REPORT

2018 CONSTRUCTION SEASON AS-BUILT REPORT TAILINGS STORAGE FACILITY MEADOWBANK GOLD PROJECT, NUNAVUT

Submitted to:

Agnico Eagle Mines Ltd

Meadowbank Division
Baker Lake, Nunavut, Canada
X0C 0A0

Submitted by:

Golder Associés Ltée

7250, rue du Mile End, 3e étage Montréal (Québec) H2R 3A4 Canada

+1 514 383 0990

1897439-1578-R-Rev0

November 2018

Distribution List

1 hard copy, 1 e-copy: Agnico-Eagle Mines Ltd

1 e-copy: Golder Associés Ltée

Table of Contents

TABLES

FIGURES

APPENDICES

APPENDIX I-3A

QC Laboratory Results – Till: Saddle Dam 3 Finalization of Stage 3

APPENDIX I-3B

QC Laboratory Results – Fine Filter: Saddle Dam 3 Finalization of Stage 3

APPENDIX I-3C

QC Field Testing Results – Till: Saddle Dam 3 Finalization of Stage 3

APPENDIX I-4

North Cell Internal Structure Construction QC Results

APPENDIX I-4A

QC Laboratory Results – Fine Filter: North Cell Internal Structure Construction

APPENDIX I-4B

QC Laboratory Results – Coarse Filter: North Cell Internal Structure Construction

APPENDIX J

QA Laboratory Results

APPENDIX J-1

Stockpile QA Results

APPENDIX J-1A

QA Laboratory Results – Till Stockpile Material

APPENDIX J-1B

QA Laboratory Results – Fine Filter Stockpile Material

APPENDIX J-1C

QA Laboratory Results – Coarse Filter Stockpile Material

APPENDIX J-2

Central Dike Stage 6 QA Results

APPENDIX J-2A

QA Laboratory Results – Fine Filter: Central Dike Stage 6

APPENDIX J-2B

QA Laboratory Results – Coarse Filter: Central Dike Stage 6

APPENDIX J-3

Saddle Dam 3 Finalization of Stage 3 QA Results

APPENDIX J-3A

QA Laboratory Results –Till: Saddle Dam 3 Finalization of Stage 3

APPENDIX J-4

North Cell Internal Structure Construction QA Results

APPENDIX J-4A

QA Laboratory Results – Fine Filter: North Cell Internal Structure Construction

APPENDIX J-4B

QA Laboratory Results – Coarse Filter: North Cell Internal Structure Construction

EXECUTIVE SUMMARY

The 2018 construction season at Meadowbank was conducted from April 23, 2018 to August 3, 2018. It consisted in the construction of Stage 6 for Central Dike, the finalization of Stage 3 for Saddle Dam 3, and the construction of the North Cell Internal Structure. Construction was completed in accordance with the requirements of the Design and Technical Specifications developed by Golder for each structure.

The data collected from the quality assurance (QA) and quality control (QC) program during the construction of Stage 6 Central Dike, the finalization of Stage 3 of Saddle Dam 3 and the construction of the North Cell Internal Structure were used to confirm that the construction of each structure was completed in compliance with the Drawings and Technical Specifications. This includes earthwork construction such as foundation preparation and fill placement as well as the installation of the geosynthetics.

During the course of the work, four design changes and thirteen field adjustments were applied to take into account the existing site conditions and to optimize construction activities.

DOCUMENT CONTROL

Document Version	Date	Revised Section	Revision
Working Copy	October 15, 2018	All	Golder Associés
Final Copy	November 30, 2018	All	Golder Associés

1.0 INTRODUCTION

The 2018 construction season of the Tailings Storage Facility (TSF) at Meadowbank was conducted from April 23 to August 8, 2018 and consisted of the construction of Stage 6 of Central Dike, the finalization of Stage 3 of Saddle Dam 3 and the construction of the North Cell Internal Structure (NCIS).

This as-built report for the 2018 construction season presents a summary of the Technical Specifications, the construction activities, the QA/QC activities, as well as the overall information used to produce the as-built drawings. This report was prepared with input from a number of contributors in a collaborative effort between Agnico Eagle Mines Limited (AEM) and Golder Associés Ltée (Golder).

The work done in the previous stages of Central Dike and Saddle Dams 3 is described in the respective construction summary as-built reports.

1.1 Roles and Responsibilities

The Drawings and Technical Specifications for Central Dike, Saddle Dams 3, 4, and 5, and the North Cell Internal Structure were developed by Golder and reviewed by the AEM Meadowbank Engineering Team (MET) and by the Meadowbank Dike Review Board (MDRB). Kivalliq Contractor Group (KCG), formerly SANA, was contracted by AEM for the work of the 2018 construction season of the South Cell and the North Cell. The Owner Representative from AEM was responsible for managing and planning the construction. Golder was responsible for the quality assurance (QA) program and provided technical review of the work to ensure that the structures were constructed according to the Technical Specifications (Technical Specifications) and Construction Drawings (Drawings). The quality control (QC) program (with the exception of aspects related to geosynthetics) was carried out by GHD consultant (GHD), under the direction of AEM. GHD monitored the construction to ensure that the work and materials met the Technical Specifications. The geosynthetics were installed by subcontractor ZTG Geosynthetics (ZTG) under the direction of KCG. The geomembrane QC was also done by ZTG.

Table 1 presents a summary of the general roles and responsibilities for each of the parties involved during the 2018 construction season. This table also includes the key companies and the key personnel that contributed to the various construction activities.

Table 1: Roles, Responsibilities and Key Personnel for the South Cell 2018 Construction Season

Company	Role	Responsibility	Key Personnel	Position
Agnico Eagle Mines Meadowbank Division	Owner	Manage and plan the construction Act as Owner's Representative	Frédérick L. Bolduc Alexandre Lavallée	Geotechnical Coordinator
			Patrice Gagnon Pier-Éric McDonald	Geotechnical Specialist
			Pierre McMullen Miles Legault (Assistant)	Engineering Superintendent
			Olivier Jacques Rock Chabot Denis Gosselin	Dike Supervisor

Company	Role	Responsibility	Key Personnel	Position
Kivalliq Contractor Group (KCG)	Contractor	Carry out 2018 TSF construction activities Provide survey and as-built drawings	Dany Pageau	Superintendant
			Christopher Gilbert Jeannot Gagnon	Project Manager
			Sabin Larouche Patrice Ouellet Michaël Gagnon	KCG Foreman
			Mikaël Lévesque Marc-André Blackburn François Gravel-Grenier Alain Girard	Surveyor
Golder Associés Ltée	Structure designer	QA program during construction Technical review of construction work	Yves Boulianne	Project Director and Dike Designer
			Marion Habersetzer	Project Manager and QA Engineer
			Samuel Barbeau	QA Engineer
GHD	Sub-contractor of the Owner	Carry out QC program and construction monitoring	Daniel Pedneault	Project Manager
			Sébastien Blackburn Cédrick Fillon-Tremblay Daniel Roy Hugues Potvin Mathieu Côté	QC Representative
ZTG Geosynthetics	Sub-contractor of the Contractor (KCG	Geosynthetics installation and QC testing	Jean-Marc Brunet	Project Director
			Stéphane Côté	Field Supervisor and QC Representative (geosynthetics)

1.2 Definitions of Terms Used in this Document

The following table presents the definition of the terms used in this report.

Table 2: Definition of Terms

Term	Definition
AEM	Agnico Eagle Mines, Owner.
As-built drawing	Document showing no new concept. It is the graphical representation of a built structure showing the real measurements, installed instruments and objects. It is not a final plan and can be seen as an inventory of what was built for reference.
Approval	A written engineering or geotechnical opinion, related to the progress and completion of the Work.
Coarse Filter –	Material produced from processing of NON-AG and PAG rockfill and meeting the Technical Specifications.
Compacted Till –	Reworked till satisfying the Technical Specifications. The Technical Specifications refer to compacted till (0-150 mm) and compacted sieved till (0-50 mm).
Contractor	Kivalliq Contractor group (KCG). On-site representative of the construction company contracted by the Owner to successfully carry out the scope of work as defined in the Technical Specifications.
Designer	Golder Associés Ltée.
Dike	Earthwork made of rockfill and natural soil to retain water and tailings.
Downstream and Upstream	The downstream direction represents the downward direction of water flow in a valley or in the direction of a slope. Upstream is defined as the opposite of downstream. For a dike, downstream is the direction of flow from the dike and upstream represents what is retained by the structure.
Field Laboratory	Area and facilities provided for QC and QA testing at Meadowbank.
Fine Filter	Material produced from processing of NON-AG and PAG rockfill and satisfying Technical Specifications.
Fine Rockfill	Processed rockfill satisfying Technical Specifications.
Geotextile	Non-woven geotextile, minimum 500 g/m^2, GSE NW16 or equivalent.
Ice-Poor Soils	Frozen soils that contain less than 10% visible ice and having a water content of less than 20%. No visible ice lenses.

Term	Definition
Ice-Rich Soils	Frozen soils that contain more than 10% visible ice and/or having a water content greater than 20%. Ice lenses may be present.
Liner Installer	ZTG Geosynthetics. Subcontractor under the responsibility of the Contractor and responsible for the installation of geotextile and LLDPE geomembrane.
LLDPE Geomembrane	Linear low-density polyethylene geomembrane satisfying Technical Specifications.
Low Quality Till	Till-like material having relative low permeability.
Owner	Agnico-Eagle Mines Limited, Meadowbank Division (AEM)
Owner’s Representative	Person(s) employed by the Owner in order to oversee the project works and the Owner’s interests. The primary point of contact for the Designer and the Contractor.
PAG / NON-AG	PAG: A material that has been geochemically classified as being potentially acid generating. NON-AG: A material that has been geochemically classified as not being acid generating.
QA Engineer	Responsible for QA activities.
Quality Assurance (QA)	A planned system of inspection and testing of documents, to the satisfaction of the Owner, the Engineer, other stakeholders and regulators, that the Work complies with the design, Drawings and Technical Specifications. Quality Assurance comprises inspections carried out during Quality Control that include verifying and assessing materials and workmanship necessary to determine and document the quality of the constructed facility. Quality Assurance refers to the measures taken by the Quality Assurance organization and the Engineer to assess whether the Contractor is in compliance with the design, Drawings and Technical Specifications.
Quality Control (QC)	A planned system of inspection, testing and documentation carried out by the Contractor during construction to ensure that the Work is being performed and completed in a manner that complies with the Drawings and Technical Specifications. The Contractor is responsible for the Quality Control of all Work performed by him and all Work performed by any Subcontractor under contract with him.
QC Representative	Person or company hired by the Owner and under the supervision of the Owner’s Representative to collaborate with the Contractor to ensure QC testing and inspection of all work done by the Contractor.

Term	Definition
Rockfill – Zone 4	NON-AG rockfill, expected to be run-of-mine material requiring little to no processing and satisfying the Technical Specifications.
Tailings Deposition Fingers	Engineered elements designed by the Owner to facilitate the deposition of tailings from the crest of Central Dike while protecting the structure.
Till	Naturally-occurring well-graded soils consisting of sizes ranging from clay to boulders.
TSF	Tailings Storage Facility
Work	All activities associated with the construction of Central Dike, and Saddle Dams 3, 4, and 5.
Working Platform	Surface of fill and/or excavated surface from which the work is conducted.

1.3 Description of the Built Structures

The South Cell of the Meadowbank TSF consists of five permanent perimeter structures: Central Dike, Stormwater Dike, Saddle Dam 3, Saddle Dam 4, and Saddle Dam 5. Central Dike is located in the southeastern end of the South Cell and adjacent to the western limits of the North Portage Pit. Saddle Dam 3 is located in the northwestern corner of the South Cell and is designed to merge with Saddle Dam 2. Saddle Dam 4 is located in the southwestern corner of the South Cell and is merged with Saddle Dam 5, which merges with the southern end of Central Dike. Figure 1 shows a plan view of the South Cell.

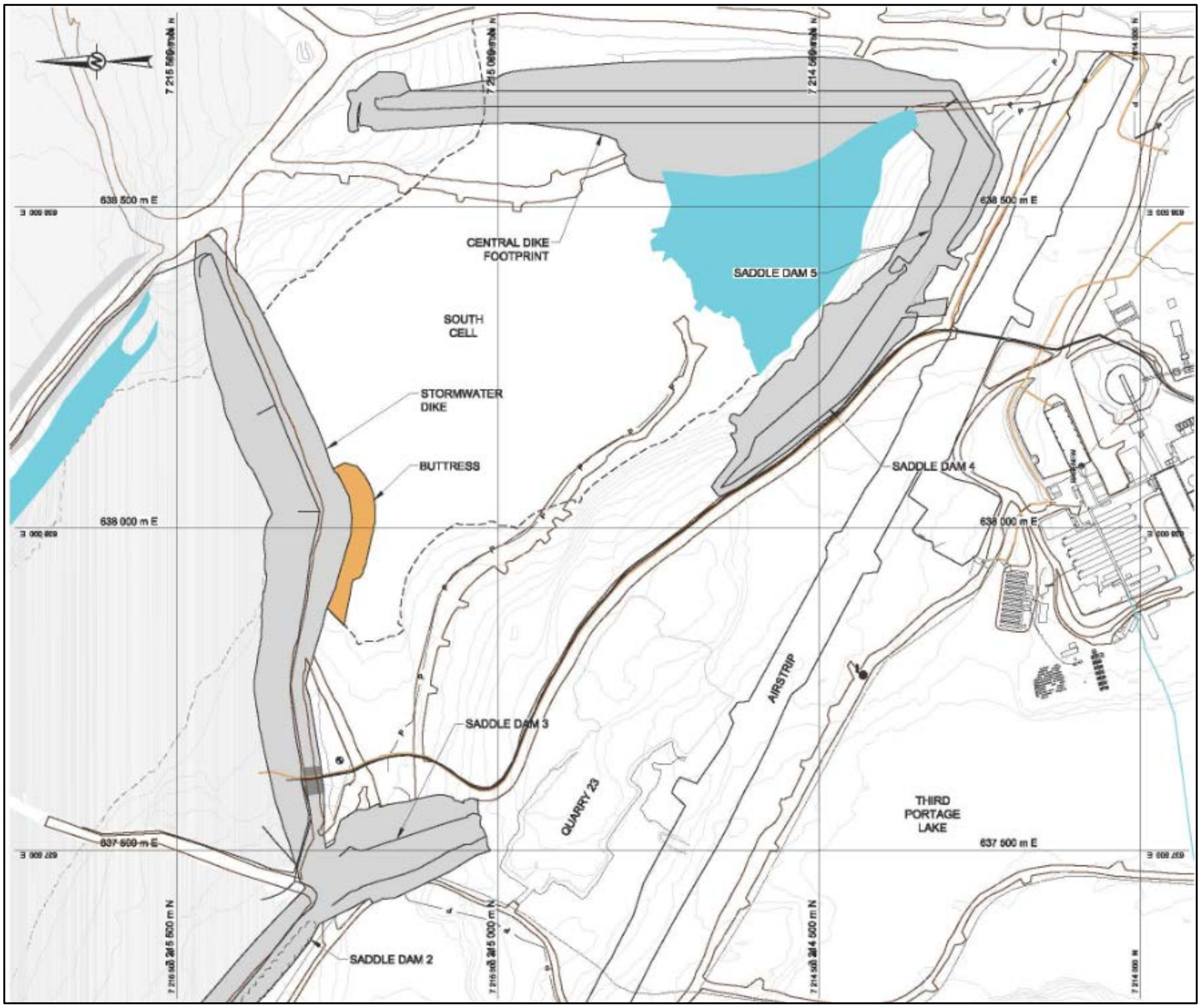


Figure 1: Layout of the South Cell of the Meadowbank Tailings Storage Facility

The North Cell of the Meadowbank TSF consists of five permanent perimeter structures: Saddle Dam 1, Saddle Dam 2, Stormwater Dike, RF1 and RF2. Saddle Dam 1 is located in the western end of the North Cell. Saddle Dam 2 is located in the southwestern corner of the North Cell and merges with Saddle Dam 3 and Stormwater Dike. Stormwater Dike is located at the south of the North Cell and is the boundary between the North Cell and the South Cell. RF1 is located in the southeastern corner of the North Cell and is merged with RF2, which is located in the eastern end of the North Cell. The North Cell Internal Structure is built over the dried top surface tailings and existing rockfill cover in the northern part of the North Cell. Figure 2 shows a plan view of the North Cell.

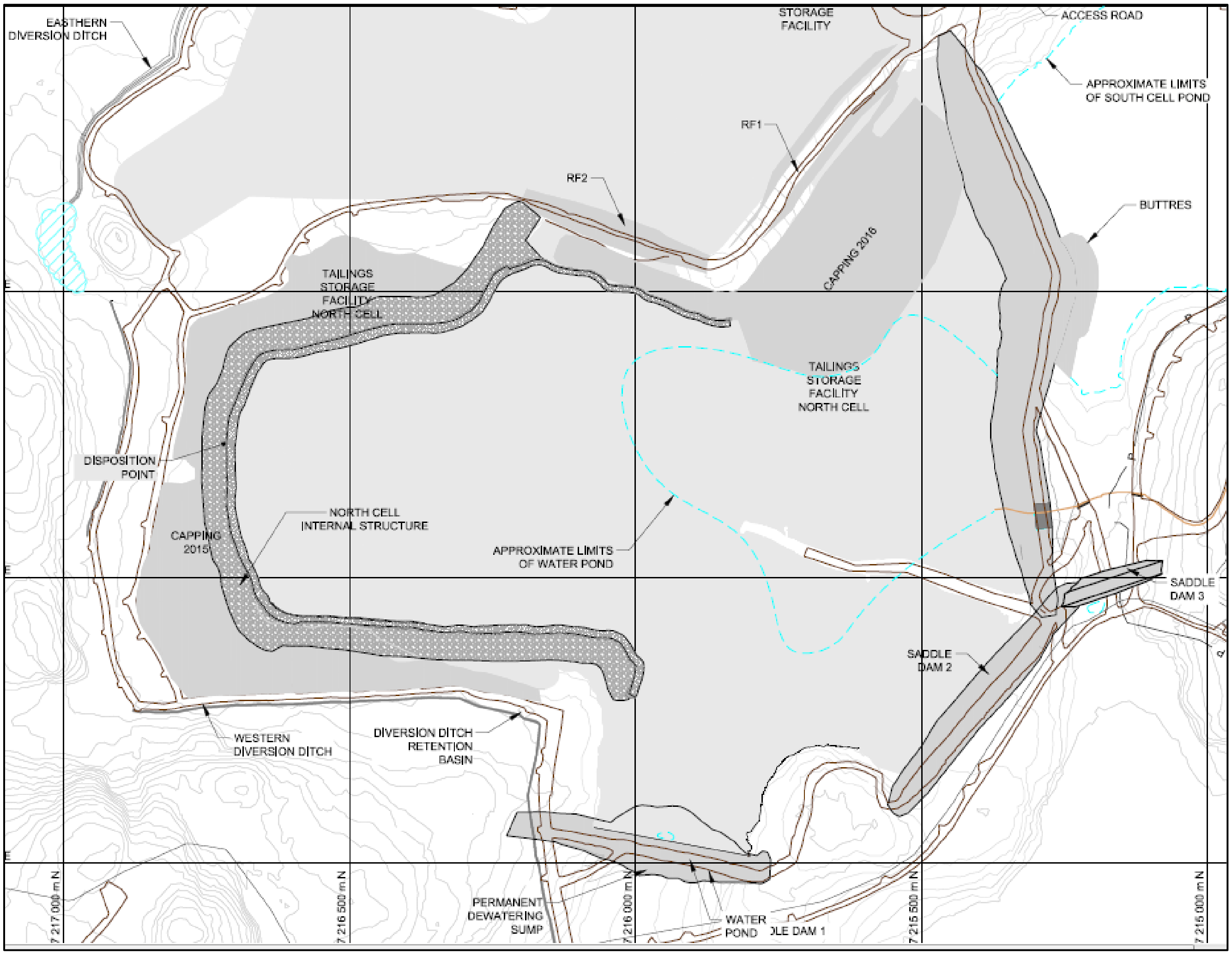


Figure 2: Layout of the North Cell of the Meadowbank Tailings Storage Facility

1.3.1 Stage 6 of Central Dike

Central Dike is designed and constructed as a zoned rockfill dam with filter zones, an impervious upstream liner, and a liner tie-in key trench. The central part of the dike was constructed in 2012 and 2013 with a centreline liner tie-in key trench. In 2013, the design was modified for the south and north abutment to have an upstream toe liner tie-in key trench. The Central Dike cross-section consists of a rockfill embankment constructed from run-of-mine waste rock, placed in lifts and compacted, with the upstream face at a 3H:1V slope from elevation (El.) 110 m to El. 130 m and 2H:1V above El. 130 m. The downstream face is at a 1.5H:1V slope. The upstream face of Central Dike comprises two granular filter zones (Zone 2 and 3) and a linear low-density polyethylene (LLDPE) liner extending along the upstream foundation. The filter zones act as the bedding to prevent damage to the liner and as a filter designed to prevent tailings migration and internal erosion. An upstream till liner tie-in key trench excavated to bedrock and filled with compacted till (Zone 1) is located along the upstream area of the structure. The bulk part of Central Dike consists of coarse rockfill (Zone 4). A cofferdam is included with Central Dike as part of the upstream face.

The north abutment of Central Dike was raised to El. 145 m in 2017. During construction in 2018, the remaining part of Central Dike was raised from a crest El. of 143 m to a crest El. of 145 m (downstream toe ranging from El. 142 m to El. 145 m approximately). The length of the dike remained at about 900 m (from Sta. 0+090 to 0+990 m).

1.3.2 Finalization of Stage 3 of Saddle Dam 3

Saddle Dam 3 is designed and constructed as a zoned rockfill dam with filter zones, a low permeability upstream liner, and an upstream toe liner tie-in key trench. The Saddle Dam 3 cross-section consists of a rockfill embankment, constructed from run-of-mine waste rock, placed in lifts and compacted. The upstream face is designed at a 3H:1V slope and the downstream faces are designed at a 1.5H:1V slope. The upstream face of Saddle Dam 3 comprises two granular filter zones (Zone 2 and 3) and an LLDPE liner extending along the upstream foundation. The filter zones act as the bedding to prevent damage to the liner and as a filter designed to prevent tailings migration and internal erosion. A liner tie-in key trench excavated to bedrock and filled with compacted till (Zone 1) is located along the upstream area of the structure. The bulk part of Saddle Dam 3 consists of coarse rockfill material (Zone 4).

During the finalization of Stage 3 construction in 2018, geosynthetics were installed on the upstream face of Saddle Dam 3 from El. 143 m to the crest at El. 145 m (downstream toe ranging from El. 134 m to El. 145 m approximately). The length of the dike remained at about 245 m (from Sta. 20+569 to 20+814 m). The upstream erosion protection cover was raised to El. 144 m during this stage.

1.3.3 Construction of the North Cell Internal Structure

The North Cell Internal Structure is designed and constructed as a permeable zoned rockfill dam with filter zones, built on the top surface dried tailings of the North Cell and on the existing rockfill cover. The North Cell Internal Structure cross-section consists of a rockfill embankment, constructed from run-of-mine waste rock, placed in lifts and compacted. The upstream face is designed at a 3H:1V slope and the downstream faces are designed at a 1.5H:1V slope. The upstream face of the North Cell Internal Structure comprises two granular filter zones (Zone 2 and 3). The filter zones are designed to prevent tailings migration and internal erosion, while allowing water to flow through the embankment. The bulk part of the North Cell Internal Structure consists of coarse rockfill material (Zone 1). A system of ditches and sumps at the downstream toe of the structure is designed to collect seepage and runoff water.

The North Cell Internal Structure was built in 2018 to El. 152 m from Sta. 1+100 m to 1+660 m and from 2+750 m to 3+200 m, and to El. 154 m from Sta. 1+660 m to 2+750 m. The length of the dike is about 2,160 m (from Sta. 1+100 to 3+260 m), and the downstream toe is at El. 148 m to 150 m approximately.

1.4 Construction Drawings and Technical Specifications

The Construction Drawings and Technical Specifications of Central Dike were developed by Golder in 2012 prior to the beginning of construction. In 2013, a change in design was made to modify the original central liner tie-in key trench under the dike to an upstream liner tie-in key trench.

The Construction Drawings and Technical Specifications for Saddle Dam 3 were developed by Golder prior to the start of the 2015 construction season.

The Construction Drawings and Technical Specifications for the North Cell Internal Structure were developed by Golder prior to the start of the 2018 construction season.

Table 3, Table 4, Table 5 and Table 6 below present the available versions of the Design Reports, Technical Specifications, and Drawings in chronological order.

Table 3: List of Design Reports for Central Dike, Saddle Dam 3 and the North Cell Internal Structure

Document Number	Date	Rev	Title
Doc 1349 11-1221-0035	06/11/2012	1	Detailed design report for Central Dike
Doc 1504 1416081	05/12/2015	0	Detailed design report for Saddle Dams 3, 4, and 5
1784383-Rev0	19/04/2018	0	Detailed engineering design of North Cell internal structure

Table 4: List of Technical Specifications for Central Dike, Saddle Dams 3 and the North Cell Internal Structure

Document Number	Date	Rev	Title
Doc. 1327 11-1221-0035	07/03/2012	0	Meadowbank Gold Project Central Dike Construction Technical Specifications
Doc. 1498 14-16081	04/30/2015	0	Meadowbank Gold Project Saddle Dams 3, 4 and 5 Construction Technical Specifications
1784383-Rev0	05/02/2018	0	Meadowbank Mine North Cell Internal Structure Construction Technical Specifications

Table 5: List of Construction Drawings for Central Dike

Drawing Number	Date	Rev	Title
CD-01	03/07/2012	0	CENTRAL DIKE LOCATION MAP AND DRAWING INDEX
CD-02	03/07/2012	0	CENTRAL DIKE PROJECT SITE PLAN
CD-03	03/07/2012	0	CENTRAL DIKE GENERAL LAYOUT PLAN OF THE TSF
CD-04	03/07/2012	0	CENTRAL DIKE GENERAL ARRANGEMENT PLAN
CD-05	03/07/2012	0	CENTRAL DIKE PLAN, PROFILE AND QUANTITIES STA 0+000 TO 0+400
CD-06	03/07/2012	0	CENTRAL DIKE PLAN, PROFILE AND QUANTITIES STA 0+400 TO 0+800

Drawing Number	Date	Rev	Title
CD-07	03/07/2012	0	CENTRAL DIKE PLAN, PROFILE AND QUANTITIES STA 0+800 TO 1+135
CD-08	03/07/2012	0	CENTRAL DIKE TYPICAL SECTION – WITH COFFERDAM
CD-09	03/07/2012	0	CENTRAL DIKE TYPICAL SECTION – ABUTMENT PORTIONS
CD-10	03/07/2012	0	CENTRAL DIKE TYPICAL DETAILS – SHEET 1 OF 2
CD-11	03/07/2012	0	CENTRAL DIKE TYPICAL DETAILS – SHEET 2 OF 2
CD-12	03/07/2012	0	CENTRAL DIKE AND SADDLE DAM 5 CONNECTION DETAILS
CD-13	03/07/2012	0	CENTRAL DIKE TAILINGS MIGRATION CONTINGENCY PLAN
CD-14	03/07/2012	0	CENTRAL DIKE CONSTRUCTION SEQUENCE
CD-15	03/07/2012	0	CENTRAL DIKE CROSS-SECTIONS
CD-16	03/07/2012	0	CENTRAL DIKE INSTRUMENTATION PLAN AND SECTION
CD-01	07/12/2013	1	CENTRAL DIKE LOCATION MAP AND DRAWING INDEX
CD-04	07/12/2013	1	CENTRAL DIKE GENERAL ARRANGEMENT PLAN
CD-08	07/12/2013	1	CENTRAL DIKE TYPICAL SECTION – WITH COFFERDAM
CD-09	07/12/2013	1	CENTRAL DIKE TYPICAL SECTION – NORTH ABUTMENT PORTIONS
CD-09A	07/12/2013	1	CENTRAL DIKE TYPICAL SECTION – SOUTH ABUTMENT PORTIONS
CD-12	07/12/2013	1	CENTRAL DIKE KEY TRENCH TO UPSTREAM LINER TIE-IN TRANSITION DETAILS – SHEET 1 OF 2
CD-12A	07/12/2013	1	CENTRAL DIKE KEY TRENCH TO UPSTREAM LINER TIE-IN TRANSITION DETAILS – SHEET 2 OF 2

Table 6: List of Construction Drawings for Saddle Dams 3, 4, and 5

Drawing Number	Date	Rev	Title
SD 3,4&5-01	04/30/2015	0	LOCATION MAP AND DRAWING INDEX
SD 3,4&5-02	04/30/2015	0	PROJECT SITE PLAN
SD 3,4&5-03	04/30/2015	0	GENERAL ARRANGEMENT PLAN
SD 3,4&5-04	04/30/2015	0	SADDLE DAM 3 PLAN, PROFILE AND QUANTITIES
SD 3,4&5-05	04/30/2015	0	SADDLE DAM 4 PLAN, PROFILE AND QUANTITIES
SD 3,4&5-06	04/30/2015	0	SADDLE DAM 5 PLAN, PROFILE AND QUANTITIES
SD 3,4&5-07	04/30/2015	0	TYPICAL CROSS-SECTION AND DETAILS
SD 3,4&5-08	04/30/2015	0	STAGED CONSTRUCTION SEQUENCE
SD 3,4&5-09	04/30/2015	0	SADDLE DAM 3 CROSS-SECTIONS
SD 3,4&5-10	04/30/2015	0	SADDLE DAM 4 CROSS-SECTIONS
SD 3,4&5-11	04/30/2015	0	SADDLE DAM 5 CROSS-SECTIONS
SD 3,4&5-12	04/30/2015	0	INSTRUMENTATION PLAN AND SECTION – SADDLE DAM 3
SD 3,4&5-13	04/30/2015	0	INSTRUMENTATION PLAN AND SECTION – SADDLE DAM 4
SD 3,4&5-14	04/30/2015	0	INSTRUMENTATION PLAN AND SECTION – SADDLE DAM 5
SD 3,4&5-15	04/30/2015	0	SUMP LOCATIONS AND DETAILS

Table 7: List of Construction Drawings for the North Cell Internal Structure

Drawing Number	Date	Rev	Title
001	07/02/2018	0	COVER PAGE
002	07/02/2018	0	GENERAL ARRANGEMENT PLAN
003	07/02/2018	0	GEOTECHNICAL INVESTIGATION PLAN

Drawing Number	Date	Rev	Title
004	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 1 OF 8
005	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 2 OF 8
006	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 3 OF 8
007	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 4 OF 8
008	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 5 OF 8
009	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 6 OF 8
010	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 7 OF 8
011	07/02/2018	0	INTERNAL STRUCTURE AND DITCH PLAN AND PROFILE 8 OF 8
012	07/02/2018	0	SECTIONS AND DETAILS OF INTERNAL STRUCTURE AND DITCHES
013	07/02/2018	0	DETAILS OF INTERNAL STRUCTURE AND DITCHES

1.5 As-Built Drawings

Table 8 presents the as-built drawings for the 2018 construction season of the TSF South Cell and North Cell. The surveying and the as-built drawings were done by KCG and verified by Golder. The as-built drawings for the 2018 construction of the South Cell and North Cell are included in Appendix A.

Table 8: List of As-Built Drawings for the Stage 6 of the Central Dike, the Finalization of Stage 3 of Saddle Dam 3 and the Construction of the North Cell Internal Structure

Drawing Title	Date	Rev	Structure
CENTRAL DIKE AS BUILT 2018 PLAN VIEW	11/08/2018	0	CENTRAL DIKE (1/2)
CENTRAL DIKE AS BUILT 2018 SECTION VIEW (0+160 TO 1+000)	11/08/2018	0	CENTRAL DIKE (2/2)
SD 3 AS BUILT 2018 PLAN VIEW	30/08/2018	0	SADDLE DAM 3 (1/2)
SD 3 AS BUILT 2018 SECTION VIEW (20+600 TO 20+800)	30/08/2018	0	SADDLE DAM 3 (2/2)
NORTH CELL INTERNAL STRUCTURE AS BUILT 2018 PLAN VIEW	10/09/2018	0	NORTH CELL INTERNAL STRUCTURE (1/2)
NORTH CELL INTERNAL STRUCTURE AS BUILT 2018 SECTION VIEW (1+300 TO 2+700)	10/09/2018	0	NORTH CELL INTERNAL STRUCTURE (2/2)

1.6 Technical Memoranda – Design Changes

Design changes and field adjustments occurred during the 2018 construction season to adapt the initial design to the field conditions encountered during construction. These design changes and adjustments were implemented by the Designer (Golder) in partnership with AEM and were documented in the present report, or in technical memoranda. Per AEM’s request, one design change memorandum was issued this year, while the other changes and adjustments are documented in Section 5.0 of this report. Relevant design changes memoranda from past construction years were applied to the 2018 construction season. Table 9, Table 10 and Table 11 list the technical memoranda that discuss field adaptation or modification from the initial Technical Specifications and Drawings relevant to the 2018 Construction Season listed in chronological order. The technical memoranda issued during the 2018 construction season can be found in Appendix B. For the other design change technical memoranda, refer to past as-built reports.

Table 9: List of Design Change Memoranda Relevant to the 2018 Construction Season of Central Dike

Doc Number	Date	Rev	Title
Doc 1102 120528	05/16/2012	0	Material placement over LLDPE geomembrane, Central Dike.
Doc 1103 120528	05/28/2012	0	Placement of fill material over LLDPE geomembrane and underlying geotextile, Central Dike.
Doc 1363 11-1221-0035	06/18/2012	0	Response to the contractor proposed work for placement of fill material over LLDPE geomembrane, Central Dike.
Doc 1385	09/18/2012	0	Central Dike – non-acid generating cover for dike closure.
Doc 1453 1312210034	04/24/2014	0	2013 Central Dike design changes.
Doc 1466 1403762	06/01/2014	0	Central Dike inverse filter details for an upstream toe liner tie-in.
Doc 1469 1403762	06/06/2014	0	Central Dike design changes in the fine filter sample frequency.
Doc 1143 1403762	06/08/2014	0	Site instruction for the use of a CAT 307 excavator for placement of material over LLDPE geomembrane, Central Dike.
Doc 1470 1403762	06/09/2014	0	Central Dike design changes, geomembrane protection cover.
Doc 1471 1403762	06/17/2014	0	Central Dike south abutment key trench and transition to the upstream toe liner tie-in details between Sta. 0+800 and 0+850.
Doc 1472 1403762	06/19/2014	0	Summary of placement of fill material.
Doc 1479 1403762	08/11/2014	0	Central Dike rockfill quality recommendations.
Doc1518 1528661	07/24/2015	0	Recommendations on the use of ultramafic rockfill on Central Dike above El. 133 m.
Doc 1544 1656047	08/01/2016	0	Presentation of a new particle size envelope for the sieved compacted till.
Doc 1545 1606047	10/17/2016	0	Technical update about the placement of good quality NON-AG rockfill on Central Dike.

Table 10: List of Design Change Memoranda Relevant to the 2018 Construction Season of Saddle Dam 3

Doc Number	Date	Rev	Title
Doc 1514 1528661	09/09/2015	0	Saddle Dam 3, 4, 5 Design changes for upstream toe liner tie-in in backfill.
Doc 1515 1528661	09/10/2015	0	Saddle Dam 3 construction over faulted zone.
Doc 1564 1777687	11/30/2017	1	Design change for the LLDPE geomembrane protection on the upstream slope of Saddle Dam 3.
1897439-1577-TM Rev0 (weekly report for time period from 7/07 to 15/07)	16/07/2018	0	Change in the LLDPE geomembrane protection on the upstream slope of Saddle Dam 3

Table 11: List of Design Change Memoranda Relevant to the 2018 Construction Season of the North Cell Internal Structure

Doc Number	Date	Rev	Title
1897439-1582-TM-Rev0	29/11/2018	0	Phased construction of the ditches, sumps and instrumentation of the north cell internal structure
1897439-1577-TM Rev0 (weekly report for time period from 21/05 to 27/05)	28/05/2018	0	Change in the downstream slope of the structure built on tailings
1897439-1577-TM Rev0 (weekly report for time period from 21/05 to 27/05)	28/05/2018	0	Change in the alignment of the structure

2.0 SUMMARY OF TECHNICAL SPECIFICATIONS REQUIREMENTS

The Technical Specifications and Requirements for the main work activities for Central Dike, Saddle Dam 3 and the North Cell Internal Structure are summarized below.

2.1 Excavation and Foundation Preparation

The technical requirements for the foundation preparation of Central Dike and the Saddle Dams include:

- Stripping of the footprints to provide suitable surface for rockfill and granular fill placement, such as removal of boulders, organic soils, soft soils and ice-rich soils, including blasting.
- Preparation of foundation surfaces for LLDPE geomembrane installation, where applicable.
- Excavation of upstream toe liner tie-in.

Stripping and excavation must be carried out in accordance with their respective Drawings and Technical Specifications, using the necessary water control measures required for safe and effective operation.

Temporary drainage and pumping systems must be provided, operated, and maintained as required to direct water away from the surface excavation areas and the toe of the dikes during construction.

Foundation approval must be completed and documented before placing granular material above the foundation.

The technical requirements for the foundation preparation of the North Cell Internal Structure include snow removal, and do not require foundation approval forms as the structure is laying over the dried top surface tailings.

2.2 Fills Materials and Placement

Central Dike and the Saddle Dams are made of six different zones of fill materials. The North Cell Internal Structure is made of three different zones of fill material. The general Technical Specifications for each fill material zone are described below. The material gradation limits are summarized in Table 12 and Table 13.

Table 12: Material Gradation Limits for Central Dike and the Saddle Dams

Grain Size (mm)	Percent Passing by Mass (%)			
	Compacted Till (Zone 1)	Compacted Sieved Till (Zone 1)	Fine Filter (Zone 2)	Coarse Filter (Zone 3)
200	-	-	-	100
152.4	100	-	-	86-100
76.2	90-100	-	-	35-100
50	-	100	-	-
25.4	75-91	85-100	-	5-40
20	-	-	100	-

Grain Size (mm)	Percent Passing by Mass (%)			
	Compacted Till (Zone 1)	Compacted Sieved Till (Zone 1)	Fine Filter (Zone 2)	Coarse Filter (Zone 3)
12.7	65-84	75-94	50-100	0-18
4.76	53-73	63-83	23-68	0-9
2	-	-	-	0-5
0.425	33-48	43-58	0-20	-
0.075	20-35	30-45	0-15	-

Table 13: Material Gradation Limits for the North Cell Internal Structure

Grain Size (mm)	Percent Passing by Mass (%)	
	Coarse Filter (Zone 2)	Fine Filter (Zone 3)
200	100	-
152	100-86	-
76	100-42	-
38.1	-	100
25	52-14	-
19.05	-	100-65
12.7	35-10	100-50
4.76	23-5	60-28
2	15-3	40-16
0.425	10-1	23-6
0.075	7-0	10-0

2.2.1 Zone 1 – Compacted Till and Compacted Sieved Till (Central Dike and Saddle Dams)

Compacted till must be an unfrozen mix of silty sand and gravel with a maximum particle size of 150 mm. Compacted sieved till is a material specified to be placed within 0.5 m of the LLDPE geomembrane for its protection. This material has a maximum particle size of 50 mm. Compacted till and compacted sieved till must be well-graded, plastic and have a certain fine content (percent of material by mass passing No. 200 sieve). This material must be free of organic material, debris, cinders, ash, refuse, snow, ice, and other deleterious materials subject to approval by the Owner's Representative.

The maximum loose horizontal lift thickness of compacted till is 0.5 m. The placement water content of the compacted till must be at 0% to 3% above the optimum water content (ASTM D698). Compaction must be carried out using a 10-T smooth drum compactor. The use, or non-use, of vibration during compaction will be based on the results of field trials. Placement and compaction of the compacted till must result in a homogeneous low hydraulic conductivity zone. The density of the compacted till material is expected to be about 95% of standard Proctor maximum density (ASTM D698).

Compacted sieved till placed over and within 0.5 m of the LLDPE geomembrane shall:

- Be placed in loose lifts having a thickness of 0.5 m using an excavator with a maximum mass of 20 T. Direct dumping of compacted till onto the LLDPE geomembrane is not allowed.
- Be compacted with a single pass of the track of an excavator having a maximum mass of 20 T and not using a roller compactor.
- Not be trafficked by any light, heavy, or haulage equipment other than that above.
- Be to the satisfaction of the Owner's Representative.

2.2.2 Zone 1A – Low Quality Till (Central Dike and Saddle Dams)

Low quality till is constituted of unfrozen silty sand and gravel. The material must be well-graded and have a gradation ranging between 0 and 500 mm. Low quality till must be free of boulders, organic material, debris, cinders, ash, refuse, snow, ice, and other deleterious materials. This material is part of the Saddle Dams design, but not of the Central Dike design.

The maximum loose lift thickness for the low-quality till shall be 1.0 m. Placement equipment shall traffic the material uniformly parallel and perpendicular to the lift front advancement to aid with compaction. Compaction of low quality till shall be carried out using a 10-T smooth drum roller vibratory compactor with a minimum of 4 passes parallel to the axis of Saddle Dam 3 and to the satisfaction of the Owner's Representative.

2.2.3 Zone 2 (Central Dike and Saddle Dams) or Zone 3 (North Cell Internal Structure) – Fine Filter

Fine filter is made of crushed NON-AG or PAG rockfill processed to satisfy the gradation limits. Fine filter shall be free of organic material, debris, cinders, ash, refuse, snow, ice, and other deleterious material subject to the satisfaction of the Owner's Representative.

The maximum loose lift thickness of fine filter is 0.5 m. Compaction of fine filter must be carried out using a 10-T smooth drum vibratory roller compactor with a minimum of 4 passes parallel to the axis of the structure.

2.2.4 Zone 3 (Central Dike and Saddle Dams) or Zone 2 (North Cell Internal Structure) – Coarse Filter

Coarse filter is made of crushed NON-AG or PAG rockfill processed to satisfy the gradation limits. Coarse filters shall be free of organic material, debris, cinders, ash, refuse, snow, ice, and other deleterious material.

The maximum loose lift thickness of the coarse filter is 0.5 m. Coarse filter shall be placed and compacted to avoid disturbing the underlying materials. Compaction of the coarse filter shall be carried out using a 10-T smooth drum vibratory roller compactor with a minimum of 4 passes parallel to the axis of the structure and to the satisfaction of the Owner's Representative.

2.2.5 Zone 4A/4B (Central Dike and Saddle Dams) or Zone 1 (North Cell Internal Structure) – Coarse Rockfill

On Central Dike and the Saddle Dams, coarse rockfill must be made of sound, hard, durable, well-graded rock fragments free from ice, frozen chunks, organic matter, debris and other deleterious materials. On the North Cell Internal Structure, the material used must be well-graded NON-AG ultramafic volcanic rock fragments free from ice, frozen chunks, organic matter, debris and other deleterious materials. Coarse rockfill must have a maximum particle size of 1.3 m. All rockfill shall be geochemically classified by the Owner prior to placement.

Coarse rockfill classified Zone 4A must comprise NON-AG or PAG rockfill material. Coarse rockfill classified Zone 4B must comprise NON-AG rockfill material only and be placed in the zones shown on the drawings and areas prioritized by the Owner's Representative. NON-AG rockfill may be used instead of PAG rockfill but only at the direction of the Owner's Representative.

The maximum loose lift thickness for coarse rockfill is 2 m. Placement equipment shall traffic the material uniformly parallel and perpendicular to the lift front advancement to aid with compaction. Coarse rockfill shall be placed and compacted to avoid disturbance of the underlying materials. Compaction of coarse rockfill shall be carried out using a fully-loaded haul truck with a minimum of 4 passes parallel to the axis of the structure. Alternatively, a 10-T smooth drum roller vibratory compactor with a minimum of 6 passes (Central Dike and the Saddle Dams) or 4 passes (North Cell Internal Structure) parallel to the axis of the structure can be used. Compaction shall be to the satisfaction of the Owner's Representative.

2.2.6 Zone 5 – Fine Rockfill (Central Dike and Saddle Dams)

Fine rockfill is made of sound, hard, durable, well-graded rock fragments free from ice, frozen chunks, organic matter, debris, and other deleterious materials. Fine rockfill must be well graded and have a gradation ranging between 0 and 300 mm. NON-AG and PAG rockfill may be used for the fine rockfill at the direction of the Owner's Representative.

The maximum loose lift thickness for fine rockfill is 0.5 m. Placement equipment shall traffic the material uniformly parallel and perpendicular to the lift front advancement to aid with compaction. Compaction of fine rockfill shall be carried out using a 10-T smooth drum roller vibratory compactor with a minimum of 4 passes parallel to the axis of the structure and to the satisfaction of the Owner's Representative.

2.3 Liner Tie-In Key Trench

The Technical Specifications for the construction of the liner tie-in key trench of Central Dike and the Saddle Dams include the following activities:

- Excavation of the liner tie-in key trench that may involve blasting and the use of a hydraulic hammer.

- Preparation of the bedrock surface at the base of the liner tie-in key trench. This includes removal of soft material and ponding water, bedrock mapping and the filling of exposed bedrock discontinuities. The filling of bedrock discontinuities for piping and erosion protection is done by the application of slush grout for Central Dike or a fine filter and bentonite mix for Saddle Dams 3, 4, and 5.
- Preparation of liner tie-in key trench surfaces for LLDPE geomembrane placement.
- Backfilling of the liner tie-in key trench with compacted till and erosion protection cover.

2.4 Geosynthetics

The Central Dike and Saddle Dams Technical Specifications define the technical requirements for installation of the non-woven geotextile (minimum mass per unit area of 500 g/m^2). The work covered by the Technical Specifications includes the purchase, fabrication (if needed), supply, transport, storage, testing, and installation of the geotextile.

The LLDPE geomembrane placed on the upstream face and within the tie-in key trench must be a micro spike geomembrane (1.5-mm thick, textured on both sides) or an approved equivalent. The work covered by the Technical Specifications includes the purchase, supply, transport, storage, installation, and testing of the LLDPE geomembrane.

The bituminous geomembrane placed in the shallow lined ditches in waste rock must be Coletanche ES2 elastomeric geomembrane (4-mm thick) or an approved equivalent. The work covered by the Technical Specifications includes the purchase, supply, transport, storage, installation, and testing of the bituminous geomembrane.

3.0 SUMMARY OF CONSTRUCTION ACTIVITIES AND SCHEDULE

This section describes the construction steps performed during the 2018 construction season to build the Central Dike, the Saddle Dam 3 and the North Cell Internal Structure. This section also includes the schedule for the work done on each structure.

3.1 Stage 6 of Central Dike– Schedule and Construction Steps

The construction of Stage 6 of Central Dike was done from April 21 to July 22, 2018, and comprised the following major work items:

- Site preparation (access ramp construction, removal of snow on the dike and scarification of the rockfill lift at El. 143 m);
- Foundation preparation and approval (excavation of snow and rock fragments);
- Fill placement, compaction, and slope profiling (rockfill and upstream filter placement);
- Geotextile and LLDPE geomembrane installation;
- Placement and compaction of compacted till layers and erosion protection material over the geosynthetics in the upstream toe liner tie-in;
- Construction of four tailings deposition points (designed by AEM).

The work procedures followed during the construction of these work items are discussed in the following subsections.

Selected photographs of the work progress taken throughout the construction season are shown in Appendix C1.

Table 14 presents the construction schedule for the main work items regarding the preparation of the north abutment of Central Dike.

Table 14: Schedule for the Construction Activity for Stage 6 of Central Dike

Activity	Beginning	End
Site preparation (access ramp, snow removal and scarification of the crest at El. 143 m)	April 23, 2018	April 27, 2018
Foundation preparation and approval	April 27, 2018	April 28, 2018
Placement, compaction and profiling of rockfill on the crest from El. 143 m to El. 145 m and on the footprint (1.5:H d/s, 2H:1V u/s)	April 21, 2018	May 16, 2018
Placement, compaction and profiling of filter material on the upstream 2H:1V slope from El. 143 m to El. 145 m	May 6, 2018	May 12, 2018
Final profiling of the 2H:1V upstream slope before geosynthetics installation	May 11, 2018	May 12, 2018
Geosynthetics installation on the upstream 2H:1V slope	May 22, 2018	June 9, 2018
Placement and compaction of compacted till layers and erosion protection material over the geosynthetics in the upstream toe liner tie-in of the north abutment to complete it (compacted till, fine filter, coarse filter, fine rockfill)	July 22, 2018	July 22, 2018

The delay between the installation of geosynthetics and the placement of the compacted till layers and erosion protection material is due to the fact that the till stockpiles were frozen, and operations could only resume once they were sufficiently thawed in July 2018.

3.1.1 Drilling and Blasting

No drilling and blasting was required during Stage 6 of Central Dike.

3.1.2 Site Preparation

The access ramp at the south extremity of Central Dike was reprofiled in order to allow access to haul trucks. This ramp is located within the footprint of Saddle Dam 5 and built with ultramafic volcanic (UM) rockfill. The access at the north extremity was adapted to ensure visibility in the curve. The West Road was used for hauling material to the south access ramp. Snow was removed from the crest and the upstream slope of Central Dike. The crest of the dike at El. 143 m was scarified to promote a good contact with the subsequent lift placed in 2018.

Instruments installed on the crest of Central Dike were preventively raised and protected by fine filter.

3.1.3 Foundation Preparation

Foundation preparation was completed on the south extremity of Central Dike on a limited surface for the extension of the structure for a dike footprint going from El. 143 m to El 145 m on the downstream side.

The foundation preparation consisted of the removal of the foundation soil to the bedrock surface within the planned footprint. As the foundation was already prepared during the 2016 construction season, most of the material to be excavated had already been removed. However, the foundation was cleared of snow accumulation, and remaining loose material was removed by excavator (CAT 345D).

Before the placement of fill materials over the dike foundation, the foundation surface was inspected and then accepted by the Owner's Representative, the QC Representative and the QA Engineer. The parties verified that the foundation to be approved was competent, dry and free of contamination or ice. The approved foundation area was then surveyed by KCG surveyors. The foundation preparation approval process before the placement of fill materials was performed once during the construction of Stage 6 of Central Dike. A foundation approval form was filled out. Refer to Appendix G for the completed foundation approval forms.

The volume material excavated during the construction of Stage 6 of Central Dike was not surveyed and represents a minor volume.

3.1.4 Placement of Rockfill for Embankment Raise to El. 145 m

The lift of rockfill between El. 143 m and 145 m had a thickness of 2 m and was placed by a dozer (D8). The rockfill was composed of good quality, NON-AG, intermediate volcanic (IV) rock. To avoid segregation, the rockfill was dumped on a flat surface and then pushed on the slope. The lift was compacted with 6 passes of a 10-T smooth-drum vibratory roller compactor on the entire surface of the lift, but not below the safety berms placed on the downstream edge of the crest due to the risk of fall down from the downstream slope. This surface will be compacted if Central Dike is raised above El. 145 m, when the crest is widened to a footprint corresponding to El. 150 m. After compaction, the slope of the lift was profiled with an excavator. The downstream slope was profiled with a 1.5H:1V slope, while the upstream rockfill slope was profiled with a 2H:1V slope.

Intermediate volcanic (IV) rockfill was placed on the footprint enlargement at the south extremity of Central Dike with an excavator instead of a dozer because of the access constraints. The lifts had a thickness of 1 m. The first lift was compacted with 8 passes of a 10-T smooth-drum vibratory roller compactor, and the subsequent lifts were compacted by passes of the excavator. The downstream slope was profiled with a 1.5H:1V slope. It was noticed at the end of the construction that the footprint was too narrow by 0.6 m and left as is, since this did not cause any stability issues and did not impact traffic on the crest significantly. The correction will be done if Central Dike is raised to an elevation higher than 145 m.

A total of 41,641 m^3 of intermediate volcanic (IV) rockfill was placed on Central Dike during the construction of Stage 6 of Central Dike.

3.1.5 Filter Placement on Foundation and on the Upstream Slope

During material placement on the 2H:1V upstream slope, fine and coarse filters were placed with the bucket of the excavator in 0.5-m thick horizontal lifts compacted against the rockfill. Coarse material was placed first and raised against the rockfill and followed by the fine filter material. The width of each lift was such that the thickness of the material perpendicular to the slope was 0.5 m. Well-graded aggregates made of sound good quality material were used on Central Dike. The material was placed by an excavator so as to prevent segregation.

After the placement of each 0.5-m lift of fine and coarse filter, the compaction of both materials was completed with 4 passes of a smooth-drum compactor in vibratory mode. Watering of the filters to promote compaction was impossible, as freezing temperatures would have caused the water to freeze within the lifts, which would have prevented compaction. Additional passes of the compactor were conducted when the material seemed visually excessively loose. When the elevation of the upstream filter reached the rockfill elevation, the slope of the fine filter was profiled with the bucket of an excavator to obtain a continuous 2H:1V upstream slope.

There were 3,825 m^3 of coarse filter and 3,469 m^3 of fine filter placed on Central Dike during the construction of Stage 6 of Central Dike.

3.1.6 Upstream Toe Liner Tie-In Key Preparation

No upstream toe liner key-in preparation was required, as the north abutment was done in 2017.

3.1.7 Geosynthetics Installation

Geosynthetics installation included the placement of a geotextile above El. 143 m on the fine filter surface and the installation of a LLDPE geomembrane above the geotextile. The missing panel between El. 143 m and 145 m on the north abutment after its preparation in 2017 was completed after the QA Engineer verified that the bedding surface was still in good condition and acceptable for geosynthetics installation. The geotextile and the LLDPE geomembrane were installed by the subcontractor, ZTG. No geosynthetics were allowed to be installed when it was raining or snowing. When not in use, the geomembrane rolls were stored on a smooth surface covered with geotextile. Stoppers generally made of sandbags were placed to secure the rolls in place.

Before the installation of the geosynthetics on the upstream slope and the upstream toe liner tie-in, the geosynthetics bedding was prepared. The upstream fine filter face was smoothed out by an excavator with a roller attachment without using vibration. Surface made of fine filters on the upstream slope was then approved by the Owner's Representative, the QC Representative, and the QA Engineer. The four existing tailings deposition points made of fine filter material and bituminous geomembrane panels placed over the LLDPE liner were also removed to allow welding of the new LLDPE panels. This activity caused damages to the existing LLDPE liner between El. 142 m and 143 m, however since the rips were located within the 1 m overlap of the new LLDPE liner panels, they did not need to be repaired. It was verified that the surface was smooth, dry and would not damage the geosynthetics. The surface was surveyed by KCG, and a geosynthetics bedding surface approval form was filled out. Refer to Appendix G for the completed approval forms.

The geotextile and the LLDPE geomembrane were buried in a 0.5-m deep anchor trench excavated into the upstream side of the rockfill crest within the coarse filter. The anchor trench was backfilled after the installation of the geosynthetics, once all QC tests passed, and compacted with 4 passes of a smooth-drum compactor in vibratory mode. The geomembrane was welded on the existing geomembrane in place at El. 143 m with a 1 m overlap.

The geotextile panels were mostly seamed with the dual hot wedge welding equipment using a minimum overlap of 0.15 m. When wedge seams were not possible (before the arrival of the dual hot wedge equipment) the geotextiles were bonded with a heat gun with a minimum overlap of 0.45 m. The geotextiles were visually inspected during installation to make sure that the overlap was sufficient and that the panels were not damaged.

The LLDPE geomembrane panels were mostly seamed with the dual hot wedge welding equipment using a minimum overlap of 0.15 m. When wedge seams were not practical (such as for seaming the new liner with the existing liner or for patches), the LLDPE geomembranes were bonded with extrusion fillet seams. The LLDPE geomembranes were visually inspected during installation to ensure that the overlap was sufficient and that the panels were not damaged.

The LLDPE geomembrane installation included air channel testing and vacuum box testing as part of the continuous QC program. In conformity with the technical specifications, an air channel test was conducted on each fusion seam, and vacuum testing was conducted on each extrusion weld, patch and repair. No air channel test failed during this construction season. When a vacuum box test indicated a leak, the extrusion material was grinded off and the weld was remade until vacuum test results were compliant with the specifications. The QA team was present for all air channel tests and half the vacuum box tests, in compliance with the design requirements. Test details and results are presented in the Liner Installers' QC report in Appendix H.

As part of the QA supervision of the LLDPE liner installation, the following destructive samples were taken, tested, and kept by the Owner's Representative:

Table 15: Details of the Destructive Testing on Central Dike

Name	Date sampled and tested	Structure	Station	Seam	Comment
D-1	Sampled and tested on May 25th	Central Dike	0+960 m, El. 145 m	Between panels 814 and 815	Compliant
D-2	Sampled on May 28th and tested on May 29th	Central Dike	0+855 m	Between panels 830 and 831	Compliant
D-3	Sampled and tested on June 1st	Central Dike	0+760 m	Between panels 845 and 846	Compliant
D-4	Sampled and tested on June 1st	Central Dike	0+655 m	Between panels 860 and 861	Compliant
D-5	Sampled and tested on June 2nd	Central Dike	0+555 m	Between panels 875 and 876	Compliant
D-6	Sampled and tested on June 3rd	Central Dike	0+450 m	Between panels 890 and 891	Compliant
D-7	Sampled and tested on June 3rd	Central Dike	0+350 m	Between panels 905 and 906	Compliant
D-8	Sampled on June 4th and tested on June 5th	Central Dike	0+240 m	Between panels 920 and 921	Compliant

After its installation, the LLDPE geomembrane surface was visually inspected and approved by the Owner's Representative and the QA Engineer. A geosynthetics approval form was completed after the installation of the LLDPE geomembrane. Refer to Appendix G for the completed approval forms.

A total of 9,239 m^2 of geotextile and 9,239 m^2 of LLDPE geomembrane were installed during the construction of Stage 6 of Central Dike.

3.1.8 Protection Cover of the Upstream Toe Liner Tie-In

The upstream toe liner tie-in was done in 2017 and only a minor section was missing and was completed during the 2018 construction season.

The 2-m erosion protection cover placed over the compacted sieved till of the upstream toe liner tie-in was completed at approximately Sta. 0+150 m. The erosion protection cover consists of 0.5 m of fine filter, 0.5 m of coarse filter and 1 m of fine rockfill (2 0.5-m thick lifts) placed with the CAT 345 excavator. The fine filter and coarse filter lift were made of intermediate volcanic (IV) rockfill and were placed with an excavator and compacted with 4 passes of a 10-T smooth-drum compactor in vibratory mode. The fine rockfill consisted of ultramafic volcanic (UM) rockfill (see Section 5.2) that was mechanically sorted to remove boulders of more than 0.5 m in diameter. The fine rockfill lifts were compacted with 4 passes of the 10-T smooth-drum compactor in vibratory mode. During the compaction of the erosion protection cover, the compactor stayed at a safe distance from the upstream slope LLDPE to avoid damaging it.

There were 30 m^3 of compacted sieved till, 66 m^3 of fine filter, 40 m^3 of coarse filter, and 104 m^3 of fine UM rockfill placed on Central Dike during the construction of Stage 6 of Central Dike.

3.2 Saddle Dam 3 – Schedule and Construction Steps

The finalization of Stage 3 of Saddle Dam 3 was done from May 14 to July 19, 2018, and comprised the following main work items:

- Site preparation (including snow removal, slope corrections and water management);
- Geotextile and LLDPE geomembrane installation;
- Placement and compaction of compacted till layers and erosion protection material over the geosynthetics in the upstream toe liner tie-in.
- Placement and compaction of the protection cover over the geosynthetics in the upstream slope.

The work procedures followed during the construction of these work items are discussed in the following subsections.

Selected photographs of the work progress taken throughout the construction season are shown in Appendix C2.

Table 16 presents the construction schedule for the main work items for the finalization of Stage 3 of Saddle Dam 3.

Table 16: Schedule for the Construction Activity for the finalization of Stage 3 of Saddle Dam 3

Activity	Beginning	End
Site preparation	May 14, 2018 (snow removal) June 5, 2018 (dewatering)	May 16, 2018 (snow removal) June 7, 2018 (dewatering)
Geosynthetics installation on the upstream 2H:1V slope	June 6, 2018	June 8, 2018
Placement and compaction of compacted till layers and erosion protection material over the geosynthetics in the upstream toe liner tie-in of the north abutment (compacted till, fine filter, coarse filter, fine rockfill)	July 11, 2018	July 19, 2018
Placement and compaction of protection cover materials over the geosynthetics in the upstream slope	July 7th, 2017	July 18th, 2018

The delay between the installation of geosynthetics and the placement of the compacted till layers and erosion protection material is due to the fact that the till stockpiles were frozen, and operations could only resume once they were sufficiently thawed in July 2018.

3.2.1 Drilling and Blasting

No drilling and blasting was required during the finalization of Stage 3 of Saddle Dam 3.

3.2.2 Site Preparation

The main access road used to get to the Saddle Dam 3 area was the Saddle Road access starting at the portion of West Road in front of the Portage Pit Central Dump and leading to Saddle Dam 3 and Saddle Dam 4 along the airstrip. Snow removal operations were conducted on the Saddle Road before the beginning of construction.

Snow was removed on the crest and the upstream slope of Saddle Dam 3 in preparation for the construction works. The fine filter slope was compacted again with a roller attachment to ensure a smooth slope for geosynthetics installation. Excess fine filter and till placed on the existing liner was also removed at Sta. 20+595 m.

Ponding water on the first compacted sieved till layer of the upstream toe liner tie-in was also pumped out before the beginning of the geosynthetics installation.

3.2.3 Geosynthetics Installation

Geosynthetics installation included the placement of a geotextile above El. 143 m on the fine filter surface and the installation of a LLDPE geomembrane above the geotextile. The geotextile and the LLDPE geomembrane were installed by the subcontractor, ZTG. No geosynthetics were allowed to be installed when it was raining or snowing. When not in use, the geomembrane rolls were stored on a smooth surface covered with geotextile. Stoppers generally made of sandbags were placed to secure the rolls in place.

Before the installation of the geosynthetics on the upstream slope and the upstream toe liner tie-in, the geosynthetics bedding was prepared. The upstream fine filter face was smoothed out by an excavator with a roller attachment without using vibration. Surface made of fine filters on the upstream slope was then approved by the Owner's Representative, the QC Representative, and the QA Engineer. It was verified that the surface was smooth, dry and would not damage the geosynthetics. The surface was surveyed by KCG and a geosynthetics bedding surface approval form was filled out. Refer to Appendix G for the completed approval forms.

The geotextile and the LLDPE geomembrane were buried in a 0.5-m-deep anchor trench excavated into the upstream side of the rockfill crest within the coarse filter. The anchor trench was backfilled after the installation of the geosynthetics, once all QC tests passed, and compacted with 4 passes of a smooth-drum compactor in vibratory mode. The geomembrane was welded on the existing geomembrane in place at El. 143 m with a 1 m overlap.

The geotextile panels were mostly seamed with the dual hot wedge welding equipment using a minimum overlap of 0.15 m. The geotextiles were visually inspected during installation to ensure sufficient overlap and ensure that the panels were undamaged.

The LLDPE geomembrane panels were mostly seamed with the dual hot wedge welding equipment using a minimum overlap of 0.15 m. When wedge seams were not practical (such as for seaming the new liner with the existing liner or for patches), the LLDPE geomembranes were bonded with extrusion fillet seams. The LLDPE geomembranes were visually inspected during installation to ensure sufficient overlap and ensure that the panels were undamaged.

The LLDPE geomembrane installation included air channel testing and vacuum box testing as part of the continuous QC program. In conformity with the technical specifications, an air channel test was conducted on each fusion seam, and vacuum testing was conducted on each extrusion weld, patch and repair. No air channel test failed during this construction season. When a vacuum box test indicated a leak, the extrusion material was grinded off and the weld was remade until vacuum test results were compliant with the specifications. The QA team was present for all air channel tests and half the vacuum box tests, in compliance with the design requirements. Test details and results are presented in the Liner Installers' QC report in Appendix H.

As part of the QA supervision of the LLDPE liner installation, the following destructive samples were taken, tested, and kept by the Owner's Representative:

Table 17: Details of the Destructive Testing on Saddle Dam 3

Name	Date sampled and tested	Structure	Station	Seam	Comment
D-9	Sampled on June 7th and tested on June 8th	Saddle Dam 3	20+615 m	Between panels 935 and 936	Compliant
D-10	Sampled and tested on June 8th	Saddle Dam 3	20+695 m	Between panels 948 and 949	Compliant
D-11	Sampled and tested on June 8th	Saddle Dam 3	20+795 m	Between panels 959 and 960	Compliant
D-12	Sampled and tested on June 8th	Saddle Dam 3	20+700 m	Bottom extrusion seam of panel 949	Non-compliant. The seam was repaired and successfully vacuum tested.

After its installation, the LLDPE geomembrane surface was visually inspected and approved by the Owner's Representative and the QA Engineer. A geosynthetics approval form was completed after the installation of the LLDPE geomembrane. Refer to Appendix G for the completed approval forms.

A total of 2,552 m^2 of geotextile and 2,552 m^2 of LLDPE geomembrane were installed during the finalization of Stage 3 of Saddle Dam 3.

3.2.4 Protection Cover of the Upstream Toe Liner Tie-In

Once the geosynthetics installation was completed in the upstream toe liner tie-in, three 0.5-m thick lifts of compacted sieved till were placed over the LLDPE geomembrane on the south abutment, two 0.5-m thick lifts of compacted sieved till and one 0.5-m-thick of compacted till (0-150 mm) on the north abutment, for a total of 2 m of compacted till including the 0.5-m bedding under the LLDPE. The compacted sieved till was well graded and taken directly from the haul truck with the excavator to avoid contamination. Compacted till (0-150 mm) was placed as the last layer on the upstream slope of the toe-liner tie-in on the north abutment, as no more thawed sieved till (0-50 mm) was available at the time. Only the compactor was allowed to traffic over the geomembrane where there was at least 1 m of material over it. The compaction of the first lift over the geomembrane was done with the excavator bucket. The remainder of the till lift was compacted with the 10-T smooth drum compactor. The compaction of each lift was controlled with a portable nuclear gauge by the QC Representative to ensure it met the Technical Specifications. The placement and compaction of till was only allowed when there was no rain. Haul trucks were not allowed to pass over the compacted till material.

The erosion protection cover design consists of 0.5 m of fine filter, 0.5 m of coarse filter and 1 m of fine rockfill placed with the CAT 345 excavator. The fine filter and coarse filter lift were made of ultramafic volcanic (UM) rockfill and were placed with an excavator and compacted with 4 passes of a 10-T smooth-drum compactor in vibratory mode. The fine rockfill consisted of ultramafic volcanic (UM) rockfill that was mechanically sorted to remove boulders of more than 0.5 m in diameter. The fine rockfill lift was compacted with 4 passes of the 10-T smooth-drum compactor in vibratory mode. During the compaction of the erosion protection cover, the compactor stayed at safe distance from the upstream slope LLDPE to avoid damaging it.

Due to the relatively high elevation of the abutments (close to El. 145 m), coarse filter and fine rockfill were only placed on the south abutment, and the fine rockfill layer was only about 0.5 m thick.

There were 497 m^3 of compacted sieved till, 450 m^3 of compacted till (0-150 mm), 266 m^3 of fine filter, 2016 m^3 of coarse filter, and 293 m^3 of fine UM rockfill placed on Saddle Dam 3 during the finalization of Stage 3 of Saddle Dam 3.

3.2.5 Protection Cover of the Upstream Liner

The protection cover for LLDPE geomembrane and the current erosion protection were raised from El. 142 m to 143.5 m.

Regarding the protection cover for the LLDPE geomembrane, the deposition plan issued by AEM showed that free water will be in direct contact with the geomembrane liner. In order to protect the LLDPE geomembrane from the water ponding, protection cover was placed directly over the liner.

The proposed configuration included the placement of a 2.0-m thick layer of till, including a 0.5-m thick layer of sieved till (0-50 mm) directly against the LLDPE liner followed by a 1.5-m thick layer of low quality till (0-300 mm). Due to a shortage in sieved till, the compacted sieved till in the protection cover was replaced with compacted till sieved with an excavator, with an objective of 150 mm maximum particle size. The LLDPE geomembrane was covered with 2 layers of TenCate Mirafi S1600 geotextile to protect it against possible oversize particles.

A 1.0-m thick layer of fine rockfill (0-500 mm) was placed directly against the 2.0-m thick layer of till. The lifts of compacted till (0-150 mm) were placed in lifts with a vertical thickness of 0.5 m and compacted with 4 passes of a 10-T smooth-drum compactor in vibratory mode. The fine rockfill consisted of IV and UM rockfill that was mechanically sorted to remove boulders of more than 0.5 m in diameter. The fine rockfill lift was placed in lifts with a vertical thickness of 2 m. The lifts were compacted 6 passes of a 10-T smooth-drum compactor in vibratory mode.

A section of sieved till was missing at the end of the 2017 construction season around Sta. 20+620 m, because of a water pond which froze and could not be removed without risking damaging the LLDPE liner. This part was completed at the beginning of the protection cover raise.

There were 1,358 m^3 of compacted (0-150 mm) till, and 2,798 m^3 of fine IV and UM rockfill placed on Saddle Dam 3 during the raise of the erosion protection cover to El. 143.5 m.

3.3 North Cell Internal Structure Construction – Schedule and Construction Steps

The construction of the North Cell Internal Structure was done from May 19 to August 8, 2018, and comprised the following major work items:

- Foundation preparation (removal snow and excavation of till and rock fragments in one area);
- Fill placement, compaction, and slope profiling (rockfill and upstream filter placement) under QA/QC, some material was already in place;

- Excavation of one ditch and two sumps, placement of an erosion protection layer in the excavations in tailings.

The work procedures followed during the construction of these work items are discussed in the following subsections.

Selected photographs of the work progress taken throughout the construction season are shown in Appendix C1.

Table 18 presents the construction schedule for the main work items for the construction of the North Cell Internal Structure.

Table 18: Schedule for the Construction Activity for the North Cell Internal Structure

Activity	Beginning	End
Foundation preparation	May 19, 2018 (snow removal) June 20, 2018 (bedrock preparation)	May 19, 2018 (snow removal) June 20, 2018 (bedrock preparation)
Placement, compaction and profiling of rockfill on the crest from the base of the tailings or existing capping to variable elevations 152 m to 154 m (1.5:H d/s, 3H:1V u/s)	May 19, 2018 (beginning of QA/QC supervision)	July 30, 2018
Placement, compaction and profiling of filter material on the upstream 3H:1V slope from the base of the tailings or existing capping to variable elevations 152 m to El. 154 m	June 18, 2018	July 31, 2018
Excavation of ditch and sumps, placement of an erosion protection layer	July 24, 2018	August 8, 2018

3.3.1 Drilling and Blasting

No drilling and blasting was required during the construction of the North Cell Internal Structure.

3.3.2 Site Preparation

The North Cell Internal Structure is partially built over the North Cell capping, constituted of ultramafic volcanic (UM) rockfill (see Figure 2). The capping construction started in 2015 by the horseshoe-shaped section at the north end and continued in 2016 with the strip along RF1 and RF2. Some of the UM rockfill constituting the North Cell Internal Structure was placed before the beginning of the QA/QC supervision, as part of the North Cell capping, under AEM's supervision only.

One instrument installed on the North Cell capping was raised during the placement of UM rockfill.

3.3.3 Foundation Preparation

Foundation preparation included snow removal on the surfaces of the capping and the tailings, and the excavation of a snow bank underlying the UM rockfill from approx. Sta 2+600 m to 2+700 m to the toe of the structure. It was verified with test pits that the snow bank was only localised underneath the excess UM rockfill placed in this area and did not extend into the North Cell Internal Structure limits.

Foundation preparation was also done on the section of foundation between Sta. 1+750 m and 1+850 m, where the North Cell Internal Structure was partially founded on a layer of till and organic soil.

The foundation preparation consisted of the removal of the foundation soil to the bedrock surface within the planned footprint, outside of the existing capping. The loose material was removed by excavator (CAT 345D) to ensure this portion of the structure was founded on sound bedrock.

Before the placement of fill materials over the dike foundation, the foundation surface was inspected by the Owner's Representative, the QC Representative and the QA Engineer. The parties verified that the foundation to be approved was competent, dry and free of contamination or ice. Approval was communicated to the concerned parties, and no foundation approval form was required by the specifications of the North Cell Internal Structure.

The volume material excavated during the construction of the North Cell Internal Structure was not surveyed and represents a minor volume.

3.3.4 Placement of Rockfill for Embankment Construction to El. 152 m to 154 m

The rockfill was placed in lifts of a maximum thickness of 2.5 m (see Section 5.4). Various numbers of lifts were required along the North Cell Internal Structure depending on the elevation of the North Cell capping (rockfill) or tailings on which the structure was founded upon. Foundation elevation ranged from approx. 148 m to 151.5 m. The limits of the lift at El. 154 m were defined based on AEM's tailings deposition plan and a ramp with a 10H:1V slope was built at the extremities of this lift to make a transition with the rest of the structure at El. 152 m. The lifts of rockfill had an average thickness of 2 m and were placed by a dozer (D8). The rockfill was composed of well graded NON-AG, ultramafic volcanic (UM) rock. To avoid segregation, the rockfill was dumped on a flat surface and then pushed on the slope. The lift was compacted with 6 passes of a 10-T smooth-drum vibratory roller compactor on the surface of the lift not trafficked by haul trucks, in accordance with the Technical Specifications. After compaction, the upstream slope of the lift was profiled with an excavator with a 3H:1V slope. The 1.5H:1V downstream slope was not profiled (see Section 5.4).

The initial UM rockfill lift built on the rockfill cover to El. 152 m exceeded the design width, however corrective measures were implemented during the QA/QC supervision of the works, which included more frequent surveying checks for width and elevation of the lift, as well as dike footprint marking on the field for operators.

The North Cell Internal Structure was built in 2018 to El. 152 m from Sta. 1+100 m to 1+660 m and from 2+750 m to 3+200 m, and to El. 154 m from Sta. 1+660 m to 2+750 m.

A total of 219,821 m^3 of ultramafic volcanic (UM) rockfill were placed on the North Cell Internal Structure during its construction.

3.3.5 Filter Placement on the Upstream Slope

During material placement on the 3H:1V upstream slope, fine and coarse filters were placed with the bucket of the excavator, each in one lift compacted against the rockfill with a thickness of 0.5 m perpendicular to the slope.

Coarse material was placed first and raised against the rockfill, compacted, followed by the fine filter material. Well-graded aggregates made of sound good quality material (both intermediate volcanic (IV) and ultramafic volcanic (UM) rockfill) were used on the North Cell Internal Structure. The material was placed by an excavator so as to prevent segregation.

After the placement of each lift of fine and coarse filter, the compaction was done with 4 passes of a smooth-drum compactor in vibratory mode in the slope (see Section 5.4). In order to stabilize material in the slope, the first pass down the slope was done without vibration in certain areas. The bottom of the slope where the compactor could not reach was reprofiled and compacted with the bucket of the excavator. No watering of the filters to promote compaction was required.

There were 13,339 m^3 of coarse filter and 13,204 m^3 of fine filter placed on the North Cell Internal Structure during its construction.

3.3.6 Excavation of Ditch and Sumps

One shallow unlined ditch was excavated at the downstream toe of the North Cell Internal Structure, on the west side, from Sta. 1+720 m to 1+140 m. The ditch alignment followed the toe of the rockfill structure, and the excavation was approximately 0.8 m deep and 1 m wide. The ditch was mostly excavated in the UM rockfill cover in place, with a section excavated in the tailings at its south extremity. Where the ditch was excavated in the tailings, a 0.3-m thick layer of till sieving reject material was placed against the surfaces to prevent erosion of the tailings. The ditch was terminated in the North Cell after by-passing the southwestern extremity of the dike with the excavation of a temporary sump at Sta. 1+140 m, as gravitational drainage alone was not effective. The excavation of this sump was done under AEM’s supervision only, after the QA and QC representatives had left the site.

Two shallow unlined sumps were identified at the location of natural low point areas and excavated at the downstream toe of the North Cell Internal Structure, on the east side, directly along the RF1 and RF2 structures. The sumps were excavated in the tailings between Sta. 3+010 m and 3+030 m, and between Sta. 3+345 m and 3+365 m, with a depth of 1.5 m for both sumps. The excavation depth was limited by the presence of the upstream slope of RF1 and RF2 at a shallow depth underneath the tailings. The north sump is approximately 3 m wide and 20 m long, and the south sump is approximately 8 m wide and 15 m long. The dimensions were optimized in the field to ensure sufficient capacity despite the limited depth. A 0.3-m thick layer of till sieving reject material was placed against the surfaces to prevent erosion of the tailings.

The changes made to the original design of the sump and ditches around the North Cell Internal structure are temporary only. The changes are considered acceptable as the site is in operation and the site engineering team is inspecting daily the performance of the surface water management system. Review of the water management system for closure and post-closure phases is mandatory so that it meets the original design intent. This is discussed in further details in the design change technical memorandum (1897439-1582-TM-Rev0) presented in Appendix B.

4.0 QA/QC PROGRAM AND RESULTS

4.1 General

During the 2018 construction season of the South Cell and the North Cell, a daily construction meeting was held each morning on the construction site with all parties present on site (AEM, KCG, Golder, GHD). This meeting was used to review the progress of the last 24 hours, plan for the next 24 hours and to discuss and resolve problems encountered during the construction. Minutes from these meeting were taken by AEM and Golder and AEM's minutes are presented in Appendix D.

The QA program was carried out by Golder during the preparation of Stage 6 of the Central Dike, the finalization of Stage 3 of Saddle Dam 3, and the construction of the North Cell Internal Structure. The content of the QA program is defined in the Technical Specifications and includes foundation preparation, fill placement, and geosynthetics installation. The QA team consisted of QA Engineers working on approximately two-week rotations. A QA Engineer was present full time on site from April 23 to August 2, 2018. No QA activities were performed during night shifts. Construction of the North Cell Internal Structure (placement of UM rockfill) began before the start of the QA supervision, as part of the North Cell Capping operations. Daily and weekly reports were prepared by the QA personnel to document the QA activities performed during the construction of Stage 6 of the Central Dike, the finalization of Stage 3 of Saddle Dam 3, and the construction of the North Cell Internal Structure. These QA daily and weekly reports are presented in Appendix E.

GHD carried out the QC program defined in the Technical Specifications for all construction activities except for the geosynthetics installation. The GHD QC team worked under the supervision of AEM and consisted of a QC representative on day shift from April 23 to August 2, 2018. The daily reports prepared by the on-site QC Representatives to document the QC activities are presented in Appendix F.

The geosynthetics installation QC activities were carried out by the geosynthetics installation crew (ZTG) under the supervision of KCG.

The Owner's representative and the QA Engineer routinely conducted visual inspection of the work done during the construction of Stage 6 of Central Dike, the finalization of Stage 3 of Saddle Dam 3, and the construction of the North Cell Internal Structure. Review of the work procedures was done on a daily basis and corrections were made as necessary. Photographs of the work progress and activities were taken every day. A selection of photographs taken throughout the construction season are presented in Appendix C.

Daily surveys were conducted by KCG to ensure that limits and grades were followed correctly during construction of the South Cell. Periodic surveys were conducted by KCG during construction of the North Cell. These surveys were reviewed by the QA Engineer.

4.2 Foundation Approval

As part of the QA/QC program, the foundations were approved before placing any material over natural soil and before the installation of geosynthetics on a bedding surface. The objective of the foundation approval process was to ensure that the foundation was prepared as per the Technical Specifications. The approval was done by the Owner's Representative, the QA Engineer and the QC Representative. It was verified that the foundation to be approved was competent, dry, free of contamination or ice, and also that:

- The clearing and stripping were adequate.
- The foundation excavation and the removal of unsuitable foundation materials were adequate.

- The preparation of the bedrock surface within the upstream toe liner tie-in was adequate.
- The bedding surface conditions for geomembrane placement were smooth and flat.

For each foundation approval, the limit of the approved area was surveyed, and a foundation approval form was signed by the surveyor, the Owner's Representative, the QA Engineer, and the QC Representative. Each foundation approval form included a sketch and picture of the approved foundation area as well as the filled inspection item checklist. Table 19 presents a summary of the foundation approvals done during the 2018 construction season of the South Cell. No foundation approval form was completed for the construction of the North Cell, as it was not required by the specifications. These foundation approvals forms are presented in Appendix G. Geosynthetics were installed at the Central Dike and Saddle Dam 3 in 2018.

Table 19: Summary of Foundation Approval for the 2018 Construction Season of the South Cell

Structure	# of Foundation Approval for Fill Placement	# of Foundation Approval for Geosynthetics Bedding
Central Dike	1 (FND-CD-139)	1 (FND-CD-140)
Saddle Dam 3	-	2 (FND-SD3-37 and FND-SD3-38)

4.3 Geosynthetics Installation

QC testing of the geosynthetics installation was done by ZTG under the supervision of the QA Engineer. QC testing was done during the assembly and the installation. QC testing during installation included welding calibration (AM and PM), air pressure tests on every seam, vacuum box testing of each extrusion weld, and destructive weld integrity tests every 150 m of welding. The QA Engineer assisted at a minimum of 20% of the vacuum box testing and 100% of the other QC tests to ensure that they were done according to Technical Specifications.

The QC report from the geomembrane installer (ZTG) is presented in Appendix H. This document presents the layout of the geosynthetics installation, the results of the geosynthetics QC testing, and the manufacturer data sheet of the LLDPE geomembrane All of the installed geomembrane passed the QC testing.

The manufacturer data sheet for the geotextile, as well as the factory QC testing program details, were not available to the QA Engineer.

After the completion of the geomembrane installation, the Owner's Representative, the QA Engineer, and the ZTG QC Representative completed an inspection of the installation to approve the installation. The inspection was done to ensure that:

- The geomembrane was not damaged (cracks or rips) and was smooth and flat.
- The welding and patches were done properly.
- The QC testing was completed and passed all tests.

After each geosynthetic approval, the limit of the approved area was surveyed and a geosynthetic approval form was signed by the surveyor, the Owner's Representative, the QA Engineer, and the QC Representative. Each geosynthetic approval form included a sketch and picture of the approved area and the filled-out inspection item checklist. Table 20 presents a summary of the geosynthetic approval completed during the 2018 construction season of the South Cell and the North Cell. The completed geosynthetic installation approval forms for the construction of Stage 6 of Central Dike and the finalization of Stage 3 of Saddle Dam 3 are included in Appendix G.

Table 20: Summary of Geosynthetic Approval for the 2018 Construction Season of the South Cell and the North Cell

Structure	# of Geomembrane Approval
Central Dike	1 (LLDPE-CD-31)
Saddle Dam 3	1 (LLDPE-SD3-003)

4.4 Material Placement

During material placement, the quality of the material and the placement technique were routinely reviewed. It was ensured that the placement technique limited segregation, that the material quality was visually acceptable, and that the maximum allowable lift thickness was not exceeded.

During placement of fine filter and coarse filter on the upstream slope, it was visually verified that the coarse filter completely wrapped the fine filter so that the fine filter did not come in direct contact with the coarse rockfill.

During rockfill placement, it was verified by the QC Representative and QA Engineer that the rockfill was well graded, did not contain oversized particles and was placed in the correct area of the dike. For the placement of UM rockfill, special attention was taken to observe whether the material was competent and was not predominantly formed of fine particles and rock powder.

4.4.1 Laboratory Testing

Samples of compacted sieved till, fine filter, and coarse filter were taken by the QC Representative and the QA Engineer during construction per the sampling intervals defined in the Technical Specifications. The QA Engineer reviewed the QC Representative sampling technique and laboratory procedures to ensure that proper techniques were being used. The QA Engineer took and tested one sample for every five samples taken by the QC Representative.

The volumes of material (coarse filter, fine filter, compacted till and compacted sieved till) placed daily were communicated by KCG to the QA and QC personnel, and samples were taken accordingly to ensure that the sampling frequency was compliant. The specifications require the following sampling frequencies:

Table 21: QC sampling frequencies for the construction of the South Cell and the North Cell

Material	Sampling frequency in stockpile	Sampling frequency in place
Coarse filter	1 sample in 5,000 m^3	1 sample in 5,000 m^3
Fine filter	1 sample in 1,000 m^3	1 sample in 1,000 m^3
Compacted sieved till	1 sample in 1,000 m^3	1 sample in 1,000 m^3

The fine filter and coarse filter samples were tested for particle size distribution (ASTM C136) to ensure that the gradation limits of the Technical Specifications were met. The samples of compacted sieved till were tested for particle size distribution (ASTM C136) and water content (ASTM D2216). The particle size distribution tests were conducted to ensure that the gradation limits of the Technical Specifications were met.

A standard Proctor test was performed in 2017 on the compacted sieved till and corrected to define the optimal dry density and water content. In order to take into account possible variability within the material from one construction season to the next (variability of the material within the stockpiles, different moisture contents), it was supplemented by reference board testing in the field. Reference boards were done for both the compacted sieved till and the low quality till placed on the upstream toe liner tie-ins. Stockpiles were tested with the portable nuclear gauge before transportation of the material to ensure that its moisture was acceptable (measured values not recorded).

The results of gradation testing on compacted sieved till (Zone 1) indicate that the material was well graded and met the Technical Specifications in the stockpile and in situ. The placed material was also visually acceptable.

The results of gradation testing on fine filter (Zone 2) indicate that the material was well graded and mostly met the Technical Specifications in the stockpile and in situ, with some samples exhibiting a slight excess of large particles. The placed material was visually acceptable. The material was still accepted by the QA Engineer and QC Representative as it was visually adequate, and it was judged that this difference would not negatively impact the performance of the filter.

The results of gradation testing on coarse filter (Zone 3) indicate that the material was well graded. Some samples were 5 to 10% finer than allowed by the Technical Specifications below the 12.5 mm fractions. The material was still accepted by the QA Engineer and QC Representative as it was visually adequate, and it was judged that this difference would not negatively impact the performance of the filter.

The results of the QC and QA laboratory testing of the material used during the construction of Stage 6 of the Central Dike, the finalization of Stage 3 of Saddle Dam 3, and the construction of the North Cell Internal Structure are presented in Appendices I and J. Table 22 indicates the number of samples tested during the 2018 construction season of the South Cell and the North Cell. Given the small volumes of filters placed on SD3 in 2018, the sampling and testing program of SD3 and the North Cell Internal Structure were combined in terms of total fine and coarse filter volumes. The sampling requirements of the Technical Specifications were met during the 2018 construction season.

Table 22: Summary of Field Laboratory Testing During South Cell and North Cell 2018 Construction Season

Sample Location	Material	# Samples QC	# Samples QA
Stockpile	Compacted Sieved Till Stockpiles 0-50 mm	1 PSD 1 WC	1 PSD 1 WC
	Fine Filter (Zone 2)	20 PSD 20 WC	5 PSD 5 WC

Sample Location	Material	# Samples QC	# Samples QA
	Coarse Filter (Zone 3)	5 PSD 5 WC	3 PSD 3 WC
Saddle Dam 3	Low-Quality Till (used for erosion protection of the liner)	-	-
	Compacted Sieved Till (Zone 1)	1 PSD 1 WC	1 PSD 1 WC
	Fine Filter (Zone 2)	1 PSD 1 WC	- -
	Coarse Filter (Zone 3)	-	-
Central Dike	Compacted Sieved Till (Zone 1)	-	-
	Fine Filter (Zone 2)	4 PSD 4 WC	1 PSD 1 WC
	Coarse Filter (Zone 3)	1 PSD 1 WC	1 PSD 1 WC
North Cell Internal Structure	Fine Filter (Zone 3)	14 PSD 14 WC	3 PSD 3 WC
	Coarse Filter (Zone 2)	3 PSD 3 WC	1 PSD 1 WC

Note: Particle size distribution (PSD) per ASTM C136-06, Water Content (WC) testing per ASTM D2216 and Standard Proctor (Proctor) testing per ASTM D698

4.4.2 Control of Compaction

The QC Representative was present at all times during material compaction to supervise the process. The compaction of the fine filter, coarse filter and rockfill was verified visually, and it was checked that a sufficient number of compactor passes was done. The overlap of the passes and the compactor speed was continuously verified by the QC Representative.

The compaction of each lift of compacted sieved till material (0-50 mm), as well as the lift of low-quality till (0-150 mm) placed on the upstream toe liner tie-ins was controlled by the QC Representative in the field with a portable nuclear gauge. The number of compactor passes was adjusted in the field until 98% of the optimal dry density of the reference board was reached. The overlap of the passes and the compactor speed were verified by the QC Representative.

The optimal dry density of the compacted sieved till material was obtained as the maximum value obtained from the Standard Proctor laboratory test in 2017, and two compaction reference boards in 2018. The maximum optimal dry density obtained with the proctor test was 2,050 kg/m^3 for a water content of 9%. However, 9% moisture was difficult to achieve in the field, as sieved till would become excessively soft to compact. Instead, the values of optimal water content and dry density provided by the reference boards were used.

During the compaction reference board testing, a test pad made of compacted sieved till was constructed in the field and compacted by the 10-T smooth-drum compactor in vibratory mode. After each pass of the compactor, the dry density and water content was measured with the portable nuclear gauge. This method was used to determine the optimal dry density and the number of compactor passes required to achieve it.

Results from the field measurement of the dry density and water content are summarized in Table 23 and are presented in Appendix I. A degree of compaction higher than 98% of the optimal was achieved for all compacted sieved till and compacted till material (Zone 1) placed during the 2018 construction season of the South Cell. It should be noted that some of the water content tests taken on Saddle Dam 3 were done several days after placement of the sieved till and thus yielded results lower than the probable realistic water content at the time of placement.

Table 23: Summary of Portable Nuclear Gauge Field Testing during South Cell 2018 Construction Season

Sample Location	Material	Water Content %	Water content % Mean	Dry Volumetric Density Kg/m^3	Dry volumetric density Kg/m^3 Mean	Compaction Rate %	Compaction Rate % Mean
Saddle Dam 3	Compacted Sieved Till (reference board)	8.2	-	2,144	-	-	-
	Compacted Sieved Till (in place)	5.9 to 9.4	7.6	2,113 to 2,228	2,159.8	97.9 to 100.6	99.5

Sample Location	Material	Water Content %	Water content % Mean	Dry Volumetric Density Kg/m³	Dry volumetric density Kg/m³ Mean	Compaction Rate %	Compaction Rate % Mean
	Low quality Till (reference board)	6.6	-	2,125	-	-	-
	Low quality Till (in place)	5.9 to 7.6	7.0	2,092 to 2,116	2,103.7	98.4 to 99.5	99.0

5.0 DESIGN CHANGES AND FIELD ADJUSTMENTS

Design changes and field adjustments were implemented during the preparation of Stage 6 of Central Dike, the finalization of Stage 3 of Saddle Dam 3, and the construction of the North Cell Internal Structure.

Some elements of the design were changed during construction to adapt the design to the encountered field conditions. These changes were implemented by the Designer in collaboration with AEM and were documented in daily and weekly field reports. Per AEM's request, one design change memorandum was issued for the 2018 construction season while the other changes were documented in the QA weekly and daily reports and are summarized in this section. This document is listed in Section 1.6 and can be found in Appendix B.

The design changes of Central Dike and Saddle Dam 3 that were implemented in previous construction seasons and still relevant to the 2018 construction season were carried out. Eighteen design changes documented in technical memoranda were carried out from previous construction seasons to the 2018 construction season. These documents are listed in Section 1.6 and can be found in their respective construction season reports.

Thirteen local field adjustments were made during construction when the encountered conditions were different than the expected conditions. These local adjustments were discussed with the Designer and implemented by the Owner's Representative without requiring a change to the design. Field adjustments were documented in the QA weekly and daily reports and are summarized in this section.

5.1 General

Field Adjustment – Modification to Sampling Quantity of Till and Coarse Filter

According to ASTM Standard C136, 60 kg of till and 300 kg of coarse filter should be taken for each particle size distribution test. These quantities were high to efficiently be manually sampled with a bucket and a shovel and tested with the available field laboratory testing equipment. As in the previous construction season, smaller quantities of materials were sampled (10-20 kg of material). Care was taken to obtain representative samples while minimizing segregation and a duplicate was taken when it was believed that segregation during sampling could have impacted the results.

Field Adjustment – Modification of Compaction Method for the Filter Materials

According to the technical specifications, filter materials should be wetted to achieve optimal compaction. Due to the subzero temperatures at the time of placement of the coarse and fine filters on Central Dike, no watering of the materials was done in order to avoid freezing of the water inside the lifts. The presence of ice within the lifts would prevent compaction and it was deemed preferable to perform additional passes of the smooth-drum compactor in order to achieve the best compaction possible. As a result, the coarse and fine filters lifts were compacted with 4 to 6 passes of the smooth-drum compactor until satisfactory compaction was obtained (visual control only).

Field Adjustment – Modification of Seaming Method for Geotextile Panels

According to the technical specifications regarding geosynthetics installation, geotextile panels should be spot-welded together with a heat gun and a minimum overlap of 450 mm. While this was done in the curve between Saddle Dam 5 and the Central Dike from Sta. 40+640 m 0+750 m due to the delay in the shipping of the Liner Installers' welding equipment, the remainder of the geotextile panels installed on the Central Dike and Saddle Dam 3 were seamed using a dual hot wedge with an overlap of 150 mm. This type of seaming produces stronger and more regular seams than spot-welding.

5.2 Central Dike North Stage 6

Field Adjustment – Compaction under the Downstream Berms at El. 145 m

Compaction of the entire width of the non-AG intermediate volcanic (IV) rockfill lift at El. 145 m required removing the downstream berms (about 2 m wide) and compacting the rockfill beneath with the 10-T smooth-drum compactor. However, given the considerable height of the downstream slope, driving the compactor so close to the edge could not be done safely. It was thus decided with AEM that no compaction under the berms would be performed this year. No significant structural issue is expected due to this change if El. 145 m is the final dike elevation. Should the Central Dike be raised to El. 150 m, this surface would need to be compacted once the dike is built at the El. 145 m to its final width.

Field Adjustment – Placement of Intermediate Volcanic (IV) Rockfill with an Excavator

Because of a restrained access, completion of the 145 m footprint at the south end of the Central Dike near SD5 was done by placing the intermediate volcanic (IV) rockfill with an excavator instead of a dozer. Care was taken to limit segregation during placement, and lift thickness was limited to 0.5 m (1 m for the first lift). The first 1-m thick lift was compacted with 8 passes of a 10-T smooth-drum compactor. Due to the restrained access, the following 0.5-m lifts were compacted with the tracks of the excavator only. The slope was then profiled and compacted with the bucket of the excavator.

Field Adjustment – Placement of Ultramafic Volcanic (UM) Rockfill on the Upstream Toe Liner Tie-in

As per the design, good quality non-AG intermediate volcanic (IV) rockfill should be used on the Central Dike. At the end of the construction season, when the upstream toe liner tie-in of the north abutment of the Central Dike was built, the IV rockfill stockpile was entirely used up. Since the purpose of the fine rockfill on the upstream toe liner tie-in is erosion protection of the till layers and it has no structural function, it was acceptable to use fine UM rockfill instead with a similar gradation.

Field Adjustment – Modification of the Thicknesses of the Fine Filter and Coarse Filter Layers Placed against the Upstream Slope of Central Dike in the Toe Liner Tie-in

Due to a field adjustment in the layers of materials placed against the upstream slope of the north upstream toe liner tie-in of the Central Dike at El. 143 m during the previous raise (compacted sieved till replaced by fine filter with a layer of geotextile and narrower total width of the fine filter layer towards the south), the footprint of the layers of compacted sieved till, fine filter and coarse filters were modified. In order to guarantee the thickness of the compacted sieved till layer (0.5 m) which is the first protection placed against the LLDPE liner, fine and coarse filter layers were thinned (about 0.3-m thick). The fine UM rockfill in place on the rest of the upstream toe liner tie-in did not allow for offsetting of the filters layers to maintain the original thickness of 0.5 m.

5.3 Saddle Dam 3 Finalization of Stage 3

Design Change – Change in the LLDPE Geomembrane Protection on the Upstream Slope of Saddle Dam 3

A design change was done in 2017 to the LLDPE geomembrane protection on the upstream slope of Saddle Dam 3. The configuration was commonly agreed upon by Golder and the Meadowbank Engineering Team (Doc 1777687-1564-TM-Rev1). The original configuration consists in a 2.0-m thick layer of till, including a 0.5-m thick layer of sieved till (0-50 mm) directly against the LLDPE liner followed by a 1.5-m thick layer of low quality till (0-300 mm). A 1.0-m thick layer of fine rockfill (Type-5 0-500 mm) was placed directly against the 2.0-m thick layer of till.

Due to a shortage in sieved till (0-50 mm) and the unavailability of a crusher to sieve new material, it was agreed upon between Golder and AEM to replace the sieved till by compacted till sieved with an excavator in order to remove as many particles larger than 150 mm as possible, and aiming for 0-150-mm till. Due to the presence of relatively large rocks that could damage the LLDPE, an additional protection against perforation was required for the LLDPE liner. As the geotextile available on site was TenCate Mirafi S1600, which did not meet thickness and density requirements, 2 layers of geotextile were placed against the LLDPE liner. Close supervision by the QA and QC personnel was done to ensure that material placement against the geotextile layers were conducted so as to prevent the second layer from slipping against the first layer and to ensure that no oversize particles or any particularly sharp rock was laid against the slope.

The modified design consisted in a 2.0-m thick layer of 0-150-mm compacted till placed against the LLDPE liner, protected by 2 layers of geotextile, followed by 1.0-m thick layer of fine rockfill (Type-5 0-500 mm). The decision to use only 0-150 mm compacted till instead of one 0.5-m thick layer of 0-150-mm compacted till followed by one 1.5-m thick layer of 0-300-mm low quality till was taken to simplify the till placement, as the excavator loading the haul trucks at the Pit E5 stockpile had enough time between loadings to sieve large volumes of till.

Field Adjustment – Use of Sieved Till in Place of Compacted Till for Upstream Toe Liner Tie-In Construction

It was originally planned to build the upstream toe line tie-in with one first 500 mm thick lift of compacted sieved till (0-50 mm) as liner bedding, followed by another 500 mm thick lift of compacted sieved till above the liner and 2 other lifts of compacted till (0-150 mm). As was done in 2017, it was decided to use only sieved till (0-50 mm) for the 4 lifts of till on Saddle Dam 3, as there was enough sieved till to do so and because this yields a more robust design than required by the Technical Specifications. However, all the thawed sieved till had been used when the last till layer of the north abutment upstream toe liner tie-in was placed, and the rest of the stockpile was still frozen. As a result, the last 0.5-m thick layer of till was made with compacted till (0-150 mm).

Field Adjustment – Merging of the Upstream Erosion Protection Cover and the Upstream Toe Liner Tie-in on the South Abutment

The upstream erosion protection cover was merged with the upstream toe liner tie-in of the south abutment of Saddle Dam 3 by extending the low quality (0-150 mm) till of the erosion protection until it reached the south abutment upstream toe liner tie-in till layers. The granular protection layers of the toe liner tie-in were then placed and completed over the low-quality till (0-150 mm) with a 3H:1V slope. The fine UM rockfill of the erosion protection merged with the fine UM rockfill layer of the toe liner tie-in in the upstream slope.

On the north abutment, no merging was necessary since the hump in the dike separated the upstream toe-liner tie-in from the erosion protection.

5.4 North Cell Internal Structure

Design Change – Change in the Downstream Slope of the Structure Built on Tailings

Following discussions with AEM and the Designer, it was agreed that the downstream slopes of the internal structure which were originally designed with a 2.5H:1V on a tailings foundation, expected to thaw in summer, could be built with a 1.5H:1V provided AEM was aware of the probability of shallow failures. Analyses showed that the potential failure paths associated with FoS values of 1.2 and 1.5 were limited to the area of the 2.3 m high safety berm and did not penetrate into the vehicle path itself on the crest. The risk of these potential shallow failures is tolerable as long as there is a regime in place to monitor localized failures and repair them if they occur. AEM decided not to profile the downstream slope with an excavator and leave the material at the angle of repose, as it was already placed at a 1.5H:1V angle. Minor rockfalls may result from slope adjustment over time.

Design Change – Change in the Alignment of the Structure

Following AEM's decision with the agreement of the Designer, the North Cell Internal structure was built on the upstream end of the North Cell capping and on the existing tailings. As a result, the Internal Structure is offset towards the centre of the North Cell as opposed to the initial plans. The upstream toe of the rockfill capping was mapped to perform a field fitting of the design and a new centerline was drawn. In this updated configuration, the filters extend down to the tailings at their base. The southwestern portion of the structure, built on tailings, was realigned in order to avoid the cyanide burning area. The structure was also shortened compared to the initial plans, as deposition plans indicated that a shorter length was required (see as-built drawings in Appendix A).

Design Change – Phased Construction of the Ditches and Sumps

Discussions between AEM and Golder concluded that it would be possible to phase the construction of the drainage system, constituted of peripheral ditches and sumps, through time and to manage water in the low points with pumping equipment. This is acceptable as the North Cell Internal Structure is still in operation and not yet in closure, provided AEM is ready to increase the pumping capacities and/or to dig additional ditches if excessive seepage or runoff is observed. The construction done during the 2018 season included:

- Clearing a channel through the area near the cyanide burning pad to allow water to flow gravitationally inside the North Cell Internal Structure;
- Digging a ditch west of the NCIS, flowing southbound towards the interior of the NCIS, without installing a liner;
- Improving the water management capacities by deepening the low points in the tailings east of the NCIS, installing a granular cover to prevent erosion of the tailings and creating an access for the pumping crew.

The QA/QC personnel conducted close supervision of the excavation in the tailings to ensure that the underlying RF2 till layers were not excavated.

This design change is documented in technical memorandum 1897439-1582-TM-Rev0, presented in Appendix B.

Field adjustment – Change in the Maximum Allowable UM Rockfill Lift Thickness

According to the survey done on the existing UM rockfill lift at El. 152 m (approximately) at the beginning of the construction season, it appeared that the actual capping thickness varied from 0.9 m to 3.5 m, with elevations ranging from 151.9 m to 153.9 m. It was agreed with the Designer that a lift thickness maximum of 2.5 m could be left as is, as it was not expected to affect the maximum achievable compaction significantly with special attention paid to compaction (6 passes of the compactor). One section of the UM rockfill lift constituting the North Cell Internal Structure was thicker than 2.5 m; this section was corrected with the dozer to maximum El. 153 m.

Field adjustment – Foundation of the Structure on Natural Ground

The North Cell Internal Structure alignment included a portion where the 2015 North Cell rockfill capping was built on the natural soil (thin layer of organic soil overlying till), between Sta. 1+800 m and 1+900 m approximately. The toe of the structure, including UM rockfill and filter materials, extended the natural ground. The foundation in this area was prepared by removing soft materials (organic soil and till) with an excavator until good quality bedrock was reached, in order to provide a sound foundation for the filter materials and limit risks of settlement which could impact filter performance.

Field adjustment – Change in the Coarse and Fine Filters Material Placement and Compaction

Due to the impossibility of trafficking over the soft, thawed tailings and the limited reach of the excavator from the crest of the structure, placement of filter materials in horizontal lifts to their full width was difficult. As a result, the coarse and fine filters were placed on the upstream slope of the North Cell Internal Structure each in a single lift, ranging from the upstream toe to the crest, with a thickness of 0.5 m perpendicular to the slope. Given the gentle 3H:1V slope, compaction was done on each lift with 4 passes of a 10-T smooth-drum compactor directly on the slope. Compaction of the coarse filter lift was done before the excavator trafficked over the coarse filter to place the fine filter lift.

Compaction of the filters was done with a 10-T smooth-drum compactor in the upstream slope, attached to an excavator to assist it when going uphill. Due to the soft tailings foundation in certain areas, the compactor was unable to reach the bottom of the slope (about 1 m from the toe), as it pushed material downwards into the tailings. This portion of the slope was flattened and compacted with the bucket of the excavator at the end of the compaction operation. In soft foundation areas, the first pass of the compactor down the slope was conducted without vibration to stabilize the material in place.

Field adjustment – Compaction under the Downstream Berms at El. 154 m

Haul trucks trafficked the entire width of the UM rockfill platform at El. 154 m except for the downstream berms and represent an acceptable compaction of the material. Since the downstream berms represent a smaller width than trafficable safely by the compactor, and since no further raise is planned above El. 154 m, it is acceptable not to compact the portion of the UM rockfill platform underneath the downstream berms.

Signature Page

Golder Associés Ltée

REGISTERED PROFESSIONAL ENGINEER
Y. BOULIANNE
LICENSEE
NT/NU
2018-11-30

Marion Habersetzer, M.Sc.
Mine Waste Group

Yves Boulianne, P.Eng.
Associate, Senior Geotechnical Engineer

Marion Habersetzer
for: Samuel Barbeau
Mine Waste Group

PERMIT TO PRACTICE
GOLDER ASSOCIATES LTD.
Signature
Date 2018-11-30
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

MH/SB/YB/

https://golderassociates.sharepoint.com/sites/1897439/preparation of deliverables/as-built/1897439-1578-r-rev0 as-built report 2018.docx

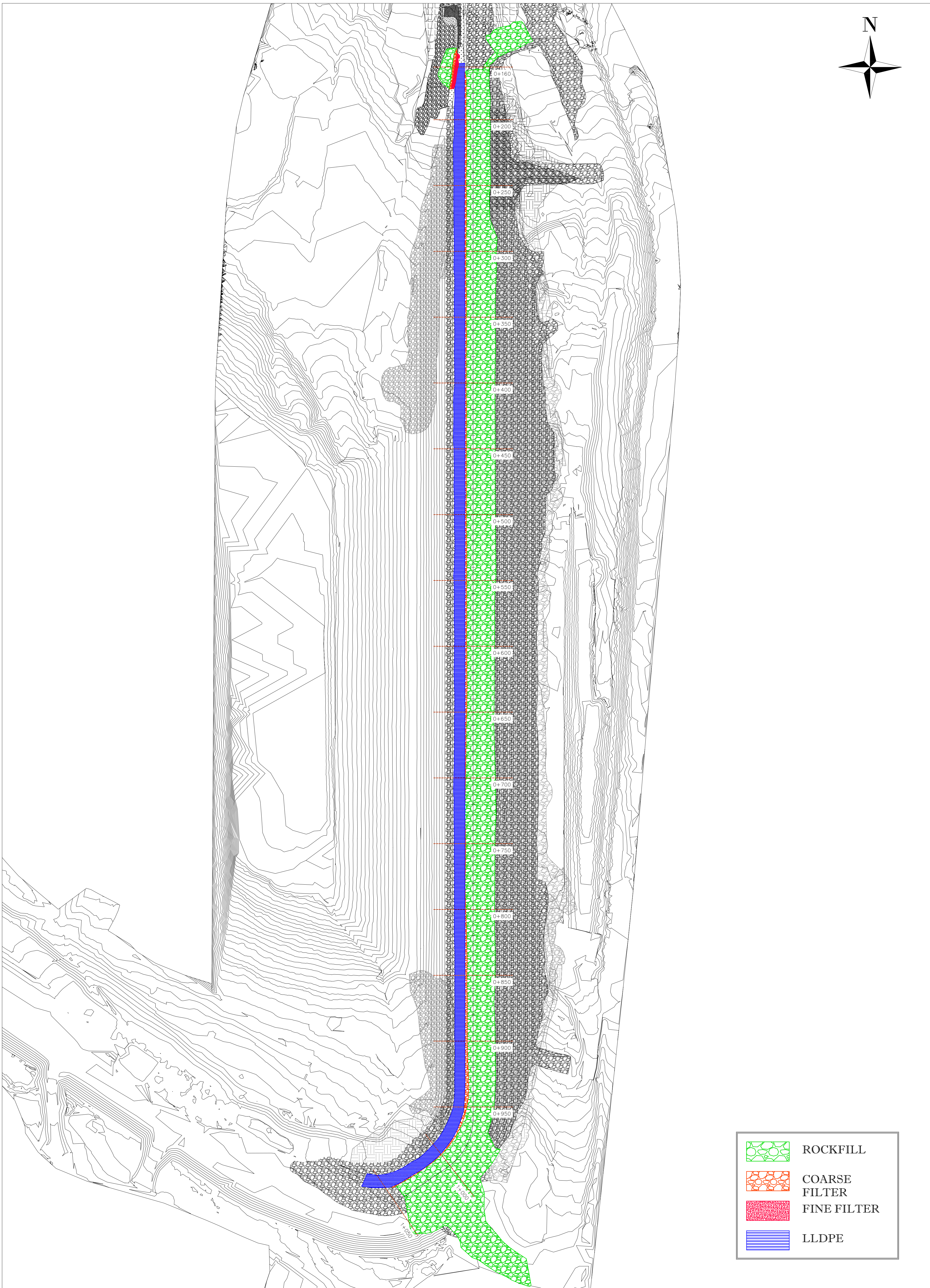
APPENDIX A

As-built drawings

APPENDIX A-1

Central Dike Stage 6

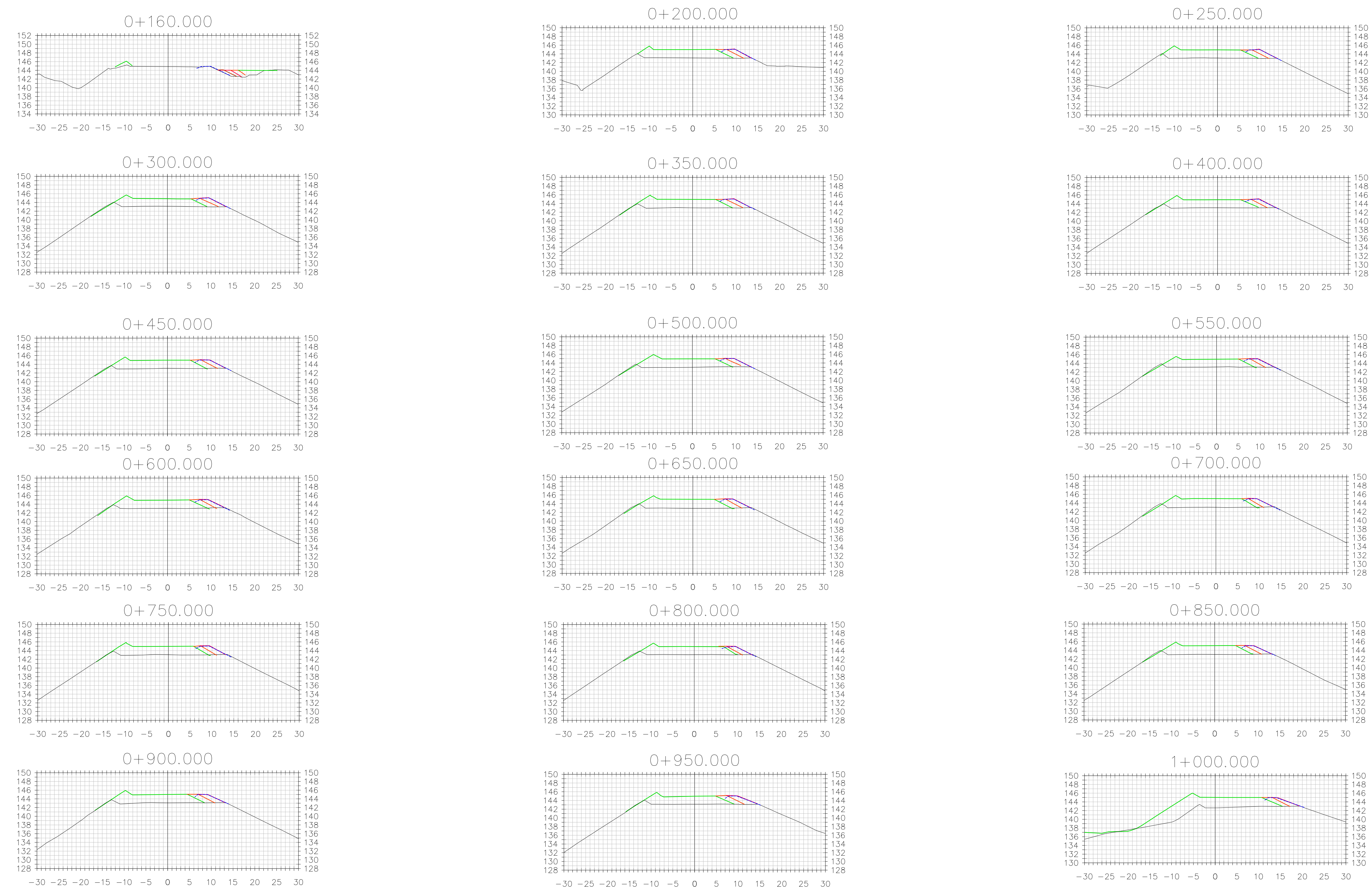
AS BUILT CENTRAL DIKE
DIKES CONSTRUCTION
CONTRACT # 11-505



KIVALLIQ CONTRACTORS
GROUP LTD

PREPARED BY : MIKAËL LÉVESQUE
DATE : 11-08-2018
CON-FD-027_CD

AS BUILT CENTRAL DIKE
DIKES CONSTRUCTION
CONTRACT # 11-505



- ROCKFILL
- COARSE FILTER
- FINE FILTER
- TILL CLASS 1
- LLDPE

KIVALLIQ CONTRACTORS GROUP LTD

PREPARED BY : MIKAËL LÉVESQUE
DATE : 11-08-2018
CON-FD-027_CD

APPENDIX A-2

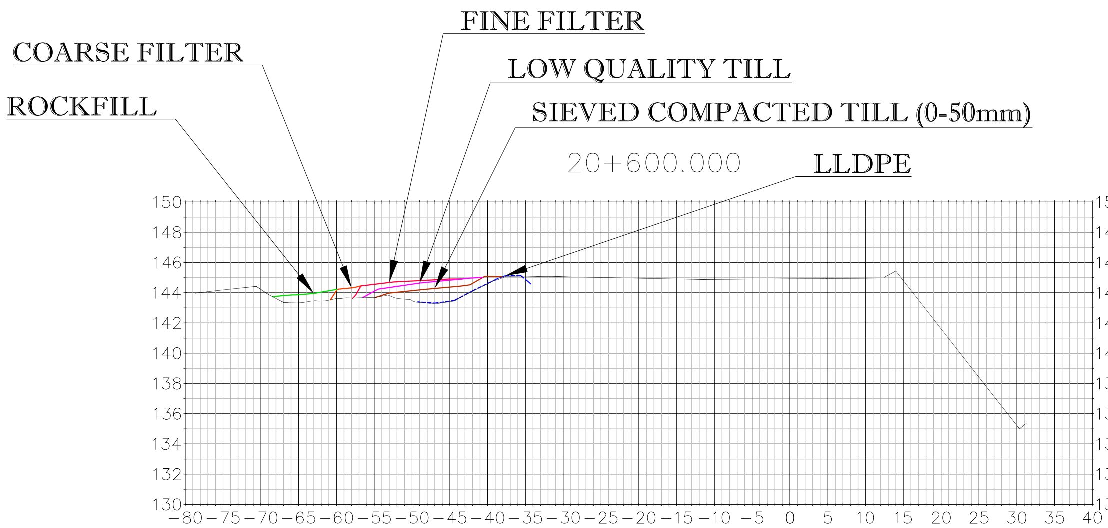
Saddle Dam 3 finalization of Stage 3

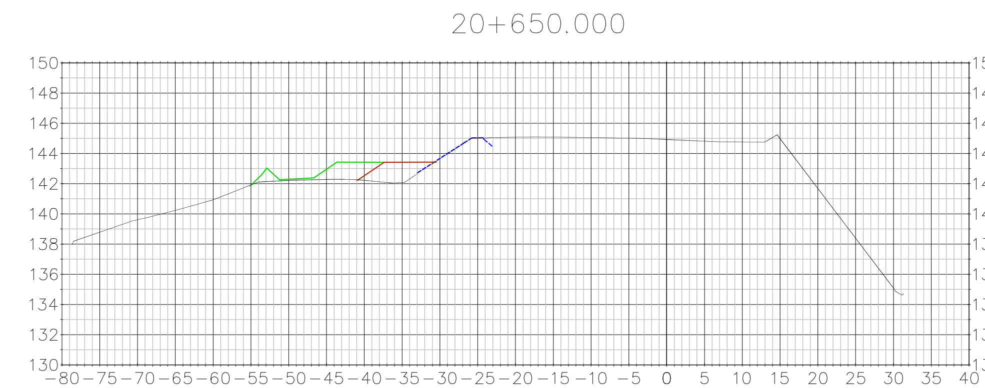
SADDLE DAM 3 AS BUILT
DIKE CONSTRUCTION
CONTRACT # 11-505

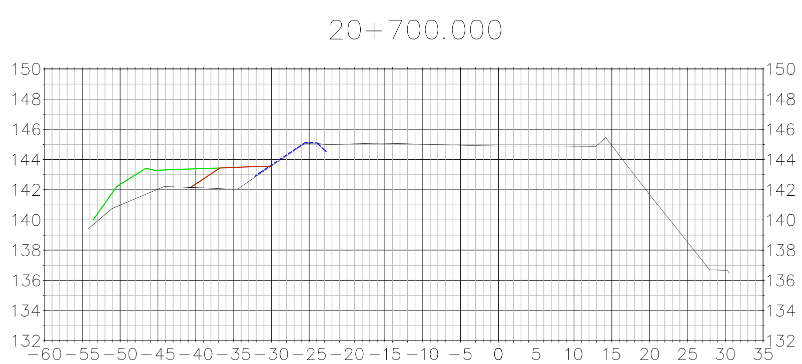
KIVALLIQ CONTRACTORS
GROUP LTD

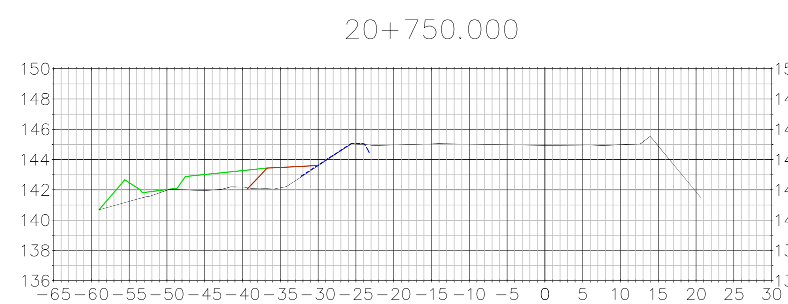
PREPARED BY : MIKAËL LÉVESQUE
DATE : 30-08-2018
CON-FD-010-SD3

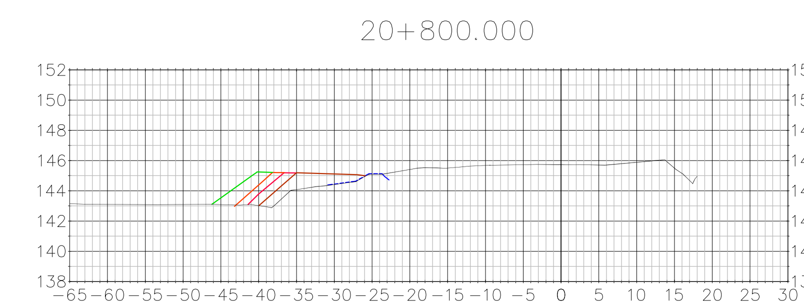
SADDLE DAM 3 AS-BUILT
DIKE CONSTRUCTION
CONTRACT # 11-505











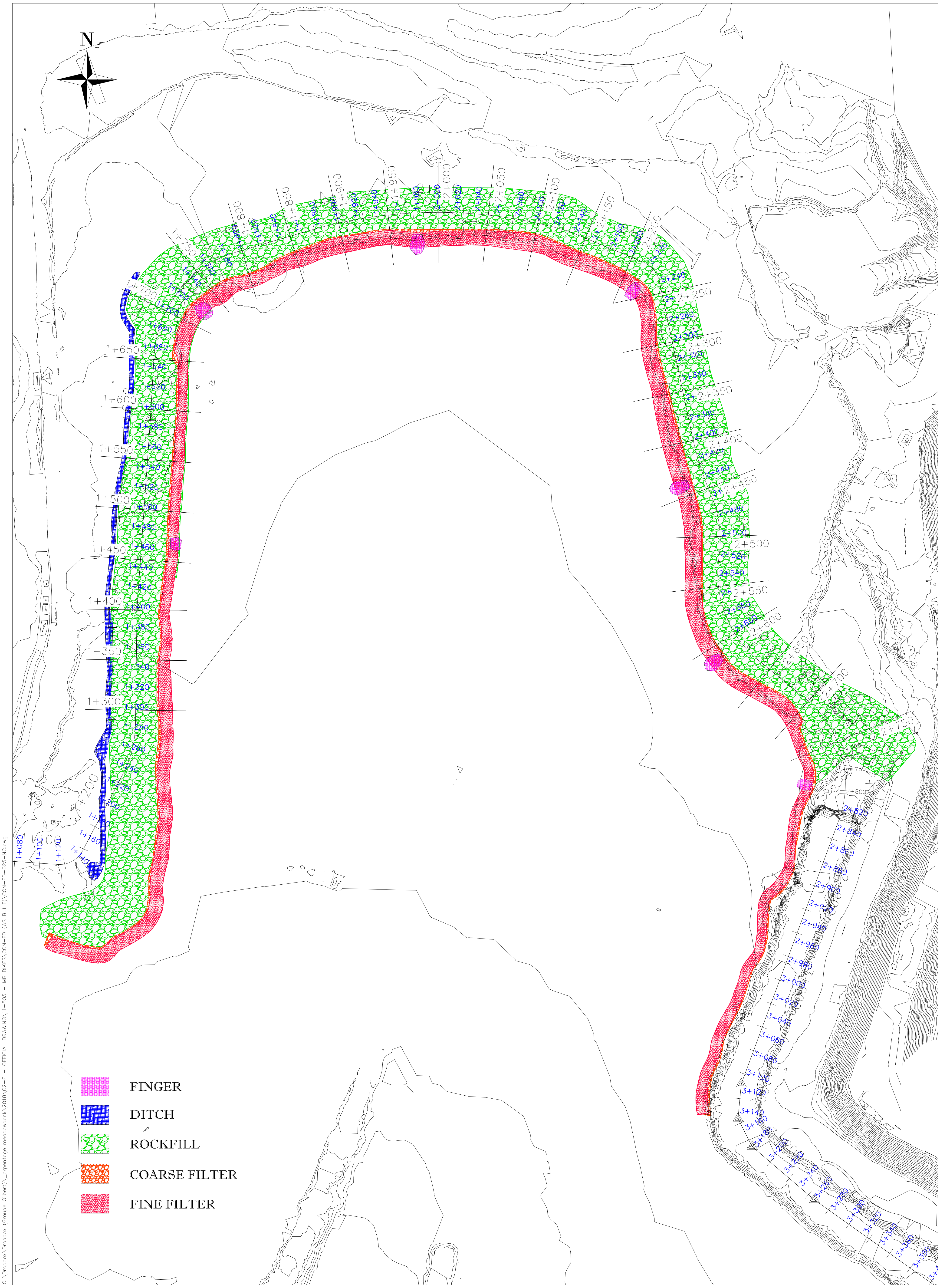
KIVALLIQ CONTRACTORS
GROUP LTD

PREPARED BY : MIKAËL LÉVESQUE
DATE : 30-08-2018
CON-FD-010-SD3

APPENDIX A-3

North Cell Internal Structure Construction

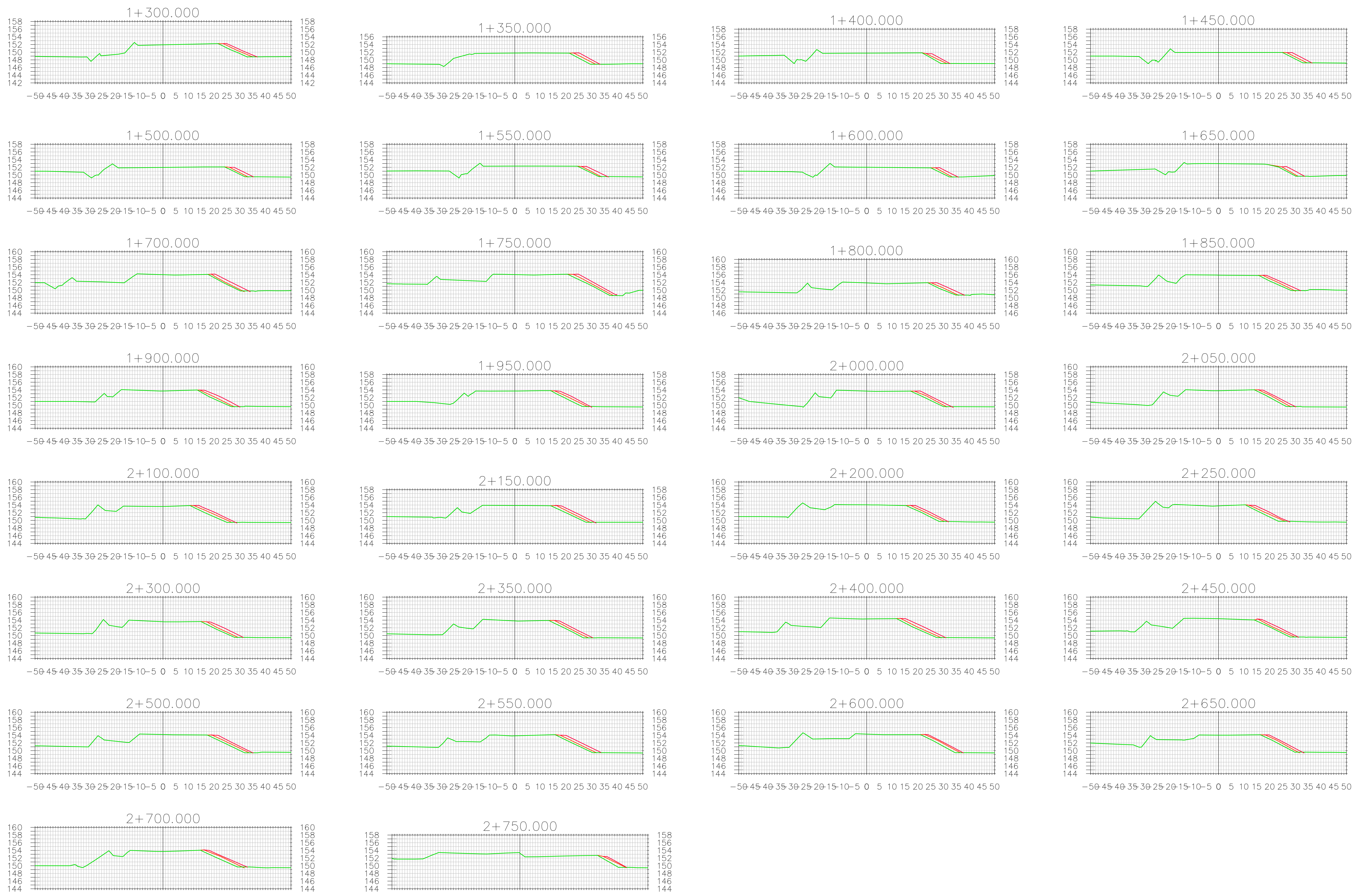
NORTH CELL AS BUILT
DIKE CONSTRUCTION
CONTRACT # 11-505



KIVALLIQ CONTRACTORS
GROUP LTD

PREPARED BY : MIKAËL LÉVESQUE
DATE : 10-09-2018
CON-FD-025_NC_REV2

NORTH CELL AS BUILT
DIKE CONSTRUCTION
CONTRACT # 11-505



KIVALLIQ CONTRACTORS
GROUP LTD

PREPARED BY : MIKAËL LÉVESQUE
DATE : 10-09-2018
CON-FD-025_NC_REV2

APPENDIX B

Design Modification Documents

GOLDER

TECHNICAL MEMORANDUM

DATE November 29, 2018 **Reference No.** 1897439-1582-TM-Rev0

TO Patrice Gagnon, Pier-Éric McDonald
Agnico Eagle Mines Ltd, Meadowbank Division

CC Frédérick Bolduc, Alexandre Lavallée

FROM Marion Habersetzer, Yves Boulianne **EMAIL** mhabersetzer@golder.com

RE: PHASED CONSTRUCTION OF THE DITCHES, SUMPS AND INSTRUMENTATION OF THE NORTH CELL INTERNAL STRUCTURE – MEADOWBANK MINE, NUNAVUT

1.0 INTRODUCTION

The North Cell of the tailings storage facility is planned for use in 2018 and 2019 to store tailings from the Meadowbank process plant. To this end, the North Cell is being raised in 2018 through the construction of the North Cell Internal Structure. The purpose of the North Cell Internal Structure is to allow for tailings deposition without water retention; together with the rock cover, it will establish the defined final landform for the closure of the North Cell. Figure 3 after the text presents the initial design of the North Cell Internal Structure as stated in the design report (reference 1784383-Rev0, Golder, 2018). The as-built footprint of the structure, as constructed during the 2018 construction season, is also indicated on the figure.

Since the structure is designed as a filtering dike to let water within the tailings slurry seep through, a drainage system was included in the design (Golder, 2018). The original design included a total of seven perimeter ditches around the Internal Structure and four sumps to be excavated below ground surface. The purpose of the perimeter ditches and sumps is to collect runoff from the downstream face of the Internal Structure and surrounding areas, while collecting toe seepage (contaminated water) for pumping into the internal pond as required.

The North Cell Internal Structure is being built in 2018 at the elevation 152 m, and 154 m in its northeastern portion, as required by the deposition plan developed by AEM for the North Cell raise. The rest of the structure may be raised to El. 154 m during a subsequent phase if needed. The dike alignment has also been shifted toward the centre of the North Cell, so that the dike lies on the inner edge of the existing rock cover (capping) built on the North Cell existing tailings, following discussions between Agnico-Eagle Mines (AEM) and Golder Associates (Golder). The stations featured on Figure 3 after the text correspond to the revised alignment (modified alignment provided by AEM). It is estimated that offsetting the dike alignment towards the centre of the cell facilitates water management towards the centre of the cell. Therefore, given the change in the location of the structure, as well as the fact that the structure will not be built in its final configuration in 2018, a phasing of the ditches and sumps has been agreed upon by AEM and Golder. This technical memorandum describes the recommendations for each drainage element for the 2018 construction season and provides recommendations on the phasing of the construction of the drainage system over the lifetime of the dike. Structures built during the operation of the dike are temporary structures, and the phasing of the construction does not alter the need for the construction of all the required drainage elements at the time of the North Cell closure as per the design report and construction drawings.

The recommended preliminary instrumentation of the North Cell Internal Structure is also described below.

2.0 DITCH 1 AND SUMP 1

As per the design, Ditch 1 is a shallow unlined ditch which collects runoff at the southwest corner of the North Cell Internal Structure and drains southwest into Sump 1.

This section of the North Cell Internal Structure (between Sta. 0+000 m and 0+400 m of the original alignment, see Figure 3 at the end of the text) will not be built in 2018. Thus, Ditch 1 and Sump 1 are not necessary at this point. These elements will need to be built when this section is built at a later time.

3.0 DITCH 2 AND SUMP 2

As per the design, Ditch 2 is a two-section shallow lined ditch which collects runoff on the west side of the North Cell Internal Structure and drains northwest (southern portion) and south (northern portion) into Sump 2. This ditch was designed to be lined with geomembrane due to its proximity to the environment.

The North Cell Internal Structure in this area is further from the environment than on the original alignment. The downstream side of the dike is mostly constituted of rockfill cover (from approx. Sta. 1+300 m to 1+900 m of the original alignment). From approx. Sta. 1+100 m to 1+300 m of the original alignment, in the vicinity of the Cyanide Burning Pad, the downstream side of the dike is constituted of North Cell tailings. The extent of structure built in 2018 being shorter than the original alignment, the downstream side of the structure still connects to the southern part of North Cell. No accumulation of water on either the rockfill cover or the tailings on the downstream side of the dike was observed before the operation of the North Cell Internal Structure, and based on the assumed tailings slope during deposition, it is expected that water from the tailings will not predominantly flow towards this portion of the dike; hence no significant seepage is expected in the short term. The presence of the Cyanide Burning Pad, however, represents a blockage for the drainage of water toward the North Cell, should seepage occur in this area.

The decision was made to excavate a shallow unlined ditch (at least 1 m wide and 0.5 m deep) in the rockfill cover and tailings on the downstream side of the dike, in order to collect and redirect possible seepage which could occur through the dike toward the North Cell (see Figure 3). The ditch will start from the northwestern extremity of the North Cell Internal Structure, cross the Cyanide Burning Pad area (the pad will ultimately be relocated) and extend beyond the southwestern extremity of the dike to ensure that water is redirected toward the North Cell pond. A layer of rockfill was placed on the surfaces of the ditch excavated within the tailings to prevent erosion of the tailings. A temporary sump was excavated at the south extremity of the ditch.

AEM should monitor the downstream area for signs of seepage and be ready to take measures if it is higher than expected (e.g. if the tailings deposition differs from the plan or if changing tailings slopes causes water to redirect toward this area). Should such a situation arise, the deposition point should be switched and Ditch 2 and Sump 2 should be built in a timely manner to control the seepage. In all cases, Ditch 2 and Sump 2 will be built in accordance with the design for the North Cell closure phase. The necessity of lining the ditch and sump can be reevaluated at that moment based on observations made during operations.

4.0 DITCH 3 AND SUMP 3

As per the design, Ditch 3 is a two-section shallow unlined ditch which collects runoff on the north side of the North Cell Internal Structure and drains west (eastern portion) and east (western portion) into Sump 3, see Figure 3 at the end of the text.

The North Cell Internal Structure in this area is built further south than on the original alignment. The downstream side of the dike is mostly constituted of rockfill cover (from approx. Sta. 1+900 m to 2+500 m of the original alignment), with till-like material and North Cell tailings being present downstream of the eastern end of the structure (from approx. Sta. 2+500 m to 2+750 m of the original alignment). On the northwestern extremity of the dike, water is accumulating in a topographic low point (clean water from runoff of the watershed north of the North Cell). On the northeastern extremity of the dike, another low point accumulating runoff water exists (in contact with tailings, thus contaminated), kept open after the area was capped with a rockfill cover, allowing it to freeze and thus providing a low-permeability medium. Deposition from the northern portion of the dike is expected to provide a slope promoting gravitational flow of the water away from this section of the structure.

It is expected that the wide rockfill cover on the downstream side of this portion of the North Cell Internal Structure will promote infiltration and natural drainage of runoff and seepage towards the North Cell. During operations, water is expected to be manageable in this area without a ditch. Low points will be monitored and pumped out at freshet or any time when water accumulation becomes significant, as it has been the case since the beginning of operations. The water of both low points will need to be pumped into the North Cell, as water could be contaminated by seepage of tailings water through the dike once it is in operation. The northeastern low point should be monitored for resurgences after capping with rockfill cover to evaluate whether it provides a satisfactory low-permeability medium. If water accumulation is noticed, the immediate construction of Ditch 3 will be required. Ditch 3 will in any case be built before closure of the North Cell. For closure, clean water runoff from the watershed outside the North Cell footprint will need to be efficiently drained by redirecting water toward the environment, while only North Cell seepage water will be collected in water sumps. Ditch 3 and Sump 3 will be built according to the design. Until the final construction to its full extent, the length of Ditch 3 toward the east could be subject to possible changes if no water is observed during operations in the northeast sector.

5.0 DITCH 4 AND SUMP 4

As per the design, Ditch 4 is a two-section deep unlined ditch which collects runoff at the southeast corner of the North Cell Internal Structure, along structures RF1 and RF2, and drains south (northern portion) and north (southern portion) into Sump 4, see Figure 3 at the end of the text.

A topographic high point is located within the proposed extent of Ditch 4 (approx. Sta. 3+400 m of the original alignment), and water is observed ponding on the tailings on both sides of this apparent rock outcrop, between the North Cell Internal Structure and the RF1 and RF2 structures. This water accumulation has been observed regularly and is currently monitored by AEM and pumped out as needed (during freshet).

During operations, water can be managed in this area by excavating two sumps of smaller size than the design but will retain the same geometry, one on each side of the high point, while being pumped out as needed. AEM could decide to install smaller capacity pumps that are sized to meet observed flows, with the prospect that it may become necessary to increase the pump sizes later if and when the seepage flows increase. It is estimated that dividing the watershed in two will effectively reduce the required magnitude of the sumps and pumping systems. The capacity of this relatively contained area in terms of water retention will also provide enough reaction time to increase the pumping capacity in case of rising water levels. The drainage system in this area was designed with one deep ditch and one deep sump. During operations, the temporary setup will be constituted of two shallow sumps only. For closure, given that the watershed will then be managed in two parts instead of centralizing all the runoff water in one sump, the sizing of the final drainage elements (ditches and sumps) will need to be confirmed to comply with the design. During excavation near RF1 and RF2, great care was taken to excavate only tailings and to avoid interfering with the RSF till plug underneath. A close follow-up by the QA and QC team will be required during these operations to ensure that the integrity of the RSF till plug is not compromised.

6.0 INSTRUMENTATION OF THE NORTH CELL INTERNAL STRUCTURE

The purpose of the instrumentation is to monitor changes in the thermal regime of the tailings and associated settlements, should they occur. To this end, thermistors and displacement monitoring points should be installed on the structure. This section describes the recommended instrumentation regarding the current configuration of the structure. Additional instruments will be required at a later date.

6.1 Thermistors

The thermistors should be installed at and around a deposition point, in order to monitor the behaviour of the foundation and structure with regards to the deposition.

- One instrument should be installed as close to the deposition point as safely manageable, on the upstream crest (number 1 on Figure 1 below);
- A second instrument should be installed on the downstream crest, across from the deposition point (number 2 on Figure 1 below);
- A third instrument should be installed on the upstream crest 25-30 m away from the first one (number 3 on Figure 1 below).

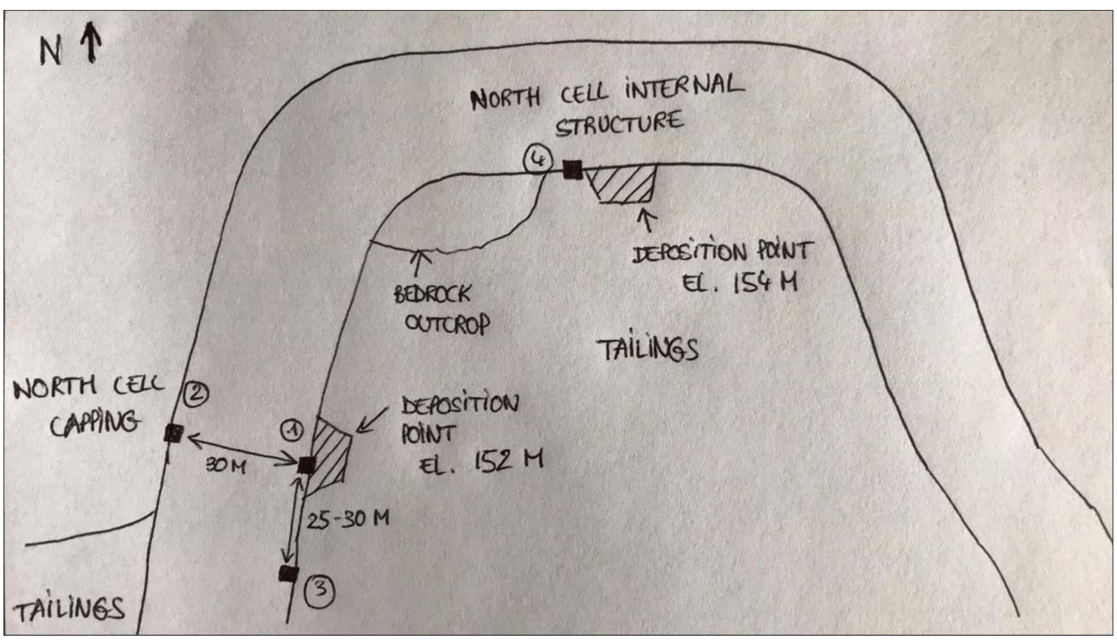


Figure 1: Proposed layout of the thermistors (symbolized by numbered blacks squares) around deposition points

The thermistors should have at least one node at the base of the rockfill, one at the top of the foundation, and extending at least 5 m through the foundation but preferably reaching the bedrock.

The thermistor node locations must be adjusted along the PVC to focus on the area from the base of the rockfill layer to a few metres under the tailings surface. Nodes are to be located within the rockfill layer and one of them 500 mm from the base of the layer. Within the tailings, a few nodes are to be placed every 500 mm from the top of the tailings surface. At least one bead should be installed within the bedrock. Figure 2 below provides an illustration of the required spacing around the rockfill-tailings interface.

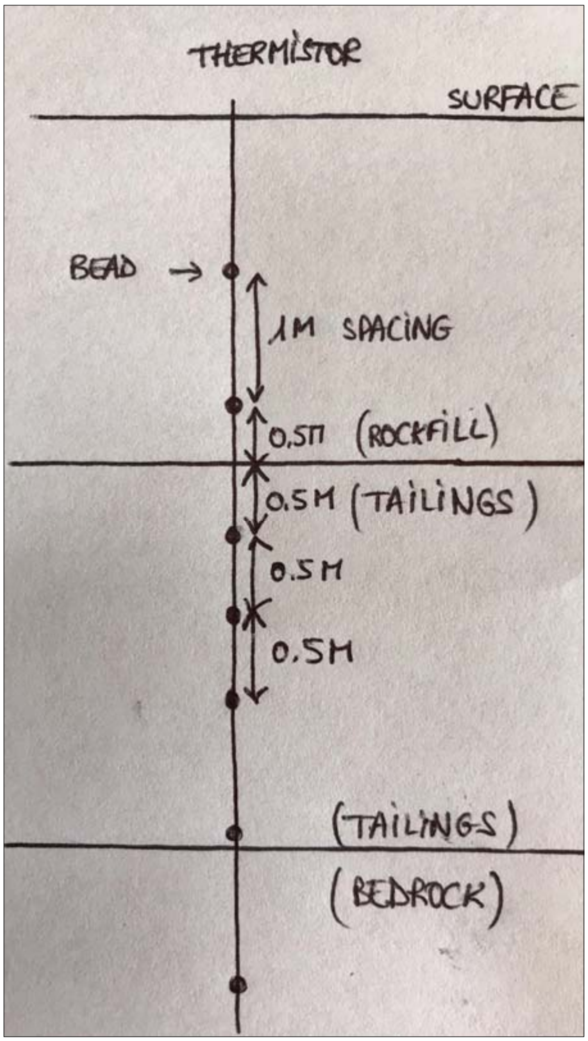


Figure 2: Schematic cross-section of a thermistor showing the required spacing around the rockfill-tailings interface

The southwestern part of the structure is built entirely on exposed tailings, whereas the rest of the structure is at least half built on the North Cell Capping (downstream side) overlying the tailings. The portion built on exposed tailings had a design change to deviate the downstream slope from 2.5:1 to 1.5:1, provided AEM was aware of the risk of skin failures, and as such, and the risk that settlements could occur in this area. Therefore, it was decided by AEM and agreed upon by Golder to install 3 instruments on the deposition point located in this section, with the above-mentioned configuration to monitor the tailings response. A fourth thermistor was installed near the deposition point located in the northern part of the structure (number 4 on Figure 1).

6.2 Settlement Monitoring points

It is recommended to install prisms along the structure to monitor tridimensional displacement. Prisms should be installed on the upstream and downstream edge of the crest at each of the deposition points, as well as at half the distance between two adjacent deposition points.

Should movement be observed within the structure (e.g. settlement, cracks, sloughing), additional monitoring points will be installed immediately to monitor the section of concern.