

**YUKON ZINC CORPORATION  
WOLVERINE PROJECT**

**Quality Compliance Program**

**Tailings Storage Facility**

**Starter Dam Construction**

**March 18, 2009**



**Klohn Crippen Berger**

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## QUALITY COMPLIANCE PROGRAM

### 1. INTRODUCTION

Quality is a relative term that refers to the degree to which something meets a given standard. In the case of a dam, quality refers to the extent the dam meets the design basis objectives as expressed in the construction specifications and drawings and long term performance.

Some tend to think of quality only in terms of the inspection and the quality control (QC) and quality assurance (QA) testing that are carried out during construction. The quality of a dam however is determined at all phases of a project including; permit requirements, design criteria and specifications, contractor qualifications and approved methodologies and construction quality compliance inspection and testing. True quality is verified by the long-term performance of the dam as indicated by instrumentation (including piezometers, slope inclinometers, settlement gauges) and visual assessment.

This document outlines only the construction quality compliance inspection and testing plan for the Wolverine Project.

This Quality Compliance Program (QCP) was prepared for construction management personnel to oversee the implementation of the Contractor's QC plans so as to ensure the tailings dam is built in accordance with the Contract Specifications. However, as it is impossible to test the whole of the completed product, visual inspection, aided by an appropriate level of QC/QA testing, must be relied upon to provide overall construction quality. The specified minimum QC/QA testing cannot replace experienced visual inspection and timely response, when needed, to unexpected variations in foundation and/or construction earth materials, which inevitably will occur during the construction of a dam.

### 2. DESCRIPTION OF THE WORK

This document presents the Quality Compliance Program (QC and QA aspects) for construction of the tailings storage facility for the Yukon Zinc Corporation (YZC) Wolverine Project in the Yukon. The Wolverine Project is an underground mine located off the Robert Campbell Highway in southeast Yukon, approximately 190 km northwest of Watson Lake and 180 km southeast of Ross River. The facility to be constructed in 2009-10 includes: a tailings starter dam, diversion ditches, an emergency spillway, a seepage recovery dam and spillway, and a pump barge access ramp. The construction work includes the following:

1. Work Summary:
  - a) clear, grub, strip work areas;
  - b) produce specified fill materials;
  - c) install liner underdrains;
  - d) construct the earthfill starter dam and seepage recovery dam;
  - e) prepare liner foundation;
  - f) excavate seepage collection pond and spillway;

- g) assist Others to install a geosynthetic liner;
  - h) install barge access ramp;
  - i) construct the spillway channel with culvert segment; and
  - j) complete post-construction survey of as-built conditions.
2. Drawings comprise the following:

DRAWING NO.	REV.	TITLE
D-4001	0	General Site Arrangement
D-4002	0	Starter Impoundment – Excavation and Fill Plan
D-4003	0	Starter Impoundment – Excavation and Fill Typical Sections
D-4004	0	Seepage Dam – Plan and Section
D-4011	0	Starter Spillway – Plan, Profile and Section

3. Reference drawings comprise the following:

DRAWING NO.	REV.	TITLE
D-4012	0	Diversion Ditch A – Plan, Profile and Sections
D-4013 (Sheet 1 of 2)	0	Diversion Ditch B – Plan and Profile
D-4013 (Sheet 2 of 2)	0	Diversion Ditch B – Sections and Details

4. Technical Specification Sections are as follows:

Starter Dam Construction Specifications

Section 1	General
Section 2	Excavation and Fills
Section 3	Channel Erosion Protection
Section 4	Pipe Culverts

Liner Construction Specifications

Section 1	General
Section 2	Liner

**3. ROLES AND RESPONSIBILITIES**

The key roles and responsibilities are defined as follows:

Owner is Yukon Zinc Corporation, who is the owner of the mine, and ultimately responsible for all aspects of mine development and construction.

Construction Project Manager is Clive Creaney, or his designate, who is responsible for administration of the contract and for all construction works.

Contractor is the Company to whom the Owner awards the construction contract. The Contractor is responsible for construction of the facilities to the specifications provided by the Owner. Quality Control (QC) is usually defined as what the Contractor does to ensure compliance with the specifications and includes using experienced personnel, appropriate equipment, materials and procedures and testing to verify results.

For Wolverine, the earthworks Contractor will not be required to conduct QC testing. The Owner's QA testing will therefore be expanded to compensate for no QC testing.

For Wolverine, the liner Contractor will do QC testing and the Owner will do QA testing.

Engineer is Klohn Crippen Berger Ltd, who is responsible, on behalf of the Owner, for QA/QC for earthworks construction and QA for the liner installation. The Engineer of Record, for the Starter Dam, is Harvey McLeod, who is a Professional Engineer in the Yukon Territory. The Engineer, or his designate, reports directly to the Construction Project Manager. The Engineer is responsible for assessing the actual conditions on site and, as required, responding to and developing design changes to suit any changes to the site conditions.

#### **4. SUMMARY OF CONSTRUCTION QUALITY COMPLIANCE ACTIVITIES**

##### QA - Changed Conditions

The Engineer is responsible for ensuring that the design intent presented in the design report and technical specifications is met and that the design, if required, is adjusted to suit actual conditions in the field. Any design changes must be approved and signed off by the Engineer of Record.

##### QA - Dam Foundations and Liner Bed Preparation Approvals

The Engineer will inspect the dam foundation and liner bed preparation and no fills or liner may be placed over the foundations without the Engineer's approval. The surface of the liner bed must be "smooth" and not contain any sharp or angular sections that could lead to a puncture of the liner. The approval of the foundation will take into account the near surface groundwater and, in the case of the liner, will assure that appropriate drainage is in place to prevent uplift of the liner due to artesian pressures.

##### QC/QA - Fill Placement

Quality control/assurance of fill placement will include control of lift thickness, moisture content and gradation of the fill materials. ASTM QA testing will be carried out to confirm as-placed densities, moisture contents and gradations.

##### QC - Liner Installation

The liner Contractor is responsible for providing specified liner material, installing the liner in an approved manner using appropriate calibrated equipment and experienced personnel. These aspects are covered by submittal requirements which are subject to Owner approvals. The Contractor is also required to provide a warranty for the work and to carry out QC testing of the liner seams during installation.

The Warranty will be provided by the manufacturer (for material) and the installation contractor (for workmanship) and will warrant quality for a specified duration.

QC ASTM testing will be based on the liner manufacturer's recommendations and will include:

- Non-destructive testing of all seams (and repairs) using air pressure or vacuum.

- Shear and peel testing of seams at the beginning of each seaming period, and at least once every 4 hours for each seaming apparatus and operator used that day. At least two samples taken from extra material from each panel will be tested.
- If the seam test specimen fails in seam, the test will be repeated on a new specimen. If the new specimen fails in seam, the material will not be used for seaming until deficiencies are corrected and two consecutive successful test seams are achieved.

Trial seams to check adequacy of welding equipment and operator will be made and tested minimum twice daily per operator and per piece of equipment, as specified.

#### QA – Liner Installation

The Engineer will monitor the liner installation for compliance with the specifications and will carry out QA functions which will include the following:

- Reviewing/approving Contractor submittals for materials, personnel, equipment and procedures.
- Monitoring the work for compliance with approved submittals and design requirements.
- Approving liner foundations.
- Monitoring the Contractor's QC testing and logs to ensure that all seams are acceptable and that all flaws, damage and seam leaks are repaired.
- QA ASTM testing of liner material and welds, including:
  - Sheet thickness;
  - Density;
  - Tensile strength at yield (before the material starts to stretch);
  - Elongation at yield (measure of ductility before rupture);
  - Tear resistance (measure of stress before onset of tearing);
  - Puncture resistance (measure of how the material conforms around a protrusion);
  - Carbon black dispersion (distribution of and homogeneity of resin);
  - Carbon black content; and
  - Destructive testing for peel and shear (at a nominal frequency of one test per 500 m of fusion welding). Results will be reviewed for adequacy. All seam failures must occur as a film tear bond (FTB).

The number of QA tests will depend upon adequacy of all QC/QA test results.

- Maintaining QC/QA logs (liner supplier certification sheets, liner deployment, trial seam, seam, seam repair and test location, air pressure test, vacuum test, seam peel and shear testing, and lab testing).
- Preparing reports as detailed below.
- Preparing Record (as-constructed) Drawings based on Contractor information.

#### QC/QA - Barge Access Ramp Fill

The barge ramp fill will be placed directly on the liner. The Contractor will be required to use specified materials and approved construction procedures to prevent liner damage. A trial pad will be constructed off-site to demonstrate adequacy of fill material and placement procedures. The Engineer will monitor the construction for compliance with the approved method.

#### QA - Instrumentation

Inclinometers and piezometers will be installed in the dam to monitor movement and water level. The Engineer will specify the installation requirements, supervise the installation, take readings, and prepare

record drawings and instrumentation summaries. The data will be assessed for compliance with design assumptions.

QC/QA - Environmental Management Plan

The Contractor will follow the Owner's Environmental Protection Plans (EPP's). The Engineer will monitor the Contractor's construction activities and advise the Owner when the activities appear not to follow the EPP's.

## 5. QC/QA REPORTS

The following reports, with the noted minimum content, will be prepared for earthworks and liner installation:

Daily Reports (Contractor and Engineer):

- Reporter's Name;
- Date;
- Weather;
- Equipment;
- Contractor Personnel;
- Construction Activities;
- Progress (general and estimated quantities);
- Problems and Solutions;
- Compliance Testing Summary;
- Approvals;
- Observations or Changed Conditions.

Weekly/Monthly Reports (Contractor and Engineer):

- Work Completed This Week;
- Weather;
- Obstacles to Progress and Plans for Resolution;
- Administration and Contract Aspects;
- Site Personnel;
- Technical Issues;
- Work Planned for Next Week; and
- QC Summary.

Photograph Record (Engineer):

- Weekly photographs from 3 or 4 fixed points;
- Photographs of all approved foundations, including both the dam and the liner base preparation; and
- Photographs of typical details and any unusual conditions.

Construction Summary Report (Engineer):

- Survey of all excavated foundation levels and final fill levels;
- QC and QA data summaries;

- Instrumentation installation records and instrumentation readings;
- Summary of construction equipment and construction manpower;
- Record (as-constructed) drawings;
- Weather summary; and
- Summary of design changes and reason for changes.

# **APPENDIX I**

## **Technical Specifications – Starter Dam**

**YUKON ZINC CORPORATION  
WOLVERINE PROJECT  
TECHNICAL SPECIFICATIONS**

**Tailings Storage Facility  
Starter Dam Construction**

**February 5, 2009**



**Klohn Crippen Berger**

YUKON ZINC CORPORATION  
Wolverine Tailings Storage Facility  
Starter Dam Construction  
Technical Specifications

February 5, 2009

Section 1	General
Section 2	Excavation and Fills
Section 3	Channel Erosion Protection
Section 4	Pipe Culverts

## SECTION 1 – GENERAL

### 1.1 SCOPE OF WORK

The Yukon Zinc Corporation (YZC) Wolverine Project is an underground mine located off the Robert Campbell Highway in southeast Yukon, approximately 190 km northwest of Watson Lake and 180 km southeast of Ross River. These specifications cover construction of the mine ore tailings starter dam, diversion ditches, emergency spillway, seepage recovery dam and spillway. The construction work includes the following:

1. Work Summary:
  - a) clear, grub, strip work areas;
  - b) produce specified fill materials;
  - c) construct the starter dam and seepage recovery dam;
  - d) prepare liner foundation;
  - e) install liner underdrains;
  - f) excavate seepage collection pond and spillway;
  - g) assist Others to install a geosynthetic liner;
  - h) install barge access ramp;
  - i) construct the spillway channel with culvert segment; and
  - j) complete post-construction survey of as-built conditions.
2. Drawings comprise the following:

DRAWING NO.	REV.	TITLE
D-4001	0	General Site Arrangement
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D-4004	0	Seepage Dam – Plan and Section
D-4011	0	Starter Spillway – Plan, Profile and Section

3. Reference drawings comprise the following:

DRAWING NO.	REV.	TITLE
D-4012	0	Diversion Ditch A – Plan, Profile and Sections
D-4013 (Sheet 1 of 2)	0	Diversion Ditch B – Plan and Profile
D-4013 (Sheet 2 of 2)	0	Diversion Ditch B – Sections and Details

4. Technical Specification Sections are as follows:

- Section 1 General
- Section 2 Excavation and Fills
- Section 3 Channel Erosion Protection
- Section 4 Pipe Culverts

## 1.2 DEFINITIONS

The following definitions and interpretations shall apply to the Technical Specifications:

1. ASTM: American Society for Testing and Materials Standard Test Methods.
2. Construction Project Manager is Clive Creaney or his designate.
3. Contract Documents means, as applicable,
  - the Letter of Acceptance;
  - the executed Agreement Form;
  - Instructions to Bidders, completed Bid Form, Schedule of Prices, and Supplements to Bid Form;
  - Information Documents specifically incorporated into the Contract Documents;
  - Definitions and Interpretation, Payment Conditions, Security Conditions, Insurance Conditions, General Conditions, Supplementary Conditions, conditions related to Public Works Act claims;
  - the Specifications;
  - the Drawings;
  - Addenda; and
  - such other documents as may be identified as Contract Documents.and shall include amendments thereto made pursuant to the provisions of the Contract.
4. Contractor means the company to whom the Owner has awarded the construction contract.
5. Drawings, mean all drawings, plans, sketches and maps issued with the Specifications or subsequently as provided for in the Contract and includes any drawings submitted by the Contractor if signed as approved by the Engineer.
6. Engineer means Klohn Crippen Berger Ltd. or any person duly authorized by the Owner to act on its behalf.

7. Environmental Management Plan (EMP) means the Owner's environmental standards and procedures for management, reporting and compliance with applicable environmental regulations.
8. Others means any person, firm or corporation employed by or having a separate contract with the Owner for work related to the project other than that required by the Contract Documents.
9. Owner, and Corporation shall have common meaning and refer to Yukon Zinc Corporation.
10. The Project means the total construction contemplated of which the Work may be the whole or part.
11. Site means the place where the work is being performed and the immediate vicinity thereof.
12. Specifications mean the Technical Specifications.
13. Where the words shown, indicated, detailed, specified, or words of a similar nature are used such words shall refer to the Specifications and/or Drawings unless expressly stated otherwise.
14. Where the words directed, permitted, approved, accepted, required, rejected, satisfactory, or words of similar nature are used such words shall refer to the direction, permission, approval, acceptance, requirements, rejection or satisfaction, of the Owner unless expressly stated otherwise.
15. The Work means the total construction and related services required by the Contract Documents.

### **1.3 HAUL ROADS**

The Contractor shall be responsible for the maintenance of haul roads, including regular grading and dust control. The Contractor shall immediately notify the Owner if other users of the roads have caused excessive damage which cannot be easily repaired using the Contractor's routine maintenance methods. The access road to the site is the responsibility of the Owner.

### **1.4 SURVEY**

1. The Owner will provide survey benchmarks with coordinates and elevations near the work areas. The Contractor shall be solely responsible for providing other survey control including layout of the work, confirmation of compliance with required lines and grades, quantity measurements for payment purposes, and final survey of as-built conditions.
2. The Contractor shall provide survey information, in three-dimensional AutoCAD 2005 or newer format, and a summary of Northing, Easting, and Elevations for all survey points in Excel. The Contractor shall submit this information routinely and upon request during the Work and upon completion and as outlined under Submittals.

### **1.5 OWNER SUPPLIED ITEMS**

The Owner will provide the following items, at site, to the Contractor:

1. Processed fills (rip rap, filters, drain rock, and culvert bedding) that require crushing and/or screening. Processed fills will be provided at the Owner's quarry or relevant borrow source as applicable. (Processed fills do not include General Fill.)

## **1.6 QUALITY ASSURANCE BY THE ENGINEER**

1. The Engineer will conduct random tests on fill materials. The Contractor shall cooperate in obtaining samples. Testing by the Engineer shall in no way relieve the Contractor of its sole responsibility for meeting specification requirements.
2. The Engineer's test results will be final in determining compliance with the Specifications. The Contractor shall perform any remedial work necessary to rectify deficiencies at no additional cost.

## **1.7 SITE POLICIES**

Without limiting Contractor responsibilities described elsewhere in the Contract Documents, the Contractor agrees to comply with Wolverine Project Environmental Protection Plan (EPP) requirements and Site procedures:

1. All safety policies of the Owner outlined elsewhere in the Contract Documents shall be followed, including the use of personal protective equipment (steel toed boots/shoes, hard hats, safety glasses and others as required). All Contractor employees shall receive site specific training before entering the work site to ensure familiarity with Owner standards and policies.
2. The Owner maintains high environmental and safety standards. The Contractor will receive Owner training on the Environmental Protection Plans and site specific safety aspects at the Site. The Contractor is responsible to have all personnel trained in the environmental and safety standards before commencement of the Work.
3. The Contractor shall have an established Safety, Health, and Environment Action Plan (SHEAP) that complies with all Owner HSE standards and EPPs. Safety aspects of the days work shall be part of the daily tool box meetings. Safety interactions shall be held daily with the Owner. Weekly documented safety meetings shall be held with the Owner in a predetermined area.
4. The Contractor shall obey all Owner vehicle and driving standards when driving on Site.
5. Any spills are to be dealt with immediately utilizing appropriate containment and clean up procedures in accordance with the Owner Spill Contingency Plan. Any release to the environment is to be reported immediately to the Owner. The Owner may be required to make notification to Government environmental authorities. No mixing of spilled materials is permitted. The Contractor's shop area shall be maintained and kept free of waste build up and have covered waste barrels to limit accumulating rain water in any containers, as per the Waste Management Plan.
6. The Contractor shall only clean equipment in contained and designated areas.
7. The Contractor shall be responsible for implementing sediment control measures, to the satisfaction of the Owner. Run-off from upstream slopes and all areas in the Work shall be managed or collected for

settling/screening-out of any solids before release of discharges from the Site. Discharges of any kind outside of the work area containment system will not be allowed under any circumstances.

8. Natural conditions such as extreme storm events should be anticipated and corrective measures taken to mitigate the effects on the Work area drainage systems. Additional monitoring for safety and the environment may be required. Loss of production time as a direct result of wind, precipitation, freezing, or other adverse weather conditions (as determined by the Owner) and the related costs are the Contractor's responsibility and deemed to be included in the unit prices for the Work.
9. The Owner will have a representative/designate on Site during the period of the project who will oversee environmental monitoring as required under the relevant permits and Project specific sediment control measures. The Owner will schedule any necessary sample collection and provide regular assessments of the performance of sediment control measures. The Contractor is responsible for compliance with all Owner standards and regulatory requirements.
10. The removal of trees is prohibited outside of the Project claim boundaries.
11. Drip pans shall be used whenever oil, diesel fuel, gasoline, hydraulic fluid and other such items may leak or spill, and are to be emptied on a regular basis into designated waste disposal containers only.
12. All oil or liquid fuel shall be kept in tightly closed labelled containers designated for that use at all times to eliminate spillage. All fuel and oil storage shall have an impervious natural or man-made containment berm/sump to enable storage of 110% of the capacity of the containers stored within. Construction or purchase of such equipment will be the responsibility and expense of the Contractor.
13. The Contractor shall provide waste oil totes and several empty drums for oil filters, oily rags, etc. These are to be maintained and kept closed during the Project by the Contractor. At completion, or as required, the totes and drums shall be removed from the Work site by the Contractor for approved disposal. Different waste types (i.e., fuel, oil, glycol) shall be stored in separate containers – mixing is not permitted.
14. The Contractor shall provide equipment for and satisfactorily carry out dust abatement, if directed.
15. The Contractor's shop, lay-down and office areas shall be kept clean and tidy. Garbage generated by the Project shall be disposed of in the appropriate locations as directed by the Owner, including:
  - a) Clean non-hazardous debris and putrescible (food) garbage shall be disposed of daily in a location specified by the Owner;
  - b) Sanitary discharge shall not be allowed to flow onto the ground or into a fresh watercourse. Portable Toilets shall be supplied and maintained by the Contractor, in an approved manner.
16. All Work sites shall be kept clean and cleaned-up prior to completing the job. Normal cleanup will include:
  - a) Cleanup of all work areas, haulage routes, lay-down areas, etc.
  - b) Removal of all garbage, cans, drums, hose, pipe, used oil filters and other such items to approved locations.
  - c) Emptying, removal and cleanup of any contaminated run-off control systems and surrounding areas into approved disposal areas.

17. If extra precautions beyond those agreed upon, prior to the start of Work, are required to prevent environmental damage the actual and reasonable cost of providing such precautions will be at the Owner's expense.
18. In the case of an emergency condition, the Owner reserves the right to enter the Work area and perform the necessary cleanup at the Owner's expense. If the said emergency condition occurs as a result of the negligence or wilful misconduct of the Contractor, the Contractor shall bear the cost of the cleanup and all fines or penalties levied by Government agencies for the condition.
19. From time to time the Work will require the coordination of activities between the Contractor and the Owner or Others. Notwithstanding any policies, contracts, agreements or the like, the Contractor shall cooperate fully with the Owner or Others, as directed by the Owner, to execute cooperative work in a timely manner and achieve the desired result for the Owner.

## **1.8 SUBMITTALS**

Without in any way limiting submittal requirements contained elsewhere in the Contract Documents, the Contractor shall submit the following information for the Owner's approval. Work shall not start until applicable approvals are obtained in writing.

### **BEFORE WORK STARTUP**

1. Construction Schedule showing the critical path.
2. Certification of hazard communication training.
3. List of all employees proposed for the Work, including name, age, and number of years working experience, social security number and position (title).
4. List of all plant, equipment, and materials proposed for the Work including size, weight, and axle loads if required.
5. Copy of site specific safety plan, JSA's (Job Safety Analysis) and SHEAP.
6. Signed company safety training forms for all employees. Contractor must comply with relevant regulatory personnel safety requirements.
7. Documentation indicating that all construction equipment meets regulatory minimum operating standards.
8. Contractor's predicted fuel and oil consumption requirements.
9. The Contractor shall be responsible for construction survey and grade work for the Work and shall submit survey methodology, equipment list, and qualifications of surveyor. Owner will confirm software compatibility with the Contractor to produce Owner formatted as-built drawings. Survey information shall be electronically collected and backed up, to ensure efficiency, accuracy and compatibility with Owner's survey software.

10. The Owner will supply the Contractor with AutoCAD format electronic drawing files of the grading plan. The Contractor shall produce shop drawings that include layout points for use during construction. The construction layout produced by the Contractor shall conform to the final grading plan in the Drawings, except where prior written approval of any change is received from the Owner.
11. Layout of access roads and work points for construction.
12. Sediment control plan.
13. A dust abatement plan.

**DURING THE WORK**

1. Copies of Daily Contractor Tool Box Safety meeting notes and Daily Equipment Pre-shift cards.
2. Copies of employee's incident reports of injury or property damage. Notification to the Owner is required immediately following any incident, with a written incident report submitted to the Owner as soon as practical, but no later than the end of shift.
3. Updates of medical reports for incident status as received.
4. Written property damage reports (by end of shift) with immediate notification to the Owner.
5. Written near miss incident reports (by end of shift) with immediate notification to the Owner.
6. Copies of completed required work permits, including excavation, hot work, confined space entry, etc., as applicable.
7. Copies of completed spill reports as per Owner Spill Contingency Plan with immediate notification to Owner and initiation of spill cleanup as a priority over the Work.
8. Copies of Daily load count reports and equipment used. Monthly reports of total man-hours on site (due on the first of every month).
9. Timely Change Order requests.
10. Daily Contractor completion/manpower sheets, showing labour and equipment hours worked on each task as well as details on any delays or breakdowns, signed and submitted to the Owner by noon the following work day.
11. Baseline surveys before starting and upon completing each component of the Work, in a timely fashion, to demonstrate compliance with design requirements and for payment and record purposes.
12. Weekly Report submitted with the weekly Construction Schedule update showing Work Completed, Work Planned, Problems Encountered, and Plans for Resolution.
13. Timely submission of invoices for all work completed, submitted within 30 days of completion of work to avoid late billing issues. This includes all progress payments and final payments.
14. Copies of all equipment safety and site specific training records.

**AT COMPLETION OF THE WORK**

1. As-built survey information of all aspects of the completed Work for as-built drawings and final payment.
2. Timely submission of Final Invoice.
3. Request for release for site cleanup.

**END OF SECTION 1 – GENERAL**

## SECTION 2 - EXCAVATION AND FILLS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

1. The Work shall include the furnishing, processing, re-processing, hauling, placement and compaction of specified fill materials, to the lines and grades shown on the Drawings.
2. The Work includes:
  - development, processing and reclamation of borrow sources;
  - foundation excavation and/or preparation;
  - excavation of collection and spillway channels;
  - fill placement;
  - installation of liner underdrains; and
  - labour and equipment assistance to Others in the placement of liner.

#### 1.2 CODES AND STANDARDS

The latest version of the following Codes and Standards shall apply (the titles shown have been abbreviated):

ASTM D4643/D2216	Laboratory Determination of Water Content of Soil and Rock by Mass
ASTM D422	Particle Size Analysis of Soils
ASTM D5519	Standard Test Method for Particle Size Analysis of Natural and Man-made Riprap Materials.
ASTM D854	Specific Gravity of Soil Solids by Water Pycnometer
ASTM D2922	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D2167	Density and Unit Weight of Soil in Place by Rubber Balloon Method
ASTM D1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1140	Amount of Material in Soils Finer than the No. 200 (75 µm) Sieve
ASTM D4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D2434	Permeability of Granular Soils (Constant Head)
ASTM C127	Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C535	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D698-Method D	Standard Proctor Density Test

ASTM D6473	Specific Gravity and Absorption of Rock For Erosion Control
CAN/CSA A23.2	Concrete Materials and Construction/Test Methods

### 1.3 RECORDS AND SUBMITTALS

1. The Contractor shall submit the information requested in Section 1 – General and the following information for approval. Work shall not start until applicable approvals are obtained in writing from the Owner.
  - a. Excavation  
The Contractor shall submit plans and descriptions of methods and sequences for common, peat and rock excavation for the dam foundation preparation and borrow area development. The Contractor shall submit a 3-week rolling schedule for its borrow operations. The schedule shall be updated and subject to approval on a weekly basis.
  - b. Fills  
The Contractor shall submit plans and descriptions of methods and sequences for fill placement.
  - c. Quality Control  
The Contractor shall submit its plan for quality control of all fill materials and the qualifications of QC personnel.
  - d. The Contractor shall submit a safety plan for encountering hazardous gases, such as hydrogen sulphide during construction.

### 1.4 SURVEY LAYOUTS

Fill layout surveys shall be accurate to +/- 100 mm for plan locations and +/- 20 mm for elevations.

## PART 2 - PRODUCTS

### 2.1 GENERAL

1. Sources of fill materials shall be those described herein and as shown on the Drawings or as approved.
2. Materials from required excavations, which are suitable for construction, either directly or by selective excavation, shall be used for construction.
3. Fill materials shall be free of organic matter or other deleterious materials.
4. Fill materials shall be within the gradation limits indicated on the Drawings and as stated herein.
5. Fill materials shall be non-acid generating.

- Liner Bedding shall be natural or screened silty sand or silty sand and gravel with maximum 20 mm particle size and less than 15 percent passing the # 200 sieve.

## 2.2 LINER UNDERDRAIN MATERIALS

- The liner underdrain pipes shall consist of 200 mm diameter perforated and un-perforated corrugated pipe as indicated on the Drawings.
- The liner underdrain filter fabric shall consist of non-woven needle punched polypropylene geotextile (Propex 4510 or equivalent).
- Drain Rock shall be free draining 20-5 mm concrete coarse aggregate or approved equivalent.

## PART 3 - EXECUTION

### 3.1 BORROW AREAS

- The Contractor shall obtain fill materials from the excavations required for the Work, designated borrow areas and other sources which may be proposed by the Contractor and approved by the Owner.
- Borrow excavations within the impoundment shall not exceed specified lines and grades, unless as directed.
- Approved borrow areas are shown on the Drawings and are listed below. The Contractor shall not remove material from any source without the prior approval of the Owner.

STRUCTURE	FILL MATERIAL	BORROW AREA
Starter Dam	General Fill Liner Bedding Drain Rock for Underdrain	Impoundment area Quarry Quarry
Seepage Dam	General Fill	Impoundment area
Spillways & Diversions	Riprap and bedding layers Culvert bedding/backfill	Quarry Selective borrow or Quarry

- Borrow operations by the Contractor shall adhere to the approved exploitation plans.
- Any pioneering work that the Contractor considers necessary to improve extraction of specified materials shall be subject to approval.
- The Contractor shall not extract material from borrow areas until the Owner has sufficiently sampled and tested it to characterize the properties and approves the material for placement.
- The Contractor shall be wholly responsible for supplying materials which conform to the specifications for each zone of fill and shall take whatever measures and precautions are necessary to achieve this objective. Such measures shall include, but not be limited to, separating material into various sizes,

blending one material with another, removing oversize material and crushing or selective excavation of materials.

8. The Contractor's borrow operations shall avoid waste of suitable material therein. The Contractor shall clear, strip and grub borrow areas, and stockpile topsoil which, in the Owner's opinion, can be salvaged before starting production. Borrow area development shall provide drainage, prevent erosion of adjacent terrain and minimize exposure of the material to precipitation. Before being abandoned, borrow area slopes and waste piles shall be brought to stable profiles that are rounded and shaped to prevent ponding or concentrations of runoff and to provide a natural appearance. Rubbish, Contractor's equipment and structures shall be removed from these areas. Runoff shall be directed to sediment ponds or designated areas.
9. Waste material from preparation of borrow areas, excavation for the Work or processing in a borrow area shall be disposed of in an approved area and in an approved manner.

### **3.2 EQUIPMENT**

The Contractor shall provide suitable loading, transporting, spreading and compaction equipment sufficient to meet the requirements of the construction schedule.

Compaction equipment shall conform to the following:

1. Vibratory Roller
  - a) Smooth drum vibratory rollers shall be equipped with a cleaning device to prevent accumulation of material on the drum during rolling. The roller shall have a static weight of not less than 10 tonnes at the drum, on level ground. The drum shall be not less than 1.5 m diameter and not more than 3 m width. Vibratory frequency of the drum during operation shall be from 1100 to 1500 vibrations per minute and the centrifugal force developed by the roller at 1250 vibrations per minute shall not be less than 18 tonnes.
  - b) Power shall be sufficient to maintain the specified performance under the most adverse condition that may be encountered during compaction of the fill and to operate at speeds up to 6 km/h.

2. Small Compactors

Hand guided vibratory compactors shall be used to compact fill in trenches, around structures, instrumentation devices and in other confined areas. Such compactors shall be capable of compacting the material to the same density as that achieved by the larger vibratory roller.

### **3.3 FOUNDATION PREPARATION**

1. Unsuitable material shall be brought to the Owner's attention and disposed of as directed.
2. Over-excavation of soft soil, sand lenses, dental rock excavation, removal of embedded boulders, and the like shall be carried out as directed.
3. The tailings basin and dam footprints shall be stripped of organic soils and the material stockpiled for future site reclamation.

4. Foundations require approval before proof rolling and placement of fills. Approved surfaces shall be dry, firm, and compacted as indicated on the drawings. The Contractor shall adjust the number of passes and moisture condition the soil as necessary, and as directed, to achieve the required compaction.

### **3.4 CONTROL OF WATER**

The Contractor shall install dewatering ditches to direct water away from the fill areas, and excavate sumps, if required, to allow pumping. The dewatering works will be integrated with the liner underdrain, as directed by the Engineer in the field, to provide passive drainage of the area upstream of the dam during construction.

### **3.5 LINER UNDERDRAIN CONSTRUCTION**

The purpose of the underdrain is to relieve uplift pressure on the liner due to groundwater. The extent of the liner underdrain will be determined by the Engineer in the field. The Contractor shall manage the works to prevent contamination and plugging of the underdrain with sediment.

### **3.6 LINER GRADE PREPARATION**

1. Grade shall be prepared to the lines shown on the Drawings. With prior approval, grade lines may be adjusted in the field to suit bedrock topography, ground conditions or to minimize the use of backfill material, provided final grades are flatter than 2.5H:1V and are free of abrupt or sharp changes unless otherwise specified. In general, adjustments to grade lines which increase the tailings or water storage capacity of the area will be acceptable provided there are no additional costs to the Owner.
2. The prepared surfaces at the required grade lines, whether on original ground or on structural fill, shall be free of ruts formed by vehicular traffic and shall be compacted to provide a firm unyielding foundation for the liner. All final liner foundation surfaces shall be smooth and free of foreign and organic matter, angular particles larger than 20 mm, any sharp objects and abrupt changes in foundation surface profile. Smooth rounded bedrock or boulder surfaces may be acceptable, as approved. Gravel and cobble bed surfaces may also be acceptable if surficial voids are infilled with sand, as directed. The liner foundation surface shall be protected from flooding, standing water, erosion and freezing.
3. Foundation surfaces shall be proof rolled and compacted with a minimum of 6 overlapping passes of a 10-tonne vibratory compactor, or as directed by the Engineer.
4. Fill used to raise excavation surfaces to required grades shall consist of General Fill, placed in the specified manner unless otherwise directed. The final lift of liner foundation fill shall consist of finer General Fill with 20 mm maximum particle size.
5. The liner foundation surface shall be raked free of sharp, angular and oversize materials. If raking does not provide an acceptable liner foundation surface Liner Bedding material shall be placed over such zones, as directed.

6. The Contractor shall be prepared to de-water the liner grade by pumping or other approved methods to provide a grade surface free of standing water.
7. Finished surfaces shall have gradual and smooth grade transitions as required for the installation of the liner.

### **3.7 SPILLWAYS AND DIVERSIONS**

1. The spillway and diversion channel footprints shall be stripped of organic soils and the material stockpiled for future site reclamation.
2. The spillway and diversion channels shall be excavated to the lines and grades shown on the Drawings. Where erosion protection, such as riprap is required, the channels shall be over-excavated to accommodate the riprap and granular filter(s) to ensure that the finished channels have the dimensions shown on the Drawings.
3. Unsuitable material along the channel alignments shall be brought to the Owner's attention and disposed of as directed.
4. Over-excavation of soft soil, sand lenses, dental rock excavation, removal of embedded boulders, and the like shall be carried out as directed.
5. Refer to Section 3 for installation of Channel Erosion Protection.
6. Refer to Section 4 for Pipe Culvert specifications.

### **3.8 FILL PLACEMENT**

1. All fills shall be placed in dry conditions.
2. The Contractor shall use materials efficiently and minimize waste.
3. Fills shall be placed incrementally in horizontal lifts starting from the lowest ground levels, unless otherwise approved.
4. The Contractor shall use placing and spreading methods that prevent segregation, or provide an approved method of repairing segregation before compacting the materials.
5. Hand operated compactors shall be used within 0.6 m of buried conduits, utilities, instrumentation or similar sensitive structures.
6. The Contractor shall prevent erosion of placed fills, and shall immediately repair any erosion damage, at no cost to the Owner.
7. Materials in permanent works and in stockpiles shall be stable and shall have a smooth final surface that sheds runoff.
8. Fill tolerances:

- a) level tolerance +100/-25 mm;
  - b) horizontal tolerance +200/-100 mm.
9. The fill surface shall be sloped only to the extent required for surface drainage.
  10. Moisture conditioning equipment shall apply water uniformly and at controlled rates to achieve the required moisture content. Positive shut-off valves shall be used to prevent leakage when the equipment is not operating. Moisture conditioning shall be carried out in a manner that will minimize flow of water between zones.
  11. Moisture conditioning shall be carried out during or immediately before compacting each lift, with the water content of the placed material being as uniform as practicable throughout the layer.
  12. The Contractor shall take necessary precautions, when operating compaction equipment, to avoid damage to adjacent structures and instrumentation, and to avoid disturbing the foundation. Damage shall be repaired by the Contractor at its expense.
  13. Fills shall be placed to the following specifications:

<b>FILL DESCRIPTION</b>	<b>AS PLACED MOISTURE CONTENT <sup>(1)</sup></b>	<b>MAX. LOOSE LIFT THICKNESS <sup>(2)</sup> (mm)</b>	<b>MIN. STANDARD PROCTOR DENSITY (%)</b>	<b>COMPACTION METHODOLOGY (minimum)</b>
General Fill	-4% to +2% of Optimum Standard Proctor	300	95%	6 passes of a 10-tonne vibratory roller

(1) Moisture content refers to 19 mm minus fraction of fill.

(2) Fills within 0.6 m of sensitive structures, as determined by the Owner, shall be hand compacted with lift thickness reduced accordingly.

14. A minimum 300 mm overlap shall be maintained between adjacent passes of the roller drum. The roller shall not exceed 3 km/h when compacting fill.
15. If the quantity of oversize cobbles or boulders in the General Fill borrow materials is less than 10% and the material otherwise meets the specified gradation (except for oversize material), it may be placed without screening provided the oversize material is selectively removed prior to compaction and is approved.
16. The fill shall be dried or water conditioned as required. Should the surface of the fill become rutted or uneven subsequent to compaction, it shall be re-graded and re-compacted, at the expense of the Contractor, before the next layer of fill is placed.
17. Fill that becomes too wet or dry for proper compaction shall be removed or moisture conditioned by approved methods to an acceptable value.

**3.9 FILL PLACEMENT ON LINER**

1. The method of placing fill directly on the liner, if required, shall not damage the liner and shall be subject to approval. No construction equipment or machinery shall operate directly on the liner and only approved light weight equipment shall be allowed to place fill within 2 m of the liner.
2. Only approved fine grained soil free of foreign and organic material, sharp objects, or debris of any kind, which could potentially damage the liner shall be placed against the liner and within 0.5 m of the liner.
3. The use of approved lightweight machinery (i.e., generator, etc.) with low ground pressure is allowed on the liner.
4. The anchor trench shall be backfilled by the earthwork contractor. Trench backfill material shall be placed and compacted in accordance with the earthworks specifications.
5. Care shall be taken when backfilling the trenches to prevent damage to the liner. If damage occurs, it shall be repaired prior to backfilling.

**3.10 SURVEY CONTROL**

1. The Contractor shall conduct regular topographic surveys to demonstrate the placement of fill to the specified lines, levels and tolerances. Survey results shall be reported within 24 hours of completion. The Owner may conduct check surveys.

**3.11 COMPLIANCE TESTING**

1. The Contractor shall be responsible for quality control aspects of construction to ensure compliance with the Specifications. However the Owner will conduct periodic testing to verify construction quality.
2. Owner testing or the time taken to interpret the results shall not constitute grounds for a claim for additional compensation or an extension of time.
3. As a minimum, the Contractor shall carry out the following tests:

FILL TYPES	TESTS AND MINIMUM FREQUENCY (1 Test Per)			
	Gradation	Moisture Content	In Situ Density	Standard Proctor <sup>(a)</sup>
General Fill	2,000 m <sup>3</sup>	1,000 m <sup>3</sup>	1,000 m <sup>3</sup>	5,000 m <sup>3</sup>
Riprap	As required <sup>(b)</sup>			

- a) A Standard Proctor test will be performed on each new material type.
- b) Riprap gradation tests, if required, will be conducted on random truckloads of stone. The Contractor, at no additional cost, shall provide equipment, a sorting site, and labour to assist the Owner in checking gradation.
4. Testing shall be carried out across the full length, width and depth of the fill zones so as to represent the overall quality of the structure.

5. Test results shall be referenced as to date, fill type, location, borrow source, and elevation. Test results shall be reported within 24 hours of completion.
6. Fill that does not meet the specified requirements, shall be removed and replaced with conforming material at no cost to the Owner. Rejection of fill material may be made at source, on transporting vehicles, or in place.
7. Final acceptance of fills will be made only after materials have been dumped, spread, moisture conditioned, compacted and quality control tests and surveys have demonstrated compliance with specified requirements.

### **3.12 INSTRUMENTATION**

The Contractor shall assist the Owner and/or Others to protect and extend instrumentation through the placed fill (if applicable). Damage caused by the Contractor shall be repaired at its cost.

### **3.13 RESTRICTIONS DUE TO WEATHER**

1. The Contractor shall not place fill when conditions for such operations are unsatisfactory due to rainfall, snow, freezing temperatures, fire hazard, or any other reason.
2. Where operations have been discontinued by the Contractor or suspended by the Owner, the effects of snow, rain, low temperatures, desiccation, or other adverse conditions shall be assessed by the Owner and the surficial layers of fill or foundation treated or replaced to the satisfaction of the Owner before resumption of fill placement.
3. The Contractor shall not place frozen fill, incorporate snow or place fill on frozen surfaces.
4. Unless otherwise directed by the Owner, the Contractor shall:
  - a) Not commence placing fill in air temperatures below 0°C;
  - b) Cease placing fill if air temperature drops below -3°C; and
  - c) Remove frozen fill and scarify the fill or foundation surface and re-compact the surface prior to placing additional material.
5. Compaction requirements shall be maintained.

## **END OF SECTION 2 – EXCAVATION AND FILLS**

## SECTION 3 – CHANNEL EROSION PROTECTION

### PART 1 - GENERAL

#### 1.1. DESCRIPTION

The Work includes hauling, placement, compaction and dressing of filters and riprap for the diversion and collection ditches and spillway channels.

#### 1.2. CODES AND STANDARDS

The latest version of the following Standard Test Methods shall apply (the titles shown have been abbreviated):

ASTM D4643/D2216	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D422	Particle Size Analysis of Soils
ASTM D854	Specific Gravity of Soil Solids by Water Pycnometer
ASTM D2922	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D2167	Density and Unit Weight of Soil in Place by Rubber Balloon Method
ASTM D1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1140	Amount of Material in Soils Finer than the No. 200 (75 µm) Sieve
ASTM D2434	Permeability of Granular Soils (Constant Head)
ASTM C127	Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
ASTM C535	Resistance to Degradation of Large-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D5519	Particle Size Analysis of Natural and Man-made Riprap Materials.
ASTM D6473	Specific Gravity and Absorption of Rock For Erosion Control

#### 1.3. RECORDS AND SUBMITTALS

For requirements refer to Section 1 – General.

#### 1.4. SURVEY LAYOUTS

Unless otherwise specified, fill layout surveys shall be accurate to +/- 100 mm for plan locations and +/- 20 mm for elevations.

## **PART 2 - PRODUCTS**

### **2.1. GENERAL**

1. Sources of fill materials shall be those described herein and as shown on the Drawings or as approved.
2. Materials from required excavations, which are suitable for construction, either directly or by selective excavation, shall be used for construction.
3. Fill materials shall be free of organic matter or other deleterious materials.
4. Fill materials shall be well graded within the specified gradation limits shown on the Drawings, and have an even distribution of all particle sizes from the coarsest to the finest. The specified gradation limits shall apply to the fill materials following placement and compaction.
5. Fill materials shall be durable, resistant to breakdown during handling, and shall not, except as otherwise specified, contain more than 5% proportion of thin, flat or elongated particles i.e. those with a length to minimum width ratio greater than 3, and shall be free from organic and other deleterious materials.
6. Fill materials shall be non-acid generating.

### **2.2. RIPRAP**

1. Riprap and filter materials will be produced, by the Owner, at the quarry.
2. Riprap and filter materials shall be well graded and have an even distribution of all particle sizes from the coarsest to the finest. The specified gradation limits shall apply to the materials following placement and compaction.
3. Fill materials shall be durable, resistant to breakdown during handling, and shall not contain more than 5% proportion of thin, flat or elongated particles (i.e. those with a length to minimum width ratio greater than 3) and shall be free from organic and other deleterious materials.
4. Riprap and filter rock shall be non acid generating (NAG) and non-metal leaching, clean, dense, and durable quarry stone free from cracks, seams and other defects.
5. Riprap shall have a minimum specific gravity of 2.60 and less than 40% loss by weight after 500 revolutions in a Los Angeles Abrasion Test (ASTM C535).
6. Riprap and filter gradation and layer thickness shall be as follows:

**Gradation and Layer Thickness**

MATERIAL	PARTICLE SIZE (mm)				LAYER THICKNESS (mm)	
	D <sub>100</sub>	D <sub>85</sub>	D <sub>50</sub>	D <sub>15</sub>	Riprap	Filter
Riprap A	300	260	200	120	400	200 Filter 1
Riprap B	450	390	300	180	600	200 Filter 1
Riprap C	525	455	350	210	700	300 Filter 1
Riprap D	675	585	450	270	900	300 Filter 1
Riprap E	1200	1040	800	480	1600	300 Filter 1 + 400 Filter 2
Riprap F	1500	1300	1,000	600	2000	400 Filter 1 + 400 Filter 2
Filter 1	75	60 to 70	35 to 50	23 to 28	-	-
Filter 2	300	260	200	120	-	-

- Riprap gradation shall be within -5% to +10% of the specified D<sub>15</sub>, D<sub>50</sub>, and D<sub>85</sub> sizes.
- Filter 1 shall be well graded between the 75 mm and 19 mm screen sizes.
- Filter 2 shall be the same gradation as Riprap A.
- Filter 1 grading is based on the subsoil being a silty sand and gravel.

**PART 3 - EXECUTION**

**3.1. SURFACE PREPARATION**

1. Areas where erosion protection is to be installed shall be graded to uniform planar surface.
2. All depressions shall be filled with approved material and compacted to provide firm bedding.
3. Wave or surface water induced erosion of the prepared bed shall be graded out as directed by the Engineer prior to placement of filter and riprap materials.

**3.2. GRANULAR FILTER PLACEMENT**

1. Placement of granular filter shall commence at the bottom of the channel and continue upslope.
2. Granular filter shall be placed to a tolerance of +50 mm to -0 mm of specified thickness.

**3.3. RIPRAP PLACEMENT**

1. Placement of riprap shall commence at the bottom of the channel and continue upslope.
2. Riprap shall be placed to grade in a manner to prevent segregation of the materials, and to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the

spaces between the larger rock fragments. The final riprap zone shall be a well-keyed, densely placed, uniform layer.

3. Riprap shall be placed to its full zone thickness in one operation and in such a manner as to avoid displacing the filter bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.
4. One sample of each riprap class shall be prepared by sorting, weighing and remixing in proper proportions. The samples shall be placed at a convenient location and used as a frequent reference for judging the riprap gradation.
5. Equipment shall not run over finished riprap surfaces.
6. Finished riprap shall be within + 100 mm to - 0.0 mm of specified thickness and within +/- 2 degrees of specified slope.

### 3.4. COMPLIANCE TESTING

1. The Contractor shall be responsible for quality control aspects of construction to ensure compliance with the Specifications. However the Owner will conduct periodic testing to verify construction quality.
2. Owner testing or the time taken to interpret the results shall not constitute grounds for a claim for additional compensation or an extension of time.
3. As a minimum, the Contractor shall conduct the following tests:
  - **Granular Filters:** 1 gradation test per 100 m<sup>3</sup> per filter class, and
  - **Riprap:** Riprap gradation tests, if required, will be conducted on random truckloads of stone. The Contractor, at no additional cost, shall provide equipment, a sorting site, and labour to assist the Owner in checking gradation.
4. Test results shall be referenced as to date, fill type, location, borrow source, and elevation.
5. Fill that does not meet the specified requirements, shall be removed and replaced with conforming material at no cost to the Owner. Rejection of fill material may be made at source, on transporting vehicles, or in place.
6. Final acceptance of fills will be made only after materials have been placed, graded and dressed, and tests and surveys have demonstrated compliance with specified requirements.

### END OF SECTION 3 – CHANNEL EROSION PROTECTION

## **SECTION 4 – PIPE CULVERTS**

### **PART 1 - GENERAL**

#### **1.1. DESCRIPTION**

The Work includes the supply and installation of pipe culverts to the lines and grades shown on the Drawings.

#### **1.2. CODES AND STANDARDS**

The latest version of the following Standards shall apply:

ASTM D698-Method D      Standard Proctor Density Test

CAN/CSA G401              Corrugated Steel Pipe Products

#### **1.3. RECORDS AND SUBMITTALS**

For general requirements refer to Section 1 – General.

#### **1.4. SURVEY LAYOUTS**

Layout surveys shall be accurate to +/- 50 mm for plan locations and +/- 10 mm for elevations.

### **PART 2 - PRODUCTS**

#### **2.1 CORRUGATED STEEL PIPE**

1. Corrugated steel pipe (CSP) shall be to CAN/CSA G401.
2. Pipes shall have interior and exterior galvanized coating.
3. Pipes 600 mm diameter and smaller shall have 68 mm x 13 mm corrugations and 2.0 mm coated thickness.
4. Pipes larger than 600 mm diameter shall have 125 mm x 28 mm corrugations and 2.8 mm coated thickness.

## **2.2 CULVERT BEDDING/BACKFILL**

Refer to the Drawings for material description.

### **PART 3 - EXECUTION**

#### **3.1 EXCAVATION, TRENCHING AND BACKFILLING**

1. Excavation, trenching and backfilling shall be carried out in accordance with Section 2.
2. The Engineer's approval of trench line and depth shall be obtained prior to placing bedding material or pipe.
3. Backfill shall not be placed until pipe grade and alignment is accepted by the Engineer.

#### **3.2 BEDDING**

1. The excavation shall be dewatered, as necessary, to allow placement of culvert bedding in the dry.
2. A minimum thickness of 100 mm of approved granular material shall be placed on the bottom of the excavation and compacted to minimum of 95% Standard Proctor density.
3. The bedding shall be shaped to provide close contact with the pipe along the lower quarter segment (haunch) of the pipe.

#### **3.3 LAYING PIPE CULVERTS**

1. Pipe placement shall commence at the downstream end.
2. The Contractor shall ensure that the bottom of the pipe is in contact with the shaped bed or that compacted fill is placed in the haunch area throughout its length.
3. Water shall not be allowed to flow through the pipes during construction except as permitted by the Engineer.

#### **3.4 JOINTS IN CORRUGATED STEEL PIPES**

1. Coupler corrugations shall be matched with pipe corrugations before tightening coupler bolts.
2. The couplers shall be tapped firmly as they are being tightened, to take up slack and ensure a snug fit.
3. Damaged pipe coating shall be repaired by applying two coats of zinc rich paint.

### **3.5 BACKFILL**

1. Backfill material shall be placed in maximum 150 mm layers to full width, alternately on each side of the culvert, so as not to displace it.
2. Each layer shall be compacted to minimum 95% Standard Proctor density taking special care to obtain required density under the haunches.
3. The installed culvert shall be protected with a minimum 600 mm cover of compacted General Fill before heavy equipment is permitted to cross during construction. Required depth of cover depends on culvert diameter and traffic axle load and therefore is subject to separate approval for each culvert installation.

### **END OF SECTION 4 – PIPE CULVERTS**

## **APPENDIX II**

# **Technical Specifications – Liner**

**YUKON ZINC CORPORATION  
WOLVERINE PROJECT  
TECHNICAL SPECIFICATIONS**

**Tailings Storage Facility  
Liner Construction**

**February 5, 2009**



**Klohn Crippen Berger**

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## SECTION 1 – GENERAL

### 1.1 SCOPE OF WORK

The Yukon Zinc Corporation (YZC) Wolverine Project is an underground mine located off the Robert Campbell Highway in southeast Yukon, approximately 190 km northwest of Watson Lake and 180 km southeast of Ross River. These specifications cover geomembrane lining of the tailings basin. Associated earthworks and drainage control will be carried out by Others. The liner construction work includes the following:

1. Comply and demonstrate compliance with environmental requirements throughout the period of the contract.
2. Mobilization and demobilization;
3. Coordinate liner placement with Others (earthworks contractor);
4. Supply, handle, store and protect liner material;
5. Place and protect liner;
6. Coordinate excavation and backfill of liner trench with Others (earthworks contractor); and
7. Provide as-built surveys of liner panel layouts and repairs.

Drawings comprise the following:

DRAWING NO.	REV.	TITLE
D-4001	0	General Site Arrangement
D-4002	0	Starter Impoundment – Excavation and Fill Plan
D-4003	0	Starter Impoundment – Excavation and Fill Typical Sections

### 1.2 DEFINITIONS

The following definitions and interpretations shall apply to the Technical Specifications:

1. ASTM: American Society for Testing and Materials Standard Test Methods.
2. Construction Project Manager is Clive Creaney or his designate.
3. Contract Documents means, as applicable,
  - the Letter of Acceptance;
  - the executed Agreement Form;

- Instructions to Bidders, completed Bid Form, Schedule of Prices, and Supplements to Bid Form;
  - Information Documents specifically incorporated into the Contract Documents;
  - Definitions and Interpretation, Payment Conditions, Security Conditions, Insurance Conditions, General Conditions, Supplementary Conditions, conditions related to Public Works Act claims;
  - the Specifications;
  - the Drawings;
  - Addenda;
  - such other documents as may be identified as Contract Documents;
  - and shall include amendments thereto made pursuant to the provisions of the Contract.
1. Contractor means the company to whom the Owner has awarded the construction contract.
  2. Drawings, mean all drawings, plans, sketches and maps issued with the Specifications or subsequently as provided for in the Contract and includes any drawings submitted by the Contractor if signed as approved by the Engineer.
  3. Engineer means Klohn Crippen Berger Ltd. or any person duly authorized by the Owner to act on its behalf.
  4. Environmental Management Plan (EMP) means the Owner's environmental standards and procedures for management, reporting and compliance with applicable environmental regulations.
  5. Others means any person, firm or corporation employed by or having a separate contract with the Owner for work related to the project other than that required by the Contract Documents.
  6. Owner, and Corporation shall have common meaning and refer to Yukon Zinc Corporation.
  7. The Project means the total construction contemplated of which the Work may be the whole or part.
  8. Site means the place where the work is being performed and the immediate vicinity thereof.
  9. Specifications mean the Technical Specifications.
  10. Where the words shown, indicated, detailed, specified, or words of a similar nature are used such words shall refer to the Specifications and/or Drawings unless expressly stated otherwise.
  11. Where the words directed, permitted, approved, accepted, required, rejected, satisfactory, or words of similar nature are used such words shall refer to the direction, permission, approval, acceptance, requirements, rejection or satisfaction, of the Owner unless expressly stated otherwise.
  12. The Work means the total construction and related services required by the Contract Documents.

### **1.3 SURVEY**

1. The Owner will provide survey benchmarks with coordinates and elevations near the work areas. The Contractor shall be solely responsible for providing other survey control including layout of the work, confirmation of compliance with required lines and grades, quantity measurements for payment purposes, and final survey of as-built conditions.
2. The Contractor shall provide survey information, in three-dimensional AutoCAD 2005 or newer format, and a summary of Northing, Easting, and Elevations for all survey points in Excel. The Contractor shall submit this information routinely and upon request during the Work and upon completion and as outlined under Submittals.

### **1.4 LAYDOWN AREA**

The Owner will provide office space, laydown and storage area on the mine site. Any additional facilities or utilities must be approved.

### **1.5 SITE POLICIES**

Without limiting Contractor responsibilities described elsewhere in the Contract Documents, the Contractor agrees to comply with Wolverine Project Environmental Protection Plan (EPP) requirements and Site procedures:

1. All safety policies of the Owner outlined elsewhere in the Contract Documents shall be followed, including the use of personal protective equipment (steel toed boots/shoes, hard hats, safety glasses and others as required). All Contractor employees shall receive site specific training before entering the work site to ensure familiarity with Owner standards and policies.
2. The Owner maintains high environmental and safety standards. The Contractor will receive Owner training on the Environmental Protection Plans and site specific safety aspects at the Site. The Contractor is responsible to have all personnel trained in the environmental and safety standards before commencement of the Work.
3. The Contractor shall have an established Safety, Health, and Environment Action Plan (SHEAP) that complies with all Owner HSE standards and EPPs. Safety aspects of the days work shall be part of the daily tool box meetings. Safety interactions shall be held daily with the Owner. Weekly documented safety meetings shall be held with the Owner in a predetermined area.
4. The Contractor shall obey all Owner vehicle and driving standards when driving on Site.
5. Any spills are to be dealt with immediately utilizing appropriate containment and clean up procedures in accordance with the Owner Spill Contingency Plan. Any release to the environment is to be reported immediately to the Owner. The Owner may be required to make notification to Government environmental authorities. No mixing of spilled materials is permitted. The Contractor's shop area shall be maintained and kept free of waste build up and have covered waste barrels to limit accumulating rain water in any containers, as per the Waste Management Plan.

6. The Contractor shall only clean equipment in contained and designated areas.
7. Natural conditions such as extreme storm events should be anticipated and corrective measures taken to mitigate the effects on the Work. Additional monitoring for safety and the environment may be required. Loss of production time as a direct result of wind, precipitation, freezing, or other adverse weather conditions (as determined by the Owner) and the related costs are the Contractor's responsibility and deemed to be included in the unit prices for the Work.
8. The Owner will have a representative/designate on Site during the period of the project who will oversee environmental monitoring as required. The Contractor is responsible for compliance with all Owner standards and regulatory requirements.
9. Drip pans shall be used whenever oil, diesel fuel, gasoline, hydraulic fluid and other such items may leak or spill, and are to be emptied on a regular basis into designated waste disposal containers only.
10. All oil or liquid fuel shall be kept in tightly closed labelled containers designated for that use at all times to eliminate spillage.
11. The Contractor's shop, lay-down and office areas shall be kept clean and tidy. Garbage generated by the Project shall be disposed of in the appropriate locations as directed by the Owner, including:
  - a) Clean non-hazardous debris and putrescible (food) garbage shall be disposed of daily in a location specified by the Owner;
  - b) Sanitary discharge shall not be allowed to flow onto the ground or into a fresh watercourse. Portable toilets will be supplied and maintained by Others.
12. All Work sites shall be kept clean and cleaned-up prior to completing the job. Normal cleanup will include:
  - a) Cleanup of all work areas.
  - b) Disposal to approved locations.
13. If extra precautions beyond those agreed upon, prior to the start of Work, are required to prevent environmental damage the actual and reasonable cost of providing such precautions will be at the Owner's expense.
14. In the case of an emergency condition, the Owner reserves the right to enter the Work area and perform the necessary cleanup at the Owner's expense. If the said emergency condition occurs as a result of the negligence or wilful misconduct of the Contractor, the Contractor shall bear the cost of the cleanup and all fines or penalties levied by Government agencies for the condition.
15. From time to time the Work will require the coordination of activities between the Contractor and the Owner or Others. Notwithstanding any policies, contracts, agreements or the like, the Contractor shall cooperate fully with the Owner or Others, as directed by the Owner, to execute cooperative work in a timely manner and achieve the desired result for the Owner.

## 1.6 SUBMITTALS

Without in any way limiting submittal requirements contained elsewhere in the Contract Documents, the Contractor shall submit the following information for the Owner's approval. Work shall not start until applicable approvals are obtained in writing.

### **BEFORE WORK STARTUP**

1. Construction Schedule showing the critical path.
2. Certification of hazard communication training.
3. List of all employees proposed for the Work, including name, age, and number of years working experience, social security number and position (title).
4. List of all plant, equipment, and materials proposed for the Work including size, weight, and axle loads if required.
5. Copy of site specific safety plan, JSA's (Job Safety Analysis) and SHEAP.
6. Signed company safety training forms for all employees. Contractor must comply with relevant regulatory personnel safety requirements.
7. Documentation indicating that all construction equipment meets regulatory minimum operating standards.

### **DURING THE WORK**

1. Copies of Daily Contractor Tool Box Safety meeting notes and Daily Equipment Pre-shift cards.
2. Copies of employee's incident reports of injury or property damage. Notification to the Owner is required immediately following any incident, with a written incident report submitted to the Owner as soon as practical, but no later than the end of shift.
3. Updates of medical reports for incident status as received.
4. Written property damage reports (by end of shift) with immediate notification to the Owner.
5. Written near miss incident reports (by end of shift) with immediate notification to the Owner.
6. Copies of completed required work permits, as applicable.
7. Copies of completed spill reports as per Owner Spill Contingency Plan with immediate notification to Owner and initiation of spill cleanup as a priority over the Work.
8. Timely Change Order requests.
9. Daily Contractor completion/manpower sheets, showing labour and equipment hours worked on each task as well as details on any delays or breakdowns, signed and submitted to the Owner by noon the following work day.

10. Baseline surveys before starting and upon completing each area of the Work, in a timely fashion, to demonstrate compliance with design requirements and for payment and record purposes.
11. Weekly Report submitted with the weekly Construction Schedule update showing Work Completed, Work Planned, Problems Encountered, and Plans for Resolution.
12. Timely submission of invoices for all work completed, submitted within 30 days of completion of work to avoid late billing issues. This includes all progress payments and final payments.
13. Copies of all equipment safety and site specific training records.

**AT COMPLETION OF THE WORK**

1. Survey information and areas that required repair for as-built drawings and final payment.
2. Timely submission of Final Invoice.
3. Request for release for site cleanup.

**1.7 CONTRACTOR'S PERSONNEL**

Should the Owner object to any person or sub-contractor used by the Contractor on the work, the Contractor shall remove such person or sub-contractor from the work. The Owner's non-objection to any person or sub-contractor shall not be deemed to be an approval of such person or sub-contractor. The Contractor, by reason of such non-objection or by reason of the Owner's approval of any person or sub-contractor, shall in no way be relieved from its responsibility for the employment of such person or sub-contractor or from the performance and fulfillment of the work.

The Contractor shall at all times in connection with the execution of the work, keep and employ a competent general superintendent and a sufficient number of senior assistants capable of speaking, reading and writing the English language, at least one of whom must be at the site of the work at all times while such work is under progress, and any explanation, orders, instructions, directions and requests given by the Owner to such superintendent or senior assistant shall be held to have been given to the Contractor.

**END OF SECTION 1 – GENERAL**

## **SECTION 2 - LINER**

### **PART 1 - GENERAL**

#### **1.1. DESCRIPTION**

The work shall consist of furnishing and installing a linear low-density polyethylene (LLDPE) geomembrane liner over the tailings basin and upstream dam face as shown in the drawings and as specified herein.

#### **1.2. CONTRACTOR QUALIFICATIONS**

##### **Manufacturing**

The manufacturer shall have at least five (5) years continuous experience in manufacturing polyethylene liner and/or experience totalling 5,000,000 m<sup>2</sup> of manufactured polyethylene liner.

##### **Installation**

1. The installation contractor shall be the manufacturer or a dealer trained to install the manufacturer's liner.
2. Installation shall be performed under the constant direction of a field installation supervisor who shall remain on site and be responsible, throughout the liner installation, for liner layout, seaming, testing, repairs, and all other activities by the Installer. The field installation supervisor shall have installed or supervised the installation of a minimum of 500,000 m<sup>2</sup> of polyethylene liner.
3. Seaming shall be performed under the direction of a master seamer (who may also be the field installation supervisor) who has seamed a minimum of 500,000 m<sup>2</sup> of polyethylene liner, using the same type of seaming apparatus approved for this project. The field installation supervisor and/or master seamer shall be present whenever seaming is performed.

#### **1.3. DEFINITIONS**

The term Geosynthetics includes both geomembranes and geotextiles. Only a geomembrane is specified for the Work. The need for geotextiles may be identified during construction. The term Liner refers to the geomembrane.

#### **1.4. CODES AND STANDARDS**

The latest version of the following Standards shall apply for the supply, installation and field testing of the liner. (Abbreviated titles are used.)

ASTM D 4437 Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes

- ASTM D 5641 Geomembrane Seam Evaluation by Vacuum Chamber
- ASTM D 6365 Non-Destructive Testing of Geomembrane Seams using the Spark Test
- ASTM D 6392 Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- ASTM D 1004 Initial Tear Resistance Of Plastic Sheeting
- ASTM D 1505 Density Of Plastics By The Density-Gradient Technique
- ASTM D 1603 Carbon Black In Olefin Plastics
- ASTM D 4833 Index Puncture Resistance Of Geotextiles, Geomembranes And Related Products
- ASTM D 5199 Measuring Nominal Thickness Of Geotextiles And Geomembrane
- ASTM D 1790 Test for Brittleness Temperature of Plastic Sheeting by Impact
- ASTM D 638 Test for Tensile Properties of Plastics

## 1.5. SUBMITTALS

The Contractor shall submit the information requested in Section 1 – General and the following information for approval.

1. In preparing submittals, the Contractor shall recognize the assistance of Others with regard to supply of labour, and equipment.
2. The Manufacturer shall provide the following information:
  - a) With the Bid:
    - List of material properties.
    - Manufacturing quality control program.
  - b) Prior to Liner Installation:
    - Copy of quality control certificates issued by the resin supplier.
    - Copy of quality control certificates for the geomembranes in conformance with Manufacturer's Quality Control and Quality Assurance Testing as set out herein.
3. The Installer shall provide the following written information:
  - a) With the Bid:

- A list of completed projects, totalling a minimum of 150,000 m<sup>2</sup>, for which the installer has installed polyethylene liner. For each installation, the following information shall be provided:
    - a) Name and purpose of facility, location, and date of installation.
    - b) Name of owner, design engineer, manufacturer, and name and telephone number of contact at the facility who can discuss the project.
    - c) Thickness and quantity of the installed liner.
  - A list of equipment that will be used to place the liner (Contractor supplied and those required from Others). In this submittal the Contractor shall provide commentary that demonstrates that the equipment is adequate to handle the load of placing the liner and that the equipment will not damage the liner.
  - A list of personnel who will install the liner system. The Contractor shall obtain approval from the liner manufacturer to use the designated personnel, as required to satisfy manufacturer warranties.
  - The Contractor shall submit construction methods in accordance with Section 1.
- b) Prior to liner installation:
- Resume of the field installation supervisor and master seamer.
  - Manufacturer approvals for liner placement
  - Calibration certificates for all liner test equipment, for approval, at least 14 days prior to starting liner installation. Calibrations shall be current and represent the actual condition of the equipment at the time of use on the Work.
  - A panel layout drawing, for approval. The Panel Layout Drawing shall indicate, at minimum, the configuration of the liner panels and the general location of field seams plus all test equipment.
- c) During installation:
- Calibration certificates for new test equipment and periodic re-calibration certificates of in-use test equipment as required
4. A written Warranty shall be submitted by the manufacturer (for material) and the installation contractor (for workmanship). These documents shall warrant both the quality of the material and workmanship for a specified duration of time.

**PART 2 - PRODUCTS**

**2.1 LINER**

The liner shall be linear low-density polyethylene (LLDPE) with properties as described below, or a liner of approved similar quality.

<b>Property</b>	<b>ASTM Test Method</b>	<b>Value</b>
Thickness	D5199	40 mil 1 mm
Density	D1505	0.92 g/cc
Tensile Properties:	D638 (Type IV at 2 in/min)	
Yield Stress		60 lb/in 10.5 N/mm
Break Stress		150 lb/in 26.3 N/mm
Yield Elongation		13%
Break Elongation		800%
Tear Resistance	D1004	22 lb 98 N
Puncture Resistance	D4833	60 lb 267 N
Low Temp. Impact Resist.	D1790	-94°F -70°C
Carbon Black Content	D1603	2% to 3%
Carbon Black Dispersion	D5596	Cat 1-2
Seam Properties:	D4437 (1 in wide at 2 in/min)	
Shear Strength		60 lb/in 10.5 N/mm
Peel Strength (FTB)		50 lb/in 8.8 N/mm

The Film Tear Bond (FTB) is defined as a failure of one of the bonded sheets before complete separation in the bonded area.

**PART 3 - EXECUTION**

**3.1. GENERAL**

1. The liner rolls shall be shipped by flatbed trailer to the job site. The liner shall be transported and stored so as to be protected from puncture, dirt, grease, moisture, direct sunlight, ultraviolet rays and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface (not wooden pallets) and shall not be stacked more than two rolls high.
2. The Contractor shall supply sandbags (liner ballasting). Sand fill will be provided by Others.
3. The Contractor shall exercise due caution to prevent injury to personnel, particularly due to slipping on the liner when wet.
4. The Contractor shall secure and protect the installation during construction to prevent wind-lifting, tearing or similar damage to the liner.

5. The Contractor shall be responsible for the material and confirm quantities prior to installation to avoid delays or shortages.
6. The Contractor shall minimize waste and shall protect the liner integrity during transportation, installation and after installation.
7. In-place seaming is required. The Contractor shall use an experienced technician/crew to supervise and perform the installation. The supervisor shall be on site at least one full day prior to liner placement for safety training and shall remain on site until 100% of the liner has been installed and approved.
8. The Contractor shall maintain the installation equipment, including power supplies, welding machines and accessories, to avoid delays and minimize repairs.
9. The Contractor shall provide spare welders and generators sufficient to prevent lost time due to equipment breakdown.
10. The liner shall be installed and quality assurance field tested in accordance with the manufacturer's recommendations.
11. The method used to unroll the panels shall not cause scratches or crimps in the liner and shall not damage the supporting soil.
12. Personnel working on the liner shall not smoke or wear damaging shoes. Only soft-soled safety footwear is allowed.
13. The Contractor shall arrive on site prepared to handle rain water collecting on the liner and have pre-made sand bags to hold the liner down during windy conditions. The Contractor is responsible to protect the liner from weather damage.
14. Vehicular traffic will not be permitted directly on the liner.

### **3.2. EARTHWORKS**

1. Prior to liner installation the subgrade shall be moisture conditioned and proof rolled, by Others, as directed, in accordance with the specifications. All surfaces to be lined shall be smooth, free of all foreign and organic material, sharp objects, or debris of any kind. The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Standing water or excessive moisture shall not be allowed.
2. The Installer, on a daily basis, shall approve the surface on which the liner will be installed. After the supporting surface has been approved, it shall be the Installer's responsibility to indicate to the Owner any changes to its condition that may require repair work.
3. The anchor trench shall be excavated to the lines, grade, and width shown on the drawings, prior to liner placement. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the liner.

### **3.3. LINER INSTALLATION**

1. Seams shall be welded in accordance with manufacturer's recommendations. If resin is used for seam welding, the physical properties of the resin shall be the same as, or better than, those used in the manufacture of the liner.
2. Liner panel placement and seaming shall not occur when ambient temperatures are below  $-5^{\circ}\text{C}$  or above  $40^{\circ}\text{C}$ , during precipitation, in the presence of excessive moisture (e.g. fog, dew), or in the presence of high winds.
3. Liner shall be protected from displacement, damage, or deterioration before, during and after placement.
4. Damaged, torn, or permanently twisted panels shall be rejected. Rejected panels shall be removed from the site.
5. Seaming shall be kept to a minimum. Seams shall be preferentially orientated up and down slopes. Horizontal seams shall be more than 2 m down slope from the toe of any slope.
6. Seam areas shall be kept clean and free of moisture, dust, dirt, debris and foreign material.
7. Minor tears and pinholes in the liner shall be repaired by patching until non-destructive testing is successful. Patches shall be round or oval in shape, made of the same liner material, and extend a minimum of 75 mm beyond the edge of the defect.

### **3.4. LINER QUALITY CONTROL**

1. Liner seams shall be tested by non-destructive methods over their full length and the results shall be documented as the seaming work progresses. Seams which do not pass non-destructive testing shall be repaired. The seam between the failed location and any passed test location shall be reconstructed until non-destructive testing is successful.
2. Seams shall be tested and documented in strength and peel at the beginning of each seaming period, and at least once every 4 hours for each seaming apparatus and seamer used that day. At least two samples taken from extra material from each panel shall be tested, such that the panel is not damaged and the blanket geometry is not altered.
3. If the seam test specimen fails in seam, the test shall be repeated on a new specimen. If the new specimen fails in seam, the material shall not be used for seaming until deficiencies are corrected and two consecutive successful test seams are achieved.
4. Seams shall be tested by non-destructive methods over their full length, using a vacuum test unit or an air pressure test.
5. Test results shall be provided to the Owner for each shift's production, including documentation of non-destructive testing and repairs at the end of each shift.

### **3.5. FILL PLACEMENT ON LINER**

1. The method of placing fill directly on the liner, if required, shall not damage the liner and shall be subject to approval. No construction equipment or machinery shall operate directly on the liner and only approved light weight equipment shall be allowed to place fill within 2 m of the liner.
2. Only approved fine grained soil free of foreign and organic material, sharp objects, or debris of any kind, which could potentially damage the liner shall be placed against the liner and within 0.5 m of the liner.
3. The use of approved lightweight machinery (i.e., generator, etc.) with low ground pressure is allowed on the liner.
4. The anchor trench shall be backfilled by the earthwork contractor. Trench backfill material shall be placed and compacted in accordance with the earthworks specifications.
5. Care shall be taken when backfilling the trenches to prevent damage to the liner. If damage occurs, it shall be repaired prior to backfilling.

### **3.6. LINER ACCEPTANCE**

The Installer shall retain ownership and responsibility for the liner until accepted by the Owner.

Final acceptance is when all of the following conditions are met:

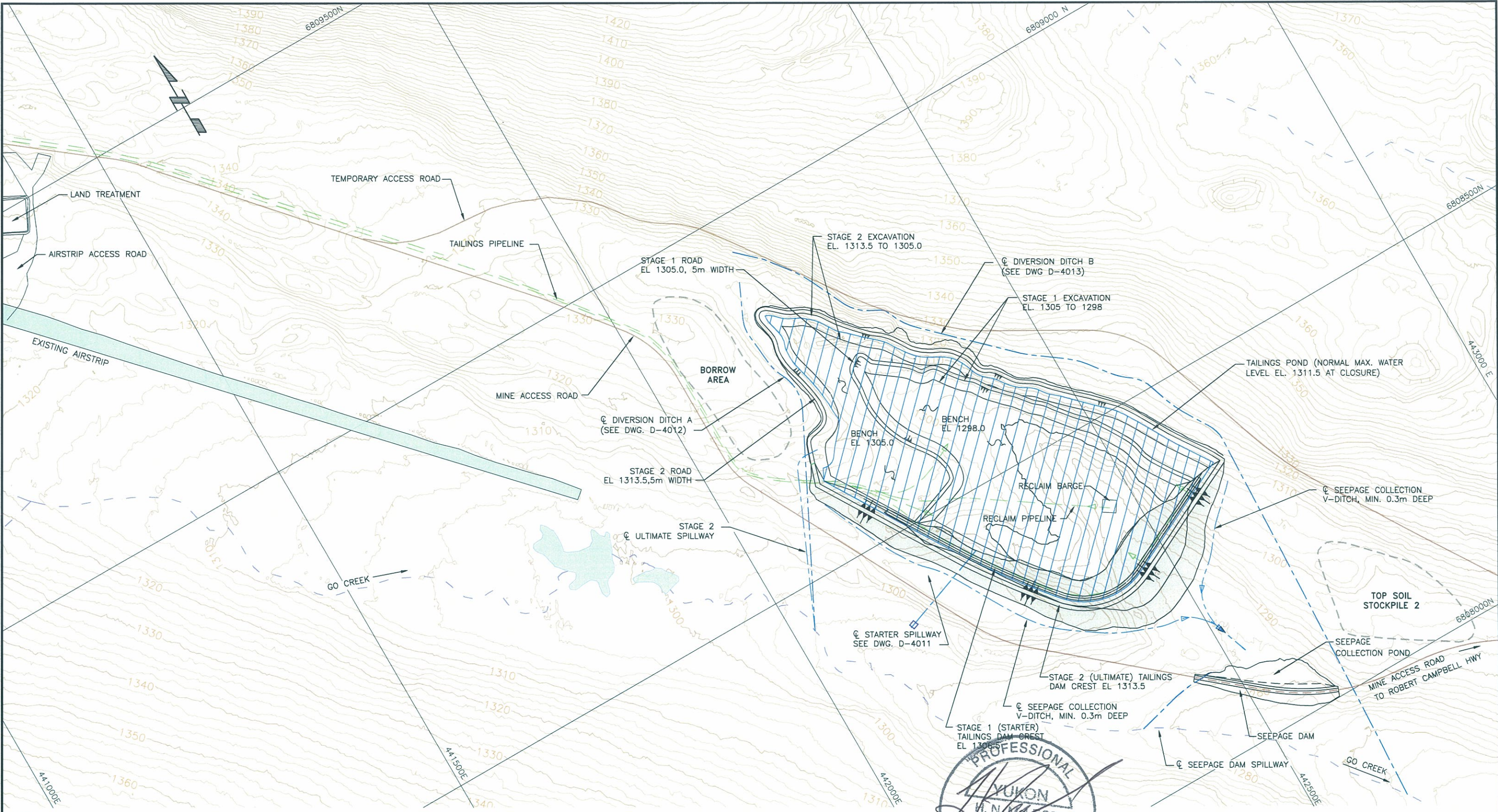
- Installation is finished.
- Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

**END OF SECTION 2 - LINER**

## **DRAWINGS**

<b>D-4001</b>	<b>General Site Arrangement</b>
<b>D-4002</b>	<b>Starter Impoundment – Excavation and Fill Plan</b>
<b>D-4003</b>	<b>Starter Impoundment – Excavation and Fill Typical Sections</b>
<b>D-4004</b>	<b>Seepage Dam – Plan and Section</b>
<b>D-4011</b>	<b>Starter Spillway – Plan, Profile and Section</b>
<b>D-4012</b>	<b>Diversion Ditch A – Plan, Profile and Sections</b>
<b>D-4013 (Sheet 1 of 2)</b>	<b>Diversion Ditch B – Plan and Profile</b>
<b>D-4013 (Sheet 2 of 2)</b>	<b>Diversion Ditch B – Sections and Details</b>

Scale: 1=25(FS)  
 31541810.DWG Drawing File: M:\09234A04-Wolverine Tailings Facility - Detail Design\400 Design\410 Drawings\c\4-3000\rev1-FC\ND-3001-4001.dwg (cwrong)  
 Xrefs: DamFootprint-0812121, Utilities(12Dec08), CONT\_2M\_MINE\_4Mgrid(23Nov06)



- NOTES  
 1. NOT ALL CULVERTS HAVE BEEN SHOWN.  
 2. ALL ELEVATIONS IN METRES.



ISSUED FOR CONSTRUCTION



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DWG. NO.	REFERENCE DRAWINGS

PROJECT	PROCESS	CIVIL	MECH.	STRUCT.	PIPING	SERVICES	ELECT.	INSTR.	NO	DESCRIPTION	BY	DATE

PROJECT	PROCESS	CIVIL	MECH.	STRUCT.	PIPING	SERVICES	ELECT.	INSTR.	NO	DESCRIPTION	BY	DATE

SECTION	SCALE	DATE
ENGINEER		

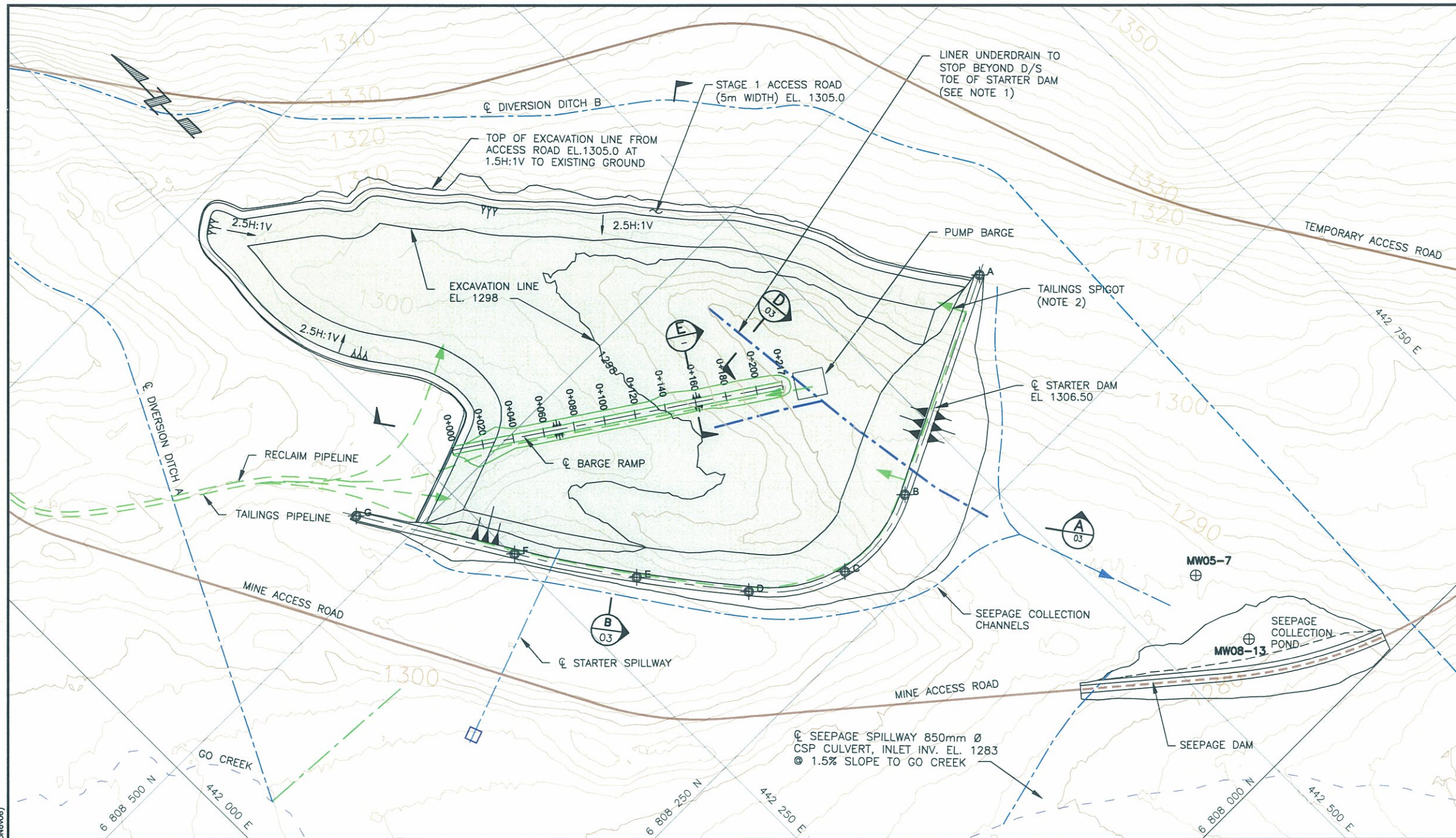
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	M09234A04	D-4001	1



YukonZinc Corp  
 WOLVERINE PROJECT  
 TAILINGS STORAGE FACILITY  
 GENERAL SITE ARRANGEMENT

DESIGN BY	DK	DEC 19/08
DRAWN BY	CYW	DEC 19/08
CHECK BY	HM	
APP. BY	HM	DEC 19/08

1	ISSUED FOR CONSTRUCTION	MD	NR	13/08
0	ISSUED FOR TENDER	DK	FEB	04/08



WORK POINTS		
No.	NORTHING	EASTING
A	6808358.95	442590.66
B	6808292.91	442456.28
C	6808285.21	442393.72
D	6808319.70	442340.96
E	6808377.49	442296.33
F	6808443.89	442251.38
G	6808533.25	442196.73

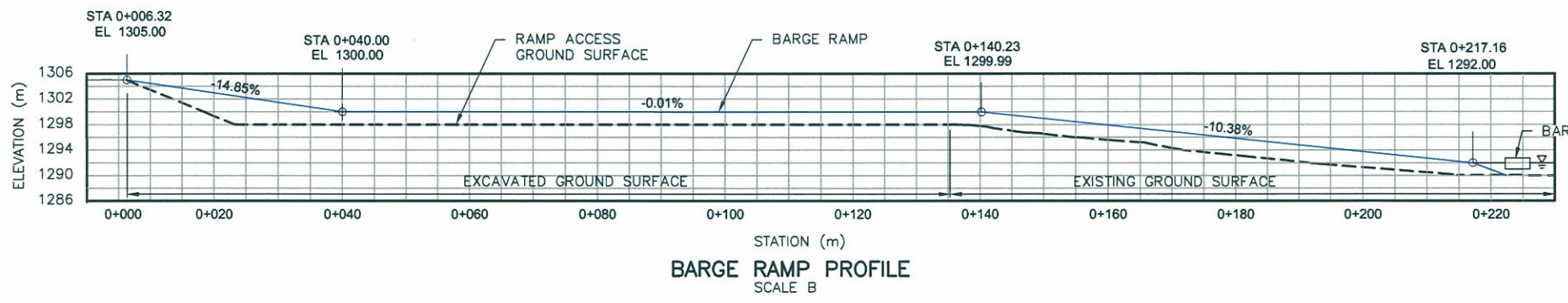
**LEGEND**

- ROADS
- CREEK
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- LINER UNDERDRAIN
- PIPELINES
- LINER AREA
- MW05-7 GROUNDWATER MONITORING WELL
- WORK POINT (COORDINATES LISTED ABOVE)

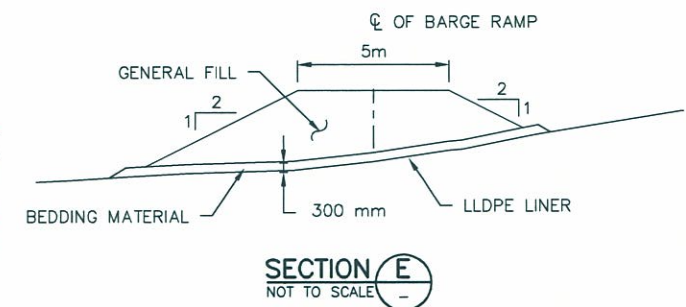
**NOTES**

1. LOCATION AND EXTENT OF LINER UNDERDRAIN WILL BE DETERMINED IN THE FIELD BY SITE ENGINEER, FOLLOWING THE LOWEST EXISTING DRAINAGE COURSE. THE UNDERDRAIN SHALL EXIT INTO A SOLID PIPE UNDER THE DAM AND INTO AN OPEN DITCH BEYOND THE DAM TOE.
2. TAILINGS TO BE SPIGGOTTED FROM DAM TO FORM POND AT NORTH/WEST END.

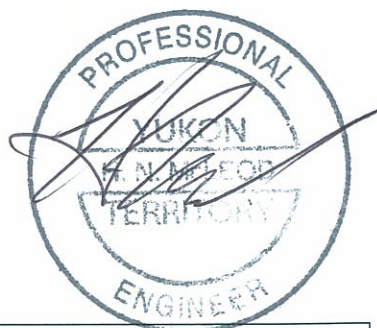
**PLAN**  
SCALE A



**BARGE RAMP PROFILE**  
SCALE B



**TYPICAL BARGE RAMP SECTION**  
SECTION TAKEN AT STA 0+160



**ISSUED FOR CONSTRUCTION**



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PROJECT	PROCESS	NO	DESCRIPTION	BY	DATE

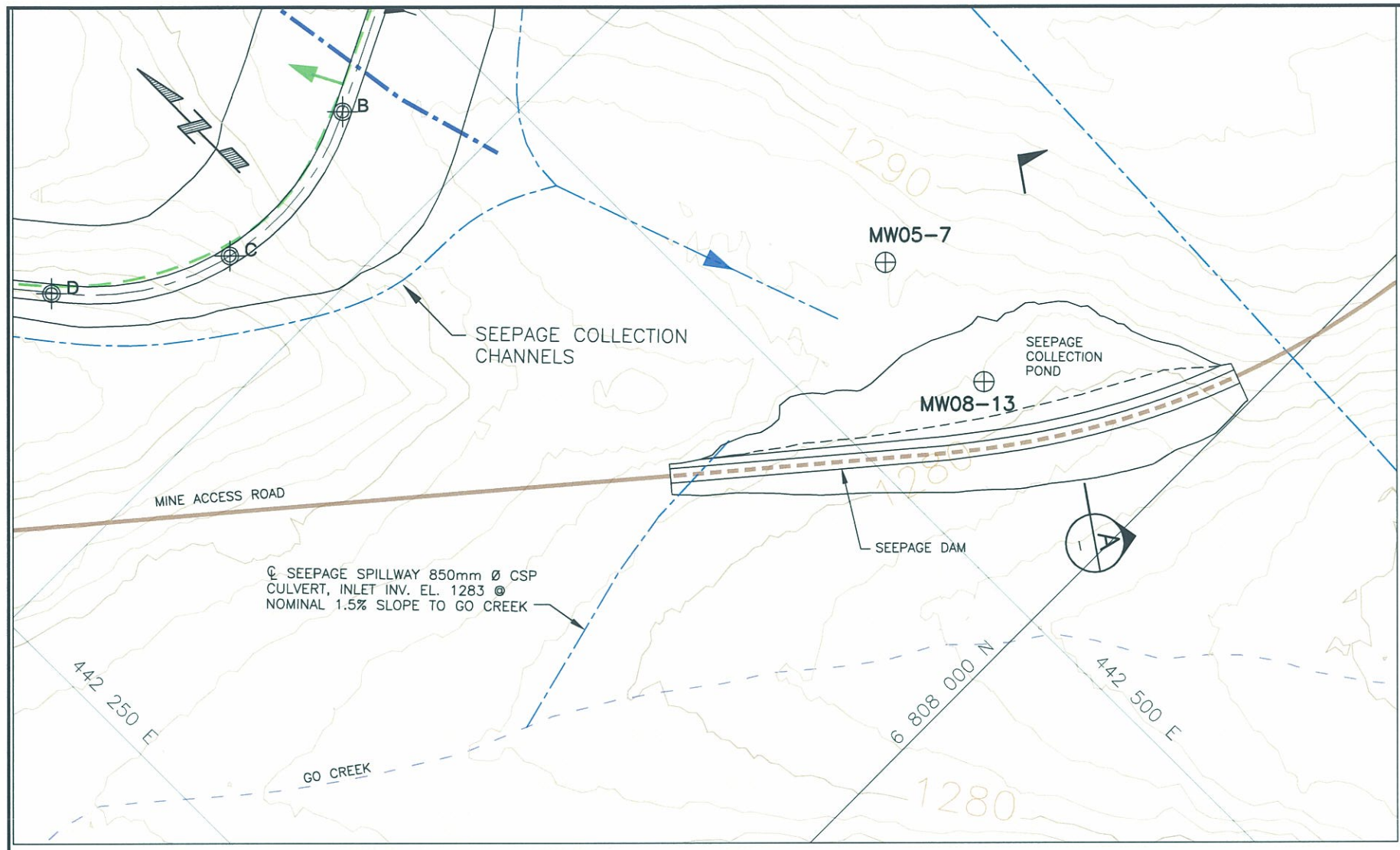
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FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
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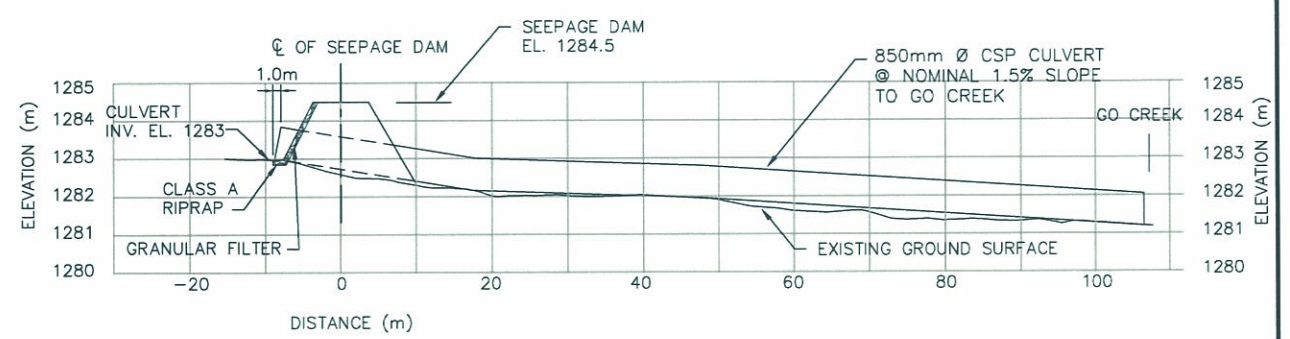
**YukonZinc Corp**  
 WOLVERINE PROJECT  
 TAILINGS STORAGE FACILITY  
 STARTER IMPOUNDMENT  
 EXCAVATION AND FILL PLAN







PLAN  
SCALE A



PROFILE OF SEEPAGE SPILLWAY  
HORIZONTAL SCALE = SCALE C  
VERTICAL SCALE = 5X HORIZONTAL SCALE

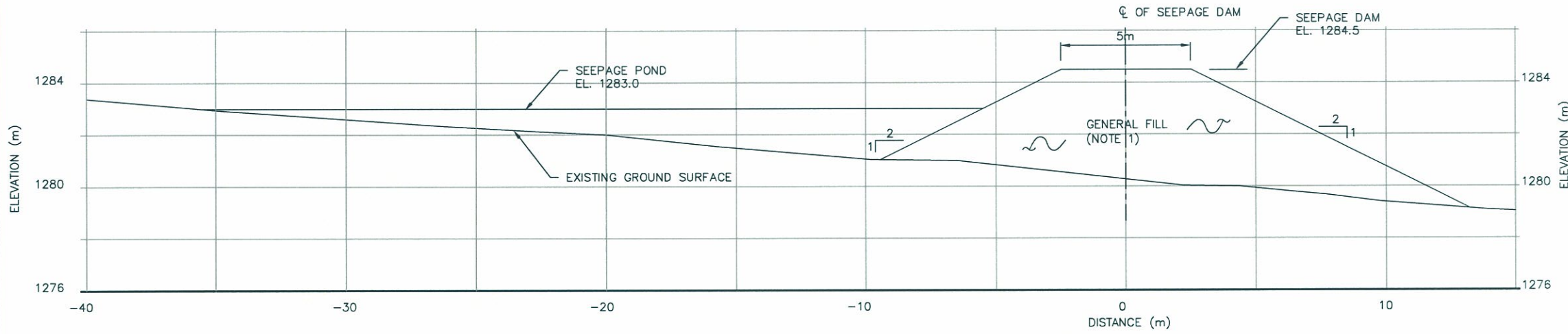
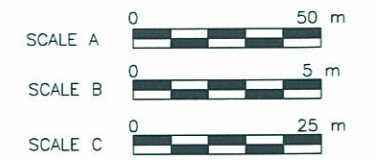
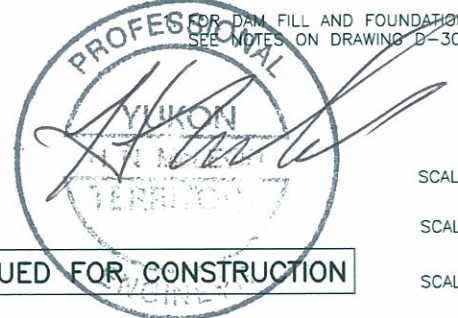
LEGEND

- ROADS
- - - CREEK
- - - DIVERSION OR COLLECTION DITCH, SPILLWAY
- - - LINER UNDERDRAIN
- - - OVERLAND FLOW

- ⊕ MW05-7 GROUNDWATER MONITORING WELL (MW08-13) TO BE RELOCATED DOWNSTREAM
- ⊕ A WORK POINT (COORDINATES LISTED ABOVE)

NOTES

FOR DAM FILL AND FOUNDATION SPECIFICATIONS, SEE NOTES ON DRAWING D-3007



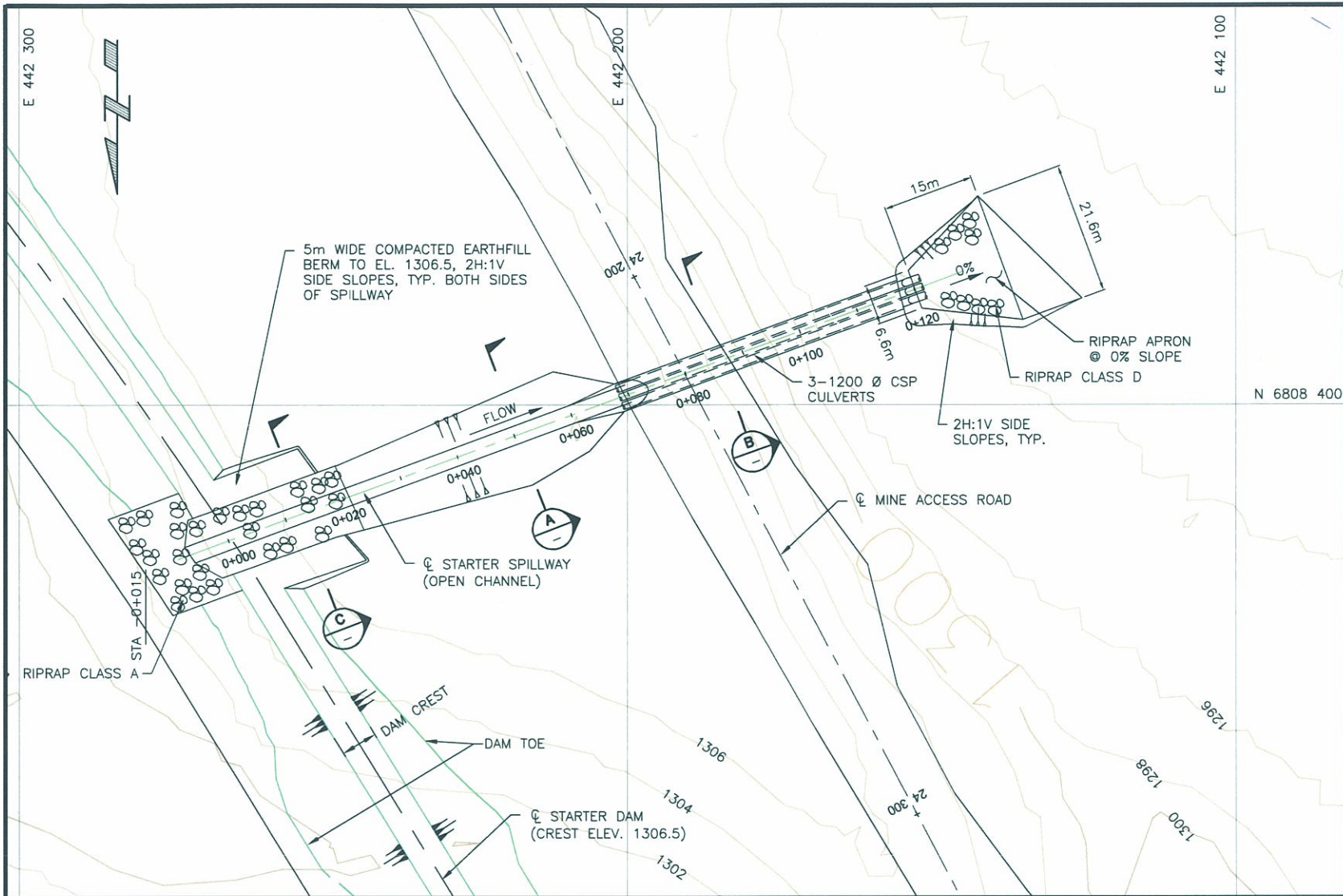
SECTION A  
SCALE B

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

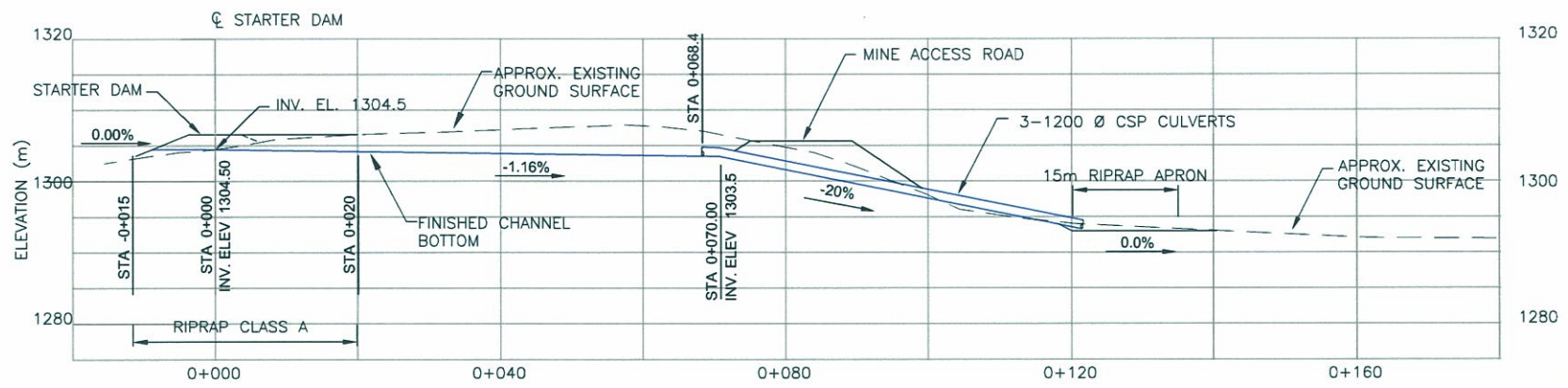
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												0	ISSUED FOR TENDER	DK	04/08
												NO	DESCRIPTION	BY	DATE
													ISSUE/REVISIONS		

SECTION:	FILENAME:	PROJECT NUMBER:	DRAWING NUMBER:	REV.
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DESIGN BY:	DATE:	CHK. BY:	DATE:	
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CYW	04/08	HM	19/08	

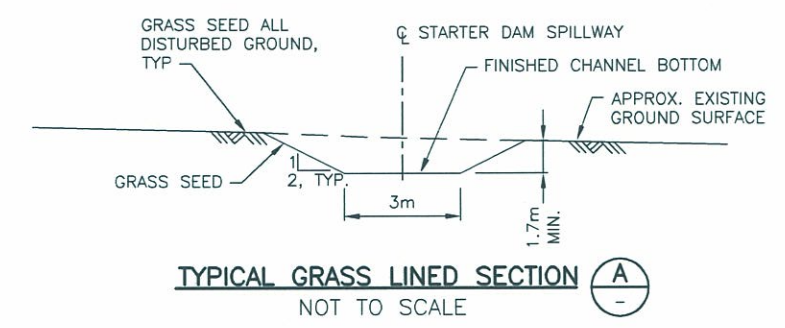
**YukonZinc**  
WOLVERINE PROJECT  
TAILINGS STORAGE FACILITY  
SEEPAGE DAM  
PLAN AND SECTION



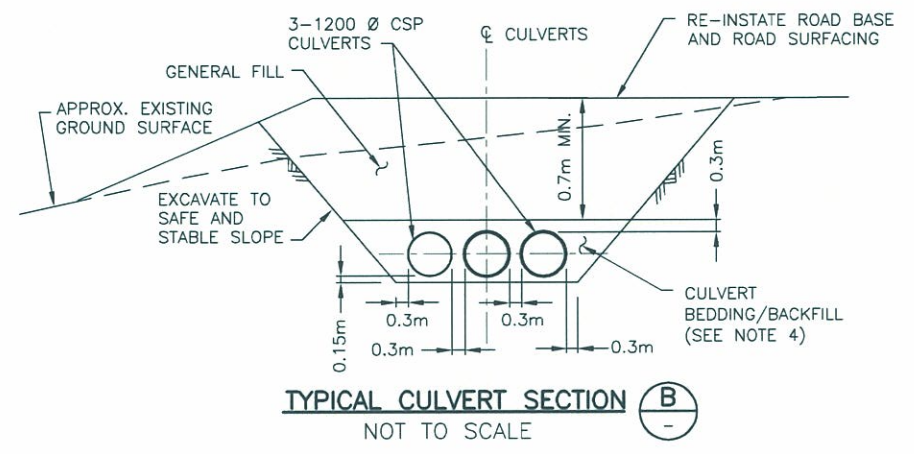
**PLAN**  
SCALE A



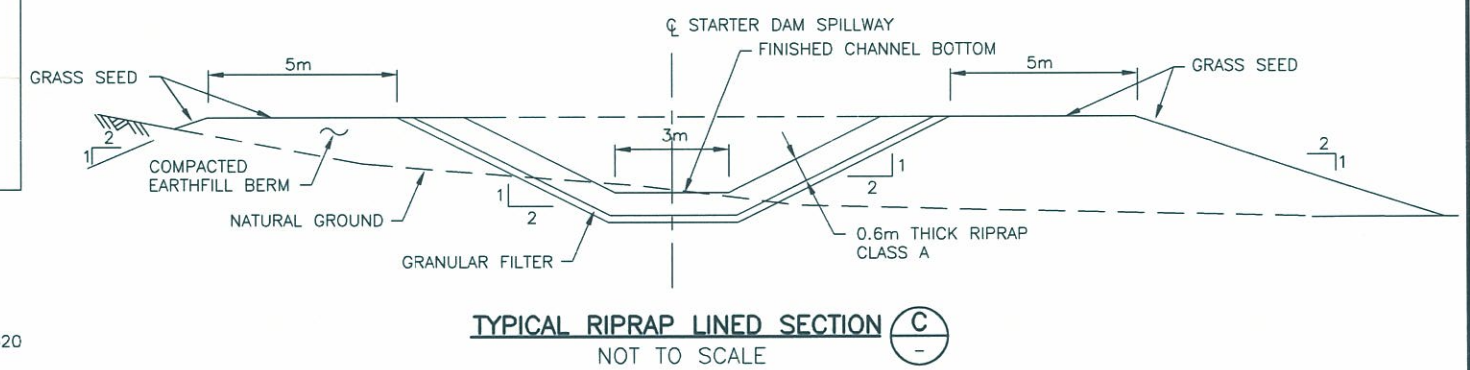
**PROFILE - STARTER SPILLWAY**  
SCALE A



**TYPICAL GRASS LINED SECTION (A)**  
NOT TO SCALE



**TYPICAL CULVERT SECTION (B)**  
NOT TO SCALE



**TYPICAL RIPRAP LINED SECTION (C)**  
NOT TO SCALE

**NOTES**

1. FOR GENERAL SITE ARRANGEMENT, SEE DWG. D-4001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D-4013 SHEET 2 OF 2.
4. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.



**ISSUED FOR CONSTRUCTION**



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Xrefs: CONT\_2N\_MINE-4Ingrd(Mon4Dec08)-2008

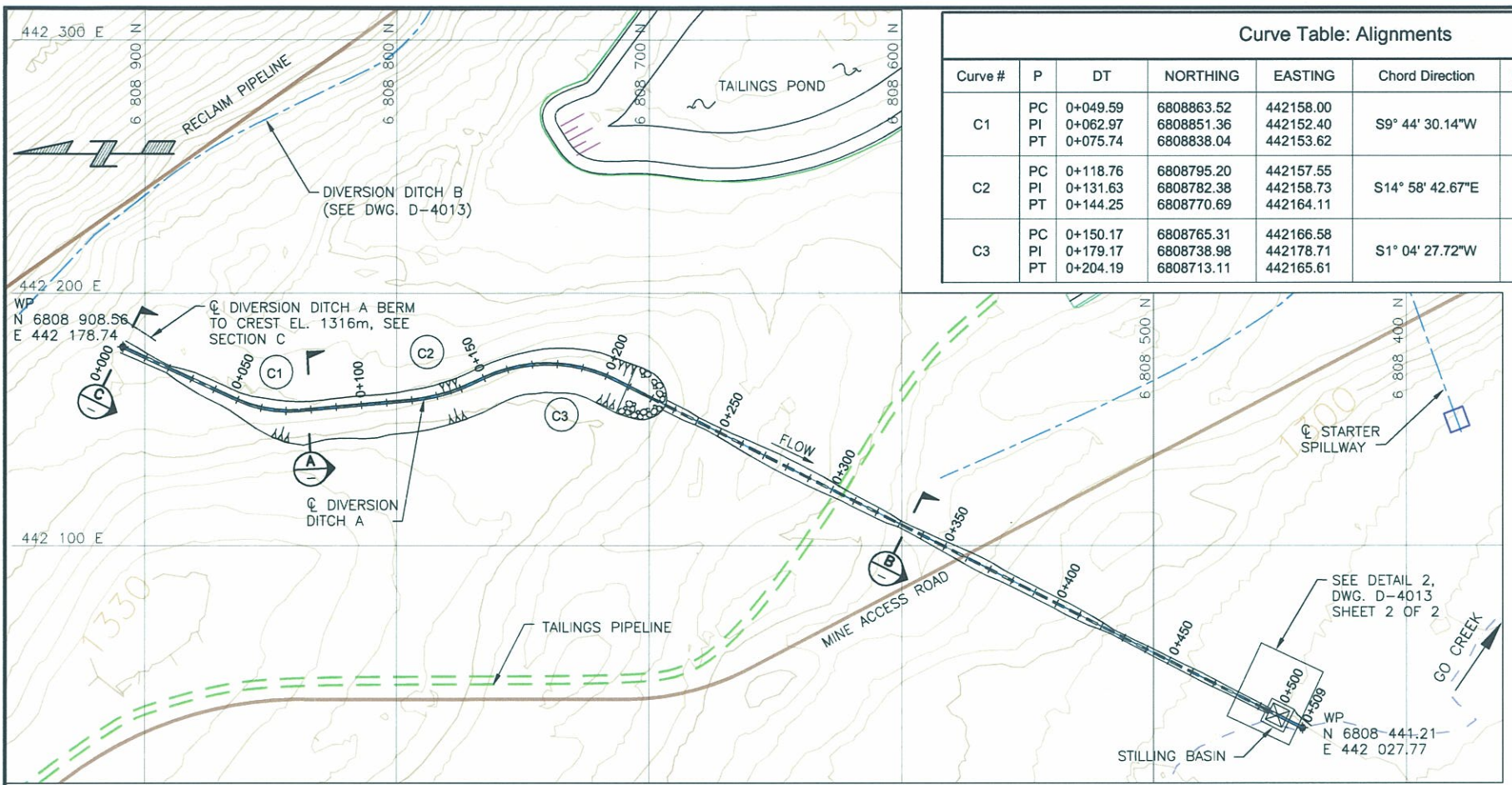
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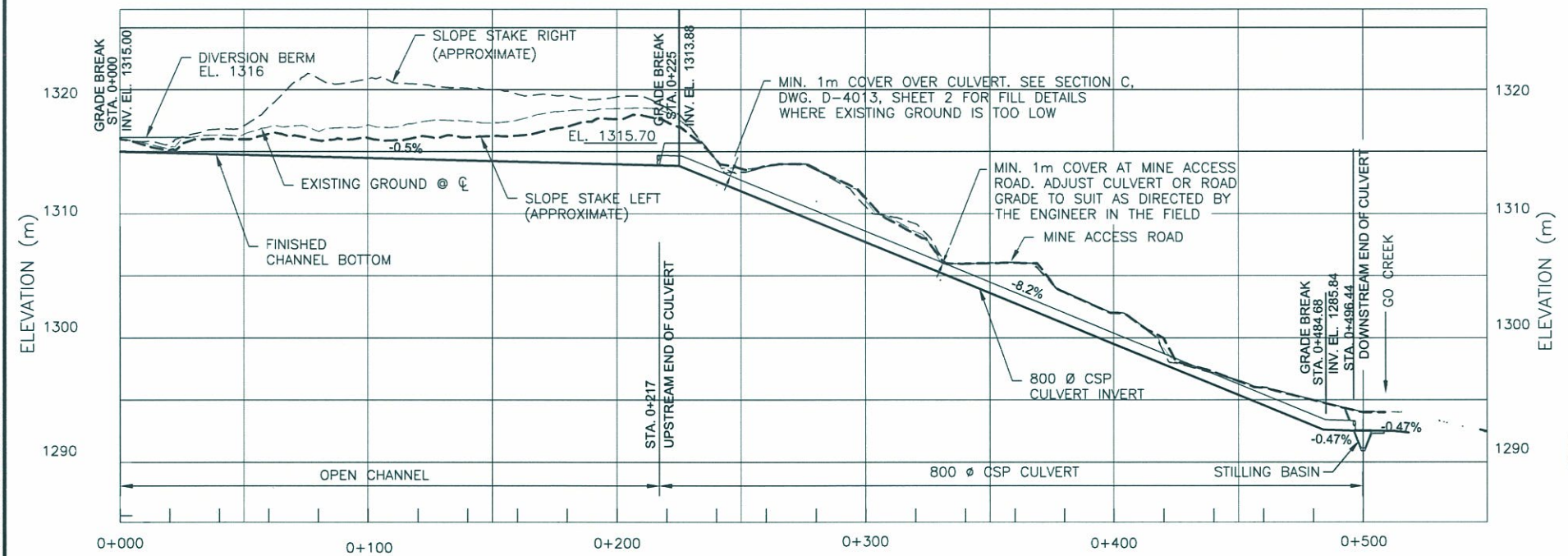
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HM	---			
APP. BY:	DATE			
HM	DEC 19/08			

**Klohn Crippen Berger**  
WOLVERINE PROJECT  
TAILINGS STORAGE FACILITY  
STARTER SPILLWAY  
PLAN, PROFILE AND SECTIONS

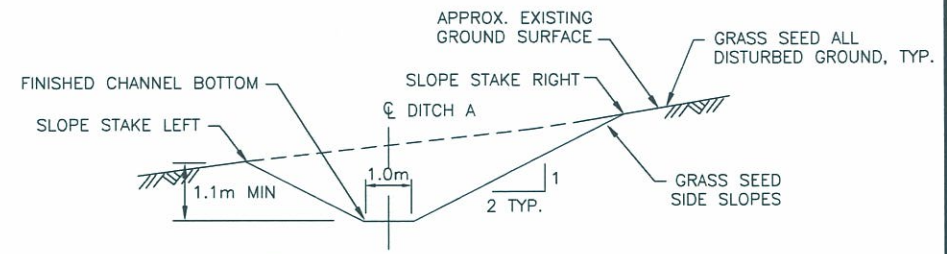
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	PI	0+062.97	6808851.36	442152.40				
	PT	0+075.74	6808838.04	442153.62				
C2	PC	0+118.76	6808795.20	442157.55	S14° 58' 42.67"E	75.00	25.49	160° 31' 43"
	PI	0+131.63	6808782.38	442158.73				
	PT	0+144.25	6808770.69	442164.11				
C3	PC	0+150.17	6808765.31	442166.58	S1° 04' 27.72"W	60.00	54.01	128° 25' 22"
	PI	0+179.17	6808738.98	442178.71				
	PT	0+204.19	6808713.11	442165.61				



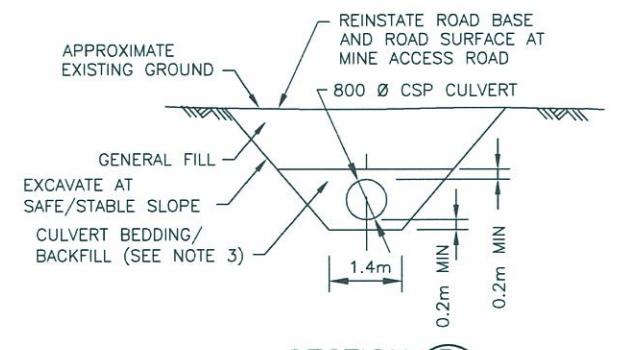
PLAN SCALE A



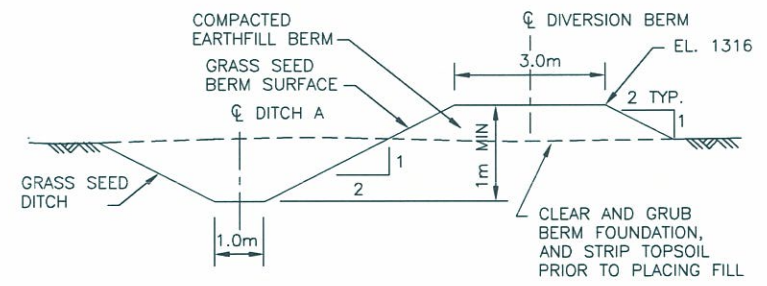
PROFILE DIVERSION DITCH A SCALE A VERTICAL SCALE = 5X HORIZONTAL SCALE



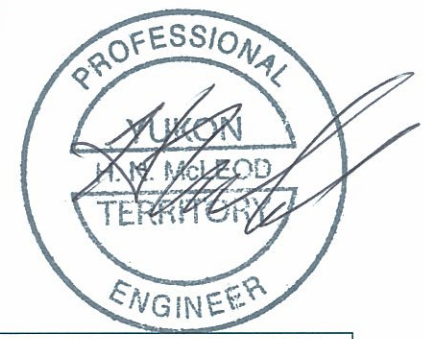
SECTION A TYPICAL OPEN CHANNEL SECTION NTS



SECTION B TYPICAL CULVERT SECTION NTS



SECTION C DITCH A DIVERSION BERM NTS



ISSUED FOR CONSTRUCTION

NOTES

- FOR GENERAL SITE ARRANGEMENT SEE DWG. D-4001.
- INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
- CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
- FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D-4013 SHEET 2 OF 2.

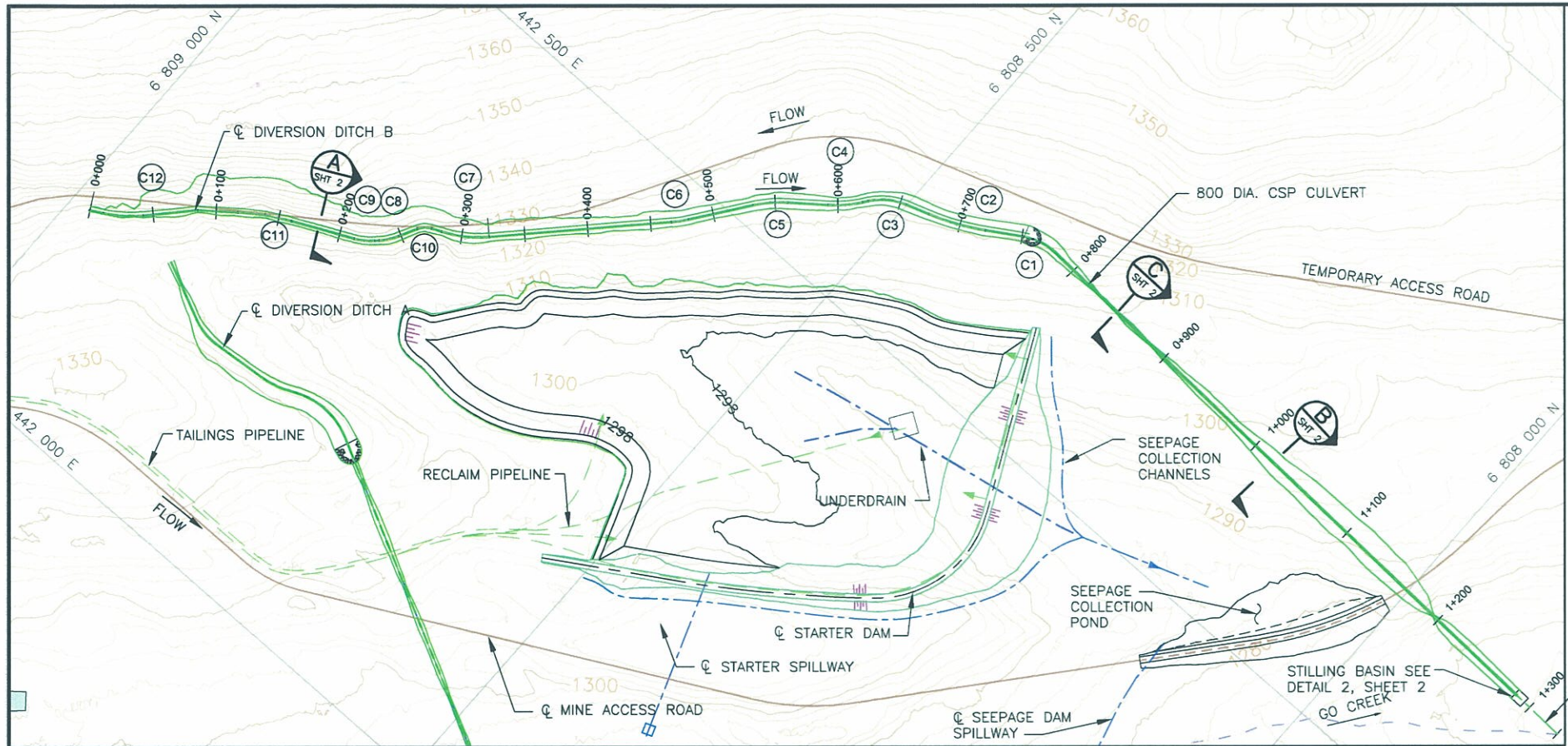


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Xrefs: Utilities(2Dec08), CONT\_2M\_MINE\_4Mgrid(23Nov06)

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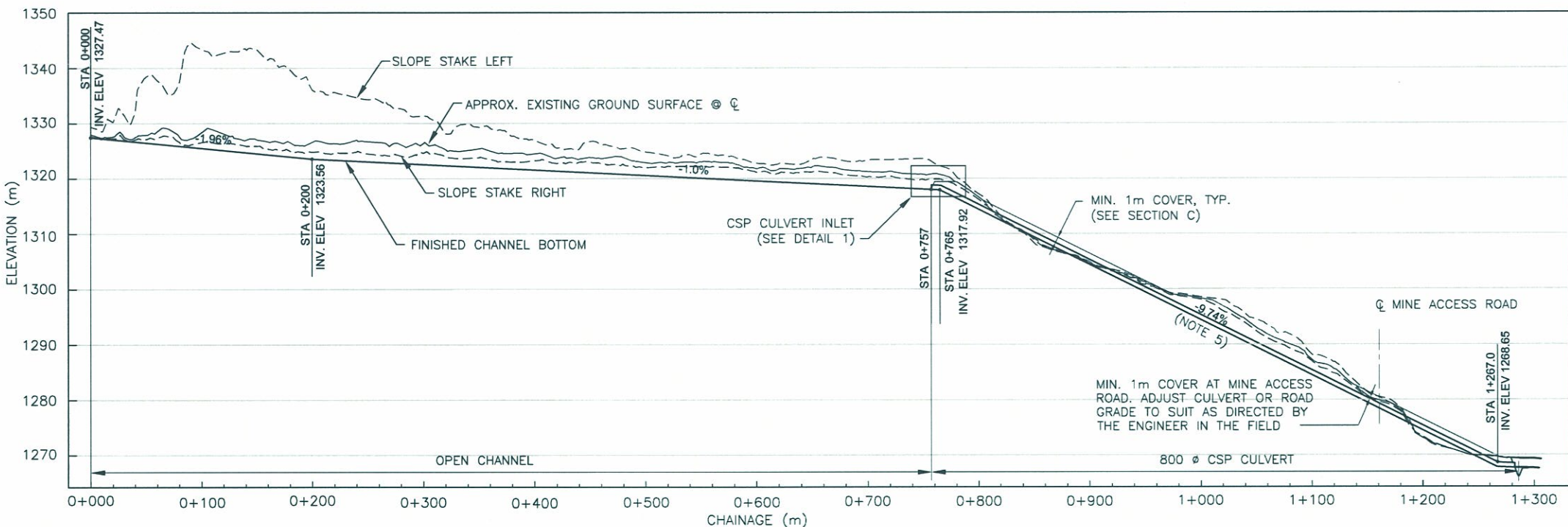
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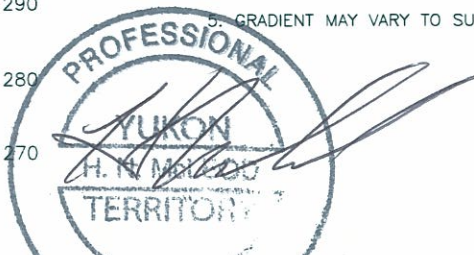
PLAN

Curve Table: Alignments								
Curve #	P	DT	NORTHING	EASTING	Chord Direction	Radius	Length	lc
C1	PC	0+750.66	6808414.57	442637.94	S12° 20' 00.26"E	50.00	33.96	141° 04' 58"
	PI	0+768.32	6808399.56	442647.25				
	PT	0+784.62	6808382.03	442645.06				
C2	PC	0+674.28	6808481.97	442602.50	S25° 07' 47.29"E	200.00	46.51	166° 40' 32"
	PI	0+697.65	6808459.81	442609.90				
	PT	0+720.80	6808439.95	442622.21				
C3	PC	0+624.40	6808524.66	442578.74	S35° 56' 35.36"E	50.00	30.50	145° 02' 56"
	PI	0+640.14	6808515.28	442591.38				
	PT	0+654.90	6808500.35	442596.36				
C4	PC	0+592.14	6808546.71	442555.36	S45° 31' 23.19"E	100.00	27.56	164° 12' 31"
	PI	0+606.01	6808535.73	442563.82				
	PT	0+619.70	6808527.46	442574.96				
C5	PC	0+532.22	6808591.51	442515.91	S45° 38' 36.55"E	100.00	27.98	163° 58' 05"
	PI	0+546.30	6808583.16	442527.26				
	PT	0+560.20	6808572.01	442535.86				
C6	PC	0+466.43	6808631.21	442463.50	S49° 46' 50.48"E	100.00	13.54	172° 14' 32"
	PI	0+473.21	6808626.49	442466.37				
	PT	0+479.97	6808622.47	442473.83				
C7	PC	0+283.83	6808762.87	442338.15	S34° 46' 17.96"E	98.25	38.17	157° 44' 23"
	PI	0+303.16	6808745.16	442345.90				
	PT	0+322.00	6808731.71	442359.78				
C8	PC	0+232.16	6808795.45	442300.22	S53° 40' 58.72"E	50.00	15.76	161° 56' 33"
	PI	0+240.11	6808789.80	442305.81				
	PT	0+247.92	6808786.16	442312.87				
C9	PC	0+212.24	6808811.29	442288.33	S35° 15' 18.59"E	50.00	16.40	161° 12' 07"
	PI	0+220.52	6808803.84	442291.94				
	PT	0+228.65	6808797.95	442297.75				
C10	PC	0+263.91	6808778.83	442327.08	S43° 10' 35.69"E	16.71	11.39	140° 55' 47"
	PI	0+269.84	6808776.11	442332.35				
	PT	0+275.31	6808770.68	442334.73				
C11	PC	0+117.34	6808894.38	442242.94	S32° 00' 57.85"E	200.00	43.00	167° 40' 48"
	PI	0+138.93	6808877.41	442256.28				
	PT	0+160.35	6808857.99	442265.69				
C12	PC	0+010.71	6808973.90	442172.53	S37° 45' 55.04"E	100.00	31.35	162° 02' 24"
	PI	0+026.51	6808960.05	442180.14				
	PT	0+042.05	6808949.22	442191.65				



PROFILE DIVERSION DITCH B VERTICAL SCALE = 5X HORIZONTAL SCALE

- NOTES:**
- FOR GENERAL SITE ARRANGEMENT SEE DWG. D-3001.
  - INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
  - CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
  - FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D-3034.
  - GRADIENT MAY VARY TO SUIT ACTUAL GROUND ELEVATIONS.



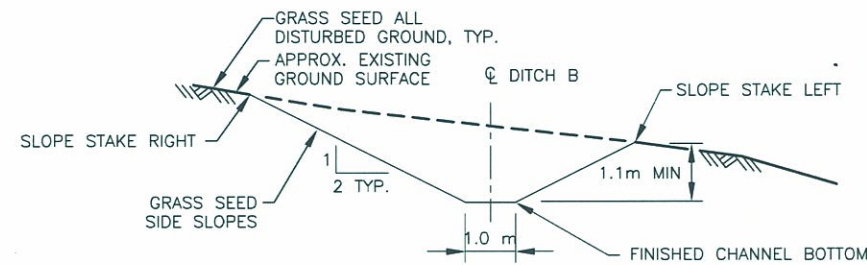
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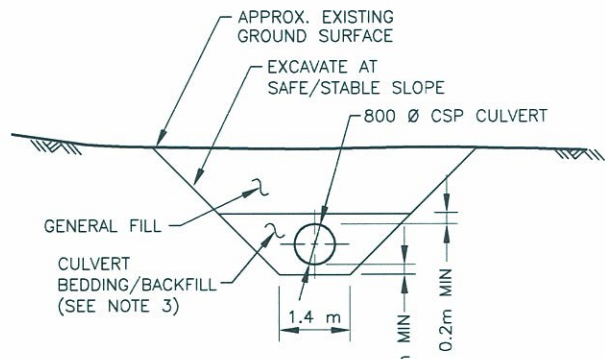
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YUKON TERRITORY PROFESSIONAL ENGINEER H.N. MEADOWS												TAILINGS STORAGE FACILITY DIVERSION DITCH B PLAN AND PROFILE - SHEET 1 OF 2			

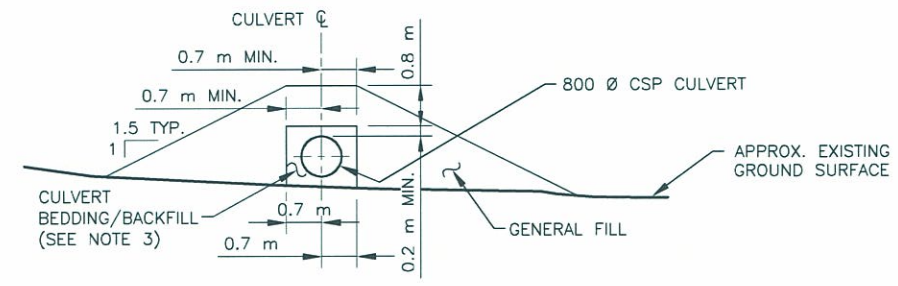
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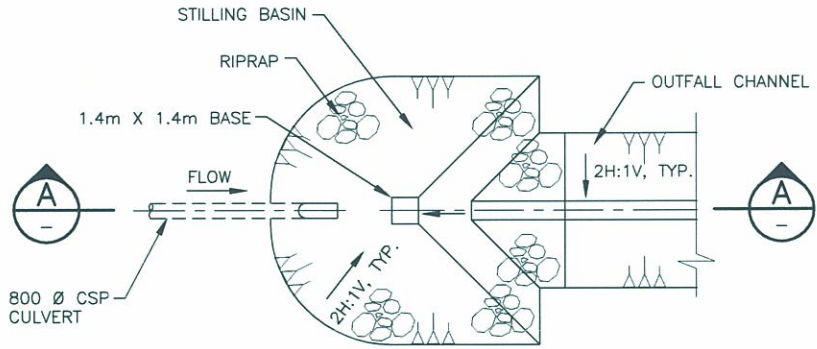
**SECTION A**  
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TYPICAL OPEN CHANNEL SECTION



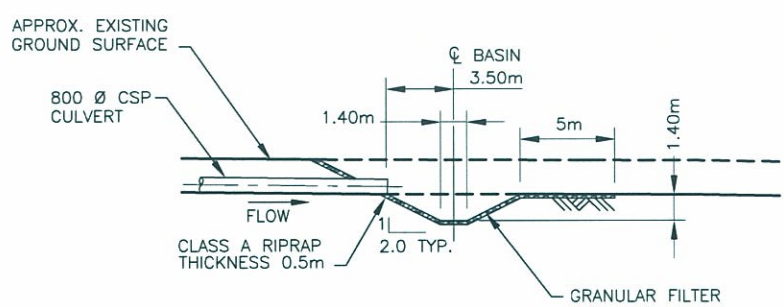
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TYPICAL CSP CULVERT SECTION IN CUT



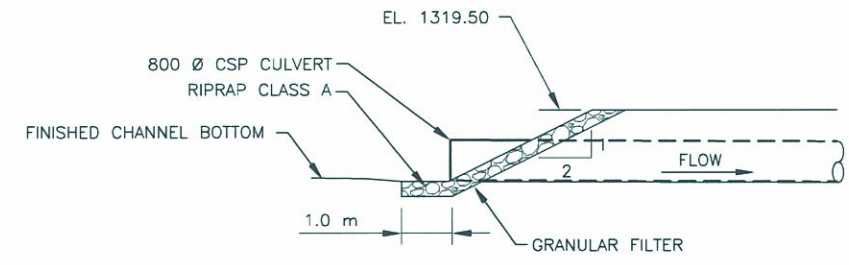
**SECTION C**  
NTS SHT 1  
CSP CULVERT SECTION IN FILL



**DETAIL 2**  
NTS SHT 1  
STILLING BASIN PLAN



**SECTION A**  
NTS



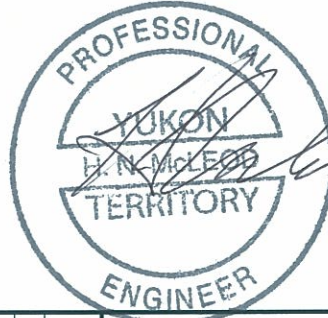
**DETAIL 1**  
NTS SHT 1  
CSP CULVERT INLET

**RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS**  
(SEE NOTE 4)

Material	Particle Size (mm)				Layer Thickness (mm)	
	D <sub>100</sub>	D <sub>85</sub>	D <sub>50</sub>	D <sub>15</sub>	Riprap	Filter
Riprap A	300	260	200	120	400	200 Filter 1
Riprap B	450	390	300	180	600	200 Filter 1
Riprap C	525	455	350	210	700	300 Filter 1
Riprap D	675	585	450	270	900	300 Filter 1
Riprap E	1200	1040	800	480	1600	300 Filter 1 + 400 Filter 2
Riprap F	1500	1300	1,000	600	2000	400 Filter 1 + 400 Filter 2
Filter 1	75	60 to 70	35 to 50	23 to 28	-	-
Filter 2	300	260	200	120	-	-

- Riprap gradation shall be within -5% to +10% of the specified D<sub>15</sub>, D<sub>50</sub>, and D<sub>85</sub> sizes.
- Filter 1 shall be well graded between the 75 mm and 19 mm screen sizes.
- Filter 2 shall be the same gradation as Riprap A.
- Filter 1 grading is based on the subsoil being a silty sand and gravel

- NOTES:**
- FOR GENERAL SITE ARRANGEMENT SEE DWG. D-3001.
  - INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
  - CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
  - UNLESS OTHERWISE DIRECTED BY THE ENGINEER, GRANULAR FILTER IS TO BE PLACED UNDER ALL RIPRAP.



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