

November 7, 2014

Mr. Carlos Lujan, PhD
Colorado Oil & Gas Conservation Commission
796 Megan Avenue, Suite 201
Rifle, CO 81650
Carlos.lujan@state.co.us

LOCATION 391314
FACILITY 116525
FACILITY 433509
DOC 2142521

Re: Final Summary Report, Roan Creek Evaporation Pond

Dear Carlos:

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has prepared this letter report as a contract deliverable under Purchase Order PHAA 20150000003 dated August 25, 2014. Please note that the statements given herein are professional opinions based solely on the documents reviewed and site observations made. These professional opinions are subject to change if additional information is obtained.

The Colorado Oil and Gas Conservation Commission (COGCC) requested that Burns & McDonnell review a produced water evaporation pit permit application and associated documents for the Roan Creek Evaporation Pond submitted by the permittee, Maralex Resources, Inc. (Maralex). Maralex has requested to use an existing pond under a new Centralized E&P (Exploration and Production) Waste Management Facility permit (Form 28). COGCC also requested Burns & McDonnell to provide an independent opinion regarding the suitability of the existing liner for long term future use. This letter report has been prepared to present our independent opinion.

Site Description

The Roan Creek Evaporation Pond is located north of DeBeque, Colorado on Bureau of Land Management (BLM) land. This pit was constructed in 1999 and originally permitted by the BLM. The pit currently does not have a permit to operate. The pit is approximately 300 feet by 200 feet in area (285 feet by 175 feet toe to toe) and five feet deep with 3:1 side slopes. It is lined with 40-mil thick high density polyethylene (HDPE) geomembrane liner. Based on design drawings provided by COGCC, there is a leak detection system (LDS) consisting of seven rows of 175-foot long French drains (trenches containing drainage pipe and gravel wrapped in geotextile) that drain into a solid collection pipe that drains to a collection manhole located on the north side of the pit. The LDS trenches are spaced 45 feet apart. No information was available on the subgrade soils between the LDS trenches.

The pit is oriented so the long direction is oriented roughly north-south with the LDS drains oriented east-west. The LDS manhole is on the north side of the pit and there is a 300 barrel tank and loading/unloading station at the southwest corner of the pit. The pit is ringed by a chain link fence with a gate near the southwest corner.

Documents Reviewed

Burns & McDonnell reviewed the documents available for the site at <http://cogcc.state.co.us/> under: Location ID: #391314; Centralized Facility ID: 433509; and Pit Facility ID: 116525. Additionally, the letter report titled *Geomembrane Leak Location Survey of the Roan Creek Evaporation Pond at the Maralex Facility near DeBeque, Colorado* by Leak Location Services, Inc. (LLSI) and dated September 29, 2014 was reviewed. No as-built nor any construction quality assurance (CQA) documentation was available for review to explain how the subgrade was constructed or what

materials were used. No documentation of manufacturer or installer quality control efforts during the 1999 construction was available for review either.

Site Visit

Brad Coleman, PE of Burns & McDonnell arrived on site with COGCC representatives on September 23, 2014 at approximately 8am to observe site conditions and to witness the LLSI leak location survey. A copy of his field notes are included as Attachment 1 and select photographs taken during the visit are provided in Attachment 2. At the time of the test, about 90-95 percent of the pond bottom was covered with 2-4 inches of water. There was a fair sized "island" of exposed liner in the north central portion of the pit and a larger exposed liner area along the southern boundary of the pit (see Photograph 1). About one inch of sediment with occasional rocks and debris were observed on the exposed liner. LLSI reported that they would only be able to test those areas covered in water via a wading survey and were not equipped to test the side slopes or the exposed areas of the pit bottom utilizing the "puddle" or "bare liner" method.

The geomembrane panels extend east to west and had previously been labeled Nos. 1 through 14 by Maralex. LLSI performed their survey from about 8 am to 2pm with a ½ hour break for lunch. Holes were marked by wrapping rocks in brightly colored rags and placing them over the hole. A total of 14 holes were marked by LLSI, including holes visually seen on the "island". Panels 1 and 2 were not tested because insufficient standing water was present (see Photographs 3 and 4). LLSI field measured the hole locations.

The exposed portions of the liner were walked several times. Uneven and soft subgrade was observed beneath the liner at several locations along the toe of slope. The locations where samples of the geomembrane panel and seam were removed and sent to a lab for strength testing were observed (Photograph 5). Also the badly deteriorated Panel 14 reported in Maralex' documentation was observed (Photograph 6). It was noted that the deterioration, which consisted of continuous lines of vertical brittle cracks spaced about one inch apart and about two feet in length. The cracks occurred where the liner was stained a whitish color on the bottom half of the northern side slope, which is assumed to be the level where water previously covered the liner. The cracks appeared to be chemical in nature and not physical scratches or striations. This deterioration was not observed in areas above the high water mark based on a whitish stain. It was also noted that the geomembrane panel and seam samples previously tested by TRI Environmental, Inc. (TRI) in late 2013 were removed from locations above the high water mark.

The LDS manhole was observed at the north end of the site. No water was present in the LDS manhole even though at least ten holes were marked by LLSI below standing water.

Numerous non-industry standard geomembrane patches were observed at several locations along the pond side slopes. Some were extrusion welded and some were not. Some of the patches utilized HDPE and some didn't. Some extrusion welds appeared to be professionally made to industry standards while others appeared to be of poor quality done by poorly trained and/or equipped technicians. Some patches were only partially welded. Most holes outside of Panel 14 had been marked for repair. Also some additional holes were observed (see Photographs 8 and 9).

Work was completed onsite at approximately 2:45 pm at which time COGCC and Burns & McDonnell left.

Conclusions and Recommendations

In it's current state, due to the geomembrane age and the defects described above, the pond design and condition is not adequate to prevent releases of the pond contents to the underlying subgrade. This statement is made for the following reasons:

1. It is suspected that something in the pond contents, possibly hydrocarbons, *may* have leached the carbon black from the geomembrane and made the geomembrane more susceptible to ultraviolet ray deterioration, resulting in the brittleness and cracking beneath the high water mark. If this theory is correct, all the panels are deteriorating – not just Panel 14. Panel 14, which is oriented with a southern aspect, receives the most sunlight and thus is just deteriorating at a faster pace than the other panels.
2. TRI's cover letter to their test report also noted that the "onset of degradation is likely in the next few months and years as the antioxidant package is completely consumed." This means that geomembrane above the high water mark is already showing evidence of degradation.
3. Geomembrane panel and seam samples from an area at or below the high water mark should be removed and sampled in the same manner as the previous samples taken above the high water mark. Preferably, these samples would be taken on the same panel and seam as the previous ones and tested for the same parameters as the original TRI tests to note any difference in values.
4. There are 17 identified holes (15 by LLSI and two by Burns & McDonnell) and several additional locations that could not be leak tested or visually inspected.
5. Due to the design of the LDS, it is likely that only a very large release from the pond would be detected. It is also likely that a significant release occurring in areas not overlying the LDS trenches may never be detected.

It is Burns & McDonnell's opinion, based on the data reviewed and observations described above, that Panel 14 cannot be simply replaced and the remaining identified holes repaired and the liner meet the requirements of its planned future use or life expectancy. This is exemplified by TRI's remark that "degradation is likely in the next few months and years". We do have the following recommendations:

1. Before any repairs are made, the pond should be filled with more water to see if any water is collected in the existing LDS sump. If no water can be collected in the sump, then that will be demonstration that the existing LDS is inadequate.
2. If the pond is filled as recommended in No. 1 above, then bring LLSI back to test the non-tested areas so that holes in those locations can be identified and repaired. All areas of the liner should either be cleaned enough to be thoroughly visually inspected or be covered with water and leak tested.
3. All holes need to be repaired to geosynthetics industry standards by professional HDPE geomembrane installers and the repairs documented by qualified CQA personnel.
4. Demonstrations should be made that the statements made by TRI in their cover letter are not valid or relevant to the performance of the liner over the desired permit length.
5. If the pond is to be put in service, consideration should be given into turning the existing liner into a secondary liner and installing a new LDS and primary geomembrane over the existing liner in accordance with industry standards. Note that it may be difficult to design a new LDS sump under this alternative as the existing pond liner is essentially flat.

We appreciate the opportunity to provide professional services to COGCC. Please do not hesitate to contact the undersigned at 303-362-2335 or bacoleman@burnsmcd.com with any questions or comments to this report. We would welcome the opportunity to sit down with you and the permittee to review any additional information or insights and work out a path forward.

Sincerely,

A handwritten signature in black ink, appearing to read "Brad Coleman", written in a cursive style.

Bradley A. Coleman, P.E.
Senior Project Manager

RBF/bac

Enclosures

Attachment A – Field Notes

Attachment B – Selected Photographs

Attachment A

Field Notes

COGCC
Maralex Pond

9/23/14

1/27

615: Carlos picked me up @ hotel

635: Picked up Stan in Parachute

700: @ conv. store - wait for Maralex

730: met Maralex - Naomi Azulai

750: on site, LESI on site - John Ortiz

~~John~~ Leland from Maralex also there

John gave overview of process

- he will be using wading method
- Maralex has only put about 2" water in pond on average - LESI would like 3"
- bottom of pond about 90-95% covered w/ water
- he is not set up to test non-covered liner areas (can't do puddle test)

815: walking liner

- subgrade very uneven in places
 - particularly SW corner - seem like erosion
- found unmarked 2" rip in rills
- Panel 5 - East side slope - showed to COGCC
- soft spots under liner along toe of slope
- north slope liner deteriorated badly @ high water mark - brittle - poke finger through it
- TRI samples taken on ^{south end of} west slope above high water mark
- numerous different materials used for repairs in past: mostly glued PVC some welded P.P., some leistered patches
- unmarked rip in NW corner by anchor trench

COGEE
Maralex
pond

2/3

~ 9am LSI starts survey

John explains its not as accurate and more
time consuming with $\pm 1''$ water in it

1030 : John has found about 4 holes - done w/
northern Y3

1130 : Lunch about 6 holes so far

1200 : back to work

2pm: John is done surveying now measuring
holes - about 12-15 found

- could not survey south 2 panels
cuz not enough water
- island in west central portion has
3-4 visual holes
- sediment, rock, broken sand bags
oil waste in sediment
- did not survey side slopes
- soft spots at toe
- Panel 10 west side

11 " "
12 " "
10 east " "
7
8

- indentation 5' from
crest

- very uneven subgrade

4 east side

- all south side - panel 1

panels 1 & 2 - ~~east~~ corner
water under lines

COGCC
Maralex

3/3

230pm: LLS1 packed up

245 - Left site - traveled back to
Denver

Attachment B
Selected Photographs

Select Photographs
Maralex Roan Creek Evaporation Pond
All photos taken September 22, 2014



Photograph 1: View looking south of pit during leak testing. Note the LLSI testing person and exposed liner in the central portion of the pit and along the southern boundary.



Photograph 2: Leak Detection Manhole



Photograph 3: View looking west at exposed liner on south side of pit



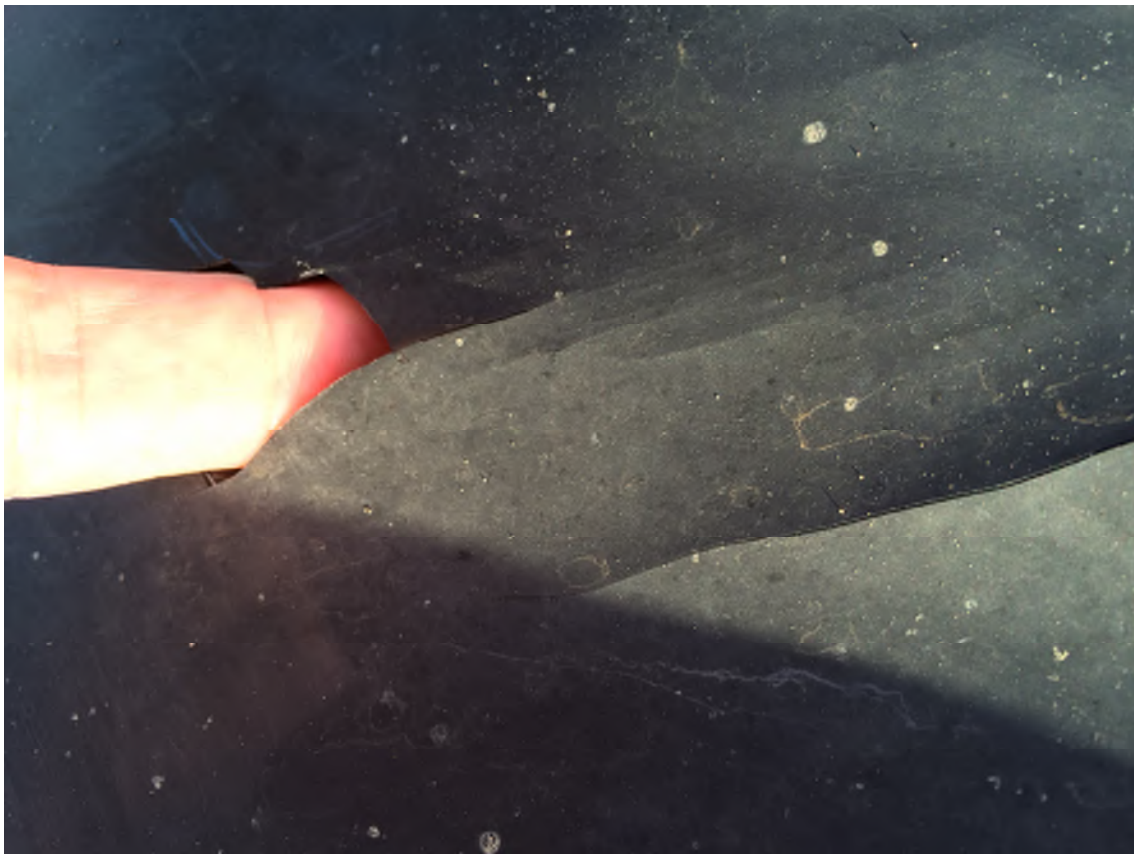
Photograph 4: Close up view of the area not covered by water in the southwest corner of the pit.



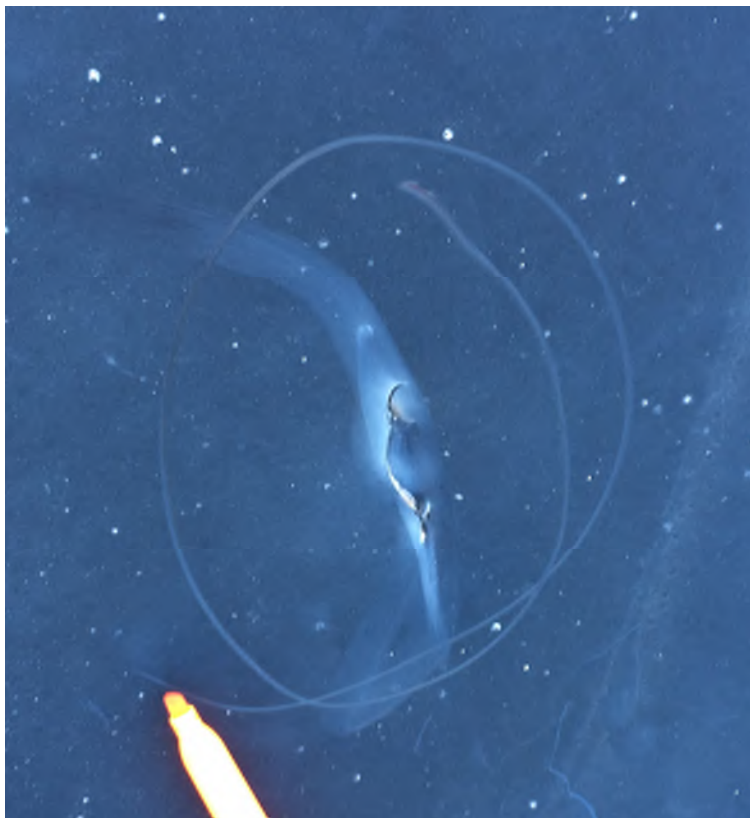
Photograph 5: View of location where a geomembrane samples were removed for testing by TRI Laboratories. Note the locations are above high water mark denoted by the lighter stained liner to the right.



Photograph 6: View of deteriorated Panel 14 along north side of pit. Note the holes and patches are all generally located at or below the high water mark.



Photograph 7: Close-up of deterioration in Panel 14. Finger punctured through liner with little pressure.



Photograph 8: 2-inch long tear observed on Panel 5 east side slope.



Photograph 9: 6-inch long rip observed along anchor trench in northwest corner.



Photograph 10: Posted sign at pit