

**R. K. FROBEL & ASSOCIATES**  
**Consulting Engineers**

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

June 20, 2014

RE: Technical Memorandum  
Site Visit and Primary Geomembrane Liner Inspection  
Roan Creek Evaporation Pond, De Beque, CO

At the request of Maralex Resources, Inc., Mr. R. K. Frobel traveled to the Roan Creek Evaporation Pond site on June 18, 2014 for the purpose of inspection of the current condition of the 40 mil HDPE primary geomembrane liner.

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. The toe of slope dimensions are 285 ft in length and 175 ft in width. 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.

**Site Observations and Comments:**

- Approximately 90% of the pond bottom is currently covered with wind blown silt and sand as well as a thin layer salt that covers the accumulated silt and sand. The depth of the relatively thin layer ranges from a dusting to approximately 4 or 5 inches at low spots or between liner wrinkles. At the time of this site visit, the soil was wet from recent rains. This accumulation of soil and salt effectively protects the bottom of the pond liner from environmental deterioration due to the effects of UV, wind movement, wrinkling and uplift.
- 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.
- To facilitate inspection, the individual panels were marked from South to North as panels 1 through 15. Each panel was inspected primarily on the side slopes due to bottom soil and salt accumulation. However, bare areas on the pond bottom were inspected and found to be in excellent condition with good flexibility, no visible damage and no visible polymer degradation.

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- Panels 1 through 14 were inspected primarily on the side slopes. Considering the length of time that the liner has been in place, only minor damage was noted and one bullet hole was observed in Panel No. 1. In particular the patches on the East side Panels 8 and 12 will require removal and replacement with 40 mil HDPE extrusion welded patches.
- Samples were taken by Maralex from Panel No. 4 slope on the West side for testing at TRI Environmental in 2013. The 5 ft x 5 ft slope sample area was patched with new 40 mil HDPE. Of particular note is the fact that the patch was extrusion welded to the old liner with excellent results. Thus any future repairs can be made very effectively with extrusion welding.
- With the exception of Panel No. 15 on the North end of the pond, all exposed sections of the panels were observed to be in very good condition with good flexibility, no cracking at wrinkles, minor surface scratching and only surface oxidation. Thus, the South, East and West Slopes are in good condition.
- The dual track thermal fusion welds connecting all panels were inspected for general appearance, adhesion and cracking. All of the weld areas that were inspected were in excellent condition with no separation at the seam area.
- Panel No.15: This panel is the panel which covers the North end of the pond and which has sustained severe damage due to the extreme south sun exposure, high winds, wrinkling and flexing of the liner at folds. Although repairs with various types of patching materials have been made over damaged areas, this panel must be removed entirely and replaced with a new 22.5 ft wide roll of 40 mil HDPE thermally welded to existing panel 14 and then securely fastened in the perimeter anchor trench.
- Weeds, grass and shrubs were observed to be growing at the perimeter of the pond up to the edge of the HDPE lining system. Additionally, erosion of perimeter soils was noted.

**Recommendations Based Site Visit Observations and Review of Available Documents:**

1. Remove and Replace the North End Panel No. 15 that has sustained severe damage over time. This will require removing approximately 4 ft of accumulated soils on panel 14, thoroughly cleaning the panel edge and thermal fusion welding a new panel in place.
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 and

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the entire lining system is tested. 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. It is not recommended to clean the bottom of the pond. 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. Additionally, the pond bottom can be tested for holes or damage with the soil accumulation in place.
  
5. Test the entire 40 mil HDPE lining in place using approved ASTM test methods ASTM D 7002 and/or ASTM D 7007. The testing must be completed by an approved and experienced Electrical Leak Location Survey (ELLS) contractor. The ELLS will locate all minor leak locations which can then be readily repaired prior to placing the pond back into service. An ELLS contractor such as Leak Location Services, Inc. (LLSI) out of San Antonio can be scheduled at any time. Their web site is [llsi.com](http://llsi.com).
  
6. A hydrostatic or water balance seepage test with a full pond is not recommended due to inaccuracy of method and the fact that actual leak locations that may be present can not be determined.
  
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 and tested by ELLS, I can provide professional certification that the lining system is fit for use for the Roan Creek Evaporation Pond.

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

Sincerely Yours,

*R. K. Frobel*

Ronald K. Frobel, MSCE, PE