (1.5 acres) in size and 5 ft in depth and has an under drain leakage collection system composed of 4 in. diameter perforated PVC pipe in gravel trenches. Side slopes are approximately 3H:1V with the top perimeter of the liner fixed in a soil backfill anchor trench. There are no pipe penetrations. The 40 mil HDPE was installed in 1998 and recent index and performance testing completed by TRI Environmental indicated that the liner is still in relatively good condition. Additionally, a thorough visual inspection was completed on June 18, 2014 by R. K. Frobel & Associates (Technical Memorandum dated June 20, 2014) which summarized recommended follow-up testing. Maralex Resources also provided soils samples from various locations at the Roan Creek Pond site for analytical testing (Analytica Environmental Laboratories Test Report dated August 4, 2014) and contracted with Leak Location Services Inc. (LLSI) to conduct a electrical leak survey of the HDPE lining in order to find potential leak sites for repair (LLSI Report 2126 dated September 29, 2014)

The 40 mil geomembrane was manufactured by Agru America, Inc. in 1998 and installation was completed in 1998. The geomembrane layout was originally designed so that the 22.5 ft wide rolls (panels) were placed East to West across the pond width. There are a total of 15 panels that are all thermally welded together at overlaps using dual track thermal fusion seams which provide an air channel for QC NDT air testing of seams during installation. The dual track thermal fusion welds are in excellent condition. With the exception of Panel No. 15 on the North end of the pond, all exposed sections of the panels were observed by R. K. Frobel to be in very good condition with good flexibility, no cracking at wrinkles, minor surface scratching and only surface oxidation. The LLSI Report on leak location found only 14 potential leak sites that are marked and located for immediate repair if required. Even when considering the damaged panel No. 15 and minor leaks found, the soils testing provided by Analytica Laboratories indicates little or no contamination of soils due to the possibility of historical leakage.

Summary Recommendations Based on Site Visit Report and Review of ELLS Report:

1. Remove and Replace the North End Panel No. 15. This will require removing approximately 4 ft of accumulated soils on panel 14, thoroughly cleaning the panel edge

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and thermal fusion welding a new panel in place. It is further recommended that the subgrade be properly repaired and compacted prior to placement of the new panel.

2. Repair any damaged areas on the side slopes and replace old patches with new extrusion welded 40 mil HDPE patches.
3. With the exception of the North End Panel No. 15, all remaining panels are in good condition and should be placed back in to service once minor repairs are made. It should be noted that the TRI Environmental test results on the 40 mil HDPE samples extracted from the liner system show that the HDPE sheet is still in relatively good condition for its age and that with monitoring will give extended service as an evaporation pond liner.
4. Again, it is not recommended to clean the bottom of the pond as cleaning will damage the intact bottom lining system and the accumulated soils and salt layer effectively protect the liner from damaging effects of wind, uplift, UV and excessive wrinkling when the pond is empty. The only areas that require soil/sediment removal are those 14 minor leak repair locations as indicated in the LLSI report.
5. The 40 mil HDPE lining was tested in place using approved ASTM test methods ASTM D 7002 and/or ASTM D 7007. The testing was completed by an approved and experienced Electrical Leak Location Survey (ELLS) contractor (Leak Location Services, Inc.). LLSI Report 2126 indicated that only 14 small potential leak sites were found over the entire bottom of the pond. It is important to note that not all leak sites are holes and thus visual inspection by a qualified installer will be necessary prior to any required repair. Considering the age of the lining system, 14 potential leak sites is a small number for inspection and repair.
6. Using the LLSI report and location map, inspect each potential leak site and repair by patching and extrusion welding as necessary.
7. Remove vegetation growth at the perimeter of the pond lining system without damaging the HDPE. Repair excessive erosion areas with infill soils and grading.
8. Once all required repairs are made to the existing 40 mil HDPE geomembrane and the lining system has been final inspected, the lining system will be fit for use for the Roan Creek Evaporation Pond.

The existing 40 mil HDPE lining system with the extensive leak collection piping under the liner is designed to contain the designated brine water for evaporation with requisite sump monitoring to detect any major breach in the liner. It is my professional opinion that the existing lining system will provide another 5 plus years of service with monitoring and thus should be placed back into service as soon as all repairs have been completed. Once all repairs are made, the existing HDPE lining system with leak collection/detection will provide the same level of protection over the next 5 years as a new 60 mil HDPE lining system.

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Based on the results of the soil testing, lining system inspection and Electrical Leak Location testing, it is my professional opinion that the sub soils under the current lining system have not been impacted by possible leakage from the potential and relatively small leak sites. Additionally, the extensive underdrain system has not collected any measurable seepage as evidenced by the dry sump conditions.

If you have any questions on this report, give me a call at 303-679-0285 or email geosynthetics@msn.com.

Sincerely Yours,

R. K. Frobel

Ronald K. Frobel, MSCE, PE

References:

1. TRI Environmental HDPE Material Test Report No.E2386-15-03 dated February 21, 2014
2. R. K. Frobel & Associates Site Visit Report dated June 20, 2014
3. Analytica Environmental Laboratories Soils Testing Report dated August 4, 2014
4. Leak Location Services, Inc. (LLSI) Report 2126 dated September 29, 2014