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TECK RESOURCES LTD.

Louvicourt Mine Tailings and Polishing Ponds 2017 Dam Safety Inspection

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REPORT

Golder Associates

Executive Summary

This report presents the 2017 annual dam safety inspection (DSI) for the tailings storage facility (TSF) and polishing pond at the closed Louvicourt mine site located near Val-d'Or, Québec. This report was prepared based on a site visit carried out on September 12, 2017 and a review of available data by the Engineer of Record, Mayana Kissiova, of Golder Associates (Golder). Routine inspections were carried out by Eric Gingras, Louvicourt Supervisor of Water Treatment and Maintenance, throughout the year. Dam maintenance and surveillance were reviewed through site observation and assessment of instrumentation monitoring data. Photographs to support the most relevant observations are presented with this report.

The report was prepared in accordance with the Teck Guideline for Tailings and Water Retaining Structures (Teck 2014).

Summary of Facility Description

The Louvicourt Mine is a closed base metal mine (primarily copper and zinc, with some gold and silver) located approximately 20 km east of Val-d'Or, Quebec, north of Highway 117.

Dam infrastructure at the site comprises of a tailings pond with a polishing pond located immediately downstream to the east of the tailings pond. The tailings pond is contained by Dam 1 to the north and east, Dam 2 to the west and high ground to the south.

The polishing pond is contained by Dam 4 to the north, the tailings pond to the west and by natural topography to the south and east.

Summary of Key Hazards and Consequences

The three key hazards for the TSF and polishing pond have been identified to be internal erosion, instability and overtopping. As a required component of a dam safety inspection, the report presents a review of the dam safety implications of the instrumentation data and the September 12, 2017 site observations relative to potential failure modes. The design basis relevant to each of the typical potential failure modes is also presented.

Internal Erosion:

Flow rates at the V-notch weirs and seepage locations around the TSF are regularly estimated or measured. Water flowing from the toe drains, the seepage points, and the V-notch weirs was clear at the time of the site visit and did not contain visible suspended particles. Flow rates were generally low. No zones of subsidence or any sink holes, which could indicate voids due to piping, were observed. No evidence of internal erosion was observed.

Instability:

The Dam Safety Guidelines (CDA, 2013) Section 3.6.3 recommends the use of dam instrumentation to supplement the ongoing visual assessment of dam performance relative to potential failure modes. The report presents a summary of settlement and horizontal movements measured and observed at the TSF and the polishing pond. All survey monuments were surveyed between September 6 and 8, and September 13, 2017 by Corriveau J.L. & Assoc. (Corriveau), a surveyor based in Val-d'Or.

Horizontal movements of the monuments remain relatively limited. Seasonal vertical movements are noticeable on most monuments on a year to year basis, which has been attributed to the result of frost action and survey limitations.

Measured differences in the elevation of monuments are small between 2008 and 2017, and no consistent long-term trend can be detected for most of 2008-2017 data. The most consistent and largest movement of former settlement points for this time interval (settlement of 24 mm) occurs at point B-2 (SP-2) located on Dam 1D, as expected in the design due to the nature of the foundation at its location.

The piezometers in the dams indicate piezometric levels that were relatively stable throughout the monitoring period and consistent with historic trends.

Localized portions of the dams' upstream faces were observed to be steeper than the design value of 2.5H:1V. No evidence of instability was however observed. Longitudinal cracks were reported to develop along the crest of Dam 1 during the last few winter seasons. These were assessed by Golder in 2015 and were attributed to freeze-thaw action. No such cracks were observed during the 2017 DSI conducted in September.

Overtopping:

The dams of the tailings pond and polishing pond were originally designed with a 2.0 m freeboard and a 1.5 m freeboard respectively. Current freeboard varies between 1.81 m and 1.95 m at the tailings area, and 3.9 m at the polishing pond. Even though some settlement has occurred at Dam 1D as a result of consolidation of the clayey foundation materials, the freeboard is higher than the minimum requirement since parts of Dams 1D and 2B were originally built with an extra 1.0 m fill allowance to compensate for the anticipated settlement.

The water level within the tailings pond was 316.10 m during the site visit. The freeboard in the tailings pond at the time of the site inspection was greater than the minimum CDA freeboard requirements (Klohn Crippen Berger, 2011), and therefore did not present concern with overtopping.

Consequence Classification

A study by SNC-Lavalin 2012 concluded the tailings dams were classified as "very high" consequence dams, as per the criteria in the Canadian Dam Association *Dam Safety Guidelines* (CDA, 2007). The classification of Dam 4B at the polishing pond was established as "high" in the 2010 Dam Safety Review (DSR) (Klohn Crippen Berger, 2011). There have been no changes to the conditions of the TSF or polishing pond, or to applicable regulations that would require a change to these classifications, therefore, they remain unchanged.

Summary of Key Observations

Summary of Field Observations

A site inspection was carried out on September 12, 2017, by Mr. Nicolas Pépin, Eng. and Mrs Mayana Kissiova, Eng., both from Golder. They were accompanied by Mr. Eric Gingras, from Teck Resources.

The following observations were made during the site inspection:

- All dams were in good condition. Water levels on September 13, 2017 were at elevation 316.10 m at the tailings pond and 306.55 m at the polishing pond.
- Spillways at Dam 4B and 1D were in good condition and functional.

- Ponding water or seepage with low flow were observed at the toe of several dams at the same locations as previous years. No dam safety concerns are associated with these seepage points or ponding water.
- The rip-rap on the upstream slope of Dam 1D is to be rehabilitated. The protection has been eroded with time by the wave action. The same effect, but on a much smaller scale, has been observed on the upstream slope of Dam 1B.
- Several minor erosion points are visible at the crest of Dams 1, 2 and 4, and should continue to be monitored.

Climate and Water Balance Summary

The 2016/2017 winter precipitation generally remained below monthly multi-annual averages. 2017 spring and late summer precipitation was higher than the multi-annual averages. May (138.7 mm), August (182.3 mm) and October (168.2 mm) 2017 were very wet months. The total precipitation over the considered period is 7% higher than the long-term average.

Based on a high level water balance analysis, it was estimated that 0.92 million m^3 of water was discharged to the polishing pond via the spillway.

Summary of Significant Changes

No construction or other significant changes have occurred since the 2016 Dam Safety Inspection. A geotechnical investigation was performed, but this is not considered to be a significant change.

Summary of Review of OMS and ERP Manuals

The Operation, Maintenance and Surveillance (OMS) Manual for the tailings management facility was updated by Golder in March 2017 (Golder, 2017).

An Emergency Response Plan (ERP) for the tailings facility was issued on June 15, 2017. The review of this document concluded that it contains recent and up to date information.

A previous Dam Safety Review (DSR) (Klohn Crippen Berger, 2011) indicated that the assessment of potential liquefaction for some of the silty soil foundations during a large earthquake requires further study. Additional post-liquefaction stability analyses were conducted by Golder in 2013 and concluded that supplemental field data and analyses were necessary to better define the current characteristics of the silt layers present in the foundations. A field program was completed in 2017 and analyses are expected to be completed in Q2 2018.

Dam Safety Review

A DSR of the TSF and polishing pond was conducted in 2015 (SNC-Lavalin, 2015). The next DSR should be completed by the end of 2020.

Status of 2016 Dam Safety Inspection Key Recommended Actions

The status of 2016 DSI deficiencies and non-conformances are presented in the following table.

ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Potential Dam Safety Risk	Recommended Action	Priority	Recommended Deadline	Status
2015-02	Existing riprap material on the upstream face of dam 1D has degraded and ravelled downslope.	CDA 2007 Section 3.5.3	Erosion of till core of dam 1D	Place new riprap material along the upper portions of the dam side slopes, starting with the upstream face of Dam 1D.	2	Q3 2016 See note 2	IN PROGRESS-Planned for Q4 2018
2015-04	Finalize the OMS manual	CDA 2007 Section 3.2	N. A.	Finalize the OMS report	4	Q4 2016	CLOSED-Completed March 2017
2015-05	Finalize the ERP	CDA 2007 Section 4.5	N.A.	Finalize the ERP report	4	Q4 2016	CLOSED-Completed June 2017
2015-06	Perform a review of dam's seismic stability and liquefaction conditions	2010 Dam Safety Review	Dam seismic stability	Perform a review of dam's seismic stability and liquefaction conditions	4	Q4 2016	IN PROGRESS-Investigation completed Q4 2017; analyses in progress
2016-01	Wood debris at the polishing pond spillway	OMS Manual Section 6.2	Potential raise in the pond operating level	Debris should be removed from the upstream trash collector	3	Q2 2016	CLOSED-Completed June 2016
2016-02	Wood debris at the tailings pond spillway	OMS Manual Section 6.2	Potential raise in the pond operating level	Debris should be removed from the spillway	3	Q2 2016	CLOSED-Completed June 2016
2016-03	Turbid water was noted at the north end of Dam 1D berm	CDA 2007 Section 3.6.1	Piping (if confirmed from future monitoring)	Regular monitoring is required to establish the cause of this occurrence	3	Immediate and on-going	CLOSED
2016-04	Presence of trees on dams	CDA 2007 Section 3.5.3	Could alter integrity of the till core	Trees higher than 1 m to be cut	3	Q3 2016	CLOSED
2016-05	Water flow trajectory at tailings pond second emergency spillway	CDA 2013 Section 3.5.5	Erosion along the toe of Dam 1D	Extend downstream earth berm	4	Q2 2018	IN PROGRESS-Planned for Q4 2018
2016-06	Improve retention of debris at the tailings pond spillway	CDA 2007 Section 3.5.5	Potential raise in the pond operating level	Finer mesh grid should be installed	4	Q2, 2018	CLOSED

2017 Dam Safety Inspection Key Recommended Actions

The key issues and recommended actions from the 2017 dam safety inspection, including unresolved deficiencies and non-conformances from the 2016 DSI are summarized in the following table.

ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Potential Dam Safety Risk	Recommended Action	Priority	Recommended Deadline
2015-02	Existing riprap material on the upstream face of dam 1D has degraded and ravelled downslope.	CDA 2007 Section 3.5.3	Erosion of till core of dam 1D	Place new riprap material along the upper portions of the dam side slopes, starting with the upstream face of Dam 1D.	2	Q4 2018
2015-06	Uncertainty regarding seismic stability and liquefaction conditions	2010 Dam Safety review	Dam seismic stability	Perform a review of dam's seismic stability and liquefaction conditions	4	In Progress. Completion scheduled for Q2 2018
2016-05	Water flow trajectory at tailings pond second emergency spillway	CDA 2007 Section 3.5.5	Erosion along the toe of Dam 1D	Extend downstream earth berm	4	Q4 2018
2017-01	Existing riprap material on the upstream face of dam 1B has started to degrade	CDA 2013 Section 3.5.3	Erosion of rip-rap and eventually core of dam 1B	Place new riprap material along the upper portions of the dam side slopes	2	Q4 2018

Priority (defined by Teck Resources)	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

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Abbreviation	Definition
CDA	Canadian Dam Association
DSI	Dam Safety Inspection
DSR	Dam Safety Review
ERP	Emergency Response Plan
OMS	Operation, Maintenance and Surveillance
PGA	Peak Ground Acceleration

UNITS OF MEASURE

Unit	Definition
kPa	kilopascals
m^3	cubic metre
tpd	tons per day

GLOSSARY

Term	Definition
Dam Safety Inspection (DSI)	An annual report summarizing the results of a dam safety inspection.
Dam Safety Review (DSR)	A systematic review and evaluation of all aspects of design, construction, maintenance, operation, process, and system affecting a dam's safety, including the dam safety management system (CDA 2013).
Downstream	The side of the embankment furthest away from the reservoir or pond.
Tailings	Fine grained residual material remaining after the valuable resources have been separated.
Freeboard	The vertical distance between the still water surface elevation in the reservoir and the lowest elevation at the top of the containment structure (CDA 2013).
Upstream	The side of the embankment nearest to the reservoir or pond.
Waste Rock	Coarse grained (gravel to boulder sized) mineral rockfill. Also referred to as rockfill.

1.0 INTRODUCTION

1.1 Purpose, Scope of Work, and Methodology

At the request of Teck Resources Limited, Golder Associates Ltd. (Golder) has completed the 2017 Dam Safety Inspection (DSI) at the Louvicourt Mine tailings management facility located near Val-d'Or, Quebec. The report is based on a site visit carried out on September 12, 2017 and the review of available data by the Engineer of Record, Mayana Kissiova of Golder. The previous annual DSI for the tailings facility dams was carried out in June 2016, and is reported in the 2016 DSI report (Golder, 2017).

The 2017 inspection included the following structures:

- Dams 1A through 1E
- Dams 2A and 2B
- Dams 4A and 4B

This report has been prepared in accordance with the Teck Guideline for Tailings and Water Retaining Structures (Teck, 2014) and the Teck Dam Safety Inspection table of contents provided May 28, 2017. Sections that are no longer applicable due to the facility being closed or because of the particular nature of the Louvicourt tailings facility have been identified as "not applicable".

1.2 Regulatory Requirements

The dam safety inspection has been performed in accordance with the following:

- *Guide de préparation du plan de réaménagement et de restauration des sites miniers au Québec*, MERN, Novembre 2016
- *Directive 019 sur l'industrie minière*, MDDELCC, Mars 2012

1.3 Facility Description

Louvicourt Mine is a closed base-metal mine (primarily copper and zinc, with some gold and silver) located approximately 20 km east of Val-d'Or, Quebec, north of Highway 117.

The Louvicourt property is currently owned by Teck Resources (55%) and Glencore Canada Corporation (45%). The site was previously managed and monitored by Golder Associates until the end of 2016. Starting in 2017, the site is managed by Teck's Supervisor, Water Treatment & Maintenance, Eric Gingras.

Dam infrastructure at the site comprises of a tailings pond with a polishing pond located immediately downstream to the east of the tailings pond. The tailings pond is contained by Dam 1 to the north and east, Dam 2 to the west and natural topography to the south. For reference purposes, the main dams have been divided into several sub dams designated Dam 1A to Dam 1E and Dam 2A to Dam 2B, typically separated by local bedrock outcrops located along the alignment of the dams.

The polishing pond is contained by Dam 4 to the north, the tailings pond to the west and natural topography to south and east. For reference purposes, Dam 4 is comprised of two segments designated Dam 4A and Dam 4B, separated by a bedrock outcrop.

1.4 Background Information and History

The Louvicourt mine began operations around 1994 and had a nominal milling rate of 4,000 tpd, with a peak estimated rate of 5,000 tpd. Mining operations effectively ceased around July 2005.

Approximately one third of the tailings from the milling process were pumped to the tailings facility, located approximately 8.5 km northwest of the mine/mill. The remainder of the tailings was used as paste backfill for the underground mine. Tailings generated from the milling process have high sulphide content (30% to 45%) and are acid generating. The tailings within the basin are covered with a water cover, approximately 1-m thick, to prevent further oxidation and generation of acid rock drainage.

Figure 1 shows a plan view of the Louvicourt tailings management site.

As of 1994, tailings were deposited within the tailings facility using floating pipelines extending from the dams into the basin. The pipeline was moved laterally as required to keep the tailings solids below elevation 315 m. During operations, regular bathymetric surveys were performed to provide information to allow adjusting the deposition plan to fill low spots and prevent overfilling in high areas. Local high tailings areas above elevation 315 m generated during deposition were generally spread using a barge-mounted dredge or a rotary harrow device.

The original design of the tailings dams and polishing pond dams was carried out by Golder in 1993. Golder had no involvement with the operation of the facility. Golder performed an inspection in 2009, and then has performed annual inspections of the facilities since 2014. Mayana Kissiova of Golder became the Engineer of Record for the Tailings Facility in 2016.

2.0 CONSTRUCTION, OPERATION, MAINTENANCE AND SURVEILLANCE

No construction or operation occurred in 2017. The maintenance and surveillance activities performed in 2017 included the following:

- Routine inspections
- Survey of monuments
- Removal of trees
- Cleaning of the culverts and spillways (tailings and polishing ponds)
- Cleaning of the access paths to the toe of dams 1A, 1B, 1C and 4D
- Beaver management
- Recovery of woody debris on berms 1D and 2B
- Replacement of two damaged culverts

3.0 CLIMATE DATA AND WATER BALANCE

3.1 Review and Summary of Climatic Information

Table 1 summarizes the Val-d'Or monthly total precipitation data over the period from May 2016 to October 2017. The data originates from the Environment Canada climate stations (ID 7098600, ID 7098603, ID and 7098605). For comparative purposes, the monthly multi-annual averages calculated from 1951 to 2017 records are also provided.

The 2016/2017 winter precipitation generally remained below monthly multi-annual averages. 2017 spring and late summer precipitation was higher than the multi-annual averages. May (138.7 mm), August (182.3 mm) and October (168.2 mm) 2017 were very wet months. The total precipitation over the considered period is 7% higher than the long-term average.

Table 1: Monthly Precipitation Data from May 2016 to October 2017

Month - Year	Total Precipitation Recorded at Val-d'Or (mm)*	Monthly Multi-Annual Average at Val-d'Or (mm)	Difference (%)*
May - 2016	73.1	70.4	4% ↑
June - 2016	63.9	88.6	39% ↓
July - 2016	123.9	101.0	23% ↑
August - 2016	85.6	94.7	11% ↓
September - 2016	78.2	99.3	27% ↓
October - 2016	59.6	82.7	39% ↓
November - 2016	72.2	81.7	13% ↓
December - 2016	64.7	67.8	5% ↓
January - 2017	48.2	59.7	24% ↓
February - 2017	63.4	47.9	32% ↑
March - 2017	35.0	56.1	60% ↓
April - 2017	98.5	59.7	65% ↑
May - 2017	138.7	70.4	97% ↑
June - 2017	48.4	88.6	83% ↓
July - 2017	69.6	101.0	45% ↓
August - 2017	182.3	94.7	92% ↑
September - 2017	80.6	99.3	23% ↓
October - 2017	168.2	82.7	103% ↑
TOTAL over 18 months	**1554.1**	**1446.4**	**7% ↑**

*: Difference between Val-d'Or current year precipitation and the multi-annual average precipitation.
↑ (↓): Current year precipitation higher (lower) than the multi annual average precipitation.
Values are based on records from Environment Canada climate stations ID 7098600, ID 7098603, ID and 7098605.

3.2 Review and Summary Water Balance

A high level Louvicourt water balance of the tailings storage facility (TSF) was compiled based on the recent climate data. The parameters were consistent with those from previous studies (SNC-Lavalin, 2006):

- The runoff from the external watershed area was estimated using a constant, volumetric annual average runoff coefficient of 0.6 as in the previous study. The value is consistent with regional, large watershed river flow records, but it has not been validated by local field measurements.
- The pond evaporation was calculated using the Morton model (Morton 1983), with historical climate data from climate stations at Val d'Or (air temperature, dew point temperature, precipitation) and Rouyn (solar radiation).
- Constant seepage flow rates were predicted by finite element seepage analyses performed by Golder (1993c) prior to construction. They have not been updated since the 1993 study. The modelled seepage rates appear to be consistent with measured rates (V-notch measurements per Table 4).

Table 2 summarizes the yearly flows resulting from the water balance for the considered year, namely November 2016 to October 2017, and for a typical year. Higher precipitation led to an estimated increase in the volume of water discharged at the spillway.

Table 2: November 2016 to October 2017 high-level water balance for the TMF

Component	Average Year Flows (m^3/year)	Current Year Flows* (m^3/year)	Difference (%)	Comment/ Source
Rainfall over the basin	955,500	1,123,290	18% ↑	Basin area = 105 ha Mean annual rainfall = 910 mm/year Current year rainfall= 1,070 mm/year
Surface runoff over the external watershed area	693,420	815,188	18% ↑	Watershed area = 127 ha Runoff coefficient = 0.6
Total of inflows	**1,648,920**	**1,938,478**	**18% ↑**	
Pond evaporation	455,080	658,948	45% ↑	Based on Morton (1983) Mean annual pond evaporation = 433 mm/year Mean annual pond evaporation = 628 mm/year
Seepage losses	362,664	362,664	0%	Based on analysis made prior to construction Golder (1993c) Seepage flow rates = 41.4 m^3/h
Spillway discharge to the polishing pond	831,176	916,866	10% ↑	Estimated based on mass balance.
Total of outflows	**1,648,920**	**1,938,478**	**18% ↑**	

* Current year extends from November 2016 to October 2017.
↑ (↓): Current year value higher (lower) than the long-term average value.

3.3 Freeboard and Storage

Freeboard and storage are addressed in Section 5.2.3.

3.4 Water Discharge Volumes

Based on a high level water balance analysis, it is estimated that 0.92 million m^3 of water was discharged to the polishing pond via the spillway.

3.5 Water Discharge Quality

Water discharge quality is presented in the Louvicourt annual environmental report (Suivi environnemental post-restauration) submitted by March 31 of each year to le Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec.

4.0 SITE OBSERVATIONS

A site inspection was carried out on September 12, 2017, by Mr. Nicolas Pépin, Eng. and Mrs Mayana Kissiova, Eng., Engineer of Record, both from Golder. They were accompanied by Mr. Eric Gingras, Louvicourt Supervisor, Water Treatment and Maintenance, from Teck Resources. The temperature during the visit was approximately 22°C under clear skies.

4.1 Visual Observations

The following observations were made during this DSI:

- The water level at the tailings pond was 316.10 m.
- The water level at the polishing pond was 306.55 m (water level from September 13, 2017).

Dams 4A, 4B and final effluent point

- Dam 4A is a structure which is sited at higher ground and is no longer in contact with water. No regular visits are conducted at this structure. Some vegetation has grown at the crest with time (photograph 1).
- The spillway at Dam 4B was in good condition and functional.
- Culverts at the final effluent point were clean. The flow rate at the final effluent point was low and water was clear.
- The Dam 4B crest was in good condition with some traces of tracked excavator movement (crest of Dam 4B is not opened in winter). Settlement plates are visible. The crest surface at plate SP11-1 is slightly disturbed, but this disturbance has no noticeable impact on its performance.
- An unused plastic pipe was present at the crest of Dam 4B, buried in the granular top material.
- Ponding water was observed at the toe of Dam 4B at the same locations as last year. The water appears to be stagnant or exhibits very low flow.

Dams 1A trough 1E

- The rip-rap on the upstream berm of Dam 1D has degraded with time by the wave action. The same effect, but on a much smaller scale, has been observed on the upstream slope of Dam 1B.
- Two seepage areas (areas 6 and 7 on Figure 1), observed previously at the extremities of Dam 1D were visited. No seepage is visible at the northern extremity of the downstream berm of Dam 1D, and area 6 was dry during the visit. Some humidity is present at the seepage point 7, located south of the downstream berm and cannot be attributed to the presence of the tailings pond.
- Ponding water was observed at the toe of Dams 1A, 1B, 1C and 1E at the same locations as last year. The water seems to be stagnant or exhibits very low flow.
- The emergency spillway located between Dams 1D and 1E was in good condition. Vegetation in the downstream channel is growing and is cleared every two years.
- The tailings pond overflow weir was in good condition, there was no debris and water was free flowing. The bridge is planned to be rehabilitated in 2018.
- Several minor erosion points are visible at the crest of Dams 1A and 1B. These are to be observed.
- Rebar for settlement point SP-6 was damaged and should be repaired.
- Geotextile fabric is visible at the downstream side of the crest of Dam 1D (2+000). Some granular material should be added to protect the geotextile from tearing.
- Vegetation is present in the water collection ditch, downstream of Dams 1A, 1B and 1C.

Dams 2A and 2B

- Some stagnant water point has been observed at the toe of Dam 2B where previously seepage area 13 has been established, close to V-notch 2, exhibiting very low flow. Further south, seepage points 10, 11 and 12 are present in the vicinity of V-notch 1. V-notch 1 exhibits low but visible flow rates, water is clear.
- Stagnant water is observed at the toe of Dam 2A. As a good practice, it would be preferable to eventually drain this area.
- Few minor erosion points are visible at the crest of Dam 2B. These are to be observed.

4.2 Photographs

Key photographs of the inspection are presented in Appendix A.

4.3 Instrumentation Review

The following information was available for this DSI:

- Yearly monitoring data of survey monuments;
- Records of monthly visual inspections, including measurement of flow at V-notches and groundwater elevations of existing piezometers (monthly inspection reports since January 2017).

4.3.1 Water Levels

Figure 3 presents available groundwater levels for the dams. A total of four piezometers (PZ-02-04, PZ-04-04, D2A, D2B) are installed on the berms of three different dams. Six other observation wells (PBR 4, PBR 6, PBR 7, PRB 8, P06-30, P06-31) are located on natural ground, some distance away from the toe of the dams. The position of these wells is shown in Figure 1. Data for 2017 was compiled by Teck. It can be seen that recent values are quite stable for all wells and consistent with previous trends.

Piezometer PZ 02-04 is located within Dam 1D downstream berm. Groundwater at this location corresponds to seepage of Dam 1D and drains toward the polishing pond. It is therefore normal that the trend line for this well is slightly higher than the level of the polishing pond.

4.3.2 Deformation/Settlement

A series of 15 movement monitoring monuments exists along the crest and berms of the tailings pond dams and four additional monuments are located along Dam 4B of the polishing pond. Some of these monuments were installed after the 1993 construction and are identified B-1 to B-11 in Appendix B and SP-1 to SP-11 in Figure 1. Other monuments, identified as SP-11-1 to SP-11-8 in Figure 1 and as 2011-1 to 2011-8 in Appendix B, were installed in September and October 2011. All monuments were surveyed between September 6 and 8, and September 13, 2017 by Corriveau J.L. & Assoc. (Corriveau), a surveyor based in Val-d'Or. The detailed report of Corriveau is presented in Appendix B. Table 3 presents total settlement and horizontal displacement of all monuments.

Table 3: Settlement and horizontal displacement

Monument	Reference period of measurement	Downstream Horizontal Movement	Settlement
Dam 1D (crest)			
B-1 (SP-2) on Dam 1D	Since 2008	14 mm	Insignificant (-1 mm)
B-2 (SP-2) on Dam 1D	Since 2008	24 mm	23 mm
B-3 (SP-3) on Dam 1D	Since 2008	Insignificant (4 mm)	Insignificant (-2 mm)
Dam 1D (berm)			
2011-2 (SP 11-2) on Dam 1D berm	Since 2011	19 mm in upstream direction	18 mm
Dam 1C (crest)			
B-4 (SP-4) on Dam 1C	Since 2008	18 mm	Insignificant (+2 mm)
B-5 (SP-5) on Dam 1-C	Since 2008	10 mm	Insignificant (+3 mm)
Dam 1C (berm)			
2011-8 (SP 11-8) on Dam 1C berm	Since 2011	13 mm parallel to the center line	9 mm
Dam 1B (crest)			
B-6 (SP-6) on Dam 1B	Since 2008	15 mm	Insignificant (+3 mm)
Dam 1A (crest)			
B-7 (SP-7) on Dam 1A	Since 2008	12 mm	19 mm upwards
Dam 2B (crest)			
B-8 (SP-8) on Dam 2B	Since 2008	Insignificant (5 mm)	Insignificant (-2 mm)
B-9 (SP-9) on Dam 2B	Since 2008	Insignificant (9 mm)	Insignificant (+1 mm)
B-10 (SP-10) on Dam 2B	Since 2008	18 mm	9 mm upwards
Dam 2B (berm)			
B-11 (SP-11) on Dam 2B berm	Since 2011	10 mm	10 mm
2011-6 (SP 11-6) on Dam 2B berm	Since 2011	16 mm parallel to center line	13 mm
2011-7 (SP 11-7) on Dam 2B berm	Since 2011	21 mm	15 mm upwards
Dam 4B (crest)			
2011-1 (SP 11-1) on Dam 4B	Since 2011	Insignificant (6 mm)	13 mm
2011-3 (SP 11-3) on Dam 4B	Since 2011	Insignificant (4 mm)	20 mm
2011-4 (SP 11-4) on Dam 4B	Since 2011	Insignificant (3 mm)	9 mm
Dam 4B (berm)			
2011-5 (SP 11-5)	Since 2011	Insignificant (5 mm)	4 mm

4.3.3 Stability/Lateral Movement

Table 3 above presents total settlement and horizontal displacement for all monuments. The observed movements are low and less than triggers that would result in dam safety concern, but annual monitoring should continue.

4.3.4 Discharge Flows

Seepage flow was measured through a series of 4 V-notch weirs installed at the toe of the dams between 1997 and 2003. Table 4 presents measured flow rates at V-notch weirs as provided by Teck in 2017. The table also presents observations and visually estimated seepage rates during the inspection.

Table 4: Measured Flow Rates at V-notch Weirs and Estimated Seepage Rates

Location	Dam	Flow (point measurements)
V-notch 1	2B	0.4 L/s (calculated and provided by Teck). Water was clear.
V-notch 2	2B	0.61 L/s (calculated and provided by Teck). Water was clear
V-notch 3	1A	0.29 L/s (calculated and provided by Teck). Water was clear
V-notch 4	1C	0.83 L/s (calculated and provided by Teck). Water was clear
1	1A	See V-notch 3
1A	1A	Puddle, no flow
1B	1A	Puddle, no flow
2	1B	Puddle, no flow
2A	1B	Puddle, no flow
2B	1B	Puddle, no flow
3	1B	Puddle, no flow
3A	1B	Puddle, very low flow, clear
4	1C	Puddle, no flow
4A	1C	Puddle, no flow or very low flow, clear
5	1C	Puddle, no flow or very low flow, clear
6	1D	Dry
7	1D	Humid, no flow nor water accumulation, located far from the main dam body
8	1E	Humid, no flow
9	2A	Standing water pond, flow cannot be assessed
10	2B	Stagnant water, very low flow
11	2B	Humid, no flow
12	2B	Puddle, flow cannot be assessed
13	2B	Stagnant, low flow, see V-notch 2
14	2B	Dry
15	4B	Puddle, no flow
16	4B	Puddle, no flow
17	4B	Standing water pond, flow cannot be assessed
18	4B	Dry

Figure 4 shows the historical trend of seepage flow measurements at these V-notch weirs since their installation. The figure indicates that seepage flows measured at the end of 2016 and 2017 were consistent with previous historical trends.

The sum of the measurable flows (~2 L/s) is approximately 20% of the expected seepage rate from the 1993 design studies and as assumed in the water balance, and is therefore considered to be within the expected range and does not indicate a dam safety concern.

4.4 Pond and Discharge Water Quality

Water discharge quality is presented in the Louvicourt annual environmental report (Suivi environnemental post-restauration) submitted by March 31 of each year to le Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec.

4.5 Site Inspection Forms

Specific site inspection forms were not filled while in the field for this year's DSI, however, they are completed for the routine inspections.

5.0 DAM SAFETY ASSESSMENT

5.1 Design Basis Review

5.1.1 General

The Dams 1A through 1E, and 2A and 2B are comprised of a till core with rockfill/sand and gravel shoulders, a filter zone along the downstream face of the core and a drain along the base of the dam. Geotextile was placed beneath the shoulders and riprap protection layer. Dam height varies along the length of the alignment and ranges from a couple of metres near the abutments up to approximately 18 m in the deeper valleys of Dam 1 and Dam 2. The upper upstream and downstream faces are typically sloped at 2.5H to 1V and 2H to 1V respectively, with upstream and downstream stability berms constructed to approximately the mid height of the dams within the deeper valley sections. The stability berms reduce the overall slope to between about 3.5H:1 to as much as 7H:1V.

Tailings pond level is controlled by a concrete overflow weir located at the south abutment of Dam 1E. Stoplogs were initially used during mine operations to control the pond level. These stoplogs were replaced after closure with mass concrete to form the weir at elevation 316.1 m, including an extra 0.1 m provided by a wood plank. Flood inflows into the tailings facility could be routed through a 5 m wide concrete spillway located adjacent to the overflow weir and set at elevation 316.3 m. In case of blockages of the weir and first spillway, flood inflows would be routed through a second emergency spillway located approximately 170 m north of the concrete overflow weir spillway. The emergency spillway has a single 5 m wide trapezoidal shaped concrete sill at elevation 316.5 m with 2H:1V side slopes. All flows through the overflow weir and either of the spillways report to the downstream polishing pond.

The polishing pond was built in the fall of 1995 and completed in the spring of 1996. The design of Dam 4B is similar to Dams 1 and 2. Dam 4A is built on higher ground and currently does not retain any water. Outflow from the polishing pond passes over aluminium stoplogs embedded into a concrete structure. The water level is currently controlled at elevation 306.54 m.

Information concerning the geology, stratigraphy, and groundwater conditions is presented in Golder's report (Golder 1993). The tailings facility has not been raised since its original construction.

Routine inspections have been carried out since closure in 2005. Monthly inspections are performed by walking the crest of the dams, while weekly inspections are done by driving the dams at low speed and inspecting the spillways.

5.1.2 Tailings Pond Dams (Dams 1 and 2)

The combined length of all five segments of Dam 1 is 1,650 m. Dam 1 has an average height of 8 m and a maximum height of 18 m. The combined length of the two segments of Dam 2 is 880 m. Dam 2 has an average height of 10 m and a maximum height of 18 m. A typical cross-section of the dams is shown in Figure 2. Dam crests within the central portion of Dam 1D and part of Dam 2B were intentionally built 1 m higher than the design elevation to compensate for anticipated settlement at these locations.

Vibrating wire piezometers and an inclinometer were used to monitor dam behaviour during construction and shortly after. These instruments are no longer operational. Current instrumentation at the tailings pond dams consists of 4 piezometers, 4 V-notch weirs and 15 settlement monitoring monuments. Other observation wells (5) are located further downstream from the dams and are used to monitor water quality. The locations of the instruments are shown in Figure 1.

5.1.3 Polishing Pond Dam (Dam 4B)

The polishing pond was operated until 2011 at an elevation consistently lower than the design pond elevation of 309.0 m. The pond has since been operated at elevation 306.54 m. The design of Dam 4B is similar to that of Dams 1 and 2.

Current instrumentation at the polishing pond consists of 1 observation well and 4 settlement monitoring monuments. The locations of the instruments are shown in Figure 1.

5.1.4 Dam Design Parameters

The design geometry of the dams is summarized in Table 5.

Table 5: Design Geometry

Item	Design Value
Upstream Slope	2.5 H:1V
Crest Width	8 m
Downstream Slope	2.0 H:1V (inter bench, without considering downstream berms)
Minimum freeboard (from dam crest)	2.0 m at tailings pond 1.5 m at polishing pond
Maximum level of tailings (below dam crest)	3.0 m
Minimum crest elevation of Dams 1 and 2 at the tailings area	318.0 m with parts of Dams 1D and 2B at 319.0 m
Minimum crest elevation of Dam 4B at the polishing pond	310.5 m

5.1.5 Subsurface Conditions

The dams of the tailings facility are located in a valley between bedrock outcrops of relatively high elevation. The tailings pond dams were constructed between the local bedrock outcrops to reduce overall fill requirements.

Geotechnical investigations indicate that subsurface conditions at the site are typically include the following layers:

- Surficial layer of topsoil/peat typically 100 mm to 300 mm thick.
- Overburden soils comprising layers of alluvial/lacustrine silty clay to clayey silt with consistencies ranging from soft to very stiff. A weathered upper crust of stiff clay was observed in most of the profiles, underneath which the consistency of the soils generally significantly decreases. Silty clay and clayey silt materials typically grade to a silt material with depth and in some cases to silty sand.
- A basal glacial till layer typically ranging from silt to silty/gravelly sand in a medium dense to dense state.
- Underlain by granodiorite bedrock.

5.1.6 Embankment Fill Materials

The tailings dams and polishing pond dam are zoned earth fill embankment structures, constructed of compacted till core with a filter zone along the downstream face of the core and a drain along the base of the dams and rockfill/sand and gravel shoulders, as shown in the typical section presented in Figure 2.

Updated material properties for the tailings, the embankment fill materials and subsurface materials were used in the 2005 DSR (SNC-Lavalin, 2005). These material properties are listed in Table 6.

Table 6: Updated Design Material Properties (SNC-Lavalin, 2005)

Material	Unit Weight (kN/m^3)	Total Stress Strength		Effective Stress Strength	
		Cohesion (kPa)	Friction Angle (degrees)	Cohesion (kPa)	Friction Angle (degrees)
Sand and gravel (Dams 1 and 2)	23 - 24*	-	-	0	35
Sand and gravel (Dam 4)	20.8 - 22.6*	-	-	0	35
Sand filter	20	-	-	0	35
Till (Core)	22 - 22.7*	-	-	0	35
Clay	15 – 16.5	30 – 85	0	0	26 – 29
Till (Foundation)	18.5 – 19	-	-	0	30 – 35
Tailings within the tailings pond	16	-	-	0	30

* Saturated Unit Weight

5.1.7 Seismicity

The seismicity values for the site were estimated by SNC-Lavalin in the 2005 DSR and reviewed by Klohn Crippen Berger as part of the 2010 DSR (Klohn Crippen Berger, 2011). Both evaluations were based on the 2005 version of the National Building Code. The predicted peak ground accelerations (PGA) on very dense soils at the corresponding return period are summarized in the following table.

Table 7: Site Seismic Hazard Values from 2010 DSR (adapted from Klohn Crippen Berger, 2011)

Structure	Return Period (Years)	PGA[1] (g)
Tailings Pond Dams	1 in 10,000	0.23
Polishing Pond Dam	1 in 2,500	0.12

Note: [1] For ground site class '"C": very dense soil and soft rock foundation.

5.2 Hazards and Failure Modes Review (Assessment of Dam Safety Relative to Potential Failure Modes)

This section reviews the dam safety implications of the instrumentation data and the September 12, 2017, site observations relative to potential failure modes. The design basis relevant to each of the typical potential failure modes is also presented.

5.2.1 Internal Erosion

Dam internal instability can be caused by materials migrating out of the dam via seepage, leaving voids. This generally happens with materials that do not have filter compatibility; that is, the fines fraction of one material can migrate into or through the voids of the adjacent material under a sufficient hydraulic gradient. Piping is caused by regressive erosion of particles towards an outside environment until a continuous pipe is formed.

Design Basis

Filter compatibility was established by Golder during the initial design phase of the structures (Golder, 1993). The initial design considered piping criteria based on grain size distributions of the till core and adjacent sand drain and between the sand drain and the gravel located at the toe drain. Filter compatibility was briefly commented upon in section 3.4 of the SNC-Lavalin (2005) dam safety review and was described to have been set with "*conservative limits*".

Instrumentation and Observed Performance

The position of the V-notch weirs and seepage locations is shown on Figure 1. Table 4 presented measured flow rates and visually estimated seepage flows. Water flowing from the toe drains, the seepage points, and the V-notch weirs was clear and did not contain visible suspended particles. Flow rates were generally low.

No zones of subsidence or any sink holes were observed, which would indicate voids due to piping. No evidence of internal erosion was observed.

5.2.2 Instability

Design Basis and Subsequent Reviews

Stability analyses were conducted during the original design phase of confinement dams (Golder, 1993). The original dam geometry was established to meet a minimum factor of safety of 1.5 under end of construction conditions and operational conditions. Seismic analysis of the dams was performed at that time using a 1:1,000 year seismic acceleration. The seismic value was modulated based on a one-dimensional soil response analysis of the soil column. The resulting horizontal ground acceleration was used in a pseudo-static stability analysis. Results showed factors of safety slightly greater than 1.1 for all dams.

Based on the results of the original 1992 field investigation, the 2005 DSR (SNC-Lavalin, 2005) confirmed a minimum factor of safety value of 1.3 for long term operational conditions, except for Dam 1D. This led to the widening of Dam 1D downstream berm in 2005. The 1.3 factor of safety was considered adequate for the long term. The seismic analysis contained in the 2005 DSR used seismic values for a 1:10,000 year seismic event and also performed a one-dimensional soil response analysis to account for the presence of a soil column. The resulting horizontal ground acceleration was used in a pseudo-static stability analysis. Results confirmed factors of safety slightly greater than unity for all dams. The liquefaction potential analysis indicated that localized zones of relatively low density till present in dam foundations could potentially be liquefiable in the case of the design earthquake. Post-liquefaction analyses have confirmed that if these zones should liquefy, the dams would remain stable.

The 2010 DSR (Klohn Crippen Berger 2011) included a preliminary liquefaction and cyclic softening screening assessment based on the results of the original 1992 field investigation. The 2010 DSR concluded a more extensive presence of potentially liquefiable materials than estimated previously by SNC-Lavalin in 2005. A preliminary stability assessment concluded that post-liquefaction factors of safety for a typical section of the tailings dam do not meet current recommended guidelines. Further field and laboratory studies were recommended.

Golder performed a supplemental liquefaction assessment and post-liquefaction stability analyses in 2013 (Golder 2013). Based on the 1992 geotechnical field data, the analysis indicated that there is a potential for the silt stratum below Dam 1C and Dam 2B to liquefy under the design seismic event. For a low bound shear strength value of the liquefied silt layer, Dam 2B was predicted to have factors of safety of less than 1. However, these analyses did not account for consolidation that may have occurred subsequent to dam construction, and it was noted that the field investigation data did not include current techniques that did not exist in 1992. It was recommended that a focused geotechnical investigation program using current investigation methods be undertaken to update the analyses. The investigation was conducted in the fall of 2017 and subsequent analyses were underway while this report was being compiled.

Movement Monitoring Instrumentation

The Dam Safety Guidelines (CDA 2013) Section 3.6.3 recommends use of dam instrumentation to supplement the ongoing visual assessment of dam performance relative to potential failure modes. Table 3 in Section 7 presents a summary of settlement and horizontal movements measured and observed at the TSF.

Horizontal movements of the monuments listed in Table 3 remain relatively limited. However some trends have been noticed and are commented on below:

- It is noticed that survey is not done at the same period every year. Individual monuments show some trends that could be attributed to some seasonal effects.
- Monument SP-1 located on Dam 1D has shown noticeable increase in downstream movement from 4 mm for the period of 2008 to 2015 to a total of 14 mm for the period between 2008 and 2017. However, with the measurements being done at different periods of the year (June 2015 and September 2017), it is difficult to conclude on a particular trend. Monument SP-2 on the same dam exhibits the largest total displacement at the site of 24 mm in the downstream direction. However, the rate of displacement is not significantly higher than the historically observed one (2 mm between 2015 and 2016 and 6 mm for the period of 2016 to 2017).
- Only SP-2 shows settlement (the largest measured on the site of 24 mm in total) while SP-1 has not shown any settlement.
- Monument SP-9 located on Dam 2B has shown direction of movement that varies over time and it seems to have experienced upstream and downstream displacements. The displacement in the downstream direction of 15 mm noticed for the period of 2008 to 2015 has decreased in 2016 to 9 mm. The nearby monument SP-8 has only shown negligible displacements. Both monuments exhibit negligible settlement.

Vertical movements are noticeable on most monuments on a year to year basis, attributed to frost action and survey limitations. Monuments installed in 2011 seem to be more prone to these yearly movements than former monuments. Measured differences for monuments installed in 2011 are however small for the period to 2017, the largest movement for this time interval (settlement of 20 mm) occurs at SP-11-3 located on Dam 4B.

Measured differences in the elevation of former monuments are small between 2008 and 2017, and no consistent long term trend can be detected for most of 2008-2017 results. The magnitude of deformations indicated by the monitoring instrumentation do not present a dam safety concern.

Observed Performance

Localized portions of the dams upstream faces were observed to be steeper than the design value of 2.5H:1V (Photo 6 in Appendix A), however no evidence of instability was noticed. Longitudinal cracks were reported to develop along the crest of Dam 1 during the last few winter seasons. No such cracks were observed during the 2017 DSI conducted in September.

5.2.3 Overtopping

Design Basis

The dams of the tailings pond and polishing pond were originally designed with a 2.0 m freeboard and a 1.5 m freeboard respectively. Current freeboard varies between 1.81 m and 1.95 m at the tailings area, and 3.9 m at the polishing pond. Even though some settlement has occurred at Dam 1D as a result of consolidation of the clayey foundations, the freeboard is higher than the minimum since parts of Dams 1D and 2B were originally built with an extra 1.0 m fill allowance to compensate for the anticipated settlement.

A review of freeboard was performed in the 2010 DSR (KCB, 2011) in accordance with CDA (2007) guidelines. Results indicated that wave run-up could reach an elevation less than or equal to 316.89 m under normal and PMF conditions. Since this is below the minimum design freeboard of 2.0 m, it was concluded that protection against a wave overtopping condition was adequate for the tailings pond. As for the polishing pond, the current 3.9 m freeboard is considered to be more than adequate.

Flood routing was improved by the construction of a second emergency spillway at the tailings pond in 2005. SNC-Lavalin (2006) estimated that in the case where the operational spillway and the first emergency spillway were blocked by beaver activity, the second emergency spillway would be able to evacuate the 1:10,000 year storm event under a maximum pond elevation of 316.77 m. This level is close to the top of the till core, but remains 1.23 m minimum below the dam crest elevation.

Instrumentation Data

The tailings pond water level was measured five times in 2017. For the 2011-2017 period, the pond water elevations generally varied between a minimum value of 316.05 m in the fall months to a maximum value of 316.20 m (0.10 m head over the weir level) in spring time. The minimum CDA freeboard requirements were maintained in 2016-2017.

Observed Performance

The water level within the tailings pond was 316.10 m during the visit. The freeboard at the time of the site inspection was greater than the minimum CDA freeboard requirements (KCB, 2011) and therefore did not present a safety concern.

5.3 Review of Downstream and Upstream Conditions

No changes to the overall conditions downstream of the polishing pond have been reported to Golder. Upstream conditions only report to a very limited water shed. No changes to the watershed conditions have been reported to Golder.

5.4 Dam Classification Review

5.4.1 Previous Dam Consequence Classification

Klohn Crippen Berger assessed the Dam Consequence of Failure Classification as part of the 2010 DSR report (Klohn Crippen Berger, 2011). Table 4 presents the dam classification criteria based on the CDA guidelines

(CDA 2007). The classification of the dams at the tailings area (Dams 1 and 2) was established as "very high" to "extreme". The classification of Dam 4B at the polishing pond was established as "high". The tailings facility dams were classified in the "very high" to "extreme" consequence categories because the population at risk is expected to be permanent residents in houses located within the floodway, for which the loss of life is expected to be between 10 to in excess of 100.

Table 8: Dam Classification in Terms of Consequences of Failure Table (taken from Klohn Crippen Berger, 2011 and based on CDA 2007)

Dam Class	Population at Risk[(a)]	Incremental Losses		
		Loss of Life [(b)]	**Environmental and Cultural Values**	**Infrastructure and Economics**
Low	None	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent	10 of fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent	100 of fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA (2007)

(a) Definition for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

(b) Implications for loss of life:

Unspecified – The appropriate level of safety required a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

An inundation study for the tailings facility was subsequently completed by SNC-Lavalin (SNC-Lavalin, 2012) based on CDA 2007 guidelines. The study considered two potential failure scenarios and assessed the resulting impact on downstream receptors. The results indicated the consequence classification for the tailings pond dams was "very high".

5.4.2 Review

No new elements are available to support dam classification modification. Class levels as determined by the 2010 DSR Report (KCB, 2011) should be maintained.

5.5 Physical Performance

The overall performance of the Louvicourt TSF and polishing pond is good. None of the observations made during the inspection is estimated to have a significant impact on its current performance. The review of the instrumentation readings presented in Section 4.3 did not show displacement or settlement that could indicate significant impact on its physical stability.

Sections 4.1 and 6.6 present the most noticeable areas of improvement and the identified recommended actions in view of supporting the facility performance in the longer term. It is to be considered that the outcome of the deformation analyses at Dams 1C and 2B should be considered in defining if additional instrumentation is required.

5.6 Operational Performance

The Louvicourt tailings facility is closed and there are no activities related to tailings disposal or operation of the ponds.

5.7 OMS Manual Review

The Operation, Maintenance and Surveillance (OMS) Manual for the tailings management facility was updated in March 2017 (Golder 2017).

5.8 Emergency Preparedness and Response Review

An Emergency Preparedness and Response Plan (EPRP) for the tailings facility was finalized in 2017. Golder reviewed the version published on June 15, 2017. The plan was up to date and no modification or changes are deemed necessary based on the observations and discussions of the 2017 site visit.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Construction and Operation/Maintenance Activities

There are no operational activities at the Louvicourt TSF except routine maintenance.

The following maintenance actions were performed between August 2016 and September 2017:

- Routine inspections
- Survey of monuments
- Removal of trees
- Cleaning of the culverts and spillways (tailings and polishing ponds)
- Cleaning of the access paths to the toe of dams 1A, 1B, 1C and 4D
- Beaver management

- Recovery of woody debris on berms 1D and 2B
- Replacement of two damaged culverts

6.2 Summary of Climate and Water Balance

The 2016/2017 winter precipitation generally remained below monthly multi-annual averages. 2017 spring and late summer precipitation was higher than the multi-annual averages. May (138.7 mm), August (182.3 mm) and October (168.2 mm) 2017 were very wet months. The total precipitation over the considered period is 7% higher than the long-term average.

Based on a high level water balance analysis, it was estimated that 0.92 million m^3 of water were discharged to the polishing pond via the spillway.

6.3 Summary of Performance

The overall performance of the Louvicourt TSF and polishing pond is good, and does not require major works or corrections. All actions recommended in Sections 6.6 aim at obtaining a good long term performance or improving the overall understanding of potential long term stability issues.

6.4 Summary of Changes to Facility or Upstream or Downstream Conditions

No changes were reported to or observed by Golder regarding the facility itself, or the upstream and downstream conditions.

6.5 Consequence Classification

No changes were recommended to the consequence classification of the facility.

6.6 Table of Deficiencies and Non-Conformances

Review of Previous Deficiencies and Non-Conformances

Deficiencies and non-conformances noted during the 2016 DSI and their status are presented in Table 9.

Table 9: Summary of Status on Issues Noted During the 2016 DSI

ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Potential Dam Safety Risk	Recommended Action	Priority	Recommended Deadline	Status
2015-02	Existing riprap material on the upstream face of dam 1D has degraded and ravelled downslope.	CDA 2007 Section 3.5.3	Erosion of till core of dam 1D	Place new riprap material along the upper portions of the dam side slopes, starting with the upstream face of Dam 1D.	2	Q3 2016 See note 2	IN PROGRESS-Planned for Q4 2018
2015-04	Finalize the OMS manual	CDA 2007 Section 3.2	N. A.	Finalize the OMS report	4	Q4 2016	CLOSED-Completed March 2017
2015-05	Finalize the ERP	CDA 2007 Section 4.5	N.A.	Finalize the ERP report	4	Q4 2016	CLOSED-Completed June 2017
2015-06	Perform a review of dam's seismic stability and liquefaction conditions	2010 Dam Safety Review	Dam seismic stability	Perform a review of dam's seismic stability and liquefaction conditions	4	Q4 2016	IN PROGRESS-Investigation completed Q4 2017; analyses in progress
2016-01	Wood debris at the polishing pond spillway	OMS Manual Section 6.2	Potential raise in the pond operating level	Debris should be removed from the upstream trash collector	3	Q2 2016	CLOSED-Completed June 2016
2016-02	Wood debris at the tailings pond spillway	OMS Manual Section 6.2	Potential raise in the pond operating level	Debris should be removed from the spillway	3	Q2 2016	CLOSED-Completed June 2016
2016-03	Turbid water was noted at the north end of Dam 1D berm	CDA 2007 Section 3.6.1	Piping (if confirmed from future monitoring)	Regular monitoring is required to establish the cause of this occurrence	3	Immediate and on-going	CLOSED
2016-04	Presence of trees on dams	CDA 2007 Section 3.5.3	Could alter integrity of the till core	Trees higher than 1 m to be cut	3	Q3 2016	CLOSED
2016-05	Water flow trajectory at tailings pond second emergency spillway	CDA 2013 Section 3.5.5	Erosion along the toe of Dam 1D	Extend downstream earth berm	4	Q2 2018	IN PROGRESS-Planned for Q4 2018
2016-06	Improve retention of debris at the tailings pond spillway	CDA 2007 Section 3.5.5	Potential raise in the pond operating level	Finer mesh grid should be installed	4	Q2, 2018	CLOSED

Deficiencies and non-conformances observed during the 2017 DSI

The Dams at the Tailings Management Facility were globally observed to be in a good condition at the time of the 2017 site visit. No significant changes were noted in the condition of the dams since the 2016 DSI. Table 10 summarizes the key issues and recommended actions identified during the 2017 DSI, including unresolved issues from previous years.

Table 10: Summary of Key Issues and Recommended Actions Following the 2017 DSI

ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Potential Dam Safety Risk	Recommended Action	Priority	Recommended Deadline
2015-02	Existing riprap material on the upstream face of dam 1D has degraded and ravelled downslope.	CDA 2007 Section 3.5.3	Erosion of till core of dam 1D	Place new riprap material along the upper portions of the dam side slopes, starting with the upstream face of Dam 1D.	2	Q4 2018
2015-06	Uncertainty regarding seismic stability and liquefaction conditions	2010 Dam Safety review	Dam seismic stability	Perform a review of dam's seismic stability and liquefaction conditions	4	In Progress. Completion scheduled for Q2 2018
2016-05	Water flow trajectory at tailings pond second emergency spillway	CDA 2007 Section 3.5.5	Erosion along the toe of Dam 1D	Extend downstream earth berm	4	Q4 2018
2017-01	Existing riprap material on the upstream face of dam 1B has started to degrade	CDA 2013 Section 3.5.3	Erosion of rip-rap and eventually core of dam 1B	Place new riprap material along the upper portions of the dam side slopes	2	Q4 2018

Priority (defined by Teck Resources)	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

6.7 Opportunities for Improvement

In addition, the following points were observed that do not present dam safety risks at present but should be considered during routine maintenance:

- Several minor erosion points are visible at the crest of dam 1A and 1B. These are to be observed.
- Rebar for settlement point SP-6 was damaged and should be repaired.
- Plastic pipe on Dam 4B crest needs to be removed and the crest rehabilitated after the work is completed.
- Traces of vehicles and erosion around settlement plate SP11-1 were observed. Some regrading of the surface should be considered.
- Vegetation is present in ditches downstream of Dams 1A to 1C, 4B and 2B. Regular cleaning of the vegetation should be performed.

7.0 CLOSURE

We trust that this report meets your present requirements. If you have any questions or requirements, please contact the undersigned.

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Study Limitations

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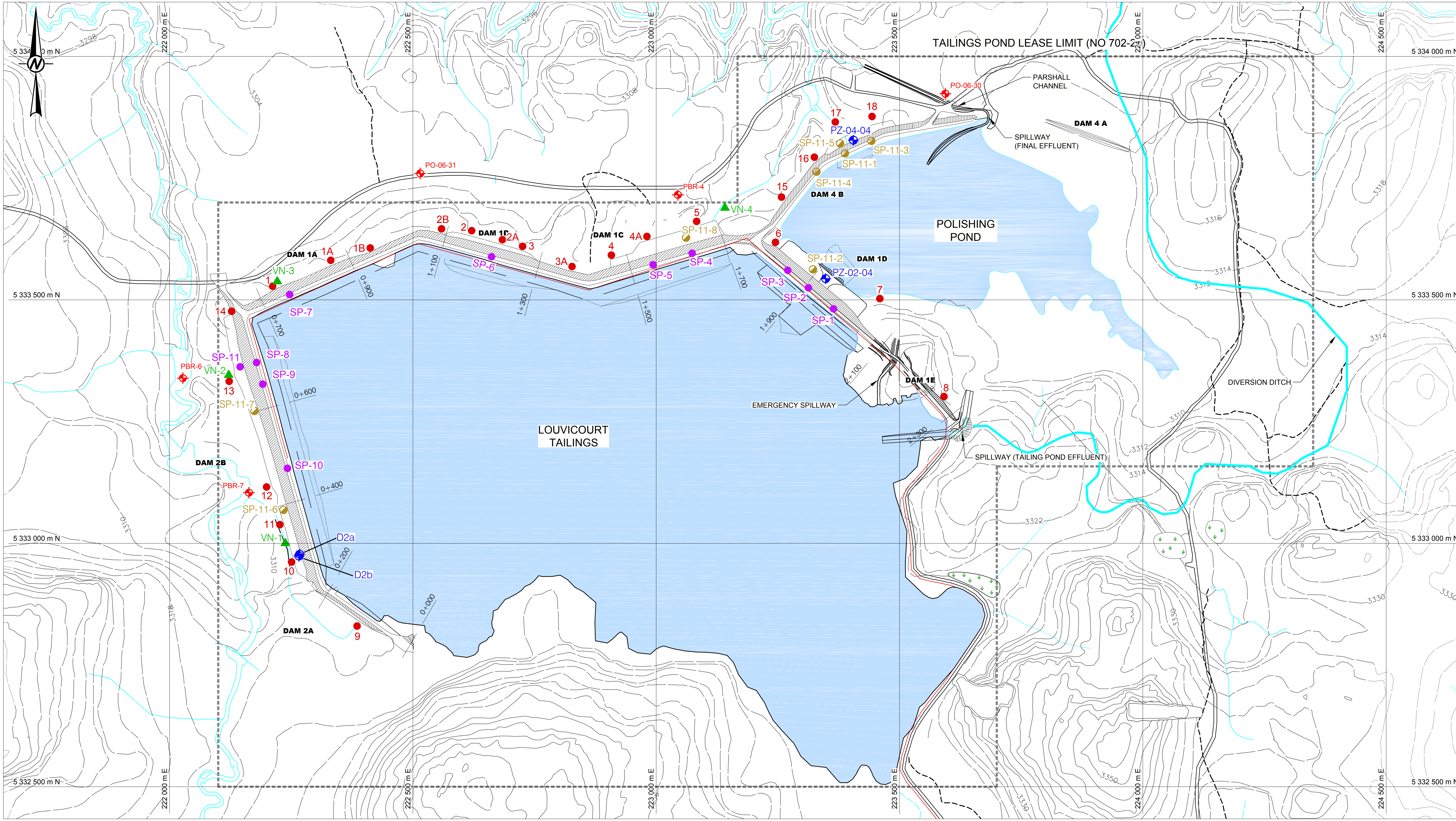


LEGEND

PIEZOMETER	SETTLEMENT POINT (GOLDER, 2011)
V-NOTCH WEIR	DOWNSTREAM FACE OF DAMS
SEEPAGE AREA	OBSERVATION WELLS
SETTLEMENT POINT	

0 125 250
1:7 500 METRES

CLIENT
TECK
MINE LOUVICOURT

PROJECT
LOUVICOURT MINE TAILINGS POND

CONSULTANT

GOLDER

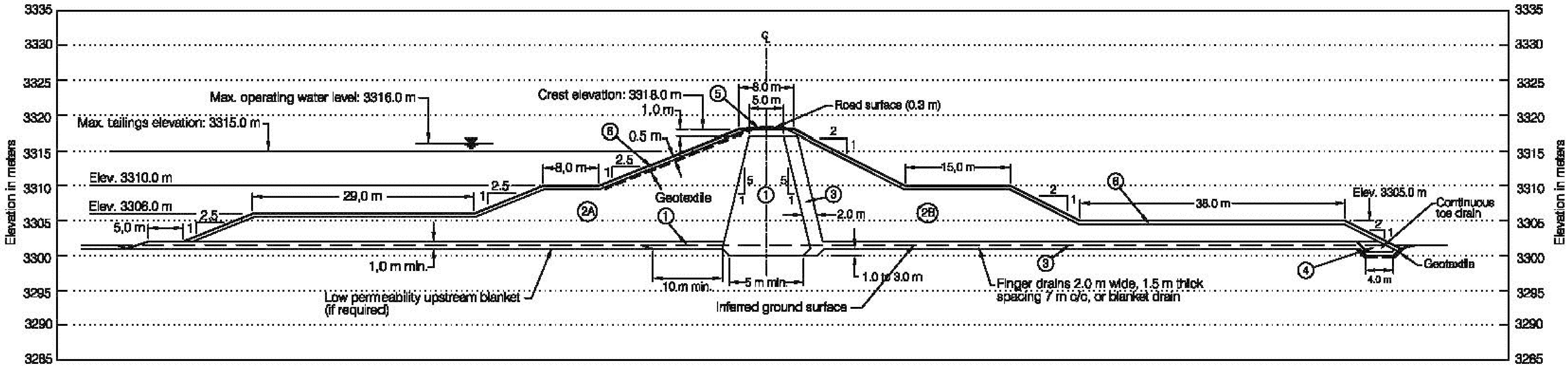
YYYY-MM-DD	2016-07-06
DESIGNED	S. Betnesky
PREPARED	M. Kissiova
REVIEWED	M. Kissiova
APPROVED	M. Kissiova

TITLE
GENERAL SITE PLAN

PROJECT NO.	PHASE	REV.	FIGURE
1775965	-	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm

Path: C:\Autodesk\Temp-Dwg\AcPublish_672\ | File Name: 1533051-01.dwg



Legend:

1. Till core
2A. Pit-run sand or sand and gravel upstream shell
2B. Sand or sand and gravel downstream shell
3. Processed filter sand
4. Toe drain - processed gravel
5. Road surface
6. Quarried rock

CLIENT TECK MINE LOUVICOURT		PROJECT LOUVICOURT MINE TAILINGS POND	
CONSULTANT GOLDER	YYYY-MM-DD: 2016-07-06 DESIGNED: S. Betnesky PREPARED: M. Kissiova REVIEWED: M. Kissiova APPROVED: M. Kissiova	TITLE **TYPICAL DIKE CROSS-SECTION**	
		PROJECT NO. 1775965	PHASE - / REV. 0 / FIGURE 2

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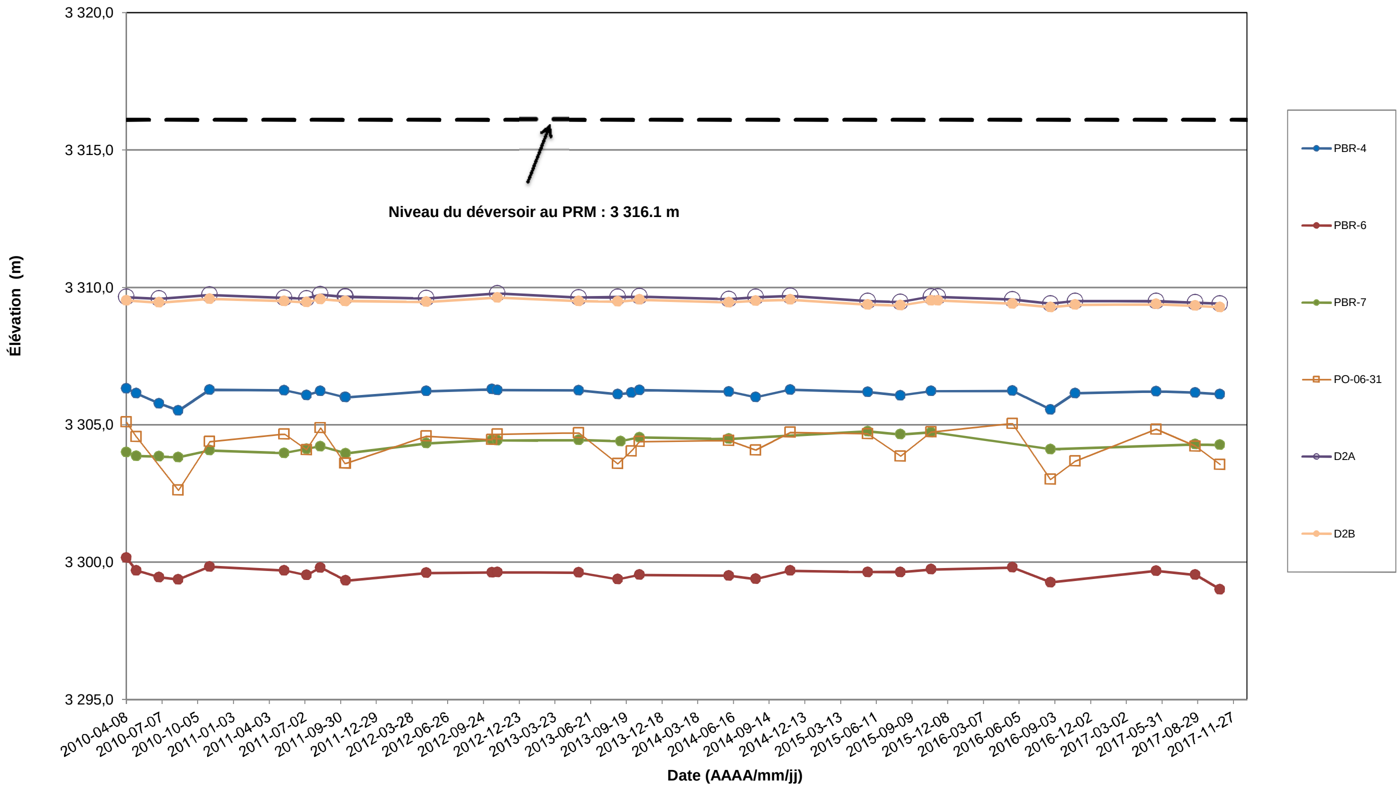
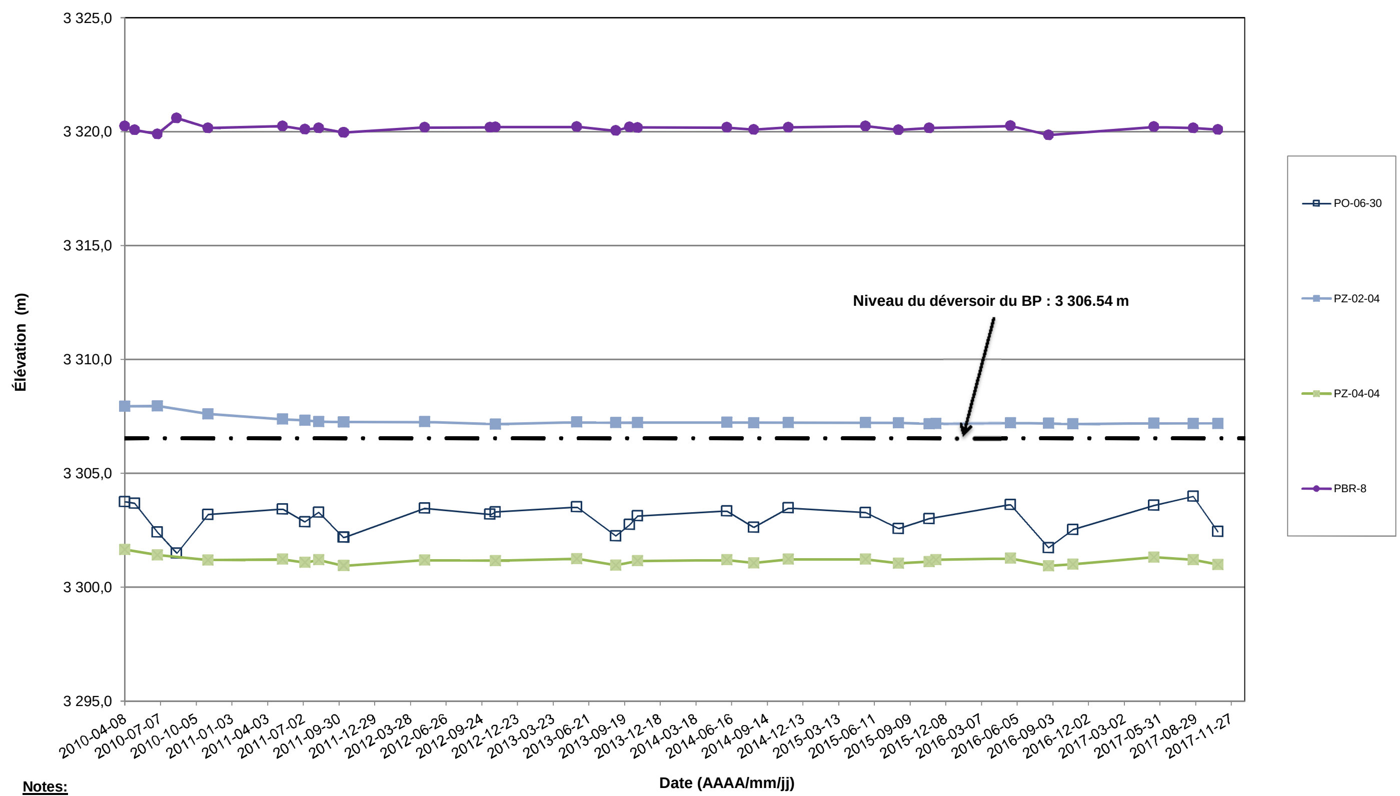
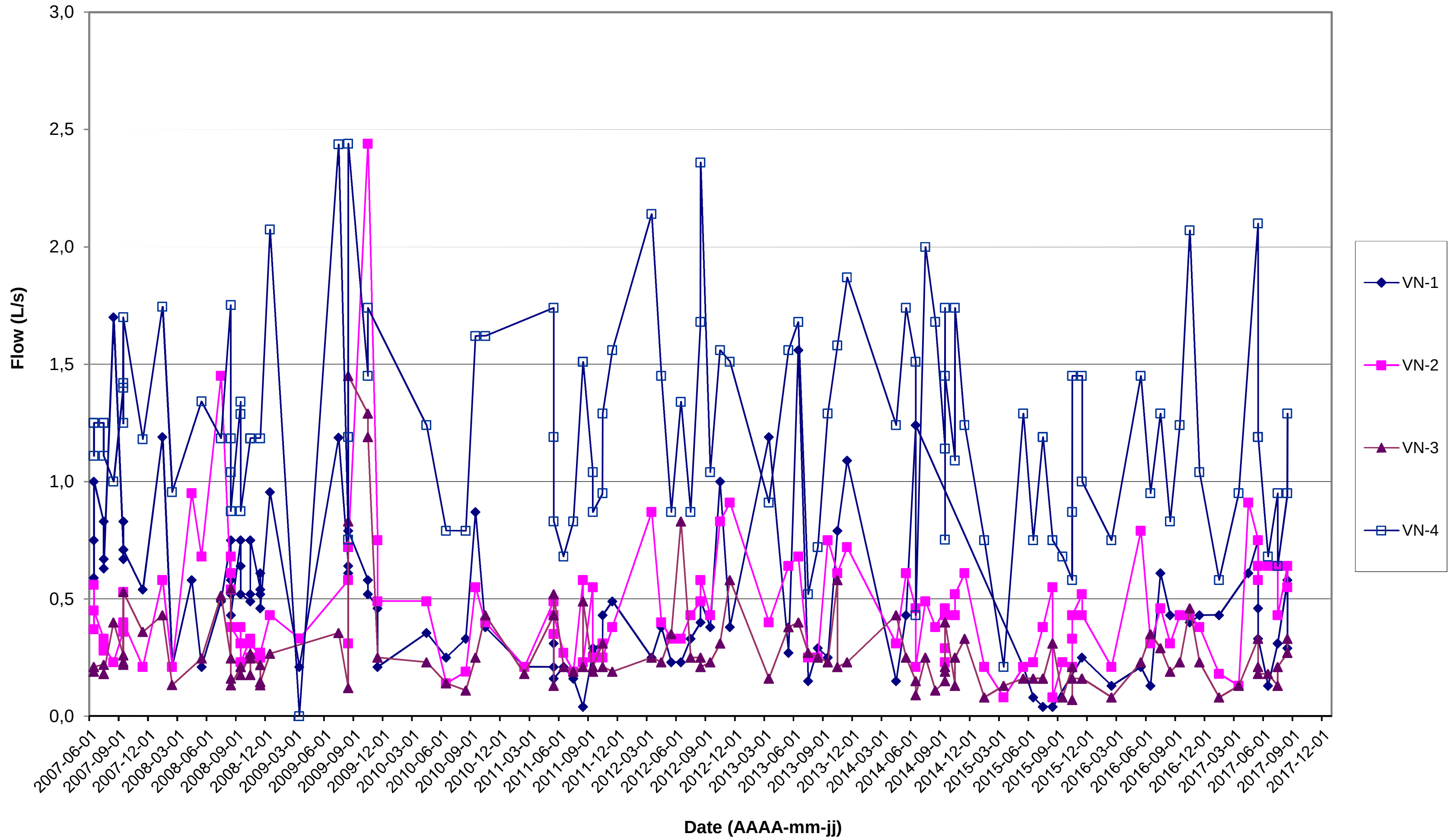
25 mm





Notes:
PRM : Parc à résidus miniers de la Mine Louvicourt
BP : Bassin de polissage au parc à résidus miniers (PRM) de la Mine Louvicourt
PBR-8 : Le puits est situé en amont hydraulique du parc à résidus

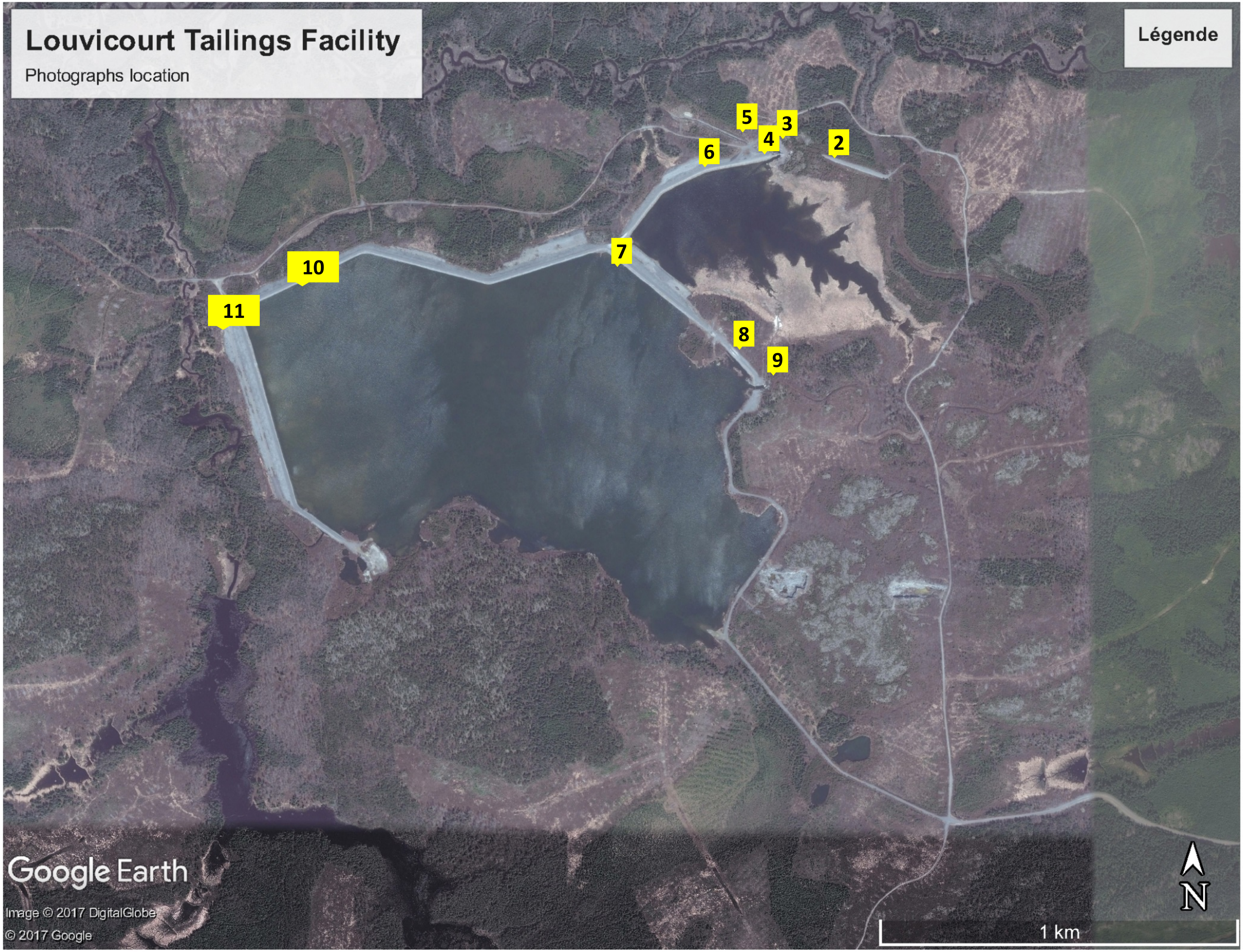
Teck	DSI 2017	Water level measurements - piezometers (provided by Teck) CONFIDENTIEL					
	Louvicrout TSF	DESIGNED BY:	BZ	DATE	14/11/2017	GOLDER ROJECT NC	1775965
	Teck Resources Ltd.	VERIFIED BY:	EG	DATE	14/11/2017		
		REVISÉ PAR:		DATE		FIGURE:	Figure 3



Teck	**DSI 2017**	**Louvicourt Mine Tailings Pond - historical trend of seepage flow measured at the V-notch weirs** **CONFIDENTIEL**					
	Mine Louvicourt **Teck Resources Ltd**	DESSINÉ PAR:	BZ	DATE	nov-17	NO. DE PROJET:	1775965
		VÉRIFIÉ PAR:	EG	DATE	nov-17		
		REVISÉ PAR:		DATE		FIGURE:	**4**

APPENDIX A

Photographs


Louvicourt Tailings Facility
Photographs location
Légende
2
3
4
5
6
7
8
9
10
11
Google Earth
Image © 2017 DigitalGlobe
© 2017 Google
N
1 km

Photograph 1: Louvicourt Mine, Dam 4A

General view of Dam 4A, looking east.

Photograph 2: Louvicourt Mine, Dam 4B

Overflow Weir at Dam 4B in good condition.

Photograph 3: Dam 4B, final effluent area

Culverts in good condition (recently rehabilitated).

Photograph 4: Final effluent point

Infrastructure in good condition, low flow, clear water.

Photograph 5: Dam 4B

View of the crest, settlement point SP11-1.

Photograph 6: Dam 1D

Rip-rap, upstream face where rehabilitation effort has been recommended.

Photograph 7: Dam 1E, emergency spillway

Emergency spillway – bed in excellent condition, downstream channel with some growing vegetation.

Photograph 8: Tailings pond effluent

Good condition, no debris, water was free flowing.

Photograph 9: Dam 1A

Typical minor erosion point visible at the crest of dams 1A and 1B.

Photograph 10: Dam 2B

Toe of downstream berm, difficult to access because of growing vegetation.

APPENDIX B

Movement Monitoring Survey

LEVÉ EN XYZ
DE DIX-NEUF (19) REPÈRES DE TASSEMENT EXISTANTS

PAR MÉTHODE GPS TEMPS RÉEL, NIVELLEMENT GÉOMÉTRIQUE ET TRIGONOMÉTRIQUE

MINE LOUVICOURT
TECK RESOURCES LIMITED

CANTON LOUVICOURT

Corriveau J.L. & Assoc. inc.
1085, 3e Avenue Ouest
Val d'Or (Québec) J9P 1T5

LEVÉ EN XYZ DE DIX-NEUF (19) REPÈRES (PLAQUES) DE TASSEMENT EXISTANTS PAR MÉTHODE GPS TEMPS RÉEL, NIVELLEMENT GÉOMÉTRIQUE ET TRIGONOMÉTRIQUE

RAPPORT D'OPÉRATION

1) INTRODUCTION :

À la demande de monsieur Éric Gingras de la compagnie Teck Resources, nous nous sommes rendus sur le site du parc à résidus de la Mine Louvicourt situé dans le canton de Louvicourt pour y effectuer le levé de dix-neuf (19) plaques de tassement en XYZ afin de contrôler leur déplacement en horizontal et en vertical, à l'aide de la méthode GPS temps réel, les méthodes de nivellement géométrique et trigonométrique.

2) TRAVAUX TERRAIN EXÉCUTÉS :

Description des travaux :

En premier lieu, les travaux consistaient à lever par GPS temps réel haute précision (± 1cm) la position XYZ de toutes les plaques de tassement. Nous avons utilisé un jalon calé avec un trépied « tripode » pour maintenir l'antenne GPS en stabilité parfaite et ainsi obtenir une meilleure précision de nos observations. De plus, chacune des plaques de tassement a fait l'objet de trois (3) séquences d'observation différentes à environ quinze (15) minutes d'intervalle ou plus pour avoir des géométries différentes de la position des satellites. Chaque séquence d'observation comptait trois (3) moyennes de dix (10) lectures chacune avec une rotation de 120° du jalon à chaque moyenne pour une plus grande justesse et annuler l'erreur de verticalité du jalon porteur du récepteur GPS. Tous les travaux ont été réalisés dans le système SCOPQ (projection MTM) fuseau 9, NAD83, mais appuyés ou comparés sur les points du « *tableau des Points d'appui et de contrôle levés au GPS Temps réel – Système SCOPQ Fuseau 9 NAD83* » (voir le point 6 du rapport), soit les mêmes points de référence ancrés dans le roc que les années précédentes.

Comme à chaque année, nous avons gardé le point **94-257** comme point de référence principal, alors que cinq (5) autres points d'appui secondaires servaient de validation du point d'appui principal ainsi que de témoin de la bonne opération et de la justesse de nos méthodes de levé au GPS RTK.

La deuxième partie des travaux consistait à faire le cheminement vertical avec un niveau géométrique électronique de haute précision et une mire code-barres pour obtenir une précision verticale de quelques millimètres de toutes les plaques de tassement placées sur le sommet des digues. Le point de départ du cheminement est le repère **94-257** (ancré dans le roc) d'une élévation fixe de **3316.707m (Mine)** ou **316.707m (altitude N.M.M)**. Nous avons effectué quatre cheminements en boucle de ce point obtenant des écarts de fermeture de 0.2, 0.5, 0.9 et 0.3 mm. Le premier cheminement en boucle s'étend sur une distance de 755m totale (incluant aller et retour) entre les repères **94-257** et **JLC-2011-3** avec une erreur de fermeture de 0.2 mm. Le deuxième cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 645m entre les repères **94-257** et **B-1** avec une erreur de fermeture de 0.5 mm. Le troisième cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 2213m entre les repères **94-257** et **B-7** avec une erreur de fermeture de 0.9 mm. Finalement, le quatrième cheminement liant les points d'appui **B7** (départ) et **94-262** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 1449m avec une erreur de fermeture globale de 0.3 mm. Les plaques de tassement ont été mesurées à l'aller et au retour, soit deux (2) déterminations différentes utilisant chacune des plaques comme des « points tournant ». Nous avons ensuite fait la moyenne de ces deux (2) déterminations pour obtenir les valeurs du « *tableau des Élévations précises des plaques de tassement* » (voir le point 8 du rapport).

La troisième partie des travaux consistait à lever les plaques de tassement placées sur les bermes. Ces plaques, étant difficilement accessibles par le nivellement géométrique à cause des grandes dénivelées entre le sommet des digues et le dessus des bermes (soit de 6 à 10 mètres), la méthode a consisté à stationner une station totale sur le sommet des digues, prendre comme points d'appui temporaires deux (2) plaques de tassement de digues (déjà nivelées par niveau géométrique) et prendre en répétition (lunette directe et renversée) l'angle vertical et la distance en pente jusqu'au petit jalon vertical (d'environ 30cm de longueur) positionné sur la plaque de tassement à déterminer en vertical.

L'opération est répétée une deuxième fois à une hauteur différente d'instrument. Le tout est calculé en effectuant les moyennes à partir des angles verticaux et de la valeur des deux (2) plaques de tassement d'appui des digues prédéterminées en élévation par le cheminement géométrique. Ces deux répétitions nous donnent une moyenne d'une précision d'environ 3mm qui additionnée à la précision du nivellement géométrique se situe à environ 3 à 5mm.

3) <u>COMMENTAIRES SUR LES OBSERVATIONS DE 2008</u> :

Comme déjà mentionné dans les rapports des années passées, il est possible qu'il y ait un cassé en déplacement entre les données de 2008 et les années précédentes qui ne soit pas nécessairement dû au déplacement des plaques de tassement, mais plutôt à un choix différent des points d'origine et l'incohérence des repères d'appui ou de référence. De plus, il y a sûrement une différence entre la procédure que nous utilisons pour faire les levés et celle qu'utilisait la compagnie minière, laquelle procédure ne nous a pas été indiquée, on aurait pu alors assurer une continuité plus rigoureuse dans les résultats par une même méthodologie de levé.

4) <u>TRAVAUX BUREAU EXÉCUTÉS</u> :

Nous avons calculé les coordonnées des points mesurés en XYZ par GPS temps réel en faisant les moyennes des répétitions, avons complété le « *tableau des Différences des coordonnées XYZ* » et avons calculé les déplacements (voir le point 7 du rapport). Il est à noter que les coordonnées XYZ obtenues par méthode GPS temps réel sont estimées avoir une précision de ± 1cm avec 1 sigma en horizontal, tandis qu'en élévation par GPS la précision n'est qu'environ 2cm.

Nous avons fait la moyenne des deux (2) lectures d'élévation obtenues par nivellement géométrique (aller et retour) de toutes les plaques de tassement des sommets de digues. Nous avons compensé le cheminement aller-retour même si l'erreur de fermeture du polygone total n'était que de quelques fractions de millimètres et n'avait pas d'incidence significative sur le résultat obtenu.

Pour les élévations des plaques de tassement des bermes, nous avons fait la moyenne des dénivelées obtenues par station totale pour chacune des plaques de tassement (soit la dénivelée entre les plaques d'appui au sommet des digues et celles à déterminer sur les bermes). Nous estimons que la précision des élévations (par méthode géométrique) est de l'ordre de ± 1mm à 3mm selon la longueur du cheminement; veuillez vous référer au tableau titré « *Élévations précises des plaques de tassement* » par nivellement géométrique et trigonométrique.

5) <u>GÉNÉRALITÉS</u> :

Les travaux ont été effectués du 6 au 8 septembre 2017 et le 13 septembre 2017 par une équipe de deux à trois hommes. Les travaux ont été supervisés par Jean-Luc Corriveau, arpenteur-géomètre.

<u>Instruments utilisés</u> :

- Un (1) système GNSS comprenant :
- Deux (2) récepteurs GNSS modèle viva de la compagnie Leica .
  La précision du système GNSS ou GPS est de ± 0,01m horizontalement et ± 0,02m verticalement à un niveau de confiance de 1σ, selon les spécifications du fabricant; cependant, par la répétition, la proximité des points d'appui et la méthodologie, ces précisions ont pu être augmentées au demi-centimètre ou mieux.
- Un (1) niveau électronique DNA 3 compagnie Leïca avec deux mires à code-barres précision en nivellement double de 1 mm/km.
- Une (1) station totale modèle T06 de la compagnie Leïca.

6) <u>TABLEAU DES POINTS D'APPUI ET DE CONTRÔLE LEVÉS AU GPS TEMPS RÉEL SYSTÈME SCOPQ FUSEAU 9 NAD83</u>

■ SCOPQ (MTM) NAD83
FUSEAU: 9
MÉRIDIEN CENTRAL : 76°30' OUEST

* Coordonnées théoriques fournies par la mine dont on a ajouté
5 300 000m en Nord et 200 000m en Est et soustrait 3 000m en élévation

Note : On doit considérer les inscriptions au mm significatives qu'au 10mm près en horizontal et qu'au 2 cm près en vertical pour les données venant des levés GPS ou GNSS.

Légende :

** Point existant ancré dans le roc avec trépied témoin.

*** Précision insuffisante en vertical, se référer au nivellement géométrique pour une meilleure précision.

Numéro		NORD (m)	EST (m)	ALTITUDE (m)***
94-257**	Théorique*	5333644.982	223183.100	316.707
Point de base	Terrain	5333644.982	223183.100	316.707
	Différence	0.000	0.000	0.000
94-258**	Théorique*	5333566.954	222891.729	311.677
Contrôle 1	Terrain 2010	5333567.016	222891.730	311.661
	Terrain 2011	5333567.027	222891.729	311.682
	Terrain 2012	5333567.011	222891.724	311.681
	Terrain 2013	5333567.022	222891.723	311.685
	Terrain 2014	5333567.020	222891.730	311.676
	Terrain 2015	5333567.019	222891.728	311.680
	Terrain 2016	5333567.028	222891.729	311.699
	Terrain 2017	5333567.015	222891.735	311.688
	Diff. Théo-2010.	-0.062	-0.001	0.016
	Diff. Théo-2011.	-0.073	0.000	-0.005
	Diff. Théo-2012.	-0.057	0.005	-0.004
	Diff. Théo-2013	-0.068	0.006	-0.008
	Diff. Théo-2014	-0.066	-0.001	0.001
	Diff. Théo-2015	-0.065	0.001	-0.003
	Diff. Théo-2016	-0.074	0.000	-0.022
	2011-2010	0.011	-0.001	0.021
	2012-2011	-0.016	-0.005	-0.001
	2013-2012	0.011	-0.001	0.004
	2014-2013	-0.002	0.007	-0.009
	2015-2014	-0.001	-0.002	0.004
	2016-2015	0.009	0.001	0.019
	2017-2016	-0.013	0.006	-0.011
94-256**	Théorique*	5333408.957	223515.007	317.777
Contrôle 2	Terrain 2010	5333408.888	223514.937	317.774
	Terrain 2011	5333408.896	223514.929	317.784
	Terrain 2012	5333408.900	223514.927	317.782
	Terrain 2013	5333408.899	223514.929	317.786
	Terrain 2014	5333408.887	223514.932	317.772
	Terrain 2015	5333408.894	223514.932	317.773
	Terrain 2016	5333408.899	223514.929	317.792
	Terrain 2017	5333408.907	223514.939	317.801
	Diff. Théo-2010.	0.069	0.070	0.003
	Diff. Théo-2011.	0.061	0.078	-0.007
	Diff. Théo-2012.	0.057	0.080	-0.005
	Diff. Théo-2013	0.058	0.078	-0.009
	Diff. Théo-2014	0.070	0.075	0.005
	Diff. Théo-2015	0.063	0.075	0.004
	Diff. Théo-2016	0.059	0.075	-0.015
	2011-2010	0.008	-0.008	0.010
	2012-2011	0.004	-0.002	-0.002
	2013-2012	-0.001	0.002	0.005
	2014-2013	-0.012	0.003	-0.014
	2015-2014	0.007	0.000	0.001
	2016-2015	0.004	-0.003	0.019
	2017-2016	0.004	-0.003	0.019
94-260**	Théorique*	5333495.201	222157.718	312.345
Contrôle 3	Terrain 2010	5333495.447	222157.739	312.333
	Terrain 2011	5333495.453	222157.733	312.360
	Terrain 2012	5333495.443	222157.735	312.350
	Terrain 2013	5333495.453	222157.735	312.369
	Terrain 2014	5333495.451	222157.737	312.345
	Terrain 2015	5333495.447	222157.738	312.354
	Terrain 2016	5333495.453	222157.731	312.368
	Terrain 2017	5333495.435	222157.742	312.385
	Diff. Théo-2010.	-0.246	-0.021	0.012
	Diff. Théo-2011.	-0.252	-0.015	-0.015
	Diff. Théo-2012.	-0.242	-0.017	-0.005
	Diff. Théo-2013	-0.252	-0.017	-0.024
	Diff. Théo-2014	-0.250	-0.019	0.000
	Diff. Théo-2015	-0.246	-0.020	-0.009
	Diff. Théo-2016	-0.252	-0.013	-0.023
	2011-2010	0.006	-0.006	0.027
	2012-2011	-0.010	0.002	-0.010
	2013-2012	0.010	0.000	0.019
	2014-2013	-0.002	0.002	-0.024
	2015-2014	-0.004	0.001	0.009
	2016-2015	0.006	-0.007	0.014
	2017-2016	-0.018	0.011	0.017
94-262**	Théorique*	5332897.066	222292.513	315.842
Contrôle 4	Terrain 2010	5332897.303	222292.387	315.827
	Terrain 2011	5332897.306	222292.381	315.840
	Terrain 2012	5332897.307	222292.382	315.856
	Terrain 2013	5332897.304	222292.381	315.859
	Terrain 2014	5332897.311	222292.390	315.840
	Terrain 2015	5332897.313	222292.386	315.851
	Terrain 2016	5332897.325	222292.386	315.870
	Terrain 2017	5332897.307	222292.386	315.878
	Diff. Théo-2010.	-0.237	0.126	0.015
	Diff. Théo-2011.	-0.240	0.132	0.002
	Diff. Théo-2012.	-0.241	0.131	-0.014
	Diff. Théo-2013	-0.238	0.132	-0.017
	Diff. Théo-2014	-0.245	0.123	0.002
	Diff. Théo-2015	-0.259	0.128	-0.028
	2011-2010	0.003	-0.006	0.013
	2012-2011	0.001	0.001	0.016
	2013-2012	-0.003	-0.001	0.003
	2014-2013	0.007	0.009	-0.019
	2015-2014	0.002	-0.004	0.011
	2016-2015	0.012	0.000	0.019
	2017-2016	-0.018	0.000	0.008
94-263**	Théorique*	5332858.918	222355.630	317.471
Contrôle 5	Terrain 2010	5332859.145	222355.493	317.465
	Terrain 2011	5332859.147	222355.487	317.467
	Terrain 2012	5332859.140	222355.487	317.485
	Terrain 2013	5332859.142	222355.485	317.488
	Terrain 2014	5332859.139	222355.491	317.468
	Terrain 2015	5332859.140	222355.492	317.478
	Terrain 2016	5332859.138	222355.487	317.495
	Terrain 2017	5332859.135	222355.488	317.524
	Diff. Théo-2010.	-0.227	0.137	0.006
	Diff. Théo-2011.	-0.229	0.143	0.004
	Diff. Théo-2012.	-0.222	0.143	-0.014
	Diff. Théo-2013	-0.224	0.145	-0.017
	Diff. Théo-2014	-0.221	0.139	0.003
	Diff. Théo-2015	-0.222	0.138	-0.007
	Diff. Théo-2016	-0.220	0.143	-0.024
	2011-2010	0.002	-0.006	0.002
	2012-2011	-0.007	0.000	0.018
	2013-2012	0.002	-0.002	0.003
	2014-2013	-0.003	0.006	-0.020
	2015-2014	0.001	0.001	0.010
	2016-2015	-0.002	-0.005	0.017
	2017-2016	-0.003	0.001	0.029

7) **TABLEAU DES DIFFÉRENCES DES COORDONNÉES XYZ DES PLAQUES DE TASSEMENT OBTENUES PAR MÉTHODE GPS TEMPS RÉEL** (voir annexe 1)

8) **TABLEAU DES ÉLÉVATIONS PRÉCISES DES PLAQUES DE TASSEMENT** (voir annexe 2)

9) **RÉSUMÉ :**

En résumé, notre travail contient :

Nombre de plaques de tassement levées par GPS (±1cm) :	19
Nombre de plaques de tassement nivelées (± 2mm) :	19
Nombre de plaques levées par st. totale pour le vertical :	6
Nombre de plaques nivelées à partir du niveau géométrique :	13
Nombre de points d'appui localisés/contrôlés en horizontal :	6
Nombre de points d'appui en vertical (cheminement géométrique) :	2
Longueur totale des cheminements altimétriques :	5.063Km

Fait à Val d'Or, le 10 octobre 2017, sous le numéro **C-13907/442.18-19** de mes minutes en référence aux dossiers : C-12762/442.18, C-12486/442.17 (2014), C-12102/442.17 (2013), C-11735/442.17 (2012), C-11471/442.17 (2011), C - 10945/442.17 (2010), C-10558/442.16 (2009) et C-10178/442.15 (2008) du soussigné.

Val-d'Or, le 10 octobre 2017 HL
CORRIVEAU J.L. & ASSOC. INC.

Jean-Luc Corriveau
A.-G., A.T.C.

Copie conforme à l'original 30 oct. 2017
Par : Jean-Luc Corriveau, Arpenteur-Géomètre A.T.C

Annexes :

Annexe 1 : Tableau des différences des coordonnées xyz des plaques de tassement obtenues par méthode GPS temps réel.

Annexe 2 : Tableau des élévations précises des plaques de tassement.

Annexe 3 : Plan de localisation des plaques de tassement révision du 20/10/2011 minute C-10945/442.17 du soussigné.

Annexe 1

Tableau des différences des coordonnées XYZ des plaques de tassement obtenues par méthode GPS Temps réel

PLAQUE DE TASSEMENT		Coordonnées théoriques	Arpentage Sept. 2008	Différence 2008-Théo		Arpentage Juin 2010	Différence 2010-2008	
B-1	Nord	5333481.600	5333481.572	-0.028	S	5333481.588	0.016	N
	Est	223364.365	223364.319	-0.046	O	223364.310	-0.009	O
	Elev.	319.120	319.085	-0.035	B	319.085	0.000	-
B-2	Nord	5333524.849	5333524.834	-0.015	S	5333524.840	0.006	N
	Est	223312.799	223312.758	-0.041	O	223312.754	-0.004	O
	Elev.	318.489	318.450	-0.039	B	318.452	0.002	H
B-3	Nord	5333560.718	5333560.716	-0.002	S	5333560.721	0.005	N
	Est	223270.316	223270.298	-0.018	O	223270.294	-0.004	O
	Elev.	319.122	319.090	-0.032	B	319.093	0.003	H
B-4	Nord	5333595.764	5333595.789	0.025	N	5333595.793	0.004	N
	Est	223073.887	223073.882	-0.005	O	223073.899	0.017	E
	Elev.	318.136	318.111	-0.025	B	318.134	0.023	H
B-5	Nord	5333572.172	5333572.224	0.052	N	5333572.230	0.006	N
	Est	222993.640	222993.630	-0.010	O	222993.641	0.011	E
	Elev.	318.157	318.151	-0.006	B	318.158	0.007	H
B-6	Nord	5333588.639	5333588.744	0.105	N	5333588.757	0.013	N
	Est	222661.587	222661.604	0.017	E	222661.649	0.045	E
	Elev.	318.176	318.139	-0.037	B	318.141	0.002	H
B-7	Nord	5333510.829	5333511.090	0.261	N	5333511.091	0.001	N
	Est	222246.790	222246.804	0.014	E	222246.868	0.064	E
	Elev.	318.176	318.185	0.009	H	318.190	0.005	H
B-8	Nord	5333371.342	5333371.603	0.261	N	5333371.609	0.006	N
	Est	222178.864	222178.871	0.007	E	222178.944	0.073	E
	Elev.	319.031	319.022	-0.009	B	319.020	-0.002	B
B-9	Nord	5333326.921	5333327.178	0.257	N	5333327.189	0.011	N
	Est	222191.523	222191.531	0.008	E	222191.610	0.079	E
	Elev.	319.181	319.161	-0.020	B	319.171	0.010	H
B-10	Nord	5333154.032	5333154.277	0.245	N	5333154.279	0.002	N
	Est	222242.232	222242.203	-0.029	O	222242.271	0.068	E
	Elev.	318.244	318.220	-0.024	B	318.226	0.006	H
B-11	Nord							
	Est							
	Elev.							
2011-1 L	Nord							
	Est							
	Elev.							
2011-2 C	Nord							
	Est							
	Elev.							
2011-3 L	Nord							
	Est							
	Elev.							
2011-4 L	Nord							
	Est							
	Elev.							
2011-5 C	Nord							
	Est							
	Elev.							
2011-6 C	Nord							
	Est							
	Elev.							
2011-7 C	Nord							
	Est							
	Elev.							
2011-8 C	Nord							
	Est							
	Elev.							

PLAQUE DE TASSEMENT		Arpentage Octobre 2011	Différence 2011-2010		Arpentage Octobre 2012	Différence 2012-2011		Arpentage Juillet 2013	Différence 2013-2012	
B-1	Nord	5333481.573	-0.015	S	5333481.567	-0.006	S	5333481.574	0.007	N
	Est	223364.316	0.006	E	223364.317	0.001	E	223364.319	0.002	E
	Elev.	319.097	0.012	H	319.089	-0.008	B	319.087	-0.002	B
B-2	Nord	5333524.842	0.002	N	5333524.839	-0.003	S	5333524.843	0.004	N
	Est	223312.766	0.012	E	223312.765	-0.001	O	223312.764	-0.001	O
	Elev.	318.454	0.002	H	318.448	-0.006	B	318.439	-0.009	B
B-3	Nord	5333560.721	0.000	-	5333560.720	-0.001	S	5333560.718	-0.002	S
	Est	223270.298	0.004	E	223270.292	-0.006	O	223270.294	0.002	E
	Elev.	319.101	0.008	H	319.098	-0.003	B	319.096	-0.002	B
B-4	Nord	5333595.798	0.005	N	5333595.802	0.004	N	5333595.802	0.000	N/A
	Est	223073.888	-0.011	O	223073.881	-0.007	O	223073.879	-0.002	O
	Elev.	318.140	0.006	H	318.141	0.001	H	318.141	0.000	N/A
B-5	Nord	5333572.233	0.003	N	5333572.227	-0.006	S	5333572.231	0.004	N
	Est	222993.631	-0.010	O	222993.632	0.001	E	222993.625	-0.007	O
	Elev.	318.166	0.008	H	318.164	-0.002	B	318.165	0.001	H
B-6	Nord	5333588.748	-0.009	S	5333588.747	-0.001	S	5333588.753	0.006	N
	Est	222661.613	-0.036	O	222661.609	-0.004	O	222661.604	-0.005	O
	Elev.	318.150	0.009	H	318.139	-0.011	B	318.143	0.004	H
B-7	Nord	5333511.093	0.002	N	5333511.087	-0.007	S	5333511.096	0.009	N
	Est	222246.809	-0.059	O	222246.807	-0.003	O	222246.802	-0.005	O
	Elev.	318.203	0.013	H	318.186	-0.017	B	318.203	0.018	H
B-8	Nord	5333371.606	-0.003	S	5333371.607	0.001	N	5333371.610	0.003	N
	Est	222178.876	-0.068	O	222178.872	-0.004	O	222178.867	-0.005	O
	Elev.	319.035	0.015	B	319.031	-0.004	B	319.035	0.004	H
B-9	Nord	5333327.187	-0.002	S	5333327.193	0.006	N	5333327.189	-0.004	S
	Est	222191.543	-0.067	O	222191.531	-0.012	O	222191.528	-0.003	O
	Elev.	319.180	0.009	H	319.186	0.006	H	319.177	-0.009	B
B-10	Nord	5333154.282	0.003	N	5333154.278	-0.004	S	5333154.275	-0.003	S
	Est	222242.254	-0.017	O	222242.192	-0.062	O	222242.189	-0.003	O
	Elev.	318.234	0.008	H	318.233	-0.001	B	318.231	-0.002	B
B-11	Nord	5333362.842	N/A		5333362.840	-0.002	S	5333362.842	0.002	N
	Est	222145.004	N/A		222145.006	0.002	E	222145.000	-0.006	O
	Elev.	307.277	N/A		307.241	-0.036	B	307.266	0.025	H
2011-1 L	Nord	5333800.878	N/A		5333800.873	-0.005	S	5333800.871	-0.002	S
	Est	223387.811	N/A		223387.817	0.006	E	223387.815	-0.002	O
	Elev.	310.020	N/A		310.018	-0.002	B	310.018	0.000	N/A
2011-2 C	Nord	5333562.623	N/A		5333562.637	0.014	N	5333562.632	-0.005	S
	Est	223322.116	N/A		223322.109	-0.007	O	223322.107	-0.002	O
	Elev.	309.270	N/A		309.252	-0.018	B	309.242	-0.010	B
2011-3 L	Nord	5333826.347	N/A		5333826.349	0.002	N	5333826.347	-0.002	S
	Est	223442.150	N/A		223442.150	0.000	-	223442.153	0.003	E
	Elev.	310.354	N/A		310.345	-0.009	B	310.344	-0.001	B
2011-4 L	Nord	5333763.037	N/A		5333763.041	0.004	N	5333763.040	-0.001	S
	Est	223329.455	N/A		223329.455	0.000	-	223329.456	0.001	E
	Elev.	310.371	N/A		310.359	-0.012	B	310.365	0.006	H
2011-5 C	Nord	5333821.228	N/A		5333821.227	-0.001	S	5333821.221	-0.006	S
	Est	223378.028	N/A		223378.028	0.000	-	223378.028	0.000	-
	Elev.	303.984	N/A		303.978	-0.006	B	303.980	0.001	H
2011-6 C	Nord	5333068.318	N/A		5333068.305	-0.013	S	5333068.308	0.003	N
	Est	222236.094	N/A		222236.095	0.001	E	222236.096	0.001	E
	Elev.	309.338	N/A		309.334	-0.004	B	309.337	0.003	H
2011-7 C	Nord	5333271.670	N/A		5333271.658	-0.012	N	5333271.660	0.002	N
	Est	222174.469	N/A		222174.459	-0.010	O	222174.458	-0.001	O
	Elev.	309.156	N/A		309.159	0.003	H	309.161	0.001	H
2011-8 C	Nord	5333627.581	N/A		5333627.573	-0.008	S	5333627.577	0.004	N
	Est	223061.472	N/A		223061.471	-0.001	O	223061.467	-0.004	O
	Elev.	310.383	N/A		310.369	-0.014	B	310.370	0.001	H

PLAQUE DE TASSEMENT		Arpentage Juin 2014	Différence 2014-2013		Arpentage Juin 2015	Différence 2015-2014		Arpentage Juin 2016	Différence 2016-2015		Arpentage Septembre 2017	Différence 2017-2016	
B-1	Nord	5333481.565	-0.009	S	5333481.569	0.004	N	5333481.576	0.007	N	5333481.586	0.010	N
	Est	223364.324	0.005	E	223364.321	-0.003	O	223364.317	-0.004	O	223364.321	0.004	E
	Elev.	319.082	-0.005	B	319.080	-0.002	B	319.098	0.018	H	319.094	-0.004	B
B-2	Nord	5333524.841	-0.002	S	5333524.836	-0.005	S	5333524.846	0.010	N	5333524.853	0.007	N
	Est	223312.774	0.010	E	223312.774	0.000	-	223312.771	-0.003	O	223312.773	0.002	E
	Elev.	318.430	-0.009	B	318.428	-0.002	B	318.441	0.013	H	318.436	-0.005	B
B-3	Nord	5333560.713	-0.005	S	5333560.717	0.004	N	5333560.730	0.014	N	5333560.720	-0.010	S
	Est	223270.302	0.008	E	223270.297	-0.005	O	223270.295	-0.002	O	223270.299	0.004	E
	Elev.	319.086	-0.010	B	319.087	0.001	H	319.099	0.001	H	319.092	-0.007	B
B-4	Nord	5333595.797	-0.005	S	5333595.803	0.006	N	5333595.808	0.005	N	5333595.807	-0.001	S
	Est	223073.885	0.006	E	223073.879	-0.006	O	223073.877	-0.002	O	223073.879	0.002	E
	Elev.	318.127	-0.014	B	318.134	0.007	H	318.146	0.012	H	318.137	-0.009	B
B-5	Nord	5333572.233	0.002	N	5333572.232	-0.001	S	5333572.233	0.001	N	5333572.234	0.001	N
	Est	222993.633	0.008	E	222993.633	0.000	-	222993.626	-0.007	O	222993.629	0.003	E
	Elev.	318.160	-0.005	B	318.163	0.003	H	318.172	0.009	H	318.160	-0.012	B
B-6	Nord	5333588.751	-0.002	S	5333588.753	0.002	N	5333588.754	0.001	N	5333588.759	0.005	N
	Est	222661.610	0.006	E	222661.608	-0.002	O	222661.609	0.001	E	222661.607	-0.002	O
	Elev.	318.132	-0.011	B	318.148	0.016	H	318.160	0.012	H	318.146	-0.014	B
B-7	Nord	5333511.093	-0.003	S	5333511.096	0.003	N	5333511.098	0.002	N	5333511.101	0.003	N
	Est	222246.805	0.003	E	222246.803	-0.002	O	222246.804	0.001	E	222246.797	-0.007	O
	Elev.	318.196	-0.007	B	318.204	0.008	H	318.221	0.017	H	318.217	-0.004	B
B-8	Nord	5333371.606	-0.004	S	5333371.607	0.001	N	5333371.610	0.003	N	5333371.607	-0.003	S
	Est	222178.872	0.005	E	222178.876	0.004	E	222178.866	-0.010	O	222178.868	0.002	E
	Elev.	319.012	-0.023	B	319.033	0.021	H	319.028	-0.005	B	319.032	0.004	H
B-9	Nord	5333327.179	-0.010	S	5333327.182	0.003	N	5333327.191	0.009	N	5333327.186	-0.005	S
	Est	222191.533	0.005	E	222191.536	0.003	E	222191.524	-0.012	O	222191.528	0.004	E
	Elev.	319.154	-0.023	B	319.173	0.019	H	319.175	0.002	H	319.173	-0.002	B
B-10	Nord	5333154.276	0.001	N	5333154.268	-0.008	S	5333154.280	0.012	N	5333154.274	-0.006	S
	Est	222242.196	0.007	E	222242.196	0.000	-	222242.186	-0.010	O	222242.185	-0.001	O
	Elev.	318.226	-0.005	B	318.232	0.006	H	318.243	0.011	H	318.243	0.000	H
B-11	Nord	5333362.843	0.001	N	5333362.849	0.006	N	5333362.854	0.005	N	5333362.834	-0.020	S
	Est	222145.004	0.004	E	222145.004	0.000	-	222144.996	-0.008	O	222144.997	0.001	E
	Elev.	307.251	-0.015	B	307.255	0.004	H	307.273	0.018	H	307.258	-0.015	B
2011-1 L	Nord	5333800.866	-0.005	S	5333800.873	0.007	N	5333800.859	-0.014	S	5333800.872	0.013	N
	Est	223387.819	0.004	E	223387.817	-0.002	O	223387.818	0.001	E	223387.812	-0.006	O
	Elev.	310.001	-0.017	B	310.003	0.002	H	309.987	-0.016	B	309.999	0.012	H
2011-2 C	Nord	5333562.627	-0.005	S	5333562.627	0.000	-	5333562.629	0.002	N	5333562.632	0.003	N
	Est	223322.116	0.009	E	223322.110	-0.006	O	223322.107	-0.003	O	223322.099	-0.008	O
	Elev.	309.240	-0.002	B	309.235	-0.005	B	309.247	0.012	H	309.252	0.005	H
2011-3 L	Nord	5333826.343	-0.004	S	5333826.350	0.007	N	5333826.338	-0.012	S	5333826.351	0.013	N
	Est	223442.157	0.004	E	223442.154	-0.003	O	223442.161	0.007	E	223442.151	-0.010	O
	Elev.	310.332	-0.012	B	310.333	0.001	H	310.307	-0.026	B	310.323	0.016	H
2011-4 L	Nord	5333763.036	-0.004	S	5333763.040	0.004	N	5333763.033	-0.007	S	5333763.039	0.006	N
	Est	223329.465	0.009	E	223329.460	-0.005	O	223329.458	-0.002	O	223329.458	0.000	-
	Elev.	310.349	-0.016	B	310.353	0.004	H	310.341	-0.012	B	310.347	0.006	H
2011-5 C	Nord	5333821.222	0.001	N	5333821.227	0.005	N	5333821.220	-0.007	S	5333821.222	0.002	N
	Est	223378.034	0.006	E	223378.031	-0.003	O	223378.030	-0.001	O	223378.030	0.000	-
	Elev.	303.967	-0.013	B	303.970	0.003	H	303.963	-0.007	B	303.973	0.010	H
2011-6 C	Nord	5333068.307	-0.001	S	5333068.308	0.001	N	5333068.313	0.005	N	5333068.302	-0.011	S
	Est	222236.100	0.004	E	222236.096	-0.004	O	222236.093	-0.003	O	222236.094	0.001	E
	Elev.	309.324	-0.013	B	309.334	0.010	H	309.349	0.015	H	309.347	-0.002	B
2011-7 C	Nord	5333271.666	0.006	N	5333271.661	-0.005	S	5333271.669	0.008	N	5333271.658	-0.011	S
	Est	222174.459	0.001	E	222174.457	-0.002	O	222174.447	-0.010	O	222174.452	0.005	E
	Elev.	309.149	-0.012	B	309.172	0.023	H	309.170	-0.002	B	309.171	0.001	H
2011-8 C	Nord	5333627.571	-0.006	S	5333627.574	0.003	N	5333627.574	0.000	N/A	5333627.568	-0.006	S
	Est	223061.476	0.009	E	223061.475	-0.001	O	223061.469	-0.006	O	223061.470	0.001	E
	Elev.	310.355	-0.015	B	310.368	0.013	H	310.383	0.015	H	310.369	-0.014	B

N.B. Valeurs des différences en "Z" significatives qu'à 2cm près; pour plus de précision, se référer au tableau des élévations prises au niveau électronique.
B-1 à B-11 Tiges existantes avec regard protecteur en métal et tige témoin.

Note: On doit considérer les inscriptions au mm significative qu'au 5 mm près

N = déplacement vers le Nord
S = déplacement vers le Sud
E = déplacement vers l'Est
O = déplacement vers l'Ouest
H = déplacement vers le Haut
B = déplacement vers le Bas

Légende
L= Repère médaillon sur longs tuyaux 2.35m x 0.33m extérieur avec 3 ailettes et bout vrillé, regard protecteur et tige témoin 2m
C= Repère médaillon sur tige d'armature de ¾ x 0.9m, regard protecteur et tige témoin de 2m.

Annexe

TABLEAU DES *ÉLÉVATIONS PRÉCISES DES PLAQUES DE TASSEMENT*

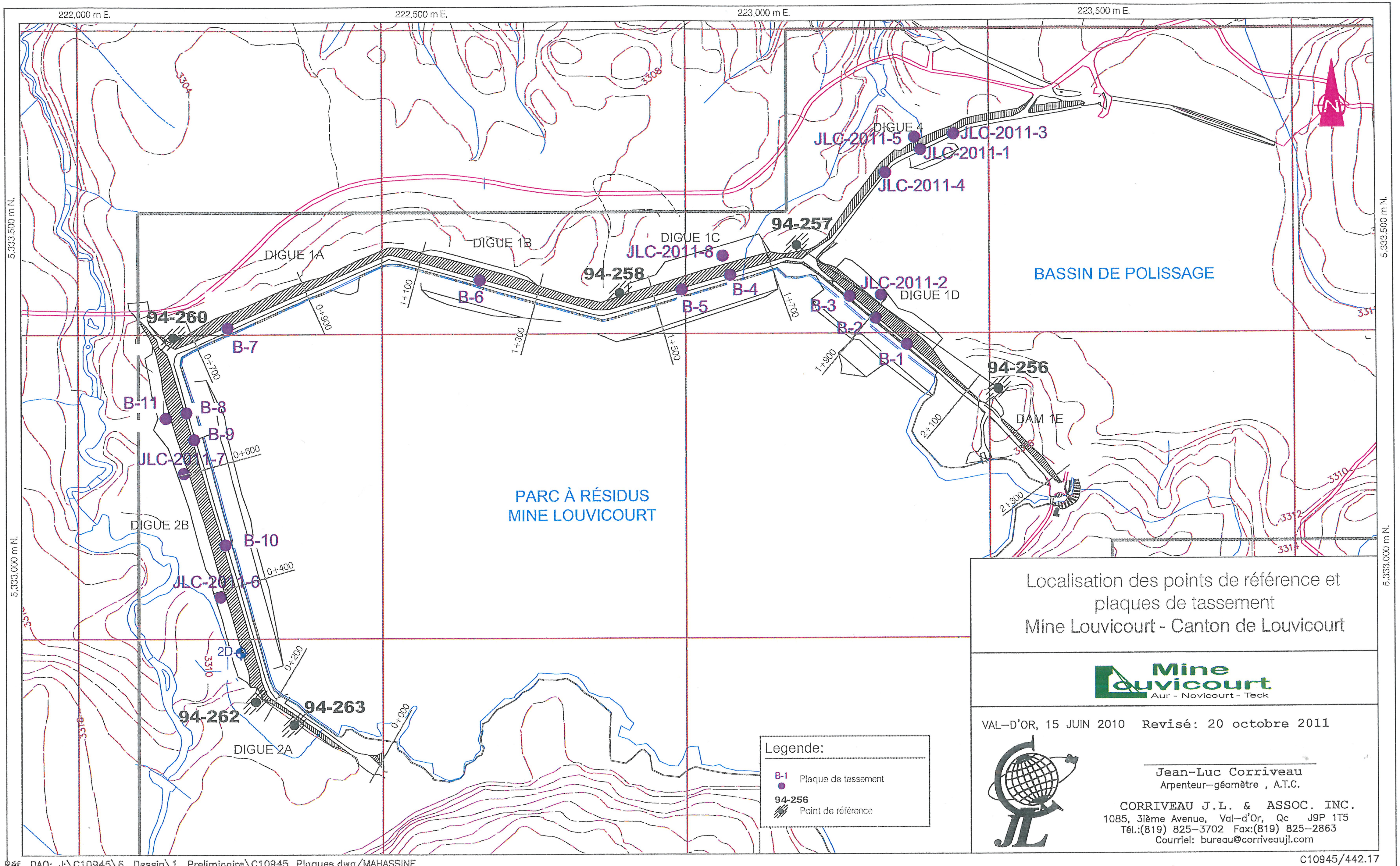
(Obtenues par nivellement géométrique-électronique et trigonométrique)

Plaque de tassement	Élévation Théorique selon mine	Année Sept. 2008	Diff. (m) 2008-Théo.	Élévation Août 2009	Diff. (m) 2009-2008	Élévation Juin 2010	Diff. (m) 2010-2009	Élévation Oct. 2011	Diff. (m) 2011-2010	Diff. (m) 2011-2008	Élévation Oct. 2012	Diff. (m) 2012-2011	Diff. (m) 2012-2008	Élévation Juil. 2013	Diff. (m) 2013-2012	Diff. (m) 2013-2008 2013-2011	Élévation Juil. 2014	Diff. (m) 2014-2013	Diff. (m) 2014-2008 2014-2011	Élévation juin-15	Diff. (m) 2015-2014	Diff. (m) 2015-2008 2015-2011	Élévation juin-16	Diff. (m) 2016-2015	Diff. (m) 2016-2008 2017-2011	Élévation septembre.17	Diff. (m) 2017-2016	Diff. (m) 2017-2008 2017-2011
94-257	3316.707	3316.707	-	3316.707	-	3316.707	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-
94-262	3315.842	-	-	-	-	-	-	3315.840	-	-	3315.839	-0.001	-	3315.859	-	-	3315.841	-	-	3315.842	-	-	3315.842	-	-	3315.878	-	-
B1	3319.120	3319.099	-0.021	3319.099	0.000	3319.100	0.001	3319.097	-0.003	-0.002	3319.097	0.000	-0.002	3319.097	0.000	-0.002	3319.099	0.002	0.000	3319.100	0.001	0.001	3319.099	-0.001	0.000	3319.100	0.001	0.001
B2	3318.489	3318.465	-0.024	3318.462	-0.003	3318.460	-0.002	3318.454	-0.006	-0.011	3318.449	-0.005	-0.016	3318.448	-0.001	-0.017	3318.448	0.000	-0.017	3318.447	-0.001	-0.018	3318.444	-0.003	-0.021	3318.442	-0.002	-0.023
B3	3319.122	3319.103	-0.019	3319.104	0.001	3319.104	0.000	3319.101	-0.003	-0.002	3319.099	-0.002	-0.004	3319.099	0.000	-0.004	3319.102	0.003	-0.001	3319.102	0.000	-0.001	3319.101	-0.001	-0.002	3319.101	0.000	-0.002
B4	3318.136	3318.143	0.007	3318.146	0.003	3318.146	0.000	3318.140	-0.006	-0.003	3318.139	-0.001	-0.004	3318.140	0.001	-0.003	3318.145	0.005	0.002	3318.145	0.000	0.002	3318.145	0.000	0.002	3318.145	0.000	0.002
B5	3318.157	3318.168	0.011	3318.172	0.004	3318.172	0.000	3318.166	-0.006	-0.002	3318.165	-0.001	-0.003	3318.166	0.001	-0.002	3318.173	0.007	0.005	3318.172	-0.001	0.004	3318.171	-0.001	0.003	3318.171	0.000	0.003
B6	3318.176	3318.153	-0.023	3318.158	0.005	3318.156	-0.002	3318.150	-0.006	-0.003	3318.148	-0.002	-0.005	3318.151	0.003	-0.002	3318.155	0.004	0.002	3318.155	0.000	0.002	3318.155	0.000	0.002	3318.156	0.001	0.003
B7	3318.176	3318.198	0.022	3318.207	0.009	3318.207	0.000	3318.203	-0.004	0.005	3318.206	0.003	0.008	3318.208	0.002	0.010	3318.215	0.007	0.017	3318.216	0.001	0.018	3318.217	0.001	0.019	3318.217	0.000	0.019
B8	3319.031	3319.034	0.003	3319.039	0.005	3319.038	-0.001	3319.035	-0.003	0.001	3319.034	-0.001	0.000	3319.033	-0.001	-0.001	3319.035	0.002	0.001	3319.036	0.001	0.002	3319.035	-0.001	0.001	3319.032	-0.003	-0.002
B9	3319.181	3319.180	-0.001	3319.186	0.006	3319.186	0.000	3319.180	-0.006	0.000	3319.179	-0.001	-0.001	3319.179	0.000	-0.001	3319.181	0.002	0.001	3319.181	0.000	0.001	3319.180	-0.001	0.000	3319.181	0.001	0.001
B10	3318.244	3318.232	-0.012	3318.239	0.007	3318.238	-0.001	3318.234	-0.004	0.002	3318.234	0.000	0.002	3318.235	0.001	0.003	3318.240	0.005	0.008	3318.240	0.000	0.008	3318.241	0.001	0.009	3318.241	0.000	0.009
**B11	3307.253	-	-	-	-	-	-	3307.277	-	-	3307.269	-0.008	-	3307.273	0.004	-0.004	3307.270	-0.003	-0.007	3307.270	0.000	-0.007	3307.269	-0.001	-0.008	3307.267	-0.002	-0.010
*2011-1	-	-	-	-	-	-	-	3310.020	-	-	3310.019	-0.001	-	3310.019	0.000	-0.001	3310.016	-0.002	-0.004	3310.016	-0.001	-0.004	3310.011	-0.005	-0.009	3310.007	-0.004	-0.013
**2011-2	-	-	-	-	-	-	-	3309.270	-	-	3309.252	-0.018	-	3309.273	0.021	0.003	3309.256	-0.017	-0.014	3309.259	0.003	-0.011	3309.257	-0.002	-0.013	3309.252	-0.005	-0.018
*2011-3	-	-	-	-	-	-	-	3310.354	-	-	3310.354	0.000	-	3310.352	-0.002	-0.002	3310.348	-0.004	-0.006	3310.346	-0.002	-0.008	3310.341	-0.005	-0.013	3310.334	-0.007	-0.020
*2011-4	-	-	-	-	-	-	-	3310.371	-	-	3310.370	-0.002	-	3310.372	0.003	0.001	3310.368	-0.004	-0.003	3310.369	0.001	-0.002	3310.366	-0.003	-0.005	3310.362	-0.004	-0.009
**2011-5	-	-	-	-	-	-	-	3303.984	-	-	3303.976	-0.008	-	3303.993	0.017	0.009	3303.980	-0.013	-0.004	3303.985	0.005	0.001	3303.981	-0.004	-0.003	3303.980	-0.001	-0.004
**2011-6	-	-	-	-	-	-	-	3309.357	-	-	3309.342	-0.015	-	3309.332	-0.010	-0.025	3309.342	0.010	-0.015	3309.345	0.003	-0.012	3309.344	-0.001	-0.013	3309.344	0.000	-0.013
**2011-7	-	-	-	-	-	-	-	3309.156	-	-	3309.172	0.016	-	3309.177	0.005	0.021	3309.175	-0.002	0.019	3309.174	-0.001	0.018	3309.172	-0.002	0.016	3309.171	-0.001	0.015
**2011-8	-	-	-	-	-	-	-	3310.383	-	-	3310.364	-0.019	-	3310.370	0.006	-0.013	3310.375	0.005	-0.008	3310.374	-0.001	-0.009	3310.374	0.000	-0.009	3310.377	0.003	-0.006

*Trait jaune = Repères implantés en 2011

**Nivellement trigonométrique (précision estimé à +/- 5 mm

Légende des écarts : pas de signe s'élève, signe négatif (-) s'enfonce



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