Government of Canada Gouvernement du Canada

3rd Floor Gallery Building
4923-52nd Street, P.O. Box 1500
Yellowknife, NT X1A 2R3

January 2, 2019

Attention: Kierney Leach
Regulatory Officer
Mackenzie Valley Land and Water Board
P. O. Box 2130, YELLOWKNIFE NT X1A 2P6

Re: Gordon Lake Group Remediation Project - #MV2016L8-0006
As Built Report

Dear Ms. Leach,

Please accept this As-Built Report for the Gordon Lake Group Remediation Project (Water Licence #MV2016L8-0006) respectfully submitted by Crown Indigenous Relations and Northern Affairs Canada (CIRNAC) – Contaminants and Remediation Division (CARD). The submission of this Report is intended to satisfy Part D Item 9 of the Water Licence.

If you have any questions or concerns regarding this report please contact A/Project Officer Jessica Wilson (email: jessica.wilson@aandc.gc.ca ph: 867-669-2744) or myself (email: amy.allan@canada.ca ph: 867 669-2467).

Sincerely,

Amy Allan

Amy Allan
A/Project Manager, Contaminants and Remediation Division
Crown Indigenous Relations and Northern Affairs Canada (CIRNAC)

cc: Carey Ogilvie, Senior Manager CIRNAC-CARD

Canada

FINAL - 2018 As-Built Construction – Camlaren TSCA, Part of GLG

Project No. 121413573

December 21, 2018

Prepared for:

Public Works and Government Services Canada and Indigenous and Northern Affairs Canada

Prepared by:

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Prepared by ______________________________
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Kris Hojka, M.Sc., P.Eng.
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Executive Summary

During the Winter and Summer of 2018, Tailings and Soil Containment Area (TSCA) was constructed at the Camlaren Mine Site, part of the Gordon Lake Group of Sites. The final cover was placed over the mine waste in August and September 2018.

Based on review of as-built drawings and other construction documentations including QA/QC, photographs and field logs, it was concluded that majority of TSCA areas were constructed in accordance with the IFC drawings and technical specifications. If there were some minor discrepancies in the design grade of the final cover, or the design alignment, the original design intent is met and the TSCA should perform well if maintained properly. The report documents any field decisions made that deviated from the original design together with justification to support the decision. There was only one small variance with the design that should be monitored closely. The final cover thickness in some areas was less than the design requirement of 0.5m. These areas should be monitored closely in the future, for possible erosion. In the event, that the BGM liner is exposed, the cover should be repaired by placing additional fill.

Please do not hesitate to contact the author of this report, if you have any questions or concerns.

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by Public Works and Government Services Canada – Northern Contaminated Sites Group (PWGSC-NCSG) on behalf of Indigenous and Northern Affairs Canada (INAC) to provide an opinion on as-built post-construction conditions to the engineered Tailings and Soil Containment Area (TSCA) at the Camlaren site, a part of the remediation works of Gordon Lake Group (GLG) of sites in the Northwest Territories (NT). This work is being completed under Contract EW699-121587/001/NCS for environmental services in the Western Region, dictated by the Terms of Reference provided to Stantec in June 2015, May 2016, and October 2017.

The purpose of this report was to provide the summary of the construction activities for TSCA facility. The construction of the TSCA was carried out from July 10 through September 15, 2018. The construction was performed by Delta Engineering Inc.and Nahanni Construction Ltd. (DNV) and supervised by inspectors from Stantec.

A survey of the final TSCA facility was completed by DNV on September 21, 2018. Final TSCA survey and layout plan is illustrated in Drawing 1 in Appendix A.

2.0 TSCA DESIGN CHANGES OVERVIEW

Tailings and Soil Containment Area (TSCA) is an engineered mine waste containment facility and includes Camlaren tailings and other mine waste from surrounding mine sites commonly known as Gordon Lake Group mine sites.

The mine waste was transported to the Camlaren TSCA in the winter of 2018, with majority of earthworks trucked from February 4 to March 13, 2018. Some of the waste was transported (flown by helicopter in bags) to the TSCA in the summer of 2018. Approximately 23,400 m3 of mining waste was brought into TSCA in total.

The design for the TSCA was presented in the following Design Basis Report (DBR):

- Stantec Consulting Ltd., May 8, 2018, Updated Report: Gordon Lake Group Design Basis, Submitted to Public Works and Government Services Canada and Indigenous and Northern Affairs Canada, File No:121414585
- and updated in:
- Stantec Consulting Ltd., September 10, 2018, Updated Report: Gordon Lake Group Design Basis, Submitted to Public Works and Government Services Canada and Indigenous and Northern Affairs Canada, File No:121414585

The final report dated September 10, 2018, was the final design basis report to account for all the changes that were made during the construction. The following changes were made since the original design dated May 08, 2018.

- Changes were made to account for the details of the liner attachment to bedrock based on new field investigation in June 2018. The new changes were addressed in drawing C-CAM-11A. The perimeter ditches were also introduced, on the west and south perimeters, the lined suspended ditch section was introduced and shown on C-CAM-11B. The updated design drawings were issued on July 13, 2018 for comments prior to construction.
- The updated design drawings were issued on July 19, 2018 that addressed comments regarding details of the BGM attachment to bedrock. More details were developed on C-CAM-11A and additional details were developed for ditches shown on C-CAM-11B.
- IFC drawings were issued on July 31, 2018, with addressed comments.
- Some of the IFC drawings were updated in August 2018, to address changes in the design due to various sub-surface conditions encountered during construction. In this regard, changes were issued to C-CAM-11B to introduce details 8B, and 9B to address design changes to Southern Ditch. Drawing C-CAM-13 was updated to address changes to the instrumentation layout around the TSCA. Drawing C-CAM-15 was produced indicating proposed liner installation layout.

All record design drawings are included in Appendix A. September 10, 2018 DBR report contains all the latest IFC drawings.

3.0 TSCA AS-BUILT CONDITIONS OVERVIEW

The TSCA was constructed by placement of the engineered cover over the approximately 23,400 m3 of the mine waste.

The following activities were performed during the Summer 2018 construction:

- The slopes were stabilized by regrading of the perimeter embankments and regrading slopes to between 3.1H:1V to 4.3H:1V (as-built).
- The engineered composite cover with Bituminous Geomembrane (BGM) was placed to prevent infiltration from entering the waste. The composite cover comprised of the BGM placed on sand bedding, and 0.5 m of sand cover over the BGM.
- Erosion protection was provided by placement of the willow branches on the top and coarse sand with rockfill and coco mats on the slopes;
- Lined ditches were constructed on the northwest and south perimeters to control drainage away from the TSCA and prevent any pooling against the embankment;
- Implementation of instrumentation and monitoring program for the long term performance of the TSCA.

The TSCA as-built drawings produced by DNV are shown in Appendix B, these drawings were processed and interpreted by Stantec and shown in Appendix C.

The TSCA is oval in shape, about 200 m (south to north) by 130 m (east to west) covering the area approximately 2.5 ha. The top of the TSCA is cone shaped with slopes with grades of about 4% shedding the surface runoff towards the perimeters. The overview of the as-Built TSCA is shown in Drawing 1 (Appendix C), the TSCA top cover was shaped with slopes 3-4%, which is in general agreement with the design requirement of minimum 3% grade.

The embankments on average are about 2 to 4 m high and up to 5 m high at the highest section on the north. In general, final regraded slopes are 3 Horizontal to 1 Vertical (3H:1V) and are up to 4.6H:1V and are in compliance with the design criteria of 3H:1V slope.

The composite BGM cover was placed over the entire TSCA, and slopes. In the embankment toe areas, the BGM was placed on the prepared bedrock foundation and covered with sand/bentonite mixture. In selected low topography areas, the BGM liner was not secured to bedrock but instead rockfill toe drains were constructed to relieve any pore pressures, if they were to develop within the TSCA at any point of time.

Perimeter ditches were constructed on the northwest, Northern Ditch (Ditch 1 on the original design drawings) and on the south perimeter – Southern Ditch (Ditch 2 on the original design drawings). The ditches were lined with the BGM and covered with rip rap. The BGM extended from the slopes into the ditches as one unit, to prevent any water backflow into the TSCA.

The construction photographs are included in Appendix D showing all construction activities in the order by dates. Construction activities are also recorded in Appendix E – Weekly Reports.

4.0 CONSTRUCTION ACTIVITIES

4.1 SLOPE REGRADING

The TSCA embankments on average are about 2 to 4 m high and up to 5 m high at the highest section on the north. All TSCA slopes around the perimeter were regraded to meet the design requirements minimum 3 Horizontal to 1 Vertical (3H:1V). Sections across the as-built TSCA were developed and shown on Drawings 8 and 9, detail embankment slope sections were illustrated on Drawing 10 and 11 in Appendix C. Based on the sections, final regraded slopes are flatter than minimum design requirement (3H:1V) and are between 3.02H:1V for the West Embankment to 4.6H:1V for the East Embankment. The West Embankment is the smallest up to 2 m in height, and the North Embankment is the highest up to 5 m in height.

Concurrently with the regrading effort, the top of the TSCA with the mine waste was also reshaped to provide required minimum 3% slope radially in all directions from the center. The final surface was recompacted and covered with the geotextile. These earthwork activities and geotextile placement was documented on the photographs in Appendix D and also documented on Weekly Construction Logs in Appendix E.

4.2 EXCAVATION AND DITCHES

Key Trenches

The BGM cover design required to secure the BGM to bedrock in higher areas around the perimeter, where bedrock was closer to the surface. The design drawing C-CAM-7 identified the areas around the perimeter, where the BGM was to be secured to bedrock. The design drawing C-CAM-11A showed typical sections with methodology, how to secure the BGM to bedrock. During construction, it was found that bedrock was highly fractured in many areas and therefore it was not feasible to use batten bars and anchors to secure the BGM to bedrock (section 5A). The method shown in section 6A and/or section 7A was preferred.

Key trench was excavated around the east and northeast perimeters. Photographs 8 through 15 illustrate the trenching activities. Deeper trench areas with fractured bedrock were treated with concrete and sand/bentonite mix.

There is no survey available for the key trenches, but their approximate alignment is shown on Drawing 2.

Anchor Trenches

Anchor trenches were excavated around the top of the TSCA embankments to provide the anchor for the BGM. Details of the BGM installation in the anchor are provided further in section 4.4.

The layout of anchor trench is presented in Drawing 2. The trenches were surveyed, and the trenches profile is shown in Drawing 12.

Ditches

Perimeter ditches, namely North Ditch and South Ditch were developed on the west and south perimeters, respectively. During excavation, the bedrock was found generally at deeper elevations than assumed, therefore the designs were modified such as to provide a continuous liner across the ditch and provide the liner anchor on the downstream side of the ditch. The North Ditch excavation was performed fully in the overburden and the liner was fully suspended over the bedrock with the anchor trench above the bedrock. In case of the South Ditch, the excavation was partially in overburden but in some places shallow excavation in bedrock was required. The South Ditch anchor trench was also excavated to bedrock and backfilled with sand/bentonite mixture. Design drawing C-CAM-11B dated August 17, 2018 shows typical sections for the ditches. Section 4B shows typical section used for North Ditch and section 8B shows typical design used for South Ditch. Photograph 11 shows the excavation the South Ditch.

Drawing 2 illustrates the ditches alignment, and ditches profiles are shown on Drawing 12. All ditches meet the design requirement of minimum gradient 2%.

Rip rap was placed in the ditches on the top of the BGM, for additional protection. Rip-rap was produced from the oversized cobble material (above 50 mm) screened from NW stockpile.

Ditches sections were reviewed during the geotechnical post-construction inspection performed on October 2, 2018. The ditches geometry and construction meet the project design requirements. The exceptions were slopes for the South Ditch. The top part of outer slopes were slightly steeper than required 3H:1V. This is a minor discrepancy to the design. A correction to the slopes can be achieved with manual labour with shovels and raking to the design 3H:1V. The correction should be performed above the BGM liner to avoid its damage.

4.3 LINER SAND BEDDING

A layer of 0.2 m sand bedding was placed on the top of the geotextile to form the subgrade in the TSCA.

Drawing 2 shows the final surface of the sand bedding placed on the TSCA. Drawings 8 and 9 illustrate as-built TSCA in sections, where the sand bedding layer is shown placed over the mine waste.

The sand material used for bedding was alluvium sand material with trace of fines below 5%.

The sand had some oversized material above specified maximum 12 mm, in the range about 5-10%. The South and West Stockpiles with finer sand were used for bedding construction. The results of gradation analyses are included in Appendix F.

The sand layer was compacted to 95% of Standard Proctor Maximum Dry Density, the required compacted density was achieved by track packing with D6 bulldozer over the sand layer with 5 full passes, while adding moisture. On the steeper slopes, along the E-NE and N slope, the D3 bulldozer and the skid steer, were used as not to damage the sand layer.

Standard Proctor test results on the sand material is presented in Appendix F. The maximum dry density was estimated at 2030 kg/m3 and the optimum moisture content was 10.5%. The soil compaction reports are presented in Appendix G. With a few exceptions, most of results exceeded the minimum compaction requirement.

Prior to the BGM installation, the sand subgrade was inspected by the Stantec inspectors and the liner installer. Any protruding materials that could potentially damage the liner, such as rocks, were removed manually or by raking. Any depressions or ruts from equipment on the finished surface were properly corrected.

The final and approved sand subgrade was documented by making a few random high resolution photographs of the sand bedding scattered around the TSCA. The photographs are presented in Appendix H.

4.4 BUTIMINOUS GEOMEMBRANE

The BGM was installed by TEXEL GÉOSOL INC. (Texel), Boucherville (Quebec), (DNV Subcontractor) specialized in the installation of the bituminous geomembrane.

GROUPE ALPHARD INC., Montreal (Quebec), mandated by DNV acted as QA/QC Supervisor for the installation of the bituminous geomembrane.

The Coletanche ES2 product was used for the project. The BGM was installed on the prepared surface once the subgrade elevation and visual inspection approvals were granted to DNV.

Texel deployed and installed the bituminous geomembrane panels in accordance with the requirements of the Bituminous Liner Plan & Quality Control Program, with a minimum overlap of 200 mm between adjacent panels. Any loose sand, water from the geomembrane surface area prior to welding.

As per the design drawings and the Bituminous Liner Plan & Quality Control Program, where applicable, the BGM was anchored into the trench. The trench was approximately 1 m of depth and penetrated into the mine waste material. The sand bedding was placed in the bottom to protect the BGM, after BGM installation the trench was backfilled with compacted sand material. Another BGM sheet was installed on the adjacent flat portion of the TSCA overlapping the anchored BGM by 1.5 m. The overlapping layers were not welded together. Photographs 20 and 21 in Appendix D show BGM installation in the anchor trench.

Based on conversation with inspectors, it is understood that the BGM was placed directly on bedrock in key trench or on prepared bedrock surface using methodology shown in sections 6A and 7A of drawing C-CAM-11A.

Prior to placement of BGM in the key trench or bedrock surface, fractured bedrock was treated with concrete to provide smooth surface. The BGM liner was placed on the smooth bedrock surface and backfilled with sand/bentonite mixture.

The BGM panels were welded together using a torch as prescribed per manufacturer. Quality control was performed by performing 74 ultrasound tests and 76 vacuum box tests spaced randomly. All non-compliant seams were reconstructed or repaired until properly seamed.

In accordance by DNV 22,883 m2 of bituminous geomembrane was installed. This quantity was verified by Stantec, using 3D projection of as-built drawings 23,321 m2 of BGM was used.

Final Liner Installation Report was prepared by Alphard, the report includes all installation details and methodology as well QA/QC documentation. This report is presented in Appendix I.

4.5 SAND COVER

The final cover of 0.5 m sand layer was placed on the top of the BGM. The sand material was alluvium sand material with trace of fines below 5%. The sand had also some oversized material above specified maximum 12 mm, in the range about 5-10%. The South and West Stockpiles with finer sand were used in the central portion of the TSCA, once these stockpiles were depleted the North-West Stockpile with coarser material was used mainly for slopes. Some oversized cobble size stones were screened and used as rip rap in ditches. mate and for bedding construction.

In general, it was recognized, that some oversized material could be in direct contact with the BGM after the sand cover placement. Larger stones could be buried under cover and not visible.

As a due diligence a trial test was performed, which tested the strength of the BGM under direct impact of sharp stones with simulated compaction to mimic the actual compaction conditions. The results showed that no puncture but only some dents in the BGM were observed. The dents were made by D6 bulldozer as it was driving over 0.2 m cover. There was no damage caused by D3. It was concluded that light compaction with bulldozers over 0.5 m cover would not cause any damage to the BGM, especially when only random stones might be in contact with the BGM. Full procedure and description of the test with the photographs is provided in Appendix J.

The sand layer was compacted to 90% of Standard Proctor Maximum Dry Density, the required compacted density was achieved by track packing with D6 bulldozer over the sand layer, while adding moisture. On the steeper slopes, along the E-NE and N slope, the D3 bulldozer and the skid steer, were used as not to damage the sand layer.

Standard Proctor test results on the sand material is presented in Appendix G. The maximum dry density was estimated at 2030 kg/m3 and the optimum moisture content was 10.5%. The soil compaction reports are presented in Appendix G. With a few exceptions, most of results exceeded the minimum compaction requirements.

Drawing 1 shows the as-built TSCA with the final cover contours. Drawing 7 presents the cover thickness spots estimated based on the difference between surveyed spot elevations for the top of cover and the bedding. The results below required 0.5 m were highlighted. It is revealed that insufficient cover was placed especially on the West Embankment (below 0.3 m) and also on the southern portion of the East Embankment (below 0.4 m). Minor non-compliance with regard to the thickness (below 0.5 m) was noted throughout the TSCA on the top and on the slopes.

The areas with minor non-compliance (below 0.5 m and above 0.4m) should be noted and monitored closely in the future, for possible erosion. Other areas with cover below 0.4 m should be repaired.

Slopes of the cover mostly meet the design requirement of minimum 3% with the exception of one spot on the south area, where slope of 2.8% was measured. This minor discrepancy should not create any problems.

4.6 INSTRUMENTATION

The instrumentation was installed in the TSCA to provide means for future monitoring. The instrumentation was installed between September 8 and 15, 2018. The instrumentation includes two (2) thermistors (VT), two (2) standpipe monitoring wells (MW), and three (3) locations for vibrating wire piezometers with double nested vibrating wire sensors (VB). In addition, there are four (4) monitoring wells outside of the TSCA footprint installed as part of the Long Term Monitoring Program. Drawing 1, illustrates location of these instrumentation. The instrumentation and borehole logs are presented in Appendix K, as well as all calibration records required for future readings' estimations.

The monitoring well screens for MW#1 and MW#2 were installed within tailings horizon above bedrock. Two sets of vibrating wire piezometers were installed at each location, one just above the bedrock surface, and one within the tailings horizon.

The following table provides general overview of the instrumentation:

Table 4.1: Overview of TSCA Instrumentation

ID	Type of Installation	Northing	Easting	Ground Surface Elevation (m)	Borehole Depth (m)
MW#1	Monitoring Well	6986005	388356	298.73	5.3
MW#2	Monitoring Well	6986051	388352	298.96	7.1
MW#3*	Monitoring Well	6986073	388393	292.41	7.2
MW#4*	Monitoring Well	6985962	388376	294.52	3.8
MW#5*	Monitoring Well	6985922	388236	296.58	4.8
MW#6*	Monitoring Well	6986066	388238	295.45	5.4
VB#1	Vibrating Wire Piezometers	6985957	388335	298.11	6.4
VB#2	Vibrating Wire Piezometers	6986026	388381	297.99	6.1
VB#3	Vibrating Wire Piezometers	6986079	388353	298.48	7.0
VT#1	Thermistor String	6986005	388351	298.89	5.9
VT#2	Thermistor String	6986055	388352	298.84	7.0

*Monitoring well outside of the TSCA footprint

The following table provides installation details from monitoring wells including screen horizons.

Table 4.2: Monitoring Wells Installation Details

Borehole ID	Ground Surface Elevation	Borehole	Top of Screen		Bottom of Screen	
		Depth	Depth	Elevation	Depth	Elevation
MW#1	298.73	5.3	2.1	291.33	5.2	286.13
MW#2	298.96	7.1	4	287.86	7	280.86
MW#3*	292.41	7.2	5.7	279.51	7.2	272.31
MW#4*	294.52	3.8	2.3	288.42	3.8	284.62
MW#5*	296.58	4.8	3.2	288.58	4.75	283.83
MW#6*	295.45	5.4	3.9	286.15	5.4	280.75

*Monitoring well outside of the TSCA footprint

The following table provides installation details for vibrating wire piezometers.

Table 4.3: Vibrating Wire Piezometers Installation Details

Borehole ID	Serial Number	Ground Surface Elevation	Depth of piezometer (m)	Elevation of Piezometer (m)
VWP #1	52115	298.11	4.95	293.16
	52116	298.11	5.95	292.16
VWP #2	52117	297.99	4.8	293.19
	52118	297.99	5.8	292.19
VWP #3	52119	298.48	5.7	292.78
	52120	298.48	6.7	291.78

The following table provides installation details for thermistors. Thermistor sensors are installed at 0.5 interval.

Table 4.4: Thermistors Installation Details

Borehole ID	Serial Number	Ground Surface Elevation	Depth of lowest thermistor (m)	Elevation of lowest Thermistor (m)
VT#1	4773	298.89	5.8	293.09
VT#2	4774	298.84	7	291.84

4.7 SUMMARY OF DESIGN CHANGES MADE DURING CONSTRUCTION

A few design changes were made during construction due to variable field conditions. The changes were made to ensure the design would meet its final objectives. These changes were described in detail in sections above and are summarized in the following table:

Design Change	Area of Construction	Justification	Supporting Documentation
Concrete dent was applied to bedrock in toe key trenches, in the areas where bedrock was found highly fractured	BGM toe key trenches on the northeast perimeter, approximate chainages 0+140 to 0+170	Bedrock was fractured with depth and it was unreasonable to excavate deeper. Concrete was poured to fill fractures and rough surface	See photographs 7,8,9 and 12 in Appendix D, weekly reports dated 8-03-2018, and 8-10-2018
The North Ditch was excavated fully in the overburden and was fully lined. The BGM liner was anchored in the trench above the bedrock..	West Perimeter, chainages 0+480 to 0+570	Original design called for ditch excavated in bedrock, this proved to be no possible due to deeper depth of bedrock i.e. 1.5-1.8 m below grade	Design drawing C-CAM-11B dated August 17, 2018 Section 4B shows typical section used for North Ditch, decision is documented in the minutes of Weekly Construction Meeting dated August 14, 2018
The South Ditch was excavated fully in the overburden and was fully lined. The liner anchor trench was excavated to bedrock and backfilled with sand/bentonite mixture.	South Perimeter, chainages 0+320 to 0+420	Original design called for ditch excavated in bedrock, this proved to be no possible due to deeper depth of bedrock i.e. 1.0-1.5m below grade	Design drawing C-CAM-11B dated August 17, 2018 Section 8B shows typical section used for North Ditch, decision is documented in the minutes of Weekly Construction Meeting dated August 14, 2018
The sand used for bedding had some oversized material above specified maximum 12 mm, in the range about 5-10%.	Sand Bedding – Zone C	Prior to the BGM installation, the sand subgrade was inspected. Any protruding materials that could potentially damage the liner, such as rocks, were removed manually or by raking.	The final and approved sand subgrade was documented by high resolution photographs of the sand bedding scattered around the TSCA. See Appendix H.
The sand used for the cover had some oversized material above specified maximum 12 mm, in the range about 5-10%.	Sand Cover – Zone D	A test was performed to assess the strength of the BGM under direct impact of sharp stones compacted with the D6 and D3 bulldozers. Only dents were observed after D6 compaction, no dents were observed under D3 compaction. No punctures were present.	. Full procedure and description of the test with the photographs is provided in Appendix J.

5.0 CONCLUSIONS

Based on review of as-built drawings and other construction documentations including QA/QC, photographs and field logs, it was concluded that majority of TSCA areas were constructed in accordance with the IFC drawings and technical specifications. If there were some minor discrepancies in the design grade of the final cover, or the design alignment, the original design intent is met and the TSCA should perform well if maintained properly. There was only one small variance with the design that should be monitored closely. The final cover thickness in some areas was less than the design requirement of 0.5m. These areas should be monitored closely in the future, for possible erosion. In the event, that the BGM liner is exposed, the cover should be repaired by placing additional fill.

6.0 REFERENCES

Stantec Consulting Ltd (2018) Updated Report Gordon Lake Group Design Basis, September 10, 2018.

Buchko, Jared. DNV. (July 30, 2018). Bituminous Liner Plan & Quality Control Program REV 1. Gordon Lake Group of Sites Remediation Project

APPENDICES