TETRA TECH

CONSTRUCTION SUMMARY (AS-BUILT) REPORT FOR DIKE D-CP1, MELIADINE GOLD PROJECT, NUNAVUT

PRESENTED TO

AGNICO EAGLE MINES LTD.

MELIADINE GOLD PROJECT

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EXECUTIVE SUMMARY

Dike D-CP1 was constructed at the outlets of two existing shallow lakes (H6 and H17) at the Meliadine Gold Project site. It is approximately 600 m long with a maximum dike height of approximately 6.6 m. The construction of Dike D-CP1 started in October 2016 and was completed in July 2017. The primary water retention element in Dike D-CP1 is a geomembrane liner tied into a key trench in underlying permafrost.

Tetra Tech Canada Inc. designed the dike, provided construction monitoring, earth-work quality control and quality assurance testing services during the construction of Dike D-CP1. Construction management was overseen by Agnico Eagle Mines Ltd. MTKSL Contracting Joint Venture produced construction materials and constructed the dike. Liner installation was performed by Texel Geosol Inc. (Texel) working as a sub-contractor for MTKSL. Liner QC testing and monitoring was performed by Texel.

Dike D-CP1 was generally completed according to its design intent and overall specifications with the available construction materials. Some variations were made during construction to accommodate the field material availability, constructability, construction method and schedule, and design changes. Variations are documented in this report, Request for Information (RFI), and Engineering Change Notices (ECN). The Tetra Tech design team was responsible for approval of all implemented RFIs. Agnico Eagle Mines Ltd. was responsible for approval of all ECNs. The variations are not expected to materially impact the performance of the dike structure. Key variations are as follows:

- Unsuccessful attempts at mixing and placing Type K (nearly-saturated 20 mm minus granular fill) resulted in the suspension of its use. The material was only placed between Stations 0+090 and 0+310 prior to the suspension of its use. The bottom liner location was modified between Stations 0+310 to 0+585 to accommodate not using Tyke K material.
- A shortage of Coletanche ES3 liner resulted in Coletanche ES2 liner being used for all top liner panels from Station 1+520 to 1+570 and intermittent ES2/ES3 panels from Station 1+570 to 585.
- Bentonite-augmented 20 mm minus was placed from the hinge point up to an Elevation of 64.7 m from Station 1+132 to 1+551 on the top liner to reduce the risk of potential seepage through this section of the liner.
- Water was observed seeping from the upstream CP1 pond through the Type F material in mid-May and ultimately over-topped the working platform from Stations 1+170 to 1+460. To prevent the water flowing into the key trench, Type H material was placed as quickly as possible. As a result, "wet" placement of material was observed and optimum compaction of the material was not possible.
- Comparison of the as-built drawings with the design indicates dike dimensions are close to design. There are small variations; however, they will not affect the overall stability of the dike.
- The north section of the seepage channel was drilled and blasted with significant over blasting. The over excavated zone was backfilled with ROM material.
- Some of the Type C and Type F materials placed in the key trench below the liner during the winter had lower densities than designed. This was due to the frozen condition of the fills.

The QA/QC material testing results and construction record drawings are presented in this report.

Five (5) horizontal and five (5) vertical ground temperature cables and five (5) steel rod settlement monitoring hubs were installed to monitor the performance of Dike D-CP1.

To follow the best practices, the performance of Dike D-CP1 must be monitored throughout its operating life. Long-term monitoring of D-CP1 should include thermal monitoring, settlement monitoring, routine visual inspections, and annual inspections according to the regulatory requirements.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
AEM	Agnico Eagle Mines Ltd.
AEP	Annual Exceedance Probability
CAT	Caterpillar
CP	Collection Pond
DRE	Dike Resident Engineer
ECN	Engineering Change Notice
GTC	Ground Temperature Cable
HGTC	Horizontal Ground Temperature Cable
IDF	Inflow Design Flood
km	Kilometers
m	Meters
QA	Quality Assurance
QC	Quality Control
RFI	Request For Information
ROM	Run-Of-Mine
VGTC	Vertical Ground Temperature Cable

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Agnico Eagle Mines Ltd. and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Agnico Eagle Mines Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

1.1 General

Tetra Tech Canada Inc. (Tetra Tech) was retained by Agnico Eagle Mines Ltd. (Agnico Eagle) to prepare a construction summary (as-built) report for Dike D-CP1 at the Meliadine Gold Project (the project) site. Agnico Eagle is currently developing the project which is located approximately 25 km north from Rankin Inlet, Nunavut. The project site is located on the peninsula between the east, south, and west basins of Meliadine Lake (63°01'23.8"N, 92°13'6.42"W). A general location plan for the project is shown in Figure 1.

Dike D-CP1 was designed by Tetra Tech. It was constructed at the project site as part of its development plan between October 2016 and July 2017. Construction management was overseen by Agnico Eagle's Meliadine Division's Construction Department. MTKSL Contracting Joint Venture (MTKSL) produced construction materials and constructed the dike. MTKSL was also responsible for survey control during construction and compilation of as-built information. Tetra Tech was retained by Agnico Eagle to provide construction monitoring, quality assurance, and earthworks quality control testing services during the construction of Dike D-CP1. Liner installation was performed by Texel Geosol Inc. (Texel) working as a sub-contractor for MTKSL. Liner QC testing and monitoring was performed by Texel.

A technical advisory committee reporting to Agnico Eagle oversaw the dike construction. The committee included Mr. Thomas Lepine from Agnico Eagle, Mr. Luciano Piciacchia from BBA, and Mrs. Fiona Esford from Golder Associates. During the dike construction the team received the daily and weekly dike construction QA/QC reports, was involved in several key technical discussions, and had several field visits to the project site.

Dike D-CP1 is located at the outlets of two existing shallow lakes (H6 and H17). The dike is approximately 600 m long with a maximum dike height of about 6.6 m above the original ground. A general site plan showing the location is presented in Figure 2. A description of the dike construction activities and the quality assurance and quality control test results are presented in this report. Construction record drawings are attached in Appendix B. The survey data used for producing Dike D-CP1 construction record drawings was provided by MTKSL.

Dike D-CP1 was generally completed according to its design intent and overall specifications with the available construction materials under the field site and construction conditions. Some variations were made during construction to accommodate the field material availability, constructability, construction method and schedule, and design changes made during the construction. These variations are described in Section 7.0. Variations are documented in this report, Request for Information (RFI), and Engineering Change Notices (ECN). The Tetra Tech design team was responsible for approval of all implemented RFIs. Agnico Eagle was responsible for approval of all ECNs.

This report, which is to be submitted to the Nunavut Water Board, is prepared to meet the requirements in the Type "A" Water Licence No. 2AM-MEL 1631 – Agnico Eagle Mines Limited for the Meliadine Gold Project (Part D, Item 3).

1.2 Dike Design Concept

The detailed design of Dike D-CP1 was presented in Design Report for D-CP1 Meliadine Gold Project, NU. Version 0 (Tetra Tech EBA 2016a). This dike is one of several water retention dikes required to manage the site contact water during pre-production, operation, and interim mine closure.

D-CP1 is located at the outlets of two existing shallow lakes (H6 and H17) which were partially dewatered from September 2016 to October 2016 prior to and at the start of the dike's construction. Following the construction of D-CP1 the former Lakes H6 and H17 will now be combined to form water storage pond CP1. Dike D-CP1 retains the water stored in the CP1 pond. CP1 is the final water collection pond for the project site and will receive all of the site contact water from the Industrial Area (plant site and accommodation complex buildings), Waste Rock Storage

Facility, Dry Stack Tailings Facility, Ore Stockpiles, and two open pits. The water stored in CP1 during the open water season will be pumped to an effluent water treatment plant. Treated water that meets discharge criteria will be pumped through a pipeline to a diffuser in Meliadine Lake for final discharge. It is intended that the water elevation in CP1 will be kept low during most of its operation. Temporary water storage will occur during the annual spring freshet or during extreme rainfall events.

Dike D-CP1 was designed and built as a lined dike with the liner keyed into a central key trench. The liner system consists of a bituminous geomembrane liner (Coletanche ES3 and ES2). The liner is tied into the base of the key trench with bentonite-augmented 20 mm minus material (Type F). The superstructure is constructed of run-of-mine rock (Types A and A1), transition rockfill (Types B and B1), sand and gravel fill (Type H), and granular fill material (Type C). A general section of D-CP1 design concept is presented in Figure 3.

1.3 Downstream Water Collection Channels and Sump

A water collection sump and two channels that feed into the sump were constructed approximately 5 m away from the downstream toe of Dike D-CP1. These structures will collect contact water seeping through the dike. The water in the channels will flow into the sump and water collected in the sump will be pumped back to CP1 on an as-needed basis.

Construction record drawings for the sump and channels are attached in Appendix B. The survey data used for producing construction record drawings was provided by MTKSL.

1.4 Related Documents

The supporting and related documents for Dike D-CP1 construction are as follows:

- Design Report for Dike D-CP1, AEM Document Number: 6515-132-007-132-REP-003, Version 0 (Tetra Tech EBA 2016a);
- Geotechnical Specifications for the Construction of Dike D-CP1, AEM Document Number: 6515-E-132-007-132-SPT-002 R1, Revision 1 (Tetra Tech EBA 2016b);
- Construction Quality Plan for Dikes D-CP1 and D-CP5, AEM Document Number: 6515-132-007-132-QQP-001, Version 0 (Tetra Tech EBA 2016c); and
- Liner Installation QC Plan prepared by Texel.

Table 1-1 below presents the list of construction drawings used for the construction of D-CP1.

Table 1-1: List of Construction Drawings used for the Construction of Dike D-CP1

AEM Design Drawing Number	Revision Number	Tittle
65-685-230-204	1	D-CP1 General Location Plan
65-685-230-205	1	D-CP1 Key Trench and Dike Layout
65-685-230-206	1	D-CP1 Profiles
65-685-230-207	1	D-CP1 Thermal Cover Layout Plan and Profiles
65-685-230-208	1	D-CP1 Typical Sections and Quantities
65-685-230-209-001	1	D-CP1 Sections Station 1+025 to 1+200
65-685-230-209-002	1	D-CP1 Sections Station 1+225 to 1+400
65-685-230-209-003	1	D-CP1 Sections Station 1+425 to 1+575
65-685-230-210	1	D-CP1 Downstream Water Collection Channel and Sump Layout Plan and Profiles

Table 1-1: List of Construction Drawings used for the Construction of Dike D-CP1

AEM Design Drawing Number	Revision Number	Tittle
65-685-230-211	1	D-CP1 Instrumentation Plan and Details for Ground Temperature Cables
65-685-230-212	1	D-CP1 Instrumentation Plan and Details for Ground Temperature Cables and Settlement Survey Monument Points
65-685-230-213	1	D-CP1 Typical Details

1.5 Request for Information (RFI)

An RFI register for Agnico Eagle's Meliadine Project (Project Number 6515) under Contract Number C-007 which included Dikes D-CP1 and D-CP5 was established during the dike's construction. Table 1-2 below summarizes RFIs related to Dike D-CP1 that were received from MTKSL or Agnico Eagle prior to and during construction. Details of these RFIs and corresponding responses are attached in Appendix D1.

Table 1-2: Summary of RFIs for Dike D-CP1

RFI Number	Description	Date Submitted	Date Closed
RFI_6515-C-230-007_001	Missing bid items for D-CP1 downstream water collection channel sump and D-CP1/D-CP5 Instrumentation	09/01/2016	09/01/2016
RFI_6515-C-230-007_002	20 mm minus material classification / Liner type for D-CP5	09/06/2016	09/06/2016
RFI_6515-C-230-007_003	D-CP1 Change materiel from type H to CL-A	10/09/2016	10/11/2016
RFI_6515-C-230-007_004	Horizontal tolerances that will be acceptable for lift placement	10/11/2016	10/12/2016
RFI_6515-C-230-007_005	Stake out point for each material	10/14/2016	10/17/2016
RFI_6515-C-230-007_006	Type K Material Mixing	10/24/2016	11/10/2016
RFI_6515-C-230-007_008_Rev1	D-CP1 Profile – Top of liner between Stations 1+560 & 1+590	10/26/2016	11/04/2016
RFI_6515-C-230-007_009	Variation of fill placement specification	11/01/2016	11/04/2016
RFI_6515-C-230-007_010	Key Excavation From 1.8 m to 2.8 m	11/04/2016	11/10/2016
RFI_6515-C-230-007_011	Liner termination details	11/16/2016	11/17/2016
RFI_6515-C-230-007_012	Crushing and screening material acceptance	11/29/2016	12/09/2016
RFI_6515-C-230-007_013	Type H material compaction	12/01/2016	12/09/2016
RFI_6515-C-230-007_014	Solutions to address potential Type A1 material shortage	12/10/2016	12/22/2016
RFI_6515-C-230-007_015	This RFI was not submitted to Tetra Tech		
RFI_6515-C-230-007_016	Type K material mixing	01/05/2017	01/09/2017
RFI_6515-C-230-007_018	Type K placement	01/19/2017	01/20/2017
RFI_6515-C-230-007_019	Downstream excavation proposal	01/22/2017	01/22/2017
RFI_6515-C-230-007_021	Design liner base width and slope	01/24/2017	01/25/2017
RFI_6515-C-230-007_022	Slope when excavating below 1.8 m	01/27/2017	01/27/2017
RFI_6515-C-230-007_023	Type H material particle size distribution specifications	01/28/2017	01/20/2017
RFI_6515-C-230-007_024	Type B Material Shortage	02/20/2017	02/21/2017

1.6 Engineering Change Notice (ECN)

An Engineering Change Notice (ECN) was issued if a change initiated by the dike design team was made and approved by Agnico Eagle during the dike construction. Table 1-3 below summarizes the ECNs related to Dike D-CP1. Details of these ECNs and corresponding responses are attached in Appendix D2.

Table 1-3: Summary of ECNs for Dike D-CP1

ECN Number	Description	Date Issued
6515-C-235-007-ECN-001_RA	Revision 1 for Construction Specifications of D-CP1 and D-CP5	11/10/2016
6515-C-235-007-ECN-002_RA	Design Change of Dike Liner Key-in Detail at Crest for D-CP1 and D-CP5	11/14/2016
6515-C-235-007-ECN-003_R0	Design Change of Dike D-CP1 Over-Liner Bedding (replacing a zone of Type C with Type F)	04/17/2017

2.0 CONSTRUCTION MATERIALS

2.1 General

The following materials were used for the construction of Dike D-CP1:

- Run-of-Mine Rockfill (600 mm minus) – Type A and A1;
- Transition Rockfill (150 mm minus) – Types B and B1;
- Granular Fill (20 mm minus) – Type C;
- Bentonite-Augmented Material (20 mm minus) – Type F;
- Esker Sand and Gravel (75 mm minus) – Type H;
- Nearly-Saturated Backfill (20 mm minus) – Type K; and
- Geomembrane Liner (Coletanche ES2 and ES3).

2.2 Run-of-Mine Rockfill (600 mm minus) – Types A and A1

Type A material consisted principally of greywacke run-of-mine (ROM) from underground operations. Type A material generally had a maximum particle size of about 600 mm and a higher residual salinity compared to Type A1 material.

Type A1 material consisted principally of greywacke ROM that was excavated from the saline water storage pond during its construction from September to October 2016. The material generally had a maximum particle size of about 600 mm. This was generally referred to on site as “clean” ROM. The principal difference between Types A and A1 material, is that the Type A material has a residual salinity as it originated from underground operations.

Based on the dike design, Type A material was to be used for the upstream shell of the dike and for thermal cover in the abutments while Type A1 material was to be used for the downstream shell of the dike.

Shortage of Type A1 material resulted in the uppermost section (Elevation 65 m to top) of the downstream shell being constructed with Type A material as per RFI_6515-C-230-007_014.

The material was placed in lifts with maximum thickness of about 900 mm. Care was taken during placement to avoid segregation and nesting of larger particles. Each lift was compacted with a 10 ton vibratory roller drum compactor (minimum of six complete passes) and haul truck traffic prior to placing the next.

2.3 Transition Rockfill (150 mm minus) – Types B and B1

Transition rockfill material was used to backfill most of the key trench and as a filter-graded material between the ROM and fine granular fill (Type C) materials.

The dike's design called for the use of transition rockfill produced from Type A1 material obtained from the Saline Pond excavation. Due to the shortage of Type A1 material, as discussed in Section 2.2, some of the transition rockfill used was produced from Type A material. Based on Tetra Tech QA/QC personnel field notes and daily reports, most of the transition material produced from Type A material was placed above the top liner (from approximately Elevation 67.0 m to 68.6 m). This information was not provided in MTKSL as-built survey data. To differentiate between these materials, transition material produced from Type A material is referred to in this report and the as-built drawings as Type B material while transition material produced from Type A1 material is referred to as Type B1 material.

Type B1 material was used to backfill the key trench and most of the transition zone between the ROM and Type C materials. Type B material was used in the upper areas over the liner crest.

The maximum particle size of materials produced and used for dam construction was typically less than 150 mm. The 150 mm minus material was produced by the jaw crusher and did not require further processing. The specified gradation limits are presented in the design documents (Tetra Tech EBA 2016a and 2016b) and shown on the particle size analyses in Appendix E1. Quality assurance particle size analysis testing conducted during production by Tetra Tech QC site representatives indicated that the average gradation was within the specified gradation limits.

The material was placed in lifts with maximum thickness of 300 mm. Despite the care taken during material handling and placement to avoid segregation and nesting of larger particles, minor segregation issues were observed throughout the placement of Type B1 material due to the nature of placing frozen material, especially when the first two lifts in the key trench between Stations 0+007 and 0+060 were being placed. Following advice from QA/QC personnel, MTKSL generally mitigated this by ripping and mixing the stockpile and placing mostly with a dozer and not excavator when feasible.

In the months of January, February, and March 2017, the Type B1 material stockpile was essentially frozen. MTKSL used a D8 or D9 CAT dozer to rip the stockpile. As a result, some larger and frozen lumps were noticed in the material placed during those months. When observed by field QC staff, MTKSL was instructed to remove the frozen chunks prior to compaction.

Lifts of transition material were generally compacted with a 10 ton vibratory roller drum compactor (minimum of six complete passes). The first lift of Type B1 material in the key trench over the Type C material and liner was lightly compacted to avoid damaging the liner.

2.4 Granular Fill (20 mm minus) – Type C

The granular fill material (20 mm minus) referred to as Type C was used to construct the key trench fillet zone and also serves as the bedding layers above and below the liner to protect it from damage.

The 20 mm minus material was produced by the crusher from natural esker material sourced from the Meliadine Esker. The specified gradation limits are presented in the design documents (Tetra Tech EBA 2016a and 2016b). Tetra Tech's QC site representatives performed quality assurance testing on the material produced for the dike's construction. The tests included particle size analyses, moisture contents, moisture-density relationship test, and single point "frozen" dry density. Test results are attached in Appendix E2.

2.5 Bentonite-Augmented Material – Type F

Bentonite-augmented material referred to as Type F was used to construct the key trench levelling course and to provide a low permeability seal between the liner and the underlying frozen till and bedrock foundation. The Type F material was also used to seal the liner hinge point. As per ECN No. 6515-C-235-007-ECN-003_R0, a design change was introduced which authorized the placement of Type F material instead of the designed Type C material in the critical section of the dike (from the hinge point up to Elevation 64.7 m) from Station 1+132 to 1+551.

Type F material was produced by blending Type C (20 mm minus) material with dry powdered bentonite to achieve an average bentonite content of not less than 10% (by weight) with a minimum of 8% (by weight) at any grab sample. Two different particle sizes of bentonite were supplied and used for dikes construction; bentonite in smaller-sized (2,500 pound) cylindrical bags which had a slightly finer grainsize and bentonite in larger (3,000 pound) bags. Both materials were tested (swell tests and bulk density) by Tetra Tech QA/QC personnel and found suitable for dike construction.

Three 20 foot containers were used to construct a U-shaped area on the Industrial Pad for the purpose of blending bentonite and Type C material. Materials were blended by dumping/spreading Type C material within the U-shaped area, followed by placing the appropriate volume of bentonite on top of it and mixing using either a CAT 980 or a CAT IT62 loader. The mix proportions developed by MTKSL are presented in Table 2-1 below. The material was loaded in CAT 740 haul trucks and hauled to the dike where it was dumped and placed along the key trench using a CAT Excavator which further assisted in the blending.

Table 2-1: Summary Mix Proportion of Bentonite Augmented (Type F) Material

Loader	Bag Type	Number of Loader buckets of Type C Material	Number of Bentonite Bags
CAT IT62	Large Bag (3,000 Lbs.)	3 level	1
CAT IT62	Small Bag (2,500 Lbs.)	3 level	1
CAT 980	Large Bag (3,000 Lbs.)	1 level and 1 heaped	1
CAT 980	Small Bag (2,500 Lbs.)	2 level	1

Tetra Tech's QC representatives frequently visited the mixing station and observed the mixing process as well as verifying the number of bentonite bags and quantity of Type C material used were as indicated. The number of bentonite bags used for the blending were tracked by MTKSL on a daily basis and recorded by Tetra Tech's QC representatives.

Visual swell assessments on samples of placed Type F material were performed with satisfactory results obtained. Density and moisture QA/QC test results on the Type F material are presented in Appendix E3.

2.6 Crushed Esker Sand and Gravel – Type H

Crushed esker sand and gravel (75 mm minus) referred to as Type H material, was used to construct the upstream shell of the dike. This material has two main roles which are as follows:

- Transition material between the ROM outermost upstream shell and Type C material; and
- Main upstream zone to provide thermal and mechanical protection to the dikes central liner system.

Type H material was produced by the crusher from natural esker material sourced from the Meliadine Esker. The specified gradation limits are presented in the design documents (Tetra Tech EBA 2016a and 2016b). Tetra Tech's QC site representatives performed quality assurance testing on the material, including particle size analyses (gradation test), moisture contents, moisture-density relationships test, and single point frozen dry densities. Test results are attached in Appendix E4.

Most of the Type H material used for the construction of D-CP1 was produced in April and May 2017 from mainly frozen esker material. Concerns of introducing frozen chunks of finer particles, and high ice content (excess water) in the material produced and placed were raised. The Design Engineer recommended that Tetra Tech's QC team perform gradation tests on both frozen and non-frozen (thawed) materials. Some test results showed moisture contents >10% and a higher than specified fines content. Such material was stockpiled separately and not used for dike construction. MTKSL had to keep sorting the material to avoid the silty/sandy frozen chunks which could raise the fines content and/or the moisture content to levels >10%.

2.7 Nearly Saturated Backfill – Type K

Nearly saturated backfill (Type K) material was produced by mixing warm water and Type C material in a pit prepared by MTKSL about 20 m from the dike south abutment end on the upstream side. This material was to be used to backfill the lower portion of all zones over-excavated (below 1.8 m from original ground surface) below the key trench base as depicted in sketches in Appendix A of the specifications. However, Type K material was only placed between Stations 0+090 and 0+310.

Tetra Tech's QC site representatives performed quality assurance testing on the material including, moisture contents and density tests. Test results are attached in Appendix E5.

Following unsuccessful attempts at mixing/placing Type K material from mid-December 2016 to January 2017 due to the mixing method, the frozen nature of Type C material and low ambient temperatures, RFI No. 6515-C-230-007_018 was issued. Recommendations from the RFI provided alternatives to backfilling over-excavated zones in the key trench base. The main alternative was placing Type F material directly on the key trench base following its specified thickness and hence lowering the liner below the specified 1.8 m from original ground elevation. Following these recommendations, the material was not used from Station 0+310 to 0+585.

2.8 Geomembrane Liner (Coletanche ES3 and ES2)

The geomembrane liner system is the primary water retention element for Dike D-CP1. Coletanche bituminous geomembrane liner ES3 was selected to be used for the construction of Dike D-CP1. A shortage of ES3 liner resulted in ES2 liner substituted for ES3 for all top liner panels from Station 1+521 to 1+570 and intermittent ES2/ES3 panels installed from Station 1+570 to 585. All changes in liner type were clearly identified and picked up by survey for inclusion on the as-built drawings.

The liner was purchased from Coletanche and shipped to site by Agnico Eagle. Liner installation was performed by Texel working as a sub-contractor for MTKSL. MTKSL provided logistical and equipment support to the Texel team. Liner QC testing and monitoring was performed by Texel while QA was performed by the Dike Resident Engineer (DRE).

The Coletanche ES2 and ES3 geomembrane were rolled and shipped to site in sea containers. It was un-rolled, placed in panels of varying lengths accordingly, and welded in place.

3.0 CONSTRUCTION EQUIPMENT

3.1 General

Most of the mobile equipment used for the construction of Dike D-CP1 was provided by MTKSL. Details of the principal equipment used for the dike construction are presented in the following subsections.

3.2 Mobile Construction Equipment

Table 3-1 presents the major equipment used during Dike D-CP1 construction.

Table 3-1: Equipment Used During D-CP1 Construction

Haul Trucks	Bulldozers	Excavators	Loaders	Others
CAT 773	CAT D5K	CAT 330C	CAT 988G	Compactor CS563E
CAT 740	CAT D6M	CAT345B	CAT 980G	Compactor CS56
CAT D300	CAT D8T	CAT345C	CAT IT62	HAMM 3205
	CAT D9R	CAT336		Walk-behind Drum roller
		CAT320E		CAT Skid Steer
		Komatsu PC400		Hydra-Trac 400 RAB Drill

3.3 Crusher

MTKSL's aggregate crushing plant was used to produce the crushed granular materials (Types B, B1, C, and H) required for the construction of Dike D-CP1. The crushing plant was operated by MTKSL employees. The crusher system consists of a primary jaw crusher, a vibratory screen deck, and a secondary cone crusher.

Quality control testing of all material produced was performed daily by Tetra Tech's QC site representatives. Test results for materials produced and used throughout the dike construction period are provided in Appendixes E1 to E5.

4.0 DIKE D-CP1 CONSTRUCTION ACTIVITIES

4.1 General

Construction activities of Dike D-CP1 occurred between October 2016 and July 2017. Dike D-CP1 was generally constructed according to the guidelines and requirements stated in the design documents. Variations from the design were documented in RFIs and ECNs and are discussed in Section 7.0.

Dike D-CP1 construction management was performed by Agnico Eagle's Meliadine Construction Division. The construction crew constituting a site superintendent, foremen, mobile equipment operators, truck drivers, laborers, drill/blast personnel, and surveyors was provided solely by MTKSL. The drill/blast of the downstream channel/sump was conducted by a sub-contractor (McCaw South). MTKSL sub-contracted Texel for liner installation and liner QC.

A technical advisory committee reporting to Agnico Eagle oversaw the dike construction. The committee received the daily and weekly dike construction QA/QC reports, was involved in several technical discussions, and had several field visits to the project site during the dike construction.

Tetra Tech's quality control team carried out quality control testing for the earthworks, prepared daily reports for their work on site, and maintained a photographic record of the work completed during construction. Liner quality control was performed by Texel technicians.

DREs from Tetra Tech carried out quality assurance and overall quality monitoring. They produced daily and weekly reports which covered all construction activities on site. The daily and weekly reports are not attached to this report but can be provided upon request.

Figure 4 summarizes the relationship between various stake holders during the dike's construction.

Selected photographs showing various aspects and activities during the dike's construction are presented in the Photographs section of the report. The major components of the construction are listed below and summarized in detail in the following sections.

- Surveying (Section 4.2);

- Working Platforms Construction (Section 4.3);
- Key Trench Excavation and Cleaning (Section 4.4);
- Bentonite-Augmented Material Placement (Section 4.5);
- Fillet Zone Material Placement (Section 4.6);
- Key Trench Backfilling (Section 4.7);
- Run-of-Mine Placement (Section 4.8);
- Type H Material Placement (Section 4.9);
- Liner System Installation (Section 4.10);
- Downstream Water Collection Channel and Sump (Section 4.11); and
- Instrumentation Installation (Section 5.0).

4.2 Survey

MTKSL surveyors provided the following survey services throughout the construction of Dike D-CP1:

- Original ground surface surveying prior to construction;
- Layout for key trench excavation;
- Construction grade control;
- Detailed survey of as-built dike fill placement, liner installation, and final graded slopes for all material zones;
- Modeled top surfaces of placed material at the end of construction; and
- Survey of instrumentation installations.

4.3 Working Platforms Construction

Prior to key trench excavation, working platforms were constructed on the upstream and downstream sides of the key trench to facilitate the movement of equipment and personnel. The upstream platform also acted as a cofferdam to minimize inflow from Lake H6 into the key trench. The working platforms were basically the first one to three lifts of either Type A (upstream side), a combination of Types A and A1 (downstream side), and Type H (upstream) materials which constitute the upstream and downstream shells of the dike. They were approximately 1 m thick and were placed and compacted following specifications for the various materials.

Foundation preparation was necessary to ensure that there was good contact between the fill materials placed for the working platforms as this material constitutes a portion of the dike's shell. Foundation preparation activities included removing loose boulders and cobbles, snow and ice within the footprint of upstream and downstream shells.

Foundation preparation was executed principally with the CAT dozers and excavators (see Photos 1, 2, and 3). Pumping of water from Lake H6 was started about a week before construction started and continued to early November 2016. This reduced the amount of seepage through the working platform in to the key trench. The loose boulders and cobbles, snow and ice were loaded and hauled to a dump location designated by Agnico Eagle.

4.4 Key Trench Excavation and Cleaning

Key trench excavation and ripping started in October 2016 and was finalized in February 2017. Excavating and ripping from Station 0+005 to ~0+400 occurred from October to December 2016 and was mostly carried out with the CAT D8T and D9R dozers and CAT excavators as the ground was predominately unfrozen. From Station ~0+400 to 0+585 excavating and ripping which was executed mainly in January and February 2017 was challenging because the ground was frozen. Ripping with excavators (PC400 and CAT 330C) with a rock breaker attached was the main digging mechanism. Cleaning and removing excavated and ripped material was done with the CAT excavators.

The key trench excavation is shown in Photos 3 to 6.

The final key trench geometry varies along the dike depending on the depth of the key trench excavation and the key trench side slopes. Variations are a result of variable ground conditions and adjustments made following RFI_6515-C-230-007_019 and RFI_6515-C-230-007_021 to achieve the design slope and dimensions of the liner.

Final key trench excavation depths were governed by where competent bedrock or non-ice-rich, ice-saturated frozen till or sediments (with an ice saturation of no less than 90%) was encountered. If the key trench was excavated to a depth of 2.8 m from the original ground, the key trench excavation was terminated at 2.8 m. The key trench was excavated to a maximum depth of 3.2 m. Appendix E6 presents the jar test results during the key trench excavation and a chart showing the final key trench depths. Table 4-1 below summarises final key trench excavation depths and material encountered at or near the base of the key trench.

Table 4-1: Summary of Final Key Trench Excavation Depths

Station in Key Trench	Final Key Trench Depth from the Original Ground Surface (m)	Material at or Near the Base of Key Trench
0+005 to 0+230	1.6 to 3.1	Bedrock at key trench bottom
0+240 to 0+255	2.4	Ice rich soil at 2.32 m depth
0+265 to 0+280	2.4 to 2.7	Ice saturated soil at 2.33 m depth
0+290	2.5	Ice rich soil at 2.43 m depth
0+300 to 0+350	2.5 to 3.1	No excess water after thaw at 2.34 m depth
0+360	3.10	Ice rich soil at 2.8 m depth
0+370 to 0+430	2.9 to 3.2	No excess water after thaw at 2.8 m depth
0+440	2.9	Ice saturated soil at 2.8 m depth
0+465	3.0	No excess water after thaw at 2.38 m depth
0+475 to 0+495	3.0 to 3.2	Icy soil at 1.94 m to 2.25 m depth
0+535 to 0+545	2.8 to 3.2	Icy soil at 2.42 m to 2.63 m depth
0+555	3.0	Ice rich soil at 2.62 depth
0+565 to 0+585	2.9 to 3.2	No excess water after thaw at 2.47 m depth

Till material, sedimentary deposits, and weathered rock from the excavation was hauled to the dump area designated by Agnico Eagle.

Key trench base bulk cleaning was carried out with CAT excavators. Final and dental cleaning was done with hand tools which included shovels, brooms, and compressed air. Loose, broken, or altered material from the base of the key trench was blown out with compressed air. Snow and ice was also hand shovelled and blown out with compressed air prior to fill placement.

Open joints identified on some isolated areas in exposed bedrock were filled with powdered Sika 100 grout prior to fill placement. Local depressions and voids on rugged solid bedrock surface were filled with bentonite-augmented material. All key trench cleaning was inspected and approved by Tetra Tech's QC personnel and the DRE prior to fill placement.

4.5 Bentonite-Augmented Material (Type F) Placement

Type F material was placed in lifts of approximately 200 mm thickness prior to placing the liner on the key trench base, below and on the liner at the hinge point, and from the hinge point up to Elevation 64.7 m from Station 1+132 to 1+551 on the top liner. The placement and compaction of Type F material is shown in Photos 7 to 9. The number of lifts at each location depended on the final key trench excavation depth and the liner depth which ranged from 1.45 m to 2.65 m below original ground level. Type F material was placed using either the CAT D5K dozer along the key trench bottom and the upstream fillet zone or using CAT excavators for the downstream fillet zone and the liner hinge point. The compaction of the Type F material was performed with the CAT CS563E or CS56 compactors for the most part with the downstream fillet compacted with a walk-behind drum roller.

The Type F material was produced by mixing Type C material with dry bentonite powder at the mixing station described in Section 2.6.

The key trench bottom was cleaned and inspected to make sure it was free of detritus prior to placement of the Type F material. As per ECN No. 6515-C-235-007-ECN-003_R0, Type F material was placed from the hinge point up to Elevation 64.7 m from Station 1+132 to 1+551 on the top liner.

Material placement and compaction was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer and/or the "modified" sand cone method. From the test results and field observations, the desired compaction under field conditions was generally achieved when compared to the single point density test results. Test results are attached in Appendix E3. Some of the Type F materials placed in the key trench below the liner had lower densities than the designed. This was due to the frozen condition of the fills.

4.6 Fillet Zone Materials Placement

The fillet zone is a wedge of Type C material underlined by a layer of Type F material. The upstream fillet was constructed prior to liner placement. Fillet construction is shown in Photos 10 to 11.

The Type C fillet was constructed in maximum 300 mm thick lifts using haul trucks, the CAT D5 dozer, CAT excavators, and a CAT skid steer. The compaction of the lifts of material in the fillet was performed by the CAT CS563E or CS56 compactors or the HAMM 3205 towards the top on the upstream fillet. Placement and compaction of the Type C upstream fillet was also monitored and tested by the QC personnel. The final surface of the upstream lifts of material were shaped using an excavator to provide a flat surface for the liner.

Type F fillet material was placed using CAT excavators or a skid steer in lifts of 200 mm thickness. Compaction was performed with the CAT CS563E or CS56 compactors on the fillet. Placement and compaction was monitored and tested by Tetra Tech's QC personnel as described in Section 4.5.

4.7 Key Trench Backfill

4.7.1 Type K Material

Type K material was placed on the key trench base between Stations 0+090 and 0+310 prior to placing Type F material. Lift thicknesses were a maximum of 300 mm and each was compacted with the CAT CS563E or CS56 compactors or the HAMM 3205 in locations with uneven ground that was not safe to use the 10 ton compactors on. This is described in Section 2.8 and shown in Photo 12. The placement and compaction of Type K material was monitored by Tetra Tech's QC site representatives. Test results are attached in Appendix E5.

4.7.2 Granular Fill Material (20 mm minus) – Type C

Two zones of Type C material were placed; one below and one above the liner system. The Type C material serves as the bedding layer for the liner system. The Type C material was placed in approximately 200 mm to 300 mm thick lifts using the skid steer over the base liner, CAT excavators above key trench slope liner and below dike slope liner, and CAT D5 dozer above the liner on dike slope. The compaction of the 20 mm minus material was performed by the walk-behind drum roller, HAMM 3205 packer, and/or the excavator bucket. Minimal compaction was applied to the Type C material directly over the liner to prevent damage to the liner. The first lift of Type C material over the liner was not compacted, while the second lift was compacted with a walk-behind drum roller. The first lift and second lifts of the Type B1 material were compacted with the HAMM 3205 packer while subsequent lifts were compacted with the CAT CS563E or CS56 compactors.

Various aspects of the 20 mm minus material placement are shown in Photos 13 and 14. The placement and compaction of Type C material was monitored by Tetra Tech's QC site representatives. Test results are attached in Appendix E2. Some of the Type C materials placed in the key trench below the liner during the winter had lower densities than designed. This was due to the frozen conditions of the fills with relatively higher moisture (ice) contents.

4.7.3 Transition Rockfill (150 mm minus)

Type B1 transition material was used to backfill the key trench and as superstructure material on the dike crest from approximately Stations 1+145 to 1+530. It was also placed below and above the liner system as transition above the key trench between the ROM superstructure and the Type C liner bedding material.

Transition material was placed in lifts approximately 300 mm in thickness using CAT excavators or the CAT D5 dozer. The compaction of the transition material was performed by the CAT CS563E, CAT CS56, or the HAMM 3205 packers. The placement of the transition rockfill material as dike superstructure on the crest is shown in Photos 13 and 14.

4.8 Run-of-Mine (ROM) Placement

ROM material (Types A and A1) constitutes the upstream erosion protection and downstream shell of the dike. The thermal cover above the dike is all built with Type A material. As stated in Sections 2.2 and 2.3, some of the downstream shell was constructed with Type A material instead of the designed Type A1.

The material was placed in lifts with maximum thickness of about 900 mm to 1,000 mm using the CAT D5 dozer and excavators. Care was taken during placement to avoid segregation and nesting of larger particles. Each lift was compacted with the CAT CS563E or CS56 packer (minimum of six complete passes) and haul truck traffic prior to placing the next.

The material was visually inspected by Tetra Tech's QC site representatives to verify that, in general, the particles adhered to the maximum particle size and that deleterious materials such as snow/ice or till were not present. Additionally, Tetra Tech observed that the specified lift thickness was maintained and that the material was compacted sufficiently. ROM placement and compaction are shown in Photos 15 and 16.

4.9 Type H Material Placement

Type H material, was used to construct the upstream section of the dike. This material acts as a transition material between the ROM outer shell and Type C material and as the main upstream zone to provide thermal and mechanical protection to the dike central liner system.

Type H material was placed in 300 mm thick lifts. Each lift was compacted with the CAT CS563E or CS56 packer and haul truck traffic prior to placing the next. The placement and compaction of Type H material was monitored by Tetra Tech's QC site representatives.

Upstream water in the CP1 pond, in mid-May, over-topped the 0.9 m high working platform from Station 1+170 to 1+460 as further discussed in Section 7.11. Some of the Type H material was placed in “wet” conditions and optimum compaction of the material was not possible in this situation.

Type H material placement and compaction activities are shown in Photos 17 and 18.

4.10 Liner Installation

4.10.1 Liner Installation Activities

The geomembrane liner (Coletanche ES2 and ES3) was installed by Texel. The liner was installed in two phases. The first phase consisted of placing the liner within the key trench and the second phase consisted of placing the liner on the upstream slope.

Dike D-CP1’s design called for the use of Coletanche ES3 liner for the dike. A shortage of ES3 liner resulted in ES2 liner being substituted for ES3 for all top liner panels from Station 1+521 to 1+570 and intermittent ES2/ES3 panels from Station 1+570 to 585. The shortage was because of a deeper and wider key trench. These changes were surveyed and are shown in the as-built drawings.

The first phase of the liner placement included placing the liner panels within the key trench. The liner extended out of the key trench to a hinge point as shown in Photos 19 and 20. The liner hinge point was covered with sheets of plywood and 20 mm minus material placed on the plywood to protect the liner while construction continued.

The first phase (bottom) of the liner hinge was uncovered and inspected for damage prior to placing the second phase (top). The liner flap had an approximately 0.5 m horizontal tie-in length at the hinge.

In the week of April 24, 2017 concerns were raised about the potential for an early freshet which may compromise Phase 2 liner placement and possibilities of water seeping into the key trench. Following discussions with the DRE, Agnico Eagle, and MTKSL personnel, a change to the construction sequencing for the dike was made to accommodate the potential for an early freshet. Downstream material placement was halted at approximately 66 m elevation between Stations 1+100 and 1+560 and Phase 2 liner installed and welded to Elevation 66 m. This was to permit upstream materials to be placed to approximately Elevation 66 m to reduce seepage into the key trench during construction. The remaining downstream materials (Types A1, B, and C) were placed from Elevation 66 m to design elevation (~67.5 m). The liner was flipped and laid on the constructed upstream material (Types C and H) as shown in Photos 21 and 22 while construction of the remaining downstream materials to final design elevation took place. Once the construction of the downstream materials was finalized, the liner was flipped back and welded to final elevation as shown on Photo 23. Damage to the liner in the form of excessive deep wrinkling as a result of this practice was observed and corrected from Stations 1+025 to 1+100. MTKSL was instructed to take greater care in minimizing liner damage moving forward.

On May 6, 2017, the northern section of the collection channel was blasted and fly rock/tundra was thrown over a significant portion of the northern dike crest. Fly rock punctured the installed liner in at least twenty (20) locations from approximate Stations 1+300 to 1+370 before the liner cover was placed. Although the majority of these punctures occurred on “excess” liner placed over the dike crest (above about 66 m elevation), at least eight of the punctures occurred on the slope and hinge point. A thorough examination was completed by Texel and the DRE. The damaged liner areas were repaired.

Liner installation quality assurance was carried out by the DRE and quality control testing by Texel. Quality control testing and monitoring was carried out following the QC plan developed by Texel. The QA/QC procedure that was executed each day when liner was installed was as follows:

- DRE reviewed survey as-built for the sub-grade to confirm it was built to design;
- DRE reviewed subgrade fill material placement QC monitoring and testing results to make sure design specifications were achieved;

- A subgrade inspection was carried out about 30 minutes before the planned installation time by the DRE, Texel's foreman, and Texel's QC technician to verify the subgrade was free of deleterious substances, snow and ice, and an adequate liner base was present;
- Test welding was performed by a Texel welder on a piece of liner beside or in the key trench about 30 minutes before planned installation time;
- An ultrasonic test was performed on the test strip by Texel's QC technician;
- Three samples for tensile resistance were taken from the test strip and tested by the Texel QC technician; and
- If all three test strips tested had results above the minimum required 86 lb/in (15 kN/m) for ES3 or 74 lb/in (13 kN/m) for ES2, the DRE approved liner placement.

The DRE observed the process of liner installation and all qualification welding tests, seam welding, and ultrasonic tests along seams. The DRE also witnessed all liner repairs and testing. Elements of the liner system were generally installed according to the requirements in the design documents and liner QC test results met specifications. The liner installation quality control report is presented in Appendix F.

4.10.2 Wrinkles in Coletanche ES3

Severe wrinkling was noted on the bottom liner between Stations 0+205 and 245 (Panels 44 to 53) and between Stations 0+285 and 0+310 (Liner Panels 62 to 66) during an inspection on February 27, 2017. It was noted that the liner which was installed the previous day had wrinkles on it which resulted from the storage in sea cans as shown in Photos 52 and 53. Additional wrinkling occurred as a result of backfilling methods employed by the contractor. Type C was placed over the liner material on the slope prior to placement on the floor, causing the liner to slide slightly downhill and compounding the wrinkling problem. Photo 54 shows wrinkles observed on Panels 62 to 66.

Severely wrinkled liner was either heated and patched or cut and new pieces installed and welded to the existing. Patches were made on minor defects by heating and welding on the spots. The mitigation measures were as follows:

- Four (4) patches were applied to wrinkles deemed unacceptable on Panels 48 (Patch R3) and 52 (Patches R4, R5, and R6 shown in Photo 55). Two of the patches (R3 and R4) were applied after cutting the liner in the longitudinal direction to alleviate the wrinkling. The remaining patches were applied after heating the wrinkled liner and reshaping it;
- Two (2) patches were applied to wrinkles deemed unacceptable on Panel 53 (Patches R7 and R8). Both patches were applied after cutting the liner in the longitudinal direction to alleviate the wrinkling;
- Seven (7) patches were applied to minor wrinkle defects observed on Panels 64 to 66 (Patches R9 to R15);
- Liner Panels 62 and 63 were cut out and removed from the D-CP1 key trench, with two new panels (67 and 68) installed in their place. To compensate for the required overlap of the seams, approximately 1 m of Panel 63 was left in place; and
- Ultrasonic testing of each patch was completed by the Texel QC personnel and witnessed by the DRE.

To alleviate the storage related wrinkling, an empty sea can was brought to site and frost fighters were used to heat it. Warped/bent Coletanche ES2 and ES3 rolls were offloaded from the storage sea cans and placed in the heated sea can overnight with the intent to heat the material and remove the wrinkles. This appeared to be successful and helped remove the wrinkles prior to liner installation.

Tetra Tech QC representatives continued to observed the placement by MTKSL of earthen construction backfill material over the liner. This material was placed using the recommended bottom-up methodology.

4.11 Downstream Water Collection Channel and Sump

4.11.1 Water Collection Channels

Two water collection channels (North and South Channels) that feed into a sump were constructed approximately 5 m away from the downstream slope toe of D-CP1.

Construction activities for the North Channel started on May 8, 2017. The ground was still frozen at that time of the year so the channel's footprint was drilled and blasted. Significant over blasting occurred, with the average depth from original ground being 1.2 m and as high as 2.2 m in some locations. MTKSL blasted and began excavation of the channel but then left construction until permafrost degradation began. Excavating started from the north end working towards the sump. MTKSL was instructed to backfill the over excavated zone with Type A material to design grade since a stable material was required. The required volumes of Type A and transition material used in place of riprap needed to stabilize the area was therefore larger than designed.

Transition material (Type B) was used in place of riprap for the channel. Geotextile was placed on the Type A material and the transition material placed on the geotextile. Types A and B material placement and compaction was executed with CAT excavators. When feasible, the 10-ton compactor was used to compact the Type A material below the geotextile. Geotextile was placed by hand.

The South Channel was excavated in June 2017. At that time the ground had thawed. The channel was dug with CAT excavators. Geotextile was placed at the base and backfilled with transition material using the CAT excavators. Channel construction activities are shown in Photos 24 to 27.

4.11.2 Water Collection Sump

The sump constructed on the downstream side of D-CP1 will collect intercepted water seeping through the dike. The channels collect the water along the dikes alignment and channel it into the sump where it is pumped back to CP1 on an as-needed basis.

The sump's footprint was drilled and blasted in the first week of May 2017 when the ground was still frozen. Similar to the North Channel, significant over blasting occurred, with the average depth from original ground being 1.2 m and as high as 2.0 m in some locations. Mucking was executed mid-June 2017 using a CAT excavator (Photo 28). The over excavated zone was backfilled with Type A material. Geotextile was placed on the Type A material and transition material placed on it and compacted by a CAT excavator. The completed sump is shown in Photo 29.

Transition material (Type B) was used in place of the designed riprap which was not available. The over excavation resulted in the required volumes of Types A and B materials needed to stabilize the area being larger than designed. However, the overall performance of the water collection sump is not expected to be negatively impacted.

Construction record drawings showing the sump and channels are attached in Appendix B. The survey data used for producing construction record drawings was provided by MTKSL.

5.0 INSTRUMENTATION

5.1 General

Ground Temperature Cables (GTCs) and survey monitoring points were installed in Dike D-CP1 for performance monitoring purposes. Horizontal Ground Temperature Cables (HGTCs) were installed in the key trench and Vertical Ground Temperature Cables (VGTCs) were installed on the upstream and downstream sides of the key trench. Survey monitoring points were installed above the liner system close to the center of the dike crest. The ground temperature cables and the survey monitoring points are discussed in the following sections.

5.2 Ground Temperature Cables

Locations of the ground temperature cables are shown on the construction record drawings in Appendix B.

Five (5) horizontal HGTCs (HGTC-1, HGTC-2, HGTC-3, HGTC-4, and HGTC-5) were installed above the liner along the key trench base covering the areas shown in Table 5-1. Note that HGTC-1 was originally installed between Stations 1+117 to 1+167 but damaged after its installation during snow removal activities. As a result, HGTC-5 was installed between Stations 1+117 to 1+158. The damaged cable from the original HGTC-1 location was repaired and later installed between Stations 1+513 to 1+562. The cables monitor the ground temperatures in the key trench. The cables were carefully inserted in 25 mm I.D. flush coupled threaded PVC pipes.

Table 5-1: HGTC Installation Locations

HGTC	Area Covered by HGTC in the Key Trench
HGTC-5	Station 1+117 to 1+158
HGTC-2	Station 1+254 to 1+304
HGTC-3	Station 1+343 to 1+394
HGTC-4	Station 1+432 to 1+482
HGTC-1	Station 1+513 to 1+562

Five (5) vertical VGTCs (VGTC-1, VGTC-2, VGTC-3, VGTC-4, and VGTC-5) were installed in selected locations on the upstream and downstream sides of the key trench as follows;

- VGTC-1 and VGTC-3 are installed through the dike, upstream of the liner system and key trench at Stations 1+278 and 1+461 respectively to monitor temperatures in the upstream portion of the dike and its foundation;
- VGTC-5 is installed over the upstream surface of the Phase 2 liner around Station 1+300 to monitor temperatures on the top liner and hinge point; and
- VGTC-2 and VGTC-4 are installed through the dike, downstream of the liner system and key trench at Stations 1+280 and 1+460 respectively to monitor temperatures in the downstream portion of the dike and its foundation.

Cable locations were carefully selected to avoid any damage to the liner system while drilling the holes to install VGTCs.

VGTC holes were drilled with a Hydra-Trac 400 RAB drill rig operated by McCaw South, except for VGTC-1, which was drilled with Canadrill's drill rig. The holes were cased with a thick walled PVC pipe for about 1 m through the fill material to prevent the holes from caving in. A 25 mm I.D. flush coupled threaded PVC pipe was lowered down each of the cased boreholes and the GTCs installed inside the pipe. After the cable installation, the holes were backfilled with sand.

Photos 30 to 34 show GTC installations. The GTC connectors were placed inside a protective thick-walled 100 mm I.D. PVC pipe with an end cap as shown in Photo 32.

Manual ground temperature readings were taken before and immediately after installations to confirm that the thermistor beads were working and several times later to allow the ground temperatures to equilibrate after backfilling/drilling. Tetra Tech's site personnel continued taking readings at least once a week during the remaining construction stage. Readings taken by Tetra Tech site representatives during the construction period and those taken by Agnico Eagle and sent to Tetra Tech prior to writing this report have been used to plot the ground temperature profiles presented in Appendix C. Readings from the GTCs indicate frozen ground conditions within the critical zones of the key trench and below it, as designed.

The locations of the GTCs are shown on As-Built Construction Drawing 65-685-230-211 to 212.

Coordinates of GTC beads are included in Appendix C.

5.3 Survey Monuments

Six (6) settlement survey monuments (M-1, M-2, M-3, M-4, M-5, and M-6) were installed in the central area of the dike and located immediately above the liner crest to monitor any settlements of the liner crest. The survey monuments consist of a 1.4 m long, 25 mm diameter metal rod welded to a 500 mm square steel plate. A thick-walled 50 mm I.D. PVC pipe is inserted around the metal rod as a protective casing. Monuments M-1, M-2, and M-3 are shown in Photo 35. A 16" pile was installed directly west of the south abutment. The hole for the pile was drilled 1 m into bedrock and grouted in place to serve as a control point for the survey monuments.

The survey points are to be used in determining how much dike settlement is occurring. The location of the survey points are shown on As-Built Construction Drawing 65-685-230-212.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Dike Resident Engineer (DRE)

Tetra Tech provided a DRE who was on site on a full time basis (dayshift only) during the construction of the dikes.

The DRE's role on site is summarized as follows:

- Performed QA activities and examine dike construction issues first hand and refer to Design Engineer if needed;
- Oversaw and monitored QC activities, including field and laboratory testing;
- Approved or rejected the materials and construction done at critical stage gates;
- Tracked, reported, and followed up with any non-conformance reports;
- Observed and approved any QC activities (including both earthworks and liner);
- Reviewed, approved, or rejected QC testing results;
- Verified the QC teams met calibration requirements for the testing facilities, equipment, and devices;
- Visually inspected materials hauled to the dike for conformance with contract or construction specifications;
- Compiled and maintained QA/QC results;
- Oversaw the installation of instrumentation;
- Prepared and distributed daily and weekly activity QA reports, documenting dike construction and QA/QC activities;
- Received and reviewed as-built survey data/drawings provided by the surveyor and ensured the as-built survey data/drawings met specified requirements; and
- Conducted other QA tasks related to dike construction, as directed by Agnico Eagle.

6.2 Quality Control

6.2.1 Earthworks Quality Control

Tetra Tech provided earthworks QC services for dikes construction. Tetra Tech provided field engineers and technologists who performed laboratory and field testing on construction materials and verified the key trench foundation conditions. The earthworks QC field personnel were onsite on a full time basis (day and night shifts) for a majority of the dike's construction duration. Earthworks QC engineers and technologists activities during dike construction are summarized as follows:

- Tested and confirmed the acceptance of the construction materials;
- Observed key trench excavation;
- Confirmed if key trench foundation depth met design requirements;
- Observed various fill material placement (lift thicknesses, segregation etc.) and compaction efforts;
- Completed in situ testing such as density testing and compaction testing using a nuclear densometer or the "modified" sand cone method;
- Conducted soil laboratory testing (sieve, moisture content, moisture-density relationship, jar test, bentonite swell test);
- Ensured proper calibrations and use of laboratory and field testing equipment; and
- Prepared and distributed daily activity and earthworks QC reports.

6.2.2 Liner Quality Control

Liner QC work was conducted by a technician from Texel. Prior to the start of liner installation, the project team reviewed and modified the Texel QC plan. The liner QC technician's activities during liner installation are summarized as follows:

- Checked liner panels and made sure they were free of punctures and wrinkles prior to installation;
- Observed the liner installation works and ensured the liner was installed according to the construction specifications and manufacturer's recommendation;
- Performed QC testing on liner installed as per the specifications and Texel's QC plan; and
- Prepared and distributed daily activity and liner QC testing reports.

6.3 Earthworks Quality Assurance and Quality Control Testing

6.3.1 Run-of-Mine Rockfill (600 mm minus)

The material was visually inspected by Tetra Tech's QC site representatives to verify that, in general, the particles adhered to the maximum particle size and that deleterious materials such as snow or till were not present. Additionally, Tetra Tech observed that the specified lift thickness was maintained during placement and that the material was compacted sufficiently.

No QA/QC testing was conducted on ROM Type A or Type A1 materials.

6.3.2 Transition Rockfill (150 mm minus) Material

6.3.2.1 Particle Size Analysis

Samples of transition material were taken after and during crushing operations. Samples that were taken after crushing were from the stockpiles crushed in September and October 2016 prior to the QC personnel's arrival on site. Samples obtained from the crusher were taken off the jaw crusher discharge belt. Particle size analyses conducted on eleven (11) samples of transition material produced from September 2016 to April 2017 indicated that average particle size distribution was generally within the limits presented in the design specifications. Results of particle size analysis for the produced transition material are presented in Appendix E1.

6.3.2.2 Moisture content

The moisture contents of the samples used for particle size analyses were also determined. Results are reported in the particle size analyses reports presented in Appendix E1 and summarized in Table E1.1.

6.3.2.3 Compaction Monitoring

Transition material placement and compaction was observed and monitored by Tetra Tech's QC site representatives. They verified transition material was placed in lifts approximately 300 mm in thickness. The material was generally handled properly to avoid segregation and each lift subjected to at least 6 passes with the smooth drum vibratory CAT CS56 or CS563E compactors. The lift thicknesses were reduced to a 200 mm maximum and the HAMM 3205 packer was used with a minimum of 10 passes made when it was not possible to use the 10 ton CAT compactors because of safety concerns.

6.3.3 Granular Fill (Type C) Material

6.3.3.1 Particle Size Analysis

Particle size analyses were conducted on Type C (20 mm minus) material produced at the crusher and used for the dike construction to verify compliance with the design specifications. A total of fifty seven (57) tests were conducted in the site laboratory from October 2016 to May 2017 during the dike construction. Two QA samples were tested in Tetra Tech's Edmonton laboratory in October and November 2016 during the early stage of dike construction. Particle size analyses for Type C material indicated that the average gradation was within the specified limits. A detailed summary of the analyses is presented in Appendix E2.

6.3.3.2 Moisture Content

The moisture contents of the samples used for particle size analyses were also determined. Moisture contents of stockpile materials were determined prior to their use when visually the material appeared to contain snow or had a high fines content. Results are reported in the particle size analyses reports presented in Appendix E2 and summarized in Table E2.1.

6.3.3.3 Moisture Density Testing (ASTM 698)

Moisture-density relationship test (ASTM 698) was performed on seven (7) samples in the site laboratory and two (2) samples in Tetra Tech's Edmonton laboratory.

The field single point frozen soil density test (single point density test) was conducted outside the laboratory under the ambient air temperature by using a frozen soil sample taken from either the stockpile or construction site and by following the standard moisture-density test (ASTM 698) procedure without thawing the soil or adding water. This test was performed because the aggregate temperatures were generally well below freezing during construction making it unrealistic to compare field densities with results from standard moisture-density tests to assess compaction. Using this approach effectively evaluated if the material had been compacted to near the maximum achievable density in the frozen state.

Nine (9) single point frozen density tests were performed on material from Type C stockpiles during dike construction. Moisture-density relationship test results are presented in Appendix E2. Single point density test results for Type C material are summarized in Table E2.2. Results from the normal and single point density tests were used to assess the level of compaction of Type C material.

6.3.3.4 Field Density Testing

Type C material placement and compaction was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer and/or using a "modified" sand cone method. As aggregate temperatures were generally well below freezing and ambient temperatures at times as low as -35°C during construction from December 2016 to March 2017, the accuracy of field density values from the nuclear densometer was suspect. The "modified" sand cone method which involved the use of bentonite with a predetermined bulk density instead of sand was introduced to remedy this shortfall. Results obtained from density tests were compared with single point density test results to estimate the compaction. From the test results and field observations, the compaction under the field conditions for the available materials was generally achieved when compared to the single point density test results. Photos 36 and 37 show density testing on a lift of Type C material. Test results are attached in Appendix E2.

Some of the field density tests indicated that some lifts of Type C placed in the key trench had relatively low density due to high native ice content (moisture content) in the frozen material that was compacted in cold winter conditions. This would increase the risk of potential high thaw settlement should the Type C materials with low density thaw during the dike operation.

6.3.4 Bentonite-Augmented Material (Type F)

6.3.4.1 Moisture Content

Moisture contents of six (6) samples of Type F material taken from the dike or the mixing station were determined. Results are summarized in Table E3.1.

6.3.4.2 Swell Test

Type F material production was monitored by Tetra Tech's QC site representatives. Regular visual swell assessment on samples of placed Type F material was performed (Photos 39 and 40) and the results confirmed the presence of bentonite in the material.

6.3.4.3 Moisture Density Testing (ASTM 698)

The presence of bentonite in this material made it not possible to do a standard moisture density relationship test on the material. Seven (7) frozen single point density tests were performed on the material. The single point density tests on Type F material under field conditions were performed without adding water. Test results were used to assess the field compaction. Single point density test results for Type F material are summarized in Table E3.2.

6.3.4.4 Field Density Testing

Type F material placement and compaction was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer and/or using a "modified" sand cone method. Results obtained from density tests were compared with frozen single point density test results to estimate the compaction. The compaction under the field conditions was generally achieved when compared to the frozen single point density results. Test results are attached in Appendix E3.

6.3.5 Type H Material

6.3.5.1 Particle Size Analysis

Particle size analyses were conducted on Type H (75 mm minus) material produced at the crusher and used for the dike construction to verify compliance with design specifications. A total of thirty two (32) tests were conducted in the site laboratory from November 2016 to June 2017. Test results are attached in Appendix E4.

Most of the Type H material used for the construction of D-CP1 was produced in April and May 2017 out of mainly frozen esker sand and gravel. Concerns of introducing frozen chunks with finer particles, and high ice content (excess water) in the material produced and placed were raised. The Design Engineer recommended that Tetra Tech's QC team perform particle size analysis tests on frozen and non-frozen (thawed) material. Some samples were therefore split into two and a gradation test performed on one of the split samples without drying and washing. The other sample was dried in the oven, washed, dried again, and sieved. Both results were then compared to determine the amount of frozen chunks in the original sample. Based on the test results, some samples had frozen chunks. This generally occurred when the samples had either a higher moisture contents >10% or a higher than specified (>10%) fines content. Such material were stockpiled separately and not used for dike construction.

MTKSL was asked by QA/QC personnel to continue sorting the material to avoid the silty/fine sandy frozen chunks which may raise the fines content and/or the moisture content to >10%.

6.3.5.2 Moisture Content

The moisture contents of the samples used for particle size analyses were also determined. Moisture contents of stockpile materials were determined prior to their use when visually the material appeared to contain snow or a high fines content. Results are reported in the particle size analyses reports presented in Appendix E4 and summarized in Table E4.1.

6.3.5.3 Moisture-Density Testing (ASTM 698)

Moisture-density relationship tests were performed on four (4) samples in the site laboratory. Two (2) single point density tests were performed on material from Type H stockpiles during dikes construction. The single point density tests were performed on frozen aggregate because the aggregate temperatures were generally well below freezing during construction making it unrealistic to compare field densities with results from standard moisture-density relationship tests to assess compaction. Standard moisture-density relationship test results are presented in Appendix E4. Single point density test results for Type C material are summarized in Table E4.2.

Results from the standard moisture-density relationship and single point density tests were used to assess the level of compaction of Type H material.

6.3.5.4 Field Density Testing

The Type H material was placed in 300 mm thick lifts. Each lift was compacted with the CAT CS563E or CS56 packer and haul truck traffic prior to placing the next. The placement and compaction of Type H material was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer (Photo 38) and/or using the "modified" sand cone method. From the test results and field observations, the specified compaction under the field conditions was generally achieved. Test Results are attached in Appendix E4.

6.3.6 Type K Material

6.3.6.1 Moisture Content

The moisture content and temperatures of Type K material was constantly monitored to make sure the material was nearly saturated (a water-saturation of 85% to 95%) prior to placement. Samples were taken from the mixing pit and at the key trench when the material was dumped from the trucks. A total of twenty three (23) samples were tested between November 2016 and January 2017 after which time it was not possible to continue making and placing this material. Test results are summarized and attached in Appendix E5.

6.3.6.2 Field Density Testing

The placement and compaction of Type K material was monitored by Tetra Tech's QC site representatives. Density testing on material placed was carried out using a nuclear densometer (Photo 41). Based on the test results and field observations, achieving the specified compaction was quite challenging which supported the recommendations provided in RFI No. 6515-C-230-007_018. Test results are attached in Appendix E5.

6.3.7 Native Till at Bottom of Key Trench

Native till material at the base of the key trench was taken for jar tests (simple indication of ice content) and moisture content to verify the quality of the foundation. The criteria for base of key trench excavation was stipulated in Appendix A of the specifications and summarized as follows:

- Minimum excavation depth 1.4 m below existing ground; and
- Key trench depth to be extended to greater than 1.4 m below existing ground surface, until a point where material at the base consists of "ice-saturated" or approved bedrock, but not "ice-rich or icy-soil". If the key trench was excavated to a depth of 2.8 m from the original ground surface and no icy soils were found at the bottom of the key trench, the key trench excavation was terminated at 2.8 m. The key trench was excavated to a maximum depth of 3.2 m.

Tetra Tech QC site representatives took samples for jar and moisture tests from the base of the key trench once a 1.4 m depth was attained and approximately every 0.5 m below that. Samples were obtained by coring with a concrete core drill or by ripping with an excavator.

The jar tests is a simple test performed on ice-rich frozen soil to estimate its volumetric ice content. The test was generally performed using an approximately 10 cm long frozen soil core sample put into a graduated glass beaker and allowed to thaw. When it was not possible to take cores with the concrete drill, disturbed samples ripped with an excavator were used. The thawed saturated soil was then thoroughly mixed and allowed to settle (Photos 42 and 43). Volumes of sediment and supernatant water are recorded to estimate excess ice content as a percent of the sample volume. Following the criteria set in Appendix A of the specifications, key trench base material was classified as either:

- Ice-saturated – having a minimum of 90% ice saturation (or a minimum of 82% of water saturation) and less than 10% free water by volume of thawed soil sample in the jar and acceptable as key trench base;
- Ice-rich – More than 10% but less than 30% free water by volume of thawed soil sample in the jar and not acceptable as key trench base; and
- Icy–soil – More than 30% free water by volume of thawed soil sample in the jar and not acceptable as key trench base.

Jar and moisture content tests results from the key trench base are attached in Appendix E6; as a summarized Table E6, and displayed on the chart in Figure E6.

6.4 Liner Quality Control Testing

Texel conducted QC testing during liner installation. The results of this program are presented in their Construction Report, which is presented in Appendix F. Photographs were taken during some of the testing (Photos 44 to 47). Liner QC activities involved the following:

- An ultrasonic test for each roll (64 m of Coletanche ES3 and 79 m of Coletanche ES2) of liner installed or one test per shift per welder when the liner is installed;
- An ultrasonic test on all patches;

- Trowel test and visual observations on the length of all seams and repairs; and
- Final visual tests to check for punctures or wrinkles on the liner placed.

6.5 Liner Quality Assurance

Liner quality assurance was performed by the DRE. The DRE conducted visual inspections throughout liner construction and observed seam welding and non-destructive tests which included the qualification welding tests, ultra-sonic tests on patches/repairs and on seams. Punctures were identified during some inspections. Texel was informed and repairs carried out following specifications. Some punctures identified during inspection and repairs effected on them are shown in selected photos (Photos 48 to 51).

Two samples (one from the top liner and one from bottom liner) were taken from completed liner seams for destructive testing. Samples were taken by Texel from locations designated by the DRE. The samples were approximately 700 mm x 300 mm each. Destructive sample locations were repaired and tested by Texel following specifications. The samples are currently stored on site and may be sent to an external laboratory for tensile shear strength and ultrasonic tests for further confirmation of performance if required.

7.0 VARIATIONS FROM DESIGN DOCUMENTS

7.1 Nearly Saturated Backfill (Type K)

Type K material which is basically nearly-saturated Type C material was designed to be used to backfill excavated zones of key trench below 1.8 m depth from the existing ground surface. Excavations below 1.8 m from ground surface were required to remove ice-rich or icy-soils following the criteria described in Appendix A of the specifications.

Type K material was placed between Stations 0+090 and 0+310. MTKSL had several unsuccessful attempts at mixing and placing Type K material from December 2016 to January 2017. This was due to an inadequate mixing method (mixing in a cold pit in the natural ground that was open to cold ambient air temperatures), no facility to pre-heat Type C material prior to mixing, the frozen nature of Type C material with relatively high natural ice contents, and low ambient temperatures. RFI No. 6515-C-230-007_018 was issued in January 2017 which suspended this material's use for the dike's construction. The RFI provided alternatives to backfilling over-excavated zones in the key trench bottom.

Rather than placing Type K material from the base of the key trench excavation up to a 1.8 m depth from original ground as recommended in the specifications, a minimum 0.15 m thick layer of Type F material was placed directly on the base of the key trench from Station 0+310 to 0+585. The liner was lowered to accommodate this change and the key trench excavation geometry adjusted as described in Section 7.2 below. The change does not negatively affect the design intent, quality of the key trench, and the expected dike overall performance as a whole.

7.2 Key Trench Excavation Geometry and Volume Increase

The key trench excavation geometry had to be adjusted to meet design requirements based on the elimination of Type K material discussed in Section 7.1. Following the elimination of Type K material and consequently the lowering of the liner to depths below 1.8 m below the existing ground surface, additional excavation in the key trench downstream side was required to comply with design liner slope criteria and required width in the key trench base.

Depth of foundation preparation was greater than anticipated (>2.8 m) in the design in some sections of the key trench. This was due to difficulty to controlling ripping with the excavator rock breaker.

Massive ground ice was encountered in the key trench upstream side between Stations 0+435 and 0+455 and between Stations 0+492 to 0+507. Following directions from the Design Engineer, the ice was excavated and removed by cutting approximately 3 m from the crest towards the upstream side for the length of the massive ground ice. An as-built survey of this section was carried out and is shown on the drawings attached in Appendix B. Some localized ice wedges were observed in the upper portion of the downstream key trench side wall. Since they were relatively remote away from the liner system and assessed to be a low risk to the dike overall performance, further excavation of the ice wedges were not conducted.

The as-built key trench geometry and depth meets the design intent of the dike. The consequence of these variations was an increase in excavation volume, additional liner required, and more backfill materials (Type B, Type F (including bentonite), and Type C).

7.3 Shortage of "Clean" Run-of-Mine Rockfill (Type A1)

Type A1 rockfill (clean ROM from the saline pond excavation) was to be used to construct Dike D-CP1's downstream zone over the key trench area and the downstream shell as per the design. The design intent was to reduce the risk of potential salts that may be introduced in the dike's zone around the key trench and its foundation if Type A rockfill from underground operations was used. In December 2016, Agnico Eagle's Construction team and MTKSL noted that the volume of Type A1 material left in the stockpile would not be adequate to complete the construction of Dikes D-CP1 and D-CP5 as designed. The shortage was due to the presence of 15% to 40% of oversized boulders in the Type A1 stockpile that could not be used for the dike construction. As a result, RFI No: 6515-C-230-007_014 was generated which authorised the use of Type A ("saline" ROM) in the uppermost sections and away from the key trench of both dikes.

The consequence of the shortage of Type A1 material was the use of Type A material to construct portions of the dike's downstream zone over the key trench and parts of the downstream shell. The location of the Type A material is shown on the as-built drawings in Appendix B. Type A material has the potential for salts to be leached from it into the key trench and dike foundations. The salts would lower the freezing point depressions of the affected soils. Since the Type A material was used in the less critical zones that were away from the key trench, its potential effect on the dike overall performance is judged to be relatively low and tolerable. Any surface runoff during rainfall events from the Type A material will be collected in the downstream sump/channels for pumping back into CP1.

7.4 Shortage of "Clean" Transition Material (Type B1)

Dike D-CP1's design assumed that "clean" ROM from the saline pond (Type A1) would be crushed to produce transition rockfill material (which was referred to in the design drawings and report as Type B). Following the material volume increases resulting from the changes discussed in Section 7.2 and the shortage of Type A1 as discussed in Section 7.3, a portion of the transition material used for the dike's construction was produced from "saline" ROM (Type A material from underground operations). The change was authorized in RFI No: 6515-C-230-007_024. Transition material produced from Type A material was placed above the top liner (from approximately elevation 67.0 m to 68.6 m based on Tetra Tech QA/QC personnel field notes and daily reports). This information was not provided in MTKSL as-built survey data.

Type B material produced from Type A is not ideal. Type A material contains salts that increase the pore water salinity of the dike fills. Since most of the Type B material was used in the less critical zones above the top liner, its potential effect on the dike overall performance is judged to be relatively low and tolerable.

7.5 Use of Coletanche ES2 Liner

As discussed in Sections 2.9 and 4.10, a shortage of ES3 liner resulted in ES2 liner being substituted for ES3 for top liner panels from Station 1+521 to 1+570 and intermittent ES2/ES3 panels from Station 1+570 to 585.

The potential risk and mitigation measures of using the ES2 liner in D-CP1 were extensively discussed among Agnico Eagle, Tetra Tech, and Texel prior to the substitution. Field trial welding indicated that the seams between ES3 and ES2 liners could be welded. It was agreed that using ES2 in the relatively short section of the dike was acceptable.

7.6 Bottom Liner Depth from Original Ground Surface

To accommodate eliminating Type K material from the base of the key trench (RFI_6515-C-230-007_018), the bottom liner had to be lowered below 1.8 m from original ground in some parts of the dike. Based on design specifications, the liner was designed to be installed at a maximum depth of ~1.8 m below original ground surface. As indicted in the as-built drawings, the liner was installed at depths >2 m from the original ground surface from Stations 0+325 to 0+575.

The as-built liner depths meet or exceed the design intent and requirements of the dike. The consequence of this variation was an increase in the liner quantity required to complete the dike.

7.7 Top Liner Key-In at Crest

During a meeting attended by the members of the Dike Review Committee, the Dike Designer, and Agnico Eagle on October 28, 2016, it was suggested that changes be made to the designed top liner key-in at the crest to avoid sharp corners when anchoring the liner over the dike crest. These modifications were made by the Dike Designer and documented in ECN # 6515-C-235-007-ECN-002_RA.

As per the ECN, these changes were made during Construction and shown in the as-built drawings. This change is not expected to affect the dike's performance.

7.8 Type F Material on Top Liner from Hinge Point to Elevation 64.7 m

Following Dike D-CP1's design, Type F material had to be placed on the key trench base and below and above the liner at the hinge point. ECN No. 6515-C-235-007-ECN-003_R0 was initiated in mid-April 2017 by the Dike Review Committee and the Design Engineer requesting that Type F material be placed from the hinge point up to Elevation 64.7 m from Station 1+132 to 1+551 on the top liner. Calculations confirmed that sufficient bentonite quantity was available at the site to implement this change. This change also had little or no impact on the construction schedule. The Type F material was substituted for the originally specified Type C material. The request was executed as per a sketch attached to the ECN. The changes are shown in the as-built drawings.

The design change will provide additional robustness and reduce the risk of potential seepage through the most critical section of the liner overlying the thickest section of Type C material within and above the upstream portion of the key trench. The variation is beneficial to the dikes performance and does not affect its design intent.

7.9 Seepage into Hinge Point and Type H Material Placement

7.9.1 Observations

- On May 11, 2017, water was observed seeping from the upstream CP1 pond through Type F material and made its way under the hinge point liner from Station 1+390 to 1+430 (Photo 56).
- On May 13, 2017 water levels in the CP1 pond was high enough to over-top the 0.9 m high working platform from Station 1+170 to 1+460 (Photo 57).

7.9.2 Mitigation Measures

- Type F material placed below and above the hinge point liner from Station 1+390 to 1+430 was removed and replaced with non-saturated material on May 11, 2017.
- Mass bulking in of Type H material and an over-build of upstream Type A material was carried out on May 13, 2017. Although attempts were made to control lift heights and maintain some compaction, the focus was to place as much material as possible as quickly as possible, rather than on maintaining strict quality control

measures. As a result, “wet” placement of material was observed and optimum compaction of the material was not possible.

The seepage into the Type F material temporarily affected the thermal conditions of the material during construction. It is expected that this would have negligible effect on the dike’s long-term performance.

Less compaction of the Types H and A materials placed during that period may result in increased future settlement of the dike’s upstream shell. If this is the case, more materials can be placed above the water line to compensate for the settlement if required based on future dike monitoring and inspection.

7.10 Dike Dimensions

7.10.1 Observations

Comparison of the as-built drawings with the design indicates that some sections of the dike have as-built dimensions slightly less than designed. Table 7-1 summarizes the stations where the upstream crest widths, as shown in the as-built drawings, are less than designed. Table 7-2 summarizes the stations where the as-built thermal cover crest widths are less than designed. The deficiencies are not critical and therefore will not affect the dike overall stability and safety of the dike. Further discussions are presented in Section 7.10.2.

Table 7-1: Stations with Shorter As-Built Upstream Crest Widths

Station Shown in As-Built Drawings	As-Built Width (m)	Designed Width (m)	Difference (m)
1+175	15.8	16.3	-0.5
1+250	17.2	17.5	-0.3
1+350	17.3	17.5	-0.2
1+375	16.9	17.5	-0.6
1+499	17.1	17.5	-0.4
1+425	17.1	17.5	-0.4
1+450	17.3	17.5	-0.2
1+475	16.6	17.1	-0.5
1+500	16.5	16.7	-0.2

Table 7-2: Stations with Shorter As-Built Thermal Cover Crest Widths

Station Shown in As-Built Drawing	As-Built Width (m)	Designed Width (m)	Difference (m)
1+025	6.9	8.0	-1.1
1+050	6.9	8.0	-1.1
1+125	9.9	10.5	-0.6
1+150	10.2	10.5	-0.3
1+475	10.1	10.5	-0.4
1+500	10.0	10.5	-0.5
1+550	8.3	9.8	-1.5

The majority of the as-built liner crest elevations are equal to or higher than the design elevation of 67.5 m, with exception that the as-built liner crest elevations in the zone from Stations 1+310 to 1+360 are slightly lower than designed. The as-built minimum liner crest elevation is approximately 67.37 m at the location around Station 1+342. This elevation is about 0.13 m lower than the design elevation of 67.5 m.

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The as-built crest elevations of Type H are lower than the design elevation of 66.2 m around Stations from 1+310 to 1+565. The lowest as-built Type H elevation is about 66.0 m around Stations 1+330 to 1+370, which is 0.2 m lower than designed. This was due to a shortage of Type H material during construction.

The as-built top elevations of the Type F material placed over the liner above the original ground in areas around Stations 1+090 to 1+150, 1+280, 1+335 to 1+415, 1+430 to 1+475 are lower than the design minimum elevation of 64.7 m. The lowest as-built elevation of the Type F is 64.59 m around Station 1+464, which is 0.11 m lower than designed.

7.10.2 Mitigation Measures

The deficiencies discussed in Section 7.10.1 are not critical and not expected to affect the dike overall stability. The reduced dimensions may have a minor impact on the thermal behavior in localized areas.

Dike performance must be regularly monitored during its service life. Further mitigation measures can be established should dike inspection and monitoring observations indicate any concerns of the dike performance.

The design maximum water elevation under the inflow design flood (IDF) for D-CP1 is 66.6 m, which is 0.77 m lower than the as-built minimum liner crest elevation of 67.37 m. Dike crest settlement survey monitoring will confirm the final liner crest elevation during and after future settlement of the dike structure. This is expected to be completed within several years of dike construction.

7.11 Fill Material Density

7.11.1 Observations

Some of the Type C and Type F materials placed in the key trench below the liner during the winter had lower densities than designed. This was due to the frozen conditions of the fill materials with higher moisture (ice) contents. Some lifts of the Type H material was placed in “wet” conditions and optimum compaction of the material was not possible.

7.11.2 Mitigation Measures

After the observation of the lower density of the Type C and Type F during the QC tests, the QC team monitored the moisture content of the Types C and F materials. Materials with excess moisture content were rejected.

The potential consequence of the localized fills with low density would increase the risk of thaw settlement. As discussed in Section 7.8, ECN No. 6515-C-235-007-ECN-003_R0 was implemented so that the Type F material (instead of Type C material) was placed from the hinge point up to Elevation 64.7 m from Station 1+132 to 1+551 on the top liner. This design change reduces the potential risk of seepage through localized patches of damaged liner that would be resulted from any thaw settlement of the low-density fills below the liner during the dike operation.

Lower than desired densities in some of the Type H material may result in increased future settlement of the dike’s upstream shell. If this occurs, additional material can be placed to compensate the settlement, if required based on future dike monitoring and inspection.

Dike performance will be regularly monitored during its service life. Further mitigation measures can be established should dike inspection and monitoring observations indicate any concerns of the dike performance.

7.12 Construction Schedule and Material Production

It was assumed in the dike design that the key trench excavation and backfill would be completed from mid-September to November 2016. This was not achieved. As a result, challenges were encountered when completion of the key trench excavation and backfill occurred under cold winter conditions. In addition, the majority of the Type H material and some of the Type C material were produced from drilled and blasted frozen natural esker source materials during the winter construction period, instead of the summer-stockpiled unfrozen materials without excess moisture content. This increased the variability of the materials.

8.0 MATERIAL QUANTITIES

8.1 General

The material quantities used for Dike D-CP1, the downstream channels and downstream sump construction are presented in Tables 8-1 and 8-2. The material quantities have been calculated from the as-built survey data. The design volumes presented in the design documents are also presented in Tables 8-1 and 8-2 for comparative purpose.

Table 8-1: Summary of Construction Material Quantities Dike D-CP1

Material Type	Dike D-CP1 Design Quantity	Dike D-CP1 As-Built Quantity
Total Key Trench Excavation (m^3)	10,450	23,018
Total Run-of-Mine Rockfill – Type A (m^3)	19,840	24,896
Total Run-of-Mine Rockfill – Type A1 (m^3)	21,635	18,347
Total Transition Rockfill – Type B1 (m^3)	10,055	10,274
Total Transition Rockfill – Type B (m^3)	0	2,690
Total Granular Fill – Type C (m^3)	9,880	12,930
Total Bentonite Augmented Material – Type F (m^3)	1,970 to 2,920	4,256
Total Sand and Gravel Fill – Type H (m^3)	15,140	14,961
Total Saturated Granular Fill – Type K (m^3)	Depend on excavation	1,127
Total Geomembrane Liner – Coletanche ES2 (m^2)	0	555
Total Geomembrane Liner – Coletanche ES3 (m^2)	12,395	14,319

Table 8-2: Summary of Construction Material Quantities for Downstream Sump and Channels

Material Type	Design Quantity	As-Built Quantity
Sump Excavation (m^3)	1,635	1,575
Rip Rap for Sump	290	0
ROM Rockfill (600 mm minus) and Transition Material (150 mm minus) for Sump (m^3)	0	280
Geotextile for Sump (m^2)	820	895
Channels Excavation (m^3)	780	1,598
Rip Rap for Channels (m^3)	410	0
ROM Rockfill (600 mm minus) and Transition Material (150 mm minus) for Sump (m^3)	0	1,450
Geotextile for Channels (m^2)	1,615	1,542

Referencing Table 8-1, the majority of the difference can be attributed to the additional volume required for the key trench excavation and backfill as discussed in Section 7.2. Further details are presented in the following section.

8.2 Discussions on Quantities

The as-built key trench excavation exceeded the design estimate by approximately 120%. The increased volume is mainly attributed to the following:

- Over 60% of the key trench was excavated to depths ranging from 2.3 m to 3 m from original ground surface because of ice-rich ground conditions; and
- Widening of the key trench to satisfy conditions discussed in Section 7.2.

The as-built Type A material volume exceeded the design estimate by approximately 25%. The increased volume of Type A material is primarily due to the shortage of Type A1 material discussed in Section 7.3. This shortage resulted in the use of Type A material to construct portions of the dike's downstream zone over the key trench and parts of the downstream shell. The over excavation of the key trench as discussed in Section 7.2 increased the width and consequently more ROM material was required.

The as-built Type A1 material volume is less than the design estimate by approximately 15%. The decreased volume of Type A1 material is primarily due to the material shortage discussed in Section 7.3.

Following the dike's design, Type B transition material was not to be used for construction. As a result of the shortage discussed in Section 7.4 some portions of the dike that were to be constructed with Type B1 material were constructed with Type B.

The total as-built volume of transition material (Types B and B1) exceeded the design estimate by approximately 29%.

The as-built Type C material volume exceeded design estimates by approximately 30%. The increased volume of Type C material is primarily due to the key trench over excavation discussed in Section 7.2.

The as-built Type F material volume exceeded design estimates by approximately 46%. The increased volume of Type F material is primarily due to the key trench over excavation discussed in Section 7.2. More Type F material was also required to fill pockets in the bedrock between Station 0+005 and 0+250.

ES2 liner was used for the construction of parts of D-CP1 because of the shortage of ES3 liner as discussed in Section 7.5. The total as-built liner (ES2 and ES3) exceeded design estimates by approximately 20%. This is due to the increases in the key trench depth and width and construction waste-age of the material.

The construction material volume increases will not affect the expected dike performance.

9.0 LONG-TERM MONITORING

9.1 Purpose

Performance monitoring is an integral part of the operation of any water retention structure. The performance of Dike D-CP1 will need to be monitored throughout its operating life.

Permafrost exists beneath the footprint of D-CP1. The design intent is to maintain the original permafrost foundation beneath the liner in the key trench in a frozen condition over the life of the dike. Long-term monitoring of D-CP1 should include the following:

- Monitor thermal regime to confirm thermal prediction;
- Monitor settlement and movements of the dike;
- Conduct routine visual inspections of the dike; and
- Satisfy regulatory requirements for the dike performance monitoring.

9.2 Thermal Monitoring

Ground temperature cables installed in D-CP1 must be read on a regular basis. Tetra Tech recommends that the cables be read twice per month during the months of June and July and on a monthly basis during the remaining months for the service life of the dike. The reading frequency can be adjusted as required. The data will be used to confirm the thermal predictions used to design the dike and identify any potential concerns in dike performance during its operation. The monitoring data should be forwarded to the Engineer of Record for assessment.

9.3 Survey Monitoring

The survey monitoring points installed in D-CP1 must be surveyed on a regular basis. Tetra Tech recommends that a survey be performed on a monthly basis for the first two years and reduced to quarterly thereafter during the service life of the dike. The survey frequency can be adjusted when required. Each survey should note northings, eastings, and elevations. Elevation measurements must be performed with a total station with a high accuracy. In addition, the dike upstream and downstream water elevations should be regularly surveyed when changes in the water elevation are observed. When required, a complete survey of the dike external surface can be conducted. Monitoring data should be sent to the Engineer of Record for assessment.

9.4 Routine Dike Visual Inspection

Dike inspection by Agnico Eagle's site field engineer or technician must be done regularly to monitor the dike conditions and performance. The frequency of the dike inspection should be at least once every two weeks during the open water seasons and monthly during the winter season. The inspection should include visual inspections for any signs of slope instability, seepage, settlements, cracks, sink holes, and lateral deformations. This inspection can be taken together with the thermal and survey monitoring activities for the dike. Any unusual observations or concerns during the routine dike inspections should be documented and forwarded to the Engineer of Record for further assessment.

9.5 Formal Annual Inspection

An annual site inspection is required to fulfil the Type "A" Water Licence (No. 2AM-MEL1631) requirements. The annual site inspection should be carried out by the design team to formally evaluate the performance of Dike D-CP1. An annual inspection report shall be produced following each inspection.

The inspection will typically take place at the end of summer when the maximum annual thaw has developed. The annual inspection will include the following, but not limited to:

- Inspection of the upstream and downstream slopes for any signs of distress or instability;
- Inspection of the dike crest for any sign of transverse cracking or excess deformations;
- Inspection of the abutments and downstream toe for any evidence of seepage;
- Review of documents generated from routine dike visual inspections by Agnico Eagle's on-site technical staff; and
- A review of GTCs and survey monument data collected.

10.0 CLOSURE

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

Respectfully submitted,
Tetra Tech Canada Inc.

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PERMIT TO PRACTICE
TETRA TECH CANADA INC.
Signature
Date
PERMIT NUMBER: P 018
NT/NU Association of Professional Engineers and Geoscientists

REFERENCES

Tetra Tech EBA, 2016a. Design Report for Dike D-CP1, Meliadine Gold Project, NU. AEM Document Number: 6515-132-007-132-REP-003, Version 0, prepared by Tetra Tech EBA and submitted to Agnico Eagle Mines Ltd., August 15, 2016.

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Tetra Tech EBA, 2016c. Construction Quality Plan for Dikes D-CP1 and D-CP5, Meliadine Gold Project, NU. AEM Document Number: 6515-132-007-132-QQP-001, Version 0, prepared by Tetra Tech EBA and submitted to Agnico Eagle Mines Ltd., October 12, 2016.

FIGURES

Figure 1 General Project Location Plan
Figure 2 General Site Plan Showing Dike D-CP1 Location
Figure 3 General Section of D-CP1 Design Concept
Figure 4 Organization Chart

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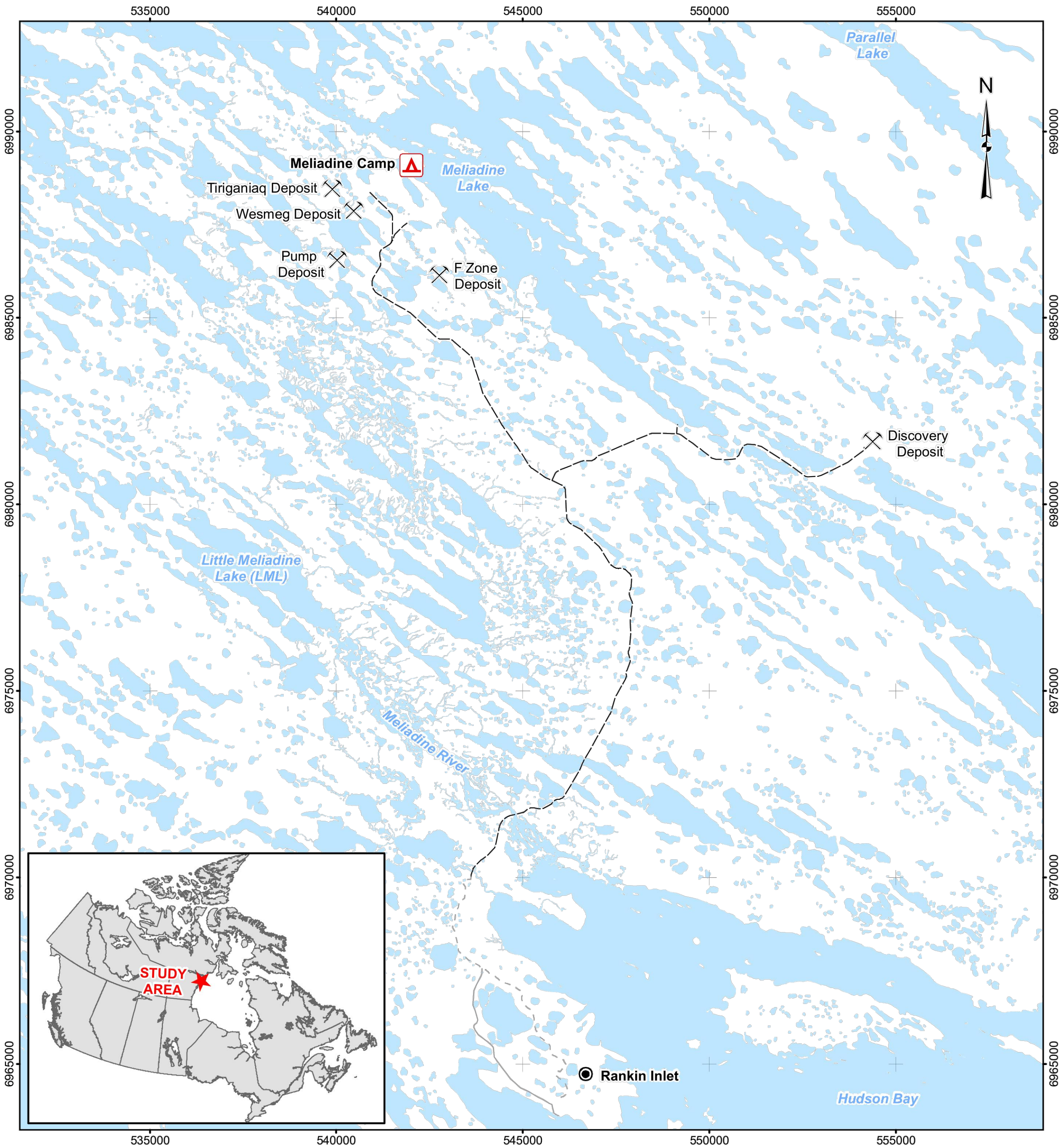

LEGEND

- Camp
- Proposed Mine Site
- All-weather Access Road (AWAR)
- Road - New
- Road - Existing
- Watercourse
- Waterbody

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FIGURE 1 GENERAL PROJECT LOCATION PLAN

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APPROUVÉ PAR APPROVED BY WTH		
NO. DESSIN DRAWING NO.		REVISION A

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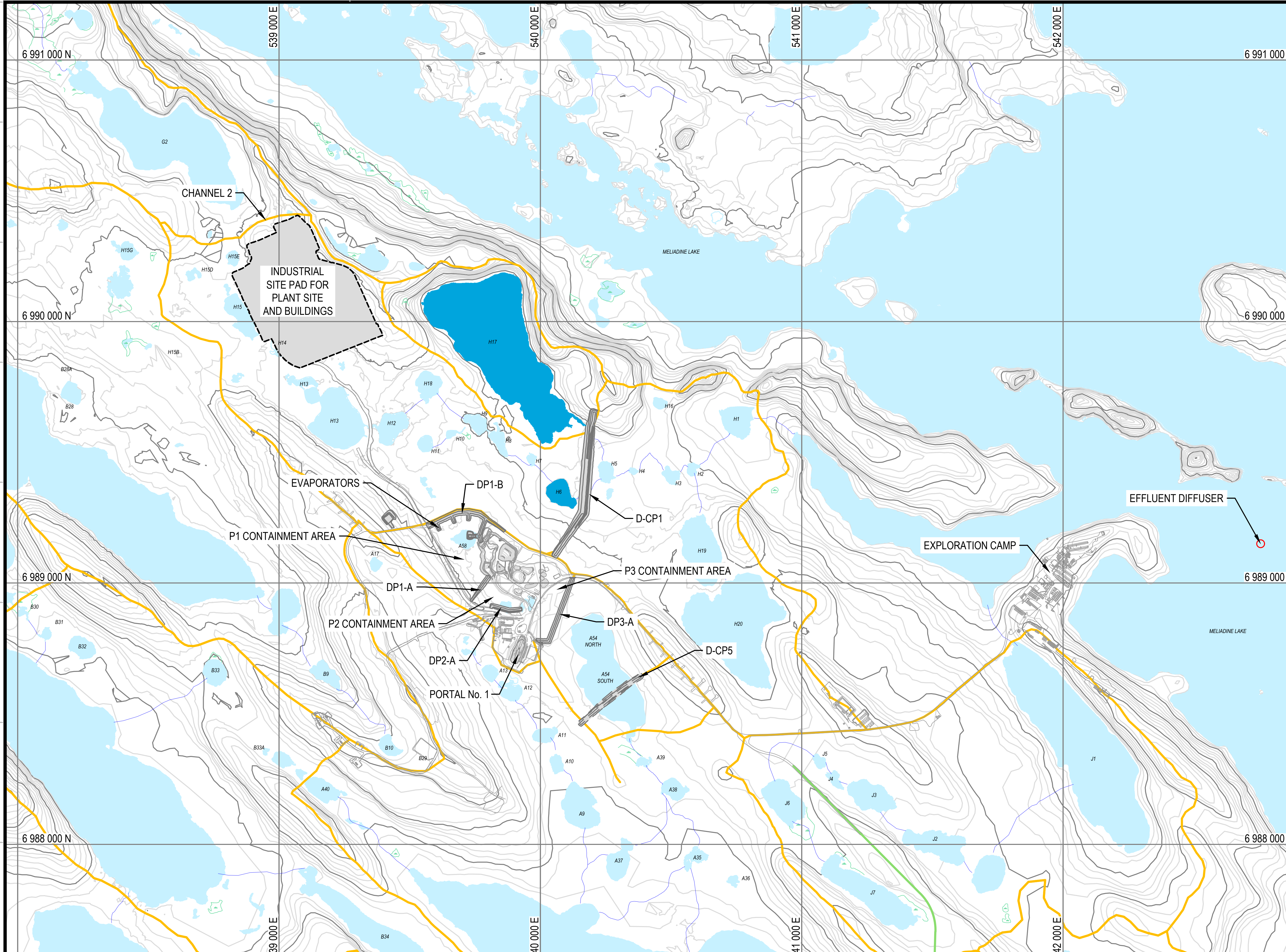

NOTES:

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TITRE / TITLE	# DWG
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A	ISSUED FOR REVIEW	08-15-2017	WTH

REVISIONS

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VÉRIFIÉ PAR / CHECKED BY	FN		08-15-2017
APPROUVÉ PAR / APPROVED BY	WTH		08-15-2017
No. PROJET / PROJECT NO.	6515		
DATE	08-15-2017		

TITRE / TITLE

AGNICO EAGLE MELIADINE GOLD PROJECT

FIGURE 2
GENERAL SITE PLAN SHOWING
DIKE D-CP1 LOCATION

ÉCHELLE/ SCALE
FICHIER FILE A

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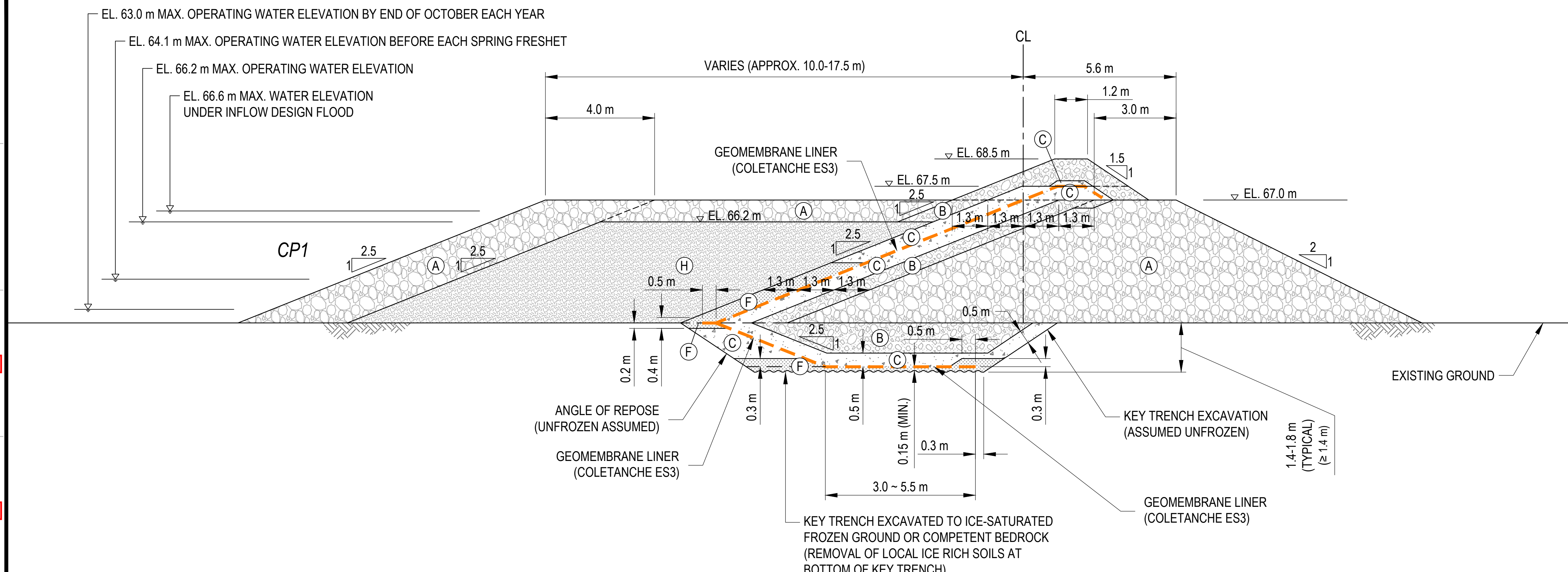
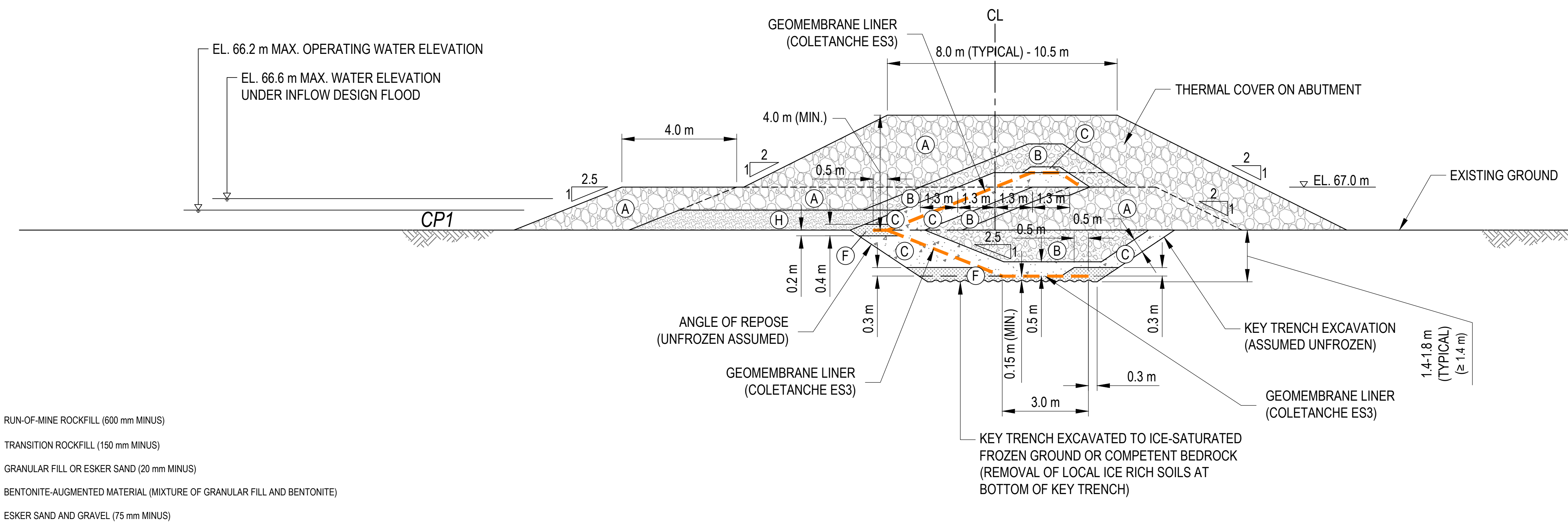


TYPICAL SECTION OF D-CP1



(A) RUN-OF-MINE ROCKFILL (600 mm MINUS)
(B) TRANSITION ROCKFILL (150 mm MINUS)
(C) GRANULAR FILL OR ESKER SAND (20 mm MINUS)
(F) BENTONITE-AUGMENTED MATERIAL (MIXTURE OF GRANULAR FILL AND BENTONITE)
(H) ESKER SAND AND GRAVEL (75 mm MINUS)
— — GEOMEMBRANE LINER (COLETANCHE ES3)

TYPICAL SECTION OF D-CP1 NEAR ABUTMENT

- ASSUMED KEY TRENCH EXCAVATION AND BACKFILL TO BE CONSTRUCTED FROM SEPTEMBER 2016 TO NOVEMBER 2016.
- THE SELECTION AND USE OF THE COLETANCHE LINER TYPE FOR D-CP1 AND D-CP5 WERE MADE BY AGNICO EAGLE MINES LIMITED.

AGNICO EAGLE

TETRA TECH

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A	ISSUED FOR REVIEW	08-15-2017	WTH

REVISIONS

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VÉRIFIÉ PAR CHECKED BY	FN		08-15-2017
APPROUVÉ PAR APPROVED BY	WTH		08-15-2017
No. PROJET PROJECT NO	6515		
DATE	08-15-2017		

TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT
GENERAL SECTION OF DIKE D-CP1 DESIGN CONCEPT

ÉCHELLE/SCALE
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REVISION A
FEUILLE/SHT 1 / 1

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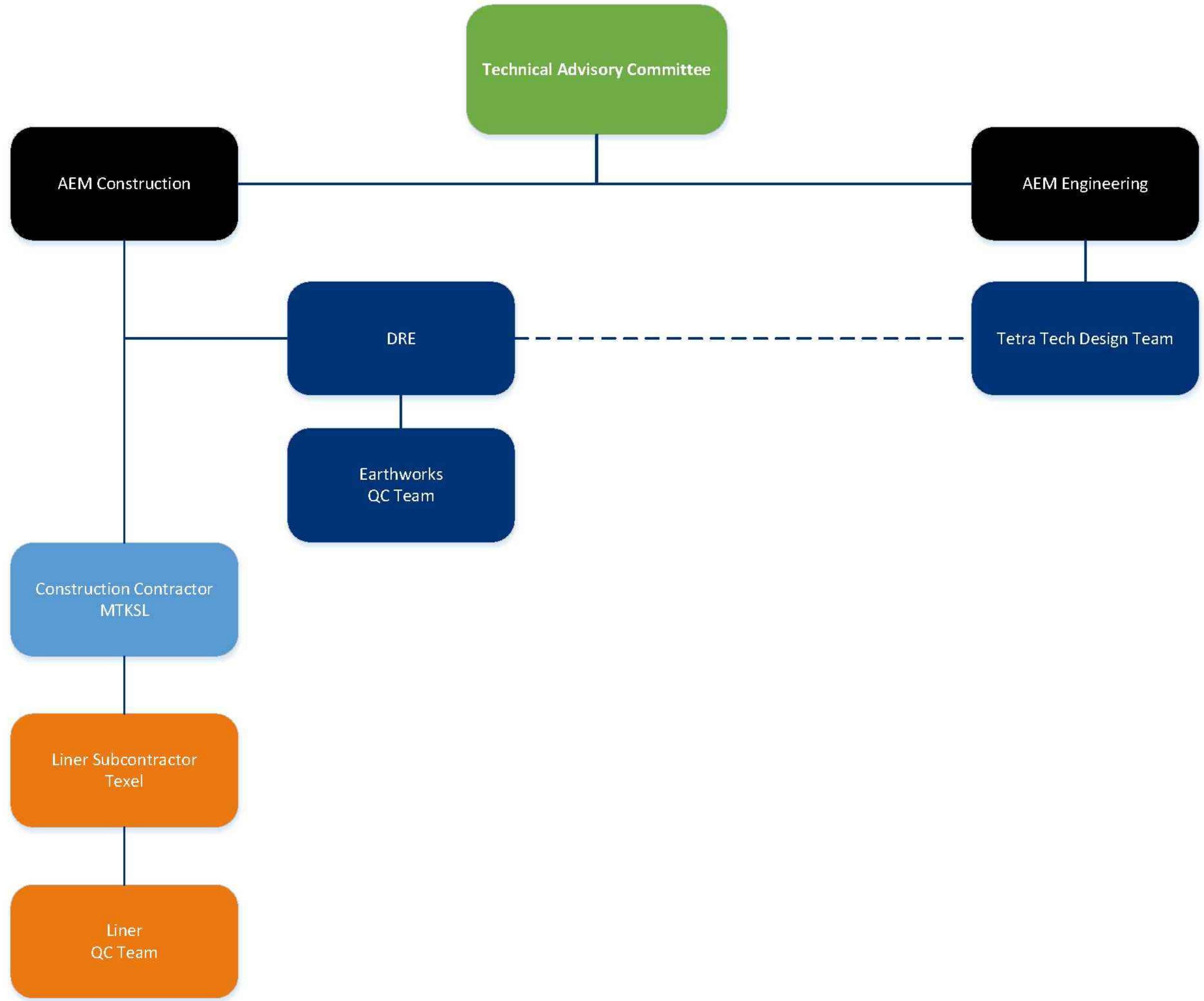

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OPERATIONAL PARAMETERS FOR D-CP1 AND D-CP5 DIKE CONSTRUCTION

ORGANIZATION CHART

PROJECT NO.	DWN	CKD	REV	
ENG.EARC03076-01	EL	GZ	A	FIGURE 4
OFFICE	DATE			
EDMONTON	OCTOBER 12, 2017			