REPORT

Heap Leach and Process Facilities Plan

Coffee Gold Mine

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January 26, 2026

REVISION TRACKING LOG

Revision Tracking Log			
Version	**Date**	**Section Updated**	**Description of Update**
0	November 2023	-	First submission of the Heap Leach and Process Facilities Plan
1	March 2024	General	Updated in response to Type A WUL SIR4 as well as minor editorial corrections
2	January 2026	Various	Updated in response to QML IR1, Type A WUL IR8, Type A WUL IR11. Also includes updates following Third-party Review, FMEA, and review of Independent Review Board Recommendations.

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APPENDIX C HLF Construction QA/QC Plan
APPENDIX D HLF Operation, Maintenance and Surveillance Manual
APPENDIX E Coffee Gold Mine Water Treatment – Preliminary Design
APPENDIX F Contingency Water Treatment Plan

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
ALR	action leakage rate
AP	acid potential
ARD	acid rock drainage
ASTM	American Society for Testing and Materials
As(III)	arsenite
As(V)	arsenate
Au	gold
BOD	biological oxygen demand
$Ca(OH)_2$	calcium hydroxide
CCL	compacted clay liner
CDA	Canadian Dam Association
CIC	carbon-in-column
CN	cyanide
CO_2	Carbon dioxide
COD	chemical oxygen demand
CPE	corrugated polyethylene
d	day
d/y	days/year
DCS	distributed control system
DM-As	dimthylarsonic acid
DSR	Dam Safety Review
EBR	Electrochemical Bioreactor
EC	electrical conductance
ELL	electrical leak location
EP	event pond
EPCM	Engineering, Procurement, and Construction Management
EQ	equilibration
ESR	Event Storage Requirement
$FeCl_3$	Ferric chloride
FoS	Factor of Safety
GCL	geosynthetic clay liner
HCL	hydrochloric acid
HDPE	high-density polyethylene
HLF	heap leach facility
HLP	heap leach pad
HLPFP	Heap Leach Processing Facility Plan
HMI	human-machine interface
HOA	Hand-off-auto
HRT	hydraulic retention time
H&S	Health & Safety

Acronym / Abbreviation	Definition
H:V	horizontal to vertical slope angle
ICMC	International Cyanide Management Code
ITP	Inspection and Test Plan
KCA	Kappes Cassiday & Associates
LCRS	leak collection and recovery system
LLDPE	linear low-density polyethylene
LOM	life of mine
ML	metal leaching
MM-As	monomthylarsonic acid
MSE	mechanically stabilized earth
M,I&I	Measure, inferred and indicated
NAR	Northern Access Route
NBCC	National Building Codes of Canada
Non-PAG	non-potentially acid generating
NP	neutralization potential
O_2	oxygen
ODF	overliner drain fill
OMS	Operations, Maintenance, and Surveillance Manual
PAG	potentially acid generating
PGA	peak ground acceleration
PLC	programmable logic controller
PMP	probable maximum precipitation
Process Facilities	Cyanide mixing facility and process plant
Project	Coffee Gold Mine
QA/QC	Quality assurance / quality control
RQD	Rock quality designation
RMR	Rock Mass Rating
RO	reverse osmosis
ROM	Run-of-mine
RQD	rock quality designation
SDI	Silt density index
SDR	Standard Dimension Ratio
SER	Sustainability and External Relations
SPTs	Standard Penetration Tests
TCLP	toxicity characteristic leaching procedure
TMG	The Mines Group
UCS	unconfined compressive strength
UF	Ultrafiltration
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
VFD	Variable Frequency Drive
WBM	water balance model

Acronym / Abbreviation	Definition
WBWQM	water balance and water quality model
WROMP	Waste Rock and Overburden Management Plan
WRSF	Waste Rock Storage Facility
YTT	Yukon-Tanana terrane

LIST OF SYMBOLS AND UNITS OF MEASURE

Symbol, Unit of Measure	Definition
%	percent
bgs	below ground surface
ºC	degrees Celsius
d	day
d/y	days per year
g	gram
g/t	Grams per tonne
g/t Au	grams of gold per tonne
ha	hectare
ha/d	hectare/day
hr	hour
hr/d	hours per day
H:V	Horizontal to Vertical ratio
km	kilometer
km^2	square kilometer
kN/m^2	ixilonewton per square meter
kN/m^3	ixilonewton per cubic meter
koz	thousand ounces
kg	kilogram
km	kilometer
km^2	square kilometers
kt	kilotonne
L	liter
$L/hr/m^2$	liters per hour per square meter
$l/m^2/hr$	liters per square meter per hour
m	meter
masl	Meters above sea level
mm	millimeter
m^2	square meters
m^3	cubic meters
m^3/hr	Cubic meters per hour
m^3/s	cubic meters per second
Mt	million metric tonnes
Mt/a	million tonnes per annum
pH	hydrogen potential
t/d	tonnes per day
yr	year

INFORMATION REQUIREMENTS FOR QUARTZ MINE LICENSE AND WATER LICENSE

Information Requirement	Location in this Plan
Table of Concordance	Appendix A: Heap Leach and Process Facilities Plan Table of Concordance
Revision Log	Page i
Provide the design criteria that guide the heap leach facility design including project constraints, regulatory and guidance-based criteria and other criteria	Section 2.0: Design Criteria
Include overall tonnage, daily and annual loading rates, and loading season.	Section 2.1: Ore Quantities
Provide leach solution application rates and methods, leaching areas, and leaching ore volumes	Section 2.2: Leaching
Describe seismic design events, factors of safety and slope angles.	Section 2.3: Geotechnical Criteria
Describe flood design events, inflow hydrographs, erosion control, sediment removal, freeboard, flood routing capacity, and emergency or event water storage capacity.	Section 2.4: Hydrologic Criteria
Describe the combination of events considered in storage estimates including climatic, operational and drain down events.	Section 2.5: Storage Criteria
Provide permeabilities and leakage rates of liners.	Section 2.6: Liner Criteria
Identify contaminants of concern and proposed water treatment, discharge and receiving water quality criteria.	Section 4.5: Water Treatment of Heap Leach Solutions; Waste Rock and Overburden Management Plan
Provide design details for all heap leach and process facilities constructed through various project phases.	Section 3.0: Construction and Design
Provide specific descriptions of foundation conditions for each of the facilities, including supporting data and analyses, referencing information provided for descriptions of soil and bedrock.	Section 3.1: Foundation Conditions and Construction
Describe site clearing, stripping and grubbing and foundation preparation.	Section 3.2: Site Preparation
Describe the construction quality assurance/quality control program that will be implemented to ensure that construction activities achieve expected performance. Describe how the construction quality assurance/quality control program will ensure appropriate implementation of construction constraints related to climatic conditions like wet, dry and freezing conditions.	Section 3.6: Construction Quality Assurance / Quality Control; Appendix C: HLF Construction QA/QC Plan
Describe the results of stability and settlement analyses for proposed facilities.	Section 3.4: Stability and Settlement Analyses; Mine Operations Plan
Describe the construction schedule, addressing proposed construction phases, and also seasonal scheduling.	Section 3.7: Construction Schedule
Provide designs for confining embankments, containment berms and liner systems, including material and construction specifications, stability analyses, flood management and erosion control.	Section 3.8: Design of Heap Leach Pad and Event Ponds
Describe the overall solution storage capacity, demonstrating how the storage capacity achieves the storage-related design criteria.	Section 3.8.1: Solution Storage Facilities

Information Requirement	Location in this Plan
Provide designs for all proposed liner systems.	Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems
Describe the gold bearing solution and leakage collection systems for the heap leach pad, including pipe layout and sizing, material permeabilities, segregation of leaching and leak collection cells, solution recovery risers or wells and solution recovery pumping systems.	Section 3.8.2: Solution Collection Systems
Describe pumping and piping facilities for conveying leach solution to and from the heap leach pad, including layout and sizing. Describe proposed solution distribution systems and emitters, including any differences for different seasons or phases. Identify any requirements for heating of solution, and how this will be accomplished. Describe facilities to maintain double containment of process solutions, and for passive draining of escaped solution to appropriate storage facilities.	Section 3.8.3: Solution Conveyance and Pumping Systems
Describe the type of ore that will be placed on the heap, including both chemical and physical properties. Provide details on how the ore will be crushed including equipment requirements, number of stages, and final specifications for placed ore. Describe any requirements for agglomeration of ore.	Section 4.1: Ore Crushing and Processing Facilities
Describe the methods proposed for conveying ore and loading ore on the pad. Describe equipment requirements, and how liner integrity will be protected during initial loading. Provide an ore loading sequence, showing proposed benches and slopes, which can be used for development of an operational water balance. Provide stability analyses both during loading and at full build-out. Describe ore characteristics including consolidation testing, permeability, and moisture characteristics. Describe any interlift liners including types and thicknesses of liners, rationale for use of any interlift liners, rationale for selection of liner type and stability analyses. Describe the barren solution distribution system that will be used and provide site-specific test work that demonstrates the ability of ore materials to convey solution at the proposed application rates.	Section 4.2: Run-of-Mine and Crushed Ore to HLP and Stockpiles
Provide designs for surface water management facilities and infrastructure. Designs for both permanent and temporary facilities must be included.	Section 4.6: Surface Water Management
Describe the processes for recovery of metal from gold bearing leach solution. Provide details about adsorption, desorption and recovery, acid wash/carbon stripping, carbon regeneration, and refining. Provide designs for processing facilities including flow sheets, sizing, capacities, process controls and containment systems. Also provide details about how health and safety issues have been addressed, including air quality and air handling. Describe how spills or releases of process solutions will be contained. Provide details about reagent storage and handling.	Section 4.3: Metal Recovery and Processing Facilities Cyanide Management Plan; Spill Contingency Plan; Waste and Hazardous Materials Management Plan
Describe proposed water treatment processes that will be used to achieve water quality design criteria during all phases of the project. Provide results of water treatment test programs that demonstrate expected performance of treatment systems. Provide designs for water treatment facilities including flow sheets, sizing, capacities, process controls, containment systems, reagent use and discharge conditions. Describe amounts and characteristics of any water treatment sludge and describe management plans for sludge. Provide designs for any sludge containment facilities/approaches, both temporary and permanent. Describe scheduling for construction of water treatment facilities, including any variations or additions that may be required for specific mines phases.	Section 4.5: Water Treatment of Heap Leach Solutions

Information Requirement	Location in this Plan
Provide quantities of borrow materials required for construction activities, including material specifications. Identify sources for proposed borrow materials and provide test work to confirm that proposed sources contain sufficient quantities of materials that have suitable geotechnical and geochemical characteristics to meet construction requirements. Include results of any test work to confirm that borrow material will not have unacceptable metal leaching characteristics. Describe any material processing that will be required.	Section 3.5: Borrow Sources
Describe measures and facilities to control and manage access to heap leach facilities by humans and wildlife during all project phases.	Section 4.10: Access Management
Provide details on any roads that are required to access the heap. Include detailed design drawings.	Section 4.11: Access Roads
Provide a detailed description of proposed heap leach operation.	Section 4.0: Heap Leach Facilities Operation
Provide a solution management plan that describes how storage and water treatment facilities will be utilized during each phase and during emergency events. Provide flow sheets that illustrate where and how solution would flow, including quantities and qualities, in various operational scenarios and emergency situations.	Section 4.4: Solution Management
Provide a detailed description of proposed operations, maintenance, and monitoring programs for the heap leach facility.	Appendix D: HLF OMS
Describe any proposed adaptive management plans that are designed to address unexpected performance of the heap leach facilities.	Section 4.8: Adaptive Management Plans
Describe how the heap leach facilities have been designed and operations will be implemented to minimize risks associated with emergency and extreme events. Provide details about how design features and operational actions will be used to ensure environmental protection during extreme climate events, power failures, forest fires, and other events that cause loss of pumping capacity for leaching solutions.	Section 4.9: Emergency Management
The Heap Leach and Process Facilities Plan needs to address shutdown (temporary and permanent) of heap leach facilities, including any detoxification, neutralization, rinsing, and drain down that entail unique challenges for heap leach facilities.	Section 5.0: Heap Leach Facilities Temporary Shutdown
Describe proposed processes and sequences for any residual leaching, rinsing, detoxification and/or neutralization of heap materials.	Section 5.4: Detoxification
Describe the sequence and plan for final drain down of the heap leach facility, considering the total quantity of solution, expected drain down rate, and the capacity of proposed water treatment systems.	Section 5.5: Draindown
Describe how rinsing, detoxification, neutralization and drain down have been incorporated into the water balance and solution management plan.	Appendix B: Heap Leach Pad Engineering Report for Licencing
Describe the types of cover that will be used to reclaim the surface of any heap leach facility.	Section 5.6: Covers
Describe what activities would be undertaken during a temporary shut-down of mining operations, including plans for continued pumping or treatment and drain down of solutions.	Section 5.0: Heap Leach Facilities Temporary Shutdown

Information Requirement		Location in this Plan
YWB EMR Plan Requirements Applicable to the Heap Leach and Process Facilities Plan		
Information Requirement	Location in this Plan	Referenced From
Provide a description of how ore will be handled on site, including location and design of stockpiles, segregation protocols, stockpile inventories, and projected life of stockpiles.	Section 4.2: Run-of-Mine and Crushed Ore to HLP and Stockpiles	General Mine Development Plan; Mine Operations Plan
Provide a description of the crushing process, including how ore is fed into the crusher(s), the capacity of the crusher(s), the components and equipment involved in each crushing circuit, the crush size achieved, and any dust suppression or collection systems that will be employed.	Section 4.1: Ore Crushing and Processing Facilities	General Mine Development Plan; Mine Operations Plan

1.0 INTRODUCTION

1.1 Project Summary

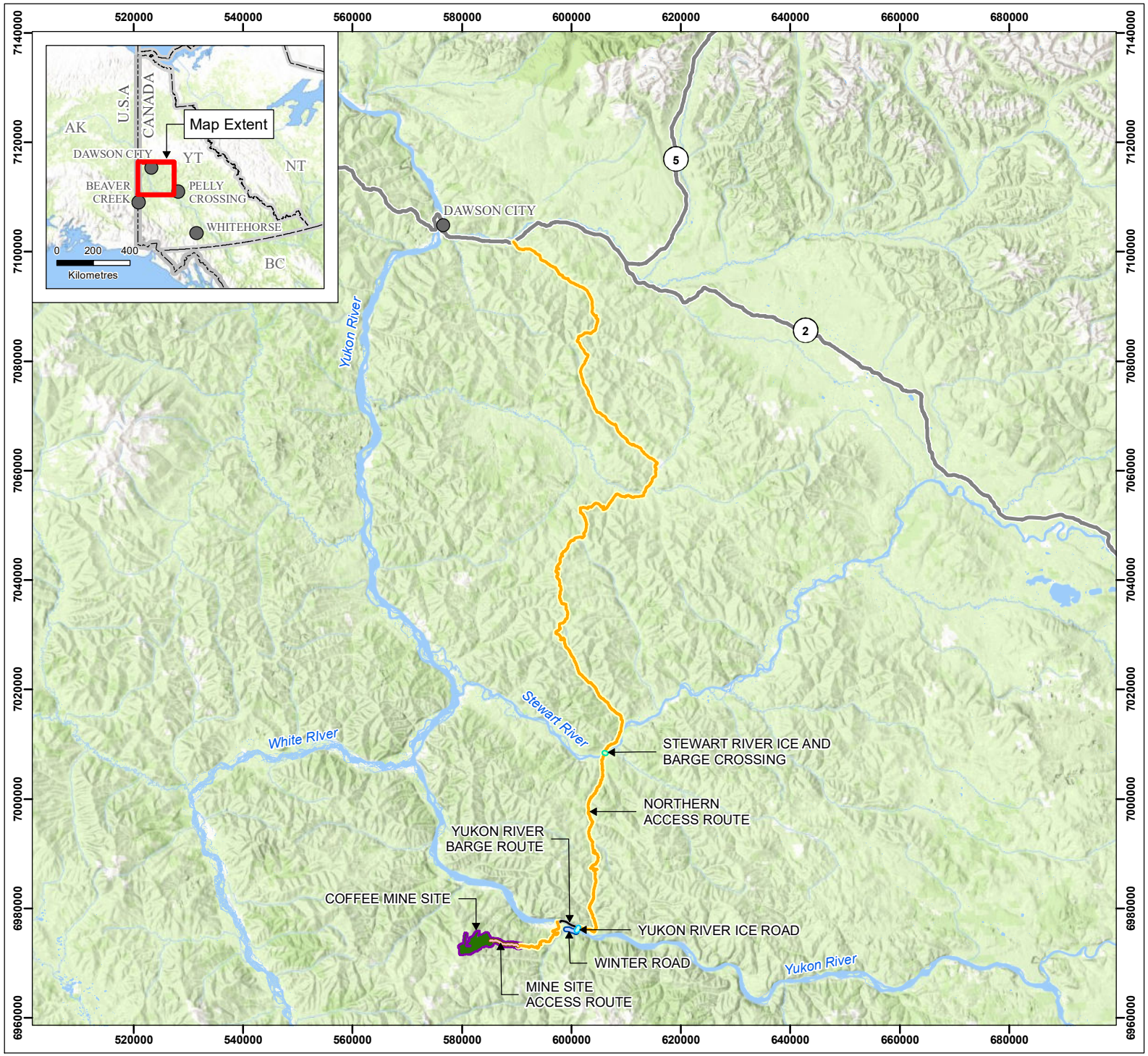
The proposed Coffee Gold Mine (the Project) is an open-pit gold mine owned by Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals, located on the south side of the Yukon River in the White Gold District of west-central Yukon. The Project site is approximately 130 km south of the City of Dawson, 140 km west of Pelly Crossing, 95 km north-east of Beaver Creek, and 340 km northwest of Whitehorse. The Project is located wholly within the traditional territory of Tr'ondëk Hwëch'in, partially within the traditional territory of Selkirk First Nation and First Nation of Na-cho Nyäk Dun, and partially within the asserted territory of White River First Nation. The Project contains several gold occurrences within an exploration concession covering an area of more than 600 km^2. The Mine Site will be accessed by road from Dawson via a 16-km stretch of Klondike Highway and 192-km all-season road, referred to as the Northern Access Route (NAR) (Figure 1-1). The NAR includes seasonal barge crossings on both the Stewart and Yukon rivers, with ice bridges and a seasonal winter road in the winter months.

The Project is comprised of four open pits: Supremo, Latte, Double Double, and Kona. Waste rock is proposed to be permanently stored in the Alpha Waste Rock Storage Facility (WRSF) (Figure 1-2). The ore production rate is proposed to be up to approximately 9.0 million tonnes (Mt) per year, producing an estimated total of 67 Mt of heap leach feed over the 10-year Operation Phase. The conceptual-level estimate for waste material to be moved over the life of mine (LOM) is up to approximately 330 Mt based on an average strip ratio of 5.0:1. The ore will be crushed and transported to the Heap Leach Facility (HLF) via overland conveyor or trucks for nine months of the year. During the three coldest months of winter, run-of-mine (ROM) ore will be stockpiled in the ROM stockpile. Gold will be extracted from gold-bearing leach solution by a six tonnes per day (t/d) adsorption, desorption, recovery carbon plant with mercury retorting to produce a final gold doré product. A total of 2.6 million ounces of gold is planned to be recovered over a 10-year mine life.

The Project phases are defined as follows:

- Construction Phase: Q2 Year –3 to end of Year –1 (30 months)
- Operation Phase: Year –1 to end of Year 9 (10 years)
- Reclamation and Closure Phase: Year 10 to end of Year 21, including a 6-year Post-Mining Closure Stage and a 5-year Active Closure Stage (11 years)
- Post-Closure Phase: Year 21 onwards as determined to be required.

These phases broadly describe the activities occurring within a particular time period; however, some activities will continue from one phase to another as mine site development advances with operational activities (e.g., Open Pits, WRSF). When areas that support mine operations are no longer required, they will be progressively reclaimed. The overall Project schedule is the general expected scenario for mine construction and operation; detailed activities are subject to change depending on detailed mine planning and the timing of receipt of authorizations.



COFFEE GOLD MINE

Coffee Project Location and Northern Access Route

Legend

- Stewart River Ice and Barge Crossing
- Yukon River Barge Route
- Yukon River Ice Road
- Winter Road
- Mine Site Access Route
- Northern Access Route
- Project Area
- Project Footprint
- Highway
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
2. Contains information licensed under the Open Government Licence - Yukon Territory
3. Basemap: ESRI World Topographic Map
4. Inset Basemap: ESRI World Topographic Map

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Kilometres

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Figure 1.1	Date: Mar 2, 2023	Drawn by: AS	Reviewed: KP

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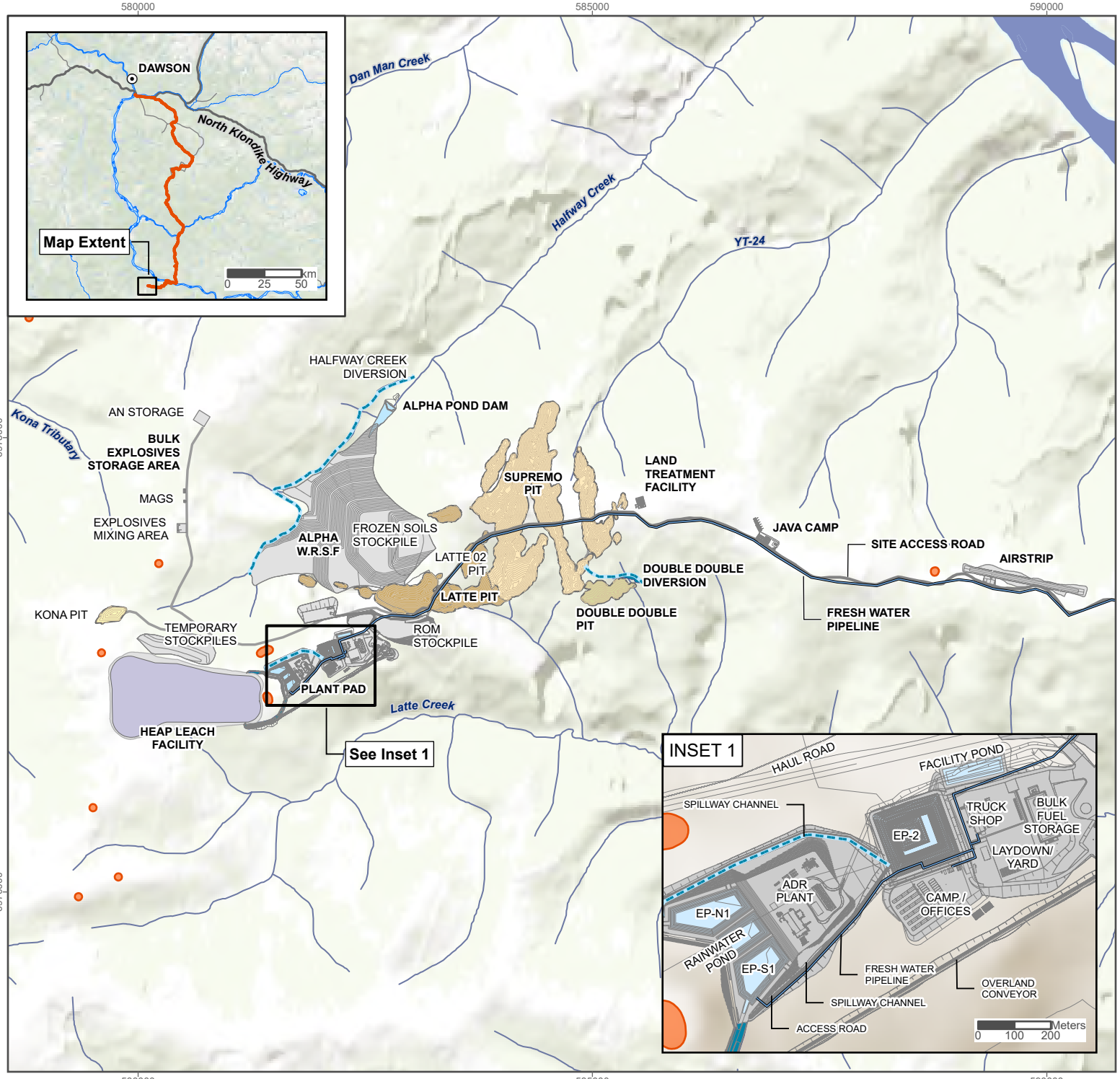

COFFEE GOLD MINE

General Arrangement - Mine Site

Legend

- Double Double Pit
- Kona Pit
- Supremo Pit
- Latte Pit
- No Ground Disturbance Zone

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitation described therein.
2. Inset Basemap: ESRI World Topographic Map
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N

Scale: 1:60,000

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Kilometers

NAD 83 Projection: UTM Zone 7N

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FIGURE 1-2

Date: JANUARY 2026

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1.2 Scope and Objectives

The Heap Leach and Process Facilities Plan (the Plan and HLPFP) has been written to meet the guidance provided in the *Plan Requirement Guidance for Quartz Mining Projects* (YWB and EMR 2013). The Plan outlines the design and construction information for the Heap Leach Facility (HLF), which is comprised of the crushing plant, heap leach pad (HLP), and process facilities including plant, ponds and crushing system. The Plan also details the procedures and protocols for management of the crushing plant, HLP and process facilities once constructed. The Plan discusses the safety measures implemented to provide safe handling practices, containment requirements, and disposal and treatment of solutions. This Plan is provided in conjunction with several other plans to meet the requirements for quartz mine applications for a Quartz Mining License and a Water Use Licence under the *Quartz Mining Act* and the *Waters Act*, respectively.

Commitments that were made during the YESAB screening process related to the Heap Leach and Process Facilities Plan as well as mitigations and monitoring requirements set out by the Decision Document terms are incorporated into the plan where possible and are summarized in Heap Leach and Process Facilities Plan Table of Concordance (Appendix A).

1.3 Incorporation of Traditional Knowledge and Consultation Feedback

First Nation engagement and consultation is ongoing, and any feedback that is received or concerns that are heard during consultation will be incorporated into this plan, where applicable.

1.4 Synergies with Other Project Documents

This plan should be viewed in concert with the following additional management plans in order to attain a holistic understanding of the Project:

- Cyanide Management Plan
- General Mine Development Plan
- Mine Operations Plan
- Emergency Response Plan
- Reclamation and Closure Plan
- Waste Rock and Overburden Management Plan
- Water Management Plan.

1.5 Roles and Responsibilities of Key Personnel

Kaminak Gold has committed to providing the necessary human, material, and financial resources to implement and maintain the Heap Leach and Process Facilities Plan and associated monitoring plan. The Environmental/Mine Department will be responsible for implementation of the monitoring components outlined in the Plan. Key Project personnel responsible for being familiar with the contents of this Plan are shown in Table 1-2.

Table 1-1 Key Project Personnel

Role	Responsibility
Mine General Manager	Overall responsibility for Mine Site management.

Role	Responsibility
Operations Manager	Responsible for mine planning and production, mine technical monitoring, and mine regulatory compliance.
Health & Safety (H&S) Manager	Responsible for conducting regular safety site inspections and implementing the appropriate controls in a timely manner. The H&S Manager shall maintain records of all safety inspections as well as any actions taken because of these inspections throughout the life of the Project. Where safety inspections show the potential for environmental effects, the H&S Manager will work in collaboration with the Environment Department.
Sustainability and External Relations (SER) Department	Responsible for recording and addressing any complaints received from nearby land users, or other interested parties regarding Project-related impacts off-site. The SER department shall maintain records of all complaints received as well as any actions taken because of these complaints.
Environmental Manager	Responsible for permitting, environmental monitoring, and regulatory compliance.
Accountable Executive Officer	One or more executive(s) directly answerable to the CEO and who is accountable for the safety of the HLF. The Accountable Executive(s) may delegate responsibilities but not accountability.
Independent Technical Reviewers	An individual or group of technical experts that perform an independent third-party review of key technical, management, operational and governance aspects of the HLF.
Responsible Heap Leach Facility Engineer	An engineer appointed by the Operator to be responsible for the heap leach facility. The RHLFE must be available at all times during construction, operations, and closure. The RHLFE has clearly defined, delegated responsibility for management of the heap leach facility and has appropriate qualifications and experience compatible with the level of complexity of the heap leach facility. The RHLFE may delegate specific tasks and responsibilities for aspects of heap leach management to qualified personnel but not accountability.
Designer of Record (DoR)	Engineering firm responsible for the design of the HLF, meeting applicable regulations, statutes, guidelines, codes, and standards. For the purpose of this project, the EoR is the DoR
Engineer of Record (EoR)	Engineering firm responsible for confirming that the HLF is designed, constructed, and decommissioned with appropriate concern for integrity of the facility, and that it aligns with and meets applicable regulations, statutes, guidelines, codes, and standards. The Engineer of Record may delegate responsibility but not accountability.
Accountable Executive Officer	One or more executive(s) directly answerable to the CEO and who is accountable for the safety of the HLF. The Accountable Executive(s) may delegate responsibilities but not accountability.
Independent Technical Reviewers	An individual or group of technical experts that perform an independent third-party review of key technical, management, operational and governance aspects of the HLF.
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2.0 DESIGN CRITERIA

The staged HLF layout is shown in Figure 2-1.

The HLF consists of a conventional lined leach pad to support a multi-lift, free-draining heap including the following:

- Solution distribution (for delivery of barren solution to the heap)
- Collection piping (for gold bearing solution and rinse water to the event ponds and process plant)
- Three events ponds and one rainwater pond
- Various access roads
- Conventional process plant for gold recovery.

Ore will be stacked with trucks and conveyors in nominal 10 m thick lifts. Barren solution containing cyanide will be irrigated onto the ore using drip irrigation. Gold bearing solution will be collected at the base of the heap by the leach pad liner and collection system, which will route the gold bearing solution to the process plant for gold recovery and reagent reconditioning. Once an area has been leached for the target leach cycle time for metal recovery, it is available for another 10 m thick lift of ore to be stacked. This will be continued until the heap is stacked to the design elevation of 1390 m for the 67 Mt capacity. Prior stages will cap out at lower elevations.

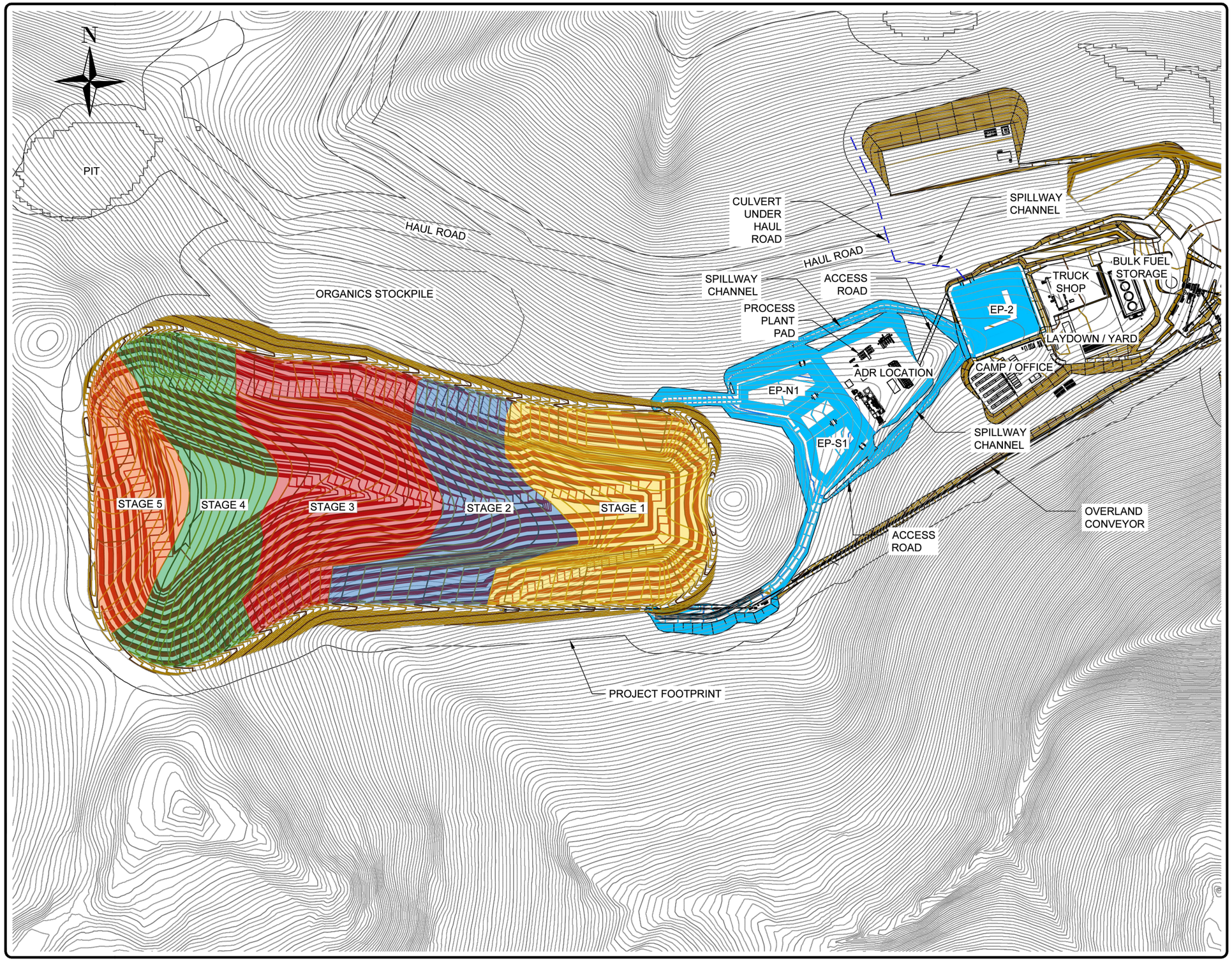
The leach pad will consist of a graded area along the ridgeline to the west of the process plant and mine. The leach pad will be constructed in stages, with each stage large enough to provide ore leaching capacity for at least 1 year. For each stage, topsoil will be removed and stockpiled for use in reclamation. Ice-rich soils (often called permafrost) will be removed and either disposed of in the Alpha Waste Rock Storage Facility (WRSF) or stockpiled in the Frozen Soil Stockpile for future conditioning and use with other soil in closure.

After removal of topsoil and permafrost, the site will be graded by cutting and filling to achieve targeted slopes, elevations and grades. Stability berms in the graded toe area as well as the cell separation berms will be constructed as part of the subgrade preparation. The resulting subgrade will then be prepared to make it suitable for supporting the liner system; this will principally consist of ensuring a fine-grained soil layer is present to eliminate puncture risk. The pad area will then be lined with two layers of synthetic liner in a composite manner, consisting of a 2.0-mm-thick single-side textured linear low-density polyethylene (LLDPE) geomembrane overlying and in direct contact with a 6-mm-thick heavily reinforced geosynthetic clay liner (GCL). A network of drainage pipes and drainage gravel will be placed to protect the liner from damage, to control the maximum hydraulic head over the liner system to well under 1 m, and to collect the gold bearing solution. Horizontal piezometers will be located in each of the Stages to allow measurement of the phreatic surface. A layer of overliner drain fill (ODF), consisting of the engineered specified manufacture rock meeting hydraulic conductivity rates will be place at a depth directly over collection piping and liner for protection. In addition to the best practice quality assurance/quality control (QA/QC) that is performed during installation of liner, a leak detection survey will be performed after the ODF is placed.

EP-1N, EP-1S, and the Rainwater ponds will be located between the east end of Stage 1 of the leach pad and the process plant, EP-2 will be located east of the process plant (Figure 2-1). A total of four ponds are planned, with all ponds, to be constructed as part of the initial, pre-production construction (Year -1). The

event ponds, EP-1N EP-1S, and the process segregation sump within EP-2 will be lined with the primary (top) liner being a 2.5 mm thick smooth HDPE (or other suitable material), and the secondary liner being a 1.5 mm HDPE or LLDPE drain liner to function as a leak detection layer between the liners. These two geomembranes will be underlain by a GCL to form a composite bottom system liner. A leak detection sump will be installed in the low corner of the ponds.

Operating solution will be stored in tanks located at the process plant. There will be three tanks, two for gold bearing, and one barren. The event ponds will be rarely used, and the EP-2 larger portion most likely will never be used, reserving their capacity for large storm or freshet events or other process plant upset conditions. The sump in the lower portion of EP-2 will be utilized approximately 30% of the time to capture flows from the gold bearing tanks. The Rainwater Pond will be rarely used and will collect direct precipitation for either use as make-up water for leaching operations, or to be tested and then discharged, or used for other site consumption, such as dust control.



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FDI PROJECT NO:

PREPARED BY:
FORTE DYNAMICS
3003 E. HARMONY ROAD, SUITE 320
FORT COLLINS, CO 80528

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH FACILITY LAYOUT

YUKON, CANADA

DRAWING NUMBER:

FIGURE 2-1

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Key design criteria for the HLF are as follows and are summarized in Table 2-1.

The Stage 1 pad can accommodate in excess of 5 M tonnes, but to accommodate loading and leaching 4 Mt of crushed ore is placed initially prior to pad expansion occurring with Stage 2. An ore average stacked density of 1.6 dry tonnes per cubic meter was used to determine the capacity. Ore will be truck and conveyor stacked in 10-meter lifts to an elevation of 1390 m.

A sufficient depth of stacked ore material, toe to crest, will be maintained going into the winter period to maintain thermal capacity of the heap with the assistance of heated barren solution.

The final pad is planned to accommodate 67 Mt of ore, with a max capacity of 69 Mt and will be constructed in five Stages, expanding in a westerly direction, with each Stage having separate cells for solution collection. Stages 2, 3,4, and 5 will be constructed to process cumulative amounts of 15, 32, 50 and 69 Mt of ore, respectively. The HLP footprint expansions allow ore to be stacked higher on previous Stages. 2.5H:1V (horizontal to vertical) overall heap side slopes have been used for the heap to ensure physical stability and facilitation heap closure and capping.

The ore will be leached at an average solution application rate of 10 liters per square meter per hour (l/m^2/hr). All gold bearing solutions will gravity drain to the gold bearing solution tank at the process plant. The process plant will have a maximum operating capacity of 1,250 m^3/hour. Normal operating capacity for the process plant will be 1,100 m^3/hr. Barren solution after gold extraction will be returned to a barren tank for recycling to the heap after the necessary addition of cyanide.

Event ponds are sized to contain the following cumulative volume:

a. the runoff from a probable maximum precipitation (PMP) event.
b. full heap drainage during a power outage or pump failure.
c. seasonal water accumulation.

The PMP storage volume is of sufficient volume to contain the runoff from the 283 mm event over a 24-hr duration. Full heap drainage has been estimated by applying the nominal barren pumping rate of 1,100 m^3/hr over a 72-hr period. Storm flows from the terrain surrounding the pad and pond, resulting from the 100-year, 24-hour storm, will be diverted around the facility.

During the operating life of the plant, the leach pad facility will be a closed system to the greatest extents possible. Treatment and discharge will be required during operations as this is a net surplus climate, however stored volumes for treatment and discharge will be selectively discharged based on water quality, with priorities for direct precipitation in lined ponds over solution coming from the HLP or Process Plant.

The following considerations were made for the layout of the proposed heap leach pad facility:

- The permafrost zone active layer will be stripped to acceptable foundation material for all stages of heap leach construction.
- Earthwork construction requirements (cuts and fills) will be minimized based upon grading requirements. The majority of fill material required will be obtained from grading within the leach pad area, or where additional fill is required, from suitable materials from overburden stripping in the open pits.

- Solution collection infrastructure, Event ponds and process facilities will be located on the down gradient and east of the of the heap leach pad, and EP-2 will be located down gradient of the Gold bearing Tanks and Process Plant providing for gravity flow of all solutions, including upset conditions.
- The toe grades for the liner for the heap leach facility will be designed to minimize grading and earthwork volumes, and while ensuring long-term physical stability of the heap.

Details of the design, design criteria, and how the design criteria were achieved are provided in the Coffee Mine Project-Heap Leach Pad Engineering Report for Licensing in Appendix B and specific infrastructure is further detailed below.

Table 2-1 Process and Heap Leach Design Criteria

General	Units	Value
Annual Ore Production Rate	t/y	7.4M
Crushing Plant Operation	d/y	275
Crushing Plant Operation	t/d	27,000
Crushing Plant Operation	h/d	20
Design Rate Crushing Plant Operation	t/hr	1,500
Heap Loading and Spreading Method	-	Conveyors, Truck and dozer
Heap Loading Operation	d/y	275
Heap Loading Operation	t/d	27,000
Heap Loading Operation	h/d	20
Design Rate Heap Loading Operation	t/hr	1,010
Process Plant Operation	d/y	365
Process Plant Operation	h/d	24
Ore Characteristics		
Specific Gravity (Average)	t/m^3	2.7
Ore Bulk Density	t/m^3	1.6
Run-Of-Mine Moisture	%	4.5
Bond Crusher Work Index (Oxides)	kWh/t (Latte)	11.5
Abrasion Index (Oxide)	g (Supremo)	0.078
Stockpile		
Feed Size, 80% Passing	Mm	50
Leach Pad (TMG)		
Leach Pad Capacity[1]	Mt	67
		69 (maximum capacity)
Slope Stability, Factor of Safety		1.0 Pseudo-Static 1.5 Static-Long Term 1.2 Post-Earthquake
Ultimate Height	M	105 (115)
Lift Height	M	10 (nominal)
Heap Slope, Overall	H:V	2.5:1
Leach Cycle, Primary	D	45
Solution Application Rate	$l/hr/m^2$	10

General	Units	Value
Barren Solution Flow Rate	m^3/h	1,100 (nominal) / 1,400 (maximum)
Area Under Leach	m^2	110,000 (nominal)
Ponds and Diversion Channels for Heap		
Diversions Design Storm Event for Peak Flow Rate, 100-yr, 24-hr	Mm	98
Design Storm Event for HLP Peak Flow Rate and Pond Storage, 24-hr PMP	Mm	283
Freeboard in Ponds	Mm	500
Gold bearing Solution	-	Piping system – Gravity to Process Plant

1. Heap Leach Pad capacities presented here are calculated utilizing loaded ore average density of 1.6 t/m^3
TMG – The MINES Group

2.1 Ore Quantities

The ore will be processed over a ten-year duration at an estimated rate of 6.7 Mt/a with an estimated average feed grade of 1.25 grams per tonne (g/t) and an anticipated overall recovery of 82.5 percent (%) (Mine Plan YESAB 2019-NOV_2021_ADJ). Heap leaching of ore will take place year around, with stacking of new ore being controlled seasonally by temperature (typically from spring to fall over a 275-day period). Crushing and stacking will occur at an estimated average rate of 27,000 tpd. During the coldest months of the year when temperatures are too low to ensure thermal stability of the heap (typically January through March), ROM ore from the mine may be placed onto a stockpile and later re-handled for crushing and processing.

2.2 Leaching

The HLF design is based on staged construction with initial capacity of approximately 4 Mt expanding to the design capacity of approximately (varies with measured densities) 67 Mt in five stages (Figure 2-1). The HLP will operate on an estimated 45-day cycle and cover a leaching or primary irrigation area of approximately 110,000 m^2, (area subject to revision following design and operational refinement) of crushed ore at an average 10 m lift thickness. The primary irrigation area will be supplemented by additional installed irrigation area of 110,000 m^2, or 100% backup, every winter starting in Year 2, as a contingency against freezing of the primary irrigation area. Barren solution will be heated and pumped at a nominal rate of 1,100 m^3/hr (design 1,400 m^3/hr) from the process plant to the HLP after adding cyanide (estimated 0.2 kg cyanide per tonne of ore), anti-scalant, and make-up water to the barren tank as needed. Heating is prescribed in order to increase the solution temperature by at least 8°C at the process plant (to provide at least 6°C at the emitters) for maintenance of adequate operating temperatures in the heap during the winter, and heat may also be applied to solution year-around to increase the thermal mass in circulation. Barren solution will be applied to the heap at a rate of 10 $L/m^2/hr$ using drip emitters. Drip emitters will be buried in winter. Drip line burial depth will be 1 m or otherwise as required to prevent freezing of solution. The gold bearing solution flow to the process plant is designed to be gravity-induced direct from the HLF with no gold bearing or barren ponds.

2.3 Geotechnical Criteria

The Coffee Mine Project is located between the Denali and Tintina faults in an area known as the Tintina Trench, which is an area of moderate seismicity. However, only several earthquake epicenters have been recorded in the Stewart and Yukon River region.

Seismic design parameters for planning of the HLF were developed by using a combination of deterministic and probabilistic approaches and are used to evaluate the seismic hazard at the site, and to provide design values of peak ground acceleration (PGA).

Observations of on-site conditions at the Project site were based on drilling and test pits performed by the MINES Group (TMG 2016). These observations concluded that soil cover in the area is relatively thin, and the underlying rock is moderately to highly weathered. Therefore, for the purpose of this investigation, the site was assigned to Site Class C (stiff soil and/or soft rock in the upper 30 m of the subsurface profile) with an assumed representative sheer velocity (Vs30) of 360 m/s to 760 m/s, which is consistent with the recommendations in the 2010 National Building Code of Canada (NBCC 2021a), (TMG 2016).

MINES used ground motion parameter provided in the 2010 edition of the National Building Codes of Canada (NBCC, 2021b) hazard mapping project. This information is provided by the NBCC on their website (NBCC, 2021a). The ground motion parameters have since been updated to the 2015 edition. Forte updated the parameters using the NBCC Seismic Hazard Values tool provided on their website (NBCC, 2021b). Coordinates for the center of the HLF were used as the location (62.869436 latitude, -139.400813 longitude). The PGA for the site is 0.136 g and is associated with a 2% probability of exceedance in 50 years (return period of 2,475). This was used for the stability analysis of the HLF as detailed in later sections.

2.4 Hydrologic Criteria

The HLF water conveyance systems interior to the footprint were sized to accommodate the peak flow rate generated by a PMP, 24-hour storm event, of 283 millimetres (mm). Stormwater conveyance outside the HL footprint otherwise know as interceptor ditches were design to convey the 100 year 24-hr event.

Surface runoff produced by precipitation or snowmelt was estimated by first assigning a parameter called a curve number to each surface (such as natural ground, top of heap, and so forth). This approach was developed by the United States Department of Agriculture (USDA) Natural Resources Conservation Services (USDA 1986) and is the most commonly used method for estimating runoff rates. The curve number is based on the hydrologic soil group, land use, ground treatment or coverage, and hydrologic conditions. Curve numbers typically range from approximately 50 to 100, with higher numbers representing more runoff and less infiltration. The selected curve number is then combined with the area under consideration and the precipitation event to estimate the peak and total volumes of flow.

For the heap, a curve number of 75 was estimated based on the expected surface conditions of the HLP, and although the ore is highly permeable leading to lower CN, a substantial portion of the HLP was considered to be exposed liner to allow for flexibility of newly constructed Stage 5, as well as the application of raincoats. The maximum area of the heap, at build-out of Stage 5, was the area used to calculate runoff rates to ensure that the conveyance system was sufficiently large. Storm runoff will report in roughly equal proportions to two lined perimeter channels, one each along the south and north side of the leach pad with

each reporting to an event pond (EP; EP-1S and EP-1N, respectively), see Figure 2-2 below. The peak flow was determined to be 52 cubic metres per second (m^3/s), and the conveyance structures are designed to safely accommodate these peak flow rates. Additional information on hydrologic criteria are provided in the Water Management Plan.

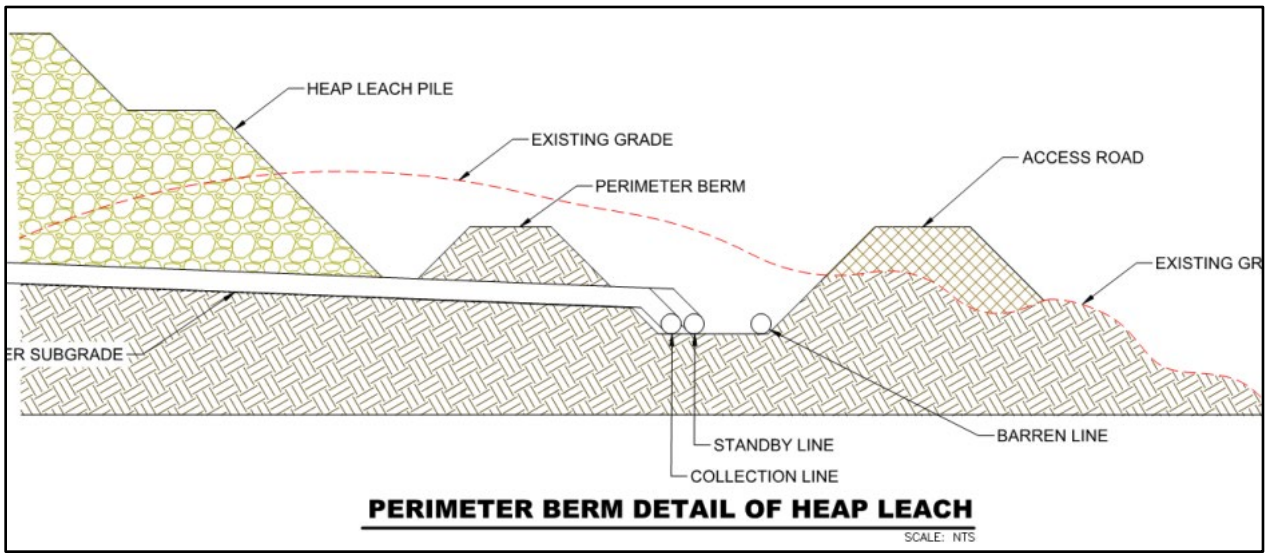


Figure 2-2 Heap Leach Facility Perimeter Channel

2.5 Storage Criteria

Storage in this section refers to the events and rainwater ponds designed to collect and store solution, direct precipitation, and precipitation runoff from the Project. A total of four ponds are planned, EP-1N, EP-1S, EP-2, and rainwater pond to be constructed as part of the initial, pre-production construction (Year -1 of the Project). Pond sizes and years placed in service are summarized in Table 2-2.

Table 2-2 Pond Sizes and Years Placed in Service

Pond	Capacity to Freeboard Elevation (1000) m^3	Year Placed in Service
EP-1N	112	-1
EP-1S	90	-1
EP-2	340	-1
Rainwater	53	-1
Total	596	-1

Event ponds are sized to contain the following cumulative volume: (a) all contact water produced by a probable maximum precipitation (PMP) event; (b) full heap drainage during a prolonged power outage or pump failure for 72-hours; and (c) seasonal water accumulation (Appendix B). The 24-hr PMP event is developed from a rainfall depth that is 2.5 times larger than the 100-year, 24-hr event, which represents the typical design criteria for HLP facilities. This storage requirement is a function of the area of liner placed and therefore a step increase when a new Stage is constructed.

Full heap drainage has been estimated by applying the barren flow rate of 1,100 m^3/hr for a 72-hour period without flow attenuation. The purpose of the last criteria is to provide storage for solution draining from the heap when the ability to pump solution back to the heap is impaired, as might happen in a power outage. The industry-standard criterion is to provide sufficient storage while the power or pumping disruption is remedied, typically for 24 hours of flow. This is often reduced if backup power and spare pumps are provided. The HLF has four separate electrical generators and pumping of solution requires a small portion of the power produced by one; there are three redundant generators, thus reducing the likelihood of any extended disruption in pumping to very low. The HLF will also have redundant pumping, which may not include full redundancy, but will provide pumping should pump failure occur. Further, as soon as the irrigation ceases, the flow rate from the heap will begin to reduce. Nevertheless, the design conservatively assumes a full flow for 72 hours.

The PMP and the 72 hr draindown present as the Event Storage Requirements as a function of Stage build out and is presented in Table 2-3.

Table 2-3 Event (PMP plus 72 hr draindown) Storage Requirements

Year	Cumulative Area (m^2)	Event Storage Requirement (m^3)
(Yr -1)	247,000	149,000
(Yr 1)	429,000	201,000
(Yr 2)	699,000	277,000
(Yr 4)	921,000	340,000
(Yr 7)	1,053,000	377,000

To capture the seasonal water accumulation, synthetic daily climate values were prepared by Lorax based on the last 30 years of climate data. This set of data allowed for 30 realizations of the water balance where the annual climate data was offset by one full year each realization to identify critical storage requirements. Figure 2-3 presents the 30 realizations and how seasonal accumulation was maintained in the “Storage Available for Operations” (green shaded) area, while allowing storage for the PMP and draindown, which is presented as the “Event Storage Requirements” (grey hatched) area in Figure 2-3. Note the line that steps down as a function of time represents the increase Event Storage Requirement presented in above Table 2-3.

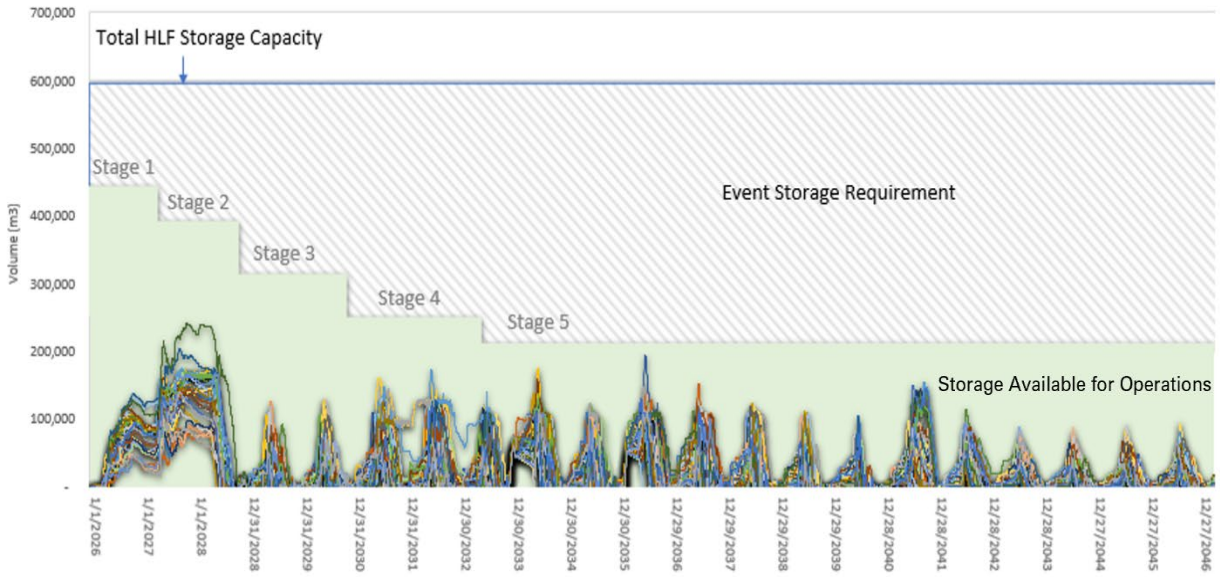


Figure 2-3 HLP Pond Storage Volumes Through Time for 30 Climate Realizations

The Event Storage Requirement of the PMP, which by definition does not have a statistical value of occurrence, also includes a 72 hr draindown, and seasonal water accumulation occurring at the same time. Although these concurrent activities do not have an accumulated quantifiable occurrence frequency as it is much too low, the model does present that the current design of solution collection infrastructure and Event ponds does include adequate storage and is considered a very conservative approach.

2.6 Liner Criteria

The leach pad liner system consists of two synthetic liners with leak detection down gradient in the form of wells and a hydraulic head control or drainage layer on top. Leak detection and monitoring will be accomplished by three separate systems: electrical leak location surveys performed after construction of each stage of the leach pad after ODF is placed, horizontal piezometers to measure phreatic surface above liner system, and monitoring wells installed away from the pad.

The leach pad will have a liner system comprising a 2.0-mm-thick LLDPE geomembrane over a reinforced GCL liner. The bottom side of the LLDPE liner will be aggressively textured to provide a close bond with the GCL.

A 500-mm-thick ODF material composed of crushed gravel and drainage pipes will be installed over the synthetic liners, within the HLP footprint. This overliner system will protect the geomembrane liner from damage during ore stacking as well as operations and will drain process and rinse waters out of the system in a manner that will minimize hydraulic head over the liner.

In event ponds EP-1N, EP-1S, and EP-2 (Figure 2-4) the segregation berm will be lined with two geomembranes, separated by a drainage layer and underlain by a GCL. Above the segregation berm the Event Pond portion of EP-2 would only be utilized during an extreme precipitation or snowmelt event. The

rainwater pond will only hold direct precipitation and therefore will have a geomembrane over a GCL liner system.

Detailed information on the liner systems is provided in Section 3.8.1.2.

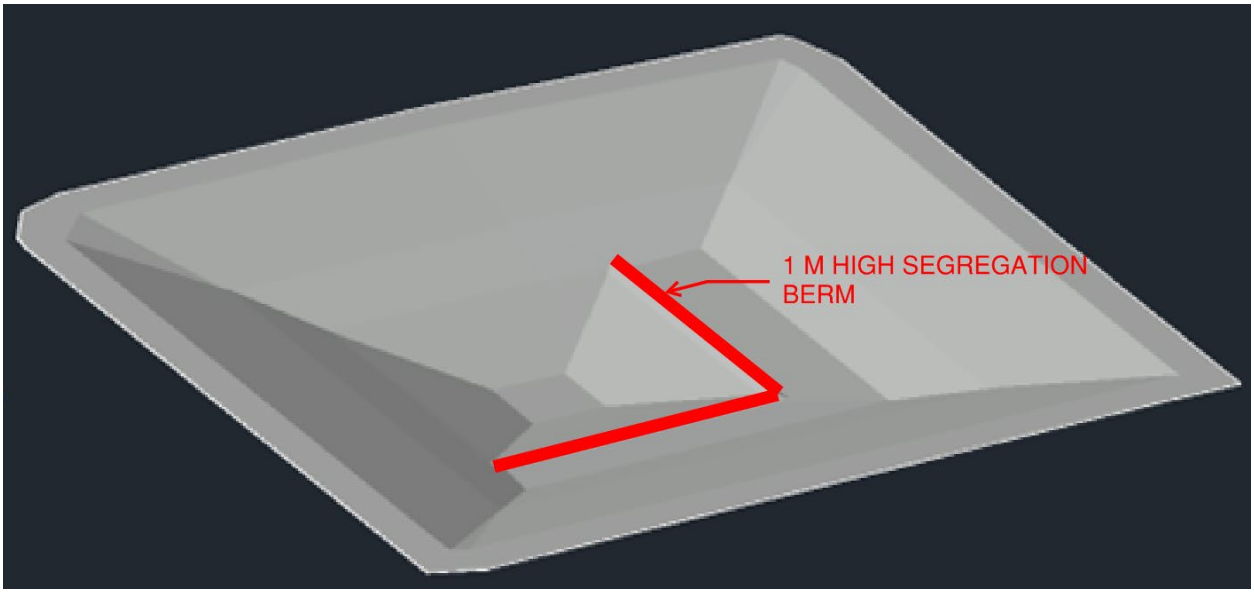


Figure 2-4 Process Segregation Sump in EP-2

2.7 Heap Leach Facility Classification

The health and safety, environmental, and cultural hazards of the HLF including the heap leach pad and event ponds have been evaluated to define a classification for the facility, and further guide the Project design, planning, and management of the HLF per Yukon Guidelines for Mine Waste Management Facilities (YG 2023). This classification of the HLF was evaluated in an assessment of the design criteria and further confirmed by a Failure Modes and Effects Analysis conducted for the HLF.

Per the Yukon Guidelines, applicable components included in the classification of the HLF for the Coffee Project include the stacked ore of the HLP, perimeter channels, pregnant and barren solution conveyance systems, the three event ponds (EP-1S, EP-1N, EP-2) designated for management of contact and process water, and the Rainwater Pond.

The Project is a Class II HLF as evaluated by characteristics defined by the Yukon Guidelines. The Project's HLF classification for each of these characteristics is provided in Table 2-4. As a Class II HLF, design events, design methods, factors of safety, liner systems, permafrost considerations, and water management during the development phase, operations phase, and closure phases are evaluated with regard to the Yukon Guidelines for a Class II Heap Leach Facility.

Table 2-4 Heap Leach Facility Classification

HEAP LEACH FACILITY CLASSIFICATION: Class II			
Classification Characteristic	Coffee Project Design	Classification	Classification Definition per Yukon Guidelines for Mine Waste Management Facilities
Maximum vertical thickness of stacked ore	115 m	Class II	Between 50 metres and 140 metres
Maximum leach solution application rate	1,400 m^3/hr	Class II	Between 1,000 m^3/hr and 5,000 m^3/hr
Solution storage	All free solution storage is provided in external ponds.	Class I	All free solution storage provided in external ponds.
Presence of permafrost	All permafrost will be removed under critical elements of the facility.	Class II	Class II: Permafrost present and ice-rich permafrost removed to thaw stable materials under critical elements of the facility.
Geochemistry of ore and residue	The ore is NAG, with only a minor presence of PAG ore.	Class II	PAG ore or residue present, but unlikely to be mobilized in the event of heap failure.
Predicted water quality of heap drainage after completion of detoxification	Contaminants of concern after detoxification and rinsing are predicted to have concentrations less than 500x above receiving water quality objectives.	Class II	Water released from HLF after detoxification and rinsing predicted to have concentrations for one or more contaminants of concern (before water treatment) that is 10x or more, but less than 500x, above applicable receiving water quality guidelines or site-specific water quality objectives.
Effluent management requirements	Active water treatment is planned during operations and passive water treatment is planned during closure.	Class II	Protection of receiving water requires: (a) active or passive management of water discharges during operations, care and maintenance and active closure; or (b) passive management of water discharges during post-closure phase.
Leaching conditions	Leaching solution is alkaline and does not use reagents with a pH<5.	Class I/II	n/a- Yukon Guidance implies Class I/II if leaching reagents have a pH>5.
Human health and safety	No population is at risk, other than the temporary presence of mine workers.	Class I	Other than the temporary presence of mine workers carrying out their duties, there is no identifiable population at risk from a failure of the facility.

3.0 CONSTRUCTION AND DESIGN

The following section describes important construction components of the HLF including descriptions of foundation conditions, site preparation requirements, stability and settlement analyses and results, and construction QA/QC. In addition, the section also presents design information with respect to the heap pad, solution storage facilities and associated leak detection and collection systems, liner systems, and solution conveyance and pumping.

3.1 Foundation Conditions and Construction

Geotechnical investigations were conducted to characterize the subsoil conditions at the primary infrastructure sites. Investigations were facilitated by sonic core drilling of soils, test pit excavation, diamond core drilling, and laboratory test programs. The results of these investigations and subsequent analyses are provided in Appendix B and were used to provide the basis for geotechnical design recommendations.

The Project site is located in the northern Dawson Range of the Yukon-Tanana terrane – an area that did not experience widespread glaciation. The landscape evolved through erosional and periglacial processes. The topography generally consists of rounded ridges with incised V-shaped valleys.

The Project site infrastructure will be located on the ridgetop east of the HLF. The ridgetops and upper slopes are generally dominated by in situ residual soils and colluvium derived from weathering of bedrock. The colluvial material is variable and typically contains mixtures of gravels, sands, and silts with organic materials in the upper approximately 0.1 m to 0.2 m. The ridgetop soils are up to approximately 1.2 to 3.3 m deep and generally ice poor (<15% visible ice). The thickness of the strongly weathered bedrock is variable but is generally less than 1m.

The Project is located in an area of discontinuous permafrost, which is deepest on the ridgetops and north-facing slopes. Permafrost depth beneath the infrastructure is estimated at approximately 70 m to 80 m below ground surface (bgs). One shallow thermistor string installed near the crusher pad indicates a permafrost temperature of approximately –0.3 °C with a 2 m active zone. Additional information on site permafrost mapping is provided in the General Mine Development Plan.

3.1.1 Crusher System

The Crusher System is located south of the Plant Site. The crusher system consists of a haul truck apron, mechanically stabilized earth (MSE) wall, dump hopper, primary and secondary crushing plants, secondary screening plant, and lime silo, as well as an interlinking system of conveyors. These facilities are located in an area with bedrock relatively close to the surface and will utilize mat foundation and slab with equipment and column loads supported on pads and pedestals. Figure 3-1 illustrates the crusher pad and MSE wall. Figure 3-2 and Figure 3-3 present general arrangements of the crushing plant. Please note that Figure 3-2 will be updated in subsequent versions of this Plan to represent an updated crushing system.

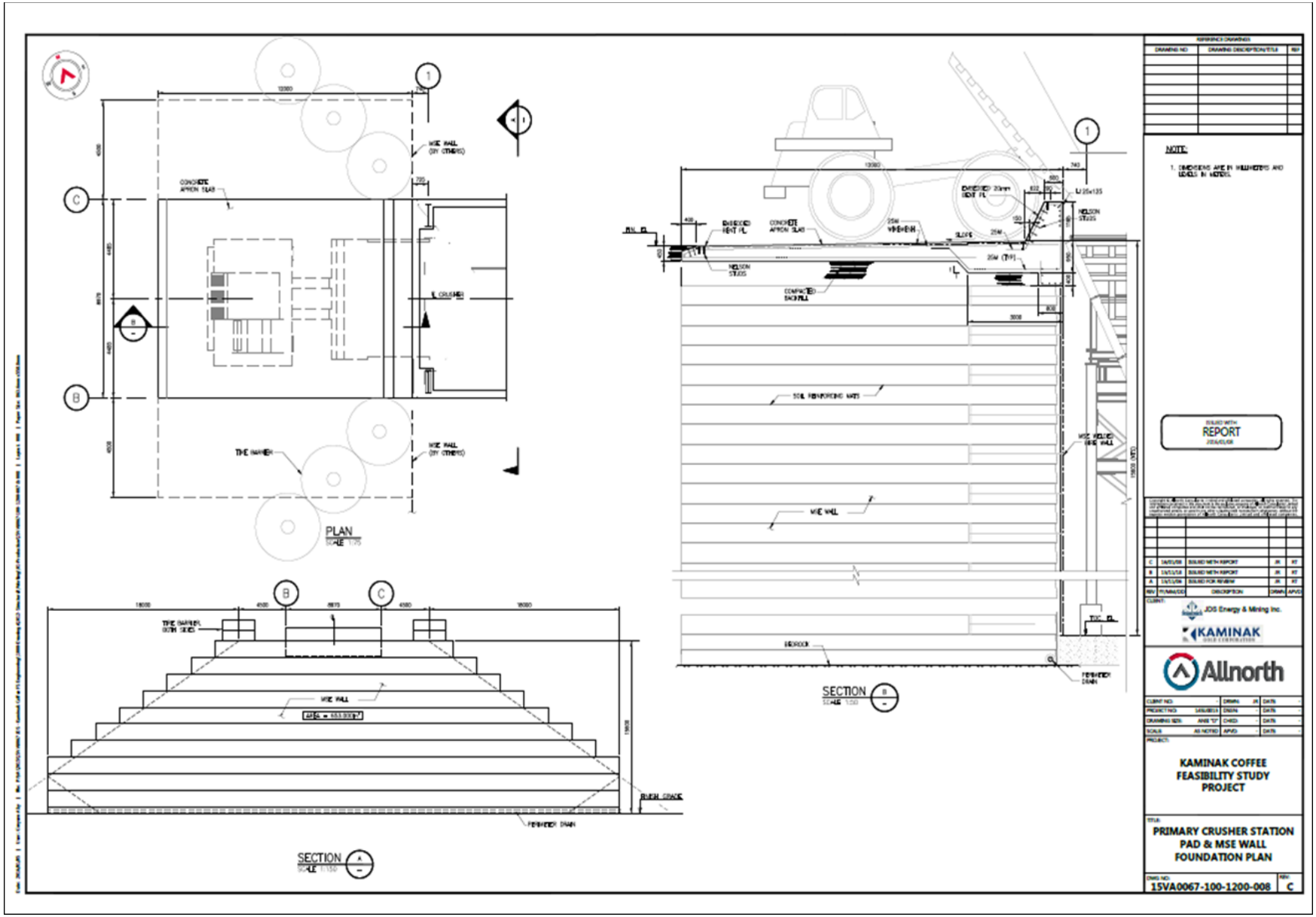
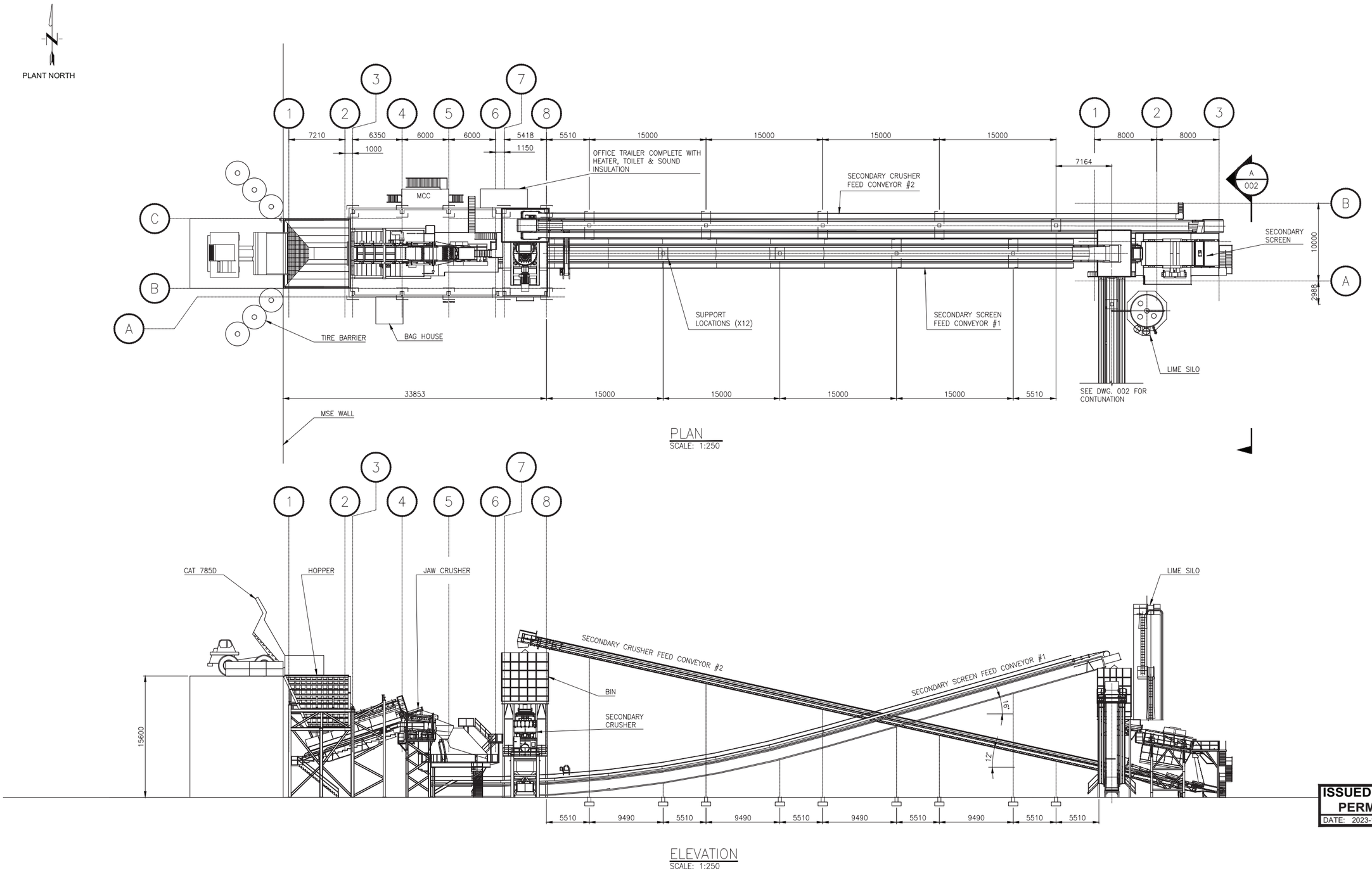


Figure 3-1 Crusher Pad and Mechanically Stabilized Earth Wall Design



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REFERENCE DRAWINGS

NO.	DWG NO.	TITLE

NOTES:

DRAWING REVISION

NO.	DESCRIPTION	DATE
0	ISSUED FOR PERMIT	2023-11-14

	NAME	DATE
DRAWN BY:	JG	2023-11-14
DESIGNED BY:	JG	2023-11-14
CHECKED BY:	TH	2023-11-14
APPROVED BY:	TH	2023-11-14

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JDS Energy & Mining Inc.

COFFEE MINE PROJECT

GENERAL ARRANGEMENT
CRUSHING PLANT
PLAN & SECTION

DWG NO. NMCCOF03C-030100-MEC-GA-001

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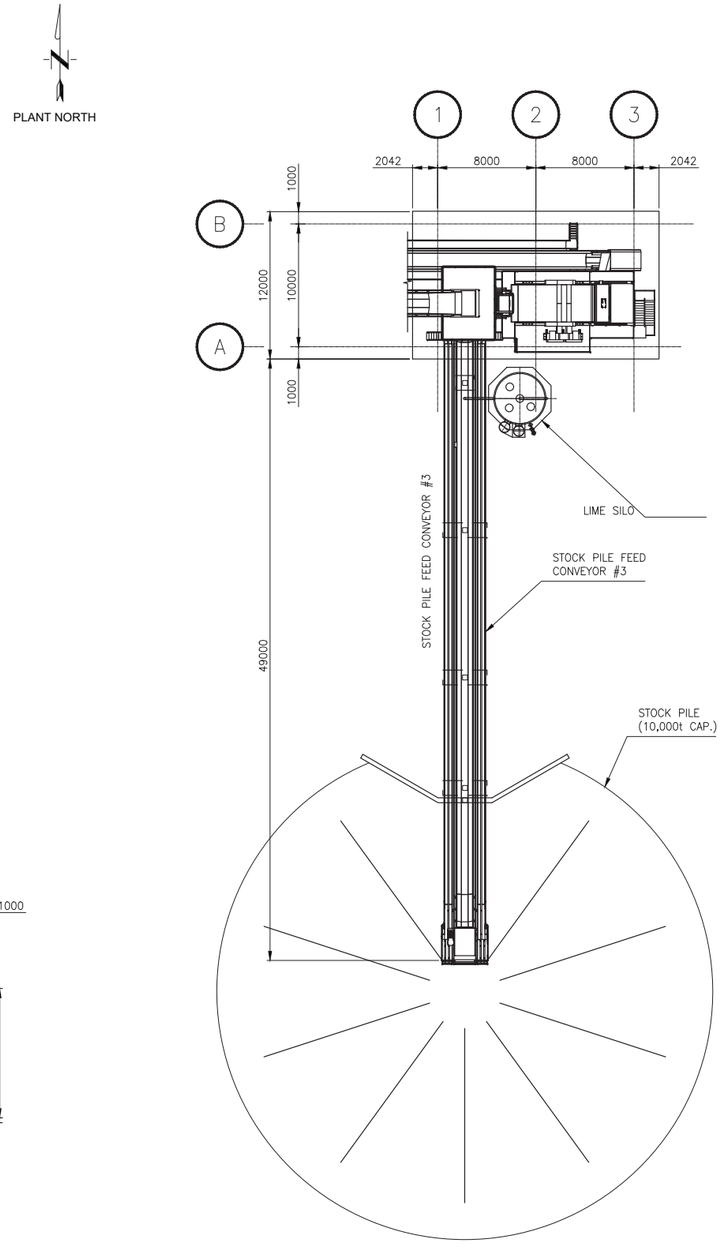

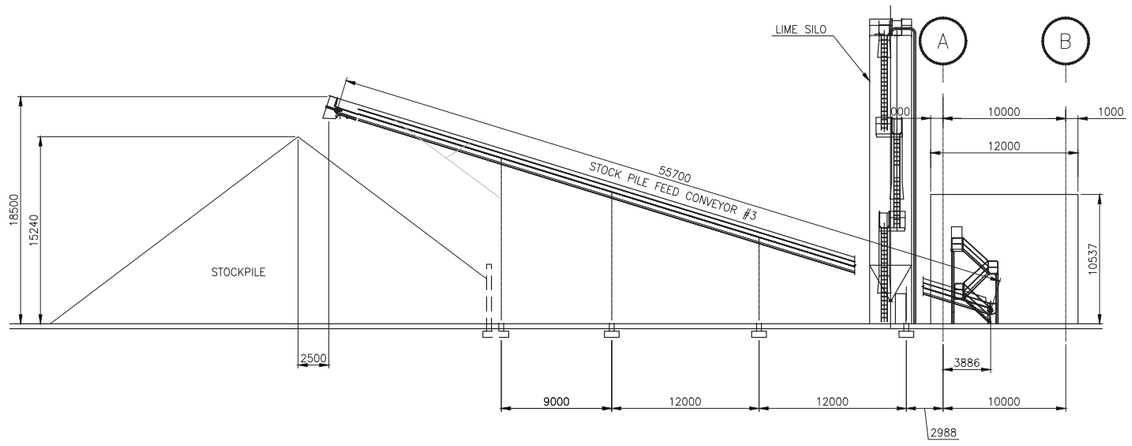

SECTION A
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REFERENCE DRAWINGS

NO.	DWG NO.	TITLE

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COFFEE MINE PROJECT

GENERAL ARRANGEMENT
CRUSHING PLANT
SECTION A

DWG NO. NMCCOF03C-030100-MEC-GA-002

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3.1.2 Process Plant

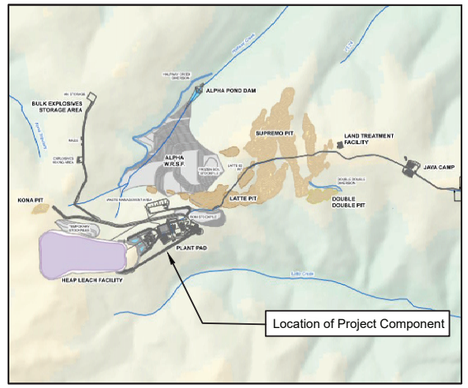
The process plant will be concrete pad on grade with concrete walls around all tanks containing cyanide and other reagents. The containment will accommodate 110% of the largest tank volume. There will also be additional containment around the acid wash, strip, and reagent mixing areas. The containment and handling of cyanide will be as outlined in the Cyanide Management Plan. Tank and column loads are supported on pads and pedestals. A liner will be installed under the process facilities to provide additional containment and leak protection to comply with international CN code. Figure 3-4 provides the general arrangement of the process plant. Please note that Figure 3-4 will be updated in subsequent versions of this Plan to represent an updated process plant layout.

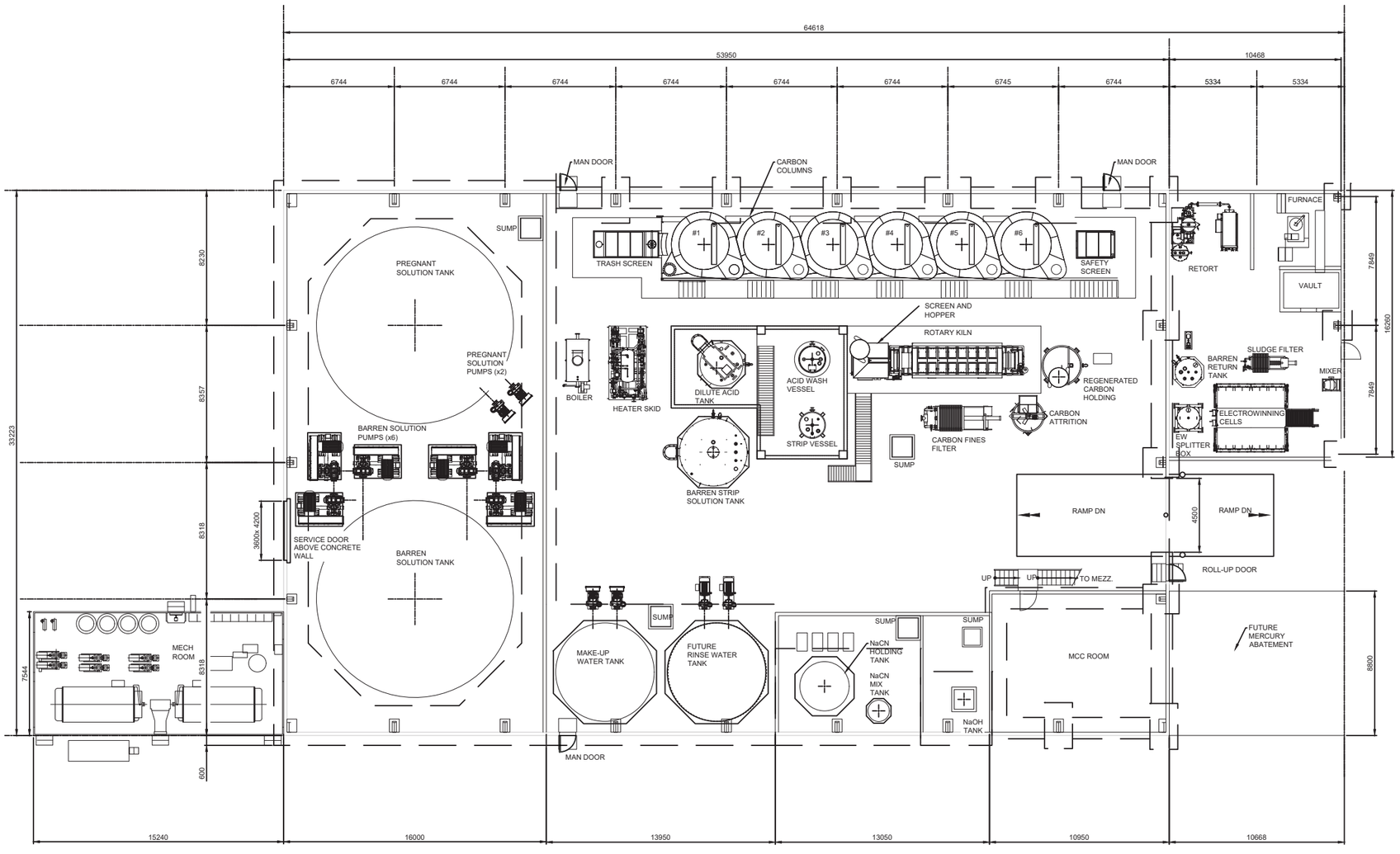
The Plant Site infrastructure will be located on the ridgetop east of the HLF. The ridgetops and upper slopes are generally dominated by in situ residual soils and colluvium derived from weathering of bedrock. The colluvial material is variable and typically contains mixtures of gravels, sands, and silts with organic materials in the upper approximately 10 cm to 20 cm. The thickness of the strongly weathered bedrock is variable but is generally less than 1m.

The process plant will be constructed on cut-and-fill pads, any filles will be engineered as it is a critical structure that cannot tolerate differential settlements. Drilling and blasting may be required for the fresh bedrock and possibly for the upper weathered bedrock and soils, if excavated in winter. Frozen soils will be placed in the frozen materials stockpile, and the weathered rock will not be suitable for re-use as structural fill and will be placed in the waste rock storage facility.

COFFEE GOLD MINE

Process Plant Layout





PLAN
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Legend

Notes

1. This figure is not intended to be a stand-alone document, but a visual aid to the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations descriped therein.
2. This is a re-creation of JDS drawing number 15VA0067-100-1400-005, project number 15VA0067.

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Metres

Page Size: 11" x 17"

Figure 3-4	Date: Nov 7, 2023	Drawn by: AS	Reviewed: KP

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3.1.3 Heap Leach Pad

The HLP and associated ponds will be located on a ridgeline, which slopes from west to east at 7.5% to 20%. The geotechnical conditions of the foundation are characterized by a multi-faceted investigation program, which was completed in 2015. This investigation included drilling, installing test pits, and laboratory testing. The field programs are discussed below, the laboratory results are summarized in Section 3.4, and both are detailed in Appendix B.

The overburden soils typically consist of sandy or gravelly silts, silty or gravelly sands, and silty or sandy gravels. Descriptions of the boring holes and test pits were primarily sandy silts with gravel, or silty sands with gravel. This was especially true when boring locations were on downward slopes departing from the ridge. Silty or sandy gravel, rubble (rockfall) or weathered bedrock was often encountered within the overburden material on the tops of the ridges. Fine contents varied by location ranging from 12 to 50 %. Soil samples from the HLF study area exhibited low to non-plastic characteristics overall. Overburden soils had an average depth of 2 m bgs, with a minimum of < 1 m bgs to a maximum of > 9 m bgs.

Topsoil within the footprint of the HLF are typically organic rich and contains ice. On average an estimated 0.2 meters of topsoil exist across the footprint of the HLF and which will require removal and disposal. This material cannot be used for construction but can be stockpiled for future use in reclamation. Ice-rich colluvium observed within the footprint of the HLF averaged between 1 to 2 meters deep with smaller pockets of ice-rich material as deep as 4 meters. Ice-rich soils excavated from the footprint of the HLF cannot be used for construction without thawing. For the purpose of this design, it was assumed this material would be removed and stockpiled as waste, and therefore, were not utilized in the project's material balance.

Underlying the overburden soils, exists primarily granitic hard rock materials with a smaller portion of schist below the easternmost portion of the HLF site. Both the granitic hard rock and the Schist hard rock has been characterized as W2 (slightly weathered) to W5 (completely weathered), and R2 (weak) to R5 (very strong). While the bedrock was identified as shallow (within 1 to 2 meters below ground surface) for most of the areas small pockets exist where bedrock was identified greater than 5 meters below ground surface.

3.2 Site Preparation

Prior to construction, vegetation, and topsoil (assumed to be 0.3 m, but up to 0.5 m thick) within the footprint of the HLF will be stripped and stockpiled in the organics stockpile for future reclamation purposes (Figure 2-1). Stripping of materials will be most productive during the fall season after the seasonal thaw has occurred in the active zone.

All organic and thaw-unstable soils will be removed from the footprint of the HLP and ponds and stockpiled for future reuse. Thaw-unstable soils are not anticipated to be extensive; preliminary investigations indicate that the average depth of removal required is less than 2 m. Investigations were completed to further delineate the extent of their nature and distribution (Section 3.1.3).

Thaw-stable material excavated from the cut areas will be used as structural fill where needed. The grading plan maintains a graded surface profile parallel to the existing profile to minimize the required earthwork, while maintaining a balanced cut-and-fill volumes approach. Intense grading requirements are generally

limited to the perimeter toe area of the leach pad to facilitate construction of stability berms. Detailed ground surveys were completed in October 2017 for the major infrastructure areas of the mine site.

As part of the site preparation, stability berms in the graded toe area and cell separation berms will be constructed and the resulting subgrade will go through a final preparation of the graded surface before placement of liner materials. This will consist of fine grading and compacting to provide a smooth surface free of protrusions that could damage the liners. Any soil fill and rock fill material will be placed at 95% of the tested maximum dry density, as per American Society for Testing and Materials D698 (ASTM 2012).

Additional information including the volumes of material removed and the identification and removal of unsuitable in-situ materials are provided in the Waste Rock and Overburden Management Plan (WROMP).

3.3 Geochemical Protocol for Construction Materials

The metal leaching (ML) and acid rock drainage (ARD) potential of various geologic materials to be disturbed at the Project site has been assessed by a variety of geochemical test work, which is presented in Coffee Mine Project Geochemical Source Term Report (Lorax 2022a). The criteria to define ARD potential and ML potential are based on intrinsic properties of mine rock and will be used to inform how mine construction material is managed. The manifestation of ARD and ML from excavated geologic material is determined in large part by the degree of exposure, handling, and storage. The specific criteria for determining neutralization potential (NP), acid potential (AP), potentially acid generating (PAG) and non-potentially acid generating (non-PAG) material, including segregation protocols, are described in the WROMP, and the monitoring methodology is described in the Geochemical Monitoring Plan.

3.4 Stability and Settlement Analyses

All constructed structures, including the process facilities, leach pad, and the event ponds, will be founded directly on the bedrock or structural fill, with the topsoil and the ice-rich ground completely stripped. The depth of non-thaw-stable material averages approximately 2 m across the Mine Site (Section 3.1).

Crushed Ore Material: Triaxial testing performed on three different ore materials gave friction angle ranging from 40.2º to 40.9º and cohesion from 6.9 kN/m^2 to 27.6 kN/m^2. As a conservative measure, the stability analysis used a lower friction angle. The physical properties of the crushed ore input to the analysis are:

Dry unit weight	1.6 tonne/m^3
Moisture content	10% by weight
Moist unit weight	1.76 tonne/m^3
Friction Angle	35° and cohesion=0

Liner Cover Material: A series of triaxial, permeability, large-scale, direct shear and puncture tests performed on crushed and screened ore material samples of Supremo #1, Supremo #2 and Latte 583150 indicated excellent hydraulic conductivity and triaxial shear strength characteristics as well as satisfactory performance in relation to puncture potential of selected liners. Accordingly, crushed ore material screened

to a crush size of 100% passing (P_{100}) 38 mm size with less than 10% fines (0.075 mm) was considered suitable for liner cover material.

Due to the coarse nature of the P_{100} 38-mm size with less than 10% fines (<0.075 mm), the frictional strength of the liner cover material is expected to be slightly higher than the crushed ore material going on the heap. Nevertheless, as a conservative measure, the stability analysis assumes the cover material strength to be the same as the stacked ore material.

Liner Interface: The liner interface strength parameters were obtained from large-scale direct shear tests on samples comprising of 2.0 mm single-sided textured LLDPE were provided by Enviro liner and Solmax. The GCL was provided by GSE. The textured side of LLDPE samples were kept in contact with the GCL in each case, and the liner system were sandwiched between an ODF representative crushed rock and representative subgrade material at the bottom.

The weakest layer of the composite liner system was found to be the GCL interface with the textured geomembrane regardless of manufacturer. At normal stresses higher than 400 kPa, the GCL/Geomembrane residual interface strength ranged from 95 to 100 kPa. A bi-linear curve was developed for the liner interface to represent the peak and residual strengths. This is presented on Figure 3-5. The curves Enviroliner-Peak and Enviroliner-Residual were used in this analysis as the most conservative result.

Liner testing was performed on various combinations of geomembrane, geo-synthetic clay liner (GCL), and ODF as part of the feasibility study completed by the Mines Group (TMG 2016). The maximum normal stress used in this testing was 861.8 kN/m^3. Higher normal stresses (up to 1,600 kN/m^3) are required to be more representative of the HLF loading expected. To better model the liner interface Forte used liner interface shear testing result conducted for a similar site, as detailed in Appendix B, located approximately 200 kilometers northeast of the Coffee project site, which tested at normal loads up to 1,600 kN/m^3. The material used for subgrade and ODF for these tests are similar to that which will be used on the Coffee HLF. Although this testing is more representative than the site-specific testing performed in 2015, final testing will still be required prior to completion of the detailed design using site specific materials and the final liner combination chosen.

The liner system used in this analysis is as follows (from top to bottom):

- Overliner drain fill (ODF)– minus 38 mm gravel based on data from a comparable site
- Double sided textured geomembrane – 2.0 mm LLDPE. Enviro Liner 4000 LLDPE material manufactured by Layfield Group was used
- GCL – GSE BentoLiner NWL-60 manufactured by Solmax was evaluated
- Prepared subgrade as specified in the design. Prepared subgrade for the HLF is expected to consist of weathered bedrock rolled by a vibratory compactor with pockets of bedding sand where needed.

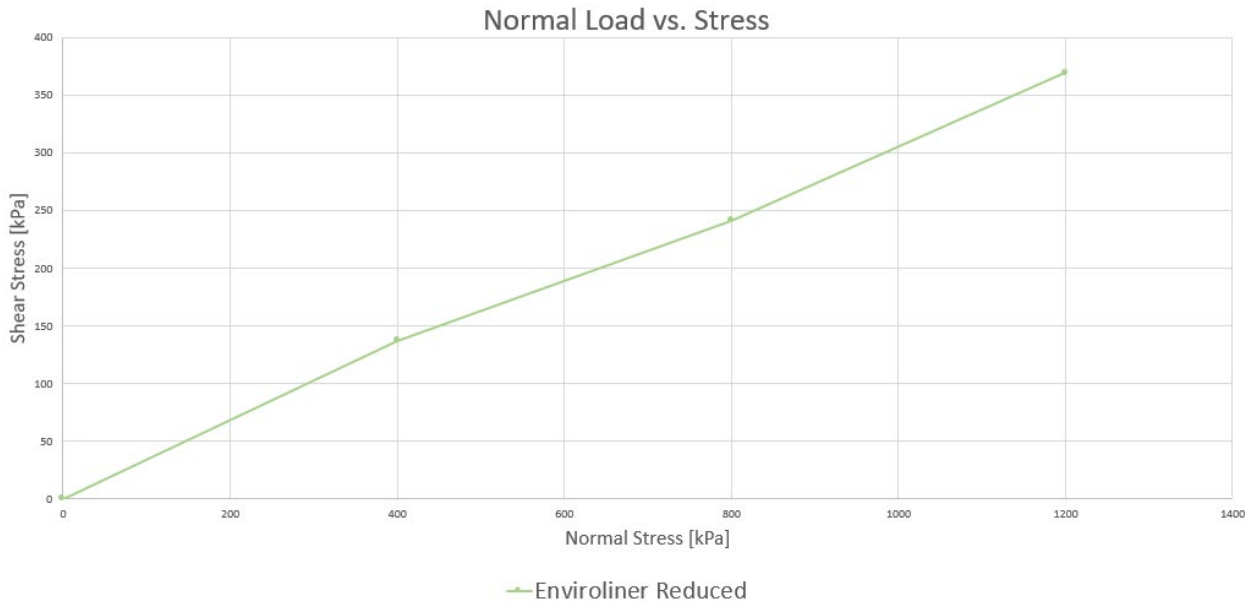


Figure 3-5 Liner Interface Strength Curve

Bedrock: A standard determination of Rock Mass Classification was performed based on limited information from historic boring logs (Tetra Tech, 2017). Diamond core boring logs completed within the footprint of the HLF contained information on drill run recover, rock quality designation (RQD), number of discontinuities, average joint condition, and strength either as a field determination of rock strength (R value) or via unconfined compressive strength (UCS) correlation from point load testing. Detailed descriptions of all joint conditions were not performed, and detailed geotechnical logs were not completed for these borings, so the data is considered limited. However, Forte developed a basic Rock Mass Rating (RMR) for use in Rock Mass Classification based on these logs and core photographs using the system developed in Engineering Rock Mass Classification (Bieniawski, 1989). The RMR develop was done so using a conservative bias (i.e., lowering joint conditions ratings where data was limited). This resulted in a weaker rock classification than actually exists in the field.

Based on this analysis the following profile was developed for the portions of the HLF where granite bedrock foundation is expected:

Class IV bedrock exists below the overburden soils ranging from 0.5 meters bgs to approximately 2 meters bgs. Class 4 bedrock observed at the site consists of highly weathered, highly fractured and jointed granite with thick (>5 mm) joint infills consisting of silt and sand.

Class III bedrock exists between approximately 2m bgs to approximately 5m bgs. This bedrock is considered moderately strong. Joints were typically rough, and infilling was reported as <5 mm in most instances. Jointing and fracturing were limited.

Class II Bedrock exists starting at approximately 5m bgs. Class II bedrock is considered strong. Boring logs reported rock strength values at R4 or greater. Jointing was reported as rough with less than <5 mm of infilling.

The weakest, most weathered layer of bedrock (Class IV in this analysis) will be removed during construction, and the bedrock foundation will consist of Class III or better. As a conservative approach, this stability analysis modeled all portions of the foundation in granite bedrock as Class III using published strength parameters for that class (Bieniawski, 1989). Density testing was not performed on the granite within the footprint of the HLF. Therefore, published values for granite was used to determine the Unit Weight. A unit weight of 27 kN/m^3 was applied (Waltham, 1994).

Portions of the event ponds are expected to be built on a foundation of shist bedrock. Drilling within this area identified shist to at least 6 meters bgs. The shist is reported as typically moderately strong with foliations. The Rock Mass Classification for the shist material that will be left in place was determined to be Class III. No photographs were available for the boreholes completed in the shist bedrock. A unit weight of 24.2 kN/m^3 was used (Waltham, 1994).

The Forte design report (Appendix B) included an analysis of the stability of the slopes of the heap under static, pseudo static, and post-earthquake loading conditions. The stability analysis considered the heap with lifts stacked at the angle of repose of the crushed ore, with horizontal inter-lift benches, at least 10 m wide, and an overall toe-to-crest slope angle of 2.5H:1V. This study also included a seismic risk analysis, which recommended that the maximum seismic event (also commonly called the Design Basis Earthquake) be taken as an event with 2% probability of exceedance in 50 years. The peak ground acceleration for this event was determined to be 0.246 gravity acceleration (*g*). A conservative approach compared tor generally accepted practice (U.S. Army Corps of Engineers 1982), of 1/2 peak, the analysis completed was at 2/3 or 0.16 g. Table 3-1 and Table 3-2 summarize the minimum factors of safety required to ensure slope stability for the HLF.

For the leach pad and heap, failure modes were considered along six critical sections of for the three loading conditions and various construction stages. The sections analyzed included ore material stacked in 10m lifts at 1.5H:1V bench slope and 10 m-wide benches between lifts, producing an average overall heap slope from crest to toe of 2.5H:1V. Models were run using both peak and post-peak shear strength parameters (Appendix B).

The resulting modeled factors of safety for the static, pseudo-static, and post-earthquake analysis of the leach pile/pad are acceptable as per the stability criteria indicated earlier in the report. The minimum factors of safety using the post-peak strength are considered as these values help define how the slope will behave in the event of large movement or a failure. Six sections were included in the analysis, with select section results summarized below.

Section A was completed through the highest portion of the HLF though a portion of the foundation that is expected to be built on a natural sand unit. A total of three cases were run. All of the cases met or exceeded the minimum recommended Factory of Safety (FoS). The results for each case are summarized in Table 3-1.

Table 3-1 Summary of Minimum Design Factors of Safety for Slope Stability Section A

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FoS	FoS	Notes
1	Circular	Static	1.5	1.6	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through liner interface.
2	Circular	Pseudo-Static	1.0	1.1	
3	Circular	Post-Earthquake	1.2	1.3	

Section B was completed through the southern boundary of the HLF where the foundation conditions are more typical for this HLF. A total of three cases were run. All of the cases met or exceeded the minimum recommended FoS. The results for each case are summarized in Table 3-2.

Table 3-2 Summary of Minimum Design Factors of Safety for Slope Stability Section B

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FoS	FoS	Notes
1	Circular	Static	1.5	1.5	Southern slope of HLF pile. Forced through the liner interface.
2	Circular	Pseudo-Static	1.0	1.0	
3	Circular	Post-Earthquake	1.2	1.2	

Settlement and consolidation analysis was performed to analyze the foundation of the HLP. Data from field investigations was used to develop soil compressibility parameters. Analyses were performed using simplified one-dimensional (1D) analyses of foundation settlement under various loading conditions. The purpose of these analyses was to estimate the amount of settlement and the potential for differential settlement to evaluate the need for foundation improvements and the need for more targeted analysis.

Results of the analysis indicated that no issues with differential settlement of the HLP where the subgrade will consist of weathered or unweathered bedrock. Areas where more significant thicknesses of potentially loose, compressible finer-grained silty sand or silt may remain in place, have the potential for vertical settlements under static ore loading to exceed 1 meter. Further investigations are to be performed in future design phases to evaluate characteristics of the finer grained layers and any remedial measures required. The complete details of the Settlement Analysis are presented in Appendix G of the *Coffee Gold Project-Heap Leach Pad Engineering Report for Licensing*.

3.5 Borrow Sources

All sources of borrow material for Mine Site development will come from site grading activities and designated borrow pits, in addition to the open pits. Priority will be given to the Double Double pit since it is one of the first pits mined; however, the biotite-poor felsic gneiss from Supremo pit has also been tested and is suitable for use as concrete aggregate. Site geochemical characterization indicates that only the Kona pit contains potentially acid generating material and therefore this pit will not be used as a borrow source. The testing protocol for construction material is provided in Section 3.3. A description of construction material sequencing and material availability is provided within the WROMP.

3.6 Construction Quality Assurance / Quality Control

A Quality Assurance / Quality Control (QA/QC) Plan is provided in Appendix C. This plan will be revised as needed during the project's detailed engineering phase. This section includes a summary of contents that will be included in the QA/QC Plan.

3.6.1 Quality Assurance

A third-party construction quality assurance (QA) team will be contracted for monitoring and providing quality assurance testing and inspection during construction. The construction QA program will also include electrical leak location (ELL) surveys for detecting defects in the geomembrane leach pad liner after placement of ODF (and optionally the various ponds). Construction QA will ensure strict adherence to the technical specifications provided in the design report and allow for any repair of defects or damage found in the liners before they are placed in service.

Site QA is the responsibility of the engineering, procurement, and construction management Field Engineering team. Quality assurance is verification that quality control (QC) is being performed by the contractor, subcontractor, laboratory, and third-party inspection services. The Field Engineering Lead will confirm that work has been performed according to the Inspection and Test Plans (ITPs) and that the contractor can demonstrate the work is in compliance with Project requirements.

Discipline Field Engineers will be responsible for witnessing all hold points on contractor ITPs. The Field Engineers will carry out independent inspections and confirm acceptance in the QA portion of the contractor's ITP checklist. The Field Engineer is responsible for confirming acceptance or rejection of the inspected work, providing final sign-off of the work, and allowing subsequent work to proceed.

3.6.2 Quality Control

The construction contractor is responsible for QC, inspections, and testing activities. These activities are performed to confirm that the works are in compliance with the Project requirements, as defined in Technical Specifications found in Appendix B. Elements that will be considered include the following:

- Sequence of work
- Scope of work to be inspected and tested
- Frequency of inspection or testing
- Test methods
- Acceptance criteria

- QC responsible party
- Required verification and checklists to record the evidence of work completed
- Witness points and hold points.

All test results and inspection details along with any corrective measures or repairs recommended and implemented will be summarized in an as-built report. As-built reports certify concordance with the original design and specifications and will be provided to the Yukon Government and to First Nations, as well as to the Yukon Water Board, if required, under the corresponding Quartz Mining and Water Use licences.

3.7 Construction Schedule

3.7.1 Site Construction Schedule

The Project Execution Plan for the Project is based on principles tested and proven in the development of remote, logistically challenged projects in northern Canada. These principles include:

- Safety in design, construction, and operations is paramount to success
- Design and develop simple, passive environmental solutions, minimizing disturbance footprint
- Implement fit-for-purpose design, construction, and operation
- Due to the high cost of transportation, consolidate construction and operational needs to the extent practical
- Common equipment fleet will be purchased by owner at the outset and used for construction needs
- Conduct efficient operations; minimize site labour requirements
- Ensure negotiated contracts are in place with suppliers, contractors, and engineers with proven track records in northern Canadian mine developments
- Strive to complete project components early for turnover to operations
- Eliminate superfluous management organizations.

A detailed schedule has been developed for the Project Construction Phase activities, utilizing the Feasibility Study cost estimate as the basis for determining the required man-hours. This scheduling exercise indicates that mechanical completion and wet commissioning can be accomplished within an 18-month construction period. Construction-related activities, including Engineering, Procurement, and Construction Management (EPCM), will commence in Q2 of Year -3 and will be substantially complete prior to the start of Mine Site construction in Year -2. Mining operations overlap with construction activities, in order to maximize equipment, use and expedite project schedule. The key schedule milestones for the site construction are presented in Figure 3-6, and may be subject to updates as mine planning advances. Further details of the site construction program are provided in the General Mine Development Plan.

ACTIVITY NAME	YEAR -3				YEAR -2				YEAR -1			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
CONSTRUCTION												
Northern Access Route	■	■	■									
21km Access Road (Coffee to Java)			■									
Construction Camp			■	■								
Operations Camp				■	■							
Water Management (Alpha Dam, Facility Ponds, West Diversion)				■	■	■						
Power Plant				■	■	■						
Office & Dry Complex, Shop & Warehouses, Bulk Fuel Storage, Explosives Facility				■	■							
ADR Plant				■	■	■	■	■				
Heap Leach Pad Construction - Phase 1				■	■	■	■	■	■			
Construct Haul Roads (with Mining Fleet)					■	■	■					
OPERATION												
Remove Overburden at Ore Body			■	■								
Remove Waste Rock at Ore Body							■	■	■			
Mine Ore for Heap Leach Overliner/Stacking and Stockpile							■	■	■			
Initial Stacking of Heap Leach										■		
Irrigation of Heap Leach										■		
First Loading of ADR										■		

Figure 3-6 Project Construction Milestones

3.7.2 Heap Leach Facility

The heap leach pad is currently scheduled to be constructed in five stages (Figure 2-1), with Stage 1 construction commencing in Year -1 (Figure 3-6).

Major grading of the pad area is proposed for Year -2 with the final grade completed in Year -1. The pad will be graded and constructed in a nominally balanced cut-and-fill manner using locally borrowed (within the heap boundary) rock for structural fill, supplemented as needed by mine waste including waste rock and, if available, thaw-stable soil. Finer material from the rock or thaw-stable soil will be used in the top lift of fill then compacted to create a smooth, non-puncturing surface for installation of the leach pad liner system.

The heap leach pad design is based on staged construction with initial capacity of approximately 4 Mt expanding to the design capacity of 69 Mt in five stages (Table 3-3).

Table 3-3 Summary of Stages of Heap Leach Pad Construction Stages

Heap Leach Pad Stage	Construction Year	Cumulative Pad Stage Area (m^2)1*	Pad Cumulative Capacity (Mt)	Heap Crest Elevation (masl)
1	Year -1	247,000	4	1324
2	Year 1	429,000	15	1350
3	Year 2	699,000	32	1388
4	Year 4	921,000	50	1392
5	*Year 7*	*1,053,000*	*69*	*1392*

*Leach pad area within the HLF containment system. Does not include lined pond area.

All ponds (EP-1N, EP-1S, EP-2 and Rainwater) will be constructed in the pre-construction Year -1 to provide containment for the drainage from HLP. (See Section 4.6.2)

3.8 Design of Heap Leach Pad and Event Ponds

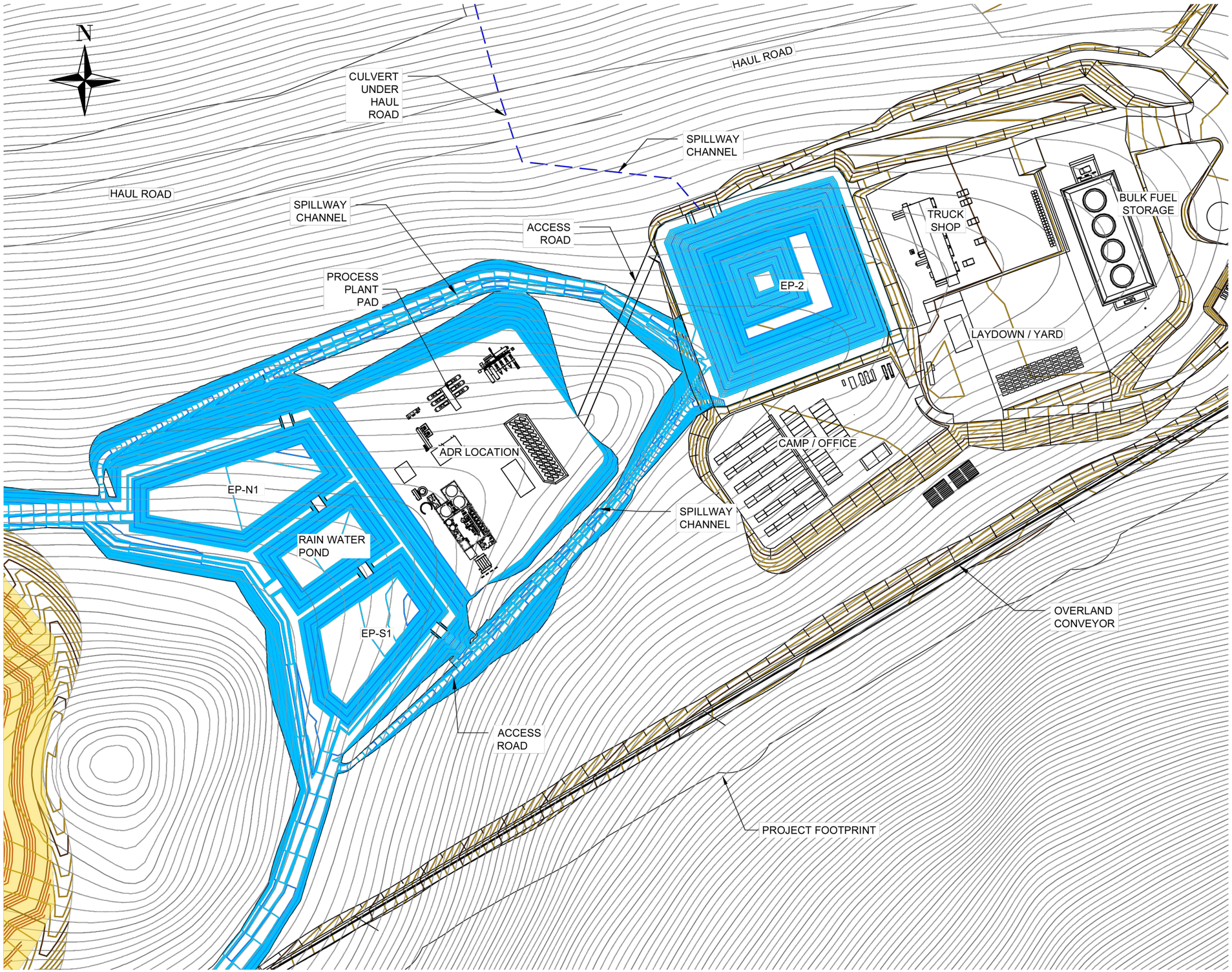
The HLF will include a conventional, multi-lift, free-draining ridge-top leach pad with an ultimate pad area as presented in the above table. Ore will be stacked with trucks and conveyor/stackers on lined leach pad in nominal 10 m thick lifts. Barren solution will be irrigated onto the heap using drip irrigation (Section 2.2). Gold bearing (gold-bearing) solution will be collected into the piping network at the base of the HLP above the liner system and will flow to the process plant by gravity for gold recovery. The liner system for the HLP is described in Section 3.8.1.2.

The process plant will be located to the east of the HLP and EP-1N, EP-1S, and Rainwater Ponds, and west upgradient of EP-2. Solutions from the leach pad will gravity flow to solution tanks at the process plant. During high precipitation events, runoff from the heap is directed via gravity flow through channels to EP-1N and EP-1S with additional solution containment available through gravity flow to the third event pond, EP-2. During upset conditions within the ADR plant, solutions will gravity flow to a process sump within the event pond, EP-2. Any process solution accumulated in EP-2 will be pumped to the process plant and recirculated to the heap or treated in the water treatment plant and discharged to the Alpha Pond via the

Alpha rock drain. A secondary option during upset conditions in the ADR plant is to move solution to the event ponds EP-1N and EP-1S by activating control valves.

The combined volume of the four ponds satisfies the storage requirements summarized in Section 2. Solution draining from the heap can be directed to any event pond at any time, and solution stored in these ponds can be sent back to the heap or to the process plant as make-up water. A leak detection sump will be installed in the low corner of each event pond. Configuration of the events and rainwater ponds are illustrated in Figure 3-7 and the liner system for the ponds is described in Section 3.8.1.2.

The Rainwater Pond, capable of being converted to an event pond, if necessary, will be built between the HLF and the process plant. The pond will only receive water directly from precipitation. Overflow from weirs in EP-1N and EP-1S would also secondarily be received by the Rainwater Pond.



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COFFEE HEAP LEACH FACILITY DESIGN

EVENT & RAINWATER PONDS

YUKON, CANADA

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FIGURE 3-7

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3.8.1 Solution Storage Facilities

3.8.1.1 Barren and Process Solution Storage

The barren and (2) gold bearing solution tanks will be located indoors in the process plant (Figure 3-4) The barren solution tank is 11 m diameter by 13 m high with a total volume of 1,360 m^3. The two gold bearing solution tanks are each sized to be 1,140 m^3 for a total volume of 2,280m^3. Each of these tanks will provide approximately one hour of storage capacity. The tanks will be fabricated from material with a steel grade of ASTM A36 with varying tank wall thickness from the bottom of the tank to the top (12 mm for the first 5m to 6 mm for the last 7 m). The tanks will be in a concrete bounded area with 110% of the tank volume for spillage containment. The event pond will provide additional emergency storage. Please note that Figure 3-4 will be updated in subsequent versions of this Plan to represent an updated process plant layout.

3.8.1.2 Heap Leach and Event Ponds Liner Systems

Heap Leach Liner System

The leach pad liner system was designed to collect process solutions and maximize recovery of gold bearing solution, as well as to protect surface and groundwater quality by providing containment through the operating life and active closure of the heap. The system consists of two layers of synthetic liners with leak detection below and a hydraulic head control or drainage layer on top of the liners. The leach pad liner system will be a 2.0 mm LLDPE geomembrane over a reinforced GCL liner. The bottom side of the LLDPE liner will be aggressively textured to provide a close bond with the GCL. Each component is shown in Figure 3-8 and discussed below (from the bottom up).

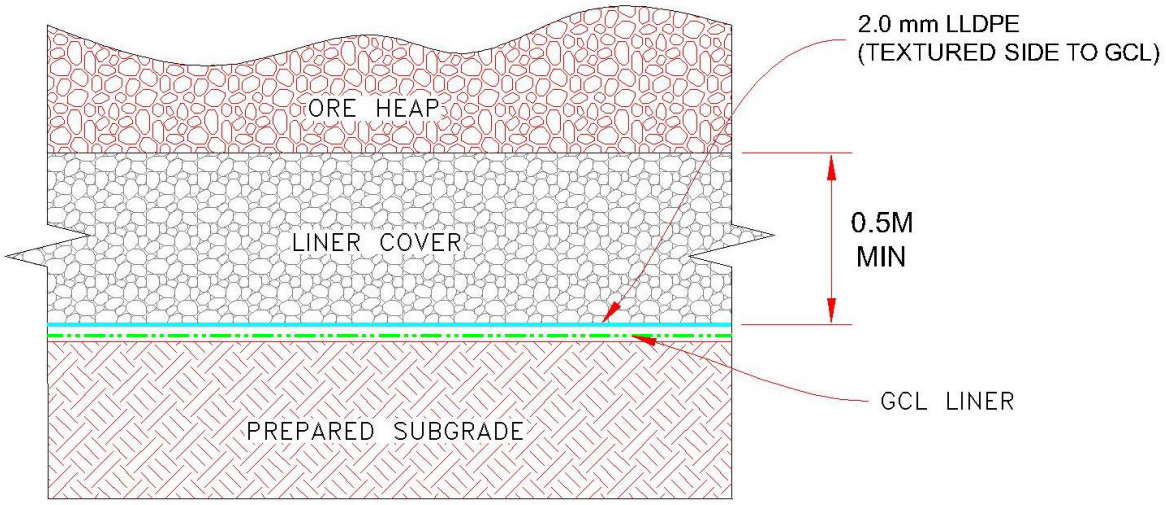


Figure 3-8 Heap Leach Pad Liner System Cross-section

Graded or Prepared Subgrade

The subgrade will be constructed using competent, thaw-stable rock borrowed from within the HLP area, supplemented with mine waste rock or thaw-stable soil from mine pre-stripping. Because the bottom liner

will be a heavily reinforced GCL, and since GCLs are self-sealing and provide excellent protection for geomembranes, the system will be very tolerant of subgrade conditions. Nevertheless, selected finer-grained materials, finer-sized rock material, or thaw-stable soil will be used in the top lift of fill as a thin plating layer for areas of exposed rock cut to create a smooth, non-puncturing surface. The selected finer-grained materials will be obtained by identifying and temporarily stockpiling such materials during excavation of the leach pad (and possibly from the Latte pit) for subsequent use in the final leach pad grading.

Reinforced Geosynthetic Clay Liner

The synthetic liner system consists of two components: a geomembrane liner over and in direct contact with a low-permeability soil liner. The Project area does not contain significant clay or clay-like materials; thus, a GCL liner was selected. Geosynthetic clay liners offer some significant advantages over compacted clay liners (CCLs), and they are often used as system upgrades even when local clay sources are available. The principal advantages can be summarized as follows:

- Geosynthetic clay liners are manufactured products with tight production tolerances and robust quality control procedures, which result in products that are more reliable than field-constructed systems.
- The bentonite used in GCLs has a permeability that is several orders of magnitude lower than CCLs.
- The bentonite is layered between geotextile fabrics so that the geotextiles provide significant additional puncture protection for the geomembrane, while the geomembranes provide confinement for the bentonite (any soil liner's permeability decreases with better confinement).
- Geosynthetic clay liners are not subject to construction defects common for CCLs such as inhomogeneity, cracking, and inclusion of high permeability materials such as stones and roots.
- The quality of contact between the geomembrane and low permeability soil layer directly affects the leakage through any defects, and geomembrane/GCL contacts are better than most geomembrane / CCL contacts.
- Geosynthetic clay liners are more resistant than CCLs to the effects of cyclic freezing-thawing and wetting-drying.

The Project design uses the thickest and the most heavily reinforced GCL on the market, which produces an installed product that is most likely to be defect-free because most of the damage occurs during installation and the reinforced products tolerate installation stresses best. The reinforcement also makes the heap more stable by increasing the shear strength of the geomembrane or GCL system. The selected product currently has the highest swell factor of any of the GCLs on the market, which improves its as-installed performance significantly. The permeability of the selected GCL is less than 5×10^{-11} m/s under little or no load and is expected to decrease by more than an order of magnitude under the ultimate heap load.

Primary Geomembrane Liner

The selected geomembrane for the HLP is a 2.0-mm-thick LLDPE with the bottom side aggressively textured to provide a close bond between the geomembrane and GCL.

The two most common materials used for leach pad liners, as well as liners for a wide range of other industrial containment systems, are HDPE and LLDPE. HDPE has been in use since the 1970s and has been the dominate liner material for most applications, including HLPs, since the 1980s. This liner is a highly reliable material with a good performance history; however, HDPE is stiffer, less puncture-resistant, and produces lower interface shear strengths than LLDPE. Stiffer materials present installation and performance problems at very low temperatures; puncture resistance is the most critical parameter for a leach pad liner; and shear strength is important for heap slope stability. Therefore, LLDPE has been chosen as the primary geomembrane liner.

LLDPE has been in common use for leach pad liners for approximately 20 years, though it is not the most common liner for the simple reasons that it is more expensive and less available. It is, in other words, a premium product and has a lower resistance to prolonged and direct exposure to sunlight than HDPE. Its resistance is in the order of two or more decades; however, no leach pad liner material should be uncovered and exposed for longer than several months (e.g., the summer construction season).

For heaps of maximum ore depth of up to approximately 120 m, the industry standard liner is 1.5-mm-thick HDPE. For the Project, a 2.0-mm-thick LLDPE liner has been selected to provide additional robustness. To have consequential leakage through a liner the system must first have defects, and the risk of defects occurring is related to the puncture resistance of the liner, which in turn is related to the liner thickness and the resin type. Increasing the thickness improves puncture resistance in a way that is greater than proportional. The geomembrane specification also calls for tighter tolerance on the quality of the resin than industry standards, and tighter control of the as-manufactured liner thickness. Industry norms and the standard specifications issued by industry organizations allow the thickness to vary by plus or minus 10%. However, current technology allows closer tolerances, and the Project specifications will require (a) the minimum thickness of any roll of geomembrane to be no thinner than minus 5% of nominal, and (b) the average of all rolls to be at least the nominal (i.e., minus 0%). This increases the possible minimum average thickness from an industry standard of 1.50 minus 10%, or 1.35 mm, to 2.00 mm, resulting in an increase of 48%.

Puncture resistance increases with thickness at an increasingly higher rate and increasing thickness by 48% probably reduces puncturing by approximately 70% (this is a generalization, as the precise increase depends on a wide variety of factors including the specific geometry of each stone in contact with the liner).

Overliner Drain Fill (ODF) (Crushed Ore) and Drainage Pipe

The overliner system serves two purposes: it protects the geomembrane liner from damage during ore stacking and operations, and it encourages draining and expels solution to minimize hydraulic head over the liner. Additionally, it helps to support the collection and drainage pipes as well as reduces the stress concentration under these pipes. The Project design includes a 0.6-m-thick layer of durable crushed ore screened to P_{100} minus 38-mm size. The overliner gravel will typically be clean (not greater than 10% fines) but the more important function is to provide a permeability consistent with the pipe spacing.

A series of laboratory tests were performed to verify that the liner and the selected gravel are compatible under the expected loads and to ensure adequate puncture protection. The depth of ore over the liner will typically be a maximum 75 m at ultimate build out with a small area receiving 110 m of ore near the end of the operational life. The Project team lab-tested the coarsest samples of durable ore from the metallurgical testing program of both Supremo and Latte. These had been crushed by the metallurgical laboratory to a

P_{80} of 50 mm. For the puncture testing they were further screened to a P_{100} of 38mm and then tested in contact with the selected geomembrane (2.0 mm LLDPE). The subgrade for the puncture test was a GCL over an open grade minus 20 mm gravel, which is more aggressive than the actual conditions for construction. The test conditions, material properties, and results of each test, including gradations of the materials used in the test, are detailed in The Mines Group Feasibility Study (TMG 2016). Additional materials and test work is planned during the project's detailed engineering phase to confirm or refine the understanding and design of the overliner system.

Leak Detection System

Leak detection will be accomplished by implementing three separate systems:

1. Electrical Leak Location (ELL) surveys after construction of each stage of the leach pad.
2. Monitoring of phreatic surface/head above liner utilizing horizontal piezometers.
3. Groundwater monitoring wells outside of the pad.

Electric leak location surveys are an adaptation of geophysical methods to liner systems and use electrical resistance to locate holes by finding areas of low resistance or high conductivity. Although ELL surveys have been used for over 20 years, they are relatively new to mining applications. These surveys dramatically reduce the likelihood of not detecting holes in the membrane during and after construction and reduce the size of any undetected holes. Several authors have postulated that over 70% of all geomembrane damage and nearly all of the significant damage (holes large enough to allow leakage of any environmental consequence) occurs during placement of the overliner layer (Peggs 2010). Electric leak location surveys can be done over bare liners as well as over the top of the overliner and filled ponds. Thus, the net result of using ELL surveys is a 10- to 100-fold reduction in risk of consequential leakage and coming as close to a perfect or leak-free liner as the best available / applicable technology allows. For the Project, ELL surveys are planned only on the leach pad after the overliner is placed, which is the most critical stage.

The horizontal piezometers are designed to be located inside the HLP footprint near the low point of each stage. They are located on the geomembrane to measure phreatic surface above the liner, to assure that this is not exceeding maximum limits. The liner system of geomembrane over GCL performance is exceptional in free draining and low head circumstances, such that pads do not typically require additional monitoring or leak detection.

Although the above two monitoring and leak detection practices exceed typical practice, the use of down gradient ground water monitoring points are used frequently to almost always for this application.

Groundwater monitoring wells

The Groundwater Monitoring Plan describes monitoring of HLF seepage in sub-permafrost groundwater and in the active zone. Two Westbay systems, designed to permit sampling of sub-permafrost groundwater, are positioned to intercept groundwater draining the HLF footprint area: MW16-01WB is located immediately adjacent to the facility in the Halfway Creek catchment while MW15-05WB is positioned kilometers downgradient in the Latte Creek catchment. Both monitoring wells are slated for quarterly groundwater quality sampling (including cyanide species analysis) during construction and operations. Each Westbay system has an adjacent thermistor/vibrating wire piezometer string that will continuously monitor water levels and ground temperature.

For potential leakage traveling in the active zone, seepage monitoring is recommended along the roadcut flanking the facility. Where persistent and measurable seeps are identified, site personnel will conduct a seep survey in the spring and the fall, collecting field measurements of pH, electrical conductance (EC) and flow (where possible). Sites that return EC values above 250 uS/cm will be sampled. Additional details on groundwater monitoring near the HLF can be found in the Groundwater Monitoring Plan.

Should the leakage detection system identify leakage from within the HLF during operations, Kaminak Gold will conduct a cause-and-effect study of the leakage and perform corrective actions as determined by the study. Examples of corrective actions that may be taken include:

- Commence early decommissioning of the specific cell
- Reduce irrigation rate in the area of concern
- Shorten the leach time
- Install an inter-lift liner before the next lift of ore is placed
- Other measures depending on the size and location of the leak.

Event Pond Liner System

Event ponds EP-1S, EP-1N, and the lower portion of EP-2 will have three synthetic layers over prepared foundation and the subgrade (Figure 3-9:) as follows:

- Primary liner: 2.0-mm-thick LLDPE
- Drainage layer: provided for leak detection and recovery (the leak detection layer may be a separate material such as an HDPE drainage net or be integral with the secondary liner such as the Drain Liner manufactured by Agru)
- Secondary liner: 1.5-mm-thick LLDPE
- GCL at the bottom.

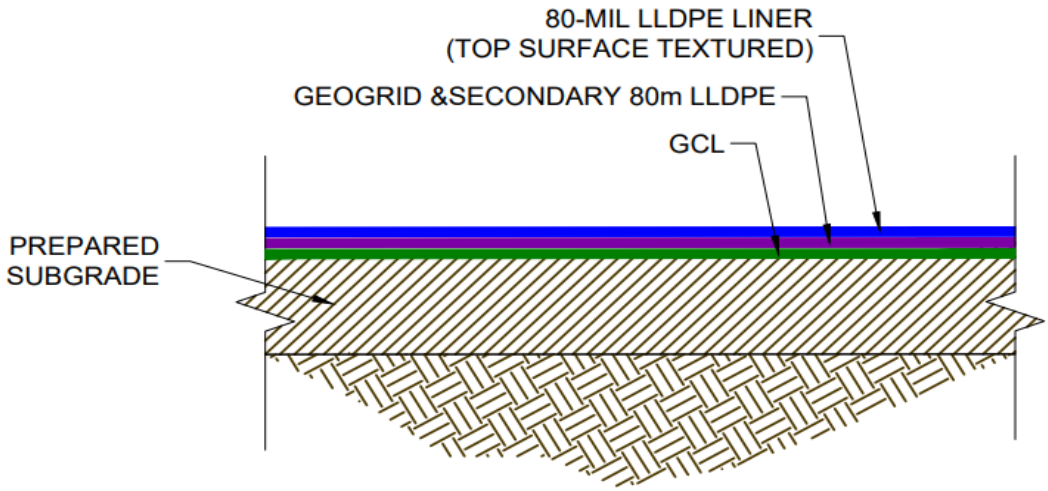


Figure 3-9 Liner System for Event Ponds-EP-1S and EP1-N

The upper portion above the segregation berm EP-2 will have two synthetic layers (primary liner and GCL) with no drainage layer or secondary liner (Figure 3-10).

A Rainwater Pond will be constructed between EP-1S and EP-1N to contain direct precipitation for either use as make-up water or to be released to the environment after verification testing. Temporary geomembrane covers (raincoats) may be used over the heap, to reduce the volume of meteorological water entering the process circuit. The rainwater pond will be lined with geomembrane over GCL.

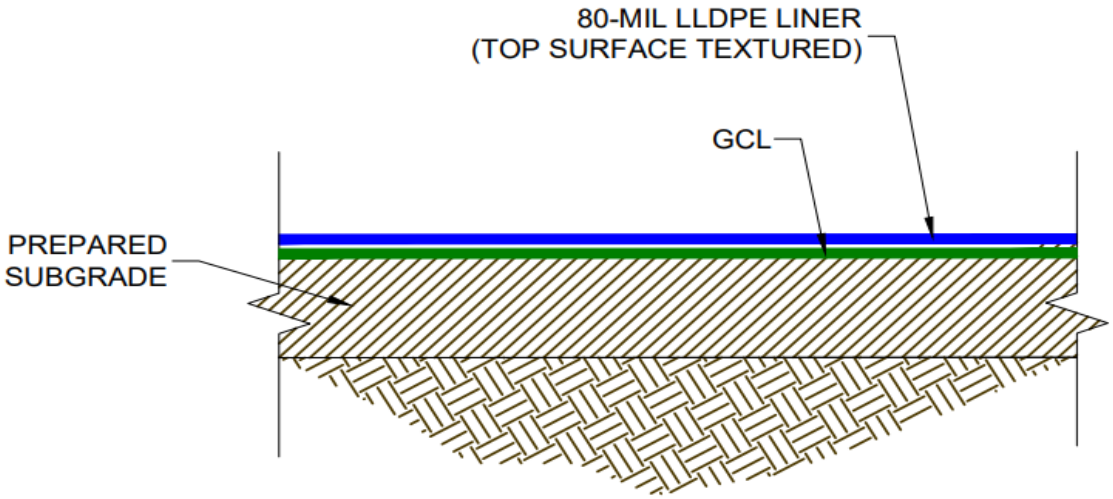


Figure 3-10 Liner System for Event Pond EP-2 (Above Segregation Berm) and Rainwater Ponds Leak Detection and Recovery Systems

Event ponds EP-1S and EP-1N, and lower portion of EP-2 will have double geomembrane liners with a leak detection and recovery system between the top and bottom liners. Recovered solution will be collected in a leak detection sump, which will include a level-activated pump. As solution accumulates, the pump will be engaged, and the solution will be pumped back into the pond. The pump will include a totalizing flow meter to allow monitoring of rates and changes to rates.

An analysis of the allowable collection rates within the event ponds is provided in the HLF Event Pond Allowable LDRS Collections Rates Technical Memo (Forte 2022) appended to the HLF Operation, Maintenance and Surveillance (OMS) Manual (Appendix D) and includes alert levels for collection of process solution above the allowable volume for each event pond. Should the leak detection system exceed collection rates beyond those indicated, Kaminak Gold will conduct a cause-and-effect study of the excess collection rate and perform corrective actions as determined by the study. Potential response actions are provided in the HLF OMS Manual (Appendix D).

3.8.2 Solution Collection Systems

Gold bearing solution will be collected on the leach pad via the overliner layer and drainage pipes. The solution will be routed to collector pipes along the north and south edges of the leach pad. Two or three pipes are provided on each edge to allow segregation of solution. The leach pad is divided into cells with a divider berm or ditch approximately every 100 m (east to west), and a valve box is provided at each location. Because the gold bearing solution will flow by gravity to the ponds or process plant, there are no pumping risers or wells. The piping is illustrated in Figure 3-11.

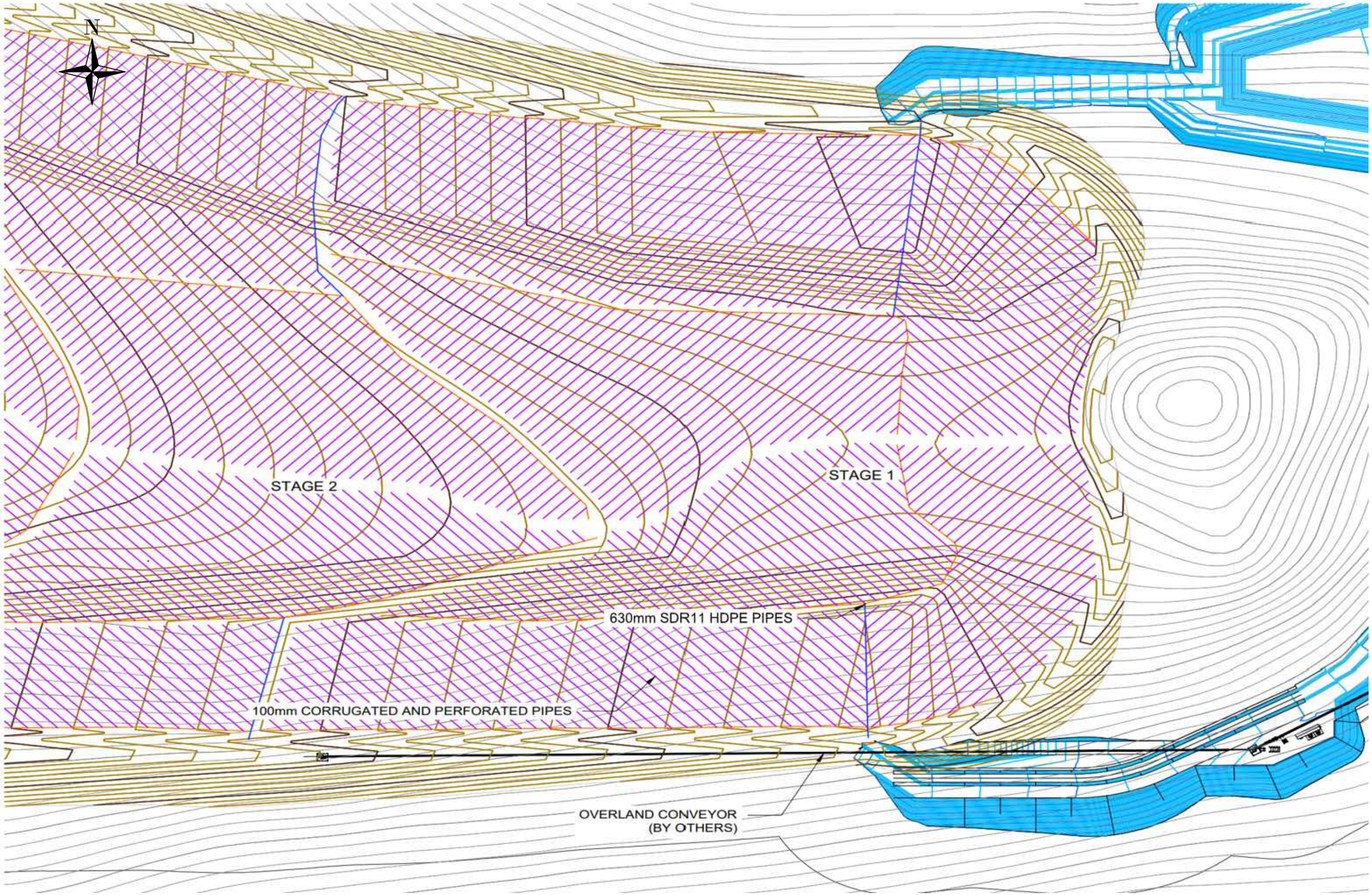
A free draining gravel layer (ODF) and drainage piping will be placed over the composite liner system to:

- Provide rapid drainage of process solutions from the base of the ore pile
- Minimize hydraulic (solution) head over the liner system to reduce risk of solution leakage, and to ensure stability of the heap
- Protect the composite liner system from damage during ore stacking.

Industry standard practice is for the drainage layer to be designed for a maximum solution head of 0.6 m over the liner area under active leach, such that the average head is much less over the entire liner area. The ODF material is crushed, and screened ore selected from the most durable areas of the open pits, which have been tested to both provide excellent drainage and puncture protection. If ore material is not available, crushing and screening of suitable overburden material will be used; this is not expected to be required except possibly for the first stage of construction. The material will be crushed to nominal 38 mm (80% passing 50-mm) size and will have less than 10 percent fines passing the 200-mesh size. Permeability test results are presented in the report by The MINES Group (TMG 2016).

The base of the leach pad includes separation cells for process solutions. These are designed to isolate sections of the leach pad utilizing berms and collection pipe for metallurgical control of the gold extraction process. The lowest elevation of each separation cell includes perimeter berm weirs which would convey any solution that extends above the ODF to the adjacent lined perimeter channel These separation cells will additionally provide the ability to separate gold bearing solution from recirculation flows for future progressive reclamation. Cell separation berms or ditches will run in a north-south direction across the entire width of the leach pad with an east-west spacing of nominally 100 meters. The liner system will be placed over the cell separation berms / ditches, with the primary cell collection pipe placed alongside the

upstream side of the berm or ditch as shown in Figure 3-11. The primary cell collection pipe reports to the perimeter solution collection pipes (gold bearing and standby pipes) after transitioning to a non-perforated pipe through a containment berm and valve system to allow switching between appropriate solution collection pipes. Initially, solutions will be directed to the gold bearing solution pipe. A parallel standby pipe can be utilized for redundancy.



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FDI PROJECT NO:

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COFFEE HEAP LEACH FACILITY DESIGN

STAGE 1 SOLUTION COLLECTION PLAN

YUKON, CANADA

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FIGURE 3-11

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The PLS collection system is designed to limit the phreatic head within the HLP to below 0.6 m and provide rapid transport of PLS flows to the ADR plant via gravity. The system was designed based on a minimum permeability of the ODF of 1X10-2 cm/s and the solution application rate of 10 L/hr/m^2. The solution collection pipe network will accommodate a total flow of 1400 m^3/hr, which includes the nominal 1100 m^3/hr flow rate generated from the applied leaching solution plus a 300 m^3/hr potential dynamic storage flow rate. The 24-hr Probable Maximum Precipitation (PMP) was also in consideration for the sizing.

The buried collection piping will consist of a herringbone pattern of perforated, dual-walled, corrugated, 100 mm HDPE collection pipes, spaced approximately 6 m apart and buried in a 0.6 m layer of ODF. These collection pipes flow to 450 mm perforated, dual-walled, corrugated collection header pipes. The collection header pipes will then tie-in to solid-wall 630 mm HDPE SDR 11 trunklines. The trunklines will tie-in to 710 mm SDR 21 return pipes within the channels to the ADR plant.

Solution in the return pipe installed in the perimeter solution collection ditches will flow by gravity directly to the gold bearing tank at the process plant. The pipe in the perimeter solution collection ditch is considered as the primary containment. Within the leach pad limits, secondary and tertiary containment will be provided by a 2-mm thick LLDPE liner and composite GCL liner in the ditch. When the solution collection pipes exit the leach pad, the pipe will transition to dual-walled pipe or a pipe within a pipe to convey solutions to the process plant while maintaining primary and secondary containment. Piping between the ADR plant and the heap perimeter will be insulated with a polyurethane foam insulation at a thickness of at least 25 mm. The insulation is designed to minimize the risk of pipes freezing.

3.8.3 Solution Conveyance and Pumping Systems

Barren solution will be pumped from the process plant at a nominal flow rate of 1,100 m^3/hr (1,400 m^3/hr max in upset conditions). Gold bearing solution at the same flow rate will return to the process plant by gravity using either the piping system on the north and south side of the HLP. All piping to and from the HLP will be double walled with leak detection systems and associated programmable logic controller (PLC) installed and tied into the process plant master PLC. Barren solution will be heated at the process plant. Pipelines from the process plant to the perimeter of the HLP will be insulated, and barren solution will be applied year-round to allow continuous flow to prevent solution in pipes from freezing.

The barren solution pipeline delivering the solution from the process plant to the HLF consists of a 24” (600 mm) Schedule 80 Carbon Steel, until pressures decrease below 1,800 kPa, and the transition is made to 24” (600 mm) Standard Carbon Steel. The north and south forks of the trunkline are designed to convey the maximum flow rate of 1,400 m^3/hr. Risers from the trunklines are 12” (315 mm) HDPE SDR 11 to convey a max of 142 m^3/hr.

Barren solution will be applied to the heap using drip emitters. During winter operations, the drip lines and emitters will be buried in the ore 1 m deep or covered with 1 m of any combination of gravel and ore, to reduce the likelihood of freezing. Beginning at the end of Year 1 before onset of winter, a backup irrigation area will be provided equal to 100% of the active irrigation area. This will provide an alternative irrigation system in the event that the primary area freezes. In the first year of operation, the starter-heap geometry does not allow for redundant piping. The backup irrigation area can be any combination of a separate, duplicate irrigation area or duplicate pipes installed within the active area.

4.0 HEAP LEACH FACILITIES OPERATION

The Project heap is a conventional free-draining heap on a relatively flat or level leach pad. Ore stacking will be by conveyor stacking or trucks, dumping lifts in nominal 10m lifts at the ore's angle of repose. Each lift will be irrigated for nominally 45 days before the subsequent lift is stacked and leached. Benches between lifts will be provided to produce a 2.5H:1V or flatter overall toe-to-crest slope. Table 4-1 summarizes the key operating criteria for the HLF.

Table 4-1 Heap Leach Facility Key Operating Parameters

Description	Design Parameters
Ore preparation	Crush to P80 = 50 mm
	No agglomeration
Ore stacking	Conveyor stacking and Truck dumping
	6.7 Mt/a
	April 1 – Dec. 31 each year, subject to ambient conditions during operations
	67 Mt design heap capacity (Stage 5)
Heap geometry	~115m maximum heap height
	10m nominal lift thickness
	Angle of repose of each lift
	10m to 14-m-wide benches between lifts
	2.5H:1V or flatter overall heap slope
Solution irrigation	10 L/m^2/hr
	1,100 m^3/hr nominal
	1,400 m^3/hr max
	365 days per year
Barren solution heating	Increase gold bearing temperature by minimum 8° C at process plant (to provide at least 6° C at drip emitters)
Pond capacities, m^3	At freeboard (at crest)
EP-1N	112,791 (122,184)
EP-1S	90,312 (98,697)
EP-2	339,819 (376,942)
Rainwater	53,016 (59,326)

Note: 1. The capacities of the event ponds include seasonal water accumulation, 72-hr heap drainage, the 24-hour PMP storm event, and seasonal solution accumulation.

4.1 Ore Crushing and Processing Facilities

4.1.1 Ore Type

The Project is located in the Yukon-Tanana Terrane (YTT), an accreted pericratonic rock sequence that covers a large portion of the Omineca Belt in Yukon and extends into Alaska and British Columbia. The YTT underlies part of the Tintina gold belt and hosts multiple gold deposits, including the Sonora Gulch gold deposit, the Casino copper-gold-molybdenum porphyry, the Boulevard gold prospect, and the Golden Saddle gold deposit. The YTT also hosts volcanogenic massive sulfide and Mississippi Valley-type deposits.

The Project area is underlain by a package of metamorphosed Paleozoic rocks of the YTT that was intruded by a large granitic body in the Late Cretaceous. The Paleozoic rock package consists of a mafic schistose to gneissic panel, which overlies the Sulphur Creek orthogneiss.

Both packages form the southwestern limb of a northwest-trending antiformal fold with limbs dipping shallowly to the northeast and southwest.

Within the schistose and gneissic mafic rock package, a thick panel of biotite (+ feldspar + quartz + muscovite ± carbonate) schist with rare lenses of amphibolite overlies a panel of amphibolite and metagabbro with arc-derived geochemical signatures. Within the schistose panel, 20-m-thick slices of serpentinized ultramafic are in tectonic contact with the surrounding rocks. This rock sequence overlies the augen orthogneiss. These rocks are in contact to the southwest with the 98.2 ± 1.3 Ma Coffee Creek granite, a phase of the Dawson Range batholith. Both the Paleozoic metamorphic rocks and Cretaceous granite are cut by intermediate to felsic dykes (andesite and dacite).

Exploration drilling has led to the discovery of gold mineralization in 15 separate areas of the Project: Supremo, Sumatra, Latte, Double Double, Arabica, Americano West, Americano, Espresso, Kona, Kona North, Macchiato, Cappuccino, Dolce, French Press, and Sugar; the main mineralization zones are Supremo, Latte, Double Double, and Kona (Table 4-2). Gold mineralization occurs in narrow to broad gold-bearing locally brecciated structures with quartz, dolomite, sericite, and pyrite alteration. The host rock varies between augen gneiss, granite, and biotite-feldspar schist.

The gold mineralization found to date is hydrothermal in origin and both structurally and lithologically controlled. Mineralization is associated with both polyphase brecciation and intense sulfidation of mica-rich host rocks by a CO_2-S-As-Sb-Au fluid, resulting in the formation of gold-bearing arsenian pyrite. Micron-scale gold is found within arsenian pyrite and is associated with As-rich growth bands. Oxidation of the arsenian pyrite along rims and cracks results in the release of micron-scale free gold. Mineralization is temporarily constrained by sulfidized biotite within the Coffee Creek granite to <98 Ma.

Table 4-2 Main Mineralized Zones Investigated by Drilling in the Project Area

Zone	Host Rocks	Summary Description
Supremo	Augen Gneiss	Narrow gold-bearing brittle fault structures with gold hosted in intense fracture zones, immature clast-supported breccia, and in zones of most intense deformation matrix-supported breccia. Mineralization commonly on the margin of and within dacite dykes that intruded along the fracture zones pre-mineralization. Gold mineralization and accompanying quartz-sericite-pyrite alteration associated with later reactivation of structures. Complete oxidation up to 250m below surface.
Latte	Biotite-feldspar Schist, Augen Gneiss	Gold is hosted in zones of brecciation and strong fracturing as well as areas with pervasive sericite alteration and strongly disseminated sulfides. Some high-grade zones associated with quartz vein breccias. Dolomite-illite/sericite-arsenian pyrite sulfidizes foliaform biotite laths. Potential remobilization of gold to other structures. Complete oxidation up to 75m below surface.
Double Double	Augen Gneiss, Biotite-feldspar Schist	Narrow gold-bearing brittle structures hosted in matrix-supported breccia including dacite porphyry fragment breccia. Anastomosing quartz vein networks and microbreccia associated with high grade. Local intense silicification and strong disseminated sulfide mineralization. Complete oxidation up to 350m below surface.
Kona	Granite	Broad zones of fracture-controlled and disseminated pyrite associated with dacite dykes. Gold hosted in quartz-sericite altered granite. Iron oxides after disseminated pyrite, pyrite veinlets, stockworks and sooty-pyrite rich shear zones.

4.1.2 Crushing Method

The ROM material from the Open Pits will be hauled by truck to the crushing plant. The ROM material will be reduced in a 2-stage crushing circuit, jaw and cone crusher, to produce a target product with a crush size of 80% passing (P_{80}) of 50 mm (Figure 4-1). Final product size may be adjusted during operations as heap performance is monitored and optimized. The final product size was chosen based on higher recoveries at the finer crush size. The KCA testing results, as discussed in Section 13 2016 JDS FS report, at the crush sizes of 80% passing (P_{80}) 150 mm and 80% passing (P_{80}) 50 mm, an approximate 6% gold recovery increase was indicated by the finer crush for Supremo, and an approximate 4% gold recovery increase was indicated by the finer crush for Latte (KCA 2015).

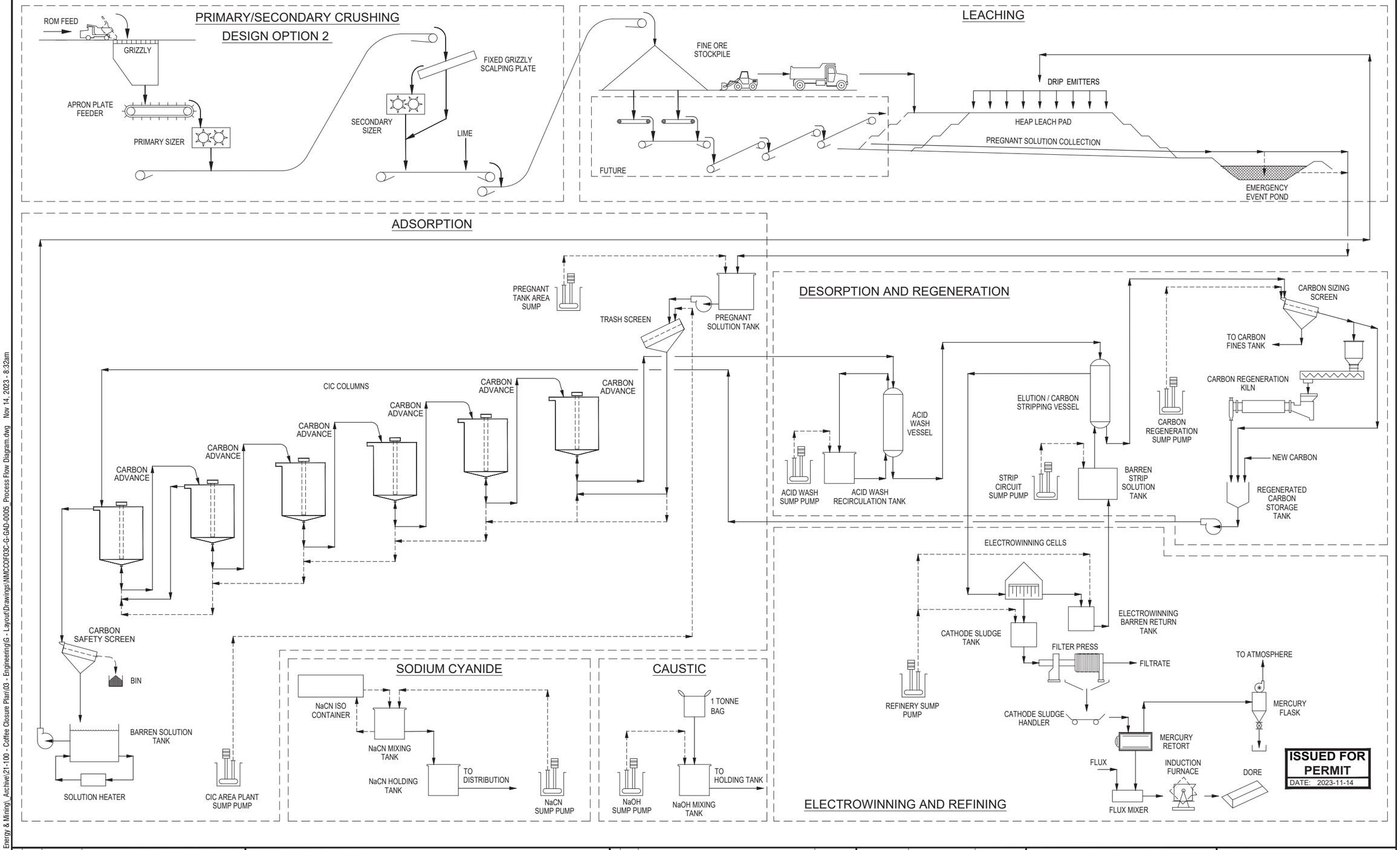
The crushed rock is then conveyed to the 10,000-tonne crushed ore stockpile (Figure 4-1). Crushed ore will be conveyed westward to the HLF. Ore will be conveyor dumped on the pad and a dozer will move the material to build the 10m lifts as required. The crushing plant will operate for a minimum of 275 days per year (contingent upon operational conditions and pad thermal balance), with no heap leach loading during the coldest period of the year; however, this will depend directly on the seasonal conditions each year and the amount of heat available in the HLF for processing. If conditions allow, crushing may be performed year-round. In an event where the conveyor system is not operational, a front-end loader will transfer the crushed ore to a fleet of haul trucks for transport to the HLF.

Run-of-mine ore, with an approximate top size of 750 mm, will be trucked from the pits and dumped directly into the primary feed hopper. A ROM stockpile area with a capacity of approximately 1.5 Mt will allow the stockpiling of ore when the crusher is not operational, particularly during the coldest period of the year.

Crushing will be done in two stages. The primary crusher feed will be drawn from the 60-tonne feed hopper by an apron feeder and discharged onto a vibrating grizzly screen. The grizzly screen oversize will feed the primary jaw crusher. The grizzly undersize and jaw crusher product will be transported to the secondary screen by a secondary screen feed conveyor, which will be equipped with a metal detector and magnet. Primary crushing will produce a final product with a P_{80} of approximately 190 mm.

Ore from the secondary screen feed conveyor will be transported to the secondary vibrating screen. Screen undersize material, with a final product with a P_{80} of 50 mm, will be conveyed to the 10,000-tonne crushed ore stockpile. Lime will be added to the stockpile feed conveyor from the 200-tonne lime silo by screw conveyor for pH control at a rate of 1.5 kg/t. Screen oversize material will be conveyed to the secondary cone crusher. The secondary cone crusher discharge and jaw crusher product combine on the secondary screen feed conveyor to feed the secondary screen.

To aid in dust suppression, dust encapsulation connections between the feed and discharge ends of the screens, crushers, and feeders have been incorporated into the design. All conveyors will be covered between crushing and screening stations. Please note the crushing method description in this Plan as well as Figure 4-1 will be updated in subsequent versions of the Plan to represent an updated crushing system.



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REFERENCE DRAWINGS

NO.	DWG NO.	TITLE

NOTES:

DRAWING REVISION

NO.	DESCRIPTION	DATE
0	ISSUED FOR PERMIT	2023-11-14

	NAME	DATE
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DESIGNED BY:	JDS	2023-11-14
CHECKED BY:	DJ	2023-11-14
APPROVED BY:		

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JDS Energy & Mining Inc.

COFFEE MINE PROJECT

PROCESS FLOW DIAGRAM FOR ORE CRUSHING, LEACHING, PROCESSING, AND REFINING

DWG NO. NMCCOF03C-G-GAD-0005

REV. 0

4.1.3 Agglomeration

Preliminary agglomeration test work was conducted by KCA, as discussed in Section 13 2016 JDS FS Report, on sub-samples of crushed material. Percolation tests were undertaken to evaluate the permeability of the agglomerated material at various cement contents. The percolation tests were conducted at a range of cement contents, with no compressive load applied, utilizing 2 kg portions of material crushed to the target size of 100% passing 31.5 mm. For agglomeration test work conducted by KCA, the parameters that are typically examined are slump, maximum flow rate, agglomerate pellet breakdown (when material is agglomerated), and discharge solution color and clarity. Based on the results, agglomeration is not required (KCA 2015).

4.2 Run-of-Mine and Crushed Ore to HLP and Stockpiles

Much of the ore will be sent directly to the primary crusher and, after crushing, trucked from the crushed ore stockpile to the HLP. A single ROM ore stockpile will be created for two reasons: firstly, to hold ore produced during the coldest period of the year, when the crusher and HLF will not be processing ore; and, secondly, to smooth ore feed and grade to the crusher and HLP. The ROM ore will be fed to the primary crusher by haul truck during the months that the HLP is actively being loaded (spring to fall), and the ROM stockpile will be operational over the entire mine life starting during pre-production. The ROM stockpile is located directly east of the primary crusher to minimize cost of re-handling the ore.

The 10,000-tonne crushed ore stockpile will provide approximately 10 hours of material storage for loading and transportation to the HLP. A conveyor system will move ore from the crusher plant to the HLF. At the HLP, the conveyors will dump the material for a dozer to distribute as required.

A conveyor system will haul the crushed ore to the HLP where it will be stacked in 10 m lifts. The leach pad is designed for a total tonnage capacity of 67.0 Mt through Stage 5. These stages were sized to accommodate the stacking tonnages and leaching area criteria for processing the ore material. The Stage 1 heap leach pad was laid out to accommodate a minimum of 4 Mt of crushed ore material at a stacked dry density of 1.6 dry tonnes/m^3.

For the future operational expansions of the leach pad, additional stages will be constructed as required. The stages shown on The Forte's drawings (Appendix B) are primarily based on the area required for solution application and also to obtain concentrated mass to maintain the target thermal balance. The leach pad stages are shown in Figure 2-1, Figure 4-2, and Figure 4-3. Table 4-3 shows a summary of Stages 1 through 5 with tonnages.

Table 4-3 Summary of Stages of Leach Pad Construction

Stage	Heap Crest Elevation (m)*	Cumulative Heap Capacity based on Mine Plan (Mt)	Est. Year of Construction
1	1324	4	-1
2	1350	15	+1
3	1388	32	+2
4	1392	50	+4
5	1392	67	+7

* Elevation when additional pad is needed.

Stacking and leaching ore on the leach pad is scheduled to start in the 2nd quarter in Year -1. A stacking plan was developed for the Life of Mine utilizing the current mine plan that includes all (5) stages as presented in Table 4-3. Due to the geometry and configuration of the base of the leach pad, stacking of the ore will have to alternate from the north to south side of the pad initially to maintain mass for thermal reasons, during winter months. This technique will also avoid thin lifts that may occur near the middle of the HLF, where the existing ridge is located. The stacking plan considers concurrent leaching and heap loading per design criteria cycles. The stacking plan provides allowance for conveyor stacking, as well as a ramp for haul trucks to place RoM to allow flexibility for the project.

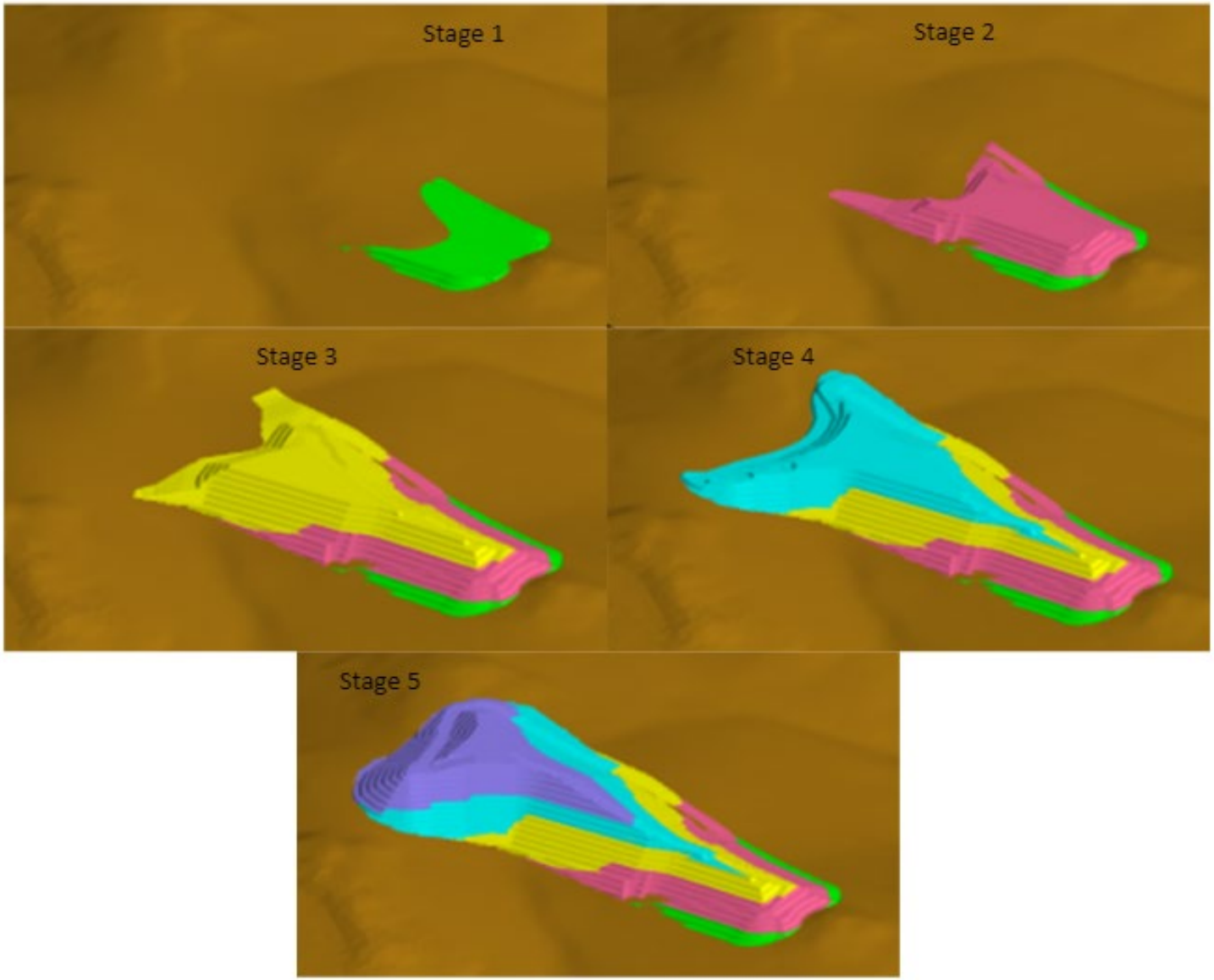

Figure 4-2 **Heap Stage 1 to 5 Configurations**

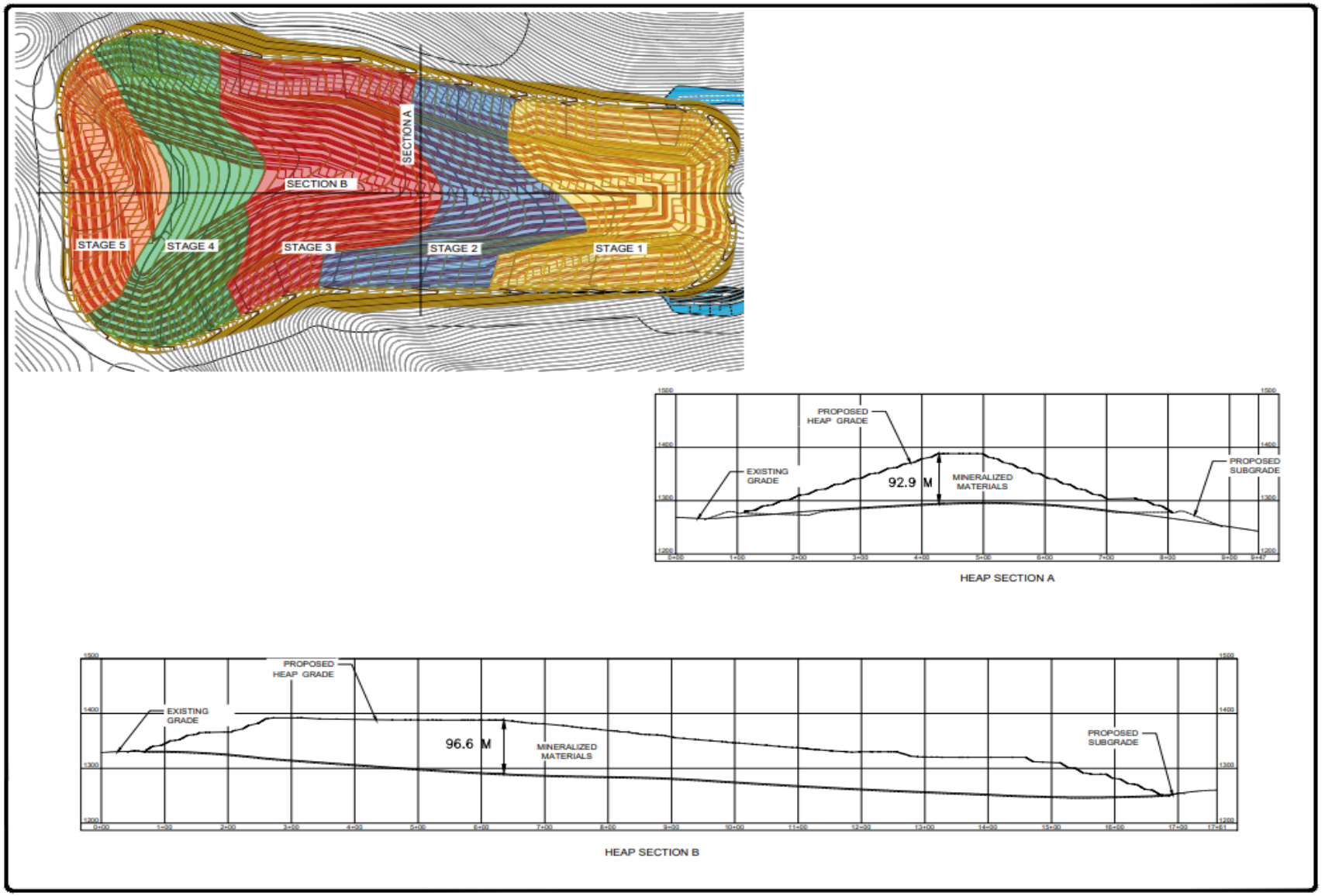

Figure 4-3 Heap Stage 5 Configuration and Cross Section

4.3 Metal Recovery and Processing Facilities

4.3.1 Metal Recovery

The leach profile for the recovery of gold shows the majority of gold is rapidly recovered followed by a slower leaching period to achieve ultimate gold extraction. Based on data from previous work conducted by KCA, the solution-to-solids ratio (tonnes of leach solution applied to tonnes of ore under leach) versus gold recovery was used to develop a standardized leach profile for all Coffee ore types (KCA 2015). This leach profile is considered the best indicator to predict the duration of the leach cycle. The leaching period has been adjusted to fit the solution-to-solids ratio. For operational scale projections, leaching time will be considerably longer than indicated by laboratory columns. Using a solution-to-solids ratio of 3.0 to achieve ultimate extraction indicates a leach time of 200 days: much longer than the laboratory leach times of between 45 and 81 days. Table 4-4: and Figure 4-4: present the leach recovery curve data as a percentage of the ultimate recoveries for all Coffee Project ores.

Table 4-4 Leach Recovery Curve for Coffee Ores

Days of Leaching	Solution to Solids Ratio	% of Ultimate Recovery
0	0	0%
40	0.6	84%
80	1.2	93%
120	1.8	97%
160	2.4	99%
200	3.0	100%

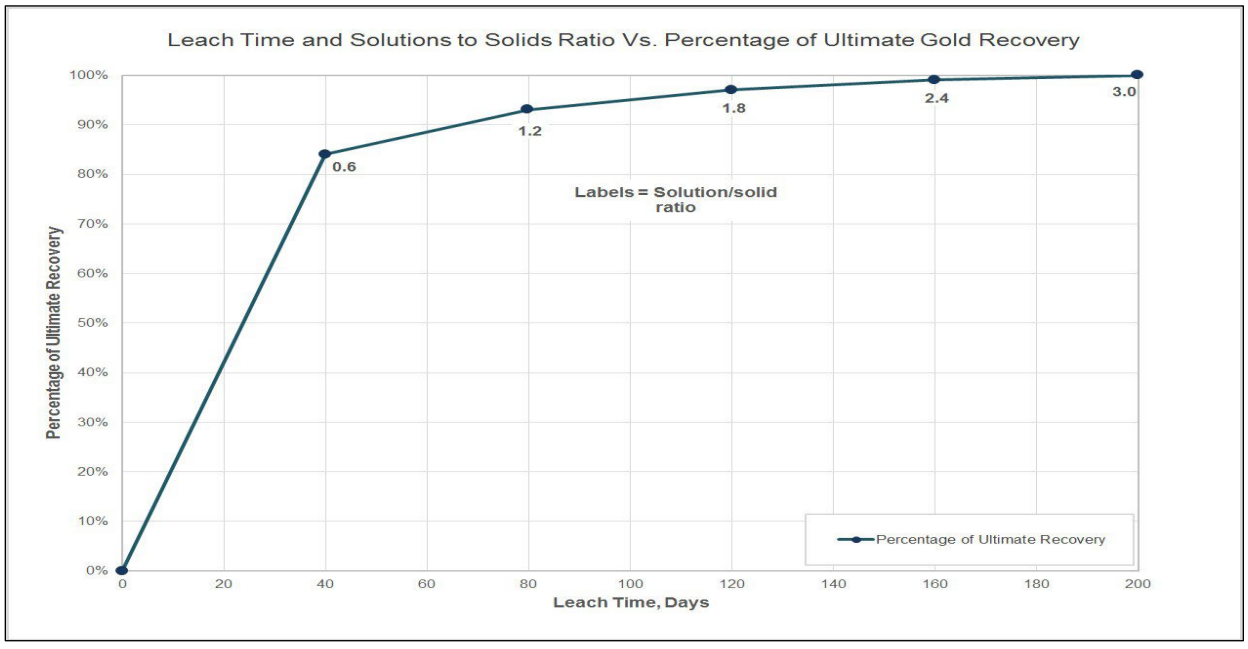

Figure 4-4 Leach Time and Solutions to Solids Ratio versus Percentage of Ultimate Gold Recovery

A combination of information from the mine plan and the heap stacking plan (JDS 2016), and the addition rate of barren leach solution were used to calculate the annual gold production.

Ultimate gold recovery for the various mineralized material types were compiled using the KCA recommended 3% reduction in gold recovery and the 25% factoring for sodium cyanide consumption (KCA 2015). Mineral resource estimates for each deposit are summarized in Table 4-5 and broken out by oxidation type in Table 4-6.

Table 4-5 Coffee Gold Open Pit Mineralized Material Parameters

Deposit	Category	Total Ore ('000's t)	Gold Cut-off Grade (Oxide) (g/t)	Average Gold Grade (g/t)	Contained Gold ('000's oz)
Latte	Resource (M,I&I)	20,962	0.24	1.24	835
Double Double	Resource (M,I&I)	1,340	0.25	2.68	115
Kona	Resource (M,I&I)	946	0.26	1.07	32
Supremo	Resource (M,I&I)	36,902	0.27	1.33	1,583
Total Mineral Resource	**Resource (M,I&I)**	**60,150**	**0.26**	**1.33**	**2,566**

Table 4-6 Coffee Gold Mineralized Material by Oxidation Type Parameters

Deposit	Oxide Ore ('000's t)	Upper Transitional Ore ('000's t)	Middle Transitional Ore ('000's t)	Lower Transitional Ore ('000's t)	Sulfide Ore ('000's t)
Latte	13,491	4,011	2,186	1,270	4
Double Double	605	521	185	30	0
Kona	791	144	10	0	0
Supremo	34,427	1,725	562	188	0
Total Mineral Resource	**49,314**	**6,401**	**2,943**	**1,488**	**4**

The gold production model (Table 4-7) was developed from a combination of metallurgical testing data, the mine production schedule, the HLF construction sequence (or stacking plan), and the leaching plan for applying barren solution to the heaps.

At the end of each year when the heaps are no longer loaded with ore, there will be an in-process inventory of recoverable gold remaining from two general areas; the recoverable gold in the ore in the heaps that has not been leached to completion, and the recoverable gold contained in solution inventories, carbon, and the electrowinning and refining area that has not yet been processed into dorè.

Table 4-7 Summary of Life of Mine Gold Production by Year

Description	Unit	Total	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
Total Ore	kt	60,150	3,317	7,940	7,317	6,946	7,337	7,451	5,402	6,369	5,149	2,921
Total Waste	kt	298,678	14,429	30,066	37,495	38,529	36,571	35,081	35,494	35,159	25,512	10,343
Strip Ratio	t:t	5.0	4.3	3.8	5.1	5.5	5.0	4.7	6.6	5.5	5.0	3.5
Total Material	kt	358,828	17,746	38,006	44,812	45,476	43,908	42,532	40,896	41,528	30,661	13,263
Average Mined	t/day	99,924	64,766	104,126	122,772	124,591	120,297	116,525	112,044	113,775	84,004	36,338
HLF head grade	g/t	1.33	1.38	1.64	1.57	1.31	1.21	1.15	1.17	1.20	1.30	1.20
Au contained ounces	koz	2,566	147	419	369	293	286	275	202	246	215	113

Note: Conceptual-level production estimate only.

4.3.2 Process Plant Facilities

The process plant, located near and down-gradient from the HLF to minimize the pumping and pipeline requirements for gold bearing and barren solutions, will operate 365 days per year. The gold bearing solution will flow to the process plant at a nominal rate of 1,100 m^3/h and a design flow rate of 1,400 m^3/h. The process plant is designed to process 6 tonnes of carbon per day using an absorption, desorption and refining process, extracting gold from the gold bearing solution to produce gold dorè.

The processing facilities will include the following operations:

- Barren and gold bearing solution storage, reagent mixing and dosing, heating, and pumping
- Carbon-in-column (CIC) adsorption of solution gold onto carbon particles
- Desorption: acid wash of carbon to remove inorganic foulants, elution (stripping) of carbon to produce a gold-rich solution, and thermal regeneration of carbon to remove organic foulants
- Gold refining: gold electrowinning (sludge production), filtration, drying, mercury retorting, and smelting to produce gold dorè.

The process plant will be located in a pre-engineered building. The building will measure approximately 33 m wide by 65 m long by 247 m tall (subject to final design refinement) and will come equipped with a 10-tonne overhead crane for equipment maintenance. The building will be heated to 10°C by glycol air handlers and unit heaters. The general arrangement of the Process Plant is shown on Figure 3-4. Please note that Figure 3-4 will be updated in subsequent versions of this Plan to represent an updated process plant layout.

4.3.2.1 Carbon-in-Column

Gold extraction via carbon adsorption is based on the principle that gold is not water soluble. During the heap leach process, oxygen (O_2) and cyanide (CN) dissolve and stabilize the gold (Au) in solution through a reaction referred to as Elsner's Equation:

$$4\ Au + 8\ CN^- + O_2 + 2\ H_2O = 4\ Au(CN)_{2^-} + 4\ OH^-$$

To ensure the cyanide remains in solution and to prevent hydrogen cyanide gas, lime is also added to maintain a pH above 10.5.

Activated carbon used in the gold mining industry is a hard-granular material ranging in size from 6 to 20 mesh, roughly 0.85 mm to 3.5 mm. Carbon's internal pore structure yields approximately 10,000 square feet of surface area per gram. Metal cyanide species such as $Au(CN)^{2-}$ adsorb onto the carbon as $M+[Au(CN)^{2-}]$. The adsorption process is reversible and is shown as:

$$M^{n+} + nAu(CN)^{2-} \Leftrightarrow M[Au(CN)_2]_n \text{ (Marsden \& House 1993)}$$

In the carbon adsorption process, soluble gold and silver cyanide species, chiefly $Au(CN)^{2-}$, is adsorbed onto the activated carbon internal and external surfaces. Gold bearing solution is directed through beds of carbon in an up-flow manner in a series of stages. Solution with the highest metal content is contacted with the loaded carbon, and solution with the lowest metal content is contacted with the unloaded carbon. In the

counter-current adsorption process, the gold bearing solution becomes barren, and the carbon becomes gold bearing with gold.

By utilizing this process, the gold can be leached from the carbon in the strip circuit. Barren solution, consisting of 1.0% caustic and 0-0.1% sodium cyanide, is circulated at 140°C (290°F) and strips the carbon to produce a gold bearing solution.

The carbon adsorption circuit at the Project will consist of a train of six – 3.2m diameter x 3.2m high cascading carbon columns. The gold bearing solution will be pumped to the carbon adsorption circuit across a stationary trash screen for removal of any debris from the HLP. The solution will flow, counter-current to the movement of carbon, from column 1 to column 6. The solution overflow from the final column will discharge onto a screen to recover any carbon. The barren solution, which at this stage will have had most of the gold in the solution adsorbed, will discharge from the final carbon column and be pumped to the barren tank. Cyanide solution, anti-scalant, and make-up water will be added to the barren tank as needed. To maintain thermal integrity in the leach pad, barren solution will be heated to increase solution temperature by at least 8°C, before being pumped back to the HLF. On average, 6 tonnes of loaded carbon from the first carbon column will be pumped daily to the acid wash and elution (stripping) circuits. The carbon in the second column will be advanced to the first and the process will be continued down the train. The carbon from the sixth column will advance to the fifth column and freshly regenerated carbon will be added to the system.

4.3.2.2 Carbon Acid Wash, Elution (Stripping), and Regeneration and Gold Refining

Acid Wash

The loaded carbon will be transferred to the acid wash vessel and treated with 3% hydrochloric acid (HCL) solution to remove calcium, magnesium, sodium salts, silica, and fine iron particles. Organic foulants such as oils and fats are unaffected by the acid and will be removed after the stripping or elution step by thermal reactivation utilizing a kiln. The dilute acid solution will be pumped into the bottom of the acid wash vessel, exiting through the top of the vessel back to the dilute acid tank. At the conclusion of the acid wash cycle, a dilute caustic solution will be used to wash the carbon and neutralize the acidity.

A recessed impeller pump will transfer acid-washed carbon from the acid wash tank into the strip or elution vessel. Carbon slurry will discharge directly into the top of the elution vessel. Under normal operation, only one elution will take place each day.

The 30% liquid HCL will be shipped to the Mine Site in 1-tonne totes. The HCL will be metered directly out of the tote into the dilute acid tanks for use in the acid wash circuit, and the HCL tote will be contained in the bunded area within the acid wash area.

Carbon Strip

After acid washing, the loaded carbon will be stripped of the adsorbed gold using a modified ZADRA process. The strip vessel holds approximately 6 tonnes of carbon. During elution, solution containing approximately 1% sodium hydroxide and 0.1% sodium cyanide, at a temperature of 140°C and 450 kPa, will be circulated through the strip vessel. Solution exiting the top of the vessel will be cooled below its boiling point by the heat recovery heat exchanger. Heat from the outgoing gold bearing solution will be transferred to the incoming cold barren solution. A diesel-powered boiler will be used as the primary solution

heater to maintain the barren solution at 140°C. The cooled gold bearing solution will flow by gravity to the electrowinning cells. At the conclusion of the strip cycle, the stripped carbon will be pumped to the carbon-regeneration circuit.

Carbon Regeneration

The stripped carbon from the strip vessel will be pumped to the carbon-sizing screen. The kiln-feed screen will double as a dewatering screen and a carbon-sizing screen, where fine carbon particles will be removed. Oversize carbon from the screen will discharge by gravity into the 7.5-tonne carbon-regeneration kiln-feed hopper. Screen undersize carbon will drain into the carbon-fines tank and then will be filtered and bagged for disposal. A 250-kg/h diesel-fired horizontal kiln, approximately 2.5 m wide x 2.5 m high x 11.5 m long, will treat 6 tonnes of carbon per day at 650°C. The regeneration-kiln discharge will be transferred to the carbon quench tank by gravity, cooled by freshwater or with carbon-fines water, prior to being pumped back into the CIC circuit.

To compensate for carbon losses by attrition, new carbon will be added to the carbon attrition tank. New carbon and fresh water will be mixed to break off any loose pieces of carbon prior to being combined with the reactivated carbon in the carbon holding tank and pumped to the sixth carbon column.

Electrowinning and Refining

Gold bearing solution will flow by gravity to a secure gold room. The solution will flow through one of two 3.54 m^3 electrowinning cells. Gold will be plated onto knitted-mesh steel wool cathodes in the electrowinning cell. Loaded cathodes will be power-washed to remove the gold-bearing sludge and any remaining steel wool. The gold-bearing sludge and steel wool will be filtered to remove excess moisture and then retorted to remove any mercury. The retort residue will be mixed with fluxes consisting of borax, silica, and soda ash before being smelted in an induction furnace to produce gold dorè and slag. The vapour from the retort will be condensed and mercury will be collected as a liquid in containers for offsite disposal. The remainder of the gases from the retort and the off gases from the furnace will report to dust collectors for removal of particulate material before being exhausted to the atmosphere. The dorè will be transported to an off-site refiner for further purification. Slag will be processed to remove prills for re-melting in the furnace. The gold bars will be stored in a vault located in the gold room prior to secure off-site transport by aircraft.

Cyanide Removal

Cyanide solution or gold bearing solution is circulated between the heap leach pad and the plant in a closed loop. Solution will be treated to remove residual cyanide during the heap leach pad rinsing and closure to achieve discharge limits prior to the released to the environment.

Process Controls

Instrumentation:

All tanks will be equipped with high- and low-level alarms. All equipment in the process plant will be equipped with manual gauges for local controls and instrumentation, in addition to being connected to a central control room located in the process plant. The instrumentation includes flowmeters, pH probes,

pressure relief valves, pressure and temperature gauges, pressure regulators and a local panel for the CIC transfer valves. HCN gas monitors will also be located within the process facilities.

Sampling:

Samples of crushed rock will be collected in the crushing circuit to provide daily head grade assays. The CIC and Elution circuits are each equipped with two wire samplers to take manual samples of both gold bearing and barren lines. In addition to gold assays, cyanide levels in the process streams will be measured.

4.4 Solution Management

The HLF solution management is governed by inputs and outputs to and from the HLF system. Inputs include:

- Pore water delivered with the ore
- Precipitation falling as rain or snow
- Fresh water (make-up water) added to the system from outside the lined limits of the pad.

System losses are slightly more complicated and include three basic categories of loss:

- Evaporative losses: evaporation from ponds and wetted surfaces
- Losses due to surface tension: wetting of the ore during operations
- Extraction losses: water removed by either draining or pumping water out of the system.

A deterministic water balance model (WBM) was used to predict and evaluate HLP performance and make-up water requirements. A deterministic model uses a chain of single valued input parameters to produce a series of single valued results. The deterministic model uses the following inputs as time series prepared by Lorax in “Coffee Gold Project:2021 Hydro-meteorology Baseline Report.”

- Probable Maximum Precipitation (PMP) = 283mm
- Precipitation Time Series
- Evapotranspiration Time Series
- Temperature Time Series
- Sublimation Time Series
- Snowpack Time Series.

The operational and closure water balance models are integrated (Appendix B) and include construction and start-up of Stage 1 through to operations and closure of Stage 5. The draindown water balance model considers the effects of heap recirculation. The primary objectives of the model were to analyze make-up water demand for the process, as well as storage and forecasted discharge to be able to adequately design treatment.

The make-up water rate is the water required for leaching of the heap leach pad only after utilizing available barren solution (recycled from the process plant) and solution stored in the event ponds. It does not include water demand for construction activities, operational or construction dust control, etc. Thus, the make-up water modeled in the HLF WBM is the water demand from outside the HLF system. The climate at the Coffee Project is such that the system generally will receive precipitation to be in a state of surplus water,

with less make-up water being required from an outside source. The source of outside make-up water (i.e., groundwater, surface water, or site pond water) is not defined in this HLF WBM, only the quantity and timing of make-up water from outside the HLF system is captured.

Make-up water added to the HLF system from external sources is not frequently required. During the early operation phase, makeup water is expected to be needed as production and barren solution flow to the HLF ramp up to the nominal operation rates. The event ponds and Rainwater Pond may be used to store water to fulfill this makeup water requirement, while maintaining solution storage requirements. Prior to each winter, the ponds will be emptied to maintain adequate capacity for storage of the PMP and 72-hour draindown to prevent freezing and to maintain volume capacity in preparation for the following Spring's freshet. The highest demand for make-up water occurs during winter months when solution storage ponds are at or near empty, and not available as make-up water sources.

Solution removal from the system is defined as all solution that is removed from containment within the HLF system regardless of treatment requirements. During operations, all solution will be tested for water quality and constituent levels. The transfer routes and fates of all removed solution is being evaluated by the site wide WBM (Lorax 2022b), which is outside the scope of this HLF water balance modeling.

The excess HLF solution can be removed in various ways depending on quality including, but not limited to:

- Pumping to active treatment during operations, when necessary
- Routing to a passive treatment system during closure.

The HLF WBM shows that the pond volumes maintain the Event Storage Requirement (ESR) throughout the life and beyond final reclamation of the HLF. The ESR is the pond storage capacity maintained to capture a 24-hr PMP event, plus 72-hr draindown of the HLP. For all the modeling simulations performed by Forte, the event ponds were assumed to be the first sources for water demand. The other sources, in order of priority, to meet make-up water demands, if required, would be the Rainwater Pond, Facility Pond, open pit sumps or pit lakes, then groundwater wells near the Yukon River. To maintain the ESR it will be necessary to periodically remove solution from the HLF circuit. It should be noted that the HLF WBM assumes that zero solution removal flows occur prior to the availability of active water treatment in May 2028 (Yr 2). The facility will maintain the capability to manage solution between ponds to maintain the ESR and for operational needs during any unforeseen events.

The 30 climate realization results, ESR, and operational storage results are presented in Figure 4-5.

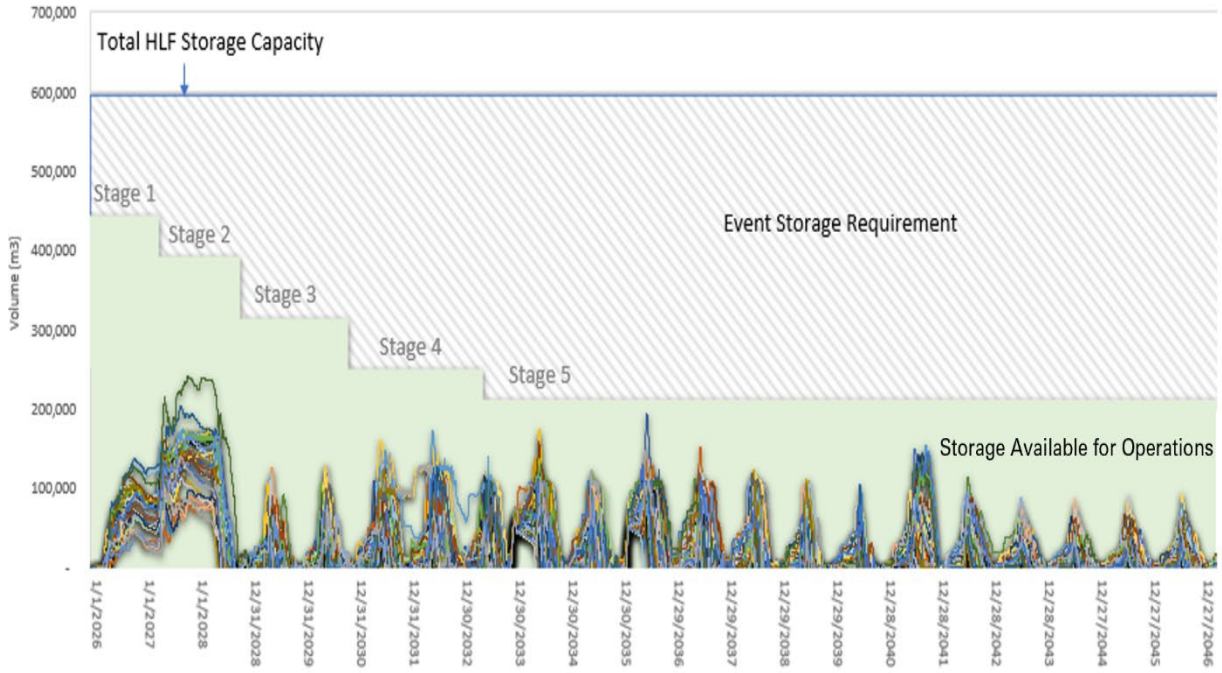

Figure 4-5 HLF Storage Volume Through Time

The below strategies are identified as operational opportunities to provide flexibility in solution management to maintain the ESR under fluctuating conditions. Although the HLF WBM includes the ability to pump solution to dynamic storage, the other strategies presented below were not necessary to maintain the ESR and were not included in the HLF WBM. These are contingency solution management options that can be employed by site as necessary during operations.

Dynamic Storage

Pumping to dynamic storage is an industry standard practice that is used to recirculate solution to areas of the HLF that have previously been leached for intentional and additional, temporary storage. It's shown (primarily during freshet or excessive rainy conditions) to be periodically practical to manage pond levels more effectively by utilizing an inactive previously leached HLF area (if available) for water storage. The maximum flow rate for dynamic storage is 300 m^3/hr. Appendix B presents occurrences of Dynamic Storage for Realization 1 only.

Raincoats

The HLF WBM presented here did not require raincoats during operations. All inflow within the HLF footprint, whether onto raincoats or not, would need to be contained and tested prior to removal. Therefore, Forte worked under the conservative assumption that raincoats would not be used for this analysis. Raincoats can be included and utilized for site as a contingency solution management method. However, the model results here show that they are not necessary from an HLF water flow perspective.

Pond Pumping System

The HLF will have the capability to transfer solution between all ponds if necessary to effectively manage solution due to any unforeseen events or operational needs.

Snow Removal

Precipitation into the HLF system can be reduced by removing snow accumulation prior to snow melt each Spring. Depending on contact and quality, snow could be pushed to the collection channel to prevent infiltration through the HLP.

4.5 Water Treatment of Heap Leach Solutions

As briefly outlined in Section 4.4, operation of the heap leach facility is projected to generate a positive water balance with the need to manage and remove (e.g., discharge) excess solution to maintain adequate storage in the event ponds system (i.e., Event Storage Requirement (ESR)) throughout operations and early closure of the heap leach facility. Solution Removal from the system is defined as all solution that is removed from containment within the HLF system. The most important solution removal strategies include pumping of water to active treatment during both operations and early closure and the release of net infiltration water at closure through semi-passive treatment. In the following sections, active treatment processes are described; the semi-passive treatment solution removal strategies are discussed in the Reclamation and Closure Plan.

4.5.1 Solution Removal Volumes to Active Treatment

The heap leach WBM indicates solution removal needs to commence in Yr 2 to maintain ESR. Specifically, the solution removal rates and schedule utilized in the WBM to maintain ESR for operations and into early closure are:

- **25 L/s** (90 m^3/h) beginning in Yr 2 through to Yr 7. This is the maximum solution removal rate required during normal operations over this period to maintain the ESR.
- **35 L/s** (126 m^3/h) from Yr 7 to Yr 16 is the max Solution Removal rate required to maintain the Event Storage Requirement Yr 7 to Yr 16.
- **14 L/s** (50 m^3/h) beginning in Yr 16 after cover placement is complete.

The active water treatment plant will be used to treat all excess rinse water during concurrent reclamation.

4.5.2 Chemistry of HLF Solutions

Heap leach solution will be a mixture of meteoric infiltration water and cyanide leaching solutions with variable water chemistry throughout the project lifecycle. Water generated through the infiltration of the heap will contain cyanide, metals, and other dissolved inorganics. Development of estimates of HLF solutions is described in detail in Lorax (2022) *Coffee Project Geochemical Source Terms* and will be summarized herein.

As indicated above, solution removal and therefore active treatment is required by Yr 2 and continues throughout operations into early closure. The WTP will be available for treatment of site impacted water year-round but is planned to be used for excess heap leach solution during the open water period. Estimates

of heap leach solution chemistry to support water treatment process design have been developed from site-specific metallurgical testwork performed on Coffee ores and from analogue gold heap leach operations, including early phase barren solution chemistry from the Eagle Gold Project, YT. Early and late phase HLF solution predictions are summarized in Table 4-8 below. Metal concentrations are for dissolved species.

Table 4-8 Early and Late Phase HLF Solution Chemistry Estimates

Parameter	Units	Early Phase HLF Solution	Later Phase HLF Solution
pH	s.u.	9 to 10	8.4
$N\text{-}NH_3$	mg/L	72	0.06
$N\text{-}NO_3$	mg/L	50	307
$N\text{-}NO_2$	mg/L	1	1.9
Cl	mg/L	300	123
Sulphate	mg/L	1100	2516
Total Alk	$mg/CaCO_3/L$	600	87
WAD-CN	mg/L	130	0.2
TDS	mg/L	2750	4100
Al-D	mg/L	0.09	0.2
Ag-D	mg/L	0.00045	0.00125
As-D	mg/L	5.0	2.0
Ca-D	mg/L	300	350
Cd-D	mg/L	0.0036	0.00013
Cr-D	mg/L	0.008	0.014
Cu-D	mg/L	2	0.014
Co-D	mg/L	0.5	0.25
Fe-D	mg/L	2.3	0.5
Hg-D	mg/L	0.005	0.00026
Mg-D	mg/L	2	155
Mn-D	mg/L	0.27	0.06
Mo-D	mg/L	0.125	0.105
Na-D	mg/L	580	1168
K-D	mg/L	8	11
Ni-D	mg/L	0.019	0.006
Pb-D	mg/L	0.0002	0.0013
Sb-D	mg/L	0.09	0.5
Se-D	mg/L	0.007	0.005
U-D	mg/L	0.1	0.685
Zn-D	mg/L	0.7	0.052

Based on the above estimates of HLF solution chemistry over time, and to determine the treatment requirements for the project, the site wide water balance and water quality model (WBWQM) was used to back-calculate maximum threshold (i.e., allowable) concentrations for each parameter in water treatment plant effluent to ensure Use-Protection water quality objectives in Halfway Creek at HC-1.0 were maintained under anticipated flow conditions during the annual period of April to October. The back-calculated

allowable concentrations were then further used to develop water treatment system design objectives (Table 4-9). A more detailed description of the approach is provided in Coffee Mine Project – Water Balance and Water Quality Model (Lorax 2022b).

Table 4-9 Summary of Parameters Requiring Treatment

Parameter	Units	Early Phase HLF Solution	Later Phase HLF Solution	Calculated Allowable Conc. In WTP Effluent	Water Treatment Required
$N\text{-}NH_3$	mg/L	72	0.06	16	Yes
$N\text{-}NO_3$	mg/L	50	307	79	Yes
$N\text{-}NO_2$	mg/L	1	1.9	0.15	Yes
Cl	mg/L	300	123	1300	No/unlikely
Sulphate	mg/L	1100	2516	1100	Yes
WAD-CN	mg/L	130	0.2	0.046	Yes
TDS	mg/L	2750	4100	3000	Yes
Al-D	mg/L	0.09	0.2	3.4	No
Ag-D	mg/L	0.00045	0.00125	0.0027	No
As-D	mg/L	5.0	2.0	0.043	Yes
Ca-D	mg/L	300	350	NA	NA
Cd-D	mg/L	0.0036	0.00013	0.002	Possibly
Cr-D	mg/L	0.008	0.014	0.05	No
Cu-D	mg/L	2	0.014	0.029	Yes
Co-D	mg/L	0.5	0.25	0.03	Yes
Fe-D	mg/L	2.3	0.5	10	No/unlikely
Hg-D	mg/L	0.005	0.00026	0.00019	Possibly
Mg-D	mg/L	2	155	NA	NA
Mn-D	mg/L	0.27	0.06	3	No
Mo-D	mg/L	0.125	0.105	0.77	No
Na-D	mg/L	580	1168	NA	NA
K-D	mg/L	8	11	NA	NA
Ni-D	mg/L	0.019	0.006	0.8	No
Pb-D	mg/L	0.0002	0.0013	0.02	No
Sb-D	mg/L	0.09	0.5	0.08	Yes
Se-D	mg/L	0.007	0.005	0.021	No
U-D	mg/L	0.1	0.685	0.7	Probable
Zn-D	mg/L	0.7	0.052	0.2	Yes

As illustrated above, twelve (12) parameters are identified as needing treatment prior to discharge to Halfway Creek and include:

- NH_3-N
- NO_3-N
- NO_2-N
- SO_4
- CN
- TDS
- As
- Sb
- Cu
- Co
- U
- Zn.

4.5.3 Proposed Water Treatment System

Developing a conceptual water treatment design for a prospective mine is challenging as no actual heap leach waters exist for treatment evaluations without an operational mine. Predicting water quality generated by the HLF is crucial for identifying the parameters of concern and developing a treatment system with appropriate unit processes. As described above, water quality modeling was performed to develop treatment targets based on a back-calculation approach to arrive at allowable concentrations in the discharge to achieve Use-Protection water quality objectives in Halfway Creek. A more detailed description of the approach is provided in Coffee Mine Project – Water Balance and Water Quality Model (Lorax 2022b).

The conceptual water treatment design described below is based on removal of the target constituents outlined in the water quality predictions to achieve those treatment targets. The Early Phase and Late Phase post recirculation water quality predictions and treatment targets are summarized in Table 4-10.

Table 4-10 Water Quality Predictions of the HLF Solutions and Treatment Targets

Parameter	Units	Early Phase HLF Solution	Later Phase HLF Solution	Treatment Target
pH		9-10	8.4	
$N\text{-}NH_3$	mg/L	72	0.06	16[a]
$N\text{-}NO_3$	mg/L	50	307	79
$N\text{-}NO_2$	mg/L	1	1.9	0.15
Cl	mg/L	300	123	1300
Sulphate	mg/L	1100	2516	1100
WAD-CN	mg/L	130	0.2	0.046
Al-D	mg/L	0.09	0.2	3.4
Ag-D	mg/L	0.00045	0.00125	0.0027
As-D	mg/L	5.0	2.0	0.043
Cd-D	mg/L	0.0036	0.00013	0.002
Cr-D	mg/L	0.008	0.014	0.05
Cu-D	mg/L	2	0.014	0.029
Co-D	mg/L	0.5	0.25	0.03
Fe-D	mg/L	2.3	0.5	10
Hg-D	mg/L	0.005	0.00026	0.00019
Mn-D	mg/L	0.27	0.06	3.0
Mo-D	mg/L	0.125	0.105	0.77
Ni-D	mg/L	0.019	0.006	0.8
Pb-D	mg/L	0.0002	0.0013	0.02
Sb-D	mg/L	0.09	0.5	0.08
Se-D	mg/L	0.007	0.005	0.021
U-D	mg/L	0.1	0.685	0.7
Zn-D	mg/L	0.7	0.052	0.2

Notes
a: This target results in an un-ionized NH3 of 0.27 mg/L assuming pH 8.0 and temperature of 10ºC

The water treatment plant is designed to discharge effluent water that reflects the minimum quality and pH as outlined in Table 4-10 in addition to consolidating contaminants into dry solids or recirculated waste streams. To accomplish this, the plant will employ multiple processes, systems, and various types of equipment to target and remove different contaminants, balance flows, and ensure sufficient monitoring and consistent performance. There are three primary treatment systems that make up the Coffee Gold mine water treatment plant, including:

- Cyanide destruction and ammonia oxidation
- Physical-chemical treatment and biological denitrification
- Reverse Osmosis (RO) treatment

Other supporting systems or processes that contribute to and are required for the overall performance of the plant and those primary systems include:

1. Flow Equalization
2. Cyanide Destruction
3. Breakpoint Chlorination
4. Physical-Chemical Treatment
5. Chemical Conditioning
6. Clarification
7. pH Neutralization
8. Media Filtration
9. Biological (denitrification)
10. pH Neutralization
11. Ultrafiltration
12. Reverse Osmosis (RO)

Descriptions of the water treatment plant processes are summarized below. Additional details of the water treatment plant, including process flow diagram drawings, are provided in the Coffee Gold Mine Water Treatment – Preliminary Design Report (Appendix E).

4.5.3.1 Process Descriptions

Flow Equilibration

The initial steps of the treatment plant processes rely on continuous and consistent forward flow to ensure more predictable treatment and removal of the target contaminants. The treatment plant will rely on flow equalization (EQ) to improve efficiency, reliability, and control; the EQ system shall allow for collection and natural mixing of various feed waters from the mine site and prevent swings in flowrates, temperatures, and water chemistry going into primary treatment plant processes.

Cyanide Destruction

The first treatment step in the plant is cyanide destruction by chemical cyanide oxidation. The pH coming into the plant will be maintained between 9 – 9.5 to prevent hydrogen cyanide gas formation upstream of the cyanide destruction step. The process of cyanide destruction itself is also highly pH dependent, and the influent pH will be monitored continuously.

Hydrogen peroxide was proven the most effective agent for cyanide destruction in barren solutions and post-recirculation waters that are anticipated from the Coffee Gold project. Due to the potential for varying levels of cyanide in the feed water, the plant will also use Oxidation-reduction monitoring (using ORP instrumentation in the process) to control the amount of hydrogen peroxide. Copper is a required catalyst to initiate the reaction. Copper ions are introduced to the solution by injecting copper sulfate ($CuSO_4$) into the initial mix tank(s) along with the hydrogen peroxide. The total sulfate added to the treatment stream with this process is minimal and would be removed with the other pre-existing sulfates later in the process.

Breakpoint Chlorination

Following the cyanide destruction step, pH is lowered to between 8.0 – 8.5 to oxidize any ammonia in the influent water using a metered sodium hypochlorite (chlorine) addition and continuous mixing. This step is commonly referred to as breakpoint chlorination.

Physical-Chemical Treatment

The next step of the treatment processes relies on chemical reactions followed by solids coagulation, flocculation, sedimentation, and separation of precipitated constituents and other suspended solids. Following the series of mechanically mixed reaction tanks, where cyanide destruction, breakpoint chlorination, and chemical conditioning occur, the influent stream will be pumped into clarifiers and media filters where the physical separation occurs, and consolidated solids can be removed in a waste stream.

Chemical Conditioning

Chemical conditioning is the first step to initiate the required ionization and precipitation reactions. Most of the required chemical conditioning will occur simultaneously or in the same reaction/mixing tank as some of the previous processes outlined above, this allows the design to limit the number of mix tanks, motors, and hydraulic losses between systems thus increasing the overall mechanical, chemical and process efficiency of the plant.

Ferric chloride will be added to the reaction tanks to precipitate and coagulate arsenic. Ferric chloride ($FeCl_3$) hydrolyzes in water to form positively charged ferric hydroxide ($Fe(OH)_3$). Dissolved arsenic oxyanions are negatively charged and readily sorb to the positively charged ferric hydroxide particles.

The process is sensitive to the oxidative state of arsenic. If any reduced arsenic oxyanions, such as arsenite, are present, they must be oxidized to arsenate first for the ferric coagulation step to be effective. The first step of the treatment design includes oxidation for cyanide detoxification, which will also ensure that all arsenic is present as arsenate (As(V)). Ferric chloride is also an excellent coagulant for any other suspended solids and may aid in precipitation of other consituents present in the influent stream.

Removal of some of the other dissolved metal ions as required within the phys-chem system is achieved using targeted pH adjustment and the addition of calcium hydroxide ($Ca(OH)_2$) a process also known as lime softening. In addition, organosulfide is used to bind other heavy metal ions, such as mercury, that may not precipitate as easily. The metal hydroxides (precipitate) and other insoluble compounds (formed by the organosulfide) generated through these reactions can then be flocculated and settled in the physical-chemical process.

Clarification

For the Project, a traditional gravity clarifier/thickener is a viable and efficient option. In a traditional clarifier, flocculant is added to the clarifier feedwell as a settling aid for the coagulated suspended solids. Solids are collected at the bottom of the clarifier tank with a slow rotating, centrally driven rake that directs solids to a central hopper to be removed for further processing.

The rake drive torque is continuously monitored by a device mounted to the drive unit that provides a continuous local readout of 0-100% of design torque and a minimum of three limit switches set to indicate alarm, lift and cutout functions. The limit switch for lift shall automatically activate an integral rake lift motor.

The limit switch for cutout shall be wired to directly cut power to the rake drive motor when the maximum design torque is reached (or at the manufactures' recommended torque level).

The settled sludge that has been conveyed to the central hopper by the rake arms is pumped out to a sludge storage tank. The clarified water will overflow the clarifier into a perimeter launder where it is channeled to a clearwell tank.

pH Neutralization

Due to elevated pH levels that will be present in the clarifier, carbon dioxide (CO_2) will be injected into the treated water to lower the pH and prevent scaling in the downstream media filter. Direct injection CO_2 was selected as the neutralization option, leaving no restricted dissolved species behind. The CO_2 is injected as a gas and dissolves, forming carbonic acid that will lower the pH within the system prior to entering the membrane filtration step.

Compressed CO_2 gas will be injected into the main process stream in the pipe directly downstream of the clarifier (using carrier water pulled from the clearwell) and will be primarily dispersed in the pipeline prior to arrival at the clearwell tank. Instrumentation located downstream in the clearwell tank will monitor the pH of the process water and control the amount of CO_2 being injected.

Media Filtration

Following pH adjustment, forwarding pumps will transfer the clarified water from the clearwell into media (silica sand) filters to remove residual solids. The clarified and neutralized water will be pumped up to the top of the filter, where the feed pipe extends down the middle to near the bottom of the tank. The suspended solids will be filtered out as the water flows up through the filter media bed. As the filtrate reaches the top of the filter, it will pass over the effluent weir and will be discharged.

The SuperSand™ filter employs a backwash rinse that is performed continuously while the tank is processing water. An airlift pump draws the media from the bottom of the filter up into the wash box. As the media is released into the wash box, it falls into the sand scrubber, where the filtered solids (waste) are separated from the media and carried by a small portion of the filtrate (backwash) to the mix tanks ahead of the clarifier. The washed sand falls down onto the base media bed for continued use.

Filtrate coming off the top of the filter is collected in the feed tank for the biological removal of nitrates.

Biological (denitrification)

The biological process requires a specific pH range to foster an environment where microorganisms can thrive. This requires the injection of phosphoric acid and organic carbon following the feed tank and pH monitoring downstream for verification and dosing adjustment.

Biological denitrification is a process that relies on microorganisms to convert nitrate to nitrogen gas under anoxic conditions. In biological systems, microbes facilitate nitrate removal through electron transfer (redox processes). In conventional biological treatment, those electrons are supplied from excess organic carbon. This typically results in excess biological growth and frequent backwashing. Contrary to conventional biological systems, the Electro-biochemical reactor (EBR) technology supplies the needed electrons directly to the reactor. The electrons supplement those supplied from a carbon source, significantly reducing operating costs and lower biomass production. The directly supplied electrons are readily available to the

microbes in a consistent, controllable manner, making the system less susceptible to low temperatures and changes in water conditions.

The EBRs will be supplied with organic carbon and supplemented with a direct current to maintain high electron availability. The size and number of denitrifying bioreactors are sensitive to the nitrate loading rate (flowrate and nitrate concentration). Further, if the heat transfer inside the treatment building is not sufficient to keep consistently warm water for the biological treatment, heaters will be required. Sizing for the denitrifying bioreactors will be adjusted based on the most current water quality information prior to detailed engineering.

Intermittent, low-flow backwashes are still required to carry any biological waste out of the reactors, the backwash water is supplied from the downstream processes. EBR bench scale testing has suggested that norm and tenorm levels in the dewatered solids are not expected to pose an issue for disposal onsite. Norm and tenorm monitoring of the dewatered solids will be carried out to verify performance expectations. If monitoring results identify levels that exceed expected performance, radioactive pathway assessment will be conducted, and a management plan will be developed at that time.

pH Neutralization

After the biological system, the treated stream from the EBR is collected in an Ultrafiltration (UF) feed tank for pH neutralization. A byproduct of the denitrification process is an elevated pH in the process stream; to lower the pH, carbonic acid is introduced system being used upstream with a dedicated skid but using the same CO_2 storage.

Ultrafiltration (UF)

The UF system is fed by clarified water from the UF feed tank using VFD-controlled feed pumps. Prior to entering the filters, the water first passes through a 200 µm pre-strainer for removal of any residual larger debris/suspended solids. From the strainer, the feed travels to the UF system, which consists of a series of membrane filtration units fed from a single header.

The filtration process is an outside/in, pressure-driven process to remove suspended solids and turbidity, and to achieve 4-log reduction of pathogens like Giardia and Cryptosporidium.

Clean water is sent to the UF filtrate tank. This tank supplies water to the downstream Reverse-Osmosis (RO) process and water used for backwashing, flushing, and makeup/push water for chemicals throughout the plant. Backwashing of the UF system itself is required to remove accumulated foulants by reversed inside/out flow at an interval of 20-60 minutes with air scour for increased agitation. A drain or filter-to-waste step is used to remove any additional accumulated material.

The backwash sequence and flush-to-waste streams are recirculated back to one of the reaction mix tanks ahead of the clarifier to be reprocessed through the phys-chem system where the eventual removal of solids and foulants will occur with the settled sludge in that system.

Following chemical cleaning procedures, the membrane units are drained by gravity or pressurized drain-to-waste, and waste is subsequently returned to the last reaction tank of the phys-chem system to neutralize it and permanently remove the solids from the process. A rinse step and backwashing are used to remove residual chemical prior to resuming production.

Reverse-Osmosis (RO)

The RO system accepts the filtrate from the UF process out of the filtrate tank. The feed goes to the RO system. The RO system required is a single pass RO designed to remove dissolved contaminates from the inlet water source with a consistent silt density index (SDI) < 5 and a turbidity < 1 NTU.

The recovery of the system is preliminary designed as 75% but may be improved or hampered by changes in the water quality and fluctuations in dissolved constituent concentrations, like TDS. The RO system has a nominal rejection rate of 95-99% of dissolved materials including those contributing to hardness and TDS.

The RO will remove any residual metals and byproducts from other processes (including cyanate, the primary byproduct of the cyanide destruction step) to acceptable levels. As a result, the permeate stream from the RO system will meet the treated effluent targets.

4.5.3.2 Adaptive Management Initiatives

The water quality at the Project is anticipated to evolved with time, this requires that the treatment plant account for these changes to the extent possible. The original design should incorporate sufficient expansion, flexibility and/or capacity to achieve treatment targets throughout the design life. The plant shall also include instrumentation and data monitoring systems to help identify trends that would reveal evolving waste streams. In the case of the Project, the primary variations anticipated are related to specific target contaminants and their concentration levels in the feed water from the HLF.

Upon completion and commissioning of the treatment plant, the controls system shall monitor various live parameters using a variety of instruments, including flowmeters, pH probes, conductivity probes, turbidity meters, etc. Much of this data is used in real time to automatically adjust chemical dosing, initiate backwash or cleaning sequences, or manage other ongoing operations and parameters. In addition, periodic sampling and lab testing of various streams within the plant will allow for observation of specific contaminant load, concentrations, and effectiveness of the various treatment stages at the targeted removal rates.

The on-going trend mapping of in-line and lab data shall be maintained to trigger the implementation or initiation of permanent or temporary adaptations within the treatment plant. Some triggers may include, but are not limited to:

- Excess use of pH control chemicals (carbon dioxide, citric acid, etc.)
- Higher than permitted target constituents in the effluent
- Underperforming equipment or premature equipment failure
- Premature or frequent fouling of membrane, filter media, etc.
- High turbidity (in effluent)
- Scaling in equipment or piping
- High membrane/filter reject flows

Other outside variables may also act as triggers, including regulatory updates for discharge constituents, climate events, or technological advancement.

Several design features are included that create flexibility for future adaptation and adjustment, including:

- The use of modular and multi-stage mixing prior to the phys-chem treatment steps.

- Chemical injection locations are often duplicated and may be relocated to different mixing stages based on the needs of the process and the constituents present.
- The placement of equipment in parallel allows for optimization of those pieces of equipment based on whether hydraulic or solids loading conditions control.
- Phys-chem clarifiers have adjustable rake speed and sludge draw-off rates, in addition to the recirculated flow rate of solids back to the third stage mixing.

The availability of temporary rental treatment systems, including trailerized mix tanks, ballasted flocculating clarifiers, UF, and RO units, creates additional flexibility for the plant in situations where a temporary spike of targeted constituents or flow is anticipated or required to maintain mine operations. Additional details for WTP adaptive management are provided in the Coffee Gold Mine Water Treatment – Preliminary Design Report (Appendix E).

4.5.3.3 Contingency Water Treatment Plan

A contingency water treatment plan was developed to provide a description of the water treatment process that would be implemented in unforeseen scenarios when the water treatment plant is not operational. The scenarios include the following:

- Delay or failure to install the proposed water treatment plant
- Exceedance in the predicted mine water volumes
- Water treatment requirements prior to installation of the water treatment plant (in Year 2)
- Water treatment plant failure.

The process involves and temporary RO unit, which would provide a quick-response solution. A description of the RO system, including management of residuals, economic and technical feasibility, and deployment schedule are provided in the Contingency Water Treatment Plan Report (Appendix F).

4.5.4 Results Summary of Water Treatment Testwork

The validation phase of the bench-scale testing using the pre-treatment physico-chemical and EBR system was completed successfully for all contaminants of concern (WesTech 2021).

Sulfate was successfully removed to below the discharge target of 1,100 mg/L in the phys-chem pretreatment stage and remained within compliance throughout the treatment (Figure 4-6). If necessary, sulfate removal in the pretreatment can be adjusted further based on Ba dose. The increase in sulfate concentration observed in the aerobic column during the post-treatment optimization was expected. The post-treatment's main goal was residual chemical oxygen demand/biological oxygen demand (COD/BOD) oxidation; once that goal was achieved, system optimization in terms of the HRT and the required aeration was performed to avoid re-oxidizing reduced species.

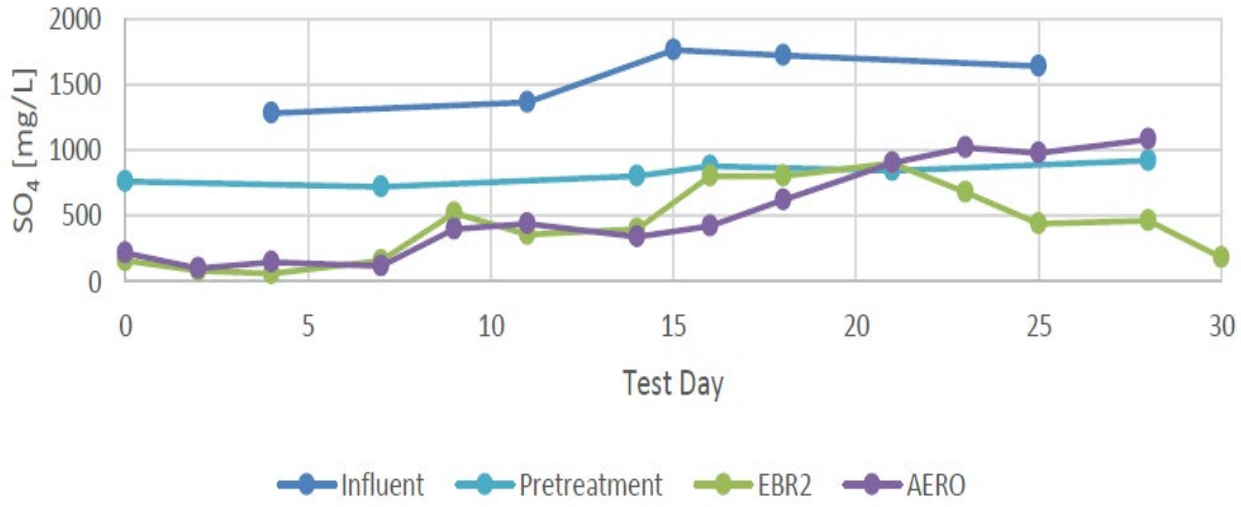

Figure 4-6 Phase II Bench Scale Treatability Results for Sulphate

Total arsenic was removed to an average of 0.4 mg/L in the phys-chem pretreatment using a 20 mg/L $FeCl_3$ dose (Figure 4-7). Further pretreatment optimization was needed to lower the As level in the pretreatment step. The goal of the optimization was to demonstrate that the arsenic discharge target can be achieved with the ferric co-precipitation alone, without the need for a biological polishing step. The EBR system polished arsenic levels to an average of 0.009 mg/L.

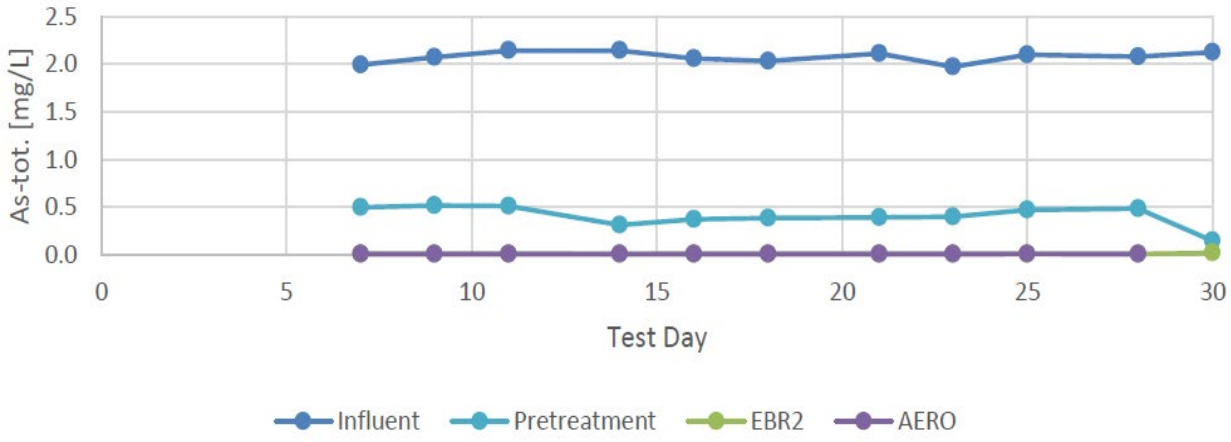

Figure 4-7 Phase II Bench Scale Treatability Results for Arsenic

As introduced above, arsenic speciation was performed three times throughout the bench trial – at the end of validation testing (day 28), early on during stress-testing when arsenic removal was still in steady-state operation (day 70), and at the end of stress-testing (day 113). The predominant arsenic species in the influent water was arsenate (Table 4-11) and is expected given the oxide nature of the ore material and the dominance of As(V) in the ore mineralogy. After arsenic precipitation pre-treatment, arsenate remained the predominant species. The EBR system generated progressively more reduced arsenic species but never produced any methylated arsenic by-products. Depending on the operating conditions, the aerobic post-treatment re-oxidized most of the arsenic remaining in the system into As(V).

Table 4-11 Results of Arsenic Speciation During Treatment Testing on Coffee Heap Leach Solutions

Test Day	As Species	Units	HLF Solution	Pretreatment	EBR1	EBR2	Aerobic
28	As(V)	µg/L	2,170	119	2.34	3.16	6.44
	As(III)	µg/L	<2.0	<0.8	200	4.88	1.77
	MM-As	µg/L	<4.5	<1.8	<1.8	<1.8	<1.8
	DM-As	µg/L	<2.5	<1.0	<1.0	<1.0	<1.06
	Unknown	µg/L	7.8	7.5	12.9	1.48	<1.0
70	As(V)	µg/L	2,000	12.4	1.55	<0.8	6.25
	As(III)	µg/L	<0.8	<0.8	31	2.31	<0.8
	MM-As	µg/L	<1.8	<1.8	<1.8	<1.8	<1.8
	DM-As	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
	Unknown	µg/L	13.2	<1.0	19.2	12.5	1.17
113	As(V)	µg/L	1,730	11.2	0.821	2.03	17.8
	As(III)	µg/L	<0.8	<0.8	25.3	5.29	<0.8
	MM-As	µg/L	<1.21	<1.21	<0.8	<0.8	<0.8
	DM-As	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
	Unknown	µg/L	6.47	<1.0	1.05	11.4	<1.0

Notes:
As(V) = arsenate
As(III) = arsenite
MM-As = monomthylarsonic acid
DM-As = dimthylarsonic acid
Unknown = sum of unknown arsenic species

Nitrate-N was consistently removed to below the detection limit of 0.5 mg/L within the first EBR stage and remained nondetectable throughout the treatment (Figure 4-8).

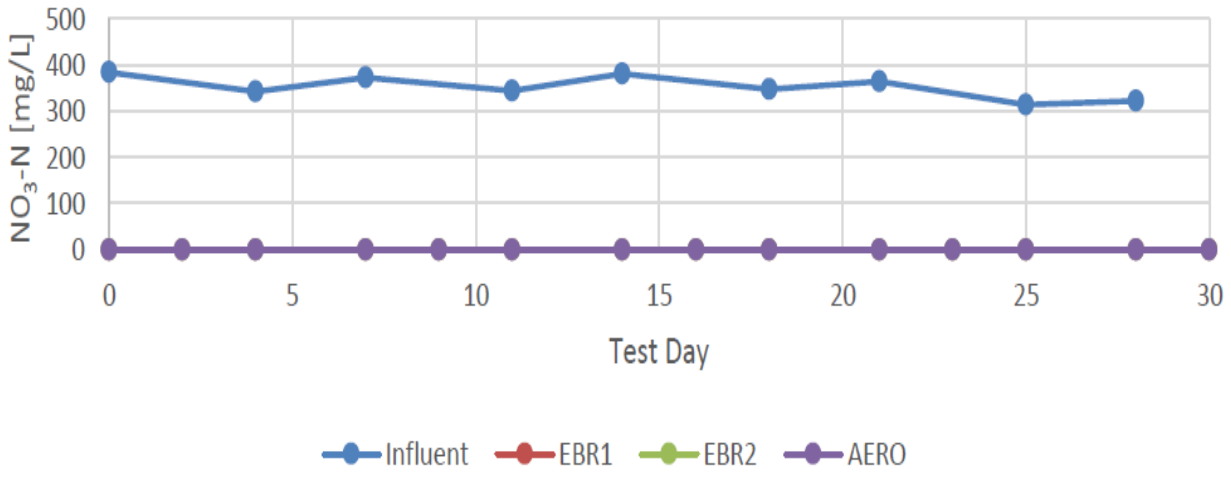

Figure 4-8 Phase II Bench Scale Treatability Results for Nitrate

A 30% total uranium reduction was achieved in the phys-chem pretreatment. The EBR system further reduced uranium to below the detection limit of 0.002 mg/L (Figure 4-9). Uranium removal kinetics followed linear fit in the first stage EBR, designed for denitrification, and an exponential fit in the second-stage EBR, designed for metals removal.

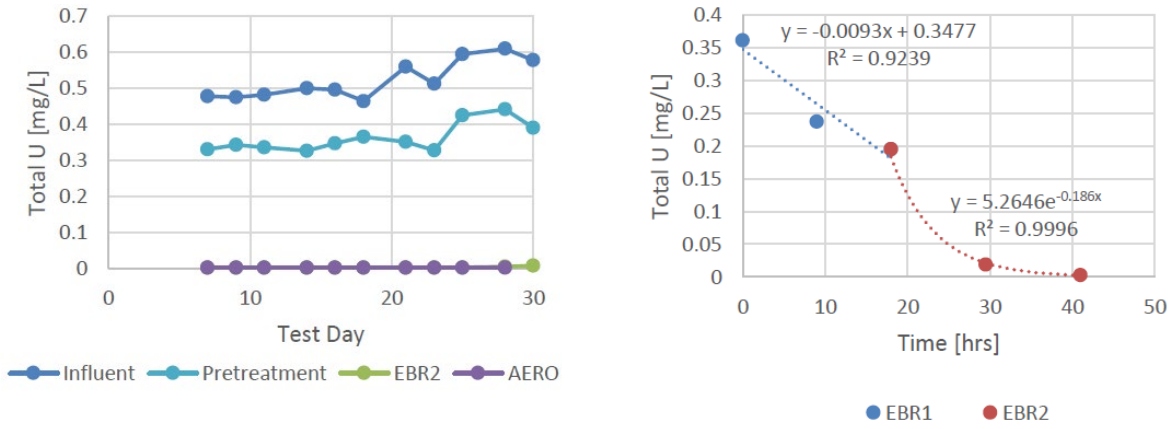

Figure 4-9 Phase II Bench Scale Treatability Results for Uranium

The proposed treatment process was also successful in removing other metals to below treatment targets and these are summarized in Table 4-12.

Table 4-12 Average Concentration of Metals throughout the Phase II Bench-Scale Testing. Three-Point Average

Parameter	Units	HLF Solution	Pretreatment	EBR1	EBR2	Aerobic	Target/Allowable
Al	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	NT / 2.2
Sb	mg/L	0.61	0.38	0.06	0.02	<0.008	0.05 / 0.05
As	mg/L	2.05	0.16	0.15	0.02	0.01	0.02 / 0.02
Cd	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001 / 0.001
Cr	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	NT / 0.05
Cu	mg/L	0.018	0.006	<0.003	<0.003	<0.004	0.017 / 0.017
Fe	mg/L	0.105	<0.1	0.23	0.12	<0.16	NT / 2.0
Pb	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	NT / 0.012
Mn	mg/L	0.029	0.024	0.062	0.064	0.271	NT / 3.0
Hg	mg/L	0.0034	0.00013	<0.0001	<0.00009	<0.00009	0.0001 / 0.0001
Ni	mg/L	0.0053	<0.003	<0.002	<0.002	<0.002	NT / 0.5
Se	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	NT / 0.015
U	mg/L	0.61	0.35	0.22	0.004	<0.002	0.4 / 0.4
Zn	mg/L	<0.008	<0.006	<0.01	<0.006	<0.006	0.1 / 0.13

Notes:
NT = not targeted by WTP

4.5.5 Preliminary Analysis of Solids Generation

At the conclusion of bench-scale testing, the columns were taken apart, and solids were collected from each treatment stage. This included the dewatered pretreatment sludge, activated carbon support media with any residual precipitates and microbial biofilm from the EBR columns, and the pumice support media with any residual precipitates and microbial biofilm from the aerobic post-treatment. The solids were submitted to AWAL laboratories for toxicity characteristic leaching procedure (TCLP) analysis.

All the collected solids passed the TCLP analysis (WesTech 2021). Most metals were not leached in detectable quantities from any generated solids. The only exceptions were arsenic (leached out of the pretreatment sludge at 0.128 mg/L – well below the allowable limit of 5 mg/L) and barium (leached out of the EBR1 solids at 0.34 mg/L – well below the allowable limit of 100 mg/L). Since the ferric co-precipitation is a one-pass system, similar TCLP results from the pretreatment sludge can be expected from the pilot-scale test and full-scale installation.

More detailed solids analysis and characterization, including estimates of sludge volumes generated will be provided as part of future testing.

4.5.6 System Controls

The treatment facility will be equipped with a fully-automated control system. The programmable logic controllers (PLC) will monitor and operate all unit processes based on flows, pressures, levels, and water quality parameters. A local control panel will be provided with unit processes to give a local indication of motor status as well as limited motor controls. The status will also be transmitted to the distributed control system (DCS) along with a common alarm and common shutdown to give a remote indication of failure. All chemical dosing and transfer pumps will be pre-assembled on skids to ensure fast mobilization.

All chemical additions will be automated and controlled by the PLC. The skids for each reagent used will consist of one operating and one standby motorized diaphragm pump with automatic stroke control and local hand-off-auto (HOA) switches. Only one pump will run at a time and will be selected at the DCS interface (Duty/Standby).

The system will be equipped with instruments that will communicate with the PLC, including flow transmitters, flow control valves, level transmitters and switches, solenoid valves, pressure transmitters, etc. Each unit process will be equipped with relevant water quality analyzers. For instance, the clarifier unit will have an integrated turbidimeter and a pH probe, while the denitrifying bioreactors will be equipped with an in-line nitrate analyzer. The provided water quality monitoring will allow the operators to assess the plant's performance in real time. The human-machine interface (HMI) will display the current plant conditions, trends, and alarms for the operators, notifying them of improper operations or out-of-spec conditions.

4.5.7 Additional Design Testwork and Schedule

The proposed water treatment plant design for the Coffee Project will incorporate a design that has been tested and validated through a phased feasibility testing approach, including laboratory testing, on-site pilot testing, and optimizations. The objective of the phased testing approach is to develop fully vetted operational parameters and design criteria prior to implementation of a full-scale WTP facility.

The work required prior to WTP operation includes development of the Detailed Engineering designs for the system, as well as Phase III pilot-scale testing. The designs will be based on outcomes of previous test work as well as ongoing test work. An overview of the work that is required prior to full-scale implementation of the WTP, including Project milestones, is provided in Figure 4-10.

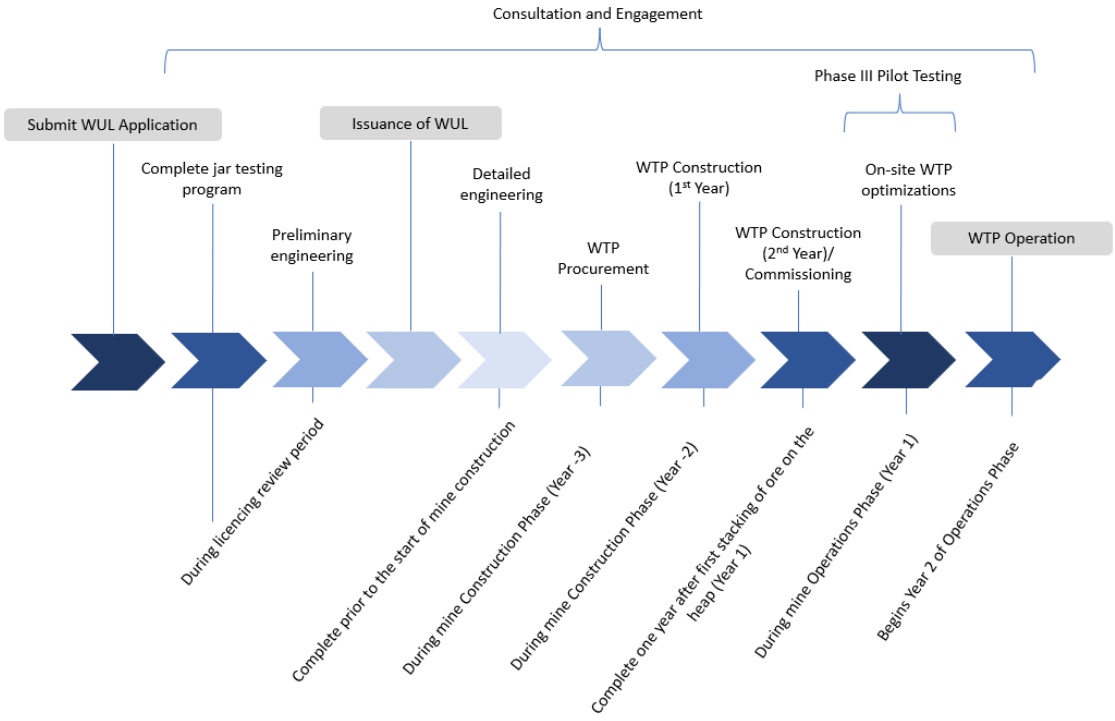

Figure 4-10 Water Treatment Plant Work Required

Detailed Engineering of the WTP will be completed to support the WTP procurement and construction processes. A Final Engineering and Design package will be produced and submitted prior to the initiation of mine site construction, which is scheduled to occur in Year -3 of mine life. The Final Engineering and Design package will build upon the Preliminary Design document and expand to include Piping and Instrumentation Diagram drawings, single-line electrical drawings, hydraulic and other calculations, plant layouts and 3D models, and mechanical design. The output will be an Issued for Construction package that will be handed over to a construction contractor. The estimated time requirement for the Detailed Engineering is 12 months.

In order to ensure a functioning water treatment plant in Year 2 of operation, the WTP procurement process will occur within the first year of mine site construction (Year -3). The procurement period, scheduled for 12 months, starts with submitting design packages and equipment scope requirements to manufacturers and approving the fabricator drawings before releasing the purchase order or fabrication. Off-the-shelf components can be delivered quickly. However, fabrication of items such as skids and tanks takes months and hinges on the state of the global supply chain. While working in the procurement period, long-lead items are prioritized first.

Construction of the WTP is anticipated to be carried out over a two-year period, which will commence during Year -2 of the mine Construction Phase, and will continue into Year -1, which is the first year of the mine Operations Phase. Stacking and leaching ore on the leach pad is scheduled to start in the 2nd quarter of Year -1; therefore, commissioning of the WTP would occur during Year -1, and will be complete one year following the first stacking of ore on the heap. Commissioning will include wet testing, instrumentation and electrical testing, and programming testing.

Once the plant is commissioned, the full-scale equipment will be utilized to run a Demonstration Pilot (Phase III pilot testing program) in Year 1. The heap leach rinse waters will be treated through the plant in a recirculating mode for a period of six months. The objective of the Demonstration Pilot is to validate and optimize the system for treatment of the contaminants in the actual Project leach rinse waters. The two main goals of piloting will be to 1) demonstrate treatability under real-life conditions; and 2) optimize the performance in terms of reagent dosing rates.

Upon meeting the objectives of the Phase III pilot testing program, including validation of the treatment system for all parameters and process optimizations, the WTP will be operational by Year 2 of mine life, when the heap leach water balance model indicates solution removal will need to commence.

4.6 Surface Water Management

Contact and non-contact water are isolated and managed separately within the HLF. A description of the contact and non-contact surface water management is provided below. Additional information on surface water management is included in the Water Management Plan.

4.6.1 Contact Water

Heap runoff from storm events in excess of the infiltration capacity has been estimated to design surface runoff conveyance structures. Although raincoats are not utilized in the water balance model to maintain storage, the peak flows for conveyance infrastructure did include raincoats to allow flexibility for solution management in operations. This conservative approach resulted in a curve number of 99. The conveyance structures were designed based on PMP 24-hr event.

4.6.2 Non-Contact Water

Non-contact water is tributary area outside of the HLP lined facilities. Interceptor ditches and energy dissipation basins are designed to divert tributary areas around the lined process facilities. The interceptor ditch(es) will be relocated as the Stages are built for expansion. At the ultimate footprint the tributary area towards the facilities is relatively small due to the ridgetop location of the facilities.

Should the performance of the interceptor ditches fall outside of design criteria, mitigations will consist primarily of ongoing maintenance. Should additional mitigations be required, they may include:

- Constructing a ‘key’ (excavation and engineering fill backfill) at the downstream toe of the diversion; or
- Shallowing up the downstream slope (i.e., adding fill on downstream to reduce slope grades).

4.7 Heap Leach Facility Inspections

The performance of the heap and ponds will be monitored via three types of inspections:

- Routine inspections
- Annual inspections
- Event-driven inspections.

4.7.1 Routine inspections

Heap leach operators will complete routine visual inspections at least weekly (unless otherwise noted), and more frequently when operational conditions dictate. Operational conditions that require more frequent inspections include: recommencement of ore stacking in the spring or any other extended down period; commissioning new stages of the leach pad; first filling of any pond; any time that a pond has been filled above its freeboard level; and any other operational changes that could affect slope stability.

These routine inspections will be conducted as indicated below, for all components of the HLF, with frequencies summarized in Section 4.7.4:

- The visible portions of the leach pad and pond liners, overliner, and drainage collection systems (daily)
- Stacked ore on the heap (daily)
- Slopes of the heap, perimeter, and exposed stage/cell divider berms (daily)
- Non-contact water diversions channels
- Cut and fill slopes for leach pad
- Ore stacking operations including ore quality (daily visual); ore samples will be obtained and tested for:
  - Geochemical properties (quarterly)
  - Geotechnical properties (quarterly for the first 12 months after start-up and annually thereafter).
- Solution pumps (daily); pump operating hours and total flow from each flow meter will be recorded
- Drip emitters and solution distribution systems for barren and rinse solutions (at least weekly)
- Event and rainwater ponds and embankments (at least weekly)
- Water level in events and rainwater ponds (continuous via instrumentation with daily visual verification)
- Leak detection ports for the ponds, and all solution piping at the following frequencies:
  - Weekly for ports monitoring any active areas of the leach pad or active pipes
  - Daily for any ports that have reported leakage in the past 90 day
  - Monthly for all other ports.
- The leak collection and recovery system (LCRS) between the primary and secondary geomembranes in EP-1S, EP-1N, and EP-2 lower portion including the level-activated pumps (installed to return any leakage to the pond or process circuit) and totalizing flow meters:
  - The hours of pump operation and the total flow will be checked and recorded daily for each pond during open water season

    - Any pond with an LDRS reporting more leakage than allowed in the approved action leakage rate (ALR) schedule will be subject to special operating procedures to reduce the LDRS flow rate; procedures will be developed on a case-by-case basis and may include reducing the operating solution level, locating and repairing any damage, or upgrading the LDRS pump (suitable to the higher flow).
- Instrumentation:
    - Data will be collected and reviewed daily from all instrumentation unless otherwise specified by the Engineer
    - Equipment will be inspected monthly or as otherwise recommended by the manufacturer or Design Engineer to verify functionality
    - Equipment will be calibrated according to the manufacturer's recommendations.

Routine inspections will also include temperature measurements for the barren, rinse, and gold bearing solution as close to the heap as practical. Solution temperatures will be taken on a weekly basis on the same day of the week and at approximately the same hour (within one hour) except during the period of November 1 to April 30 each year when these readings will be taken daily at approximately the same time (within one hour).

Ore sampling and testing programs will be in place to monitor ore properties and stacking plans, including geotechnical, geochemical, and ore permeability. Any deviations from normal or expected conditions will be immediately reported to the General Manager and communicated to the Engineer of Record.

Written records of routine inspections will be maintained as a permanent record at the Mine Site. Any deviations from normal or expected conditions will be immediately reported to the General Manager and communicated to the Engineer of Record as needed.

4.7.2 Annual inspections

Annual inspections will be performed by an independent Professional Engineer experienced with gold heap leaching in cold climates and licensed to practice in Yukon. Annual inspections will be completed each summer, at a date providing sufficient time before the end of the open water season to allow any resulting action plans to be implemented in a timely manner. These inspections will include all of the elements within the routine inspection program, plus the following:

- Review recommendations from the prior annual inspection and verify that they have been implemented.
- Review all instrumentation and monitoring systems, and all related data for the prior year.
- Review the routine inspection reports.
- Review the results of the ore sampling and testing programs for geochemical and geotechnical properties and verify that these are consistent with the design. Revise this program as indicated.
- Prepare a photographic log of the facilities.
- Review the facility for safety and environmental containment.
- Verify the design basis relative to current regulations, industry and engineering standards, and operating practices.
- Verify the adequacy of the inspection programs and this operating plan.

- Review the heap stacking plans (as built and forecast) and verify that they are consistent with the design.
- Review the water balance model, which should be reconciled quarterly to actual solution levels and flow rates for the prior year (revising the model as needed).
- Review the water quality model to observed solution chemistry and revise source term assumptions as required.
- Quarterly updates (monthly tracking and reporting) will be carried out where the forecast surplus water accumulation or make-up water demand will be estimated for the next 12 months based on the actual water in the system at the time of the update.
- Review temperature measurements and reconcile with the thermal model (revising the model as needed).

The Inspecting Engineer will prepare a report of the annual inspection, and this report will be kept as a permanent record at the Mine Site. Any deviations from normal or expected conditions will be immediately reported to the General Manager.

In addition to the annual inspection, a periodic Dam Safety Review (DSR) of the embankments for the event ponds, will be conducted by an independent Professional Engineer in accordance with the Canadian Dam Association standards (CDA 2007). Comprehensive dam reviews will be performed as recommended by the CDA according to the dam hazard classification for each facility, in the year prior to decommissioning, and following closure.

4.7.3 Event-driven inspections

Special inspections will be facilitated by the Process Manager if any of the following occurs. Inspections will be completed as soon as possible after the subject event.

- Unusually large precipitation, freshet or seismic events, as per the following guidance:
  - Precipitation or freshet in excess of the 25-yr / 24-hr event; or
  - Ground acceleration in excess of 0.08 g (as estimated from earthquakes recorded by the regional seismograph network).
- Unusual operating conditions, including any material damage to pipes, liners, and all other components of the solution containment systems. Material damage means damage that can adversely affect the serviceability of the component.
- Unusual observations, including stretching of the geomembrane liners sufficient to cause damage or loss of anchorage; slippage or unusual erosion on the heap slopes or embankments for the ponds; tension cracks or sinkholes in the heap, leach pad platform, or any embankments; any large deformation of any fills including the heap, embankments, and perimeter of the leach pad.
- Measured flows in the LCRS of any pond that exceeds the approved ALR schedule. A response plan will be developed to manage or reduce the flow rate within seven days of first occurrence of exceedance, unless a faster response is dictated by the ALR schedule.
- Unusual readings from any instrumentation (as compared to historical trends and current operating conditions), readings that are within any specified action levels (Section 4.8), or the failure of any instrumentation system.

Event-driven inspections, which require follow-up action, will include a detailed description of such action with timelines and compliance criteria.

4.7.4 Inspection Frequency

Table 4-13 provides the inspection frequencies for the HLF components to be completed by site staff.

Table 4-13 Inspection Requirements for the Heap Leach Facility

Location / Item Description	Inspection Frequency
Leach pad and pond liners, overliner, and drainage collection systems (exposed areas)	Daily
Stacked ore heap	Daily
Heap slopes, perimeter and exposed stage, and cell divider berms and ditches	Daily
Cut and fill slopes for pad and ponds including surveys to measure settlement	Visual: Weekly (at least) Survey: Annual
Non-contact water diversion channels	Visual: Weekly (at least) Survey (fixed points): Monthly
Ore stacking operations and ore quality (visual)	Daily
Ore sampling and testing for geochemical and geotechnical properties	Quarterly for the first 12 months and annually thereafter
Solution pumps: Visual inspection and recording pump operating hours and total flow from each flow meter	Daily
Drip emitters, solution distribution systems	Daily
Events and rainwater pond embankments	Weekly (at least)
Water levels in ponds: Data collection	Continuous
Visual verification	Daily
Leak detection ports for leach pad, and pipes:	
Ports monitoring any active areas of the leach pad or active pipes	Weekly (at least)
Any ports which have reported leakage in the past 90 days	Daily
All other ports	Monthly
Leak collection and recovery system for EP-1S and EP-1N: Recording of pump operating hours and total flow during open water season	Daily
Instrumentation:	
Data to be collected and reviewed	Daily (unless otherwise specified by the Engineer),
Equipment to be inspected	Monthly (or as otherwise recommended by the manufacturer or Design Engineer to verify functionality)
Equipment to be calibrated	According to the manufacturer's recommendations
Temperatures of barren, rinse, and gold bearing solutions	Weekly (May 1 – October 31)
	Daily (November 1 – April 30)

Location / Item Description	Inspection Frequency
Review and verify adequacy, ensure compliance with current regulations/standards, or reconcile measurements with models, as applicable:	
Previous year routine inspection reports	Annual
Previous year annual report	
Sampling and testing programs	
Safety and environmental containment	
Heap stacking plans	
Water balance model	
Temperature measurements	
Dam safety of event ponds	
Independent inspection of dams and HLF	Annual
Dam Safety Review (DSR)	According to the CDA dam hazard classification.
Event-driven inspection	Following unusual events
International Cyanide Management Code (ICMC) Audit	Every 3 years

4.7.5 Reporting

Routine Inspections: Written records of routine inspections will be maintained as a permanent record at the Mine Site. Any deviations from normal or expected conditions will be immediately reported to the Geotechnical Engineer and operational management personnel.

Annual Inspections: The Inspecting Engineer will be a Yukon-registered Professional Engineer and will prepare a Report of Annual Inspection each year, which will be shared with First Nations as well as with regulatory authorities. This report will be kept as a permanent record at the Mine Site. Any deviations from normal or expected conditions will be immediately reported to the Geotechnical Engineer and operational management personnel.

Event-driven Inspections: Event-driven inspections, which require follow-up action, will produce a Report of Special Inspection, and will include a detailed description of such action with timelines and compliance criteria. This report will be provided to the Area Lead for the impacted area(s); otherwise, event-driven inspections will be documented as routine inspections.

International Cyanide Management Code (ICMC) Audit: In accordance with ICMI audits will be conducted every three years during operations. Audits will confirm the operation is following the ICMC and associated protocols. More details are provided in the Cyanide Management Plan.

4.8 Adaptive Management Plans

Each item in Section 4.7 has a corresponding item in the Adaptive Management Plan. The triggers are set to provide reasonable reaction time to address adverse changes without being overly sensitive and thus resulting in false positive results from the triggers. Both the triggers and the actions should be revised as the HLF design is advanced and as operating experience is gained. Table 4-14 presents the Triggers and Action by area of the HLF. Table 4-15 presents additional action details for the containment systems for the ponds.

Table 4-14 Adaptive Management Triggers and Actions

Location / Item Description	Triggers	Action
Leach pad and pond liners, overliner, and drainage collection system (exposed areas)	Any exposed areas show signs of distress, mechanical damage, chemical or weathering damage, erosion, plugging, or any other performance not in accordance with design or forecast	Engineer will investigate the discrepancy and develop corrective action plan as needed.
Stacked ore heap and heap slopes	a) Any bulging or deformation of toes, crests, or faces of the heap. b) Material stacked outside the design limits. c) Erosion to any surfaces or slopes caused by precipitation, snow melt, or operating solutions.	a) Engineer will investigate the discrepancy and develop corrective action plan as needed, which may include: • Increased monitoring frequency • Detailed review and analysis of performance data • Reduction in the rate of or cessation of ore stacking in the affected area • Stabilization of the area of concern by appropriate combinations of slope flattening, surface water controls, and changes to the irrigation plan. b) Remove the material that is outside of the design limits and repair any resulting damage. Advise operators about the appropriate stacking areas. c) Repair the erosion and implement changes to the irrigation and stacking plans to reduce or eliminate erosion.
Heap perimeter and exposed stage and cell divider berms and ditches	Erosion, slope movements, accumulation of debris that may impede serviceability, actual or evidence of overtopping during use, or other signs of distress	Engineer will investigate the discrepancy and develop corrective action plan as needed.
Cut and fill slopes for pad and ponds	a) Any bulging or deformation of toes, crests, or faces of the heap. b) Erosion of the slope, crest, or toe of the slopes.	a) Engineer will investigate the discrepancy and develop corrective action plan as needed. b) Repair the erosion and implement changes to the surface water controls to reduce or eliminate erosion.
Runoff diversion works	Erosion, slope movements, accumulation of debris that may impede serviceability, actual or evidence of overtopping during use, or other signs of distress	Engineer will investigate the discrepancy and develop corrective action plan as needed.

Location / Item Description	Triggers	Action
Ore stacking operations and ore quality (visual, and testing for geochemical and geotechnical properties)	Ore quality, physical or chemical properties are not within tolerances of the design and forecast conditions	Engineer will investigate the discrepancy and develop corrective action plan as needed, which may include: • Revisions to the mining, crushing or ore stacking plans such that lower quality ore is placed in non-critical locations • Blending of ores to produce the targeted properties of the as-stacked ore • Revisions to the crushing plan to improve the quality of the stacked ore • Review of the heap stability, hydraulic design and irrigation plan to accommodate material changes in ore properties.
Solution pumps	a) Any material departure from design or forecast operating conditions, including flow, pressure, and power consumption. b) Excessive leakage from cases, glands, or other components; excessive or unusual noise, or vibration.	a) Engineer will investigate the discrepancy and develop corrective action plan as needed. b) Repair or replace the pump as needed.
Drip emitters, solution distribution systems	a) Uneven flow or plugging producing unacceptable variation in solution distribution to the heap. b) Frequent or excessive line ruptures or leaks. c) System not operating according to design, such as excessive pressure loss or inadequate flow rates.	a) Clean or replace affected areas. b) Replace affected areas or investigate the cause and take indicated actions. c) Engineer will investigate the discrepancy and develop corrective action plan as needed.
Events and rainwater pond embankments	a) Any bulging or deformation of toes, crests, or faces of the heap. b) Erosion to any surfaces or slopes caused by precipitation, snow melt, or operating solutions. c) Seepage noted in slope, at or near the toe.	a) Engineer will investigate the discrepancy and develop corrective action plan as needed, which may include: • Increased monitoring frequency • Detailed review and analysis of performance data • Reduction in solution levels in the affected pond • Stabilization of the area of concern by appropriate combinations of slope buttressing, surface water controls, slope compaction, or armouring. b) Repair the erosion and implement changes to the surface water controls and slope armouring to eliminate erosion. c) Engineer will investigate the discrepancy and develop corrective action plan as needed.

Location / Item Description	Triggers	Action
Water levels in ponds	Actual water levels exceed design or forecast by more than the specified tolerance. Actual water levels are above the freeboard level	a) Engineer will investigate the discrepancy, review the water balance model, and develop corrective action plan as needed. b) The subject pond will be immediately taken out of service and solution transferred to another pond until the level is reduced to below the freeboard limit.
Water quality in ponds and feed to WTP	a) Observed chemistry is greater than predicted.	a) Monitor concentrations in various HL solutions including gold bearing and barren solutions at increased resolution b) Track concentration changes overtime to determine if trends are upwards or variable
Leak detection ports for leach pad	Leakage detected in any of the leak detection ports	Engineer will investigate the discrepancy and develop corrective action plan as needed.
Leak detection ports for pipes	Leakage detected in any of the leak detection ports	Engineer will investigate the discrepancy and develop corrective action plan as needed
Leak detection system for ponds	Leakage rate in EP-1S or EP-1N detected above the triggers set forth in Table 4-11 Leakage detected in the leak detection port for EP-2	a) Implement the actions in the respective tables. b) Engineer will investigate develop corrective action plan as needed.
Data collection	Data from instrumentation does not match visual observation or is not within tolerance, or both	Engineer will investigate the discrepancy and develop corrective action plan as needed.
Instrumentation: • Data to be collected and reviewed • Equipment to be inspected • Equipment to be calibrated	a) Operating conditions for any instrumented component departs from forecast by more than the specified tolerance. b) Equipment that is not operating as specified or within the manufacturer's tolerances or appears to be reporting incorrect values.	a) Engineer will investigate the discrepancy and develop corrective action plan as needed. b) Any equipment that is not operating as specified will be repaired, replaced, or recalibrated as needed.

Location / Item Description	Triggers	Action
Temperatures of barren, rinse, and gold bearing solutions	a) Operating temperatures below forecast by more than the specified tolerance b) Temperature of rinse or gold bearing solutions below 3°C	a) Engineer will review operating temperatures and the thermodynamic modeling; determine possible causes of the discrepancy; and implement operating changes as needed. b) Operations personnel will take measures to increase the temperature of the solutions, which may include: • Increasing the operating temperature of the boiler and heat exchanger • Increasing the capacity of the boiler • Reducing solution flow rates (if the model supports this move) • Reducing or halting irrigation of freshly stacked ore (the coldest ore and thus the largest heat sink).
Event-driven inspections	Inspection required as soon as possible after trigger event	Inspections will be conducted in accordance with the Report of Special Inspection as defined in Section 4.7.3.
Annual inspections	Required as specified in Table 4-9	Inspections will be conducted in accordance with the Report of Annual Inspection as defined in Section 4.7.2.

Table 4-15 Draft Action Leakage Rate Schedule for Event Ponds EP-1S and EP-1N

LCRS Flow Rate (m^3/ha/d)	Action
Up to 5.0	Pump LCRS solution and return solution to pond.
5.1 to 25.0	a) Increase pumping rate to keep LCRS depressurized.
	b) Increase frequency of sampling and testing of all monitoring wells within the influence zone of subject pond.
	c) Manage solution level in pond to reduce LCRS flow rate to the extent practical.
25.1 to 100.0	a) Continue monitoring of all wells within the influence zone with an increased frequency (to be determined by the Engineer).
	b) Reduce solution level in pond to reduce LCRS flow to not greater than 25 m^3phd or
	c) Locate and repair defects within 180 days to reduce LCRS flow to not greater than 25 m^3phd.
Greater than 100.0	Within 180 days, locate and repair defects, or replace primary liner, or decommission pond.

1. ALRs adapted from: Alberta Environmental Protection (1996), US EPA (1987 and 1992). Actionable LCRS flow rates and actions to be revised with detailed design of the facility and as operating experience is gained after commissioning.
2. Area applicable to ALR is the plan area of the subject pond wetted by solution.
3. LCRS flow rates are average flows over a 30-day period.

4.9 Emergency Management

Situations outside the normal operating parameters may result in upset conditions within the heap leach facility. Upset condition could occur due to:

- Loss of pumping capacity
- Power (electrical) outage; or
- Extreme climatic events (rainfall or freshet).

In the event of an emergency situation, response is covered in the “Heap Leach Facility Emergency Response Plan”, detailing the appropriate actions to be taken for the following:

- Event Pond Failure
- Liner System Failure
- Solution Collection System Failure
- Ore Heap Slope Failure
- Closure Drain System Failure
- Release of HCN Gas within the ADR Plant
- Sodium Cyanide Briquette Spill
- Dilute Cyanide Spill.

Management activities for the heap leach facility are described below.

4.9.1 Heap

In the event of a power outage or loss of pumping capacity, the irrigation system would stop working and the heap would begin to drain (Section 4.9.2). This reduces gold production but is not otherwise disruptive.

An extreme climatic event such as rainfall or freshet in excess of the design capacity (plus freeboard) could create the following operational disruptions for the heap leach pad:

- Erosion of the slopes of the heap, which could deposit sediment in the channels and pipes, diminishing their carrying capacity.
- Saturation of localized zones of the heap (i.e., where lower-permeability ore may have been stacked), which would reduce the stability of the slopes and possibly trigger bench failures. These could block the channels designed to carry rainwater off the heap and to the rainwater pond. In the extreme, a sufficiently large failure could cause ore to cross the perimeter berm and leave the containment area.
- Surface runoff from areas outside the heap (especially to the west) could erode the perimeter berm or, in the extreme, overtop the berm and enter the process circuit. This flow could overwhelm the capacity of the drainage pipes and introduce sediment into the system.

Similar effects could be caused by the rupture of a main irrigation distribution pipe (i.e., a header) should the automated control system not detect the rupture and depressurize the circuit. The design of the heap includes a reasonable factor of safety to minimize the potential for the occurrence of such operational disruptions. However, in the event that these disruptions lead to an emergency the “Heap Leach Facility Emergency Response Plan” addresses the appropriate responses.

4.9.2 Ponds

The HLF will have four ponds, three each for extreme events and one for rainwater. The rainwater pond volume is accounted for in storage volumes when analyzing the extreme event of PMP concurrently with a 72-hr shut down. In the event of surplus water accumulation, each pond is designed to spill into the next pond downstream, until all ponds are full. The pond capacities have been designed to accommodate all of the following upset or extreme events (in combination):

- Normal operating freeboard
- Seasonal water accumulation during the wettest year on record
- Complete drainage of the heap in the event of temporary shut-down
- The PMP event including freshet.

The pond capacities, therefore, are designed to accommodate an emergency that disrupts operations even for an extended period. The ponds will store the surplus water generated from the facility until the disruption is remedied and the plant returns to normal operation. In the event that power generation is lost, there will be 100% replacement generation capacity (50% replacement during the first year of operations) on site, which would return the system to full operations usually within hours.

In the event of a pump failure, complete replacement kits will be inventoried in the warehouse, and a new pump could be installed, or the damaged pump rebuilt, in less than one shift. Alternatively, one of the other installed pumps could be switched to circulate solution to the heap until the damaged pump is replaced, reducing the irrigation down time to approximately one hour.

If there is an event or series of events that exceed the design leading to a pond failure the “Heap Leach Facility Emergency Response Plan” addresses the appropriate responses.

4.9.3 Process Plant

The process plant would be affected by a loss of pumping capacity or loss of power but would be minimally affected by extreme climatic events as the water flow to the plant will be regulated to match the circuit capacity. In the event of pumping system failure or loss of power, the flow of gold bearing solution to the plant would begin diminishing causing an operational disruption but not an emergency situation.

4.9.4 Water Treatment Plant

A contingency water treatment plan was developed to provide a description of the water treatment process that would be implemented in an emergency scenario. The contingency water treatment plan is described in Section 4.5.3.3 and in the Contingency Water Treatment Plan Report (Appendix F).

4.10 Access Management

The HLF event ponds will be surrounded by a fence with gates to control access to only authorized personnel and to prevent ingress by larger wildlife (e.g., ungulates). In addition, wildlife deterrents, including water surface features, will be implemented to reduce the presence of wildlife at the HLF event ponds.

The gold refinery and vault are in a separated secured building adjacent to the process plant. Signs will be placed at the site to advise personnel of the status, access restrictions, required personal protective

equipment, etc. Roads that are inactive will be blocked with berms and signs. The remote location will further restrict unauthorized access.

4.11 Access Roads

Access to the mine site will be via the Northern Access Route (NAR), a 214-km all-weather road, south from the North Klondike Highway east of the City of Dawson Figure 1-1. The NAR will operate year-round with the exception of periods when the Stewart River and Yukon River are either freezing up in the fall/early winter or breaking up in the spring. The NAR is expected to be open an average of 295 days per year, with barge service beginning in late May and ending in early November. Details of the NAR are provided in the Access Route Construction Management Plan and the Access Route Operational Management Plan.

5.0 HEAP LEACH FACILITIES TEMPORARY SHUTDOWN

Temporary shut-down means any cessation of irrigation of the heap other than that required for normal ore stacking and irrigation system deployment, redeployment, and maintenance. Temporary shutdown of leaching could occur due to any of the following:

- Disruption to the workforce (e.g., labor dispute)
- Inability to import consumables to the site (e.g., due to blockages in the access road or river crossings); or
- Disruption to other components of the process, which affect upstream operations (such as a slope failure on the heap, which would reduce or prohibit irrigation until the problem was remediated).

Details of measures to be taken in the event of a temporary or unplanned shutdown are provided below. Guidance for reclamation and permanent closure of heap leach facilities is detailed in the *Reclamation and Closure Plan*.

5.1 Process Plant

The process plant can sit idle for an indefinite period without environmental impact. During temporary closure, normal maintenance would continue to return the plant to service once the condition causing the temporary shut-down is resolved. Reagent and other chemical storage would be secured to protect the agents from the weather or any other intrusions. Tanks, pipes, and pumps would be drained to prevent freezing. Direct or indirect heating of the plant would continue to the extent that fuel or electricity is available.

5.2 Heap and Leach Pad

The heap itself would be mostly unaffected by temporary shutdown, with the main effects being changes to the water balance, discussed in Section 4.9.2. Stacking is seasonal, and thus the facility is designed for extended disruptions to ore stacking. Irrigation will normally be year-round; however, temporary shutdown would disrupt irrigation. In the coldest months of the year, approximately December 1 to April 30, the interior temperature of the heap is elevated by the irrigation, and if this is halted the heap would be expected to cool. In the extreme, some zones of freezing (near the exterior of the heap) could develop. These would then require a slow and deliberate return to operation by applying heated barren solution at a sufficiently slow irrigation rate to allow thawing without creating ponds on the heap or saturated zones within the heap. The time required to complete re-heating would depend on the extent of the shut-down and the degree of freezing which had occurred (if any). Depending on the extent and expected duration of a temporary shutdown, thermistors may be installed in the heap to allow monitoring of the temperatures during shutdown and when the heap is returned to normal operations.

The ore is durable and erosion resistant and thus will not degrade under the normal actions of weather during even a prolonged shutdown. Any areas of the heap covered with raincoats at the time of shutdown will have those raincoats secured and anchored, and the diversion works designed to remove surface water from the heap will be placed in working order (if not already). For extended shutdown, those expected to last more than approximately nine months, most or the entire heap should be covered with raincoats. During a temporary shutdown, it may be appropriate to route this flow into natural drainage channels rather than the events and rainwater ponds.

The leach pad will be built in stages, and at any given time there may be areas of the recently constructed pad that are uncovered. These areas will be covered with overliner or other suitable material to protect the liner system during a shut-down.

All monitoring performed during operations will continue during any period of temporary shut-down, as described in Section 4.7.

5.3 Events and Rainwater Ponds

The HLF will have four ponds, each for extreme events. The pond capacities have been designed to accommodate all of the following upset or extreme events (in combination):

- Normal operating freeboard
- Seasonal water accumulation during the wettest year on record
- Complete drainage of the heap in the event of temporary shutdown
- The probable maximum precipitation (PMP) event including freshet.

The pond capacities anticipate solution storage for an extended shut-down period. If a shut-down continued longer than one year prior to commissioning of the water treatment plant, and if that year received the maximum design precipitation, then any further water accumulation would infringe on the PMP storage capacity. While this would not create an immediate crisis, a plan for extended shut-down would then need to be drafted. This plan could incorporate any combination of the following actions to reduce water accumulation:

- Increase the area of the heap under raincoats and improve the performance of the raincoats by active management (repairing damage, properly seaming panels, other actions that reduce infiltration into the heap).
- Increase evaporation in the dry seasons by removing raincoats and/or recommencing or increasing the area under irrigation (if pumping capacity is available). Irrigation of both active gold recovery areas and rinsing as part of progressive closure would increase evaporation and reduce accumulated water. Irrigating freshly stacked ore would increase water uptake in the ore and thereby reduce the accumulation in the ponds.
- Accelerate closure activities, including:
    - Construct closure caps over any areas of the heap that have been recirculated (rinsed); and
    - If the treatment plant is operational, treat (or increase the treatment rate) surplus water to meet discharge criteria. If the plant has not yet been commissioned, consider commissioning it ahead of schedule (this would only be appropriate for an extended temporary shutdown.

Monitoring of the heap should continue through the duration of any shutdown as described in the HLF OMS (Appendix D).

5.4 Detoxification

Water treatment for peak operations is expected in Year 2 for any discharges that are required.

5.5 Draindown

Once irrigation ceases, the heap will drain to very low effluent flow rates. Assuming that the heap is covered with the closure capping system or raincoats, the effluent flow would then decline slowly.

5.6 Covers

Temporary covers or raincoats will be used during temporary shutdowns to minimize infiltration of precipitation into the process circuits. Raincoats will be light-weight HDPE or similar material, deployed by the operators on a regular schedule to correspond to heap stacking and wet/dry seasons. Raincoat water will be stored in the HLF ponds and either reused in the circuit as make-up water or tested to determine the appropriate discharge method (through water treatment or via discharge to the natural drainages).

For areas of the heap that have been fully leached and rinsed, closure capping may commence or continue during temporary shutdowns. Closure capping is detailed in the *Reclamation and Closure Plan*.

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APPENDIX A

Heap Leach and Process Facilities Plan
Table of Concordance

Decision Document Mitigation Measures				
Mitigation Number	**Proposed Mitigation**	**Term included in Management Plan**	**Project Phases**	**Notes**
Wildlife and Wildlife Habitat				
1	The Proponent shall apply for a lease or another form of regulatory approval under the Territorial *Lands Act* that will provide the Proponent with the authority and ability to control access between Maisy May Creek and the Stewart River. The point of access control shall be the beginning of new road connecting the existing road network with the Stewart River barge landing. Access shall be restricted through means such as a gatehouse or equivalent access restriction until the road is decommissioned such that this section of new road not become a public road.	**Access Route Construction Management Plan** Section 2.0: Authorizations for Construction; Section 7.0: Access Tie-in, Access Control, and Staging Area	Construction / Operation	
		Access Route Operational Management Plan Section 3.1: Access Control		
		Wildlife Protection Plan Section 4.2.4.1: Access Management		
2	The Proponent shall restrict public access to the Coffee Creek barge landing and roads connected to the barge landing that it maintains. Access shall be restricted through means such as a gatehouse, as near the barge landing as possible, until such time the road network attached to the barge landing is decommissioned such that these roads not become public roads.	**Access Route Construction Management Plan** Section 7.0: Access Tie-in, Access Control, and Staging Area	Construction / Operation	Access restricted through operation of the barge landings and through a gatehouse located approximately 2.8 km northeast of the north Stewart River barge landing.
		Access Route Operational Management Plan Section 3.1: Access Control		Access restricted through operation of the barge landings and through a gatehouse located approximately 2.8 km northeast of the north Stewart River barge landing.
		Wildlife Protection Plan Section 4.2.4.1: Access Management		
2.1	The Proponent shall ensure that all new road sections do not become public roads and that all new road sections be decommissioned by the conclusion of project activities. New barge landings shall be obstructed in a manner to prevent unloading of vehicles by barge.	**Access Route Construction Management Plan** Section 9.13: Decommissioning and Reclamation	Closure	
		Access Route Operational Management Plan Section 3.1: Access Control	Construction / Operation / Closure	
		Reclamation and Closure Plan Section 7.8.2: On-site Access Road **NAR Reclamation and Closure Plan** Section 5.2: Final Reclamation and Closure	Closure	
3	The Proponent shall not use the NAR, except for maintenance purposes, when caribou migrations are expected to intersect the NAR or caribou are persistently crossing the NAR over a period of three days. Normal road use shall not resume until caribou are considered to have cleared the road corridor.	**Access Route Operational Management Plan** Section 4.5: Interaction with Wildlife	Construction / Operation / Closure	
		Wildlife Protection Plan Section 4.3.1: Species Specific Mitigation: Caribou		Phased approach to caribou mitigation: Response Level 3.
4	Snowbanks along the Northern Access Route shall be maintained at a level of less than 50 cm above the roadbed. Flowthrough breaks should be included at appropriate intervals and locations along the Northern Access Road.	**Wildlife Protection Plan** Section 4.1: Project Design; Section 4.2.4: Manage Road Operations	Construction / Operation / Closure	Snowbanks will be managed and maintained to 0.5 m high where safe to do so and allowed by other design considerations and will include periodic breaks to allow wildlife to move across the road, spaced between 500 m and 1 km apart on alternating sides of the road.
		Access Route Operational Management Plan Section 4.3: Snow Removal and Snow Management	Construction / Operation	Snowbanks will be managed and maintained to 0.5 m high where safe to do so and allowed by other design considerations and will include periodic breaks to allow wildlife to move across the road, spaced between 500 m and 1 km apart on alternating sides of the road.
5	The proponent shall retain an individual qualified in caribou behavior who will, in consultation with Government of Yukon, implement design features to reduce the likelihood of entrapment within project infrastructure as well as design features that reduce noise, visual, and light stimuli in alpine and subalpine habitats of high importance to caribou that are within line of sight of the mine site's activities to assist in reducing stimuli that may cause an expansion of the zone of influence (ZOI) for the mine site.	**Noise Management Plan** Section 5.0: Environmental Protection Measures	Construction / Operation / Closure	
		Wildlife Protection Plan Section 4.0: Wildlife Protection Measures Framework; Section 4.2: General Wildlife Protection Measures		
		Access Route Construction Management Plan Section 9.11: Wildlife Management		
6	Between May 1 and August 31, the minimum cruising altitude for project-related aircraft shall be 600m. This window will be extended as necessary based on seasonal caribou presence documented in the Wildlife Monitoring Plan and decision criteria in the Adaptive Management Plan.	**Wildlife Protection Plan** Section 4.2.5: Manage Aircraft Operations	Construction / Operation / Closure	

Decision Document Mitigation Measures				
Mitigation Number	**Proposed Mitigation**	**Term included in Management Plan**	**Project Phases**	**Notes**
Water and Aquatic Resources				
7	In evaluating whether the non-degradation threshold for Coffee Creek is met, the Proponent shall be subject to performance evaluation criteria that incorporate a suitable method to determine if the Coffee Gold Project is the primary or most substantial cause of any exceedance of the non-degradation threshold. The Proponent's non-degradation thresholds shall be revised to require that the Project not be the primary or most substantial cause of any exceedance of a non-degradation threshold.	**Environmental Monitoring and Adaptive Management Plan, Appendix L, Surface Water Quality and Aquatic Life Adaptive Management Plan** Section 2.3.2: Non-Degradation Water Quality Objectives - Coffee Creek and Yukon River	Construction / Operation / Closure	
8	The proponent shall revise water quality objectives prior to licensing, as necessary, dictated by the current relevant science and using the same level of protection assessed during the Screening. That is, use-protection objectives in Halfway, Latte and YT-24 creeks, and performance evaluations that reflect non-degradation objectives in Coffee Creek and the Yukon River downstream of Halfway, Latte and YT24 creeks.	**Water Management Plan** Section 1.4.2: Territorial Regulations	Construction / Operation / Closure	
9	Prior to licencing, the Proponent shall revise use-protection water quality objectives to ensure they incorporate the most recent toxicological information and guidance from CCME, Government of Canada, and BCMoE for the protection of freshwater aquatic life.	**Water Management Plan** Section 1.4.2: Territorial Regulations	Construction / Operation / Closure	
10	Reclamation and closure plans required under the Quartz Mining Act will include, at a minimum, the same use protection and non-degradation objectives as during operations. Water quality early warning triggers for reclamation and closure will be developed and applied for all watercourses as part of the Environmental Monitoring and Adaptive Management Plan.	**Reclamation and Closure Plan** Section 3.1.5: Water Quality Objectives **Reclamation and Closure Plan** Section 5.8.2: Contingency Planning and Adaptive Management Approach	Closure	
11	The Proponent shall develop water related adaptive management plans in accordance with Government of Yukon's 2021 guidance document, including any future revisions, "Guidelines for developing adaptive management plans in Yukon: water-related components of quartz mining projects".	**Environmental Monitoring and Adaptive Management Plan** Section 2.2: Adaptive Management Approach **Environmental Monitoring and Adaptive Management Plan, Appendix L, Surface Water Quality and Aquatic Life Adaptive Management Plan**	Construction / Operation / Closure	
12	Ore shall not remain on the ROM ore pad at the end of operations, during scheduled or unscheduled closure, without prior confirmation of long-term attenuation capacity of the schist pad for the key COPIs, arsenic and uranium that has been reviewed and accepted by the relevant regulator.	**Reclamation and Closure Plan** Section 6.4.1: Heap Leach Facility and ROM Stockpile; Section 7.4.2: ROM Stockpile Area Closure Measures	Temporary Closure	
13	The proponent shall provide to the relevant regulator all iterative water balance and water quality model runs generated in support of future licensing applications based on project updates, additional water quality mitigation measures proposed during screening and licensing, and new information. During operations, the proponent shall provide results of monitoring data to allow comparison with predictions with relevant regulators and affected First Nations.	**Water Management Plan** Section 7.0: Reporting **Water Management Plan** Section 8.0: Annual Water Management Planning	Construction / Operation / Closure	
14	Prior to licensing, the proponent shall summarize the results of all test work completed for the development of the proposed bioreactor treatment system (EBR system), identify treatment performance objectives for the EBR, provide timelines to complete the remaining test work and develop the detailed design of the EBR system.	**Heap Leach and Process Facilities Plan** Section 4.5: Water Treatment of Heap Leach Solutions **Heap Leach and Process Facilities Plan** Appendix E: Coffee Gold Mine Water Treatment - Preliminary Design	Construction / Operation	
15	The overall timeline for development of the EBR system must meet the conditions evaluated during the Screening, such that detailed plans for the EBR are submitted, reviewed and accepted by the responsible regulator, and the EBR is operational prior to the HLF water balance reaching a threshold that requires discharge of treated excess water to Halfway Creek or the Latte Pit.	**Heap Leach and Process Facilities Plan** Section 4.4: Solution Management **Heap Leach and Process Facilities Plan** Section 4.5 Water Treatment of Heap Leach Solutions	Construction / Operation	
16	The proponent shall provide contingency plans contemplating scenarios where timelines or effluent quality objectives cannot be met prior to licensing. Contingency plans shall include a proof of concept, an estimated implementation time, and water quality early warning triggers which will be developed and applied for all affected watercourses as part of the Environmental Monitoring and Adaptive Management Plan.	**Water Management Plan** Section 4.3.8.1: Alpha Pond Performance Targets and Mitigation Measures **Water Management Plan** Appendix A: Coffee Gold Project Contingency Water Management Measures - Memo	Construction / Operation	
		Heap Leach and Process Facilities Plan Section 4.5.3.3 and Appendix F: Contingency Water Treatment Plan	Construction / Operation	
17	The proponent must define acceptable performance conditions for the Alpha Pond in terms of water quantity and quality for seepage from the Pond as part of the adaptive management for the Alpha Pond.	**Water Management Plan** Section 4.3.8.1: Alpha Pond Performance Targets and Mitigation Measures	Construction / Operation	
18	The proponent shall provide contingency plans contemplating scenarios where the management of surface effluent discharged from Alpha Pond fails to meet water quality objectives in Halfway Creek.	**Water Management Plan** Section 4.3.8.1: Alpha Pond Performance Targets and Mitigation Measures	Construction / Operation	

Decision Document Mitigation Measures				
Mitigation Number	**Proposed Mitigation**	**Term included in Management Plan**	**Project Phases**	**Notes**
Traditional Land Use and Heritage Resources				
18.1	The Noise Management Plan shall include the following measures to reduce the effects on traditional land uses: a) The plan shall include an objective to mitigate noise from a traditional land use perspective. b) In collaboration with affected First Nations, mitigations measures shall be identified that achieve the above objective. This may include reducing the timing and frequency of noise-related activities during critical times for traditional land use, such as fall harvesting. c) The Proponent shall develop a system for tracking, recording, and responding to complaints related to noise in collaboration with Environmental Health Services. Complaints are to be submitted to Environmental Health Services for recording purposes. d) The Proponent shall establish, in discussion with affected First Nations and communities, a means by which to communicate and inform individuals and communities who may be affected by Project-related noise in advance of any changes in sound levels that may occur, including when planned blasts are predicted to occur or deviations in the blasting plans. e) This aspect of the plan shall be adaptive and be based on inputs from the Noise Monitoring Plan and/or through the Socio-economic Management Plan undertaken in collaboration with affected First Nations.	a) **Noise Management Plan** Section 1.2: Scope and Objectives b) **Noise Management Plan** Section 5.0: Environmental Protection Measures c) **Noise Management Plan** Section 5.1.5: Noise Complaint Procedure d) **Noise Management Plan** Section 5.1.3: Blasting e) **Noise Management Plan** Section 5.2: Adaptive Management **Company Procedures**	Construction / Operation / Closure	
19	The Proponent shall facilitate and support traditional land use activities within the project area to the extent possible (that is, within the limits of safety and in areas under the control of the Proponent). Facilitation and support shall include, but not be limited to: a) Making all or a portion of the Coffee Creek camp available for traditional uses; b) Funding suitable infrastructure at the Coffee Creek camp for traditional uses; c) Funding and supporting culture camps for affected First Nations; d) Ensuring staff are provided with information regarding traditional land uses they may encounter.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Traditional Knowledge and Lands and Resource Use Management Strategy	Construction / Operation / Closure	
20	The Proponent shall establish an elder-in-residence program in order to better: a) improve cross cultural awareness; b) increase First Nations physical presence at the mine site; c) improve First Nation knowledge of project development, and improve the Proponent's understanding of First Nation perspectives regarding the Project's development; d) ensure First Nation workers can access elders at the mine site.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Cultural Awareness and Diversity Management Strategy	Construction / Operation / Closure	
21	The Proponent shall include the following in the scope of the Socio-Economic Management Plan: a) A management objective to continue to identify effects on each affected First Nation's Traditional Land Use in the Coffee Creek Area b) A commitment to carrying thorough effectiveness monitoring and adaptive management of measures intended to mitigate impacts from construction until post-closure; c) A commitment to ensure that all affected First Nations have an opportunity to participate in developing end land use objectives for the site that are consistent with traditional land use values for the area, including future uses. d) Development of a Terms of Reference with each affected First Nation for the methodology to undertake studies under the umbrella of the SEMP relating to effects to Traditional Land Use, including roles and responsibilities of Proponent and First Nation contributors; and e) Capacity funding to ensure the affected First Nations' full participation in the SEMP management and monitoring components that are relevant to the affected First Nations interests, if they so choose.	a) **Socio-economic Monitoring Plan** Section 6.0: Monitoring b) **Socio-economic Monitoring Plan** Section 6.0: Monitoring c) **Socio-economic Monitoring Plan** Section 1.6.2: Potentially Affected First Nations' Role and Responsibility d) **Socio-economic Monitoring Plan Section** 1.6.2: Potentially Affected First Nations' Role and Responsibility e) **Socio-economic Monitoring Plan** Section 1.6.2: Potentially Affected First Nations' Role and Responsibility	Construction / Operation / Closure	
22	The Proponent shall fund efforts of affected First Nations (TH, WRFN, SFN and FNNND) to collect traditional knowledge with respect to the Coffee Creek area for the purposes of supporting a First Nation-developed culture program aimed at transmitting knowledge about the area to future generations.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Traditional Knowledge and Lands and Resource Use Management Strategy	Construction / Operation / Closure	

Decision Document Mitigation Measures				
Mitigation Number	**Proposed Mitigation**	**Term included in Management Plan**	**Project Phases**	**Notes**
23	The Proponent shall provide capacity funding for each affected First Nation to retain Indigenous Project Monitors, if they so choose, which shall have the following functions in relation to reducing effects to traditional land use; a) To identify, document and develop mechanisms to support resolution of potential conflict between mining activities and First Nation cultural values and practices in the Coffee Creek area. b) The monitors shall be involved in the collection of information on matters on-site related to harvestable resources in the project area and surrounding landscape and ways in the accessibility to those resources or quality of experience in harvesting those resources may be diminished. c) The monitors shall be on-site during mining activities but also be given means for community-based outreach work. This may include but not be limited to travel to First Nation primary communities and/or accommodating First Nation elders and land users at the site. d) The monitors shall also be involved in data collection for other culturally important land uses. Data collection shall include but not be limited to land user perceptions, regarding compatibility of traditional activities and adjacent industrial activities (e.g. user tolerance for noise, visual scarring, or other "sense of place" determinants). e) The Monitors shall be provided authority and resources to scope traditional knowledge and traditional use studies aimed at documenting mining / land use conflicts (actual or potential), and ways in which those conflicts could be mitigated. For greater clarity, this condition envisions that the Monitor may, from time to time, employ supporting staff of their choosing to support special projects. f) Funding for the Monitors shall be sufficient to enable the above functions, if so desired by each affected First Nation. The Indigenous Project Monitors act as a liaison between the affected First Nations and the Proponent and are a mechanism to implement the adaptive management framework outlined in the SEMP to address effects to traditional land uses. The Indigenous Project Monitors may act in conjunction with, or replace, the Environmental Monitors as committed to by the Proponent, depending on the needs and preferences of each affected First Nation. The Indigenous Project Monitors are intended to be independent of the Proponent and represent the interests of the affected First Nations.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Traditional Knowledge and Lands and Resource Use Management Strategy	Construction / Operation / Closure	
24	The proponent shall only landfill inert substances at the project site. The Proponent shall work with affected First Nations and regulatory agencies to develop an Approved Landfill Materials list and mechanism for establishing suitably low leachability risk for proposed landfill materials.	**Waste and Hazardous Materials Management Plan** Section 1.3: Incorporation of Traditional Knowledge and Consultation Feedback, Section 5.0 Waste Management and Appendix B: Waste Materials List	Construction / Operation	
Health and Safety				
25	The Proponent shall develop mandatory, regular harassment prevention training, in consultation with a qualified expert, to be delivered to all the Proponent's employees, contractors and consultants working on the Project. The qualified expert must also be proficient in cross-cultural awareness training.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
26	The Proponent shall ensure that human resource staff complete training to enable them to effectively support employees who disclose workplace harassment. In order to support reporting of sexual harassment and assault, human resource staff shall provide all new staff members with information about ways in which they can record and provide evidence of harassment or bullying, what happens after they make a disclosure, and how they will be protected from reprisals.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
27	The Proponent shall ensure that all HR staff complete training to effectively support employees who disclose sexualized or gender-based violence, as well as harassment and discrimination against Indigenous people in their workplace or at home. It is recommended that a counsellor be available on site for support through this as well.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
28	The Proponent shall create a mentor program for Yukon First Nation employees to achieve three goals: a) ensure that First Nation women have access to a mentor or supervisor who has the authority to and regularly checks in to address any negative experiences related to the male-dominated work environment, and who pays special attention to potential cases of abuse; b) develop a formal feedback process to ensure that enquiries are regularly made of First Nation employees to ensure that they are able to voice their concerns and address any negative experiences; and c) involve TH, SFN, FNNND and WRFN in further developing the program to ensure that it meets the needs of First Nation employees.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy	Construction / Operation / Closure	

Decision Document Mitigation Measures				
Mitigation Number	**Proposed Mitigation**	**Term included in Management Plan**	**Project Phases**	**Notes**
29	The Proponent shall, in consultation with a qualified expert and with TH, SFN, FNNND and WRFN, develop gender appropriate and gender- and sexuality-specific policies and processes that promote a safe, respectful, and inclusive environment for women and gender and sexual minorities.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
30	The Proponent shall ensure that HR staff administer confidential exit surveys with explicit questions about whether workplace harassment occurred, if disclosures were made, and what supports were provided. The proponent shall use this information to track trends and inform hiring, policy, and other initiatives at the mine site, and shall provide an annual report to Health and Social Services and the Women's Directorate detailing the Proponent's efforts to prevent workplace harassment as well as statistics on reported incidences of harassment, disclosures, etc.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
31	The Proponent shall ensure that the on-site First Aid Technician or Emergency Medical Technician is trained in Mental Health First Aid and/or has formal mental health training to provide short-term or crisis support at the mine site and has referrals to other mental wellness supports or navigation to other systems.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy	Construction / Operation / Closure	
32	The Proponent shall ensure that on-site employees have the ability to utilize the Employee Assistance Plan (EAP) services available (i.e., make available a private phone line or Internet connection so employees can discreetly reach EAP services)	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
33	The Proponent shall retain professional services in the appropriate field to help their on-site mental health first aid staff develop the methods and tools that are appropriate to provide support to perpetrators of violence and harassment to help end cycles of abuse.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy	Construction / Operation / Closure	
34	The Proponent shall consider gender equity/diversity in hiring processes.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policy**	Construction / Operation / Closure	
35	To address and mitigate impacts to employees who are or become victims of domestic abuse, the Proponent must create a policy that: a) outlines clear procedures for the workplace to deal with affected employees and provide appropriate resources and support; b) plans for and addresses the safety concerns of the affected employees while at work to ensure that all workers are safe from threats of domestic violence; and c) includes a personal safety plan for employees suffering from domestic violence.	**Code of Conduct**		Additional detail will not be provided
36	The Proponent shall provide access to the EAP for the eligible dependents of employees and inform all employees of this.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy **HR Policies - EAP**	Construction / Operation / Closure	
37	The Proponent shall develop clear standards for behaviour at work and codes of conduct against sexual harassment and gender-based violence on the job site and in the broader community, including standards/codes of conduct in relation to the sex trade, and shall distribute education and awareness campaign materials on gender-based violence. Refer to Unlocking Opportunities for Women and Business: Actions and Strategies for Oil, Gas and Mining Companies Tool Suite 4: Addressing Gender Based Violence in the Workforce (2018) for information and resources.	**Code of Conduct**		Additional detail will not be provided

Decision Document Mitigation Measures				
Mitigation Number	**Proposed Mitigation**	**Term included in Management Plan**	**Project Phases**	**Notes**
38	The Proponent's Noise Management and Monitoring Plans submitted at licensing should incorporate all recommendations outlined in Appendix 10-A Noise Intermediate Component Analysis Report 2017, s.43.3. In addition, the Proponent must implement the following measures based on industry best-practice guidelines: a) Workers' living quarters shall be designed to limit noise, with mitigating features such as high-quality soundproofing for windows and seals on doors. b) Physical barriers shall be used to maximize shielding and reduce noise transmission. Physical barriers shall be of an appropriate height and thickness to break the line-of-sight between the project related noise sources and the dormitory and other sensitive receptors at the permanent camp, to reduce noise levels to lower than 30 dBA (Leq) indoors to be protective of sleep. c) Optimization of operations shall include notifying workers of the schedule for loud procedures or particularly annoying noise events. Periods of respite shall be provided in the case of unavoidable maximum noise level events.	a) **Noise Management Plan** Section 5.1.4: Design of Permanent Camp b) **Noise Management Plan** Section 5.1.1: Heavy Equipment c) **Noise Management Plan** Section 5.1.3: Blasting	Construction / Operation / Closure	
39	If thresholds under YAAQS are being approached at the sites of the monitoring stations, or where CACs have exceeded thresholds, activities involving sources of emission be reduced or have additional emission mitigations applied. In this way, air quality and adaptive management may reduce or prevent further increases in CACs, and reduce the risk to employees during non-working hours. The Proponent shall notify workers traversing areas that have elevated outdoor concentrations and require them to use appropriate PPE. Off-duty workers will be advised to reduce exposure by remaining indoors to the extent possible and closing windows in camp residences at times of peak emissions.	**Air Quality and Greenhouse Gas Monitoring Plan**	Construction / Operation / Closure	Emission sources determined to cause excursions of or approaches to CAC thresholds will be reduced, curtailed and/or have additional emission mitigations applied.
40	The Proponent shall incorporate an adaptive management plan in collaboration with First Nations and regulators, that establishes concrete actions for approaching and exceeding thresholds. The following adaptive management actions and corresponding triggering thresholds are to be used until such time as a detailed project specific approach is jointly developed to operationally target the reduction of CAC's and particulates and management of air quality at, and in proximity to, the Project site.	**Environmental Monitoring and Adaptive Management Plan, Appendix I, Air Quality and Greenhouse Gas Monitoring Plan**	Construction / Operation / Closure	
41	The Proponent shall ensure that impacts on employee health (both on and off-duty, on-site) are considered in assessing the need for adaptive measures. The Proponent shall ensure that ambient air quality in camp buildings meets indoor air quality guidelines through various means including the use of adequate ventilation and air filtration systems, effective insultation, seals on windows and doors, bans on vehicles idling in the immediate vicinity. Indoor air monitoring will occur to ensure that emissions are not accumulating in indoor environments.	**Air Quality and Greenhouse Gas Management Plan** Section 7.1.4: Design of Camp Accommodations **Health and Safety Program**	Construction / Operation / Closure	
Community and Economics				
42	The Proponent shall maintain a transition fund, as a component of the Workforce Transition Strategy, of an amount sufficient to ensure, in the event of unscheduled closure: a) the funding of programs and other financial commitments outlined in the Socio-Economic Monitoring Program for a period of 12 months, b) maintenance of the Employee Assistance Program for a minimum of 6 months.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Local Employment and Procurement Management Strategy	Construction / Operation / Closure	
43	The Proponent will promptly notify Health and Social Services of unscheduled closures, the supports and services the Proponent has in place for impacted employees and their families, and any forecasted implications beyond the scope of what the Proponent can address. Health and Social Services will assess the need to coordinate or deploy health and social resources to support impacted communities, in alignment with mandate(s) and scope.	**Reclamation and Closure Plan** Section 6.7.1: Management of Socio-economic Aspects of Temporary Closure	Temporary Closure	
44	The Proponent shall provide staff with access to online information and resources for money management and budgeting.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Local Employment and Procurement Management Strategy **HR Policies - EAP**	Construction / Operation / Closure	
45	Recruitment for care and maintenance positions shall follow the same process used for hiring mine employees, prioritizing local hire, with preference given to former qualified mine employees.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Local Employment and Procurement Management Strategy	Construction / Operation / Closure	
46	Security requirements shall take into consideration the potential for early unscheduled closure and the need for care and maintenance requirements to maintain environmental safeguards prior to decommissioning.	**Reclamation and Closure Plan** Section 9.0: Reclamation and Closure Liability	Closure	
47	The Proponent shall match the current Government of Yukon incentive for secondary suite renovation ($10,000). Residents in Dawson and its environs will be eligible, with the number of Proponent grants capped at 30 approved and matched incentives.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Infrastructure and Services Management Strategy	Construction / Operation / Closure	
48	The Government of Yukon shall work with the City of Dawson and Tr'ondëk Hwëch'in Government to identify and make available suitable lands for housing development.	**Yukon Government**		Additional detail will not be provided

Decision Document Monitoring Requirements				
Mitigation Letter	**Proposed Mitigation**	**Management Plan**	**Project Phases**	**Notes**
Wildlife and Wildlife Habitat				
A	The Government of Yukon shall implement a monitoring program for linear development (i.e. roads) and surface disturbance (i.e. mined areas) in the White Gold area in relation to effects to moose and other wildlife (i.e. caribou). The program shall be scoped with the following considerations: 1. Monitoring shall include past developments and disturbances as well as reclamation efforts. 2. Monitoring shall seek to consolidate the quantity and quality of data submitted by Proponents into a consistent format for intended use in this program. 3. The program shall aspire to define significant cumulative linear and surface disturbance thresholds in the White Gold area for moose and caribou prior to issuance of any new Quartz Mining Land Use approvals, or expansion by more than 5% of the disturbance area for existing approvals. 4. The program shall be developed collaboratively with First Nations with traditional territory overlapping the area. First Nation participation in the monitoring program shall be funded by Government of Yukon. 5. The program shall be guided by a Terms of Reference (ToR), developed by consensus with Government of Yukon and First Nation government representatives. The ToR shall define temporal and spatial scopes, roles and responsibilities, and overall mandate. 6. Monitoring shall reflect and complement priorities identified in and work undertaken for the Dawson Land Use Plan.	**Yukon Government**		
B	The Government of Yukon shall implement monitoring of the overall abundance of moose in the Dawson Gold Fields MMU using a variety of methods that allow for tracking of population abundance and spatial distribution, such as aerial surveys and tracking of licensed harvest data, and which are performed consistently throughout the Project's lifecycle. Surveys should be conducted in early winter, commencing prior to construction, with subsequent surveys at five-year intervals, where possible, and include involvement of monitors from affected First Nations. The subsequent effects monitoring shall be informed by survey results and annual monitoring of all licensed moose harvest in game management subzones adjacent to, and intersecting the Northern Access Route.	**Yukon Government**		
C	The Proponent shall, in coordination and consultation with Government of Yukon, undertake effects monitoring of moose populations for areas of direct overlap with mine infrastructure, including the Northern Access Route, and for areas determined to be in the ZOI for moose within the Dawson Gold Fields MMU, Lower Stewart MMU and White Gold MMU.	**Environmental Monitoring and Adaptive Management Plan, Appendix G Wildlife Monitoring Plan**, Section 5.0: Moose Monitoring.	Construction / Operation / Closure	
D	Within 5 years of commencing operations, Government of Yukon shall conduct regional surveys, focusing on the interactions between the Fortymile and Klaza caribou herds and the Project. These surveys shall be conducted for the purposes of understanding the direct effects of the Project as well as the effects of the Project's induced development on herd movements and populations, establishing adaptive management thresholds and determining if additional measures are required should the evidence indicate there are negative project-related effects on caribou, either directly or indirectly.	**Yukon Government**		

Decision Document Monitoring Requirements				
Mitigation Letter	**Proposed Mitigation**	**Management Plan**	**Project Phases**	**Notes**
Water and Aquatic Resources				
E	The proponent shall develop and implement a plan to monitor seepage quality downgradient of the ROM ore pad to serve enable detection of any arsenic or uranium breakthrough from the pad to the underlying groundwater. Monitoring data shall be compared to triggers developed under the proponent's Environmental Monitoring and Adaptive Management Plan.	**Environmental Monitoring and Adaptive Management Plan, Appendix C, Groundwater Monitoring Plan** Section 2.3.5: Seepage Monitoring	Construction / Operation / Closure	GW Monitoring Plan includes a visual survey once a month during the non-frozen season to confirm the presence of persistent seepage around facility perimeters (ROM).
		Environmental Monitoring and Adaptive Management Plan, Appendix L, Surface Water Quality and Aquatic Life Adaptive Management Plan Section 4.5.3: Indicators, Performance Thresholds and Responses		Latte Creek thresholds tied to completing an evaluation of the ROM stockpile pad seepage.
F	The proponent's Environmental Monitoring and Adaptive Management Plan (EMAMP) plan shall include: 1. Water management goals defined as use-protection in Halfway, Latte and YT-24 creeks, and non-degradation in Coffee Creek and the Yukon River downstream of Halfway, Latte and YT-24 creeks;	1) **Water Management Plan** Section 1.4.2: Territorial Regulations 1) **Environmental Monitoring and Adaptive Management Plan, Appendix L, Surface Water Quality and Aquatic Life Adaptive Management Plan** Section 1.2: Adaptive Management Plan Objectives	Construction / Operation / Closure	
	2. For the purpose of non-degradation performance evaluation for the Yukon River extend monitoring spatially to the Yukon River downstream of Halfway, YT-24 and Coffee creeks, in areas directly affected by each creek's plume. This is in addition to water quality for the purpose of non-degradation performance evaluation in the fully mixed areas of the Yukon River downstream of Coffee Creek.	2) **Environmental Monitoring and Adaptive Management Plan, Appendix B Surface Water Quality Monitoring Plan** Section 2.0: Monitoring Locations and Frequencies		
	3. The rationale for the scope of the monitoring programs;	3) **Environmental Monitoring and Adaptive Management Plan** Section 2.0: Environmental Monitoring Approach		
	4. Descriptions of how the Project effects assessments informed the development of the monitoring programs; and	4) **Environmental Monitoring and Adaptive Management Plan** Section 2.0: Environmental Monitoring Approach		
	5. Descriptions and rationales for which programs require an adaptive management component.	5) **Environmental Monitoring and Adaptive Management Plan** Section 2.2: Adaptive Management Approach		
	6. Include AMP events for Halfway Creek closer to the site than HC1.0, which is located in the lower reaches of Halfway Creek upstream of the Yukon River, where use-protection WQOs can be proposed;	6) **Water Management Plan** Section 4.3.8.1: Alpha Pond Performance Targets and Mitigation Measures		
	7. Include annual assessments to confirm non-degradation of surface water quality in Coffee Creek downstream of Latte Creek and the Yukon River downstream of Halfway, Latte and YT-24 creeks; such assessments will include comparison to a reference watershed;	7) **Environmental Monitoring and Adaptive Management Plan, Appendix L, Surface Water Quality and Aquatic Life Adaptive Management Plan**		Will not include a comparison to a reference watershed.
	8. Thresholds for arsenic and uranium levels in downgradient seepage of the ROM ore pad and triggers for adaptive measures	8) **Environmental Monitoring and Adaptive Management Plan, Appendix L, Surface Water Quality and Aquatic Life Adaptive Management Plan** Section 4.5.3: Indicators, Performance Thresholds and Responses		Latte Creek thresholds tied to doing an evaluation of the ROM stockpile pad seepage.
	9. And shall develop Adaptive Management initiatives to address areas of uncertainty relevant to: i. Performance of the Alpha Rock Drain; ii. Performance of the Alpha Pond(s) (water quality and seepage quantity and quality); iii. Performance of the bioreactor treatment system for HLF seepage (EBR system); and iv. NORM/TENORM for long-term storage of uranium-rich materials (EBR materials)	9i) **Water Management Plan** Section 4.3.7: Alpha Rock Drain 9ii) **Water Management Plan** Section 4.3.8.1: Alpha Pond Performance Targets and Mitigation Measures 9iii) **Heap Leach and Process Facilities Plan** Section 4.5.3.1: Process Descriptions; Appendix E: Coffee Gold Mine Water Treatment - Preliminary Design. 9iv) **Heap Leach and Process Facilities Pla**n, Section 4.5.3.1 Process Descriptions		
	10. Define stabilization of water quality in the Alpha Pond (during the Closure phase, as a pre-condition for decommissioning of the Alpha Pond in Post-Closure) as: i. No notable upward trends in the COPIs ii. A sustained reduction in inter-annual variability in COPI concentrations from Operations phase conditions iii. Discharge concentrations for all COPIs are consistently at levels that allow WQOs to be achieved in Halfway Creek.	10) **Reclamation and Closure Plan** Section 7.11.2: Aquatic Conditions Monitoring, Section 5.8.2 Contingency Planning and Adaptive Management Approach		

Decision Document Monitoring Requirements				
Mitigation Letter	**Proposed Mitigation**	**Management Plan**	**Project Phases**	**Notes**
Health and Safety				
G	The Proponent shall include the following parties in the development of a monitoring program to ensure that the Project's effects on personal safety are adequately monitored: Government of Yukon, the Yukon Status of Women Council, and the Yukon Aboriginal Women's Council.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Health and Well-Being Management Strategy		
H	To position Government of Yukon with adequate information to act on recommendations and preparation of services within communities, data collected in the monitoring program must be shared and used by parties in the development of response and resources to address effects as they occur. To support that, information relating to the amount and percentage of workforce that is transient to the Yukon will be required. The Proponent shall provide a quarterly report detailing the numbers and percentage of workforce that is transient (i.e. fly-in/fly-out and non-resident to the Yukon) to the Government of Yukon.	**Socio-economic Monitoring Plan** Section 6.0: Monitoring **Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Infrastructure and Services Management Strategy and Community Health and Well-Being Management Strategy		
I	The Proponent shall develop an Air Quality and Dust Management and Monitoring Plan which incorporates the following: 1. Long-term Monitoring stations o Long-term monitoring stations will be operated throughout the phases of the Project. The long-term monitoring stations: o Shall be placed at the permanent camp facilities, mine dry and office complex); the truck shop/warehouse; and at the Yukon River foreshore, east of the existing Coffee Creek camp. These are sites of predicted exceedances and worker presence (including off-duty workers) and likely exposure. The aim of establishing these stations is to redress the insufficient number of monitoring stations suggested by the Proponent for the mine site area. o Employ continuous monitoring, as opposed to the periodic and volumetric monitoring currently proposed. 2. Apply the use of MicroPulse LiDAR technology to monitor and track dust and particulates throughout the Project and adjacent areas. 3. At the commencement of Project Operations, Government of Yukon (YG) shall develop a repository for the monitoring data collected by the Proponent under the Air Quality and Dust Management Plan, and which it will provide on a timely (quarterly) basis. This repository will be accessible to First Nations, industry parties, regulators and the general public. YG shall review repository data and ensure compliance with the Adaptive Management Measures outlined under Mitigations 40 and 41. 4. A system for implementing additional monitoring and/or mitigation measures in the event of: o Changes to overall air quality, particularly increases in particulates, dust and contaminant concentrations approaching thresholds; o Complaints o Such a plan is required for submission during the Quartz Mining Licence phase for the Project. 5. A system for tracking, recording and responding to complaints related to air quality in collaboration with Environmental Health Services. Complaints are to be submitted to Environmental Health Services for recording purposes.	1. **Environmental Monitoring and Adaptive Management Plan, Appendix I, Air Quality and Greenhouse Gas Monitoring Plan** Section 2.0: Monitoring Locations, Section 3.0: Monitoring Methodology 2.**Environmental Monitoring and Adaptive Management Plan, Appendix I, Air Quality and Greenhouse Gas Monitoring Plan** Section 4.0 Data Analysis and Interpretation; Yukon Government 3.**Environmental Monitoring and Adaptive Management Plan, Appendix I, Air Quality and Greenhouse Gas Monitoring Plan** Section 6.0 Reporting and Annual Review 4. **Coffee Grievance Mechanism** 5. **Coffee Grievance Mechanism**	Construction / Operation / Closure	1. Continuous monitoring for PM10, PM2.5, NOx and SO2 and discrete monitoring for dustfall with metals analysis is proposed for the mine dry and office complex. Passive monitoring for dustfall fall with metals analysis and NOx and SO2 is proposed for the Yukon River Foreshore. The Yukon river foreshore location is only inhabited for part of the year and will likely have unreliable power, therefore, passive monitoring is proposed for this site. The truck shop/warehouse and the existing Coffee Creek Camp are not expected to produced statistically different results than the mine dry and office complex and may have reliable power and/or equipment interference effects. 2. MicroPulse LiDAR is not a currently available and accepted practice.
Community and Economics				
J	A working group shall be formed consisting of Government of Yukon, City of Dawson, Tr'ondëk Hwëch'in Government and the Proponent. This working group will monitor project-induced population growth and housing demand across project life. Project monitoring must involve the collection of data on the population of Dawson, rental and homeownership rates, availability of rental and market housing and associated prices. The Proponent shall provide an annual report on workforce numbers and place of worker residence, made publicly available, to establish clear reporting of inmigration trends.	**Socio-economic Monitoring Plan** Appendix B: SEMP Management Strategies - Community Infrastructure and Services Management Strategy		

Proponent Commitments

FSR Plan	Mitigation Name	Reference	Proponent Committed Mitigation	Commitment Incorporated	Section Location	Notes
Heap Leach and Process Facility (HLPF)	Heap Leach Solutions	SIR1-5.7-R98 (YOR 2017-0211-324-1)	Upon completion of active leaching operations, solution management will be required until the closure cover is established, and clean runoff is diverted off the facility.	Yes	**RCP** Section 7.3.1: Heap Leach Pad Closure measures	
Heap Leach and Process Facility (HLPF)	Heap Leach Solutions	SIR1-9.4-R207 (YOR 2017-0211-325-1)	Water treatment of HLF draindown waters will continue until both seepage volumes and seepage chemistry are reduced sufficiently such that additional polishing measures (e.g., biological passive treatment) are demonstrated to meet post-closure discharge limits. An extensive testing and piloting program is planned for post-closure water management using biological passive treatment. Results of this program, along with results from the progressive rinsing and in situ reclamation proposed for the HLF, will dictate the timing of post-closure water treatment.	Yes	**RCP** Section 5.3.12: Site Water Management Infrastructure; Section 2.3.1: Reclamation Research	
Heap Leach and Process Facility (HLPF)	Heap Leach Solutions	SIR2-2.6-R2-14 (YOR 2017-0211-411-1)	The EBR will be operating year-round for treatment of rinse waters for the heap, but only during the open water period of May to September for treatment of excess heap leach rinse waters that are to be discharged to the environment. Phase 2 testing will optimize the EBR system to include and test any needed pre-and/or post-treatments required to achieve site water treatment objectives.	Yes	**HLPF Plan** Section 4.5.2: Chemistry of HLF Solutions	The WTP will be available for treatment of site impacted water year round, but is planned to be used for excess heap leach solution during the open water period.
Heap Leach and Process Facility (HLPF)	Heap Leach Solutions	SIR1-Appendix 2-A(YOR 2017-0211-327-1)	A risk management control Secondary containment and maintenance of surrounding vegetation for passive filtration will be implemented as controls to manage risk of HLF pumping system failure and uncontrolled discharge of process solution.	Yes	**ERP** Appendix A: Heap Leach Facility ERP	Commitment has been met with the design features of the HLF.
Heap Leach and Process Facility (HLPF)	Heap Leach Solutions	SIR3-R3-56 (YOR 2017-0211-501-1)	If on site disposal of EBR sludge is not deemed viable, it will be disposed at a licensed offsite disposal facility.	Yes	**HLPF Plan** Section 4.5.3.1: Process Descriptions	Currently, dewatered solids could be stored in a lined facility and/or in completed sections of the heap leach facility.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	PP Table 32-1 (YOR 2017-0211-027-1)	Surface water and rainwater will be kept away from the HLF and process circuit to the maximum extent possible through: • Installation of permanent and interim perimeter diversion channels and berms around perimeter of heap leach pad.	Yes	**HLPF Plan** Section 4.6.2: Non-contact water	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• Installation of a drainage ditch or berm and drainage pipe between each heap leach stage, and between cells within each stage by construction of a ditch or berm with a drainage pipe every 100 m. These berms and ditches will allow high-resolution tracking of solution chemistry and aid in progressive closure by allowing rinsing of older portions of the heap leach pad.	Yes	**HLPF Plan** Section 3.8.2: Solution Collections Systems	100 m drainage ditch spacing is approximate. Rinsing/recirculation is terminology used in the plan.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• Expected to begin in Year 3, placement of raincoats (i.e., exposed geomembrane covers) over portions of the heap leach pad to minimize infiltration of rainwater and snowmelt into the heap leach pad and process circuit, and to increase heat retention in the winter.	No		HLF WB indicates that raincoats are not required, and the HLF design has been udpdated to not require the use of raincoats.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR1-2.8-R24 (YOR 2017-0211-323-1)	• From year 4 to 8, approximately 40 to 80 % of heap is expected to be covered with raincoats. From 9 through closure, approximately 90 % of heap is expected to be covered with raincoats. From Year 5 through Closure, the cited percentages are the combined area of installed raincoats and completed closure (rinsing, grading, and capping), as both are treated the same in the water balance model.	No		HLF WB indicates that raincoats are not required, and the HLF design has been udpdated to not require the use of raincoats.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	PP Table 32-1 (YOR 2017-0211-027-1)	• Progressive closure of HLF will reduce length of time that HLF is at its maximum footprint size.	Yes	**HLPF Plan** Apppendix B: Heap Leach Pad Engineering Report for Licensing	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SLR4-R4-2 (YOR 2017-0211-4259)	• Progressive reclamation of the heap leach pad will entail rinsing individual sections of the heap leach ore once they have undergone the complete gold recovery cycle. The heap will be rinsed (via solution from the rinse pipelines) and capped in stages; as each stage is capped, the raincoats for that area will be removed and used in other areas or incorporated as part of the closure capping.	Yes	**HLPF Plan** Apppendix B: Heap Leach Pad Engineering Report for Licensing	Partially incporporated. The heap solution will be recirculated for rinsing and not through specific "rinse pipelines", and reliance on raincoats is not included in current design.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR3-R3-20b (YOR 2017-0211-501-1)	• The monitoring of the diversion channels is expected to consist of monthly survey checks (fixed survey monitoring points will be installed for reference), and weekly visual checks / inspections during operation (diversion decommissioned for closure). These weekly inspections and monthly surveys will be completed by site staff.	Yes	**HLPF Plan** Section 4.7.4: Inspection Frequency	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR3-R3-20c (YOR 2017-0211-501-1)	• If the performance of the diversion channels is less than what has been assessed during the screening, mitigation will consist primarily of ongoing maintenance. • Although not expected additional mitigation measures that could be applied (if the performance of the diversion channels is less than what was assessed during screening) would consist of: o Constructing a 'key' (excavation and engineering fill backfill) at the downstream toe of the diversion, or o Shallowing up the downstream slope (i.e., adding fill on downstream to reduce slope grades).	Yes	**HLPF Plan** Section 4.6.2: Non-Contact Water	

Proponent Commitments

FSR Plan	Mitigation Name	Reference	Proponent Committed Mitigation	Commitment Incorporated	Section Location	Notes
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR2-2.3-R2-10 (YOR 2017-0211-411-1)	• Diversion channels will be used to convey upstream non-contact water around the site. The collection channels are designed for the 100-years peak flow and have base grades aimed to eliminate the need for pumping systems. Specifically: o The Waste Rock Perimeter Collection channel will collect runoff and seepage downgradient from the ROM stockpile and convey flows to the downstream Facility Pond. o The surface runoff from roads will drain across the roads to the upgradient side slope, where the drainage ditch will run parallel to the road.	Yes	**WMP** Section 4.3.3.1: Diversion Berms	Non-contact water diversion channels have been designed to convey the 1 in 10-year 24-hour flood event. This event was selected based on the secondary controls for water downstream of the divesrions. Specifically: * The Double Double Diversion Berm will collect non-contact water around the northern perimeter of the Double Double Pit. Overflows will be collected in the Double Double Pit and used for dust suppression or makeup water at the mill. * The Halfway Creek Diversion Berm will collect non-contact water around the northwet perimeter of the Alpha WRSF and discharge to Halfway Creek. Overflows will be collected in the Alpha Pond and conveyed through the emergency spillway to Halfway Creek. * Surface runoff from roads will drain across the roads to the upgradient side slope, where a drainage ditch will run parallel to the road.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• The alignment of the roads will be constructed of fill and the upstream toe of the road will be designed so that water will flow downgradient along the road alignment.	Yes	**WMP** Section 4.3.3.2: Roadside Runoff Conveyance	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• At set locations, the runoff travelling alongside the upstream toe will be directed downgradient through the use of a conveyance structure, such as a culvert, or in some cases, an open pit.	Yes	**WMP** Section 4.3.3.2: Roadside Runoff Conveyance	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• Erosion and sediment control practices will be applied along roads to reduced erosion.	Yes	**WMP** Section 4.3.3.2: Roadside Runoff Conveyance	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• Where warranted, to limit the rate of potential permafrost degradation, cuts will aim to be avoided, and only fill used.	Yes	**WMP** Section 4.3.3.2: Roadside Runoff Conveyance	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• The roadside drainage will be designed with a minimum depth of 1.0 m (from the upstream toe to the top crest of the road).	Yes	**WMP** Section 4.3.3.2: Roadside Runoff Conveyance	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR4-R4-2 (YOR 2017-0211-4259)	• A non-woven geotextile may be placed only in areas of higher expected ground ice content or with more exposed soil slopes (less vegetation) that are determined (based on field mapping) to be more prone to erosion. When used, the geotextile material would be covered with a thin layer of riprap protection.	Yes	**WMP** Section 4.3.3.2: Roadside Runoff Conveyance	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• The diversion berm will divert non-contact water around the Double Double Pit, and around Kona Pit, and the Alpha Rock Waste Rock Storage Facility.	Yes	**WMP** Section 4.3.3.1: Diversion Berms	There will be diversion berm to divert non-contact water around the Double Double Pit and towards a tributary of Latte Creek (Double Double Diversion Berm). An additional diversion berm (Halfway Creek Diversion Berm) will collect non-contact water aroun the northeast perimeter of the Alpha WRSF and discharge downstream of the Alpha Pond
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• Non-contact water from these diversions will be discharged towards the valley bottom (towards Latte for the Double Double Diversion and towards Halfway Creek for the Alpha WRSF / Halfway Diversion).	Yes	**WMP** Section 4.3.3.1: Diversion Berms	
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water		• These berms will typically consist of building a berm on the natural slope to create a v-notch channel on natural ground. When slopes exceed approximately 10% additional erosion protection measures will be put in place.	Yes	**WMP** Section 4.3.3.1: Diversion Berms	These berms will typically consist of building a berm on the natural slope to create a 1-m wide trapezoidal channel on natural ground. When slopes exceed approximately 10% additional erosion protection measures will be put in place.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR6-R6-14 (YOR 2017-0211-7131)	The diversion channel along the western edge of the Alpha WRSF will be decommissioned in the Post-Closure phase once the water quality in the Alpha Pond has stabilized. The Facility Ponds will be decommissioned in the Post-Closure phase.	Yes	**RCP** Section 7.7: Site Water Management Infrastructre	Diversion channels and and Facility Pond will be decommissioned during the Active Closure Phase, once water quality in the Alpha Pond has stabilized.
Heap Leach and Process Facility (HLPF)	Management of Non-Contact Water	SIR4-R4-2 (YOR 2017-0211-4259)	Surface runoff within the Mine Site will be directed via conveyance structures to the Alpha and Facility sedimentation ponds, all located downstream of proposed mining areas. These ponds are designed to settle the total suspended solids (TSS) load prior to discharge and reduce the peak discharge rate of a storm by attenuating (storing and releasing) runoff and discharging it at a lower peak rate.	Yes	**WMP** Section 3.2.1: Alpha Waste Rock Storage Facility (WRSF) and Alpha Pond; Section 3.2.3: Plant Site	
Heap Leach and Process Facility (HLPF)	Management of Potential ARD at HLF	PP Table 32-1 (YOR 2017-0211-027-1)	PAG granite ore will be excluded from the bottom 10m lift on the HLF and will be placed at least 10m below the final elevation of the HLF and at least 10m away from HLF slope. Excluding granite ore from the bottom lift will ensure that excess NP associated with the gneiss and schist ores will neutralize any acidity generated from granite ore within the HLF. Excluding granite ore from the bottom and top lift and keeping it 10 m away from the HLF slopes will ensure that granite ore is encapsulated at the end of mine life.	Yes	**WROMP** Section 5.4: Heap Leach Facility	10 m away from the HLF slope not explicitely stated, but implied by the limited amount of PAG material that will be stored wtihin the HLF.

Proponent Commitments						
FSR Plan	**Mitigation Name**	**Reference**	**Proponent Committed Mitigation**	**Commitment Incorporated**	**Section Location**	**Notes**
Heap Leach and Process Facility (HLPF)	Heap Leach Process Facilities Plan	TH Proposed Conditions (March 2020) (YOR 2017-0211-3971)	In addition to other requirements, the Heap Leach and Process facilities plan will: a) Provide information on mercury abatement and management;	Yes	**HLPF Plan** Section 4.3.2.2: Carbon Acid Wash, Elution (Stripping), and Regeneration and Gold Refining	
Heap Leach and Process Facility (HLPF)	Heap Leach Process Facilities Plan		b) Describe snow management that considers thermal properties and melt water management;	Yes	**HLPF Plan** Section 4.4: Solution Management	
Heap Leach and Process Facility (HLPF)	Heap Leach Process Facilities Plan		c) Provide a schedule of HLF stacking, rinsing and water treatment; and	Yes	**HLPF Plan** Section 4.2: Run-of-Mine and Crushed Ore to HLP and Stockpiles; Section 4.5.1: Solution Removal Volumes to Active Treatment	
Heap Leach and Process Facility (HLPF)	Heap Leach Process Facilities Plan		d) A description of water balance update frequency.	Yes	**HLPF Plan** Section 4.7.2: Annual Inspections	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System	PP Table 32-1 (YOR 2017-0211-027-1)	Liner system design will provide for collection of process and rinse solutions and protection of surface and groundwater quality through heap leach pad operation and active closure. Liner system elements include:	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System		• Development of a graded subgrade, overlain with a thin plating layer of finer material from the rock or thaw-stable soil, to prevent puncturing of the geosynthetic clay liner (GCL).	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System		• Leak detection system consisting of monitoring wells installed away from the heap leach pad, unsaturated or vadose zone monitoring under the leach pad using an adaptation of lysimeter technology (i.e., wick drains), and electrical leak location surveys performed after construction of each stage of the leach pad.	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System	SIR1-9.3.2-R183 (YOR 2017-0211-325-1)	• If leakage is detected in a cell during operations, one or more of the following options can be implemented: commence early decommissioning of the specific cell; reduce irrigation rate in the area of concern; shorten the leach time; install an inter-lift liner before the next lift of ore is placed; or other measures depending on the size and location of the leak.	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System		• Should groundwater and/or surface water monitoring indicate a leak after the facility has been decommissioned, an investigation will be undertaken to determine the size and extents of the leak and if natural attenuation processes are active. If warranted, active remediation such as groundwater interception, may be undertaken as appropriate.	Yes	**RCP** Section 7.3.1: Heap Leach Pad Closure Measures	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System		• Placement of a reinforced GCL. The permeability of the GCL will be less than 5x10-9 centimetres per second (cm/sec) under little or no load (i.e., under the first lift of ore), and this will decrease to less than 1x10-10 cm/sec under the ultimate load of the heap.	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Eveng Ponds Liner Systems; Apppendix B: Heap Leach Pad Engineering Report for Licensing - Technical Specifications	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System	SIR1-Appendix 2-A (YOR 2017-0211-327-1)	• The HLF will be monitored to manage the risk of losing production and early closure due to loss of permeability.	Yes	**HLPF Plan** Apppendix B: Heap Leach Pad Engineering Report for Licensing: Engineering drawings-Horizontal piezometer Tech Specs-ODF CQA/QC OMS-Ore permeability testing	ODF has CQA/QC in place to assure permeable material is selcted. Horizontal piezometers are also included in design to evaluate permeability of the heap leach facility. Operational inspection/observations for solution puddling on pad, and or expressing at side slopes. Samples from the conveyor of ore should also be included in OMS for permeability testing.
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System	PP Table 32-1 (YOR 2017-0211-027-1)	• Placement of a primary, low permeability geomembrane liner consisting of 2.0 mm thick linear polyethylene (LLDPE), aggressively textured on its bottom side to allow for a close bond with the GCL.	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System		• Placement of overliner gravel (crushed ore), 500 mm thick, with drainage pipes, to protect the liner from damage during initial ore stacking and operations, and to drain process and rinse waters out of the system in a manner that minimizes the hydraulic head directly over the liner.	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	Heap Leach Pad Liner System		• The HLF liner system is designed to maximize recovery of pregnant solution by minimizing any losses to the groundwater system.	Yes	**HLPF Plan** Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	
Heap Leach and Process Facility (HLPF)	HLF Cover System	SIR1-2.11-R44 (YOR 2017-0211-323-1)	Most of the HLF cover will be composed exclusively of geologic materials of rock and soil. In a small portion of the Coffee heap, the crest, and benches, a GCL will be included beneath the rock and soil layers.	Yes	**RCP** Section 7.3.1: Heap Leach Pad Closure Measures	
Heap Leach and Process Facility (HLPF)	HLF Cover System	SIR1-2.12-R52 (YOR 2017-0211-323-1)	Field trials with a minimum of two to three years of monitoring of the selected capping system is envisioned for the Project. For example, beginning in the fourth year of operation, the oldest portion of the heap will be rinsed, graded, and capped. This area will produce 15 years of data before final closure is completed. Even the last portions of the heap to be capped will undergo several years of monitoring.	Yes	**RCP** Section 2.3.1.3: Site Characterization Reclamation Research	

Proponent Commitments

FSR Plan	Mitigation Name	Reference	Proponent Committed Mitigation	Commitment Incorporated	Section Location	Notes
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure	PP Table 32-1 (YOR 2017-0211-027-1)	The heap leach pad will be constructed in 5 stages, separated into cells, and closed progressively. Final closure design will allow for site transition to passive management.	Yes	**HLPF Plan** Section 2: Design Criteria; Section 4.5 Water Treatment of Heap Leach Solutions	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure		Toe of each lift will be set back from crest of lower lift by approximately 10 m to create an overall slope of 2.5H:1V. The benches will provide heap slope stability, protect the liner system from damage due to sloughing, and provide access to the heap. The overall slope will facilitate closure.	Yes	**HLPF Plan** Section 3.4: Stability and Settlement Analyses; Section 4.0: Heap Leach Facilities Operation	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure	SIR4-R4-2 (YOR 2017-0211-4259)	Bench widths will vary between 12.0 m and 14.4 m depending on the angle of repose.	Yes	**HLPF Plan** Section 4.0: Heap Leach Facilities Operation; Apppendix B: Heap Leach Pad Engineering Report for Licensing - Engineering Drawings	Plan indicates that bench widths will be 10 -14 m
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure		Because the heap will be free-draining with no in-heap solution storage, there will be no dams or embankments associated with the leach pad.	Yes	**HLPF Plan** Apppendix B: Heap Leach Pad Engineering Report for Licensing - Engineering Drawings	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure		The north and south halves of the leach pad are separated hydraulically; the south half slopes and drains to the southeast while the north half slopes and drains to the northeast. The pad will also contain north and south event and rainwater channels in order to route water from the heap leach pad to the event ponds. The design also includes hydraulic separation of the leach solutions by cell (approximately every 100 m of pad in the east-west or long axis direction) and by stage.	Yes	**HLPF Plan** Section 3.8: Design of Heap Leach Pad and Event Ponds	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure		Each cell will be separated by a drainage ditch or berm, preventing solution in one cell from entering the adjacent cell. The stages will be separated in a similar way but with a larger berm to provide more definitive separation.	Yes	**HLPF Plan** Section 3.8.2: Solution Collections Systems	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure	SIR1-2.12-R48 (YOR 2017-0211-323-1)	Side sloping may need to be scheduled for the warmer months due to freezing. Soils and rock placement will generally be done between May and December. GCL will only be installed immediately before the rock or soil cover is to be installed. GCL installation in May, July, and August will be limited to dry periods.	Yes	**RCP** Section 7.3.1: Heap leach Pad Closure Measures	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure	SIR1-2.12-R51 (YOR 2017-0211-323-1)	The RCP will also be frequently updated and reviewed (every two years) as part of the licensing conditions, and this will allow adaptations to the design based on field experience.	Yes	**RCP** Section 2.2: Sequences and Phases of Reclamation and Closure Planning	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure	SIR1 Appendix 21A (YOR 2017-0211-327-1)	Risk management controls for slope failure of the HLF is to include monitoring systems in operations.	Yes	**HLPF Plan** Section 4.7.4: Inspection Frequency; Section 4.9: Emergency Management	
Heap Leach and Process Facility (HLPF)	HLF Design to Facilitate Progressive Closure	SIR1-Appendix 9-B (YOR 2017-0211-368-1)	Progressive reclamation and closure of the HLF includes measures designed to improve heap seepage water quality. Specifically, the addition of microbes, carbon, and nutrients to the heap during progressive rinsing and reclamation will foster reducing conditions within 368-1) the heap pore waters allowing for in situ denitrification and ultimately reductive precipitation of metals.	No	RCP Section 2.3.1.2: Treatment Technologies Reclamation Research	The HLF will be recirculated for rinsing and final gold recovery during early Post-mining Phase (Year 10-15). The addition of amendments during rinsing remains an option that may be considered. As part of treatment technologies reclamatio research, a pre-feasibility study evaluating permeable reactive barrier and biological reactor technologies has been completed, and a full feasibility study is being considered.
Heap Leach and Process Facility (HLPF)	HLF Event Ponds	PP Table 32-1 (YOR 2017-0211-027-1)	Two event ponds (EP-1S and EP-1N) will be built between the heap leach pad and the process plant prior to commencement of operations (Year -1). These ponds, to be in use over the life of mine, will be capable of containing seasonal water accumulation, full heap drainage, the 24-hour Probable Maximum Precipitation (PMP) storm event, and seasonal solution accumulation. Each pond will have 3 synthetic liner layers: a double HDPE geomembrane, separated by a leak detection and collection layer, and underlain by a GCL.	Yes	**HLPF Plan** Section 2.5: Storage Criteria; Section 3.7.2: Heap Leach Facility; Section 3.8: Design of Heap Leach Pad and Event Ponds; Section 3.8.1.2: Heap Leach and Event Ponds Liner Systems	The event ponds liner will consist of 3 synthetic liner layers: a double LLDPE geomembrane, separated by a leak detection and collection layer, and underlain by a GCL.
Heap Leach and Process Facility (HLPF)	HLF Event Ponds		A third event pond, EP-2, will be built in an adjacent location and placed in service in Year 6 to accommodate the expanded heap leach pad footprint. The pond will be sized to contain a PMP storm event, complete heap drainage, and maximum seasonal water accumulation, plus additional freeboard, in excess of industry standards and regulatory requirements. It will be used only in response to a PMP event (i.e., highly diluted solution). EP-2 will have 2 geosynthetic liners: an HDPE liner over a GCL.	Yes	**HLPF Plan** Section 2.5: Storage Criteria	The HLF Event Pond EP-2 will be placed in service in Year 1 and is included in the total storage capacity of the HLP. The event ponds liner will consist of 3 synthetic liner layers: a double LLDPE geomembrane, separated by a leak detection and collection layer, and underlain by a GCL.
Heap Leach and Process Facility (HLPF)	HLF Event Ponds	SIR1-Appendix 2-A (YOR 2017-0211-327-1)	Event Ponds will be monitored during operations to manage risk of embankment failure.	Yes	**HLPF Plan** Section 4.7.1: Routine Inspections	
Heap Leach and Process Facility (HLPF)	HLF Makeup Water Requirements	SIR2-2.3-R2-4 (YOR 2017-0211-411-1)	The makeup water requirements for the HLF will be met in the following order of priority: 1) Kona Pit water; 2) Facility Pond water, 3) raincoat water and; 4) Latte Pit Lake supernatant. Water will be moved via a pump and piping system or by water truck.	Yes	**HLPF Plan** Section 4.4: Solution Management	Priority sequence for the use of outside make-up water, if required, would be the Rainwater Pond, Facility Pond, then water wells near the Yukon River.
Heap Leach and Process Facility (HLPF)	HLF Rainwater Storage Pond	PP Table 32-1 (YOR 2017-0211-027-1)	A rainwater storage pond, capable of being converted to an event pond, if necessary, will be built between the HLF and the process plant. The pond, which will receive only clean water, will have 2 geosynthetic liners: an HDPE liner over a GCL.	Yes	**HLPF Plan** Section 3.8: Design of Heap Leach Pad and Event Ponds	

Proponent Commitments						
FSR Plan	**Mitigation Name**	**Reference**	**Proponent Committed Mitigation**	**Commitment Incorporated**	**Section Location**	**Notes**
Heap Leach and Process Facility (HLPF)	HLF Site Selection	PP Table 32-1 (YOR 2017-0211-027-1)	The HLF site was selected to be a ridgetop configuration; non-impounding heap leaches located on relatively flat slopes are by far the safest heap leach facilities to construct, operate, and close.	Yes	N/A	Mine design feature.
Heap Leach and Process Facility (HLPF)	HLF Water Balance	PP Table 32-1 (YOR 2017-0211-027-1)	HLF water balance will be designed to minimize demand for withdrawal of make-up water from external sources and to avoid need to treat surplus water until near the end of the mine life.	Yes	**HLPF Plan** Apppendix B: Heap Leach Pad Engineering Report for Licensing - HLF Water Balance	
Heap Leach and Process Facility (HLPF)	HLF Water Balance		Process water for use in heap pad leaching will be sourced from site contact water (i.e., process solution), minimizing the need to withdraw water from area creeks.	Yes	**HLPF Plan** Section 4.4: Solution Management	
Heap Leach and Process Facility (HLPF)	HLF Water Balance	SIR2-2.1-R2-1 (YOR 2017-0211-411-1)	The HLF water balance will be updated periodically: • Quarterly updates (monthly tracking and reporting) where the forecast surplus water accumulation or make-up water demand will be estimated for the next 12 months based on the actual water in the system at the time of the update.	Yes	**HLPF Plan** Section 4.7.2: Annual Inspections	
Heap Leach and Process Facility (HLPF)	HLF Water Balance		• Annual reconciliation (after spring freshet) where the water balance forecasts will be reconciled with the actual behaviour of the system since the last annual reconciliation Adjustments to the model assumptions will be made to improve the forecast reliability.	Yes	**HLPF Plan** Section 4.7.2: Annual Inspections	
Heap Leach and Process Facility (HLPF)	Pregnant Solution Management	SIR2-2.1-R2-1 (YOR 2017-0211-411-)	Design provides for gravity drainage from heap leach pad to the pregnant tank at the process plant (or in the case of an upset, the event ponds) via double-contained, buried pipes. A leak detection system will monitor air pressure in the annular void between the two pipes.	No		HLF leak detection system does not require air pressure monitoring. Other leak detection systems are available.
Heap Leach and Process Facility (HLPF)	Treatment of Surplus HLF Water	SIR2-2.1-R2-1 (YOR 2017-0211-411-)	Installation of water treatment facility to treat surplus water from HLF.	Yes	**HLPF Plan** Section 4.5: Water Treatment of Heap Leach Solutions	
Heap Leach and Process Facility (HLPF)	Treatment of Surplus HLF Water	SIR4-R4-2 (YOR 2017-0211-4259)	The proposed water treatment system will be a two-stage process. The first stage of the treatment process, which requires the addition of hydrogen peroxide to oxidize residual cyanide, requires a carbon or stainless-steel tank with an agitator, as well as a dedicated metering pump to dose the tank with hydrogen peroxide. The tank effluent will flow by gravity to the second stage of the process, which is currently planned to utilize a biological reactor system termed Electrochemical Biological Reactor.	No		Cyanide destruction will occur through the SO2/air method. Chlorination will be evaluated as an alternative. The water treatment system includes a 6 stage process, with cyanide destruction and EBR being two of the stages.
Heap Leach and Process Facility (HLPF)	Treatment of Surplus HLF Water		The water treatment plant is currently planned to be in operation in the fourth quarter of year 6, (subject to operational updates to HLF water balance guiding alternative timing).	Yes	**HLPF Plan** Section 4.5.7: Additional Design Testwork and Schedule; Appendix E: Coffee Gold Mine Water Treatment - Preliminary Design	The water treatment plant design has been updated. Active water treatment will commence in Year 2.

APPENDIX B

Coffee Gold Project Heap Leach Pad Engineering Report for Licensing

FUERTE METALS

Coffee Mine Project

Heap Leach Pad Engineering Report for Licensing

Document #123022-51010-CV-EDR-2001



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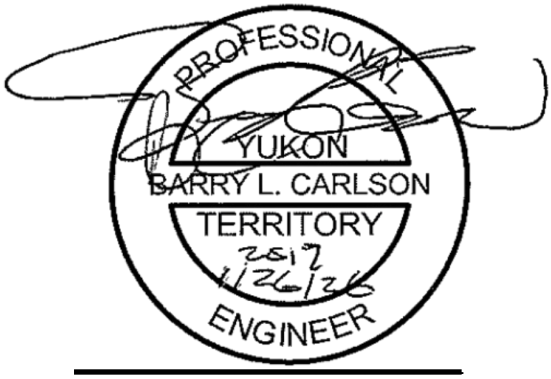
Revision	Date	Status	Prepared By	Checked By	Approved By
REV 0	07/25/2023	Issued for Licensing	J. Burke	R. Morlan	C. Green
REV 1	05/30/2025	Issued for Licensing	A. Reiman	R. Morlan	C. Green
REV 2	01/26/2026	Issued for Licensing	A. Reiman	C. Green	C. Green

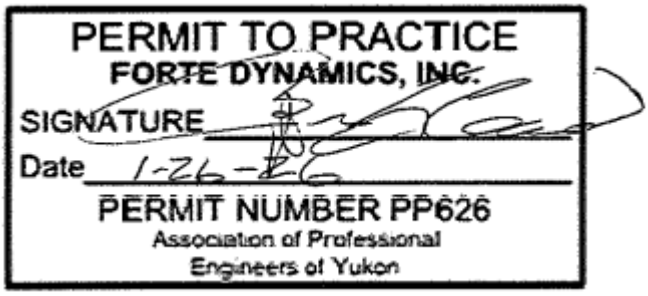
STATEMENT OF REPORT

The report enclosed titled “Coffee Project, Heap Leach Pad Engineering for Licensing,” has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without the written consent of Kaminak and Forte Dynamics (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak or Forte.

This report has been prepared under the direct supervision of Barry Carlson, P.Eng. of Forte, with the assistance of Clint Green, P.E. of Forte and Roy Morlan, P.G., of Forte. The design and analyses presented have been completed according to the project information provided by Kaminak. The design level and limits presented in this report are in accordance with standard engineering practices, and to the best of our knowledge, are accurate to the limits as specified herein.



Barry Carlson, P.Eng



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ACRONYMS, ABBREVIATIONS, AND UNITS

Acronym / Abbreviation	Definition
ADR	Adsorption, Desorption and Recovery (Process Plant)
ASTM	ASTM International
CIC	Carbon in Column
ESR	Event Storage Requirements (PMP+72 hr draindown)
DSHA	Deterministic Seismic Hazard Analysis
GCL	Geosynthetic Clay Liner
HDPE	High-density Polyethylene
HLF	Heap Leach Facility
HLP	Heap Leach Pad
LLDPE	Linear Low Density Polyethylene
MCE	Maximum Credible Earthquake
MINES	The MINES Group, Inc.
NAR	Northern Access Route
NBCC	National Building Code of Canada
ODF	Overliner Drain Fill
PGA	Peak Ground Acceleration
PLS	Pregnant Leach Solution
PMP	Probable Maximum Precipitation
PSHA	Probabilistic Seismic Hazard Analysis
ROM	Run of Mine
TT	Tetra Tech EBA, Inc.
WUL	Water Use License
WRSF	Waste Rock Storage Facility
YESAB	Yukon Environmental and Socio-economic Assessment Board

Symbol, Unit of Measure	Definition
%	Percent
d	Day
d/y	Days per Year
g	Gram
g/t Au	Grams of Gold per Tonne
H:V	Horizontal to Vertical Ratio
ha	Hectare
hr	Hour
Hr/d	Hours per Day
kg	Kilogram
km	Kilometer
km^2	Square Kilometers
kN/m^2	KiloNewton per Square Meter
kN/m^3	KiloNewton per Cubic Meter
koz	Thousand Ounces
kt	Kilotonne
L	Liter
$L/hr/m^2$	Liters per Hour per Square Meter
m	Meter
m^2	Square Meter
m^3	Cubic Meter
m/s	Meters per Second
m^3/s	Cubic Meters per Second
mm	Millimeter
Mt	Million Metric Tonnes
Mt/yr	Million Metric Tonnes per Annum
ºC	Degrees Celsius
pH	Hydrogen Potential
t/d	Tonnes per Day
yr	Year

1. INTRODUCTION

This report prepared by Forte Dynamics, Inc. (Forte) presents the engineering results and design for the proposed Heap Leach Facility (HLF) for the Coffee Mine Project in Yukon, Canada. This report and supporting information are written to support the Water Use License (WUL) as well as the Quartz Mining License (QML) application to be submitted by Newmont. The information presented in this report was prepared in accordance with the requirements outlined by the Yukon Environmental and Socio-economic Assessment Board (YESAB).

1.1 Project Summary

The proposed Coffee Mine (the Project) is an open-pit gold mine owned by Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals, located in the White Gold District of west-central Yukon, approximately 130 km south of the City of Dawson, 140 km west of Pelly Crossing, 95 km south-west of Beaver Creek, and 330 km northwest of Whitehorse. The Project is located wholly within the traditional territory of Tr'ondëk Hwëch'in, partially within the traditional territory of Selkirk First Nation and First Nation of Na-cho Nyäk Dun, and partially within the asserted territory of White River First Nation. The Project contains several gold occurrences within an exploration concession covering an area of more than 600 km^2. The Mine Site will be accessed by road from Dawson via a 214-km all-season, gravel road with pull-outs, referred to as the Northern Access Route (NAR) (Figure 1-1). The NAR includes upgrades to 177 km of existing road and construction of 37 km of new single-lane, forestry-type access road. The NAR includes seasonal barge crossings on both the Stewart and Yukon rivers, with ice bridges in the winter months.

The Project is comprised of open pits named Latte, Double Double, Supremo and Kona, and one permanent Waste Rock Storage Facility (WRSF) named Alpha. The ore production rate is proposed to be up to approximately 9.0 million tonnes (Mt) per year, producing an estimated total of 67 Mt of heap leach feed over the 10-year Operation Phase. The conceptual-level estimate for waste material to be moved over the life of mine (LOM) is 330 Mt based on an average strip ratio of 5.0:1. The ore will be crushed and transported to the Heap Leach Facility (HLF) via overland conveyor or trucks for nine months of the year. During the three coldest months of winter, run-of-mine (ROM) ore will be stockpiled in the ROM stockpile. Gold will be extracted from gold-bearing leach solution by a six tonnes per day (t/d) adsorption, desorption, recovery carbon plant with mercury retorting to produce a final gold doré product. A total of 2.6 million ounces of gold is planned to be recovered over a 10-year mine life.

The Project phases are defined as follows:

- Construction Phase: Q2 Year –3 to End of Year –1 (30 months)
- Operation Phase: Year –1 to End of Year 9 (10 years)
- Reclamation and Closure Phase: Year 10 to End of Year 21, including a 6-year Post-Mining Closure Stage and a 5-year Active Closure Stage (11 years)
- Post-Closure Phase: Year 21 Onwards as Determined to be Required.

These phases broadly describe the activities occurring within a particular time period; however, some activities will continue from one phase to another as mine site development advances with operational activities (e.g., Open Pits, WRSF). When areas that support mine operations are no longer required, they will be progressively reclaimed. The overall Project schedule is the general expected scenario for mine construction and operation; detailed activities are subject to change depending on the detailed mine planning and the timing of receipt of authorizations.

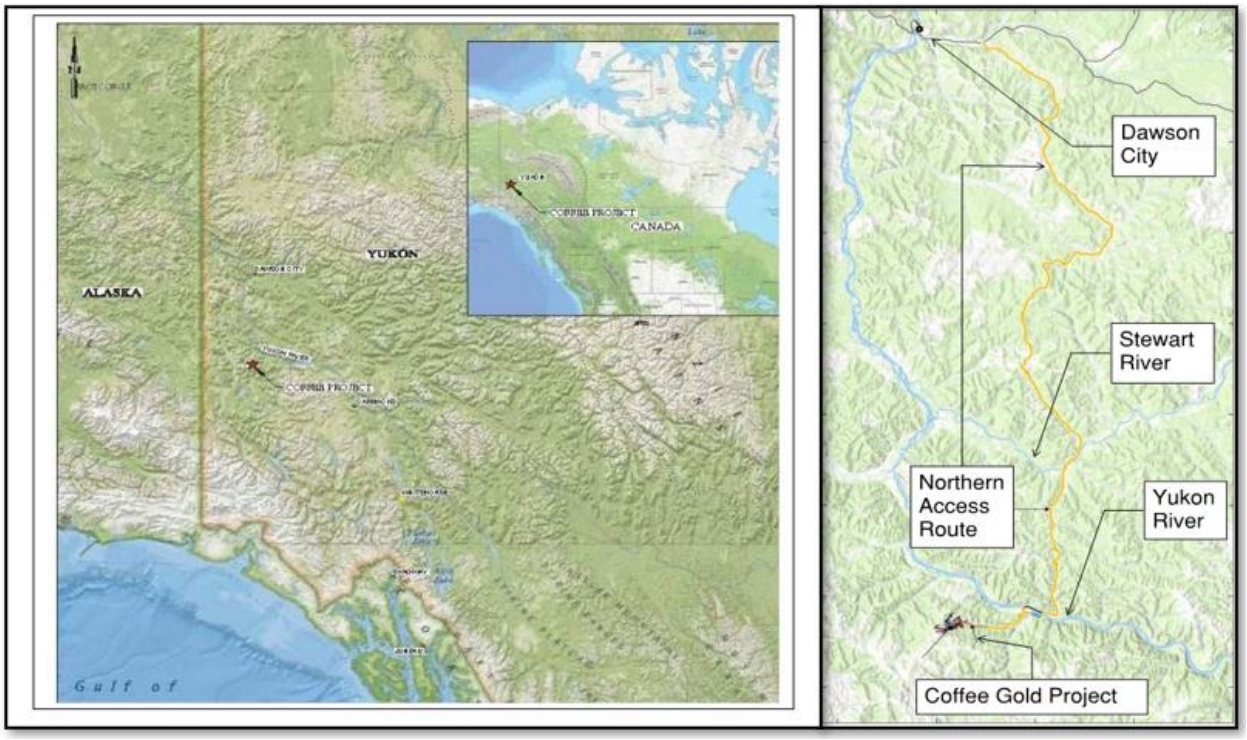

Figure 1-1: Coffee Project Location and Northern Access Route

2. PROJECT DESCRIPTION

Kaminak proposes new mining facilities to be used for the production of gold and silver from the Coffee Mine Project area, located in the White Gold District of Yukon, Canada. Oxide resource will be mined by open pit mining methods and recovered with heap leach processing. The mined oxide material will come from four (4) open pit deposits: Latte, Double Double, Supremo, and Kona. Waste material will be placed in dedicated waste rock storage facilities (WRSF).

The Coffee Mine Project will operate primarily as a crushed material leach pad that will be constructed in five (5) stages as the mine plan requires. Material will be excavated from the open pits and stacked on HLF. The mine plan indicates a total of approximately 67 million Mt of mined ore over the life of the mine. Ore will undergo a crushing and screening process at an average rate of 19 thousand tpd (6.7 million Mt per annum), up to a maximum rate of 23 thousand tpd in peak mining years then transported to and stacked on a lined heap leach pad (HLP). A ROM stockpile will be constructed and used for temporary storage of ore from the open pits when necessary and have a footprint of 13 ha and a total capacity of 3 million Mt. ROM will be placed on the HLP if the crushing circuit is not in operation.

Gold extraction will utilize sodium cyanide heap leaching technology. A diluted solution of alkaline cyanide (referred to as the barren solution) will be applied to the stacked ore (also referred to as heap leach) on the HLP using drip irrigation. As the barren solution percolates through the heap leach, gold will react with the cyanide and dissolve into the solution. This gold-bearing solution (referred to as the pregnant leach solution (PLS)) will then be transported by pipe where it will be processed via conventional gold recovery methods at an on-site adsorption, desorption, and recovery (ADR) plant. The end product of the ADR plant is poured doré bars, which will be shipped off-site for further refinement.

Forte's design includes the HLP footprint, and heap to full stacked height of the Mine Plan. The leaching solution conveyance pipelines, and storage facilities have also been analyzed and designed by Forte. The

ROM Stockpile, crusher, conveyor, and Process Plant, barren and pregnant pumps while understood by Forte for vital integration are ultimately designed by others. Processing and mining ancillary facilities presented in the Process Pad have also been designed by others.

2.1 Proposed Process Operations

The proposed operations related to the heap leach facility (HLF) are comprised of the following major elements:

- Heap Leach Pad (HLP) and Ponds.
- Crushing and Conveying System Design by Others Integrated into HLF Design.
- Process Plant (Currently Understood as ADR) Design by others Integrated into HLF Design.
- Utilities Design by others Integrated into HLF Design.
- Reagents Design by Others Integrated into HLF Design.
- Site Infrastructure Design by Others Integrated into HLF Design.

2.2 Heap Leach Facility

The HLF will be located on the ridgeline to the west of the ADR plant, with the eastern edge of the leach pad located approximately 2 km west of the Latte pit. The HLF consists of a conventional HLP, three event ponds, a rain water pond, solution distribution pipeline for delivery of the barren solution to the heap, and collection piping for PLS conveyance to the event ponds and ADR plant. The solution trunk lines are contained within the lined perimeter channel(s) one on the north and one along the south side of the pad providing positive drainage from west to east. The general arrangement of the HLF is provided in Figure 2-1.

The HLP will be a conventional pad, constructed directly on bedrock or structural fill after the removal of the topsoil and ice-rich material by grading the local terrain and using competent waste rock for fill to support the multi-lift, free-draining heap. The results of geotechnical investigations, stability and settlement analysis, and the characterization of foundation conditions at the HLF are provided in Appendix F and Appendix G.

The designs for the HLP incorporate a double-sided textured 2 mm (80 mil) linear low-density, polyethylene (LLDPE) liner. A geosynthetic clay liner (GCL) will be used in lieu of a layer of compacted low-permeability fill. The GCL will be placed underneath the geomembrane and have a saturated hydraulic conductivity of no greater than $5x10^{-9}$ cm/sec.

The HLP design is based on staged construction with an initial capacity of approximately 4 Mt expanding to the ultimate mine plan of approximately 67 million Mt in five stages. The total surface area of the Stage five HLP will be approximately 1 million m^2.

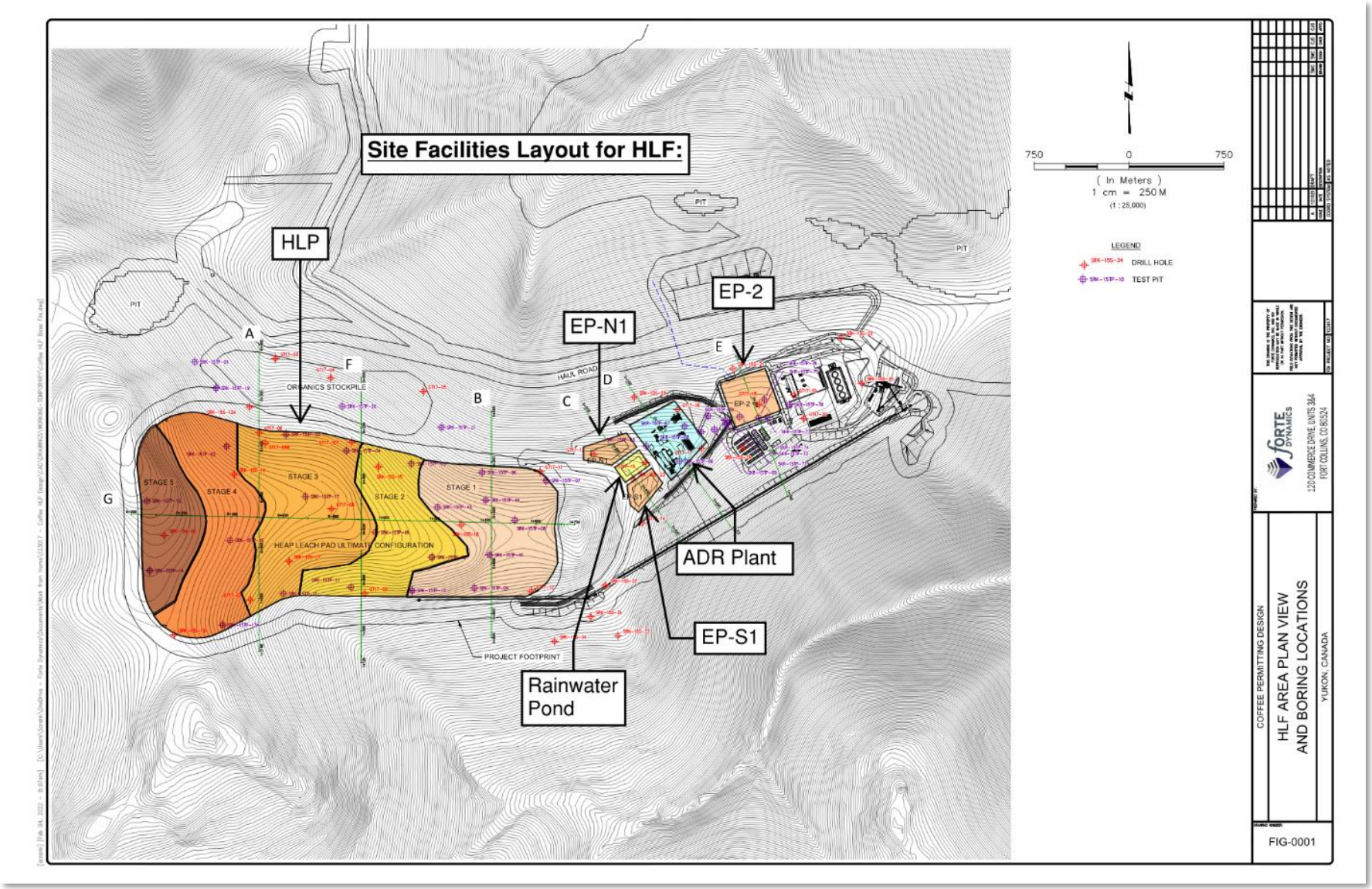

Figure 2-1: Site Facilities Layout

2.3 Process Facilities

The Process Plant and ADR facility will be located on the ridgetop, east of the HLP. It is our understanding that it will be a slab on competent bedrock with concreate walls around all tanks containing cyanide and other reagents providing secondary containment. Process facilities are not covered in the scope of this report.

2.4 Surface Water Management Facilities

During the initial stage, temporary interceptor ditches will be designed to divert upstream tributary runoff from entering the HLF facilities, meeting design criteria. Due to the ridge top site selection of the HLP facility, as Stages 1-5 are built out, most tributary areas are eliminated from the HLP facility, requiring much smaller interceptor ditches through time while meeting the same design criteria.

2.5 Ancillary Facilities

Ancillary facilities at the Coffee Mine Project include the Northern Access Route (NAR), freshwater pipeline, airstrip, laydown areas, man camp, truck shop, fuel, chemical and explosives storage, warehouse buildings, power plant, water treatment plant, and waste management facilities. Forte's current understanding of locations for these facilities adjacent to the HLF are presented in Appendix B. Ancillary facilities are not covered in the scope of this report.

2.6 Waste Rock Storage Facilities

Currently the Coffee Mine Project has one permanent WRSF planned named Alpha. The conceptual-level estimate for waste material to be moved over the life of mine (LOM) is 330 Mt based on an average strip ratio of 5.0:1. Additionally, ice-rich soils (permafrost) and soil/weathered rock unsuitable for re-use as structural fill will be transported to the Alpha WRSF. WRSFs are not covered in the scope of this report.

2.7 Stockpiles

Stockpiles at the Coffee Mine Project include a ROM Stockpile, Overburden Stockpile, and Ice-Rich Overburden Stockpile. The ROM stockpile will be used for the storage of ore during the times when the crusher is not in operation. Both the Overburden Stockpile and Ice-Rich Overburden Stockpile will be used for temporary storage of material that may be used at a later date for reclamation purposes. These stockpiles are not covered in the scope of this report.

3. SITE CONDITIONS

3.1 Location and Setting

The Coffee Mine Project is approximately 130 km south of Dawson City, and 340 km northwest of the Yukon capital of Whitehorse **(**Figure 1-1**)**. Dawson City is the closest town to the project, having a population of about 1,400. The Mine Site will be accessible via the NAR spanning from Dawson City to the Yukon River. Crossing the Stewart and Yukon River to the Mine Site is restricted to ice road or barge route. A 1,220 m all-weather airstrip will be constructed approximately 7 km east of the Coffee Mine Project process plant. The airstrip will accommodate large turboprop fixed wing aircrafts and will be primarily used for personnel transportation.

The Coffee claim block (or Property) is located in the Northern Dawson Range, on the traditional territory of the Tr'ondëk Hwëch'in and the asserted area of the White River First Nation. The NAR is also located within the traditional territory of the Tr'ondëk Hwëch'in, and portions of the route are located within the shared traditional territories of Selkirk First Nation and the First Nation of Na-cho Nyäk Dun and the asserted White River First Nation.

3.2 Climate and Vegetation

Coffee Mine Project is in west-central Yukon, Canada, which receives a mean of 504 mm of precipitation per year, mostly as rainfall, with snow accumulation in the winter (Lorax, 2022). Monthly average temperatures at the ridgetop elevation of 1,300 m vary from -15°C in December to an average of +14°C in July (Lorax, 2021). Pronounced valley bottom inversions can occur during the winter months, with ridgetop temperatures up to 10°C higher than measurements recorded at the valley bottom locations. The majority of the terrain consists of mixed forests of deciduous and coniferous tree species (aspen, birch, larch and spruce). The lower extent of the creek valley is covered by shrubs and thick organic material. Slopes surrounding the HLF at higher elevations tend to contain black spruce with lichen for groundcover (Tetra Tech, 2016b).

3.3 Surface Drainage

The general slope of the HLF is west to east. While there are no specified drainages for the HLF, surface runoff that occurs as overland flow will be collected in the Halfway Creek or Upper Coffee Creek. These creeks are both tributaries of the Yukon River, which runs adjacent to the site, approximately 10 kilometers to the northeast. Surface flows may occur during small to large scale precipitation events due to the close proximity of permafrost from the surface. Diversions are planned upgradient of disturbed areas from mining and processing to the greatest extent possible, while runoff from direct precipitation to these facilities will be managed.

3.4 Subsurface Conditions

The Coffee Mine Project area is located in a zone of extensive discontinuous permafrost. The overall site contains a thin, active overburden veneer consisting of soil and organics that is subject to freeze-thaw cycles. Soils in this active layer are typically silty, light to dark brown in color and loosely compacted with high amounts of gravel and ice. The typical depth of active layer soils in the HLF footprint is about 1.2 to 3.3 meters underlain by bedrock. Soils are generally of low permeability and exhibit high surficial runoff characteristics (Tetra Tech, 2016b).

Vegetation throughout the project site ranges from dense shrubbery to scattered trees with little undergrowth. The soil veneer is generally regarded as growth media for this vegetation. Vegetation typically consists of coniferous and deciduous trees, and low-lying shrubs. Typical creatures of the Boreal forests of

Yukon, Canada include squirrels, voles, hares, lemmings, and wolverines, and commonly dig shallow burrows amongst the overburden layer.

The Project is in Klondike Plateau physiographic region of Yukon, Canada. Topographic relief is several hundred meters. Topography varies from deep V-shaped valleys to rounded summits and ridges. The project plan of operations area ranges from 370 meters to 1,300 meters above sea level in elevation. Most of the Project is characterized by rolling hills, and local relief is typically between 300 and 400 meters.

The Mine Site is located near the headwaters of three watersheds. These watersheds include Halfway Creek, YT-24, and Latte Creek. Surface drainages within the Mine Site are limited to small seeps and spring, which may be encountered during mine development and may be intercepted and used as required. As part of the permitting process, hydrological studies have been initiated to determine the effect of mine operations on the local water supply.

Fresh water wells are to be developed near the Coffee exploration camp mine, and water is to be transported by water truck or fresh water line to both the fire water tank and the fresh water tank at the Camp Site. A water well closer to the Project site may be developed.

3.5 Geology and Geotechnical Background

This section provides a summary of the site geology, geologic hazards, and site seismicity for the Coffee Mine Project as related to the HLF. This information was obtained from previous studies, including The MINES Group's Feasibility Design Report (MINES, 2016), SRK Consulting's Geotechnical Investigation (SRK, 2016), Tetra Tech's Technical Memorandum (Tetra Tech, 2016a), Tetra Tech's Environmental Baseline Report (Tetra Tech, 2016b), and Tetra Tech's Summer Geotechnical Investigation (Tetra Tech, 2017).

3.5.1 Site Geology

The regional and local geology of the site has been described in the Environmental Baseline Report prepared by Tetra Tech and elsewhere, and a summary is provided herein. All citations in the section are from Tetra Tech (Tetra Tech, 2016b), unless otherwise noted.

According to The MINES Group's assessment of the geologic setting, "The Coffee Gold Project is located in the Yukon-Tanana Terrane, an accreted pericratonic rock sequence that covers a large portion of the Omineca Belt in the Yukon and extends into Alaska and British Columbia… [and] is composed of basal metasiliclastic sequences overlain by three subsequent volcanic arcs" (Tetra Tech, 2016a). "Devonian to Mississippian-aged quartzite and muscovite quartz-rich schist of the Nasina assemblage are the most extensive." The Late Devonian- to Mississippian-aged Pelly Gneiss Suite of granitic gneisses occurs throughout the region. "The Klondike Schist, a Carboniferous to Permian-aged assemblage of metamorphosed pelitic and volcanic rocks, is widespread in the vicinity of Dawson." In the mid-Cretaceous, The Dawson Range Batholith intruded the schist-dominated rocks of the region. "It's Whitehorse Suite consists of granitic rocks of felsic to mafic composition; granodiorites, granites and quartz monzonites are common."

The resulting bedrock beneath the proposed HLF has been identified by Tetra Tech as the Coffee Creek Granite formation. The Coffee Mine Project study area also happens to fall in an unglaciated portion of the Yukon Territory, which means that the study area has experienced a significant period of weathering. Consequently, the granites that underlie the proposed HLF have shallow in-situ weathered horizons which transition to moderately competent bedrock material within 2 to 10 meters of the ground surface (MINES, 2016). This weathered bedrock is exposed on several ridges in the proposed mine area and locally exhibits cryoplanation terraces or granitic tors.

In addition to the Coffee Creek Granite bedrock, Tetra Tech (Tetra Tech, 2016b) identified the following geologic units at the site:

- Colluvium (C)
- Weathered Bedrock (D)
- Eolian (E)
- Fluvial (F)
- Active Fluvial (FA)
- Organic (O)
- Bedrock (R)

Surficial deposits atop bedrock have been derived by weathered bedrock colluvium, loess, eolian and fluvial deposits (Tetra Tech, 2016b). However, colluvial deposits dominate high elevation areas and valley slopes, which suggests that most of the topsoil within the HLF footprint is colluvium. These colluvial deposits comprise loose, poorly sorted angular gravel, boulders, and sandy silt to silty sand matrix. Occasionally, these colluvial deposits include ice-rich resedimented loess peat. Ice-rich colluvium is most common on north-facing lower valley slopes and commonly contains segregated ice bodied and buried ice wedges.

3.5.2 Geologic Hazards

The Coffee Mine Project is located in an area that can be characterized as gentle rolling mountain tops separated by stream-cut V-shaped valleys. As such, geologic hazards in the area are more often generated from slow-moving processes rather than rapid mass wasting events. Types of mass movements in the study area can include soil creep, debris slides, rock falls, rotational slides, and active layer detachments- all of which can be heavily influenced by permafrost activity. Although these hazards are common in the Yukon Territory, none have been identified in close proximity of the HLF (Figure 3-1).

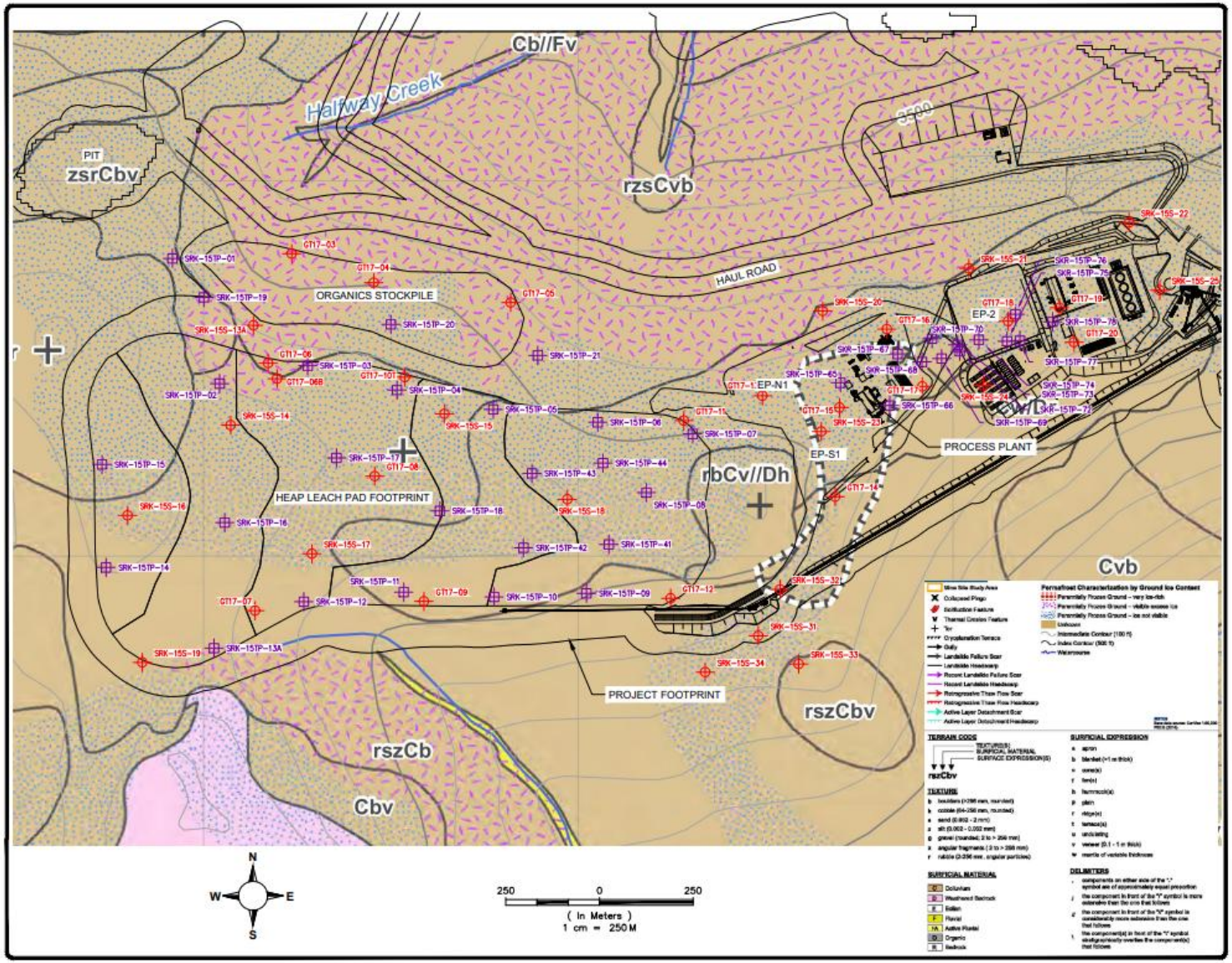

Figure 3-1: Site Surficial Geology

3.5.3 Site Seismicity

The Coffee Mine Project is located between the Denali and Tintina faults in an area known as the Tintina Trench, which is an area of moderate seismicity. However, earthquake epicenters have been recorded in the Stewart and Yukon River region.

Seismic design parameters for planning of the HLF were developed by The MINES Group in their 2016 Feasibility Report (MINES, 2016). This was done by using a combination of deterministic and probabilistic approaches and are used to evaluate the seismic hazard at the site, and to provide design values of peak ground acceleration (PGA).

The PGA for the maximum credible earthquake (MCE) determined by Mines was 0.116g. This MCE is associated with a 2% probability of exceedance (return period of 2475 yrs.) in 50 yrs.

Observations of on-site conditions at the Coffee Mine Project site were based on drilling and test pits performed by the MINES Group. These observations concluded that soil cover in the area is relatively thin, and the underlying rock is moderately to highly weathered. Therefore, for the purpose of this investigation, the site was assigned to Site Class C (stiff soil and/or soft rock in the upper 30 m of the subsurface profile) with an assumed representative sheer velocity (Vs30) of 360 m/s to 760 m/s, which is consistent with the recommendations in the 2010 National Building Code of Canada (NBCC, 2021), (MINES, 2016). The assumption of Site Class C at the site is considered conservative since it was based on near-surface observations whereas decreased weathering of bedrock has also been noted and the Vs30 is intended to represent the upper 30 meters of foundation material.

MINES used ground motion parameter provided in the 2010 edition of the National Building Codes of Canada (NBCC, 2020) hazard mapping project. This information is provided by the NBCC on their website (NBCC, 2021). The ground motion parameters have since been updated to the 2020 edition.

Forte updated the parameters using the NBCC Seismic Hazard Values tool provided on their website (NBCC, 2020). Coordinates for the center of the HLF were used as the location (62.869436 latitude, -139.400813 longitude). The site location relative the 2015 edition seismic hazard values is included in Figure 3-2. The updated PGA for the site is 0.246 g. This corresponds to a 2% probability of exceedance in 50 years. Forte has assumed this PGA value for the MCE for the purpose of analyses.

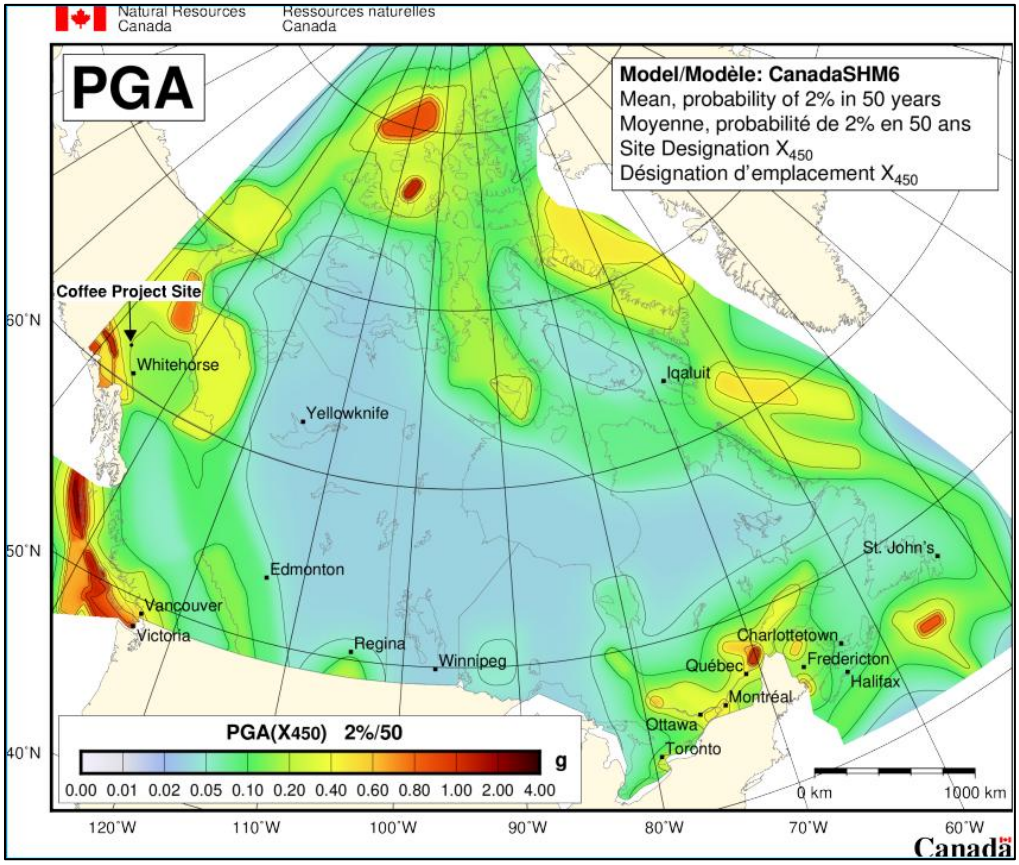

Figure 3-2: Seismic Hazard Values of Canada

3.5.4 Ground Ice

The Coffee Mine Project area is located in a zone of extensive discontinuous permafrost. The overall site contains a thin, active overburden veneer consisting of soil and organics that is subject to freeze-thaw cycles. It is estimated that 50% to 90% of the HLF footprint is perennially frozen (Tetra Tech, 2023).

The extent of ground ice and frozen ground as discontinuous permafrost was analyzed from the information provided within SRK Consulting's Geotechnical Investigation (SRK, 2016), Tetra Tech's Summer Geotechnical Investigation (Tetra Tech, 2017), and Tetra Tech's Ground Temperature Monitoring Update, Coffee Mine Project, YT (Tetra Tech 2023). SRK provided boring logs for 15 locations, and test pit photos for 43 locations within (or in close proximity to) the HLF footprint. Out of the total 59 locations, 37 of which showed the presence of ice or frozen material (SRK, 2016). Similarly, out of Tetra Tech's 19 boring locations withing (or in close proximity to) the HLF footprint, 14 locations showed the presence of ice or frozen material. In all, ice or frozen material was identified in 65% of the HLF during the geotechnical investigations (Tetra Tech 2016). This information was updated by Tetra Tech in 2022 with new readings of the existing thermistors collected in 2019 and 2022. No new thermistors were installed. When observed in plan view, the boring/test pits with frozen ground are primarily located on the north slope of the ridge where the proposed HLP is planned. Frozen ground was typically encountered within colluvial gravel, gravel, and sands with depths varying between 0.3 m to 2.3 m and occasionally included excess ice with limited thickness. Ground ice content in the perennially frozen surficial layer is highly variable, Figure 3-3 shows the estimated extent of Frozen ground per the 2023 Tetra Tech update (facility layouts are outside the scope of this report and may not reflect the latest version).

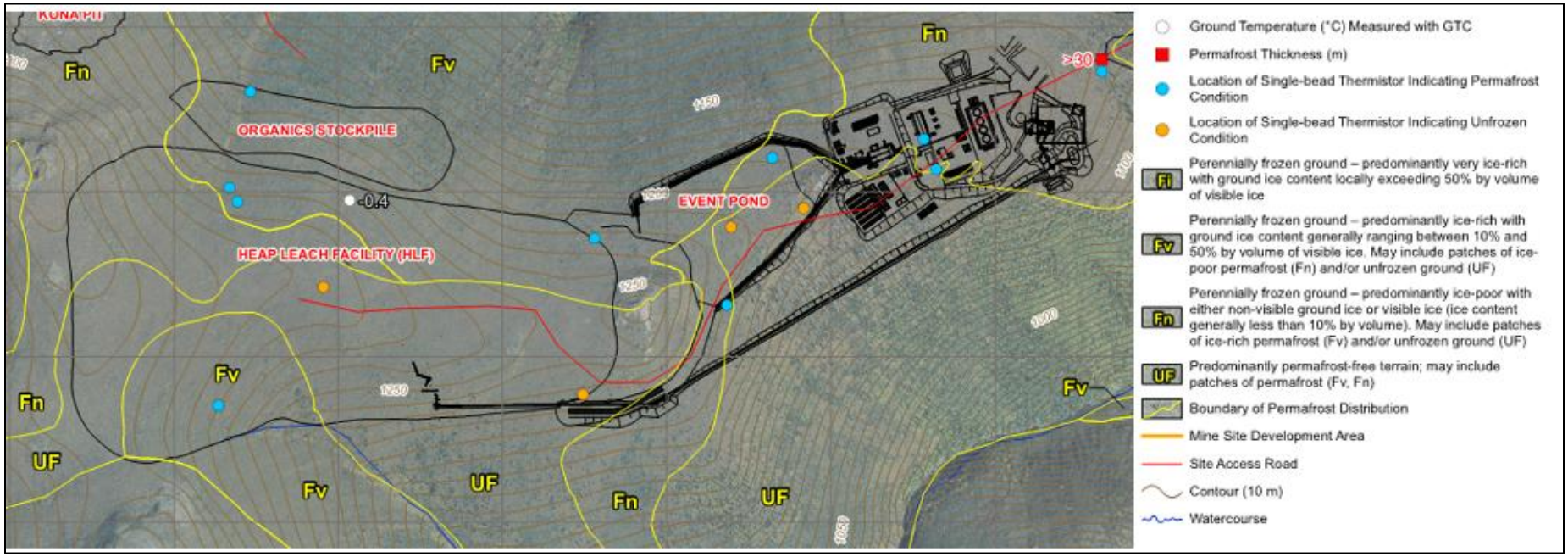

Figure 3-3: Estimated Extent of Ice-Rich Material (Tetra Tech, 2023)

4. HISTORIC SITE INVESTIGATIONS

Historic field investigations were used in the design of this HLF. These included the following investigations:

- SRK Consulting, “2015 Geotechnical Field Investigation Coffee Gold Project” (SRK, 2016);
- Tetra Tech EBA, 2016 “Coffee Gold Project, Environmental Baseline Report, Mine Study Area: Surficial Geology, Permafrost, and Terrain Stability” (Tetra Tech, 2016b);
- Tetra Tech, “Summer 2017 Geotechnical Investigation Data Report, Coffee Mine Site” (Tetra Tech, 2017);
- Tetra Tech, 2022 “Ground Temperature Monitoring Update, Coffee Mine Project, YT” (Tetra Tech 2022)

Figure 4-1 illustrates the boring and test pit locations within or adjacent to the HLF footprint from the aforementioned reports.

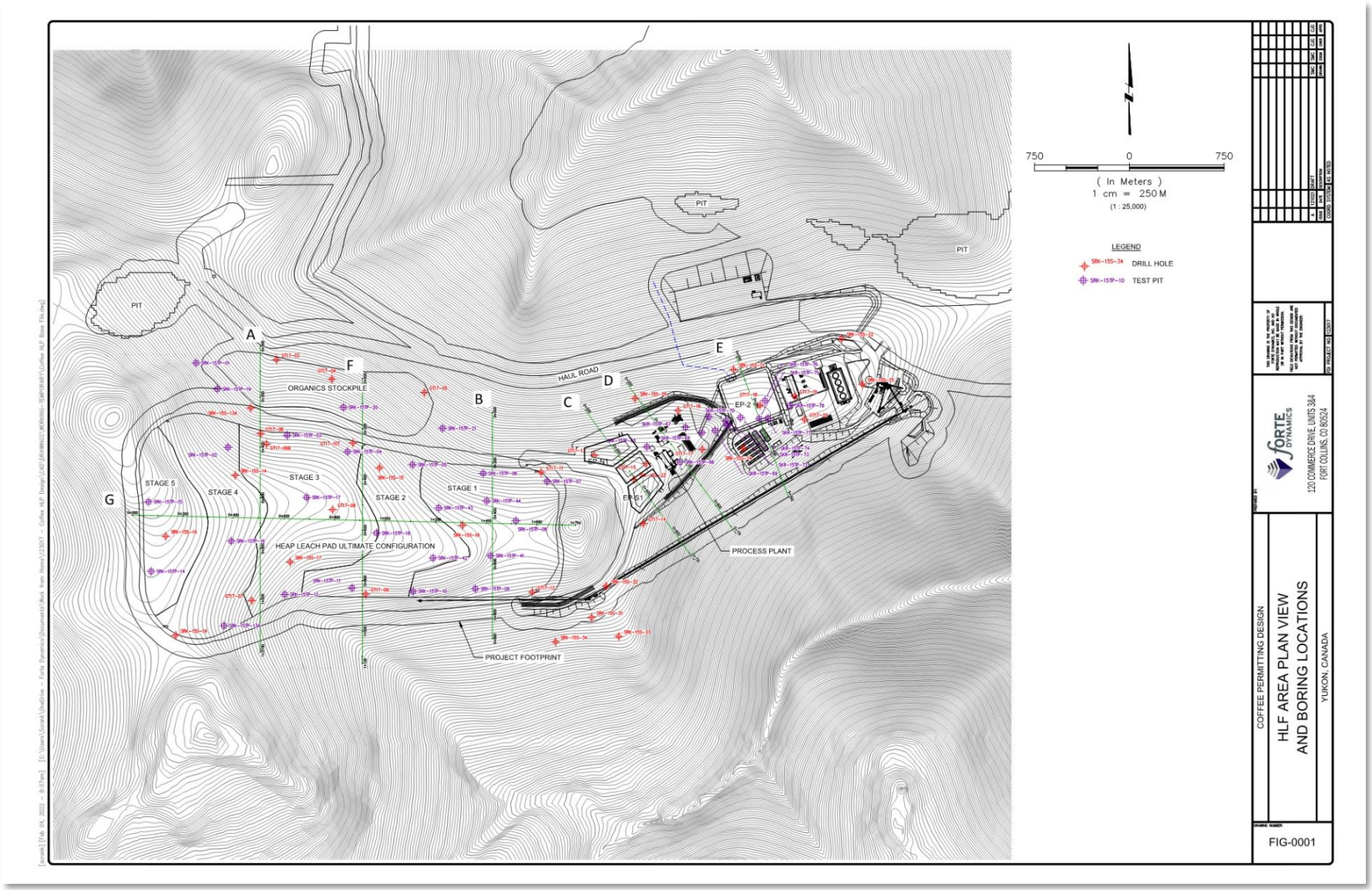

Figure 4-1: Boring Locations

4.1 Field Investigations

The design of the HLP is based on the existing knowledgebase as described below. Additional field investigations are recommended to be executed prior to detailed engineering to further confirm geotechnical parameters and conditions utilized in the design of the HLP. Refinements to the design and associated documentation will progress as necessary based on additional material characterization.

4.1.1 SRK Consulting (2016)

In 2015, SRK Consulting completed a feasibility-level geotechnical investigation for the Coffee Mine Project, which included field and laboratory characterization of the proposed HLF footprint. Field investigations were carried out between April and July 2015 and included a drilling program and a supplemental test pit program. Sonic drilling methods were used for the majority of locations and primarily focused on characterization of the soil characteristics and ground ice. Drilling into competent bedrock was limited to drilling equipment and lack of available water on site. Diamond core drilling methods were applied at two locations to incorporate ground temperature (thermistor) cables. Test pits were dug by an excavator to observe conditions and collect representative samples. A total of 15 borings were drilled using a sonic drill rig to depths ranging from 1.5 m to 9.6 m. A total of 43 test pits were excavated to depths ranging from 0.1 m to 3.5 m. The report for this work was published in 2016.

4.1.2 Tetra Tech Consulting (2016)

In 2015, Tetra Tech provided surficial geology, permafrost, terrain, and soils baseline information for the Coffee Mine Project. Field reconnaissance was carried out for this investigation from August to September 2015. Reconnaissance for permafrost conditions required active measurement of permafrost thickness with a probe, and hand dug test pit excavation. Terrain characteristics and hazards, drainage conditions and vegetation conditions were completed using helicopter reconnaissance, and detailed ground investigations. The report for this work was published in 2016.

4.1.3 Tetra Tech Consulting (2017)

In 2017, Tetra Tech completed the secondary phase of the geotechnical site investigation, which had originally commenced in 2015. The primary focus of this investigation was to acquire geotechnical and permafrost data, including frozen and unfrozen overburden and bedrock conditions, that would allow design of all site infrastructure. The site investigation was carried out from June to August 2017, and included a drilling and coring program, as well as a ground temperature and ground water monitoring program. A total of 19 borings were drilled within or adjacent to the HLF conceptual design footprint, using diamond core drilling methods, and utilizing chilled propylene glycol drilling fluid to minimize thermal disturbance to samples. Depth of borings ranged from 4.5 m to 201.5 m below ground surface. One (1) multi-bead thermistor was installed within the HLP footprint to monitor ground temperature data to a depth of 20.3 m. Rock cores required the logging of several geo-mechanical aspects in the field upon recovery. Representative samples of material were logged, and shipped to either the Coffee Camp geotechnical lab, or Tetra Tech laboratories in Whitehorse, YT and Edmonton, AB for analysis.

4.2 Laboratory Testing

4.2.1 SRK Consulting (2016)

Representative samples were selected for laboratory testing to determine the engineering parameters of the in-situ materials. Samples were analyzed by Tetra Tech EBA's (EBA) laboratory in Whitehorse, YT and Edmonton, AB. The laboratory testing program is summarized in Table 4-1.

Table 4-1: Summary of 2016 SRK Consulting Testing

ASTM Test Method Designations		HLF Samples
Natural Moisture Content	ASTM D2216	42
Particle Size Distribution	ASTM D422, C136 & C117	30
Atterberg Limits	ASTM D4318	6
Specific Gravity	ASTM D854	1
Frozen Density	ASTM D560	2
Proctor Compaction Test	ASTM D698 Standard	3
Direct Sheer Test	ASTM D3080	1

The laboratory testing program consisted of natural moisture content, particle size distribution, Atterberg limits, specific gravity, frozen density, proctor compaction tests, and direct sheer tests. The results of the aforementioned testing are detailed herein.

- Natural moisture testing on samples from various depths concluded that the moisture content typically ranged from 3-30 percent, with ice-rich soils ranging from 50-300 percent.
- Particle size distribution testing results showed well graded gravely material with fines ranging as high as 50% and as low as 19%.
- Specific gravity for one sample in the HLF indicated a value of 2.63.
- Proctor compaction tests were ran on three (3) samples collected in the HLF. The optimum moisture ranged from 10 to 11% at a dry density ranging from 1.885 to 2,094 kg/m^3.
- Frozen density tests were ran on two (2) samples collected in the HLF, Frozen densities were reported as 1.405 and 1,746 kg/m^3.
- Atterberg tests ran on samples within the HLF yielded low to non-plastic characterization.
- Direct sheer tests were ran on two (2) samples collected in the HLF. The laboratory results reported a cohesion of 12 kPa and a friction angle of 35 degrees for sample SRK-15S-13A and a cohesion of 77 kPa and friction angle of 42 degrees for sample SRK-15S-17.

4.2.2 Tetra Tech Consulting (2017)

Laboratory testing for representative samples included some geotechnical testing conducted at the Coffee Camp, with the majority of the samples being shipped to labs in Whitehorse, YT and Edmonton, AB for testing. The testing program summarized in Table 4-2.

Table 4-2: Summary of 2017 Tetra Tech Testing

ASTM Test Method Designations		HLF Samples (Onsite Lab)	HLF Samples (Off-site Lab)
Natural Moisture Content	ASTM D2216	5	2
Particle Size Distribution	ASTM D422, C136 & C117	-	2
Porewater Salinity	ASTM D4542-15	3	-
Bulk Density & Ice Content	ASTM D1895B	5	2
Diametral Point Load Rock Strength	D5731-16	-	73

The laboratory testing program consisted of natural moisture content, particle size distribution, porewater salinity, bulk density & ice content, and diametral point load rock strength. The results of the aforementioned testing are detailed herein.

- Natural moisture testing on samples from various depths concluded that the moisture content ranged from 15.4-73.3 percent.
- Particle size distribution reported gravely material with fines ranging from 15% to 61%.
- Results from the diametral point load rock strength testing on 73 samples collected within (or adjacent to) the HLF ranged from Very Weak to Very Strong. However, results generally tended to Strong to Very Strong.
- The multi-bead thermistor installed in the HLP footprint showed temperature readings indicative of permafrost conditions.
- Bulk density was analyzed for 1 sample (GT17-05). A result of 1,511 kg/m^3 was reported.
- Ice content tests were run on five (5) samples. Excess ice content was reported in each sample. The lowest reported value was 3.4% (GT17-16). All other samples reported results between 13.5% and 34%.

4.3 Properties of the Overburden Soils

The overburden soil typically consists of sandy or gravelly silts, silty or gravelly sands, and silty or sandy gravels. Descriptions of the boring holes and test pits were primarily sandy silts with gravel, or silty sands with gravel. This was especially true when boring locations were on downward slopes departing from the ridge. Silty or sandy gravel, rubble (rockfall) or weathered bedrock was often encountered within the overburden material on the tops of the ridges. Fine contents varied by location ranging from 12 to 50 percent. Soil samples from the HLF study area exhibited low to non-plastic characteristics overall. Overburden soils had an average depth of 2 m bgs, with a minimum of < 1 m bgs to a maximum of > 9 m bgs.

Topsoil within the footprint of the HLF is typically organic rich and contains ice. On average an estimated 0.2 meters of topsoil exists across the footprint of the HLF and which will require removal and disposal. This material cannot be used for construction but can be stockpiled for future use in reclamation. Ice-rich colluvium observed within the footprint of the HLF averaged between 1 to 2 meters deep with smaller pockets of ice-rich material as deep as 4 meters. Ice-rich soils excavated from the footprint of the HLF cannot be used for construction without thawing. For the purpose of this design, it was assumed this material would be removed and stockpiled as waste, and therefore, were not utilized in the project's material balance. The estimated removal of overburden material required based on review of the geotechnical data is included in Figure 4-2.

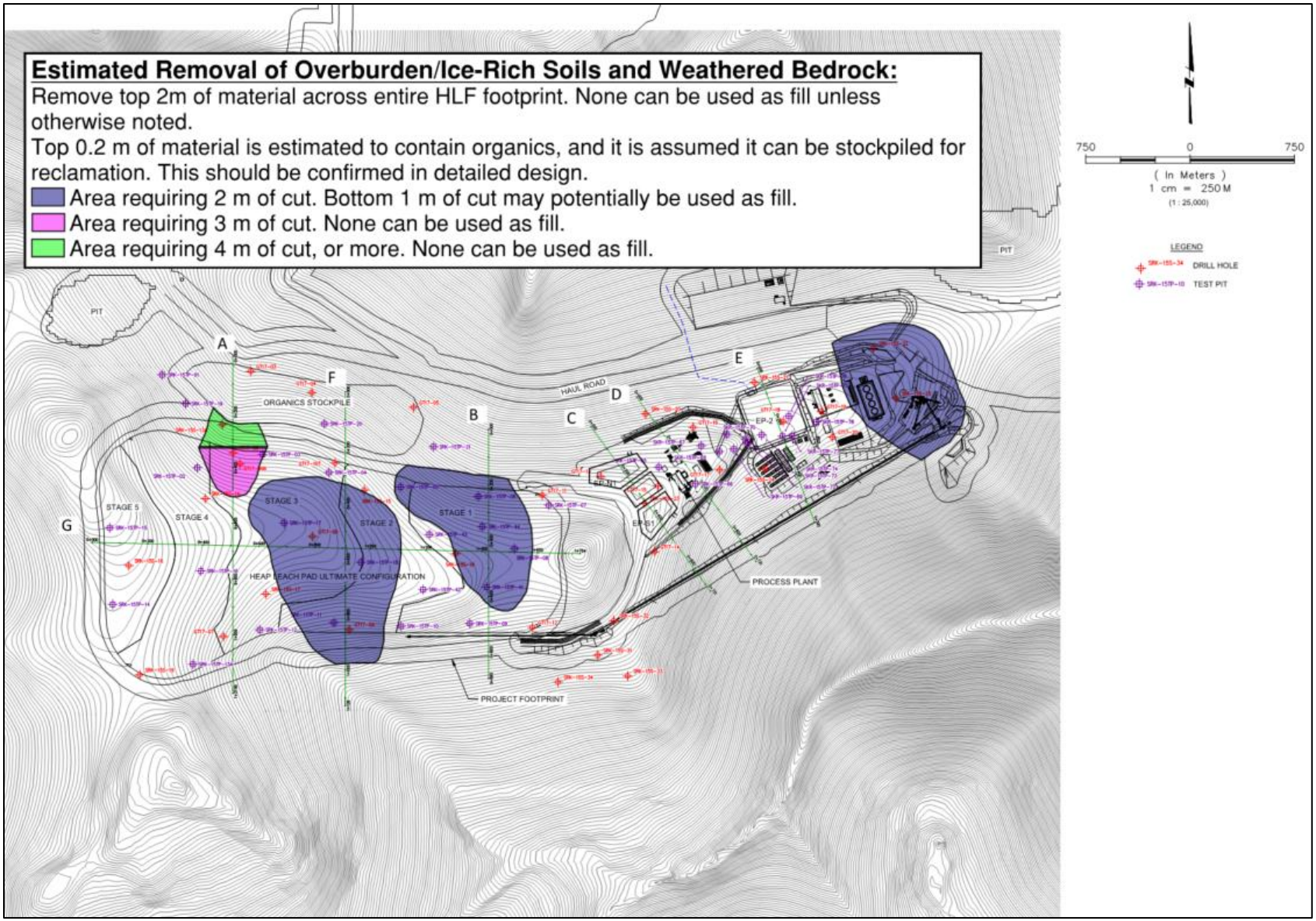

Figure 4-2: Estimated Removal of Material

4.4 Foundation Conditions

Underlying the overburden soils, exists primarily granitic hard rock materials with a smaller portion of schist below the easternmost portion of the HLF site. Both the granitic hard rock and the Schist hard rock have been characterized as W2 (slightly weathered) to W5 (completely weathered), and R2 (weak) to R5 (very strong). While the bedrock was identified as shallow (within 1 to 2 meters below ground surface) for most of the areas small pockets exist where bedrock was identified greater than 5 meters below ground surface. Estimated foundation conditions after removal of overburden material are shown in Figure 4-3 below.

4.5 Limitations to Field Observations and Foundation Conditions

A desktop review of the field investigation, climate, design, and geotechnical documents referenced throughout this report were used to develop the assumptions made for foundation conditions as well as other design elements. A data gap analysis and field investigation tailored to filling in gaps and confirm assumptions should be completed prior to final design. A site and Yukon specific Foundation Improvement Plan that defines what confirmatory subsurface investigations are needed to properly delineate ice rich and thaw unstable materials may be required before finalization of the foundation and grading plans. In regard to frozen and ice rich materials; for the analysis presented in this document it is assumed that only thaw unstable materials require removal and that bedrock containing ice is thaw stable.

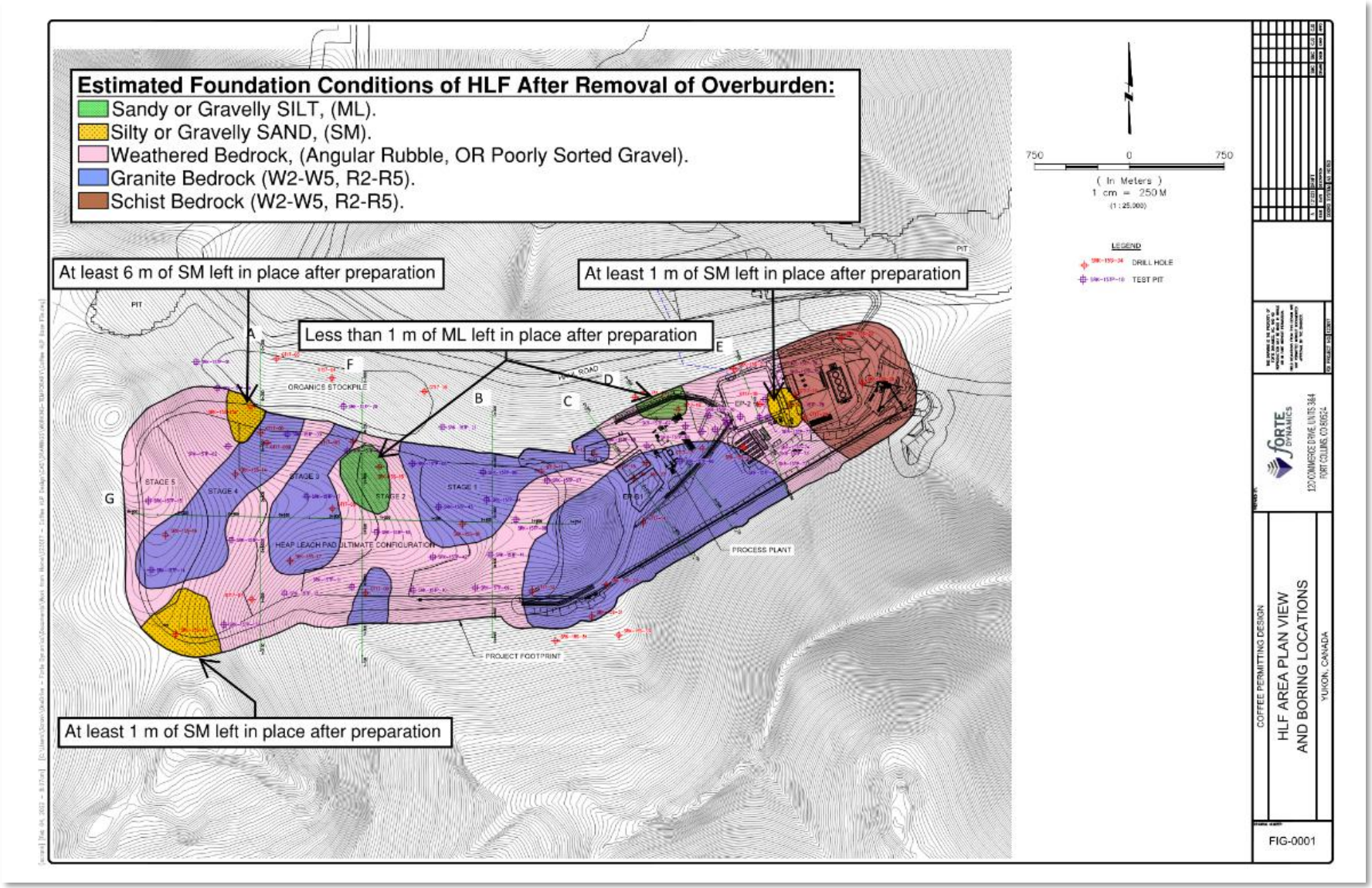

Figure 4-3: Estimated Foundation Material

5. DESIGN CRITERIA

The Engineering Design Criteria is presented in Appendix A and forms the basis for design of the HLF. It presents meteorological inputs, mine plan, and engineering basis for the contents listed in Table 5-1.

Table 5-1: Engineering Design Criteria Contents

Description
Site Conditions
Ore Characteristics
HLP Hydrodynamics
General HLP Parameters
HLP Stability Parameters
Leaching Parameters
Liner Systems
Leak Detection Recovery Systems
Event Ponds
Spillways
Interceptor Ditches

6. INFRASTRUCTURE

6.1 Site Access

The Northern access Route (NAR) spans from Dawson City to the Coffee Mine Project and is the primary point of access. Crossing of the Stewart and Yukon River is also required and may be restricted to ice road or barge route during the winter and summer months respectively. Additionally, a 1,220 m all-weather airstrip is planned to be constructed approximately 7 km east of the Coffee Mine Project process plant. The airstrip will accommodate large turboprop fixed wing aircraft and will be primarily used for personnel transportation.

6.2 Haul Roads and Conveyor Access

The Coffee Mine Project site will include a network of approximately 40 km of mine site roads and haul roads. This includes roads used by site personnel to access specific areas within the mine site. The location of the mine site haul roads may be changed throughout the construction and operation of the mine to facilitate safe travel of light and heavy vehicle traffic, permitting them to remain in the existing footprint of the Project. Mine site roads are designed for light and medium sized machinery.

6.3 Heap Leach Pad

The HLP design will incorporate a double side textured 2.0 mm (80 mil) linear low-density, polyethylene (LLDPE) liner. A geosynthetic clay liner (GCL) will be placed underneath the geomembrane and will provide a saturated hydraulic conductivity of no greater than $5x10E^{-9}$ cm/sec.

A 0.6-meter-thick layer of overliner drain fill (ODF) material will be placed over the LLDPE geomembrane in a single lift based on a designed maximum allowable phreatic surface thickness over the liner. The method for placement of the ODF is discussed in Technical Specification 123022-83010-PC-TS-0023 Drainage Layers – 33 46 23 included in Appendix C. Final method and equipment used for placement of the ODF should be revisited after completion of the detailed design and as discussed in the Technical Specifications, will be dependent on completion of site and equipment specific test fill in the field before placement begins. The HLP is designed to contain a network of pipes that will be distributed throughout the

limits of the facility and will collect and convey PLS in addition to stormwater. Areas requiring ore stacking via trucks will require additional ODF thickness depending on the specific equipment utilized in stacking the ore. The ODF will be placed in bulk onto the liner using suitable haulage equipment or conveyors and spread by dozers in a uniform layer. The liner material properties shall meet or exceed the requirements and be installed as indicated in the Technical Specifications.

The HLP is designed to accommodate an anticipated capacity of approximately 42 million m^3 of ore on an ultimate footprint (exclusive of solution collection channels and perimeter berm) of approximately 1 million m^2 with a maximum thickness of 110m. The HLP will be stacked between the months of April and December. Ore will be ripped and cross-ripped to improve solution infiltration. The HLF water balance models take into account consolidation of ore that is stacked on the pad as it affects ore density and hydraulic conductivity properties.

6.3.1 Description of Design Features

6.3.1.1 Foundation

Preparation of the HLP will consist of clearing and grubbing of all vegetation including grass, shrubs, roots, etc. by removing the upper 6 to 12 inches of soil. The growth media will be relocated to a designated stockpile area for use during future reclamation activities. It is assumed that the foundation does not need to be excavated to bedrock unless the overburden presents characteristics which do not meet specifications and approval of the EoR. Further field investigations are required to determine the extent of thaw unstable soils and weathered bedrock.

Subgrade preparation in cut areas and areas to receive fill will be moisture conditioned and compacted to a minimum of ninety (90) percent of ASTM D1557 maximum dry density. The native, predominately granular soils typically encountered at the site can be used as site grading fills. Site grading fills shall be placed in maximum loose lift thickness of 12 inches and compacted to a minimum of ninety (90) percent of ASTM D1557 maximum dry density, or as approved by the Engineer.

6.3.1.2 Liner System

The liner system will include a GCL secondary liner with a single-sided textured 2.0 mm LLDPE geomembrane primary liner and an ODF layer. The liner system is designed with consideration of climate for both installation and operational periods. Extremes are analyzed including max/min temperatures and max loading depths for both tearing/shearing of the liner system as well as puncture.

The ODF material's purpose is to serve as protection to both the geosynthetic liner system as well as to assist with the solution collection system in creating a free draining lens above the collection piping. The ODF material will consist of processed material (crushed and screened) or other suitable approved borrow material. The material shall meet the specifications and be placed as described in the Technical Specifications. Generally, the ODF material shall be placed using light, low ground pressure equipment and caution to prevent any damage to the geomembrane liner. At no time will there be any vehicle traffic on the exposed geomembrane liner.

6.3.1.3 Collection System

A PLS collection system consisting of perforated and solid HDPE pipe will be placed within the ODF to minimize phreatic surface above the primary geosynthetic liner and convey PLS flows to the Process Plant via gravity. Perimeter berm weirs are included in the design at the lowest elevation point of every cell to further ensure the phreatic surface cannot exceed 0.6 m. If solution within the heap footprint exceeds 0.6m,

the solution would flow through the weirs and into the adjacent lined perimeter channel, remaining in containment. The particle size distribution & permeability of the ODF along with the slope of the lined surface and the maximum phreatic head on the geosynthetic liner drive the collection piping spacing criteria.

6.3.1.4 Loading and Leaching System

Placement of ore must be performed in a specific, controlled sequence in order to provide adequate stability of the heap. The ore material will be placed utilizing a conveyor and radial stacker system, although mine haul trucks and associated equipment will be available if necessary to provide an alternate means of stacking. Generally, materials shall be placed uphill (normal to the slope) until the entire HLP area is covered. Caution shall be taken to ensure acceptable ODF, and ore thickness is attained in areas under load by equipment to prevent damage to the underlying collection system and geomembrane liner.

Dilute cyanide solution, otherwise known as barren solution, is applied to the HLP to dissolve the precious metals into solution. The barren solution is pumped to the HLP from the barren solution tanks located at the adsorption area on the north side of the HLP. Barren solution will be applied via drip emitters at a nominal application rate of 10 (L/h)/m^2.

6.3.2 Stability Analysis

Stability analyses were performed on the ultimate HLP and pond designs. Details of the stability analyses are included as Appendix F. Ore properties are based on triaxial testing performed on three ore samples which were excavated from different parts of the ore body. The samples were crushed and leached to determine gold recovery and reagent consumption. Triaxial tests were performed on the leached samples (MINES, 2016). The slope stability calculations were performed using Bentley PLAXIS LE Connect Edition v21 (PLAXIS). PLAXIS is a computer program that performs two and three-dimensional slope stability computations using limit equilibrium methods. The Morgenstern-Price method (Morgenstern & Price, 1965) was selected for performing the computations in PLAXIS for 2-D. Morgenstern-Price can be used for both circular and non-circular shear surfaces and satisfies both moment and force equilibrium.

Three loading cases were used as part of these analyses: static stability under long-term steady state seepage conditions, pseudo-static seismic, and post-earthquake. A horizontal seismic coefficient of 0.164 g was used to represent earthquake loadings. This seismic coefficient is equal to 2/3 of the design PGA of 0.246 g.

Factor of Safety (FoS) calculations were performed on numerous assumed potential failure surfaces (trial surfaces) along each selected critical slope stability section. FoS calculations were performed for assumed circular failure surfaces. For sections in the HLP footprint, where geomembrane liner will be present (which is considered a potential weak zone in terms of shear strength), failure surfaces representing translational failures along the liner interface (assuming both block type-failure surfaces and circular failure surfaces that were truncated at the liner surface) were also considered. The trial surfaces resulting in the lowest factor of safety at each section are considered the critical failure surfaces and used for comparison to the design minimum FoS criteria. The minimum factors of safety against slope failure used are those recommended by The Canadian Dam Association (CDA) Dam Safety Guidelines (CDA, 2013). The minimum recommended factors of safety for the analyses presented herein are summarized in Table 6-1.

Table 6-1: Target Factors of Safety for Slope Stability, after CDA (2013).

Loading Condition	Minimum Factor of Safety (FoS)
Static, Long-Term	1.5
Pseudo-Static	1.0
Post-Earthquake	1.2

Anticipated foundation conditions were determined based on the field investigations performed by SRK Consulting (SRK, 2015) and Tetra Tech EBA (Tetra Tech, 2016b and Tetra Tech, 2017).

A summary of the strength values assigned to the materials for the evaluated conditions are presented in Table 6-2 and are further discussed in this section.

Stability analysis results met or exceeded the target FOS. Results are included in Table 6-3.

Table 6-2: Material Strength Properties

Material	Unit Weight (kN/m3)	Cohesion (kPa)	Friction Angle (Φ)	Notes
Crushed Ore (Peak Strength)	17.3	0	35	Based on testing (MINES, 2016)
Crushed Ore (80% Reduced of Peak)	17.3	0	28	Calculated from Above Line Item
Liner Interface (Peak Strength)	20	NA	NA	Enviroliner (see Appendix F – Figure 1)
Liner Interface 80% Reduced of Peak)	20	NA	NA	Calculated from Above Line Item
Embankment Fill	23	NA	NA	See Table 4 of Appendix F
Granite Bedrock Foundation[1]	27	300	35	Rock Mass Classification Class III (Tetra Tech, 2017)
Shist Bedrock Foundation[1,2]	24.2	300	35	Rock Mass Classification Class III (Tetra Tech, 2017)

1. For the heap leach pad, failures were forced through liner interface, bedrock foundation not utilized.
2. Granite Bedrock Foundation utilized in all pond stability analysis for conservatism.

Table 6-3: FOS Results for Pond Analysis

Section	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
A-A’	Circular	Static	1.5	1.6	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through the liner interface.
A-A’	Circular	Pseudo	1.0	1.1	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through liner interface.
A-A’	Circular	Post-Earthquake	1.2	1.3	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through the liner interface.
B-B’	Circular	Static	1.5	1.5	Southern slope of HLF pile. Failure assumed along liner interface.
B-B’	Circular	Pseudo	1.0	1.0	Southern slope of HLF pile. Failure assumed along liner interface.
B-B’	Circular	Post-Earthquake	1.2	1.2	Southern slope of HLF pile. Failure assumed along liner interface.
C-C’ (L-R)	Circular	Pseudo	1.0	3.7	EP-1N, RWP, and EP-1S embankments.
C-C’ (L-R)	Circular	Static	1.5	2.8	EP-1N, RWP, and EP-1S embankments.
C-C’ (R-L)	Circular	Pseudo	1.0	2.2	EP-1N, RWP, and EP-1S embankments
C-C’ (R-L)	Circular	Static	1.5	1.5	EP-1N, RWP, and EP-1S embankments
D-D’ (R-L)	Circular	Pseudo	1.5	2.1	Process Plant Pad
D-D’ (R-L)	Circular	Static	1.0	1.5	Process Plant Pad
E-E’ (L-R)	Circular	Pseudo	1.0	2.7	Critical failure surface is shallow surface failure low-height EP-2 embankment section.
E-E’ (L-R)	Circular	Static	1.5	1.9	Critical failure surface is shallow surface failure low-height EP-2 embankment section.

Section	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
E-E' (R-L)	Circular	Pseudo	1.0	2.8	Critical failure surface is shallow surface failure low-height EP-2 embankment section.
E-E' (R-L)	Circular	Static	1.5	2.0	Critical failure surface is shallow surface failure low-height EP-2 embankment section.
F-F'	Circular	Static	1.5	2.2	Tallest Pond Embankment
F-F'	Circular	Pseudo	1.0	1.5	Tallest Pond Embankment

Ore properties evaluated to-date are recommended to be further refined in advanced design stages and through operations. Key ore properties that should be monitored include permeability and shear strength.

6.3.3 Settlement Analysis

Consolidation analysis was performed for the foundation of the HLP. Data from previous field investigations was used to develop soil compressibility parameters. Analyses were performed using simplified one-dimensional (1D) analyses of foundation settlement under various loading conditions. The purpose of these analyses was to estimate the amount of settlement and the potential for differential settlement to evaluate the need for foundation improvements and the need for more targeted analysis.

Results of the analysis indicated that there were no issues with differential settlement of the HLP where the subgrade will consist of weathered or unweathered bedrock. However, in areas where more significant thicknesses of potentially loose, compressible finer-grained silty sand or silt may remain in place, vertical settlements under static ore loading could exceed 1 meter. This amount of settlement could be disruptive for the geomembrane liner system and drainage system. Maximum axial strain on textured LLDPE liner is reported by the Geosynthetic Institute (GSI) to be 30% and elongation before breakage is reported to be 250% (GSI 2021). As a best practice, a maximum strain on the LLDPE liner of no more 10% is assumed. Maximum strain on GCL is much lower and reported as low as 2% (GSI 2013), which is a factor in the amount of GCL panel overlapping. As a result, it is recommended that further investigations be performed as part of future design phases. If additional detailed investigations do confirm that the finer grained layers are in a loose, highly compressible state, remedial measures such as over excavation and compaction of the fine-grained layers, or removal and replacement with less compressible fill may be warranted in these areas. The results and further details of the analysis are presented in the Coffee Project Heap Leach Facility Foundation Settlement Analysis Memorandum by Forte, 2025 and included in Appendix G.

6.3.4 Solution Collection Piping System Analysis

The PLS collection system is designed to limit the phreatic head within the HLP to below 0.6 m and provide rapid transport of PLS flows to the ADR plant via gravity. The system was designed based on a minimum permeability of the ODF of $1X10^{-2}$ cm/s and the solution application rate of 10 L/hr/m^2The solution collection pipe network will accommodate a total flow of 1400 m3/hr, which includes the nominal 1100 m3/hr flow rate generated from the applied leaching solution plus a 300 m3/hr potential dynamic storage flow rate. The 24-hr Probable Maximum Precipitation (PMP) was also in consideration for the sizing. Calculations for pipe spacing are presented in Appendix H.1. 1.

The buried collection piping will consist of perforated, dual-walled, corrugated, 100 mm diameter HDPE collection pipes branching from 450 mm perforated, dual-walled, corrugated collection header pipes. The collection header pipes will then tie-in to a solid-wall 630 mm HDPE SDR 11 heap trunklines. The heap trunklines will tie-in to 710 mm SDR 21 return pipes along the channels to the ponds. The collection trunklines will have dual-containment as they will be routed within the lined solution collection channels

along the HLP before transitioning into a pipe-in-pipe configuration until reaching the ADR plant. The 100 mm pipes will be arranged in a herringbone fashion and spaced approximately every 6 m apart and buried in a 0.6 m layer of ODF. Refer to Appendix B for further details. Calculations for the solution collection system can be found in Appendix H.1. 2. Piping will be insulated with a polyurethane foam insulation at a thickness of at least 25 mm. The insulation is designed to minimize the risk of pipes freezing while flowing. The hydraulic calculations for capacity and sizing of the pipe are presented in Appendix H. 3. Table 6-4 shows the sizing of each collection pipe type along with the criteria used to design them.

Table 6-4: Pipe Size and Spacing Design

Design Criteria	Size/Spacing	Flow
Collectors		
Maximum Application Flow Rate + PMP (Infiltration) 50% Full	100mm ADS N-12 6 m (spaced)	13.38 L/m2/hr
Headers		
Maximum Application Flow Rate 10 L/m2/hr*1.2*Largest Cell Area + PMP Infiltration 55% Full	450 mm ADS N-12	1,174 m3/hr (Max Header Flow)
Heap Trunklines		
Maximum Nominal Flow Rate (1,400 m3/hr)*1.2 + PMP 93% Full	630 mm HDPE SDR 11	2,031 m3/hr
Preg Return/Standby		
Maximum Nominal Flow Rate (1,400 m3/hr)*1.2 + PMP 93% Full	710 mm HDPE SDR 21	2,031 m3/hr (N and S)
Barren		
Maximum Application Flow Rate (1,400 m3/hr)	600 mm STD STL	1,400 m3/hr (nominal barren flow rate of 1,100 m3/hr plus 300 m3/hr dynamic storage)

6.3.5 Barren Solution Delivery System Analysis

As the HLP is stacked, barren solution will be delivered to the surface of the ore. The barren solution is to be pumped through a network of distribution pipelines, transitioning to driplines which emit the barren solution onto the surface of the HLP at a nominal application rate of 10 L/hr/m^2 to leach the stacked ore. The piping network was sized based on a target velocity of 1.2 to 2.5 m/s with a target pressure at the crest of the HLP of greater than 275 kPa. The pipe schedules were adequately selected so the design pressures exceed the maximum operating pressures in the system. Piping will be insulated with a polyurethane foam insulation at a thickness of at least 25 mm. The insulation is designed to minimize the risk of pipes freezing both while flowing and in an upset condition where the solution is static. In the event of a leak in the pipeline, the insulation also provides a barrier against spray while allowing for quick visual identification of the leak and easier access. Calculations of heat loss from flowing and static insulated pipes can be found in Appendix H. 2 and hydraulic calculations can be found in Appendix H. 4.

- **Trunk Lines:** A single trunk line runs from the ADR plant up to the east end of the HLP where it splits running along the toe of the HLP on both the north and south perimeters of the HLP. These separate lines are a best practice offering redundancy and versatility to deliver solution from either side of the HLP where stacking operations could otherwise complicate piping layouts. The trunk lines are designed to exceed the 1400 m/3hr flow rate. The specified pipe classifications ensure that the pipe design pressure is greater than the maximum operating pressure.

- **Selection:** 600 mm (24”) Schedule 80 Steel, transitioning to 600 mm (24”) STD Steel when maximum operating pressure decreases below 1,800 kPa.

- **Riser Lines:** The riser lines will tee off of the trunk lines and run along the side slopes of the HLP. The riser lines are designed to convey 142 m^3/h of barren solution through each individual riser, from the toe to the crest of the HLP. Butterfly valves will be installed at every tee to manage flow through each riser. The specified pipe classifications ensure that the pipe design pressure is greater than the maximum operating pressure.
  - **Selection:** 315 mm (12”) HDPE SDR 11

6.3.6 Perimeter Channels

The perimeter channel is a liner system consisting of 2 mm (80 mil) LLDPE double-sided texture and GCL. The perimeter channel(s) enclose the HLP and are delineated to the north and south by the ridge in the approximate center of the footprint. The HLP’s lowest point is near the east side, where the channels combine and ultimately flow via gravity to the ponds. Figure 6-1 below presents the general arrangement of the HLF.

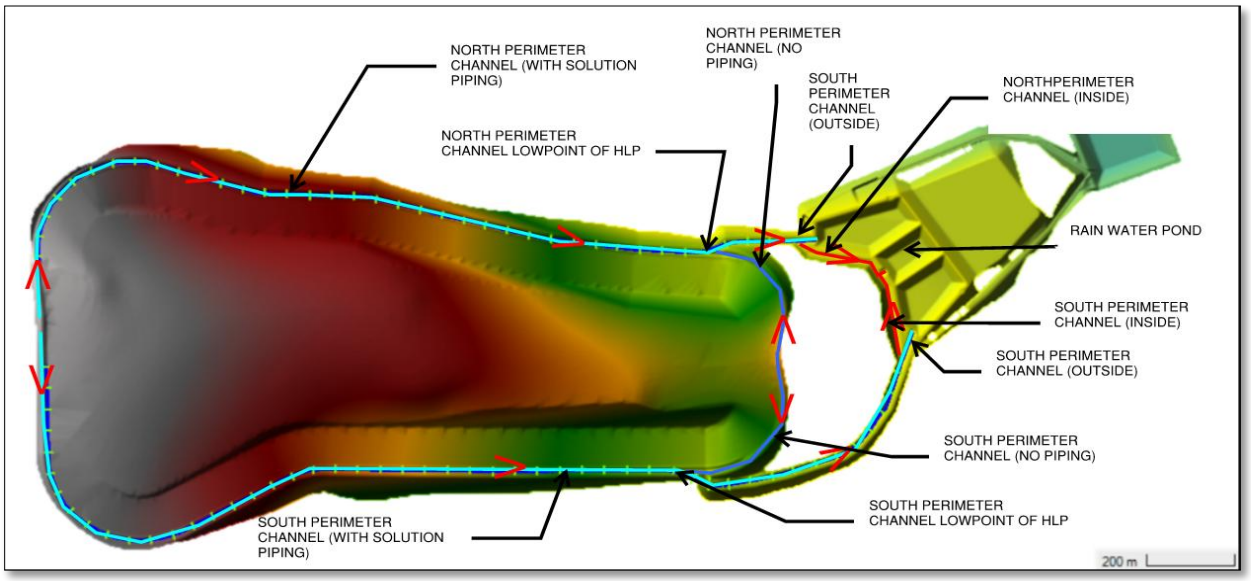

Figure 6-1: Perimeter Channel Arrangement

Solution collection and delivery pipelines will be contained within the perimeter channels along the north and south perimeter of the heap with gravity flow from west to east. The portion of the channel along the east side of the heap will not contain piping. In addition to providing secondary containment for the pipelines, the channel provides conveyance for flows during a precipitation event that would produce surface runoff. The HLF water balance model took a conservative approach by not including the use of raincoats in modeling, however, the opportunity for operations to utilize raincoats is a contingency option to manage water.

The capacity of the perimeter channel will convey the 24-hr PMP event per the pond storage design criteria. The full HLP footprint was considered in calculating the peak flow rates for both the north and south tributary areas. Although use of raincoats is not a criterion of the channels, consideration for raincoats in regard to curve numbers and peak flows was considered. The peak flow rate for the channel was calculated as 52 m^3/s. The hydrological calculations are presented in Appendix D.

A conservative approach was taken in hydraulic model utilizing HEC-RAS by applying the peak flow rate at the most upstream point of the channel(s) and modeling it to the discharge point, ensuring that 0.5 meters of freeboard were maintained.

The piping designs within the perimeter channel (Figure 6-2), was modeled in HEC-RAS as polygons that occupy more cross-sectional area than the actual pipe outside diameters, as shown in Figure 6-3. Velocities in the channel were maintained below 15 m/s, where LLDPE is proposed. The last 100 meters of channels were predicted to exceed 15 m/s with LLDPE liner only, and therefore a Hydro-Turf liner is proposed for those sections. The Hydro-Turf includes armoring and a higher frictional factor to reduce velocities. The hydraulic calculations and details are presented in Appendix D.

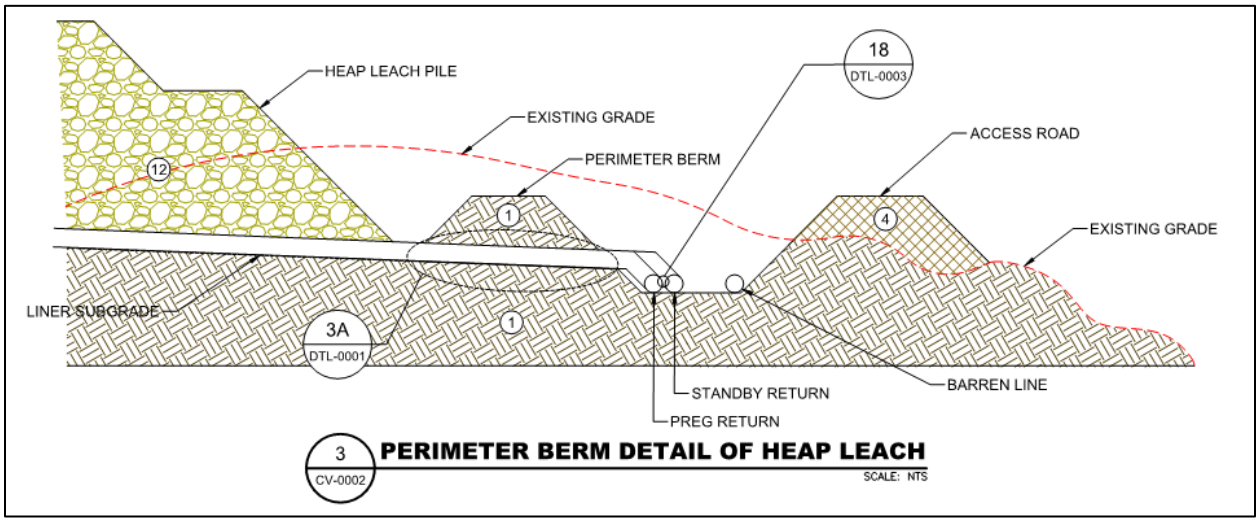

Figure 6-2: Perimeter Channel Typical Section

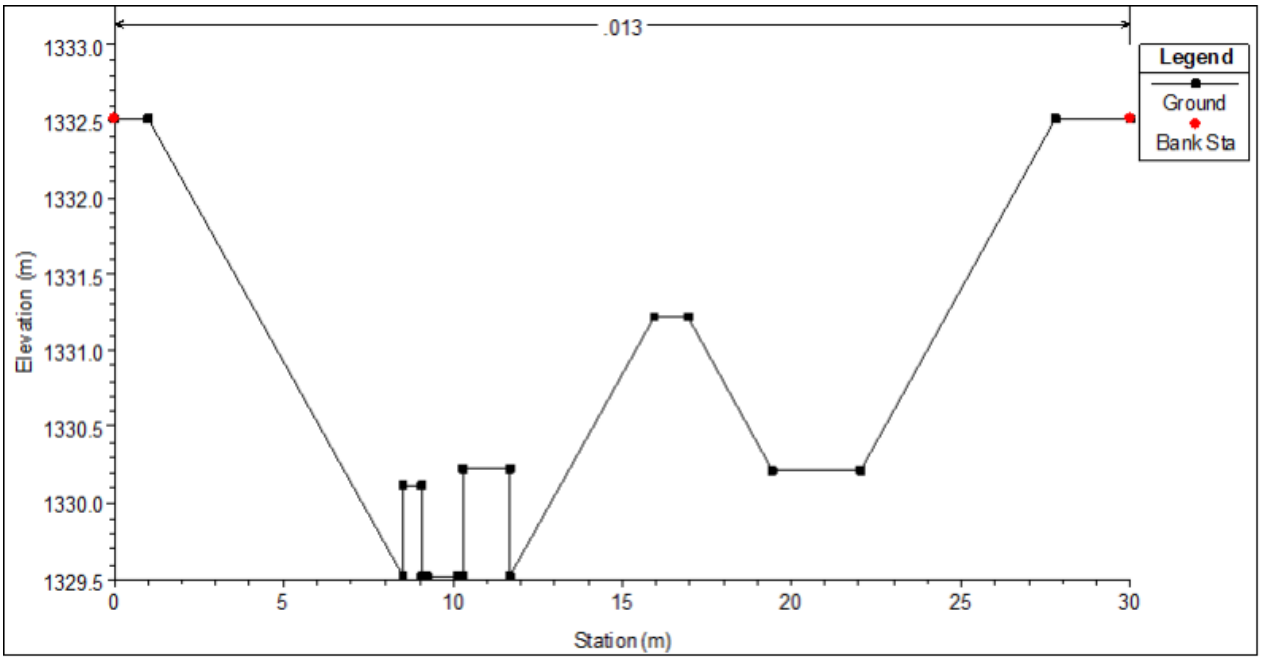

Figure 6-3: HEC-RAS North Perimeter Channel Typical Section: Adjacent to Heap

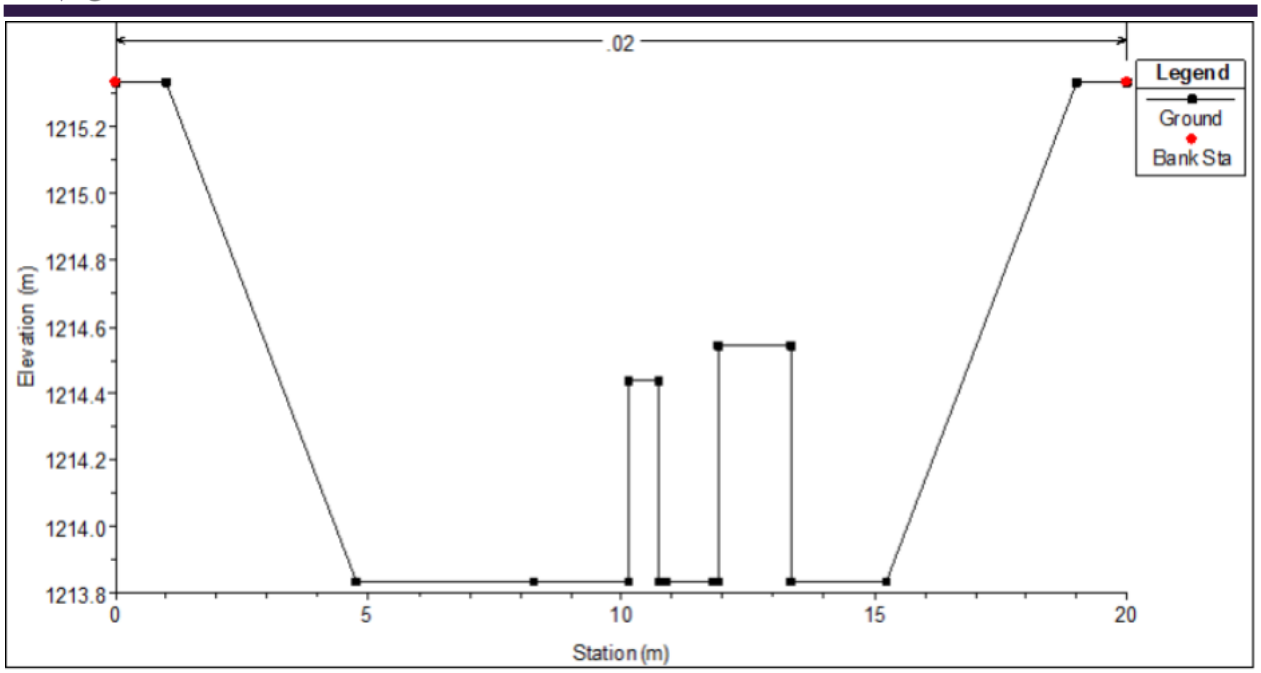

Figure 6-4: HEC-RAS North Perimeter Channel Typical Section: East of Heap

6.4 Heap Leach Facility Ponds

6.4.1 Event Pond Analysis

The event ponds will be constructed to seasonally store precipitation and process solution that may flow to the ponds through the HLF perimeter channels during operation and precipitation events. The solution contained in the ponds will be recycled back into the heap leach circuit for use as make-up water or removed from the HLF system if needed.

The HLF has been designed with four ponds for management of solution to maintain the event storage requirement of the 24-hour PMP and concurrent 72-hour heap drain down volume, in addition to the capacity to contain the maximum seasonal precipitation and snowmelt as evaluated for 30 climate scenarios (detailed in the HLF Water Balance Modeling Report, Appendix E), and 0.5 m of freeboard in each pond. The HLF water balance evaluated the design volume required for the event ponds and their expected inflows and outflows. The event pond volumes are as follows:

- Event Pond 1 North (EP-1N) = 112,000 m^3
- Event Pond 1 South (EP-1S) = 90,000 m^3
- Event Pond 2 (EP-2) = 340,000 m^3
- Rain Water Pond (RWP) = 53,000 m^3

The EP-1N and EP-1S liner systems will consist of two geomembranes with allowance for leak detection and recovery. The 30 climate realizations analyzed in the HLF Water Balance Model resulted in two distinct inflows for EP-2: direct precipitation and pregnant tank solution overflow. To maintain the water quality of the direct precipitation, EP-2 is designed with a segregation berm to create two ponds within the EP-2 footprint. The process solution will be contained in the segregated lower pond area with a liner system

consisting of two geomembranes with allowance for leak detection and recovery. The upper portion of EP-2 will be single lined for containment of direct precipitation.

The Rain Water Pond is designed with overflow weirs that allow for gravity flow of water to EP-1N and EP-1S. Spillways are included in the designs of EP-1N and EP-1S to allow for gravity flow to EP-2. The total capacity of the four hydraulically connected ponds provide storage capacity for the 24-hr PMP and 72-hr heap drain down occurring concurrently, in addition to seasonal precipitation and snowmelt, and 0.5 m of freeboard.

All HLF ponds are designed with weirs that would control potential discharge. Table 6-4 presents the max flow capacity of the weirs. Weir flow capacity calculations are included in Appendix D.

Table 6-4: Pond Weir Capacities

Pond	Weir Flow Capacity (m^3/s)
EP-1N	22.8
EP-1S	22.8
Rain Water Pond	72.4
EP-2	22.8

6.4.2 Rain Water Pond

The Rain Water Pond is designed for contingent water storage capacity. Snow management strategies may involve pushing snow from the heap footprint to the channel and ultimately report to the Rain Water Pond.

The Rain Water Pond has a storage volume of 53,000 m^3 for temporary storage and water quality testing. The Rain Water Pond is designed with a single geomembrane liner and will be connected to Event Ponds 1N and 1S via overflow weirs. The HLF Water Balance Model presented in Appendix E did not utilize or require raincoats to manage solution flows. The raincoats are identified as an opportunity in operations to allow for flexibility in water management but are not required from a flow quantity perspective. Therefore, no flows were modeled for the Rain Water Pond in the HLF Water Balance Model other than direct precipitation captured within the footprint of the pond. The Rain Water Pond contributes to the total storage available for the HLF during a concurrent 24-hr PMP and 72-hr drain down.

6.5 Stockpiles

6.5.1 ROM Stock Pile

Forte's understanding is that the crusher will not operate during the winter months and Run-of-Mine (ROM) ore will be stockpiled. Ore transported from the open pits will either report directly to the crusher system, or to the ROM stockpile. The amount of ROM material stored at the facility will fluctuate, with peak volumes occurring during the winter months of January to March when the crusher is not anticipated to be in operation. The stockpiled ore will be processed during the mine life and therefore will not remain at closure. In the present design, the ROM Stockpile is located directly east of the primary crusher. The ROM material slopes will be at their natural angle of repose (approximately 1.5H:1V).

6.5.2 Overburden Stock Pile

The Temporary Organics Stockpile is located immediately north of the HLP, near the top of a northeast facing slope. Topsoil which will be removed in the process of stripping the pits, HLP, site infrastructure pads and portions of the WRSF footprints will be stockpiled and progressively transferred from the stockpile for

reclamation purposes as certain areas of the Project are ready to be closed. The organic materials are not anticipated to be ice rich.

6.5.3 Ice-Rich Overburden Stock Pile

Frozen soil that is not immediately re-used as fill will be deposited in a designated frozen soil storage area located within the Alpha WRSF. will likely not be suitable for immediate re-use as fill during construction or reclamation and will require storage in the frozen soil storage area. As necessary, waste rock berm will be constructed around the perimeter of this storage area to enhance stability and provide drainage of the stored materials.

6.5.4 Heap Diversion

The HLP will be constructed in five stages of liner expansion over the life of the mine. The expansion will progress from east to west, and temporary interceptor ditches will be constructed to divert upgradient runoff from tributary areas that are composed of native soils.

6.6 Borrow Sources

Borrow materials will be required for the construction of the HLF perimeter berms, the event pond berms, and for the ODF. In general, material obtained from the HLF and event pond footprint excavations or from the cuts for the processing plant will be used as fill material for the Project. ODF is expected to be produced from ore. If needed, processing of durable rock from deeper cuts within the event ponds or HLF footprint may occur.

6.7 Environmental Measures

6.7.1 Water Balance

Discretized modeling was conducted on the proposed HLF to provide input into the design, inform the water management strategies for the HLF, and confirm that adequate solution storage can be maintained. Flow results were also utilized in a site-wide water balance and water quality model prepared by others. The HLF was modeled deterministically using 30 unique time series of daily climate data based on historic data (Lorax, 2021). The climate series includes seasonal precipitation, freshet, and varying storm events. In addition to climate, the model incorporates the proposed mine plan, site operational design data, and geotechnical and ore hydrodynamic properties, with a model timeframe from January 1, 2026, through January 1, 2047 (Mine year -1 =2026, and Mine year 21=2047). The HLF water balance model predicts daily transfer flows and daily pond levels based on precipitation, snow accumulation and melt, leaching operations, and daily tonnage placed on the HLF.

Figure 6-5 shows the flow schematic as modeled for the HLF. Details for the HLF water balance model are presented in Appendix E.

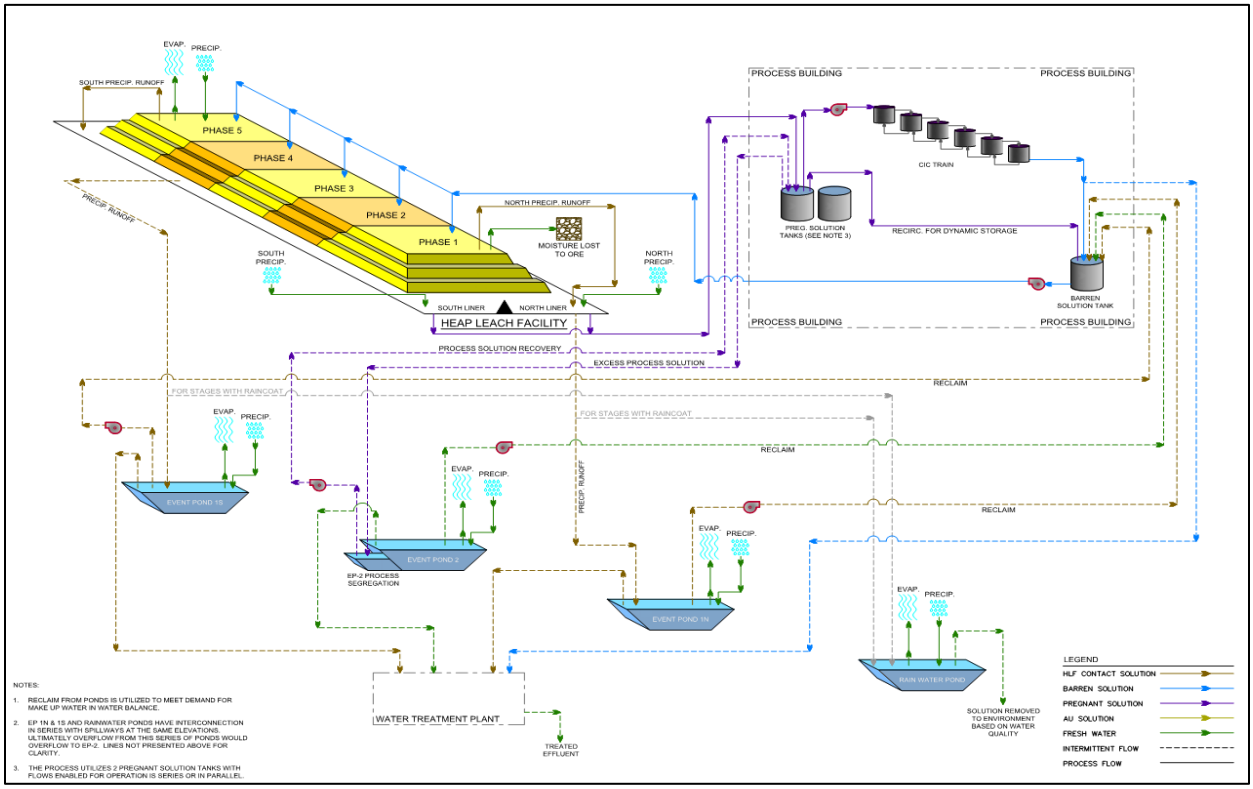

Figure 6-5: HLF Flow Schematic

The Event Storage Requirement (ESR) includes volume for the 24-hr PMP, applied to the HLF which increases with each Stage, plus volume for a 72-hour drain down period, based on the nominal flowrate to the HLF. As operations progress through the 5 Stages of the HLF, the ESR increases as shown in Figure 6-6. The daily total pond volumes depicted in Figure 6-6 include precipitation, snowmelt, and any process solution predicted to overflow to the EP-2 process segregation.

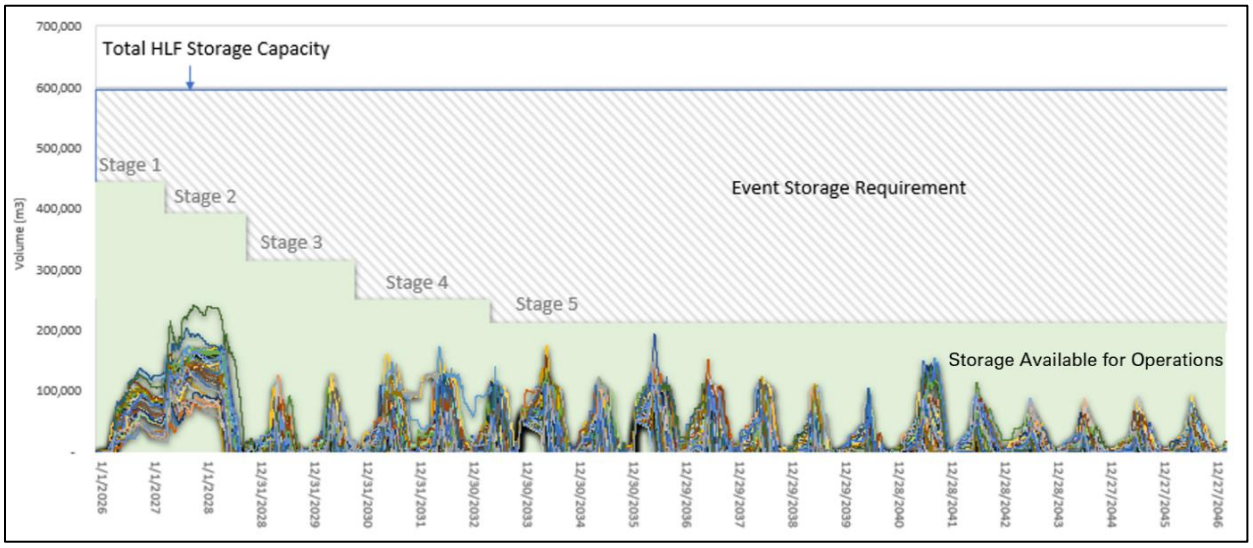

Figure 6-6: Available Pond Storage Volume Results: Climate Iterations 1-30

The results confirm sizing and management strategies of the event ponds to ensure sufficient volume and solution removal rates (incorporated into the site-wide water balance by others) to maintain the ESR from the start of construction through the transition to long-term closure of the HLF, under varying climate conditions. By making periodic use of pumping to the HLF for additional dynamic storage as an active solution management strategy during operations and through the determined solution removal rates required, no infringements occur with respect to the ESR volume. Additional operational options that give flexibility to solution management, although not explicitly modeled include, but are not limited to, inter-pond pumping, snow removal, and raincoats. These are solution management contingency options but were not modeled as requirements to maintain the ESR. Additional water management strategies are represented in the site wide water balance model, which may utilize and/or store water for purposes outside the scope of the HLF water balance.

The modeling of the HLF shows that Pregnant Solution Tank overflow may occur during freshet or other periods of high precipitation. A segregation volume within EP-2 has been implemented as a design strategy to manage this overflow prior to it being pumped to the process plant. Modeling shows a quantity of solution within the system from make-up water and meteoric inflows such that the nominal plant flow rate of 1100 m^3/hr is easily achieved. Meteoric inflow has seasonal fluctuations which are managed by the pond capacities, EP-2 segregation design, and dynamic storage to maintain total available storage beyond the ESR throughout the life and closure of the HLF.

6.7.2 Construction Quality Assurance

Qualified personnel will perform third party construction quality assurance (CQA) testing and inspection during all phases of construction of the proposed facilities. The CQA program will include sufficient testing and observations during earthwork, geomembrane lining, and piping operations to adequately assess the quality of work and to document that the work has been performed in substantial conformance with the Drawings and Specifications. CQA requirements and testing frequencies are provided in the Technical Specifications in Appendix C.

6.7.3 Site Monitoring Wells

Monitoring of the groundwater system within the area of the HLF will be conducted using monitoring wells, as required by the WUL. To adequately monitor any potential contamination of groundwater caused by loss of containment or liner damage, we recommend the installation of monitoring wells that will extend into groundwater, as detailed by Lorax. Analysis results will be documented and reported in accordance with the conditions of the approved WUL. Detection of indicator parameters will result in a response in accordance with the terms of the WUL. These monitoring wells will be placed per Lorax's design.

6.7.4 Cold Climate Considerations

The design and operation of the HLP includes several parameters and best practices specific to cold climate heap leach operations.

- During construction, ice-rich soils within the HLF footprint, including process facilities, leach pad, and event ponds will be removed for construction on bedrock or structural fill.
- The HLP is planned to be stacked seasonally based on temperatures. During the coldest periods of the year, ore from the mine may be stockpiled and later re-handled for stacking on the HLP.
- Ore will be triple-ripped to prevent ice lenses and improve solution infiltration.
- Barren solution will be heated at the process plant prior to being pumped to the HLP.

- Leach solution will be applied year-round to allow continuous flow to prevent pipes from freezing.
- Drip emitters will be buried or covered with gravel and/or ore during months with freezing temperatures.
- Pipelines from the perimeter of the HLP to the process plant will be insulated and some pipes will be heat traced.
- A backup irrigation area will allow for 100% redundancy in available irrigation area in the event that the primary irrigation area freezes, beginning at the end of Year 1.
- The HLP stacking plan utilizes strategies to enhance thermal mass to the extent feasible, by maintaining a sufficient depth of stacked ore material going into the winter period.
- New ore will not be placed on snow with excessive accumulation.
- Pregnant and barren solution tanks are located inside the ADR.
- Routine measurement of snow water equivalent on the HLF to monitor and plan for water management needs.
- Pond storage is sized to accommodate freshet, in addition to other seasonal water accumulation, the PMP, and 72-hrs of heap draindown.
- Standby pregnant solution collection pipe that can be used in upset conditions caused by cold weather.
- Thermistors will be installed to monitor temperatures within the HLP.

6.8 Drawings and Technical Specifications

Design Drawings and Technical Specifications have been developed as guidance to aid in meeting the level of accuracy required for the consideration of permitting the design and construction requirements in this report. The Design Drawings are provided in Appendix B. The Technical Specifications are provided in Appendix C.

7. RECOMMENDATIONS

To advance the design report beyond a level to support licensing, detailed engineering efforts should include refinements to the existing Project knowledgebase, designs, and documentation. These advancement efforts should include integrating the planned, site-specific geotechnical characterization, construction materials (overliner drain fill, and liners) characteristics, and ore characterization data into detailed design analyses, and integrating any refinements that occur upstream and downstream of the HLF during detailed engineering and that may have an impact on the HLF design or operation. These detailed engineering evaluations will result in the issuance of issued for construction (IFC) plans, technical specifications, construction QA/QC plans, and other relevant documents; with all revisions reviewed and approved by the Engineer of Record (EoR). Given the current level of engineering, it is anticipated that detailed engineering revisions will remain within the boundaries and definitions presented in this licensing design.

As the project continues to progress toward detailed design and construction, design documentation and drawings will be advanced to an IFC level per engineering standards and with consideration of the Yukon Guidelines for Mine Waste Management Facilities (YG-MWMF), including progressive updates to the following:

- Heap Leach Process Facilities Plan
- Heap Leach Pad Engineering Detailed Design Report and associated analyses
- IFC drawings and specifications
    - Construction QA/QC Plan
- Operation, Maintenance, and Surveillance (OMS) Manual, including TARPS and Emergency Response Plan (ERPs)
- Reclamation and Closure Plan
- Heap Leach Facility Risk Assessment

Additional investigations, test work, and engineering recommended to advance the detailed design and IFC documents include:

- Geotechnical Advancements:
    - Develop a work plan and conduct a geotechnical investigation and laboratory testing program. This will include a detailed geotechnical knowledgebase review and gap analysis to supplement the recommendations below and improve project and site understanding. Advancements will be made to further develop and understand results of surface mapping, delineation of geological formations and major geological structures, borehole logs, geotechnical laboratory test results, and core photos. This work will include:
        - Site-specific liner system material testing to demonstrate adequate liner strength and thickness; The liner system includes GCL, geomembrane, and overliner drainfill (ODF).
        - Geotechnical testing to include index, compacted permeability, shear strength on material/rock type to be mined in the first 6 months of operation, 6 months to 12 months, first year, years 2-5, or more frequent if differences in rock type are determined;
        - In-situ strength, compressibility and liquefaction potential of overburden soils that may remain in place after completion of site grading and removal of ice-rich soils in the HLF;
        - Site-specific seismic response characteristics, specifically near-surface characterization of shear wave velocity, using MASW geophysical survey data;
        - Confirmatory geotechnical drilling and test pitting to confirm assumptions made with respect to soil foundation, heap leach, and borrow material characterizations;
        - Review latest ground temperature profile data being measured on site to expand the measurement dataset applied in analyses and designs;
        - Extent of thaw unstable soils and weathered bedrock and define any areas with unacceptable settlements or strain per the settlement/strain parameters defined by the EoR;
        - Develop a cut and fill isopach drawing that is based on the geotechnical investigations and presents an understanding where material needs to be excavated and placed for the grading plan, including ice-rich overburden;

- Document borehole and test pit locations and the refined understanding of geotechnical conditions (including areas of ice-rich overburden material) via a drawing in the IFC drawing set;

- Develop a comprehensive Site Characterization Report to present all geotechnical information used in the IFC design of the HLF;
- Advance design parameters, settlement analyses, and stability analyses based on above data.

- Stability Analyses
  - Refine analyses and reduce uncertainty with respect to construction materials using properties defined via site-specific material testing, to include shear strength testing of the liner interface and demonstrate adequate liner strength and thickness; and implement any required design modifications;
  - Conduct sensitivity analyses to evaluate the phreatic surface or degree of saturation at critical locations;
  - Develop an ore depth isopach to understand the ore thicknesses across the entire HLP area, and confirm design criteria and loading conditions;
  - Develop an ore loading plan on a lift-by-lift basis to evaluate and document any ore loading constraints or limitations. The loading plan will be developed by rock type and with subsequent reviews by the EoR during operations at a frequency defined in the (OMS) manual, such as monthly. The loading plan will be developed and updated with ongoing consideration of potentially liquefiable or contractive material. Additional material characteristics by material/rock type will be required to complete a detailed design for operational and closure stability analyses.

- Other:
  - A follow up facility classification, risk assessment, and failure modes and effects analysis be conducted if material changes occur during final designs/documentation based on recent engineering standards and the YG-MWMF;
  - Appoint an Independent Technical Review Board per YG-MWMF;
  - Conduct geomembrane load testing that demonstrates the liner configuration provides the puncture resistance required for the design height;
  - Thermal modeling based on heap design coupled with seepage models. This model can be further applied and validated during operations;
  - Additional detail in the Construction QA/QC Plan and Technical Specifications regarding the method and equipment used for placement of the ODF, based on completion of site and equipment-specific test fill in the field before placement begins;
  - Detailed IFC drawings for the HLF including elevations, ponds, liners, any liner transitions, piping, valves, piezometers, per standard engineering practices;
  - Owner and EoR to form a team to conduct a constructability review based on final designs;
  - Develop a Design Basis Report to define key design assumptions and criteria;
    - Develop a records system for tracking design and operational data, and any material changes to the design and operating procedures per the Design Basis Report;
    - Develop a procedure to define monitoring requirements to be documented in the records system for validation, defined roles and responsibilities, deviation

thresholds, and roles and responsibilities to validate or address deviations from the Design Basis Report;

- Update water balance model based on detailed design, to include an evaluation of pond usage and liner requirements;
- Conduct a construction and operational readiness assessment and develop a Construction Readiness Plan and Operational Readiness Plan;
- Advance the performance monitoring defined in the Operations, Maintenance, and Surveillance (OMS) Manual to include the following:
  - Relevant OMS guidance for tailings and water management facilities per the most recent publication of The Mining Association of Canada (MAC) Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities, as relevant to heap leach and water management facilities as no tailings facilities are proposed for the Project;
  - Refined monitoring and inspection requirements to include ore testing (shear strengths, permeability), geotechnical performance (ground and air-borne monitoring), liner and drainage systems, solution levels within the HLP, temperature monitoring, and other operational obligations coordinated by the EoR, operations, management teams, and a qualified third party; in alignment with the MAC and YG-MWMF.
  - Trigger Action Response Plans (TARPS) for solution management, monitoring of HLP slopes, phreatic surface, solution temperatures, and other operational components identified by the EoR as key metrics upon finalization of detailed engineering;
  - Finalize roles and responsibilities for design, construction, operation, and surveillance teams, including communication guidelines between the Owner and EoR, and RACI matrix;

8. REFERENCES

Coffee Gold Mine, YESAB Project Proposal, Prepared by Kaminak Gold Corp. (Vancouver, BC, Canada) for Newmont Gold Corp., December 2019. (Kaminak, 2019)

Coffee Gold Baseline Hydrogeological Assessment, 2019 Update, prepared by Lorax Environmental (Vancouver, BC, Canada) for Newmont Gold Corp, December 2021. (Lorax, 2021)

Coffee Gold Project: 2021 Hydro-meteorology Baseline Report, prepared by Lorax Environmental (Vancouver, BC, Canada) for Newmont Gold Corp, January 2022. (Lorax, 2022)

Feasibility Design Report for Coffee Gold Heap Leach Facility, Yukon Territory, Canada, prepared by The MINES Group, Inc. (Reno, NV, USA) for Kaminak Gold Corporation, January 2016. (MINES, 2016)

2015 National Building Code of Canada, Seismic Hazard Maps, website: https://earthquakescanada.nrcan.gc.ca/concon-en.php, prepared by Earthquakes Canada, National Resources Canada, and Pacific Geoscience Center (Sidney, BC, Canada) April 2021. (NBCC, 2020)

2015-2005 National Building Code of Canada, Seismic Hazard Values, website: https://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php, prepared by Earthquakes Canada, National Resources Canada, and Pacific Geoscience Center (Sidney, BC, Canada) April 2021. (NBCC, 2021)

2015 Geotechnical Field Investigation, Coffee Gold Project, Yukon Territory, Canada, prepared by SRK Consulting, Inc. (Denver, CO, USA) for Kaminak Gold Corp., January 2016. (SRK, 2016)

Summer 2017 Geotechnical Investigation Data Report, Coffee Mine Site, Coffee Gold Project, prepared by Tetra Tech Canada, Inc. (Edmonton, AB, Canada) for JDS Energy & Mining, Inc., November 2017. (Tetra Tech, 2017)

Technical Memo: Permafrost and Related Geohazard Mapping within the Coffee Mine Area, prepared by Tetra Tech EBA, Inc. (Edmonton, AB, Canada) for the Kaminak Gold Corp., February 2016 (Tetra Tech, 2016a).

Coffee Gold Project, Environmental Baseline Report, Mine Study Area: Surficial Geology, Permafrost, and Terrain Stability, prepared by Tetra Tech EBA, Inc. (Edmonton, Alberta, Canada) for Kaminak Gold Corporation, May 2016. (Tetra Tech, 2016b)

Ground Temperature Monitoring Update, Coffee Mine Project, YT, prepared by Tetra Tech, Inc. for Newmont Corporation, August 2023. (Tetra Tech, 2023)

Dam Safety Guidelines, prepared by the Canadian Dam Association (CDA), October 2013. (CDA, 2013)

APPENDIX A: DESIGN CRITERIA

Kaminak Gold Ltd. a Subsidiary of Fuerte Metals

Coffee Project

HLF Engineering for Permitting Design Criteria

Document #123022-51100-01-EDC-0001



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1. INTRODUCTION

The Coffee Mine Site is located in the White Gold District of west-central Yukon, approximately 130 km south of the City of Dawson, 140 km west of Pelly Crossing, 100 km north-east of Beaver Creek, and 325 km north-west of Whitehorse. Mining of the deposits is planned to produce a total of 67.0 Mt of heap leach feed.

The heap leach facility (HLF) with a heap leach pad (HLP) footprint of approximately 1.0M m^2 can accommodate approximately 48.2M m^3 of ore and is located approximately 2 km west of the Latte Pit. The HLP will be stacked in five phases moving in a westerly direction with a cumulative capacity at completion as stated.

2. SCOPE OF DOCUMENT

The following design criteria is for the Coffee Gold Project HLF. The criteria are for a Permitting Level of design in order to produce a cost estimate having an accuracy of +/- 15%.

3. SOURCE CODES

Design criteria are based on the data sources referenced below. Where specific data are not available, assumptions have been made based on generally accepted practice and on Forte's experience.

Table 3-1: Source Codes

Source Code	Description
Forte	Forte recommended/research
Mass Balance	Determined from mass balance analysis
Calculated	Calculated in design criteria
Vendor	Information provided by vendors
Test Work	Information from laboratory test work
Others	Information provided by others
Lorax	Information provided by Lorax
The Mines Group (TMG)	Feasibility Study Prepared by TMG dated January 2016
Client	Supplied by Owner, Project Description
Client/YESAB	Screening Report issued October 12,2021
Yukon Guidelines	Yukon Guidelines for Waste Management Facilities

4. UNITS AND SYMBOLS

The following table describes the units (and symbols) used in the Design Criteria:

Table 4-1: Units & Symbols

Unit of Measure	SI Units	Description
Time	y	year
	d	day
	h	hour
	min	minute
	s	seconds
Length	m	meter
	cm	centimeter
	mm	millimeter
	µm	microns
Angle	°	degrees
Area	m^2	square meters
Mass	mt	metric ton (tonne)
	dmt	dry metric tonnes
	kmt	thousand dry metric tonnes
	kg	kilogram
	g	gram
Grade	gpt	grams per tonne
Volume	m^3	cubic meter
	L	liter
Density	kg/m^3	kilograms per cubic meter
	sg	specific gravity
Hardness	kWh/t	kilowatt-hours per tonne
Elevation – Above Mean Sea Level (AMSL)	MASL	meters above sea level
Volumetric Flow rate	Lpm	liters per minute
	m^3/hr	cubic meters per hour
Throughput	mtph	dry metric tons per hour
	mtpy	dry metric tons per year
Temperature	˚C	degrees Celsius
Concentration	mg/L	milligrams per liter
	g/L	grams per liter
Work Index	kWh/mt	kilowatt hour per metric ton
Power	kW	kilowatt
Pressure	kPa	kilopascal

5. ABBREVIATIONS

The following table describes the units (and symbols) used in the Design Criteria:

Table 5-1: Abbreviations

Abbreviation	Definition
AMSL	Above Mean Sea Level
CDA	Canadian Dam Association
CN	Curve Number
DAS	Desired Available Storage
EQ	Earthquake
EP	Event Pond
FOS	Factor of Safety
GCL	Geosynthetic Clay Liner
HLF	Heap Leach Facility
HLP	Heap Leach Pad
LDRS	Leak Detection and Recovery System
LLDPE	Low Linear Density Polyethylene
MDE	Maximum Design Earthquake
ODF	Overliner Drain Fill
PGA	Peak Ground Acceleration
PLS	Pregnant Leach Solution
PMP	Probable Maximum Precipitation
ROM	Run of Mine
SCS	Soil Conservation Service
SWE	Snow Water Equivalent
TSS	Total Suspended Solids

6. DEFINITIONS

“Contact water” is used to describe water that will come into contact with the mineralized material on the heap leach pad and/or water in contact with process facilities. This type of water may require additional treatment (i.e., at the mine-water treatment plant, passive treatment system) during operations and/or closure prior to discharge to the environment. Conversely, “non-contact water” is used to describe water that has not come into contact with any process facilities. “Make-up water” is used to describe water that will be used by the HLF for process needs.

7. METEOROLOGICAL INPUTS

The table below presents depths for 24-hour storm events as developed by Lorax 2022 [1] for the Coffee Mine Site and have been scaled for various project elevations (AMSL). A larger elevation scalar (4% per 100 m gain) was applied to a recent update which was appropriately based on the gradients measured local to the project site. Elevation 1,300 m is representative of the top of the HLP.

Table 7-1: Event Precipitation Depth (mm)

Exceedance Probability	Return Period	Precipitation Depth, mm							
		Elev. 600 m	700 m	800 m	900 m	1000 m	1100 m	1200 m	1300 m
0.5	1:2	29	30	32	33	34	36	37	38
0.2	1:5	43	44	46	48	50	52	54	56
0.1	1:10	51	53	55	57	60	62	65	67
0.04	1:25	61	63	66	68	71	74	77	80
0.02	1:50	68	70	73	76	79	82	86	89
0.01	1:100	74	77	80	83	87	90	94	98
0.005	1:200	80	83	87	90	94	98	102	106
	PMP								283

Table 7-2: Basis of Environmental Parameters

Description	HLF	Resource
Precipitation	Based on Lorax, 2022	Lorax [1]
Evapotranspiration	Calculated via FAO Penman-Monteith Evapotranspiration method based on daily climate data provided in Lorax, 2022 (Max, Min, Average Temperatures and Precipitation) and average daily historic energy balance parameters (Radiation, Wind, Humidity).	Forte
Temperature	Based on Lorax, 2022	Lorax [1]
Sublimation	Calculated via FAO Penman-Monteith Evapotranspiration method based on daily climate data provided by Lorax, 2022 (Max, Min, Average Temperatures and Precipitation) and average daily historic energy balance parameters (Radiation, Wind, Humidity) with a Kc factor of 0.3 used for Snow (multiplied by the reference evapotranspiration)	Forte
Snowpack	A modified form of the Snow-17 Model developed for the U.S. National Weather Service River Forecasting System uses energy balance parameters and/or temperature-indices to model the energy exchange at the snow-air interface. Precipitation is determined to be snow, rain, or a mixture of the two depending on the energy exchange at the snow-air interface. The internal state of the snowpack as SWE and the rate of melt is tracked on a daily interval.	Forte

8. MINE PLAN

The total material mined over the course of 10 years is approximately 359 Mt, with approximately 67.0 Mt of ore and 292 Mt of waste rock, which will vary with the economics at the time of mining and stacking as well as with continued analysis of ore properties throughout the mine's process development. This range in tonnage reflects the inherent variance involved in the HLP development including natural variations in ore properties, produced variations in ore bulk density varying with processing optimizations, and economic trade-off analysis undergone in mining and stacking optimizations. The operating schedule is described in Table 8-1. Note that for water balance modeling, an estimate of 275 loading days per year was used to be conservative in estimating rates of outside water addition that would be necessary.

Table 8-1: Ore Stacking Operating Schedule

ORE STACKING SCHEDULE			
Description	**Units**	**HLF**	**Resource**
Operating Schedule (9 month/yr.)	days/year	275	Owner
	days/week	7	Owner
	hours/day	24	Owner

Table 8-2: Annual Mined Tonnage

Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
3,481 kt	8,365 kt	7,829 kt	7,470 kt	7,928 kt	8,064 kt	6,562 kt	7,679 kt	6,130 kt	3,499 kt

9. ENGINEERING DESIGN BASIS

The following sections present the engineering design criteria for the HLF. Design and analyses included: HLP design, geotechnical stability, liner system design, HLF water balance, and pond design.

9.1 Heap Leach Facility

The designs for the HLP incorporate a single-side textured 2.0 mm linear low-density, polyethylene (LLDPE) liner. A geosynthetic clay liner (GCL) will be used in lieu of a 300mm thick layer of compacted low-permeability material. GCL will be placed underneath the geomembrane and will provide equal or greater protection than 300mm material having a saturated hydraulic conductivity of no greater than 5x10E-9 cm/sec.

The pad is designed to contain a network of pipes that will be distributed throughout the limits of the facility and will collect and convey pregnant leach solution (PLS) in addition to stormwater.

A minimum 0.6 m thick layer of overliner drain fill (ODF) material will be placed over the LLDPE geomembrane in a single lift based on a designed maximum allowable phreatic surface thickness over the liner. Areas requiring ore stacking via trucks will require additional overliner thickness depending on the specific equipment utilized in stacking the ore. The ODF will be placed in bulk onto the liner using suitable haulage equipment or conveyors and spread by dozers in a uniform layer.

Solution collection pipes will be placed within the ODF to convey PLS flows to the processing plant via gravity. The barren leach solution and pregnant leach solution nominal flowrate is 1,100 m3/hr with a maximum design flowrate of 1,400 m3/hr. The permeability of the ODF along with the slope of the lined surface and the maximum phreatic head on the geosynthetic liner will drive the particle size distribution and collection piping spacing criteria in future design phases.

The HLP is designed to accommodate an anticipated capacity of approximately 41.9M m3 of ore on an ultimate footprint (exclusive of solution collection channels and perimeter berm) of approximately 1.0M m2 with a maximum thickness of 110m. The pad will be stacked between the months of April and December. Ore will be ripped and cross-ripped to improve solution infiltration. The HLF water balance models take into account consolidation of ore that is stacked on the pad as it affects ore density and hydraulic conductivity properties.

Table 9-1: Solution Management Design Criteria

Description	Quantity / Criteria	Resource
Total Pond Volume	Sized to contain maximal seasonal water accumulation, runoff volume from a 24-hour PMP rainfall event, plus the 72-hour drain down from the heap leach pad at plant flow rate[1] with 0.5m of freeboard from the spillway invert.	Owner/YESAB [4]

Table 9-2: Stability Design Criteria

Description	Unit	Value	Resource
Static-Long Term FOS	-	1.5	CDA [2]/Yukon Guidelines [5]
Post-Earthquake FOS	-	1.2	CDA [2]
Pseudo-static FOS	-	1.0	CDA [2]/Yukon Guidelines [5]
Material Strengths (Pseudostatic and Static Analyses)	-	Peak	Forte – Published and Similar Projects
Design Earthquake Return Period	-	AEP Earthquake 2,475 year	Yukon Guidelines [5]
Design Earthquake PGA (g)	-	0.246	2020 NBC Seismic Hazard Tool
Liner Interface Strength (Post-EQ Analysis)		Reduced to 80% of Peak Strength	Non-impounding structures
Horizontal Coefficient (2/3 PGA) (Kh)	g	0.164	Forte
Vertical Coefficient (Kv)	g	0	Forte
Phreatic Conditions Above Liner	m	0.6 above liner	Yukon Guidelines [5]

Table 9-3: HLF Engineering Design Parameters

Description	Unit	Value	Resource
SITE CONDITIONS			
Annual Precipitation	mm	504	Lorax [1]
Min Air Temperature	°C	-37.6	Lorax [1]
Max Air Temperature	°C	29.7	Lorax [1]
Average Air Temperature	°C	-2.0	Lorax [1]
Annual Evapotranspiration	mm	190	Lorax [1]
Average Relative Humidity	%	69	Lorax [1]
Average Solar Radiation	kW/m^2	0.113	Lorax [1]
Average Wind Speed	m/s	2.1	Lorax [1]
ORE CHARACTERISTICS			
Specific Gravity	SG	2.7	Owner
Ore Bulk Density[1]	t/m^3	1.6	Owner
Angle of Repose	°	34	Owner
LEACH PAD HYDRODYANMIC PROPERTIES			
Initial Moisture Content[1]	%	4.5 by weight	Measured
Residual Moisture Content[1]	%	6.5 by weight	Calibration
Target P80	mm	50	Owner
Saturated Hydraulic Conductivity[1]	cm/s	0.004	Measured
GENERAL HLP PARAMETERS			
Heap Ore Capacity-Ultimate	m^3	48,250,000 (approx.)	Forte
Heap Ore Capacity- Current Mine Plan	m^3	41,900,000 (approx.)	Forte
Total Footprint	m^2	1,200,000 (approx.)	Forte
Footprint (Without Channel)	m^2	1,100,000 (approx.)	Forte
Heap Elevation, Ultimate	m	1400	Forte
Heap Elevation - Current Mine Plan	m	1390	Forte
Stacking Method	-	Conveyor with Radial Stacker and Haul Trucks	Owner
Overall Slope Angle of Stacked Ore During Operations	-	2.5:1 (H:V)	Owner
Overall Slope Angle for Reclamation and Closure	-	2.5:1 (H:V)	Forte

Description	Unit	Value	Resource
Maximum Ore Height Above Liner -Current Mine Plan	m	110	Forte
Lift Height	m	10	Owner
Liner CN (SCS)	-	99	TMG [3]
Ore CN (SCS) Unleached	-	70	TMG [3]
Ore CN (SCS) Leached	-	75	TMG [3]
Raincoat CN (SCS)	-	99	TMG [3]
Reclaimed Surface CN (SCS)	-	95	TMG [3]
SCS Method Initial Abstraction	%	20	Forte
Evaporation Loss on Drip - Emitters	%	0-0.5	Forte
PMP 24-hr Event	mm	283	Lorax [1]
Haul Road Min Width	m	46	Forte
Haul Road Max Slope	%	10	Forte
Conveyor Min Width	m	23	Forte
Conveyor Max Slope	%	10	Forte
BARREN SOLUTION APPLICATION			
Solution Application Method	-	Drip Emitter	Owner
Leach Schedule	days/ yr	365	Owner
Nominal Barren Solution Application Rate	$(L/h)/m^2$	10	Owner
Target Barren Solution pH		9-10.5	Forte
Maximum Design Barren Solution Flow Rate	m^3/h	1,400	Forte
Primary Leach Cycle[2]	d	45	Owner
Area Under Leach[2]	m^2	110,000	Calculation
PREGNANT SOLUTION COLLECTION			
Maximum Nominal Flow Rate (1,400 m3/hr)*1.2 + PMP 93% Full	m^3/h	2,031	Forte

1- Ore characteristics listed, which are currently being used in modeling, are subject to change with additional testing and data collection, processing optimizations, and field conditions during processing.

2- Leaching process is subject to change and naturally varies somewhat throughout heap leach pad development; nominal values listed are based on application rates and the nominal pumping rate was used in modeling work.

9.2 Spillways

The Event Pond emergency spillways are designed to exceed the CDA 2013 standards. [2]

Table 9-4: Spillway Design Criteria

Description	Quantity / Criteria	Resource
Event Pond Spillways	Sized to exceed CDA 2013	CDA [2]

9.3 Solution Management

The Event Ponds will be constructed to temporarily store excess process solution that may flow to the pond through the HLF collection channels during upset conditions, and with excess precipitation. The solution contained in the ponds will be recycled back into the heap leach circuit. EP-1S, EP-1N, and the EP-2 Process Segregation will incorporate a leak detection and recovery system between the LLPDE liners.

If solution cannot be recycled back to the HLP or process plant due to water balance constraints, it will be stored within the event ponds. In the unlikely event that storage volume within the event ponds is at capacity, the solution will be treated through the cyanide detoxification plant and the water treatment plant prior to discharge.

Table 9-5: Solution Management Parameters

Description	Quantity / Criteria	Resource
EVENT PONDS		
General	The purpose of the event ponds is to temporarily store precipitation and excess inflows that cannot be stored in the Pregnant Solution Tank. During the initial heap operation, the event ponds may also be used as temporary storage for make-up water.	Forte
Liner System	Lining to comprise a double LLPDE geomembrane liner system with LDRS between the layers for EP-1S and EP-1N and the EP-2 Process Segregation. A single layer of LLPDE will be used to line EP-2 outside the Process Segregation. A GCL layer will be placed below the liner of all ponds and will have an objective maximum permeability of 5x10E-9 cm/s.	Owner/YESAB [4]
Leak Detection and Recovery System (LDRS)	A system within the EP-1S, EP-1N, and EP-2 Process Segregation to collect leakage through the composite liner and convey it to monitoring points. The system to comprise geonet or similar synthetic drainage product to collect and convey any leaked solution to a gravel filled sump and pumping system.	Owner/YESAB [4]
[1] – For initial design calculations of drain down, the nominal plant flow rate was the assumed flow rate plus the maximum pumping to dynamic storage rate.		
PREGNANT LEACH SOLUTION		
Solution Collection and Recovery System	A system to collect PLS and convey it by gravity. System to comprise overliner drain fill and a network of collection pipes to convey solution to the processing plant.	Owner/YESAB [4]
LEAK DETECTION SYSTEM		
Leak Detection System	System to consist of monitoring wells installed away from the heap leach pad, unsaturated or vadose zone monitoring under the leach pad using an adaptation of lysimeter technology (i.e. wick drains), and electrical leak location surveys performed after construction of each stage of the leach pad	Owner/YESAB [4]
PAD LINER SYSTEM		
Geosynthetic Liner	2.0mm Linear Low Density polyethylene (LLDPE) liner material to provide required puncture resistance, elastic strain range and resistance to solution attack and chemical breakdown along with cold weather performance for the project's climate conditions.	Owner/YESAB [4]
Geosynthetic Clay Liner	Geosynthetic clay liner below the geosynthetic liner to provide a composite liner to minimize leakage. Objective maximum permeability of 5x10E-9 cm/s.	Owner/YESAB [4]
Overliner Drain Fill (ODF)	Crushed clean rock to provide a free draining layer under the placed ore and to protect the lining system from damage by ore placement while not impacting the conveyance of solution.	Forte
PAD RINSING SYSTEM		
Rinsing Collection System	Separate collection system will be required for rinsing phases.	Owner/YESAB [4]

10. WATER MANAGEMENT

Surface water near the mine site is located near the headwaters of three watersheds. These watersheds include Halfway Creek, YT-24, and Latte Creek. Surface drainages within the mine site are limited to small seeps and springs, which may be encountered during mine development, and may be intercepted and used as required. Conveyance structures and sedimentation ponds will be used to divert non-contact water around and away from the HLF.

10.1 Water Management Infrastructure Sizing Criteria

Table 10-1 below presents the design criteria used for sizing of water-related infrastructure:

Table 10-1: Water Management Infrastructure Sizing Criteria

Infrastructure	Design Element	Design Basis Criteria
Temporary interceptor ditches	Design storm event	1 in 100-year 24 hour for capacity

11. REFERENCES

[1] Coffee Gold Project: 2021 Hydro-meteorology Baseline Report, prepared by Lorax Environmental (Vancouver, BC, Canada) for Newmont Gold Corp, January 2022. (Lorax, 2022).

[2] EN Dam Safety Guidelines 2013 Edition, Prepared by Canadian Dam Association.

[3] Kaminak Gold Corporation, 2016. Feasibility Design Report For Coffee Gold Heap Leach Facility, Prepared by The Mines Group, Nevada, United States. January 2016

[4] Screening Report and Recommendation, Coffee Gold Mine 2017-0211, Prepared by YESAB Executive Committee, Yukon Environmental and Socio-economic Assessment Board, October 2021

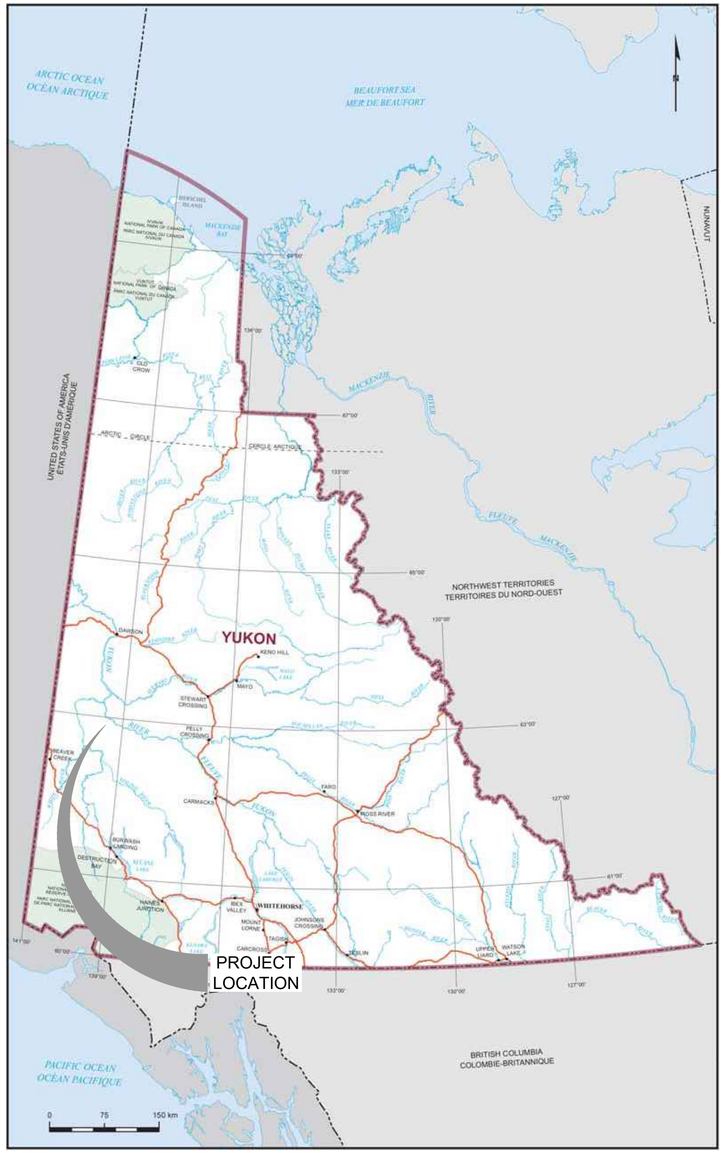
[5] Guidelines for Mine Waste Management Facilities 2023, Yukon Environmental and Socio-economic Assessment Board, February 2023.

END OF 123022-51100-01-EDC-0001

APPENDIX B: ENGINEERING DRAWINGS

COFFEE
HEAP LEACH FACILITY
DESIGN

JANUARY, 2026



NORTH

VICINITY MAP

NOT TO SCALE

DRAWING NUMBER	DESCRIPTION	CURRENT REV.	REV. DATE
OV-2001	COVER SHEET AND DRAWING INDEX	0	1/26/2026
OV-2002	NOTES AND LEGEND	0	1/26/2026
GA-2001	HEAP LEACH FACILITIES GENERAL ARRANGMENT	0	1/26/2026
GA-2002	HEAP LEACH PAD STAGE 1 GENERAL ARRANGMENT	0	1/26/2026
CV-2001	PONDS GRADING	0	1/26/2026
CV-2002	SUBGRADE AND LINER PLAN	0	1/26/2026
CV-2003	HEAP LEACH PAD OVERVIEW	0	1/26/2026
CV-2004	HEAP LEACH PAD COLLECTION PIPPING PLAN	0	1/26/2026
CV-2005	HEAP LEACH PAD OVER LINER PLAN	0	1/26/2026
CV-2006	PROCESS PLANT PAD	0	1/26/2026
CV-2007	EVENT POND 1 NORTH, 1 SOUTH, AND RAIN WATER POND	0	1/26/2026
CV-2008	EVENT POND 2	0	1/26/2026
CV-2009	PONDS AND PAD SECTIONS PAGE 1 OF 4	0	1/26/2026
CV-2010	PONDS AND PAD SECTIONS PAGE 2 OF 4	0	1/26/2026
CV-2011	PONDS AND PAD SECTIONS PAGE 3 OF 4	0	1/26/2026
CV-2012	PONDS AND PAD SECTIONS PAGE 4 OF 4	0	1/26/2026
DTL-2001	TYPICAL DETAIL PAGE 1 OF 6	0	1/26/2026
DTL-2002	TYPICAL DETAIL PAGE 2 OF 6	0	1/26/2026
DTL-2003	TYPICAL DETAIL PAGE 3 OF 6	0	1/26/2026
DTL-2004	TYPICAL DETAIL PAGE 4 OF 6	0	1/26/2026
DTL-2005	TYPICAL DETAIL PAGE 5 OF 6	0	1/26/2026
DTL-2006	TYPICAL DETAIL PAGE 6 OF 6	0	1/26/2026

Prepared for:

Newmont Corporation
166 Titanium Way, Suite 201
Whitehorse, YT Y1A 0G1

YUKON, CA

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0	012826	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
YUKON
TERRITORY
BARRY L. CARLSON
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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

COVER SHEET AND SHEET INDEX

YUKON, CANADA

DRAWING NUMBER:
OV-2001

[Steven] [Jan 27, 2026 – 12:22pm] [C:\Users\Steven\OneDrive – Forte Dynamics\FOR PROJECTS\123000 – Newmont Coffee\123017 – Coffee HLP Engineering for Licensing\04 – Deliverables\04 – Drawings\CAD\DRAWINGS\PLAN SET\123017 – Civil sheets.dwg]

UNLESS OTHERWISE INDICATED ON THE DRAWINGS, THE FOLLOWING GENERAL NOTES SHALL APPLY:

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4. ALL DIMENSIONS, STATIONING, AND SCALES ARE IN METRIC SYSTEM.
5. ROAD SURFACES TO BE SLOPED AND GRADED TO DRAIN. CULVERTS TO BE INSTALLED AS REQUIRED TO PREVENT PONDING.
6. FINAL DESIGN OF SITE-WIDE ACCESS ROADS BY OTHERS, OTHER THAN THAT SHOWN HEREIN.
7. FINAL DESIGN OF THE PROCESS PLANT, CONVEYORS AND RELATED FACILITIES BY OTHERS. ELECTRICAL UTILITIES DESIGNED BY OTHERS.
8. ALL FOUNDATIONS AND OTHER EXCAVATIONS SHALL BE INSPECTED BY THE OWNER'S ENGINEER PRIOR TO FILL PLACEMENT.
9. ALL DRILL HOLES SHALL BE PLUGGED WITH CEMENT OR BENTONITE (WITHIN LIMITS OF AFFECTED AREA).

NOTES:

1. ALL PIPE CONNECTIONS SHALL BE FORMED USING MANUFACTURER SUPPLIED TEES, WYES AND COUPLERS. ALL PIPE CONNECTIONS SHALL BE SECURED TO THE PIPE USING WIRE TIES AROUND BOTH ENDS OF THE CONNECTIONS. ALL SOLUTION COLLECTION PIPEWORK CONNECTED WITH SPLIT COUPLERS SHALL HAVE THE COUPLER SEAM ROTATED TO THE SIDE OF THE PIPE.
2. WHERE CPP SOLUTION PIPES TERMINATE, THEY SHALL BE FITTED WITH MANUFACTURER SUPPLIED END CAPS. ALL PIPEWORK, INCLUDING TERMINATION POINTS, SHALL BE SURVEYED FOR FUTURE IDENTIFICATION.
3. OVERLINER DRAIN FILL THICKNESS SHALL BE A MINIMUM 0F 0.6 m OVER TOP OF LINER.
4. CAP UPHILL END OF ALL PIPES.
5. THE FIRST 3 m OF ALL HEADER PIPES WILL BE 450mmØ HDPE SDR 11, THEN WILL TRANSITION TO 450mmØ CORRUGATED & PERFORATED PE N-12.

ABBREVIATIONS:

ADS	- ADVANCED DRAINAGE SYSTEMS, INC.
ASTM	- AMERICAN SOCIETY FOR TESTING AND MATERIALS
BGC	- BGC ENGINEERING INC.
CL	- CENTRELINE
CPP	-CORRUGATED PLASTIC PIPE
CS	- CARBON STEEL
CSRS	- CANADIAN SPATIAL REFERENCE SYSTEM
DIA.	- DIAMETER
E	- EASTING (COORDINATE)
EL.	- ELEVATION
GCL	- GEOSYNTHETIC CLAY LINER
HDPE	- HIGH-DENSITY POLYETHYLENE
HLF	- HEAP LEACH FACILITY
INV	- INVERT
LDRS	- LEAK DETECTION AND RECOVERY SYSTEM
LLDPE	- LINEAR LOW-DENSITY POLYETHYLENE
MAX.	- MAXIMUM
MIN.	- MINIMUM
N	- NORTHING (COORDINATE)
NIC	- NOT IN CONTRACT
NOM	- NOMINAL
NTS	- NOT TO SCALE
O.C.	- ON CENTER
OD	- OUTSIDE DIAMETER
ODF	- OVERLINER DRAIN FILL
OZ.	- OUNCE
PLS	- PREGNANT LEACH SOLUTION
PE	- POLYETHYLENE
SDR	- STANDARD DIMENSION RATIO
SG	-SUBGRADE
SL	- SEISMIC LINE
STA	- STATION
TYP	- TYPICAL
UV	- ULTRAVIOLET
50 m	- DIMENSION IN METRES
2.5:1	- 2.5 HORIZONTAL TO 1 VERTICAL SLOPE
~	- APPROXIMATELY

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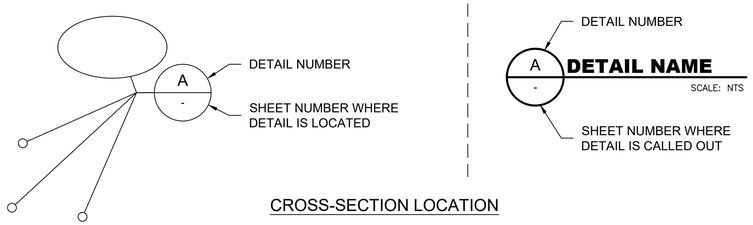
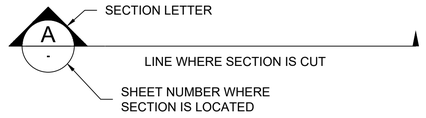
DETAIL CALL-OUT



CROSS-SECTION LOCATION



AREA	PRIMARY	SECONDARY	GEOCOMPOSITE BETWEEN PRIMARY AND SECONDARY	GCL
HEAP	2mm (80MIL) LLDPE DS TEXTURED	NONE	N	Y
PERIMETER CHANNEL N&S, EXCEPT LAST 100 METERS	2mm (80MIL) LLDPE DS TEXTURED	NONE	N	Y
LAST 100m PERIMETER CHANNEL	HYDRO TURF	GEOMBRANE-H	N	Y
EP 1N	2mm (80MIL) LLDPE DS TEXTURED	1.5mm (60 MIL) LLDPE DS TEXTURED	Y	Y
EP 1S	2mm (80MIL) LLDPE DS TEXTURED	1.5mm (60 MIL) LLDPE DS TEXTURED	Y	Y
RAIN WATER POND	2mm (80MIL) LLDPE DS TEXTURED	NONE	N/A	Y
EP2	2mm (80MIL) LLDPE DS TEXTURED	NONE	N/A	Y
EP 2 SEGREGATION	2mm (80MIL) LLDPE DS TEXTURED	1.5mm (60 MIL) LLDPE DS TEXTURED	Y	Y
POND SPILLWAYS	CONCRETE CLOTH		N/A	N

FILL TYPES FOR CONSTRUCTION

MATERIAL NO.	FILL MATERIAL NAME	FILL DESCRIPTION	MOISTURE CONDITIONING	LOOSE LIFT THICKNESS	COMPACTION EFFORT
1	SITE GRADING FILL	SITE GRADING SOILS FROM REQUIRED EXCAVATIONS AND CUT/FILL ACTIVITIES	2% +/- OF OPTIMUM	300mm MAX.	95% OF ASTM D698 COMPACTION
2	PREPAIRED SUBGRADE	SUBGRADE PREPAIRED FOR LINED SURFACES			
3	SELECT FILL	FINE GRAINED MATERIALS FOR LINER BEDDING	-2% + 1% OF OPTIMUN	150mm MAX.	95% OF ASTM D698 COMPACTION
4	STRUCTURAL FILL	WELL GRADED SOILS AND WEATHERED BEDROCK FROM REQUIRED EXCAVATIONS FOR EMBANKMENT	2% +/- OF OPTIMUM	300mm MAX.	95% OF ASTM D698 COMPACTION
5	OVERLINER DRAIN FILL (OD	CLEAN GRAVEL MATERIALS FOR HLF LINER COVER, PLS AND LDRS SUMPS	NONE	FILL NOTE 1	NONE REQUIRED
6	SELECT DRAIN FILL	CLEAN GRAVEL MATERIAL FOR UNDERDRAIN PIPES	NONE	AS REQUIRED	NONE REQUIRED
7	PIPE TRENCH BACKFAILL	COARSE AGGREGATE STONE	NONE	AS REQUIRED	NONE REQUIRED
8	COMPACTED ROCKFILL	HIGH STRENGTH ROCK MATERIALS	AS REQUIRED	FILL NOTE 2	LARGE SCALE TEST FILL REQUIRED (FILL NOTE 2)
9	ANCHOR THRENCH BACKFIL	SITE GRADING FILL MATERIAL FOR USE IN LINER ANCHOR TRENCHES	AS REQUIRED	150mm	85% OF ASTM D698 COMPACTION
10	ROAD WEARING COARSE	WELL GRADED SANDY GRAVEL	AS REQUIRED	150mm	95% OF ASTM D698 COMPACTION
11	RIP-RAP	COMPETENT ROCK FROM EXCAVATIONS	NONE	AS REQUIRED	NONE REQUIRED
12	ORE	CRUSHED ORE MATERIAL FOR HEAP LEACHING	N/A	N/A	N/A

ISSUE	DATE	DESCRIPTION	COORD SYSTEM
0	012826	ISSUED FOR LICENSING	NAD83 UTM ZONE 7

SMC DRAWN | SMC ESGN | AR CHKD | BC APPD

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FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

NOTES AND LEGEND

YUKON, CANADA

DRAWING NUMBER:
OV-2002

[Steven] [Jan 27, 2026 – 12:22pm] [C:\Users\Steven\OneDrive – Forte Dynamics\FOR PROJECTS\123000 – Newmont Coffee\123017 – Coffee HLP Engineering for Licensing\04 – Deliverables\04 – Drawings\CAD\DRAWINGS\PLAN SET\123017 – Civil sheets.dwg]



300 0 300

(In Meters)
1 cm = 100 M
(1 : 10,000)

LEGEND

- EXISTING CONTOURS (2m / 10m)
- PROPOSED POND / CHANNEL CONTOURS
- PROPOSED PAD CONTOURS
- PROPOSED ORE HEAP CONTOURS
- PROJECT BOUNDARY
- 100mmØ CORRUGATED & PERFORATED PE N-12
- 450mmØ CORRUGATED & PERFORATED PE N-12
- 630mm Ø SDR 11 HDPE
- PRW PRW PRW — 710mm Ø SDR 21 HDPE PREG RETURN LINE
- FW FW FW — 710mm Ø SDR 21 HDPE STANDBY RETURN LINE
- BS BS BS — 600mm Ø STD STEEL BARREN SOLUTION LINE
- HAUL ROAD OUTLINE
- LINED AREA
- HYDRO TURF AREA
- CONCRETE CLOTH

NOTE:

GRADING PRESENTED HERE WITH BLACK CREST AND TOE BREAKLINES COMPLETED BY OTHERS. PRESENTED HERE FOR REFERENCE ONLY. (CONTOURS FOR THESE AREAS NOT PRESENTED HERE)

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COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER — YUKON TERRITORY — BARRY L. CARLSON — 12436

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

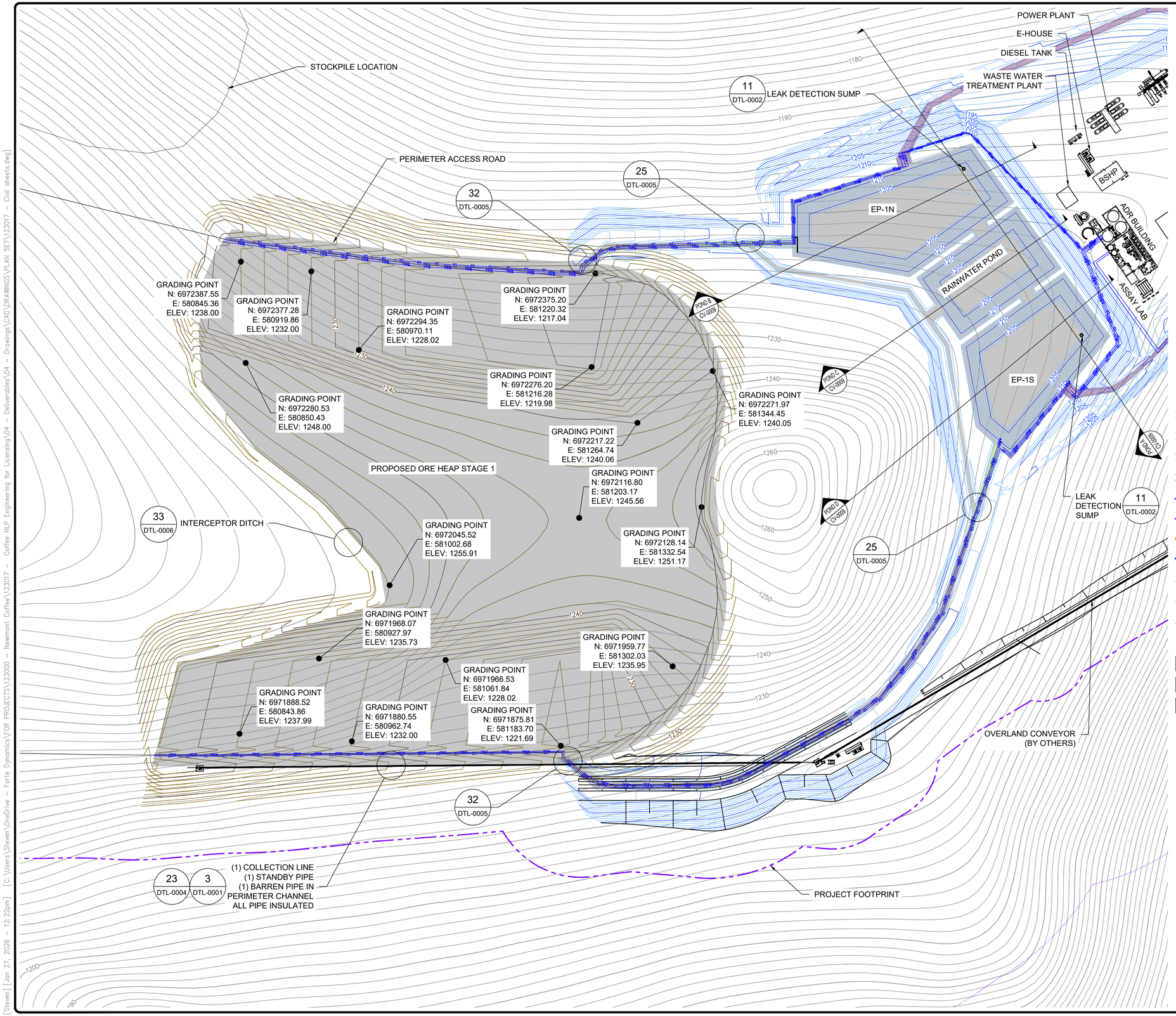
COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH FACILITIES GENERAL ARRANGMENT

YUKON, CANADA

DRAWING NUMBER: GA-2001

[Steven] [Jan 27, 2026 – 12:22pm] [C:\Users\Steven\OneDrive – Forte Dynamics\FOR PROJECTS\123000 – Newmont Coffee\123017 – Coffee HLP Engineering for Licensing\04 – Deliverables\04 – Drawings\CAD\DRAWINGS\PLAN SET\123017 – Civil sheets.dwg]



LEGEND

- EXISTING CONTOURS (2m / 10m)
- PROPOSED POND / CHANNEL CONTOURS
- PROPOSED PAD CONTOURS
- PROPOSED ORE HEAP CONTOURS
- PROJECT BOUNDARY
- 100mmØ CORRUGATED & PERFORATED PE N-12
- 450mmØ CORRUGATED & PERFORATED PE N-12
- 630mm Ø SDR 11 HDPE
- 710mm Ø SDR 21 HDPE PREG RETURN LINE
- 710mm Ø SDR 21 HDPE STANDBY RETURN LINE
- 600mm Ø STD STEEL BARREN SOLUTION LINE
- HAUL ROAD OUTLINE
- LINED AREA
- HYDRO TURF AREA
- CONCRETE CLOTH

ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
0	012826	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

REGISTERED PROFESSIONAL ENGINEER YUKON TERRITORY BARRY L. CARLSON 17246

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
STAGE 1 GENERAL ARRANGMENT

YUKON, CANADA

DRAWING NUMBER: GA-2002

PERMIT TO PRACTICE
FORTE DYNAMICS, INC.
SIGNATURE
Date 1-26-26
PERMIT NUMBER PP626
Association of Professional Engineers of Yukon

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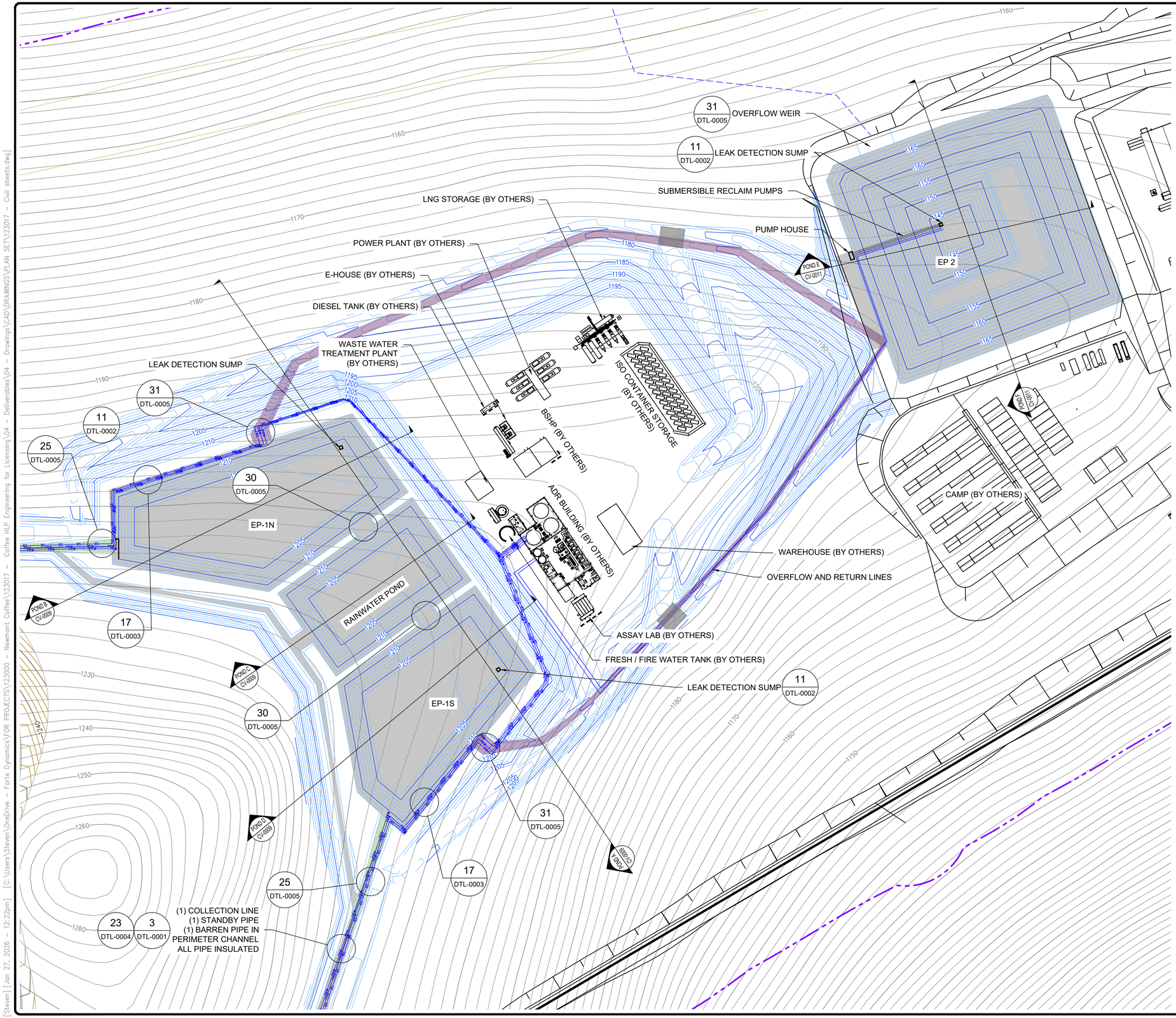

LEGEND

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- PROPOSED POND / CHANNEL CONTOURS
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- HAUL ROAD OUTLINE
- LINED AREA
- HYDRO TURF AREA
- CONCRETE CLOTH

PERMIT TO PRACTICE
FORTE DYNAMICS, INC.
SIGNATURE
Date 1-26-26
PERMIT NUMBER PP626
Association of Professional Engineers of Yukon

ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
0	012826	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
YUKON TERRITORY
BARRY L. CARLSON
17214

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

PONDS GRADING

YUKON, CANADA

DRAWING NUMBER:
CV-2001

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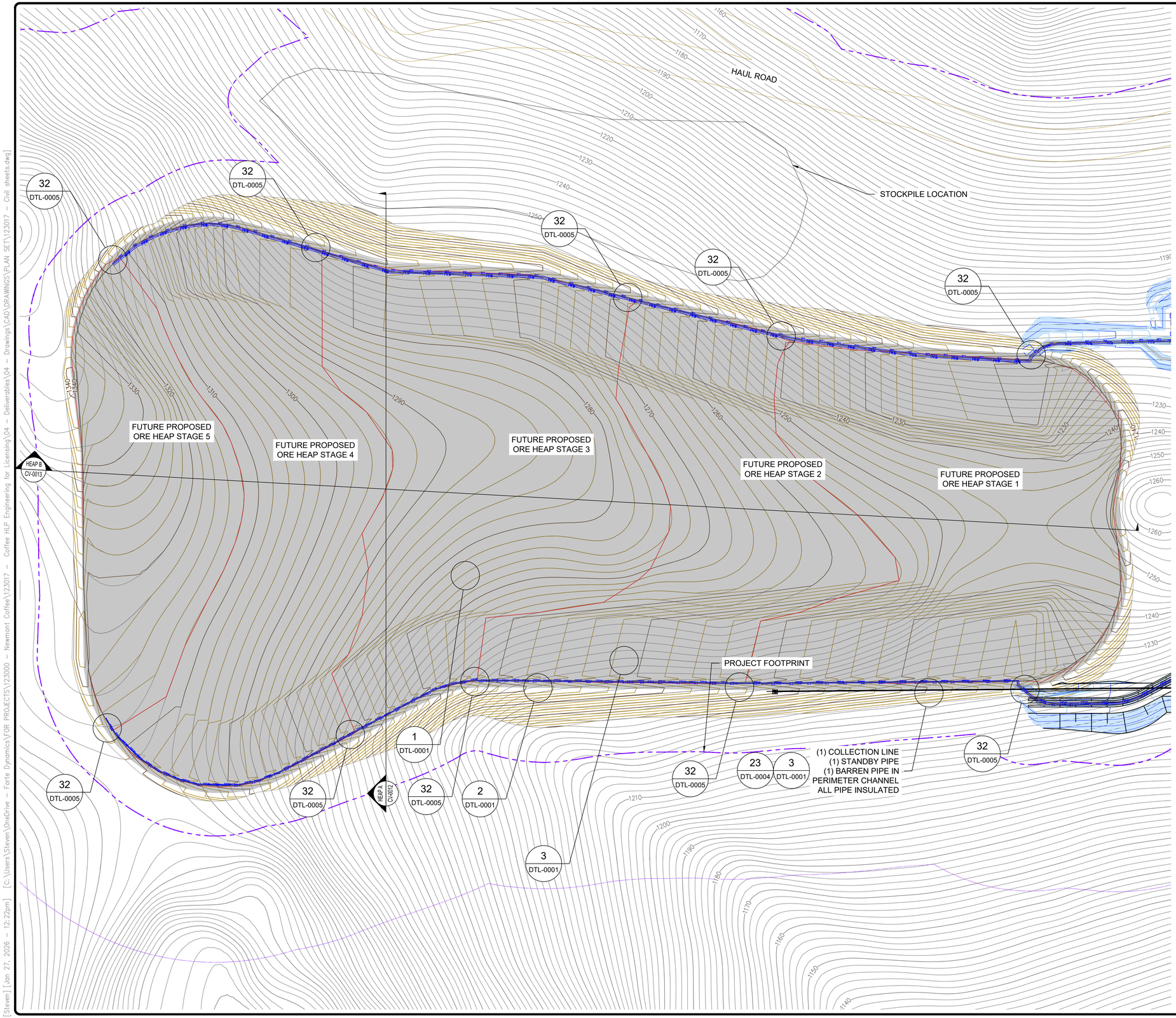

180 0 180

(In Meters)
1 cm = 60 M
(1 : 6,000)

LEGEND

- EXISTING CONTOURS (2m / 10m)
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ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
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COORD SYSTEM: NAD83 UTM ZONE 7

REGISTERED PROFESSIONAL ENGINEER YUKON TERRITORY BARRY L. CARLSON 17246

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FDI PROJECT NO: 123021

PREPARED BY:

FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

SUBGRADE AND LINER PLAN

YUKON, CANADA

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Date 1-26-26
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Association of Professional Engineers of Yukon

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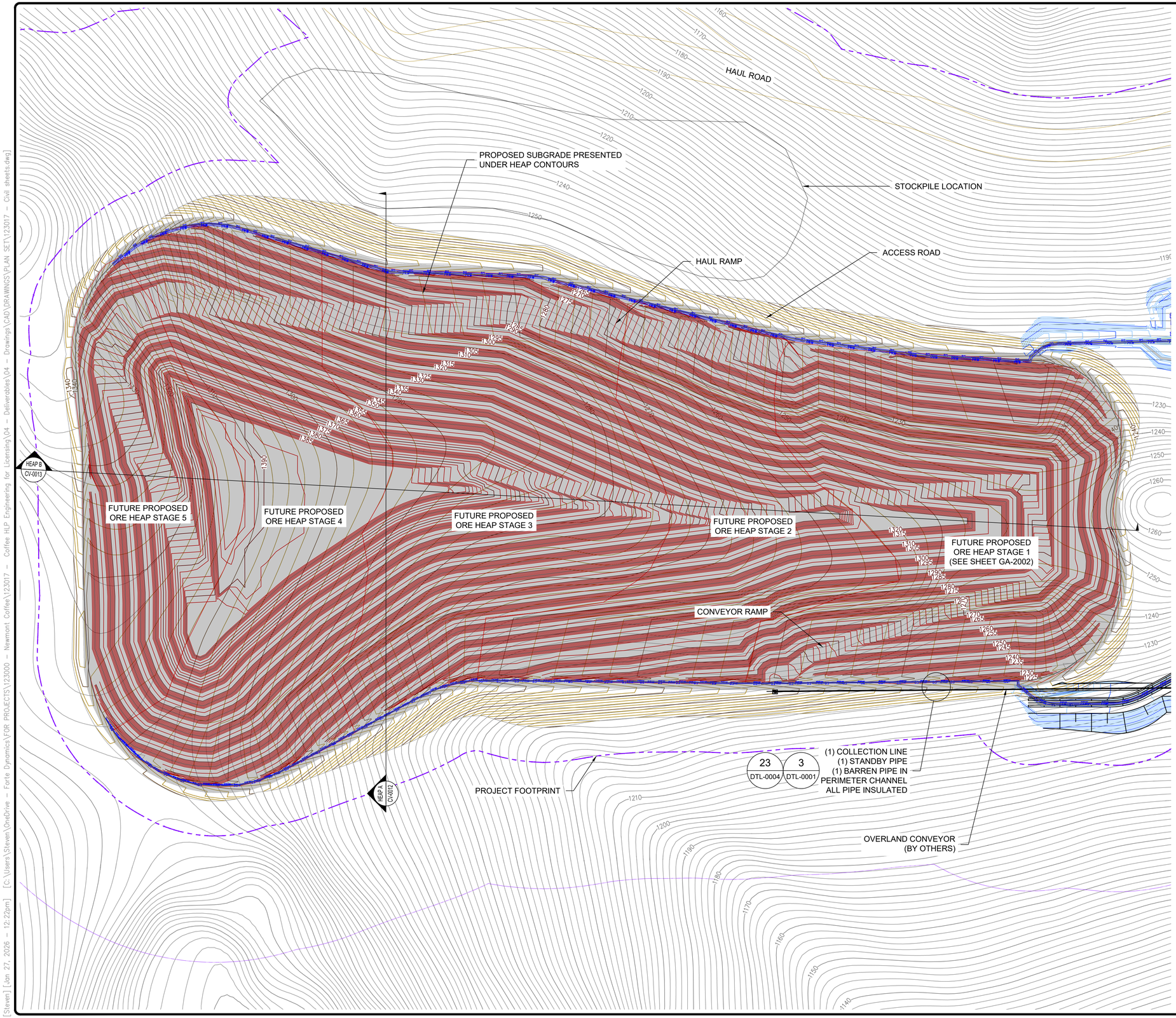

180 0 180

(In Meters)
1 cm = 60 M
(1 : 6,000)

LEGEND

- EXISTING CONTOURS (2m / 10m)
- PROPOSED POND / CHANNEL CONTOURS
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- PRW PRW PRW — 710mm Ø SDR 21 HDPE PREG RETURN LINE
- FW FW FW — 710mm Ø SDR 21 HDPE STANDBY RETURN LINE
- BS BS BS — 600mm Ø STD STEEL BARREN SOLUTION LINE
- HAUL ROAD OUTLINE
- LINED AREA
- HYDRO TURF AREA
- CONCRETE CLOTH

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PROFESSIONAL ENGINEER YUKON TERRITORY BARRY L. CARLSON 17244

FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
ULTIMATE CONFIGURATION

YUKON, CANADA

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CV-2003

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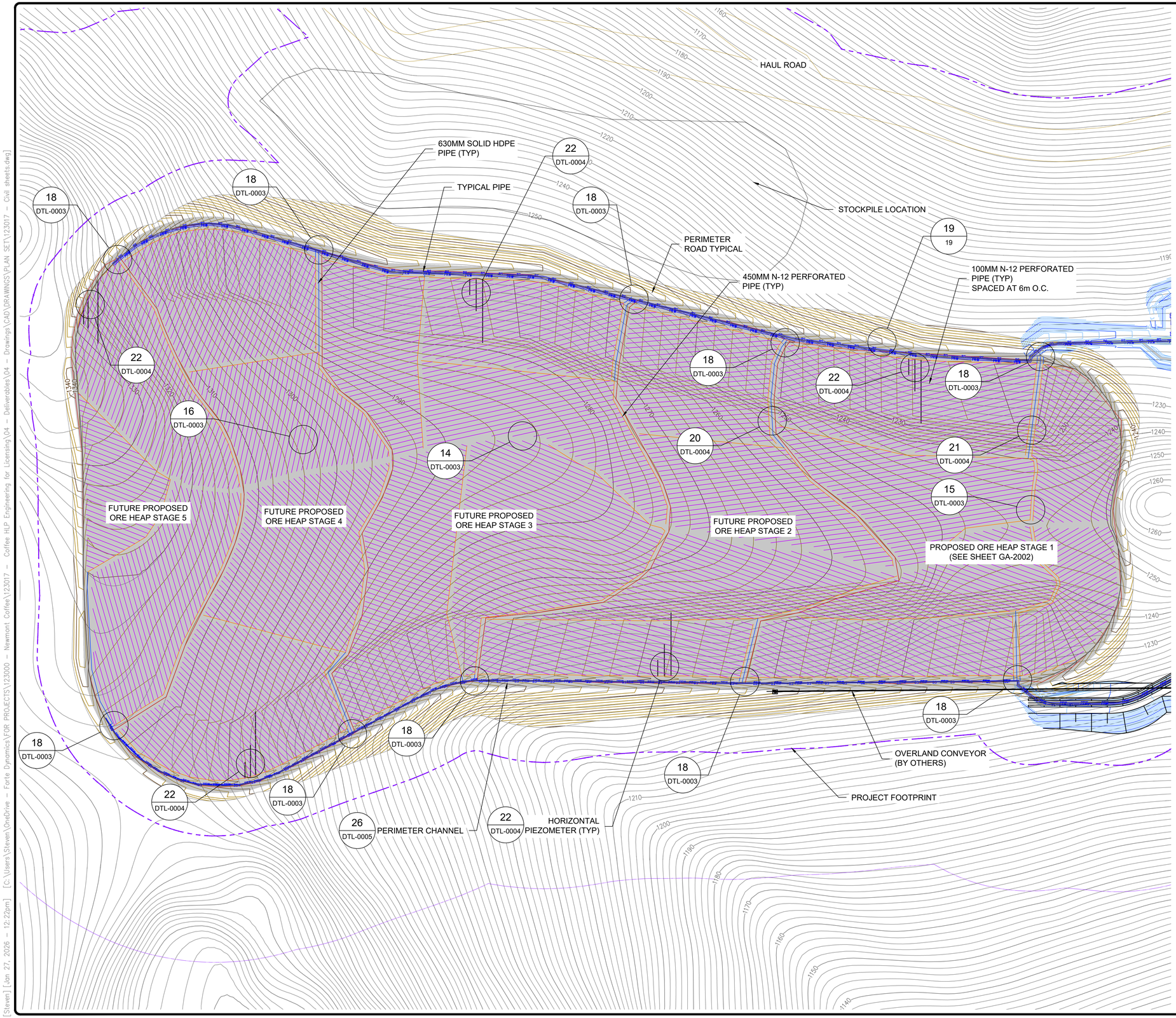

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FORTE DYNAMICS, INC.
SIGNATURE
Date 1-26-26
PERMIT NUMBER PP626
Association of Professional Engineers of Yukon

180 0 180
(In Meters)
1 cm = 60 M
(1 : 6,000)

LEGEND

- EXISTING CONTOURS (2m / 10m)
- PROPOSED POND / CHANNEL CONTOURS
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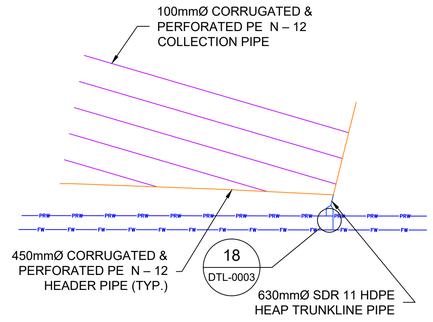

TYPICAL COLLECTION SYSTEM ARRANGEMENT

ISSUE	DATE	DESCRIPTION	DRAWN	CHKD	APPD
0	012826	ISSUED FOR LICENSING	SMC	AR	BC

COORD SYSTEM: NAD83, UTM, ZONE 7

PROFESSIONAL ENGINEER YUKON TERRITORY BARRY L. CARLSON 12278

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD COLLECTION PIPPING PLAN

YUKON, CANADA

DRAWING NUMBER:
CV-2004

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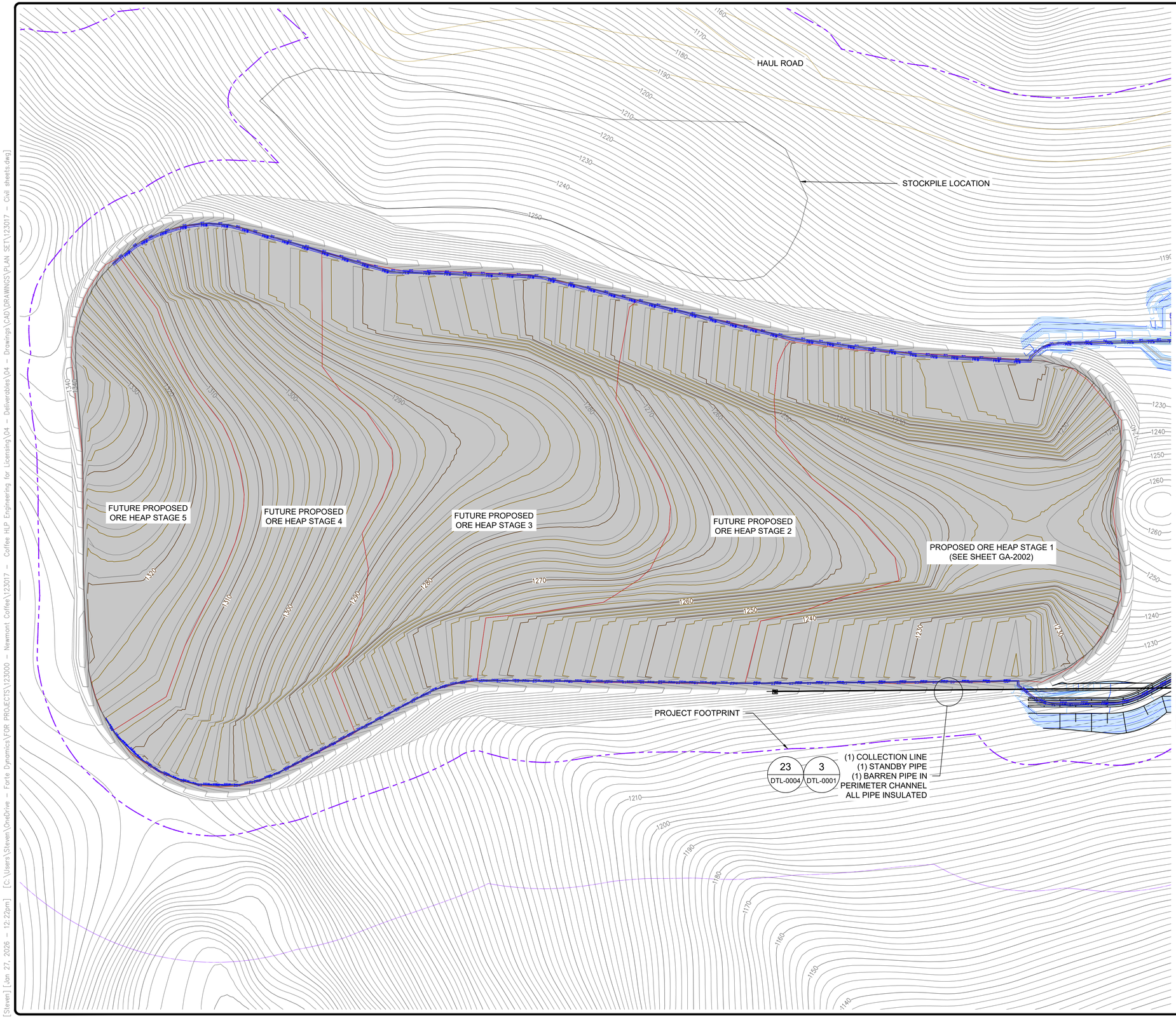

180 0 180

(In Meters)

1 cm = 60 M

(1 : 6,000)

LEGEND

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ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
0	012826	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER — YUKON TERRITORY — BARRY L. CARLSON — 12176

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FDI PROJECT NO: 123021

PREPARED BY:

FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD OVER LINER PLAN

YUKON, CANADA

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Association of Professional Engineers of Yukon

DRAWING NUMBER:

CV-2005

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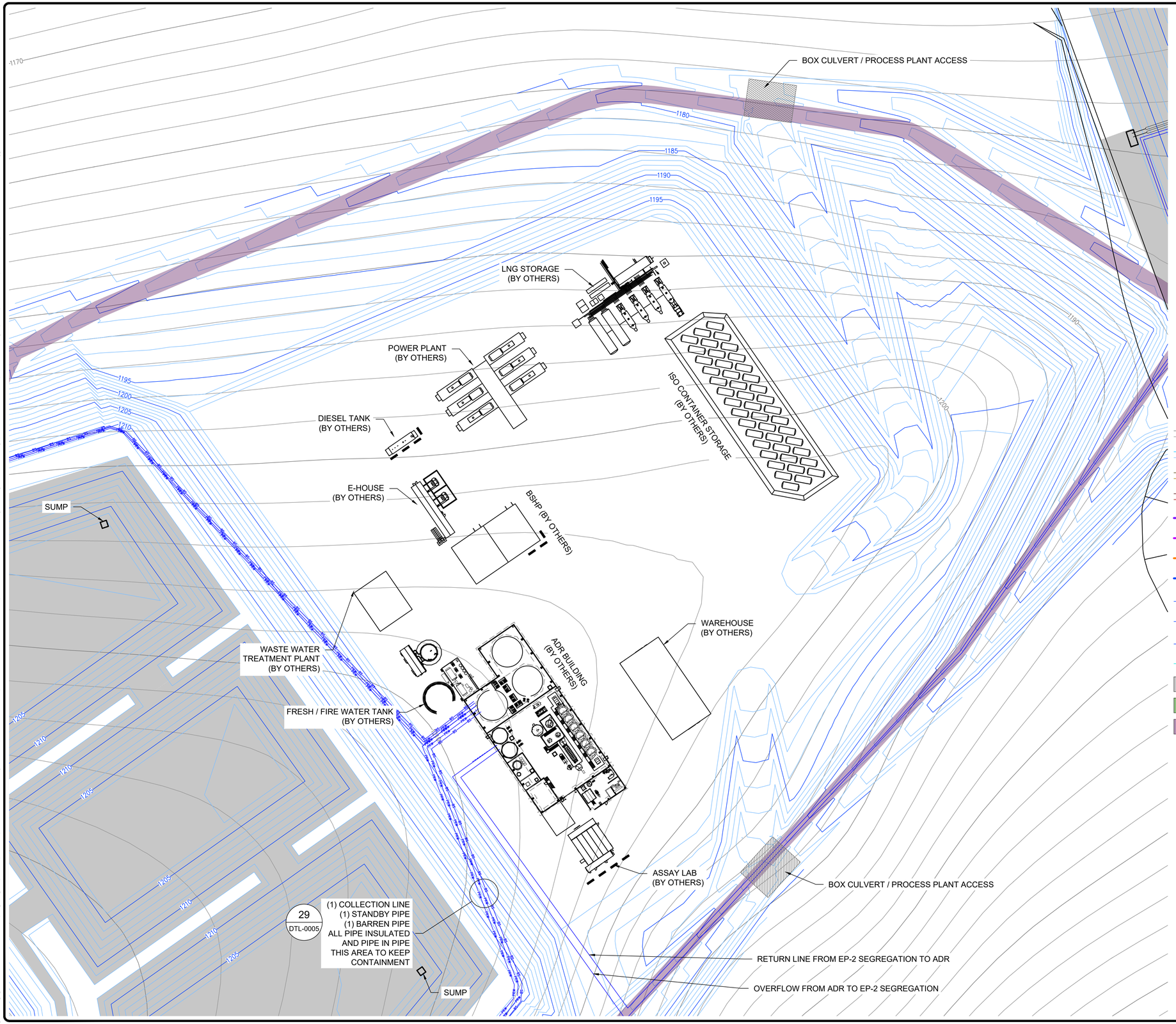

45 0 45

(In Meters)
1 cm = 15 M
(1 : 1,500)

LEGEND

- EXISTING CONTOURS (2m / 10m)
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COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
YUKON TERRITORY
BARRY L. CARLSON
17274

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

PROCESS PLANT PAD

YUKON, CANADA

DRAWING NUMBER:
CV-2006

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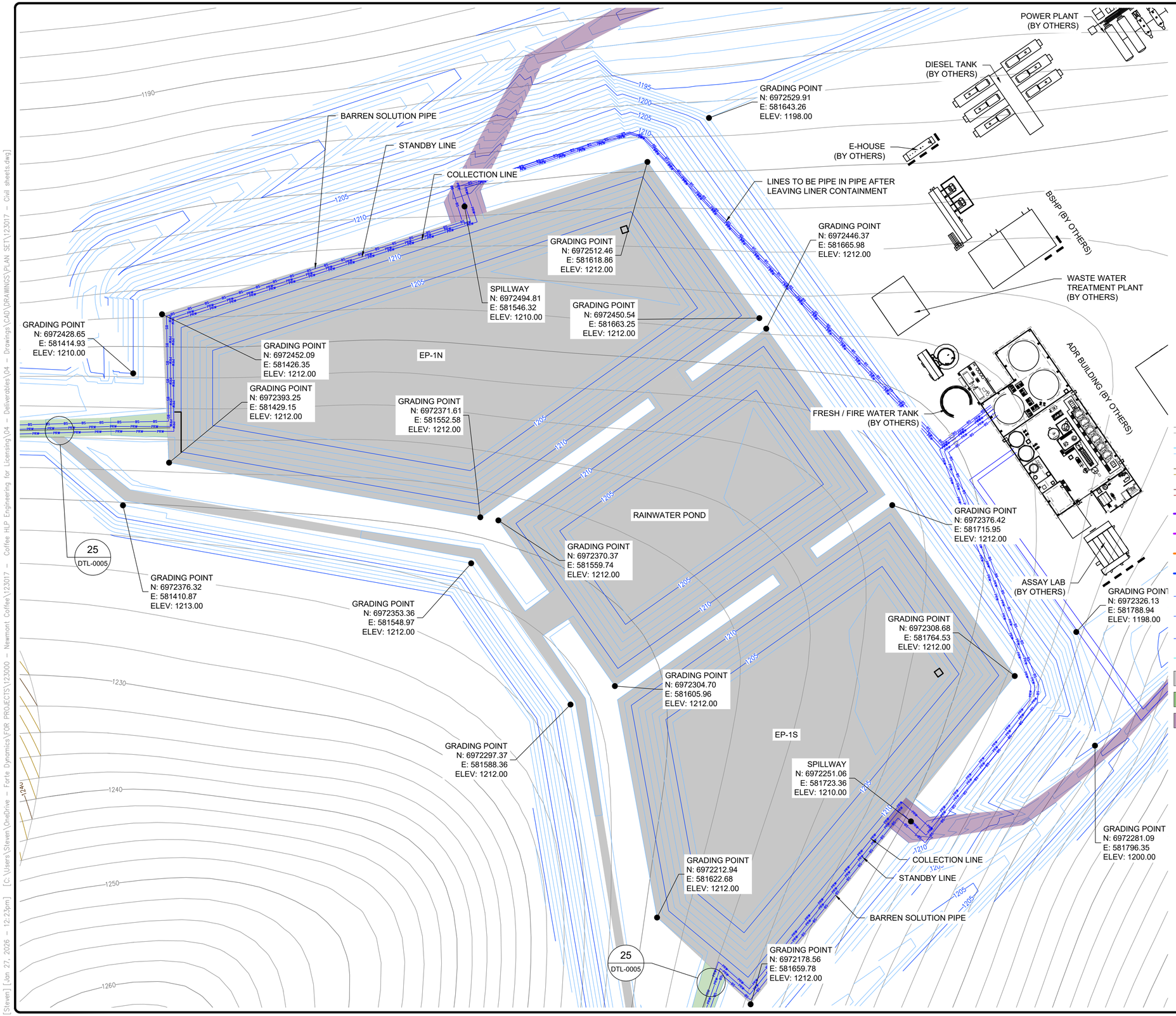

LEGEND

- EXISTING CONTOURS (2m / 10m)
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ISSUE	DATE	DESCRIPTION	DRAWN	CHKD	APPD
0	012826	ISSUED FOR LICENSING	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
YUKON TERRITORY
BARRY L. CARLSON
17246

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FDI PROJECT NO: 123021

PREPARED BY:

forte DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

EVENT PONDS 1 NORTH
1 SOUTH AND RAIN WATER POND

YUKON, CANADA

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SIGNATURE
Date 1-26-26
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Association of Professional Engineers of Yukon

DRAWING NUMBER:
CV-2007

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GRADING POINT
N: 6972764.85
E: 582168.44
ELEV: 1168.00

GRADING POINT
N: 6972709.09
E: 581999.42
ELEV: 1168.00

GRADING POINT
N: 6972696.91
E: 581993.74
ELEV: 1168.00

SEGREGATION AREA TO UTILIZE BIRD BALLS

LEAK DETECTION SUMP

EP 2

7
DTL-0001

POND E
CV-0011

POND C
CV-0001

TRUCK SHOP (BY OTHERS)

LAYDOWN YARD (BY OTHERS)

GRADING POINT
N: 6972601.81
E: 582229.20
ELEV: 1168.00

RETURN LINES

OVERFLOW LINES

GRADING POINT
N: 6972536.63
E: 582056.50
ELEV: 1168.00

OFFICE (BY OTHERS)

KITCHEN (BY OTHERS)

CAMP (BY OTHERS)

GRADING POINT
N: 6972469.09
E: 581928.95
ELEV: 1198.00

45 0 45
(In Meters)
1 cm = 15 M
(1 : 1,500)

LEGEND

- EXISTING CONTOURS (2m / 10m)
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- HAUL ROAD OUTLINE
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PERMIT TO PRACTICE
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COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEERS ASSOCIATION OF YUKON
BARRY L. CARLSON
TERRITORY
17212
ENGINEER

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FDI PROJECT NO: 123021

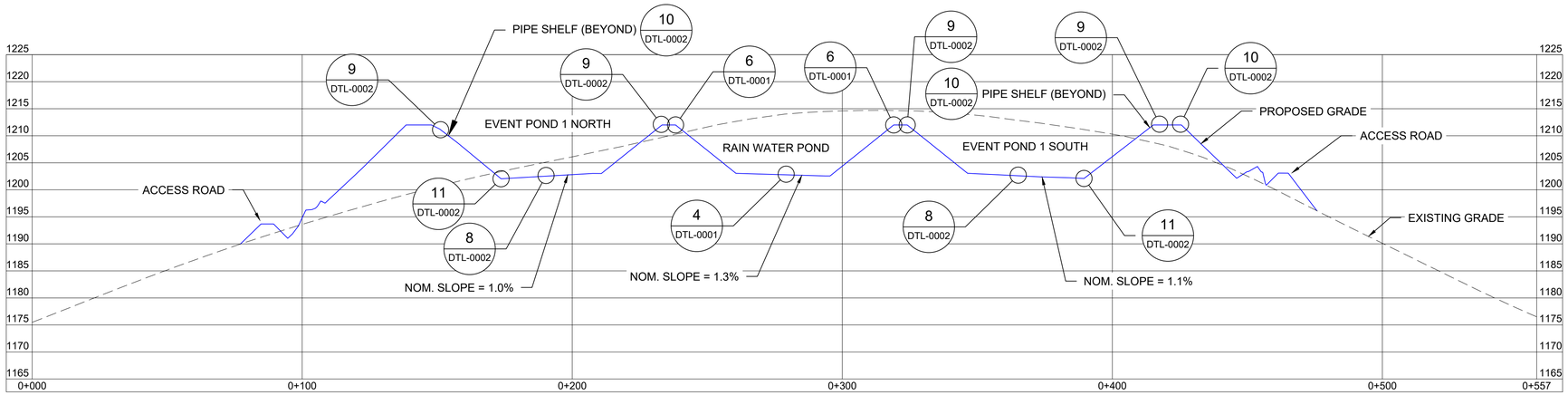
PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

EVENT POND 2

YUKON, CANADA

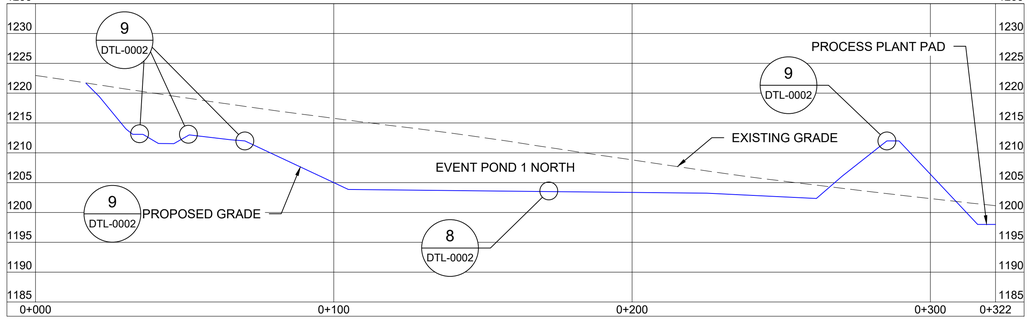
DRAWING NUMBER:
CV-2008



POND A
CV-0001

EVENT PONDS

SCALE: 1CM=20M HORIZ.
1CM=10M VERT.



POND B
CV-0001

EVENT POND 1 NORTH

SCALE: 1CM=20M HORZ.
1CM=10 VERT.

ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
0	012826	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
YUKON TERRITORY
BARRY L. CARLSON
12214

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FDI PROJECT NO: 123021

PREPARED BY:

FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

PONDS AND PAD SECTION PAGE 1 OF 4

YUKON, CANADA

DRAWING NUMBER:

CV-2009

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Association of Professional Engineers of Yukon

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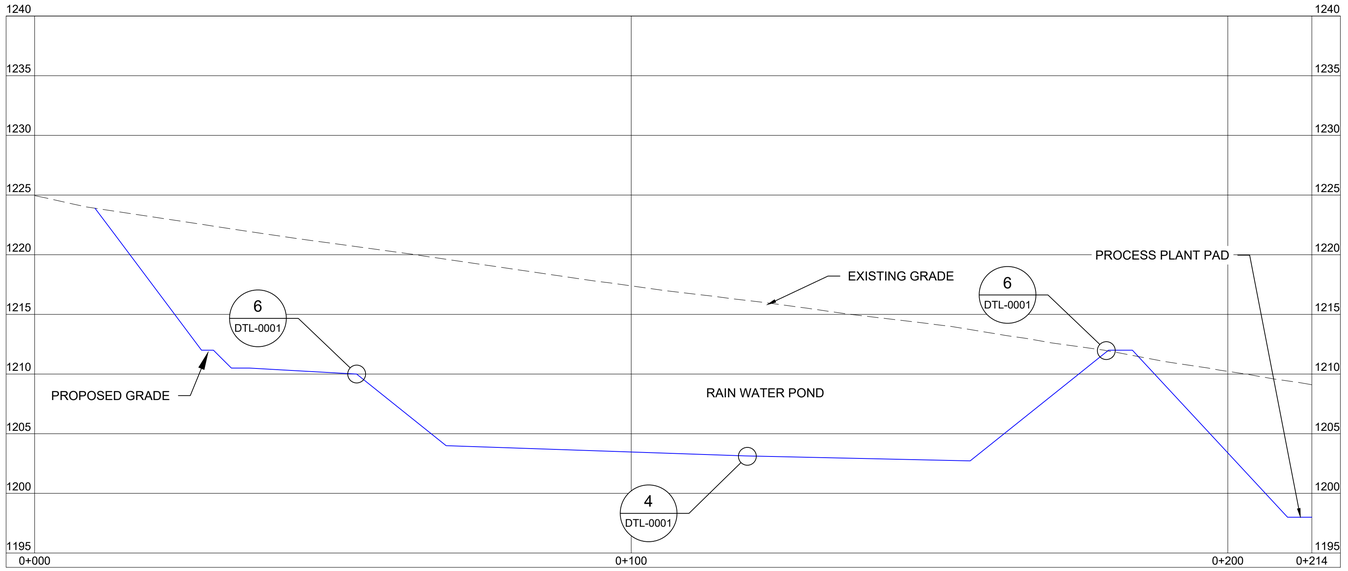
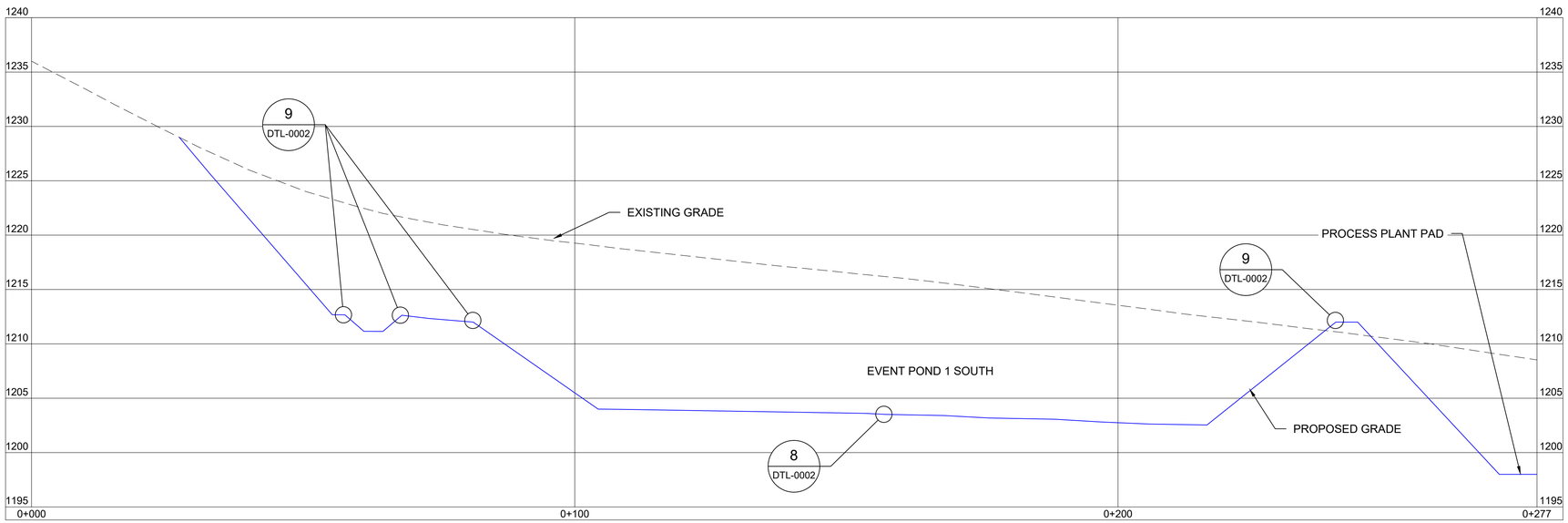


POND C
CV-0001

RAIN WATER POND

SCALE: 1CM=20M HORIZ.
1CM=10M VERT.



POND D
CV-0001

EVENT POND 1 SOUTH

SCALE: 1CM=20M HORIZ.
1CM=10M VERT.

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Date 1-26-26
PERMIT NUMBER PP626
Association of Professional Engineers of Yukon

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COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
YUKON TERRITORY
BARRY L. CARLSON
12717

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

PONDS AND PAD SECTION PAGE 2 OF 4

YUKON, CANADA

DRAWING NUMBER:
CV-2010

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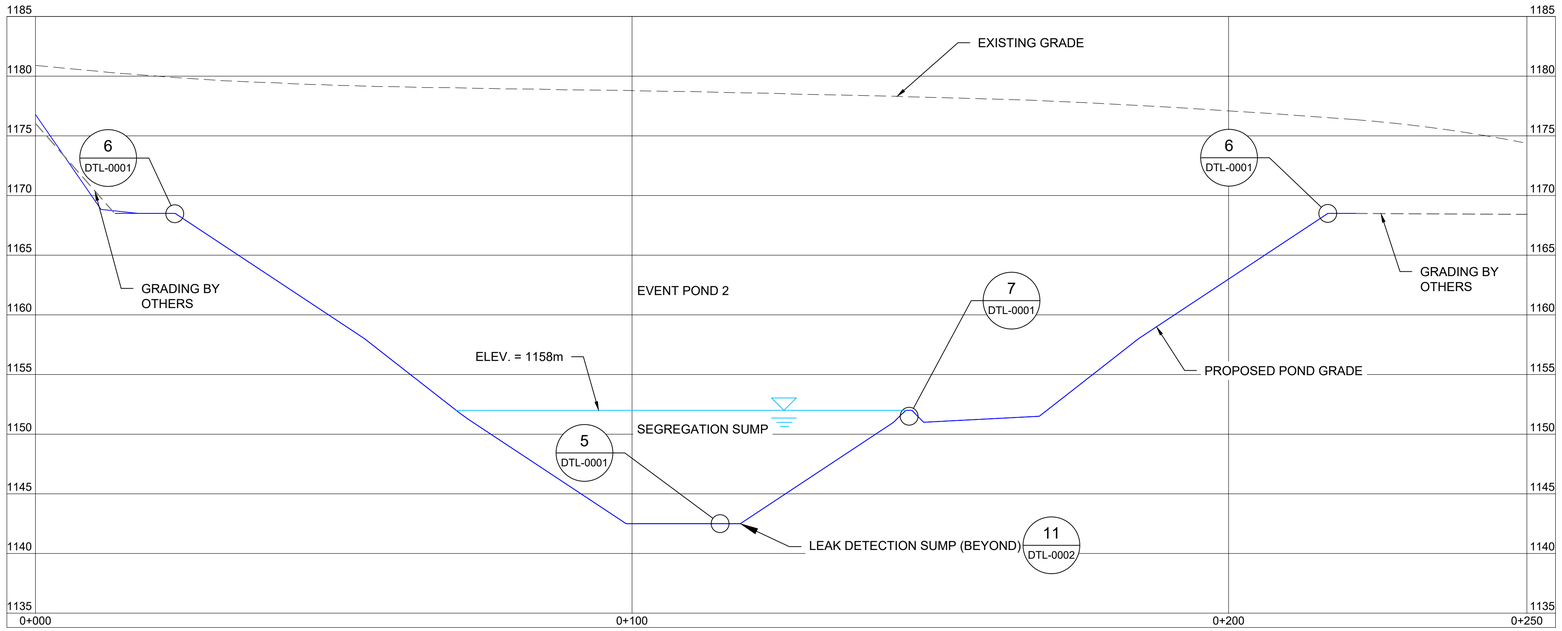
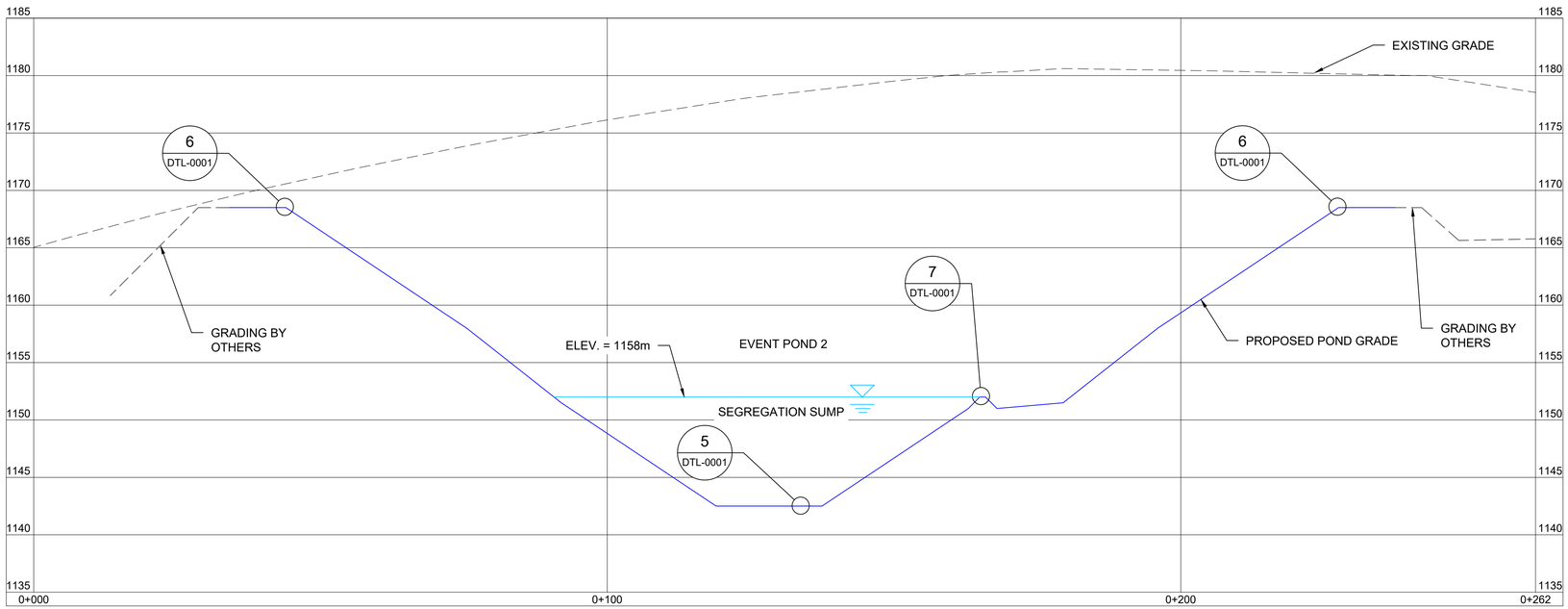


POND E
CV-0001

EVENT POND 2

SCALE: 1CM=20M HORIZ.
1CM=10M VERT.



POND F
CV-0001

EVENT POND 2

SCALE: 1CM=20M HORIZ.
1CM=10M VERT.

ISSUE	DATE	DESCRIPTION				
0	012826	ISSUED FOR LICENSING	SMC	SMC	AR	BC
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COORD SYSTEM: NAD83 UTM ZONE 7

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PROFESSIONAL ENGINEER
YUKON TERRITORY
BARRY L. CARLSON
17246

FDI PROJECT NO: 123021

PREPARED BY:

FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

PONDS AND PAD SECTION PAGE 3 OF 4

YUKON, CANADA

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DRAWING NUMBER:
CV-2011

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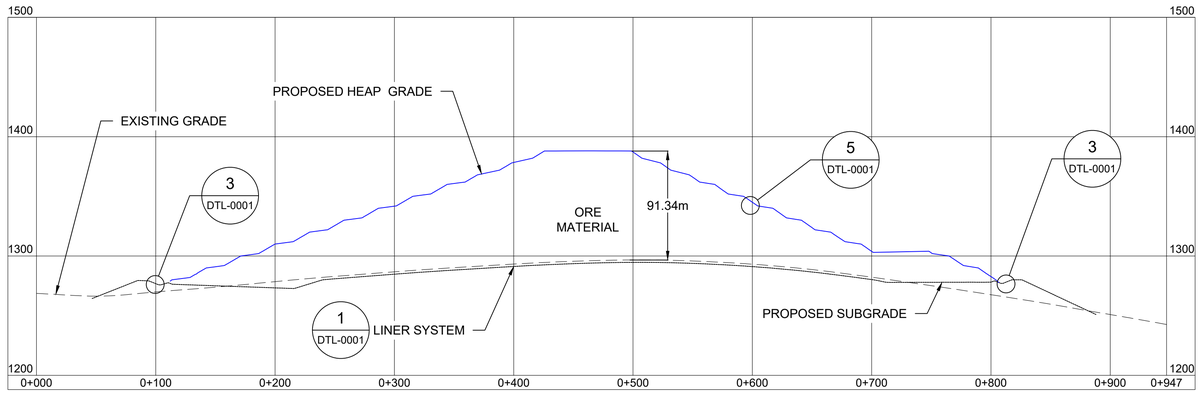
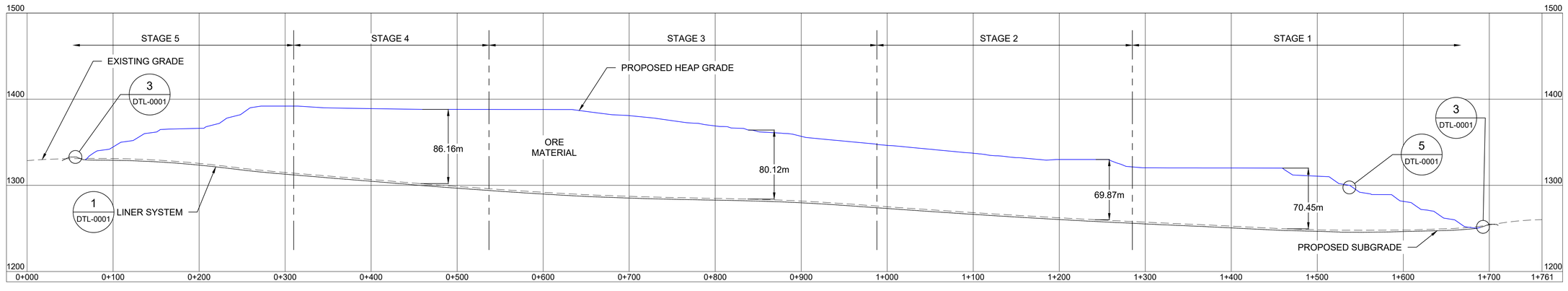


HEAP A
CV-0003

HEAP SECTION

SCALE: 1CM=50M



HEAP B
CV-0003

HEAP SECTION

SCALE: 1CM=50M

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BARRY L. CARLSON
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12717

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FDI PROJECT NO: 123021

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120 COMMERCE DRIVE, UNITS 3&4
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COFFEE HEAP LEACH FACILITY DESIGN

PONDS AND PAD SECTION PAGE 4 OF 4

YUKON, CANADA

DRAWING NUMBER:
CV-2012

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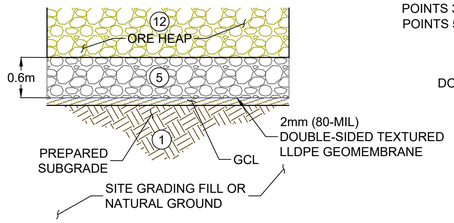
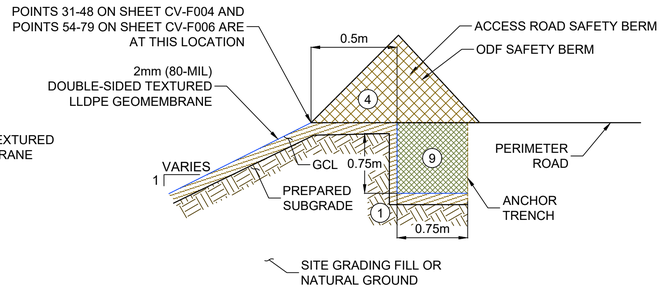


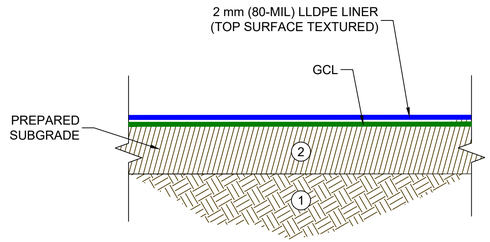
1 CV-0002 **PAD SINGLE LINER DETAIL**

SCALE: NTS

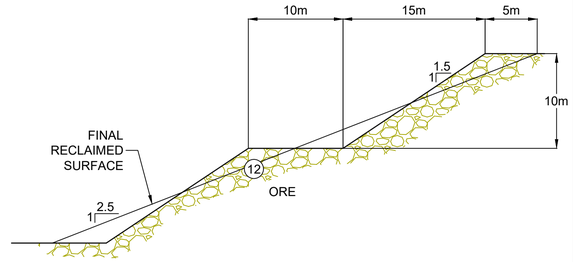


2 CV-0002 **SINGLE LINER ANCHOR TRENCH DETAIL**

SCALE: NTS

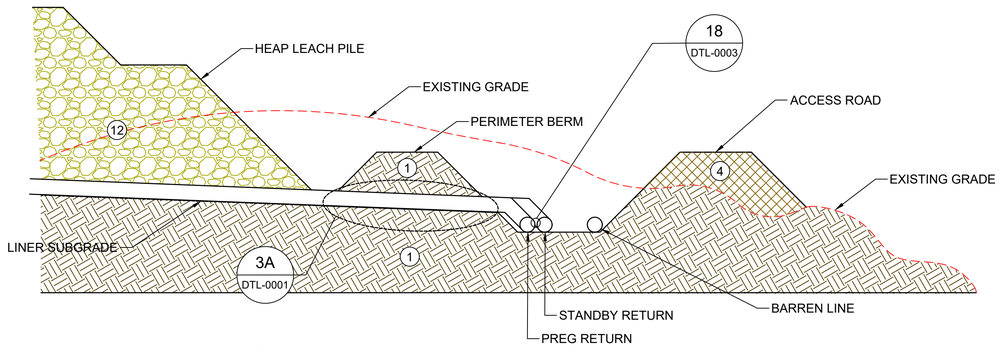


4 CV-0011 **EP-2 AND RAINWATER POND LINER SYSTEM DETAIL**



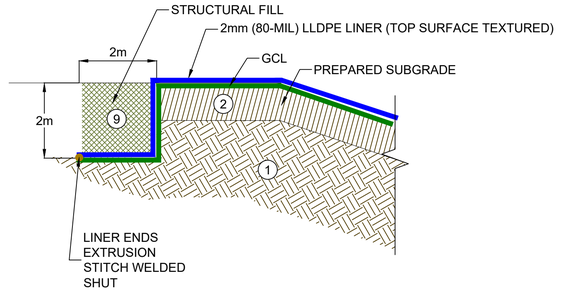
5 CV-0012 **HEAP SLOPE CROSS-SECTION**

SCALE: NTS



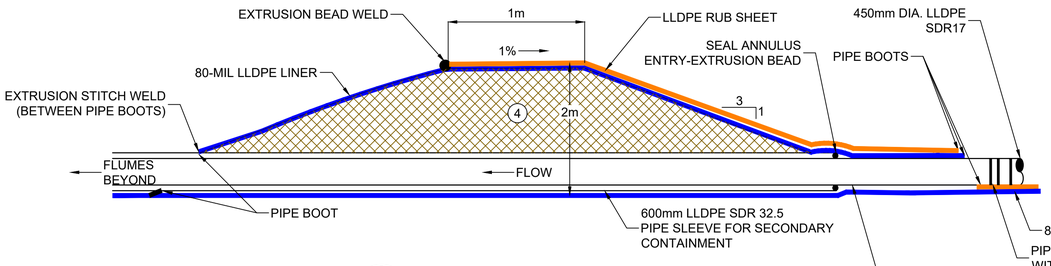
3 CV-0002 **PERIMETER BERM DETAIL OF HEAP LEACH**

SCALE: NTS



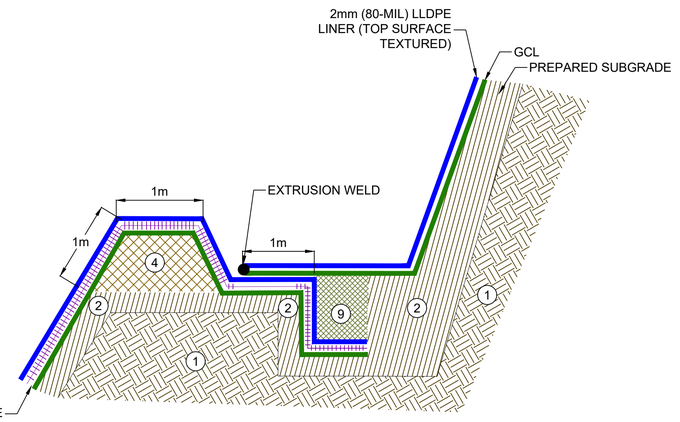
6 CV-0011 **EP-2 AND RAINWATER POND ANCHOR DETAIL**

SCALE: NTS



3A DTL-0001 **PIPE BOOT DETAIL**

SCALE: NTS



7 CV-0011 **EVENT POND 2 PROCESS TO EVENT POND TRANSITION DETAIL**

SCALE: NTS

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PROFESSIONAL ENGINEER YUKON BARRY L. CARLSON TERRITORY 23212 12-26

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
TYPICAL DETAIL PAGE 1 OF 6

YUKON, CANADA

DRAWING NUMBER:
DTL-2001

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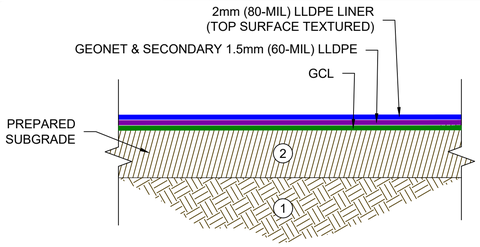
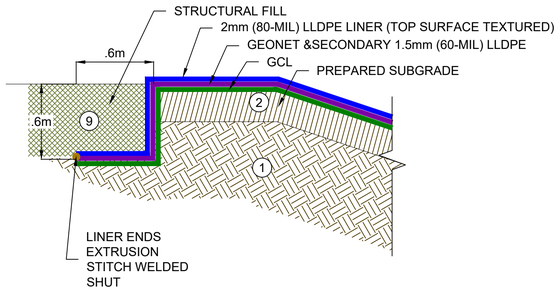


8 - **PROCESS / EVENT POND LINER SYSTEM DETAIL**
SCALE: NTS



9 - **PROCESS / EVENT POND LINER ANCHOR DETAIL**
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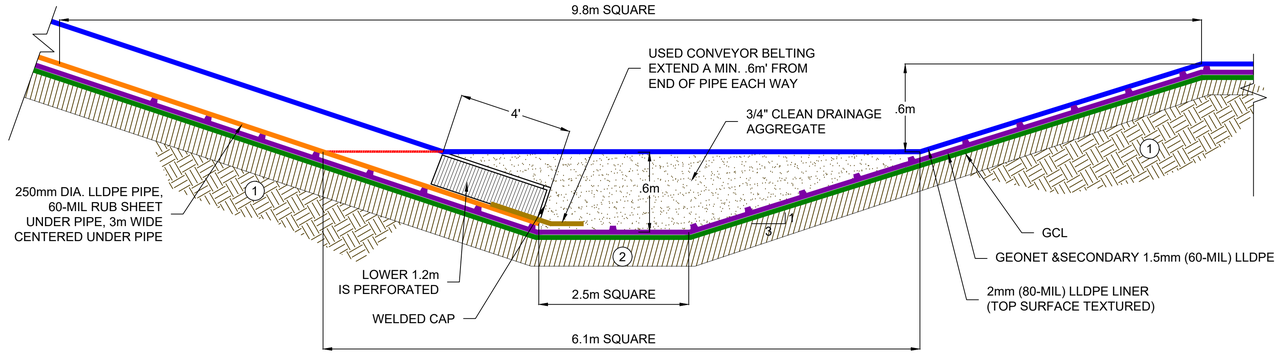
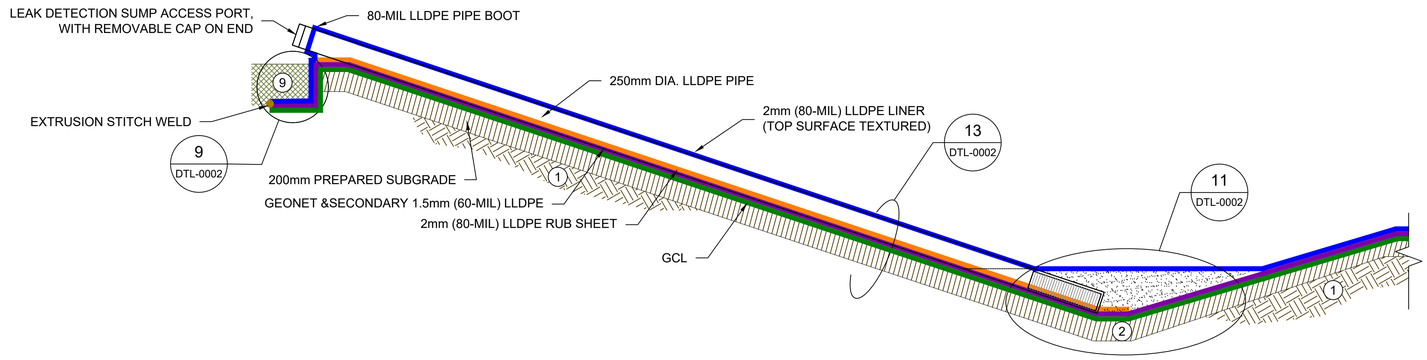


11 - **PROCESS / EVENT POND LEAK DETECTION SUMP DETAIL**
SCALE: NTS



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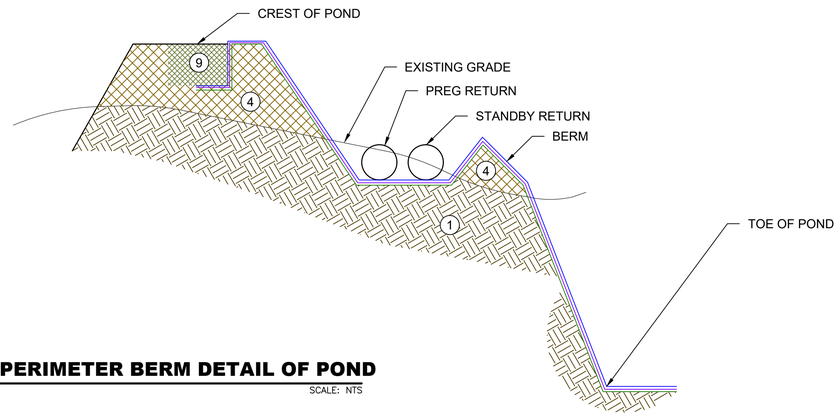
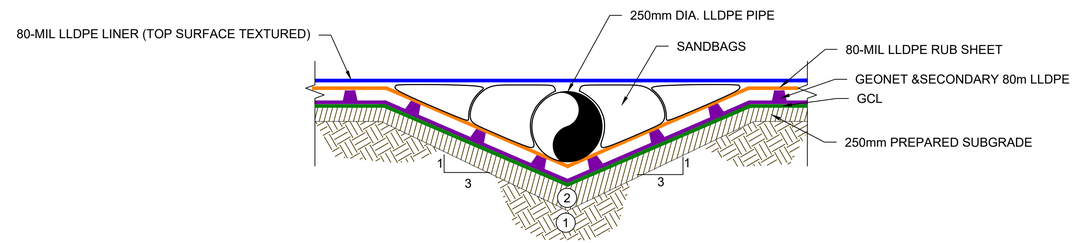
SCALE: NTS



10 - **PERIMETER BERM DETAIL OF POND**
SCALE: NTS



13 - **EVENT POND LEAK DETECTION SUMP ACCESS PORT**
SCALE: NTS

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COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
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BARRY L. CARLSON
17247

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FDI PROJECT NO: 123021

PREPARED BY:
forte DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

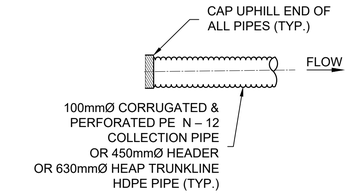
COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
TYPICAL DETAIL PAGE 2 OF 6

YUKON, CANADA

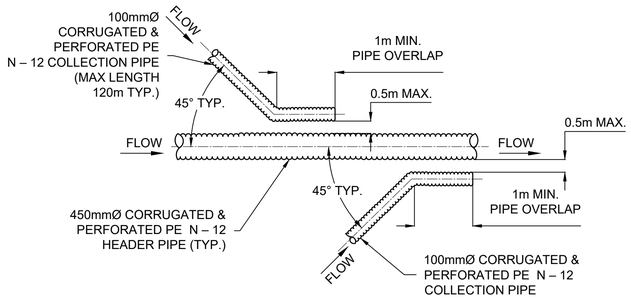
DRAWING NUMBER:
DTL-2002

[Steven] [Jan 27, 2026 – 12:34pm] [C:\Users\Steven\OneDrive – Forte Dynamics\FOR PROJECTS\123000 – Newmont Coffee\123017 – Coffee HLP Engineering for Licensing\04 – Deliverables\04 – Drawings\CAD\DRAWINGS\PLAN SET\123017 – Details.dwg]



14 CV-0004 **TYPICAL PIPE CAP DETAIL**

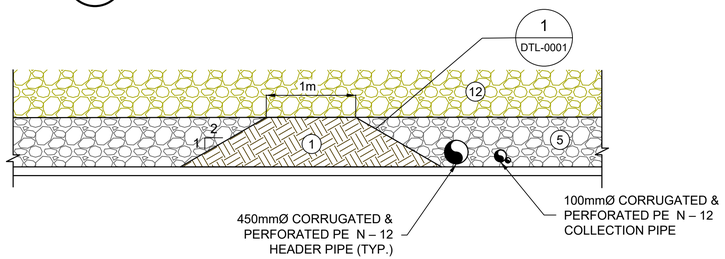
SCALE: NTS



TYPICAL PRIMARY DRAIN TO SINGLE COLLECTOR PIPE ON TWO SIDES DETAIL

15 CV-0004

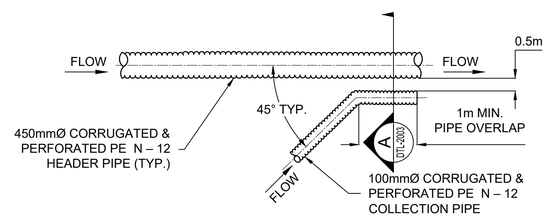
SCALE: NTS



PRIMARY DRAIN TO SINGLE COLLECTOR CROSS SECTION

16-A CV-0004

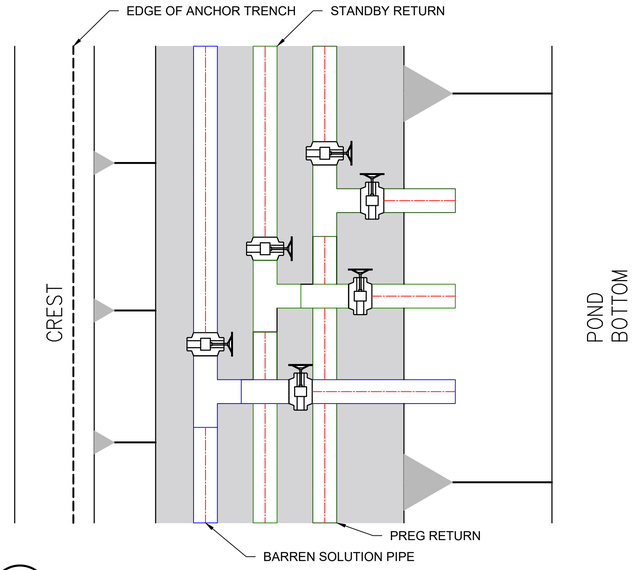
SCALE: NTS



TYPICAL PRIMARY DRAIN TO SINGLE COLLECTOR PIPE ON ONE SIDE DETAIL

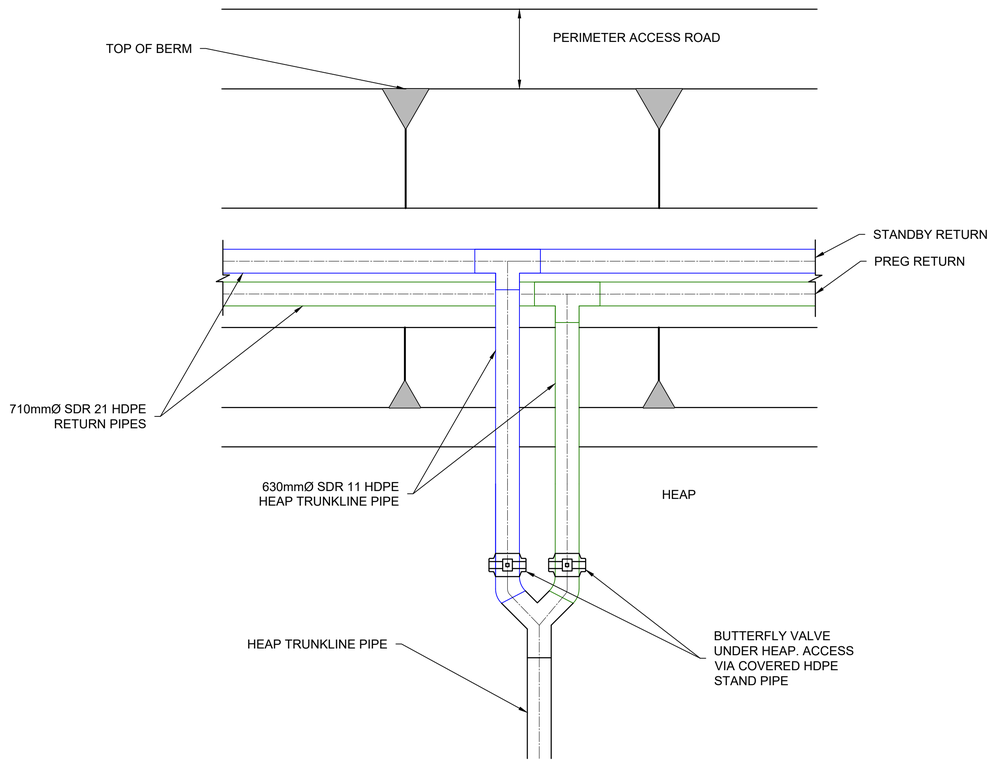
16 CV-0004

SCALE: NTS



17 CV-0004 **POND SHELF**

SCALE: NTS



TRUNK LINE TO COLLECTION HEADERS TRANSITION DETAIL

18 CV-0004

SCALE: NTS

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FDI PROJECT NO: 123021

PREPARED BY:

FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
TYPICAL DETAIL PAGE 3 OF 6

YUKON, CANADA

DRAWING NUMBER:

DTL-2003

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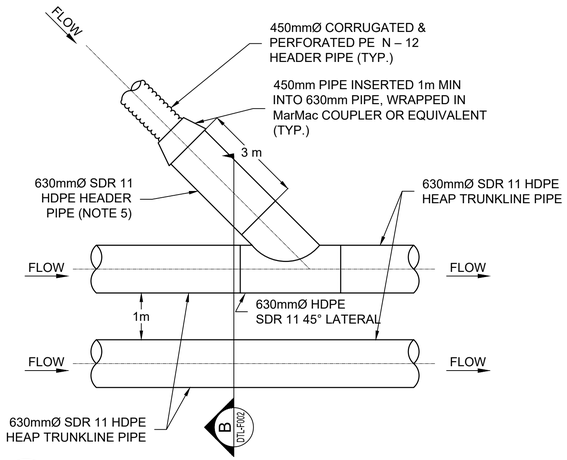
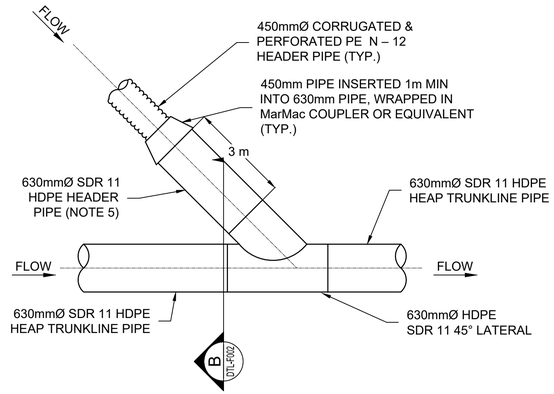


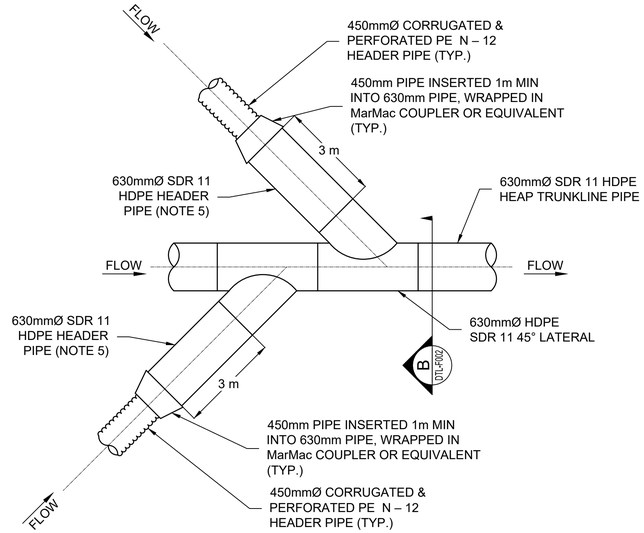
19 CV-0004 **TYPICAL DOUBLE HEADER PIPE DETAIL**

SCALE: NTS



20 CV-0004 **TYPICAL SINGLE HEADER PIPE DETAIL**

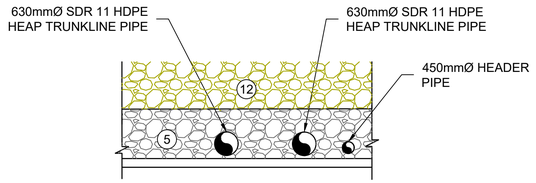
SCALE: NTS



TYPICAL SINGLE HEADER PIPE WITH TWO COLLECTION CONNECTIONS DETAIL

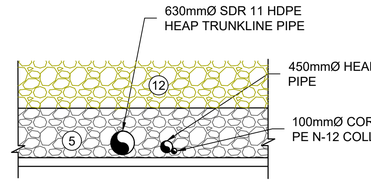
21 CV-0004

SCALE: NTS



19-A CV-0004 **PRIMARY DRAIN TO SINGLE COLLECTOR CROSS SECTION**

SCALE: NTS



20-A CV-0004 **PRIMARY DRAIN TO SINGLE COLLECTOR CROSS SECTION**

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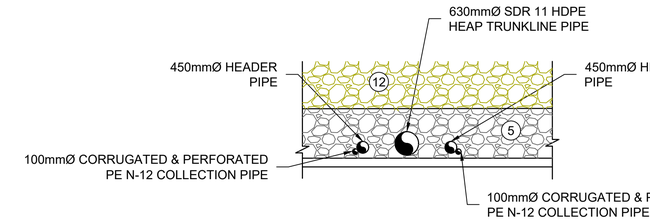

21-A CV-0004 **PRIMARY DRAIN TO SINGLE COLLECTOR CROSS SECTION**

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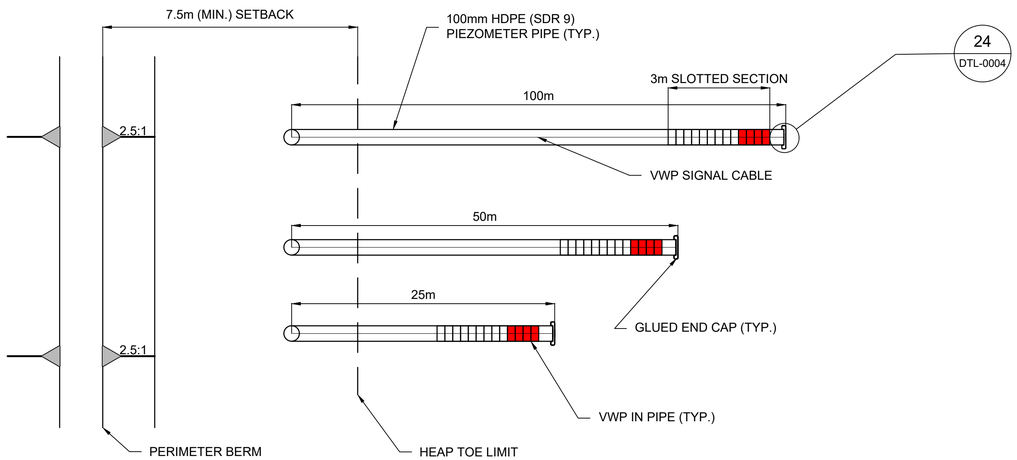
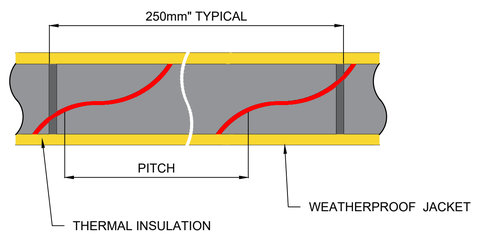


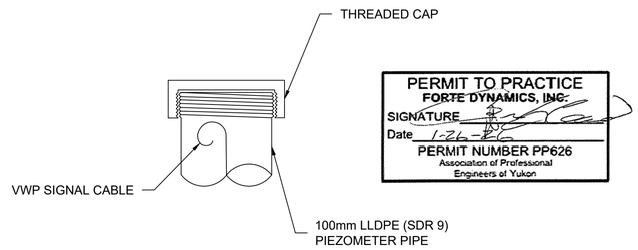
22 CV-2004 **PAD CELL PIEZOMETER TYPICAL LAYOUT**

SCALE: NTS



23 CV- **INSULATE PIPE**

SCALE: NTS



24 CV-0004 **PIEZOMETER CAP DETAIL**

SCALE: NTS

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PROFESSIONAL ENGINEER YUKON TERRITORY BARRY L. CARLSON 2517

FDI PROJECT NO: 123021

PREPARED BY:

FORTE DYNAMICS

120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
TYPICAL DETAIL PAGE 4 OF 6

YUKON, CANADA

DRAWING NUMBER:

DTL-2004

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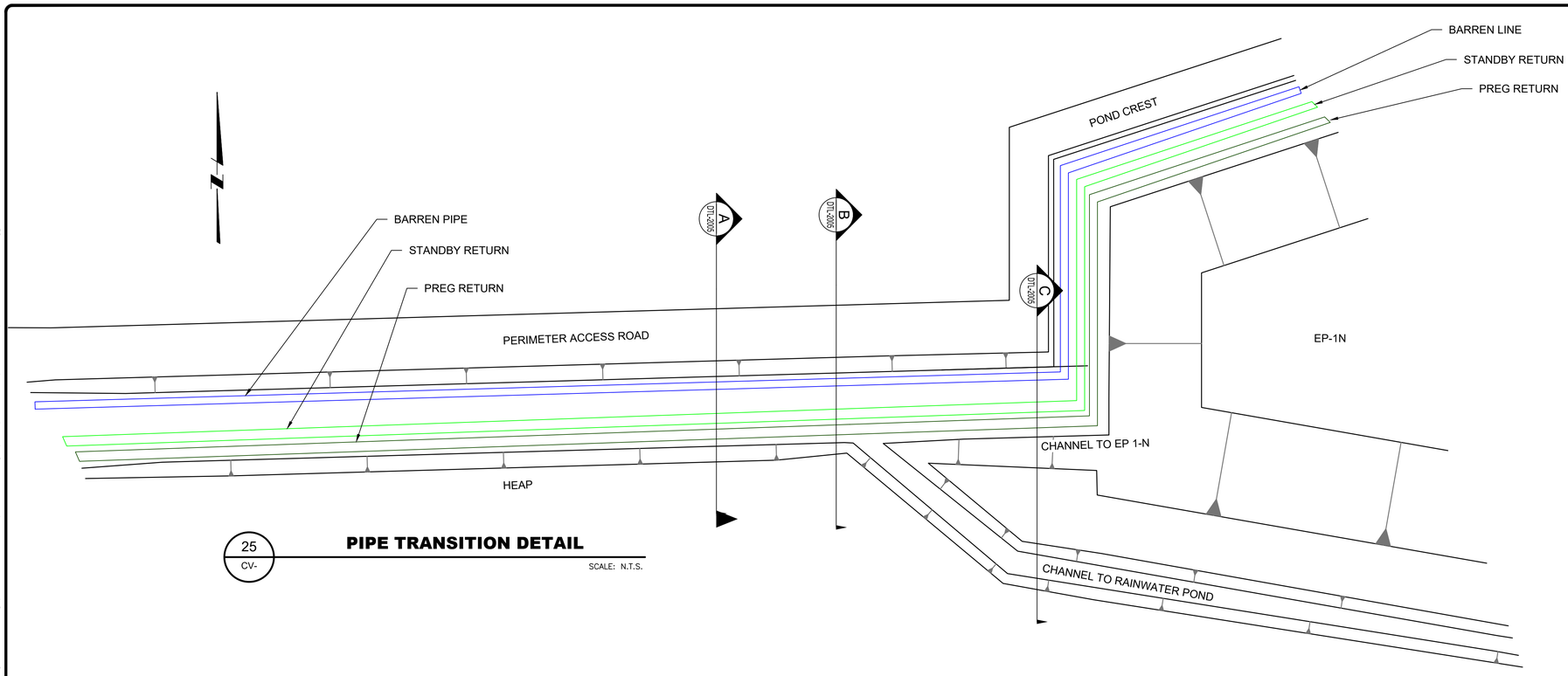

25 / CV-

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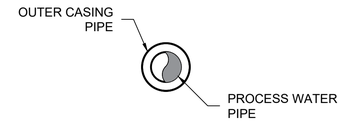

29 / CV-2006

PIPE IN PIPE DETAIL

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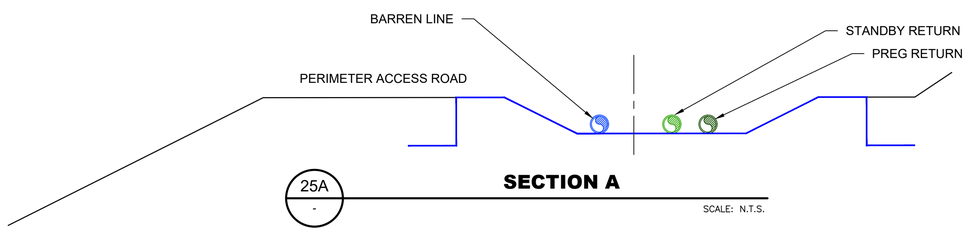

25A / -

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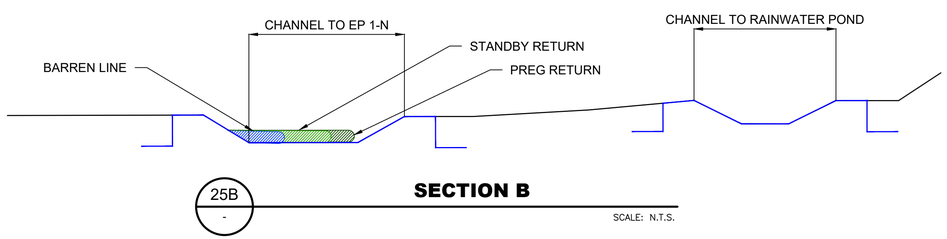

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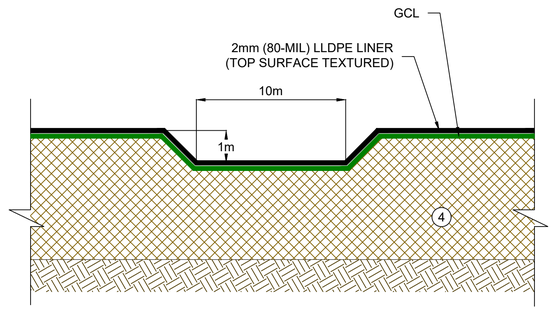

30 / -

RAINWATER POND WEIR

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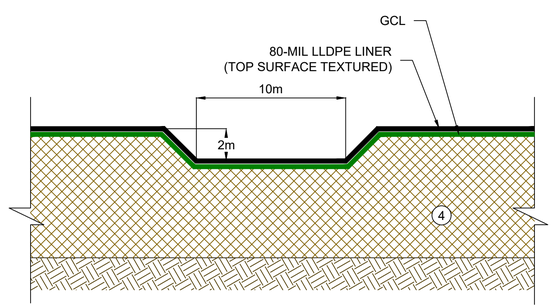

31 / -

EVENT POND WEIR

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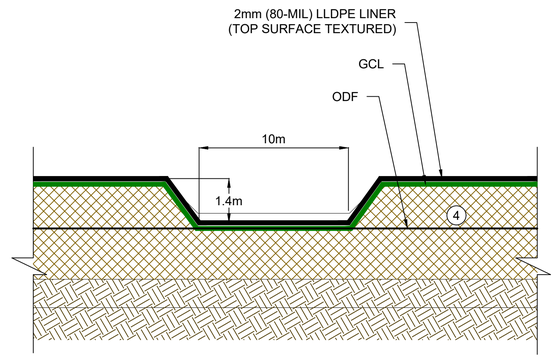

32 / -

PERIMETER BERM WEIR

SCALE: N.T.S.

PERMIT TO PRACTICE
FORTE DYNAMICS, INC.
SIGNATURE
Date 1-26-26
PERMIT NUMBER PP626
Association of Professional Engineers of Yukon

ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
0	012626	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER YUKON TERRITORY BARRY L. CARLSON 17246

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FDI PROJECT NO: 123021

PREPARED BY:
FORTE DYNAMICS
120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
TYPICAL DETAIL PAGE 5 OF 6

YUKON, CANADA

DRAWING NUMBER:
DTL-2005

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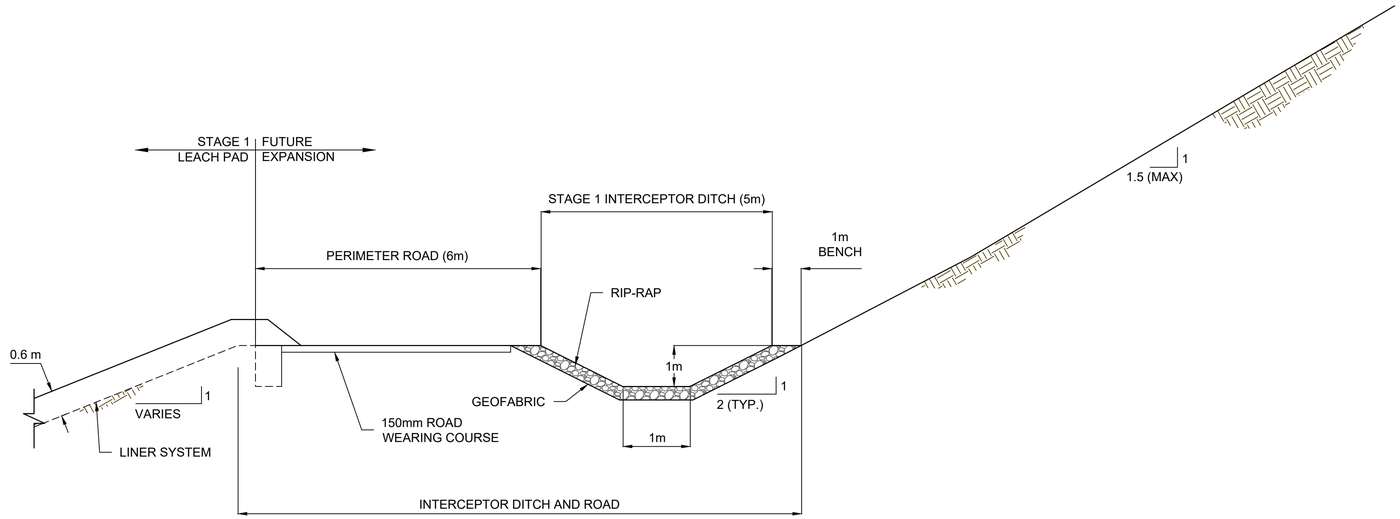
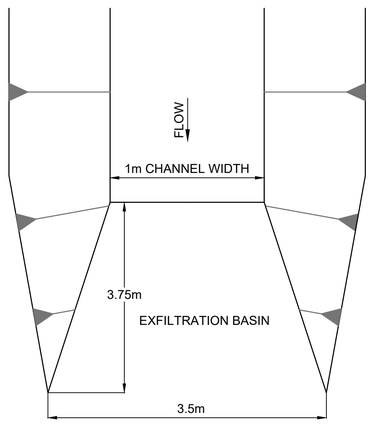


33 GA-2002 TYPICAL STAGE 1 PERIMETER ROAD W/ INTERCEPTOR DITCH

SCALE: NTS

Channel Name	Ditch Invert Slope	Minimum Stable Riprap Size, D_{50}
Stage 1 North	1% to 12%	300 mm (12 in)
Stage 1 North	12% to 25%	600 mm (24 in)
Stage 1 South	1% to 20%	300 mm (12 in)



34 - TYPICAL EXFILTRATION BASIN

SCALE: NTS

PERMIT TO PRACTICE
FORTE DYNAMICS, INC.
SIGNATURE
Date 1-26-26
PERMIT NUMBER PP626
Association of Professional Engineers of Yukon

ISSUE	DATE	DESCRIPTION	DRAWN	DSGN	CHKD	APPD
0	012626	ISSUED FOR LICENSING	SMC	SMC	AR	BC

COORD SYSTEM: NAD83 UTM ZONE 7

PROFESSIONAL ENGINEER
BARRY L. CARLSON
YUKON TERRITORY

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PREPARED BY:
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120 COMMERCE DRIVE, UNITS 3&4
FORT COLLINS, CO 80524

COFFEE HEAP LEACH FACILITY DESIGN

HEAP LEACH PAD
TYPICAL DETAIL PAGE 6 OF 6

YUKON, CANADA

DRAWING NUMBER:
DTL-2006

[Steven] [Jan 27, 2026 – 12:34pm] [C:\Users\Steven\OneDrive – Forte Dynamics\FOR PROJECTS\123000 – Newmont Coffee\123017 – Coffee HLP Engineering for Licensing\04 – Deliverables\04 – Drawings\CAD\DRAWINGS\PLAN SET\123017 – Details.dwg]

APPENDIX C: TECHNICAL SPECIFICATIONS

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

SUMMARY OF WORK 01 11 00

Document No. 123022-83010-PC-TS-0001

Prepared by:

FORTE DYNAMICS, INC
120 Commerce Drive
Units 3 & 4
Fort Collins, CO 80524
(720) 642-9328

Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	L. Burnett	C. Green	B. Carlson

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3. **Project Description** 6
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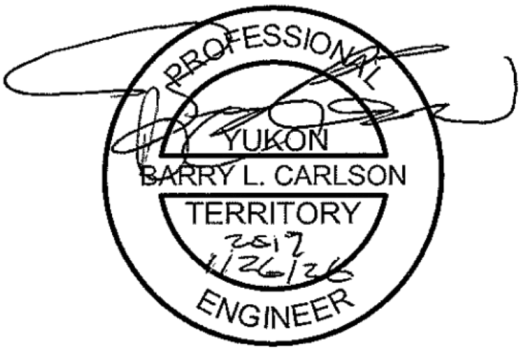
5. **Discrepancies** 8
6. **Contractor's Responsibilities** 8
7. **Products (Not Used)** 8
8. **Execution (Not Used)** 8

SUMMARY

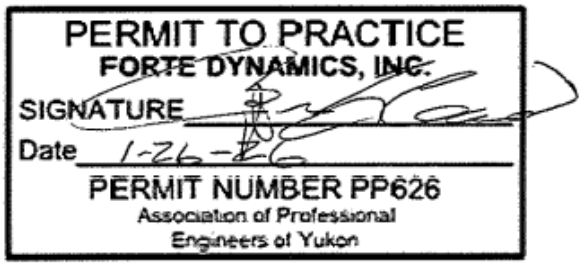
The technical specification enclosed has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without the written consent of Kaminak and Forte Dynamics (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak or Forte.

This report has been prepared under the direct supervision of Barry Carlson, P.Eng. of Forte, with the assistance of Clint Green, P.E. of Forte and Roy Morlan, P.G., of Forte. The design and analyses presented have been completed according to the project information provided by Kaminak. The design level and limits presented in this report are in accordance with standard engineering practices, and to the best of our knowledge, are accurate to the limits as specified herein.



Barry Carlson, PE

PP626



1. RELATED SECTIONS

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	01 66 00	Product Storage and Handling Requirements
Section	01 71 13	Mobilization
Section	01 71 23	Field Engineering
Section	03 38 00	Cast-In-Place Concrete
Section	31 05 13	Soils for Earthwork
Section	31 05 16	Aggregate for Earthwork
Section	31 22 13	Rough Grading
Section	31 23 16	Excavation
Section	31 05 19.13	Geotextile for Earthworks
Section	31 05 19.16	Geomembrane for Earthworks
Section	31 23 23	Fill
Section	31 25 00	Erosion and Sediment Control
Section	31 37 16.13	Rounded-Stone Riprap
Section	33 46 16	Sub-Drainage Piping
Section	33 46 23	Drainage Layers

2. DEFINITIONS

The following definitions apply to these technical **Specifications**:

- **Compacted Fill**: Engineered fill meeting the requirements set forth in these Specifications.
- **Contract Documents**: The agreement/addenda which pertain to the Work:
  - **Contractor's** bid including documentation accompanying the bid;
  - Any post-bid documentation submitted prior to the notice of award when attached as an exhibit to the agreement;
  - These general conditions and any supplementary conditions;
  - The **Drawings**;
  - The **Specifications**; and
  - All **Modifications** issued after the execution of the agreement.
- **Contractor**: The party which has executed a contractual agreement for the specified Work with the Owner.
- **Drawings** are defined as the Issued for Construction (IFC) design drawings prepared by the **Engineer.**
- **Engineer** is defined as a representative appointed and authorized by the Owner and responsible for the Drawings and Specifications.
  - The **Engineer** shall be a registered professional Engineer in the State of Yukon, Canada.
- **Geomembrane**: The arrangement of low permeability synthetic material specified in the design and approved by the **Engineer** for use in construction of the HLF and its components.
- **Geomembrane Installer**: The **Contractor** or **Sub-Contractor** retained by the **Owner** or the Contractor to install the **Geomembrane** and related appurtenances.
- **Geotextile**: A permeable fabric used to separate, reinforce, and protect the geomembrane overlain by rock trench fill specified in the design and approved by **the Engineer** for use in the construction of the HLF and its components.
- **Land Surveyor** is defined as the surveyor responsible for horizontal and vertical control points used in the Work.
  - The **Land Surveyor** shall be a registered by the Association of Canada Land Surveyors (ACLS).
- **Modifications**: Changes made to the **Specifications** or the **Drawings** that are approved by the **Owner** and/or the **Engineer** in writing after the **Specifications** or the **Drawings** have been issued for construction.
- **Off-Site Material**: Material obtained from sources other than on-site.
- **On-Site Material**: Borrow materials obtained within the immediate project/mine property.

- **Over Liner Drain Fill**: Material placed over the liner that will, along with the piping, serve as the drainage layer for pregnant leachate solution.
- **Owner**: Kaminak Gold Ltd.
- **Owner's Representative**: An authorized representative of Kaminak.
- **Pipe (HDPE):** Solid, non-perforated, high-density, polyethylene piping (HDPE).
- **Products**: New or previously acquired materials, machines, components, equipment, fixtures, and systems forming the **Work**.
    - This does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the **Work**.
- **Quality Assurance Consultant**: The individuals working under the direction of the **Owner** to perform on-site quality assurance on behalf of the **Owner**.
- **Record Drawings**: The documents prepared and certified by the **Contractor** documenting the progress, location, type, and quantity of materials placed to complete the **Work.**
- **Slope**: The ratio of horizontal distance to vertical distance (H:V).
- **Specifications**: This document of Issued for Construction (IFC) technical Specifications prepared by the Engineer for the **Owner** to establish acceptable standards of the **Work**.
- **Sub-Contractor**: A **Contractor** employed by the primary **Contractor.**
- **Third-Party: Work** or services performed under the direction of the **Owner** and/or the **Engineer** and not under the direct supervision or control of the **Contractor.**
- **Unsuitable Material:** Any material that contains vegetation, organic silt, frozen materials, man-made objects or waste, or do not meet the requirements under Section 31 23 23 – Fill and 31 23 13 – Subgrade Preparation.
- **Work:** The entire constructed project, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, as required by the Contract Documents.

3. PROJECT DESCRIPTION

The construction covered under these Specifications provides for construction of the Coffee Heap Leach Facility (HLF) and all its components including but not limited to: The heap leach pad, its foundation, liner system, pregnant leachate solution collection system, drain medium, containment berms, roads, ditches, culverts, conveyance channels, embankments, spillways, ponds, and irrigation system. The **Drawings** contain the details for each part of the construction and these Technical Specifications describe the methods and materials required for construction.

4. SCOPE OF WORK

The scope of Work for this project will include, but is not limited to:

- Mobilization of all equipment and materials required for the **Work**;
- Installation of temporary and permanent surface water control, including diversion structures;
- Removal of structures and obstructions, and removal of materials to salvage;
- Constructing temporary access roads, as needed;
- Clearing and grubbing of the areas associated with the construction of the **Work**;
- Excavating in required areas, as needed;
- Applying construction water for moisture conditioning on fills and dust control on roads associated with construction of the **Work**;
- Hauling, and placing **Compacted Fill** material;
- Excavating, and hauling of material for **Liner Bedding Fill** and **Overliner Drain Fill**;
- Processing, hauling, placement, and compaction of **Liner Bedding Fill**;
- Furnishing and installing all materials and constructing all items appurtenant and incidental to the placement of **Geomembrane** liner system;
- Installation of **Geomembrane**, and processing, hauling, and placement of **Overliner Drain Fill**;
- Furnishing and installing all material and constructing all items apparent and incidental to the Leak Detection and Recovery System;
- Furnishing and installing all materials and constructing all items appurtenant and incidental to stormwater diversion channels and lined solution ditches;
- Furnishing and installing all materials and constructing all items appurtenant and incidental to the Pipe, including backfill;
- Furnishing and installing all materials and constructing all items appurtenant and incidental to new overhead electrical lines;
- Furnishing and installing all materials and constructing all items appurtenant and incidental to the placement of the fencing, storm drain culverts, rip rap, and other miscellaneous items of **Work**;
- Demobilization which includes removing temporary structures and shaping, contouring, and final grading of surfaces used for staging or borrow

5. DISCREPANCIES

- Should any discrepancy, either implied or real, exist between the **Specifications** and the **Drawings**, the **Contractor** shall:
  - Notify the **Owner's Representative**.
  - Stop all **Work** that concerns the discrepancy until the discrepancy is remedied or clarified by the **Owner** or the **Owner's Representative**.
- The decision of the **Owner** and the **Owner's Representative** is final.

6. CONTRACTOR'S RESPONSIBILITIES

The **Contractor** shall:

- Comply with all laws and rights for workmen as specified by all applicable regulatory agencies and the contract with the **Owner**.
- Become familiar with the relevant regional and site-specific conditions which may have an impact on the **Work**.
- Before proceeding with the **Work**, examine all **Drawings** and report to the **Owner's Representative** any apparent discrepancies or interferences;
  - The **Owner Representative** shall be authorized to make minor alterations to the **Drawings**;
  - All alterations shall be issued under a covering **Work** order signed by the **Owner's Representative** prior to the start of the alteration.
- Perform the **Work** in accordance with these **Specifications** and **Drawings** in a timely, orderly, and safe manner.
- Be responsible for making his own measurements and installing his **Work** to fit the conditions encountered.
- Schedule adequate time for **Owner's Representative** to inspect and approve of the **Work**.

7. PRODUCTS (NOT USED)

8. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

PROJECT MANAGEMENT & COORDINATION 01 31 00

Document No. 123022-83010-PC-TS-0002

Prepared by:

FORTE DYNAMICS, INC
120 Commerce Drive
Units 3 & 4
Fort Collins, CO 80524
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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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3. Products (Not Used) **4**

4. Execution (Not Used) **4**

SUMMARY

The technical specification enclosed titled “Summary of Work” has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without the written consent of Kaminak and Forte Dynamics (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak or Forte.

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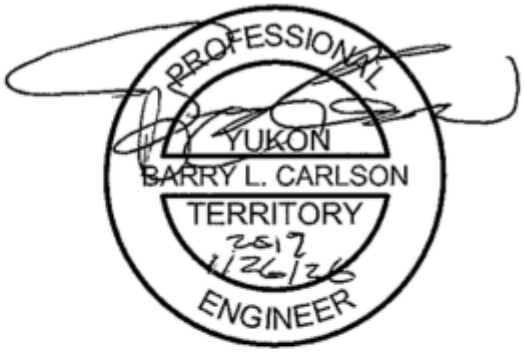

Barry Carlson, PE

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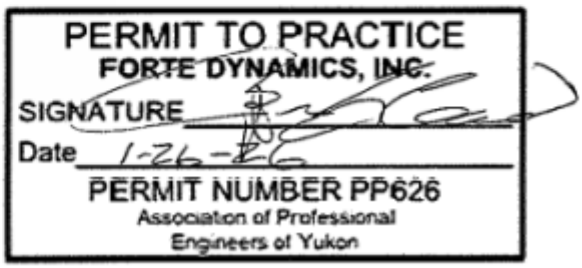

1. RELATED SECTIONS

Section	01 32 00	Construction Progress Documentation
Section	01 71 13	Mobilization

2. PROJECT COORDINATION

2.1 Contractor's Responsibilities

- Cooperate with the Owner in allocation of mobilization areas, areas for field offices, access, traffic, and parking facilities;
- During construction, coordinate use of site and facilities through the Owner;
- Comply with Owner's procedures for intra-project communications;
- Comply with instructions from the Owner for use of temporary utilities and construction facilities; and
- Submit requests for interpretation of the Contract Documents to Owner and obtain instructions through Owner.

3. PRODUCTS (NOT USED)

4. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

CONSTRUCTION PROGRESS DOCUMENTATION 01 32 00

Document No. 123022-83010-PC-TS-0003

Prepared by:

FORTE DYNAMICS, INC
120 Commerce Drive
Units 3 & 4
Fort Collins, CO 80524
(720) 642-9328

Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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5. **Products (Not Used)** 5
6. **Execution (Not Used)** 5

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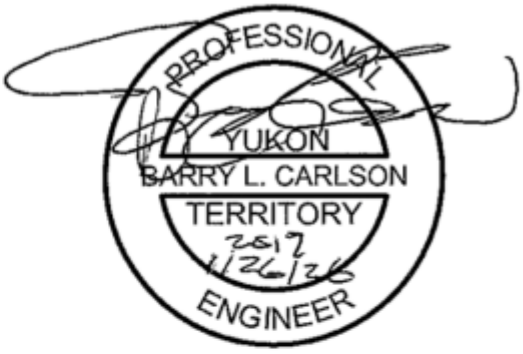

Barry Carlson, PE

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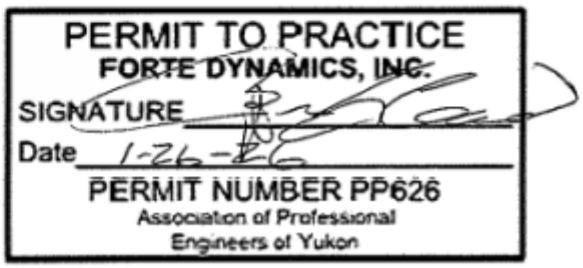

1. RELATED SECTIONS

Section	01 11 00	Summary of Work
Section	01 31 00	Project Management and Coordination
Section	01 33 00	Submittal Procedures

2. CONSTRUCTION PROGRESS SUBMITTALS

Contractors:

- A monthly survey or measured accounting of the completed works and volumes of material for payment.
- Submit daily progress reports listing Equipment and Labor hours by major category, areas worked, and progress achieved.
- Submit monthly summary of hours worked and average number of workers.
- Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- Provide **Sub-Contractors** activity schedules monthly.
- Provide separate schedule of submittal dates for shop drawings, product data, and samples, including **Owner**-furnished **Products**, and dates that reviewed submittals shall be required from the **Owner's Representative** and/or the **Engineer**, and indicate delivery data for **Products**.
- Schedules shall be in a format that is acceptable to the **Owner**.
- Distribute copies of reviewed schedules to the project file, the **Sub-Contractors**, the suppliers, and the **Engineer**.
- Instruct the recipient to promptly report, in writing, problems anticipated by projections indicated in schedules.

3. CONSTRUCTION PROGRESS REPORTING

- Submit daily progress reports listing Equipment and Labor hours by major category, areas worked, and progress achieved.
- Submit monthly summary of hours worked and average number of workers.
- Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- Provide **Sub-Contractors** activity schedules.
- Provide separate schedule of submittal dates for shop drawings, product data, and samples, including **Owner**-furnished **Products**, and dates that reviewed submittals shall be required from the **Owner's Representative** and/or the **Engineer**, and indicate delivery data for **Products**.
- Schedules shall be in a form that is acceptable to the **Owner**.

- Distribute copies of reviewed schedules to the project file, the **Sub-Contractors**, the suppliers, and the **Engineer**.
- Instruct the recipient to promptly report, in writing, problems anticipated by projections indicated in schedules.

4. AS-BUILT DOCUMENTATION

- The **Contractor** shall be responsible for all as-built documentation unless otherwise specified in the CQA Plan.
- The **Contractor** shall provide and keep up to date a complete "as-built" record set of full-size plan prints.
    - The As-Built records shall:
        - Be corrected daily;
        - Show every change from the original drawings and **Specifications**;
        - Show the exact as-built locations, size, and type of equipment installed;
        - Be kept onsite; and
        - Be used only as a record set.
    - The as-built drawings shall also serve as **Work** progress sheets.
        - The **Contractor** shall make neat and legible annotations thereon, daily as the **Work** proceeds, showing the **Work** as actually installed;
        - These drawings shall be available at all times for inspection; and
        - Shall be kept in a location acceptable to the **Owner's Representative**.
    - On or before the date of final inspection, the **Contractor** shall deliver the corrected and approved as-built record set of prints to the **Owner's Representative**.
        - Delivery of the as-built prints will not relieve the **Contractor** of the responsibility of furnishing required information that may have been omitted.
        - Final payment is contingent upon acceptance of the as-built drawings.
- Submittal – Completed as-built documentation will be submitted within two (2) weeks of project acceptance in the following manner:
    - Submit one (1) reproducible copy to the **Owner's Representative**; and
    - Submit one (1) non-reproducible copy to the **Owner's Representative**.

5. PRODUCTS (NOT USED)

6. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

SUBMITTAL PROCEDURES 01 33 00

Document No. 123022-83010-PC-TS-0004

Prepared by:

FORTE DYNAMICS, INC
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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	A. Reiman	C. Green

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SUMMARY

The technical specification enclosed has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without the written consent of Kaminak and Forte Dynamics (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak or Forte.

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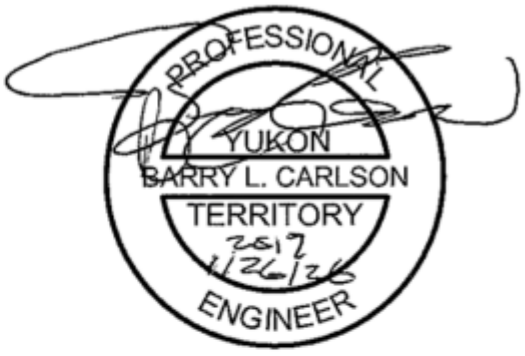

Barry Carlson, PE

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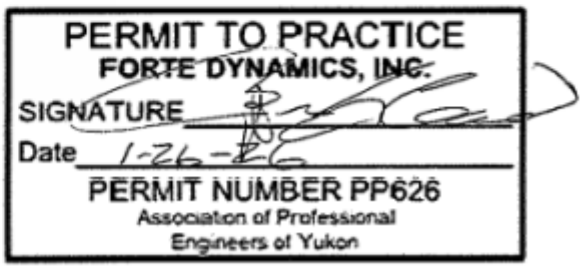

1. RELATED SECTIONS

Section	01 32 00	Construction Progress Documentation
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	03 38 00	Cast-In-Place Concrete
Section	31 05 13	Soils for Earthwork
Section	31 05 16	Aggregate for Earthwork
Section	31 05 19	Geosynthetics for Earthwork
Section	31 25 00	Erosion and Sediment Control
Section	31 37 16.13	Rounded-Stone Riprap
Section	33 46 16	Sub-Drainage Piping
Section	33 46 23	Drainage Layers
Section	40 05 13.19	Stainless-Steel Process Piping

2. TECHNICAL DATA

- Engineering data related to **On-Site** and **Off-Site Materials** to be used in the construction of the facilities as indicated on the **Drawings** and in these **Specifications** shall be submitted to the **Engineer** for review and acceptance prior to using the material for construction;
    - The **Contractor** shall provide three (3) copies of the submittal for each material, i.e. Engineering data, to the **Engineer**;
    - Each submittal shall be clearly marked with the name of the project, the Contractor's name, and references to applicable **Specifications** and **Drawings**;
    - The **Contractor** shall provide submittals a minimum of ten (10) business days prior to the use of the material;
- Engineering data covering all equipment and fabricated materials to be furnished under this Contract shall be submitted to the **Engineer** for review;
    - These data shall include:
        - Drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component material and devices;
        - The external connections, anchorages, and supports required;
        - Performance characteristics; and
        - Dimensions needed for installations and correlation with other materials and equipment.

- Data submitted shall include Drawings showing essential details of any changes proposed by **Contractor**;

- When catalog pages are submitted, the applicable items shall be identified;

- No **Work** shall be performed in connection with the fabrication or manufacture of materials and equipment, nor shall any accessory or appurtenance be purchased until the drawings and data have been reviewed and approved by the **Engineer**, except at the **Contractor's** own risk and responsibility;

- The **Engineer** shall return one (1) copy of the submittal to the **Contractor** with comments.

  - When the Drawings and data are returned marked “Comments Attached – Resubmit” and/or “Rejected”, the corrections shall be made as instructed by the **Owner’s Representative** and not less than three (3) corrected copies shall be resubmitted.

  - Unless otherwise directed by the **Engineer**, when Drawings and data are returned marked “Note Markings”, “Comments Attached – Confirm”, and/or “See Below - Comments highlighted in yellow”, the changes shall be made as noted thereon and not less than three (3) corrected copies shall be furnished to the **Engineer**.

  - When the Drawings and data are returned marked “No Exceptions Taken”, one (1) copy shall be returned to the **Contractor**, one (1) copy shall be retained for the **Owner**, and one (1) copy shall be retained by the **Engineer**;

- The **Engineer** review of Drawings and data submitted by the **Contractor** shall cover only general conformity to the **Drawings** and **Specifications**, external connections, and dimensions which affect the layout;

  - The **Engineer’s** review of **Drawings** and data returned marked “No Exceptions Taken” or “Note Markings” does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, devices, or items shown; and

  - Does not relieve the **Contractor** from any responsibility for errors or deviations from the contract requirements;

- All Drawings and data, after final processing by the **Engineer**, shall become a part of the **Contract Documents** and the **Work** shown or described thereby shall be performed in conformity therewith unless otherwise authorized by the **Owner** and/or the **Engineer**.

3. PRODUCTS (NOT USED)

4. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

REGULATORY REQUIREMENTS 01 41 00

Document No. 123022-83010-PC-TS-0005

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	R. Morlan

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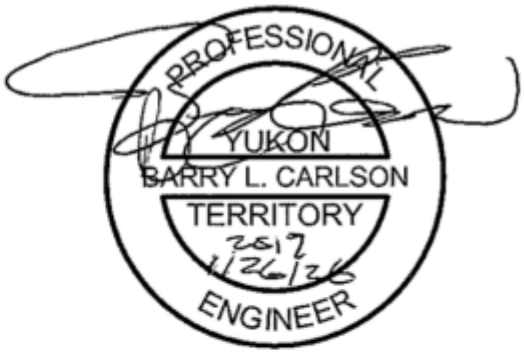

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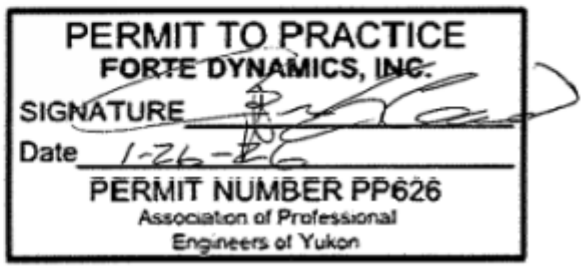

1. RELATED SECTIONS

Section	01 50 00	Temporary Facilities and Controls
Section	01 66 00	Product Storage and Handling Requirements
Section	01 71 13	Mobilization
Section	01 71 23	Field Engineering
Section	02 40 00	Demolition
Section	03 38 00	Cast-In-Place Concrete
Section	31 05 13	Soils for Earthwork
Section	31 05 16	Aggregate for Earthwork
Section	31 22 13	Rough Grading
Section	31 23 16	Excavation
Section	31 05 19	Geosynthetics for Earthwork
Section	31 23 23	Fill
Section	31 25 00	Erosion and Sediment Control
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Section	33 46 16	Sub-Drainage Piping
Section	33 46 23	Drainage Layers
Section	40 05 13.19	Stainless-Steel Process Piping

2. CODES AND REGULATIONS

- The **Work** shall conform to applicable local, provincial, and Canadian regulations.
- The following publications, regulations, and/or codes current at the date of issue of the **Contract Documents**, unless specified otherwise, are part of these **Specifications**, except where modified or replaced by local codes or ordinances having jurisdiction, in which case such local codes or ordinances shall govern:
    - CAC – Cement Association of Canada
    - CCA – Canadian Construction Association
    - CCME – Canadian Council of Ministers of the Environment
    - CDA – Canadian Dam Association
    - CEC – Canadian Electrical Code
    - CSA – Canadian Standards Association
    - MAC – Mining Association of Canada
    - NBC or NBCC – National Building Code of Canada
    - NFC or NFCC – National Fire Code of Canada
    - YESAB – Yukon Environmental and Socio-Economic Assessment Board
    - YG – Government of Yukon
- The **Contractor** shall be responsible for obtaining all permits and/or authorizations required to execute the **Work**;
- The **Contractor** shall be responsible for developing and maintaining a Storm Water Pollution Prevention Plan (SWPPP) and a Spill Prevention Control and Countermeasure (SPCC) Plan as applicable for execution of the **Work**.
- The **Owner** shall be responsible for obtaining all necessary permits for operation of the facility.

3. PRODUCTS (NOT USED)

4. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

REFERENCE STANDARDS 01 42 19

Document No. 123022-83010-PC-TS-0006

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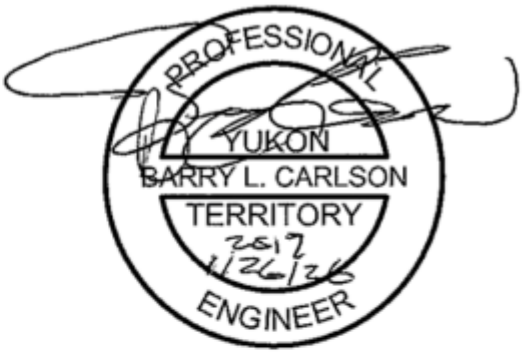

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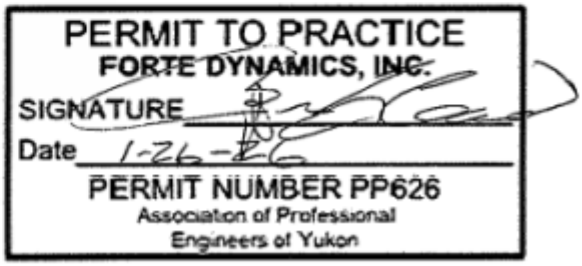

1. RELATED SECTIONS

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	01 50 00	Temporary Facilities and Controls
Section	01 66 00	Product Storage and Handling Requirements
Section	01 71 13	Mobilization
Section	01 71 23	Field Engineering
Section	02 40 00	Demolition
Section	03 38 00	Cast-In-Place Concrete
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2. SCHEDULE OF REFERENCES

All **Products** of workmanship specified by association, trade, or federal reference standards shall comply with the requirements of the standard, except when more rigid requirements are specified or are required by applicable codes. The reference standard that is current at the **Contract Document's** date of issue shall be used. As a minimum, the following reference standards shall be used for this project:

Abbreviation	Full Name
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
CISC	Canadian institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
MAC	Mining Association of Canada
CDA	Canadian Dam Association
CSA	Canadian Standards Association
GRI	Geosynthetics Research Institute

3. PRODUCTS (NOT USED)

4. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

QUALITY ASSURANCE 01 43 00

Document No. 123022-83010-PC-TS-0007

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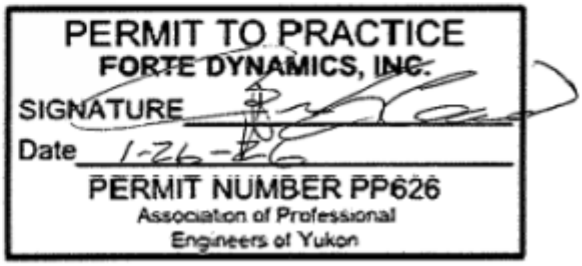

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Section	40 05 13.73	Plastic Process Piping

2. QUALITY ASSURANCE

- Quality Assurance (QA) shall consist of inspection and verification, as needed, performed by the **Quality Assurance Consultant** and **Third-Party** laboratory retained by the **Owner**.
- **Contractor** shall schedule the Work to facilitate QA activities and advise Quality Assurance Consultant and/or Third-Party Laboratory two (2) business days in advance of QA inspection needs.
- The results of QA inspection and verification testing, as needed, will be the sole basis for acceptance of the **Work**

3. FIELD INSPECTION, SAMPLING, TESTING

- The **Contractor** shall maintain access at all times for quality assurance personnel to perform inspections, testing, sampling, etc.;
- At no time shall the **Contractor** deny Quality Assurance personnel, the Engineer, or **Owner's Representative** access to any **Work** area, fabrication area, staging area, or any other area associated with the **Work**;
- The **Contractor** shall make allowances for the quality assurance functions to be performed and divert equipment elsewhere during the required quality assurance testing;
- All **Work** performed by the **Contractor** shall comply with these **Specifications**.
    - The method and manner of doing the **Work** will be under the control of the **Contractor**;
    - The **Owner's** inspections will not relieve the **Contractor** of responsibility for the acceptability of the finished **Work**, or portions thereof;
- There is no provision for claims of delays due to quality assurance inspection, testing, or sampling;
    - Should the **Contractor** feel that delays are being incurred due to quality assurance inspection, testing, sampling, or other activities, notify the **Owner's Representative** and/or the **Engineer** in writing documenting in detail the date, time, and quality assurance activity of each occurrence;
    - Should the **Owner's Representative** and/or the **Engineer** determine that excessive time is being spent at quality assurance activities causing delay to **Work**, corrective action will be taken;
- If any **Work** should be covered up without prior approval or consent of the **Quality Assurance Consultant**, it must; if required by the **Quality Assurance Consultant**, be uncovered for examination.
    - After the uncovered **Work** has been observed and authorization given by the **Quality Assurance Consultant**, the **Work** shall be recovered in accordance with the **Specifications**.
    - The cost of uncovering and recovering the **Work** and any consequential costs shall be born entirely by the **Contractor** regardless of the condition of the **Work** uncovered.
    - If the **Work** is found to be deficient, the **Contractor** shall expose all **Work** that was covered prior to approval, correct any **Work** that is deficient, and proceed according to the **Specifications**.
    - The cost of correcting deficient **Work**, and any consequential costs shall be born entirely by the **Contractor**.
- Frequency of testing: Quality Assurance testing frequency will be performed at a minimum rate of 1 test per 10 test performed by the **Quality Control Contractor**. For in-situ density testing using a nuclear density gauge the **Quality Assurance Consultant** may use observations of the **Quality Control Contractors** testing and review of the machines calibration logs in leu of collection a separate reading.

4. INSPECTION AND LABORATORY TESTING

- The **Owner** will appoint, employ, and pay for services of a **Quality Assurance Consultant**, to perform the quality assurance inspections, testing, sampling, etc.
- The **Quality Assurance Consultant** will perform inspections, tests, and other services, as needed, under the supervision and control of the **Owner's Representative** while **Work** is in progress;
- The **Contractor** shall cooperate with the **Quality Assurance Consultant**, furnish samples of materials, etc., and provide equipment, tools, storage, and any other assistance, as required;
- The **Contractor** shall notify the **Owner's Representative** and **Quality Assurance Consultant** two (2) business days prior to the expected time for required QA services;
- The **Quality Assurance Consultant's** QA testing and inspections, etc., will not relieve the Contractor of responsibility for the acceptability of the finished **Work**, or portions thereof;
- Any retesting due to non-compliance with the specified requirements of these **Specifications** shall be performed by the same independent **Quality Assurance Consultant** on instructions of the **Owner's Representative**.
    - The costs of retesting shall be borne by the **Contractor**

5. PRODUCTS (NOT USED)

6. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

QUALITY CONTROL 01 45 00

Document No. 123022-83010-PC-TS-0008

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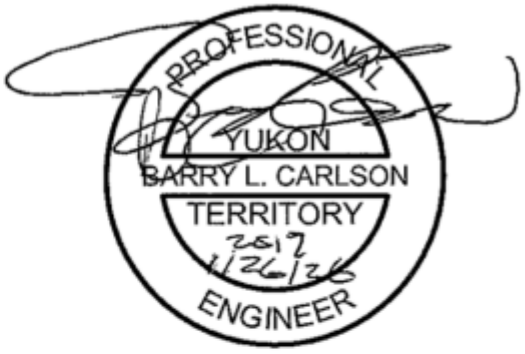

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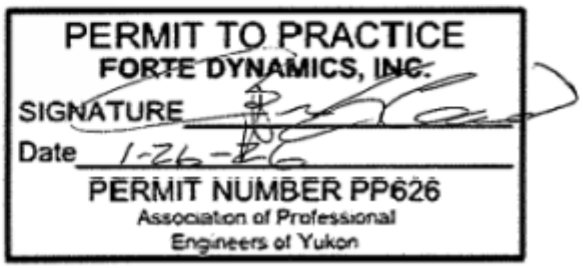

1. RELATED SECTIONS

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2. QUALITY CONTROL

- Quality Control shall consist of inspection and testing performed by the **Contractor**, manufacturer, and/or **Third Party** retained by the **Contractor** and/or manufacturer prior to and after the material is incorporated in the **Work**;
- The **Contractor** shall be responsible to monitor quality control over suppliers, manufacturers, **Products**, services, site conditions, and workmanship to produce **Work** of specified quality;
- The **Contractor** shall comply fully with the manufacturer's instructions;
- Should the manufacturer's instructions conflict with the **Contract Documents**, the **Contractor** shall request clarification from the **Engineer** before proceeding;
- The **Contractor** shall comply with specified standards, as a minimum quality for the **Work**, except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship;
- The **Work** shall be performed by persons qualified to produce workmanship of specified quality;
- Quality control results are not a basis of acceptance of the **Work**;
- Results of quality control tests are subject to verification by the **Engineer**;
- Should a discrepancy between the quality control results and the **Engineer's** results occur, the **Engineer's** results and conclusions shall prevail.

3. REFERENCES

- Unless otherwise specified, the **Contractor** shall conform to reference standards current on date of issue of the **Contract Documents**;
- Should the specified reference standards conflict with the **Contract Documents**, the **Contractor** shall request clarification from the Engineer before proceeding;
- The contractual relationship of the parties to the **Contract** shall not be altered from the **Contract Documents** by mention or inference otherwise in any reference document.

4. MANUFACTURER'S SAMPLES

The manufacturer shall sample and perform quality control testing at the frequencies specified in these Specifications.

5. PRODUCTS (NOT USED)

6. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

PRODUCT STORAGE & HANDLING REQUIREMENTS 01 66 00

Document No. 123022-83010-PC-TS-0009

Prepared by:

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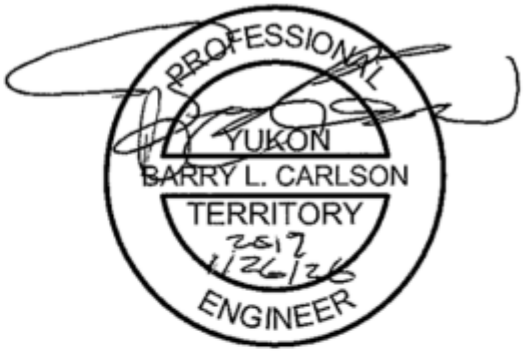

Barry Carlson, PE

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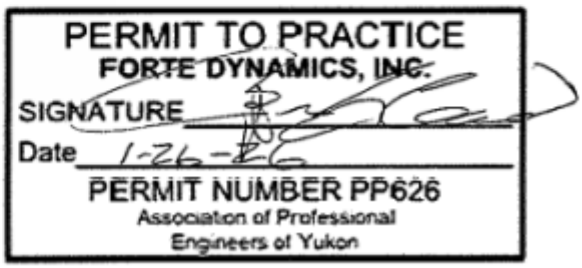

1. RELATED SECTIONS

Section 31 05 19 Geosynthetics for Earthwork

2. GEOMEMBRANE

2.1 Delivery, Storage, and Handling

- The **Geomembrane Manufacturer** shall be responsible for manufacturing and shipment of geosynthetic materials.
    - At the discretion of the **Owner**, conformance testing and a plant audit may be performed by the **Engineer** and/or **Owner's Representative** prior to shipment;
    - In the event that conformance testing is to be performed, the Manufacturer shall not arrange for transport of the **Geomembrane** until such testing is complete;
    - The **Geomembrane Installer** or **Geomembrane Manufacturer** shall provide the **Engineer** and **Owner's Representative** a schedule for manufacturing the materials at least 14 days prior to manufacturing so that testing and travel can be arranged;
    - This schedule shall remain firm throughout the duration of the Project;
    - Any proposed changes to the production schedule must be approved by the **Owner's Representative**;
    - The **Owner's Representative** shall notify the **Geomembrane Manufacturer** at least seven (7) days in advance of the intention to perform conformance testing or a plant audit;
- The **Geomembrane** shall be shipped such that it is not damaged in transport;
    - The **Geomembrane Installer** shall be responsible for unloading and storing the **Geomembrane**;
    - **Geomembrane** shall be offloaded in the presence of the **Quality Assurance Consultant**.
    - Any damage to the **Geomembrane** during the offloading process will be documented by the **Quality Assurance Consultant**;
        - All damaged rolls shall be separated from undamaged material;
        - The final disposition of the damaged rolls shall be determined by the **Owner's Representative** with input from the **Engineer**;
        - Damaged or otherwise unacceptable rolls shall be replaced at no additional cost to the **Owner**;
- Once the **Geomembrane** rolls have been offloaded, they shall be stacked on a prepared surface no more than three (3) rolls high.
    - The surface shall be prepared such that the **Geomembrane** is not subjected to rocks or sharp objects, water, oil, or other deleterious conditions.
    - The **Geomembrane** rolls shall not be placed on wooden pallets.

- The **Geomembrane Installer** shall use appropriate equipment to transport the **Geomembrane** from the storage area to the deployment area.
    - This equipment may include a spreader and roll bars and shall not damage the **Geomembrane** or subgrade.
    - Any damage shall be repaired to the satisfaction of the **Quality Assurance Consultant**.

2.2 Transportation

- The **Geomembrane** shall be packaged and shipped in such a manner that the material is not damaged or exposed to damaging substances.
- Transportation shall be the responsibility of the **Geomembrane Manufacturer** unless agreed to by the **Geomembrane Installer** and the **Owner's Representative**, in writing, prior to the initiation of shipment.
-

3. PRODUCTS (NOT USED)

4. EXECUTION (NOT USED)

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

MOBILIZATION AND DEMOBILIZATION 01 71 13

Document No. 123022-83010-PC-TS-0010

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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SUMMARY

The technical specification enclosed has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without the written consent of Kaminak and Forte Dynamics (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak or Forte.

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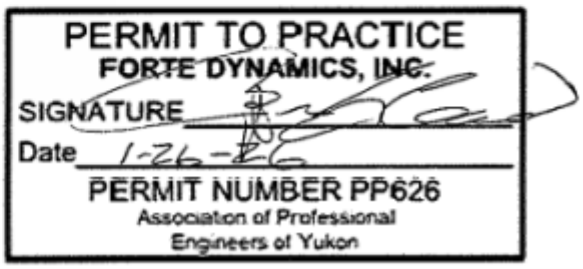

1. RELATED SECTIONS

Section 00 11 00 Summary of Work

2. EXECUTION

2.1 Mobilization

- Upon receipt notice to proceed, the **Contractor** shall furnish, mobilize, and install such temporary works, materials, equipment, and construction plant(s) as necessary for the successful completion of the **Work**;
- The **Contractor** shall operate and maintain such temporary works, equipment, and construction plant(s) throughout the period of construction;
- The **Contractor** shall remove all temporary works, equipment, and construction plants following completion of the construction;
- All applicable temporary works, including sanitation facilities, shall fully comply with the rules and regulations of the government agency having jurisdiction;
- Clearing, grading, earthwork, and construction of access roads necessary for the temporary works, if any, shall be included as mobilization; and
- The **Contractor** shall also obtain any permits necessary to complete the Work.

2.2 Demobilization

- An item has been included in the bidding schedule to provide for payment for demobilization. The item for payment for demobilization is intended to compensate the **Contractor** for operations including, but not limited to, those necessary for the removal of personnel, equipment, supplies, and incidentals from the project site.
- Included in the payment for demobilization will be the cost of all site clean-up and regrading to appropriate grades as required by the Specifications or as indicated by the **Engineer**.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

FIELD ENGINEERING 01 71 23

Document No. 123022-83010-PC-TS-0011

Prepared by:

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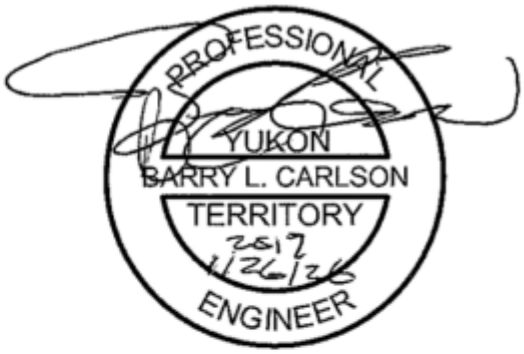

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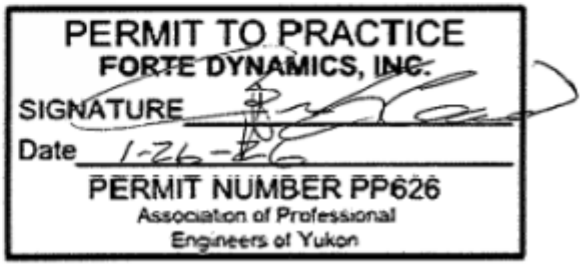

1. RELATED SECTIONS

Section	00 11 00	Summary of Work
Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards

2. PROJECT RECORD DOCUMENTS

The **Contractor** shall:

- Maintain a complete and accurate log of control and survey **Work**.
- Make log available for review by the **Owner's Representative** and/or **Engineer**;
- After project completion, submit **Record Documents** per Section 01 32 00: Construction Progress Documentation - As-Built Documentation.

3. EXAMINATION

The Contractor shall notify the Engineer of any discrepancies discovered in the surveying or layout.

4. SURVEY

- The **Owner** will provide survey control points at the project site;
- The **Contractor** will also be provided with the final lines and grades as shown on the **Drawings** in digital format;
- It is the **Contractor's** responsibility to set out the **Work**;
- The **Contractor** shall:
    - Use the survey control points to layout the **Work**;
    - Triangulate between the three (3) control points to verify accuracy prior to using the points for control **Work**;
    - Perform a survey of the heap area at the following times on a 100-foot (center to center) grid locations as shown on the **Drawings**:
        - After placement of the **Geomembrane Liner** and prior to placement of the **Overliner Drain Fill**.
    - Each survey will be submitted to the Engineer, in a timely manner, for review;
    - The surveys will be used as a basis for quantity verification.

- The **Contractor** shall:
  - Provide additional surveying necessary to accurately maintain slopes and grades for control of the **Work**;
  - Preserve above mentioned **Owner**-provided control and layout points;
  - If, in the opinion of the **Owner**, any surveying control or layout points have been carelessly or willfully disturbed or destroyed by the **Contractor** or his employees, the control points will be replaced at no additional cost to the **Owner**.

5. ALTERATIONS TO DRAWINGS AND SPECIFICATIONS

- No alterations shall be made to either the **Specifications** or **Drawings** unless approved by the **Engineer**;
- Alterations made by the **Contractor** to either the **Specifications** or **Drawings** shall be subject to the **Engineer's** approval and, where applicable, to the approval of regulatory government agencies;
- All alterations shall be issued under a covering **Work** order signed by the **Owner** prior to the start of alteration.

6. PRODUCTS (NOT USED)

7. EXECUTION

7.1 Verification

Bidders shall visit the site and familiarize themselves with all existing surface and subsurface conditions, whether covered in the report or not, and shall understand all recommendations associated with the earthwork.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

CAST IN PLACE CONCRETE 03 38 00

Document No. 123022-83010-PC-TS-0012

Prepared by:

FORTE DYNAMICS, INC
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0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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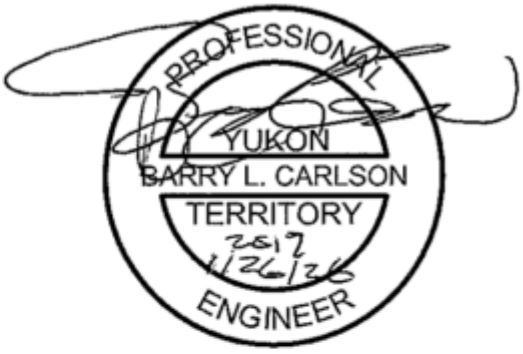

Barry Carlson, PE

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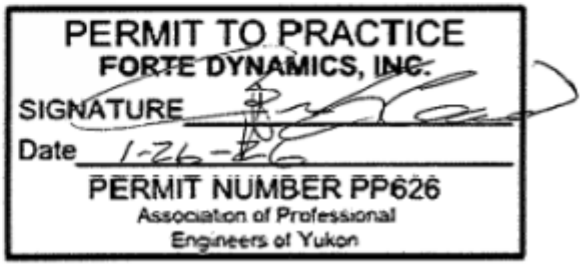

1. RELATED SECTIONS

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control

2. REFERENCES

In general, the manufacture, placement, sampling and testing of concrete shall be conducted in accordance with the best practices of American Concrete Institute (ACI).

ASTM C 31-21a Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 33-13 Standard Specification for Concrete Aggregates

ASTM C 192-19 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 39-21 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

3. PERFORMANCE REQUIREMENTS

- The **Contractor** shall supply all labor and materials and perform operations necessary to furnish, place, and install concrete, reinforcing steel (re-bar), and formwork necessary for construction of the concrete structures described in these **Specifications**.
- In the event that concrete construction fails to conform to the requirements of these **Specifications**, the **Contractor** may be required to repair or remove and replace the affected concrete in a manner satisfactory to the **Engineer**;
    - When the **Engineer** determines that such repair or removal and replacement is required, **Owner's Representative** will notify the **Contractor** in writing, stating the extent of the repair or replacement to be made.

4. SUBMITTALS

- Design of the concrete mixes shall be the responsibility of the **Contractor**;
- Certified copies of laboratory trial mix reports shall be sent to the **Engineer** from the testing laboratory;
- No concrete shall be placed prior to the review and acceptance in writing, by the **Engineer**, of the concrete mixes and the compressive strength test results from these laboratory mixes.

5. PRODUCTS

5.1 Materials

- All materials utilized are subject to approval by the **Engineer**.
- Materials furnished by the **Contractor** for use in concrete construction shall conform to the requirements of the following sections.
    - Aggregate
        - Aggregate shall be stone aggregate conforming to ASTM C 33-13;
        - Maximum size of aggregate shall be 1½ inches.
        - The portion of fine aggregates finer than the #200 sieve shall not exceed four (4) percent;
        - The portion of coarse aggregates finer than the #200 sieve shall not exceed 0.5 percent;
    - Cement
        - Cement, except as otherwise specified herein, shall be:
            - A brand of Type V Portland cement that is sulfate resistant;
            - Conforming to ASTM C 150 or C 175; and
            - Only one (1) brand and type of cement shall be used throughout the duration of the Work.
    - The concrete shall be proportioned in accordance with ACI 211 subject to the following:
    - The design strength for reinforced and unreinforced concrete shall be 3,000 psi at 28 days, unless otherwise shown on the Drawings or specified herein.

The water-cement ratio shall not exceed 0.49 by weight, unless otherwise approved in writing by the Engineer.

6. EXECUTION

6.1 General Workmanship

- Formwork
    - The **Contractor** shall provide suitable and adequate formwork conforming to shapes, lines, elevations, and dimensions of concrete shown on the **Drawings**;
    - The forms shall be such that exposed concrete will have a smooth surface free from offsets, fins, or other objectionable defects;
    - Forms shall be made of wood, steel, or other approved materials by the **Engineer**;
    - The **Contractor** shall be responsible for adequacy and safety of formwork, the design of which is subject to the approval of the **Engineer**; and

- The **Engineer's** approval, however, does not release the **Contractor** of the responsibility for the adequacy of the formwork.

- Embedded Items
  - Prior to placement of concrete and during formwork erection, the **Contractor** shall properly locate and set all items to be placed in the forms or set into the concrete;
  - Anchor bolts, if used, shall be accurately placed in accordance with the **Drawings**;
    - The use of templates shall be required in setting the anchor bolts;
  - Embedded items shall be adequately secured to prevent movement during concrete placement.

- Construction Tolerance
  - The forms shall be constructed and rigidly braced in place with the tolerances shown below:
    - Variation from plumb in lines and surfaces of walls:
      - In 10 feet ¼ inch;
    - Variation from the lines and grades indicated on the Drawings:
      - In 10 feet ¼ inch;
      - In 20 feet ½ inch;
    - Variation in thickness of slabs and walls:
      - Plus ½ inch; and
      - Minus ¼ inch.

6.2 Placement

- Inspection
  - Prior to any concrete placement, the **Quality Assurance** shall inspect the reinforcement, formwork, clean-up, and such other aspects of the placement as deemed necessary by the **Owner's Representative**.
  - The **Contractor** shall schedule his placement operations to allow the **Quality Assurance Consultant** sufficient time to perform said inspection.
  - No placement operation shall commence prior to the **Quality Assurance Consultant** performing said inspection and approving the area in writing.
  - Said inspection shall not relieve the **Contractor** of responsibility for the concrete construction conforming to all the provisions of these **Specifications**.

- Conveying and Placing
  - The methods and equipment used for transporting concrete, and the time that elapses during transportation, shall be such as will not cause appreciable segregation of coarse aggregate or slump loss in excess of one (1) inch in the concrete as it is delivered to the **Work** site;

- The temperature of the concrete when delivered to the site, and when ready for placement, shall not exceed 90 degrees F (32 degrees C);
- The time between initial mixing at the plant and placement in the forms shall not exceed 90 minutes, unless otherwise approved in writing by the **Engineer**;
- Re-tempering of concrete, or jobsite addition of water, will not be permitted;
- Any concrete which has become so stiff that proper placing cannot be assured shall be wasted;
- Placement of concrete shall conform to the requirements and recommendations of ACI 304 and 318, except as modified herein; and
- The **Owner's Representative** and/or **Quality Assurance Consultant** shall have the authority to reject, prior to placement, any concrete having excessive slump or otherwise not meeting the requirements of these **Specifications**. Rejected concrete shall be wasted in an area designated by the **Owner**.

- Consolidation
  - During and immediately after placing, concrete shall be worked into the corners and angles of the forms and around all reinforcements and embedded items without permitting the materials to segregate;
  - Consolidation equipment and methods shall conform to ACI 209;
  - Concrete shall be consolidated with internal vibrators having a frequency of at least 8000 vpm, with the amplitude required to consolidate the concrete in the section being placed;
  - The **Contractor** shall provide a sufficient number of vibrators so that consolidation can be started immediately after the concrete has been deposited in the forms;
  - Concrete shall be deposited as close as possible to its final position in the forms;
  - The depositing of concrete shall be regulated so that concrete may be effectively compacted with a minimum of lateral movement;
  - Vibration shall extend through the entire depth of each new layer and several inches into the preceding layer;
  - Vibration shall be applied at the point of deposit and uniformly throughout the freshly placed concrete;
  - The **Contractor** shall be responsible for protecting all finished concrete surfaces from damage which will leave finished surface in a condition unsuitable for its intended use, as determined by the **Quality Assurance Consultant**.

- Curing
  - Concrete shall be cured either by water curing or by membrane curing;
  - The unformed top surfaces of concrete structures shall be moistened by covering with water- saturated materials or by other effective means as soon as the concrete has hardened sufficiently to prevent damage by water;

- These surfaces and steeply sloping vertically formed surfaces shall be kept completely and continually moist, prior to and during form removal, by water applied on the unformed top surfaces and allowed to pass down between the forms and the formed concrete faces;
- This procedure shall be followed by the specified water curing or membrane curing.

6.3 Concrete Strength

- Verification
  - A minimum of one (1) set of four (4) cylinders shall be made for each 50 cubic yards or fraction thereof of all concrete, but not less than one (1) set for any one (1) day's production nor less than one set for each structural component;
  - Tests shall be performed on one (1) cylinder seven (7) days after pouring and on two (2) cylinders 28 days after pouring;
  - If the 28-day strength test does not meet the required strength, the fourth cylinder should be held for a period of 90 days after pouring and be tested at the **Engineer's** request during that period.
  - Concrete shall be considered as not meeting the strength requirements if, at 28 days:
  - The average of any set of strength tests is less than 3,000 psi; and/or Any one (1) strength test falls below 2,750 psi.
- Properties
  - The concrete mix shall, at the time of placement, have the following properties:
    - Air content of four (4) – six (6) percent;
    - Slump of three (3) inches, plus or minus one (1) inch; and
    - Maximum temperature of mix of 90 degrees Fahrenheit.

6.4 Reinforcement

Concrete reinforcement shall be in accordance with Section 03 32 00 of these specifications.

- Bar List:
  - The **Contractor** shall furnish, bend, cut, and place steel reinforcement required for concrete construction;
  - All bars shall be Grade 60 unless otherwise noted on the **Drawings**;
  - The **Drawings** show the type and general arrangement of the reinforcement;
  - The **Contractor** shall provide detailed bar lists and shop drawings conforming to the requirements of ACI 318 and ACI 315;
  - Bar lists and shop drawings shall be submitted to the **Engineer** for approval prior to reinforcement fabrication;

- Fabrication and Cleaning
    - Before the reinforcement is placed, all loose rust, scale, and other objectionable material such as paint, oil, grease, dried mud, and dried mortar likely to contaminate the reinforcing bars shall be removed;
    - Removal of objection material shall be accomplished by wire brushing, sand-blasting, wiping with burlap, or other effective means to the satisfaction of the **Quality Assurance Consultant**.
    - Reinforcement shall be accurately formed to the dimensions indicated on the **Drawings**;
    - All bars shall be bent cold;
    - Reinforcement shall not be straightened or re-bent;
    - Bars with kinks or bends not shown on the **Drawings** shall not be used;
    - Heating or welding of the reinforcement shall not be permitted, except, bars may be flame-cut to length.
- Placement
    - Reinforcement shall be accurately positioned and secured against displacement by using annealed iron wire ties or suitable clips at intersections and shall be supported by concrete or metal supports, spacers, or hangers;
    - In all cases, sufficient supports for horizontal reinforcement shall be provided to prevent sagging of the bars;
    - Protection, spacing, and positioning of reinforcement shall conform to the current edition of the ACI Standard Building Code requirements for reinforced concrete (ACI 318);
    - The reinforcement placing shall conform to “Placing Reinforcing Bars,” Recommended Practices, Joint Effort of CRSI-WCRSI, prepared under the direction of the CRSI Committee on Engineering Practice;
    - The **Quality Assurance Consultant** shall be notified when reinforcing is ready for observation and sufficient time shall be allowed for this observation prior to casting concrete;
    - The splices, other than lap splices, shall not be used except when specifically indicated or permitted in writing by the **Engineer**;
    - Unless otherwise noted, the minimum overlap for lap splices shall be 40 bar diameters.
- Field Bending
    - Field Bending of reinforcing steel bars is not permitted when re-bending will later be required to straighten bars;
    - Re-bending of bars at the same place where strain hardening has taken place due to the original bend will damage the bar;
    - Consult with the **Engineer** prior to any pour if the **Contractor** foresees a need to **Work** out a solution to prevent field bending.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

SOILS FOR EARTHWORKS 31 05 13

Document No. 123022-83010-PC-TS-0013

Prepared by:

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0	01/26/2026	Issued for Licensing	J. Burke	R. Morlan	R. Morlan

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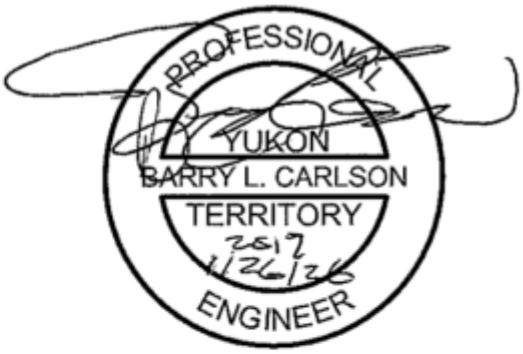

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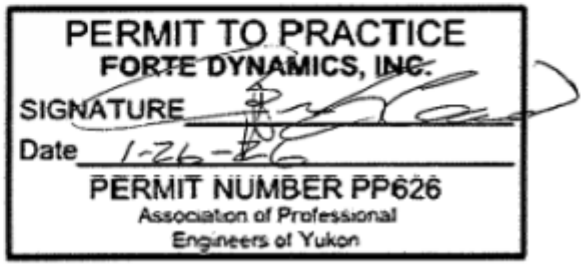

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Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 14 00	Earth Stripping and Stockpiling
Section	31 22 13	Rough Grading
Section	31 23 16	Excavation
Section	31 23 23	Fill

2. REFERENCES

ASTM C 136-19	Test Method for Sieve Analysis of Fine and Coarse Aggregate.
ASTM D 6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D 698-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft3 (600 kN-m/m3)].
ASTM D 1557-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 2216-19	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
ASTM D 2435-11	Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading.
ASTM D 6938-17	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 3385-18	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
ASTM D 4318-17	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4643-17	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Method.
ASTM D 5084-16	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

3. PRODUCTS

3.1 Soil Materials

3.1.1 General

- Soil materials used are:
  - **Site Grading Fill**;
  - **Select Fill**;
  - **Structural Fill**;
  - **Compacted Rockfill**;
  - **Road Wearing Coarse**;
  - **Anchor Trench Backfill**.
- Soil materials shall be free of brush, roots larger than ½-inch, sod, or other deleterious or unsuitable materials;
- The Contractor shall provide all necessary labor and equipment to remove such materials from fill areas;
- The suitability of all fill materials intended for use in the **Work** shall be subject to approval by the **Engineer**

3.1.2 Site Grading Fill

- Site Grading Fill shall be:
  - Soil material derived from the excavation cut or other approved sources as shown on the project Drawings;
  - Free of vegetation or other deleterious material;
    - Unsuitable material shall be disposed of as directed by the Owner's Representative.
  - Site Grading Fill should not contain containing rock or other solid materials which are larger than six (6) inches in greatest dimension. If material greater than six (6) inches is present the material can be placed with approval from the Engineer in the following cases:
    - No surface of this material is within three (3) feet horizontally of any planned piling, structure, pole, foundation, piping, or underground conduit; or
    - No surface of this material is within three (3) feet of finished subgrade elevation;
    - If conditions a and b cannot be met it may be necessary to reduce the size of the excavated material by crushing, screening, or otherwise breaking down the material in order to comply with this requirement.
  - Site Grading Fill should have a plasticity index of less than 7 and a liquid limit of less than 30.

- Select Fill shall:
    - Consist of material derived from the excavation cut or from other approved sources;
    - Have a maximum particle size of 1/2-inch;
    - Provide a surface free of rock protrusions as a protective base for the **Geo-synthetic Clay Liner (GCL)** and **Geomembrane Liner** installation.
    - **Liner Bedding Material** should have a plasticity index of less than 7 and a liquid limit of less than 30.
- Structural Fill shall be:
    - Soil material derived from the excavation cut or other approved sources as shown on the project **Drawings**;
    - Free of vegetation or other deleterious material;
        - Unsuitable material shall be disposed of as directed by the **Owner's Representative**.
    - **Structural Fill** should meet the following size requirements:
        - 100% material passing 150 mm.
        - Less than 30% material passing 19 mm.
        - Must be well graded. Gap graded material will not be accepted.
        - Should have a plasticity index of less than 7 and a liquid limit of less than 30.
- **Rockfill** shall be:
    - Soil material derived from the excavation cut or other approved sources as shown on the project **Drawings**;
    - Free of vegetation or other deleterious material;
        - Unsuitable material shall be disposed of as directed by the **Owner's Representative**.
    - **Rockfill** should meet the following size requirements:
        - Maximum particle size should be less than 2/3 the construction lift thickness as determined by a test fill.
        - Less than 30% material passing 19 mm.
        - Must be well graded. Gap graded material will not be accepted.
- Road Wearing Course shall be:
    - Soil material derived from the excavation cut or other approved sources as shown on the project **Drawings**;
    - Free of vegetation or other deleterious material;
        - Unsuitable material shall be disposed of as directed by the **Owner's Representative**.
    - **Road Wearing Course** should meet the following size requirements:
        - 100% passing 50 mm.
        - 90 to 100% passing 38 mm.
        - 65 to 90% passing 19 mm.
        - 35 to 55% passing No. 4 Sieve.
        - 15 to 45% passing No. 16 Sieve.
        - Less than 15% passing No. 200 Sieve.
        - Must be well graded. Gap graded material will not be accepted.
- Anchor Trench Backfill shall:
    - Consist of material derived from the excavation cut or from other approved sources;

- Have a maximum particle size of 3-inch;
- **Anchor Trench Backfill** should had a plasticity index of less than 7 and a liquid limit of less than 30.

3.2 Source Quality Control

- General inspection and testing shall be performed under the provisions set forth in Sections 01 43 00 Quality Assurance and 01 45 00 Quality Control.
- Testing and analysis of soil materials shall be in accordance with:

Table 3-1: Minimum Borrow Source Quality Control Testing Frequency

Material Type	Unit	Frequency [1] (No. of Units Per Test)		
		Laboratory Sieve Analysis	Laboratory Atterberg Limits	Laboratory Moisture- Density
Site Grading Fill[2]	m^3	5,000	5,000	5,000
Select Fill[2]	m^3	2,000	2,000	2,000
Structural Fill[2]	m^3	5,000	5,000	5,000
Compacted Rockfill	m^3	NA	NA	NA
Road Wearing Coarse	m^3	5,000	5,000	NA
Anchor Trench Fill[3]	m	500	500	500

1. Testing frequency should be performed as specified in the table above or when changes in the material source, type, or properties are observed; whichever is more frequent.

2. Laboratory moisture – density relationship should be performed using modified effort (ASTM 1557).

3. Anchor trench testing frequency is based on liner meters of anchor trench.

- Gradation testing and analysis of **Soil Materials** shall be in accordance with ASTM D 6913;
- Liquid limits, plastic limits, and plasticity index (Atterberg Limits) shall be completed in accordance with ASTM D 4318;
- Testing for laboratory moisture – density relationship of soils (Proctor Testing) should be completed using standard effort (ASTM D 698) for Road Wearing Course. Proctor testing should be completed using modified effort (ASTM D 1557) for all other materials.

4. EXECUTION

4.1 Stockpiling

- If stockpiling is performed, materials shall be stockpiled at locations designated by the Owner;
- The **Contractor** shall:
  - Prevent mixing of native subgrade with stockpiled material;
  - Prevent different stockpiled materials from mixing;
  - Direct surface water away from stockpiles to prevent erosion or contamination of the materials;
  - Leave the unused stockpile material in a neat, compact stockpile;
  - Install signage to clearly label what material each stockpile stores.

4.2 Borrow Area Closure

- The Contractor shall leave the unused stockpile material in a neat, compact stockpile;
- The **Contractor** shall leave the area in a clean and neat condition;
- The site shall be graded to prevent ponding of surface water; and
- The **Slopes** shall be graded no steeper than 3H:1V or as directed by the **Engineer**.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

AGGREGATE FOR EARTHWORKS 31 05 16

Document No. 123022-83010-PC-TS-0014

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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SUMMARY

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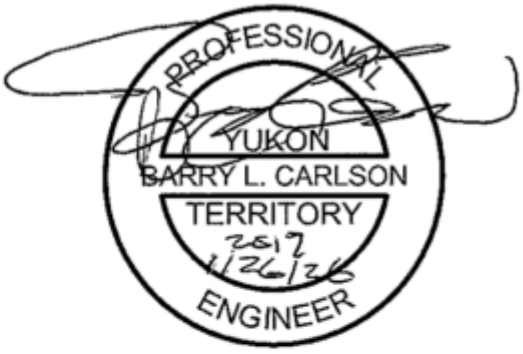
This report has been prepared under the direct supervision of Barry Carlson, P.Eng. of Forte, with the assistance of Clint Green, P.E. of Forte and Roy Morlan, P.G., of Forte. The design and analyses presented have been completed according to the project information provided by Kaminak. The design level and limits presented in this report are in accordance with standard engineering practices, and to the best of our knowledge, are accurate to the limits as specified herein.



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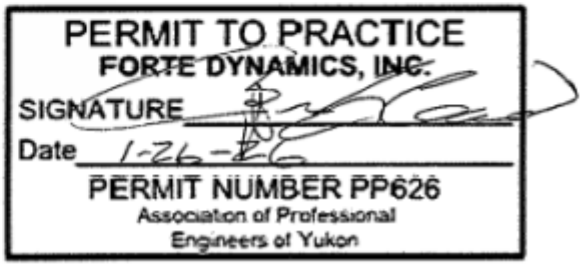

1. RELATED SECTIONS

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Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 14 00	Earth Stripping and Stockpiling
Section	31 22 13	Rough Grading
Section	31 23 16	Excavation
Section	31 23 23	Fill

2. REFERENCES

ASTM C 136-19	Test Method for Sieve Analysis of Fine and Coarse Aggregate.
ASTM D 6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D 698-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft3 (600 kN-m/m3)].
ASTM D 1557-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 2216-19	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 4318-17	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

3. PRODUCTS

3.1 Aggregate Materials

- Overliner Drain Fill shall be:
  - Free draining with a minimum operational permeability of 1.0 x 10^{-2} cm/s as determined by ASTM D 2434 or ASTM D 3385;
  - Non-calcareous;
  - Durable material;

- Free of clay and debris;
- Must be durable as determined by Los Angeles Abrasion Testing (ASTM C535). A loss of less than 45% is required.
- Conform to the following gradation:

Table 3-1: Overliner Drain Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
3-inch	100%
No. 200	0-5%

- Pipe Trench Backfill shall be:
  - Free draining;
  - Non-calcareous;
  - Durable material;
  - Free of clay and debris;
  - Must be durable as determined by Los Angeles Abrasion Testing (ASTM C535). A loss of less than 45% is required.
  - Conform to the following gradation:

Table 3-2: Pipe Trench Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
3-inch	100%
No. 200	0-10%

- Select Drain Fill shall be:
  - Free draining;
  - Rounded or river run stone;
  - Non-calcareous;
  - Durable material;
  - Free of clay and debris;
  - Must be durable as determined by Los Angeles Abrasion Testing (ASTM C535). A loss of less than 45% is required.
  - Conform to the following gradation:

Table 3-3: Select Drain Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
2-inch	100%
3/8-inch	0-10%
No. 200	0-2%

3.2 Source Quality Control

- Inspection and testing shall be performed under the provisions set forth in Sections 01 43 00 Quality Assurance and 01 45 00 Quality Control;
- Testing and analysis of aggregate materials shall be in accordance with:

Table 3-4: Minimum Aggregate Production Testing Frequency

Material Type	Unit	Frequency[1] (No. of Units Per Test)		
		Laboratory Sieve Analysis	Laboratory Permeability	Durability Testing
Overliner Drain Fill	m^3	5,000	50,000	50,000
Pipe Trench Backfill	m^3	5,000	50,000	50,000
Select Drain Fill	m^3	5,000	50,000	50,000

1. Testing frequency should be performed as specified in the table above or when changes in the material source, type, or properties are observed; whichever is more frequent.

- Laboratory Sieve Analysis of **Aggregate Materials** shall be in accordance with ASTM C 136;
- Laboratory Permeability analysis shall be performed in accordance with ASTM D 2434;
- The **Quality Control Consultant** and/or the **Quality Assurance Consultant** will retrieve samples of the Aggregate Materials from the conveyor belt during production prior to placement in the stockpile;
- The results of the analyses will be provided to the screening/crushing Contractor within 24 hours so that operations can be adjusted, if necessary;
- If tests indicate that materials do not meet specified requirements, change material source or screening/crushing operation;
    - Reject material may be rescreened and/or crushed and retested at no additional cost to the **Owner**;
    - Any **Aggregate Materials** already placed and found not to meet these **Specifications** shall be removed and replaced with suitable **Aggregate Materials**, as required by the **Quality Assurance Consultant**, at no additional cost to the **Owner**.

4. EXECUTION

4.1 Stockpiling

- If stockpiling is performed, materials shall be stockpiled at locations designated by the **Owner**;
- The **Contractor** shall take practical measures to prevent mixing of native subgrade materials with the stockpiled material;
- The **Contractor** shall prevent different stockpiled materials from mixing;
- The **Contractor** shall direct surface water away from stockpiles to prevent erosion or contamination of the materials;
- The **Contractor** shall install signage that labels the material being stored at each stockpile.
- Contaminated stockpiled materials that no longer meet **Specifications** shall not be used in the **Work**.
    - Reject material may be rescreened and/or crushed and retested at no additional cost to the **Owner**;

4.2 Borrow Area Closure

- The **Contractor** shall leave the unused stockpile material in a neat, compact stockpile.
- The **Contractor** shall leave the area in a clean and neat condition;
- The site shall be graded to prevent ponding of surface water;
- The **Slopes** shall be graded no steeper than 3H:1V or as directed by the **Engineer**.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

GEOTEXTILE FOR EARTHWORKS 31 05 19.13

Document No. 123022-83010-PC-TS-0015

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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SUMMARY

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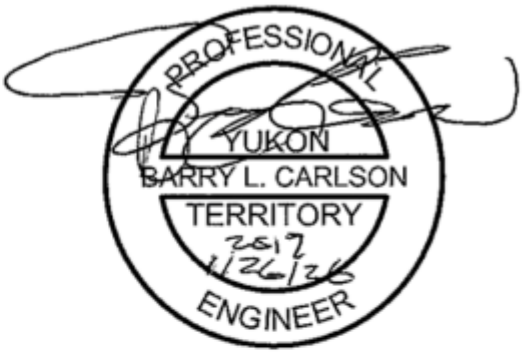

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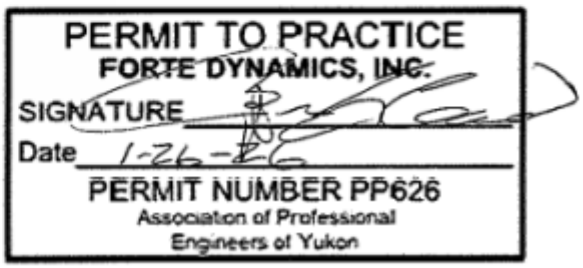

1. RELATED SECTIONS

Section	01 31 00	Project Management and Coordination
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Section	01 41 00	Regulatory Requirements
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Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 05 16	Aggregate for Earthwork
Section	31 22 13	Rough Grading
Section	31 05 19.16	Geomembranes for Earthwork
Section	31 23 16	Excavation

2. REFERENCES

ASTM D 3776-20	Test Methods for Mass Per Unit Area (Weight) of Fabric.
ASTM D 3786-18	Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method.
ASTM D 4632-15a	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).
ASTM D 4751-21a	Test Methods for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833-07	Test Method for Index Puncture Resistance of Geomembranes and Related Products.

3. DEFINITIONS

Geotextile Subcontractor is defined as the **Subcontractor** retained by the **Contractor** to install the geotextile or it is the **Contractor**, if **Contractor** elects to install the geotextile.

4. PERFORMANCE REQUIREMENTS

- **Geotextile Subcontractor** shall furnish and install the geotextile and all miscellaneous materials incidental to the installation in accordance with these **Specifications**, including material for all seams and laps;
- Alignment, lengths, and areas for geotextile placement are shown on the **Drawings**;
    - Exact locations and lengths may be adjusted to suit the conditions encountered in the field as approved by the **Engineer.**

5. SUBMITTALS

- Submittals detailed below shall be in accordance with Section 01300;
- After Contract Award:
  - Product Data: The **Geotextile Subcontractor** shall provide manufacturer's data regarding filtration, permeability, and mechanical properties;
  - Sample: The **Geotextile Subcontractor** shall submit one (1) five (5)-foot long by one (1) roll width wide sample with the machine direction marked;
- Prior to Installation: The **Geotextile Subcontractor** shall provide the manufacturer quality control certificates.

6. DELIVERY, STORAGE, AND HANDLING

- Transportation:
  - The geotextile shall be packaged and shipped in such a manner that the material is not damaged or exposed to damaging substances; and
  - Transportation shall be the responsibility of the **Geotextile Subcontractor** unless agreed to by the Manufacturer and the **Owner**, in writing, prior to the initiation of shipment of geotextile to the project.
- Off-Loading:
  - Off-loading of the geotextile is the responsibility of the **Geotextile Subcontractor**;
  - No off-loading of geotextile shall be performed unless the Quality Assurance Consultant is **present**;
  - Any damage to the rolls during off-loading shall be documented by the Quality Assurance **Consultant** and the **Geotextile Subcontractor**;
  - All damaged rolls must be stored separately from the undamaged rolls;
  - The rolls shall be unrolled to determine the extent of the damage;
  - The use of the roll or portions of the roll shall be only at the approval of the **Quality Assurance Consultant**; and
  - The cost of evaluating, replacing, or repairing rolls damaged during off-loading shall be the sole responsibility of the **Geotextile Subcontractor**.
- Storage:
  - The geotextile shall be stored according to the manufacturer's recommendations and such that it is protected from puncture, dirt, grease, gasoline, diesel fuel, water, moisture, mud, mechanical abrasion, excessive heat, and other causes of damage to the material; and
  - Rolls without the proper documentation shall be stored separately until all the required documentation is received and approved by the **Engineer.**

7. PRODUCTS

7.1 Materials

Non-woven, Needle Punched Geotextile shall:

- Consist of polypropylene fibers;
- Free of holes, contamination, and foreign matter; and
- Meet or exceed the minimum (unless noted otherwise) roll values shown in the table below:

Table 7-1: Minimum Average Roll Values for Geotextile Material

Property	Test Method	Value
Mass per Unit Area	ASTM D5261	16 oz./sq.
Grab Tensile Strength	ASTM D4632	390 lb
Grab Tensile Elongation	ASTM D4632	50 %
Puncture Strength	ASTM D4833 or	240 lb
	ASTM D6241	440 lb
Trap. Tear Strength	ASTM D4533	150 lb
Apparent opening size, Sieve No.	ASTM D4751	100
Permittivity	ASTM D4491	0.60 sec^{-1}
Water Flow Rate	ASTM D4491	45 gpm/ft^2
UV Resistance (Retained after 500 hours)	ASTM D4355	70 %

8. EXECUTION

8.1 Deployment

The Geotextile Subcontractor shall deploy geotextile only in areas approved by the Quality Assurance Consultant.

8.2 Seaming

- Seams shall be sewn; or
- Overlapped a minimum of 18 inches.

8.3 Construction Quality Assurance

- CQA shall consist of:
  - Review of required documentation;
  - Approval of geotextile rolls for deployment;
  - Observation of unrolled material for damage; and
  - Observation of seaming procedure and completed seams.

- The **Engineer** has final authority in the CQA for the project;
- Compliance Testing:
    - Compliance testing of the **Geotextile** is not required, unless otherwise required by the **Owner**;
    - At the option of the **Owner**, compliance testing may be performed at any time prior to, during, or after the installation;
    - The cost of the compliance testing shall be negotiated between the Owner and the **Geotextile Subcontractor**;
    - The tests performed during compliance testing shall be determined by the **Owner**;
    - Compliance testing shall not include any tests that are not listed in these **Specifications** as a basis for evaluating compliance of the geotextile to these **Specifications**;
    - Sampling for Compliance Testing:
        - Samples shall be obtained by the **Quality Assurance Consultant**;
        - The sample for a roll shall be three (3) feet long and cut across the entire width of the roll; and
        - The sample shall be taken no closer than six (6) feet to the end of a roll.
    - The sample shall be labeled by the **Quality Assurance Consultant**, in permanent marker, with the following information:
        - Roll number;
        - Machine direction;
        - Date sampled; and
        - Name of the individual that sampled the material.
    - Seams
        - Seams shall be observed for the required minimum overlap; and
        - Seams that do not have the required minimum overlap shall be marked for adjustment.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

GCL FOR EARTHWORKS 31 05 19.14

Document No. 123022-83010-PC-TS-0016

Prepared by:

FORTE DYNAMICS, INC
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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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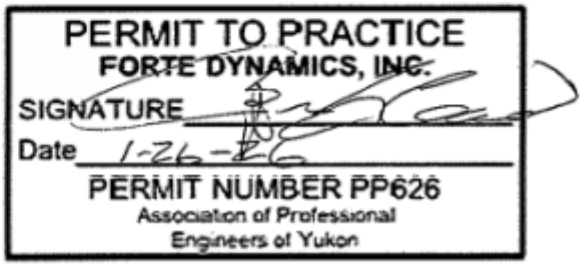

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Section	31 05 16	Aggregate for Earthwork
Section	31 22 13	Rough Grading
Section	31 05 19.16	Geomembranes for Earthwork
Section	31 23 16	Excavation

2. REFERENCES

ASTM D 5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

ASTM D 5887 Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter

ASTM D 5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners

ASTM D 5890 Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners

ASTM D 5891 Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners

ASTM D 5993 Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners

ASTM D 6243 Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method

ASTM D 6495 Standard for Acceptance Testing Requirements for Geosynthetic Clay Liners

ASTM D 6496 Standard Test Method for Determining Average Bond Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners

ASTM D 6768 Standard Test Method for Tensile Strength of Geosynthetic Clay Liners

3. DEFINITIONS

- **Geosynthetic Clay Liner (GCL):** A factory manufactured hydraulic barrier consisting of granular sodium bentonite clay, sandwiched between, supported and encapsulated by two geotextiles, held together by needle punching.
- **GCL Subcontractor** is defined as the **Subcontractor** retained by the **Contractor** to install the geotextile or it is the **Contractor**, if **Contractor** elects to install the geotextile.

4. CONSTRUCTION SUBMITTALS

- Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.
- Prior to shipping material to site:
  - Certification of quality control tests from manufacturer on **GCL** product
  - Certification of quality control tests from manufacturer on Bentonite
- Prior to installing **GCL**:
  - Certification signed by the Contractor and **Quality Assurance Contractor** of subgrade
  - Measures must be taken to prevent saturation of GCL. If the GCL becomes saturated, the EOR must be notified prior to installation.
- Upon completion of **GCL** installation:
  - Certification by Installer that the **GCL** was installed per project specifications
  - Material and Installation Warranties
- As-built drawings showing actual **GCL** placement
- Samples
  - **GCL:** One-piece, minimum 3” x 5” of proposed **GCL** taken across a roll of each type of **GCL**. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.
- Qualifications
  - The **Contractor** shall abide by all qualification and submittal requirements for the CQA Plan. The **Contractor** shall require the **GCL** manufacturer to comply with the submittal requirements of the CQA plan.
  - **GCL Manufacturer** must have produced at least 100 million square feet of **GCL** within the past year. The manufacturing facility must have produced at least 200 million square feet of **GCL** within the past 5 years in order to ensure consistency in material and workmanship.
  - The **GCL Installer** must either have installed at least 1 million square feet of **GCL**, or must provide to the **Engineer** satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the **GCL** will be installed in a competent, professional manner.

5. CONSTRUCTION QUALITY ASSURANCE

- The **Contractor** shall engage and pay for the services of a third party **Quality Assurance Consultant** and lab for monitoring the quality and installation of the **GCL**.
- All work will be constructed, monitored and tested in accordance with the requirements of the CQA plan.
- The **Contractor** shall be aware of all activities outlines in the CQA Plan, and the **Contractor** shall account for these activities in the construction schedule. No additional costs to the **Owner** shall be allowed by the **Contractor** as a result of the performance of the CQA activities.
- The **Contractor** shall deliver **GCL** to the site at least 14 days prior to installation to allow sufficient time for testing required in the CQA Plan.
- The **GCL** rolls that do not meet the requirements of this Specification will be rejected. The **Contractor** shall replace rejected material with new material that conforms to the specification requirements, at no additional cost to the **Owner**.

6. PRODUCTS

6.1 GCL Properties

- The **GCL** material shall be in accordance with the test methods, test frequencies and material physical properties as listed in Table 1.
- In addition to the property values listed in Table 1, the **GCL** material shall meet the following requirements:
    - The **GCL** shall have only nonwoven carrier geotextiles.
    - The **GCL** shall be manufactured by mechanically bonding the geotextiles using a needle punching or stitching process to create frictional and shear strength characteristics.
    - In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needle punch or stitching process. Their use to enhance the physical properties of the **GCL** is not permitted.
    - Accessory Bentonite: Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same bentonite as used in the production of the **GCL** itself.

Table 6-1: Required GCL Properties

Property	Test Method	Manufacturers Test Frequency	Required Values
Nonwoven Mass/Unit Area	ASTM D 5261	1/ 200,000 sq. ft. (1/20,000 sq. m)	6.0 oz/yd^2 MARV
BENTONITE			
Swell Index	ASTM D 5890	1 per 50 tonnes	24 mL/2g min
Fluid Loss	ASTM D 5891	1 per 50 tonnes	18 mL max
FINISHED GCL			
Bentonite Mass Per Unit Area[1]	ASTM D 5993	40,000 sq. ft. (4,000 sq. m)	0.75 lb/sq ft min
GCL Grab Strength[2]	ASTM D 6768	200,000 sq. ft. (20,000 sq. m)	45 lbs/in 79 MARV
GCL Peel Strength	ASTM D 6496	40,000 sq. ft. (4,000 sq. m)	3.5 lbs/in min
GCL Index Flux	ASTM D 5887	Weekly	1 x 10^{-8} m^3/m^2/sec max
GCL Hydraulic Conductivity	ASTM D 5887	Weekly	5 x 10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength	ASTM D 5321 ASTM D 6243	Periodic	500 psf typ @ 200 psf

[1] Bentonite mass/area reported at zero (0) percent moisture content

[2] All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496.

6.2 Manufacturer Quality Control

- The **Contractor** shall require that the **GCL Manufacturer** sample and test the **GCL**, at the frequencies outlined in Table 1 the tests shall demonstrate that the **GCL** properties conform to the values specified in Table 1. All Quality Control testing required by these Specifications and/or conducted at the discretion of the **Contractor** shall be the responsibility of the **Contractor**. **GCL** rolls that do not have acceptable manufacturing quality control test results shall be rejected by the **Owner**.

- Quality Control certificates shall be issued by the **GCL Manufacturer** to the **Engineer**, **Quality Assurance Consultant** or other designated party for each delivery of material. The certifications shall be signed by the quality control manager of the **GCL Manufacturer** or other responsible party and shall include the following information:

    - Shipment Packing List and Bill of Lading - Lists indicating the rolls shipped on a particular truckload.
    - Letter of Certification - The letter indicating the material is in conformance with the physical properties specified.
    - Physical Properties Sheet - The material specification for the **GCL** supplied in accordance with this specification.

- Quality Control submittals shall be issued by the **GCL Manufacturer** to the **Engineer**, **Quality Assurance Consultant** or other designated party for each lot of material if necessary. The submittals shall include the following information:

    - Bentonite Manufacturer Certification - Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered.

- Geotextile Manufacturer Certification - Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered.
- **GCL Manufacturer** Tracking List - Cross referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered.
- Manufacturing Quality Control Data - The manufacturing quality control test data indicating the actual test values obtained when tested at the appropriate frequencies for the properties specified in Table 1.

6.3 Labeling

- The **GCL** shall be labeled with the following information
  - Length and wide of the roll or factory panel
  - Name of Manufacturer
  - Product Identification
  - Lot number
  - Roll or Factory Panel Number

6.4 Transportation

The **GCL** Transportation of the **GCL** is the responsibility of the **Contractor**. The **Contractor** shall be liable for all damage to materials prior to and during transportation to the site. The **Contractor** shall replace any damaged rolls at no additional cost to the **Owner**.

6.5 Handling and Storage

- Handling, storage, and care of the **GCL** prior to and following incorporation in the work is the responsibility of the **Contractor**. The **Contractor** shall be liable for all damage to the material incurred prior to final acceptance of the installation by the **Owner**. The **Contractor** shall repair any damage in accordance with this Section and at no additional cost to the **Owner**.
- The **Contractor** shall be responsible for storage of the **GCL** at the site. The **GCL** shall be protected from water, dirt, puncture, cutting, or other damaging or deleterious conditions. The **GCL** shall also be stored in accordance with any additional requirements of the **GCL** Manufacturer, **Owner**, or **Engineer**.
  - **GCL** should be stored no higher than the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by chocking the bottom layer of rolls.
  - Rolls shall not be stacked on uneven or discontinuous surfaces as this may cause bending or deformation of the rolls and in turn damage the **GCL** or cause difficulty inserting the core pipe.
  - An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for **GCL** material stored outdoors.
  - Bagged bentonite material shall be stored and tarped next to **GCL** rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue pre-hydration.

- **GCL** must be supported during handling to ensure worker safety and prevent damage to the liner. Under no circumstances should the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.
    - The CQA inspector shall verify that suitable handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the **GCL** material itself. Typical handling equipment is described below:
        - Spreader Bar Assembly - A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the **GCL** core while the spreader bar beam will prevent chains or straps from chafing the roll edges.
        - Stinger - A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to its full length into the roll to prevent excessive bending of the roll when lifted.
        - Roller Cradles - Roller cradles consist of two larger diameter rollers spaced approximately 3 inches apart which both support the **GCL** roll and allow it to be freely unrolled. The use of roller cradles shall be permitted if the rollers support the entire width of the **GCL** roll.
        - Straps - Straps may be used to support the ends of the spreader bars but are not recommended as the primary support mechanism. As straps may damage the **GCL** where around the roll and generally do not provide sufficient uniform support to prevent roll bending or deformation, great care must be exercised when this option is used.

7. EXECUTION

7.1 Subgrade Preparation

- Inspection: The surface upon which the **GCL** material will be installed shall be inspected by the **Quality Assurance Consultant** and certified by the **Contractor** to be in accordance with the requirements of this specification.
- Compaction: Site specific compaction requirements should be followed in accordance with the project Drawings and Specifications. At a minimum, the level of compaction should be such that no rutting is caused by installation equipment or other construction vehicles which traffic the area of deployment.
- Clearing: The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials larger than one inch as well as free of any voids, large cracks or standing water or ice.
- Grading: Directly prior to deployment of the **GCL**, the subgrade shall be final graded to fill remaining voids or desiccation cracks, and smooth drum rolled to eliminate sharp irregularities or abrupt elevation changes. The surfaces to be lined shall be maintained in this smooth condition.

7.2 GCL Subgrade

- Select Fill Layer: Bedding layer shall be installed as shown in the Drawings and shall conform to the requirements of Section 31 05 13 – Soils for Earthworks.
- Inspection: Prior to **GCL** deployment the, the earthen base layer shall be inspected and approved by the third party **Quality Assurance Consultant** in accordance with the requirements of the project specification documents.
    - The earthen subgrade shall be continuously inspected, approved and certified by the **Quality Assurance Consultant** prior to **GCL** placement.
    - Upon approval by the **Quality Assurance Consultant**, it shall be the installer's responsibility to indicate to the ENGINEER any change in the condition of the subgrade that could cause it to be out of compliance with any of the requirements of this section or the project specific specification.

7.3 GCL Placement

- **GCL** Panel Position: Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation.
- Panel Deployment: **GCL** materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.
- Reinforced **GCL**: Reinforced **GCL** shall be used on both slopes as well as the flat areas to ensure the **GCL** withstands the rigors of the installation and subsequent low load hydration.
    - Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.
    - The **GCL** may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.
    - Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize dragging the **GCL**. Slip-sheet may be used to facilitate positioning of the liner while ensuring the **GCL** is not damaged from underlying sources.
    - Longitudinal overlaps shall be a minimum of 15 cm and be free of wrinkles, folds or fish mouths.
    - The **Contractor** shall only install as much **GCL** as can be covered at the end of the day. No **GCL** shall be left exposed overnight. The exposed edge of the **GCL** shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.
- Detailing: Detail work, defined as the sealing of the liner to appurtenances, shall be performed as recommended by the **Engineer** and the **GCL Manufacturer**.
- Damage Repair: Prior to **GCL** material placement, damage to the **GCL** materials shall be identified and repaired by the **Contractor**. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles, or a displaced panel.

- Rip and Tear Repair (Flat Surfaces) - Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil and by then placing a patch cut from unused **GCL** over the damage (damaged material may be left in place), with a minimum of overlap of 30 cm on all edges.
- Rip and Tear Repair (Slopes) - Damaged **GCL** material on slopes shall be repaired by the same procedures above. The minimum overlap of 30 cm on all edges may be increased as recommended by the **Engineer**.
- Displaced Panels - Displaced panels shall be adjusted to the correct position an orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.
- Premature Hydration - If the **GCL** is subjected to premature hydration, the **GCL** installer shall notify the **Engineer** for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design-dependent upon the degree of damage

7.4 GCL Cover Placement

- The **Contractor** shall not leave any tools or equipment on the **GCL**.
- The **Contractor** shall take all necessary precautions to ensure that the **GCL** is not damaged during its installation or during other construction activities. Installation on rough surfaces shall be performed carefully.
- Geomembrane liner cover shall be placed immediately after approval **GCL** installation by the **Engineer**

7.5 Protection of Work

- The **Contractor** shall use all means necessary to protect all materials and partially completed and completed work.
- In the event of damage, the **Contractor** shall make repairs and replacements necessary to the approval of the **Owner** and at no additional cost to the **Owner**.
- The **Quality Assurance Consultant** will issue an approval of the **GCL** liner installation to the **Owner** in accordance with the CQA Plan prior to placement of any material over the **GCL**.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

GEOMEMBRANE FOR EARTHWORKS 31 05 19.16

Document No. 123022-83010-PC-TS-0017

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0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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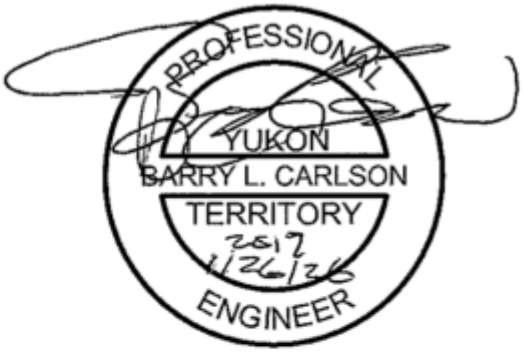
SUMMARY

The technical specification enclosed has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without the written consent of Kaminak and Forte Dynamics (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak or Forte.

This report has been prepared under the direct supervision of Barry Carlson, P.Eng. of Forte, with the assistance of Clint Green, P.E. of Forte and Roy Morlan, P.G., of Forte. The design and analyses presented have been completed according to the project information provided by Kaminak. The design level and limits presented in this report are in accordance with standard engineering practices, and to the best of our knowledge, are accurate to the limits as specified herein.



Barry Carlson, PE

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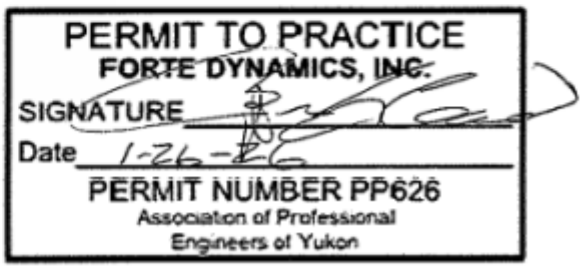

1. GENERAL

1.1 Related Sections

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 05 16	Aggregate for Earthwork
Section	31 05 19.23	Geosynthetic Clay Liner
Section	31 05.19.13	Geotextiles for Earthwork
Section	31 5.19.29	Geonet

1.2 References

The publications listed below form part of this **Specification** Section:

American Society for Testing and Materials (ASTM) most current versions.

ASTM D 570-98	Standard Test Method for Water Absorption of Plastics
ASTM D 638-14	Standard Test Method for Tensile Properties of Plastics
ASTM D 696-16	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
ASTM D 746-20	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 1004-21	Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
ASTM D 1203-21	Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
ASTM D 1204-14	Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D 1238-20	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1505-18	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1603-20	Standard Test Method for Carbon Black Content in Olefin Plastics

ASTM D 1693-21	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 3895-19	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D 4833-07	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM D 5199-12	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D 5397-20	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D 5596-03	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D 5641-16	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D 5820-95	Standard Practice for Pressurized Air Channel Evaluation of Dual-Seamed Geomembranes
ASTM D 5994-10	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D 6392-12	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM E 96-00	Standard Test Methods for Water Vapor Transmission of Materials

1.3 Summary

- **Geomembrane** shall be installed at the locations and to the lines and grades shown on the **Drawings**;
- **Geomembrane** shall be provided and placed as specified in these **Specifications**;
- The **Geomembrane Installer** and/or manufacturer shall be responsible for performing all **Geomembrane** testing and certifying the material quality and workmanship as specified in this section;

2. PERMFORMANCE REQUIREMENTS

- The **Geomembrane Installer** shall furnish and install the **Geomembrane** and miscellaneous materials incidental to the liner installation in accordance with these Specifications and with the **Drawings**.
    - Miscellaneous material includes material for seams, laps, anchors, and pipe boots;
    - **Geomembrane Installer** shall determine the liner quantity required for the project and purchase said materials prior to mobilizing; and
    - **Geomembrane Installer** supplied materials shall be compatible with tie-in to **Owner's** existing facilities.
- The alignment, lengths, and areas for **Geomembrane** placement are shown on the **Drawings**.
    - Exact locations and lengths may be adjusted, as approved by the **Quality Assurance Consultant,** to suit conditions encountered in the field.

3. SUBMITTALS

This section describes the information to be submitted by the resin supplier, **Geomembrane Manufacturer** and the **Geomembrane Installer**. Some of the information shall be submitted with the bid documents, while other items shall be submitted after the contract has been awarded and prior to installation. The information submitted after the contract is awarded must be received by the **Owner** a minimum of 14 days prior to commencing with the liner installation.

- Upon Award the following shall be submitted to the **Engineer** for approval:
  - The Geomembrane Manufacturer's minimum specifications for materials;
  - A copy of the **Geomembrane Manufacturer's** Quality Control Manual;
  - A copy of the **Geomembrane Installer's** Quality Control Manual;
- The **Geomembrane Installer** and/or **Geomembrane Manufacturer** shall furnish the following product data, in writing, to the **Engineer** at least seven (7) days prior to shipping liner materials to the site:
  - Resin Data, including the following:
    - Certification stating that the resin meets the specification requirements;
    - Copy of Quality Assurance/Quality Control certificates issued by the resin supplier, including density and melt index.
      - One suite of tests shall be performed per batch of resin;
    - Certification that all resin is from the same supplier.
    - Statement certifying no reclaimed polymer is added to the resin.
  - Geomembrane
    - Statement of the production date or dates and production plant;
    - Certification that all **Geomembrane** rolls are from the **Geomembrane Manufacturer**;
    - Copy of quality assurance certificates issued by the **Geomembrane Manufacturer**;
    - Test reports from the **Geomembrane Manufacturer**;
      - The Geomembrane Manufacturer shall take random samples of the **Geomembrane** material during production;
      - Samples shall be tested by a qualified Testing Laboratory using methods specified within this Section, or applicable ASTM standards, for:
        - Thickness (ASTM D 751-19 or ASTM D 1593-19);
        - Tensile Characteristics (ASTM D 638-14);
        - Puncture Resistance (ASTM D 4833-07);
        - Tear Resistance (ASTM D 1004-21); and
        - Density (ASTM D 1505-18);

- Testing Laboratory certification that the textured and non-textured **Geomembrane** meets the **Specifications** outlined in Article 2.02; and
- Statement that no reclaimed polymer was added.

- The **Geomembrane Installer** shall furnish the following information to the **Engineer** prior to installation:
  - Installation Layout **Drawings**
    - Must show proposed panel layout including field seams and details;
    - Must show direction of deployment;
    - Must be approved by the **Engineer** prior to installing the **Geomembrane**;
      - Approved **Drawings** will be for concept only and actual panel placement will be determined by site conditions;
  - **Geomembrane Installer's** Geosynthetic Field Installation Quality Assurance Plan; and
  - Resumes for the Superintendent, Master Seamer(s), and the QC Technician(s) that are proposed to conduct the **Work**.

- The **Geomembrane Installer** will submit the following to the **Owner's Representative** upon completion of the **Work** related to **Geomembrane** installation:
  - Certificate stating the **Geomembrane** has been installed in accordance with the **Contract Documents**;
  - Material and installation warranties; and
  - As-built **Drawings** showing actual surveyed **Geomembrane** panel placement and seams including typical anchor trench detail.

4. QUALITY ASSURANCE

- The **Geomembrane Installer** will designate a full time Quality Control (QC) Technician who shall be responsible for supervising and/or conducting the field quality control program throughout construction;
  - Field quality assurance testing conducted by the QC Technician during installation shall be as outlined in **Geomembrane Installer's** Quality Control Plan;

- The **Owner** will engage and pay for the services of a **Geosynthetic Quality Assurance Consultant** to monitor installation;
  - Field quality assurance testing conducted by the **Geosynthetic Quality Assurance Consultant** during installation shall be as outlined in Section 01 43 00 – Quality Assurance of these Specifications and/or the CQA Plan;
  - The Geosynthetic **Quality Assurance Consultant** shall observe 100% of the Quality Control testing for the **Geomembrane** installation including:
    - Trial Welds;
    - Air Pressure Testing;
    - Destructive Sample Testing;
    - Vacuum Box Testing; and
    - Spark Testing (if required);

- Prior to shipment, an authorized representative of the third-party testing laboratory will obtain one (1) random sample per 9,000 square meters of **Geomembrane**;
    - The sample shall be forwarded to a qualified Testing Laboratory for the following tests:
        - Density (ASTM D 1505-18); Thickness (ASTM D 751-19 or ASTM D 1593-19);
        - Tensile Characteristics (ASTM D 638-14);
        - Puncture Resistance (ASTM D 4833-07);
        - Tear Resistance (ASTM D 1004-21);
        - Carbon Black Content (ASTM D 1603-20); and

5. QUALIFICATIONS

- **Geomembrane Manufacturer** shall have manufactured a minimum of 2 million square meters of polyethylene **Geomembrane** during the last year;
- **Geomembrane Installer** shall:
    - Be a qualified **Geomembrane Installer**;
    - Approved by the **Geomembrane Manufacturer**;
    - Approved by the **Owner's Representative** and/or the **Engineer**;
    - **Geomembrane Installer** shall have installed a minimum of 1.5 million square meters of **Geomembrane**;
    - **Geomembrane Installer** shall have worked in a similar capacity on at least three (3) projects similar in complexity to the project described in the **Contract Documents**;
    - The **Geomembrane Installer's** Superintendent shall have installed a minimum of ten 1 million square meters of **Geomembrane**;
        - The Superintendent shall have worked in a similar capacity on projects similar in size and complexity to the project described in the **Contract Documents**;
    - The **Geomembrane Installer** shall provide a minimum of one (1) Master Seamer for the project;
        - The Master Seamer shall have completed a minimum of 500,000 square metes of **Geomembrane** seaming using the type of seaming apparatus proposed for the use on the Project; and
        - The Master Seamer must be on site whenever seaming is being conducted.
- **Quality Assurance Consultant** shall:
    - Have performed CQA services for the installation of more than 1 million square-meters of **Geomembrane**;
    - Have worked in a similar capacity on at least three (3) projects similar in complexity to the project described in the **Contract Documents**;

- The **Quality Assurance Consultant's** Superintendent shall have performed CQA monitoring for a minimum of 500,000 square meters of **Geomembrane**; and
    - The Superintendent shall have worked in a similar capacity on projects similar in size and complexity to the project described in the **Contract Documents**.

6. DELIVERY, STORAGE, AND HANDLING

- Each roll of **Geomembrane** delivered to the site shall be labeled by the **Geomembrane Manufacturer**.
    - The label will identify:
        - **Geomembrane Manufacturer's** name;
            - Product Identification;
            - Thickness;
            - Length;
            - Width; and
            - Roll Number.
- Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading;
- All packaging shall be clearly labeled with the same identification as the sheet within;
- The **Contractor** and/or **Geomembrane Installer** shall prepare an on-site storage location for **Geomembrane** material that shall be approved by the **Owner**:
    - The storage location shall have the following characteristics:
        - Level;
        - Smooth;
        - Dry;
        - Free of vegetation, large rock, and other debris that may damage **Geomembrane** rolls;
        - **Geomembrane** rolls shall not be stored on wooden pallets;
        - Protected from mud, soil, dirt and debris and from theft and vandalism;
        - Adjacent to the area being lined or in another suitable location as directed by the **Owner**;
        - Approved by the **Geosynthetic Quality Assurance Consultant**;
        - The **Geomembrane** shall be protected from:
            - Punctures;
            - Abrasions;
            - Mud;

- Excessive Dirt;
- Stormwater Runoff;

- All materials shall be stored in their original packaging material stacked no more than three (3) rolls high; and

  Handling and storage of liner material shall be in accordance with the **Geomembrane Manufacturer's** printed instructions and in a safe manner.

7. WARRANTY

- All workmanship furnished by the **Geomembrane Installer** under these **Specifications** shall be guaranteed against failure due to improper installation for a period of at least two (2) years;
- All permanent materials furnished under these **Specifications** shall be guaranteed **Geomembrane Manufacturer** for a period of at least 20 years; and
- Upon written notice that the material fails to meet the original intent of the Design or of failure of guaranteed materials or workmanship during the guarantee period, the **Geomembrane Installer** and/or the **Geomembrane Manufacture** shall promptly furnish and install new materials and/or furnish the workmanship necessary to repair the failure at no additional cost to the **Owner**.

8. PRODUCTS

8.1 Resin

- Resin shall be new, first quality, compounded, and manufactured specifically for producing **Geomembrane**;
- There shall be no intermixing with other resin types, blending of recycles or seconds, or reclaimed polymer added to the resin;
- Resin shall meet the following additional minimum requirements:

Table 8-1: Resin Requirements

Property	Units	Test Method	Requirement	
			HDPE	LLDPE
Density	g/cm^3	ASTM D 1505-18	0.940	0.939
Melt Flow Index	g/10 min	ASTM D 1238-20 (Condition 190/2.16)	≤ 1.0	
Oxidative-Induction Time (OIT)	Minutes	ASTM D 3895-19 (1 atm at 200°C)	≥ 100	
Carbon Black Content	%	ASTM D 1603-20	2.0 to 3.0	

8.2 Geomembrane

- The **Geomembrane** for the Leach Pads Optimization shall be 80-mil thick, smooth, seamless, linear low-density, polyethylene (LLDPE) **Geomembrane** supplied in rolls;
- The total combined percentage of all additives shall be under 3.5 percent by weight of the finished **Geomembrane**.
    - All additives other than carbon black shall be no greater than 0.75 percent by weight of the finished **Geomembrane**;
    - Additives shall be thoroughly dispersed; and
    - Processing aids, antioxidants, and additives shall be identified by name and percent.
- **Geomembrane** shall be free of:
    - Holes;
    - Pinholes;
        - Each roll of **Geomembrane** liner shall be tested by an acceptable method of inspecting for pinholes;
        - If pinholes are located, identified, and indicated during manufacturing, these pinholes may be marked and corrected during installation;
    - Bubbles;
    - Blisters;
    - Gels;
    - Undispersed Resin; or
    - Excessive contamination by foreign matter; and
    - Factory seams shall not be permitted.
- Each roll is to be identified with labels indicating:
    - Roll Number;
    - Thickness;
    - Length;
    - Width;
    - Weight;
    - The **Geomembrane Manufacturer**, and
    - Plant Location.
- There shall be no tears, abrasions, nicks or cuts on roll edges; and
- All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in the following Tables:

Table 8-2: Liner Physical Requirements

Property	Test Designation	Property Values			
		60-mil HDPE	80-mil LLDPE		
		Smooth	Smooth	Textured	Drain Liner®
Thickness (mil), Minimum Average	ASTM D 5199-12	60	80		
Thickness (mil), Lowest Individual Specimen		54	72		
Asperity / Drain Stud Height (mil) Minimum Average	ASTM D 7466-10	NA	NA	16	130
Density, (g/cm^3) Minimum	ASTM D 792-20	0.94	0.939		
Melt Flow Index, (g/10 minutes) Maximum	ASTM D 1238-20	≤ 1.0			
Carbon Black Content, (%) Allowable Range	ASTM D 4218-20	2.0 to 3.0			
Carbon Black Dispersion Acceptable Levels	ASTM D 5596-03	Category 1 or 2, 9 of 10 views			
Tensile Properties (Average Both Directions)					
Strength at Yield, (kg/in)	ASTM D 638-14	132	NA	NA	NA
Elongation at Yield, %		13	NA	NA	NA
Strength at Break, (kg/in)		240	320	224	168
Elongation at Break, %		700	800	400	300
Tear Resistance (lb.), Minimum	ASTM D 1004-21	45	48	50	53
Puncture Resistance (lb.), Minimum	ASTM D 4833-07	120	120	90	90
Oxidation Induction Time (minutes)	ASTM D 3895-19 (200°C, 1 atm O2)	300	≥ 100		
Oven Aging With HP OIT (% Retained after 90 Days)	ASTM D 5721-08 ASTM D 5885-20 (150°C, 500psi O2)	≥ 100	60		
UV Resistance With HP OIT (% Retained after 1,600 Hours)	ASTM D 5885-20 (150°C, 500psi O2)	80	35		
2% Secant Modulus (lb./in) Maximum	ASTM D 5323-19a	NA	4,800		
Axi-Symmetric Break Resistance Strain (%) Minimum	ASTM D 5617-04	NA	30		

8.3 Extruded Rod or Bead

- Extrudate material shall be manufactured from the same resin used to produce the **Geomembrane**, and shall be provided by the same supplier;
- All additives shall be thoroughly dispersed throughout the extrudate rod or bead; and
- Materials shall be free of contamination by moisture or foreign matter.

9. EXECUTION

9.1 Examination

- The **Quality Assurance Consultant** Superintendent shall inspect the prepared surfaces to verify that the surfaces are;
    - Smooth;
    - Firm; and

- Acceptable for liner placement;

- Surfaces shall be Free of any:
  - Rocks, larger than 3/8-inch;
  - Sticks;
  - Ruts;
  - Surface cracks deeper than one (1) inch and wider than 1/4-inch;
  - Surface irregularities; and/or
  - Debris which could damage the liner.

- Any surface areas or other conditions requiring correction shall be brought to the attention of the **Owner's Representative** and will be corrected at no additional cost to the **Owner**.

- Upon notification by the **Quality Assurance Consultant** of release of an area(s) for liner installation, the **Geomembrane Installer** shall verify in writing that the surface on which the **Geomembrane** will be installed is acceptable;
  - The initiation of installation indicates acceptance of existing conditions;
  - The **Geomembrane Installer** shall be responsible for maintenance of the subgrade surface in the accepted area or areas once installation begins; and
  - The maintenance of the surface includes repair or replacement of any surface damaged following acceptance.

9.2 Preparation

- The **Geomembrane Installer** shall maintain the surface suitability and integrity until the lining installation is completed and accepted by the **Owner**;

- The **Geomembrane Installer** shall repair rough areas and any damage to the subgrade caused by installation of the **Geomembrane**, and shall fill any ruts caused by equipment prior to deployment; and

- In order to avoid sharp bends in the **Geomembrane**, the **Contractor** or **Geomembrane Installer** shall slightly round the leading edges of the anchor trench.

9.3 Equipment

- Seaming equipment and accessories shall meet the following:
  - The **Geomembrane** Installer shall utilize a power source capable of providing constant voltage under combined line load;
  - The **Geomembrane Installer** shall provide containment large enough to catch spilled fuel under any electric generators or fuel powered equipment when it is located on the liner;
  - Adequate welding equipment shall be available to avoid delaying **Work**;

- At least one (1) spare operable seaming apparatus shall be maintained for each three (3) seaming teams;
- The primary welding method for the **Geomembrane** shall be the double fusion (wedge) welding method;
- Fusion Welding:
  - The welding apparatus for hot wedge welding shall be a self-propelled device equipped with an electronic controller which displays the operating temperature and the rate of advance;
  - No fusion welding equipment is allowed to commence welding on the liner until the field test sample made by that equipment has passed a trial weld test;
  - The **Geomembrane Installer** shall place a protective fabric or a piece of **Geomembrane** beneath hot welding apparatus when resting the apparatus on the **Geomembrane**;
- Extrusion Welding:
  - Extrusion Welding machines will be equipped with temperature gauges that display the preheat and nozzle temperatures;
  - No personnel are allowed to commence extrusion welding on the liner until the field test sample made by that person using the same welding equipment had passed a trial weld test; and
  - The **Geomembrane Installer** shall purge the welding apparatus of heat-degraded extrudate for at least ten (10) seconds before welding if the extruder is stopped for longer than three (3) minutes.

9.4 Trial Welds

The **Geomembrane Installer** shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds in accordance with the following requirements:

- Perform trial welds on **Geomembrane** samples to verify welding equipment is operating properly;
- Make trial welds under the same surface and environmental conditions as the production welds, (i.e., in contact with subgrade and similar ambient temperature to simulate the condition in the **Work** area);
- The trial weld sample should be at least 1 meter long and 30 cm wide with seam centered lengthwise;
- The trial weld shall be marked with date, ambient temperature, welding machine operator, machine number, temperature(s) and speed;
- Trial welds shall be conducted at the following frequency:
  - At beginning of each seaming period or shift (i.e., start of the day, after lunch etc.);
  - At least once for each five (5) hours of seaming;
  - For each seaming apparatus used;

- For each liner type and seaming condition (i.e., smooth to smooth, textured to textured, smooth to texture) that will be welded during the shift;
- After repairs or adjustments have been made to the seaming equipment; and
- At the discretion of the **Quality Assurance Consultant** when there is reason to believe the conditions have changed significantly since trial welds were last conducted.

- Cut seven (7), one (1)-inch wide by six (6)-inch long test strip specimens from the trial weld;
- Quantitatively test specimens for peel five (5) specimens for adhesion, and two (2) specimens for bonded seam strength (shear);
- Trial weld specimens shall pass when:
  - The break is ductile;
  - The break, when peel testing, occurs in the liner material itself, not through peel separation, or film tearing bond (FTB);
  - A break at the weld sheet interface is considered acceptable if the break is ductile and if the strength meets the minimum required values;
  - Otherwise the break is considered a non-FTB (failure);
  - The break is not an Adhesion Failure greater than 25% of the weld, or a separation in the plane of the sheet; and
  - The results shown in the following Table are achieved in both peel and shear test for each of the test specimens:

Table 9-1: Weld Requirements

Test	Designation	Required Strength	
		60-mil HDPE	80-mil LLDPE
Bonded Seam Strength (Shear)	ASTM D 6392-12	120 lb./in	120 lb./in
Fusion Peel Adhesion		95 lb./in (1)	100 lb./in
Extrusion Peel Strength		82 lb./in (2)	88 lb./in

Notes: (1) 72% of Yield Strength (2) 62% of Yield Strength

- Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear;
- When repeated test seams fail, the **Geomembrane Installer** shall not use the seaming apparatus (fusion), and/or operator (extrusion) for welding until:
  - Deficiencies or conditions are corrected; and
  - Two (2) consecutive successful field test seams are achieved.
- No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed a trial weld

9.5 Deployment

- The **Geomembrane Installer** shall assign each panel a simple and logical identifying code during liner deployment consistent with the layout plan;
    - The coding system shall be subject to approval by the **Quality Assurance Consultant** and shall be determined at the job site;
- The **Geomembrane Installer** shall visually inspect the **Geomembrane** during deployment for imperfections and mark faulty or suspect areas;
    - Geomembrane panels with more than one (1) hole, larger than one (1) inch, per 23 square meters prior to installation shall be cut out and wasted;
    - Faulty **Geomembrane** shall be repaired and/or replaced at no cost to **Owner**;
- Deployment of panels shall comply with the following:
    - The **Geomembrane** shall not be deployed during precipitation;
    - The **Geomembrane** shall not be deployed in the presence of excessive moisture;
    - The **Geomembrane** shall not be deployed in areas of ponded water;
    - The **Geomembrane** shall not be deployed during excessive winds;
    - The number of panels deployed in one (1) day shall be limited by the number of panels which can be seamed, sufficiently ballasted, and anchored on the same day;
    - Unroll panels using methods that will not damage the **Geomembrane** and will protect underlying surface from damage (i.e., spreader bar, protected equipment bucket);
    - Use methods to minimize wrinkles, especially differential wrinkles between adjacent panels;
    - **Slope** panels shall extend a minimum of 1.5 meters beyond grade breaks into flatter areas.
    - Sufficient material (slack) shall be provided during panel deployment to allow for thermal expansion and contraction;
    - The liner shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation;
    - Stretching of the liner to fit shall not be permitted;
    - Place ballast (piles of **Overliner Drain Fill** and/or sandbags) which will not damage **Geomembrane** to prevent wind uplift;
    - Personnel walking on the **Geomembrane** shall not engage in activities or wear shoes that could damage the **Geomembrane**;
    - Smoking will not be permitted on the **Geomembrane**;
    - Do not allow clamps and other metal tools to be dropped or thrown on the **Geomembrane**;
        - Do not allow vehicular traffic directly on **Geomembrane**;
        - All-Terrain Vehicles (ATVs) with tire pressure less than about eight (8) psi are acceptable;

- ATVs shall not turn sharply, or accelerate or brake suddenly; and
- ATVs shall not be operated on a **Geomembrane** containing wrinkles that can fold over.

- Protect heavily trafficked areas by placing protective cover over the **Geomembrane**; and
- The **Geomembrane Installer** will be responsible for any damage related to deployment and installation procedures.

9.6 Field Seaming

- All welding operations will be supervised by the Master Seamer who shall provide direct supervision over other welders as necessary;
- Seams shall meet the following requirements:
  - A sequential seam numbering system compatible with the panel numbering system, that is agreeable to the **Quality Assurance Consultant** and **Geomembrane Installer**, shall be used;
  - To the maximum extent possible, seams shall be oriented down and not across **Slopes**;
  - The number of field seams in corners, odd-shaped geometric locations and outside corners shall be minimized;
  - **Slope** seams shall extend a minimum of 1.5 meters beyond grade breaks into flatter areas;
  - Seaming shall not take place during inclement weather;
    - The **Quality Assurance Consultant** shall have final authority to determine if weather conditions warrant halting or not starting seaming operations;
    - These conditions include but are not limited to the following:
      - Precipitation of any kind, including condensing fogs;
      - Areas of ponded water; and
      - Excessive winds.
  - No seaming shall be performed when the temperature, as measured 15 cm above the **Geomembrane** surface, is above 43°C or below 4.5°C;
    - Seaming may be conducted outside the temperature range if seaming techniques are shown to produce acceptable consistent results;
    - Personnel safety is evaluated; and
    - When the temperature is below 10°C, the **Geomembrane Installer** shall provide preheating by a hot air device.
  - All seam overlaps shall be aligned consistent with the requirements of the welding equipment being used;
- The **Geomembrane Installer** must take into account that rapid weather changes are possible, resulting in delays in construction of field seams;
- The Seaming Technicians shall record the following information on the Geomembrane adjacent to the beginning of each seam:

- Machine Number;
- Technicians Name or Initials;
- Date;
- Time seaming began; and
- Direction of seaming.

- Fusion Seams:
  - Fusion seams shall be made by lapping the uphill material over the downhill material;
  - Fusion seaming shall have a minimum overlap of 10 cm;
  - Clean seam areas of grease, moisture, mud, dust, dirt, debris or other foreign material immediately ahead of the hot wedge welder;
  - Protect against moisture build-up between sheets;
  - Use a firm, dry substrate (piece of **Geomembrane** or other material) directly under seam overlaps where the subgrade is soft;
  - Use plywood or other firm material under seams when welding over the anchor trench;
  - If a seam must be constructed by overlapping the downhill material over the uphill material, the flowing procedure shall be implemented:
    - The seam shall be welded;
    - The seam shall be air pressure tested following normal procedures;
    - Any destructive test samples shall be removed, tested, and repaired following normal procedures;
    - If acceptable Quality Control / Quality Assurance results are achieved, the flap of excess material on the outside of the fusion seam shall be removed;
  - All tie-in "T' junctions of two (2) fusion welds shall be patched; and
  - The **Geomembrane Installer** shall avoid stop-start welding.

- Extrusion Seams:
  - Clean seam areas of grease, moisture, mud, dust, dirt, debris or other foreign material;
  - Extrusion seaming shall have a minimum overlap of 7.5 cm;
  - Hot-air tack adjacent pieces together using procedures that do not damage **Geomembrane**;
  - Procedures used to temporarily bond seams together shall not damage the **Geomembrane** and shall not be detrimental to seaming;
  - Adhesive shall not be used for seaming or temporary bonding of membranes;
  - Clean **Geomembrane** surfaces by disc grinder or equivalent not more than one (1) hour before seaming;

- Use number 80 grit sandpaper for disc grinding;
- Grind liner surface to the extents of the weld bead;
- All grind marks should be covered however, the ground area may extend a maximum 1/4 inch beyond the extrudate bead in small areas;
- Use only soft bristle brush or leaf blowers after grinding if cleaning is required;
  - Wire brushes shall not be used to clean grinding;
  - Rags shall not be used to clean prepared grinding;
- The **Geomembrane Installer** shall grind existing welds 5 cm from the point of stoppage before resuming the welding process;
- Purge welding apparatus of heat-degraded extrudate before welding;
- The **Geomembrane Installer** shall restart welds 5 cm from where the edge of patch intersects a previous weld; and
- Areas where grinding reduces the sheet thickness by more than six (6) mils shall be repaired with a single extrudate bead.

9.7 Connect to Existing Liner

Geomembrane will be attached to existing polyvinyl (PVC) liner using a pre-fabricated anchor system in accordance with the plan details, using a combination of Butyl tape and polyester thread meeting the following requirements

- Materials
  - Polyethylene/Butyl Rubber Pipeline Tape shall be Denso 35 or equal meeting following material requirements;

Table 9-2: Polyethylene/Butyl Rubber Pipeline Tape Material

Property	Requirement	
Tensile Strength (ASTM D638-14)	23 lb/in width	
Elongation at Break (ASTM D 5035-95)	250%	
Dielectrical Strength (ASTM D 149)	20 kV	
Water Vapor Transmission (ASTM E 96-00)	<0.2g/110 in^2/24 hour	
Temperature Range for Continuous Service	0° to 160^oF	
Thickness (ASTM D1000)	Backing	2 mil
	Adhesive	33 mil
	Total	35 mil

  - Double-Sided Butyl Adhesive Tape shall be Denso Butyl Mastic Tape or equal, meeting following material requirements;

Table 9-3: Butyl Mastic Tape Material Properties

Property	Requirement
% Solid	100%
Elongation at Break (ASTM D 5035-95)	300%
Tensile Strength (ASTM D 638-14)	10-18 PSI
Lap Shear Strength	6 PLI minimum
Low Temperature Flexibility (ASTM C765-97)	Pass @ 0°F
Temperature Range	0° to 120°F

- Polyester thread shall meet the requirements of MIL SPEC MIL-DTL-32072(VT-285F) with the following material requirements;

- Installation
  - Surfaces shall be prepared by removing all loose scale, rust or other foreign matter by grit blasting or wire brush. Surface must be clean, dry and free of grease.
  - The anchor system shall be seam welded to the primary HDPE liner in accordance with the requirements of Section 3.06 of these specifications.
  - The anchor system shall be seam welded to the existing PVC liner using a solvent adhesive, a capable hot air welder, or a wedge welder. These seams shall be made as a lap joint formed by lapping the edges of the sheets in accordance with the following recommendations or as specified by welder manufacturer.
    - Panel Overlapping for Seams:
      - Chemical Seam: 6” to 8” overlap with a 2” wide seam.
      - Thermal Seams: 4” to 6” overlap and a minimum 1.5” wide seam.
    - Fishmouths, wrinkles, folds or pleats in the same area shall be avoided. Where fishmouths do occur, they should be slit out far enough from the seam to dissipate them, lapped, seamed together in the lapped area and patched.
    - Any necessary repairs to the PVC geomembrane shall be done using an additional piece of the specified parent material. All patching material shall have rounded edges.

- Inspection and Testing of Seams
  - Anchor system HDPE seams shall be inspected in accordance with the requirements of Section 3.08 Field Quality Control of these specifications
  - Anchor system PVC seams welded to the existing PVC liner using chemical and solid thermal, i.e., single track, welds shall be tested utilizing the Air Lance Test Method ASTM D4437.
    - The installer shall provide an air compressor, air hose and air lance wand with a pressure gauge capable of measuring the air flow at the tip. Experienced technicians familiar with this procedure shall perform the testing. All seams tested by the air lance method shall be marked with the date tested, name of the technician, length of the seam, and test results.
    - Vacuum Box testing shall not be used on PVC geomembranes.

- The **Geomembrane Installer** and **Quality Assurance Consultant** shall inspect seams before, during, and after field seaming to identify all dirty and wrinkled areas and any defects. Each suspect location (both in seam and non-seam areas) shall be non-destructively tested using the air lance test method in ASTM 04437. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily installation drawings and subsequently repaired.

9.8 Field Quality Control

- The **Geomembrane Installer's** QC Technician shall be responsible for supervising and/or conducting the field quality control program throughout construction;
  - The QC Technician(s) shall not be replaced without authorization from the **Owner's Representative** and/or **Quality Assurance (QA) Consultant**; and
  - There shall be a designated QC Technician present during every work shift.
- The **Geomembrane Installer** shall non-destructively test 100 percent of all field seams and repairs, to ensure watertight uniform seams on a continuous basis as installation proceeds;
- The **Quality Assurance Consultant** shall observe 100% of;
  - Trial weld testing;
  - Air pressure testing;
  - Vacuum testing; and
  - Destructive testing.
- The **Geomembrane Installer's** QC Technician and the **Quality Assurance Consultant** shall inspect the seams and surfaces of **Geomembrane** for defects, holes, blisters, undispersed raw materials, or signs of contamination by foreign matter;
  - The **Geomembrane Installer** shall brush, blow, or wash **Geomembrane** surfaces if debris inhibits inspection; and
  - The **Geomembrane Installer's** QC Technician shall distinctively mark repair areas and indicate the required type of repair.
- **Geomembrane Installer's** QC Technician and the **Quality Assurance Consultant** shall visually inspect each field seam for:
  - Poor workmanship;
  - Insufficient overlap;
  - Fusion Seaming:
    - Check machines for cleanness, temperature, and related items;
    - Water and air blisters in the weld in fusion seaming;
    - Centering of the weld in fusion seaming;
  - Extrusion Seaming;

- Squeeze out, footprint, melt, and overlap;
- Proper adhesion of the bead in extrusion seams;
- Lack of extrudate in the extrusion seam bead; and
- Overgrinding of the panel adjacent to the extrusion seams;
    - If the over-grind is greater than 10 percent of the panel thickness, an extrusion bead shall be placed on the overgrind.

- Non-destructive seam testing shall be performed over the full length of welds by the **Geomembrane Installer's** QC Technician;
- All field seams and patches shall be tested with Air Pressure Testing, Vacuum Testing, or other approved methods;
- Non-destructive seam testing shall be conducted within 24-hours of completed seaming **Work**;
- Testing methods and procedures will be subject to the approval of **Quality Assurance Consultant**.
- Air Pressure Testing shall be conducted by the **Geomembrane Installer's** QC Technician for all Fusion Seams;
- All Extrusion seams shall be non-destructively tested using vacuum box testing;
- Air pressure testing shall be performed in accordance with ASTM D 5820-95:
    - Pass air through the channel to guarantee a clear pathway;
    - Seal both ends of the seam to be tested;
    - Insert a needle or other approved pressure feed device into the tunnel created by double hot wedge seaming;
    - Pressurize the channel to for:
        - For 50-mil HDPE **Geomembrane**: the starting pressure shall be between 25 to 28 psi;
        - For 60-mil HDPE **Geomembrane**: the starting pressure shall be between 27 to 30 psi;
        - For 80-mil LLDPE **Geomembrane**: the starting pressure shall be between 30 to 35 psi;
    - Close the valve while sustaining the air pressure and allow the air pressure to stabilize;
    - Read the pressure gauge and record the starting pressure, time, and QC Technicians Name or Initials on the liner;
    - Sustain the test for a minimum of five (5) minutes and re-read the pressure gauge;
    - If the pressure loss does not exceed three (3) psi after the five (5) minute period, cut the air channel at the opposite end of the seam to release the pressure and verify that the entire seam was tested;
        - If the pressure does not release, locate the blockage in the air channel and retest the remainder of the seam;

        - If the location of the blockage cannot be determined, follow the procedures for a failed pressure test outlined below;
    - If the loss of pressure exceeds three (3) psi after the five (5) minute period or does not stabilize, faulty areas shall be located, repaired, and retested using the procedures for a failed pressure test outlined below;
    - The following procedure shall be used to resolve failing pressure tests:
        - Attempt to locate the leak or blocked air channel;
        - If the faulty seam location can be determined, divide the seam at that location and test the two (2) sections separately using the same procedure outlined above;
        - If the faulty seam location cannot be determined, divide the seam at the mid-point and test the two (2) sections separately using the same procedure outlined above;
        - If a seam section continues to fail pressure testing, divide the seam section at the midpoint and retest the two (2) sections separately;
        - Continue to divide the seam section until the failure is isolated to a seam section that is less than or equal to 1.5 meters:
            - If the failed seam section is caused by a blocked air channel, cut the excess overlap (flap) and test the outer fusion weld section using vacuum testing methods;
            - If vacuum testing indicates passing results, the seam will be considered acceptable;
            - If vacuum testing indicates a pin hole leak, apply an extrusion bead and continue testing;
            - If failed seam section is caused by a leaking seam, cap strip the failed seam section.
    - All pressure testing shall be documented by the QC Technician and observed **Quality Assurance Consultant**.
    - The liner shall be legibly marked near the seam to indicate passing or failing test results accordingly.
- Air Pressure Testing shall be completed prior to the removal of destructive test samples;
- Defects:
    - All defects shall be assigned a unique code:
    - The code shall be used by the **Quality Assurance Consultant** and the **Geomembrane Installer's** QC Technician to track:
        - The nature of the defect;
        - The type of repair; and
        - The non-destructive testing of the repair;

- The code shall be agreed upon by the Geosynthetics **Quality Assurance Consultant** and the **Geomembrane Installer's** QC Technician;
- Cut wrinkles and "fishmouths" along grade breaks;
- Overlap and seam wrinkles and fishmouths; and
- Patch wrinkles and fishmouths where overlap is less than 7.5 cm.

- Do not cover **Geomembrane** at locations that have been repaired until test results with passing values are available;
- Repairs:
  - The **Geomembrane Installer** shall repair and non-destructively test each suspect location in both seam and non-seam areas;
  - The **Geomembrane Installer** shall repair any portion of unsatisfactory Geomembrane or seam area failing a destructive or non-destructive test;
  - The appropriate repair method shall be agreed upon by Geosynthetics **Quality Assurance Consultant** and the **Geomembrane Installer**;
  - Repairs shall consist of:
    - Patching;
    - Spot Welding;
    - Capping; and/or
    - Removing the unacceptable seam and replacing with new material.
  - All Repairs shall be marked with:
    - The Name or Initials of the repair technician;
    - The machine number of the extrusion welder; and
    - The date and time that the repair was completed.
  - All Repairs shall be non-destructively tested;
- Patching:
  - Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter;
  - Patch materials shall be of the same material type and thickness as the material being repaired;
  - A patch shall be a minimum of six 15 cm larger than the defect in all directions than the area requiring repair;
  - All patches shall have rounded corners;
  - All intersections of two or more fusion seams shall be patched;
  - Repair all pressure testing locations using patches;
  - All destructive sampling locations shall be patched;

- All holes larger than 1/8-inch, blisters, undispersed raw materials, and contamination by foreign matter shall be patched;
- Tears shall be patched with the ends of tears rounded prior to patching;
- Patches shall be secured by extrusion welding;
- All patches shall be non-destructively tested;
- The **Geomembrane Installer** shall:
  - Bevel the edge of the patch;
  - Heat seal to the **Geomembrane** by an approved method;
  - Grind the edges of the patch; and
  - Extrusion weld and then vacuum test the patch.

- Spot Welding:
  - Used to repair pinholes or other minor, localized flaws or where **Geomembrane** thickness has been reduced;
  - Cuts, holes smaller than 1/8 inch, scratches, and areas where grinding reduces the sheet thickness by more than ten (10) percent shall be repaired by spot welding; and
  - The surface of the **Geomembrane** shall be ground to a minimum of 1-inch around small defects immediately before welding and shall be vacuum tested after welding.

- Capping:
  - Used to repair long lengths of failed seams;
  - Capping shall be used in the repair of fail destructive test samples fusion welds;
  - Wrinkles; and
  - Fishmouths.

- The following procedures shall be observed when a repair method is used:
  - All **Geomembrane** surfaces shall be clean and dry at the time of repair;
  - Surfaces of the **Geomembrane** which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness; and
  - Extend patches or caps at least 15 cm beyond the edge of the defect and around all corners of patch material.

- Repair Verification:
  - The **Quality Assurance Consultant** shall number and log each patch repair;
  - The **Geomembrane Installer's** QC Technician shall non-destructively test each repair using methods specified in this **Specification**.

- The **Geomembrane Installer** shall remove damaged **Geomembrane** and replace with acceptable **Geomembrane** materials if damage cannot be satisfactorily repaired.

- Vacuum Testing
  - Vacuum tests shall be performed on all extrusion welds within 24-hours of completion of the welds, not at completion of the project;
  - Vacuum Testing shall be conducted in accordance with ASTM D 5641-94;
  - The vacuum box assembly shall consist of the following:
    - Rigid housing;
    - Transparent viewing window;
    - Soft rubber gasket attached to bottom of housing;
    - Porthole or valve assembly;
    - Vacuum gauge; and
    - A vacuum pump capable of delivering a minimum of four (4) to eight (8) psi of vacuum.
  - When vacuum testing, the **Geomembrane Installer's** QC Technician shall:
    - Carefully trim all overlapped material using an approved cutting instrument;
    - The "pull-tear" method of overlap removal shall not be accepted;
    - Clean the window(s) and gasket surfaces of the vacuum box;
    - Check the vacuum box for leaks;
    - Wet a strip of **Geomembrane** approximately one (1) foot by two (2) foot (length of box) with soapy solution;
    - Place the vacuum box over the wetted area;
    - Ensure that a leak tight seal is created;
    - Apply a minimum vacuum pressure of four (4) psi;
    - For a period of not less than ten (10) seconds, examine the length of weld through the viewing window for the presence of soap bubbles;
    - If no bubbles appear after ten (10) seconds, move the box over the next adjoining area with a minimum three 7.5 cm of overlap within the viewing area and repeat the process;
      - Areas where soap bubbles appear shall be marked, repaired, and re-tested;
  - All vacuum testing will be documented by the **Geomembrane Installer's** QC Technician and observed by the **Quality Assurance Consultant**;
  - The liner shall be indelibly marked near the seam to indicate:
    - Passing or failing test results accordingly;
    - The date of the test; and
    - The name or initials of the tester;
  - Alternative testing methods other than vacuum or air pressure testing may be proposed by the **Geomembrane Installer** and will be subject to the approval of the **Engineer** prior to their use;

- At locations where seams cannot be non-destructively tested, the **Geomembrane Installer** shall:
  - Spark Test the seams per ASTM D 6365-99;
  - Cap-strip seams with the same **Geomembrane**;
  - If the seam is accessible to testing equipment prior to final installation, non-destructively test the seam prior to final installation; and
  - Seaming and cap-stripping operations will be observed by the **Quality Assurance Consultant** for uniformity and completeness;

- Destructive Seam Sampling:
  - Destructive testing shall be performed in accordance with ASTM D 6392-12;
  - The **Quality Assurance Consultant** shall track fusion and extrusion seaming operations and shall select destructive sample locations.
    - The minimum sampling frequency for fusion seaming shall be one (1) destructive sample per 150 meters of seam per fusion wedge;
    - The minimum sampling frequency for extrusion seaming shall be one (1) destructive sample per 75 meters of seam per extrusion welder;
      - Patches smaller than 3 meters in the greater dimension shall not be counted in the destructive testing frequency;
  - The location shall be selected by the **Quality Assurance Consultant** and the **Geomembrane Installer** shall not be informed in advance of the sample location;
  - To the greatest extent possible, the **Quality Assurance Consultant** shall select destructive sample locations within 1.5 meters of the end of a seam to minimize the number of repairs;
    - Destructive samples will be collected after non-destructive testing has been completed;
    - Destructive samples shall be approximately 30 cm wide by 45 cm long with the seam centered lengthwise;
    - The **Geomembrane Installer** or **Quality Assurance Consultant** shall record the following on a destructive test log and on the sample;
      - The seam number;
      - The location of the sample along the seam;
      - The direction of seaming;
      - The machine number;
      - The operators name or initials;
      - The seaming temperature(s) and speed (not applicable for extrusion);
      - The date of seaming;
      - The ambient temperature measured six 15 cm above the liner;

- A unique destructive test number;
- The initials of the Geosynthetics QA Monitor; and
- Mark the outside fusion track.

- The **Geomembrane Installer** shall remove and test destructive sample within 24-hour of the completion of non-destructive testing;
- The destructive sample shall be cut into two (2) pieces;
  - One (1) piece shall be given to the owner for archiving;
  - The other piece will be tested using a calibrated field tensiometer; and
  - Destructive Testing shall be observed by the **Quality Assurance Consultant**.
- Cut four (4) one (1) inch wide test strips from the remaining piece;
- Test three (3) strips for peel strength and one (1) strip for shear strength using the same criteria as trial welds;
- In the event of a failure of the destructive test sample, the **Geomembrane Installer** and **Quality Assurance Consultant** shall:
  - Retrace the welding path a minimum 3 meters in both directions from the failed test location and remove a destructive test sample;
  - Repeat the testing process;
  - Repeat the process if additional tests fail;
  - Reconstruct the seam between passing test locations to the satisfaction of the **Quality Assurance Consultant**;
  - Reconstruction may be by one of the following methods;
    - Cut out the old seam, reposition the panel and re-seam; or
    - Add a cap strip.
  - Cut additional destructive samples from the reconstructed seam at the discretion of the **Quality Assurance Consultant**;
- The **Geomembrane Installer** shall immediately repair holes in **Geomembrane** resulting from obtaining destructive samples.

9.9 Protection of Work

- The **Geomembrane Installer** shall maintain the **Geomembrane** surface as set forth by the **Quality Assurance Consultant** until final acceptance;
- The **Geomembrane Installer** shall repair all weather-related damage to the **Geomembrane**, including contamination with foreign materials, or other portions of the Work which have not been covered, at no additional cost to **Owner**;
- If reasonable preventive control measure were neglected by the **Geomembrane Installer**.

- The **Geomembrane Installer** shall repair the **Geomembrane** to meet all requirements of these **Specifications**, or remove and replace with material meeting these **Specifications**, as directed by the **Quality Assurance Consultant**.

9.10 Acceptance

- The **Geomembrane Installer** shall retain ownership and responsibility for the **Geomembrane** until acceptance by the **Owner**.
- The **Owner's Representative** shall accept the **Geomembrane installation** when the installation, or portions thereof, are:
    - Finished and the adequacy of field seams and repairs has been verified, and testing, is complete, as certified by the **Quality Assurance Consultant**; and
    - Certifications, warranties, and As-Built **Drawings** as described elsewhere in these **Specifications** have been received and verified.
- Any and all **Work** required to facilitate the final inspection, such as cleaning of the liner shall be the responsibility of the **Geomembrane Installer**;
    - The construction area shall be cleaned of remnant pieces of **Geomembrane**, debris, and garbage before acceptance;
- The final inspection procedures shall be as follows:
    - The **Quality Assurance Consultant** and the **Owner's Representative** shall be informed of readiness for final inspection when installation in any particular area is finished;
    - Seams, panel surfaces, and repairs shall be visually inspected by the Geosynthetics **QA Consultant** and/or the **Owner's Representative**;
    - Defects, suspicious looking welds, permanent wrinkles, and bridging shall be distinctively marked for repair;
    - Findings and corrective actions shall be documented; and
    - Arrangements for subsequent final inspection shall be made after corrective actions have been completed.
- The results of final inspection shall be documented.

9.11 Survey Control

- The **Geomembrane Installer**, **Contractor**, or the **Quality Assurance Consultant** shall provide a surveyed As-Built panel layout of the final location and layout of all panels, numbered in accordance with the deployment log;
- The locations of all destructive tests shall be identified along with locations of any repairs; and
- As a minimum, As-Built **Drawings** shall be submitted at the end of each month as the **Work** progresses showing **Work** completed that month.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

EXCAVATION 31 23 16

Document No. 123022-83010-PC-TS-0018

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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SUMMARY

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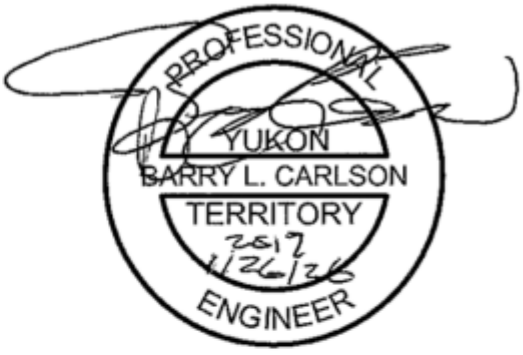
This report has been prepared under the direct supervision of Barry Carlson, P.Eng. of Forte, with the assistance of Clint Green, P.E. of Forte and Roy Morlan, P.G., of Forte. The design and analyses presented have been completed according to the project information provided by Kaminak. The design level and limits presented in this report are in accordance with standard engineering practices, and to the best of our knowledge, are accurate to the limits as specified herein.



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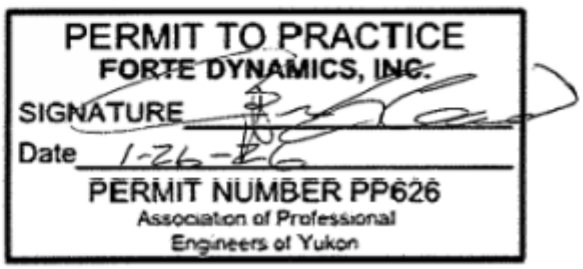

1. RELATED SECTIONS

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 14 00	Earth Stripping and Stockpiling
Section	31 22 13	Rough Grading
Section	31 23 23	Fill

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Lines and Grades

- The **Contractor** shall locate existing survey control points and verify that the vertical and horizontal positioning is as indicated on the **Drawings**;
- The **Contractor** shall stake lines, levels, contours, and datum, as necessary;
- The **Contractor** shall protect **Owner**-supplied survey control points from excavation equipment and vehicular traffic; and
- The **Contractor** shall replace destroyed or lost **Owner**-supplied survey control points at no additional cost to the **Owner**.

3.2 Excavation

- The **Contractor** shall excavate soils to the lines and grades shown on the **Drawings**. Additional excavation beyond lines and grades shown on the drawings may be required if **Unsuitable Material** is still present in the excavation but should be approved by the **Engineer**.
- The **Contractor** shall grade or berm the perimeter of excavations to prevent surface water from draining or ponding in the excavations;
- The final cut surface for areas receiving Soils for Earthworks shall be prepared as described in Section 31 23 13 – Subgrade Preparation;

- Ponding and flowing water should not be allowed in excavations. In excavations that cannot be graded to drain the **Contractor** shall provide equipment and labor necessary to keep the excavation free of ponded and flowing water;
- Excavation operations shall be suspended when the site is wet, muddy, or in any condition where the area cannot be properly maintained or the subgrade properly prepared per Section 31 23 13 – Subgrade Preparation.
- It is expected that most excavation (soil and rock) can be accomplished using conventional equipment such as a Caterpillar D-10 (or equivalent) track mounted tractor with a single shank ripper. If material is encountered which **Contractor** believes cannot be excavated by conventional equipment, the **Owner** shall be immediately notified. The **Contractor** shall conduct performance tests of the conventional or equivalent equipment. Approval from the **Owne**r will be required for a change in equipment that will result in a change in cost of schedule.
- Explosives and blasting will not be permitted without review and acceptance of the blasting plan by the **Engineer**.
- **Slopes** shall be afforded a tolerance of 0.5 percent of those shown on the **Drawings**;
- Finished grades shall **Slope** uniformly between given spot and contour elevations;
- Finished grades shall be afforded a tolerance of ± 6 cm from the lines indicated on the **Drawings**;
- Excavations extending beyond the lines, grades, dimensions, and tolerances shown on the **Drawings** and discussed in these specifications shall be brought to grade with material methods discussed in the **Technical Specifications** or approved by the **Engineer** at no additional cost to the **Owner**.

3.3 Field Quality Assurance

- Quality Control and Quality assurance will be completed in conformity with Section 01 43 00 – Quality Assurance and Section 01 45 00 – Quality Control;
- Visual inspection of the excavated surface shall be performed by the **Quality Control Consultant** and the **Engineer** to verify that all **Unsuitable Material** has been removed. Final preprepared subgrades will be completed in conformity with Section 31 23 13 – Subgrade Preparation.

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

FILL 31 23 23

Document No. 123022-83010-PC-TS-0019

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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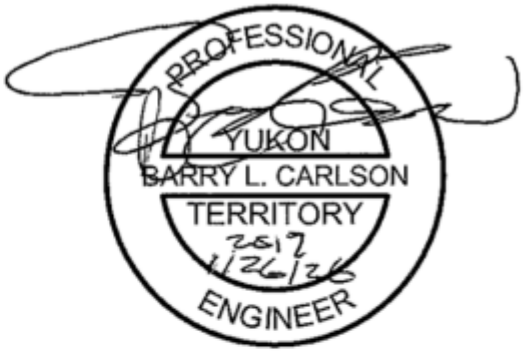

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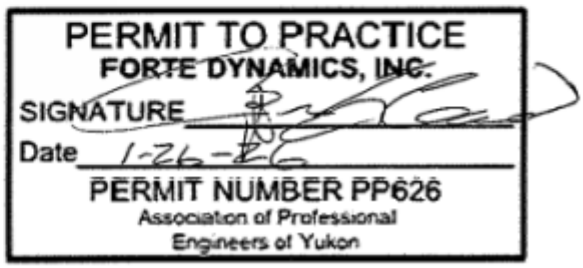

1. GENERAL

1.1 Related Sections

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 14 00	Earth Stripping and Stockpiling
Section	31 22 13	Rough Grading
Section	31 23 16	Excavation
Section	31 23 23	Fill

1.2 References

ASTM D 6913/6913M-17	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D 698-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft3 (600 kN-m/m3)].
ASTM D 1556-15	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D 1557-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 2167-15	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216-19	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
ASTM D 2435-11	Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading.
ASTM D 6938-17	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 3385-18	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.

ASTM D 4318-17	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4643-17	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Method.
ASTM D 5084-16	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM C33/C33M-18	Standard Specification for Concrete Aggregate.
ASTM C535-16	Standard Test Method for Resistance to Degradation of Large-Size Course Aggregate by Abrasion and Impact in the Las Angeles Machine.
ASTM D 4318-17e1	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index for Soils

2. PRODUCTS

2.1 Fill Materials

- Soil fill material requirements are discussed in 31 05 13 - Soils for Earthworks Section. These materials include **Site Grading Fill, Select Fill, Structural Fill, Compacted Rockfill, Road Wearing Course, and Anchor Trench Backfill**.
- Course aggregate material requirements are discussed in in 31 05 16 - Aggregate for Earthworks Section. These materials include **Overliner Drain Fill, Pipe Trench Backfill, and Select Drain Fill.**

3. EXECUTION

3.1 Verification

- The **Contractor** shall verify that lines, grades, and limits of fill meet these **Specifications**; and
- The **Contractor** shall verify location of all borrow areas and their limits.

3.2 Preparation

- The **Contractor** shall prepare the subgrade according to Section 31 23 13 – Subgrade Preparation.
- The **Contractor** shall not place any fill materials until the subgrade has been approved by the **Engineer**.

3.3 Fill Placement

- Placement of fill shall be made only in areas approved by the **Engineer** for fill placement;
- Fill shall be placed to the lines and grades shown on the **Drawings** and according to the **Specifications**;

- The **Contractor** shall conduct his hauling operations in a safe manner and provide flagmen to provide traffic control for the **Contractor's** equipment, as required;
- The distribution of materials shall be such that the fill is free of lenses, pockets, segregation or layers of material differing substantially in texture or gradation from the surrounding material;
- The combined borrow excavation and fill placement operation shall be such that the materials, when placed in the fill, will be blended sufficiently to provide the best practical distribution to the satisfaction of the **Engineer;**
- If, in the opinion of the **Engineer**, the surface of the prepared foundation or the surface of any layer of the fill is too dry or too smooth to bond properly with the layer of material to be placed thereon, it shall be moisture conditioned and/or worked with discs, scarifier, or other equipment to provide a satisfactory bonding surface before the next layer of fill is placed;
- If, in the opinion of the **Engineer**, the surface of the prepared foundation or the rolled surface of any layer of the fill in place is too wet for proper compaction of the layer of fill to be placed thereon, the wet material shall be removed and allowed to dry or shall be worked with discs, scarifier, or other equipment to reduce the moisture content to the required amount, and then compacted before the next layer of fill is placed;
- The **Contractor** shall place fill only after subgrade has been adequately prepared and approved by the **Engineer**;
    - Should any of the **Work** be covered before it has been approved, the **Contractor** shall uncover all such **Work** at no additional cost to the **Owner**;
    - After the **Work** has been examined, tested, and approved by the **Owner's Representative**, the **Contractor** shall make all repairs and replacements necessary to restore the **Work** to meet these **Specifications** at no additional cost to the **Owner**.
- During compaction operations, the borrow and reworked in-place materials requiring moisture conditioning shall be maintained within the range of the moisture content required in these **Specifications** to achieve the specified density;
- The moisture content of the fill material prior to, and during, compaction shall be uniform throughout the material;
- The compaction of fill materials shall be inspected and tested at a minimum per the schedule provided in this specification to verify compliance with the **Specifications**;
- The **Contractor** shall extend compaction to the edge of fill **Slopes**;
- All finished fill **Slopes** will be moisture-conditioned and track-walked with a bulldozer or another method approved by the **Engineer**, to provide a dense, uniform, free-draining surface;
- The **Contractor** shall maintain and protect fills at all times until completion and final acceptance of the **Work**;
- Any approved fill which becomes unsuitable for any reason before final acceptance of the **Work**, shall be removed and replaced by the **Contractor** to meet these **Specifications** at no additional cost to the **Owner**;

- **Site Grading Fill** shall be:
  - Have a moisture range within 2% of the optimal moisture as determined by ASTM D 1557.
  - **P**laced in 300 mm loose lifts, and compacted to a minimum of 95.0 percent of maximum dry density as determined by ASTM D 1557.
- **Select Fill** shall be:
  - Have a moisture range within 2% of the optimal moisture as determined by ASTM D 1557.
  - **P**laced in 150 mm loose lifts, and compacted to a minimum of 95.0 percent of maximum dry density as determined by ASTM D 1557.
- **Structural Fill** shall be:
  - Have a moisture range within 2% of the optimal moisture as determined by ASTM D 1557.
  - **P**laced in 300 mm loose lifts, and compacted to a minimum of 95.0 percent of maximum dry density as determined by ASTM D 1557.
- **Compacted Rock Fill** shall be:
  - Placement and compaction tracking and/or testing will be determined by Test Fill method. The test fill will be developed and overseen by the **Engineer** or a third party if accepted by the **Engineer**.
  - Test Fills will be completed for each material type used or if there are significant changes the material properties as determined by the **Engineer**.
- **Road Wearing Course** shall be:
  - **P**laced in 150 mm loose lifts.
  - The layer shall be graded to provide a relative smooth surface.
  - The material shall be compacted with a minimum of 3 passes using a 10 ton smooth drum roller.
- **Anchor Trench Backfill** shall be:
  - Have a moisture range within 2% of the optimal moisture as determined by ASTM D 698.
  - Placed in 150 mm maximum loose lifts, and compacted to a minimum of 85 percent of maximum dry density, as determined by ASTM D 698.
- **Overliner Drain Fill** shall be:
  - Placed in one single continuous lift per the thickness in the design drawings.
  - Should not be compacted by any method. Traffic over the **Overliner Drain Fill** should be controlled and limited to placement.
- **Pipe Trench Backfill** shall be:
  - Placed in one single continuous lift per the thickness in the design drawings.

- Should not be compacted by any method. Traffic over the **Pipe Trench Backfill** should be controlled and limited to placement.

- **Select Drain Fill** shall be:
  - Placed in one single continuous lift per the thickness in the design drawings.
  - Should not be compacted by any method. Traffic over the **Select Drain Fill** should be controlled and limited to placement.

3.4 Quality Control and Quality Assurance

- Quality control and quality assurance should be executed in accordance with the protocols discussed in Section 01 45 00 – Quality Control and 01 43 00 – Quality Assurance.

- Material production testing are discussed in Section 31 05 13 – Soils for Earthworks and Section 31 05 16 – Aggregate for Earthworks.

- Frequency of Tests for Fill Placement:
  - The following tables show the minimum frequency of testing by **Quality Control Consultant** unless otherwise approved by the **Engineer**:

Table 3-1: Minimum Quality Control Testing Frequency

Laboratory/Field Test	Minimum Test Frequency
Site Grading Fill, Structural Fill, and Select Fill	
In-Place Density and Moisture (ASTM D 6938)	1 per 1,500 m^3 placed
Compacted Rockfill	
In-Place Density	Method and frequency to be determined by Test Fill
Anchor Trench Backfill	
In-Place Density and Moisture (ASTM D 6938)	1 per 150 linear meters of trench.
Road Wearing Course	
In-Place Density	Not required.

- Field density and moisture testing shall be performed using a nuclear density gauge per ASTM D 6938. Field density testing should be collected from as close to the bottom of the lift as possible. If readings are not possible from the surface to the bottom of the lift then the Engineer may require a portion of the lift be trimmed off to collect a reading from the bottom of the lift.

- In cases where a nuclear density gauge cannot be used due to material type the **Contractor** may propose another method for determining and documenting density such as water replacement, development of a method specification by test fill, or other method. Any substituted method will require approval from the **Engineer**.

- If tests/inspections indicate that the **Work** does not meet these **Specifications**, the **Contractor** shall undertake remedial action as described below:
  - Density testing below specified minimum:
    - Apply additional compaction effort and retest; or

- Scarify to the depth of the lift, moisture condition, blend to achieve uniform moisture content, compact, and retest.

- Moisture content outside of specified limits:
  - Moisture content below specified minimum:
    - No remedial action required unless lift does not meet density requirements.
  - Moisture content above specified maximum:
    - Remove and dispose of the wet material; or
    - Scarify to the depth of the lift, allow to dry, blend to achieve uniform moisture content, compact, and retest;
    - Mixing of dry material to lower the moisture content is not allowed without the prior approval of the **Engineer**.
- Material does not meet required Atterberg Limits, Gradation, LA Abrasion, or Hydraulic Conductivity:
  - Material should not be placed unless approved by the **Engineer**.
  - Any material placed without the **Engineer's** approval that does not meet the requirements in the Specifications will be removed at the **Contractor's** expense.

- Modifications to these QC Procedures:
  - Test frequencies may be modified at the discretion of the **Owner**;
  - More frequent testing shall be performed where indicated by the following guidelines:
    - Areas where special compaction equipment or methods are used;
    - Areas where the height of fill rises quickly versus the quantity of fill placed;
    - Areas where compaction control is particularly important, including around appurtenant structures;
    - Areas where doubtful construction procedures are being used;
    - Areas where the required compaction may not have been achieved based upon visual observations; and
    - Areas where unacceptable material may have been placed

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

RUBBLE-STONE RIPRAP 31 37 16.13

Document No. 123022-83010-PC-TS-0020

Prepared by:

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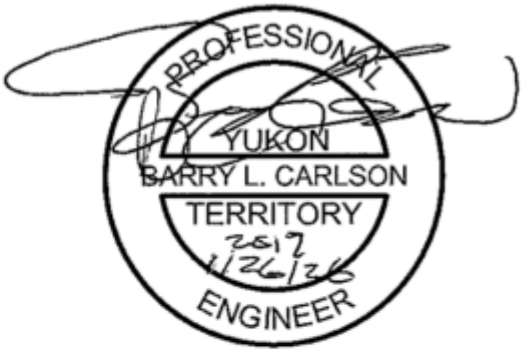

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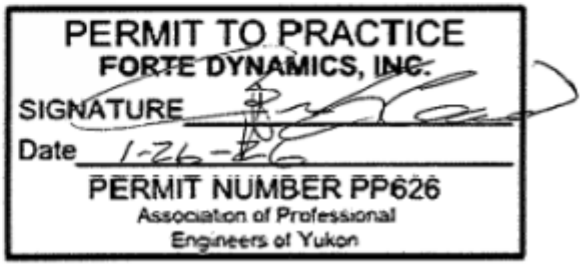

1. RELATED SECTIONS

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 22 13	Rough Grading

2. PRODUCTS

2.1 Materials

- Riprap shall consist of hard, dense, durable stone, and resistant to weathering;
- The stone shall have a specific gravity of at least 2.4;
- Riprap shall have a minimum mean particle size that conforms to the gradation requirements as shown on the **Drawings** and/ or as listed below;
- Riprap shall be inorganic non-plastic, screened, crushed, or run of mine rock aggregate, free of clay, friable material, and debris;
- Shall have no net acid generation potential;
- Material used for Riprap shall be approved by the **Quality Assurance Consultant** (by visual means);
- The **Quality Assurance Consultant** will require the **Contractor** to furnish laboratory results to verify that the materials meet the gradation requirements on a weekly composite basis for the as-built documentation records. Rip Rap shall be D50 = 12” Coarse Rock with the following gradation:

Table 2-1: Riprap Specifications

Particle/U.S. Standard Sieve Size	Percent Passing by Dry Weight
24 Inch	100
15 Inch	75
12 Inch	50
4 Inch	10

- Riprap materials not meeting the above requirements must be approved of by the **Engineer** prior to placement.

3. EXECUTION

3.1 Stockpiling

- Do not place Riprap on soft or yielding surfaces unless approved by the **Engineer**.

3.2 Placement

- Place Riprap as shown on **Drawings**;
- Place to the thicknesses and sizes shown on the **Drawings**; and
- Place Riprap in an Up-Slope direction

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

ROUGH GRADING – 31 22 13

Document No. 123022-83010-PC-TS-0021

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	A. Reiman	R. Morlan	C. Green

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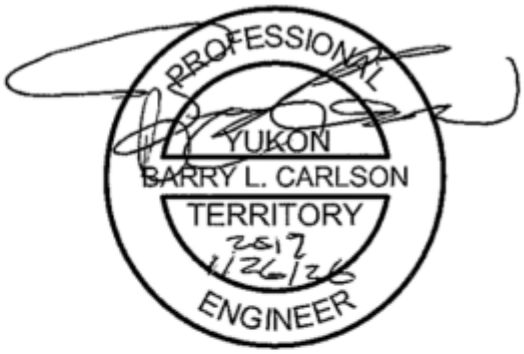

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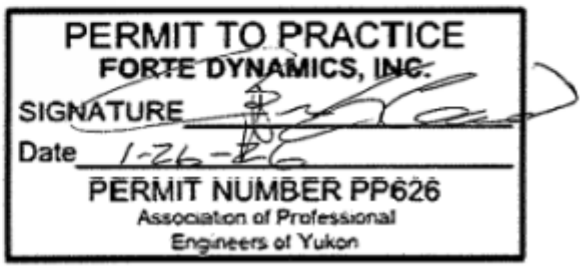

1. GENERAL

1.1 Related Sections

Section	01 31 00	Project Management and Coordination
Section	01 32 00	Construction Progress Documentation
Section	01 33 00	Submittal Procedures
Section	01 41 00	Regulatory Requirements
Section	01 42 19	Reference Standards
Section	01 43 00	Quality Assurance
Section	01 45 00	Quality Control
Section	31 14 00	Earth Stripping and Stockpiling
Section	31 23 16	Excavation
Section	31 23 23	Fill

1.2 References

ASTM C 136-19	Test Method for Sieve Analysis of Fine and Coarse Aggregate.
ASTM D 6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D 698-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft3 (600 kN-m/m3)].
ASTM D 1557-12	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 2216-19	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
ASTM D 2435-11	Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading.
ASTM D 6938-17	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 3385-18	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
ASTM D 4318-17	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4643-17	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Method.
ASTM D 5084-16	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Lines and Grades

- The **Contractor** shall locate survey control points and verify that the vertical and horizontal positioning of the **Work** is as indicated on the **Drawings**;
- The **Contractor** shall stake lines, levels, contours, and datum, as necessary;
- The **Contractor** shall protect survey control points from excavation equipment and vehicular traffic; and
- The **Contractor** shall replace destroyed or lost survey control points at no additional cost to the **Owner**.

3.2 Subgrade Preparation

- The **Contractor** shall grade materials to the lines and grades as indicated on the design **Drawings**; and
- The **Contractor** shall remove loose, soft, and otherwise unsuitable subgrade soils to a depth determined by the **Drawings** and to the satisfaction of the **Engineer**.

3.3 Grading Fill Placement

- Where **Compacted Fill** is required for achieving grade it should be placed per the requirements for the material type as discussed in Section 31 23 23.
- In areas that are inaccessible using conventional compaction equipment, these areas shall be compacted using hand-guided equipment with the approval of the **Engineer**;

3.4 Field Quality Assurance

- Field inspection and testing shall be performed in accordance with Section 01 43 00 – Quality Assurance and Section 01 45 00 - Quality Control

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

SUBDRAINAGE PIPING 33 46 16

Document No. 123022-83010-PC-TS-0022

Prepared by:

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SUMMARY

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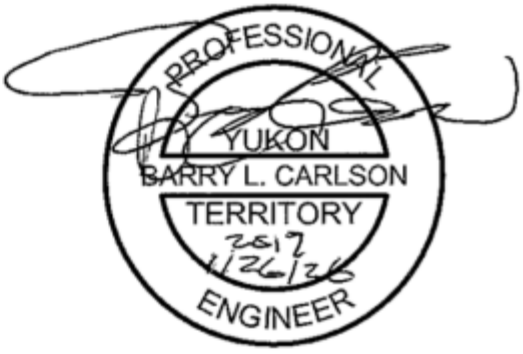

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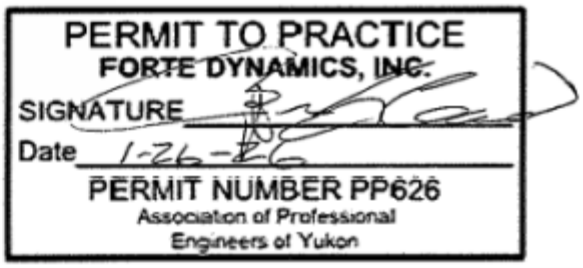

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2. PIPEWORK

2.1 Corrugated PE Pipe

- This section refers to all corrugated polyethylene (PE) **Pipework** to be used in the Project, including solution collection and drainage **Pipes** and culvert **Pipes**.
    - All **Pipe** and fittings shall be made of virgin polyethylene compounds, which shall have a minimum cell classification as defined by ASTM D 3350.
    - All **Pipe** and fittings shall be manufactured in compliance with AASHTO Standard **Specifications**.
    - All sizes shall conform to the AASHTO classification:
        - “Type S” for dual-wall, smooth interior solid **Pipe**
        - “Type SP” for dual-wall, smooth interior perforated **Pipe**
        - “Type CP” for single-wall, perforated **Pipe**.
    - Sealed couplers shall conform to ASTM D 3212.
- Where perforations are specified, they shall conform to the requirements as follows:
    - ASTM F 667-16 for three 76 mm diameter **Pipe**;
    - AASHTO M-252 “Class 2” for 100 mm to ten 250 mm diameter **Pipe**;
    - AASHTO M-294 “Class 1” for 300 mm to three 915 mm diameter **Pipe**; and
    - Slots shall be cut circumferentially unless specified otherwise.
- Couplings shall be corrugated to match the **Pipe** corrugations and shall provide sufficient longitudinal strength to preserve **Pipe** alignment and prevent separation at the joints.
- Couplings, unless watertight connections are specified, shall be split collar and shall engage at least two (2) full corrugations on each Pipe section

2.2 HDPE Pipe

- Materials used for the manufacture of high-density polyethylene **(HDPE) Pipe** and fittings shall not contain any recycled compounds other than those generated in the Manufacturer's plant from the resin of the same specification and from the same raw material supplier.
    - The material shall be a very high molecular weight, high-density ethylene/hexene copolymer polyethylene resin, having a material designation of PE 3408;
    - The material classification shall be Type III, PE 34; and
    - The minimum Cell Classification shall be 345464C as per ASTM D 3350-20.
- Dimensions and workmanship for **HDPE Pipe** shall be as specified by ASTM F 714-21a, and D 2513-20. **Pipe** diameters shall be as specified on the **Drawings**.
- **HDPE Pipe** lengths shall be joined by thermal butt fusion in strict accordance with the **Pipe** Manufacturer's recommendations, unless flanged end **Pipes** are specified on the **Drawings**.
    - The butt fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the **Pipe** Manufacturer;
    - Stub ends and **Pipe** fittings for butt fusion shall be of at least the same wall thickness and pressure rating and the same resin type, grade, and cell classification and Manufacturer as the **Pipe** to be joined, unless otherwise recommended by the Manufacturer; and
    - Thermal butt fusion of **HDPE Pipe** shall be carried out by qualified technicians.
- Backup rings for flanged joints shall be the convoluted type of ductile iron material (ASTM 536-80 Grade Range from 60/40/18 to 64/45/12), drilled to ANSI bolt circles, and have a pressure rating of 150 psi, unless otherwise specified.
- Backup flanges and bolts shall be as approved or supplied by the **Pipe** Manufacturer

3. PRODUCTS (NOT USED)

4. EXECUTION

4.1 Installation

- The **Owner** or **Contractor** shall furnish the **Pipework** and miscellaneous materials appurtenant to, and in accordance with, the Manufacturer's instructions and recommendations.
- The **Contractor** shall install the **Pipework** and miscellaneous materials appurtenant to, and in accordance with, the Manufacturer's instructions and recommendations.
- The **Pipework** shall be installed to the lines and grades and generally in the manner shown on the Drawings;

- Where specific lines and grades are not indicated on the **Drawings**, the lines and grades will be specified by the **Quality Assurance Consultant** in the field to suit the existing ground conditions.
- The **Pipe** shall be installed using equipment and methods described in these Technical **Specifications** and in accordance with the **Pipe** Manufacturer's recommendations for handling and placement of the **Pipe** and fittings.

- The **Pipework** shall be installed in accordance with good piping practices, whether such practices are specifically detailed on the **Drawings** or not.
  - The general layout as shown on the **Drawings** shall be maintained; and
  - Where interference is encountered during installation or relocation of **Pipework** is deemed necessary, the **Engineer** shall be consulted and shall approve the revised plan before any changes are made.
- All **Pipework** shall be erected to preserve accurate alignments.
- Care shall be taken during the installation of **Pipeline** runs where drainage is required to ensure that the **Pipeline** has a continuous **Slope** to the point of drainage.
- Construction equipment shall not cross over installed **Pipework** unless covered with specified material or protective cover fill approved by the **Engineer**.
- If **Pipework** is damaged by the **Contractor's** method of installation and construction and are deemed not suitable for use in the permanent construction as determined by the **Engineer**, the damaged **Pipework** shall be replaced by the **Contractor** at no additional cost to the **Owner**.
- Prior to installation, each segment of **Pipe** and all fittings shall be inspected for defects and/or damage.
  - Care shall be exercised to prevent foreign matter from entering the **Pipe** while it is being installed.
  - Open ends of the **Pipe** shall be covered by temporary end caps or other approved means when installation is not in progress to prevent foreign matter from entering the **Pipe**.
- **Pipe** bends to form curves, either in the horizontal or vertical plane, shall not exceed that recommended by the Manufacturer or as approved by the **Engineer**.
- The cutting of **Pipe** for inserting fittings or closure pieces shall be done in a neat and workmanship like manner without damage to the Pipe and so as to leave a smooth end at right angles to the axis of the **Pipe**.
- Couplers used to join two (2) sections of corrugated **Pipe** together or to join a **Pipe** section with a fitting (i.e., wye, tee, etc.) shall be of the snap variety for diameters of ten (10) inches or less and of the split variety for diameters greater than one (1) foot.
  - Zip ties used to secure split couplers must be manufactured of the same material as that of the couplers themselves.

- All unions between **Pipe** sections or specific fittings shall be completed such that the seam in the split coupler (for diameters that require split couplers) shall be rotated to the **Pipe** springline (such that the potential ingress of solids is eliminated).

- During actual solution collection **Pipework** installation, methods shall be developed to ensure the corrugated **Pipe** is not damaged during installation or backfilling.

- Sequencing of corrugated **Pipe** placement on the leach pad shall be done such that vehicle traffic is minimized over the completed areas.

- The culvert PE Pipes shall be installed in accordance with the Manufacturer's **instructions** and **recommendations**.

  - The culvert **Pipes** shall be handled with fabric, non-metallic slings and shall not be dragged along the ground.

  - Pipe connections shall be banded with one (1) foot minimum width metal straps provided by the Manufacturer.

  - Joint bands shall be positioned and drawn tight before the next section of Pipe is positioned.

  - Deflections or "kinks" at joints shall be acceptable, provided they are not greater than the maximum deflection recommended by the Pipe Manufacturer

End of Specification

Technical Specification

KAMINAK GOLD LTD. A SUBSIDIARY OF FUERTE METALS

COFFEE PROJECT

DRAINAGE LAYERS 33 46 23

Document No. 123017-83010-PC-TS-0023

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0	01/26/2026	Issued for Licensing	L. Burnett	A. Reiman	C. Green

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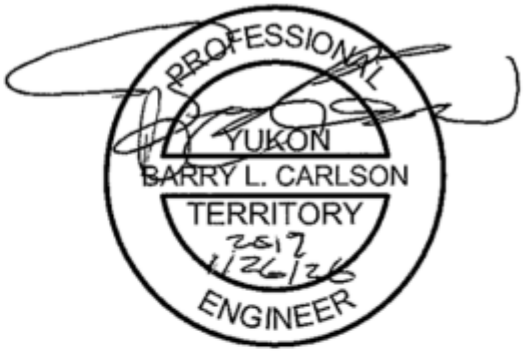

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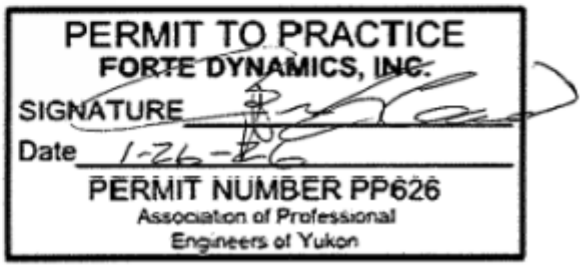

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2. PRODUCTS

2.1 Overliner Drain Fill Materials

- **Overliner Drain Fill** is described in Section 31 05 16 – Aggregate for Earthwork and shall be placed as specified in this section.
- The **Owner** shall provide the **Overliner Drain Fill** material for the leach pad area in stockpiles near the crusher site and/or other stockpile areas as needed. The material shall be free of organic matter and soft, friable particles in quantities objectionable to the **Engineer**

3. EXECUTION

3.1 Overview

- The **Overliner Drain** material shall be placed in such a manner as to reduce segregation and construct the zones in accordance with the details and to the lines and grades shown on the **Drawings**, or as specified by the **Engineer**.
    - Methods shall be developed on-site for placing the material in a manner that will protect the **Geomembrane** and/or **Pipework** from damage and keep compaction of the material to a minimum.
- **Overliner Drain Fill** placed on the heap leach pad liner shall be placed in a lift by suitable dozer and truck equipment, as approved by the **Engineer**.
    - **Overliner Drain Fill** placement equipment shall not exceed eight (8) psi at the liner surface;
    - A thicker layer of **Overliner Drain Fill** shall be placed over the heap leach pad liner in areas trafficked by haul trucks with a payload capacity of 40 tons or less. The thickness of this layer will be determined by Test Fill method which will be overseen by the **Quality Assurance Consultant**.
    - No moisture conditioning or compaction of the **Overliner Drain Fill** is required.

- Haul truck speeds, braking, and turning during **Overliner Drain Fill** placement on the heap leach pad liner shall be strictly controlled by the **Contractor** to prevent damage to the underlying **Geomembrane** and **Pipework**.
    - The thickness of the **Overliner Drain Fill** shall also be increased in concentrated traffic areas or across collector **Pipes**, as required, to prevent damage to the **Geomembrane** and **Pipework**. This thickness will should be approved by the **Engineer**.
    - Haul traffic on the **Overliner Drain Fill** surface shall be spread out as much as practical to prevent over-compaction in localized areas.

End of Specification

APPENDIX D: HYDROLOGY AND HYDRAULICS

FUERTE METALS

Coffee Mine Project

HLF Water Conveyance Infrastructure Hydrology & Open Channel Hydraulic Report

Document #123022-51010-CV-EDR-2003



Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
0	01/26/2026	Issued for Licensing	J. Prendergast	A. Reiman	C. Green

STATEMENT OF REPORT

The report enclosed entitled “HLF Water Conveyance Infrastructure Hydrology and Open Channel Hydraulic Report” has been prepared for the exclusive use of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. No third party shall be entitled to use this report without written consent of Kaminak and Forte Dynamics, Inc (Forte). The use of any and all information contained herein shall be at the sole risk of the user regardless of any fault or negligence of Kaminak Gold Corp or Forte Dynamics, Inc.

This report has been prepared under the direct supervision of Clint Green, P.E., with assistance from Joseph Prendergast of Forte Dynamics, Inc. This report was prepared as part of a greater project and assesses the hydrology and hydraulics of storm water for the proposed site developments. Our opinions and recommendations regarding design criteria and construction details for site development, channels, culverts and drainage are provided. The information and recommendations presented are according to the project information and reports provided by Kaminak.

We believe this assessment was conducted in a manner consistent with that level of skill and care ordinarily used by members of the profession currently practicing under similar conditions in the locality of this project. No warranty, express or implied, is made.

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1. INTRODUCTION

This hydrology and hydraulics (H&H) report was prepared by Forte Dynamics, Inc. (Forte) for Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals. Kaminak contracted Forte as a consultant to provide engineering services related to storm water management in and around the proposed heap leach facilities at their Coffee Gold Project site. This report details the methods and calculations used to determine hydrologic and hydraulic assessments for the site.

As part of a greater project, a hydrologic and hydraulic assessment was completed for the proposed Heap Leach Pad (HLP) developments at the Coffee Gold Project, to convey flows within the footprint, and diversion for tributary areas outside the footprint. This H&H report outlines the required performance standards, documents design flows, and details the development of the hydrologic methodology and hydraulic model used to evaluate how storm water can be managed throughout the life of the mine.

1.1 Background

The Coffee Gold Project is located about 130 km south of Dawson City and 180 km northwest of Whitehorse, Yukon Territory, Canada. The proposed operations on the project will include standard heap leaching technology to extract and recover gold and precious metal resources. Currently, the elevations of the proposed heap leach facilities range from 1150 m above sea level (ASL) and 1370 m ASL.

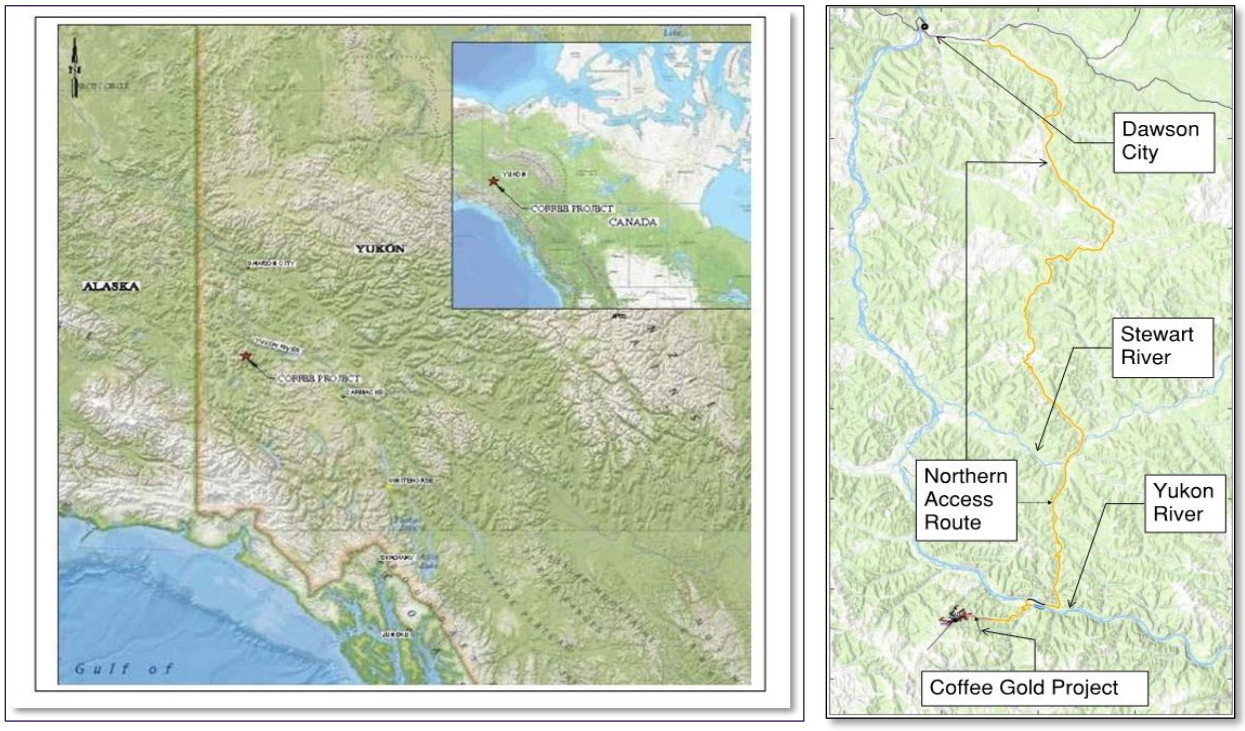

Figure 1-1: General and Project Location

Ore processing operations include the design of a multi-phased heap leach pad (HLP), solution conveyance infrastructure, process ponds, crushing and conveying system (design by others), Process Plant (Adsorption, Desorption, Refinery (ADR)) (design by others), utilities (design by others), reagents (design by others) and site infrastructure (design by others). The figure below displays a proposed layout of the project facilities.

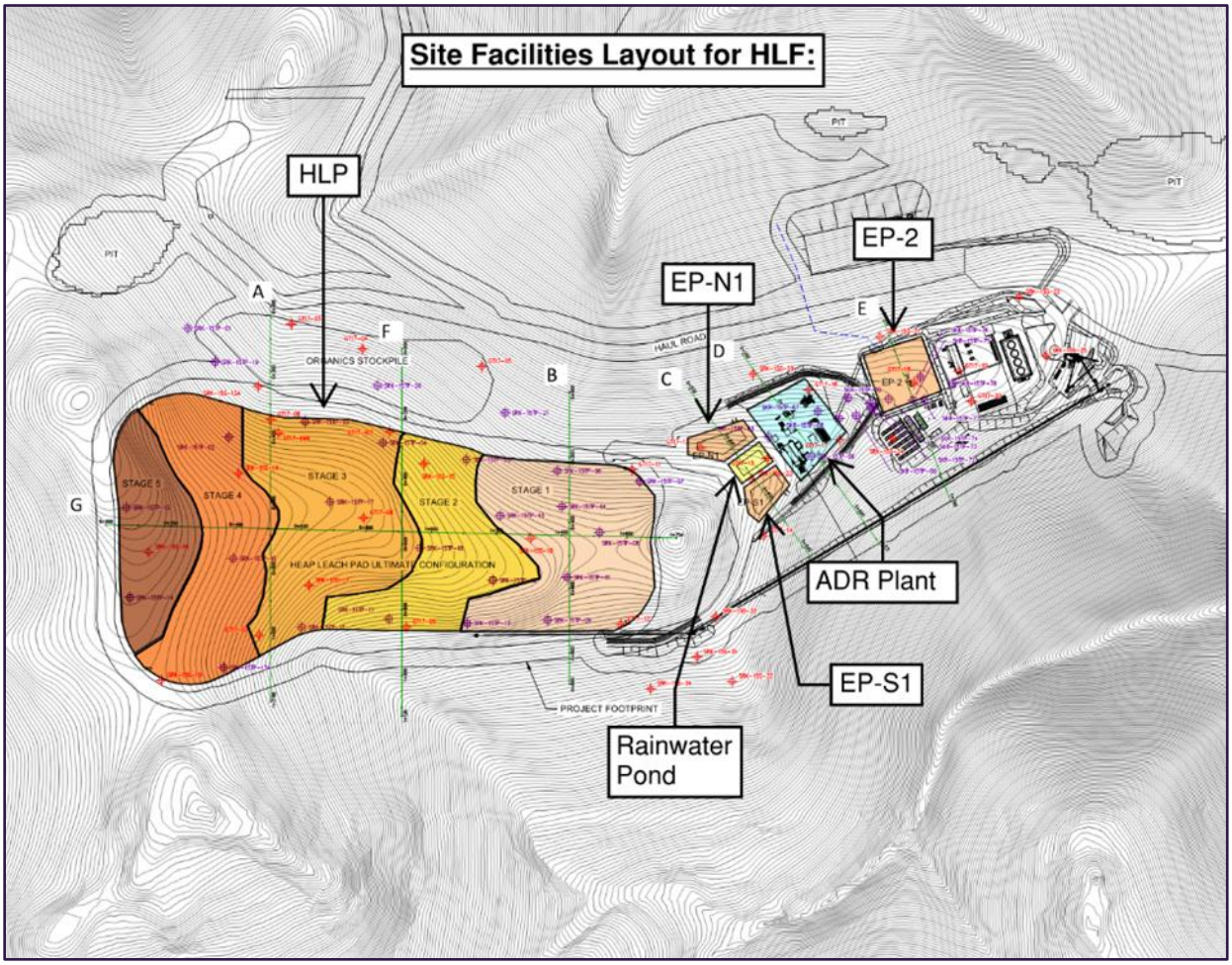

Figure 1-2: Coffee Gold Project HLF Layout

2. SITE DESCRIPTION

The project site resides in an overall sparsely populated and remote location of the White Gold District of Yukon Territory, Canada. The Project is located in the Northern Dawson Range, on the traditional territory of the Tr'ondëk Hwëch'in and the asserted area of the White River First Nation.

Currently, the Coffee claim block (or Property) is owned by Kaminak Gold. The project terrain is typical for west-central Yukon, comprising rolling hills, and rounded mountains and V-shaped valleys. The vegetation primarily consists of a mixed forest of deciduous and coniferous tree species (aspen, birch, larch and spruce), and low-lying shrubs typical of the Boreal Forest. Most of the surrounding landscape is characterized by rounded mountain summits and ridges with a typical relief between 300 and 400 meters in elevation. The headwaters of three watersheds exist nearby including Halfway Creek, Latte Creek and YT-24.

2.1 Site Conditions

The Coffee Gold Project area is located in a zone of extensive discontinuous permafrost. The overall site contains a thin, active overburden veneer consisting of soil and organics that is subject to freeze-thaw cycles. Soils in this active layer are typically silty, light to dark brown in color and loosely compacted with high amounts of gravel and ice. The typical depth of active layer soils in the HLF footprint is about 1.2 to 3.3 meters underlain by bedrock. Soils are generally of low permeability and exhibit high surficial runoff characteristics (Tetra Tech, 2016b).

Vegetation throughout the project site ranges from dense shrubbery to scattered trees with little undergrowth. The soil veneer is generally regarded as growth media for this vegetation. Vegetation typically consists of coniferous and deciduous trees, and low-lying shrubs. Typical creatures of the Boreal forests of Yukon, Canada include squirrels, voles, hares, lemmings and wolverines, and commonly dig shallow burrows amongst the overburden layer.

Current groundwater levels are not expected to significantly affect the site development as it is estimated the groundwater table is below any planned construction depths.

Soil infiltration rates are affected by subsurface permeability and surface intake rates. Soils are classified into four hydrologic soil groups (A through D) according to their minimum infiltration rate which is obtained for bare soil after prolonged wetting. The following table defines the four groups as defined by TR-55.

Table 2-1: Hydrologic Soil Group Definitions

HSG	Definitions
Group A	Soils with high infiltration rates even when thoroughly wetted. These consist chiefly of deep, well-drained sands and gravels. These soils have a high rate of water transmission (final infiltration rate greater than 0.30 in (7.6 mm) per hour)
Group B	Soils with moderate infiltration rates when thoroughly wetted. These consist chiefly of soils that are moderately deep to deep, moderately well drained to well drained with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (final infiltration rate of 0.15–0.30 inches (3.8–7.6 mm) per hour.
Group C	Soils with slow infiltration rates when thoroughly wetted. These consist chiefly of soils with a layer that impedes downward movement of water or soils with moderately fine to fine textures. These soils have a slow rate of water transmission (final infiltration rate 0.05–0.15 inches (1.3–3.8 mm) per hour).
Group D	Soils with very slow infiltration rates when thoroughly wetted. These consists chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission (final infiltration rate less than 0.05 inches per hour.

Ground temperature data obtained from thermistors installed in, around and downgradient of major mine facilities as well as observations from drilling and monitoring well sampling indicate that permafrost is discontinuous but extensive across the project area. The thickest and coolest permafrost was found on the north-facing slopes (~168 meters and -1.9°C to -1.4°C respectively). Permafrost appears to decrease in thickness with declining ground surface elevation (Lorax, 2021).

The overall site contains a thin, active overburden veneer consisting of soil and organics that is subject to freeze-thaw cycles. Soils in this layer are typically silty, light to dark brown in color and loosely compacted with high amounts of gravel and ice. The typical depth of active layer soils in the HLF footprint is about 1.2 to 3.3 meters underlain by bedrock. Soils are generally of low permeability and exhibit high surficial runoff characteristics (Tetra Tech, 2016b).

3. SCS CURVE NUMBER

First issued by the Soil Conservation Service (SCS, now NRCS) in January 1975, the Technical Release 55 (TR-55) presents procedures to estimate storm runoff volumes, peak rates of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small (under 250 km^2) watersheds in the U.S. The model described in TR-55 begins with a rainfall amount uniformly imposed on the small watershed over a specified time distribution. Mass rainfall is converted to mass runoff by using a runoff curve number (CN).

The major factors that determine the SCS runoff curve number are hydrologic soil groups, cover type, treatment, hydrologic condition, antecedent runoff conditions (ARC). Mean annual precipitation ranges from about 300 mm to 500 mm, giving the region a semi-arid classification (Yukon Ecoregions Working Group, 2004).

The following table is a replica of TR-55's Table 2-2d Runoff curve numbers for arid and semiarid rangelands.

Table 3-1: Runoff Curve Number for Arid and Semiarid Rangelands[1] (TR-55, Table 2-2d)

Cover Description		Curve Numbers for Hydrologic Soil Groups			
Cover Type	Hydrologic Condition[2]	A[3]	B	C	D
Herbaceous – mixture of grass, weeds, and low-growing brush, with brush the minor element	Poor	-	80	87	93
	Fair	-	71	81	89
	Good	-	62	74	85
Oak-Aspen – mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor	-	66	74	79
	Fair	-	48	57	63
	Good	-	30	41	48
Pinyon-Juniper – pinyon, juniper, or both; grass understory	Poor	-	75	85	89
	Fair	-	88	73	80
	Good	-	41	61	71
Sagebrush with grass understory	Poor	-	67	80	85
	Fair	-	51	63	70
	Good	-	35	47	55
Desert shrub – major plants include saltbush, greasewood, creosote bush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Table 3-2 below presents the CN values selected for the site. The prepared (cleared and grubbed) HLP Surface is utilized for analysis of the Interceptor Ditch which has tributary inside and outside of the current operating HLP footprint. The Exposed Liner, Ore Leached, and Ore Unleached, and associated CN presented in Table 3-3 all represents ground covers relative to inside the HLP and utilized in analysis of Perimeter Channel.

Table 3-2: Composite CN for the Site

Interceptor Ditch	Perimeter Channel
86	98

Table 3-3: HLP Interior Footprint Selected Curve Numbers

Prepared HLP Surface	Exposed Liner	Ore Leached	Ore Unleached
86	99	75	75

Referencing Table 3-1 above, the CN for HLP Surface was selected as identifying it for a mountain brush mixture cover type of poor hydrologic condition in Group D, a curve number of 79 is appropriate for the area of interest of current/native conditions. To allow flexibility to the project and allow for the potential to clear, grub and to prepare subgrade for HLP expansion, a CN of 86 was selected and used for calculations.

The Exposed Liner represents areas inside the operating HLP that at the completion of improvements, liner remains exposed. These areas include perimeter channels, and raincoats. The Ore Leached includes areas of the pad under nominal leach rate of 1100 m^3/hr plus an additional 300 m^3/hr of flow for the potential use of dynamic storage, resulting in a total potential pumping flow of 1400 m^3/hr,

The weighted or composite CN for the conveyance infrastructure of Interceptor Ditch and Perimeter Channel are presented in Table 3-2.

All of the tributary area to the Interceptor Ditch including future stages 2-5, and area outside of ultimate HLP footprint were analyzed utilizing CN of 86 matching Prepared HLP Surface from Table 3-3. This is considered conservative as it is currently only foreseen that 1 stage in advance will be cleared and grubbed but again allows operations flexibility for clearing more area for use as laydown or other. The tributary area outside the footprint is primarily knobs with assumed little vegetation and therefore CN of 86 also utilized in hydrological calculations.

In consideration of composite CN for the Perimeter Channels, both north and south have tributary areas inside the HLP footprint consisting of Exposed Liner, Ore Leached, and Ore Unleached. Although the HLF Water Balance prepared by Forte shows that usage of Raincoats is not required, it is identified as a potential opportunity in operations to manage solution. Another consideration is concurrent reclamation. There is potential for some period of time during cover placement and after that runoff from covered areas may have to be collected sampled and tested. Although a CN for cover is not listed here, its purpose is to be low permeability. Due to the considerations of potential use of raincoats and potential for temporary storage of cover runoff, a conservative CN value of 98 was selected to allow for almost all the HLP to be covered by raincoats or reclamation cover. This is equivalent to 91% of the HLP area being covered by exposed liner, and 9% being leached ore.

4. HYDROLOGIC ASSESSMENT

The tributary areas contributing to any runoff flowing through or near the proposed heap leach facility were delineated in AutoCAD Civil 3D 2021 and found using existing topography, natural surface features and/or projected grading plans. These areas were then further analyzed to assess infiltration and runoff flow progression. Due to the unique ridge top location of the HLP, the tributary areas could be further subdivided into two drainage subbasins (north and south). The subbasins delineated represent a circumstance that considers area, and surface condition, which produces a conservative (largest) runoff flowrate. More detail on basin delineation is presented in Section 4.3 Basin Delineations.

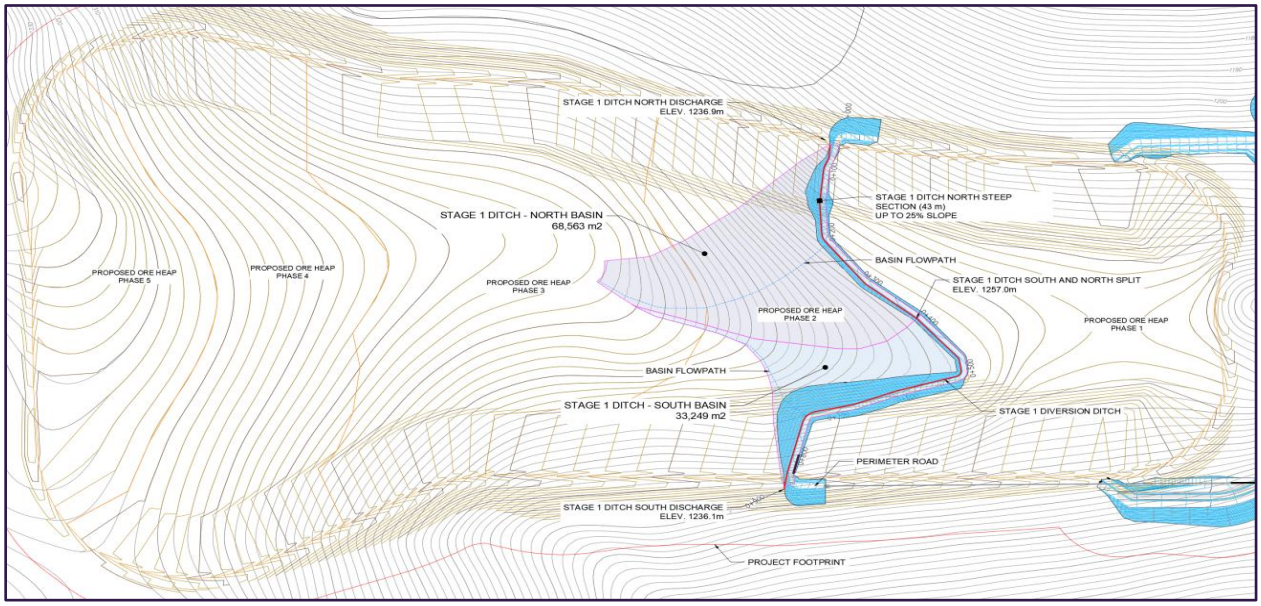

Figure 4-1: Interceptor Ditch Basins

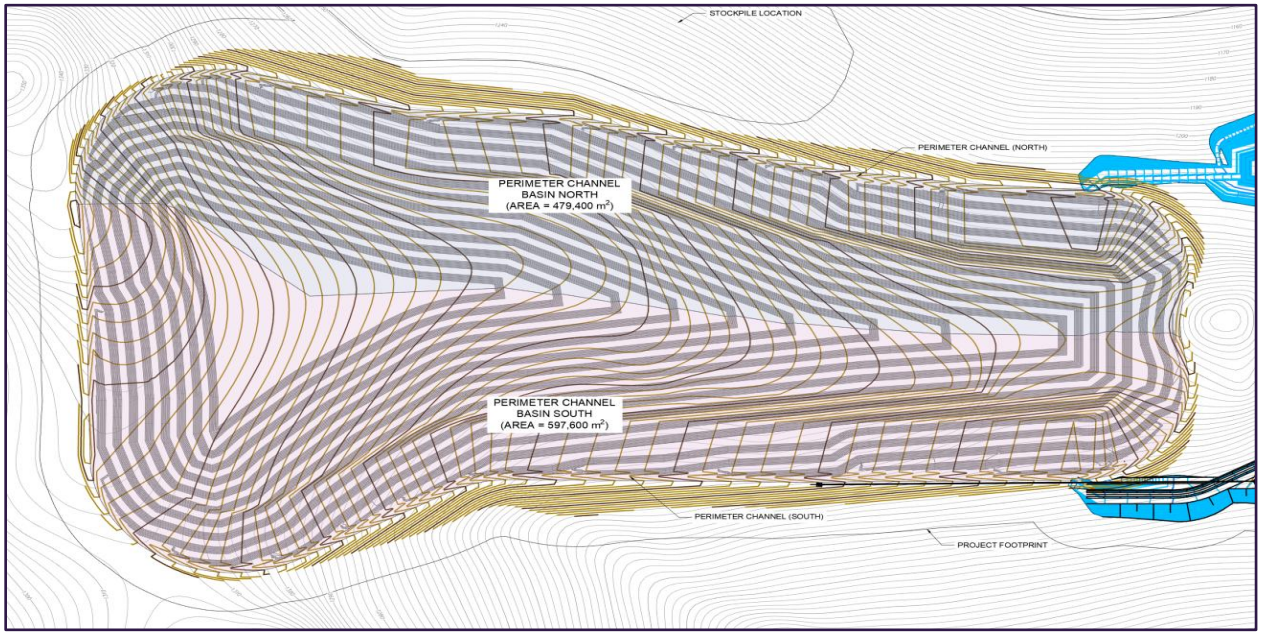

Figure 4-2: Perimeter Channel Basins

4.1 Precipitation

Estimates of precipitation depths came from Table 4-18 of the Coffee Gold Project: 2021 Hydro-meteorology Baseline Report (Lorax, 2022).

Table 4-1 below summarizes the estimated 24-hour rainfall recurrence interval estimated depths for the project at an elevation of 1,300 m (average HLP elevation). The probable maximum precipitation (PMP) is defined as the greatest depth of precipitation for a given duration meteorologically possible for a designed watershed at a particular. The estimated 24-hour PMP rainfall depth was not included in Table 4-18 of the baseline report but was reported later in Section 4.4.2 and was based on statistical methods using nearby regional climate records and scaled to the reference elevation of 1,300 m.

Table 4-1: 24-Hr Storm Event Precipitation Estimates at HLP Elevation (Lorax, 2022)

Recurrence (years)	Depth (mm)
2	38
5	56
10	67
25	80
50	89
100	98
200	106
PMP	283

Calculations used to size the Interceptor Ditch and Perimeter Channel only considered precipitation as rainfall; other factors including snowfall, evaporation and transpiration were not considered in this analysis.

4.2 Design Storm

The intensity of rainfall varies considerably during a storm as well as by geographic region. For this reason, TR-55 provides four U.S regional rainfall time distributions (Type I, IA, II and III) for a 24-hour period. These calculated synthetic rainfall distributions correlate with typical climates and storm intensities. Type IA and Type II are the least and most intense short duration rainfall respectively. The following figures show the four distributions and their approximate geographic boundaries within the United States.

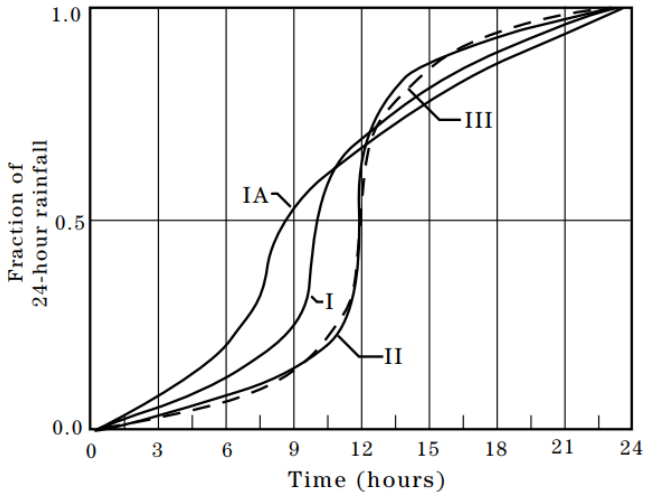

Figure 4-3: SCS 24-Hour Rainfall Distributions

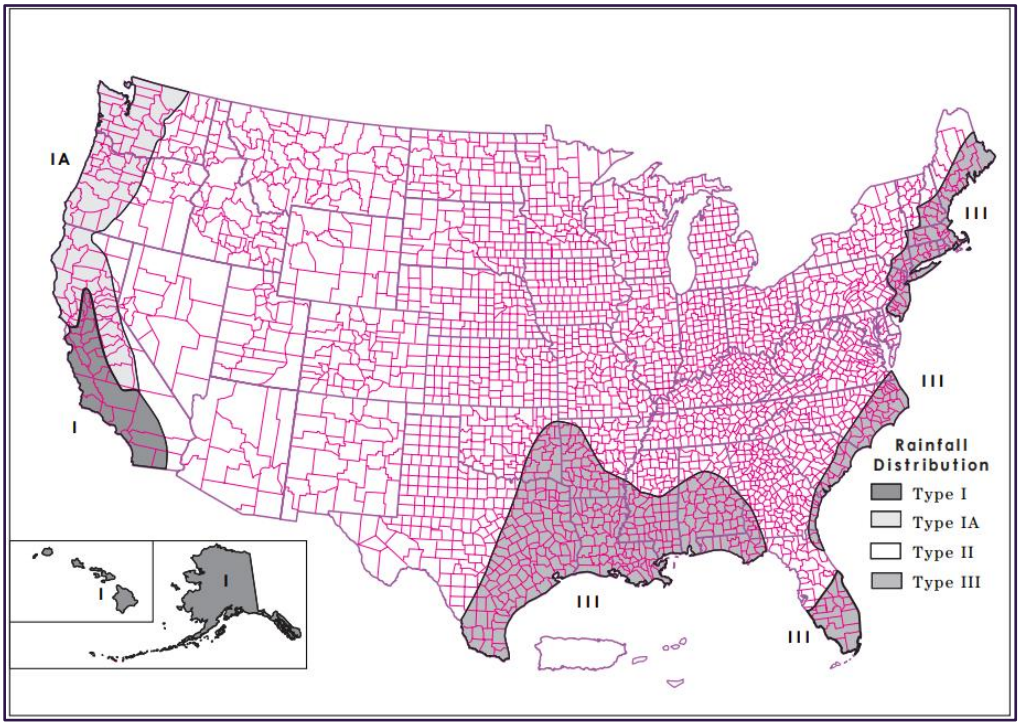

Figure 4-4: Approximate Geographic Boundaries for NRCS (SCS) Rainfall Distributions

For the Coffee Mine Project, an SCS Type II storm distribution pattern was selected based on geography, similar weather patterns, comparisons of cumulative precipitation for typical storms in the area and to maintain consistency with previous hydrology reports at the project site. A Type II storm distribution is characterized by a longer peak storm intensity during the middle of the storm event and having the most intense short duration rainfall of all storm types.

4.3 Basin Delineations

Upstream watershed basins were delineated by natural topography and/or by proposed constructed diversion. Two basins for the Interceptor Ditch and two basins for the Perimeter Channel were delineated and analyzed, Figure 4-1 and Figure 4-2 respectively, during the most critical time to determine surface runoff. The most critical time represents a time where a storm event would yield the most runoff to a defined basin. The timing and phasing of the development of site facilities were considered to determine the ground conditions that promote the most runoff.

For the Interceptor Ditch basin, the most critical time was defined when Stage 1 is under construction. The Interceptor Ditch basin includes over 100,000 m^2 of tributary area and all within the proposed HLP footprint. To allow for flexibility to the project, the entire tributary area was considered Prepared HLP Surface which assumes a greater runoff than the natural surface, and a CN of 86 was selected and used for calculations.

For the Perimeter Channel basin, the most critical time correlated with circumstances that presented the full footprint construction through Stage 5, with Stages 1-4 being covered with raincoats, and stage 5 being exposed liner prior to loading. Although raincoats are not included in water balance to maintain adequate available storage in the ponds, the perimeter channels did consider the implementation for them to allow flexibility in operations for their use. The same surface condition was considered for both north and south, and areas adjusted appropriately based on the grade of the liner and basin break. The largest peak flow produced from each of the basins was utilized in hydraulic analysis for both perimeter channels.

4.4 Time of Concentration

Time of concentration (T_c) is the time required for runoff to travel from the hydraulically most distant point in the watershed to the discharge outlet. Factors affecting the time of concentration include surface roughness, overland and channelized flow slopes, flow length and the potential for any retention. The time of concentration for the Interceptor Ditch basin was estimated using the NRCS Lag Method where:

$$T_c = \frac{\ell^{0.8}(S+1)^{0.7}}{1140Y^{0.5}}.$$

Here, ℓ = flow length (ft), S = maximum potential retention (in) and Y = average watershed land slope (%).

Due to a larger majority of flow being channelized flow, the time of concentration for the Perimeter Channel was estimated using the NRCS Velocity Method where the time of concentration is assumed to be the sum of travel times for segments along the hydraulically most distant flow path.

$$T_c = T_{t1} + T_{t2} + T_{t3} + \ldots T_{tn}.$$

Here, T_{tn}= travel time of segment n (hr), and n = index of segment comprising the total hydraulic length. The segments used in the velocity method may be one of three types 1) sheet flow 2) shallow concentrated flow and 3) open channel flow.

The lag time is the delay between the time runoff from a rainfall event begins until the runoff reaches its maximum peak. For average natural watershed conditions and an approximately uniform distribution of runoff, the relationship between lag and time of concentration can be described by the below equation:

$$L = 0.6T_C$$

where L = lag time. The table below summarizes the time of concentration and lag time for each basin.

Table 4-2: 24-Hr Storm Event Precipitation Estimates at HLP Elevation (Lorax, 2022)

Basin	Time of Concentration (min)	Lag Time (min)
Interceptor Ditch Basin (North)	15.0	9.0
Interceptor Ditch Basin (South)	14.7	8.8
Perimeter Channel Basin (South)	14.5	8.7

4.5 Surface Hydrology

Runoff is determined primarily by the amount of precipitation and by infiltration characteristics related to soil type, soil moisture, antecedent rainfall, cover type, impervious surfaces, and surface retention.

4.6 Interceptor Ditch

Surface water management infrastructure was designed to convey the runoff at the most critical times and to withstand dynamic forces due to increased water levels or increased flow velocities. The interceptor was designed just upgradient of Stage 1, to intercept tributary flows. Clear and grub of surface areas for Stage 2-5 were assumed conditions for a conservative design. Before a subsequent stage begins construction, the above stage interceptor ditch will be required to be reconstructed. Only after the upstream interceptor ditch is constructed can the downstream diversion ditch be removed. The tributary area to the ditch will be reduced, therefore reducing the peak flow in future interceptor ditches.

4.7 Perimeter Channel

Surface water management infrastructure was designed to convey the runoff at the most critical times and to withstand dynamic forces due to increased water levels or increased flow velocities. This included raincoat covers on Stages 1-4, and exposed foundation liner on Stage 5 prior to loading, resulting in a very conservative CN.

4.8 Hydrologic Model

The U.S Army Corps of Engineers HEC-HMS, version 4.9 computer application, was used to calculate peak flow rates and runoff volumes.

The following parameters were common to all basin components calculated by the software:

- Model time interval: *1 minute*
- Transform Method: *SCS Unit Hydrograph*
- Storm Distribution: *SCS Type II*
- 100-yr, 24-hr precipitation depth: *98 mm (Interceptor Ditch)*
- PMP, 24-hr precipitation depth: *283 mm (Perimeter Channel)*

4.9 Hydrologic Results

Human influenced modifications such as urbanization, regrading, farming, mining, etc. change a watershed's response to precipitation. The most common effects are reduced infiltration and decreased time of concentration. These reductions significantly increase peak discharges and runoff.

The following table displays a basin summary and incorporated the results calculated by the HEC-HMS software for each basin.

Both north and south basins were evaluated and the basin with the largest peak discharge was used to size the ditch or channel. For the perimeter berm, the south basin resulted in the larger peak discharge, and for the interceptor ditch, the north basin resulted in the larger peak discharge.

Table 4-3: Overall Subbasin Summary

Subbasin Outlet	Area m^2	Hydrologic Length m	CN	Lag Time min	Peak Discharge cms
Interceptor Ditch (North)	68,563	524	86	9.0	1.71
Perimeter Channel (South)	597,600	2,932	98	8.7	52

5. HYDRAULIC ASSESSMENT OF STAGE INTERCEPTOR DITCH

During each stage of HLP construction, surface runoff for the watershed basins above the construction area will be managed using a lined interceptor ditch. Once construction of the stage is complete, a new interceptor ditch will be constructed upstream of the subsequent stage before the existing interceptor ditch can be removed.

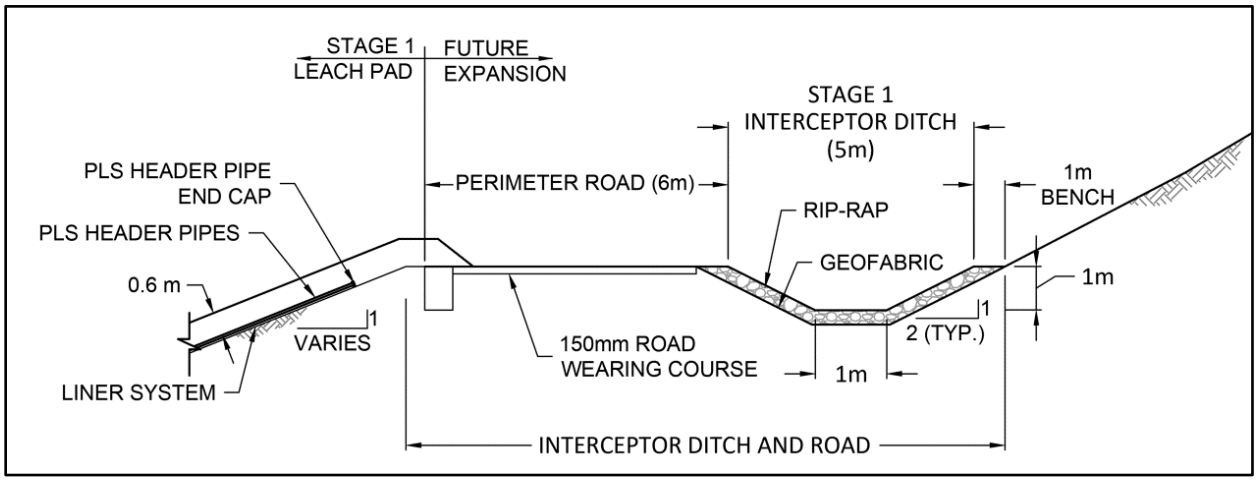

Figure 5-1: Stage Interceptor Ditch Detail

5.1 Hydraulic Performance Standards

The Interceptor Ditch will convey stormwater and is designed to contain a 100-year, 24-hour storm event, while maintaining a minimum of 0.15 m freeboard.

5.2 Interceptor Ditch Design

The Interceptor Ditch is designed to be constructed prior to construction of a HLP stage and then removed once a new Interceptor Ditch is constructed upstream of additional HLP stage construction. Although temporary, the ditch is designed to be permanent in case HLP construction is interrupted for an extended amount of time.

The Interceptor Ditch is designed to intercept runoff upstream of any planned HLP construction stage and direct the stormwater either to the north or to the south of the HLP footprint and which will flow into natural or existing drainage features.

5.3 Hydraulic Analysis Interceptor Ditch

Manning's equation was utilized to analyze the interceptor ditch. Given the peak flow rate, and constraint of the slope generally following HLF foundation the cross section was varied to determine adequate cross section to provide freeboard. The velocity was also a result of the calculation see below section of international work completed on determining adequate lining system give expected velocities. See Appendix A for calculations.

The analysis inputs including designed cross section are included in Table 5-1, and the results of which in Manning's equation are presented in Table 5-2.

Table 5-1: Interceptor Ditch Analysis Inputs

Channel Name	Design Flow (m3/s)	Min Bottom Slope (m/m)	Manning's N	Bottom Width (m)	Total Depth (m)	Side Slope (H:1V)
Stage 1 North	1.71	0.011	0.077	1.0	1.0	2
Stage 1 South	0.83	0.010	0.070	1.0	1.0	2

Table 5-2: Interceptor Ditch Analysis Results

Channel Name	Water Depth (m)	Critical Depth (m)	Velocity (m/s)	Froude
Stage 1 South	0.59	0.33	0.65	0.34
Stage 1 North	0.77	0.49	0.87	0.40

5.4 Ditch Lining and Construction

Riprap linings are considered permanent flexible linings and may be described as a non-cohesive layer of stone or rock. General design procedures for flexible channel linings based on concepts presented in "Design of Riprap Erosion Mitigation Systems" (WSMC) were used to determine the minimum stable riprap size for the ditch bottom and side slopes. Riprap gradation should follow a smooth size distribution curve and the value D_{50} represents the median riprap stone size.

Riprap to be used for the Interceptor Ditch lining is assumed to be crushed rock with a typical specific weight of stone of 25,900 N/m^3 (SG = 2.64). The angle of repose for crushed rock riprap is typically between 42 and 43 degrees depending on the mean size. If the available stone is different from these values, the site-specific values should be used, and suitability of the available stone should be verified.

For the section of the Interceptor Ditch that discharges to the north (labeled as Stage 1 North), a proposed steep section of about 43 m in length and up to 25% grade is proposed. This grading allows for the ditch to continue to parallel the proposed perimeter road and to capture the most runoff. For stability of the rock in that section, a larger riprap size is proposed. A rigid liner type can also be implemented in that section, but further analysis would be required.

The following table presents the minimum stable mean riprap sizes for the Interceptor Ditch bottom and side slopes. See Appendix A. 2 for riprap calculations.

Table 5-3: Minimum Stable Riprap Size for Interceptor Ditch

Channel Name	Ditch Invert Slope	Minimum Stable Riprap Size, D_{50}
Stage 1 North	1% to 12%	300 mm (12 in)
Stage 1 North	12% to 25%	600 mm (24 in)
Stage 1 South	1% to 20%	300 mm (12 in)

5.5 Energy Dissipation Basin

The design of an energy dissipation basin is included for the discharge points of the interceptor ditch at both the North and South perimeters to prevent erosion during higher flows. The textbook Essentials of Hydraulics (Pierre Y. Julien) provides a table (Table 5-4 below) of maximum acceptable velocities for flows under 1 meter in depth to prevent any significant erosion. These velocities are based on soil types, and their corresponding Manning's n value. For conservative purposes, the lowest acceptable velocity of 0.46 m/s was used as the target, and the corresponding increase in channel area was derived to achieve this

velocity based on the design flow (1.71 m3/s). The resulting basin has a length of 3.75 m, with the initial channel bottom width being 1m, and the final channel bottom width being 3.5m. The outward slope to achieve this channel bottom width increase was assumed to be 3:1 (1 unit increase in width for every 3 unit increase in length). These dissipation basins are assumed to be lined with the same rip-rap size used to line their corresponding regions (North and South) and have a depth of 2x the Rip-Rap D50.

Table 5-4: Maximum Velocities in Canals for Erosion Prevention

Soil Type	Manning, n	Clear Water, No Detritus	Water Transporting Colloidal Silt	Water Transporting Silts, Sands/Gravels
Stiff Clay (Very Colloidal)	0.025	1.14	1.52	0.91
Alluvial Silt When Colloidal	0.025	1.14	1.52	0.91
Alluvial Silt When Noncolloidal	0.02	0.61	1.07	0.61
Volcanic Ash	0.02	0.76	1.07	0.61
Silt Loam (Noncolloidal)	0.02	0.61	0.91	0.61
Ordinary Firm Loam	0.02	0.76	1.07	0.69
Sandy Loam (Noncolloidal)	0.02	0.53	0.76	0.61
Fine Sand (Colloidal)	0.02	0.46	0.76	0.46
Fine Gravel	0.02	0.76	1.52	1.14
Coarse Gravel (Noncolloidal)	0.025	1.22	1.83	1.98
Cobbles and Shingles	0.035	1.52	1.68	1.98
Shales and Hardpans	0.025	1.83	1.83	1.52

6. HYDRAULIC ASSESSMENT OF HEAP PERIMETER CHANNELS

Surface water runoff on the HLP will be managed using a lined, perimeter channel. This channel will convey heap runoff to the event pond. Additionally, the perimeter channel will be utilized to convey pipe systems from the heap to the ADR.

6.1 Hydraulic Performance Standards

The perimeter channel was designed to contain a Probable Maximum Precipitation (PMP), 24-hour storm event, while maintaining a minimum of 0.5 m freeboard. In considering the PMP event, the cross-sectional area consumed by pipes were considered.

6.2 Perimeter Channel Design

The main stretch of both the North and South Perimeter Channels is split into two different cross sections: one bordering the heap, and one not. The perimeter channel will be confined by an access road on both north and south sides of the heap. Thus, restricting the elevation and slope of the channel to that of the heap perimeter. The base width of the channel was designed to include a 600 mm barren line, and two 710 mm diameter collection lines. An additional 25.4 mm between all pipes was modeled to allow for maintenance access. Side slopes of the channel were determined to provide an adequate surface for liner application, while remaining within the current restraints of the heap perimeter and access road. Figure 6-1 below shows the cross-section geometry of the North Channel as it borders the heap. It can be noted that the South Channel has the same geometry but is mirrored (road side on the right and heap side on the left) Overall channel dimensions are as follows:

Bordering Heap:

- Base width: 3.2m
- Side slopes: V 1: H 2.5
- Width at crest (from road surface to heap slope): 15.0 m
- Depth (road surface to base): 3 m

Not Bordering Heap:

- Base width: 10.5m
- Side slopes: V 1: H 2.5
- Width at crest: 18.0 m
- Depth (road surface to base): 1.5 m

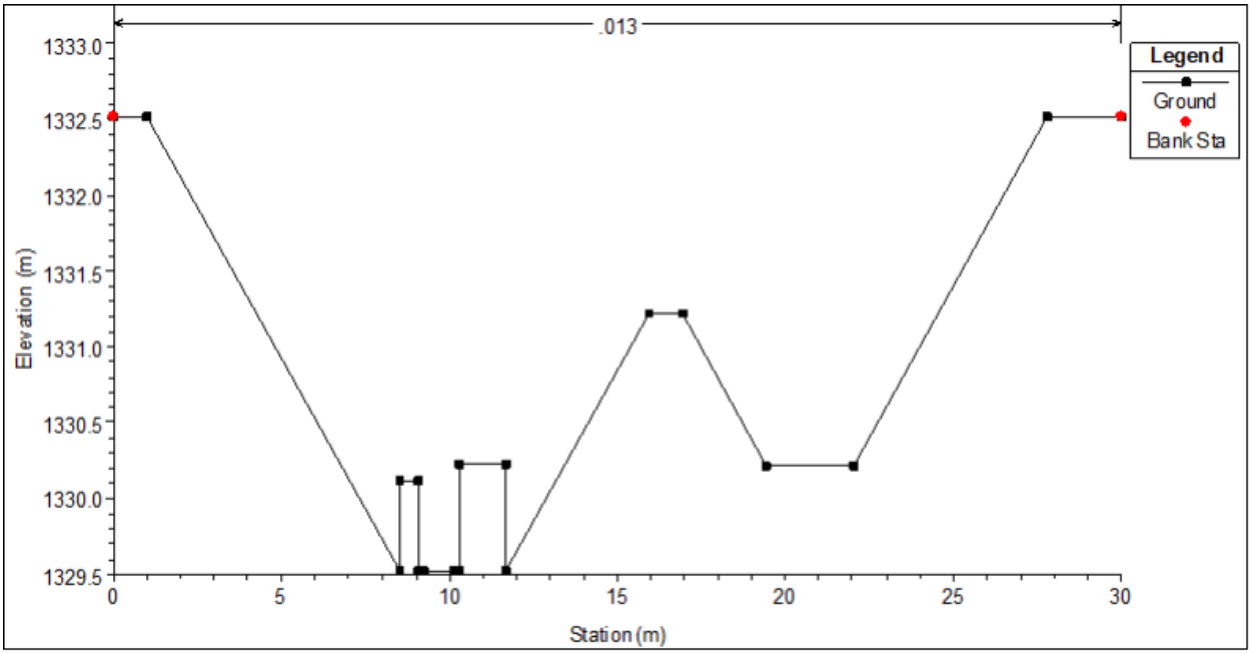

Figure 6-1: North Channel Cross Section Geometry

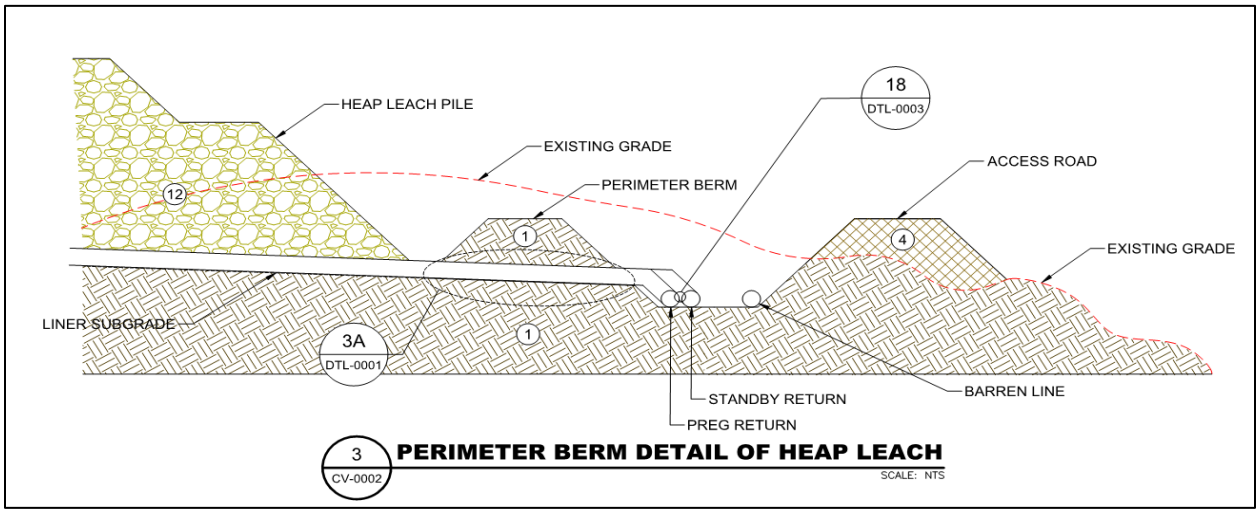

Figure 6-2: Perimeter Channel Detail

The rainwater runoff and heap runoff portions of the channel will split 50 m upstream from the North and South Event ponds. Rainwater runoff channels will be identified as “inside” channels, (IN-N & IN-S). Conversely, heap runoff channels will be identified as “outside” channels, (OUT-N & OUT-S). Piping will utilize channels OUT-N & OUT-S to convey pipe systems. Piping will then be routed out of the channel before the event pond invert. Figure 6-3 shows this configuration.

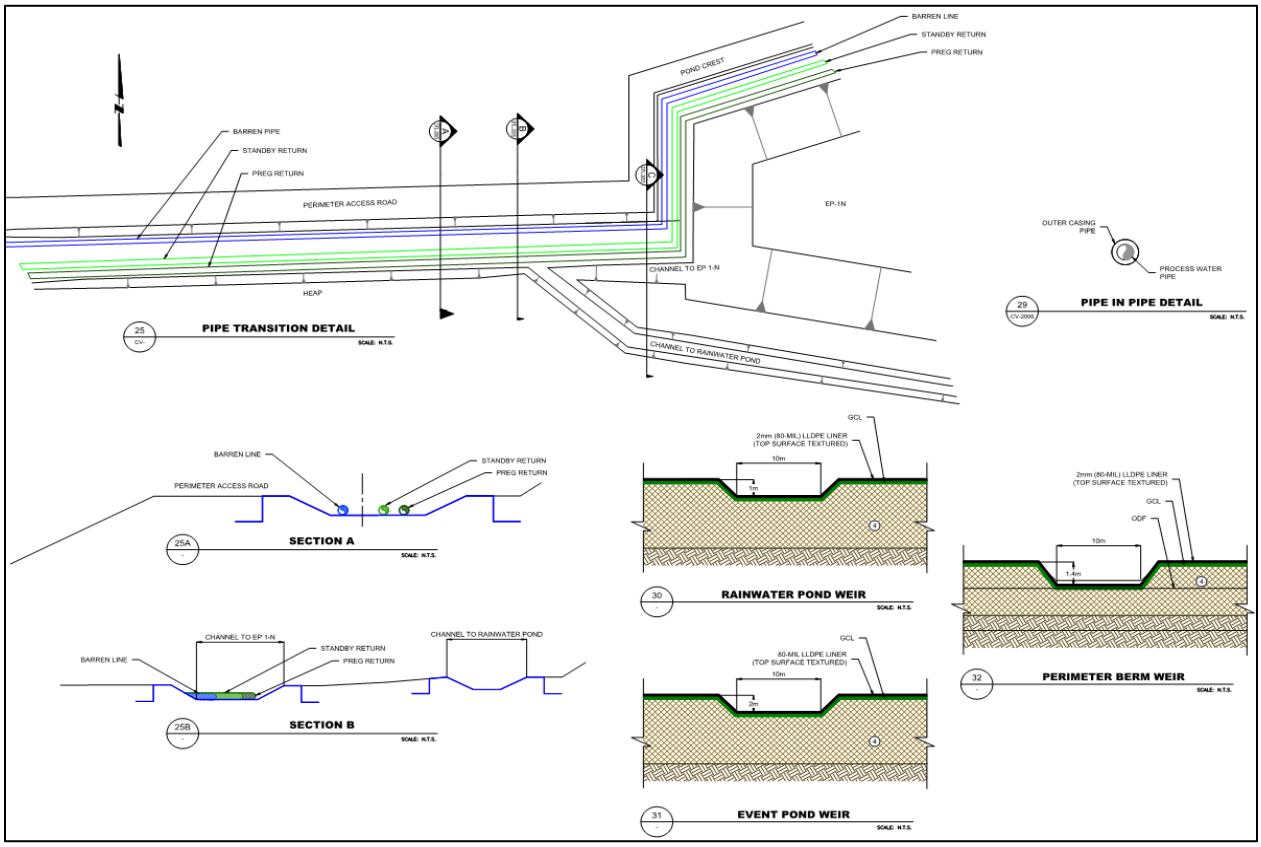

Figure 6-3: Typical Channel Split

6.3 Model Preparation

HEC-RAS, a program developed by the United States Army Corps of Engineers, was used to model the hydraulics conditions of the proposed channel system. HEC-RAS aided in providing computational fluid dynamics data and verifying containment of a peak discharge of 52 m^3/s in the event of a PMP, 24-hour storm.

Models were constructed for both the north and south perimeter channels. The overall channel elevation, slope, and length was modeled to that of the current heap design at completion of Stage 5. Components that occupy the overall volume of the channel (i.e., piping systems), were modeled as *polygons* to provide a conservative estimate for the as-built volumes. Additionally, the junctions of IN-N/OUT-N & IN-S/OUT-S were not incorporated into the model. This provides a more conservative approach to the model by excluding the division of the flow into two equally sized channels. Figure 6-4 shows the plan view of the HEC-RAS model.

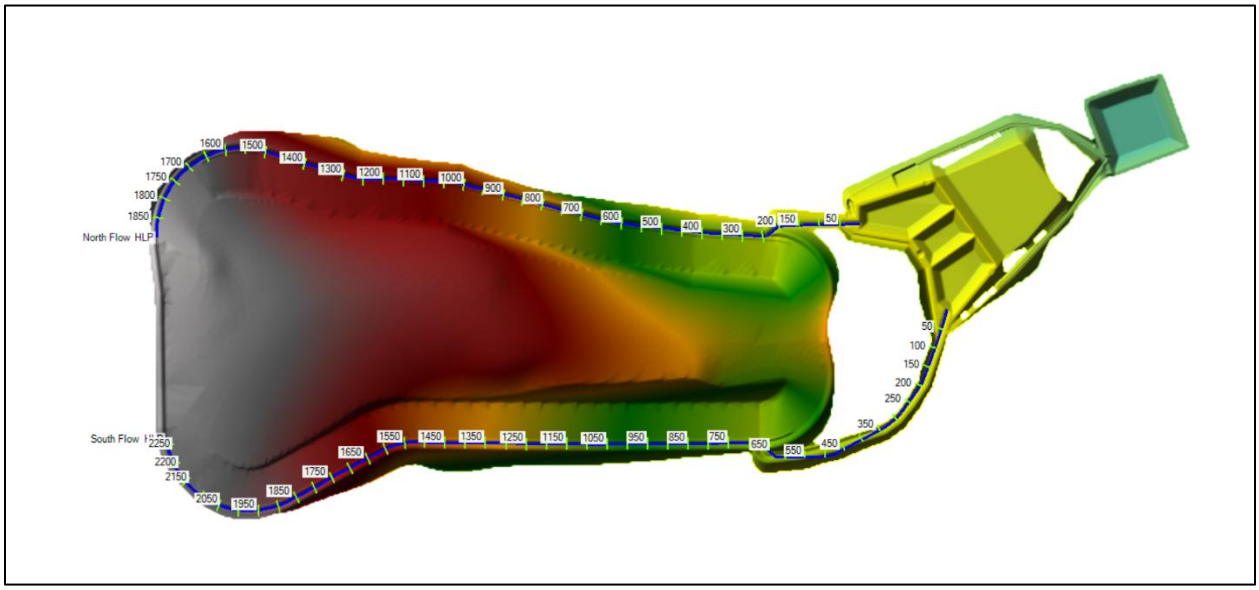

Figure 6-4: HEC-RAS Model Plan View

Typical Perimeter Channel cross sections were modeled such as the configuration shown in Figure 6-2. This was replicated in the model with polygons larger than the pipe diameter as presented in Figure 6-5 and Figure 6-6 The section call outs are presented in plan view of Figure 6-4. A Manning's n-value of 0.013 was used for Section A, representing LLDPE liner. A manning's n value of 0.02 was utilized for Section B representing the armored Hydro-Turf liner.

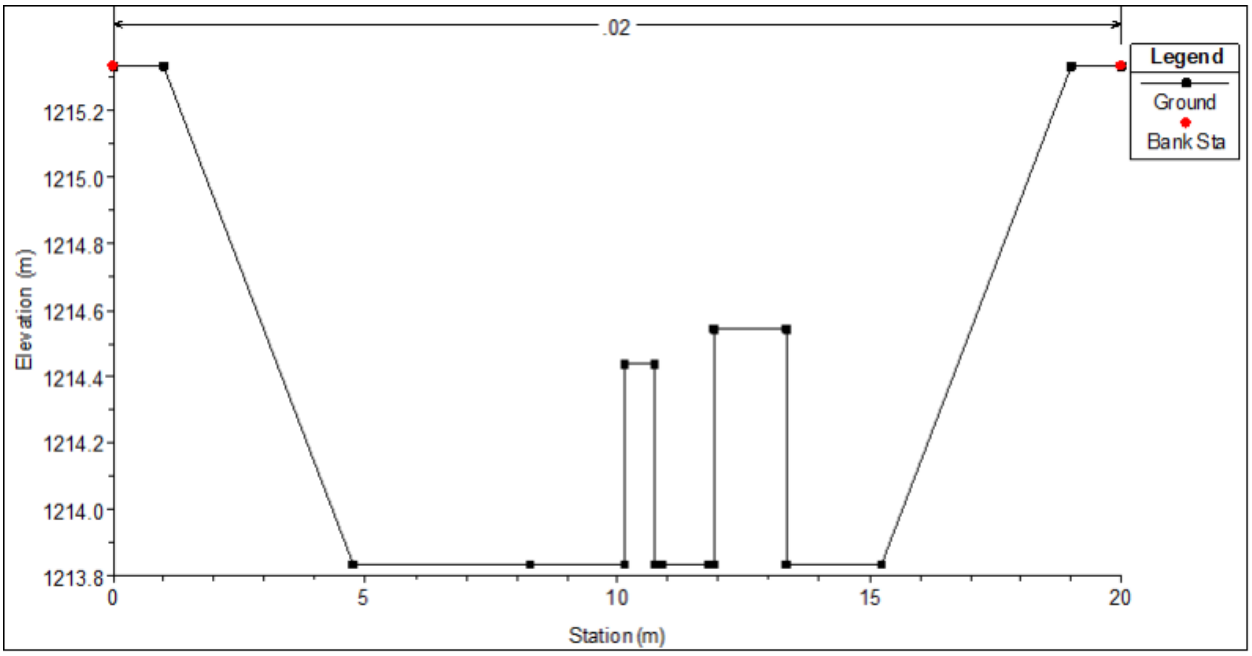

Figure 6-5: Typical Channel Cross Section-Section “”

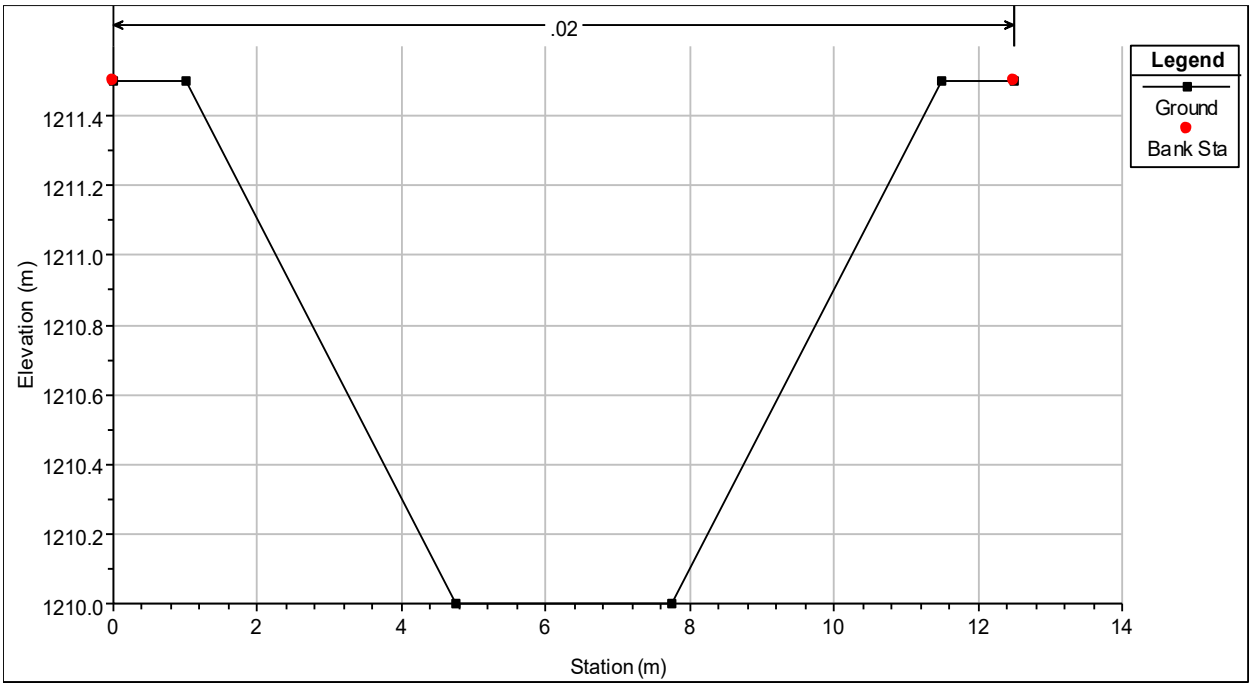

Figure 6-6: Section "B" at Channel Split - IN

The upstream boundary conditions of the model were set to the slope at Normal Depth, $S_{North\text{-}Up}$ = 0.12 and $S_{South\text{-}Up}$ = 0.038. Downstream boundaries of the channels were both set at the pond inlet elevation, 1210 m ASL, with boundary conditions set to slope at Normal Depth, $S_{North\text{-}Down}$ = 0.038. and $S_{South\text{-}Down}$ = 0.02.

The North Flow has an average slope of 0.06, a maximum of 0.22 between STA = 18+50to 18+00and a minimum of 0.018 between STA = 2+00to 1+50 The South Flow has an average slope of 0.047, a maximum of 0.095 between STA = 17+50 to17+00, and a minimum of 0.015between STA = 6+50to6+00. Profiles of both channels modeled, are presented in Figure 6-7 and Figure 6-8.

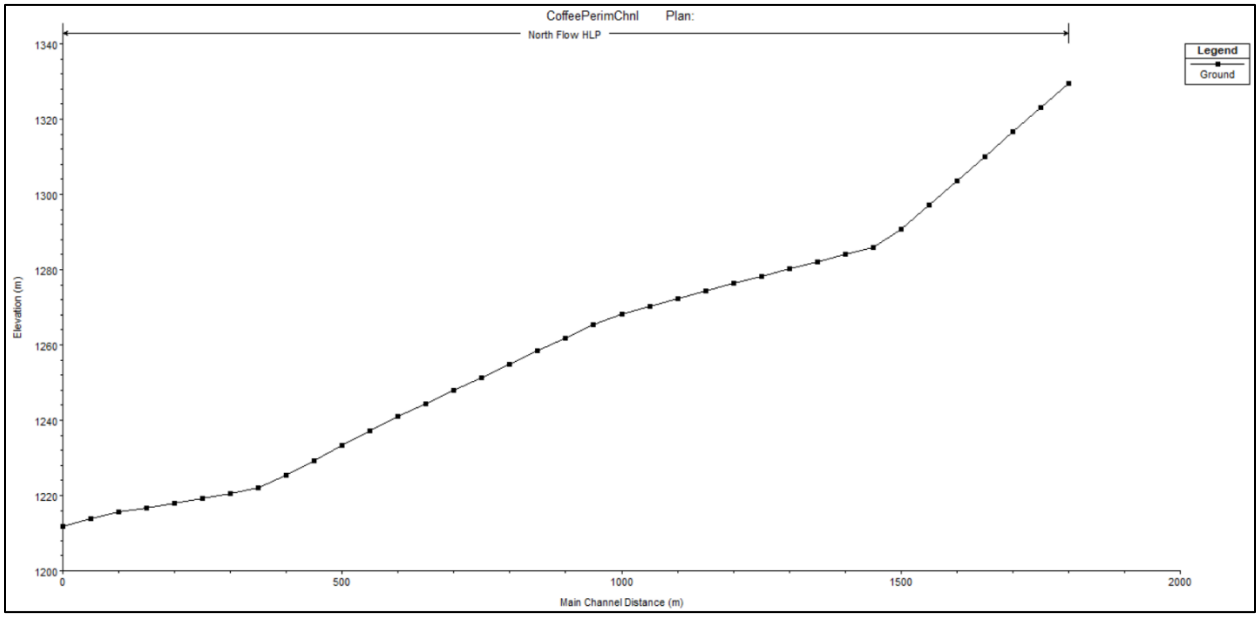

Figure 6-7: North Perimeter Channel Profile

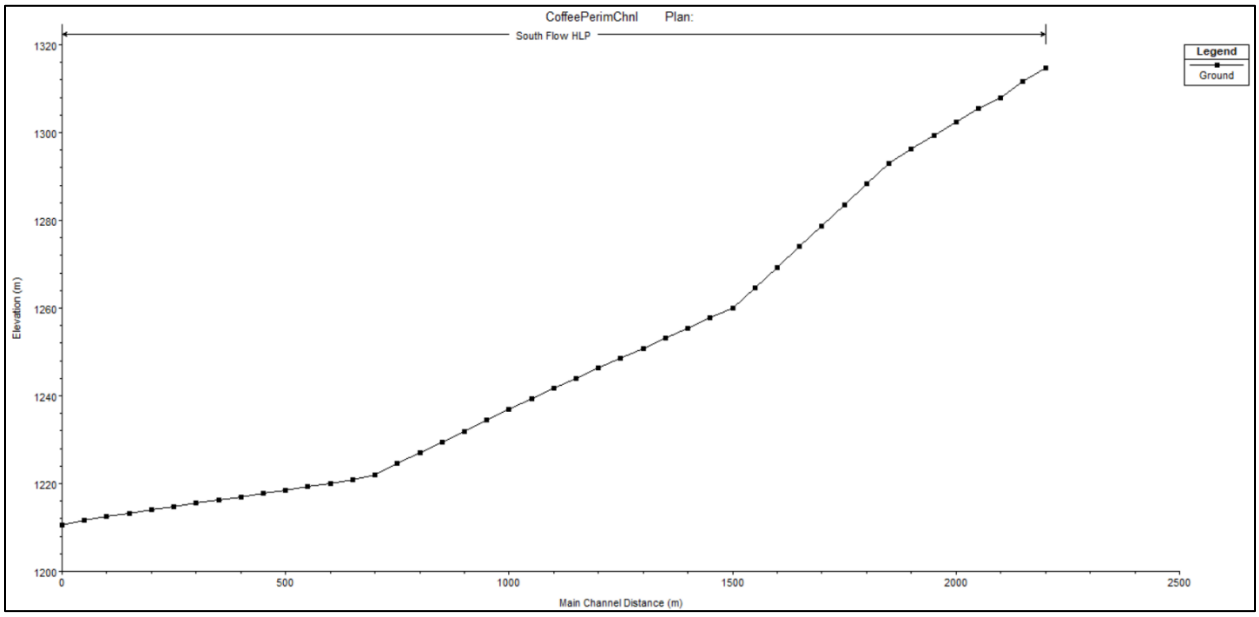

Figure 6-8: South Perimeter Channel Profile

6.4 Summary of HEC-RAS Modeling

HEC-RAS steady flow modeling supports that the design will yield containment during a PMP, 24-hour storm event with a peak discharge of 52 m^3/s. Table 6-1 provides a condensed performance summary of hydraulic data derived from the model. Water surface heights around channel bends were calculated using the equation for superelevation for supercritical flows, as shown below.

$$\Delta y = \frac{WV^2}{gr}$$

Where:

Δy = Superelevation height of water above the depth of the water (m)

W = Straight channel water surface width (m)

V = Cross sectional velocity (m/s)

g = Acceleration of gravity (m/s^2)

r = Channel radius (m)

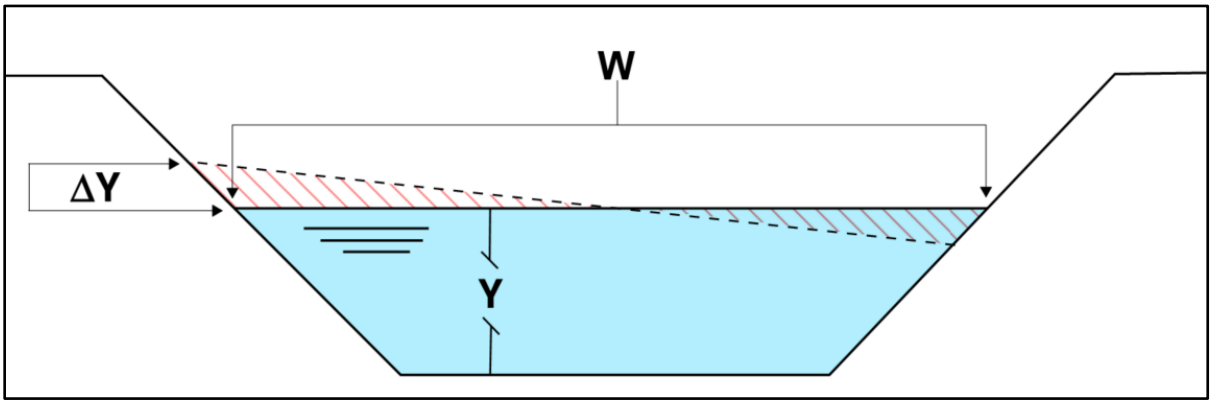

Figure 6-9: Water Surface Superelevation Example

Table 6-1: Performance Summary of Hydraulic Data – North Flow

		Q Total	Channel Base Elevation	Water Surface Height	Channel Flow Velocity	ΔY Super-elevation	Adjusted (ΔY) Water Surface	Available Free-board	Froude Number
Reach	River Station	(m^3/s)	(m)	(m)	(m/s)	(m)	(m)	(m)	
North Flow	18+50	52.00	1329.52	1.02	11.94	0.79	1.71	1.30	6.19
	18+00	52.00	1323.04	1.02	12.17	0.82	1.73	1.30	6.35
	17+50	52.00	1316.57	1.01	12.11	0.81	1.72	1.30	6.31
	17+00	52.00	1310.10	1.01	12.37	0.84	1.75	1.20	6.49
	16+50	52.00	1303.62	1.01	12.36	0.84	1.74	1.30	6.48
	16+00	52.00	1297.15	1.02	12.25	0.83	1.74	1.30	6.41
	15+50	52.00	1290.68	1.01	12.25	0.83	1.74	1.30	6.40
	15+00	52.00	1285.99	1.05	11.12	0.71	1.65	1.40	5.63
	13+00	52.00	1278.20	1.19	8.15	0.44	1.53	1.50	3.71
	12+50	52.00	1276.32	1.19	8.12	0.44	1.53	1.50	3.67
	10+50	52.00	1268.32	1.18	8.20	0.43	1.51	1.50	3.76
	10+00	52.00	1265.46	1.14	8.89	0.49	1.53	1.50	4.19
	2+50	52.00	1217.84	1.24	7.25	0.37	1.51	1.40	3.20
	2+00	52.00	1216.66	0.69	7.39	0.32	1.22	0.60	3.24

Table 6-2: Performance Summary of Hydraulic Data – South Flow

		Q Total	Channel Base Elevation	Water Surface Height	Channel Flow Velocity	ΔY Super-elevation	Adjusted (ΔY) Water Surface	Available Free-board	Froude Number
Reach	River Station	(m^3/s)	(m)	(m)	(m/s)	(m)	(m)	(m)	
South Flow	22+50	52.00	1314.64	1.01	9.44	0.54	1.55	1.50	4.53
	22+00	52.00	1311.57	1.01	9.48	0.54	1.55	1.50	4.56
	21+50	52.00	1308.00	1.00	9.82	0.57	1.57	1.50	4.77
	21+00	52.00	1305.45	1.03	9.09	0.51	1.54	1.50	4.31
	19+50	52.00	1302.39	1.02	9.35	0.53	1.55	1.50	4.55
	19+00	52.00	1299.33	1.02	9.44	0.54	1.56	1.40	4.63
	18+50	52.00	1296.28	1.01	9.47	0.54	1.55	1.40	5.29
	16+00	52.00	1264.62	0.95	10.95	0.67	1.67	1.30	5.52
	15+50	52.00	1260.02	0.95	10.92	0.67	1.67	1.30	5.49
	15+00	52.00	1257.73	1.03	9.13	0.49	1.56	1.40	4.34
	7+00	52.00	1220.79	1.12	7.52	0.18	1.31	1.70	3.36
	6+50	52.00	1219.98	0.94	7.02	0.17	1.09	0.60	3.06
	6+00	52.00	1219.24	0.99	6.53	0.13	1.12	0.60	2.72
	5+50	52.00	1218.50	1.00	6.36	0.17	1.17	0.50	2.51
	5+00	52.00	1217.75	1.00	6.33	0.16	1.16	0.50	2.47
	4+50	52.00	1217.01	1.01	6.30	0.16	1.17	0.50	2.44
	4+00	52.00	1216.26	1.01	6.30	0.16	1.17	0.50	2.44
	3+50	52.00	1215.51	1.01	6.31	0.16	1.17	0.50	2.45
	3+00	52.00	1214.75	1.00	6.32	0.16	1.16	0.50	2.45
	2+50	52.00	1213.98	1.01	6.33	0.16	1.17	0.50	2.46
	2+00	52.00	1213.22	1.01	6.34	0.16	1.17	0.50	2.46
	1+50	52.00	1212.46	1.01	6.34	0.16	1.17	0.50	2.46

Full data output tables for the PMP storm event are included in Appendix B.

6.5 Model Discussion

The model results conclude that the proposed channel design will provide containment of the hydraulic conditions during a PMP, 24-hour storm event. A minimum freeboard of 0.5 m was maintained throughout the channel models.

6.6 Perimeter Channel Lining and Construction

The proposed channel shall be constructed on prepared subgrade. 80-mil HDPE liner atop geosynthetic clay liner (GCL) shall be used for all channel segments, except for the OUT-N & OUT-S segments. HEC-RAS modeling has shown that the entirety of the channel will be supercritical flow in the event of a PMP, 24-hour storm. In response, an armored HDPE liner should be used on the OUT-N & OUT-S segments to protect against damage from debris or liner uplift as runoff flows into the event ponds. We recommend *HydroTurf* or equivalent revetment systems to significantly improve the life of the channel.

7. WEIR FLOW CALCULATIONS

It should be noted that the pond capacities are designed to contain the entire runoff volume from the PMP event. Therefore, the Weirs will only be utilized in the scenario where a significant storm event occurs while the ponds are completely full.

A collection of weirs exists at the discharge points of the channels into their respective Event Ponds, as well as from the Rain Water Pond into the Event Ponds. The below equations from Essentials of Hydraulics Textbook (Pierre Y. Julien) were used in calculating the flow capacity of the weirs. The first equation is for a triangular weir, the second equation is for a rectangular weir. The equations can be combined to find the flow capacity of a trapezoidal weir.

$$Q = C_\Delta \frac{8}{15}\sqrt{2g}\tan\left(\frac{\theta}{2}\right)H^{5/2}$$

$$Q = CLH^{3/2}$$

The weir coefficients (C_Δ and C) are defined as $C_\Delta \sim 0.6$ and $C \sim 1.66$ in relevant literature and through past project experience. H is defined as the upstream head above the crest of the weir, and L is defined as the weir length. The upstream head value was varied by increments of 10 with respect to the weir height where the final value equaled the weir height to produce the maximum flow value. These equations were summed to produce a total flow capacity for each type of weir. Table 7 below shows the inputs and flow capacity of both weirs.

Table 7: Weir Metrics and Flow Capacities

Weir Name	Maximum H (m)	Weir Length L (m)	C	C_Δ	Maximum total Q (m^3 /s)
Event Pond Weirs	1	12	1.66	0.6	22.8
Rain Water Pond Weirs	2	12	1.66	0.6	72.4

The figures below show the flow capacity curves for the weirs varied by the upstream head value.

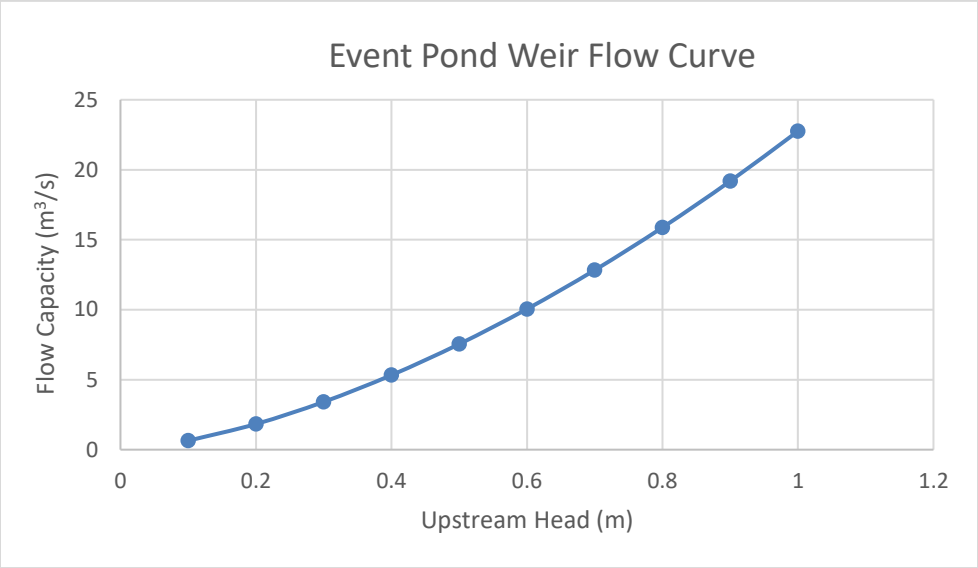

Figure 10: Event Pond Weir Flow Curve

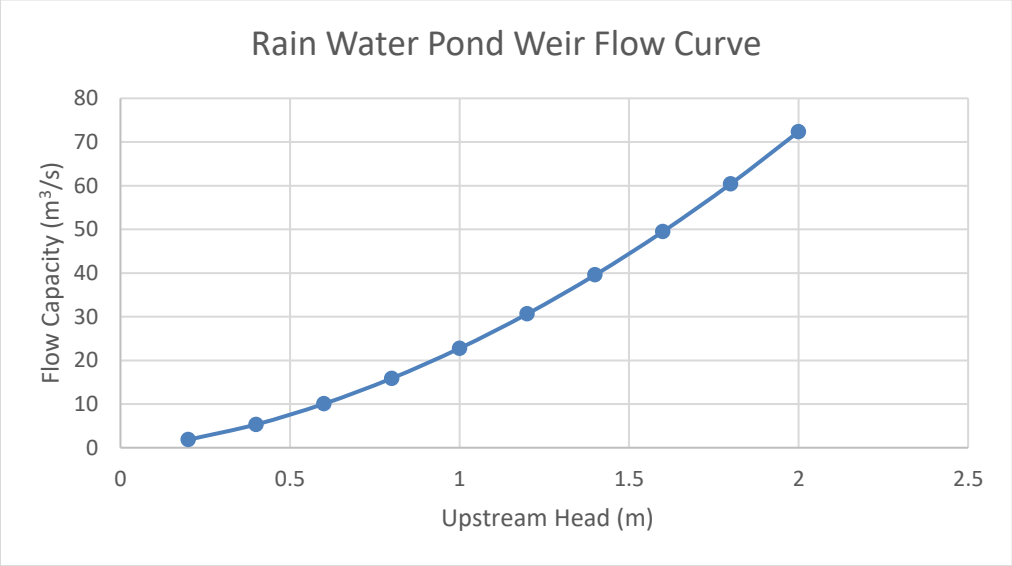

Figure 11: Rain Water Pond Weir Flow Curve

8. CONCLUSIONS

Due to the physiographic nature of the proposed heap leaching operation, great care and consideration should be given to the implementation of this design, and subsequent construction and maintenance. The design included in this report has accounted for the worst-case scenario in terms of overall leach pad size, raincoat coverage, and peak discharge. Modeling and calculations show the design will achieve these hydraulic performance standards.

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APPENDIX A: ENGINEERING CALCULATIONS

APPENDIX A. 1: INTERCEPTOR DITCH HYDRAULIC CALCULATIONS

Stage 1 North

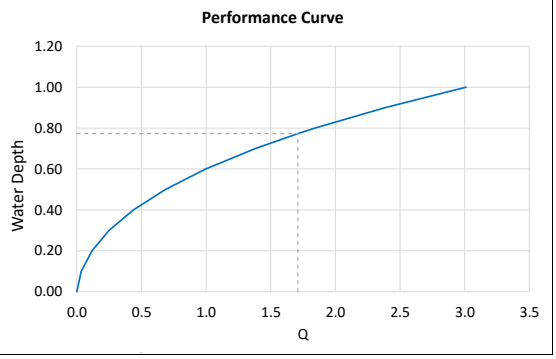
Coffee Heap Design
Project # 123017
August 31, 2022

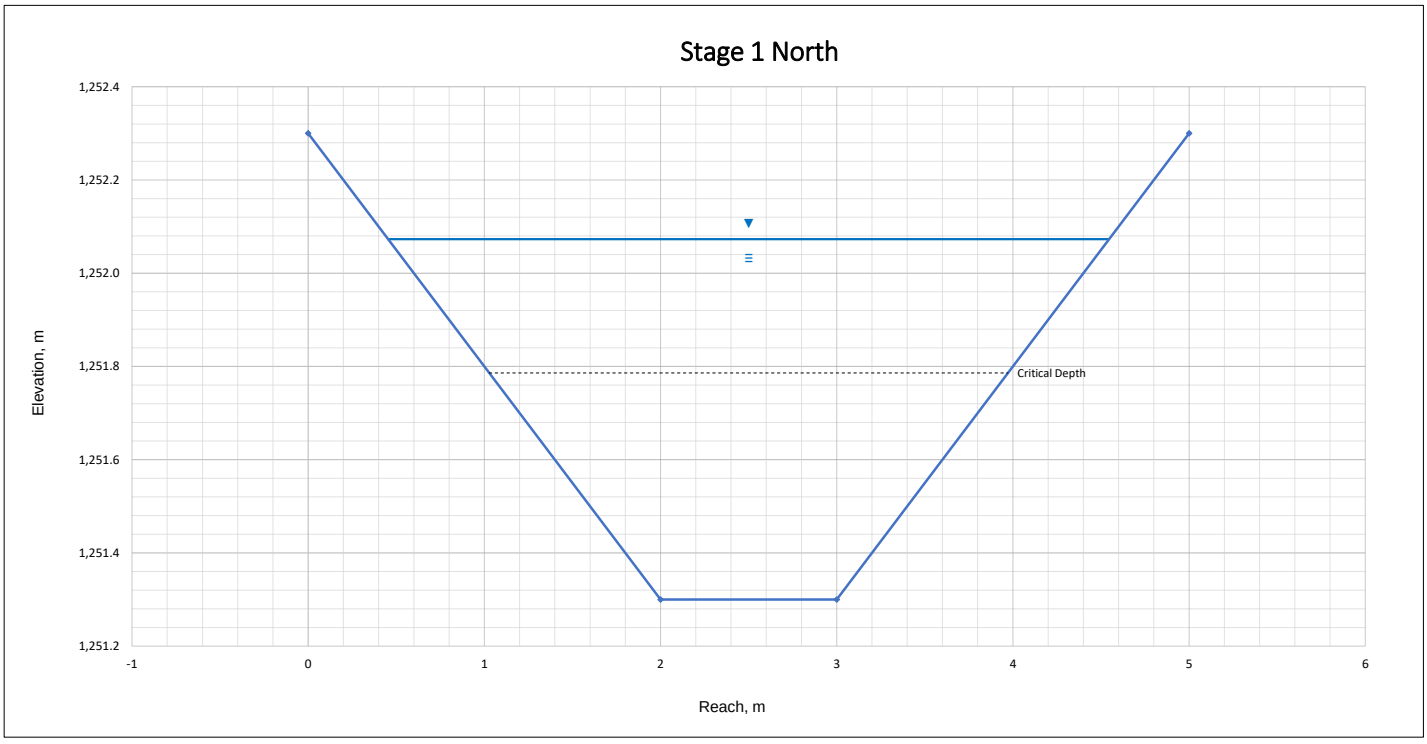
Channel Stage 1 Storm Diversion Ditch (North Basin)

Bottom Width	1.00 m	Total Channel Area	3.00 m2	Design Flow	1.71 cms
Total Channel Depth	1.00 m	Invert Elevation	1251.30 m	Critical Depth	0.49 m
Side Slope 1	2.0 H:1V	Bottom Slope	0.0110 m/m	Normal Depth	0.77 m
Side Slope 2	2.0 H:1V	Channel Liner	12" D50 riprap	Velocity	0.87 m/s
Top Channel Width	5.00 m	Manning's n coef.	0.070	Froude	0.40 (subcritical)

Performance Curve

Q	Normal Depth	Area	Wetted Perim	Top Water Width	Velocity	Froude
cms	m	m2	m	m	m/s	
0.00	0.00	0.00	1.00	1.00	0.00	0.00
0.03	0.10	0.12	1.45	1.40	0.28	0.31
0.12	0.20	0.28	1.89	1.80	0.42	0.34
0.25	0.30	0.48	2.34	2.20	0.52	0.36
0.44	0.40	0.72	2.79	2.60	0.61	0.37
0.68	0.50	1.00	3.24	3.00	0.68	0.38
1.00	0.60	1.32	3.68	3.40	0.76	0.39
1.38	0.70	1.68	4.13	3.80	0.82	0.40
1.71	***0.77***	***1.97***	***4.46***	***4.09***	***0.87***	***0.32***
1.84	0.80	2.08	4.58	4.20	0.89	0.40
2.38	0.90	2.52	5.02	4.60	0.95	0.41
3.01	1.00	3.00	5.47	5.00	1.00	0.41





Stage 1 South

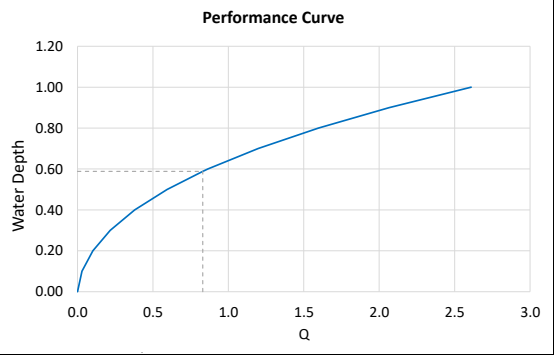
Coffee Heap Design
Project # 123017
August 31, 2022

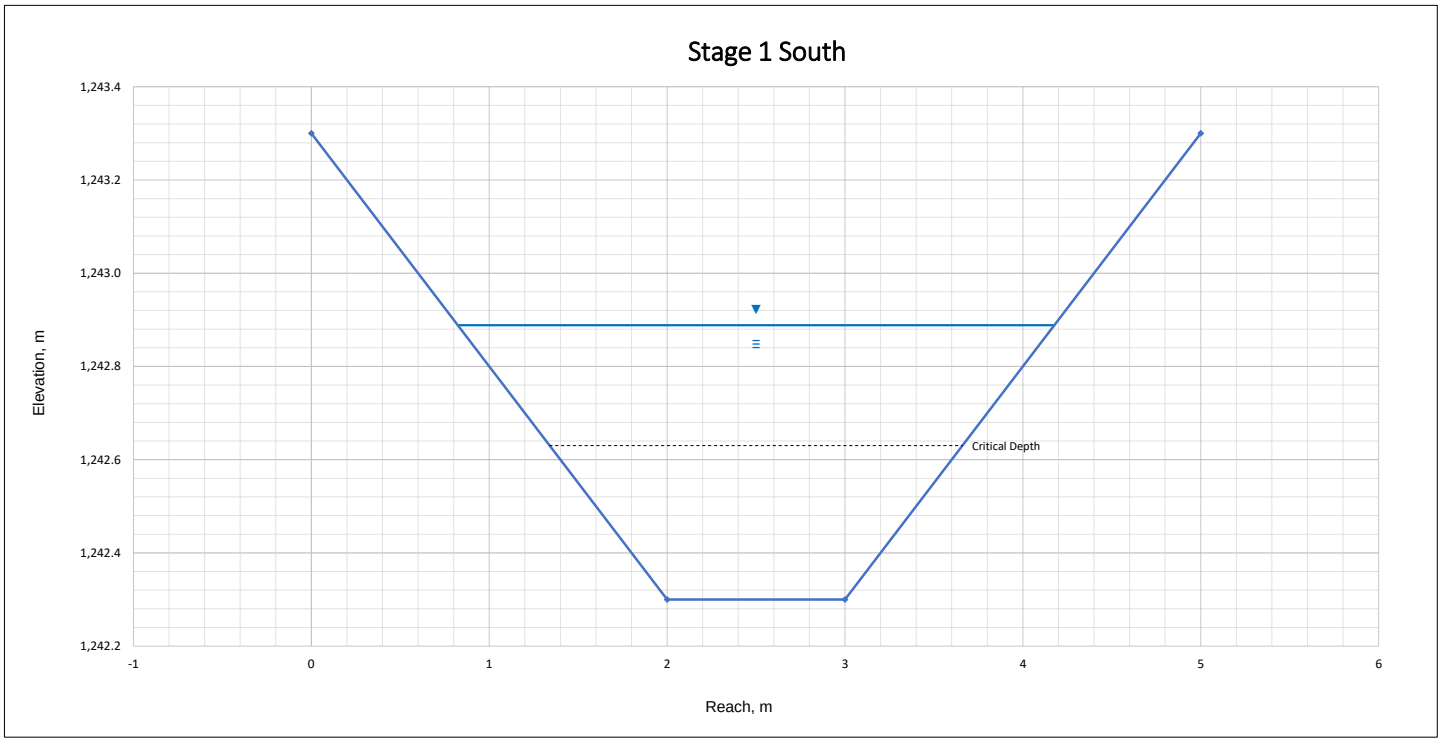
Channel Stage 1 Storm Diversion Ditch (South Basin)

Bottom Width	1.00 m	Total Channel Area	3.00 m2	Design Flow	0.83 cms
Total Channel Depth	1.00 m	Invert Elevation	1242.30 m	Critical Depth	0.33 m
Side Slope 1	2.0 H:1V	Bottom Slope	0.0100 m/m	Normal Depth	0.59 m
Side Slope 2	2.0 H:1V	Channel Liner	12" D50 riprap	Velocity	0.65 m/s
Top Channel Width	5.00 m	Manning's n coef.	0.077	Froude	0.34 (subcritical)

Performance Curve

Q	Normal Depth	Area	Wetted Perim	Top Water Width	Velocity	Froude
cms	m	m2	m	m	m/s	
0.00	0.00	0.00	1.00	1.00	0.00	0.00
0.03	0.10	0.12	1.45	1.40	0.25	0.27
0.10	0.20	0.28	1.89	1.80	0.36	0.29
0.22	0.30	0.48	2.34	2.20	0.45	0.31
0.38	0.40	0.72	2.79	2.60	0.53	0.32
0.59	0.50	1.00	3.24	3.00	0.59	0.33
0.83	***0.59***	***1.28***	***3.63***	***3.35***	***0.65***	***0.27***
0.86	0.60	1.32	3.68	3.40	0.66	0.34
1.20	0.70	1.68	4.13	3.80	0.71	0.34
1.60	0.80	2.08	4.58	4.20	0.77	0.35
2.07	0.90	2.52	5.02	4.60	0.82	0.35
2.61	1.00	3.00	5.47	5.00	0.87	0.36





APPENDIX A. 2: INTERCEPTOR DITCH RIPRAP CALCULATIONS

PROJECT NUMBER: 123017
DATA INPUT BY: David Bolanos
DATE: 9/2/2022
LOCATION: Coffee HLP - Stage 1 Diversion Ditch North

Objective straight channels only

Design of small open channels and roadside channels with flexible linings using HEC-15, For maximum depths of 1.5 m (5 ft)

Calculations Based on "HEC-15 Third Edition: Design of Roadside Channels with Flexible Linings" FHWA-NHI-05-114 September 2005

Iterate on Specified D_{50} to gain value near the calculated D_{50}

Channel Geometry Input Parameters, (all caluclations are made in metric units then converted)			
Parameter	**Symbol**	**Value**	**Units**
Total Design Discharge	Q=	*60.39*	cfs
	Q=	1.71	m^3/s
Channel Slope	S_O=	*12.00%*	
	α=	*6.84*	Degrees
Channel Bottom Width	B=	*3.28*	ft
	B=	1.000	m
Left Flank Channel Side Slope	Z_L=	*2*	_H:1V
Right Flank Channel Side Slope	Z_R=	*2*	_H:1V

Method Specific Input Parameters and Factor Calculations			
Specific Weight of Water	γ_w=	*62.4*	lb/ft^3
Specific Weight of Stone	γ_s=	*165*	lb/ft^3
Rock Specific Gravity	G_s=	*2.64*	
Rock Angle of Repose	ϕ_R=	*42.5*	Degrees (Fig. 6.1)
Specified Rip Rap D-50	D_{50}=	*12.00*	in
Taken Steepest Side Slope	Z=	2	_H:1V
Side Slope Angle	θ=	26.57	Degrees

Shear Stress			
Applied Shear Stress	τo	6.111	lb/ft^2
Shear stress in channel at maximum depth	τd	9.38	lb/ft^2
safety factor	SF	1.00	
side shear stress	τs	7.52	lb/ft^2
ratio of channel side to bottom shear stress	K_1	0.80	1.5 < Z < 5
flow depth, riprap size ratio	d_a/D_{50}	0.87	
Manning n (Eq. 6.1 Range (1.5 <= d_a/D_{50} <= 185))	n	0.132	
Manning n (Eq. 6.2 Range (0.3 < d_a/D_{50} < 1.5))	n	0.054	
	f(Fr) =	1.03	
	f(REG) =	11.09	
	f(CG) =	0.41	
	b	0.39	
Shear velocity	V*	2.20	ft/s
Reynolds Number	Re	180789	
Shields' Parameter	F*	0.138	
safety factor	SF	1.00	Must be ≥ 1
permissible shear stress	τp	0.00	lb/ft^2
Calculated D-50 Rock Size	D_{50}	0.67	ft (Eq. 6.8, slope < 5%)
Calculated D-50 Rock Size	D_{50}	0.90	ft (Eq. 6.11, slope > 10%)
	Δ	1.36	
	β	26.97	Degrees
	η	0.53	

Channel Hydraulic Calculation Results			
Manning n (Based on relative depth ratio)	n=	0.054	Eq. 6.2 (Bathurst 1991)
Flow Depth (Solved by zeroing Mannings Formula)	d=	1.25	ft
Cross-sectional Flow Area	A=	7.25	ft^2
Wetted Perimeter	P=	8.88	ft
Hydraulic Radius	R_h=	0.82	ft
Hydraulic Depth	d_a=	0.87	ft
Manning's Equation solved for 0		0.00	Use goal seek to zero
Average Velocity	V=	8.33	ft/s
Water Surface Top Width	T_w=	8.29	ft
Froude #	Fr=	1.57	SUPERcritical

Riprap Calculation Results			
Minimum stable riprap size	**D_{50}=**	0.90	ft (Eq. 6.11, slope > 10%)
	D_{50}=	10.86	in

Method	Valid Slope?	Calculated D_{50} (mm)	Calculated Flow Depth (m)
HEC-15	Yes	275.78	0.38
Method	**Valid Slope?**	**Calculated D_{50} (inches)**	**Calculated Flow Depth (feet)**
HEC-15	Yes	10.86	1.25

PROJECT NUMBER: 123017
DATA INPUT BY: David Bolanos
DATE: 9/2/2022
LOCATION: Coffee HLP - Stage 1 Diversion Ditch South

Objective straight channels only

Design of small open channels and roadside channels with flexible linings using HEC-15, For maximum depths of 1.5 m (5 ft)
Calculations Based on "HEC-15 Third Edition: Design of
Iterate on Specified D_{50} to gain value near the calculated D_{50}

Channel Geometry Input Parameters, (all caluclations are made in metric units then converted)			
Parameter	**Symbol**	**Value**	**Units**
Total Design Discharge	Q=	*29.31*	cfs
	Q=	0.83	m^3/s
Channel Slope	S_O=	*20.00%*	
	α=	*11.31*	Degrees
Channel Bottom Width	B=	*3.28*	ft
	B=	1.000	m
Left Flank Channel Side Slope	Z_L=	*2*	_H:1V
Right Flank Channel Side Slope	Z_R=	*2*	_H:1V

Method Specific Input Parameters and Factor Calculations			
Specific Weight of Water	γ_w=	*62.4*	lb/ft^3
Specific Weight of Stone	γ_s=	*165*	lb/ft^3
Rock Specific Gravity	G_s=	*2.64*	
Rock Angle of Repose	ϕ_R=	*42.5*	Degrees (Fig. 6.1)
Specified Rip Rap D-50	D_{50}= ✓	*12.00*	in
Taken Steepest Side Slope	Z=	2	_H:1V
Side Slope Angle	θ=	26.57	Degrees
Shear Stress			
Applied Shear Stress	τo	6.790	lb/ft^2
Shear stress in channel at maximum depth	τd	9.44	lb/ft^2
safety factor	SF	1.00	
side shear stress	τs	7.57	lb/ft^2
ratio of channel side to bottom shear stress	K_1	0.80	1.5 < Z < 5
flow depth, riprap size ratio	d_a/D_{50}	0.57	
Manning n (Eq. 6.1 Range (1.5 <= d_a/D_{50} <= 185))	n	0.241	
Manning n (Eq. 6.2 Range (0.3 < d_a/D_{50} < 1.5))	n	0.055	
	f(Fr) =	1.21	
	f(REG) =	7.65	
	f(CG) =	0.47	
	b	0.32	
Shear velocity	V*	2.21	ft/s
Reynolds Number	Re	181344	
Shields' Parameter	F*	0.138	
safety factor	SF	1.00	Must be ≥ 1
permissible shear stress	τp	0.00	lb/ft^2
Calculated D-50 Rock Size	D_{50}	0.67	ft (Eq. 6.8, slope < 5%)
Calculated D-50 Rock Size	D_{50}	0.94	ft (Eq. 6.11, slope > 10%)
	Δ	1.41	
	β	25.87	Degrees
	η	0.53	

Channel Hydraulic Calculation Results			
Manning n (Based on relative depth ratio)	n=	0.055	Eq. 6.2 (Bathurst 1991)
Flow Depth (Solved by zeroing Mannings Formula)	d=	0.76	ft
Cross-sectional Flow Area	A=	3.63	ft^2
Wetted Perimeter	P=	6.66	ft
Hydraulic Radius	R_h=	0.54	ft
Hydraulic Depth	d_a=	0.57	ft
Manning's Equation solved for 0	✓	0.00	Use goal seek to zero
Average Velocity	V=	8.09	ft/s
Water Surface Top Width	T_w=	6.31	ft
Froude #	Fr=	1.88	SUPERcritical

Riprap Calculation Results			
Minimum stable riprap size	**D_{50}=**	0.94	ft (Eq. 6.11, slope > 10%)
	D_{50}= ✓	11.33	in

Method	Valid Slope?	Calculated D_{50} (mm)	Calculated Flow Depth (m)
HEC-15	Yes	287.88	0.23
Method	**Valid Slope?**	**Calculated D_{50} (inches)**	**Calculated Flow Depth (feet)**
HEC-15	Yes	11.33	0.76

PROJECT NUMBER: 123017
DATA INPUT BY: David Bolanos
DATE: ######
LOCATION: Coffee HLP - Stage 1 Diversion Ditch North - Steep Slope

Objective straight channels only

Design of small open channels and roadside channels with flexible linings using HEC-15, For maximum depths of 1.5 m (5 ft)
Calculations Based on "HEC-15 Third Edition: Design of Roadside Channels with Flexible Linings" FHWA-NHI-05-114 September 2005
Iterate on Specified D_{50} to gain value near the calculated D_{50}

Channel Geometry Input Parameters, (all caluclations are made in metric units then converted)			
Parameter	**Symbol**	**Value**	**Units**
Total Design Discharge	Q=	60.39	cfs
	Q=	1.71	m^3/s
Channel Slope	S_O=	25.00%	
	α=	14.04	Degrees
Channel Bottom Width	B=	3.28	ft
	B=	1.000	m
Left Flank Channel Side Slope	Z_L=	2	_H:1V
Right Flank Channel Side Slope	Z_R=	2	_H:1V

Method Specific Input Parameters and Factor Calculations			
Specific Weight of Water	γ_w=	62.4	lb/ft^3
Specific Weight of Stone	γ_s=	165	lb/ft^3
Rock Specific Gravity	G_s=	2.64	
Rock Angle of Repose	ϕ_R=	42.5	Degrees (Fig. 6.1)
Specified Rip Rap D-50	D_{50}=	24.00	in
Taken Steepest Side Slope	Z=	2	_H:1V
Side Slope Angle	θ=	26.57	Degrees

Shear Stress			
Applied Shear Stress	τo	11.789	lb/ft^2
Shear stress in channel at maximum depth	τd	17.76	lb/ft^2
safety factor	SF	1.00	
side shear stress	τs	14.24	lb/ft^2
ratio of channel side to bottom shear stress	K_1	0.80	1.5 < Z < 5
flow depth, riprap size ratio	d_a/D_{50}	0.40	
Manning n (Eq. 6.1 Range (1.5 <= d_a/D_{50} <= 185))	n	1.331	
Manning n (Eq. 6.2 Range (0.3 < d_a/D_{50} < 1.5))	n	0.065	
	f(Fr) =	1.27	
	f(REG) =	6.01	
	f(CG) =	0.51	
	b	0.29	
Shear velocity	V*	3.03	ft/s
Reynolds Number	Re	497473	
Shields' Parameter	F*	0.150	
safety factor	SF	1.00	Must be ≥ 1
permissible shear stress	τp	0.00	lb/ft^2
Calculated D-50 Rock Size	D_{50}	1.16	ft (Eq. 6.8, slope < 5%)
Calculated D-50 Rock Size	D_{50}	1.67	ft (Eq. 6.11, slope > 10%)
	Δ	1.44	
	β	22.41	Degrees
	η	0.46	

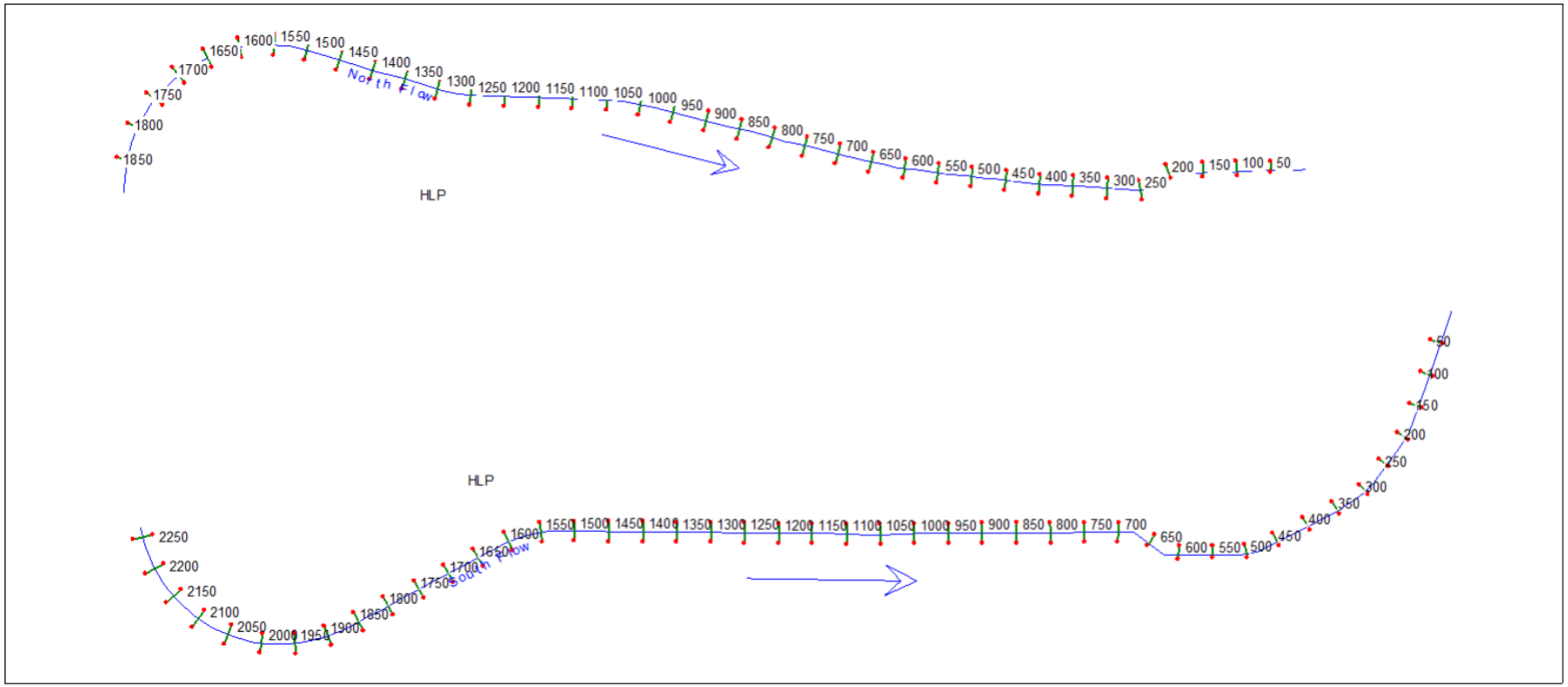
Channel Hydraulic Calculation Results			
Manning n (Based on relative depth ratio)	n=	0.065	Eq. 6.2 (Bathurst 1991)
Flow Depth (Solved by zeroing Mannings Formula)	d=	1.14	ft
Cross-sectional Flow Area	A=	6.33	ft^2
Wetted Perimeter	P=	8.37	ft
Hydraulic Radius	R_h=	0.76	ft
Hydraulic Depth	d_a=	0.81	ft
Manning's Equation solved for 0		0.00	Use goal seek to zero
Average Velocity	V=	9.55	ft/s
Water Surface Top Width	T_w=	7.83	ft
Froude #	Fr=	1.87	SUPERcritical

Riprap Calculation Results			
Minimum stable riprap size	**D_{50}=**	1.67	ft (Eq. 6.11, slope > 10%)
	D_{50}=	20.02	in

Method	Valid Slope?	Calculated D_{50} (mm)	Calculated Flow Depth (m)
HEC-15	Yes	508.51	0.35

Method	Valid Slope?	Calculated D_{50} (inches)	Calculated Flow Depth (feet)
HEC-15	Yes	20.02	1.14

APPENDIX B: PERIMETER CHANNEL HYDRAULIC MODEL RESULTS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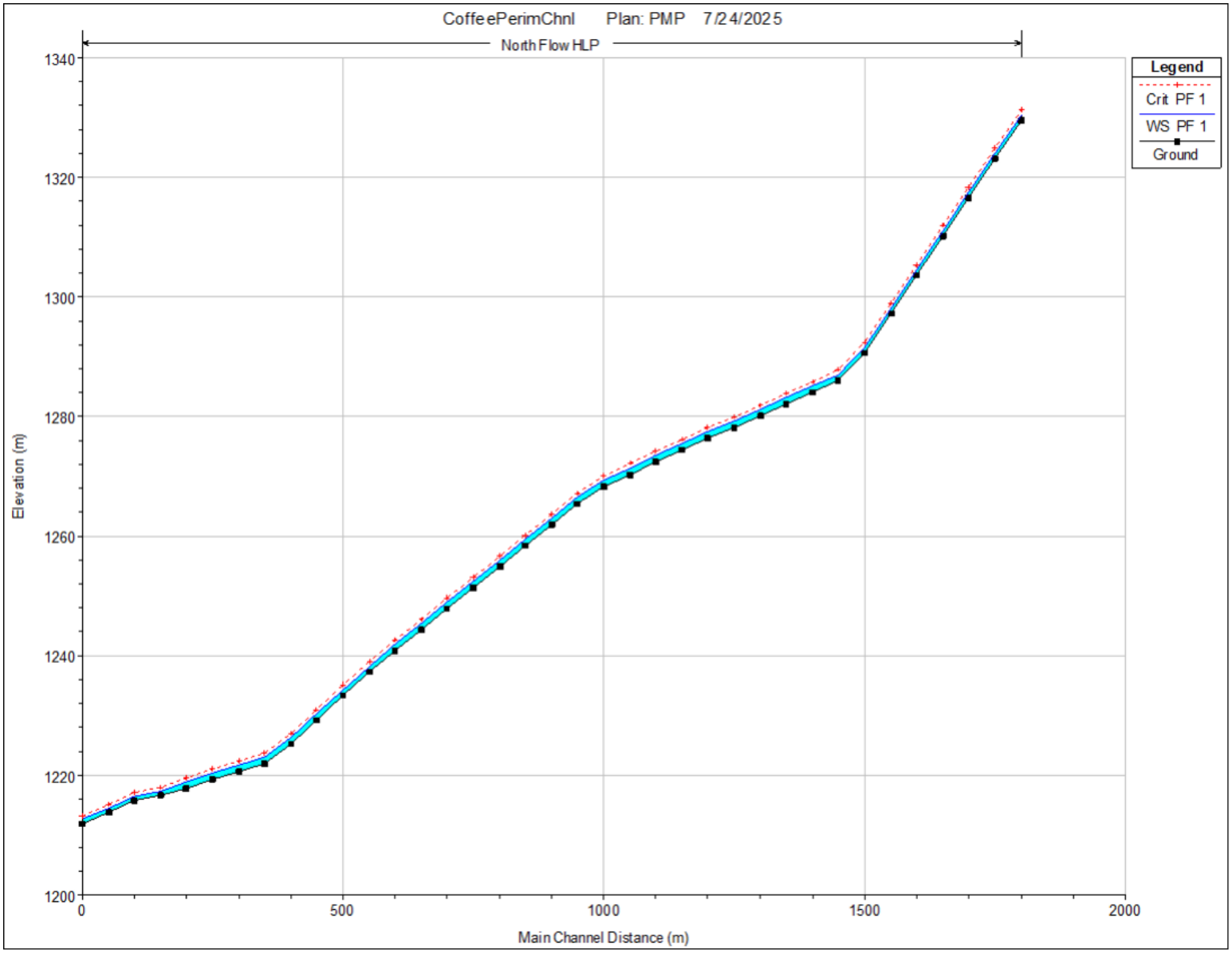
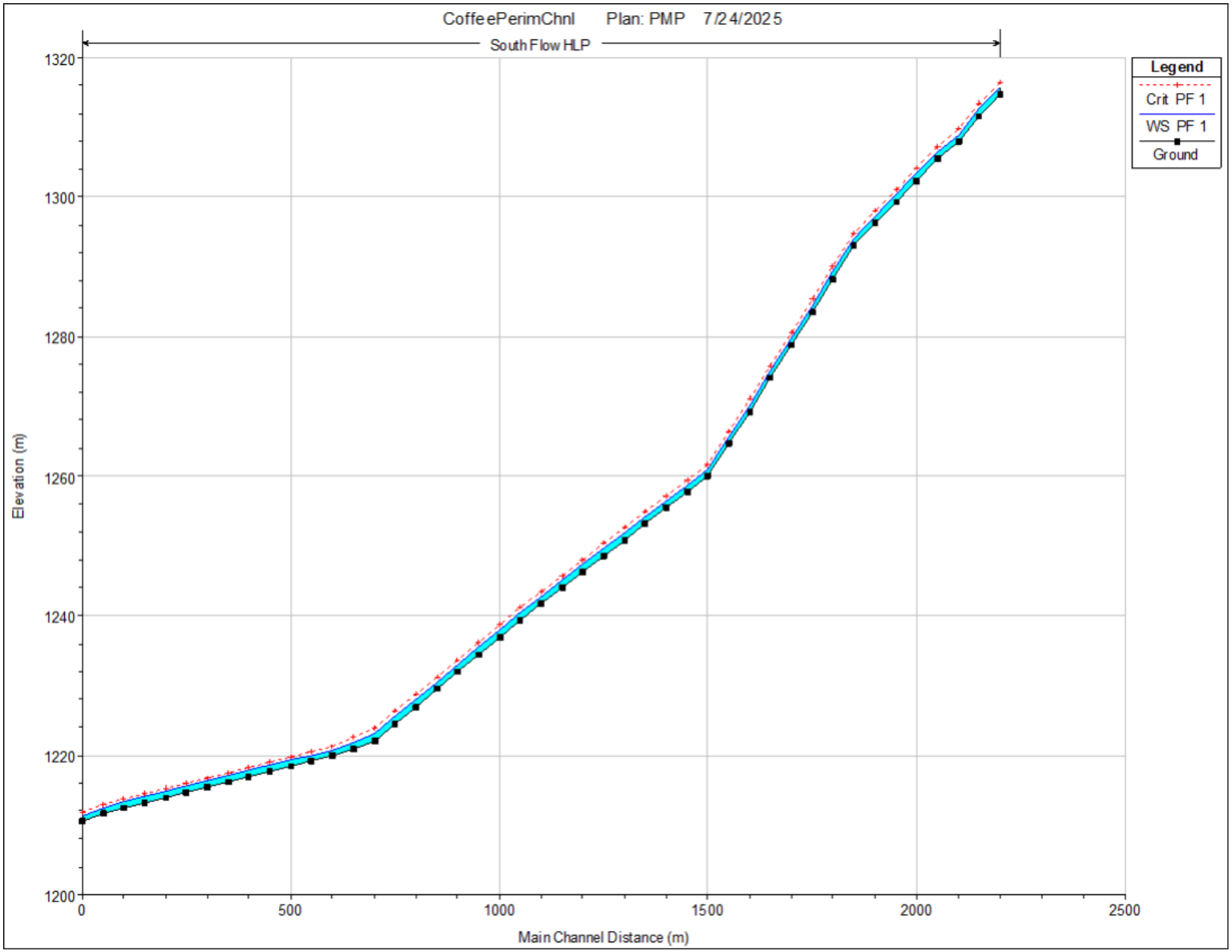
1650 1700 1750 1800 1850
North Flow
HLP
HLP
50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150 1200 1250 1300 1350 1400 1450 1500 1550 1600
2250 2200 2150 2100 2050 2000 1950 1900 1850 1800 1750 1700 1650
South Flow


CoffeePerimChnl Plan: PMP 7/24/2025
North Flow HLP
Legend
Crit PF 1
WS PF 1
Ground
Elevation (m)
1340
1320
1300
1280
1260
1240
1220
1200
0
500
1000
1500
2000
Main Channel Distance (m)


CoffeePerimChnl Plan: PMP 7/24/2025
South Flow HLP
Legend
Crit PF 1
WS PF 1
Ground
Elevation (m)
1320
1300
1280
1260
1240
1220
1200
0
500
1000
1500
2000
2500
Main Channel Distance (m)

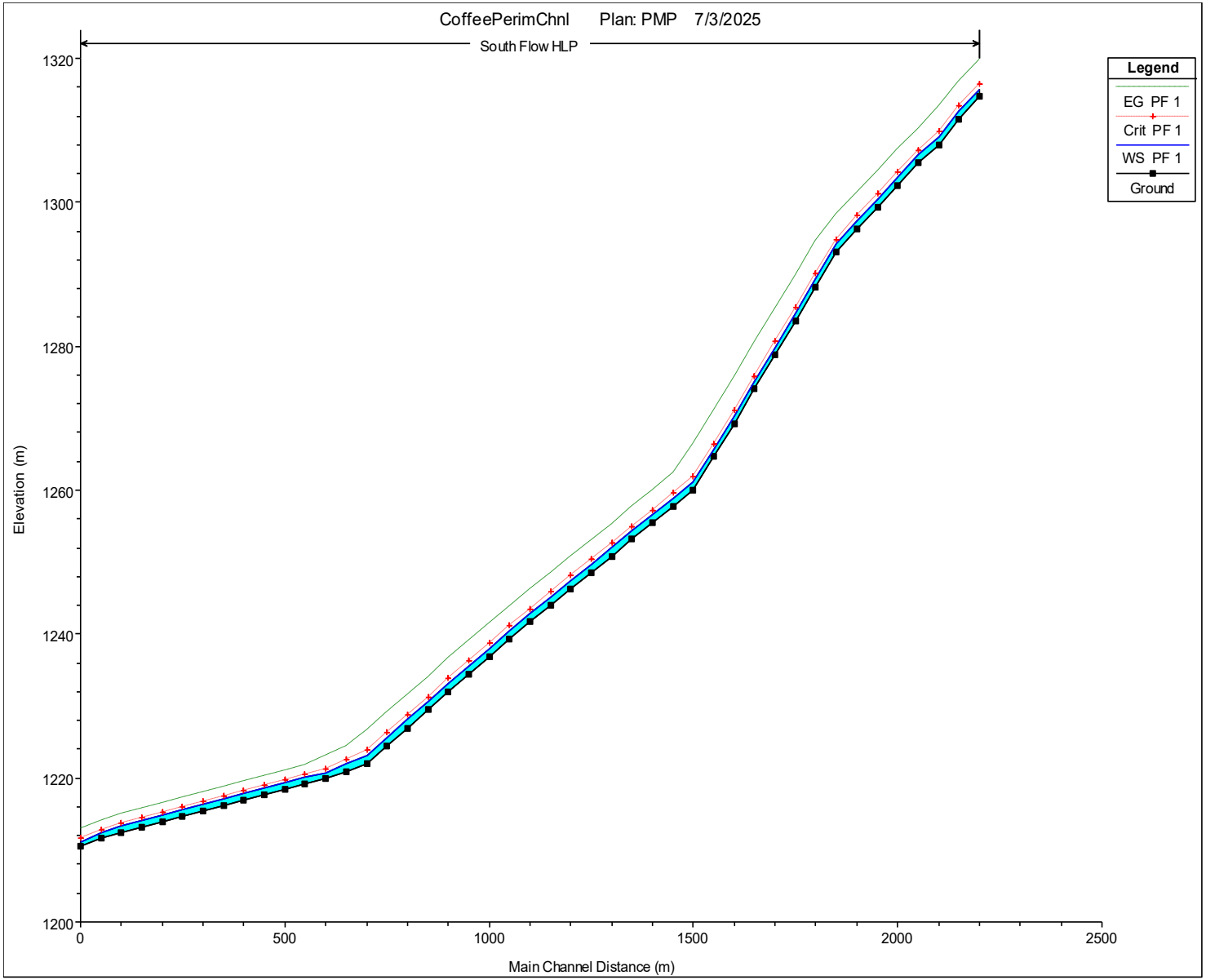

CoffeePerimChnl Plan: PMP 7/3/2025
South Flow HLP
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Elevation (m)
1320
1300
1280
1260
1240
1220
1200
0
500
1000
1500
2000
2500
Main Channel Distance (m)

Table 1: Flow Summary

	Reach	River Sta	Prof	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
South Flow	HLP	2250	PF 1	52	1314.64	1315.65	1316.4	1320.19	0.060106	9.44	5.51	12.44	4.53
South Flow	HLP	2200	PF 1	52	1311.57	1312.58	1313.33	1317.16	0.060965	9.48	5.48	12.42	4.56
South Flow	HLP	2150	PF 1	52	1308	1309	1309.76	1313.92	0.06763	9.82	5.29	12.26	4.77
South Flow	HLP	2100	PF 1	52	1305.45	1306.48	1307.21	1310.69	0.053943	9.09	5.72	12.61	4.31
South Flow	HLP	2050	PF 1	52	1302.39	1303.41	1304.15	1307.86	0.058481	9.35	5.56	12.48	4.47
South Flow	HLP	2000	PF 1	52	1299.33	1300.35	1301.1	1304.89	0.060134	9.44	5.51	12.44	4.53
South Flow	HLP	1950	PF 1	52	1296.28	1297.29	1298.04	1301.86	0.06082	9.47	5.49	12.42	4.55
South Flow	HLP	1900	PF 1	52	1293.06	1294.07	1294.83	1298.76	0.063026	9.59	5.42	12.37	4.63
South Flow	HLP	1850	PF 1	52	1288.3	1289.27	1290.06	1295.01	0.084954	10.62	4.9	11.94	5.29
South Flow	HLP	1800	PF 1	52	1283.55	1284.5	1285.31	1290.57	0.092011	10.91	4.77	11.83	5.49
South Flow	HLP	1750	PF 1	52	1278.79	1279.74	1280.55	1285.79	0.091601	10.89	4.77	11.83	5.48
South Flow	HLP	1700	PF 1	52	1274.03	1274.98	1275.79	1281.14	0.094048	10.99	4.73	11.8	5.54
South Flow	HLP	1650	PF 1	52	1269.27	1270.22	1271.04	1276.41	0.09482	11.02	4.72	11.79	5.56
South Flow	HLP	1600	PF 1	52	1264.62	1265.57	1266.39	1271.69	0.09312	10.95	4.75	11.81	5.52
South Flow	HLP	1550	PF 1	52	1260.02	1260.97	1261.78	1267.05	0.09228	10.92	4.76	11.82	5.49
South Flow	HLP	1500	PF 1	52	1257.73	1258.76	1259.49	1263.01	0.054667	9.13	5.69	12.59	4.34
South Flow	HLP	1450	PF 1	52	1255.44	1256.49	1257.2	1260.35	0.047416	8.7	5.98	12.81	4.07
South Flow	HLP	1400	PF 1	52	1253.15	1254.23	1254.93	1258.01	0.045304	8.61	6.04	13.1	4.05
South Flow	HLP	1350	PF 1	52	1250.86	1251.91	1252.63	1255.71	0.046357	8.63	6.02	12.85	4.03
South Flow	HLP	1300	PF 1	52	1248.57	1249.63	1250.34	1253.4	0.045887	8.6	6.05	12.86	4.01
South Flow	HLP	1250	PF 1	52	1246.28	1247.34	1248.05	1251.11	0.045849	8.6	6.05	12.86	4.01
South Flow	HLP	1200	PF 1	52	1243.99	1245.05	1245.76	1248.82	0.045849	8.6	6.05	12.86	4.01
South Flow	HLP	1150	PF 1	52	1241.7	1242.75	1243.47	1246.53	0.045862	8.6	6.05	12.86	4.01
South Flow	HLP	1100	PF 1	52	1239.37	1240.43	1241.14	1244.22	0.046258	8.63	6.03	12.85	4.02
South Flow	HLP	1050	PF 1	52	1236.9	1237.94	1238.66	1241.85	0.0482	8.75	5.94	12.78	4.1
South Flow	HLP	1000	PF 1	52	1234.42	1235.47	1236.19	1239.41	0.049027	8.8	5.91	12.76	4.13
South Flow	HLP	950	PF 1	52	1231.94	1232.99	1233.71	1236.95	0.049317	8.82	5.9	12.75	4.14
South Flow	HLP	900	PF 1	52	1229.47	1230.51	1231.23	1234.48	0.049443	8.83	5.89	12.74	4.14
South Flow	HLP	850	PF 1	52	1226.99	1228.03	1228.76	1232.01	0.049502	8.83	5.89	12.74	4.15
South Flow	HLP	800	PF 1	52	1224.51	1225.56	1226.28	1229.53	0.049505	8.83	5.89	12.74	4.15
South Flow	HLP	750	PF 1	52	1222.04	1223.08	1223.81	1227.06	0.049511	8.83	5.89	12.74	4.15
South Flow	HLP	700	PF 1	52	1220.79	1221.91	1222.56	1224.8	0.0311	7.52	6.91	13.52	3.36
South Flow	HLP	650	PF 1	52	1219.98	1220.67	1221.29	1223.35	0.024668	7.25	7.17	12.56	3.06
South Flow	HLP	600	PF 1	52	1219.24	1220	1220.55	1222.1	0.018969	6.41	8.11	14.32	2.72
South Flow	HLP	550	PF 1	52	1218.5	1219.3	1219.81	1221.16	0.015903	6.06	8.59	14.48	2.51
South Flow	HLP	500	PF 1	52	1217.75	1218.55	1219.06	1220.37	0.015264	5.98	8.7	14.52	2.47
South Flow	HLP	450	PF 1	52	1217.01	1217.82	1218.32	1219.61	0.014896	5.93	8.77	14.55	2.44
South Flow	HLP	400	PF 1	52	1216.26	1217.07	1217.57	1218.86	0.014896	5.93	8.77	14.55	2.44
South Flow	HLP	350	PF 1	52	1215.51	1216.32	1216.82	1218.12	0.014994	5.94	8.75	14.54	2.45
South Flow	HLP	300	PF 1	52	1214.75	1215.55	1216.05	1217.36	0.015101	5.95	8.73	14.53	2.45
South Flow	HLP	250	PF 1	52	1213.98	1214.79	1215.29	1216.6	0.015171	5.96	8.72	14.53	2.46
South Flow	HLP	200	PF 1	52	1213.22	1214.03	1214.53	1215.84	0.015225	5.97	8.71	14.53	2.46

	Reach	River Sta	Prof	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
South Flow	HLP	150	PF 1	52	1212.46	1213.27	1213.77	1215.08	0.015223	5.97	8.71	14.53	2.46
South Flow	HLP	100	PF 1	52	1211.58	1212.37	1212.89	1214.28	0.016515	6.13	8.48	14.45	2.55
South Flow	HLP	50	PF 1	52	1210.5	1211.31	1211.81	1213.08	0.0345	5.89	8.83	14.57	2.41
North Flow	HLP	1850	PF 1	52	1329.52	1330.44	1331.28	1337.71	0.120173	11.94	4.35	11.47	6.19
North Flow	HLP	1800	PF 1	52	1323.04	1323.95	1324.81	1331.5	0.127043	12.17	4.27	11.4	6.35
North Flow	HLP	1750	PF 1	52	1316.57	1317.48	1318.34	1324.96	0.125312	12.11	4.29	11.42	6.31
North Flow	HLP	1700	PF 1	52	1310.1	1311.01	1311.87	1318.81	0.133337	12.37	4.2	11.34	6.49
North Flow	HLP	1650	PF 1	52	1303.63	1304.53	1305.39	1312.32	0.133147	12.36	4.21	11.34	6.48
North Flow	HLP	1600	PF 1	52	1297.15	1298.06	1298.91	1305.71	0.129709	12.25	4.24	11.38	6.41
North Flow	HLP	1550	PF 1	52	1290.68	1291.59	1292.44	1299.23	0.129461	12.25	4.25	11.38	6.4
North Flow	HLP	1500	PF 1	52	1285.99	1286.93	1287.75	1293.24	0.097476	11.12	4.67	11.75	5.63
North Flow	HLP	1450	PF 1	52	1284.01	1285.05	1285.77	1289.12	0.051303	8.94	5.82	12.69	4.21
North Flow	HLP	1400	PF 1	52	1282.07	1283.15	1283.84	1286.66	0.041327	8.3	6.27	13.03	3.82
North Flow	HLP	1350	PF 1	52	1280.14	1281.22	1281.9	1284.61	0.039205	8.15	6.38	13.12	3.73
North Flow	HLP	1300	PF 1	52	1278.2	1279.29	1279.97	1282.65	0.038808	8.12	6.4	13.14	3.71
North Flow	HLP	1250	PF 1	52	1276.32	1277.41	1278.09	1280.72	0.037872	8.05	6.46	13.18	3.67
North Flow	HLP	1200	PF 1	52	1274.32	1275.41	1276.09	1278.79	0.039117	8.14	6.39	13.13	3.73
North Flow	HLP	1150	PF 1	52	1272.32	1273.4	1274.09	1276.82	0.039645	8.18	6.36	13.1	3.75
North Flow	HLP	1100	PF 1	52	1270.32	1271.4	1272.09	1274.83	0.039857	8.2	6.34	13.09	3.76
North Flow	HLP	1050	PF 1	52	1268.32	1269.4	1270.09	1272.83	0.039929	8.2	6.34	13.09	3.76
North Flow	HLP	1000	PF 1	52	1265.46	1266.5	1267.22	1270.53	0.050565	8.89	5.85	12.71	4.19
North Flow	HLP	950	PF 1	52	1261.91	1262.91	1263.67	1267.64	0.063707	9.62	5.4	12.35	4.65
North Flow	HLP	900	PF 1	52	1258.41	1259.4	1260.17	1264.33	0.067753	9.83	5.29	12.26	4.78
North Flow	HLP	850	PF 1	52	1254.91	1255.9	1256.67	1260.9	0.069196	9.9	5.25	12.23	4.82
North Flow	HLP	800	PF 1	52	1251.41	1252.4	1253.17	1257.42	0.069682	9.92	5.24	12.22	4.84
North Flow	HLP	750	PF 1	52	1247.91	1248.9	1249.67	1253.93	0.069863	9.93	5.24	12.22	4.85
North Flow	HLP	700	PF 1	52	1244.41	1245.4	1246.17	1250.43	0.069952	9.94	5.23	12.22	4.85
North Flow	HLP	650	PF 1	52	1240.91	1241.9	1242.67	1246.94	0.069984	9.94	5.23	12.21	4.85
North Flow	HLP	600	PF 1	52	1237.26	1238.25	1239.02	1243.38	0.071924	10.03	5.18	12.18	4.91
North Flow	HLP	550	PF 1	52	1233.26	1234.24	1235.03	1239.63	0.077249	10.28	5.06	12.07	5.07
North Flow	HLP	500	PF 1	52	1229.26	1230.24	1231.03	1235.71	0.079073	10.36	5.02	12.04	5.12
North Flow	HLP	450	PF 1	52	1225.26	1226.24	1227.03	1231.74	0.079679	10.39	5.01	12.03	5.14
North Flow	HLP	400	PF 1	52	1221.95	1222.94	1223.71	1227.89	0.06819	9.85	5.28	12.25	4.79
North Flow	HLP	350	PF 1	52	1220.58	1221.67	1222.34	1224.93	0.037107	8	6.5	13.21	3.64
North Flow	HLP	300	PF 1	52	1219.21	1220.34	1220.97	1223.13	0.029711	7.41	7.02	13.6	3.29
North Flow	HLP	250	PF 1	52	1217.84	1218.98	1219.6	1221.66	0.027942	7.25	7.17	13.71	3.2
North Flow	HLP	200	PF 1	52	1216.66	1217.33	1217.97	1220.24	0.027878	7.56	6.88	12.44	3.24
North Flow	HLP	150	PF 1	52	1215.74	1216.48	1217.05	1218.82	0.02256	6.78	7.67	14.16	2.94
North Flow	HLP	100	PF 1	52	1213.83	1214.54	1215.14	1217.12	0.055072	7.11	7.31	12.62	2.98
North Flow	HLP	50	PF 1	52	1211.92	1212.71	1213.23	1214.62	0.038908	6.12	8.5	14.45	2.55

Plan: PMP North Flow HLP RS: 1850 Profile: PF 1					
E.G. Elev (m)	1337.71	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	7.27	Wt. n-Val.		0.013	
W.S. Elev (m)	1330.44	Reach Len. (m)	50	50	50
Crit W.S. (m)	1331.28	Flow Area (m2)		4.35	
E.G. Slope (m/m)	0.120173	Area (m2)		4.35	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.47	Top Width (m)		11.47	
Vel Total (m/s)	11.94	Avg. Vel. (m/s)		11.94	
Max Chl Dpth (m)	0.92	Hydr. Depth (m)		0.38	
Conv. Total (m3/s)	150	Conv. (m3/s)		150	
Length Wtd. (m)	50	Wetted Per. (m)		14.53	
Min Ch El (m)	1329.52	Shear (N/m2)		353.14	
Alpha	1	Stream Power (N/m s)		4216.87	
Frctn Loss (m)	6.18	Cum Volume (1000 m3)		10.21	
C & E Loss (m)	0.03	Cum SA (1000 m2)		22.46	

Plan: PMP North Flow HLP RS: 1800 Profile: PF 1					
E.G. Elev (m)	1331.5	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	7.55	Wt. n-Val.		0.013	
W.S. Elev (m)	1323.95	Reach Len. (m)	50	50	50
Crit W.S. (m)	1324.81	Flow Area (m2)		4.27	
E.G. Slope (m/m)	0.127043	Area (m2)		4.27	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.4	Top Width (m)		11.4	
Vel Total (m/s)	12.17	Avg. Vel. (m/s)		12.17	
Max Chl Dpth (m)	0.91	Hydr. Depth (m)		0.37	
Conv. Total (m3/s)	145.9	Conv. (m3/s)		145.9	
Length Wtd. (m)	50	Wetted Per. (m)		14.46	
Min Ch El (m)	1323.04	Shear (N/m2)		368.32	
Alpha	1	Stream Power (N/m s)		4481.58	
Frctn Loss (m)	6.4	Cum Volume (1000 m3)		9.99	
C & E Loss (m)	0.01	Cum SA (1000 m2)		21.89	

Plan: PMP North Flow HLP RS: 1750 Profile: PF 1					
E.G. Elev (m)	1324.96	Element	Left OB	Channel	Right OB
Vel Head (m)	7.48	Wt. n-Val.		0.013	
W.S. Elev (m)	1317.48	Reach Len. (m)	50	50	50
Crit W.S. (m)	1318.34	Flow Area (m2)		4.29	
E.G. Slope (m/m)	0.125312	Area (m2)		4.29	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.42	Top Width (m)		11.42	
Vel Total (m/s)	12.11	Avg. Vel. (m/s)		12.11	
Max Chl Dpth (m)	0.91	Hydr. Depth (m)		0.38	
Conv. Total (m3/s)	146.9	Conv. (m3/s)		146.9	
Length Wtd. (m)	50	Wetted Per. (m)		14.48	
Min Ch El (m)	1316.57	Shear (N/m2)		364.5	
Alpha	1	Stream Power (N/m s)		4414.55	
Frctn Loss (m)	6.34	Cum Volume (1000 m3)		9.78	
C & E Loss (m)	0.01	Cum SA (1000 m2)		21.32	

Plan: PMP North Flow HLP RS: 1700 Profile: PF 1					
E.G. Elev (m)	1318.81	Element	Left OB	Channel	Right OB
Vel Head (m)	7.8	Wt. n-Val.		0.013	
W.S. Elev (m)	1311.01	Reach Len. (m)	50	50	50
Crit W.S. (m)	1311.87	Flow Area (m2)		4.2	
E.G. Slope (m/m)	0.133337	Area (m2)		4.2	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.34	Top Width (m)		11.34	
Vel Total (m/s)	12.37	Avg. Vel. (m/s)		12.37	
Max Chl Dpth (m)	0.9	Hydr. Depth (m)		0.37	
Conv. Total (m3/s)	142.4	Conv. (m3/s)		142.4	
Length Wtd. (m)	50	Wetted Per. (m)		14.39	
Min Ch El (m)	1310.1	Shear (N/m2)		382.05	
Alpha	1	Stream Power (N/m s)		4725.34	
Frctn Loss (m)	6.57	Cum Volume (1000 m3)		9.57	
C & E Loss (m)	0.04	Cum SA (1000 m2)		20.75	

Plan: PMP North Flow HLP RS: 1650 Profile: PF 1					
E.G. Elev (m)	1312.32	Element	Left OB	Channel	Right OB
Vel Head (m)	7.79	Wt. n-Val.		0.013	
W.S. Elev (m)	1304.53	Reach Len. (m)	50	50	50
Crit W.S. (m)	1305.39	Flow Area (m2)		4.21	
E.G. Slope (m/m)	0.133147	Area (m2)		4.21	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.34	Top Width (m)		11.34	
Vel Total (m/s)	12.36	Avg. Vel. (m/s)		12.36	
Max Chl Dpth (m)	0.9	Hydr. Depth (m)		0.37	
Conv. Total (m3/s)	142.5	Conv. (m3/s)		142.5	
Length Wtd. (m)	50	Wetted Per. (m)		14.39	
Min Ch El (m)	1303.63	Shear (N/m2)		381.64	
Alpha	1	Stream Power (N/m s)		4717.9	
Frctn Loss (m)	6.57	Cum Volume (1000 m3)		9.36	
C & E Loss (m)	0.04	Cum SA (1000 m2)		20.19	

Plan: PMP North Flow HLP RS: 1600 Profile: PF 1					
E.G. Elev (m)	1305.71	Element	Left OB	Channel	Right OB
Vel Head (m)	7.66	Wt. n-Val.		0.013	
W.S. Elev (m)	1298.06	Reach Len. (m)	50	50	50
Crit W.S. (m)	1298.91	Flow Area (m2)		4.24	
E.G. Slope (m/m)	0.129709	Area (m2)		4.24	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.38	Top Width (m)		11.38	
Vel Total (m/s)	12.25	Avg. Vel. (m/s)		12.25	
Max Chl Dpth (m)	0.91	Hydr. Depth (m)		0.37	
Conv. Total (m3/s)	144.4	Conv. (m3/s)		144.4	
Length Wtd. (m)	50	Wetted Per. (m)		14.43	
Min Ch El (m)	1297.15	Shear (N/m2)		374.17	
Alpha	1	Stream Power (N/m s)		4584.94	
Frctn Loss (m)	6.48	Cum Volume (1000 m3)		9.14	
C & E Loss (m)	0	Cum SA (1000 m2)		19.62	

Plan: PMP North Flow HLP RS: 1550 Profile: PF 1					
E.G. Elev (m)	1299.23	Element	Left OB	Channel	Right OB
Vel Head (m)	7.65	Wt. n-Val.		0.013	
W.S. Elev (m)	1291.59	Reach Len. (m)	50	50	50
Crit W.S. (m)	1292.44	Flow Area (m2)		4.25	
E.G. Slope (m/m)	0.129461	Area (m2)		4.25	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.38	Top Width (m)		11.38	
Vel Total (m/s)	12.25	Avg. Vel. (m/s)		12.25	
Max Chl Dpth (m)	0.91	Hydr. Depth (m)		0.37	
Conv. Total (m3/s)	144.5	Conv. (m3/s)		144.5	
Length Wtd. (m)	50	Wetted Per. (m)		14.43	
Min Ch El (m)	1290.68	Shear (N/m2)		373.61	
Alpha	1	Stream Power (N/m s)		4575.01	
Frctn Loss (m)	5.59	Cum Volume (1000 m3)		8.93	
C & E Loss (m)	0.4	Cum SA (1000 m2)		19.05	

Plan: PMP North Flow HLP RS: 1500 Profile: PF 1					
E.G. Elev (m)	1293.24	Element	Left OB	Channel	Right OB
Vel Head (m)	6.31	Wt. n-Val.		0.013	
W.S. Elev (m)	1286.93	Reach Len. (m)	50	50	50
Crit W.S. (m)	1287.75	Flow Area (m2)		4.67	
E.G. Slope (m/m)	0.097476	Area (m2)		4.67	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.75	Top Width (m)		11.75	
Vel Total (m/s)	11.12	Avg. Vel. (m/s)		11.12	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	166.6	Conv. (m3/s)		166.6	
Length Wtd. (m)	50	Wetted Per. (m)		14.83	
Min Ch El (m)	1285.99	Shear (N/m2)		301.34	
Alpha	1	Stream Power (N/m s)		3352.12	
Frctn Loss (m)	3.45	Cum Volume (1000 m3)		8.71	
C & E Loss (m)	0.67	Cum SA (1000 m2)		18.47	

Plan: PMP North Flow HLP RS: 1450 Profile: PF 1					
E.G. Elev (m)	1289.12	Element	Left OB	Channel	Right OB
Vel Head (m)	4.07	Wt. n-Val.		0.013	
W.S. Elev (m)	1285.05	Reach Len. (m)	50	50	50
Crit W.S. (m)	1285.77	Flow Area (m2)		5.82	
E.G. Slope (m/m)	0.051303	Area (m2)		5.82	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.69	Top Width (m)		12.69	
Vel Total (m/s)	8.94	Avg. Vel. (m/s)		8.94	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	229.6	Conv. (m3/s)		229.6	
Length Wtd. (m)	50	Wetted Per. (m)		15.84	
Min Ch El (m)	1284.01	Shear (N/m2)		184.84	
Alpha	1	Stream Power (N/m s)		1651.97	
Frctn Loss (m)	2.3	Cum Volume (1000 m3)		8.45	
C & E Loss (m)	0.17	Cum SA (1000 m2)		17.86	

Plan: PMP North Flow HLP RS: 1400 Profile: PF 1					
E.G. Elev (m)	1286.66	Element	Left OB	Channel	Right OB
Vel Head (m)	3.51	Wt. n-Val.		0.013	
W.S. Elev (m)	1283.15	Reach Len. (m)	50	50	50
Crit W.S. (m)	1283.84	Flow Area (m2)		6.27	
E.G. Slope (m/m)	0.041327	Area (m2)		6.27	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.03	Top Width (m)		13.03	
Vel Total (m/s)	8.3	Avg. Vel. (m/s)		8.3	
Max Chl Dpth (m)	1.07	Hydr. Depth (m)		0.48	
Conv. Total (m3/s)	255.8	Conv. (m3/s)		255.8	
Length Wtd. (m)	50	Wetted Per. (m)		16.21	
Min Ch El (m)	1282.07	Shear (N/m2)		156.66	
Alpha	1	Stream Power (N/m s)		1299.99	
Frctn Loss (m)	2.01	Cum Volume (1000 m3)		8.14	
C & E Loss (m)	0.04	Cum SA (1000 m2)		17.22	

Plan: PMP North Flow HLP RS: 1350 Profile: PF 1					
E.G. Elev (m)	1284.61	Element	Left OB	Channel	Right OB
Vel Head (m)	3.39	Wt. n-Val.		0.013	
W.S. Elev (m)	1281.22	Reach Len. (m)	50	50	50
Crit W.S. (m)	1281.9	Flow Area (m2)		6.38	
E.G. Slope (m/m)	0.039205	Area (m2)		6.38	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.12	Top Width (m)		13.12	
Vel Total (m/s)	8.15	Avg. Vel. (m/s)		8.15	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.49	
Conv. Total (m3/s)	262.6	Conv. (m3/s)		262.6	
Length Wtd. (m)	50	Wetted Per. (m)		16.3	
Min Ch El (m)	1280.14	Shear (N/m2)		150.47	
Alpha	1	Stream Power (N/m s)		1226.17	
Frctn Loss (m)	1.95	Cum Volume (1000 m3)		7.83	
C & E Loss (m)	0.01	Cum SA (1000 m2)		16.56	

Plan: PMP North Flow HLP RS: 1300 Profile: PF 1					
E.G. Elev (m)	1282.65	Element	Left OB	Channel	Right OB
Vel Head (m)	3.36	Wt. n-Val.		0.013	
W.S. Elev (m)	1279.29	Reach Len. (m)	50	50	50
Crit W.S. (m)	1279.97	Flow Area (m2)		6.4	
E.G. Slope (m/m)	0.038808	Area (m2)		6.4	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.14	Top Width (m)		13.14	
Vel Total (m/s)	8.12	Avg. Vel. (m/s)		8.12	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.49	
Conv. Total (m3/s)	264	Conv. (m3/s)		264	
Length Wtd. (m)	50	Wetted Per. (m)		16.32	
Min Ch El (m)	1278.2	Shear (N/m2)		149.29	
Alpha	1	Stream Power (N/m s)		1212.31	
Frctn Loss (m)	1.92	Cum Volume (1000 m3)		7.51	
C & E Loss (m)	0.02	Cum SA (1000 m2)		15.91	

Plan: PMP North Flow HLP RS: 1250 Profile: PF 1					
E.G. Elev (m)	1280.72	Element	Left OB	Channel	Right OB
Vel Head (m)	3.31	Wt. n-Val.		0.013	
W.S. Elev (m)	1277.41	Reach Len. (m)	50	50	50
Crit W.S. (m)	1278.09	Flow Area (m2)		6.46	
E.G. Slope (m/m)	0.037872	Area (m2)		6.46	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.18	Top Width (m)		13.18	
Vel Total (m/s)	8.05	Avg. Vel. (m/s)		8.05	
Max Chl Dpth (m)	1.09	Hydr. Depth (m)		0.49	
Conv. Total (m3/s)	267.2	Conv. (m3/s)		267.2	
Length Wtd. (m)	50	Wetted Per. (m)		16.37	
Min Ch El (m)	1276.32	Shear (N/m2)		146.53	
Alpha	1	Stream Power (N/m s)		1179.93	
Frctn Loss (m)	1.92	Cum Volume (1000 m3)		7.19	
C & E Loss (m)	0.01	Cum SA (1000 m2)		15.25	

Plan: PMP North Flow HLP RS: 1200 Profile: PF 1					
E.G. Elev (m)	1278.79	Element	Left OB	Channel	Right OB
Vel Head (m)	3.38	Wt. n-Val.		0.013	
W.S. Elev (m)	1275.41	Reach Len. (m)	50	50	50
Crit W.S. (m)	1276.09	Flow Area (m2)		6.39	
E.G. Slope (m/m)	0.039117	Area (m2)		6.39	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.13	Top Width (m)		13.13	
Vel Total (m/s)	8.14	Avg. Vel. (m/s)		8.14	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.49	
Conv. Total (m3/s)	262.9	Conv. (m3/s)		262.9	
Length Wtd. (m)	50	Wetted Per. (m)		16.31	
Min Ch El (m)	1274.32	Shear (N/m2)		150.2	
Alpha	1	Stream Power (N/m s)		1223.02	
Frctn Loss (m)	1.97	Cum Volume (1000 m3)		6.87	
C & E Loss (m)	0	Cum SA (1000 m2)		14.59	

Plan: PMP North Flow HLP RS: 1150 Profile: PF 1					
E.G. Elev (m)	1276.82	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.41	Wt. n-Val.		0.013	
W.S. Elev (m)	1273.4	Reach Len. (m)	50	50	50
Crit W.S. (m)	1274.09	Flow Area (m2)		6.36	
E.G. Slope (m/m)	0.039645	Area (m2)		6.36	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.1	Top Width (m)		13.1	
Vel Total (m/s)	8.18	Avg. Vel. (m/s)		8.18	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.49	
Conv. Total (m3/s)	261.2	Conv. (m3/s)		261.2	
Length Wtd. (m)	50	Wetted Per. (m)		16.29	
Min Ch El (m)	1272.32	Shear (N/m2)		151.75	
Alpha	1	Stream Power (N/m s)		1241.38	
Frctn Loss (m)	1.99	Cum Volume (1000 m3)		6.55	
C & E Loss (m)	0	Cum SA (1000 m2)		13.94	

Plan: PMP North Flow HLP RS: 1100 Profile: PF 1					
E.G. Elev (m)	1274.83	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.42	Wt. n-Val.		0.013	
W.S. Elev (m)	1271.4	Reach Len. (m)	50	50	50
Crit W.S. (m)	1272.09	Flow Area (m2)		6.34	
E.G. Slope (m/m)	0.039857	Area (m2)		6.34	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.09	Top Width (m)		13.09	
Vel Total (m/s)	8.2	Avg. Vel. (m/s)		8.2	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.48	
Conv. Total (m3/s)	260.5	Conv. (m3/s)		260.5	
Length Wtd. (m)	50	Wetted Per. (m)		16.28	
Min Ch El (m)	1270.32	Shear (N/m2)		152.37	
Alpha	1	Stream Power (N/m s)		1248.78	
Frctn Loss (m)	1.99	Cum Volume (1000 m3)		6.23	
C & E Loss (m)	0	Cum SA (1000 m2)		13.28	

Plan: PMP North Flow HLP RS: 1050 Profile: PF 1					
E.G. Elev (m)	1272.83	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.43	Wt. n-Val.		0.013	
W.S. Elev (m)	1269.4	Reach Len. (m)	50	50	50
Crit W.S. (m)	1270.09	Flow Area (m2)		6.34	
E.G. Slope (m/m)	0.039929	Area (m2)		6.34	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.09	Top Width (m)		13.09	
Vel Total (m/s)	8.2	Avg. Vel. (m/s)		8.2	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.48	
Conv. Total (m3/s)	260.2	Conv. (m3/s)		260.2	
Length Wtd. (m)	50	Wetted Per. (m)		16.27	
Min Ch El (m)	1268.32	Shear (N/m2)		152.58	
Alpha	1	Stream Power (N/m s)		1251.26	
Frctn Loss (m)	2.24	Cum Volume (1000 m3)		5.91	
C & E Loss (m)	0.06	Cum SA (1000 m2)		12.63	

Plan: PMP North Flow HLP RS: 1000 Profile: PF 1					
E.G. Elev (m)	1270.53	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	4.03	Wt. n-Val.		0.013	
W.S. Elev (m)	1266.5	Reach Len. (m)	50	50	50
Crit W.S. (m)	1267.22	Flow Area (m2)		5.85	
E.G. Slope (m/m)	0.050565	Area (m2)		5.85	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.71	Top Width (m)		12.71	
Vel Total (m/s)	8.89	Avg. Vel. (m/s)		8.89	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	231.2	Conv. (m3/s)		231.2	
Length Wtd. (m)	50	Wetted Per. (m)		15.86	
Min Ch El (m)	1265.46	Shear (N/m2)		182.8	
Alpha	1	Stream Power (N/m s)		1625.64	
Frctn Loss (m)	2.83	Cum Volume (1000 m3)		5.61	
C & E Loss (m)	0.07	Cum SA (1000 m2)		11.98	

Plan: PMP North Flow HLP RS: 950 Profile: PF 1					
E.G. Elev (m)	1267.64	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	4.72	Wt. n-Val.		0.013	
W.S. Elev (m)	1262.91	Reach Len. (m)	50	50	50
Crit W.S. (m)	1263.67	Flow Area (m2)		5.4	
E.G. Slope (m/m)	0.063707	Area (m2)		5.4	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.35	Top Width (m)		12.35	
Vel Total (m/s)	9.62	Avg. Vel. (m/s)		9.62	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	206	Conv. (m3/s)		206	
Length Wtd. (m)	50	Wetted Per. (m)		15.48	
Min Ch El (m)	1261.91	Shear (N/m2)		218.05	
Alpha	1	Stream Power (N/m s)		2098.73	
Frctn Loss (m)	3.28	Cum Volume (1000 m3)		5.33	
C & E Loss (m)	0.02	Cum SA (1000 m2)		11.35	

Plan: PMP North Flow HLP RS: 900 Profile: PF 1					
E.G. Elev (m)	1264.33	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	4.93	Wt. n-Val.		0.013	
W.S. Elev (m)	1259.4	Reach Len. (m)	50	50	50
Crit W.S. (m)	1260.17	Flow Area (m2)		5.29	
E.G. Slope (m/m)	0.067753	Area (m2)		5.29	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.26	Top Width (m)		12.26	
Vel Total (m/s)	9.83	Avg. Vel. (m/s)		9.83	
Max Chl Dpth (m)	1	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	199.8	Conv. (m3/s)		199.8	
Length Wtd. (m)	50	Wetted Per. (m)		15.38	
Min Ch El (m)	1258.41	Shear (N/m2)		228.54	
Alpha	1	Stream Power (N/m s)		2246.49	
Frctn Loss (m)	3.42	Cum Volume (1000 m3)		5.06	
C & E Loss (m)	0.01	Cum SA (1000 m2)		10.74	

Plan: PMP North Flow HLP RS: 850 Profile: PF 1					
E.G. Elev (m)	1260.9	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	5	Wt. n-Val.		0.013	
W.S. Elev (m)	1255.9	Reach Len. (m)	50	50	50
Crit W.S. (m)	1256.67	Flow Area (m2)		5.25	
E.G. Slope (m/m)	0.069196	Area (m2)		5.25	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.23	Top Width (m)		12.23	
Vel Total (m/s)	9.9	Avg. Vel. (m/s)		9.9	
Max Chl Dpth (m)	0.99	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	197.7	Conv. (m3/s)		197.7	
Length Wtd. (m)	50	Wetted Per. (m)		15.35	
Min Ch El (m)	1254.91	Shear (N/m2)		232.24	
Alpha	1	Stream Power (N/m s)		2299.36	
Frctn Loss (m)	3.47	Cum Volume (1000 m3)		4.8	
C & E Loss (m)	0	Cum SA (1000 m2)		10.13	

Plan: PMP North Flow HLP RS: 800 Profile: PF 1					
E.G. Elev (m)	1257.42	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	5.02	Wt. n-Val.		0.013	
W.S. Elev (m)	1252.4	Reach Len. (m)	50	50	50
Crit W.S. (m)	1253.17	Flow Area (m2)		5.24	
E.G. Slope (m/m)	0.069682	Area (m2)		5.24	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.22	Top Width (m)		12.22	
Vel Total (m/s)	9.92	Avg. Vel. (m/s)		9.92	
Max Chl Dpth (m)	0.99	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	197	Conv. (m3/s)		197	
Length Wtd. (m)	50	Wetted Per. (m)		15.33	
Min Ch El (m)	1251.41	Shear (N/m2)		233.49	
Alpha	1	Stream Power (N/m s)		2317.24	
Frctn Loss (m)	3.49	Cum Volume (1000 m3)		4.53	
C & E Loss (m)	0	Cum SA (1000 m2)		9.52	

Plan: PMP North Flow HLP RS: 750 Profile: PF 1					
E.G. Elev (m)	1253.93	Element	Left OB	Channel	Right OB
Vel Head (m)	5.03	Wt. n-Val.		0.013	
W.S. Elev (m)	1248.9	Reach Len. (m)	50	50	50
Crit W.S. (m)	1249.67	Flow Area (m2)		5.24	
E.G. Slope (m/m)	0.069863	Area (m2)		5.24	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.22	Top Width (m)		12.22	
Vel Total (m/s)	9.93	Avg. Vel. (m/s)		9.93	
Max Chl Dpth (m)	0.99	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	196.7	Conv. (m3/s)		196.7	
Length Wtd. (m)	50	Wetted Per. (m)		15.33	
Min Ch El (m)	1247.91	Shear (N/m2)		233.93	
Alpha	1	Stream Power (N/m s)		2323.58	
Frctn Loss (m)	3.5	Cum Volume (1000 m3)		4.27	
C & E Loss (m)	0	Cum SA (1000 m2)		8.9	

Plan: PMP North Flow HLP RS: 700 Profile: PF 1					
E.G. Elev (m)	1250.43	Element	Left OB	Channel	Right OB
Vel Head (m)	5.03	Wt. n-Val.		0.013	
W.S. Elev (m)	1245.4	Reach Len. (m)	50	50	50
Crit W.S. (m)	1246.17	Flow Area (m2)		5.23	
E.G. Slope (m/m)	0.069952	Area (m2)		5.23	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.22	Top Width (m)		12.22	
Vel Total (m/s)	9.94	Avg. Vel. (m/s)		9.94	
Max Chl Dpth (m)	0.99	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	196.6	Conv. (m3/s)		196.6	
Length Wtd. (m)	50	Wetted Per. (m)		15.33	
Min Ch El (m)	1244.41	Shear (N/m2)		234.16	
Alpha	1	Stream Power (N/m s)		2326.8	
Frctn Loss (m)	3.5	Cum Volume (1000 m3)		4.01	
C & E Loss (m)	0	Cum SA (1000 m2)		8.29	

Plan: PMP North Flow HLP RS: 650 Profile: PF 1					
E.G. Elev (m)	1246.94	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	5.04	Wt. n-Val.		0.013	
W.S. Elev (m)	1241.9	Reach Len. (m)	50	50	50
Crit W.S. (m)	1242.67	Flow Area (m2)		5.23	
E.G. Slope (m/m)	0.069984	Area (m2)		5.23	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.21	Top Width (m)		12.21	
Vel Total (m/s)	9.94	Avg. Vel. (m/s)		9.94	
Max Chl Dpth (m)	0.99	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	196.6	Conv. (m3/s)		196.6	
Length Wtd. (m)	50	Wetted Per. (m)		15.33	
Min Ch El (m)	1240.91	Shear (N/m2)		234.24	
Alpha	1	Stream Power (N/m s)		2328.03	
Frctn Loss (m)	3.55	Cum Volume (1000 m3)		3.75	
C & E Loss (m)	0.01	Cum SA (1000 m2)		7.68	

Plan: PMP North Flow HLP RS: 600 Profile: PF 1					
E.G. Elev (m)	1243.38	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	5.13	Wt. n-Val.		0.013	
W.S. Elev (m)	1238.25	Reach Len. (m)	50	50	50
Crit W.S. (m)	1239.02	Flow Area (m2)		5.18	
E.G. Slope (m/m)	0.071924	Area (m2)		5.18	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.18	Top Width (m)		12.18	
Vel Total (m/s)	10.03	Avg. Vel. (m/s)		10.03	
Max Chl Dpth (m)	0.99	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	193.9	Conv. (m3/s)		193.9	
Length Wtd. (m)	50	Wetted Per. (m)		15.29	
Min Ch El (m)	1237.26	Shear (N/m2)		239.18	
Alpha	1	Stream Power (N/m s)		2399.42	
Frctn Loss (m)	3.73	Cum Volume (1000 m3)		3.49	
C & E Loss (m)	0.03	Cum SA (1000 m2)		7.07	

Plan: PMP North Flow HLP RS: 550 Profile: PF 1					
E.G. Elev (m)	1239.63	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	5.39	Wt. n-Val.		0.013	
W.S. Elev (m)	1234.24	Reach Len. (m)	50	50	50
Crit W.S. (m)	1235.03	Flow Area (m2)		5.06	
E.G. Slope (m/m)	0.077249	Area (m2)		5.06	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.07	Top Width (m)		12.07	
Vel Total (m/s)	10.28	Avg. Vel. (m/s)		10.28	
Max Chl Dpth (m)	0.98	Hydr. Depth (m)		0.42	
Conv. Total (m3/s)	187.1	Conv. (m3/s)		187.1	
Length Wtd. (m)	50	Wetted Per. (m)		15.18	
Min Ch El (m)	1233.26	Shear (N/m2)		252.53	
Alpha	1	Stream Power (N/m s)		2595.68	
Frctn Loss (m)	3.91	Cum Volume (1000 m3)		3.23	
C & E Loss (m)	0.01	Cum SA (1000 m2)		6.47	

Plan: PMP North Flow HLP RS: 500 Profile: PF 1					
E.G. Elev (m)	1235.71	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	5.47	Wt. n-Val.		0.013	
W.S. Elev (m)	1230.24	Reach Len. (m)	50	50	50
Crit W.S. (m)	1231.03	Flow Area (m2)		5.02	
E.G. Slope (m/m)	0.079073	Area (m2)		5.02	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.04	Top Width (m)		12.04	
Vel Total (m/s)	10.36	Avg. Vel. (m/s)		10.36	
Max Chl Dpth (m)	0.97	Hydr. Depth (m)		0.42	
Conv. Total (m3/s)	184.9	Conv. (m3/s)		184.9	
Length Wtd. (m)	50	Wetted Per. (m)		15.14	
Min Ch El (m)	1229.26	Shear (N/m2)		257.06	
Alpha	1	Stream Power (N/m s)		2663.41	
Frctn Loss (m)	3.97	Cum Volume (1000 m3)		2.98	
C & E Loss (m)	0	Cum SA (1000 m2)		5.86	

Plan: PMP North Flow HLP RS: 450 Profile: PF 1					
E.G. Elev (m)	1231.74	Element	Left OB	Channel	Right OB
Vel Head (m)	5.5	Wt. n-Val.		0.013	
W.S. Elev (m)	1226.24	Reach Len. (m)	50	50	50
Crit W.S. (m)	1227.03	Flow Area (m2)		5.01	
E.G. Slope (m/m)	0.079679	Area (m2)		5.01	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.03	Top Width (m)		12.03	
Vel Total (m/s)	10.39	Avg. Vel. (m/s)		10.39	
Max Chl Dpth (m)	0.97	Hydr. Depth (m)		0.42	
Conv. Total (m3/s)	184.2	Conv. (m3/s)		184.2	
Length Wtd. (m)	50	Wetted Per. (m)		15.13	
Min Ch El (m)	1225.26	Shear (N/m2)		258.56	
Alpha	1	Stream Power (N/m s)		2685.84	
Frctn Loss (m)	3.68	Cum Volume (1000 m3)		2.73	
C & E Loss (m)	0.17	Cum SA (1000 m2)		5.26	

Plan: PMP North Flow HLP RS: 400 Profile: PF 1					
E.G. Elev (m)	1227.37	Element	Left OB	Channel	Right OB
Vel Head (m)	4.33	Wt. n-Val.		0.013	
W.S. Elev (m)	1223.05	Reach Len. (m)	50	50	50
Crit W.S. (m)	1223.77	Flow Area (m2)		5.64	
E.G. Slope (m/m)	0.067269	Area (m2)		5.64	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.97	Top Width (m)		12.97	
Vel Total (m/s)	9.21	Avg. Vel. (m/s)		9.21	
Max Chl Dpth (m)	1.1	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	200.5	Conv. (m3/s)		200.5	
Length Wtd. (m)	50	Wetted Per. (m)		17.99	
Min Ch El (m)	1221.95	Shear (N/m2)		206.96	
Alpha	1	Stream Power (N/m s)		1906.49	
Frctn Loss (m)	2.35	Cum Volume (1000 m3)		2.45	
C & E Loss (m)	0.46	Cum SA (1000 m2)		4.63	

Plan: PMP North Flow HLP RS: 350 Profile: PF 1					
E.G. Elev (m)	1224.93	Element	Left OB	Channel	Right OB
Vel Head (m)	3.26	Wt. n-Val.		0.013	
W.S. Elev (m)	1221.67	Reach Len. (m)	50	50	50
Crit W.S. (m)	1222.34	Flow Area (m2)		6.5	
E.G. Slope (m/m)	0.037107	Area (m2)		6.5	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.21	Top Width (m)		13.21	
Vel Total (m/s)	8	Avg. Vel. (m/s)		8	
Max Chl Dpth (m)	1.09	Hydr. Depth (m)		0.49	
Conv. Total (m3/s)	269.9	Conv. (m3/s)		269.9	
Length Wtd. (m)	50	Wetted Per. (m)		16.41	
Min Ch El (m)	1220.58	Shear (N/m2)		144.25	
Alpha	1	Stream Power (N/m s)		1153.42	
Frctn Loss (m)	1.66	Cum Volume (1000 m3)		2.18	
C & E Loss (m)	0.14	Cum SA (1000 m2)		4.02	

Plan: PMP North Flow HLP RS: 300 Profile: PF 1					
E.G. Elev (m)	1223.13	Element	Left OB	Channel	Right OB
Vel Head (m)	2.8	Wt. n-Val.		0.013	
W.S. Elev (m)	1220.34	Reach Len. (m)	50	50	50
Crit W.S. (m)	1220.97	Flow Area (m2)		7.02	
E.G. Slope (m/m)	0.029711	Area (m2)		7.02	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.6	Top Width (m)		13.6	
Vel Total (m/s)	7.41	Avg. Vel. (m/s)		7.41	
Max Chl Dpth (m)	1.13	Hydr. Depth (m)		0.52	
Conv. Total (m3/s)	301.7	Conv. (m3/s)		301.7	
Length Wtd. (m)	50	Wetted Per. (m)		16.82	
Min Ch El (m)	1219.21	Shear (N/m2)		121.62	
Alpha	1	Stream Power (N/m s)		900.66	
Frctn Loss (m)	1.44	Cum Volume (1000 m3)		1.84	
C & E Loss (m)	0.03	Cum SA (1000 m2)		3.35	

Plan: PMP North Flow HLP RS: 250 Profile: PF 1					
E.G. Elev (m)	1221.66	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	2.68	Wt. n-Val.		0.013	
W.S. Elev (m)	1218.98	Reach Len. (m)	50	50	50
Crit W.S. (m)	1219.6	Flow Area (m2)		7.17	
E.G. Slope (m/m)	0.027942	Area (m2)		7.17	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.71	Top Width (m)		13.71	
Vel Total (m/s)	7.25	Avg. Vel. (m/s)		7.25	
Max Chl Dpth (m)	1.14	Hydr. Depth (m)		0.52	
Conv. Total (m3/s)	311.1	Conv. (m3/s)		311.1	
Length Wtd. (m)	50	Wetted Per. (m)		16.94	
Min Ch El (m)	1217.84	Shear (N/m2)		116.01	
Alpha	1	Stream Power (N/m s)		841.06	
Frctn Loss (m)	1.4	Cum Volume (1000 m3)		1.48	
C & E Loss (m)	0.02	Cum SA (1000 m2)		2.67	

Plan: PMP North Flow HLP RS: 200 Profile: PF 1					
E.G. Elev (m)	1220.24	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	2.91	Wt. n-Val.		0.013	
W.S. Elev (m)	1217.33	Reach Len. (m)	50	50	50
Crit W.S. (m)	1217.97	Flow Area (m2)		6.88	
E.G. Slope (m/m)	0.027878	Area (m2)		6.88	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.44	Top Width (m)		12.44	
Vel Total (m/s)	7.56	Avg. Vel. (m/s)		7.56	
Max Chl Dpth (m)	0.67	Hydr. Depth (m)		0.55	
Conv. Total (m3/s)	311.4	Conv. (m3/s)		311.4	
Length Wtd. (m)	50	Wetted Per. (m)		15.25	
Min Ch El (m)	1216.66	Shear (N/m2)		123.37	
Alpha	1	Stream Power (N/m s)		932.25	
Frctn Loss (m)	1.25	Cum Volume (1000 m3)		1.13	
C & E Loss (m)	0.17	Cum SA (1000 m2)		2.01	

Plan: PMP North Flow HLP RS: 150 Profile: PF 1					
E.G. Elev (m)	1218.82	Element	Left OB	Channel	Right OB
Vel Head (m)	2.34	Wt. n-Val.		0.013	
W.S. Elev (m)	1216.48	Reach Len. (m)	50	50	50
Crit W.S. (m)	1217.05	Flow Area (m2)		7.67	
E.G. Slope (m/m)	0.02256	Area (m2)		7.67	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.16	Top Width (m)		14.16	
Vel Total (m/s)	6.78	Avg. Vel. (m/s)		6.78	
Max Chl Dpth (m)	0.73	Hydr. Depth (m)		0.54	
Conv. Total (m3/s)	346.2	Conv. (m3/s)		346.2	
Length Wtd. (m)	50	Wetted Per. (m)		17.07	
Min Ch El (m)	1215.74	Shear (N/m2)		99.43	
Alpha	1	Stream Power (N/m s)		674.04	
Frctn Loss (m)	1.68	Cum Volume (1000 m3)		0.77	
C & E Loss (m)	0.02	Cum SA (1000 m2)		1.35	

Plan: PMP North Flow HLP RS: 100 Profile: PF 1					
E.G. Elev (m)	1217.12	Element	Left OB	Channel	Right OB
Vel Head (m)	2.58	Wt. n-Val.		0.02	
W.S. Elev (m)	1214.54	Reach Len. (m)	50	50	50
Crit W.S. (m)	1215.14	Flow Area (m2)		7.31	
E.G. Slope (m/m)	0.055072	Area (m2)		7.31	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.62	Top Width (m)		12.62	
Vel Total (m/s)	7.11	Avg. Vel. (m/s)		7.11	
Max Chl Dpth (m)	0.71	Hydr. Depth (m)		0.58	
Conv. Total (m3/s)	221.6	Conv. (m3/s)		221.6	
Length Wtd. (m)	50	Wetted Per. (m)		15.5	
Min Ch El (m)	1213.83	Shear (N/m2)		254.76	
Alpha	1	Stream Power (N/m s)		1811.41	
Frctn Loss (m)	2.3	Cum Volume (1000 m3)		0.4	
C & E Loss (m)	0.2	Cum SA (1000 m2)		0.68	

Plan: PMP North Flow HLP RS: 50 Profile: PF 1					
E.G. Elev (m)	1214.62	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.91	Wt. n-Val.		0.02	
W.S. Elev (m)	1212.71	Reach Len. (m)			
Crit W.S. (m)	1213.23	Flow Area (m2)		3.61	
E.G. Slope (m/m)	0.038908	Area (m2)		3.61	
Q Total (m3/s)	52	Flow (m3/s)		27.2	
Top Width (m)	14.45	Top Width (m)		7.8	
Vel Total (m/s)	6.12	Avg. Vel. (m/s)		7.53	
Max Chl Dpth (m)	0.79	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	263.6	Conv. (m3/s)		95.4	
Length Wtd. (m)		Wetted Per. (m)		9.41	
Min Ch El (m)	1211.92	Shear (N/m2)		306.18	
Alpha	1	Stream Power (N/m s)		2306.14	
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			

Plan: PMP South Flow HLP RS: 2250 Profile: PF 1					
E.G. Elev (m)	1320.19	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	4.54	Wt. n-Val.		0.013	
W.S. Elev (m)	1315.65	Reach Len. (m)	50	50	50
Crit W.S. (m)	1316.4	Flow Area (m2)		5.51	
E.G. Slope (m/m)	0.060106	Area (m2)		5.51	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.44	Top Width (m)		12.44	
Vel Total (m/s)	9.44	Avg. Vel. (m/s)		9.44	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	212.1	Conv. (m3/s)		212.1	
Length Wtd. (m)	50	Wetted Per. (m)		15.57	
Min Ch El (m)	1314.64	Shear (N/m2)		208.6	
Alpha	1	Stream Power (N/m s)		1968.34	
Frctn Loss (m)	3.03	Cum Volume (1000 m3)		14.17	
C & E Loss (m)	0	Cum SA (1000 m2)		28.69	

Plan: PMP South Flow HLP RS: 2200 Profile: PF 1					
E.G. Elev (m)	1317.16	Element	Left OB	Channel	Right OB
Vel Head (m)	4.58	Wt. n-Val.		0.013	
W.S. Elev (m)	1312.58	Reach Len. (m)	50	50	50
Crit W.S. (m)	1313.33	Flow Area (m2)		5.48	
E.G. Slope (m/m)	0.060965	Area (m2)		5.48	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.42	Top Width (m)		12.42	
Vel Total (m/s)	9.48	Avg. Vel. (m/s)		9.48	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	210.6	Conv. (m3/s)		210.6	
Length Wtd. (m)	50	Wetted Per. (m)		15.55	
Min Ch El (m)	1311.57	Shear (N/m2)		210.88	
Alpha	1	Stream Power (N/m s)		1999.5	
Frctn Loss (m)	3.21	Cum Volume (1000 m3)		13.9	
C & E Loss (m)	0.03	Cum SA (1000 m2)		28.07	

Plan: PMP South Flow HLP RS: 2150 Profile: PF 1					
E.G. Elev (m)	1313.92	Element	Left OB	Channel	Right OB
Vel Head (m)	4.92	Wt. n-Val.		0.013	
W.S. Elev (m)	1309	Reach Len. (m)	50	50	50
Crit W.S. (m)	1309.76	Flow Area (m2)		5.29	
E.G. Slope (m/m)	0.06763	Area (m2)		5.29	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.26	Top Width (m)		12.26	
Vel Total (m/s)	9.82	Avg. Vel. (m/s)		9.82	
Max Chl Dpth (m)	1	Hydr. Depth (m)		0.43	
Conv. Total (m3/s)	200	Conv. (m3/s)		200	
Length Wtd. (m)	50	Wetted Per. (m)		15.38	
Min Ch El (m)	1308	Shear (N/m2)		228.22	
Alpha	1	Stream Power (N/m s)		2241.87	
Frctn Loss (m)	3.01	Cum Volume (1000 m3)		13.63	
C & E Loss (m)	0.21	Cum SA (1000 m2)		27.45	

Plan: PMP South Flow HLP RS: 2100 Profile: PF 1					
E.G. Elev (m)	1310.69	Element	Left OB	Channel	Right OB
Vel Head (m)	4.22	Wt. n-Val.		0.013	
W.S. Elev (m)	1306.48	Reach Len. (m)	50	50	50
Crit W.S. (m)	1307.21	Flow Area (m2)		5.72	
E.G. Slope (m/m)	0.053943	Area (m2)		5.72	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.61	Top Width (m)		12.61	
Vel Total (m/s)	9.09	Avg. Vel. (m/s)		9.09	
Max Chl Dpth (m)	1.03	Hydr. Depth (m)		0.45	
Conv. Total (m3/s)	223.9	Conv. (m3/s)		223.9	
Length Wtd. (m)	50	Wetted Per. (m)		15.75	
Min Ch El (m)	1305.45	Shear (N/m2)		192.07	
Alpha	1	Stream Power (N/m s)		1746.46	
Frctn Loss (m)	2.81	Cum Volume (1000 m3)		13.35	
C & E Loss (m)	0.02	Cum SA (1000 m2)		26.83	

Plan: PMP South Flow HLP RS: 2050 Profile: PF 1					
E.G. Elev (m)	1307.86	Element	Left OB	Channel	Right OB
Vel Head (m)	4.46	Wt. n-Val.		0.013	
W.S. Elev (m)	1303.41	Reach Len. (m)	50	50	50
Crit W.S. (m)	1304.15	Flow Area (m2)		5.56	
E.G. Slope (m/m)	0.058481	Area (m2)		5.56	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.48	Top Width (m)		12.48	
Vel Total (m/s)	9.35	Avg. Vel. (m/s)		9.35	
Max Chl Dpth (m)	1.02	Hydr. Depth (m)		0.45	
Conv. Total (m3/s)	215	Conv. (m3/s)		215	
Length Wtd. (m)	50	Wetted Per. (m)		15.62	
Min Ch El (m)	1302.39	Shear (N/m2)		204.29	
Alpha	1	Stream Power (N/m s)		1909.6	
Frctn Loss (m)	2.96	Cum Volume (1000 m3)		13.07	
C & E Loss (m)	0.01	Cum SA (1000 m2)		26.2	

Plan: PMP South Flow HLP RS: 2000 Profile: PF 1					
E.G. Elev (m)	1304.89	Element	Left OB	Channel	Right OB
Vel Head (m)	4.54	Wt. n-Val.		0.013	
W.S. Elev (m)	1300.35	Reach Len. (m)	50	50	50
Crit W.S. (m)	1301.1	Flow Area (m2)		5.51	
E.G. Slope (m/m)	0.060134	Area (m2)		5.51	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.44	Top Width (m)		12.44	
Vel Total (m/s)	9.44	Avg. Vel. (m/s)		9.44	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	212.1	Conv. (m3/s)		212.1	
Length Wtd. (m)	50	Wetted Per. (m)		15.57	
Min Ch El (m)	1299.33	Shear (N/m2)		208.68	
Alpha	1	Stream Power (N/m s)		1969.45	
Frctn Loss (m)	3.02	Cum Volume (1000 m3)		12.79	
C & E Loss (m)	0	Cum SA (1000 m2)		25.58	

Plan: PMP South Flow HLP RS: 1950 Profile: PF 1					
E.G. Elev (m)	1301.86	Element	Left OB	Channel	Right OB
Vel Head (m)	4.58	Wt. n-Val.		0.013	
W.S. Elev (m)	1297.29	Reach Len. (m)	50	50	50
Crit W.S. (m)	1298.04	Flow Area (m2)		5.49	
E.G. Slope (m/m)	0.06082	Area (m2)		5.49	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.42	Top Width (m)		12.42	
Vel Total (m/s)	9.47	Avg. Vel. (m/s)		9.47	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	210.9	Conv. (m3/s)		210.9	
Length Wtd. (m)	50	Wetted Per. (m)		15.55	
Min Ch El (m)	1296.28	Shear (N/m2)		210.49	
Alpha	1	Stream Power (N/m s)		1994.19	
Frctn Loss (m)	3.1	Cum Volume (1000 m3)		12.52	
C & E Loss (m)	0.01	Cum SA (1000 m2)		24.96	

Plan: PMP South Flow HLP RS: 1900 Profile: PF 1					
E.G. Elev (m)	1298.76	Element	Left OB	Channel	Right OB
Vel Head (m)	4.69	Wt. n-Val.		0.013	
W.S. Elev (m)	1294.07	Reach Len. (m)	50	50	50
Crit W.S. (m)	1294.83	Flow Area (m2)		5.42	
E.G. Slope (m/m)	0.063026	Area (m2)		5.42	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.37	Top Width (m)		12.37	
Vel Total (m/s)	9.59	Avg. Vel. (m/s)		9.59	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.44	
Conv. Total (m3/s)	207.1	Conv. (m3/s)		207.1	
Length Wtd. (m)	50	Wetted Per. (m)		15.49	
Min Ch El (m)	1293.06	Shear (N/m2)		216.29	
Alpha	1	Stream Power (N/m s)		2074.2	
Frctn Loss (m)	3.64	Cum Volume (1000 m3)		12.25	
C & E Loss (m)	0.11	Cum SA (1000 m2)		24.34	

Plan: PMP South Flow HLP RS: 1850 Profile: PF 1					
E.G. Elev (m)	1295.01	Element	Left OB	Channel	Right OB
Vel Head (m)	5.75	Wt. n-Val.		0.013	
W.S. Elev (m)	1289.27	Reach Len. (m)	50	50	50
Crit W.S. (m)	1290.06	Flow Area (m2)		4.9	
E.G. Slope (m/m)	0.084954	Area (m2)		4.9	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.94	Top Width (m)		11.94	
Vel Total (m/s)	10.62	Avg. Vel. (m/s)		10.62	
Max Chl Dpth (m)	0.96	Hydr. Depth (m)		0.41	
Conv. Total (m3/s)	178.4	Conv. (m3/s)		178.4	
Length Wtd. (m)	50	Wetted Per. (m)		15.03	
Min Ch El (m)	1288.3	Shear (N/m2)		271.48	
Alpha	1	Stream Power (N/m s)		2882.37	
Frctn Loss (m)	4.42	Cum Volume (1000 m3)		11.99	
C & E Loss (m)	0.03	Cum SA (1000 m2)		23.73	

Plan: PMP South Flow HLP RS: 1800 Profile: PF 1					
E.G. Elev (m)	1290.57	Element	Left OB	Channel	Right OB
Vel Head (m)	6.07	Wt. n-Val.		0.013	
W.S. Elev (m)	1284.5	Reach Len. (m)	50	50	50
Crit W.S. (m)	1285.31	Flow Area (m2)		4.77	
E.G. Slope (m/m)	0.092011	Area (m2)		4.77	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.83	Top Width (m)		11.83	
Vel Total (m/s)	10.91	Avg. Vel. (m/s)		10.91	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	171.4	Conv. (m3/s)		171.4	
Length Wtd. (m)	50	Wetted Per. (m)		14.91	
Min Ch El (m)	1283.55	Shear (N/m2)		288.44	
Alpha	1	Stream Power (N/m s)		3146.57	
Frctn Loss (m)	4.65	Cum Volume (1000 m3)		11.75	
C & E Loss (m)	0.01	Cum SA (1000 m2)		23.14	

Plan: PMP South Flow HLP RS: 1750 Profile: PF 1					
E.G. Elev (m)	1285.79	Element	Left OB	Channel	Right OB
Vel Head (m)	6.05	Wt. n-Val.		0.013	
W.S. Elev (m)	1279.74	Reach Len. (m)	50	50	50
Crit W.S. (m)	1280.55	Flow Area (m2)		4.77	
E.G. Slope (m/m)	0.091601	Area (m2)		4.77	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.83	Top Width (m)		11.83	
Vel Total (m/s)	10.89	Avg. Vel. (m/s)		10.89	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	171.8	Conv. (m3/s)		171.8	
Length Wtd. (m)	50	Wetted Per. (m)		14.92	
Min Ch El (m)	1278.79	Shear (N/m2)		287.47	
Alpha	1	Stream Power (N/m s)		3131.23	
Frctn Loss (m)	4.64	Cum Volume (1000 m3)		11.51	
C & E Loss (m)	0.01	Cum SA (1000 m2)		22.55	

Plan: PMP South Flow HLP RS: 1700 Profile: PF 1					
E.G. Elev (m)	1281.14	Element	Left OB	Channel	Right OB
Vel Head (m)	6.16	Wt. n-Val.		0.013	
W.S. Elev (m)	1274.98	Reach Len. (m)	50	50	50
Crit W.S. (m)	1275.79	Flow Area (m2)		4.73	
E.G. Slope (m/m)	0.094048	Area (m2)		4.73	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.8	Top Width (m)		11.8	
Vel Total (m/s)	10.99	Avg. Vel. (m/s)		10.99	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	169.6	Conv. (m3/s)		169.6	
Length Wtd. (m)	50	Wetted Per. (m)		14.88	
Min Ch El (m)	1274.03	Shear (N/m2)		293.27	
Alpha	1	Stream Power (N/m s)		3223.1	
Frctn Loss (m)	4.72	Cum Volume (1000 m3)		11.27	
C & E Loss (m)	0	Cum SA (1000 m2)		21.96	

Plan: PMP South Flow HLP RS: 1650 Profile: PF 1					
E.G. Elev (m)	1276.41	Element	Left OB	Channel	Right OB
Vel Head (m)	6.19	Wt. n-Val.		0.013	
W.S. Elev (m)	1270.22	Reach Len. (m)	50	50	50
Crit W.S. (m)	1271.04	Flow Area (m2)		4.72	
E.G. Slope (m/m)	0.09482	Area (m2)		4.72	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.79	Top Width (m)		11.79	
Vel Total (m/s)	11.02	Avg. Vel. (m/s)		11.02	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	168.9	Conv. (m3/s)		168.9	
Length Wtd. (m)	50	Wetted Per. (m)		14.87	
Min Ch El (m)	1269.27	Shear (N/m2)		295.09	
Alpha	1	Stream Power (N/m s)		3252.07	
Frctn Loss (m)	4.7	Cum Volume (1000 m3)		11.03	
C & E Loss (m)	0.02	Cum SA (1000 m2)		21.37	

Plan: PMP South Flow HLP RS: 1600 Profile: PF 1					
E.G. Elev (m)	1271.69	Element	Left OB	Channel	Right OB
Vel Head (m)	6.12	Wt. n-Val.		0.013	
W.S. Elev (m)	1265.57	Reach Len. (m)	50	50	50
Crit W.S. (m)	1266.39	Flow Area (m2)		4.75	
E.G. Slope (m/m)	0.09312	Area (m2)		4.75	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.81	Top Width (m)		11.81	
Vel Total (m/s)	10.95	Avg. Vel. (m/s)		10.95	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	170.4	Conv. (m3/s)		170.4	
Length Wtd. (m)	50	Wetted Per. (m)		14.89	
Min Ch El (m)	1264.62	Shear (N/m2)		291.08	
Alpha	1	Stream Power (N/m s)		3188.27	
Frctn Loss (m)	4.63	Cum Volume (1000 m3)		10.8	
C & E Loss (m)	0.01	Cum SA (1000 m2)		20.78	

Plan: PMP South Flow HLP RS: 1550 Profile: PF 1					
E.G. Elev (m)	1267.05	Element	Left OB	Channel	Right OB
Vel Head (m)	6.08	Wt. n-Val.		0.013	
W.S. Elev (m)	1260.97	Reach Len. (m)	50	50	50
Crit W.S. (m)	1261.78	Flow Area (m2)		4.76	
E.G. Slope (m/m)	0.09228	Area (m2)		4.76	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	11.82	Top Width (m)		11.82	
Vel Total (m/s)	10.92	Avg. Vel. (m/s)		10.92	
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.4	
Conv. Total (m3/s)	171.2	Conv. (m3/s)		171.2	
Length Wtd. (m)	50	Wetted Per. (m)		14.91	
Min Ch El (m)	1260.02	Shear (N/m2)		289.09	
Alpha	1	Stream Power (N/m s)		3156.82	
Frctn Loss (m)	3.49	Cum Volume (1000 m3)		10.56	
C & E Loss (m)	0.55	Cum SA (1000 m2)		20.19	

Plan: PMP South Flow HLP RS: 1500 Profile: PF 1					
E.G. Elev (m)	1263.01	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	4.25	Wt. n-Val.		0.013	
W.S. Elev (m)	1258.76	Reach Len. (m)	50	50	50
Crit W.S. (m)	1259.49	Flow Area (m2)		5.69	
E.G. Slope (m/m)	0.054667	Area (m2)		5.69	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.59	Top Width (m)		12.59	
Vel Total (m/s)	9.13	Avg. Vel. (m/s)		9.13	
Max Chl Dpth (m)	1.03	Hydr. Depth (m)		0.45	
Conv. Total (m3/s)	222.4	Conv. (m3/s)		222.4	
Length Wtd. (m)	50	Wetted Per. (m)		15.73	
Min Ch El (m)	1257.73	Shear (N/m2)		194.02	
Alpha	1	Stream Power (N/m s)		1772.25	
Frctn Loss (m)	2.54	Cum Volume (1000 m3)		10.3	
C & E Loss (m)	0.12	Cum SA (1000 m2)		19.58	

Plan: PMP South Flow HLP RS: 1450 Profile: PF 1					
E.G. Elev (m)	1260.35	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.86	Wt. n-Val.		0.013	
W.S. Elev (m)	1256.49	Reach Len. (m)	50	50	50
Crit W.S. (m)	1257.2	Flow Area (m2)		5.98	
E.G. Slope (m/m)	0.047416	Area (m2)		5.98	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.81	Top Width (m)		12.81	
Vel Total (m/s)	8.7	Avg. Vel. (m/s)		8.7	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	238.8	Conv. (m3/s)		238.8	
Length Wtd. (m)	50	Wetted Per. (m)		15.97	
Min Ch El (m)	1255.44	Shear (N/m2)		174.04	
Alpha	1	Stream Power (N/m s)		1514.1	
Frctn Loss (m)	2.32	Cum Volume (1000 m3)		10.01	
C & E Loss (m)	0.02	Cum SA (1000 m2)		18.94	

Plan: PMP South Flow HLP RS: 1400 Profile: PF 1					
E.G. Elev (m)	1258.01	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.78	Wt. n-Val.		0.013	
W.S. Elev (m)	1254.23	Reach Len. (m)	50	50	50
Crit W.S. (m)	1254.93	Flow Area (m2)		6.04	
E.G. Slope (m/m)	0.045304	Area (m2)		6.04	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.1	Top Width (m)		13.1	
Vel Total (m/s)	8.61	Avg. Vel. (m/s)		8.61	
Max Chl Dpth (m)	1.08	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	244.3	Conv. (m3/s)		244.3	
Length Wtd. (m)	50	Wetted Per. (m)		15.84	
Min Ch El (m)	1253.15	Shear (N/m2)		169.38	
Alpha	1	Stream Power (N/m s)		1458.15	
Frctn Loss (m)	2.29	Cum Volume (1000 m3)		9.71	
C & E Loss (m)	0	Cum SA (1000 m2)		18.29	

Plan: PMP South Flow HLP RS: 1350 Profile: PF 1					
E.G. Elev (m)	1255.71	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.8	Wt. n-Val.		0.013	
W.S. Elev (m)	1251.91	Reach Len. (m)	50	50	50
Crit W.S. (m)	1252.63	Flow Area (m2)		6.02	
E.G. Slope (m/m)	0.046357	Area (m2)		6.02	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.85	Top Width (m)		12.85	
Vel Total (m/s)	8.63	Avg. Vel. (m/s)		8.63	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	241.5	Conv. (m3/s)		241.5	
Length Wtd. (m)	50	Wetted Per. (m)		16.01	
Min Ch El (m)	1250.86	Shear (N/m2)		171.06	
Alpha	1	Stream Power (N/m s)		1476.69	
Frctn Loss (m)	2.31	Cum Volume (1000 m3)		9.4	
C & E Loss (m)	0.01	Cum SA (1000 m2)		17.64	

Plan: PMP South Flow HLP RS: 1300 Profile: PF 1					
E.G. Elev (m)	1253.4	Element	Left OB	Channel	Right OB
Vel Head (m)	3.77	Wt. n-Val.		0.013	
W.S. Elev (m)	1249.63	Reach Len. (m)	50	50	50
Crit W.S. (m)	1250.34	Flow Area (m2)		6.05	
E.G. Slope (m/m)	0.045887	Area (m2)		6.05	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.86	Top Width (m)		12.86	
Vel Total (m/s)	8.6	Avg. Vel. (m/s)		8.6	
Max Chl Dpth (m)	1.06	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	242.8	Conv. (m3/s)		242.8	
Length Wtd. (m)	50	Wetted Per. (m)		16.03	
Min Ch El (m)	1248.57	Shear (N/m2)		169.72	
Alpha	1	Stream Power (N/m s)		1459.94	
Frctn Loss (m)	2.29	Cum Volume (1000 m3)		9.1	
C & E Loss (m)	0	Cum SA (1000 m2)		17	

Plan: PMP South Flow HLP RS: 1250 Profile: PF 1					
E.G. Elev (m)	1251.11	Element	Left OB	Channel	Right OB
Vel Head (m)	3.77	Wt. n-Val.		0.013	
W.S. Elev (m)	1247.34	Reach Len. (m)	50	50	50
Crit W.S. (m)	1248.05	Flow Area (m2)		6.05	
E.G. Slope (m/m)	0.045849	Area (m2)		6.05	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.86	Top Width (m)		12.86	
Vel Total (m/s)	8.6	Avg. Vel. (m/s)		8.6	
Max Chl Dpth (m)	1.06	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	242.9	Conv. (m3/s)		242.9	
Length Wtd. (m)	50	Wetted Per. (m)		16.03	
Min Ch El (m)	1246.28	Shear (N/m2)		169.62	
Alpha	1	Stream Power (N/m s)		1458.62	
Frctn Loss (m)	2.29	Cum Volume (1000 m3)		8.8	
C & E Loss (m)	0	Cum SA (1000 m2)		16.36	

Plan: PMP South Flow HLP RS: 1200 Profile: PF 1					
E.G. Elev (m)	1248.82	Element	Left OB	Channel	Right OB
Vel Head (m)	3.77	Wt. n-Val.		0.013	
W.S. Elev (m)	1245.05	Reach Len. (m)	50	50	50
Crit W.S. (m)	1245.76	Flow Area (m2)		6.05	
E.G. Slope (m/m)	0.045849	Area (m2)		6.05	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.86	Top Width (m)		12.86	
Vel Total (m/s)	8.6	Avg. Vel. (m/s)		8.6	
Max Chl Dpth (m)	1.06	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	242.9	Conv. (m3/s)		242.9	
Length Wtd. (m)	50	Wetted Per. (m)		16.03	
Min Ch El (m)	1243.99	Shear (N/m2)		169.62	
Alpha	1	Stream Power (N/m s)		1458.62	
Frctn Loss (m)	2.29	Cum Volume (1000 m3)		8.5	
C & E Loss (m)	0	Cum SA (1000 m2)		15.71	

Plan: PMP South Flow HLP RS: 1150 Profile: PF 1					
E.G. Elev (m)	1246.53	Element	Left OB	Channel	Right OB
Vel Head (m)	3.77	Wt. n-Val.		0.013	
W.S. Elev (m)	1242.75	Reach Len. (m)	50	50	50
Crit W.S. (m)	1243.47	Flow Area (m2)		6.05	
E.G. Slope (m/m)	0.045862	Area (m2)		6.05	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.86	Top Width (m)		12.86	
Vel Total (m/s)	8.6	Avg. Vel. (m/s)		8.6	
Max Chl Dpth (m)	1.06	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	242.8	Conv. (m3/s)		242.8	
Length Wtd. (m)	50	Wetted Per. (m)		16.03	
Min Ch El (m)	1241.7	Shear (N/m2)		169.65	
Alpha	1	Stream Power (N/m s)		1459.07	
Frctn Loss (m)	2.3	Cum Volume (1000 m3)		8.2	
C & E Loss (m)	0	Cum SA (1000 m2)		15.07	

Plan: PMP South Flow HLP RS: 1100 Profile: PF 1					
E.G. Elev (m)	1244.22	Element	Left OB	Channel	Right OB
Vel Head (m)	3.79	Wt. n-Val.		0.013	
W.S. Elev (m)	1240.43	Reach Len. (m)	50	50	50
Crit W.S. (m)	1241.14	Flow Area (m2)		6.03	
E.G. Slope (m/m)	0.046258	Area (m2)		6.03	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.85	Top Width (m)		12.85	
Vel Total (m/s)	8.63	Avg. Vel. (m/s)		8.63	
Max Chl Dpth (m)	1.06	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	241.8	Conv. (m3/s)		241.8	
Length Wtd. (m)	50	Wetted Per. (m)		16.01	
Min Ch El (m)	1239.37	Shear (N/m2)		170.78	
Alpha	1	Stream Power (N/m s)		1473.14	
Frctn Loss (m)	2.36	Cum Volume (1000 m3)		7.89	
C & E Loss (m)	0.01	Cum SA (1000 m2)		14.43	

Plan: PMP South Flow HLP RS: 1050 Profile: PF 1					
E.G. Elev (m)	1241.85	Element	Left OB	Channel	Right OB
Vel Head (m)	3.9	Wt. n-Val.		0.013	
W.S. Elev (m)	1237.94	Reach Len. (m)	50	50	50
Crit W.S. (m)	1238.66	Flow Area (m2)		5.94	
E.G. Slope (m/m)	0.0482	Area (m2)		5.94	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.78	Top Width (m)		12.78	
Vel Total (m/s)	8.75	Avg. Vel. (m/s)		8.75	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	236.9	Conv. (m3/s)		236.9	
Length Wtd. (m)	50	Wetted Per. (m)		15.94	
Min Ch El (m)	1236.9	Shear (N/m2)		176.24	
Alpha	1	Stream Power (N/m s)		1541.84	
Frctn Loss (m)	2.43	Cum Volume (1000 m3)		7.59	
C & E Loss (m)	0	Cum SA (1000 m2)		13.79	

Plan: PMP South Flow HLP RS: 1000 Profile: PF 1					
E.G. Elev (m)	1239.41	Element	Left OB	Channel	Right OB
Vel Head (m)	3.95	Wt. n-Val.		0.013	
W.S. Elev (m)	1235.47	Reach Len. (m)	50	50	50
Crit W.S. (m)	1236.19	Flow Area (m2)		5.91	
E.G. Slope (m/m)	0.049027	Area (m2)		5.91	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.76	Top Width (m)		12.76	
Vel Total (m/s)	8.8	Avg. Vel. (m/s)		8.8	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	234.8	Conv. (m3/s)		234.8	
Length Wtd. (m)	50	Wetted Per. (m)		15.91	
Min Ch El (m)	1234.42	Shear (N/m2)		178.54	
Alpha	1	Stream Power (N/m s)		1571.16	
Frctn Loss (m)	2.46	Cum Volume (1000 m3)		7.3	
C & E Loss (m)	0	Cum SA (1000 m2)		13.15	

Plan: PMP South Flow HLP RS: 950 Profile: PF 1					
E.G. Elev (m)	1236.95	Element	Left OB	Channel	Right OB
Vel Head (m)	3.96	Wt. n-Val.		0.013	
W.S. Elev (m)	1232.99	Reach Len. (m)	50	50	50
Crit W.S. (m)	1233.71	Flow Area (m2)		5.9	
E.G. Slope (m/m)	0.049317	Area (m2)		5.9	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.75	Top Width (m)		12.75	
Vel Total (m/s)	8.82	Avg. Vel. (m/s)		8.82	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	234.2	Conv. (m3/s)		234.2	
Length Wtd. (m)	50	Wetted Per. (m)		15.9	
Min Ch El (m)	1231.94	Shear (N/m2)		179.35	
Alpha	1	Stream Power (N/m s)		1581.48	
Frctn Loss (m)	2.47	Cum Volume (1000 m3)		7	
C & E Loss (m)	0	Cum SA (1000 m2)		12.51	

Plan: PMP South Flow HLP RS: 900 Profile: PF 1					
E.G. Elev (m)	1234.48	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.97	Wt. n-Val.		0.013	
W.S. Elev (m)	1230.51	Reach Len. (m)	50	50	50
Crit W.S. (m)	1231.23	Flow Area (m2)		5.89	
E.G. Slope (m/m)	0.049443	Area (m2)		5.89	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.74	Top Width (m)		12.74	
Vel Total (m/s)	8.83	Avg. Vel. (m/s)		8.83	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	233.9	Conv. (m3/s)		233.9	
Length Wtd. (m)	50	Wetted Per. (m)		15.9	
Min Ch El (m)	1229.47	Shear (N/m2)		179.7	
Alpha	1	Stream Power (N/m s)		1585.91	
Frctn Loss (m)	2.47	Cum Volume (1000 m3)		6.71	
C & E Loss (m)	0	Cum SA (1000 m2)		11.87	

Plan: PMP South Flow HLP RS: 850 Profile: PF 1					
E.G. Elev (m)	1232.01	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	3.97	Wt. n-Val.		0.013	
W.S. Elev (m)	1228.03	Reach Len. (m)	50	50	50
Crit W.S. (m)	1228.76	Flow Area (m2)		5.89	
E.G. Slope (m/m)	0.049502	Area (m2)		5.89	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.74	Top Width (m)		12.74	
Vel Total (m/s)	8.83	Avg. Vel. (m/s)		8.83	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	233.7	Conv. (m3/s)		233.7	
Length Wtd. (m)	50	Wetted Per. (m)		15.9	
Min Ch El (m)	1226.99	Shear (N/m2)		179.87	
Alpha	1	Stream Power (N/m s)		1588.06	
Frctn Loss (m)	2.48	Cum Volume (1000 m3)		6.41	
C & E Loss (m)	0	Cum SA (1000 m2)		11.24	

Plan: PMP South Flow HLP RS: 800 Profile: PF 1					
E.G. Elev (m)	1229.53	Element	Left OB	Channel	Right OB
Vel Head (m)	3.97	Wt. n-Val.		0.013	
W.S. Elev (m)	1225.56	Reach Len. (m)	50	50	50
Crit W.S. (m)	1226.28	Flow Area (m2)		5.89	
E.G. Slope (m/m)	0.049505	Area (m2)		5.89	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.74	Top Width (m)		12.74	
Vel Total (m/s)	8.83	Avg. Vel. (m/s)		8.83	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	233.7	Conv. (m3/s)		233.7	
Length Wtd. (m)	50	Wetted Per. (m)		15.9	
Min Ch El (m)	1224.51	Shear (N/m2)		179.87	
Alpha	1	Stream Power (N/m s)		1588.14	
Frctn Loss (m)	2.48	Cum Volume (1000 m3)		6.12	
C & E Loss (m)	0	Cum SA (1000 m2)		10.6	

Plan: PMP South Flow HLP RS: 750 Profile: PF 1					
E.G. Elev (m)	1227.06	Element	Left OB	Channel	Right OB
Vel Head (m)	3.97	Wt. n-Val.		0.013	
W.S. Elev (m)	1223.08	Reach Len. (m)	50	50	50
Crit W.S. (m)	1223.81	Flow Area (m2)		5.89	
E.G. Slope (m/m)	0.049511	Area (m2)		5.89	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.74	Top Width (m)		12.74	
Vel Total (m/s)	8.83	Avg. Vel. (m/s)		8.83	
Max Chl Dpth (m)	1.04	Hydr. Depth (m)		0.46	
Conv. Total (m3/s)	233.7	Conv. (m3/s)		233.7	
Length Wtd. (m)	50	Wetted Per. (m)		15.9	
Min Ch El (m)	1222.04	Shear (N/m2)		179.89	
Alpha	1	Stream Power (N/m s)		1588.28	
Frctn Loss (m)	1.94	Cum Volume (1000 m3)		5.82	
C & E Loss (m)	0.33	Cum SA (1000 m2)		9.96	

Plan: PMP South Flow HLP RS: 700 Profile: PF 1					
E.G. Elev (m)	1224.8	Element	Left OB	Channel	Right OB
Vel Head (m)	2.89	Wt. n-Val.		0.013	
W.S. Elev (m)	1221.91	Reach Len. (m)	50	50	50
Crit W.S. (m)	1222.56	Flow Area (m2)		6.91	
E.G. Slope (m/m)	0.0311	Area (m2)		6.91	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	13.52	Top Width (m)		13.52	
Vel Total (m/s)	7.52	Avg. Vel. (m/s)		7.52	
Max Chl Dpth (m)	1.12	Hydr. Depth (m)		0.51	
Conv. Total (m3/s)	294.9	Conv. (m3/s)		294.9	
Length Wtd. (m)	50	Wetted Per. (m)		16.73	
Min Ch El (m)	1220.79	Shear (N/m2)		125.97	
Alpha	1	Stream Power (N/m s)		947.71	
Frctn Loss (m)	1.38	Cum Volume (1000 m3)		5.5	
C & E Loss (m)	0.06	Cum SA (1000 m2)		9.31	

Plan: PMP South Flow HLP RS: 650 Profile: PF 1					
E.G. Elev (m)	1223.35	Element	Left OB	Channel	Right OB
Vel Head (m)	2.68	Wt. n-Val.		0.013	
W.S. Elev (m)	1220.67	Reach Len. (m)	50	50	50
Crit W.S. (m)	1221.29	Flow Area (m2)		7.17	
E.G. Slope (m/m)	0.024668	Area (m2)		7.17	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	12.56	Top Width (m)		12.56	
Vel Total (m/s)	7.25	Avg. Vel. (m/s)		7.25	
Max Chl Dpth (m)	0.7	Hydr. Depth (m)		0.57	
Conv. Total (m3/s)	331.1	Conv. (m3/s)		331.1	
Length Wtd. (m)	50	Wetted Per. (m)		15.42	
Min Ch El (m)	1219.98	Shear (N/m2)		112.49	
Alpha	1	Stream Power (N/m s)		815.77	
Frctn Loss (m)	1.08	Cum Volume (1000 m3)		5.15	
C & E Loss (m)	0.18	Cum SA (1000 m2)		8.65	

Plan: PMP South Flow HLP RS: 600 Profile: PF 1					
E.G. Elev (m)	1222.1	Element	Left OB	Channel	Right OB
Vel Head (m)	2.1	Wt. n-Val.		0.013	
W.S. Elev (m)	1220	Reach Len. (m)	50	50	50
Crit W.S. (m)	1220.55	Flow Area (m2)		8.11	
E.G. Slope (m/m)	0.018969	Area (m2)		8.11	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.32	Top Width (m)		14.32	
Vel Total (m/s)	6.41	Avg. Vel. (m/s)		6.41	
Max Chl Dpth (m)	0.76	Hydr. Depth (m)		0.57	
Conv. Total (m3/s)	377.6	Conv. (m3/s)		377.6	
Length Wtd. (m)	50	Wetted Per. (m)		17.23	
Min Ch El (m)	1219.24	Shear (N/m2)		87.56	
Alpha	1	Stream Power (N/m s)		561.29	
Frctn Loss (m)	0.87	Cum Volume (1000 m3)		4.77	
C & E Loss (m)	0.07	Cum SA (1000 m2)		7.98	

Plan: PMP South Flow HLP RS: 550 Profile: PF 1					
E.G. Elev (m)	1221.16	Element	Left OB	Channel	Right OB
Vel Head (m)	1.87	Wt. n-Val.		0.013	
W.S. Elev (m)	1219.3	Reach Len. (m)	50	50	50
Crit W.S. (m)	1219.81	Flow Area (m2)		8.59	
E.G. Slope (m/m)	0.015903	Area (m2)		8.59	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.48	Top Width (m)		14.48	
Vel Total (m/s)	6.06	Avg. Vel. (m/s)		6.06	
Max Chl Dpth (m)	0.8	Hydr. Depth (m)		0.59	
Conv. Total (m3/s)	412.4	Conv. (m3/s)		412.4	
Length Wtd. (m)	50	Wetted Per. (m)		17.41	
Min Ch El (m)	1218.5	Shear (N/m2)		76.91	
Alpha	1	Stream Power (N/m s)		465.74	
Frctn Loss (m)	0.78	Cum Volume (1000 m3)		4.35	
C & E Loss (m)	0.01	Cum SA (1000 m2)		7.26	

Plan: PMP South Flow HLP RS: 500 Profile: PF 1					
E.G. Elev (m)	1220.37	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.82	Wt. n-Val.		0.013	
W.S. Elev (m)	1218.55	Reach Len. (m)	50	50	50
Crit W.S. (m)	1219.06	Flow Area (m2)		8.7	
E.G. Slope (m/m)	0.015264	Area (m2)		8.7	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.52	Top Width (m)		14.52	
Vel Total (m/s)	5.98	Avg. Vel. (m/s)		5.98	
Max Chl Dpth (m)	0.8	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	420.9	Conv. (m3/s)		420.9	
Length Wtd. (m)	50	Wetted Per. (m)		17.45	
Min Ch El (m)	1217.75	Shear (N/m2)		74.63	
Alpha	1	Stream Power (N/m s)		445.95	
Frctn Loss (m)	0.75	Cum Volume (1000 m3)		3.92	
C & E Loss (m)	0.01	Cum SA (1000 m2)		6.54	

Plan: PMP South Flow HLP RS: 450 Profile: PF 1					
E.G. Elev (m)	1219.61	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.79	Wt. n-Val.		0.013	
W.S. Elev (m)	1217.82	Reach Len. (m)	50	50	50
Crit W.S. (m)	1218.32	Flow Area (m2)		8.77	
E.G. Slope (m/m)	0.014896	Area (m2)		8.77	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.55	Top Width (m)		14.55	
Vel Total (m/s)	5.93	Avg. Vel. (m/s)		5.93	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	426.1	Conv. (m3/s)		426.1	
Length Wtd. (m)	50	Wetted Per. (m)		17.48	
Min Ch El (m)	1217.01	Shear (N/m2)		73.3	
Alpha	1	Stream Power (N/m s)		434.58	
Frctn Loss (m)	0.74	Cum Volume (1000 m3)		3.48	
C & E Loss (m)	0	Cum SA (1000 m2)		5.81	

Plan: PMP South Flow HLP RS: 400 Profile: PF 1					
E.G. Elev (m)	1218.86	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.79	Wt. n-Val.		0.013	
W.S. Elev (m)	1217.07	Reach Len. (m)	50	50	50
Crit W.S. (m)	1217.57	Flow Area (m2)		8.77	
E.G. Slope (m/m)	0.014896	Area (m2)		8.77	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.55	Top Width (m)		14.55	
Vel Total (m/s)	5.93	Avg. Vel. (m/s)		5.93	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	426.1	Conv. (m3/s)		426.1	
Length Wtd. (m)	50	Wetted Per. (m)		17.48	
Min Ch El (m)	1216.26	Shear (N/m2)		73.3	
Alpha	1	Stream Power (N/m s)		434.59	
Frctn Loss (m)	0.75	Cum Volume (1000 m3)		3.05	
C & E Loss (m)	0	Cum SA (1000 m2)		5.08	

Plan: PMP South Flow HLP RS: 350 Profile: PF 1					
E.G. Elev (m)	1218.12	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.8	Wt. n-Val.		0.013	
W.S. Elev (m)	1216.32	Reach Len. (m)	50	50	50
Crit W.S. (m)	1216.82	Flow Area (m2)		8.75	
E.G. Slope (m/m)	0.014994	Area (m2)		8.75	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.54	Top Width (m)		14.54	
Vel Total (m/s)	5.94	Avg. Vel. (m/s)		5.94	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	424.7	Conv. (m3/s)		424.7	
Length Wtd. (m)	50	Wetted Per. (m)		17.47	
Min Ch El (m)	1215.51	Shear (N/m2)		73.65	
Alpha	1	Stream Power (N/m s)		437.59	
Frctn Loss (m)	0.75	Cum Volume (1000 m3)		2.61	
C & E Loss (m)	0	Cum SA (1000 m2)		4.36	

Plan: PMP South Flow HLP RS: 350 Profile: PF 1					
E.G. Elev (m)	1217.36	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.81	Wt. n-Val.		0.013	
W.S. Elev (m)	1215.55	Reach Len. (m)	50	50	50
Crit W.S. (m)	1216.05	Flow Area (m2)		8.73	
E.G. Slope (m/m)	0.015101	Area (m2)		8.73	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.53	Top Width (m)		14.53	
Vel Total (m/s)	5.95	Avg. Vel. (m/s)		5.95	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	423.2	Conv. (m3/s)		423.2	
Length Wtd. (m)	50	Wetted Per. (m)		17.46	
Min Ch El (m)	1214.75	Shear (N/m2)		74.04	
Alpha	1	Stream Power (N/m s)		440.93	
Frctn Loss (m)	0.76	Cum Volume (1000 m3)		2.17	
C & E Loss (m)	0	Cum SA (1000 m2)		3.63	

Plan: PMP South Flow HLP RS: 250 Profile: PF 1					
E.G. Elev (m)	1216.6	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.81	Wt. n-Val.		0.013	
W.S. Elev (m)	1214.79	Reach Len. (m)	50	50	50
Crit W.S. (m)	1215.29	Flow Area (m2)		8.72	
E.G. Slope (m/m)	0.015171	Area (m2)		8.72	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.53	Top Width (m)		14.53	
Vel Total (m/s)	5.96	Avg. Vel. (m/s)		5.96	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	422.2	Conv. (m3/s)		422.2	
Length Wtd. (m)	50	Wetted Per. (m)		17.46	
Min Ch El (m)	1213.98	Shear (N/m2)		74.29	
Alpha	1	Stream Power (N/m s)		443.04	
Frctn Loss (m)	0.76	Cum Volume (1000 m3)		1.73	
C & E Loss (m)	0	Cum SA (1000 m2)		2.9	

Plan: PMP South Flow HLP RS: 200 Profile: PF 1					
E.G. Elev (m)	1215.84	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.82	Wt. n-Val.		0.013	
W.S. Elev (m)	1214.03	Reach Len. (m)	50	50	50
Crit W.S. (m)	1214.53	Flow Area (m2)		8.71	
E.G. Slope (m/m)	0.015225	Area (m2)		8.71	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.53	Top Width (m)		14.53	
Vel Total (m/s)	5.97	Avg. Vel. (m/s)		5.97	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	421.4	Conv. (m3/s)		421.4	
Length Wtd. (m)	50	Wetted Per. (m)		17.46	
Min Ch El (m)	1213.22	Shear (N/m2)		74.49	
Alpha	1	Stream Power (N/m s)		444.74	
Frctn Loss (m)	0.76	Cum Volume (1000 m3)		1.3	
C & E Loss (m)	0	Cum SA (1000 m2)		2.18	

Plan: PMP South Flow HLP RS: 150 Profile: PF 1					
E.G. Elev (m)	1215.08	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.82	Wt. n-Val.		0.013	
W.S. Elev (m)	1213.27	Reach Len. (m)	50	50	50
Crit W.S. (m)	1213.77	Flow Area (m2)		8.71	
E.G. Slope (m/m)	0.015223	Area (m2)		8.71	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.53	Top Width (m)		14.53	
Vel Total (m/s)	5.97	Avg. Vel. (m/s)		5.97	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.6	
Conv. Total (m3/s)	421.5	Conv. (m3/s)		421.5	
Length Wtd. (m)	50	Wetted Per. (m)		17.46	
Min Ch El (m)	1212.46	Shear (N/m2)		74.48	
Alpha	1	Stream Power (N/m s)		444.69	
Frctn Loss (m)	0.79	Cum Volume (1000 m3)		0.86	
C & E Loss (m)	0.01	Cum SA (1000 m2)		1.45	

Plan: PMP South Flow HLP RS: 100 Profile: PF 1					
E.G. Elev (m)	1214.28	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.92	Wt. n-Val.		0.013	
W.S. Elev (m)	1212.37	Reach Len. (m)	50	50	50
Crit W.S. (m)	1212.89	Flow Area (m2)		8.48	
E.G. Slope (m/m)	0.016515	Area (m2)		8.48	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.45	Top Width (m)		14.45	
Vel Total (m/s)	6.13	Avg. Vel. (m/s)		6.13	
Max Chl Dpth (m)	0.79	Hydr. Depth (m)		0.59	
Conv. Total (m3/s)	404.6	Conv. (m3/s)		404.6	
Length Wtd. (m)	50	Wetted Per. (m)		17.37	
Min Ch El (m)	1211.58	Shear (N/m2)		79.08	
Alpha	1	Stream Power (N/m s)		484.77	
Frctn Loss (m)	1.15	Cum Volume (1000 m3)		0.43	
C & E Loss (m)	0.04	Cum SA (1000 m2)		0.73	

Plan: PMP South Flow HLP RS: 50 Profile: PF 1					
E.G. Elev (m)	1213.08	**Element**	**Left OB**	**Channel**	**Right OB**
Vel Head (m)	1.77	Wt. n-Val.		0.02	
W.S. Elev (m)	1211.31	Reach Len. (m)			
Crit W.S. (m)	1211.81	Flow Area (m2)		8.83	
E.G. Slope (m/m)	0.0345	Area (m2)		8.83	
Q Total (m3/s)	52	Flow (m3/s)		52	
Top Width (m)	14.57	Top Width (m)		14.57	
Vel Total (m/s)	5.89	Avg. Vel. (m/s)		5.89	
Max Chl Dpth (m)	0.81	Hydr. Depth (m)		0.61	
Conv. Total (m3/s)	280	Conv. (m3/s)		280	
Length Wtd. (m)		Wetted Per. (m)		17.5	
Min Ch El (m)	1210.5	Shear (N/m2)		170.75	
Alpha	1	Stream Power (N/m s)		1005.2	
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			

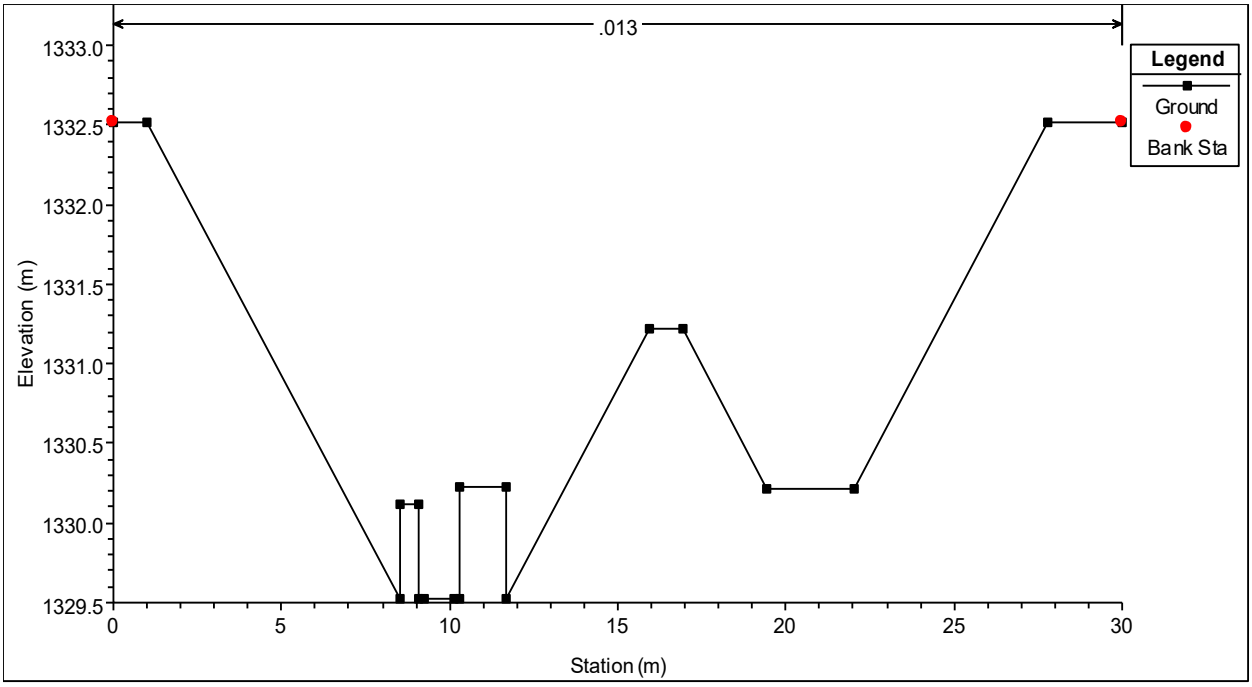


Figure 1: North Flow Station 1850-250

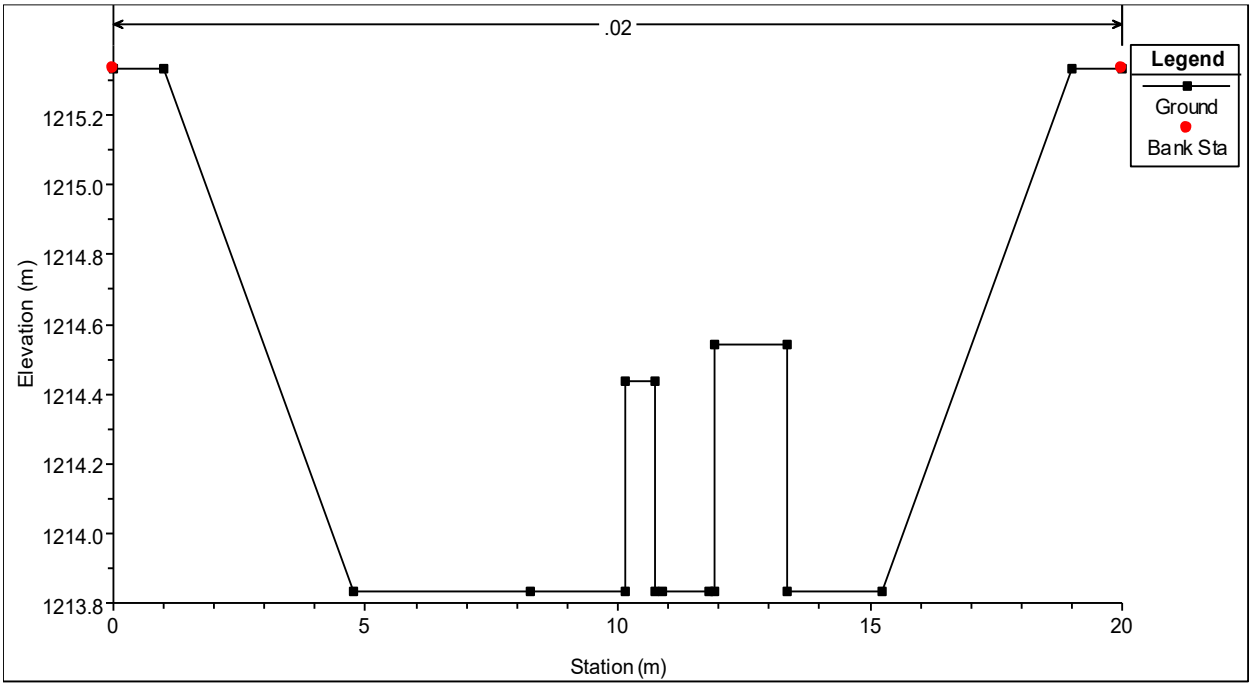


Figure 2: North Flow Station 200 – 50

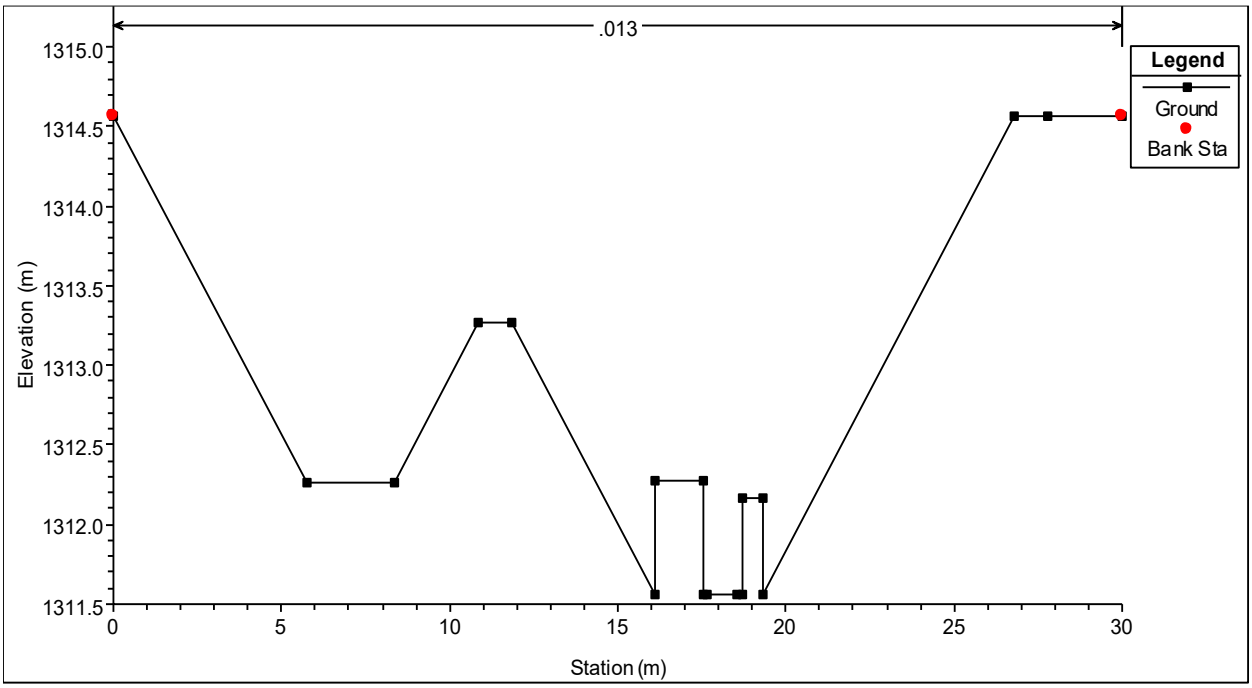


Figure 3: South Flow 2250 – 700

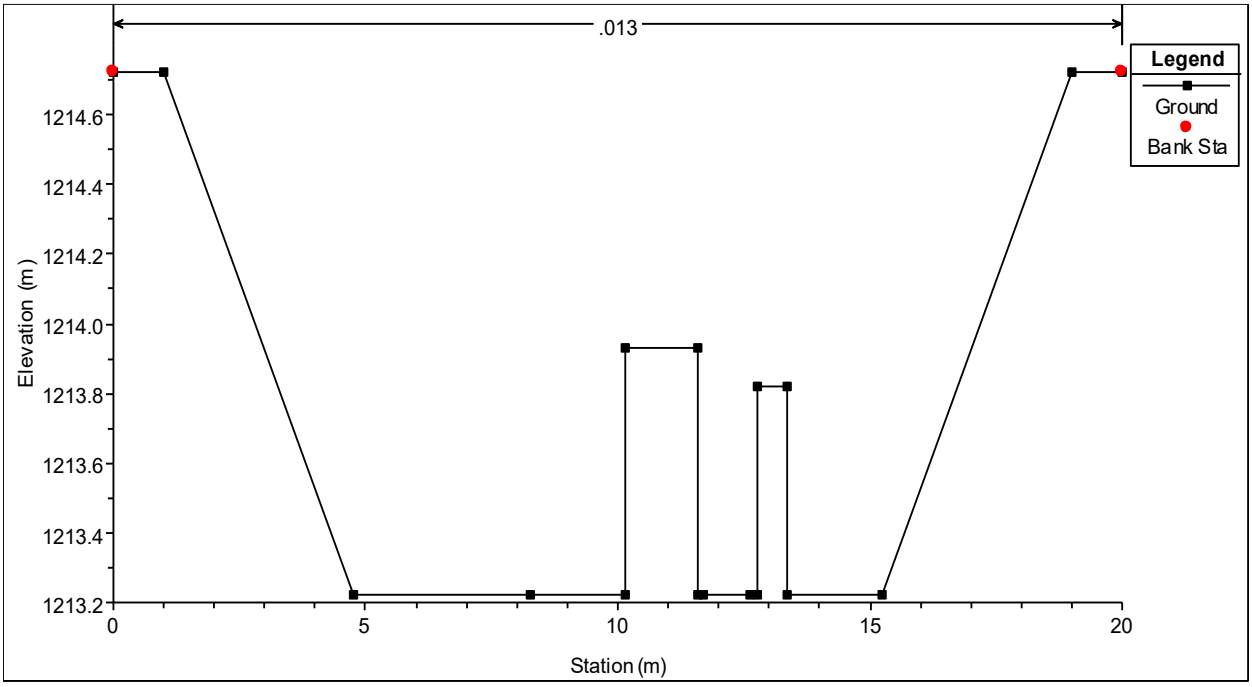


Figure 4: South Flow 650 – 50



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APPENDIX E: WATER BALANCE

FUERTE METALS

Coffee Mine Project

Heap Leach Facility Water Balance Modeling Report

Document #123022-51010-CV-EDR-2002



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Appendix A: Water Balance Modeling Results

Appendix B: Pond Inflows

ABBREVIATIONS AND ACRONYMS

Abbreviation or Acronym	Definition
Forte	Forte Dynamics, Inc.
Lorax	Lorax Environmental Service Ltd.
HLF	Heap Leach Facility (typically refers to ponds, and pads)
HLP	Heap Leach Pap (extents is the footprint of the pad)
ESR	Event Storage Requirement
EP-1N	Event Pond 1 North
EP-1S	Event Pond 1 South
EP-2	Event Pond 2
RWP	Rain Water Pond
WBM	Water Balance Model

1. INTRODUCTION

This document has been prepared by Forte Dynamics, Inc. (Forte) on behalf of Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals, for the Coffee Gold Heap Leach Facility Water Balance Project (Project). Discretized modeling was conducted on the proposed Heap Leach Facility (HLF) to provide input into the design and inform the water management strategies for the HLF to ensure that sufficient storage is maintained for various climate events and operational parameters. The HLF was modeled deterministically using 30 unique time series of daily climate data provided by Lorax Environmental Services Ltd (Lorax) as part of the hydro-meteorology report (Coffee Gold Project: 2021 Hydro-meteorology Baseline Report). These 30 unique time series of daily climate data are based on historic daily climate data with the incorporation of an estimate of climate change to assist in the evaluation of climatic impact on HLF operations. The HLF Water Balance Model results summarized below have been provided to Lorax for input and integration into the Project site-wide water balance model.

2. INPUTS AND ASSUMPTIONS

The HLF Water Balance Model (WBM) combines meteorological and site operational design data from January 1st, 2026, through January 1st, 2047, which correlates to mine Year (Yr) -1 through Yr 21. Based on the mine plan provided by the Coffee team, the projected stacking start date for the HLF is April 1st, 2026 (Yr -1). A staged closure is projected to begin May 1st, 2037 (Yr 11), with a projected transition from short-term closure to long-term closure occurring on August 1st, 2042 (Yr 16). It is expected this model will be utilized as the operational model and will include calibration of input parameters based on actuals, to forecast and prepare for water management responsibilities.

The HLF WBM makes use of a large array of operational, meteorological, geotechnical ore hydrodynamic properties. The HLF WBM incorporates daily climate data, daily transfer flows, daily pond levels, snow accumulation and melt, leaching operations (e.g., daily changes to application rate and leach area), and daily tonnage placed on the HLF. The HLF WBM incorporates all necessary details surrounding the HLF to better understand solution and pond level management.

2.1 Ore Properties

The HLF WBM incorporates hydrodynamic properties of the ore utilizing Brooks-Corey methodology for unsaturated flow. The model captures the increased density due to elastic distortion and compaction as material is loaded on the HLP through time. These effects with loading capture initial wet-up and flow through the HLP along with macropore flow and potential channeling. This ultimately results in a change in degree of saturation, flux, and solution to rock contact through time. The ensuing hydrodynamic change is captured within the model through time to better represent heap hydrodynamics, the moisture retention, and drainage for the HLF.

The following Ore Properties are utilized in the model and can also be found in Forte's Design Criteria (Doc# 123022-51010-CV-EDC-0001). These values are very similar and noted where calibration occurred to those utilized in the "Water Balance Modeling for the Kaminak Gold Coffee Gold Project Heap Leach Pad Facility" (The Mines Group, 2016):

- Initial Moisture Content-(4.5%) (gravimetric)
- Residual Moisture Content (calibrated for scale-up)-(9%) (gravimetric)
- Ore Specific Gravity-(2.7)
- Dry Ore Density-(1.6 t/m3)
- Saturated Hydraulic Conductivity –(0.04 cm/s)

Forte conducted additional analysis and calculations, which are captured within the HLF WBM to determine the remaining Ore Properties:

- Active Leaching Ore Moisture Content-Varies and is calculated

2.2 Stacking

Table 2-1 below shows the modeled timing and sizes of the 5 stages of the HLF from the stacking plan developed by Forte. Figure 2-1 and Figure 2-2 show the mine plan and stacking of the heap leach pad stages, respectively.

Table 2-1: HLF Stacking Metrics by Stage

Heap Leach Pad Stage	Stacking Start Date Based on Mine Plan	Construction Year	Pad Phase Stage Area (m^2)	Pad Capacity @ 1.6 t/m^3 (Mt)	Heap Crest Elevation (masl)	Stage Stacking Completion Date
1	4/1/2026	Year-1	247,000	4	1,324	7/1/2032 (Yr 6)
2	4/1/2027	Year 1	182,000	11	1,350	4/1/2033 (Yr 7)
3	10/1/2028	Year 2	270,000	17	1,388	7/1/2035 (Yr 9)
4	10/1/2030	Year 4	222,000	18	1,392	10/1/2035 (Yr 9)
5	4/1/2033	Year 7	132,000	19	1,392	10/1/2035 (Yr 9)

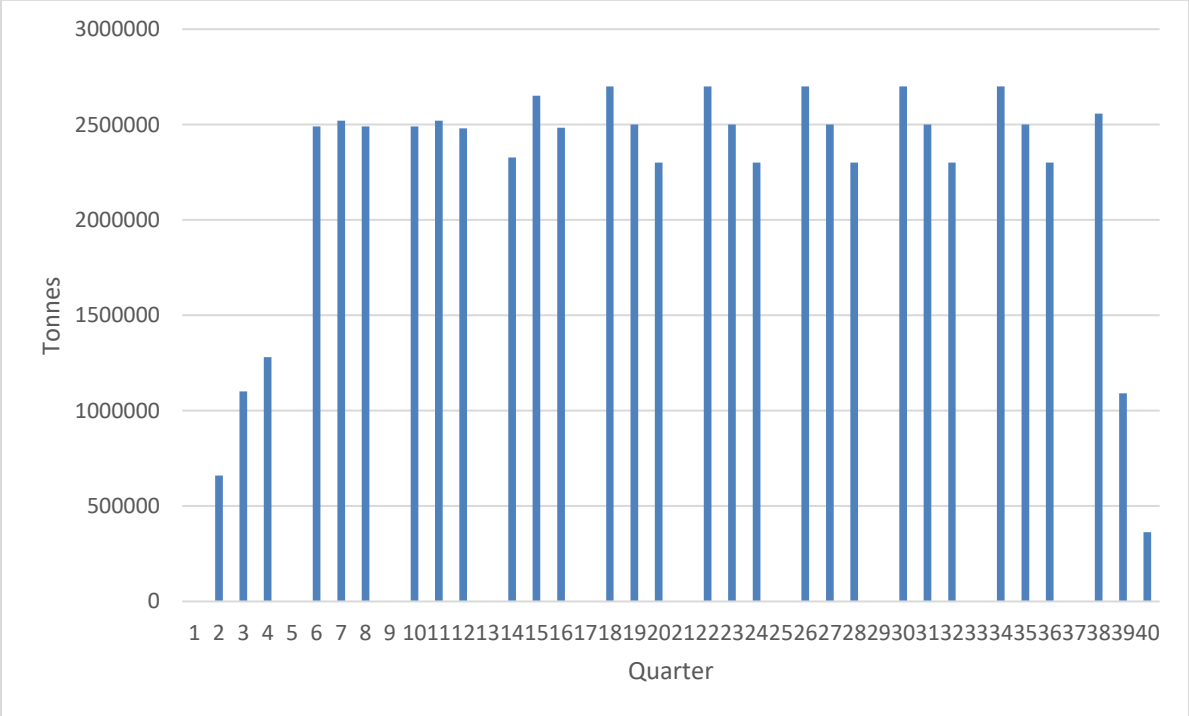

Figure 2-1: HLF Mine Plan (67 Million tonnes Total)

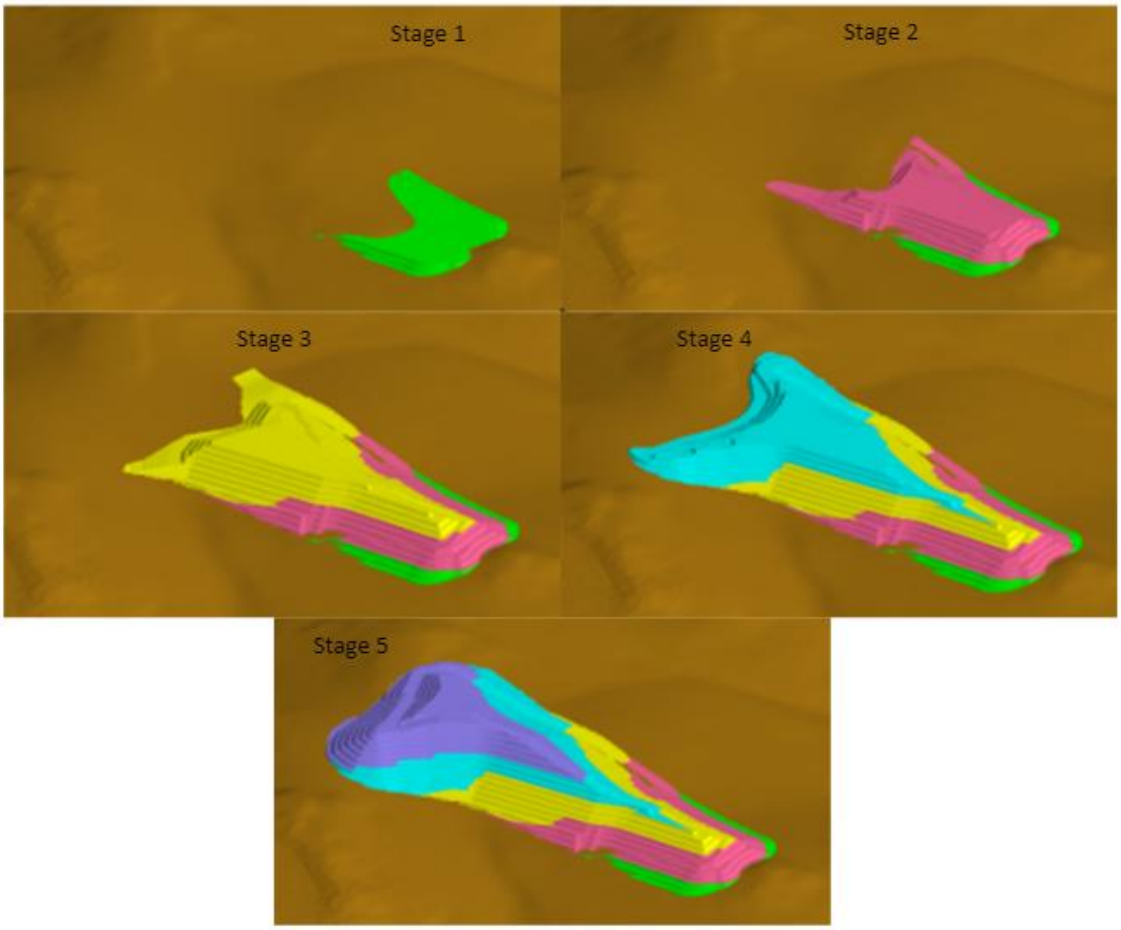

Figure 2-2: Stacking of the Heap Leach Pad Stages

Additionally, the following HLF Parameters can be found in the Coffee HLF Design Criteria (Forte, 2025):

- Heap Ore Capacity-(48 million m^3)
- Lift Height (10 m)
- Evaporation Loss from Drip Emitters (0-0.5% of barren flow rate varies seasonally)
- Soil Conservation Service (SCS) Curve Numbers (CNs) for Various HLF Surfaces 70 unleached ore, 70 leached ore, 100 exposed liner

2.3 Leaching Parameters

The following Leaching Parameters can be found in the Coffee HLF Design Criteria (Forte, 2025):

- Nominal Primary Leach Cycle Time = 200 days
- Nominal Solution Application Rate = 10 $L/s/m^2$
- Nominal Solution Application Flow Rate = 1100 m^3/hr
- Event Storage Requirement, described in detail in Section 2.5.

2.4 Meteorological Inputs and Parameters

The following Meteorological Inputs and Parameters can be found in the "Coffee Gold Project: 2021 Hydro-meteorology Baseline Report" (Lorax, 2022):

- Probable Maximum Precipitation (PMP) = 283mm
- Precipitation Time Series
- Evapotranspiration Time Series
- Temperature Time Series
- Sublimation Time Series
- Snowpack Time Series

The 30-time series of Snowmelt and precipitation from rain are presented in Figure A-1 in Appendix A.

2.5 Event Storage Requirement

The Event Storage Requirement (ESR) includes volume for the PMP applied to the lined area of the HLF which increases with each Stage, plus volume for a 72-hour draindown period, based on the nominal flowrate to the HLF of 1100 m^3/hr. The ESR volume is required to be available and is therefore exclusive of the solution volumes that are anticipated to be present and transferred due to operations of the HLF. Table 2-2 shows the ESR as the HLF area increases with each Stage. These calculations were done with a conservative assumption that the heap is impermeable (Curve Number = 100), thus all precipitation is considered as runoff and would report immediately to the ponds.

Table 2-2: Event Storage Requirement

Date	Cumulative Area (m^2)	Event Storage Requirement (m^3)
4/1/2026 (Yr -1)	247,000	149,000
4/1/2027 (Yr 1)	429,000	201,000
10/1/2028 (Yr 2)	699,000	277,000
10/1/2030 (Yr 4)	921,000	340,000
4/1/2033 (Yr 7)	1,053,000	377,000

The HLF has been designed with four ponds for management of solution. These ponds were incorporated into the HLF WBM for evaluation of the design volume required for each pond and expected inflows and outflows.

- Event Pond 1 South (EP-1S) -Volume results presented in Appendix A Figure A-4, Flow results presented in Appendix B Figure B- 1
- Event Pond 1 North (EP-1N) - Volume results presented in Appendix A Figure A-5, Flow results presented in Appendix B Figure B- 2
- Event Pond 2 (EP-2) - Volume results presented in Appendix A Figure A-6, Flow results presented in Appendix B Figure B- 3
    - Process Segregation Volume results Appendix A Figure A-7
- Rain Water Pond (RWP), Flow results presented in Appendix B Figure B- 4

2.6 Concurrent Reclamation

Concurrent Reclamation progresses with a phased recirculation for rinsing and phased cover placement on the HLF. This is done using 10 recirculation areas that are sized based on the total flow to the HLF and the target application rate (see Figure 2-3).

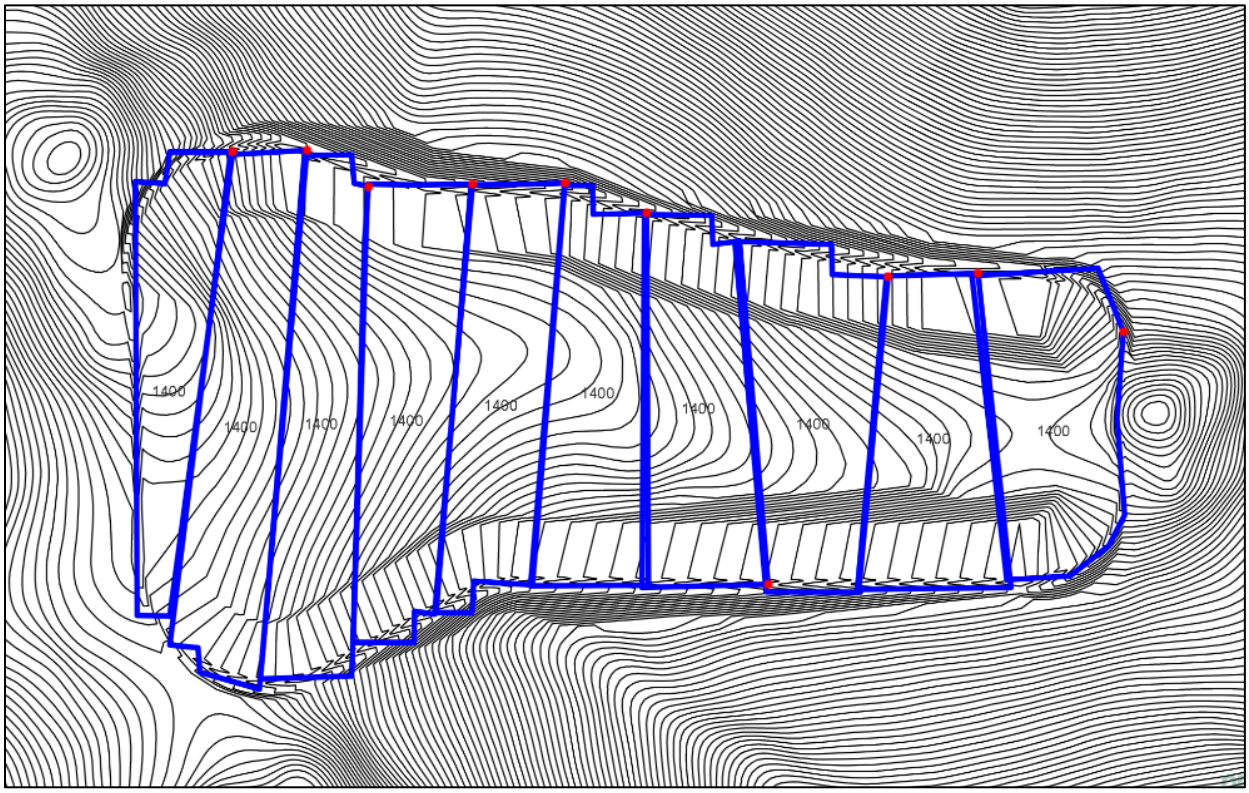

Figure 2-3: Concurrent Reclamation Areas

Recirculation for rinsing is assumed to be complete 200 days after the Recirculation for Rinsing start date for each recirculation area and is followed by cover placement set to begin the subsequent Spring. The actual Recirculation for Rinsing time will be dependent on water quality measurements. It is assumed that cover placement requires 3 months to complete for each recirculation area and is to include installation of GCL along the top slope of the heap with a capture and release cover for the side slopes, per the design provided in the Coffee Mine Heap Leach Cover Design-Analytical Water Balance to Support Alternatives Assessment (Okane, 2021). Table 2-3 shows the modeled timing and sizing of the HLF Concurrent Reclamation. Figure A-2 in Appendix A presents the effect the cover has as infiltration is reduced.

Table 2-3: Concurrent Reclamation Schedule

Area	Start Date of Recirculation for Rinsing	Recirculation for Rinsing Area (m^2)	Completion Date of Recirculation (Rinsing)	Date Cover Placement Starts	Date Cover Placement Ends	Cumulative Area Covered ($1000m^2$)	Cumulative Tonnage Covered (Mtonnes)
1	1/1, Yr 10	110,000	7/20, Yr 10	5/1, Yr 11	8/1, Yr 11	110	4.6
2	7/21, Yr 10	110,000	2/6, Yr 11	5/1, Yr 11	8/1, Yr 11	220	10.1
3	2/7, Yr 11	110,000	8/25, Yr 11	5/1, Yr 12	8/1, Yr 12	330	16.4
4	8/26, Yr 11	110,000	3/14, Yr 12	5/1, Yr 12	8/1, Yr 12	440	23.7
5	3/15, Yr 12	110,000	10/1, Yr 12	5/1, Yr 13	8/1, Yr 13	550	31.5
6	10/2, Yr 12	110,000	4/20, Yr 13	5/1, Yr 13	8/1, Yr 13	660	39.6
7	4/21, Yr 13	110,000	11/7, Yr 13	5/1, Yr 14	8/1, Yr 14	770	49.5
8	11/8, Yr 13	110,000	5/27, Yr 14	5/1, Yr 15	8/1, Yr 15	880	56.9
9	5/28, Yr 14	110,000	12/14, Yr 14	5/1, Yr 15	8/1, Yr 15	990	64.4
10	12/15, Yr 14	63,000	7/2, Yr 15	5/1, Yr 16	8/1, Yr 16	1,053	67.0

2.7 Flow Schematic

Figure 2-4 shows a detailed flow schematic with solution routing within the HLF WBM. The system is closed with the exception of climate, make-up water and solution removal. It should be noted that all (4) ponds are connected by overflow weirs and as required, spillways.

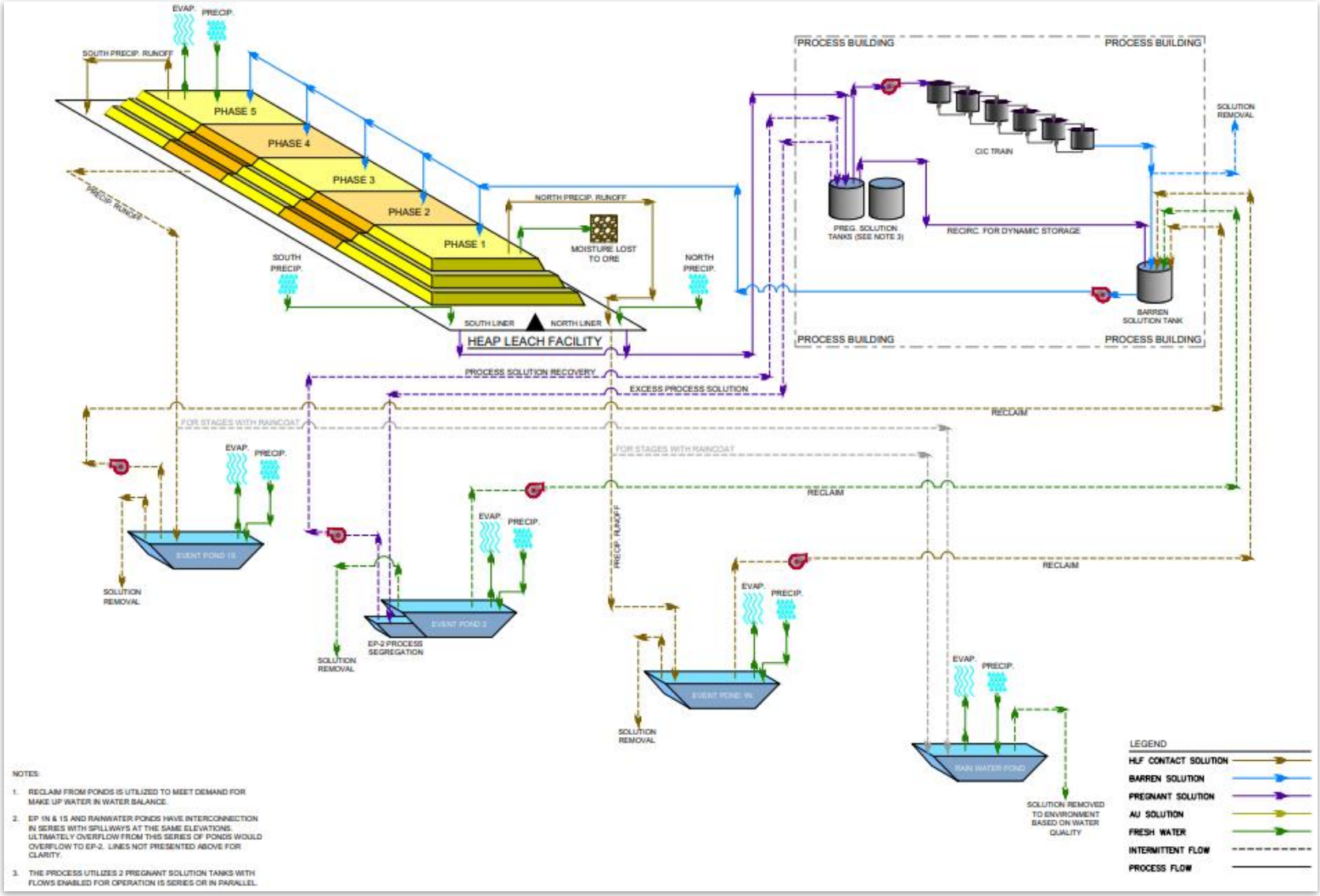

Figure 2-4: HLF Flow Schematic

3. MODEL OPERATIONAL LOGIC

3.1 HLF Target Solution Flow Rate

The HLF operations progress in 5 Stages (refer to Figure 2-1). The operational timeframes outlined in the following sections are represented in the HLF WBM.

3.1.1 Ramp-Up

The HLF data reflects a ramp-up period from 4/1/2026 (Yr -1) to about 5/1/2027 (Yr 1). During the ramp-up period, the total solution flow rate to the HLF is primarily based on volume of ore loaded; as additional ore is loaded, and the area available for leaching increases, the flow rate to the HLF is increased accordingly up to the nominal target flow rate.

3.1.2 Normal Operation

During the normal operation period for each Stage, the target flow rate is maintained at the nominal solution rate of 1100 m^3/hr after accounting for evaporation loss from drip emitters during applicable months when evaporation is occurring. This flow rate remains fairly constant, with fluctuations if dynamic storage is being utilized. Discussion on dynamic storage use is detailed in Section 3.6 of this report.

3.1.3 Concurrent Reclamation

This occurs progressively in 10 Recirculation (Rinsing) areas as discussed previously in Section 2.4.

3.1.3.1 Recirculation (Rinsing)

During this period, solution is recirculated for rinsing of the HLP at the target nominal flow rate to reduce constituent levels within the heap. Current timing is based on an assumed Recirculation for Rinsing time of 200 days for each Stage as directed by the Coffee team (see Table 2-3). Once the assumed Recirculation for Rinsing period is complete, the HLF moves into controlled draindown and cover placement. Figure A-15 and Figure A-16 presents HLP flowrates during concurrent reclamation. Figure A-17 and Figure A-18 presents the runoff from cover placed on HLP during precipitation events.

3.1.3.2 Controlled Draindown:

Upon completion of Recirculation, the final draindown process begins, currently modeled as occurring in July of 2041 (Yr 15). Flow to the HLF is gradually reduced to zero, at which point meteoric water is the sole source of inflow to the HLF. Draindown solution will be actively managed through a relatively steady removal of solution from the storage facilities. Once sufficient solution has been removed from all storage facilities, all solution in the system is entirely a function of meteoric inflow by approximately November of 2041 (Yr 15), marking the last step toward final cover placement. The draindown of the HLF takes approximately 5 months to complete.

3.1.3.3 Passive Draindown and Cover Placement:

From approximately November 2041 (Yr 15) onward, it is assumed infiltration from the HLF is in metastable equilibrium with meteoric input. Pumping of solution is no longer required, meteoric water that flows into the system can be passively treated only can be considered, and active water management is no longer required. The phased placement of covers is modeled to begin 5/1/2037 (Yr 11) and is modeled to be complete on 8/1/2042 (Yr 16) per Table 2-3.

3.2 HLF Make-Up Water Rate

The make-up water rate is the water required for leaching of the heap leach pad after utilizing available barren solution (recycled from the process plant) and solution stored in the Event Ponds. Thus, the make-up water modeled in the HLF WBM is the water demand from outside the HLF system. The climate at the Coffee Project is such that the system generally will receive precipitation to be in a state of surplus water, with less make-up water being required from an outside source. The source of outside make-up water (i.e., groundwater, surface water, or site pond water) is not defined in this HLF WBM, only the quantity and timing of make-up water from outside the HLF system is captured.

- Make-up water added to the system from external sources is not frequently required. Prior to each winter, the ponds will be emptied to the extent possible to prevent freezing and to maintain volume capacity in preparation for the following Spring's freshet. The highest demand for make-up water occurs during winter months when solution storage ponds are at or near empty, and not available as make-up water sources.
- From 7/2/2040 (Yr 14) onward, make-up water from external sources is no longer required as Concurrent Reclamation is well underway. See Figure A-8 in Appendix A.
- This HLF WBM report includes an exercise in which precipitation was neglected to determine the maximum make-up water requirement, given the assumption that zero precipitation is available for make-up water use. See Figure A-9 and Figure A-10 in Appendix A.
- The flowrates presented in Figure A-8 to Figure A-10 are based on instant demand. Peak flowrates could be reduced by utilizing storage.

3.3 HLF Solution Removal

Solution Removal from the system is defined as all solution that is removed from containment within the HLF system regardless of treatment requirements. During operations, all solution will be tested for water quality and constituent levels. The transfer routes and fates of all removed solutions are being evaluated by the site-wide WBM (Lorax), which is outside the scope of this HLF water balance modeling.

The excess HLF solution can be removed in various ways depending on quality including, but not limited to:

- Pumping to other site processing areas for use as make-up water,
- Pumping to active treatment during operations, when necessary,
- Routing to a passive treatment system during closure,
- Use for construction water,
- Transfer for storage elsewhere on site,

In all results and discussion herein, the term "Solution Removal" is used only in the context of solution leaving the HLF system. The solution could be solution that infiltrated through HLP, runoff from HLP during and event, or direct precipitation to the lined ponds. The HLF WBM tracks solution in the system in these categories to be further analyzed by the Site Wide Water balance and Water Quality as to fate of removal. The HLF WBM maintains a Solution Removal rate of zero until active water treatment is planned to be available in Spring of 2028 (Yr 2). Solution Removal is assumed to begin each year in the Spring at freshet onset as determined by the Coffee Gold Project: 2021 Hydro-meteorology Baseline Report (Lorax, 2022). Solution Removal from the HLF is assumed to be zero from November 1st each year through the

following Spring freshet due to freezing temperatures. This results in a modeled water treatment period of approximately 7 months each year.

3.3.1 HLF Solution Removal Rates

Appendix A presents Figure A-11 presents the below solution Max rates, as it applies to Climate Realization #1 only.

- 25 L/s (90 m3/h) is the max Solution Removal rate required during normal operations to maintain the Event Storage Requirement as outlined in Table 2-2, beginning in April of 2028 (Yr 2) to April 2033 (Yr 7).
- 35 L/s (126 m^3/h) is the max Solution Removal rate required to maintain the Event Storage Requirement as outlined in Table 2-2, beginning in April of 2033 (Yr 7).
- 14 L/s (50 m^3/h) beginning in April of 2042 (Yr 16) is the passive treatment rate after Concurrent Reclamation is complete. Figure A-20 in Appendix A presents long term storage requirements through 2069 for a single realization.

3.4 HLF Event Pond Level Management

The HLF WBM shows that the pond volumes maintain the ESR throughout the life and beyond final reclamation of the HLF. For all the modeling simulations performed by Forte, the Event Ponds were assumed to be the first sources for water demand, prior to demand being from outside the system as captured in this report as make-up water. To maintain the ESR, it will be necessary to periodically remove solution as described previously in section 3.3. It should be noted that the HLF WBM assumes that zero Solution Removal flows occur prior to the availability of active water treatment in May 2028 (Yr 2). The facility will maintain the capability to manage solution between ponds to maintain the ESR and for operational needs during any unforeseen events.

3.5 Pregnant Solution Tank Level Management

For all the modeling simulations performed by Forte, the maximum flow from the Pregnant Solution Tank(s) with total volume 2,000 m^3 to the process plant was set the nominal plant flowrate of 1100 m^3/hr. At this nominal plant flow rate, the Pregnant Solution tank is expected to utilize an EP-2 Process Segregation as temporary storage, especially during periods of high precipitation. Figure A-13 and Figure A-14 in Appendix A presents the flow rate to be received at the Pregnant Tank. The Process Segregation is within EP-2 as a sump as presented in Figure 3-1. The 1 meter high berm will keep flows segregated in day to day operations, as EP-2 will only see flows during significant events. This Process Solution will be pumped to the process plant as make-up water to maintain the nominal target plant flow rate or, if needed, utilize the additional 150 m^3/hr of available plant capacity, as the plant is designed to operate up to 1250 m^3/hr. Process Solution may also be managed by pumping through a dynamic storage loop for temporary storage within the heap as discussed in the following section.

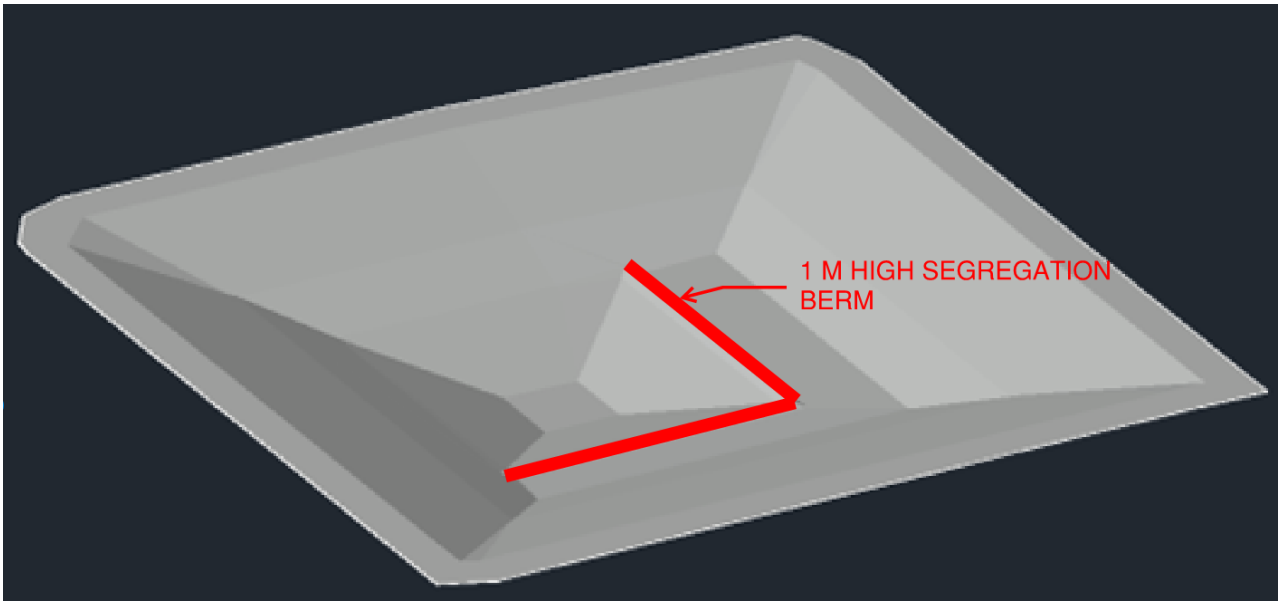

Figure 3-1: Process Segregation Sump in EP-2

3.6 Additional Solution Management Methods

This section includes strategies that provide flexibility in solution management to maintain the ESR under fluctuating conditions. The HLF WBM includes the ability to pump solution to dynamic storage. The other strategies presented below were not necessary to maintain the ESR and were not included in the HLF WBM, but are contingency solution management options that can be employed by site as necessary during operations.

3.6.1 Dynamic Storage

Pumping to dynamic storage is an industry standard practice that is used to recirculate solution to areas of the HLF that have previously been leached for intentional and additional, temporary storage. It's shown (primarily during freshet or excessive rainy conditions) to be periodically practical to manage pond levels more effectively by utilizing an inactive previously leached HLF area (if available) for water storage. The maximum flow rate for dynamic storage is 300 m^3/hr. Figure A-12 in Appendix A presents occurrences of Dynamic Storage for Realization 1 only.

3.6.2 Raincoats

The HLF WBM presented here did not require raincoats during operations. All inflow within the HLF footprint, whether onto raincoats or not, would need to be contained and tested prior to removal. Therefore, Forte worked under the conservative assumption that raincoats would not be used for this analysis. Raincoats can be included and utilized for site as a contingency solution management method, primarily assumed to be for water quality purposes. However, the model results here show that they are not necessary from an HLF water flow perspective.

3.6.3 Pond Pumping System

The HLF will have the capability to transfer solution between all ponds if necessary to effectively manage solution due to any unforeseen events or operational needs.

3.6.4 Snow Removal

Precipitation into the HLF system can be reduced by removing snow accumulation prior to snow melt each Spring.

4. DETERMINISTIC REALIZATION MODELING RESULTS FOR THE HEAP LEACH FACILITY

Deterministic modeling of the HLF was performed using the synthetic climate approach (30 sets of daily climate/meteorological data) provided by Lorax (Lorax, 2022). The HLF WBM results for all 30 climate realizations show that pond volumes withing the HLF maintain the ESR throughout the life and final reclamation of the HLF as shown in Figure 4-1.

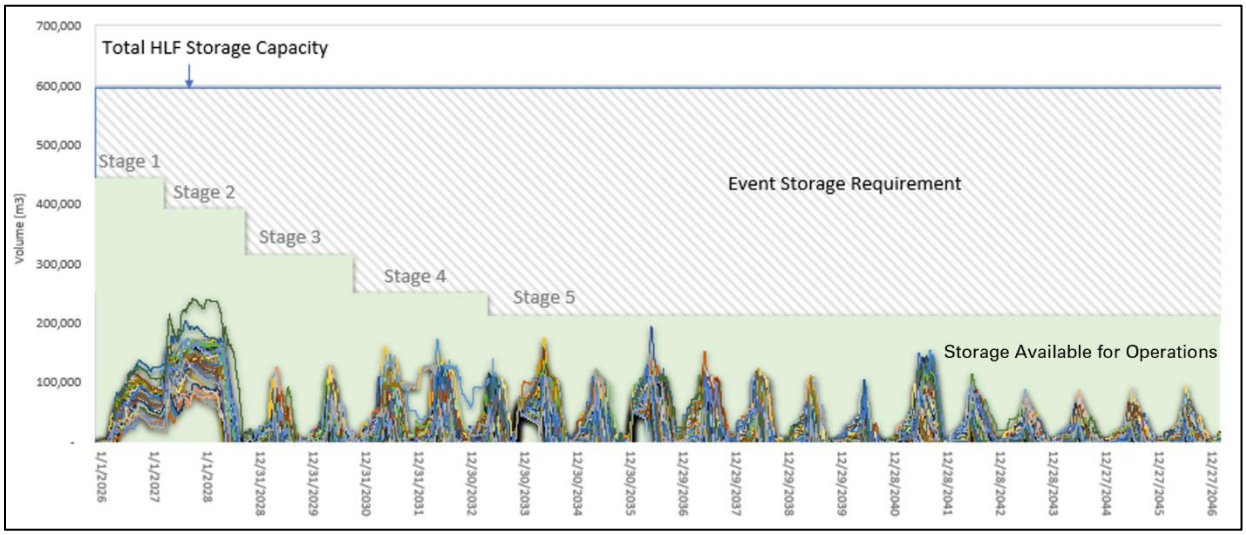

Figure 4-1: HLF Pond Storage Volumes Through Time for 30 Climate Realizations

4.1 Total Available Storage Volume and Event Storage Requirement

- The maximum total available storage volume for the HLF was modeled to be 596,000 m^3, which is calculated by adding the solution storage volumes to the spillway inverts of each Event Pond:
  - Event Pond 1 South (EP-1S) = 90,312 m^3-Stage Storage presented in Appendix A Table A-1.
  - Event Pond 1 North (EP-1N) = 112,791 m^3 -Stage Storage presented in Appendix A Table A-2
  - Event Pond 2 (EP-2) = 339,819 m^3 -Stage Storage presented in Appendix A Table A-3.
  - Rain Water Pond (RWP) = 53,016 m^3-Stage Storage presented in Appendix A Table A-4.
- As shown in Figure 4-1, for all model runs of the 30 unique climate timeseries, the total solution volume in the ponds never exceeds the volume required to maintain the ESR.
- The effects of the variations between the 30 unique climate time series on the total available storage volume are shown to be minimal throughout the operational life of the project. The most notable differences between the realizations occurs in the first 3 years of modeling when the Solution Removal rate is modeled to be zero, resulting in varying accumulation of water until active water treatment is modeled to be available beginning in the Spring of 2028 (Yr 2). While variation occurs during this timeframe, the volume in the ponds maintains the ESR.

- These storage results are based on the HLF WBM reported here, and as stated prior, these volumes and flows will be incorporated into the site-wide WBM for determination of final storage needs for the Project.
- Refer to Appendix A for all realization results of storage volumes by pond.

4.2 Flow Rates

- Water contained in the Rain Water Pond and EP-2 (outside of the EP-2 Process Segregation) is meteoric only and is unlikely to require water treatment prior to Solution Removal.
- The HLF WBM indicates that Event Pond 2 (EP-2) is generally expected to have two inflows: precipitation and excess Process Solution from the Pregnant Solution Tank (see Figure 4-2). This excess Process Solution is routed to the EP-2 Process Segregation with the intent of maintaining the water quality of precipitation contained within EP-2. The EP-2 Process Segregation was designed specifically for this purpose, and the segregated Process Solution will be directed to the process plant for gold recovery prior to removal from the HLF. Flows between the Pregnant Solution Tank and the EP-2 Process Segregation are expected, and their respective designs provide the ability to effectively manage all solution during operations.
- Solution Removal flowrates described in Section 3.3.1 remain constant most years from the modeled start of Solution Removal (freshet onset in the Spring) through November 1 when Solution Removal is assumed to be zero until the following Spring. The HLF system receives precipitation and snowmelt during warmer months, which requires regular Solution Removal prior to the return of freezing temperatures. The HLF WBM results show that emptying the ponds prior to winter will result in increased preparation and success at managing runoff water the following Spring.
- Refer to Appendix A to see all realization results of HLF flow rates.
- Refer to Appendix B to see inflows for all HLF ponds.

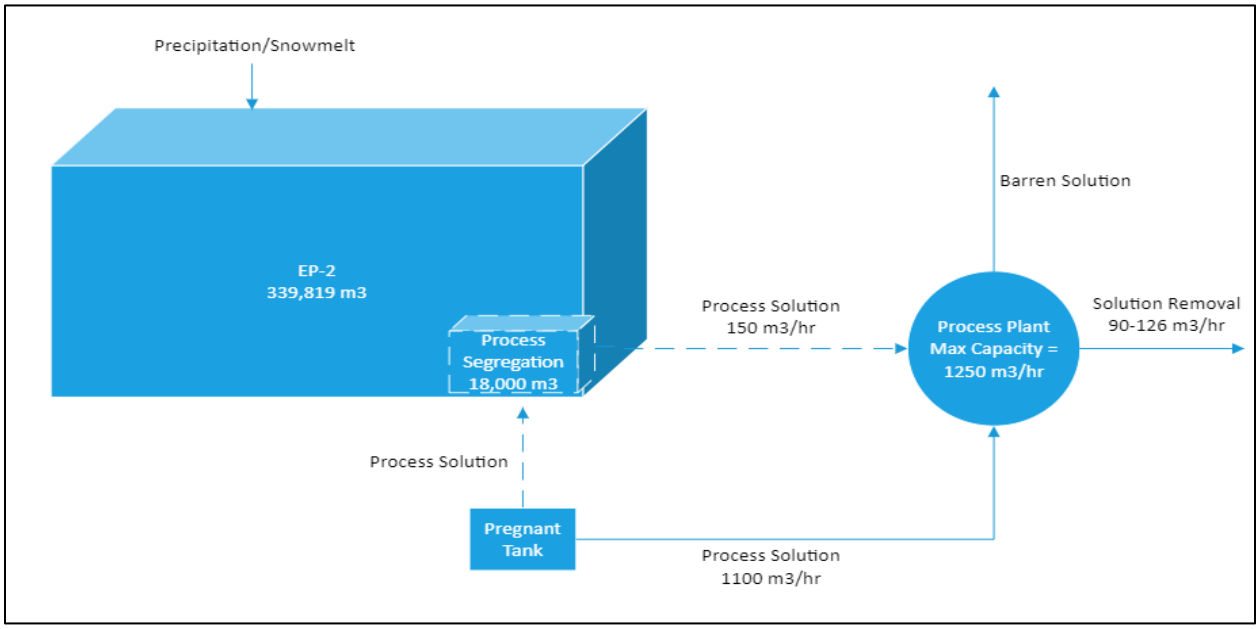

Figure 4-2: EP-2 Process Segregation Flow Schematic

4.3 Concurrent Reclamation

This HLF WBM provides data from all 30 climate realizations on drainage and runoff flows during and after concurrent reclamation of the HLF. This data informed on the passive Solution Removal rate required to maintain the ESR through 1/1/2047 (Yr 21). Additional modeling was done and confirmed the stability of passive water management at the passive Solution Removal rate through 2069 (See Appendix A).

5. CONCLUSION

The deterministic water balance modeling, making use of 30 daily timeseries of climate data provided by Lorax, yielded several important outcomes. The results confirm sizing and management strategies of the Event Ponds to ensure sufficient volume to maintain the ESR from the start of construction and beyond Concurrent Reclamation of the HLF, under varying climate conditions. By making periodic use of pumping to the HLF for additional dynamic storage as an active solution management strategy during operations, no infringements occur with respect to the ESR volume. Additional operational options that give flexibility to solution management, although not explicitly modeled include, but are not limited to, inter-pond pumping, snow removal, and raincoats. These are solution management contingency options, not requirements to maintain the ESR. As noted above, this also does not consider additional water management strategies as represented in the site-wide WBM which may utilize water for purposes outside the scope of this HLF WBM.

The modeling of the HLF shows that Process Solution is expected to be temporarily stored in the EP-2 Process Segregation during periods of high precipitation. This segregation volume within EP-2 has been implemented as a design strategy to manage this excess Process Solution prior to it being pumped to the process plant. Modeling shows a quantity of solution within the system from make-up water and meteoric inflows such that the target plant flow rate of 1100 m^3/hr is easily achieved. Meteoric inflow has seasonal fluctuations which are managed with the stated pond volumes, EP-2 Process Segregation design, and dynamic storage to maintain total available storage beyond the ESR throughout the life and reclamation of the HLF.

6. REFERENCES

Coffee Gold Project: 2021 Hydro-meteorology Baseline Report, prepared by Lorax Environmental Services, Ltd. (Vancouver, BC) for Newmont Corporation, January 2022. (Lorax, 2022)

Water Balance Modeling for the Kaminak Gold Coffee Gold Project Heap Leach Pad Facility, prepared by The Mines Group, Inc. (Reno, NV, USA) for Kaminak Gold Corporation, January 2016. (The Mines Group, 2016)

Feasibility Design Report for Coffee Gold Heap Leach Facility Yukon Territory, Canada, prepared by The Mines Group, Inc. (Reno, NV, USA) for Kaminak Gold Corporation, January 2016. (The Mines Group, 2016)

Newmont Coffee Project HLF Engineering for Permitting Design Criteria, prepared by Forte Dynamics (Fort Collins, CO, USA) for Newmont Corporation, May 2022. Document No. 12 (Forte, 2022)

Coffee Mine Heap Leach Cover Design – Analytical Water Balance to Support Alternatives Assessment, prepared by Okane Consultants (Calgary, AB) for Ensero Solutions, November 2021 (Okane, 2021)

APPENDIX A: WATER BALANCE MODELING RESULTS

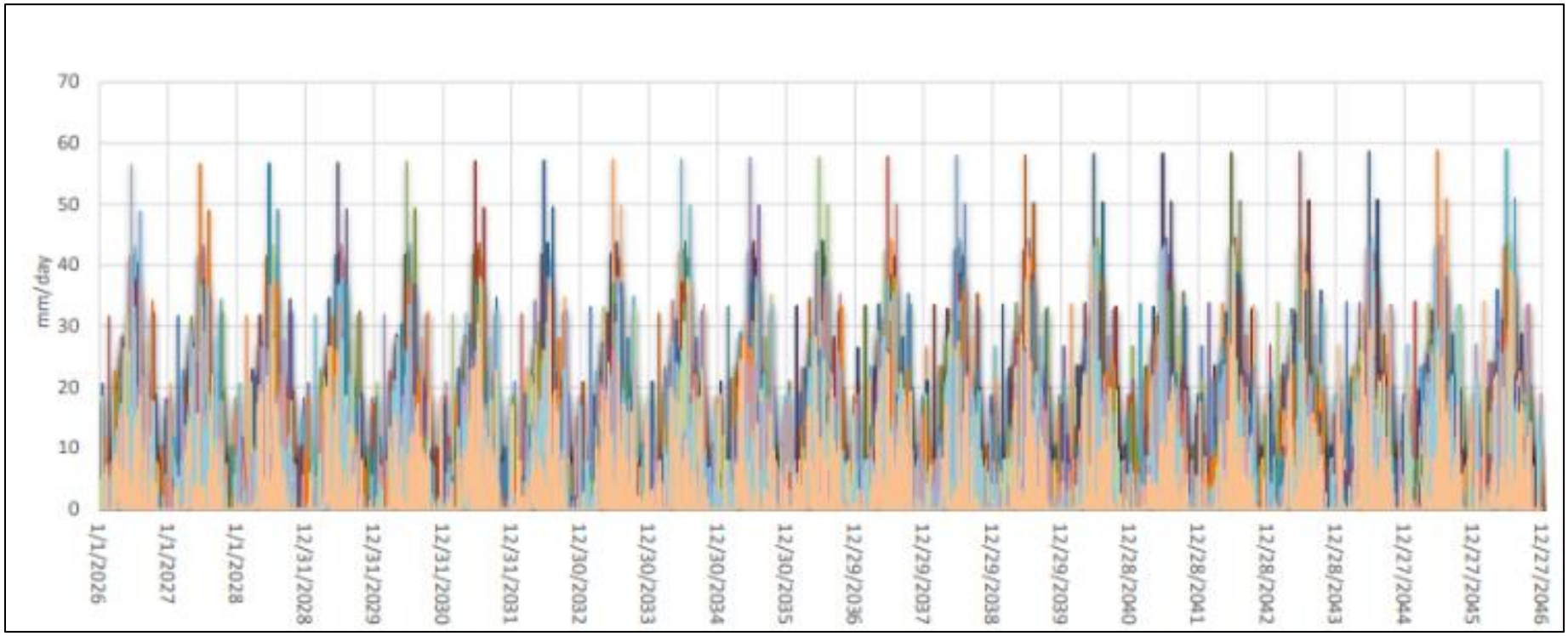

Figure A- 1: Precipitation and Snowmelt HLF WBM Inputs - Climate Realizations # 1 -30

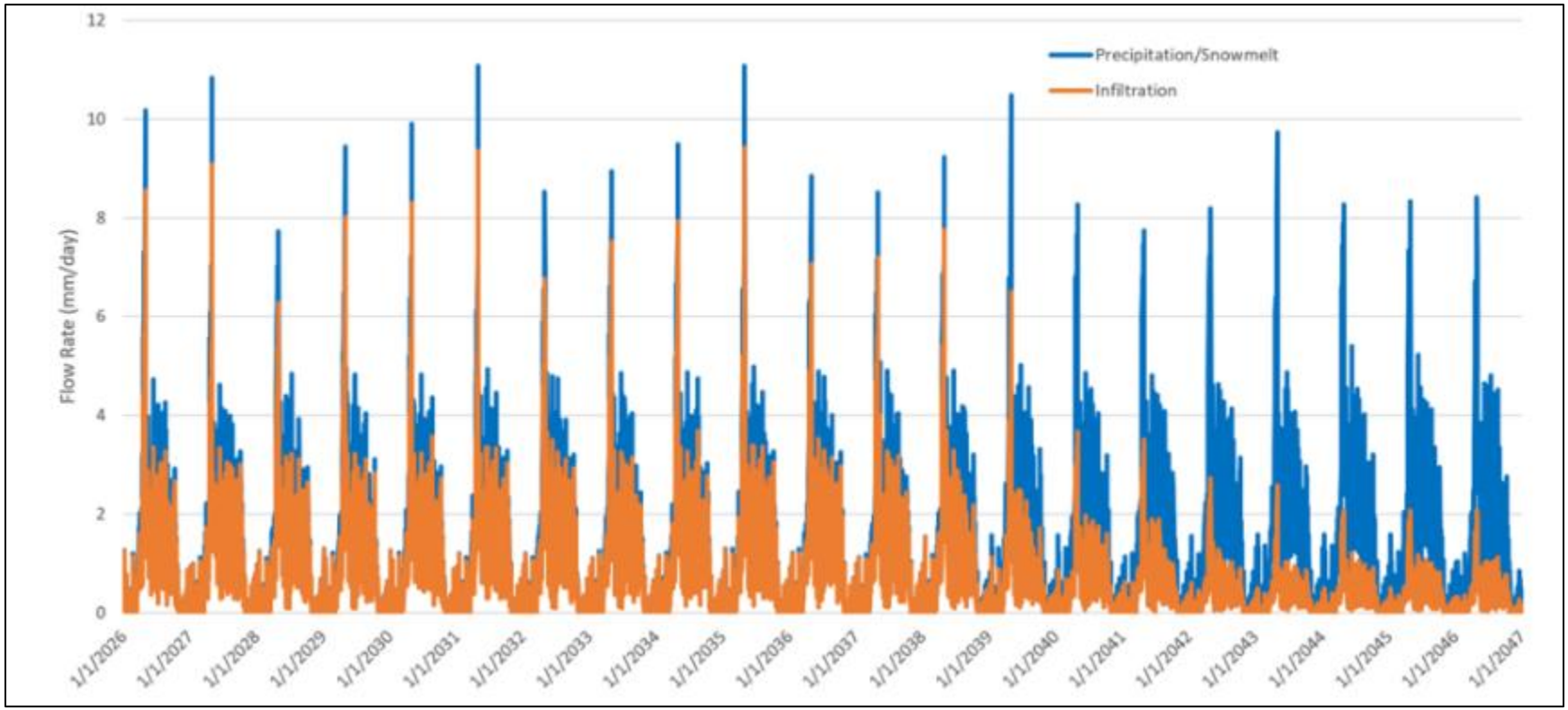

Figure A-2: Infiltration HLF WBM Inputs - Average of 30 Climate Realizations

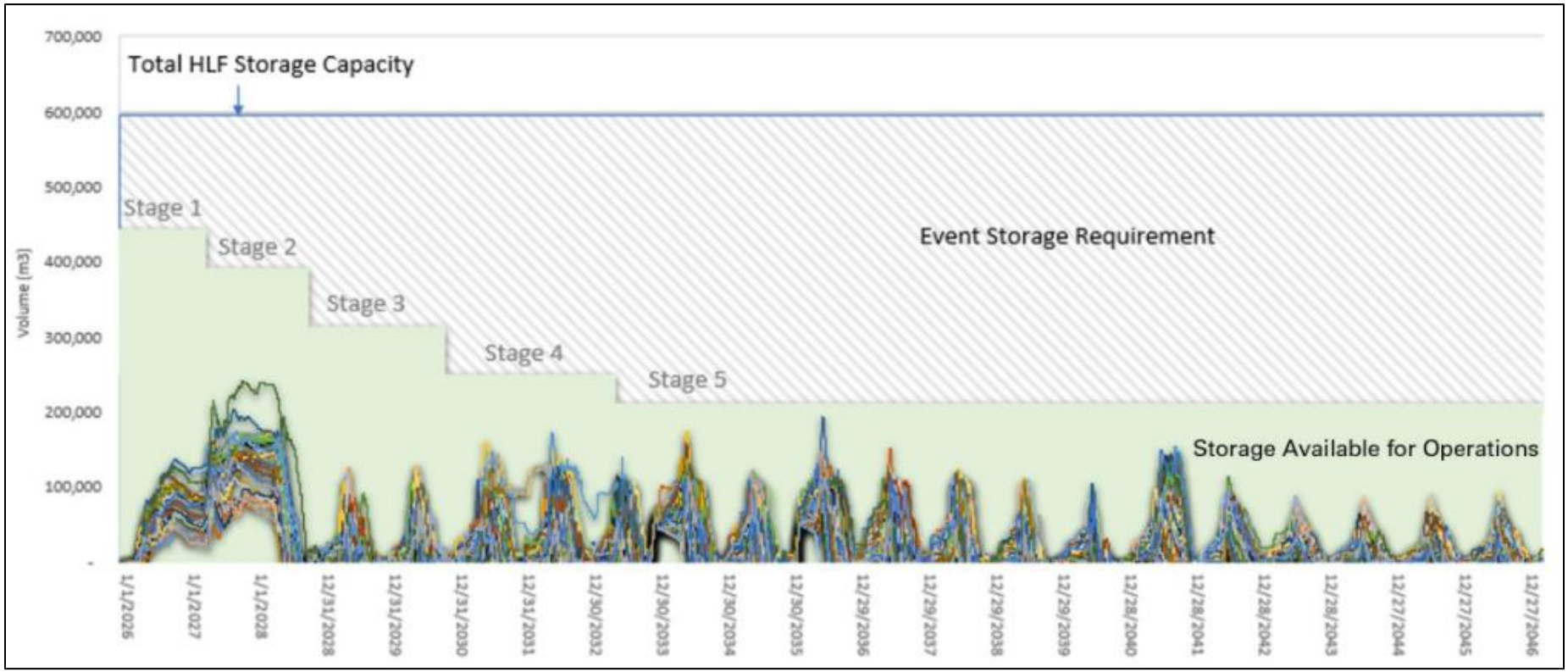

Figure A-3: HLF Pond Storage Volume Results - Climate Realizations #1 - 30

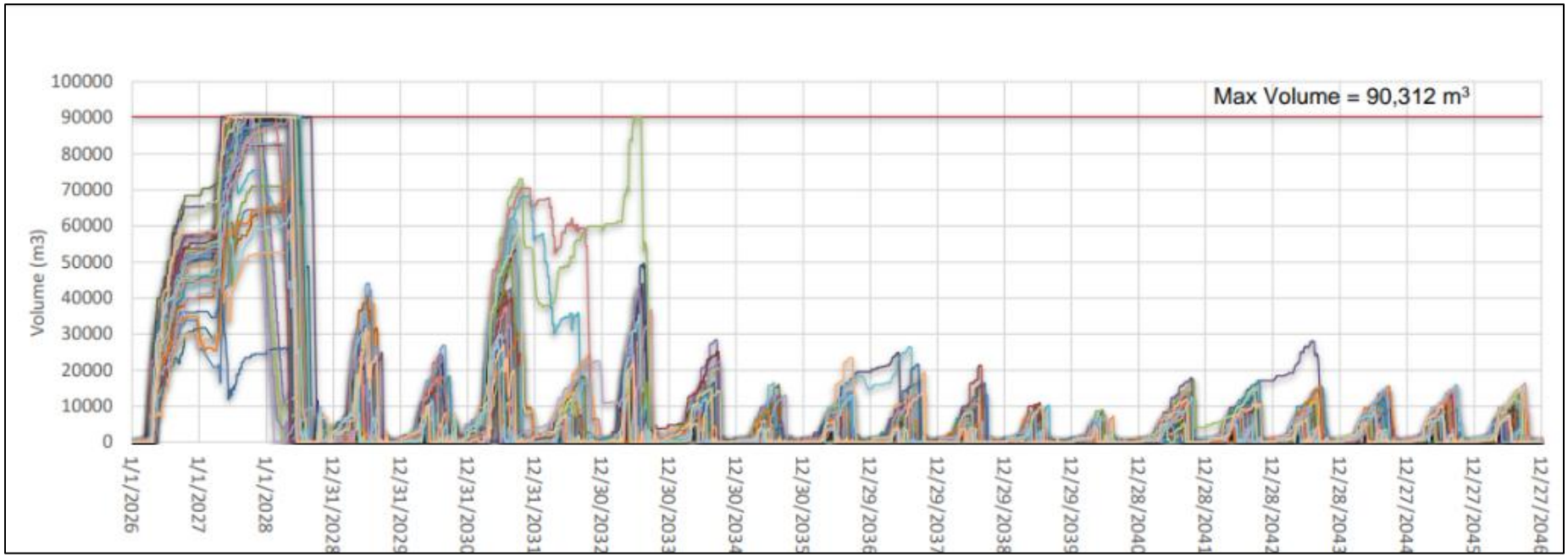

Figure A-4: Event Pond 1 South Volume Results: Climate Realizations #1 - 30

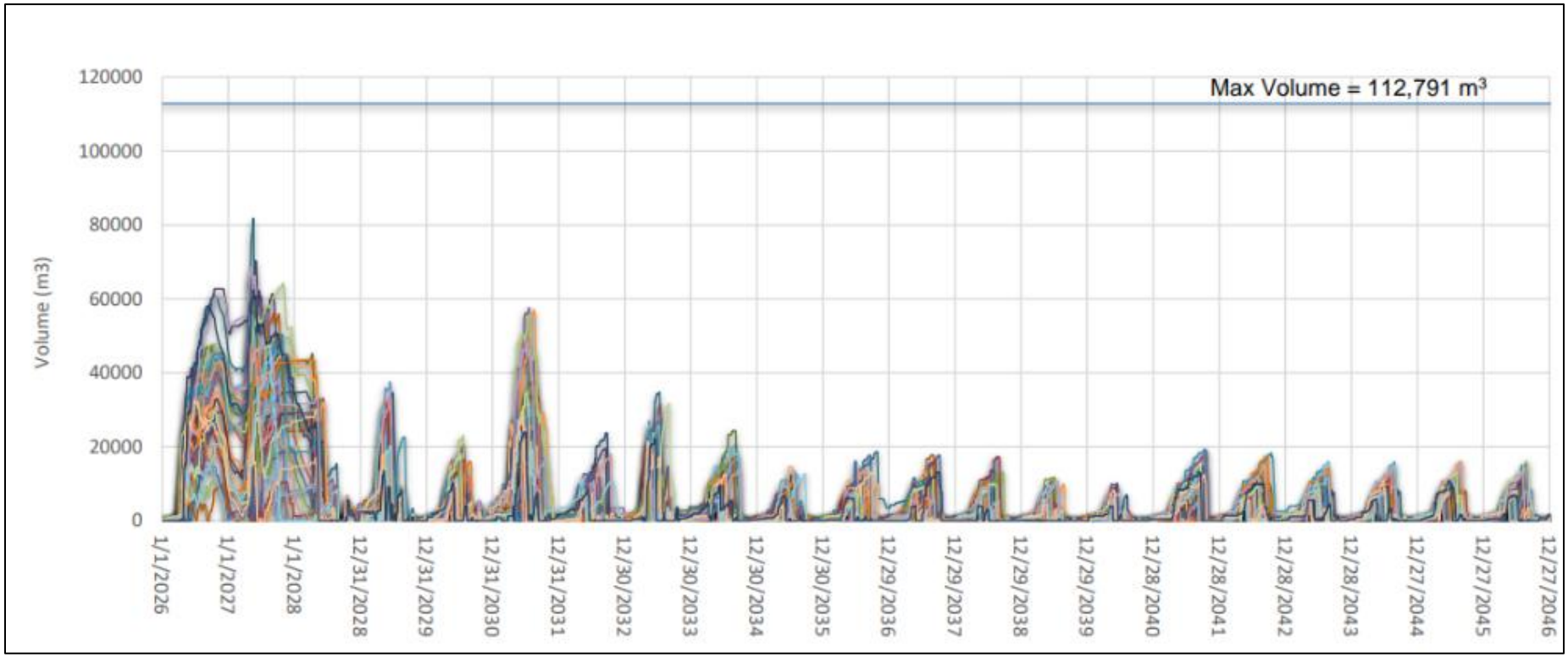

Figure A-5: Event Pond 1 North Volume Results: Climate Realizations #1 - 30

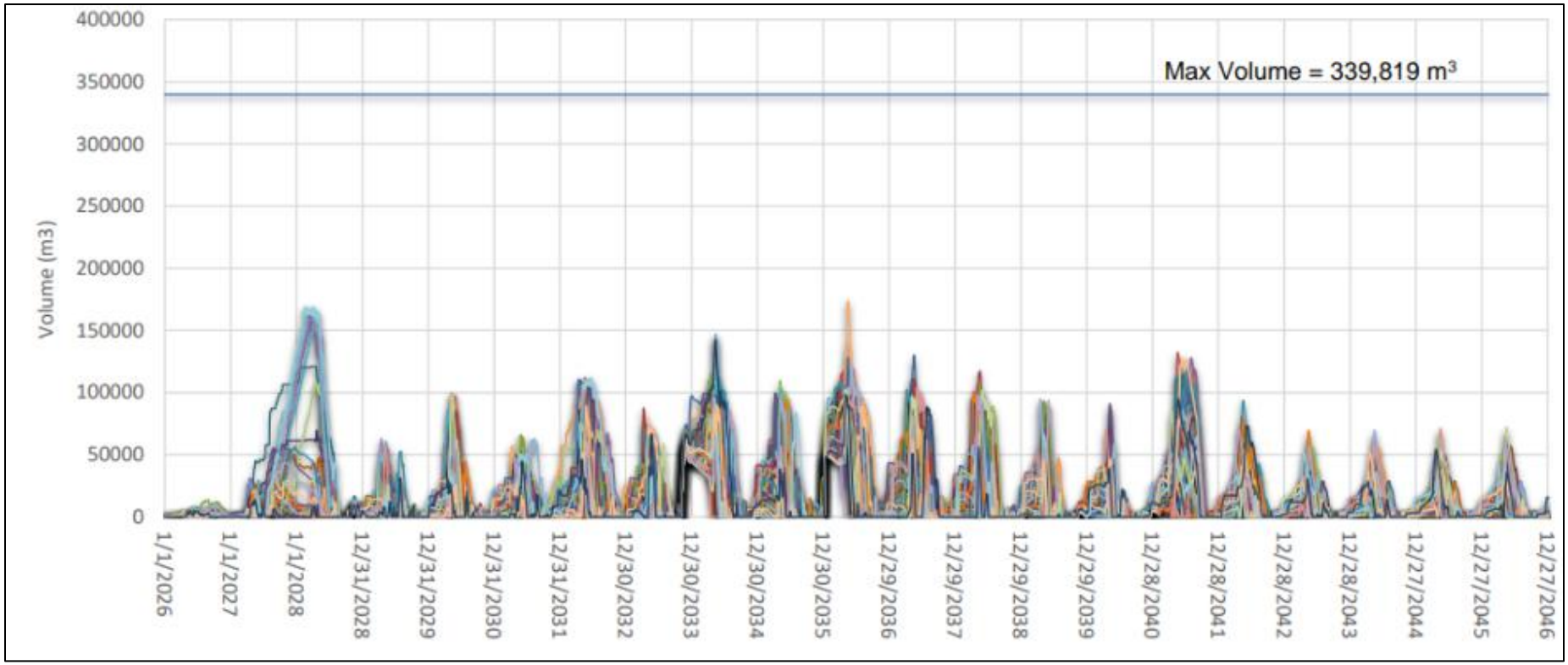

Figure A-6: Event Pond 2 Volume (Includes EP-2 Process Segregation Results) – Climate Realizations #1 – 30

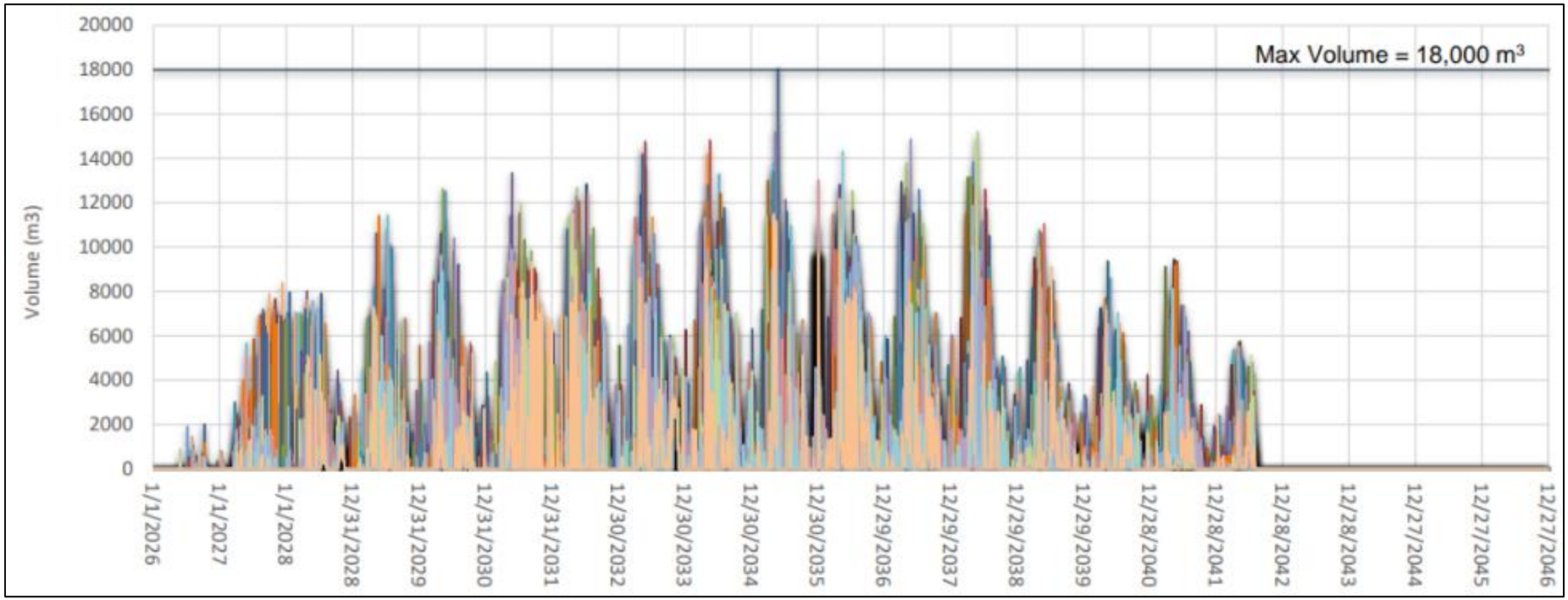

Figure A-7: Event Pond 2 - Process Segregation Volume Results - Climate Realizations #1 - 30

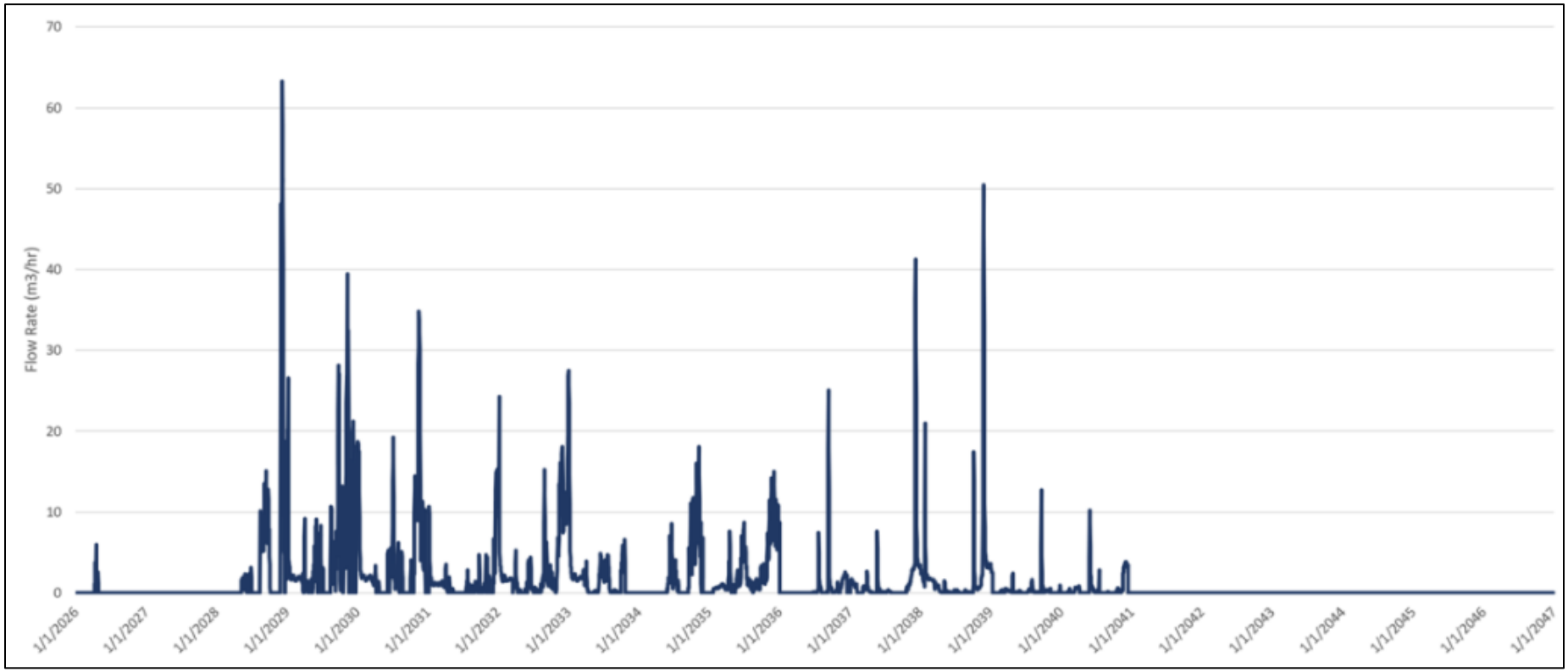

Figure A-8: Make-Up Water Flow Rate Results - Average of 30 Climate Realizations

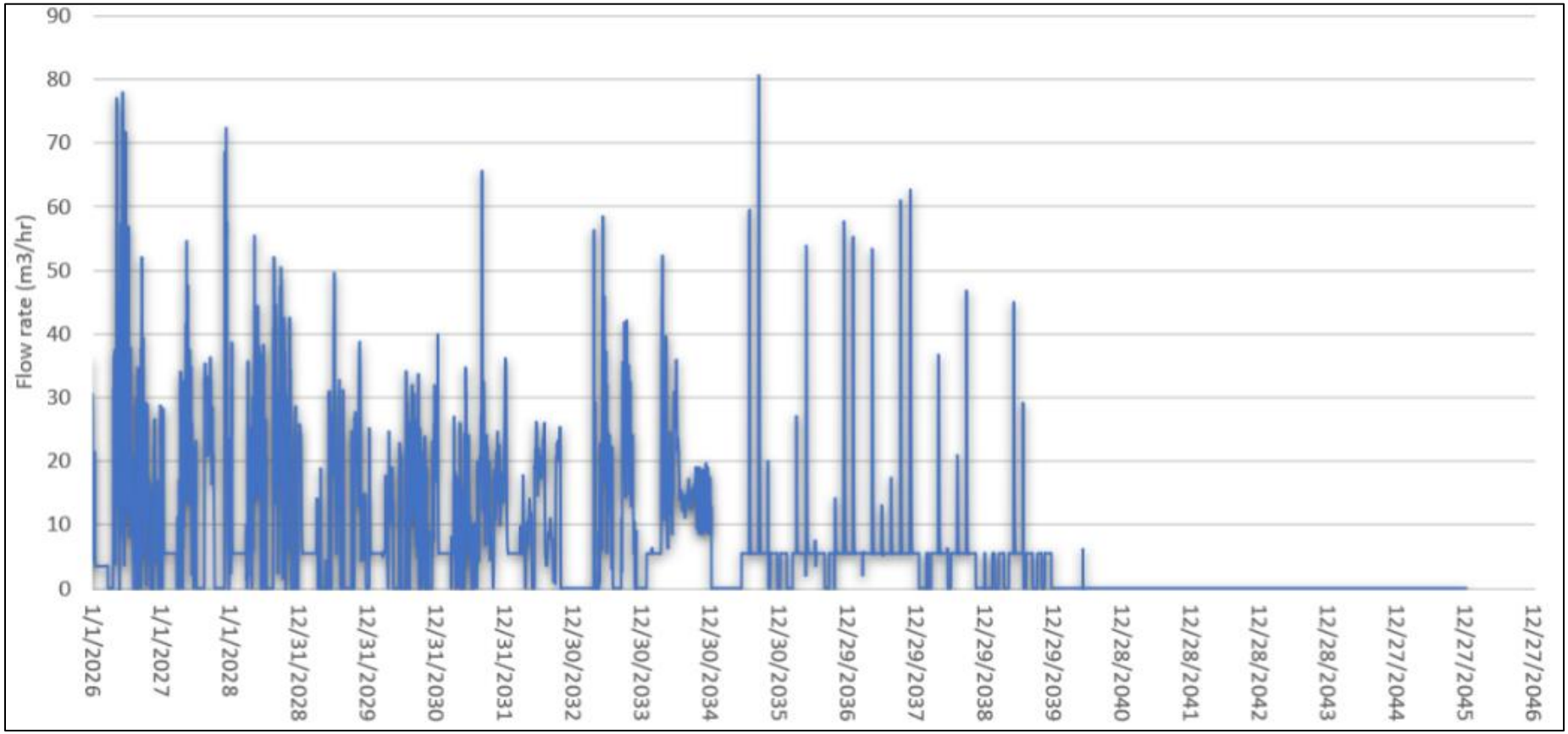

Figure A-9: Make-Up Water Flow Rate Result - Neglecting Precipitation for Maximum Make-Up Water Requirement

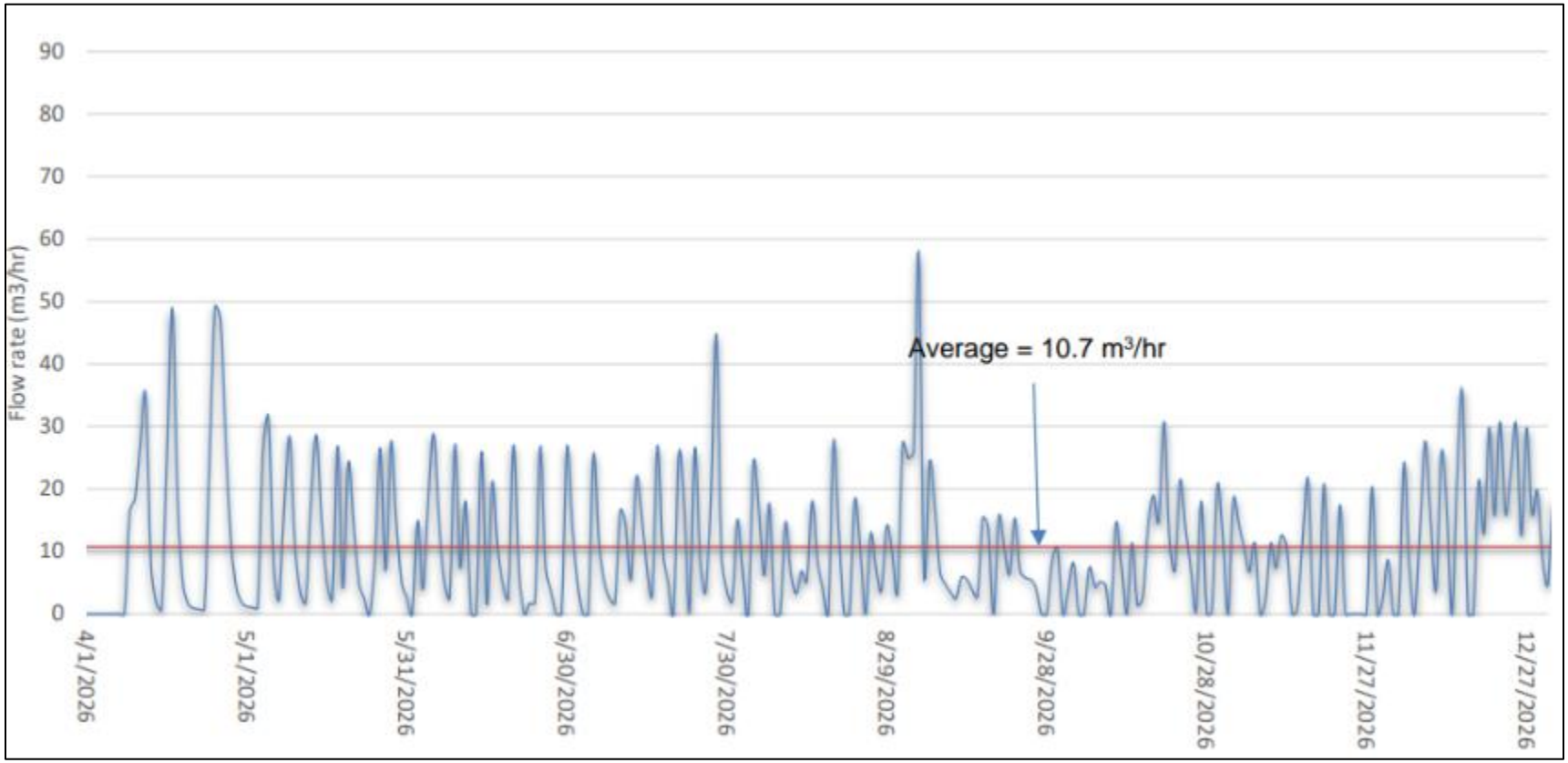

Figure A-10: Make-Up Water Flow Ratte Result for Year 1 – Neglecting Precipitation for Maximum Make-Up Water Requirements

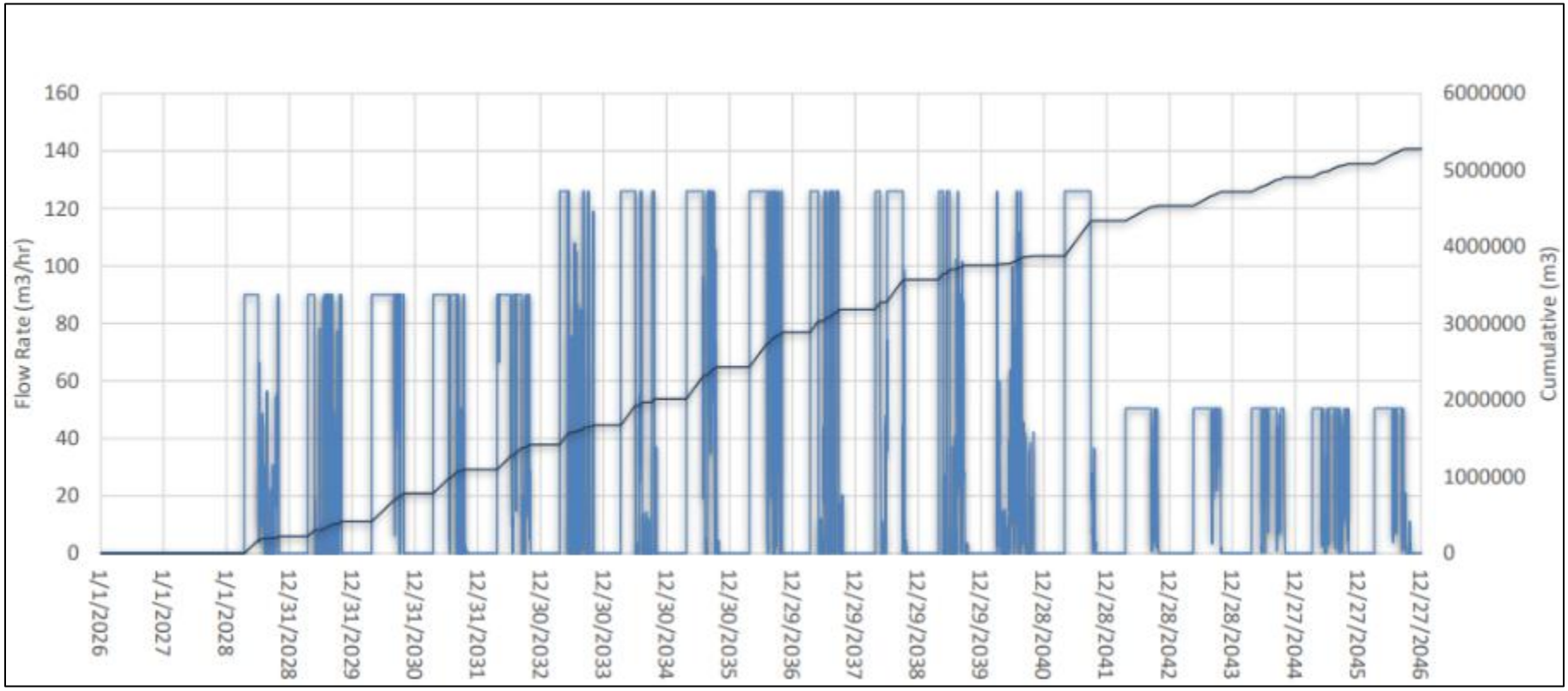

Figure A-11: Discharge Flow Rates and Cumulative Discharge Results – Climate Realization #1

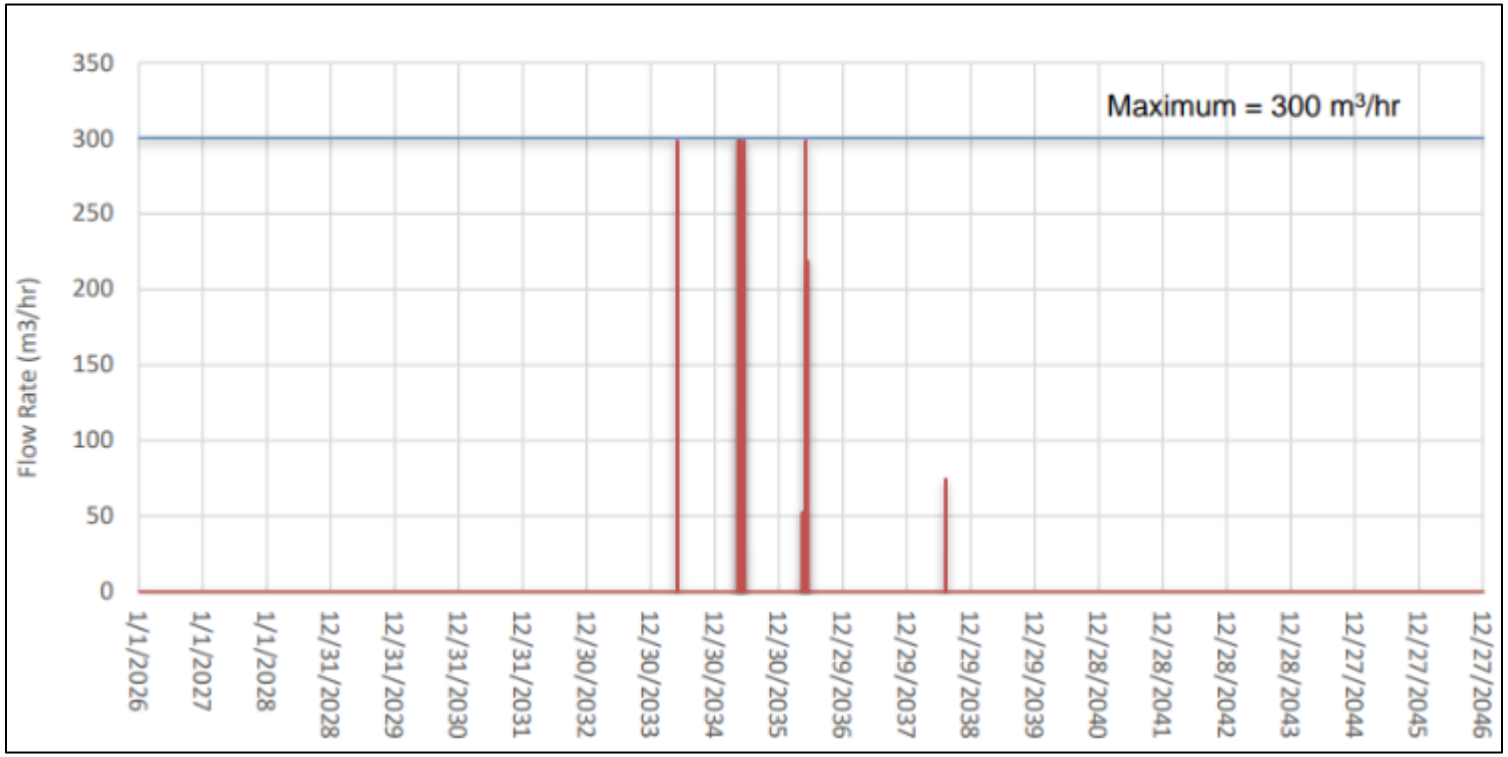

Figure A-12: Recirculation of Dynamic Storage Flow Rate Result - Climate Realization #1

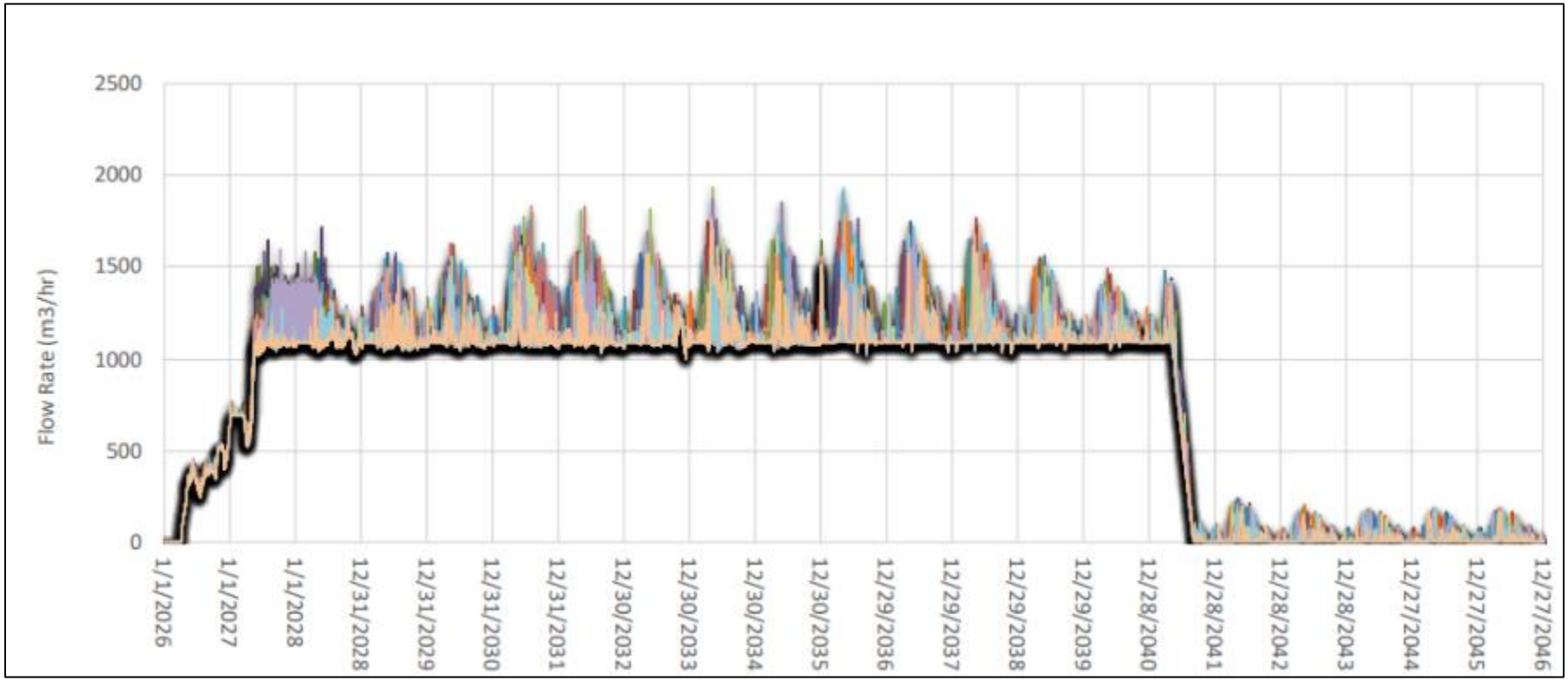

Figure A-13: Heap Leach Pad Drainage Flow Rate Results - Climate Realizations #1 - 30

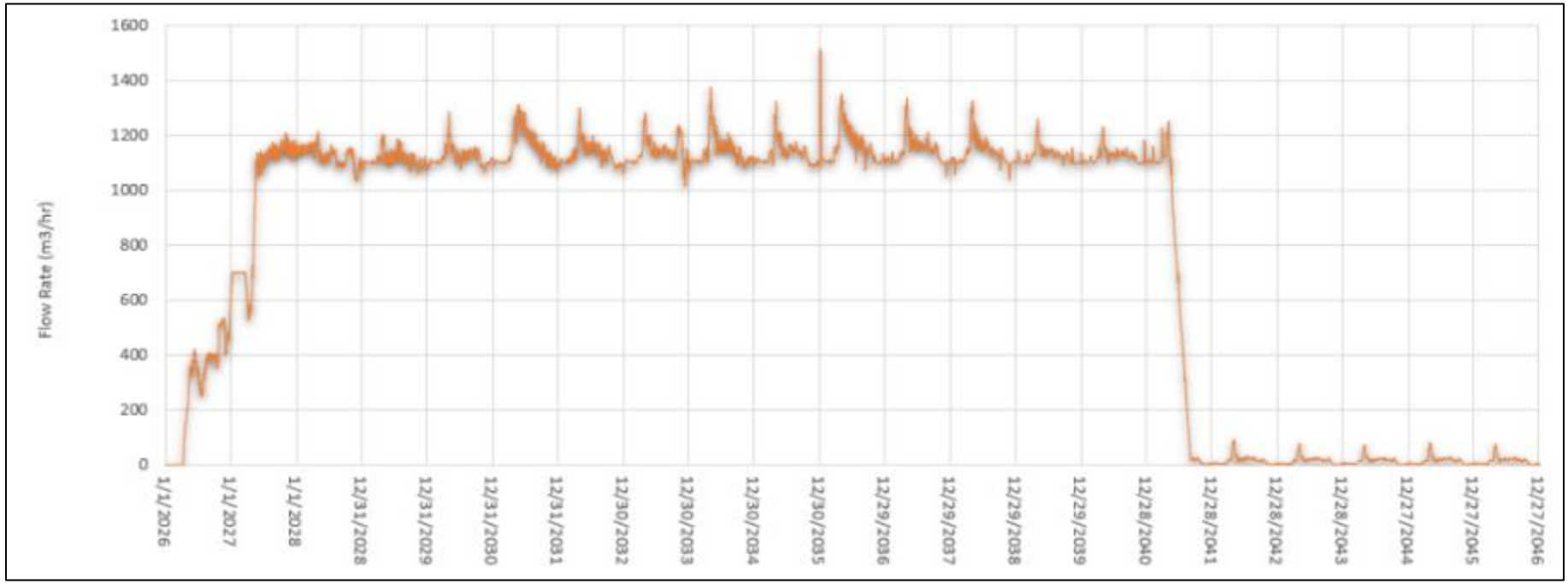

Figure A-14: Heap Leach Pad Drainage Flow Rate Results - Average of 30 Climate Realizations

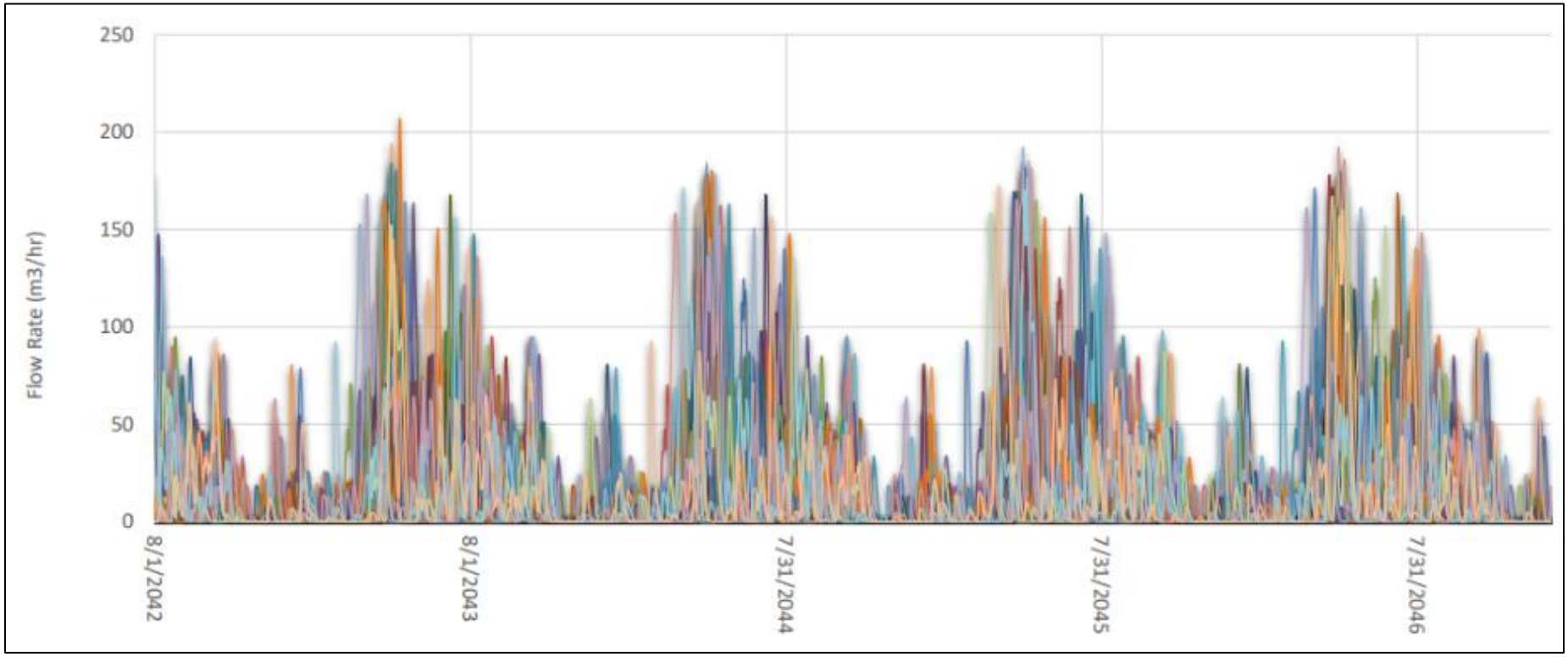

Figure A-15: Heap Leach Pad Drainage Flow Rate Post Cover Placement Results – Climate Realizations #1 - 30

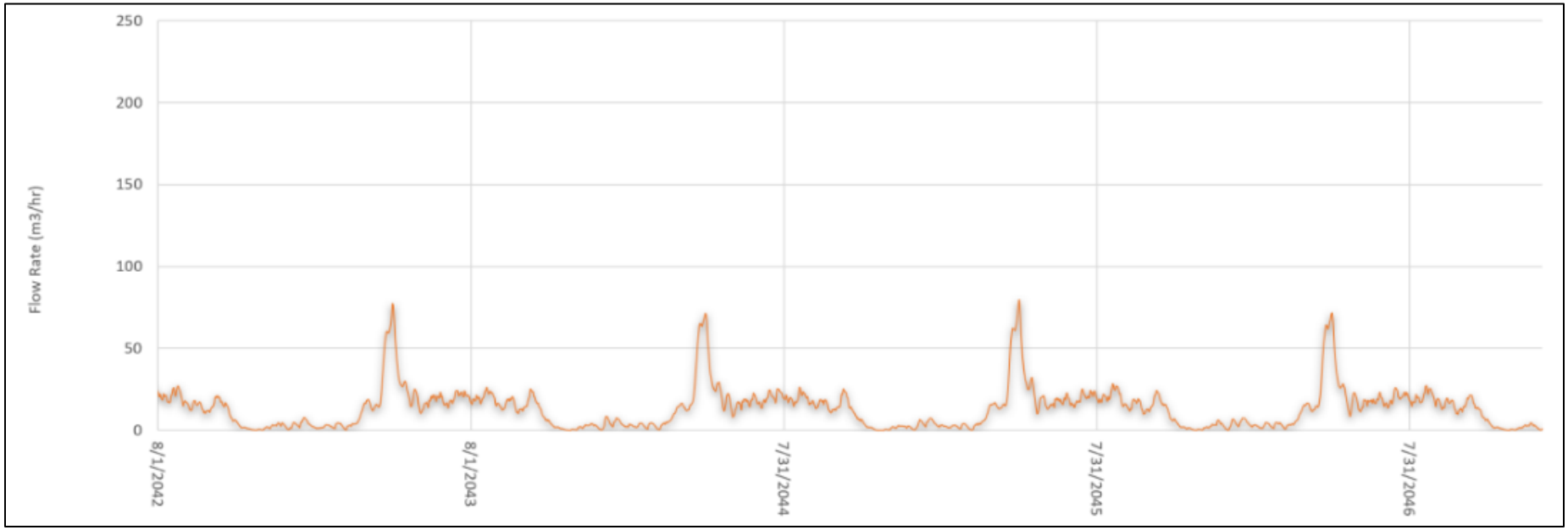

Figure A-16: Heap Leach Pad Drainage Flow Rate Post Cover Placement Results - Average of 30 Climate Realizations

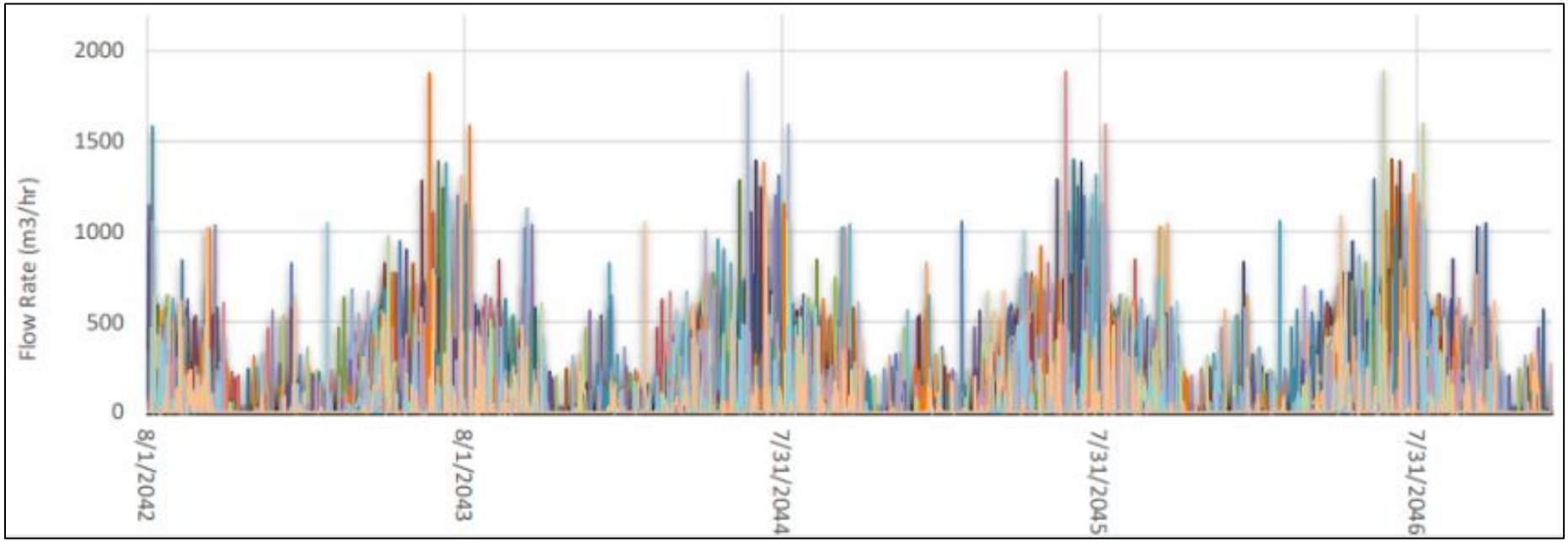

Figure A-17: Post Cover Placement Runoff Results - Climate Realizations #1 - 30

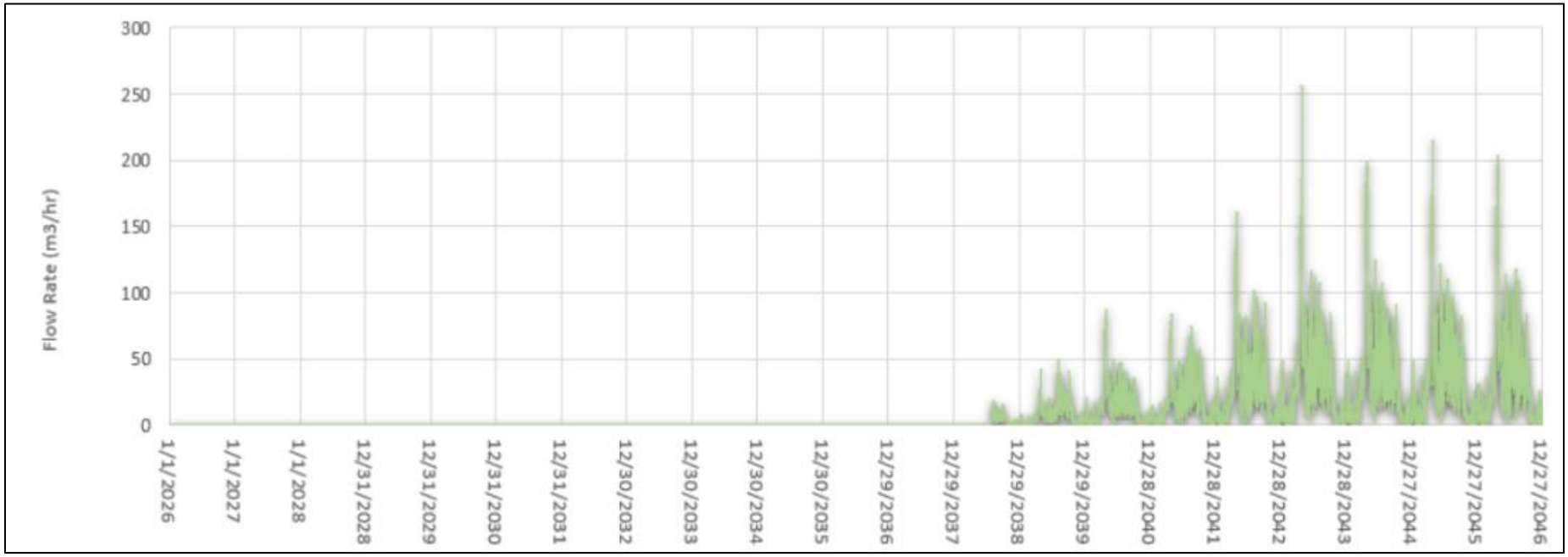

Figure A-18: Post Cover Placement Runoff Results - Average of 30 Climate Realizations

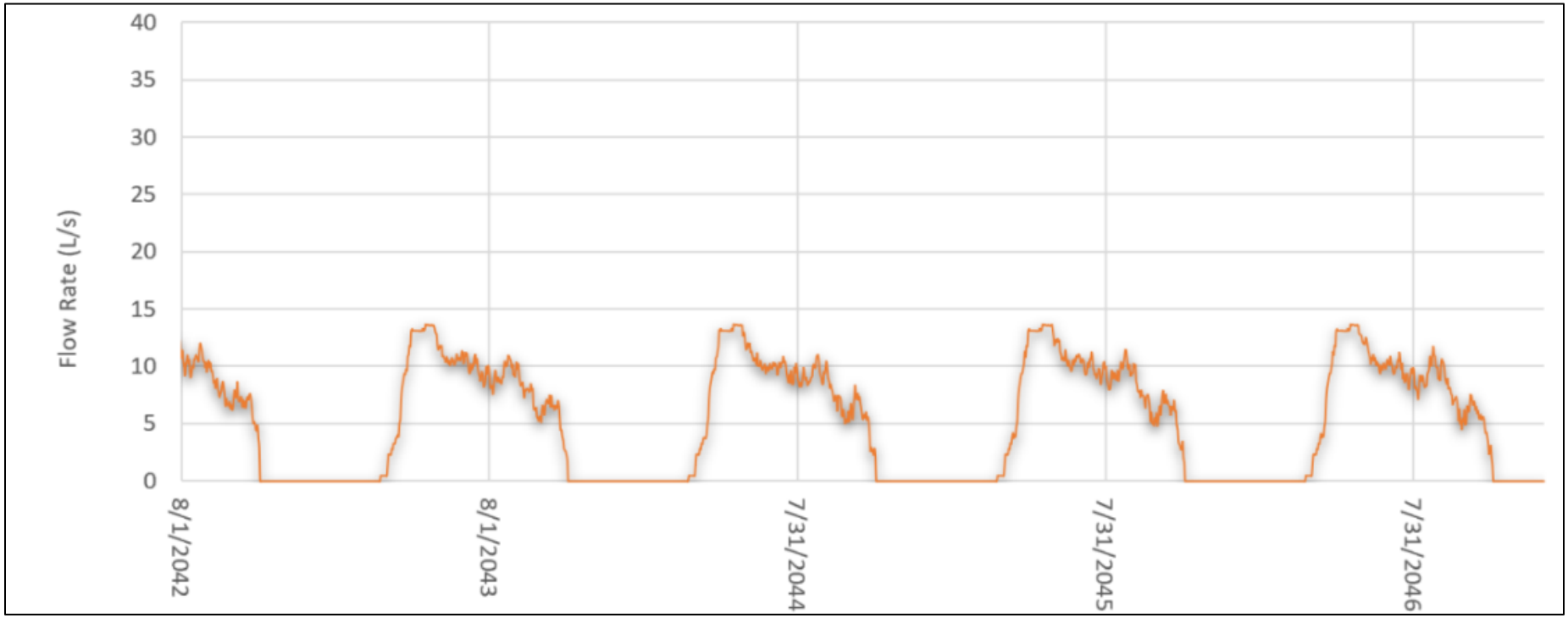

Figure A-19: Solution Removal Flow Rate Post Cover Placement Results Average of 30 Climate Realizations

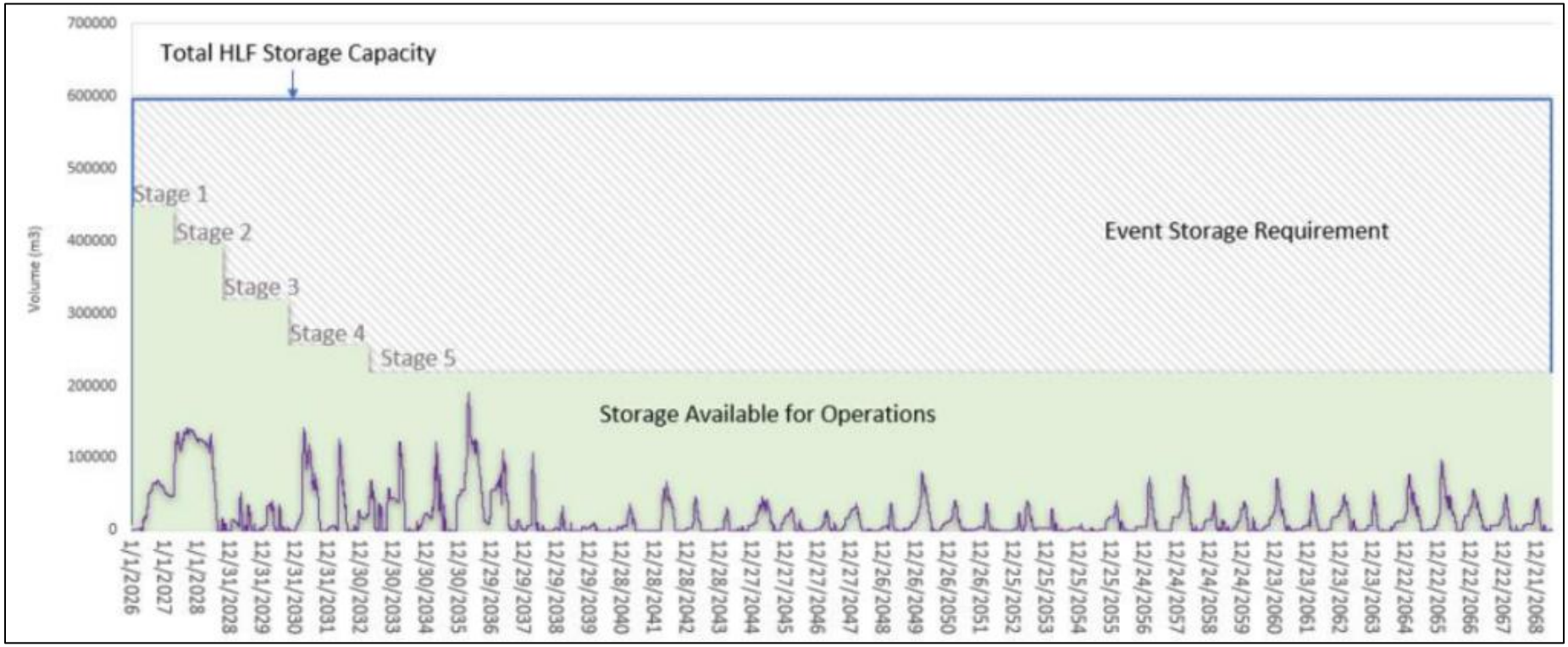

Figure A-20: Available Pond Storage Volume Results Through Extended Closure (Year 2069) - Single Climate Realization

Table A-1: EP-1S Stage Storage

Elevation	Area (m2)	Incremental Volume (m3)	Total Volume (m3)
1202.5	311	31	31
1203	1,354	416	447
1203.5	3,135	1,122	1,570
1204	7,552	2,672	4,242
1204.5	8,015	3,892	8,133
1205	8,491	4,127	12,260
1205.5	8,979	4,367	16,627
1206	9,478	4,614	21,241
1206.5	9,989	4,867	26,108
1207	10,511	5,125	31,233
1207.5	11,046	5,389	36,622
1208	11,592	5,660	42,282
1208.5	12,150	5,936	48,218
1209	12,720	6,218	54,435
1209.5	13,302	6,506	60,941
1210	13,895	6,799	67,740
1210.5	14,616	7,128	74,868
1211	15,430	7,512	82,380
1211.5-Spillway	16,300	7,933	90,312
1212-Crest	17,240	8,385	98,697

Table A-2: EP-1N Stage Storage

Elevation	Area (m2)	Incremental Volume (m3)	Total Volume (m3)
1202.5	261	26	26
1203	1,043	326	352
1203.5	5,060	1,526	1,878
1204	9,684	3,686	5,564
1204.5	10,239	4,981	10,545
1205	10,806	5,261	15,806
1205.5	11,386	5,548	21,354
1206	11,978	5,841	27,195
1206.5	12,582	6,140	33,335
1207	13,199	6,445	39,780
1207.5	13,828	6,757	46,536
1208	14,469	7,074	53,611
1208.5	15,123	7,398	61,009
1209	15,789	7,728	68,737
1209.5	16,468	8,064	76,801
1210	17,158	8,406	85,207
1210.5	17,968	8,781	93,989
1211	18,794	9,190	103,179
1211.5-O/F Weir	19,653	9,612	112,791
1212-Crest	20,546	10,050	122,841

Table A-3: EP-2 Stage Storage

Elevation	Area (m2)	Incremental Volume (m3)	Total Volume (m3)
1157	9,445	945	945
1157.5	8,318	4,441	5,386
1158	8,873	4,298	9,684
1158.5	10,036	4,727	14,411
1159-PS Crest	10,644	5,170	19,582
1159.5	11,270	5,479	25,060
1160	11,914	5,796	30,857
1160.5	12,576	6,123	36,980
1161	13,256	6,458	43,438
1161.5	13,954	6,803	50,241
1162	14,669	7,156	57,396
1162.5	15,402	7,518	64,915
1163	16,154	7,889	72,804
1163.5	16,923	8,269	81,073
1164	17,709	8,658	89,731
1164.5	18,513	9,056	98,787
1165	19,335	9,462	108,249
1165.5	20,174	9,878	118,127
1166	21,031	10,302	128,429
1166.5	21,906	10,734	139,163
1167	22,798	11,176	150,339
1167.5	23,708	11,627	161,966
1168	24,635	12,086	174,052
1168.5	25,580	12,554	186,605
1169	26,542	13,031	199,636
1169.5	27,522	13,516	213,152
1170	28,520	14,011	227,163
1170.5	29,535	14,514	241,677
1171	30,568	15,026	256,703
1171.5	31,618	15,547	272,250
1172	32,686	16,076	288,326
1172.5	33,772	16,615	304,941
1173	34,875	17,162	322,103
1173.5-O/F Weir	35,988	17,716	339,819
1174	37,118	18,277	358,096
1174.5-Crest	38,264	18,846	376,942

Table A-4: Rain Water Pond Stage Storage

Elevation	Area (m2)	Incremental Volume (m3)	Total Volume (m3)
1203	747	75	75
1203.5	2,231	745	819
1204	3,696	1,482	2,301
1204.5	4,032	1,932	4,233
1205	4,379	2,103	6,336
1205.5	4,740	2,280	8,616
1206	5,113	2,463	11,079
1206.5	5,498	2,653	13,731
1207	5,896	2,848	16,580
1207.5	6,306	3,050	19,630
1208	6,729	3,259	22,889
1208.5	7,164	3,473	26,362
1209	7,612	3,694	30,056
1209.5	8,072	3,921	33,977
1210	8,545	4,154	38,132
1210.5	9,211	4,439	42,570
1211	10,374	4,896	47,467
1211.5-O/F Weir	11,822	5,549	53,016
1212-Crest	13,417	6,310	59,326

APPENDIX B: POND INFLOWS

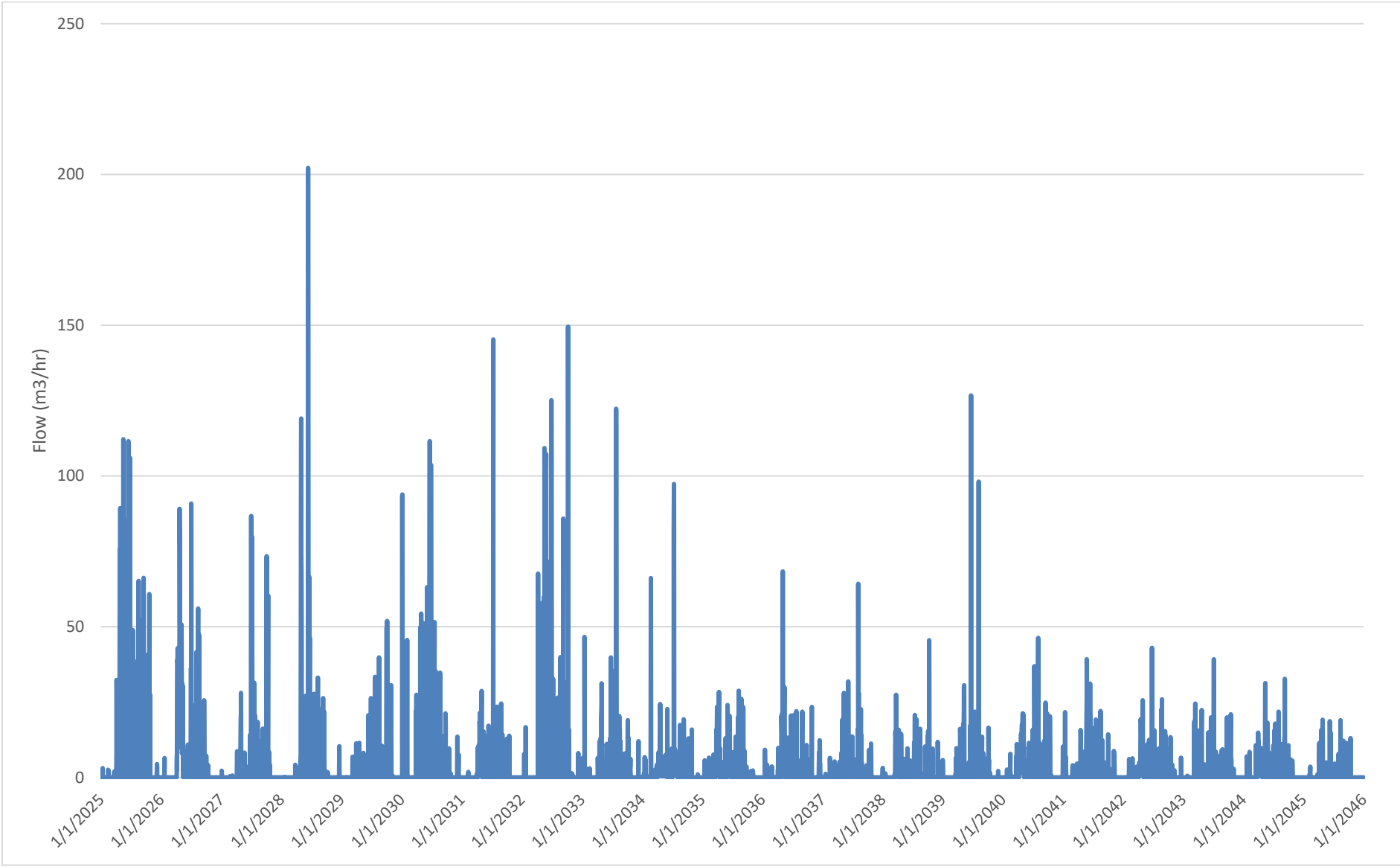

Figure B- 1: Inflow to Event Pond 1 South – Average Climate Scenario

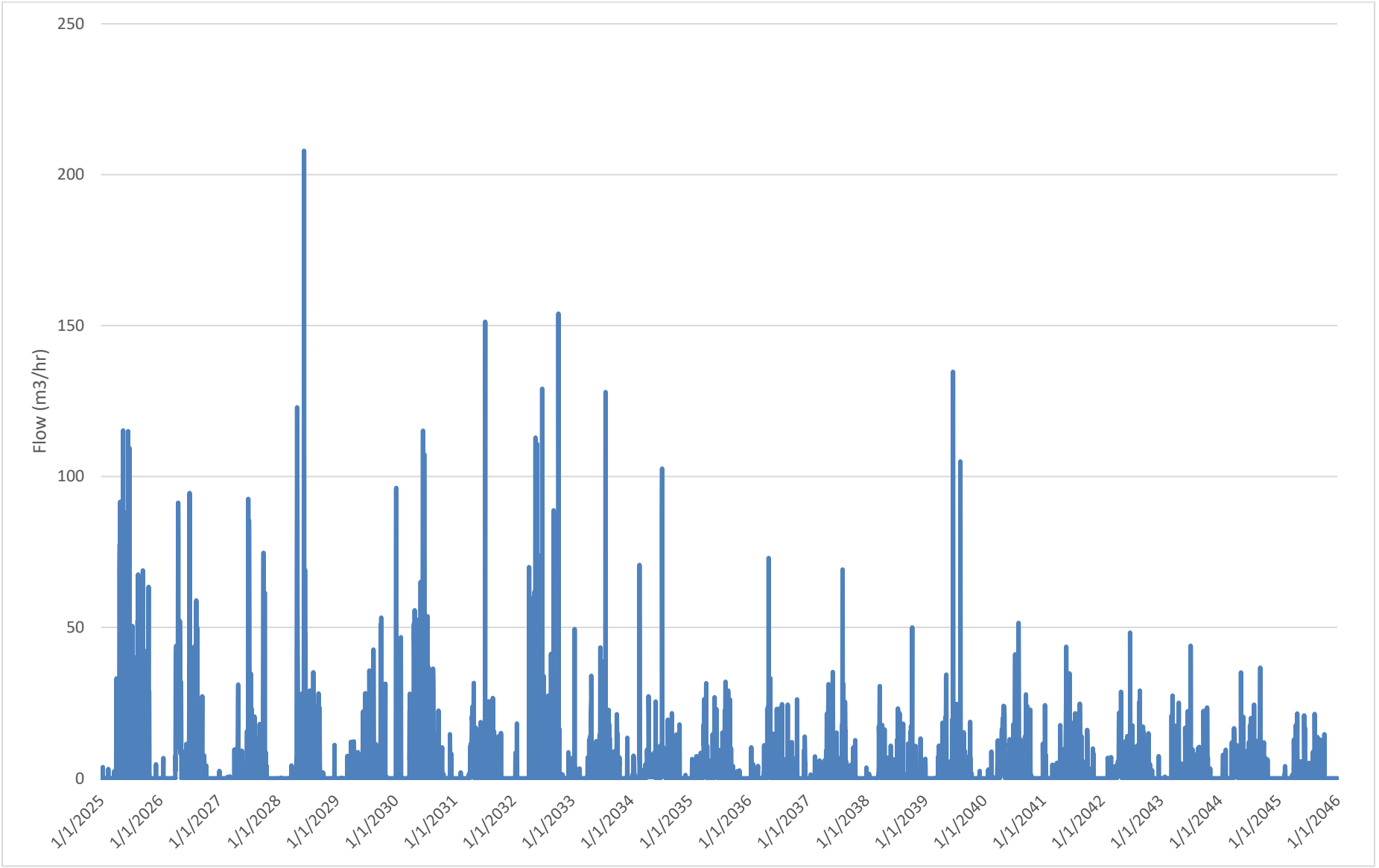

Figure B- 2: Inflow to Event Pond 1 North – Average Climate Scenario

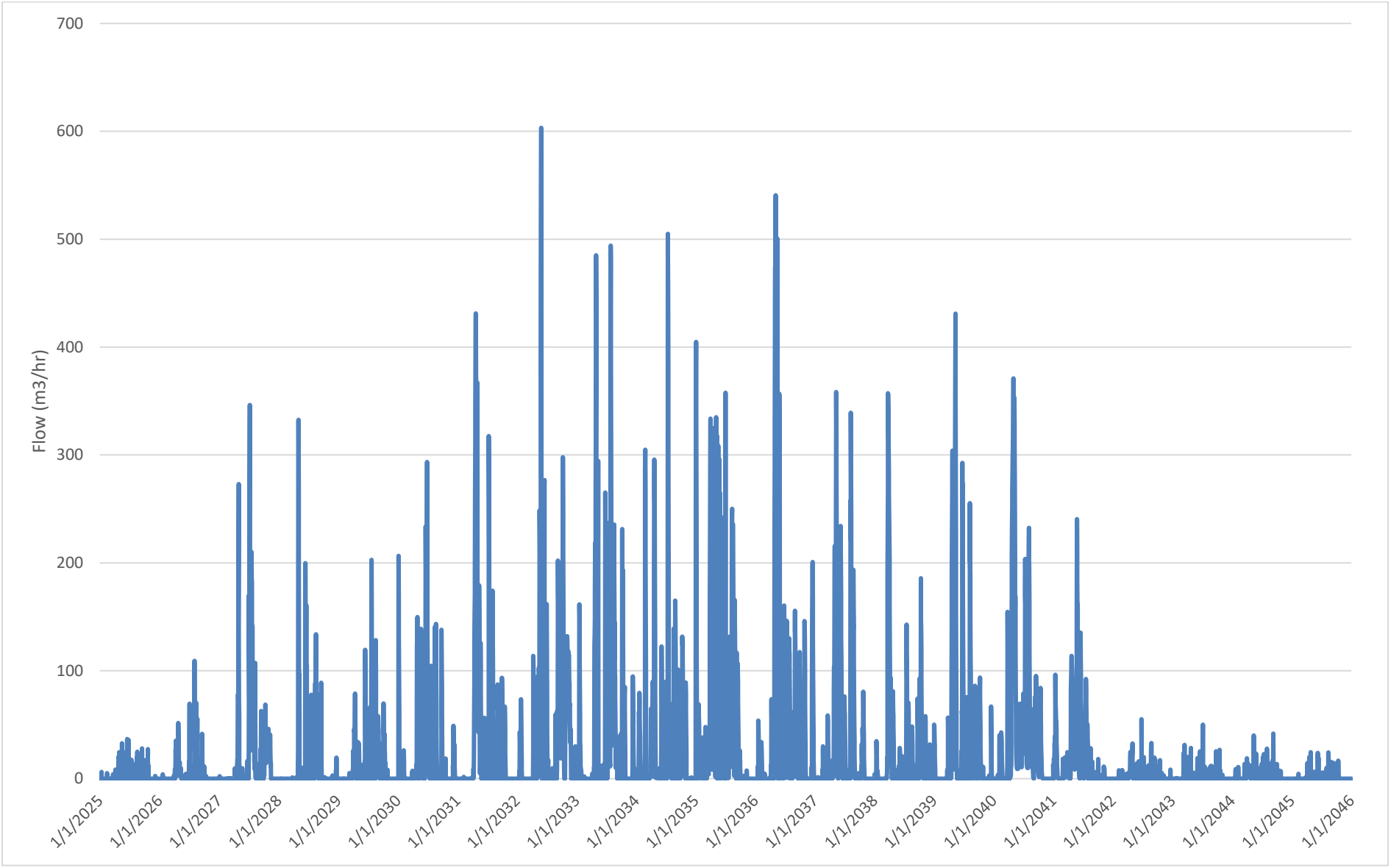

Figure B- 3: Inflow to Event Pond 2 (Includes EP-2 Process Segregation Flow) – Average Climate Scenario

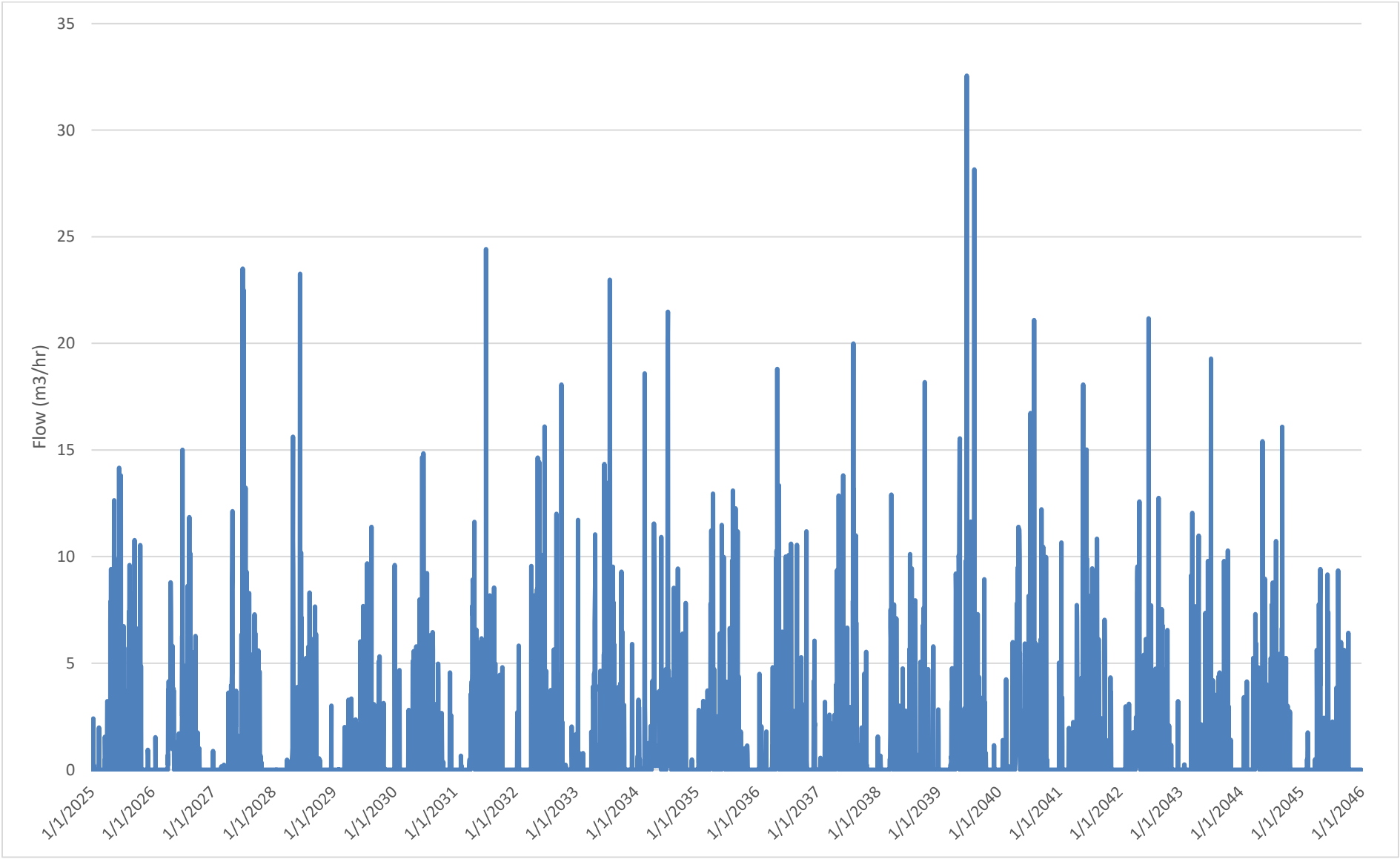

Figure B- 4: Direct Precipitation Inflow to the Rain Water Pond – Average Climate Scenario



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APPENDIX F: STABILITY ANALYSIS

TECHNICAL MEMORANDUM

To:	Project Team	**Document No.:**	123022-51010-CV-EM-2001
From:	Roy Morlan/Tom Kelley	**Date:**	January 26, 2026

COFFEE PROJECT HLF STABILITY ANALYSIS FOR PERMITTING

INTRODUCTION

The purpose of this memorandum is to present the stability analyses performed for the Heap Leach Facility (HLF) at the Coffee Mine Project (CMP) project located in Yukon Territory, Canada. These analyses were performed for the submittal of the Heap Leach Pad Engineering Report for Licensing which was developed for submittal as part of the permitting process. These stability analyses include evaluation of the heap leach pad (HLP) foundation, heap pile liner interface, event ponds, and effective slopes of the heap leach pad.

The CGP HLF consists of a HLP and associated event ponds. The ore will be stacked on the pad, and storm runoff managed by four ponds: three event ponds and one rainwater pond. There is no confining embankment associated with the HLP; however, some of the pond walls will be formed partially with embankment fills.

1. METHODOLOGY AND ASSUMPTIONS

1.1 Analysis Method

The slope stability calculations were performed for the ultimate heap leach pad (HLP) and pond configurations using Bentley PLAXIS LE Connect Edition v21 (PLAXIS). PLAXIS is a computer program that performs two and three-dimensional slope stability computations using limit equilibrium methods. The Morgenstern-Price method (Morgenstern & Price, 1965) was selected for performing the computations in PLAXIS for 2-D. Morgenstern-Price can be used for both circular and non-circular shear surfaces and satisfies both moment and force equilibrium.

1.2 Loading Cases

Static (Long-Term Steady State): The static case was analyzed for the HLP and associated ponds. Peak drained (effective-stress) strength parameters were used for all materials. The facilities are lined and no pore water pressures were assumed for the components built with structural fill. Pore water pressures were assumed for the ore pile based on the anticipated phreatic surface at the top of the Overliner Drain Fill (ODF) layer extending to an elevation of 0.6 meters above the surface of the liner system.

Pseudo-Static (Seismic): The pseudo-static loading condition was analyzed for the HLF embankment and ponds using pseudo-static methods where forces associated with ground motions during the design earthquake event are represented by a constant horizontal static force in the downslope direction using a horizontal pseudo-static coefficient. A horizontal seismic coefficient of 0.164 g was used. This is 2/3rds the peak ground acceleration (PGA) of 0.246 g. The seismic considerations used in this analysis are further discussed in Section 1.4.

No reduction in effective-stress strength parameters was applied to material strengths in the pseudo-static analyses since saturation is not anticipated in the embankment fills. The majority of the foundation is anticipated to be bedrock, and the saturated ore portions of the HLP are limited to the ODF layer which will have a gradation consistent with a gravel/rock fill with low fines content and is not considered to be liquefiable or prone to development of significant pore pressures during shaking.

Post-Earthquake: Post-earthquake stability analyses were performed assuming conditions similar to the Long-Term Steady State case, however with reduced strength parameters for some HLP materials that may be at a higher degree of saturation and experience strength reductions during an earthquake event. Reduced effective strength parameters, assumed to be 80 percent of peak effective strength values, were used to represent the Ore and Liner Interface layers in order to evaluate the sensitivity of the HLP stability to strain softening at the end of an earthquake event. As with the Long-Term Steady State Case, no pore water pressure or strength reductions were assumed for other components. Pore water pressures corresponding to hydrostatic conditions were assumed for the ore pile based on the anticipated phreatic surface at the top of the ODF. The HLP is designed as a free-draining facility without any embankment dam impounding solution.

1.3 Factors of Safety

The minimum factors of safety against slope failure used are those recommended by The Canadian Dam Association (CDA) Dam Safety Guidelines (CDA, 2019). The minimum recommended factors of safety for the analyses presented herein are summarized in Table 1.

Table 1: Target Factors of Safety for Slope Stability, After CDA (2019)

Loading Condition	Minimum Factor of Safety (FoS)
Static, Long-term Steady State	1.5
Pseudo-static, Seismic	1.0
Post-earthquake	1.2

1.4 Seismicity

According to the site-specific seismic hazard analysis previously performed (MINES, 2016), a design peak ground acceleration (PGA) of 0.116 g should be used for facilities requiring 1 in 2,475-year (2% probability of exceedance in 50 years). MINES used ground motion parameter provided in the 2010 edition of the National Building Codes of Canada (NBCC) hazard mapping project. Forte updated the parameters using the NBCC Seismic Hazard Values tool provided on their website (NBCC, 2021). Coordinates for the center of the HLF were used as the location (62.869436 latitude, -139.400813 longitude). The updated PGA for the site applied in these analyses for the maximum design earthquake (MDE) is 0.246 g, corresponding to a 2% probability of exceedance in 50 years.

The pseudo-static analysis was completed at 2/3 PGA utilizing peak strengths for both liner interface and ore materials. This is considered a conservative method for determining ground acceleration for pseudo-static analysis.

1.5 Geometry

Four typical sections were evaluated for the stability analysis. The sections were selected for the following reasons:

- A section through the HLF and ore pile at its highest section with a typical bedrock foundation. This was used to evaluate the stability of the overall HLF and the liner interface.
- A section that includes the HLF and a portion of the ore pile where the foundation will consist of an area with sand. This was used to evaluate the stability of the HLF under different scenarios.
- A section that includes the HLF ponds and was used to evaluate the stability of the ponds separately and as a whole.
- A section to evaluate the embankment fills for each pond and overall stability.

1.6 Material Properties

Anticipated foundation conditions were determined based on the field investigations performed by SRK Consulting (SRK, 2015) and Tetra Tech EBA (Tetra Tech, 2016 and Tetra Tech, 2017).

Although it is anticipated that competent granite bedrock will be present under large portions of the HLF, all bedrock in this analysis was modeled with the strength of weathered granite bedrock.

Silt pockets were observed in limited areas of the design footprint. The potential silt pockets in the foundation are expected to be less than 0.3 meters thick. This material will be removed during construction when

encountered, unless entrained by competent bedrock. Therefore, the impact of this material on the foundation strength was considered negligible for this analysis and the material was not included.

Portions of the event ponds are expected to be constructed on schist bedrock. Scenarios for the ponds include strengths determined for the schist bedrock.

A summary of the strength values assigned to the materials for each scenario is presented in Table 2 and are further discussed in this section.

Table 2: Material Strength Properties

Material	Unit Weight (kN/m3)	Cohesion (kPa)	Friction Angle (Φ)	Notes
Crushed Ore (Peak Strength)	17.3	0	35	Based on testing (MINES, 2016)
Crushed Ore (80% Reduced of Peak)	17.3	0	28	Calculated from Above Line Item
Liner Interface (Peak Strength)	20	NA	NA	Enviroliner (see **Figure 1**)
Liner Interface (80% Reduced of Peak)	20	NA	NA	Calculated from Above Line Item
Embankment Fill	23	NA	NA	See Table 4
Granite Bedrock Foundation[1]	27	300	35	Rock Mass Classification Class III (Tetra Tech, 2017)
Shist Bedrock Foundation[1,2]	24.2	300	35	Rock Mass Classification Class III (Tetra Tech, 2017)

1. For the heap leach pad, failures were forced through liner interface, bedrock foundation not utilized.
2. Granite Bedrock Foundation utilized in all pond stability analysis for conservatism.

Crushed Ore: The Mines group reported triaxial testing performed on three ore samples which were excavated from different parts of the ore body. The samples were crushed and leached to determine gold recovery and reagent consumption. Triaxial tests were performed on the leached samples (MINES, 2016). The results from this testing are summarized in Table 3.

Table 3: Triaxial Shear Test Results for Ore Materials (MINES, 2016)

Sample Description	Sample No.	Initial Sample State		Confining Stress (kPa)	Dev. Stress (kPa)	Pore Press. (kPa)	Strength Parameters		Final Moist. Content. %
		Moist. Content %	Dry Dens. Kg/m3				Effect. Stress kPa; ⁰	Total Stress kPa; ⁰	
Latte 583150 Trench	72114*	8.4	1802	95.8	200.6	55.2	C = 6.89 Ø = 40.2°	C = 27.6 Ø = 22.3°	11.9
				239.2	390.2	135.1			
				487.5	672.2	311.6			
Latte Oxide West	72147*	6.8	1730	95.8	121.3	57.2	C = 0 Ø = 40.6°	C = 6.9 Ø = 20°	12.5
				239.2	273.7	158.6			
				487.5	513.7	350.3			
Supremo #1	73010*	8.9	1699.6	95.8	124.1	68.9	C = 0 Ø = 40.9°	C = 13.8 Ø = 18.9°	13.7
				239.2	254.4	160.6			
				487.5	490.2	360.6			

Ore loaded on the pile will not be saturated or contain greater than its in-situ moisture content prior to crushing. Static conditions are anticipated to be reached after leachate solution is applied. For this analysis,

a friction angle of 35º for peak strength was applied as a conservative estimate, and a cohesion of 0 kPa was used.

Liner System: Liner testing was performed on various combinations of geomembrane, geo-synthetic clay liner (GCL), and overliner drain fill (ODF) as part of the feasibility study completed by the Mines Group (MINES, 2016). The maximum normal stress used in this testing was 861.8 kN/m^3. Higher normal stresses (up to 1,600 kN/m^3) are required to be more representative of the HLP loading expected. To model the liner interface, Forte used liner interface shear testing results conducted for another site with comparable materials and climate, located approximately 200 kilometers northeast of the Coffee project site, which tested at normal loads up to 1,600 kN/m^3. The material used for subgrade and ODF for these tests are similar to that which will be used on the Coffee HLF. Additional testing will be required prior to detailed design using site-specific materials and the final liner combination chosen for construction.

The liner system used in this analysis is as follows (from top to bottom):

- Overliner drain fill (ODF)– minus 38 mm gravel produced from another site with comparable materials and climate.
- Double sided textured geomembrane – 2.0 mm linear low-density polyethylene (LLDPE). Enviro Liner 4000 LLDPE material manufactured by Layfield Group was used.
- GCL - GSE BentoLiner NWL-60 manufactured by Solmax was used in this analysis.
- Prepared subgrade as specified in the design. Prepared subgrade for the HLF is expected to consist of weathered bedrock rolled by a vibratory compactor with pockets of bedding sand where needed.

Multi-interface shear testing was performed on the composite liner materials. Results from those tests were used to determine strength parameters for this stability analysis. Laboratory results from these tests are included in ATTACHMENT A. Data sheets for geosynthetic products are included in ATTACHMENT B. A description of those tests follows.

Bulk samples of representative subgrade and ODF material were collected from the site and tested for index properties to verify they met the requirements of the technical specifications. The geomembrane and GCL products samples were provided by the project liner suppliers. GCL and LLDPE samples were sent to BGC labs for shear strength tests.

The weakest layer of the composite liner system was found to be the GCL interface with the textured geomembrane, regardless of manufacturer. At normal stresses higher than 400 kPa, the CL/Geomembrane residual interface strength ranged from 95 to 100 kPa. A bi-linear curve was developed for the liner interface to represent the peak and residual strengths, shown on Figure 1. The curves for Enviroliner-Peak were used in the stability analysis as the most conservative values.

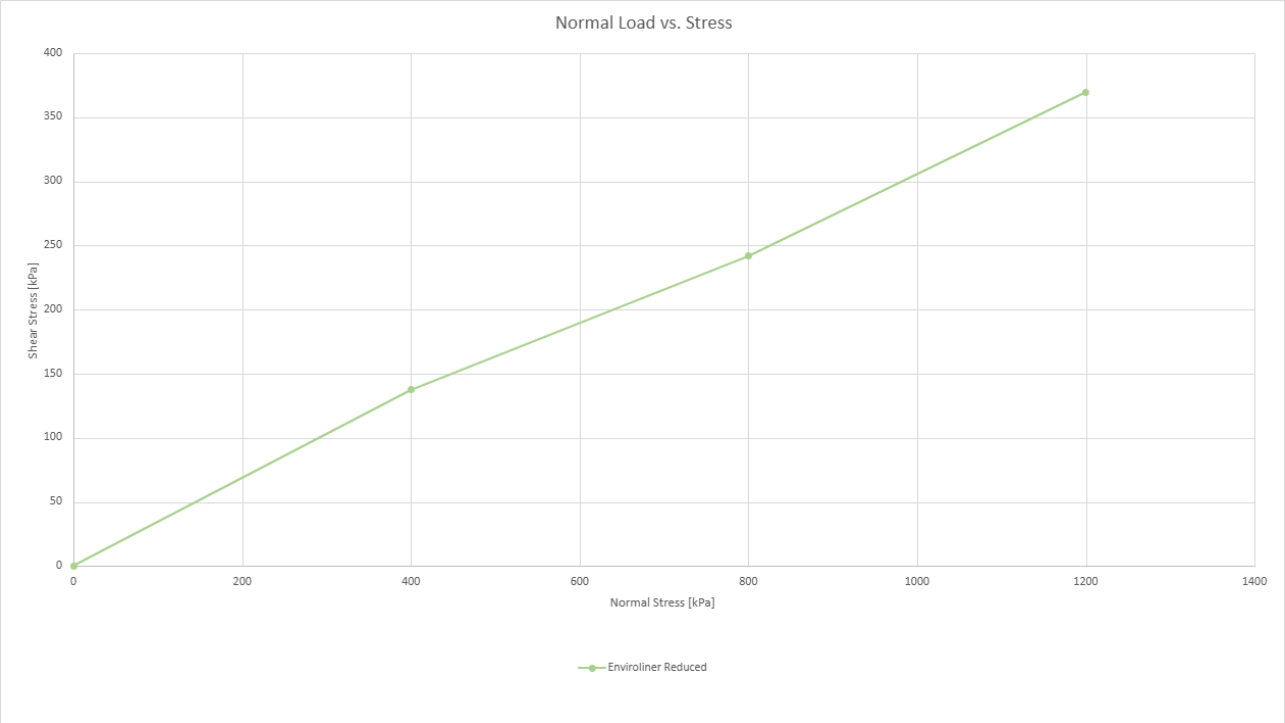

Figure 1: Liner Interface – Shear Stress Curve

Embankment Fill: Embankment Fill is anticipated to consist of a well-graded rockfill with a maximum size of 12-inches. A normal-shear stress curve was developed using Leps' analysis of shear testing on rockfill of varying strengths, shown in Table 4 (Leps, 1970). As a conservative method, the shearing strength curve developed by Forte is based on Leps' results for loose, poorly-graded, low compressive strength rockfill, shown on Figure 2.

Table 4: Normal – Shear Stress Function Derived from Leps, 1970 for Weak Rockfill

Normal Stress (kPa)	Shear Stress (kPa)	Approximate Friction Angle (º)
0	0	NA
20	21	47
60	57	44
100	90	42
200	167	40
600	457	37
2000	1349	34

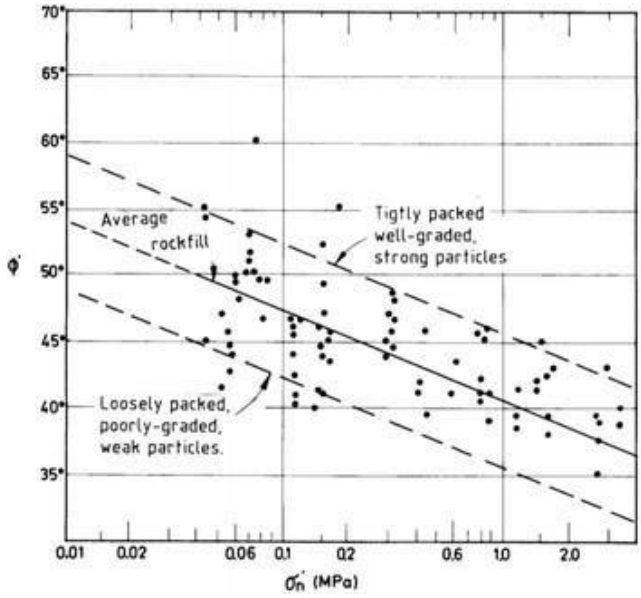

Figure 2: Leps' Shearing Strength of Rockfill From Large Triaxial Tests (Leps, 1970)

Bedrock Foundation: A standard determination of Rock Mass Classification was performed based on limited information from historic boring logs (Tetra Tech, 2017). Diamond core boring logs completed within the footprint of the HLF contained information on drill run recovery, rock quality designation (RQD), number of discontinuities, average joint condition, and strength either as a field determination of rock strength (R value) or via unconfined compressive strength (UCS) correlation from point load testing. Detailed descriptions of all joint conditions were not performed, and detailed geotechnical logs were not completed for these borings. The detailed engineering phase will include additional geotechnical work to enhance the understanding of material quantities and properties. For the purpose of this analysis, a basic Rock Mass Rating (RMR) for use in Rock Mass Classification was developed based on the historic logs and core photographs, using the system developed in Engineering Rock Mass Classification (Bieniawski, 1989). The RMR developed applied a conservative approach by lowering joint conditions ratings where data was limited. This results in a weaker rock classification than predicted to exist in the field.

The following profile was developed for the portions of the HLF where granite bedrock foundation is expected:

- Class IV bedrock exists below the overburden soils ranging from 0.5 meters bgs to approximately 2 meters bgs. Class 4 bedrock observed at the site consists of highly weathered, highly fractured and jointed granite with thick (>5 mm) joint infills consisting of silt and sand.
- Class III bedrock exists between approximately 2m bgs to approximately 5m bgs. This bedrock is considered moderately strong. Joints were typically rough and infilling was reported as <5 mm in most instances. Jointing and fracturing were limited.
- Class II Bedrock exists starting at approximately 5 meters bgs. Class II bedrock is considered strong. Boring logs reported rock strength values at R4 or greater. Jointing was reported as rough with less than <5 mm of infilling.

The weakest, most weathered layer of bedrock (Class IV in this analysis) will be removed during construction, and the bedrock foundation will consist of Class III or better. As a conservative approach, this stability analysis modeled all portions of the foundation in granite bedrock as Class III using published strength parameters for that class (Bieniawski, 1989). Density testing was not performed on the granite within the footprint of the HLF. Therefore, published values for granite were used to determine the Unit Weight. A unit weight of 27 kN/m^3 was applied (Waltham, 1994).

Portions of the event ponds are expected to be built on a foundation of shist bedrock. Drilling within this area identified shist to at least 6 meters bgs. The shist is reported as typically moderately strong with foliations. The Rock Mass Classification for the shist material that will be left in place was determined to be Class III. No photographs were available for the boreholes completed in the shist bedrock. A unit weight of 24.2 kN/m^3 was used (Waltham, 1994).

2. RESULTS AND INTERPRETATIONS

2.1 Section A

Section A was completed through the highest portion of HLF though a portion of the foundation that is expected to be built on an natural sand unit. A total of 3 cases were run. All of the cases met or exceeded the minimum recommended FOS. The results for each case are included in ATTACHMENT C and summarized in Table 5.

Table 5: FOS Results for Section A

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
1	Circular	Static	1.5	1.6	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through the liner interface.
2	Circular	Pseudo-Static	1.0	1.1	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through liner interface.
3	Circular	Post-Earthquake	1.2	1.3	Highest portion of HLF. Foundation partially on natural sand unit. Failure forced through the liner interface.

2.2 Section B

Section B was completed through the southern boundary of the HLF where the foundation conditions are more typical for this HLF. A total of 3 cases were run. All of the cases met or exceeded the minimum recommended FOS The results for each case are included in ATTACHMENT C and summarized in Table 6.

Table 6: FOS for Section B

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
1	Circular	Static	1.5	1.5	Southern slope of HLF pile. Failure assumed along liner interface.
2	Circular	Pseudo-Static	1.0	1.0	Southern slope of HLF pile. Failure assumed along liner interface.
3	Circular	Post-Earthquake	1.2	1.2	Southern slope of HLF pile. Failure assumed along liner interface..

2.3 Section C

Section C was completed through the EP-1N, RWP, and EP-1S embankments. Four cases were run. All of the cases met or exceeded the minimum recommended FOS The results for each case are included in ATTACHMENT C and summarized in Table 7.

Table 7: FOS Results for Section C

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
1	Circular	L-R Static	1.5	3.7	EP-1N, RWP, and EP-1S embankments.
2	Circular	L-R Pseudo-Static	1.0	2.8	EP-1N, RWP, and EP-1S embankments.
3	Circular	R-L Static	1.5	2.2	EP-1N, RWP, and EP-1S embankments.
4	Circular	R-L Pseudo-Static	1.0	1.5	EP-1N, RWP, and EP-1S embankments.

2.4 Section D

Section D was completed through Process Plant Pad. Two cases were run. All of the cases met or exceeded the minimum recommended FOS The results for each case are included in ATTACHMENT C and summarized in Table 8.

Table 8: FOS Results for Section D

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
1	Circular	R-L Static	1.5	2.1	Process Plant Pad
2	Circular	R-L Pseudo-Static	1.0	1.5	Process Plant Pad

2.5 Section E

Section E was completed through the Critical failure surface is shallow surface failure low-height EP-2 embankment section. Four cases were run. All the cases met or exceeded the minimum recommended FOS. The results for each case are included in ATTACHMENT C and summarized in Table 9 .

Table 9: FOS Results for Section E

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
1	Circular	L-R Static	1.5	2.7	Critical failure surface is shallow surface failure low-height EP-2 embankment section.
2	Circular	L-R Pseudo-Static	1.0	1.9	Critical failure surface is shallow surface failure low-height EP-2 embankment section.
3	Circular	R-L Static	1.5	2.8	Critical failure surface is shallow surface failure low-height EP-2 embankment section.
4	Circular	R-L Pseudo-Static	1.0	2.0	Critical failure surface is shallow surface failure low-height EP-2 embankment section.

2.6 Section F

Section F was completed through the tallest embankment fill needed for construction of the event ponds. Two cases were run. All of the cases met or exceeded the minimum recommended FOS. The results for each case are included in ATTACHMENT C and summarized in Table 10.

Table 10: FOS Results for Section F

Loading Case	Failure Surface Shape	Load Condition	Minimum Recommended FOS	FOS	Notes
1	Circular	Static	1.5	2.2	Tallest pond embankment
2	Circular	Pseudo-Static	1.0	1.5	Tallest pond embankment

3. RECOMMENDATIONS

A detailed geotechnical field investigation will be required to further define subsurface conditions beneath and surrounding the HLF, process plant areas, and ponds, and including detailing permafrost extents. Ore strength testing is required and should be performed for ore delivered in the first 6 months, years 1-2, years 3-4 and beyond and include any other ore type changes that may occur periodically during mining that may contain varying strength parameters. Ore testing shall include shear strength testing, decrepitation testing, and compacted permeability at a minimum.

A comprehensive site investigation plan for investigation and testing will be developed for these activities.

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ATTACHMENT A: LAB TEST RESULTS

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AN APPLIED EARTH SCIENCES COMPANY
330 Alison Blvd
Fredericton, NB Canada E3C 0A9
Telephone (506) 460-8660
Fax (506) 460-8679

March 25, 2020
Project No.: 2140001

Clint Green
Principal Engineer
Forte Dynamics Inc.
3003 E. Harmoney Road
Suite 320, Fort Collins, Co 80528

Dear Mr. Green,

Re: Forte Dynamics Lab Testing

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) was retained by Forte Dynamics Inc. to conduct a series of liner interface shear tests for the expansion phases of the Victoria Gold Corp Project "Eagle Gold Mine". The results of these tests are attached herein.

2.0 BACKGROUND

On January 20th, 2020, BGC received a shipment of geosynthetic clay liners (GCL) and geomembranes from Layfield Group LTD. The product name associated with the GCL and the geomembrane was GSE BentoLiner NWL-60 and Layfield Enviro Liner 4280 CT, respectively. Product data sheets are included in Appendix A.

During the first three tests, BGC observed lower than expected shear strengths between the GCL and the geomembrane. When comparing the 2020 GCL with the GCL tested by BGC in 2018 and 2019 (also GSE BentoLiner NWL-60), the results were incongruent. BGC observed that the 2020 GCL swelled approximately twice as much when compared to the GCL tested in 2018 and 2019 GCL. The lower internal shear strength of the 2020 GCL was attributed to the higher water content of the bentonite.

BGC notified Forte Dynamics Inc. of the apparent discrepancy in GCL types, and Forte Dymamics said they would reach out to Layfield and arrange to have new GCL sent to the BGC laboratory for testing.

On March 4th, 2020, BGC received the new shipment of GCL with product name GSE BentoLiner NWL-60. A second round of liner interface testing was completed using this GCL. The new GCL swelled to a similar water content and hydrated thickness as the GSE BentoLiner NWL-60 tested in 2018 and 2019.

In addition to completing the liner interface shear tests, BGC also completed Standard Proctor and particle size distribution tests on subgrade and overliner materials.

Individual laboratory reports for the completed tests are included in Appendix B. This work was conducted in general accordance with the scope of work provided in an email sent by Clint Green of Forte Dynamics Inc. to David Oldford of BGC on January 13, 2020 entitled "VGC-Eagle-Interface Shear", and according to the terms and conditions provided in Appendix C.

3.0 STANDARDS FOLLOWED

The index tests and the liner interface samples were tested in accordance with the latest editions of applicable American Society for Testing and Materials (ASTM) standards and recognized good practice. The following ASTM Standards were utilized:

- ASTM D5321 - Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear.
- ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
- ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3).

4.0 EQUIPMENT

The liner interface tests were completed using BGC's large direct shear box apparatus. The shear box has horizontal dimensions of 40 cm x 40 cm and a height of 51 cm, and allows testing to be completed at vertical stresses of up to 5.5 MPa. The vertical stress is applied to a top plate by means of two 50 ton jacks. A horizontal force is applied by means of a single 50 ton jack. Vertical and horizontal displacements are measured and logged continuously throughout the test by means of Liner Variable Displacement Transducers (LVDT). The use of two vertical jacks and LVDT's allows adjustment of the top plate throughout the test. This ensures that the top plate remains parallel while maintaining a constant vertical stress. The horizontal force is continuously measured and logged by means of a load cell. A photograph of the equipment is provided in Figure 4-1.



Figure 4-1. BGC's Large Direct Shear Apparatus

5.0 METHODOLOGY

The liner interface tests were conducted by placing a subgrade material into the bottom half of the shear box. The subgrade was compacted to a minimum of 92% of the maximum Standard Proctor dry density as requested by Forte Dynamics. Next, a pre-soaked GCL was placed on top of the subgrade, followed by a geomembrane. The top half of the shear box was placed over the geomembrane and was filled with the overliner material. Finally, a top plate was placed above the overliner material. For each GCL type tested, two rounds of testing were completed at vertical stresses 400, 800 and 1200 kPa. The vertical stresses were applied to the system until the vertical deformation had stabilized. After consolidation, the liner systems were sheared at an average displacement rate of approximately 0.28 cm/min while maintaining a constant vertical stress.

6.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of Forte Dynamics Inc. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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Yours sincerely,

BGC ENGINEERING INC.
per:



David Oldford, P.Eng.
Geotechnical Engineer

Reviewed by:

Simon Dickinson, Ph.D., P.Eng.
Principal Geotechnical Engineer, CTO

DO/SD/dk/md

Attachment: Appendix A Product Data Sheets
Appendix B Laboratory Testing Reports
Appendix C BGC's Standard Terms and Conditions

APPENDIX A
PRODUCT DATA SHEETS

PRODUCT DATA SHEET

GSE BentoLiner NWL-60 Geosynthetic Clay Liner

GSE BentoLiner "NWL-60" is a heavily needlepunched reinforced composite geosynthetic clay liner (GCL) comprised of a uniform layer of granular sodium bentonite encapsulated between a nonwoven and a scrim-nonwoven geotextile for dimensional stability. The product is intended for steep slopes and high load applications where increased internal shear strength is required.

AT THE CORE:

This composite clay liner is intended for steep slopes and high load applications where increased internal shear strength is required.

Product Specifications

Tested Property	Test Method	Frequency	VALUE
Geotextile Property			
Cap Nonwoven, Mass/Unit Area	ASTM D 5261	1/200,000 ft^2	6.0 oz/yd^2 MARV(1)
Carrier Scrim Nonwoven, Mass/Unit Area	ASTM D 5261	1/200,000 ft^2	6.0 oz/yd^2 MARV
Bentonite Property			
Swell Index	ASTM D 5890	1/100,000 lb	24 ml/2 g min
Moisture Content	ASTM D 4643	1/100,000 lb	12% max
Fluid Loss	ASTM D 5891	1/100,000 lb	18 ml max
Finished GCL Property			
Bentonite, Mass/Unit Area(2)	ASTM D 5993	1/40,000 ft^2	0.75 lb/ft^2 MARV
Tensile Strength(3)	ASTM D 6768	1/40,000 ft^2	50 lb/in MARV
Peel Strength	ASTM D 6496 ASTM D 4632(4)	1/40,000 ft^2	12 lb/in MARV 60 lb MARV
Hydraulic Conductivity(5)	ASTM D 5887	1/Week	5 x 10^{-9} cm/sec max
Index Flux(5)	ASTM D 5887	1/Week	1 x 10^{-8} m^3/m^2/sec max
Internal Shear Strength(6)	ASTM D 6243	Periodically	500 psf Typical
TYPICAL ROLL DIMENSIONS			
Width x Length(7)	Typical	Every Roll	15.5 ft x 150 ft
Area per Roll	Typical	Every Roll	2,325 ft^2
Packaged Weight	Typical	Every Roll	2,600 lb

NOTES:

- (1)Minimum Average Roll Value.
- (2)At 0% moisture content.
- (3)Tested in machine direction.
- (4)Modified ASTM D 4632 to use a 4 in wide grip. The maximum peak of five specimens averaged in machine direction.
- (5)Deaired, deionized water @ 5 psi maximum effective confining stress and 2 psi head pressure.
- (6)Typical peak value for specimen hydrated for 24 hours and sheared under a 200 psf normal stress.
- (7)Roll widths and lengths have a tolerance of ±1%.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

This Information is provided for reference purposes only and is not intended as a warranty or guarantee. GSE assumes no liability in connection with the use of this Information. Specifications subject to change without notice. GSE and other trademarks in this document are registered trademarks of GSE Lining Technology, LLC in the United States and certain foreign countries. REV 13JUN2012

LAYFIELD

Geomembrane [EL4280, 2-sided Coarse Textured]

Our Enviro Liner 4000 coarse textured series Geomembranes have better interface friction capabilities compared to our standard textured geomembranes. Texturing can be accomplished either on one side or on both sides. Enviro Liner 4000 coarse textured product can be manufactured to custom asperity heights and is available by special order. Layfield is capable of supplying the friction and strength properties you require for your design build project. Enviro Liner 4280 Coarse Textured Geomembrane meets or exceeds the requirements of Table 2(B) GRI GM 17 specification for textured Linear Low-Density Polyethylene Geomembranes.



Property	ASTM	EL4280[1] 2-sided Coarse Textured	Frequency
Thickness nominal	D5994	2.00 mm	
- min.ave -lowest individual for 8 out of 10 values -lowest individual for any of the 10 values	D5994	1.90 mm 1.80 mm 1.70 mm	Every Roll
Sheet Density	D792	≤0.939 g/cc	Every 10 rolls
Dimensional Stability	D1204	±2%	Once per formulation
Tensile Properties (min. avg) Strength @ Break Elongation @ Break	D6693, Type IV Die	 31 kN/m 380%	Every 2 rolls
Asperity Height (min.ave)	D7466	0.50 mm	Every roll
Tear Resistance (min. avg)	D1004	200 N	Every 5 rolls
Puncture Resistance (min. avg)	D4833	500 N	Every 5 rolls
Multi-axial Elongation (typical)	D5617	30%	Once per formulation
Carbon Black Content	D4280	2.0-3.0%	Every 2 rolls
Carbon Black Dispersion	D5596	9 in Cat 1/ Cat 2 1 in Cat 3	Every 10 rolls
Oxidative Induction Time (OIT) High Pressure Oxidative Induction Time (HPOIT)	D5885	100 mins 400 mins	Per resin batch
Oven aging, 85 deg C, HOPIT % retained after 90 days	D5721 D5885	60%	Once per formulation
UV Resistance, HPOIT retained after 1600 hrs	D7238 D5885	35%	Once per formulation
Low Temperature Brittleness	D746	-70°C	Once per formulation
Roll Width	-	6.85 mtrs	
Roll Length	-	128 mtrs	

[1]*This product is made in Richmond, B.C, Canada.*

Disclaimer: Layfield disclaims any and all express, implied, or statutory standards, warranties or guarantees, including without limitation any implied warranty as to merchantability or fitness for a particular purpose or arising from a course of dealing or usage of trade as to any equipment, materials, or information furnished herewith. This document should not be construed as engineering advice.

Rev-12/19

APPENDIX B
LABORATORY TESTING REPORTS

PROJECT INFORMATION		LINER SYSTEM	
Number	2140-001	Subgrade	Gravel, sandy, trace fines
Name	Forte Dynamics Liner Testing	GCL	GSE BentoLiner NWL-60 GCL
Location	Yukon Territory	Geomembrane	Layfield Enviro Liner 4280 CT
Client	Forte Dynamics Inc.	Overliner	Poorly graded gravel with sand (GP)

INDEX PROPERTIES OF SUBGRADE	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	14.6
Bulk Density ρ_b (g/cm^3)	2.30
Dry Density ρ_d (g/cm^3)	2.14
Void Ratio e	0.26
Water Content (%)	7.3
Specific Gravity G_s (Assumed)	2.70

INDEX PROPERTIES OF OVERLINER	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	10.4
Bulk Density ρ_b (g/cm^3)	2.25
Dry Density ρ_d (g/cm^3)	2.12
Void Ratio e	0.23
Water Content (%)	6.3
Specific Gravity G_s (Assumed)	2.60

INDEX PROPERTIES OF GCL	
Initial Average Hydrated Thickness (cm)	1.16
Initial Water Content (%)	205.1
Final Water Content (%)	162.8

SHEARING PARAMETERS	
Vertical Stress σ'_v (kPa)	400
Displacement Rate (cm/min)	0.21

RESULTS	
τ_{max} (kPa)	144
τ_{res} (kPa)	22

Note: Internal failure was observed in the geosynethetic clay liner (GCL). Displacement between the subgrade and the GCL was observed, along with displacement between the geomembrane and GCL.

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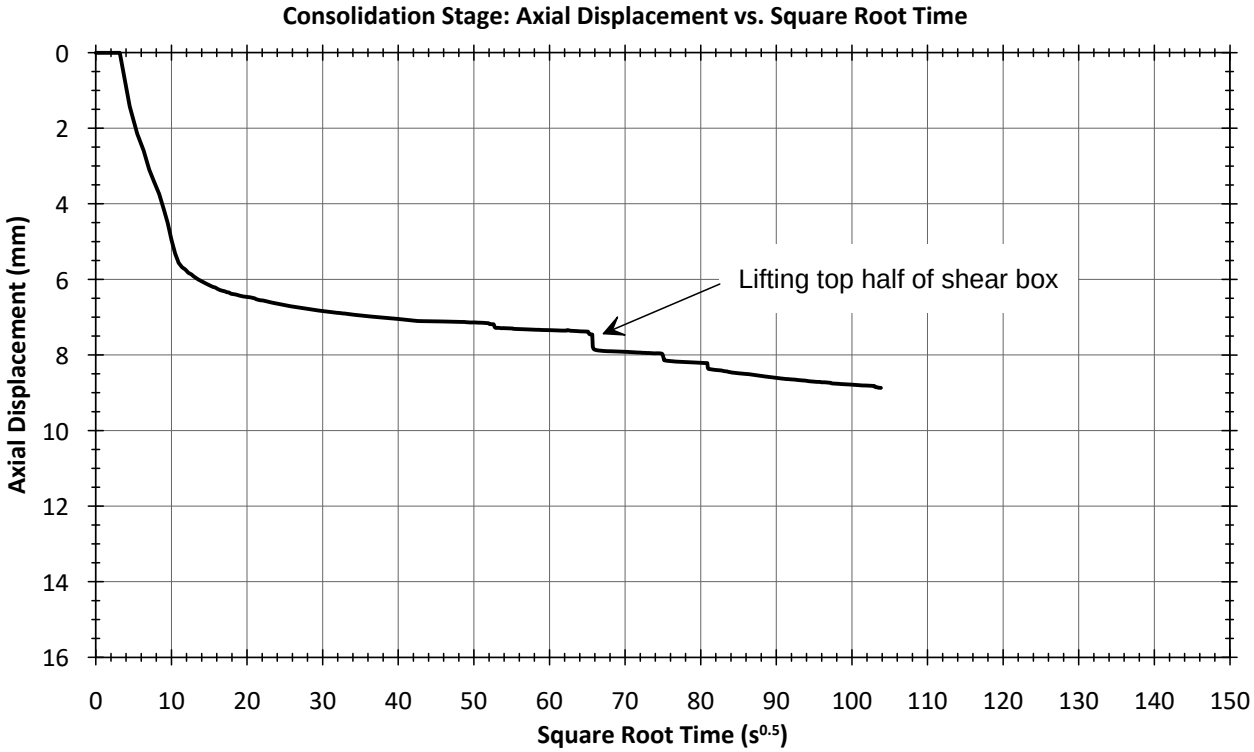

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Reviewed by KS (2020-02-25)
Approved by SD (2020-03-17)
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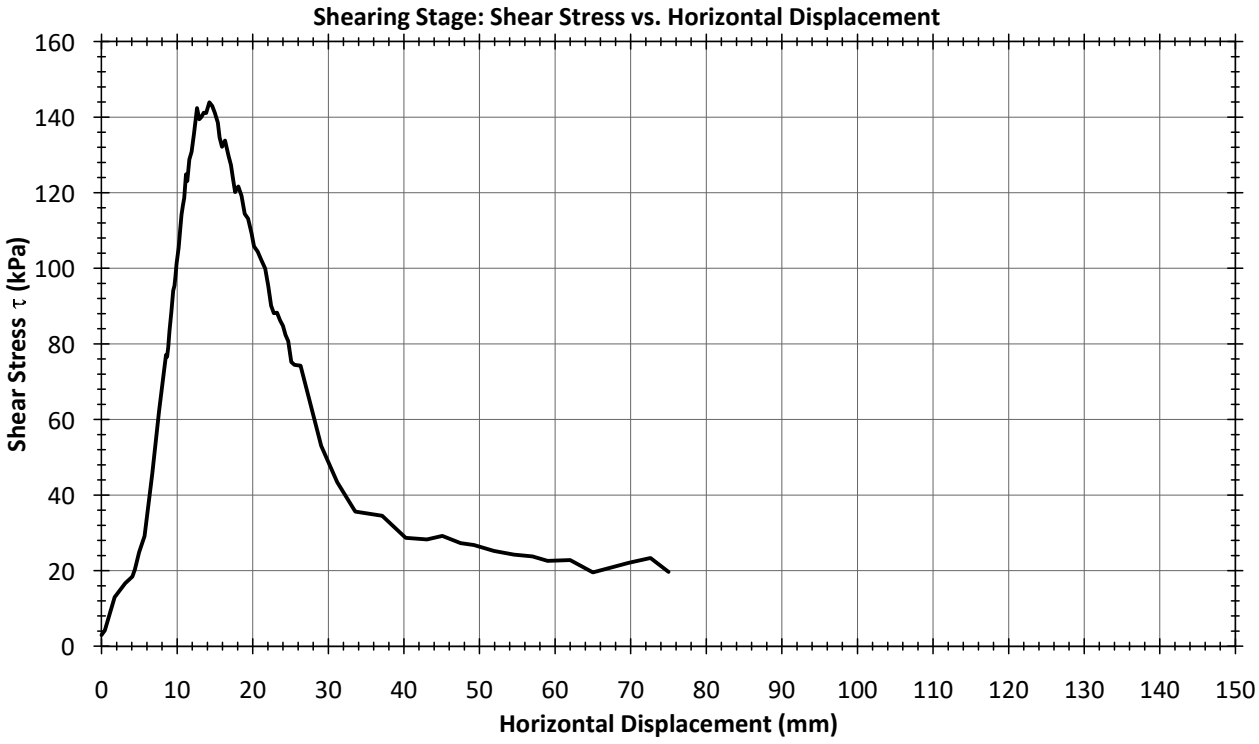

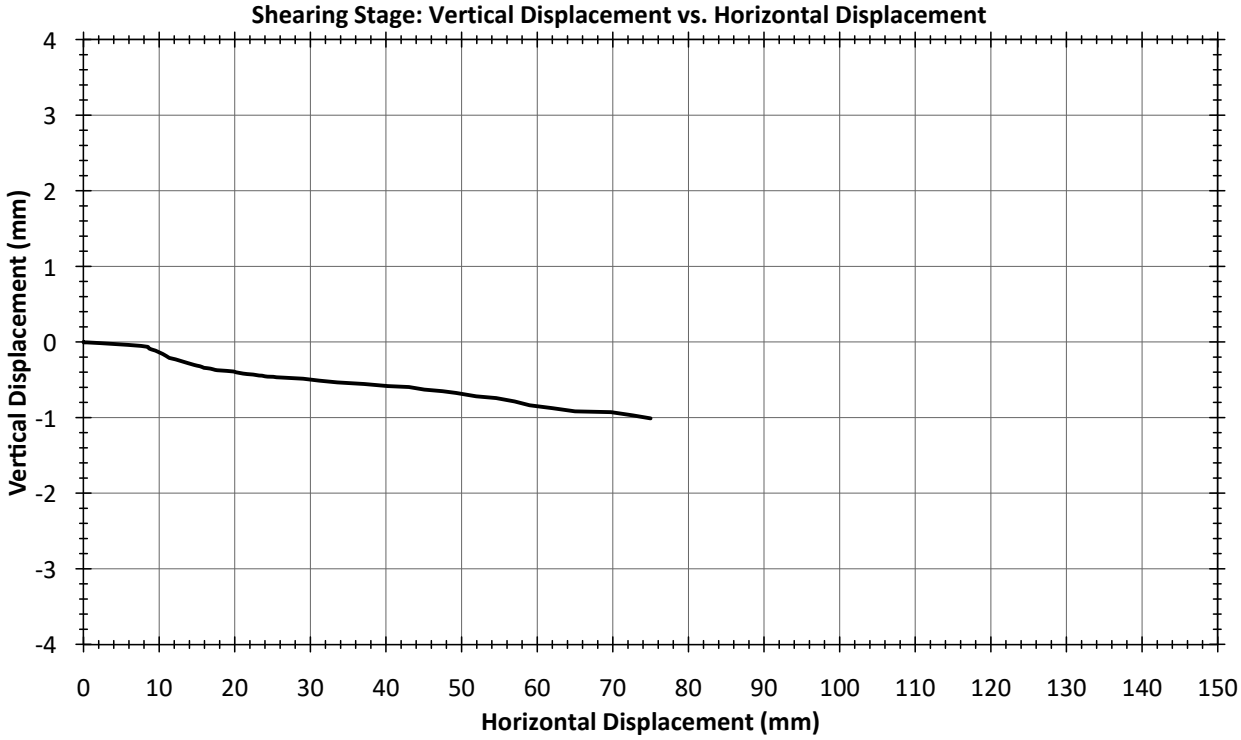

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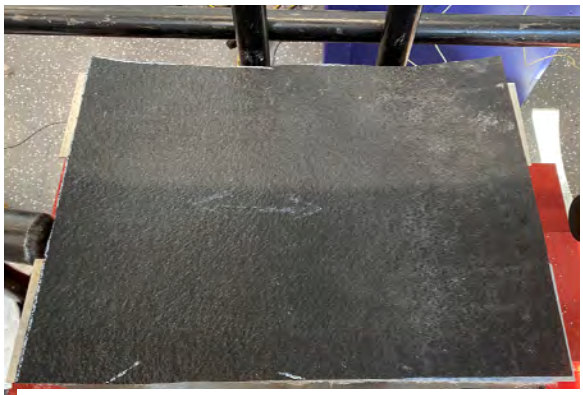
Subgrade



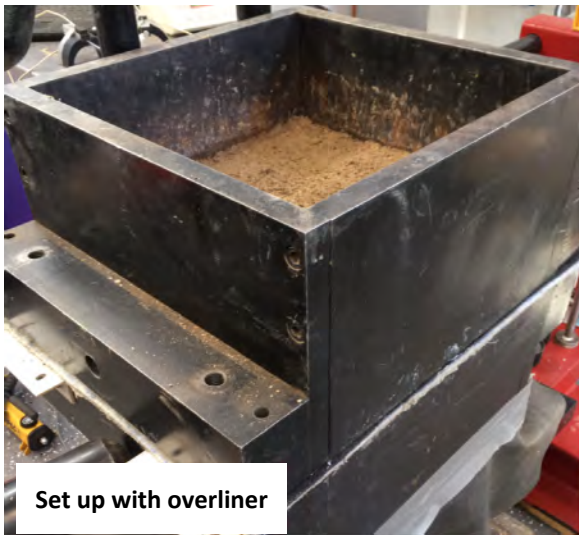
GCL over subgrade



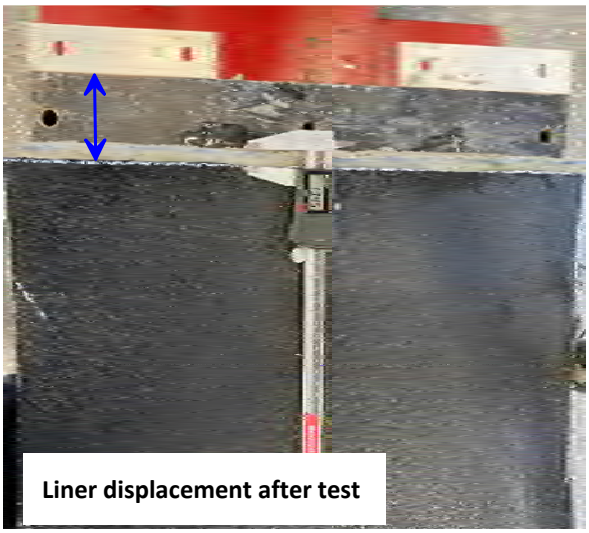
Alignment of GCL and geomembrane before test



Loading direction



Set up with overliner



Liner displacement after test

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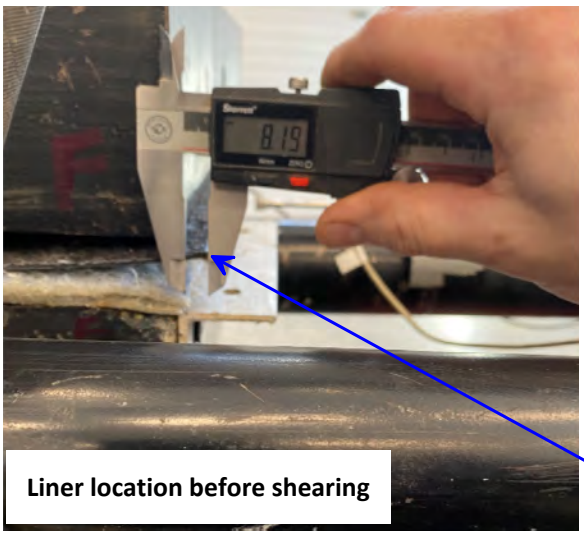

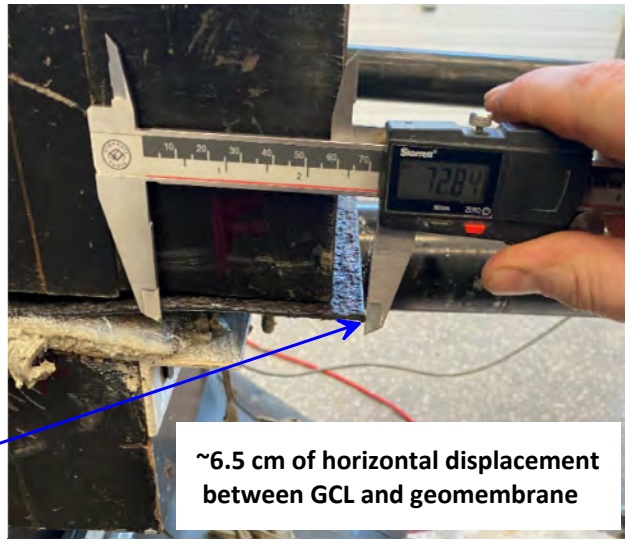






Subgrade after test



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PROJECT INFORMATION		LINER SYSTEM	
Number	2140-001	Subgrade	Gravel, sandy, trace fines
Name	Forte Dynamics Liner Testing	GCL	GSE BentoLiner NWL-60 GCL
Location	Yukon Territory	Geomembrane	Layfield Enviro Liner 4280 CT
Client	Forte Dynamics Inc.	Overliner	Poorly graded gravel with sand (GP)

INDEX PROPERTIES OF SUBGRADE	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	14.8
Bulk Density ρ_b (g/cm^3)	2.29
Dry Density ρ_d (g/cm^3)	2.13
Void Ratio e	0.27
Water Content (%)	7.3
Specific Gravity G_s (Assumed)	2.70

INDEX PROPERTIES OF OVERLINER	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	11.0
Bulk Density ρ_b (g/cm^3)	2.25
Dry Density ρ_d (g/cm^3)	2.12
Void Ratio e	0.23
Water Content (%)	6.3
Specific Gravity G_s (Assumed)	2.60

INDEX PROPERTIES OF GCL	
Initial Average Hydrated Thickness (cm)	1.09
Initial Water Content (%)	186.4
Final Water Content (%)	140.5

SHEARING PARAMETERS	
Vertical Stress σ'_v (kPa)	800
Displacement Rate (cm/min)	0.15

RESULTS	
τ_{max} (kPa)	195
τ_{res} (kPa)	32

Note: Internal failure was observed in the geosynethetic clay liner (GCL). Displacement between the subgrade and the GCL was observed, along with displacement between the geomembrane and GCL.

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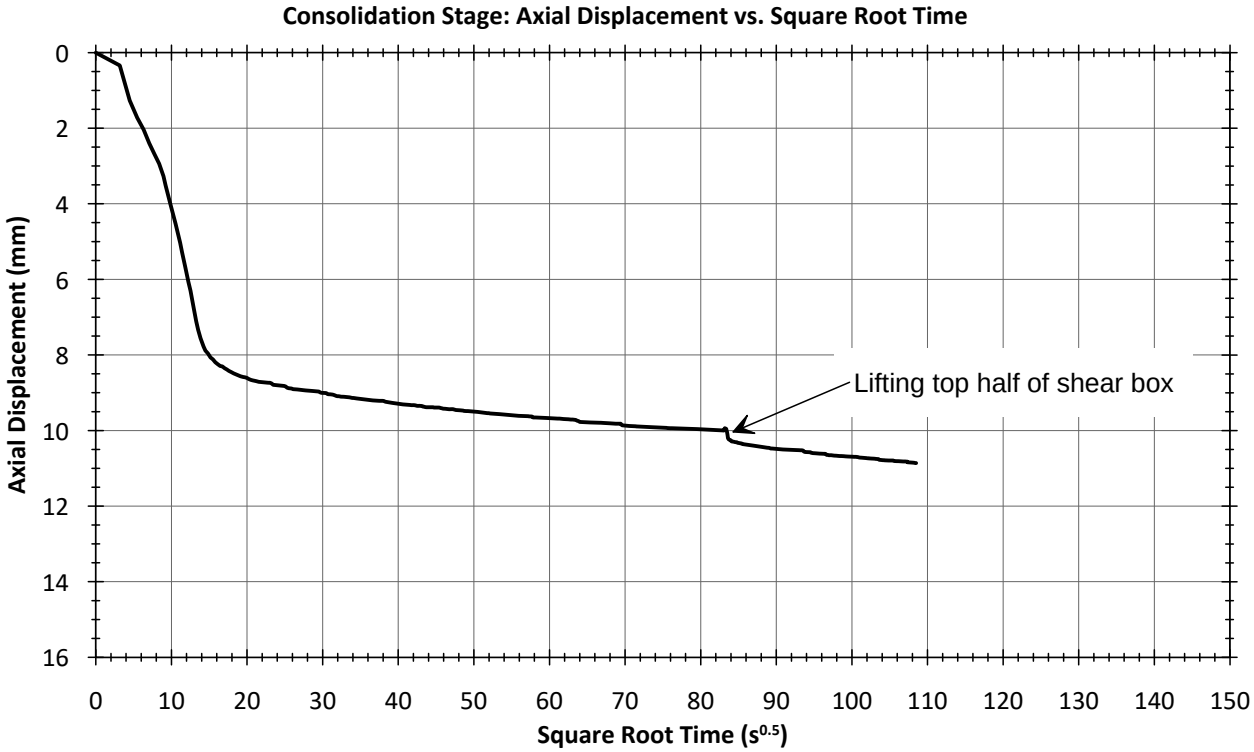

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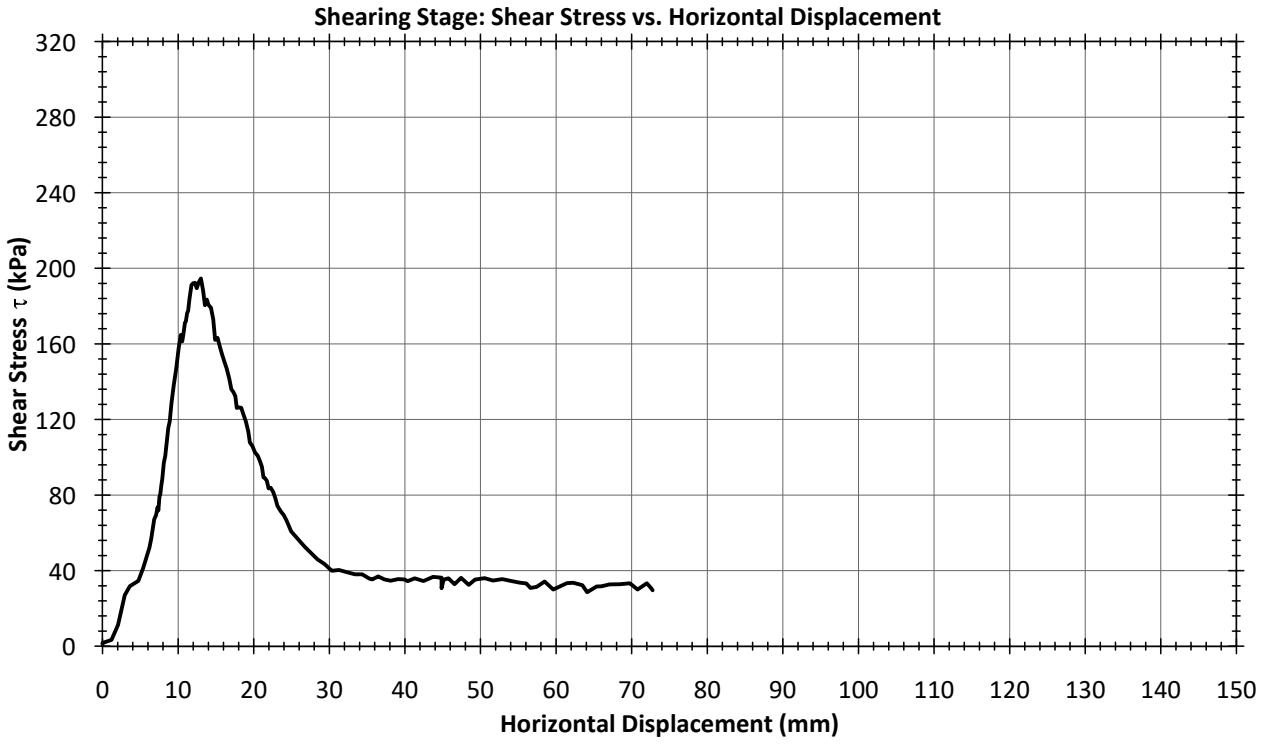

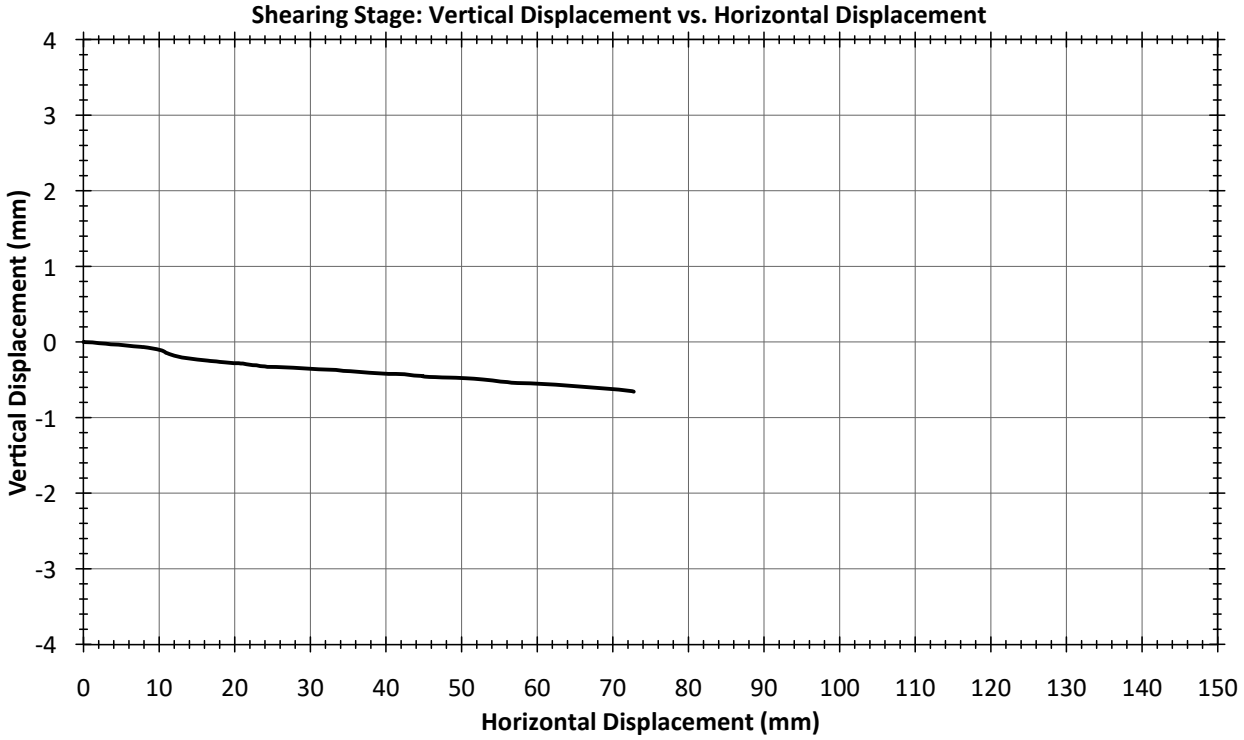

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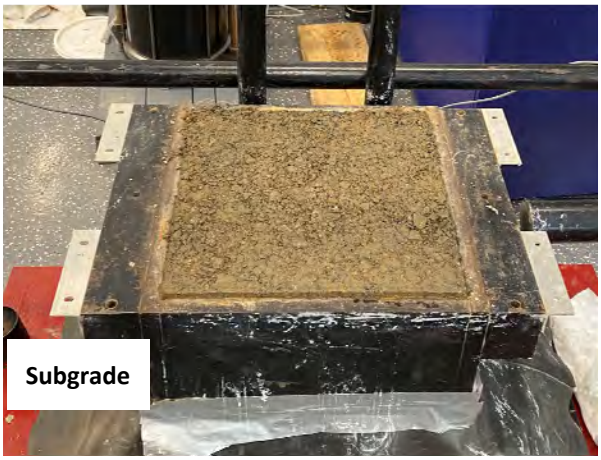
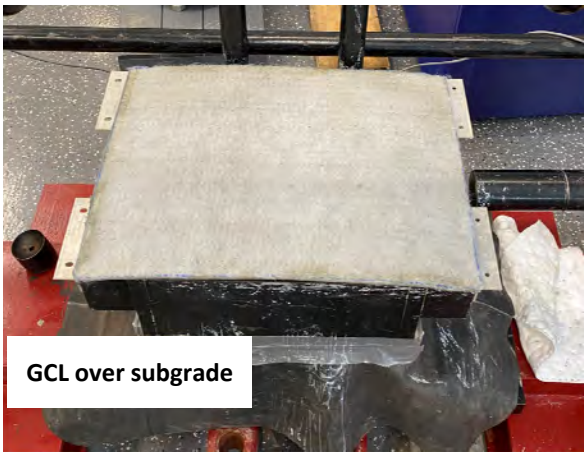


Subgrade



GCL over subgrade



Alignment of GCL and geomembrane before test



Loading direction on GCL



Overliner



Shear box after test

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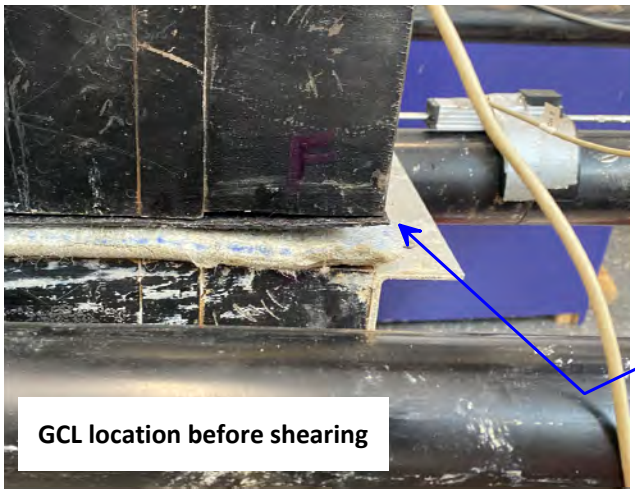
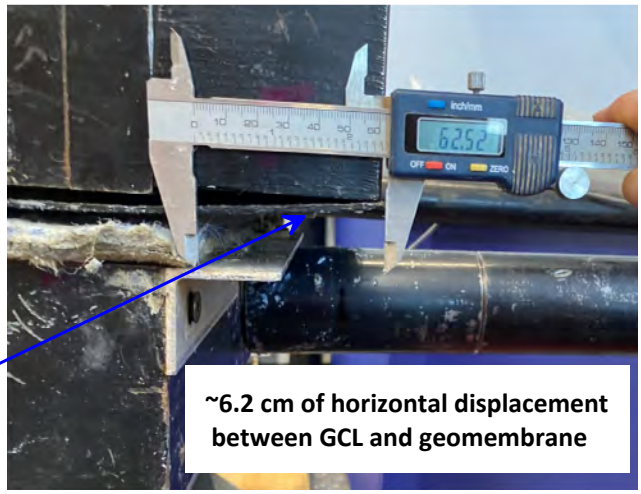


GCL location before shearing



~6.2 cm of horizontal displacement between GCL and geomembrane



~2.8 cm wrinkle in front of GCL



~2.9 cm wrinkle in back the GCL



Subgrade after test



Geomembrane after test

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Approved by SD (2020-03-17)
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PROJECT INFORMATION		LINER SYSTEM	
Number	2140-001	Subgrade	Gravel, sandy, trace fines
Name	Forte Dynamics Liner Testing	GCL	GSE BentoLiner NWL-60 GCL
Location	Yukon Territory	Geomembrane	Layfield Enviro Liner 4280 CT
Client	Forte Dynamics Inc.	Overliner	Poorly graded gravel with sand (GP)

INDEX PROPERTIES OF SUBGRADE	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	15.0
Bulk Density ρ_b (g/cm^3)	2.29
Dry Density ρ_d (g/cm^3)	2.13
Void Ratio e	0.27
Water Content (%)	7.3
Specific Gravity G_s (Assumed)	2.70

INDEX PROPERTIES OF OVERLINER	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	9.3
Bulk Density ρ_b (g/cm^3)	2.22
Dry Density ρ_d (g/cm^3)	2.10
Void Ratio e	0.24
Water Content (%)	5.8
Specific Gravity G_s (Assumed)	2.60

INDEX PROPERTIES OF GCL	
Initial Average Hydrated Thickness (cm)	1.02
Initial Water Content (%)	190.1
Final Water Content (%)	135.5

SHEARING PARAMETERS	
Vertical Stress σ'_v (kPa)	1200
Displacement Rate (cm/min)	0.17

RESULTS	
τ_{max} (kPa)	285
τ_{res} (kPa)	80

Note: Internal failure was observed in the geosynethetic clay liner (GCL). Displacement between the subgrade and the GCL was observed, along with displacement between the geomembrane and GCL.

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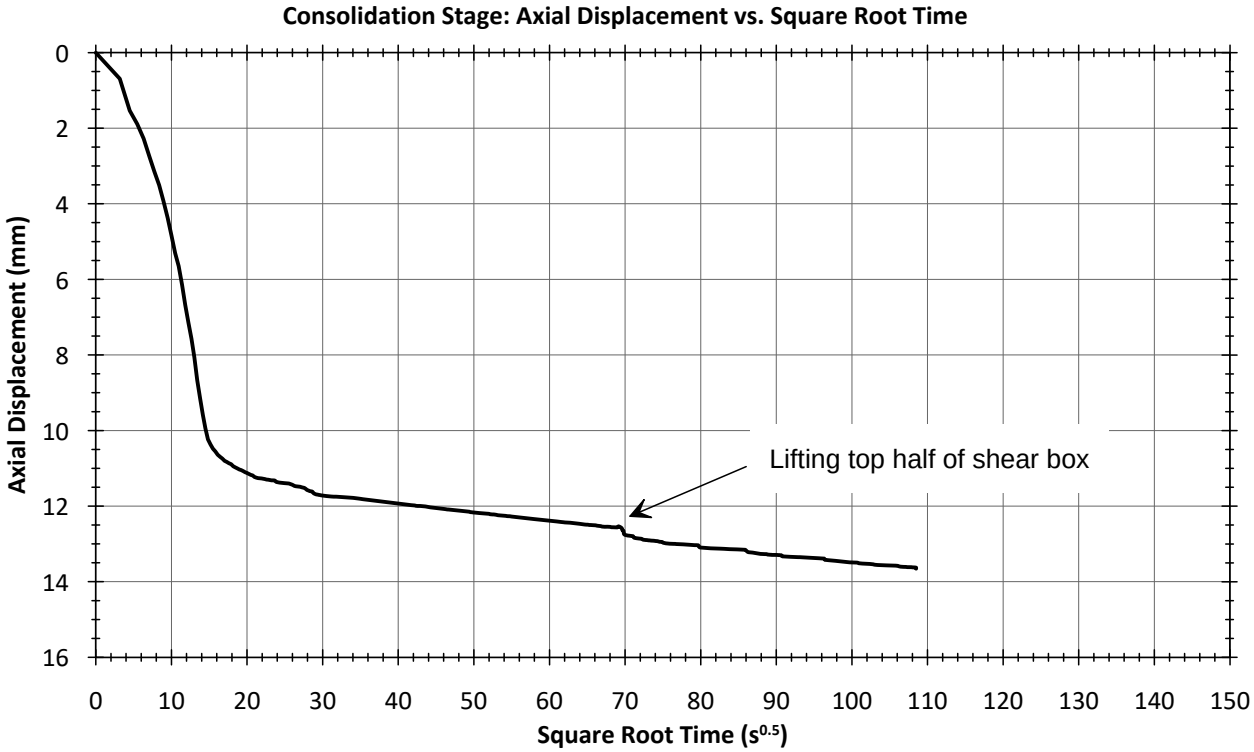

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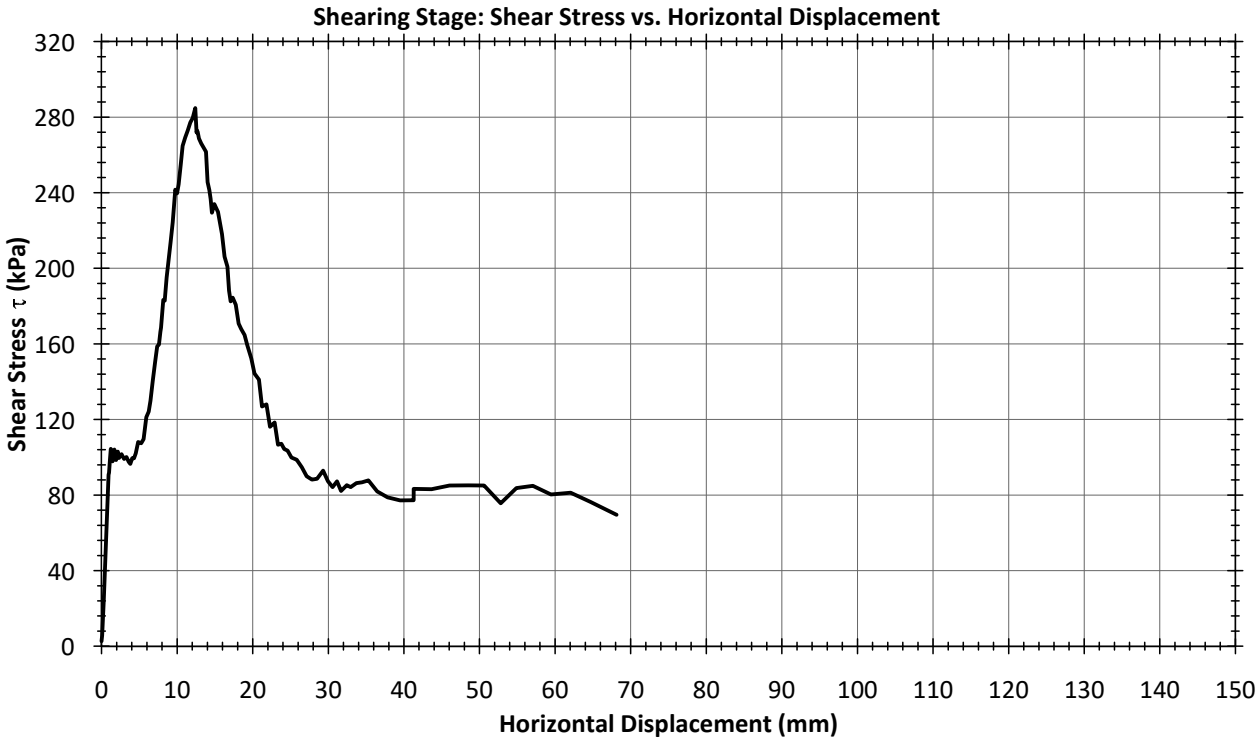

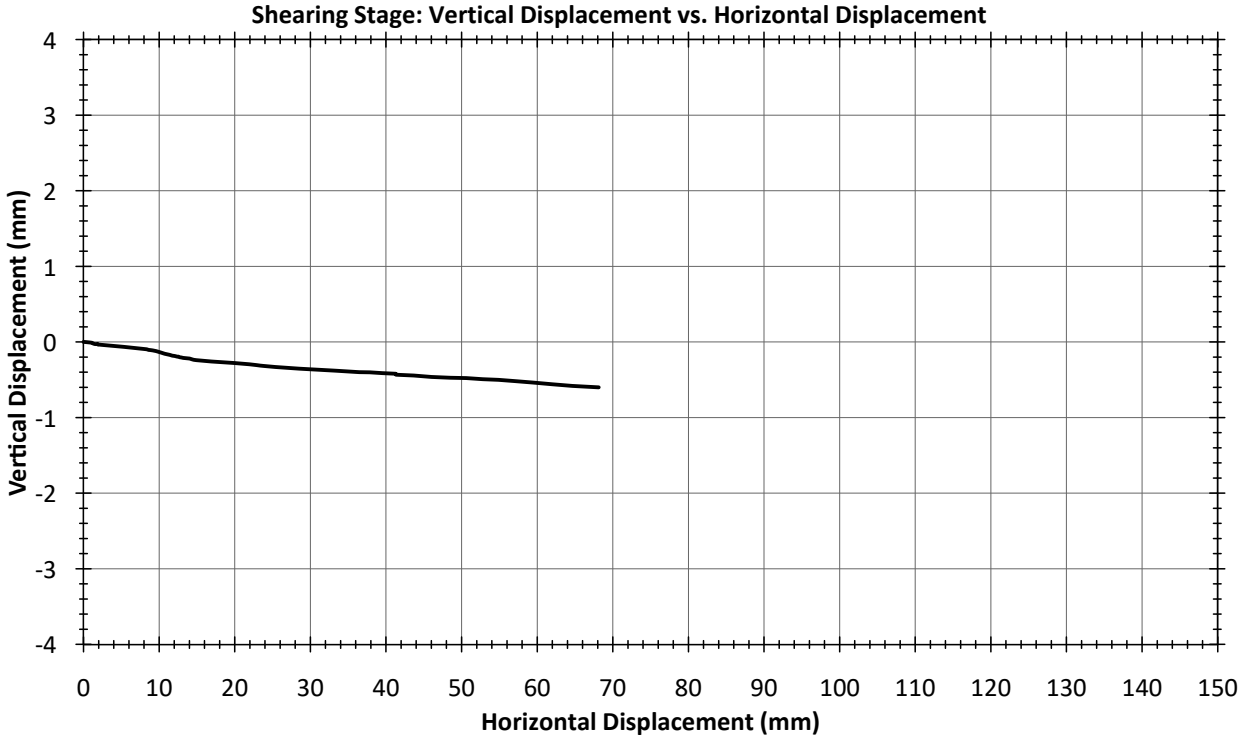

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Reviewed by KS (2020-03-02)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



Subgrade



GCL over subgrade



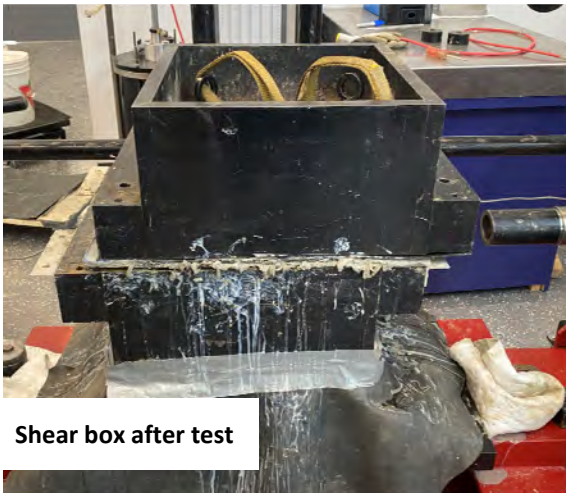
Alignment of GCL and geomembrane before test



Loading direction on GCL



Overliner



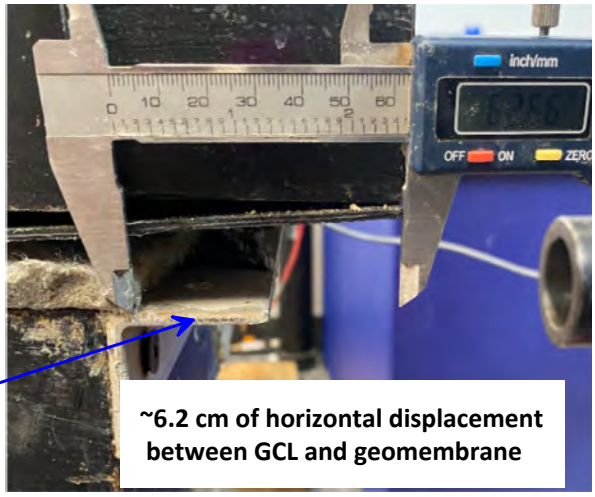
Shear box after test

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by DO (2020-02-28)
Reviewed by KS (2020-03-02)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



GCL location before shearing



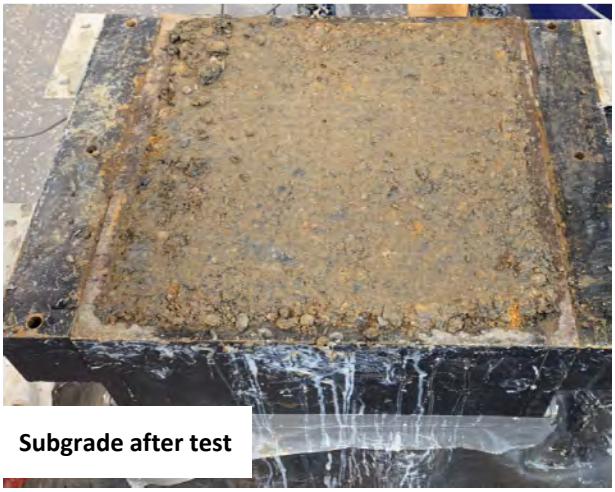
~6.2 cm of horizontal displacement between GCL and geomembrane



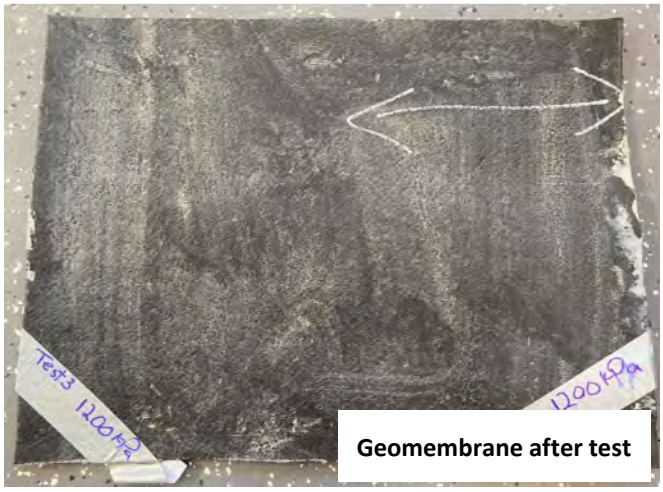
~2.5 cm wrinkle in front of GCL



~3.05 cm wrinkle in back the GCL



Subgrade after test



Geomembrane after test

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by DO (2020-02-28)
Reviewed by KS (2020-03-02)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

PROJECT INFORMATION		LINER SYSTEM	
Number	2140-001	Subgrade	Gravel, sandy, trace fines
Name	Forte Dynamics Liner Testing	GCL	GSE BentoLiner NWL-60 GCL
Location	Yukon Territory	Geomembrane	Layfield Enviro Liner 4280 CT
Client	Forte Dynamics Inc.	Overliner	Poorly graded gravel with sand (GP)

INDEX PROPERTIES OF SUBGRADE	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	15.5
Bulk Density ρ_b (g/cm^3)	2.32
Dry Density ρ_d (g/cm^3)	2.17
Void Ratio e	0.25
Water Content (%)	7.3
Specific Gravity G_s (Assumed)	2.70

INDEX PROPERTIES OF OVERLINER	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	15.8
Bulk Density ρ_b (g/cm^3)	2.21
Dry Density ρ_d (g/cm^3)	2.11
Void Ratio e	0.23
Water Content (%)	4.6
Specific Gravity G_s (Assumed)	2.60

INDEX PROPERTIES OF GCL	
Initial Average Hydrated Thickness (cm)	0.72
Initial Water Content (%)	108.9
Final Water Content (%)	86.7

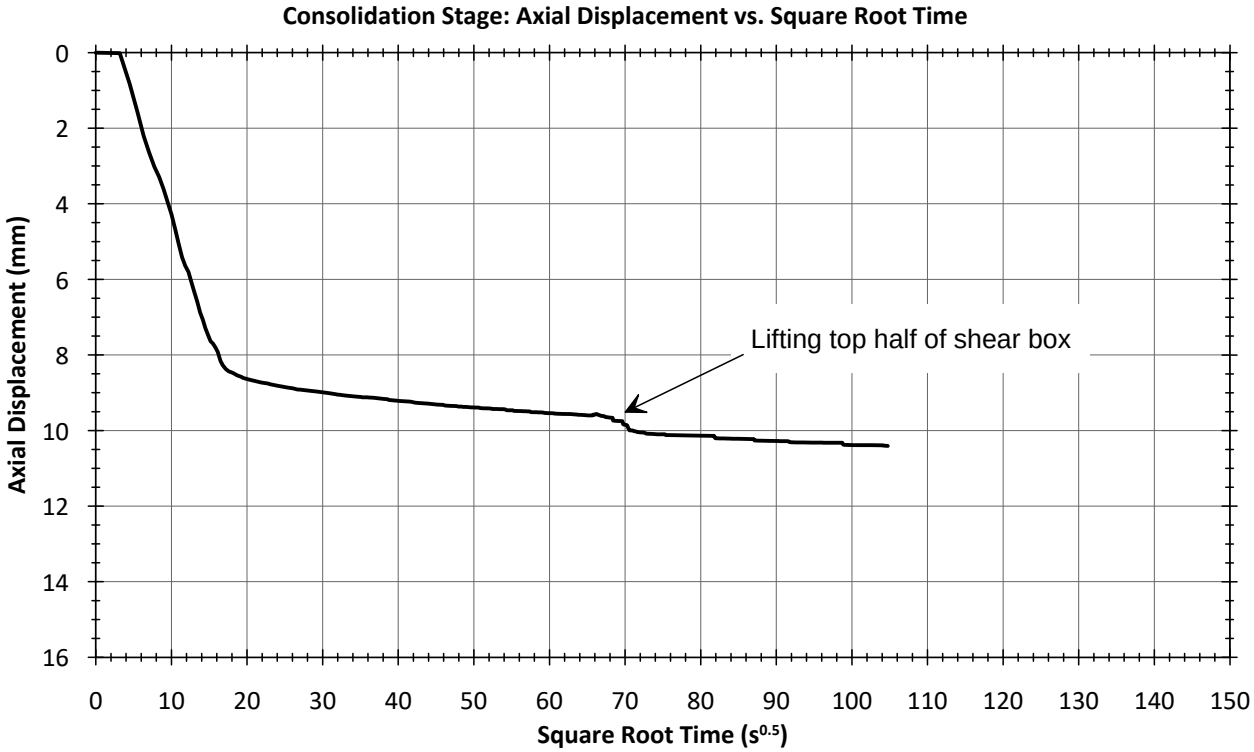
SHEARING PARAMETERS	
Vertical Stress σ'_v (kPa)	800
Displacement Rate (cm/min)	0.48

RESULTS	
τ_{max} (kPa)	302
τ_{res} (kPa)	95

Note: The liner system failed between the geosynethetic clay liner (GCL) and Geomembrane. No failure was observed in the GCL. There was no evidence that any shearing occurred in either the subgrade or overliner.

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

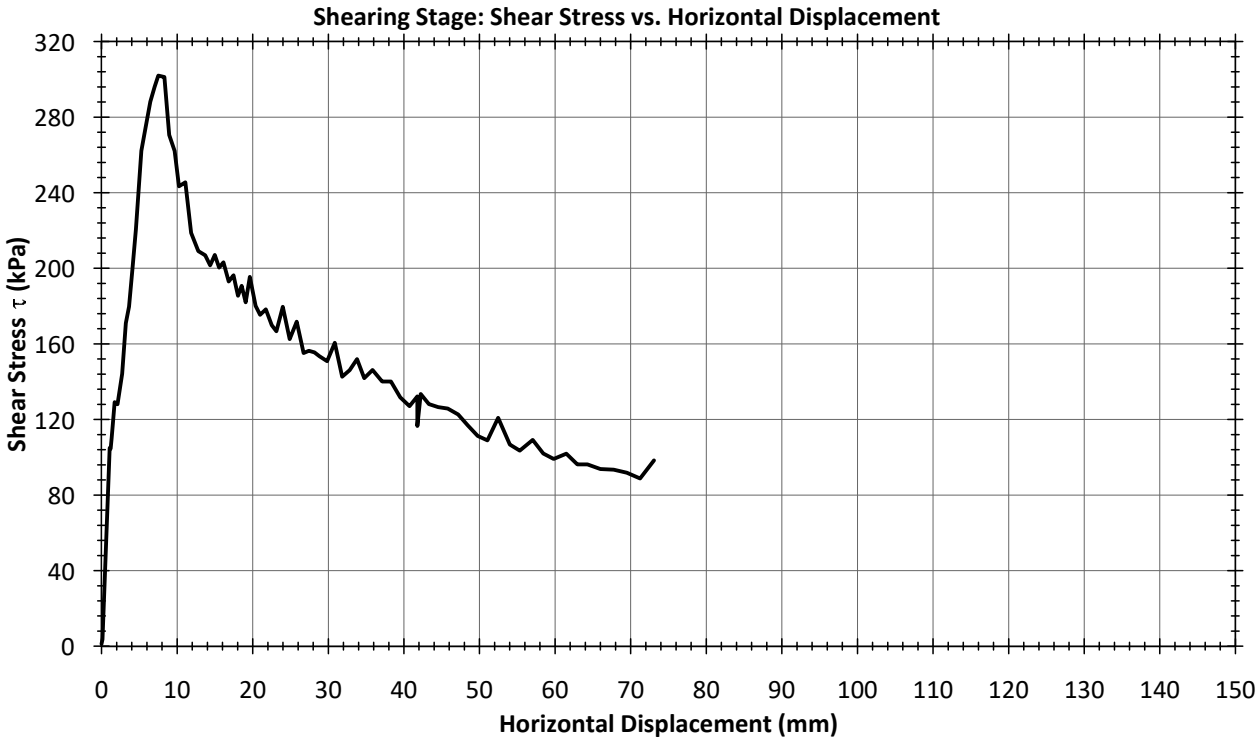
Tested by KS (2020-03-06)
Reviewed by DO (2020-03-09)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

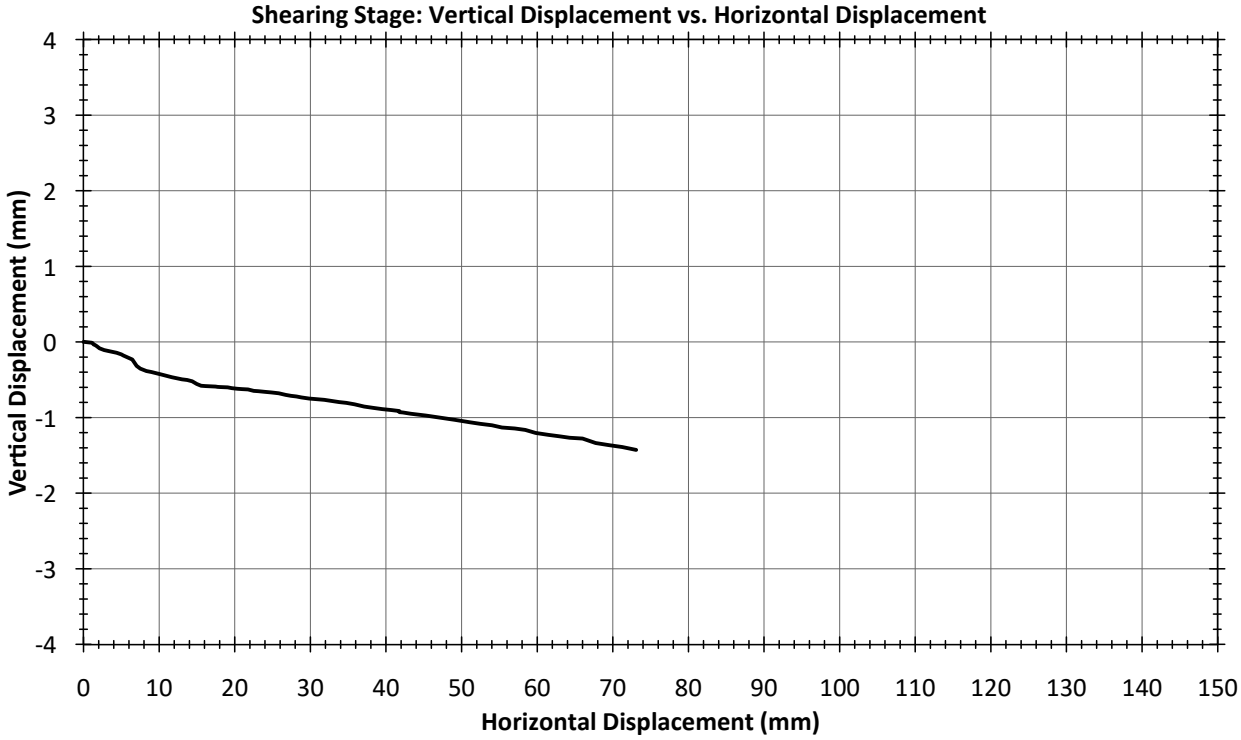


330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-06)
Reviewed by DO (2020-03-09)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY





330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-06)
Reviewed by DO (2020-03-09)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



Subgrade



GCL over subgrade

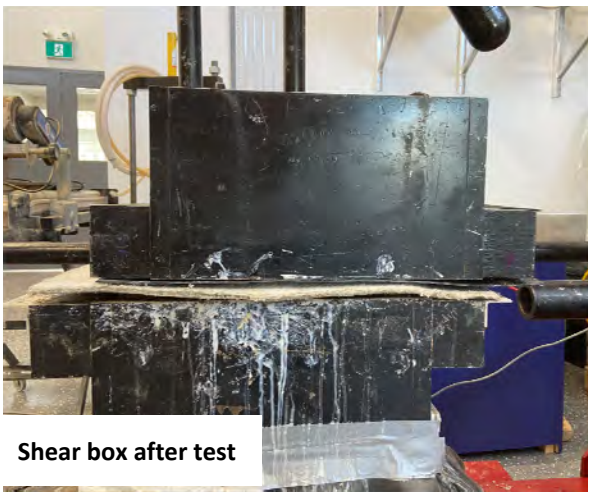


Alignment of GCL and geomembrane before test





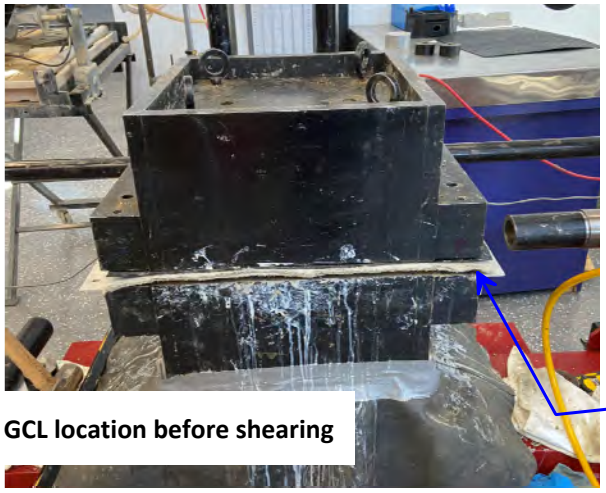
Overliner



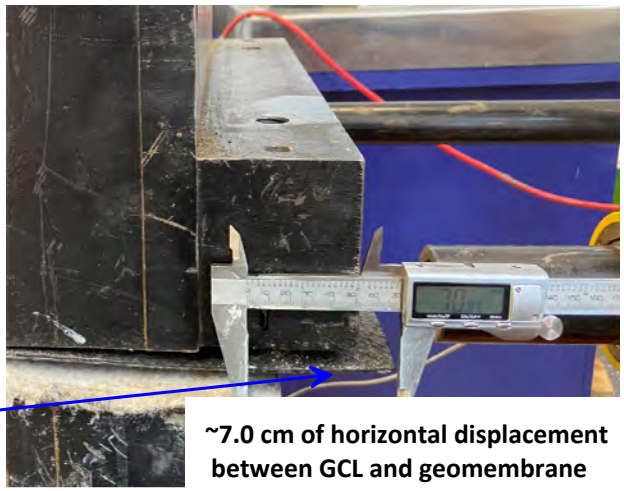
Shear box after test

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-06)
Reviewed by DO (2020-03-09)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



GCL location before shearing



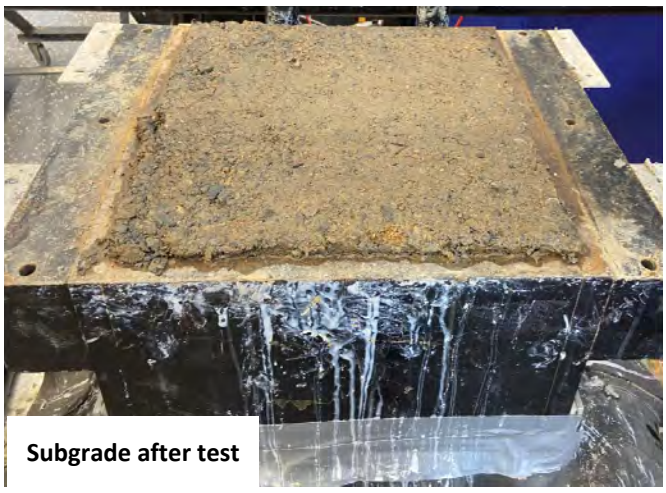
~7.0 cm of horizontal displacement between GCL and geomembrane



No GCL wrinkle on top



No GCL wrinkle on bottom



Subgrade after test



Geomembrane after test

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-06)
Reviewed by DO (2020-03-09)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

PROJECT INFORMATION		LINER SYSTEM	
Number	2140-001	Subgrade	Gravel, sandy, trace fines
Name	Forte Dynamics Liner Testing	GCL	GSE BentoLiner NWL-60 GCL
Location	Yukon Territory	Geomembrane	Layfield Enviro Liner 4280 CT
Client	Forte Dynamics Inc.	Overliner	Poorly graded gravel with sand (GP)

INDEX PROPERTIES OF SUBGRADE	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	15.1
Bulk Density ρ_b (g/cm^3)	2.30
Dry Density ρ_d (g/cm^3)	2.17
Void Ratio e	0.25
Water Content (%)	6.1
Specific Gravity G_s (Assumed)	2.70

INDEX PROPERTIES OF OVERLINER	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	12.0
Bulk Density ρ_b (g/cm^3)	2.16
Dry Density ρ_d (g/cm^3)	2.03
Void Ratio e	0.28
Water Content (%)	6.5
Specific Gravity G_s (Assumed)	2.60

INDEX PROPERTIES OF GCL	
Initial Average Hydrated Thickness (cm)	0.71
Initial Water Content (%)	95.5
Final Water Content (%)	82.0

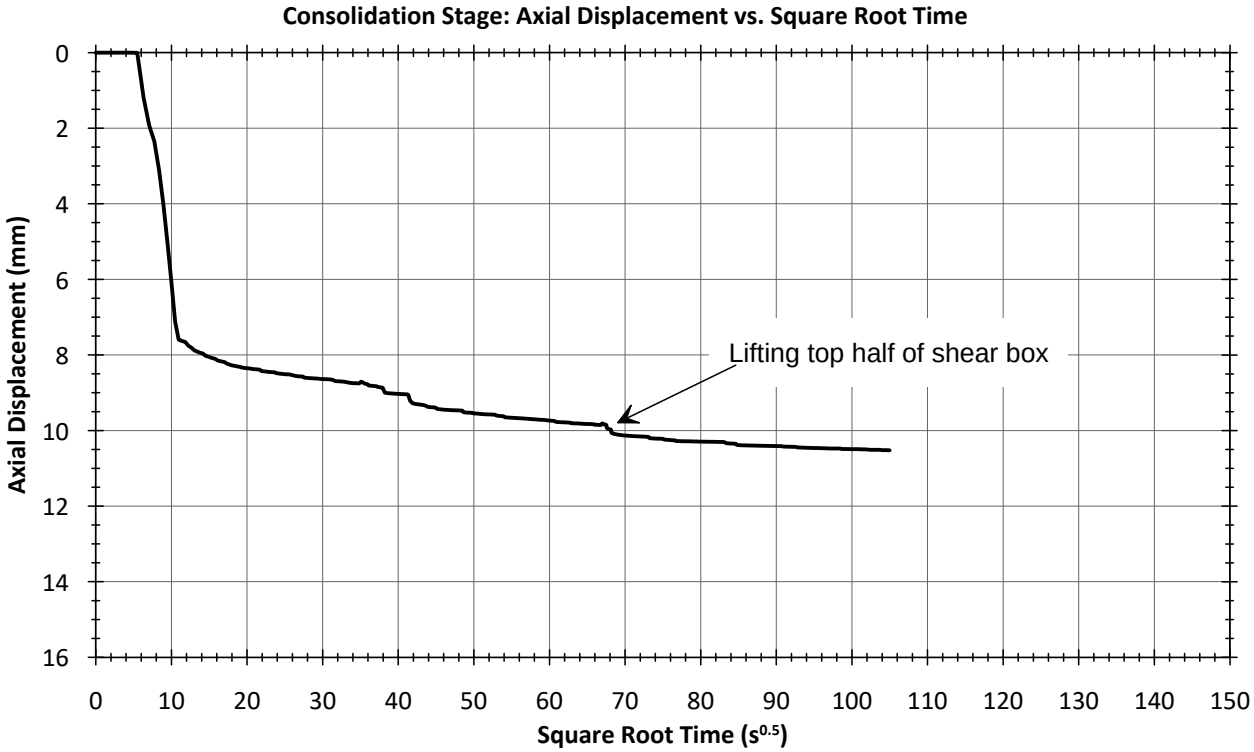
SHEARING PARAMETERS	
Vertical Stress σ'_v (kPa)	1200
Displacement Rate (cm/min)	0.35

RESULTS	
τ_{max} (kPa)	462
τ_{res} (kPa)	130

Note: The liner system failed between the geosynethetic clay liner (GCL) and Geomembrane. No failure was observed in the GCL. There was no evidence that any shearing occurred in either the subgrade or overliner.

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-11)
Reviewed by DO (2020-03-13)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-11)
Reviewed by DO (2020-03-13)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

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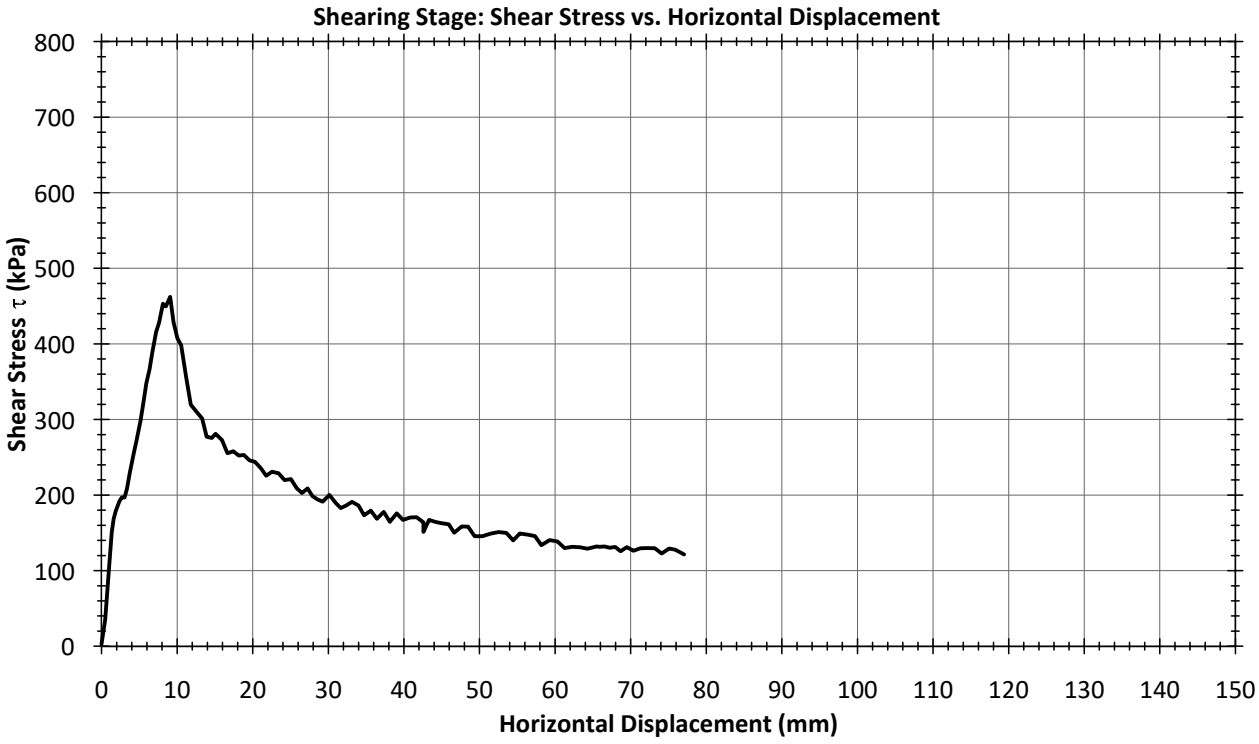

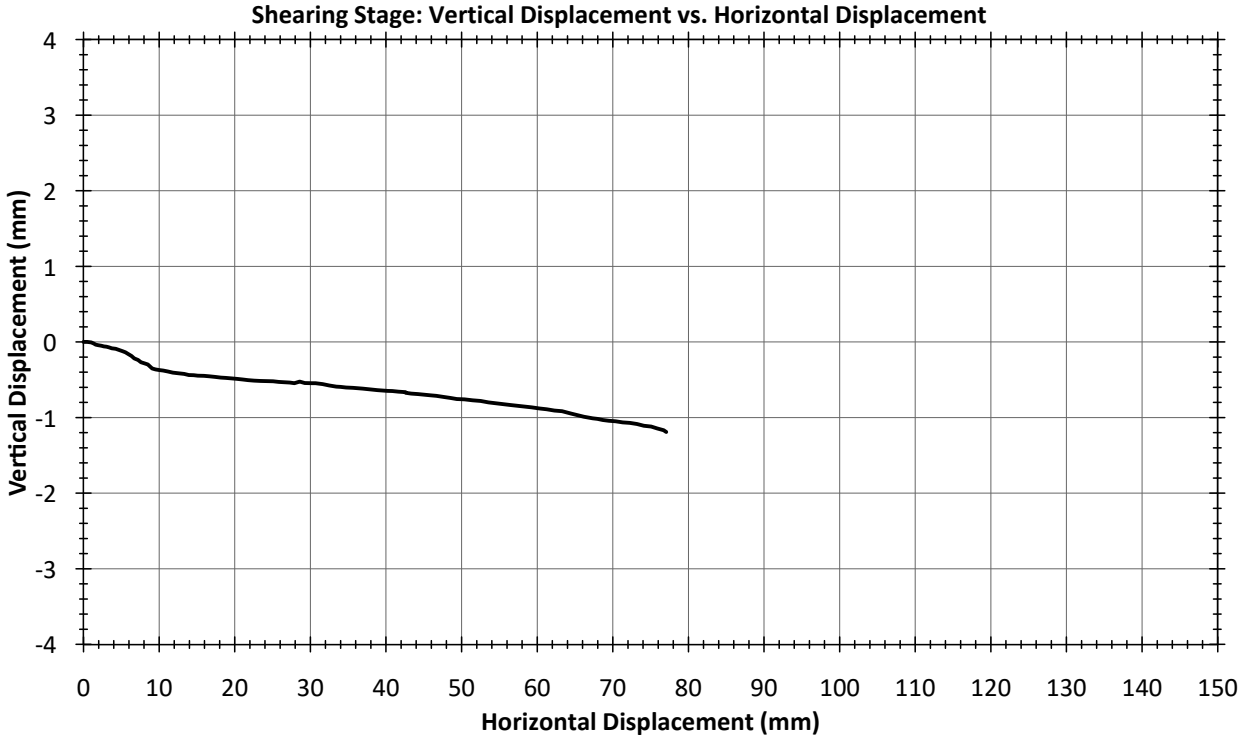

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
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Tested by KS (2020-03-11)
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Approved by SD (2020-03-17)
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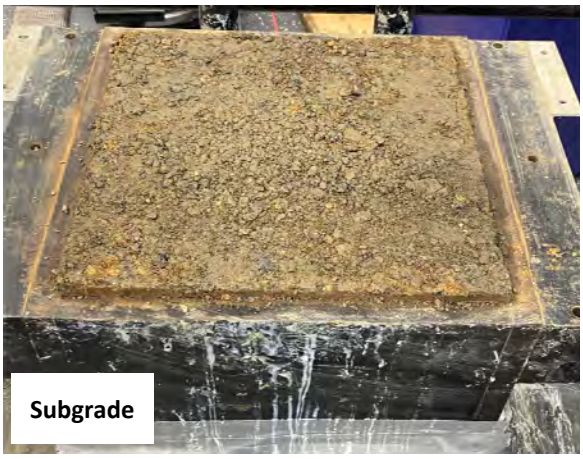


Subgrade



GCL over subgrade



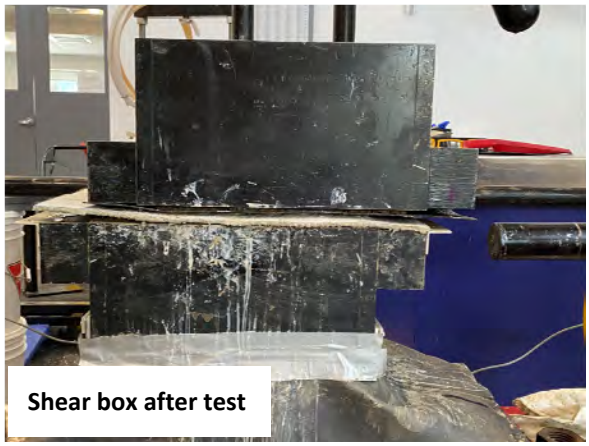
Alignment of GCL and geomembrane before test



Loading direction on GCL



Overliner



Shear box after test

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-11)
Reviewed by DO (2020-03-13)
Approved by SD (2020-03-17)
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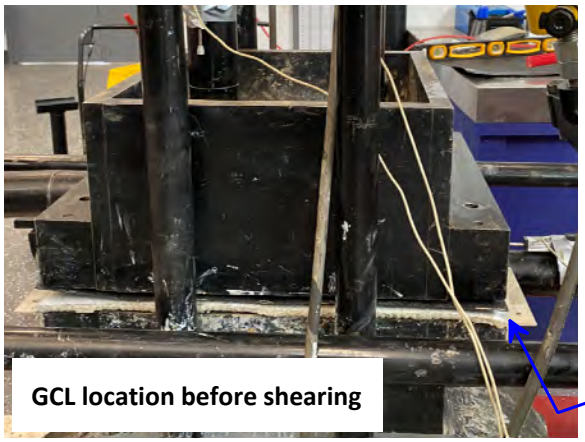
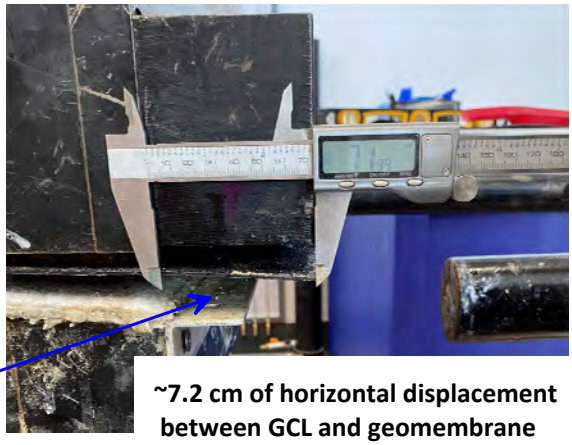
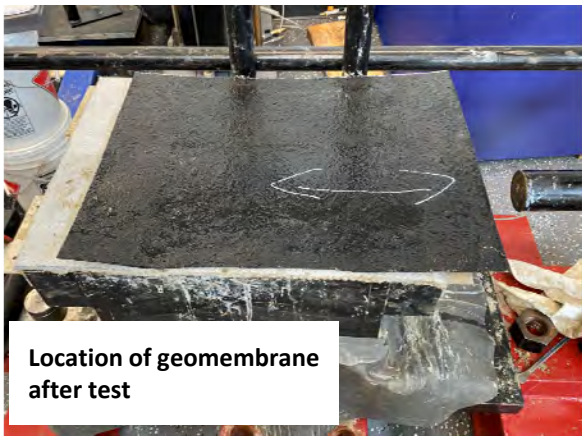


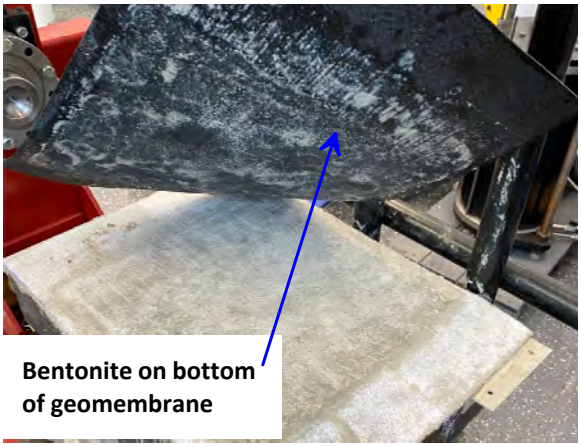
GCL location before shearing



~7.2 cm of horizontal displacement between GCL and geomembrane



Location of geomembrane after test



Bentonite on bottom of geomembrane



Subgrade after test



No wrinkles in GCL

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by KS (2020-03-11)
Reviewed by DO (2020-03-13)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

PROJECT INFORMATION		LINER SYSTEM	
Number	2140-001	Subgrade	Gravel, sandy, trace fines
Name	Forte Dynamics Liner Testing	GCL	GSE BentoLiner NWL-60 GCL
Location	Yukon Territory	Geomembrane	Layfield Enviro Liner 4280 CT
Client	Forte Dynamics Inc.	Overliner	Poorly graded gravel with sand (GP)

INDEX PROPERTIES OF SUBGRADE	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	15.1
Bulk Density ρ_b (g/cm^3)	2.30
Dry Density ρ_d (g/cm^3)	2.17
Void Ratio e	0.24
Water Content (%)	6.1
Specific Gravity G_s (Assumed)	2.70

INDEX PROPERTIES OF OVERLINER	Initial
Length and Width (cm)	40.5 x 40.5
Thickness (cm)	10.6
Bulk Density ρ_b (g/cm^3)	2.22
Dry Density ρ_d (g/cm^3)	2.08
Void Ratio e	0.25
Water Content (%)	6.5
Specific Gravity G_s (Assumed)	2.60

INDEX PROPERTIES OF GCL	
Initial Average Hydrated Thickness (cm)	0.75
Initial Water Content (%)	106.7
Final Water Content (%)	95.8

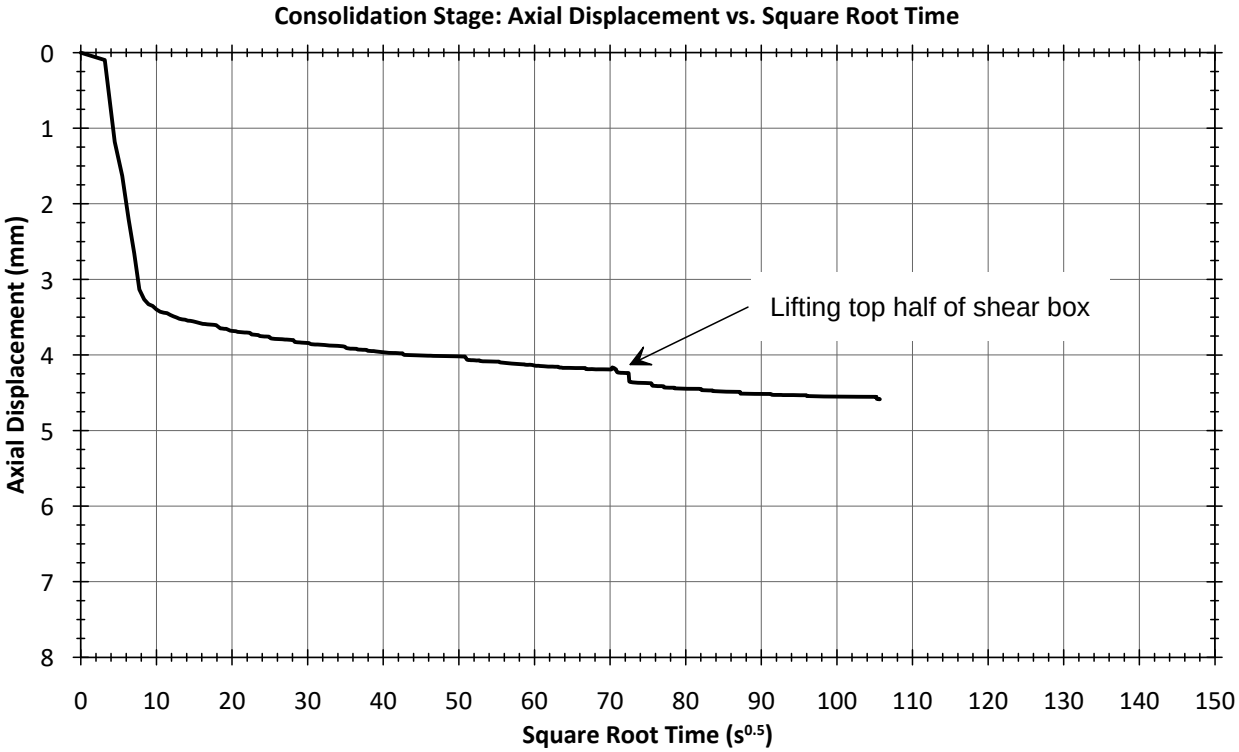
SHEARING PARAMETERS	
Vertical Stress σ'_v (kPa)	400
Displacement Rate (cm/min)	0.30

RESULTS	
τ_{max} (kPa)	172
τ_{res} (kPa)	75

Note: The liner system failed between the geosynethetic clay liner (GCL) and Geomembrane. No failure was observed in the GCL. There was no evidence that any shearing occurred in either the subgrade or overliner.

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by DO (2020-03-13)
Reviewed by KS (2020-03-16)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
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Tested by DO (2020-03-13)
Reviewed by KS (2020-03-16)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)

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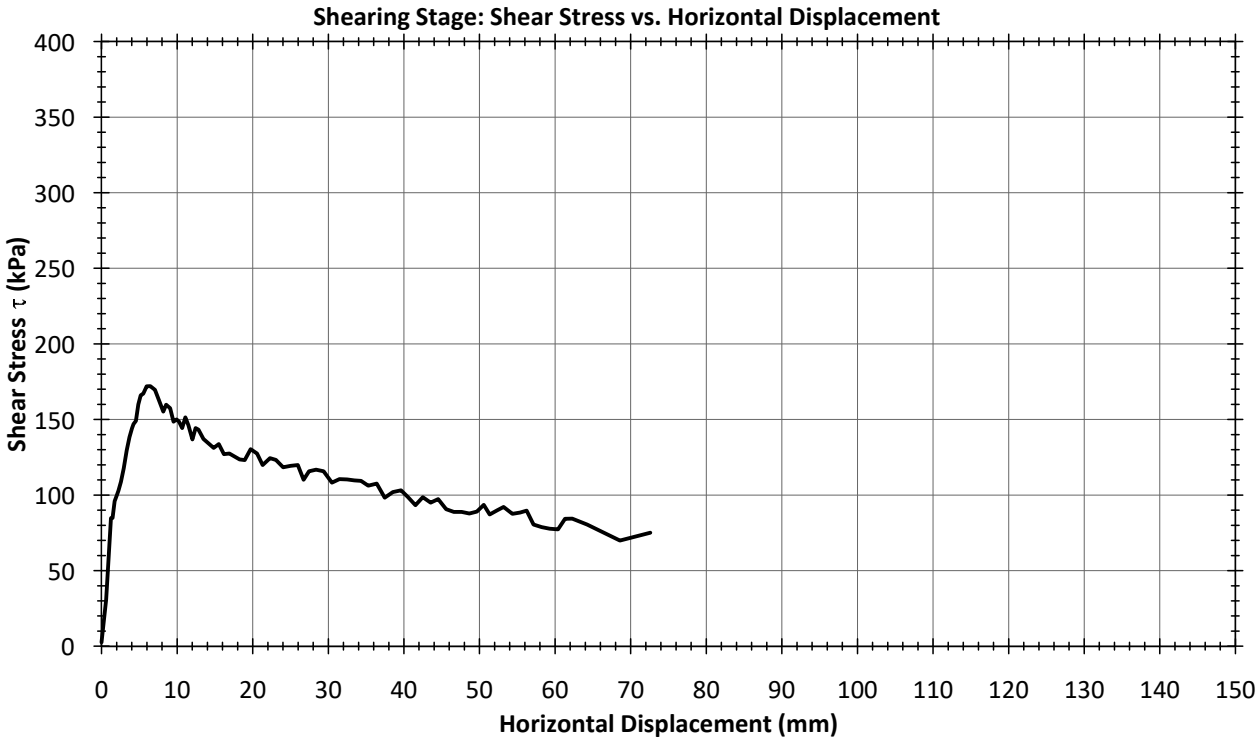

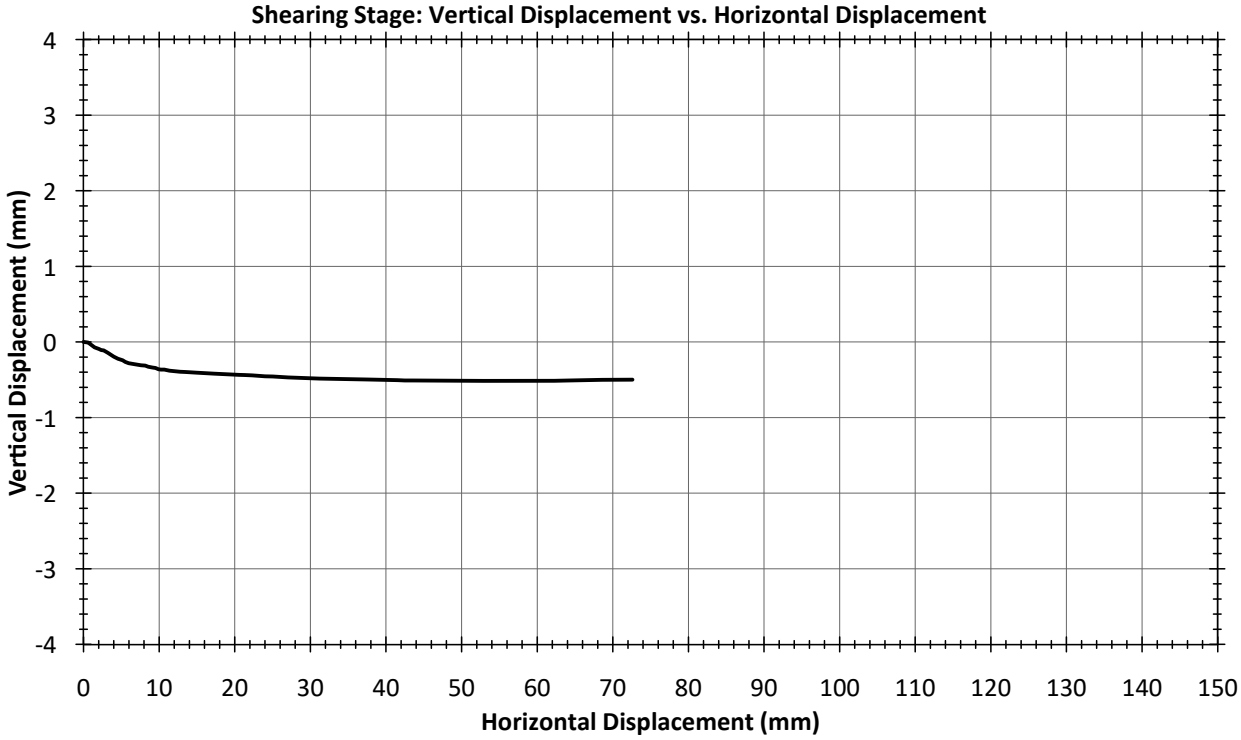

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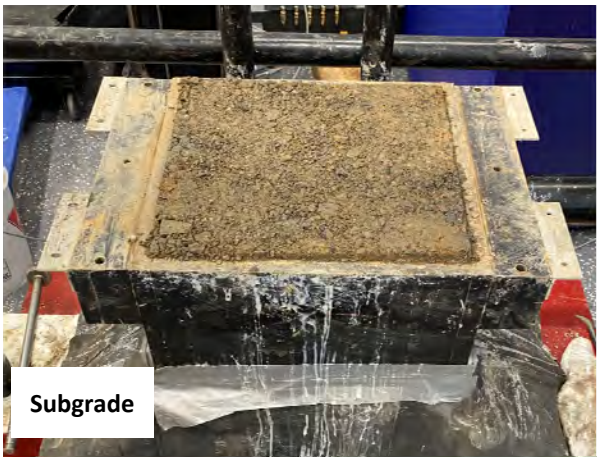


Subgrade



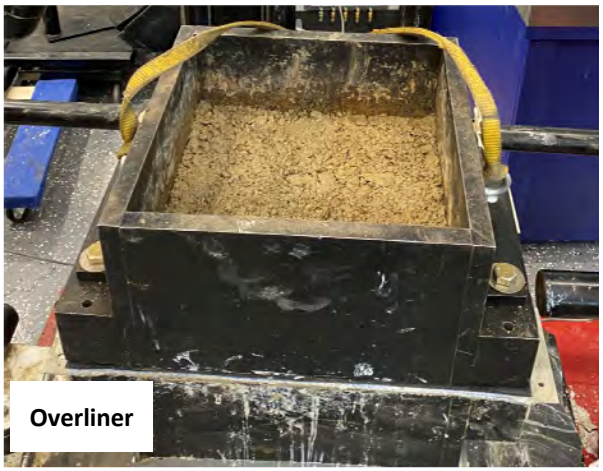
GCL over subgrade



Alignment of GCL and geomembrane before test



Loading direction on GCL



Overliner



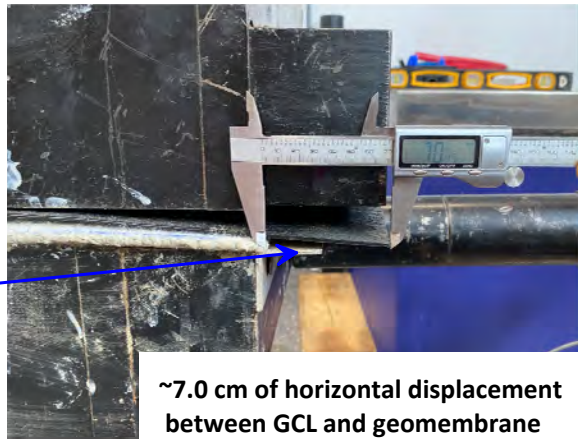
Shear box after test

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

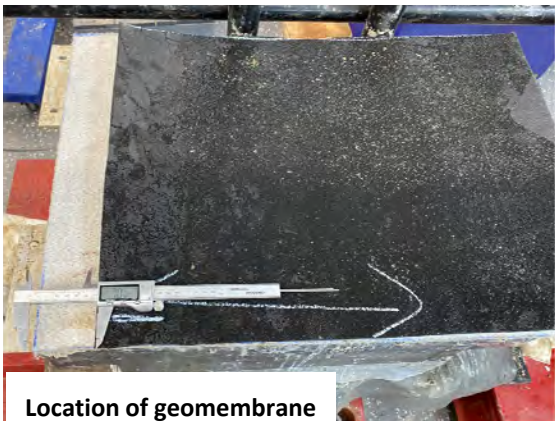
Tested by DO (2020-03-13)
Reviewed by KS (2020-03-16)
Approved by SD (2020-03-17)
Date Format (YYYY-MM-DD)



GCL location before shearing



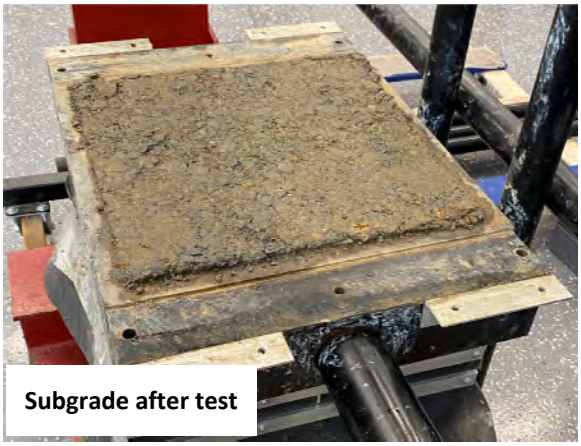
~7.0 cm of horizontal displacement between GCL and geomembrane



Location of geomembrane after test



Bentonite on bottom of geomembrane



Subgrade after test



No wrinkles in GCL

330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

BGC ENGINEERING INC.
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PARTICLE-SIZE DISTRIBUTION (GRADATION) OF SOILS
ASTM D6913
ASTM D7928

PROJECT INFORMATION

Project No.	2140-001
Project Name	Forte Dynamics Liner Testing
Project Location	Yukon Territory
Client	Forte Dynamics Inc.

SAMPLE INFORMATION

Borehole / Test Pit	-
Sample ID	Overliner
Sample Depth	0.00 m
Sample Type	Grab

GRADATION SUMMARY

Coarser than Gravel (%)	0
Gravel (%)	81
Sand (%)	15
Fines (%)	4
D_{60} (mm)	14.700
D_{30} (mm)	8.360
D_{10} (mm)	1.300
C_c	3.6
C_u	11

RESULTS

Size (mm)	Passing (%)	Size (mm)	Passing (%)
75	100.0		
50	100.0		
37.5	100.0		
25.0	95.5		
19.0	76.0		
9.5	32.5		
4.75	18.9		
2.00	11.8		
0.850	8.2		
0.425	6.3		
0.250	5.3		
0.150	4.5		
0.106	4.0		
0.075	3.5		

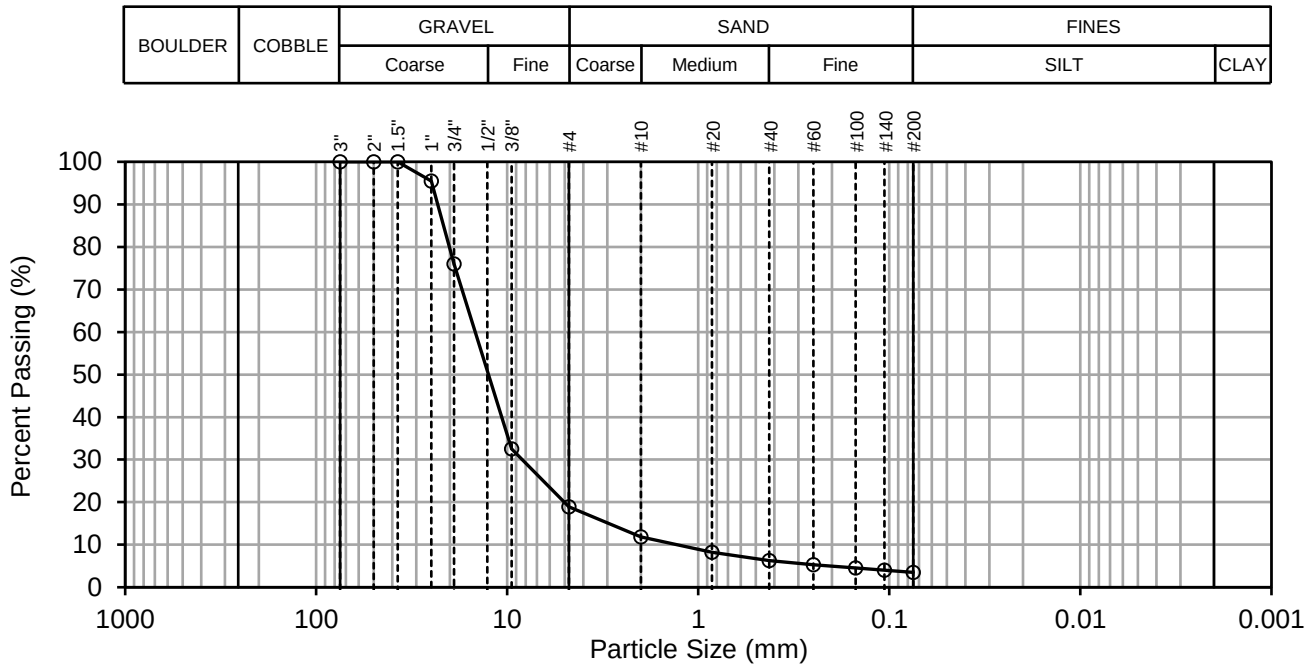
LABORATORY COMMENTS

PREPARATION METHOD

Oven dried

USCS DESCRIPTION (ASTM D2487)

Poorly graded gravel with sand (GP)



330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by D.Oldford (2020-02-14)
Reviewed by M.Billings (2020-03-13)
Approved by S.Dickinson (2020-03-17)
Date Format (YYYY-MM-DD)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

PARTICLE-SIZE DISTRIBUTION (GRADATION) OF SOILS
ASTM D6913
ASTM D7928

PROJECT INFORMATION

Project No.	2140-001
Project Name	Forte Dynamics Liner Testing
Project Location	Yukon Territory
Client	Forte Dynamics Inc.

SAMPLE INFORMATION

Borehole / Test Pit	-
Sample ID	Subgrade
Sample Depth	0.00 m
Sample Type	Grab

GRADATION SUMMARY

Coarser than Gravel (%)	0
Gravel (%)	58
Sand (%)	32
Fines (%)	10
D_{60} (mm)	10.300
D_{30} (mm)	2.210
D_{10} (mm)	0.079
C_c	6
C_u	130

RESULTS

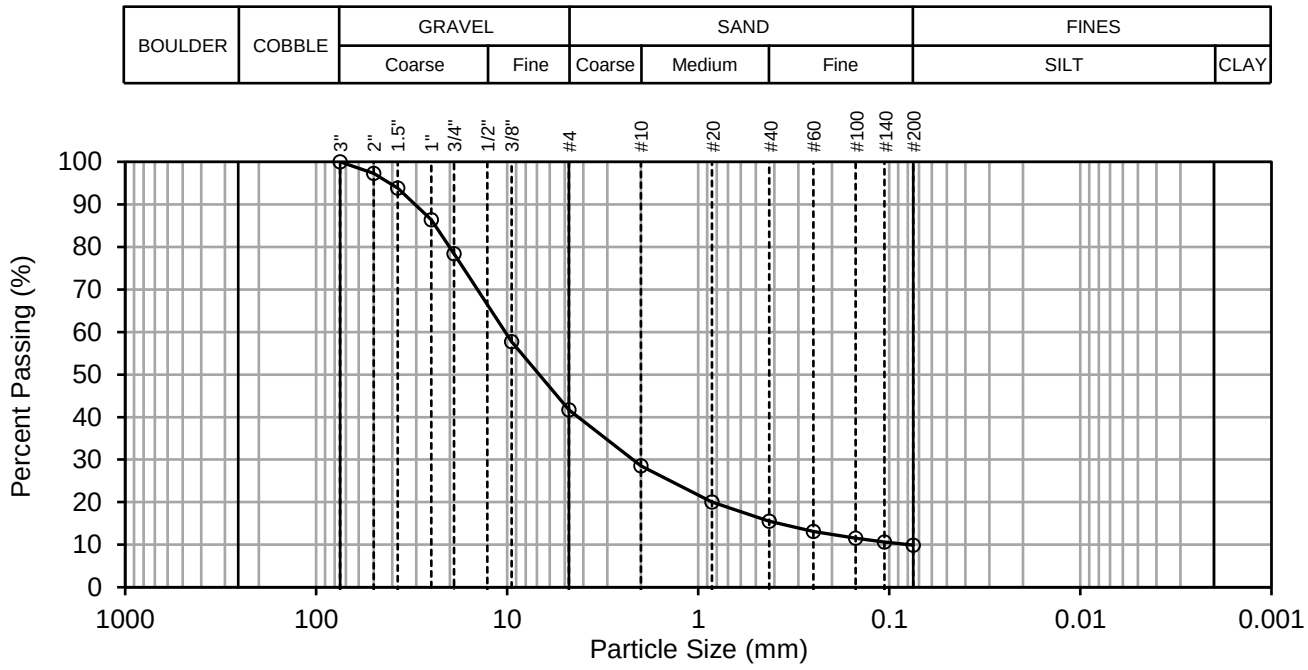
Size (mm)	Passing (%)	Size (mm)	Passing (%)
75	100.0		
50	97.3		
37.5	93.8		
25.0	86.4		
19.0	78.4		
9.5	57.7		
4.75	41.7		
2.00	28.5		
0.850	20.0		
0.425	15.5		
0.250	13.1		
0.150	11.5		
0.106	10.6		
0.075	9.9		

LABORATORY COMMENTS

PREPARATION METHOD

Oven dried

USCS DESCRIPTION (ASTM D2487)



330 Alison Boulevard
Fredericton, NB Canada E3C 0A9
T 506.460.8660 | F 506.460.8679

Tested by D.Oldford (2020-02-14)
Reviewed by M.Billings (2020-03-13)
Approved by S.Dickinson (2020-03-17)
Date Format (YYYY-MM-DD)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING STANDARD EFFORT
ASTM D698

PROJECT INFORMATION	
Project No.	2140-001
Project Name	Forte Dynamics Liner Testing
Project Location	Yukon Territory
Client	Forte Dynamics Inc.

SAMPLE INFORMATION	
Borehole / Test Pit	-
Sample ID	Subgrade
Sample Depth	0.00 m
Sample Type	Grab

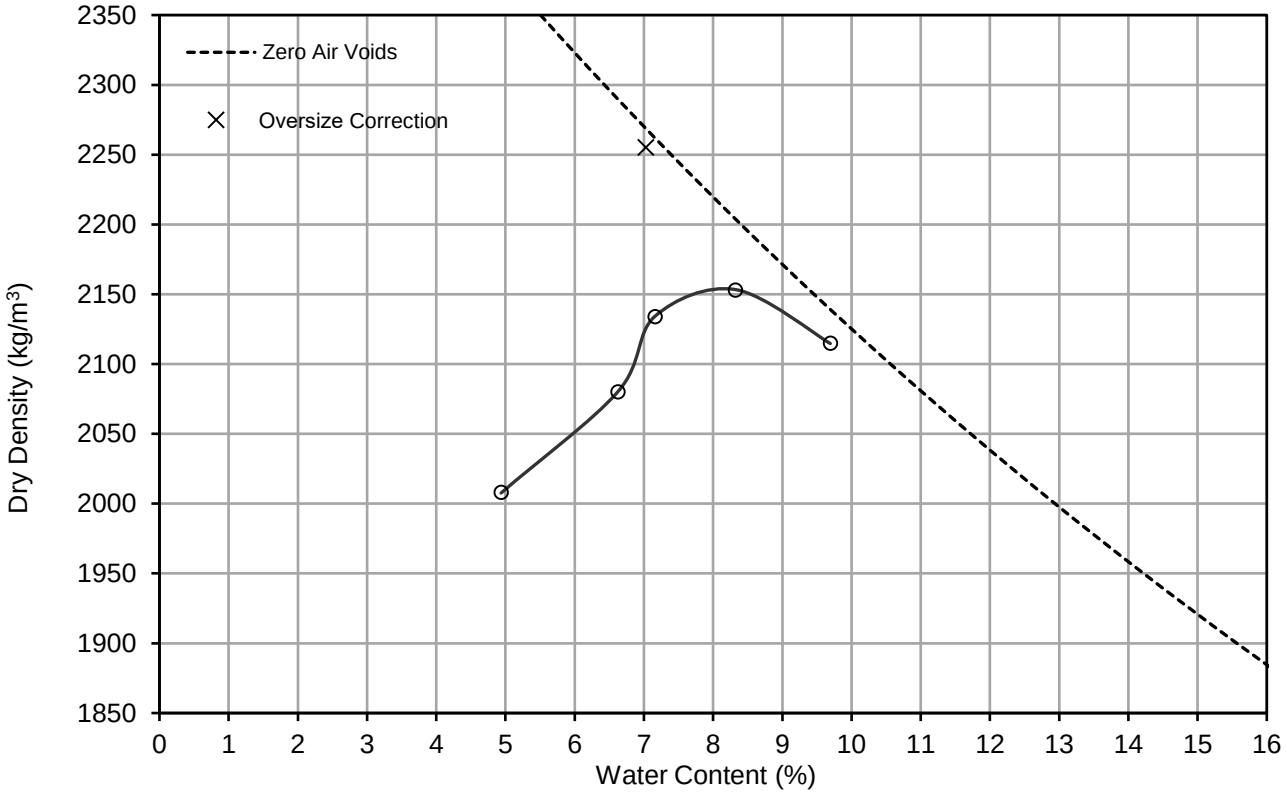
TEST INFORMATION	
Method Used	C
Preparation Method	Dry
Type of Rammer	Manual

SAMPLE PROPERTIES	
Percent Retained on 19 mm Sieve (%)	22
Percent Passing 19 mm Sieve (%)	78
As Received Water Content (%)	4.7
Specific Gravity (Assumed)	2.70

TRIAL RESULTS

Trial Number	1	2	3	4	5	6
Dry Density (kg/m^3)	2008	2080	2134	2153	2115	-
Water Content (%)	4.9	6.6	7.2	8.3	9.7	-

PROCTOR TEST RESULTS	AS TESTED	OVERSIZE CORRECTION
Maximum Dry Density (kg/m^3)	2153	2255
Optimum Water Content (%)	8.3	7.0



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Tested by D.Oldford (2020-02-19)
Reviewed by M.Billings (2020-03-13)
Approved by S.Dickinson (2020-03-17)
Date Format (YYYY-MM-DD)

APPENDIX C
BGC's STANDARD TERMS AND CONDITIONS

AGREEMENT FOR LABORATORY TESTING SERVICES

Dated as of this 21 day of February, 2020, is made by and between:

Client: Forte Dynamics ("the **Client**"),

Address: 3003 E. Harmony Road, Suite 320
Fort Collins, Co 80528

AND:

BGC ENGINEERING INC. ("**BGC**")
Suite 500 – 980 Howe Street
Vancouver BC, V6Z 0C8
Canada

The Client and BGC agree as follows:

1. THE LABORATORY SERVICES

1.1 BGC will provide Client certain Laboratory Services (as defined below) for the following project:

(Insert brief description of the project (the "Project").

1.2 The Laboratory Services BGC will provide Client for the Project are either described below, or are described in the following document: SEE ATTACHED SCOPE OF WORK FOR LINER INTERFACE SHEAR

(Either add a description of the lab testing work BGC will perform, or insert the date and description/title of a document that contains the scope of work. Note whether the document is attached to this Agreement – e.g., see attached Proposal for Laboratory Services dated September 24, 2019) (the "Scope of Services Document")

2. AGREEMENT DOCUMENTS

2.1 The following documents form part of and are incorporated into this Agreement:

- This *Agreement For Laboratory Testing Services*
- Definitions
- General Conditions
- Scope of Services Document

If there is any conflict or inconsistency between or among the documents listed above, then the provision in the document listed closer to the top of the list will prevail.

[Rest of page intentionally blank. Signature page follows.]

3. SUCCESSION

3.1 This Agreement will inure to the benefit of and be binding upon the Parties, and their respective administrators, successors, and permitted assigns.

IN WITNESS THEREOF, the Parties hereto have executed this Agreement as of the day and year indicated on page one of this Agreement.

CLIENT: Forte Dynamics

ACCEPTED FOR **CLIENT** by:

(signature)

Name: Clint Green
(print)

Title: Principal Engineer

Date: Feb. 21, 2020

BGC ENGINEERING INC.

ACCEPTED FOR **BGC ENGINEERING INC.** by:

(signature)

Name: SIMON DICKINSON
(print)

Title: CTO

Date: Feb 22, 2020.

DEFINITIONS

In addition to any other terms defined elsewhere in this Agreement, the following terms have the meanings set forth below when capitalized and used in this Agreement:

"**Affiliate**" means any Person which directly or indirectly controls, is controlled by, or is under common control with, a Party to this Agreement. For purposes of the preceding sentence, "**control**" means the power to direct or manage affairs through ownership of voting securities, contract, voting trust, or any other means.

"**BGC**" means BGC Engineering Inc., a British Columbia, Canada corporation.

"**BGC Group**" refers collectively to BGC, BGC's Affiliates, BGC's sub-contractors, BGC's sub-consultants, and each of their respective Personnel.

"**Claim**" means any claim, action, legal proceeding, lawsuit, claim through arbitration, or other cause of action of any kind, including third party claims for contribution or indemnity.

"**Client**" means the Person identified as the "Client" in the *Agreement For Laboratory Testing Services*.

"**Client Group**" refers collectively to Client and Client's Affiliates.

"**Damages**" means any of the following: damages, losses, liabilities, costs, expenses, arbitration awards, penalties, fines, or assessments.

"Laboratory Services" means the laboratory testing and analysis that BGC performs for Client on one or more Samples, as well as the preparation of any Work Product related to such testing and analysis.

"Party" refers to either of BGC or Client, and **"Parties"** refers to both of BGC and Client.

"Person" means, as applicable, a natural person or an entity, including a partnership, corporation, company, limited liability company, joint venture, trust, government agency, unincorporated organization or other form of entity.

"Personnel" means current, former and future directors, officers, employees, shareholders, agents, and representatives.

"Sample" means any specimen of soil, rock, material, or other substance that BGC evaluates or tests for Client pursuant to the terms of this Agreement.

"Third Party" means any Person other than a member of BGC Group or a member of Client Group.

"Work Product" means any report or deliverable that BGC generates in connection with the Laboratory Services.

GENERAL CONDITIONS

1. STANDARD OF CARE

BGC will perform the Laboratory Services in accordance with the prevailing standard of care, skill, and diligence ordinarily exercised by a consulting engineering firm when performing similar services under comparable circumstances at the same or a similar location. BGC provides no other warranty, guarantee, representation, or covenant with respect to the Laboratory Services, either express or implied.

2. COMPENSATION

2.1 BGC will charge Client for the Laboratory Services in accordance with *BGC's Schedule of Fees and Disbursements,* as updated from time to time. Unless otherwise agreed, all charges are payable in Canadian Dollars (CAD). or US Dollars,

2.2 BGC may charge Client for any applicable sales taxes, value-added taxes, import duty, and any other transactional taxes arising, accruing, or collectable with respect to the Laboratory Services. The Client bears all costs and risks of carrying out customs formalities related to the Samples, including but not limited to payment of duties, taxes, and import fees before the Samples are delivered to BGC's laboratory.

2.3 Invoices are due and payable by the Client within thirty (30) days of the invoice date.

3. RIGHT OF ENTRY AND PROJECT INFORMATION

3.1 On a timely basis, the Client shall permit, or arrange for permission, for the BGC Group to enter onto and pass over all properties to which access is necessary for the Laboratory Services. However, BGC will only visit the Project site if both Parties agree that it is necessary for BGC to do so.

3.2 The Client shall promptly provide BGC all available documents, data, and other information relevant to either the Samples or the Laboratory Services. BGC may assume that all documents, information, and data provided to BGC by the Client, the Client's Personnel or the Client's other consultants are accurate and complete. The Client will immediately notify BGC if any such document, data, or information changes or is discovered to be incomplete or unreliable.

4. SCOPE OF WORK

4.1 The Scope of Services Document will specify the scope and nature of Laboratory Services (including the applicable testing standards) that BGC will perform on a Sample. BGC is only required to prepare a report as part of the Laboratory Services if the Scope of Services Document states that BGC will prepare a report. Otherwise, BGC may only provide the raw data resulting from any tests performed during the Laboratory Services.

4.2 If BGC and the Client do not confirm in writing the scope and nature of Laboratory Services that BGC is required to perform on a Sample, then BGC may perform such tests and analyses as BGC deems appropriate, based on information the Client previously provided BGC.

4.3 Unless BGC expressly agrees otherwise in writing, BGC is not required to evaluate the Samples for pollution, radioactivity, volatile organic compounds, or toxicity. Client must notify BGC immediately if Client determines or suspects that any Sample may contain unsafe levels of pollution, radioactivity, volatile organic compounds, or toxicity.

4.4 BGC is committed to the safety of its Personnel. BGC complies with occupational safety and environmental protection codes. To safely conduct the Laboratory Services, BGC requires compliance with the conditions listed below. Failure to comply with those conditions will cause delay or refusal of a Sample delivery:

4.4.1 A Safety Data Sheet (SDS) must accompany all Samples. At a minimum, the SDS must provide the following information for all Samples:

a. Responsible Person and phone number
b. Chemical name (for mixtures list percentage composition)
c. Specific gravity, appearance, color and odor
d. Explosion hazards or reactivity
e. Health hazards
f. Personal protective equipment and any special procedures required for safe handling.

4.4.2 If any material in a Sample is known or suspected to be carcinogenic, radioactive, pathogenic, infectious, or extremely hazardous, then Client must email the SDS for the Sample to BGC at least five (5) business days before Client intends to ship the Sample to BGC. BGC may decline to accept or test any such Sample.

4.4.3 All samples must be transported in suitable containers not larger than ten (10) gallons unless BGC approves another sample size and appropriate container.

4.5 Unless BGC expressly agrees otherwise in writing, BGC is not responsible for either: (a) collecting or gathering any Samples; (b) shipping or handling for any Samples while in transit to BGC's laboratory testing facility; or (c) any loss, damage, or deterioration of any Samples while in transit to BGC's laboratory testing facility.

4.6 Client is solely responsible, at the Client's expense, for: (a) properly collecting the Samples, (b) appropriately labelling the Samples, and (c) carefully shipping the Samples to BGC's laboratory facility.

4.7 **Client acknowledges that Samples may not be fully representative of the Project's actual site conditions. Project site conditions may vary from place to place. BGC does not represent, warrant or guarantee that the results of the Laboratory Services will provide a full, complete, or representative summary of actual Project site conditions.**

4.8 Unless the Parties agree otherwise in writing, BGC may destroy or permanently dispose of any Sample one hundred eighty (180) days after BGC first receives the Sample. Until BGC is permitted to dispose of a Sample, BGC will make reasonable efforts to follow accepted industry practice for storing the Sample. If BGC agrees to return a Sample to Client, then Client will reimburse BGC for all costs incurred to do so. A disposal fee will apply if BGC is required to dispose of a Sample.

5. INTELLECTUAL PROPERTY

5.1 BGC retains sole and exclusive ownership of all right, title, and interest for, in, and to all inventions, software, programs, processes, innovations, and other intellectual property in any form that BGC creates, invents, conceives of, or acquires while performing the Laboratory Services or as a result of the Laboratory Services.

6. WORK PRODUCT

6.1 Only qualified geotechnical experts should review and interpret the Work Product. BGC will not be responsible or liable for any Claims or Damages arising from any misinterpretation of the Work Product.

6.2 BGC is entitled to retain a file copy of any Work Product and all documents the Client provides BGC.

6.3 The Client agrees to use the Work Product solely for the specific purpose(s) for which BGC prepared or disclosed such Work Product. Any alteration or other use of Work Product not authorized by BGC shall be at the Client's sole risk.

7. INSURANCE

BGC shall carry the following insurance:

a. Such coverage as may be required pursuant to applicable Worker's Compensation legislation, or satisfactory employer's liability insurance;

b. Commercial general liability insurance for bodily injury and property damages in the amount of Two Million Canadian Dollars ($2,000,000.00 CAD) per occurrence and in the aggregate; and

c. Professional liability insurance, which insures BGC against liability arising from negligent acts, errors, and omissions in BGC's professional services, in the amount of Five Hundred Thousand Canadian Dollars ($500,000.00 CAD) per claim and in the aggregate.

8. ABSOLUTE LIMIT OF LIABILITY

8.1 Claims by Client Group

8.1.1 The absolute maximum aggregate liability of the BGC Group, or any of them, to the Client Group for Claims or Damages arising out of the Laboratory Services or related in any way to the Project shall not exceed **TWO HUNDRED FIFTY THOUSAND CANADIAN DOLLARS ($250,000.00 CAD)**. For greater certainty, this liability limitation applies whether all or any of the Client Group bring one or more Claims against all or any of BGC Group in any way related to this Agreement, the Project, or the Laboratory Services. This limit of liability shall apply to all Claims and Damages including, but not limited to, those arising due to breach of contract, tort, negligence, negligent misrepresentation, errors, omissions, breach of warranty, strict liability, breach of any statutory or regulatory requirement, or under any other theory of recovery or liability at law or in equity.

8.1.2 The Client, for itself and as agent for and on behalf of the other entities of the Client Group, hereby releases the BGC Group, and each of them, from any and all past, present and future liability for Claims or Damages arising from the Laboratory Services or the Project in excess of $250,000.00 CAD.

8.1.3 The Client confirms and expressly acknowledges that it has authority to act as agent for the other entities in the Client Group for the purposes of providing the liability limitation and release noted above.

8.1.4 The Client waives and releases any right to assert any Claims against the individual Personnel of either BGC, BGC's Affiliates, or BGC's subcontractors, even if Claims or Damages arise due to the negligence, errors, omissions, or other fault of such individuals.

8.2 Claims by Third Parties

8.2.1 The Client agrees to limit the total aggregate liability of the BGC Group, or any of them, to Third Parties for Claims or Damages arising out of the Laboratory Services to **TWO HUNDRED FIFTY THOUSAND CANADIAN DOLLARS ($250,000.00 CAD)** (the "Third Party Liability Limit"). If the total aggregate liability of all or any of the BGC Group for Third Parties' Claims or Damages exceeds the Third Party Liability Limit, then the Client will indemnify the BGC Group, and each of them, for all liability above the Third Party Liability Limit.

8.2.2 The indemnity in section 8.2.1 shall apply to all Claims or Damages including, but not limited to, those arising due to breach of contract, tort, negligence, negligent misrepresentation, errors, omissions, breach of warranty, strict liability, breach of any statutory or regulatory requirement, or under any other theory of recovery or liability at law or in equity.

9. EXCLUSIONS OF LIABILITY, AGREEMENTS TO DEFEND, AND INDEMNITIES

9.1 The Client agrees to defend, indemnify and hold harmless the BGC Group, and each of them, against any Claim asserted, brought, or prosecuted by a Third Party against the BGC Group, or any of them, that relates, in whole or in part, to any of the following:

9.1.1 the negligence, breach of contract, breach of duty, or any other fault of the Client, the Client's Affiliates, the Client's other contractors, the Client's other consultants, or any of their respective Personnel;

9.1.2 defects in data or Samples supplied to BGC by the Client or the Client's contractors or other consultants; or

9.1.3 use of any Work Product by the Client, its Affiliates, or their respective Personnel for any purpose other than the specific purpose or Project for which BGC prepared such Work Product.

9.2 All the Client's obligations to defend, release, and indemnify BGC Group in this Agreement shall survive any termination or expiry of this Agreement.

10. MUTUAL WAIVER OF PUNITIVE, EXEMPLARY, INDIRECT, INCIDENTAL, AND CONSEQUENTIAL DAMAGES

10.1 Each Party, for itself and as agent on behalf of its Affiliates, hereby releases the other Party, such other Party's Affiliates, and their respective Personnel from all liability for any punitive, exemplary, aggravated, indirect, incidental, and consequential damages that may arise in connection with the performance, purported performance, or non-performance of this Agreement or the Laboratory Services, howsoever caused, and whether arising due to breach of contract, tort (including negligence), strict liability, or under any other theory of liability at law or in equity. This waiver and release applies even if the possibility of

such losses or damages was known or foreseeable. Examples of such waived damages include, but are not limited to, lost profits, lost revenue, loss of contracts, loss of production, loss of business opportunity, costs of capital, business interruptions, loss of goodwill, loss of work, and loss of Project use. Each Party confirms and acknowledges that it has authority to act as agent for its Affiliates for the purposes of providing this waiver and release.

11. TERMS FAIRLY NEGOTIATED IN CONSIDERATION OF RELATIVE RISKS AND BENEFITS

11.1 The Parties acknowledge and agree that the exclusions of liability, limitations of liability, agreements to defend, indemnities, and waivers in this Agreement were fairly negotiated between them in consideration of the relative risks and benefits of the Laboratory Services to the Parties.

12. EARLY TERMINATION

12.1 Either Party may terminate this Agreement for any reason upon thirty (30) days written notice to the other Party.

12.2 Either Party may terminate this Agreement upon ten (10) days written notice to the other Party if the other Party is in default of its obligations under this Agreement and has failed within five (5) business days after receiving a default notice to cure such default, or to take reasonable steps towards curing such default.

12.3 Either Party may immediately terminate this Agreement if the other Party becomes insolvent, takes the benefit of any insolvency or bankruptcy law without providing prompt assurance that it will perform the balance of its obligations under this Agreement, makes a general assignment for the benefit of its creditors, or enters into a plan or arrangement for the benefit of its creditors.

12.4 If this Agreement is terminated for any reason, the Client shall forthwith pay BGC all amounts the Client owes BGC for satisfactorily performed Laboratory Services.

13. ASSIGNMENT

13.1 Except as otherwise agreed in writing, no Party may assign this Agreement without the other Party's written consent. The Parties' permitted successors and assigns are entitled to the benefit of, and shall be bound by, this Agreement.

14. FORCE MAJEURE

14.1 BGC shall not be in breach of this Agreement or liable for any Claims or Damages caused by delay or failure to perform, in full or in part, any of its obligations under this Agreement when such delay or failure to perform is due to any circumstance beyond BGC's reasonable control, including, without limitation: any strikes, walk-outs, riots, unavoidable incidents, floods, fires, earthquakes, natural disasters, inclement weather, acts of God or a public enemy, or a lawful order issued by a governmental authority.

15. NOTICES

15.1 Required written notices between the Parties shall be considered to have been received by the addressee on the date of delivery if personally delivered by hand during normal business hours to the addressee, or to a member of the addressee's firm, or to an officer of the corporation for whom the notice is intended. If sent by regular post, such written notice shall be deemed to have been delivered five (5) business days from the date of mailing. Notices sent by email or facsimile shall be deemed delivered upon completed transmission if properly directed and sent before 4:30pm Atlantic Time on a normal workday that is not a federal Canadian holiday, provided that the sending Party has an electronic acknowledgement that the facsimile or e-mail was received by the other Party.

15.2 Each Party shall designate a representative who is authorized to act on behalf of that Party and to receive notices under this Agreement. In the absence of such designation of an authorized representative, a Party's signatory to this Agreement is deemed to be that Party's representative. If this Agreement has not been signed, then the notice shall be provided by delivering written notice in accordance with section 15.1 to a Party's place of business.

16. SURVIVAL

16.1 All rights and obligations between the Parties under Sections 5 (Intellectual Property), 6 (Work Product), 8 (Absolute Limit of Liability), 9 (Exclusions of Liability, Agreements to Defend and Indemnities), 10 (Mutual Waiver of Punitive, Exemplary, Indirect, Incidental and Consequential Damages) shall survive and remain binding on the Parties after completion of the Laboratory Services or the expiry or any termination of this Agreement.

17. GENERAL PROVISIONS

17.1 This Agreement is governed by the law of British Columbia, Canada, without regard to any conflicts of law principles or any international treaty that may direct the application of the substantive law of another jurisdiction.

17.2 A Party's waiver of any breach of the other Party's obligations under this Agreement shall not be binding unless the waiver is in writing and signed by an authorized representative of the waiving Party.

17.3 If a court of competent jurisdiction determines that any part or provision of this Agreement is illegal, invalid, or unenforceable, then any such part or provision shall be limited or modified to the minimum extent necessary to make it and the remainder of this Agreement enforceable, and the provisions of this Agreement as so amended shall remain in full force and effect.

17.4 In this Agreement, the singular includes the plural and vice versa. All headings in this Agreement are for convenience only, and shall not be used to interpret this Agreement. This Agreement may be executed in separate counterparts, including electronically or by facsimile, and all such counterparts taken together shall be deemed the same original instrument.

SCOPE OF WORK FOR LINER INTERFACE SHEAR

Approved Project Number	Current Short Description	Synthetic Liner Genral Description	Synthetic Liner Short Description	Testing Required(y/n)[1]	Estimated Cost ($CAD)	LLDPE Sample Required (m2)-0.5x0.7	ODF Sample Required (# 20L buckets)	Subgrade Sample Required	Notes
1	Current Approved System	GCL LLDPE	GSE-NWL60 SOLMAX 80 MIL-11007064	n	$ -	0	0	0	Nilex Quoted LLDPE
N/A- as of 2020-01-09	Proposed System #A (Layfield)	GCL LLDPE	GSE-NWL60 EnviroLiner 4280 80 MIL (LF)	y	$ 6,300	1.05	6	3	
N/A- as of 2020-01-09	Proposed System #B	GCL LLDPE	BENTOMATOMAT DN SOLMAX 80 MIL-11007064	y	$ 6,300	1.05	6	3	
N/A- as of 2020-01-09	Proposed System #C	GCL LLDPE	BENTOMATOMAT DN EnviroLiner 4280 80 MIL (LF)	y	$ 6,300	1.05	6	3	
TOTAL TO OBTAIN (3) ADDITIONAL SYNTHETIC SYSTEM OPTIONS					$ 18,900	5.25	18	9	

1. Linear interface shear tests ASTM D5321-17. (3) shear tests at vertical stress of 400, 800, 1600 kPa per proposed system.
Additional testing to determine soil charcteristics may also be performed in order to perform the liner interface shear Test

ATTACHMENT B: LINER PRODUCT SPECIFICATIONS SHEETS

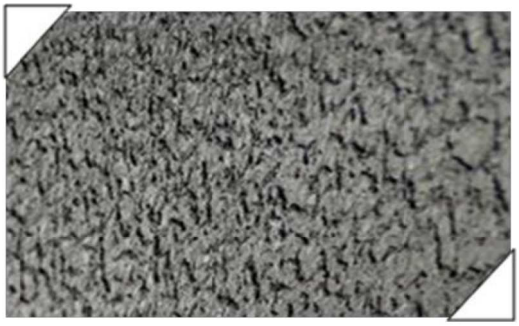
APPROVED

☐ PROCEED TO NEXT SUBMISSION
☐ PROCEED WITH EXCEPTIONS AS NOTED TO NEXT SUBMISSION
☐ DO NOT PROCEED, REVISE AS NOTED AND RESUBMIT
☒ COMPLETE NO FURTHER SUBMISSIONS REQUIRED
FORTE

LAYFIELD

Geomembrane [EL4280, 2-sided Coarse Textured]

Our Enviro Liner 4000 coarse textured series Geomembranes have better interface friction capabilities compared to our standard textured geomembranes. Texturing can be accomplished either on one side or on both sides. Enviro Liner 4000 coarse textured product can be manufactured to custom asperity heights and is available by special order. Layfield is capable of supplying the friction and strength properties you require for your design build project. Enviro Liner 4280 Coarse Textured Geomembrane meets or exceeds the requirements of Table 2(B) GRI GM 17 specification for textured Linear Low-Density Polyethylene Geomembranes.



Property	ASTM	EL4280[1] 2-sided Coarse Textured	Frequency
Thickness nominal	D5994	2.00 mm	
- min.ave -lowest individual for 8 out of 10 values -lowest individual for any of the 10 values	D5994	1.90 mm 1.80 mm 1.70 mm	Every Roll
Sheet Density	D792	≤0.939 g/cc	Every 10 rolls
Dimensional Stability	D1204	±2%	Once per formulation
Tensile Properties (min. avg) Strength @ Break Elongation @ Break	D6693, Type IV Die	 31 kN/m 380%	Every 2 rolls
Asperity Height (min.ave)	D7466	0.50 mm	Every roll
Tear Resistance (min. avg)	D1004	200 N	Every 5 rolls
Puncture Resistance (min. avg)	D4833	500 N	Every 5 rolls
Multi-axial Elongation (typical)	D5617	30%	Once per formulation
Carbon Black Content	D4280	2.0-3.0%	Every 2 rolls
Carbon Black Dispersion	D5596	9 in Cat 1/ Cat 2 1 in Cat 3	Every 10 rolls
Oxidative Induction Time (OIT) High Pressure Oxidative Induction Time (HPOIT)	D5885	100 mins 400 mins	Per resin batch
Oven aging, 85 deg C, HOPIT % retained after 90 days	D5721 D5885	60%	Once per formulation
UV Resistance, HPOIT retained after 1600 hrs	D7238 D5885	35%	Once per formulation
Low Temperature Brittleness	D746	-70°C	Once per formulation
Roll Width	-	6.85 mtrs	
Roll Length	-	128 mtrs	

[1]*This product is made in Richmond, B.C, Canada.*

Disclaimer: Layfield disclaims any and all express, implied, or statutory standards, warranties or guarantees, including without limitation any implied warranty as to merchantability or fitness for a particular purpose or arising from a course of dealing or usage of trade as to any equipment, materials, or information furnished herewith. This document should not be construed as engineering advice.

Rev-12/19

PRODUCT DATA SHEET

GSE BentoLiner NWL-60 Geosynthetic Clay Liner

GSE BentoLiner "NWL-60" is a heavily needlepunched reinforced composite geosynthetic clay liner (GCL) comprised of a uniform layer of granular sodium bentonite encapsulated between a nonwoven and a scrim-nonwoven geotextile for dimensional stability. The product is intended for steep slopes and high load applications where increased internal shear strength is required.

- ☐ PROCEED TO NEXT SUBMISSION
- ☐ PROCEED WITH EXCEPTIONS AS NOTED TO NEXT SUBMISSION
- ☐ DO NOT PROCEED, REVISE AS NOTED AND RESUBMIT
- ☒ COMPLETE NO FURTHER SUBMISSIONS REQUIRED

FORTE

[*]

AT THE CORE:

This composite clay liner is intended for steep slopes and high load applications where increased internal shear strength is required.

Product Specifications

Tested Property	Test Method	Frequency	VALUE
Geotextile Property			
Cap Nonwoven, Mass/Unit Area	ASTM D 5261	1/200,000 ft²	6.0 oz/yd² MARV(1)
Carrier Scrim Nonwoven, Mass/Unit Area	ASTM D 5261	1/200,000 ft²	6.0 oz/yd² MARV
Bentonite Property			
Swell Index	ASTM D 5890	1/100,000 lb	24 ml/2 g min
Moisture Content	ASTM D 4643	1/100,000 lb	12% max
Fluid Loss	ASTM D 5891	1/100,000 lb	18 ml max
Finished GCL Property			
Bentonite, Mass/Unit Area(2)	ASTM D 5993	1/40,000 ft²	0.75 lb/ft² MARV
Tensile Strength(3)	ASTM D 6768	1/40,000 ft²	50 lb/in MARV
Peel Strength	ASTM D 6496 ASTM D 4632(4)	1/40,000 ft²	12 lb/in MARV 60 lb MARV
Hydraulic Conductivity(5)	ASTM D 5887	1/Week	5 x 10^{-9} cm/sec max
Index Flux(5)	ASTM D 5887	1/Week	1 x 10^{-8} m³/m²/sec max
Internal Shear Strength(6)	ASTM D 6243	Periodically	500 psf Typical
TYPICAL ROLL DIMENSIONS			
Width x Length(7)	Typical	Every Roll	15.5 ft x 150 ft
Area per Roll	Typical	Every Roll	2,325 ft²
Packaged Weight	Typical	Every Roll	2,600 lb

NOTES:

- (1)Minimum Average Roll Value.
- (2)At 0% moisture content.
- (3)Tested in machine direction.
- (4)Modified ASTM D 4632 to use a 4 in wide grip. The maximum peak of five specimens averaged in machine direction.
- (5)Deaired, deionized water @ 5 psi maximum effective confining stress and 2 psi head pressure.
- (6)Typical peak value for specimen hydrated for 24 hours and sheared under a 200 psf normal stress.
- (7)Roll widths and lengths have a tolerance of ±1%.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP]

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

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SOLMAX

☐ PROCEED TO NEXT SUBMISSION
☐ PROCEED WITH EXCEPTIONS AS NOTED TO NEXT SUBMISSION
☐ DO NOT PROCEED, REVISE AS NOTED AND RESUBMIT
☒ COMPLETE NO FURTHER SUBMISSIONS REQUIRED
FORTE

TECHNICAL DATA SHEET

LLDPE Series, 2.00 mm

Black, Textured

2801 Marie-Victorin Blvd. Varennes, Quebec Canada J3X 1P7
Tel: (450) 929-1234 Sales: (450) 929-2544 Toll free in North America:1-800-571-3904 www.Solmax.com www.solmax.com

PROPERTY	TEST METHOD	FREQUENCY(1)	UNIT Metric	1007064
SPECIFICATIONS				
Nominal Thickness	-	-	mm	2.00
Thickness (min. avg.)	ASTM D-5994	Every roll	mm	1.90
Lowest ind. for 8 out of 10 values			mm	1.80
Lowest ind. for 10 out of 10 values			mm	1.70
Asperity Height (min. avg.) (3)	ASTM D-7466	Every roll	mm	0.50
Melt Index - 190/2.16 (max.)	ASTM D-1238	1/Batch	g/10 min	1.0
Sheet Density (8)	ASTM D-792	Every 10 rolls	g/cc	≤ 0.939
Carbon Black Content (9)	ASTM D-4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D-5596	Every 10 rolls	Category	Cat. 1 / Cat. 2
OIT - standard (avg.)	ASTM D-3895	1/Batch	min	100
Tensile Properties (min. avg) (2)	ASTM D-6693	Every 2 rolls		
Strength at Break			kN/m	31
Elongation at Break			%	400
2% Modulus (max.)	ASTM D-5323	Per formulation	kN/m	840
Tear Resistance (min. avg.)	ASTM D-1004	Every 5 rolls	N	220
Puncture Resistance (min. avg.)	ASTM D-4833	Every 5 rolls	N	500
Dimensional Stability	ASTM D-1204	Certified	%	± 2
Multi-Axial Tensile (min.)	ASTM D-5617	Per formulation	%	30
Oven Aging - % retained after 90 days	ASTM D-5721	Per formulation		
STD OIT (min. avg.)	ASTM D-3895		%	35
HP OIT (min. avg.)	ASTM D-5885		%	60
UV Res. - % retained after 1600 hr	ASTM D-7238	Per formulation		
HP-OIT (min. avg.)	ASTM D-5885		%	35
Low Temperature Brittleness	ASTM D-746	Certified	°C	- 77
SUPPLY SPECIFICATIONS (Roll dimensions may vary ±1%)				
Roll Dimension - Width	-		m	6.80
Roll Dimension - Length	-		m	121.9
Area (Surface/Roll)	-		m²	828.9

NOTES

1. Testing frequency based on standard roll dimension and one batch is approximately 180,000 lbs (or one railcar).
2. Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
3. ASTM D7466 is identical to GRI-GM12.
8. Correlation table is available for ASTM D792 vs ASTM D1505. Both methods give the same results.
9. Correlation table is available for ASTM D1603 vs ASTM D4218. Both methods give the same results.

* All values are nominal test results, except when specified as minimum or maximum.
* The information contained herein is provided for reference purposes only and is not intended as a warranty of guarantee. Final determination of suitability for use contemplated is the sole responsability of the user. SOLMAX assumes no liability in connection with the use of this information.

Solmax is not a design professional and has not performed any design services to determine if Solmax's goods comply with any project plans or specifications, or with the application or use of Solmax's goods to any particular system, project, purpose, installation or specification.

ATTACHMENT C: STABILITY ANALYSIS RESULTS

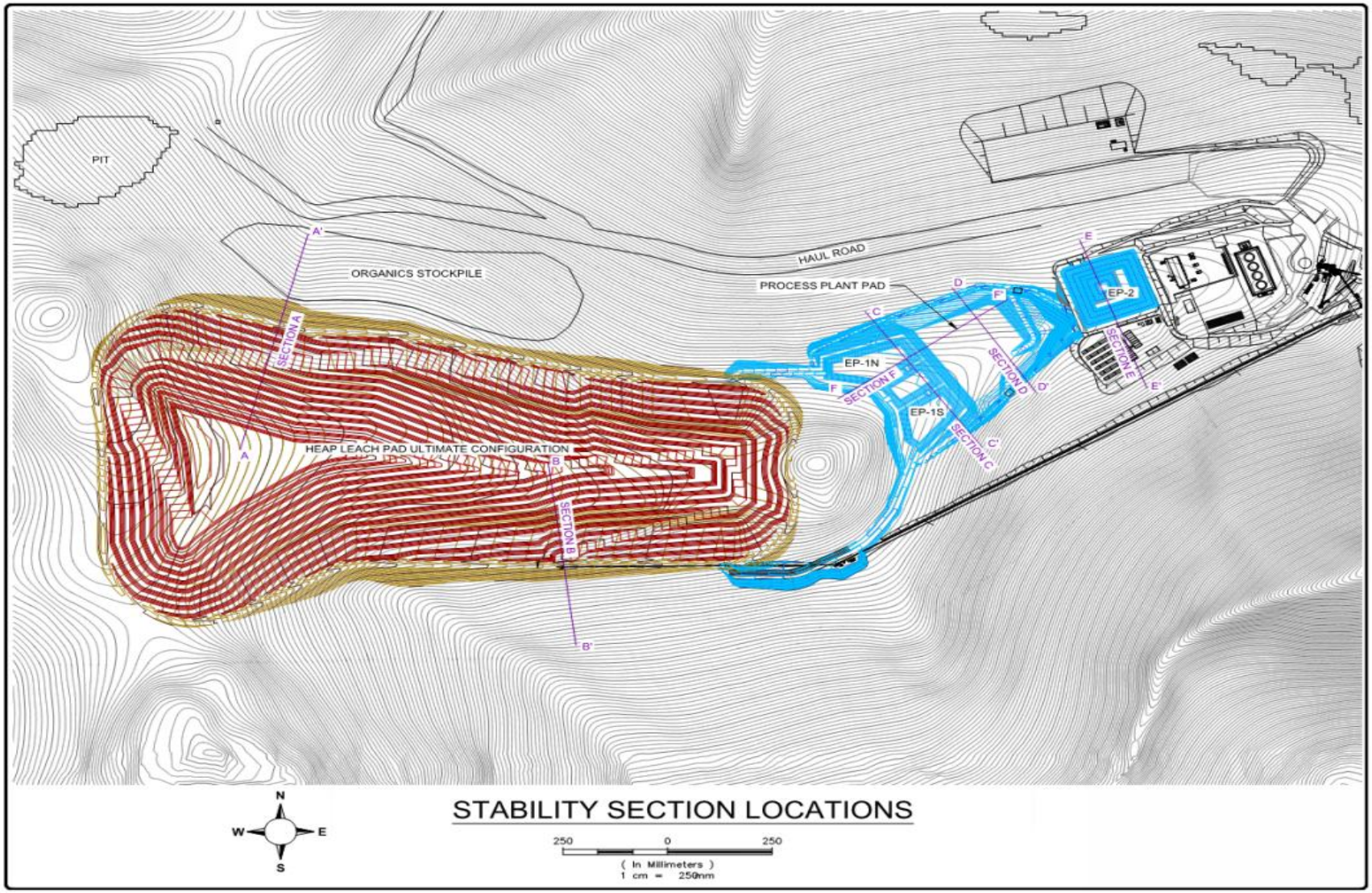


Figure 1: Stability Section Locations

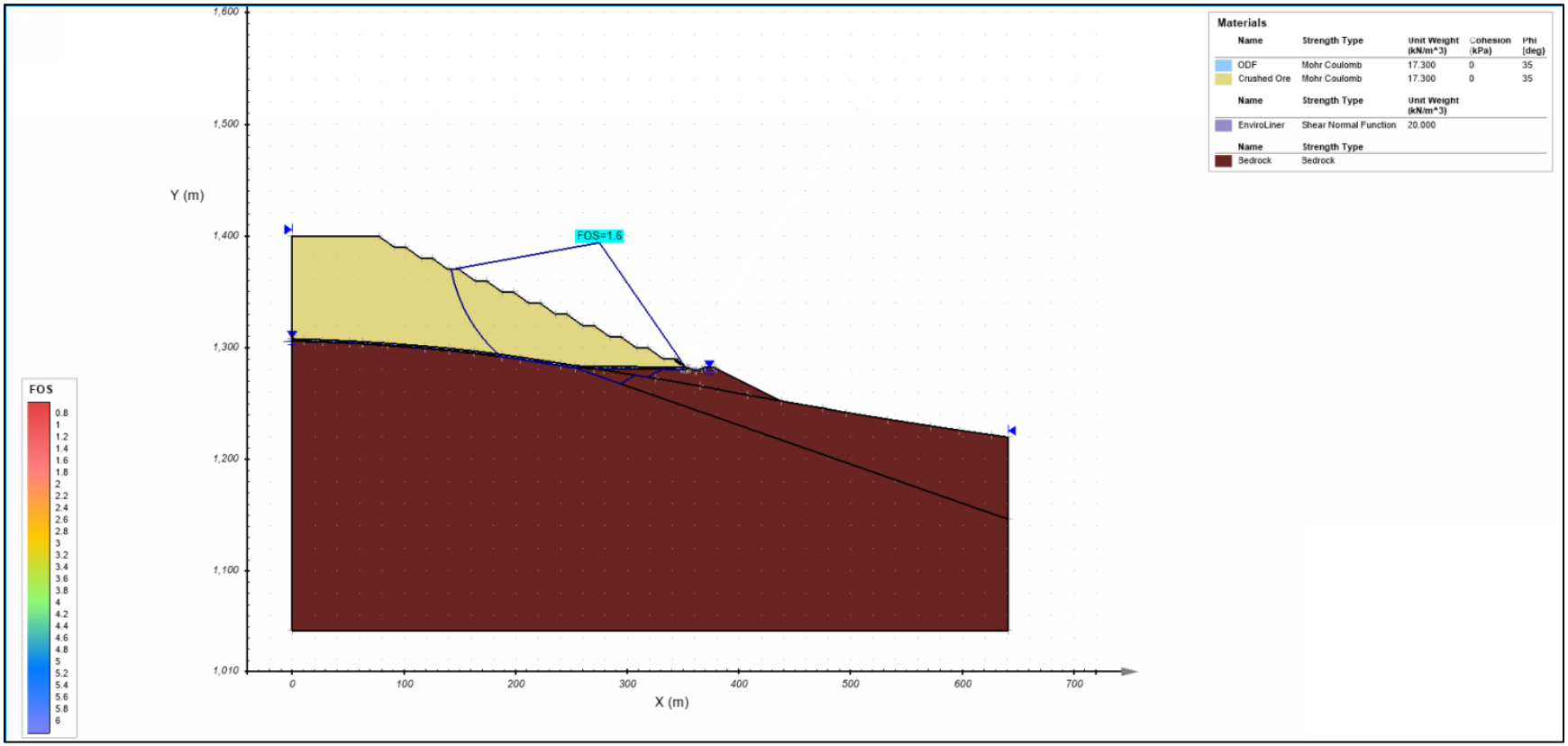


Figure 2: Section A - Static Circular Through Liner

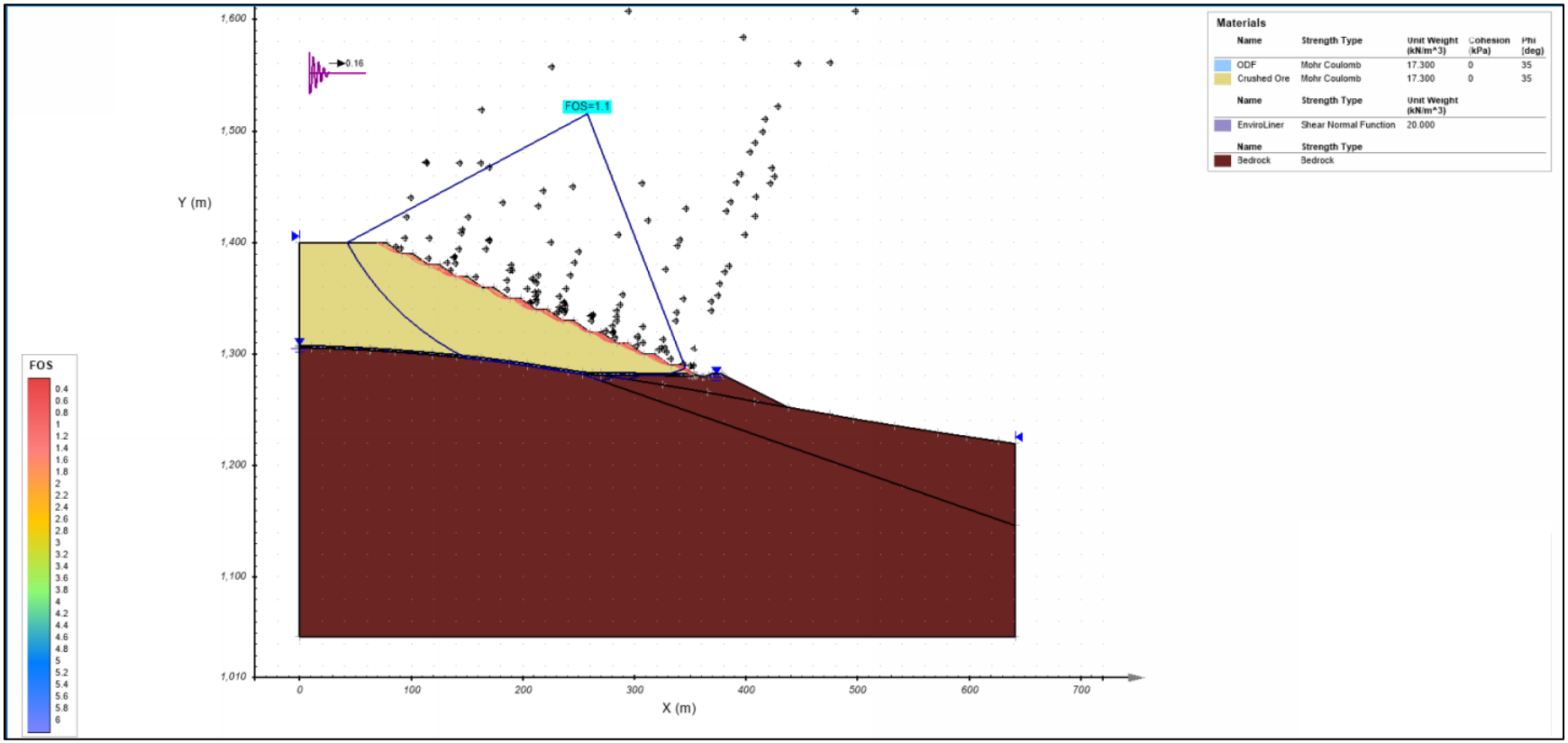


Figure 3: Section A – Pseudo-Static Circular Through Liner

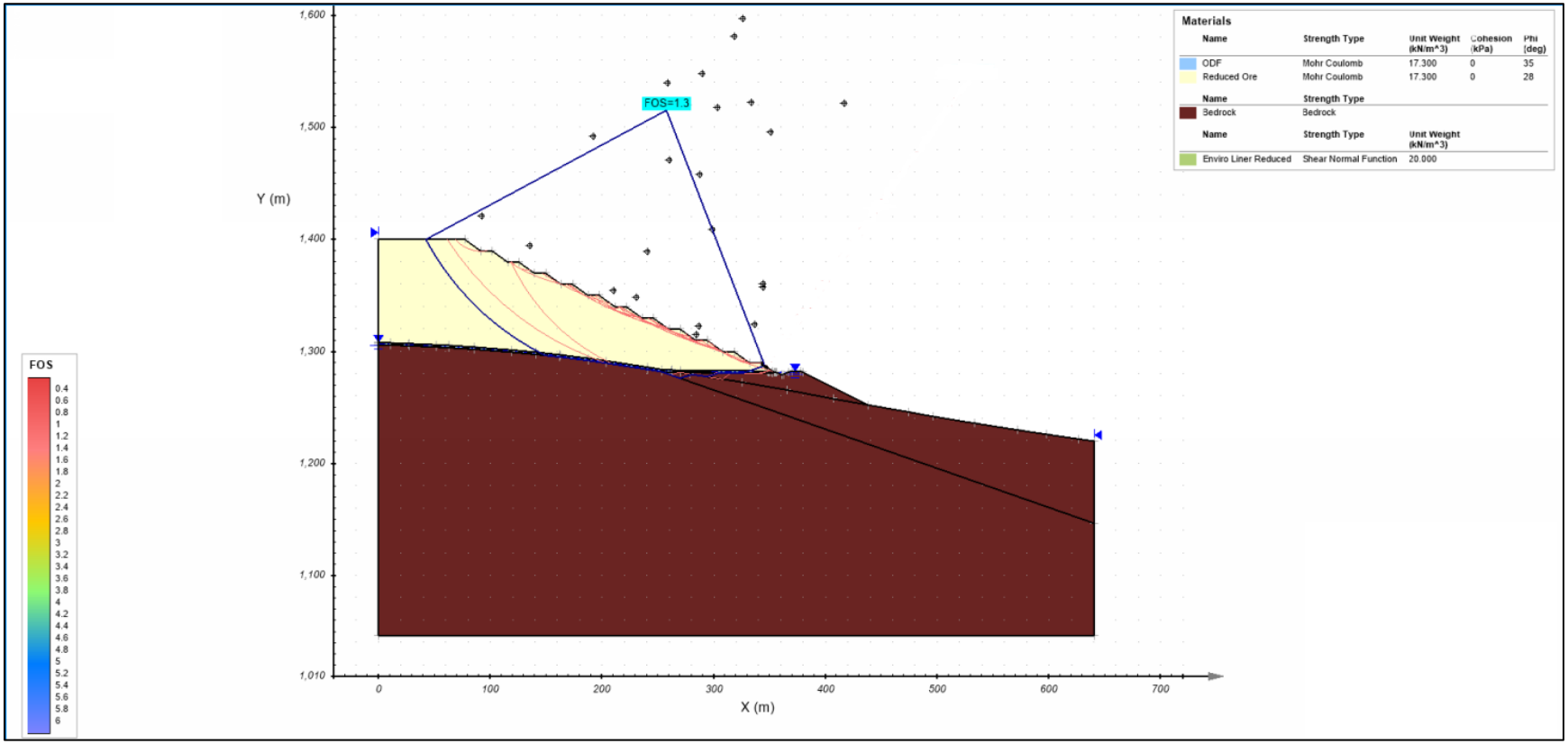


Figure 4: Section A - Post Earthquake

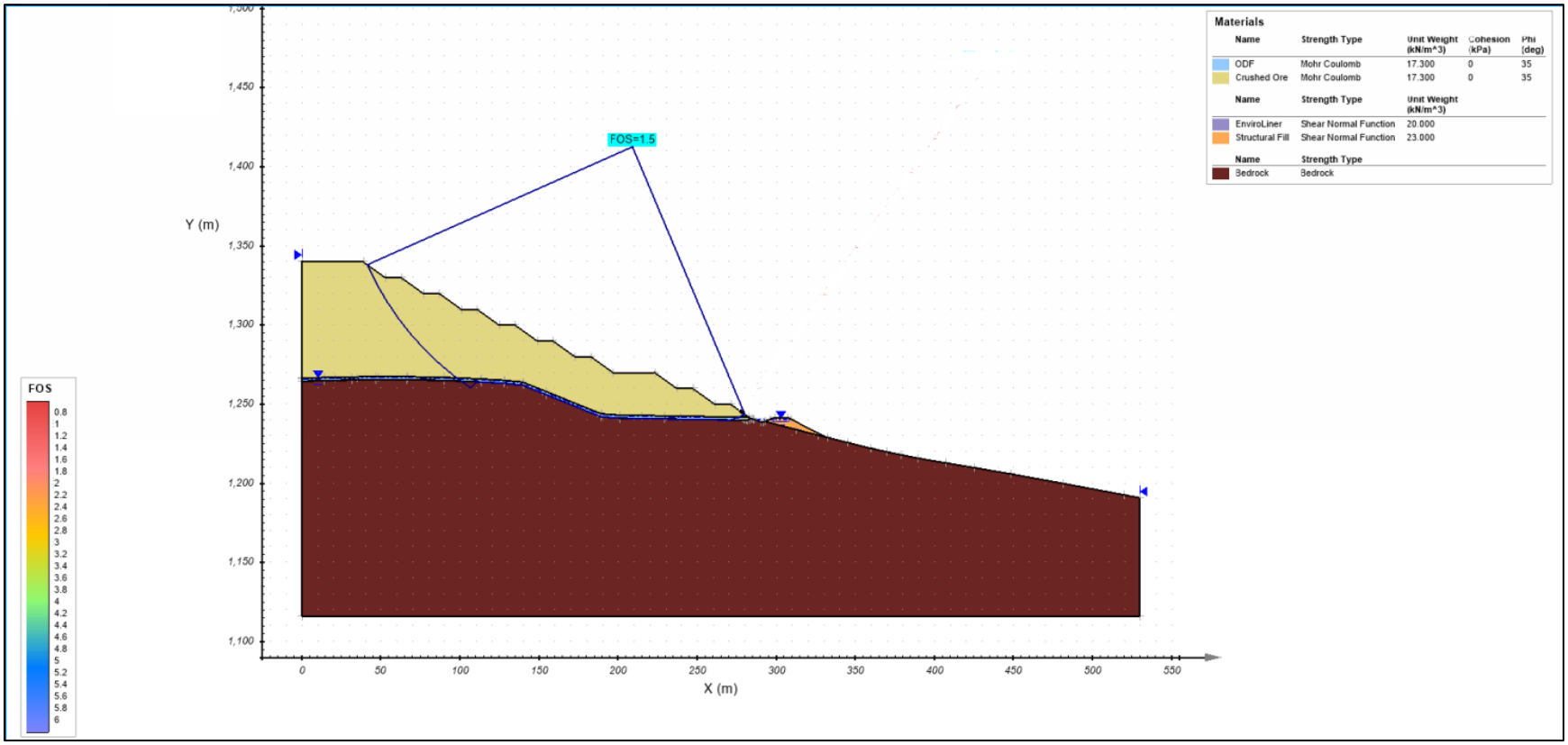


Figure 5: Section B – Static Circular Through Liner

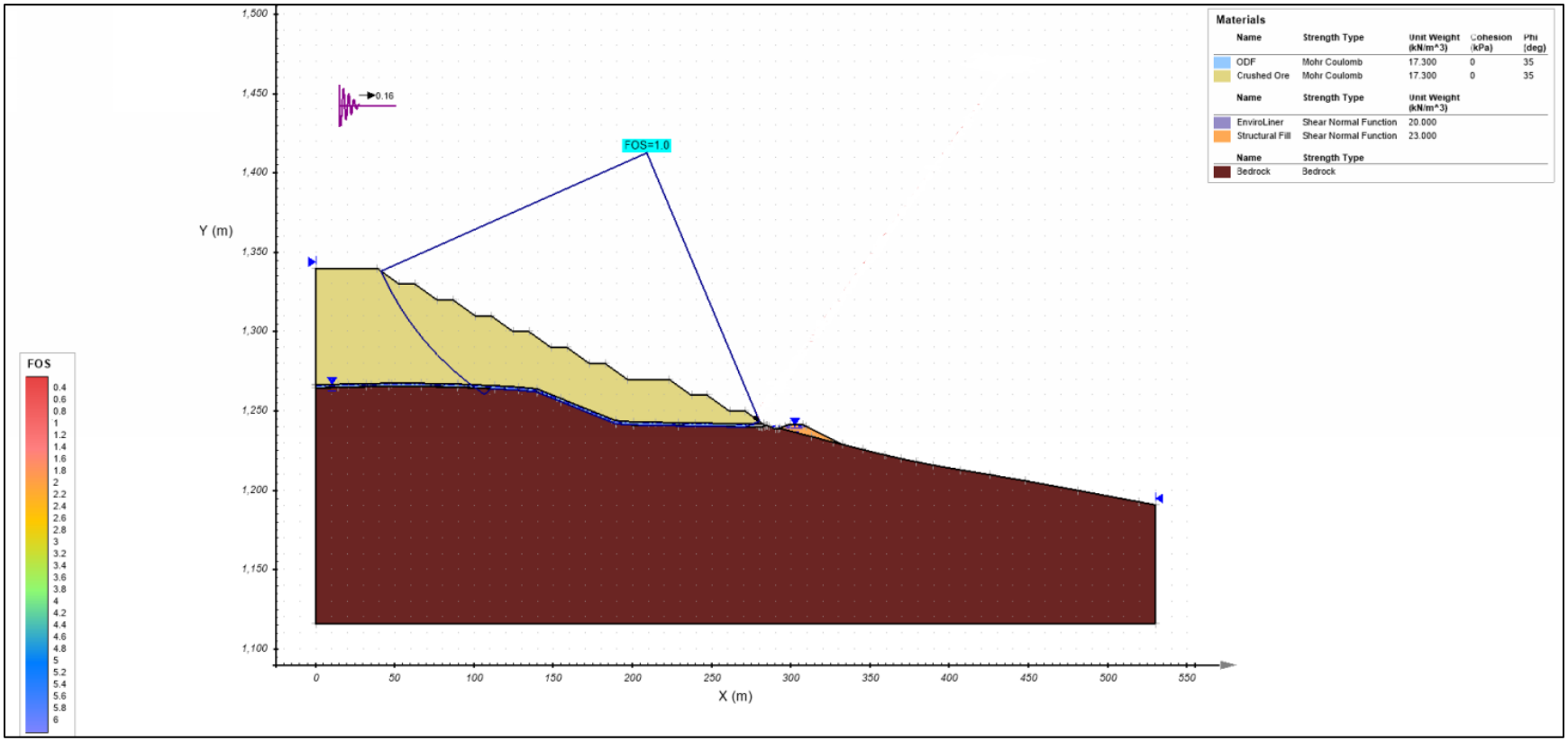


Figure 6: Section B – Pseudo-Static Circular Through Liner

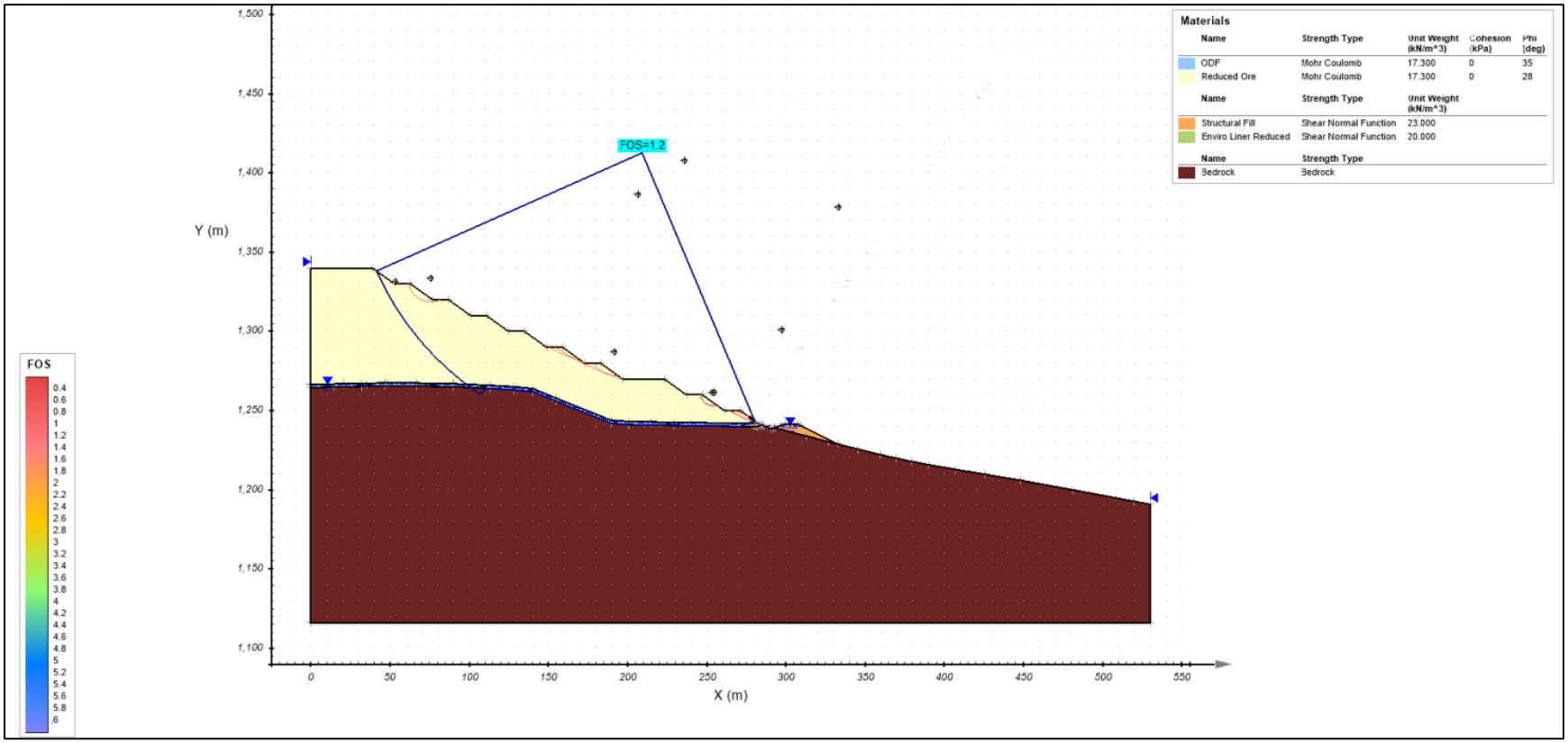


Figure 7: Section B - Post Earthquake

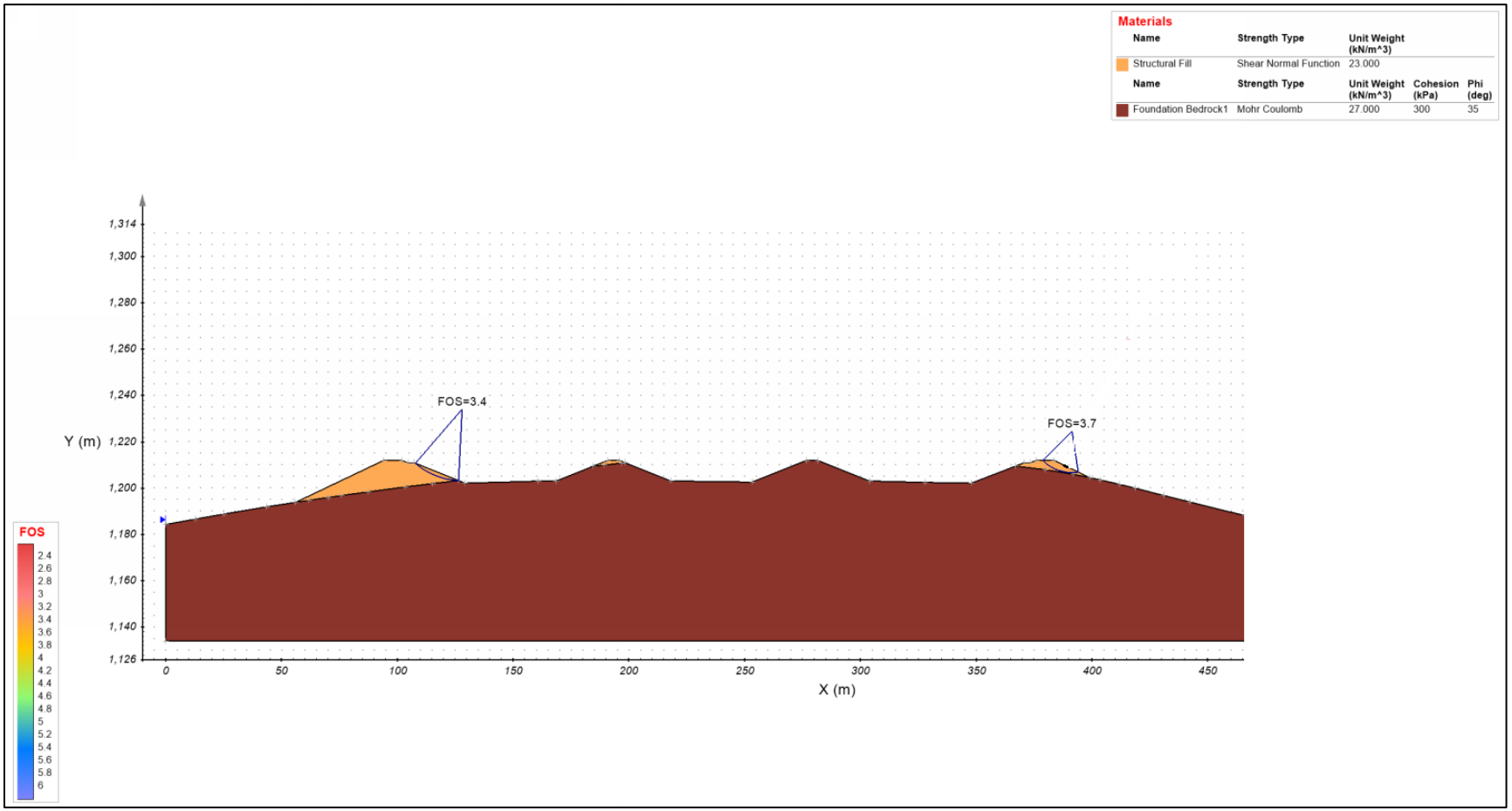


Figure 8: Section C – L-R Static

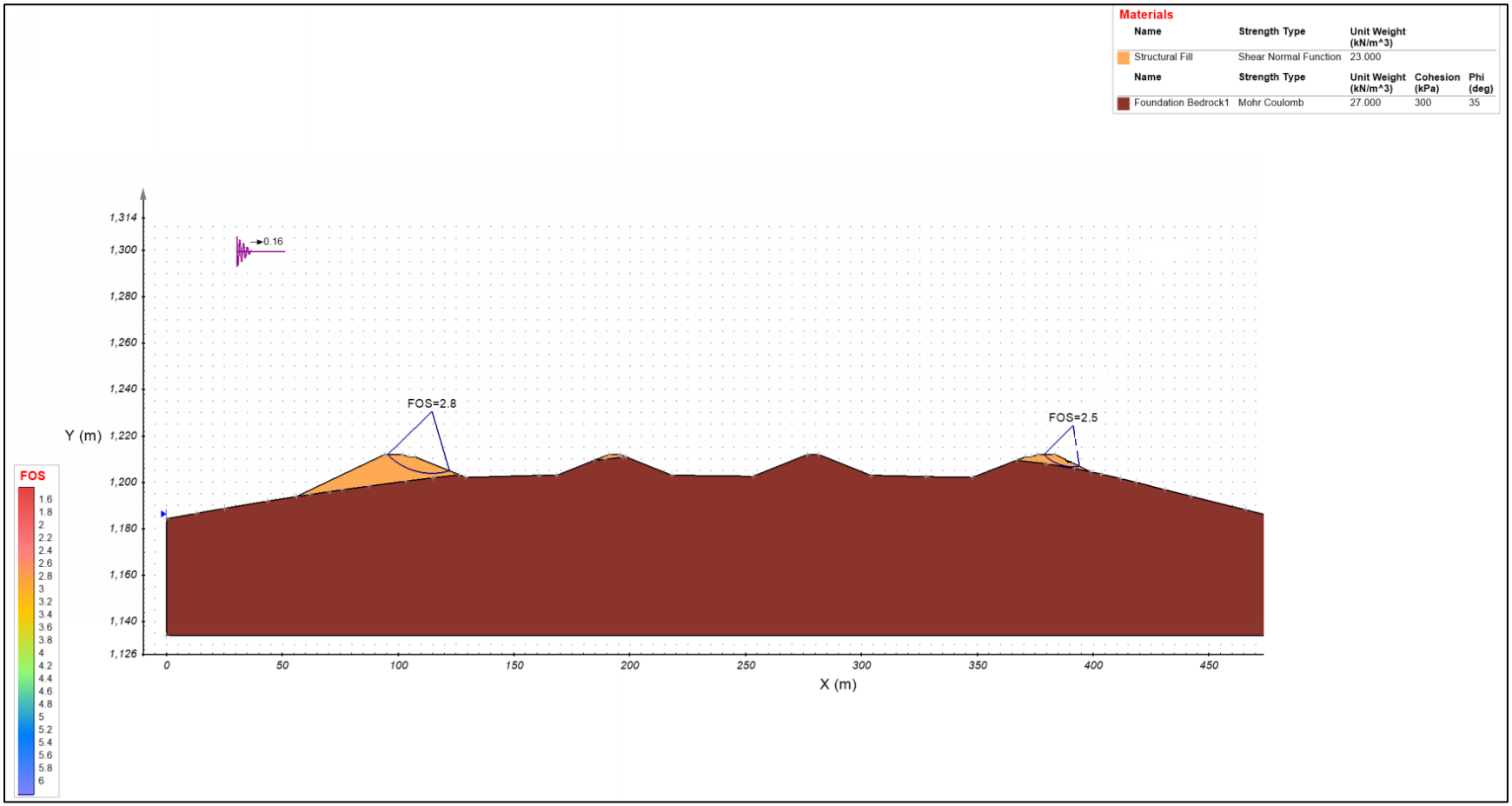


Figure 9: Section C - L-R Pseudo

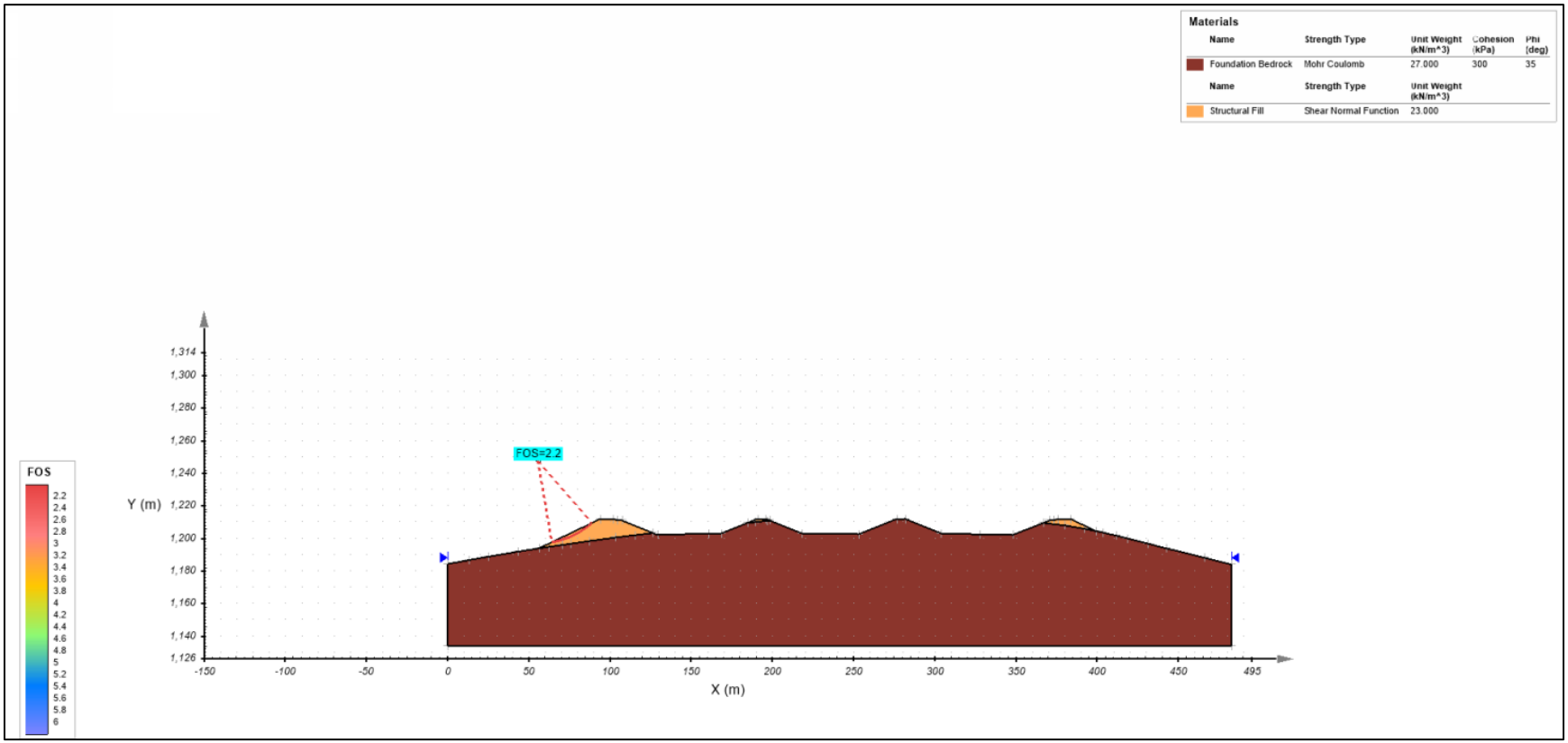


Figure 10: Section C - R-L Static

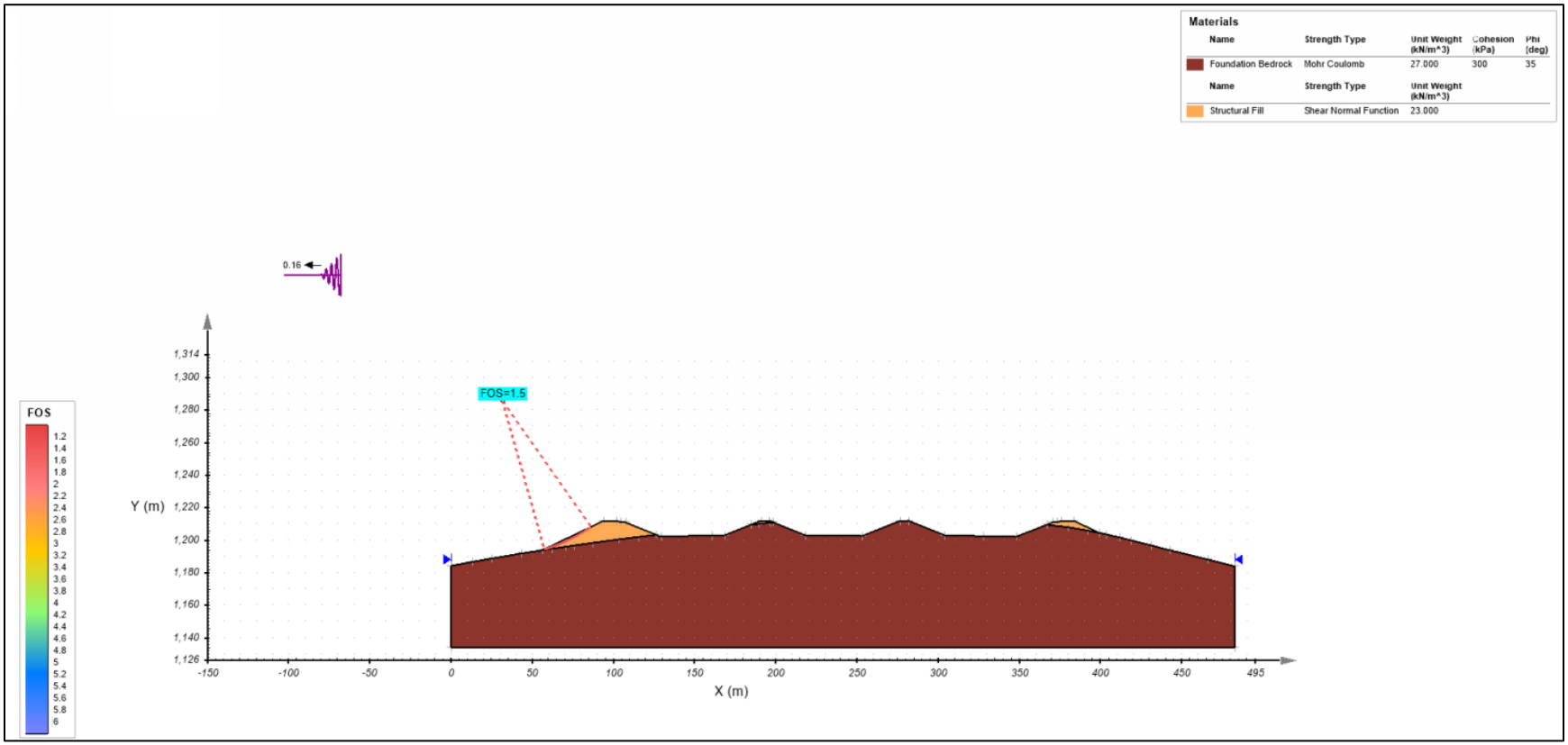


Figure 11: Section C - R-L Pseudo

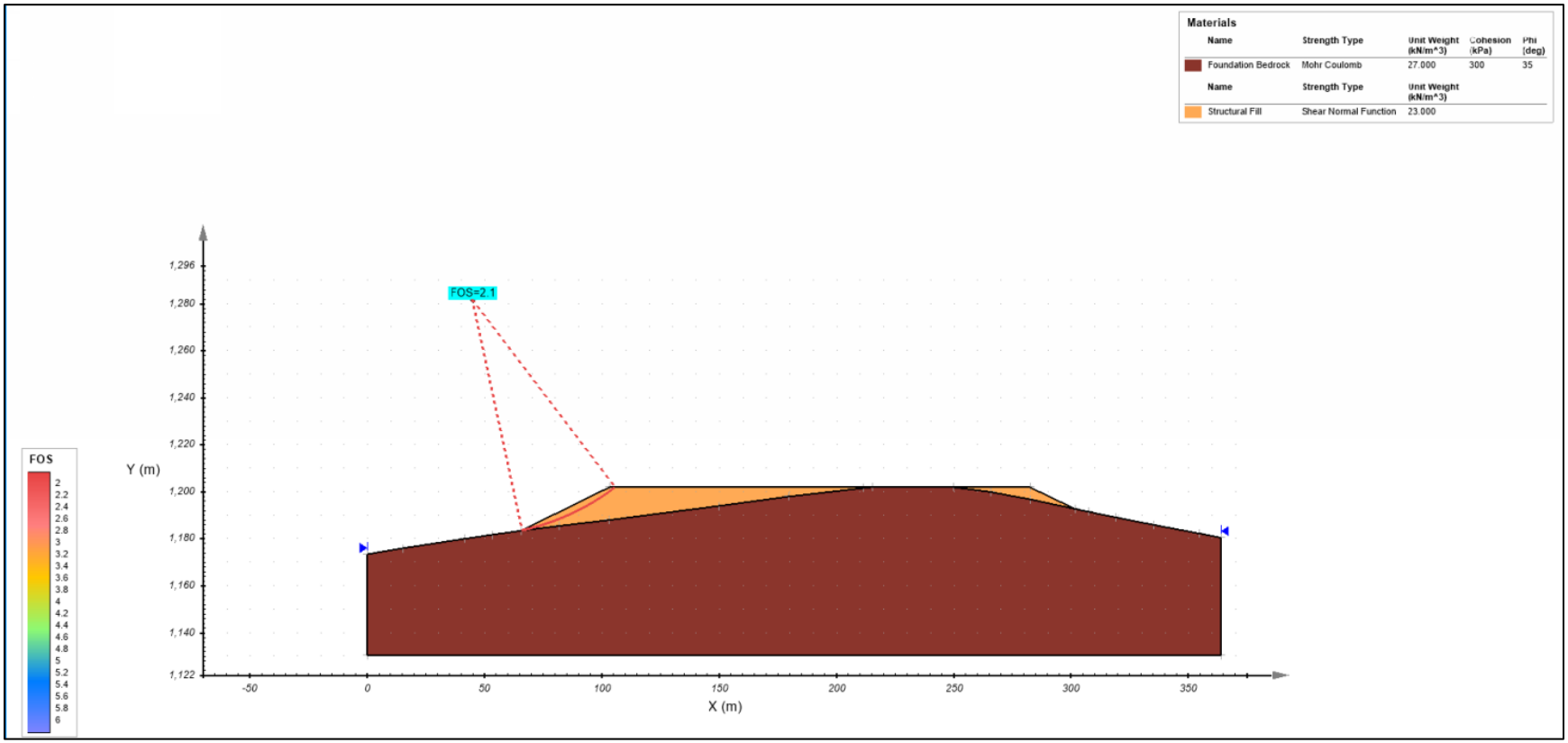


Figure 12: Section D - R-L Static

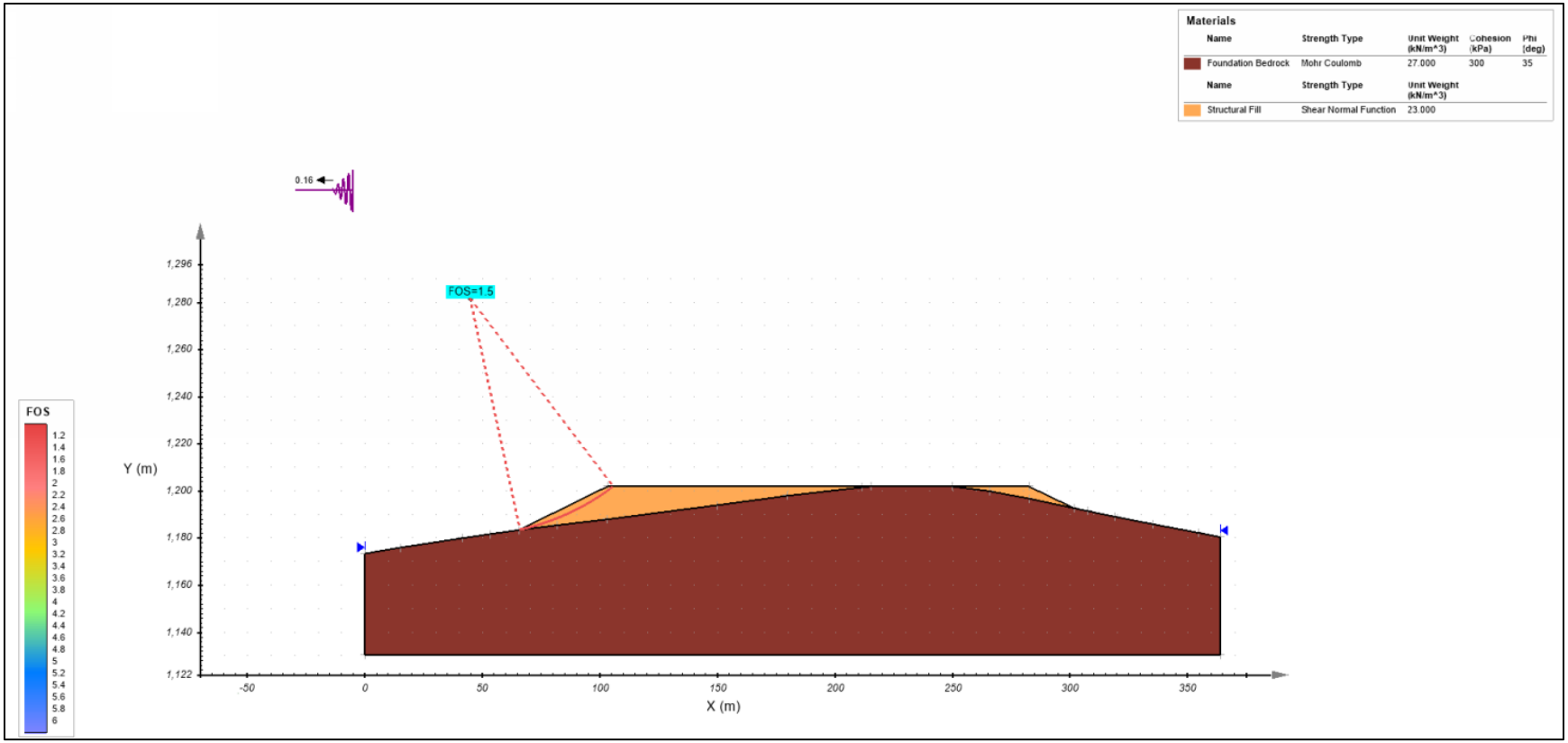


Figure 13: Section D - R-L Pseudo

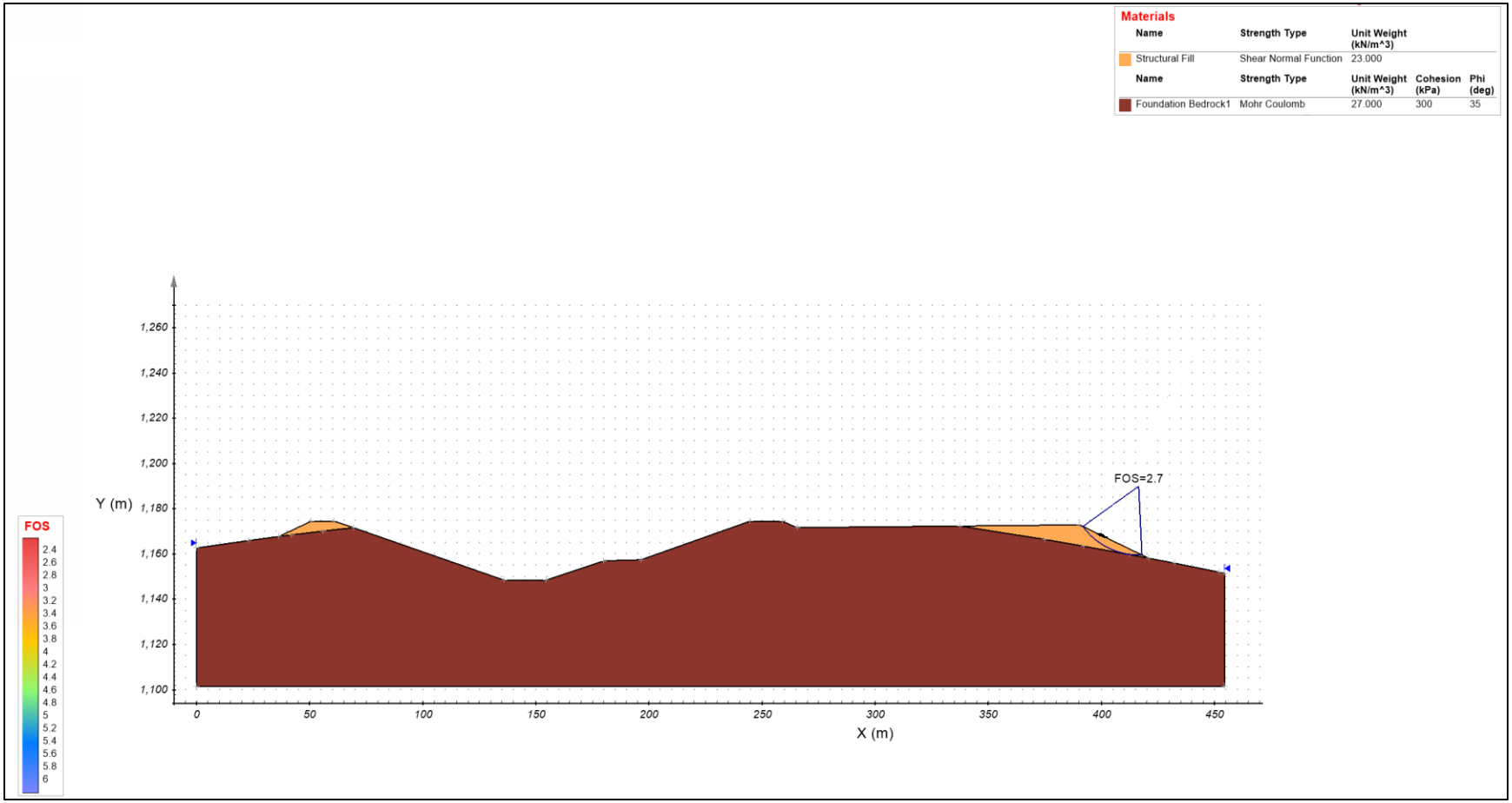


Figure 14 : Section E - L-R Static

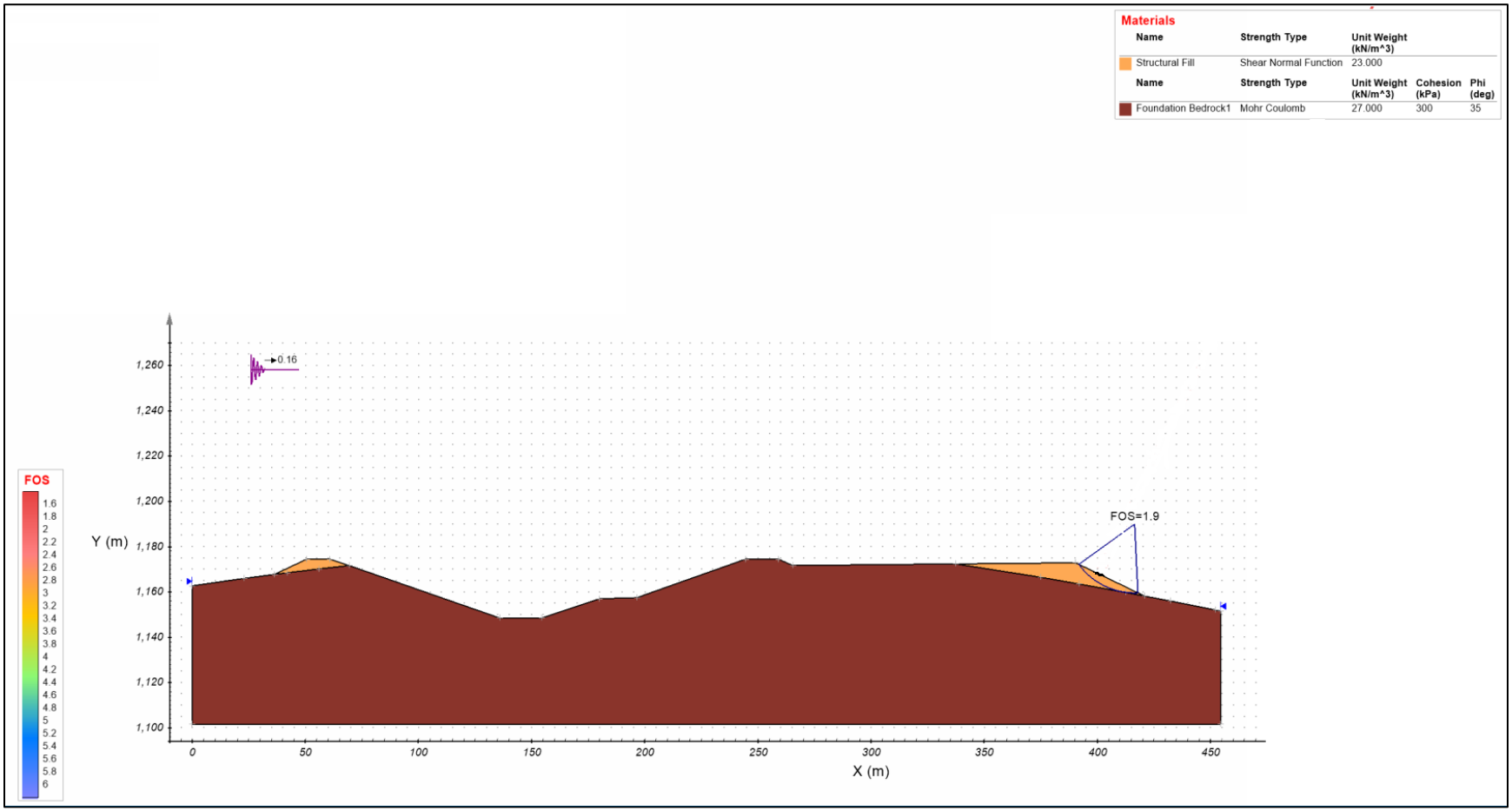


Figure 15: Section E - L-R Pseudo

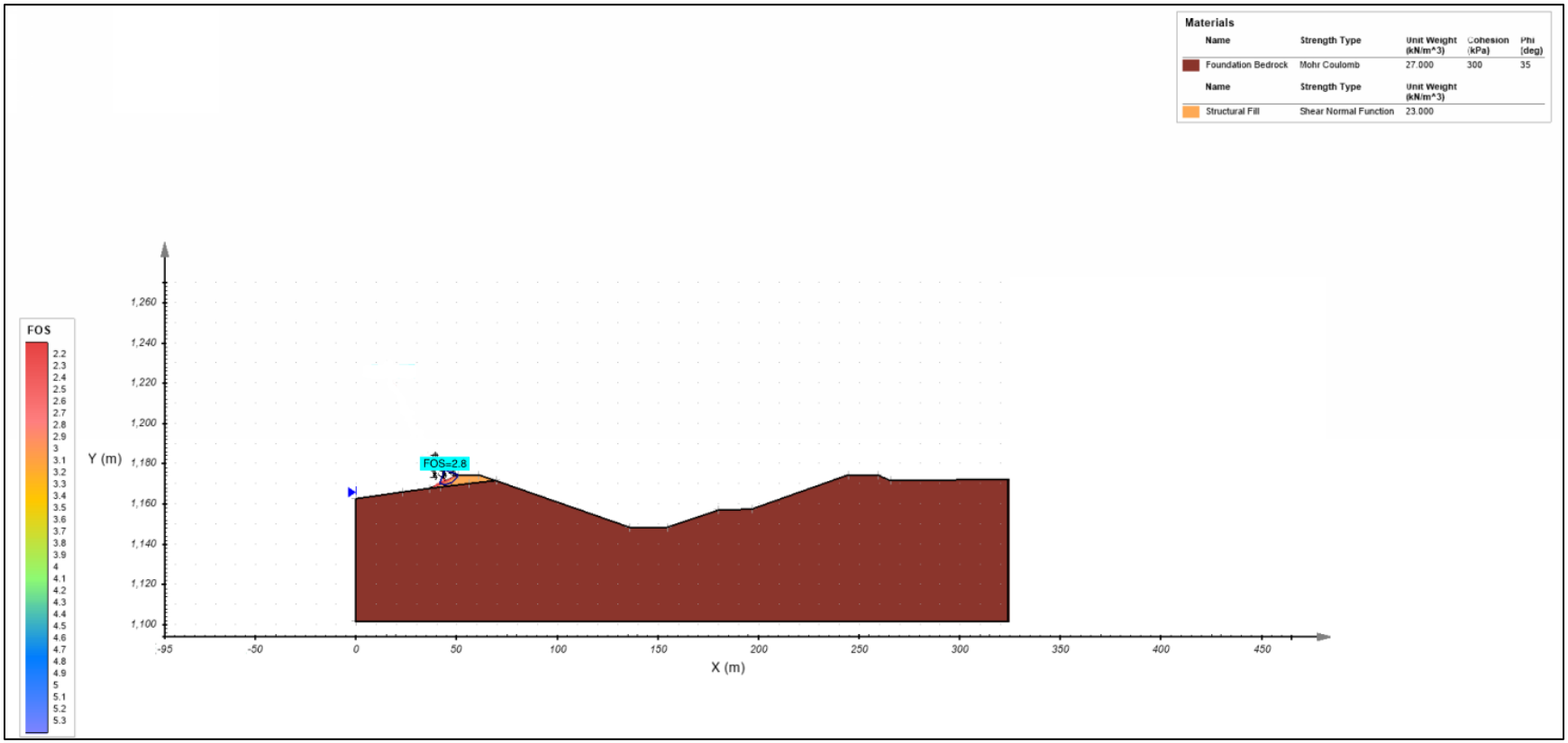


Figure 16: Section E - R-L Static

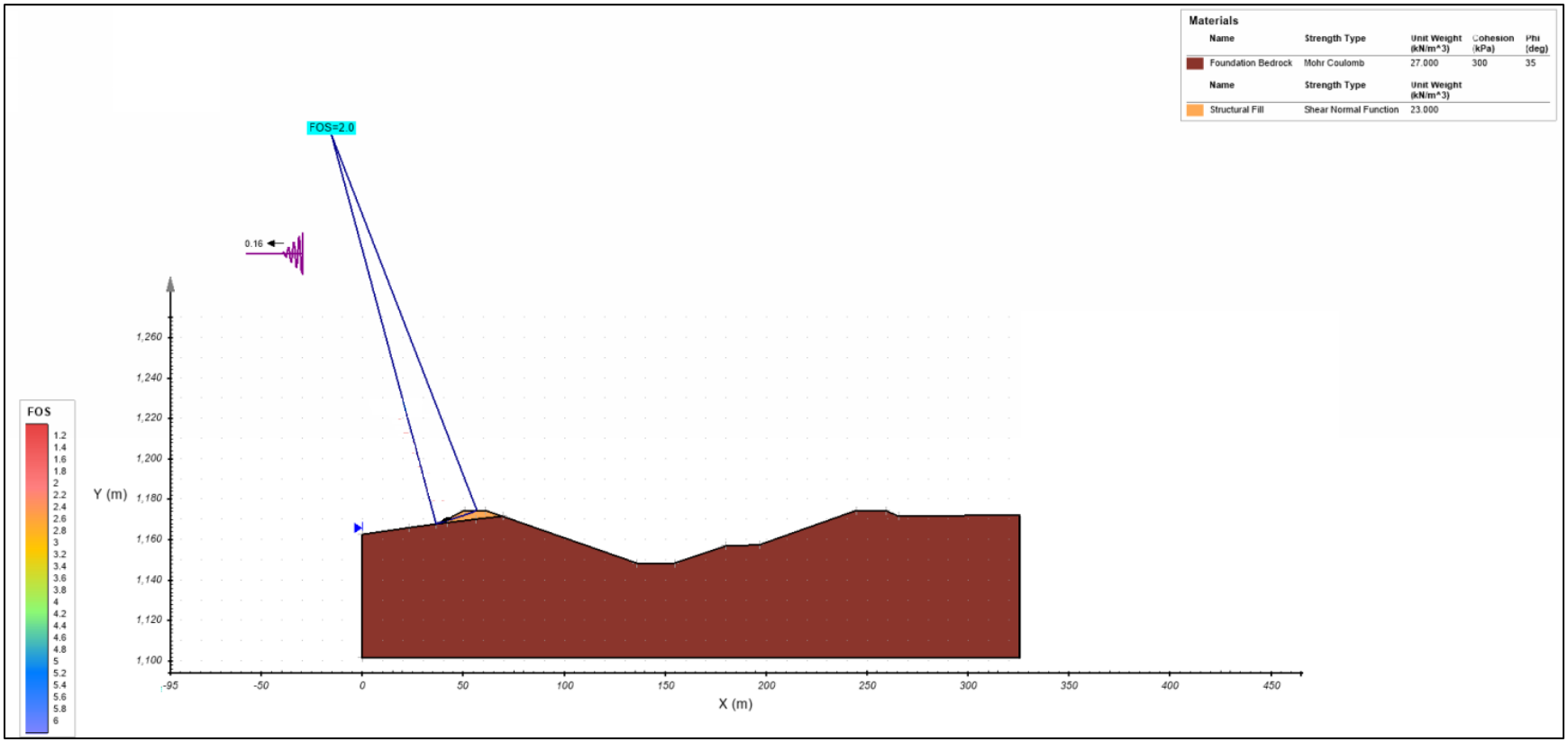


Figure 17: Section E - R-L Pseudo

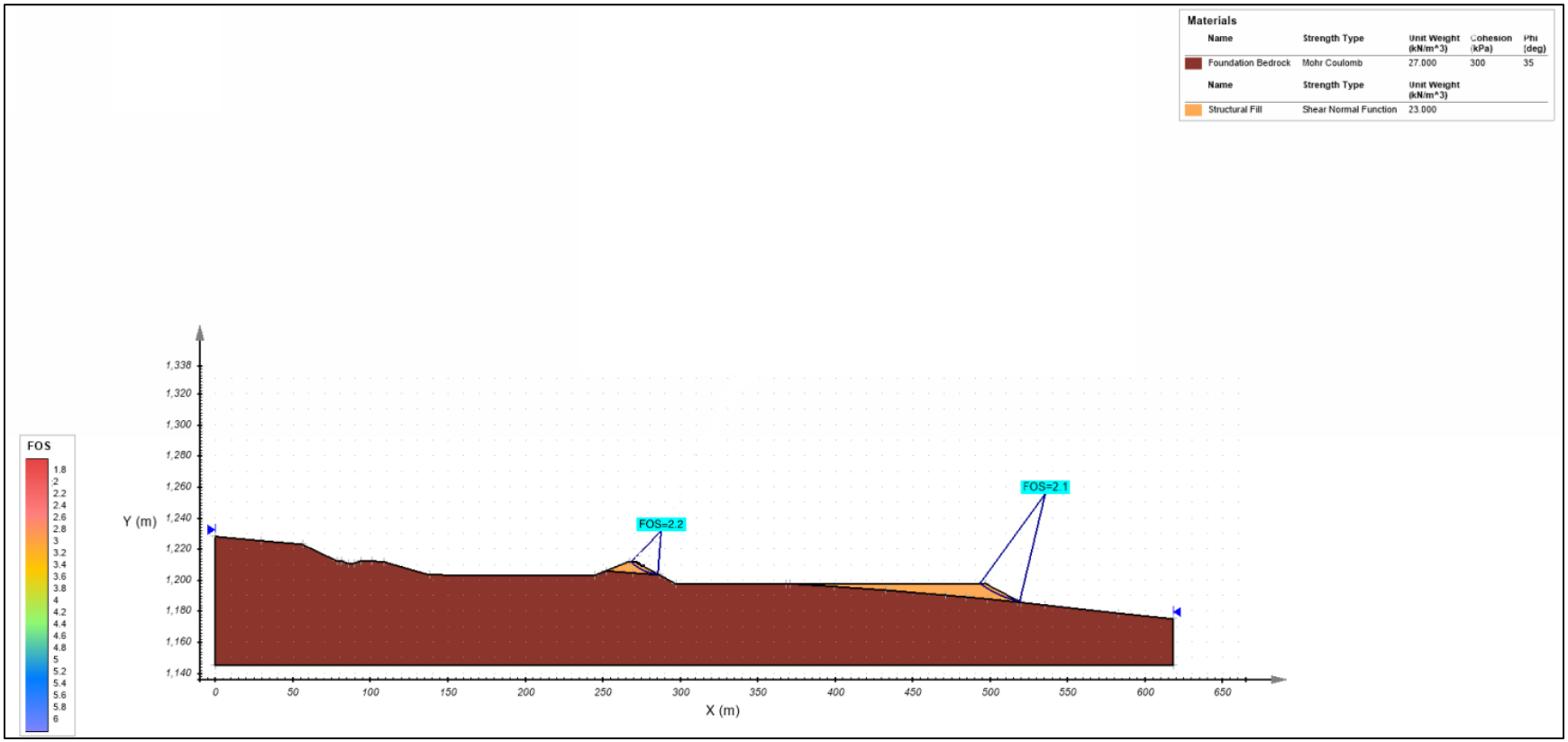


Figure 18: Section F - Static

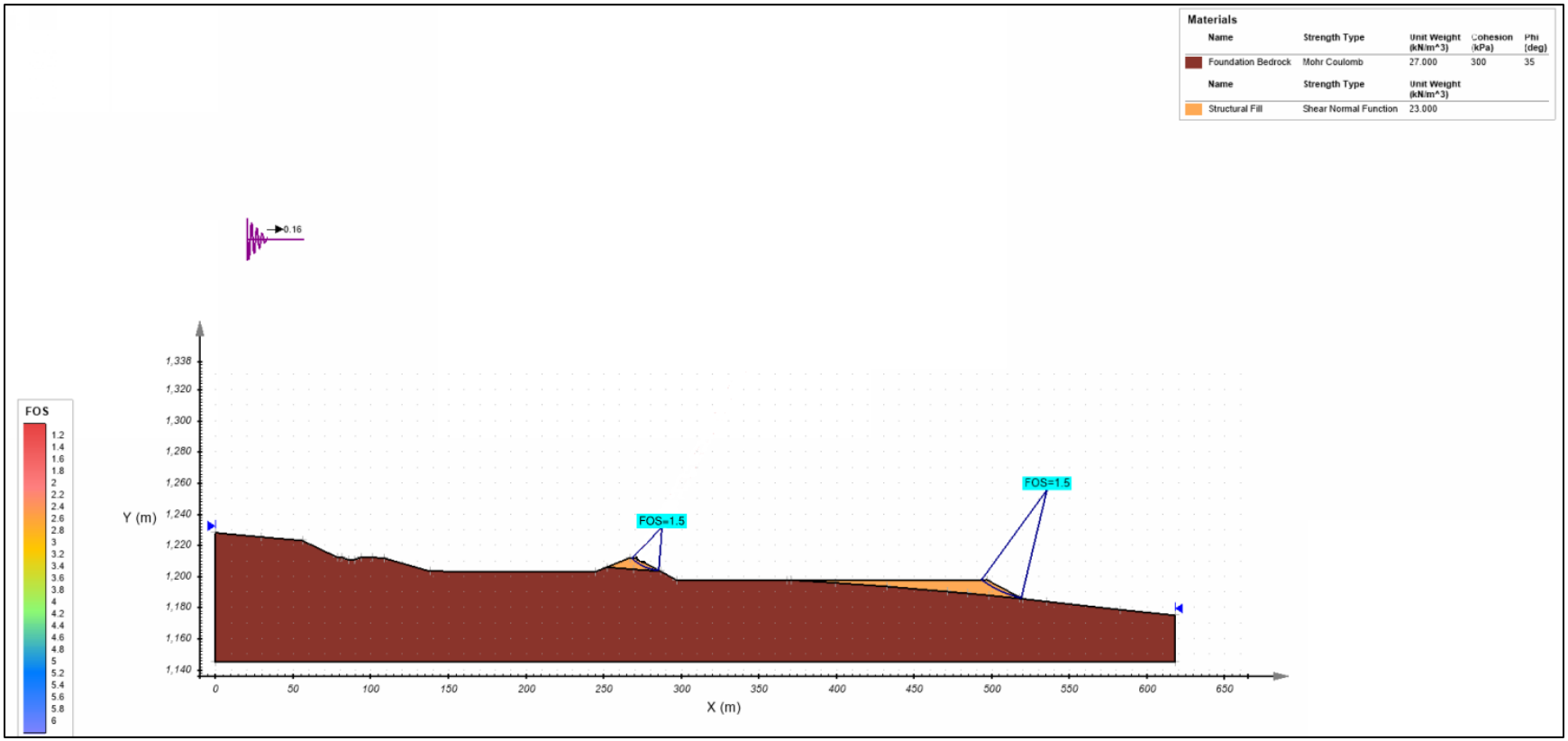


Figure 19: Section F - Psuedo

APPENDIX G: SETTLEMENT ANALYSIS

TECHNICAL MEMORANDUM

To:	Jennie Gjertsen	Doc No.:	123017-01020-CV-EM-2000
From:	Roy Morlan, P.G., P.M.P	Date:	January 26, 2026
cc:	Tom Kelley, P.E., Clint Green, P.E.		

Coffee Mine Project – Heap Leach Facility Foundation Settlement Analysis

1. INTRODUCTION

Settlement analyses were performed for the foundation of the Coffee Project heap leach facility (HLF). Data from previous field investigations by others was used to develop soil compressibility parameters. The analysis was performed using simplified one-dimensional (1D) analyses of foundation settlement under various loading conditions. The purpose of this analysis is to estimate the amount of foundation settlement anticipated due to gravity loading from ore placement and to evaluate the need for more detailed investigations, analyses, and the need for potential foundation improvements.

2. ANALYSIS METHODS

The amount of foundation settlement was calculated at selected horizontal locations within the HLF footprint using simplified 1D analyses assuming a linear elastic (constrained modulus) response due to static loading from ore placement. Although fines were present in the soils samples no clay layers, organics, or abnormally weak materials were observed in the subgrade. Therefore, the analyses performed for this memorandum, assumed only immediate settlement. As the purpose for this analysis was to develop a preliminary understanding of foundation improvements that may be required, staged ore loading was not evaluated. No groundwater was present in the soils in the previous field investigations conducted, and it is assumed that groundwater is located in the bedrock, making it unlikely that groundwater fluctuations will have an effect on effective stresses for this analysis.

Ground pressures were calculated using the wet bulk density for the ore. Vertical gravity loading due to HLF design features such as liner, overliner drain fill, and solution collection piping were considered negligible for this analysis and were not included in the analysis of applied vertical stresses on the HLF subgrade settlement.

Data used to estimate the material parameters in this analysis were gathered from previous field investigations. These investigations were described in the Coffee Gold Project Heap Leach Pad Engineering Report for Licensing (Forte, 2023) and included:

- SRK 2016: In 2015, SRK Consulting completed a feasibility-level geotechnical investigation for the Coffee Gold Project, which included field and laboratory characterization of the proposed HLF footprint. Sonic drilling methods were used for the majority of locations, and primarily focused on characterization of the soil characteristics and ground ice. Test pits were dug by an excavator to observe conditions and collect representative samples. A total of 15 borings were drilled and 43 test pits were excavated.
- Tetra Tech 2016: In 2015, Tetra Tech provided surficial geology, permafrost, terrain, and soils baseline information for the Coffee Gold Project. Field reconnaissance for permafrost conditions required active measurement of permafrost thickness with a probe, and hand dug test pit

excavation. Terrain characteristics and hazards, drainage conditions and vegetation conditions were completed using helicopter reconnaissance, and detailed ground investigations.

- Tetra Tech 2017: The primary focus of this investigation was to acquire geotechnical and permafrost data, including frozen and unfrozen overburden and bedrock conditions, that would allow design of all site infrastructure. A total of 19 borings were drilled within or adjacent to the HLF conceptual design footprint, using diamond core drilling methods.

3. MODEL GEOMETRY

The footprint of the proposed HLF as of July 24, 2023 was considered as the loaded area for this analysis. The subsurface geologic model was developed using test pit and borehole logs as well as laboratory index texting results. Soils were grouped into two units. Silty sands – Sandy Silts (SM-ML) and bedrock that has been weathered to soil residuum (Highly Weathered Bedrock). Based on field logs Highly Weathered Bedrock consists of gravels and sands that are present in relatively thin layers overlying Unweathered Bedrock. Groundwater was not encountered and no phreatic surface was used in modelling the geometry. 1-D settlement analyses were performed at four locations across the HLF footprint to provide an estimate of the range of expected settlements. The locations included:

- The area of thickest ore loading.
- The area of thinnest ore loading.
- The area with the greatest thickness of SM-ML soils in the subgrade.
- An area of intermediate thickness pf SM-ML soil in the subgrade.

4. MATERIAL PROPERTIES

Materials were classified by Forte using a combination of laboratory grain size analysis interpretation from the Forte field engineer. Undisturbed samples of soil-like materials in the HLF footprint were not obtained and tested during the previous investigations and thus, conservative interpretations of foundation soil density and stiffness properties based on literature values were used for the analyses presented in this memorandum. A summary of the compressibility properties assigned to the materials for the evaluated conditions are presented in Table 4-1 and are further discussed in this section.

Table 4-1: Material Compressibility Properties

Material Type	Unit Weight (KN/m^3)	Poisson's Ratio (n)	Es (MPa)
Ore	17.3	NA	NA
Silty Sand (SM-ML)	18.4	0.30	4.8
Highly Weathered Bedrock	21.3	0.375	100
Unweathered Bedrock	n/a	Incompressible	

Ore: Ground pressures imparted on the foundation by the weight of the ore were calculated from the unit weight for the ore based on analyses performed by the Mines Group (MINES, 2016).

Silty Sand and Silty Sand (SM-ML): Silty sand and sandy silt were observed in drainages on the northern and southern side of the HLF. The Young's Modulus (Stiffness) parameter for the silty sand can vary considerably depending on density. For the purposes of these analyses, the silty sand was conservatively assumed to be in a loose to medium dense state over the entire layer thickness and stiffness was calculated

using an assumed Standard Penetration Test (SPT) blow count (N=10) and an empirical correlation between SPT blow count and Young's Modulus. A summary of soil parameters assumed for the SM-ML unit is included in Table 4-2.

Table 4-2: Silty Sand Material Properties

Material Type	Laboratory Analysis [1]	Literature Reference [2]	Notes
Unit Weight (kN/m^3)	18.4	17.4-22.5	1. Testing not performed. 2. Unit weight by soil type table (Carter, 1991)
Elasticity Modulus (MPa)	NA	4.8	1. Testing not performed 2. Based on empirical correlation between assumed SPT blow count and stiffness per Bowles (1998)
Poisson Ratio (unitless)	NA	0.15 – 0.4	1. Testing not performed 2. Lookup table by soil type (Bowles, 1998)

Weathered Bedrock: The HLF foundation is expected to be excavated to competent bedrock. However, pockets of weathered bedrock will still remain. Weathered bedrock consists of sandy gravel with clay. A summary of soil parameters determined for the SM unit are included in Table 4-3.

Table 4-3: Weathered Bedrock Material Properties

Material Type	Laboratory Analysis [1]	Literature Reference [2]	Notes
Unit Weight (KN/m^3)	21.3	19.6-22.5	1. Testing not performed. 2. Unit weight by soil type table (Carter, 1991)
Elasticity Modulus (MPa)	NA	50-150	1. Testing not performed. 2. Lookup table by soil type (Bowles, 1998)
Poisson Ratio (unitless)	NA	0.3 – 0.4	1. Testing not performed. 2. Lookup table by soil type (Bowles, 1998)

5. RESULTS

Details of the of settlement magnitude results at selected locations within the HLF are included as Attachment A. Most of the HLF subgrade will consist of varying thicknesses of weathered bedrock overlying unweathered bedrock and HLP settlement at the foundation contact is expected to be minimal (ranging from 0.02 meters and 0.05 meters). However, larger amounts of settlement can be expected in the areas where silty sand/sandy silt may remain at the foundation contact after completions of subgrade preparations. Settlements in these areas are estimated to be as high as 1.18 m.

6. CONCLUSIONS AND RECOMMENDATIONS

Foundation soils over most of the site consist of highly weathered to weathered bedrock and settlements are not expected to impact HLF geomembrane and underdrain performance. However, portions of the HLF will be founded over finer grained silty sand and sandy silt. The compressibility of these finer grained materials can vary greatly and may be highly compressible if in a loose state. Field and laboratory investigations to-date have not provided information regarding the in-situ density of these finer grained layers. The analyses presented in this memorandum indicate that if in a loose state, the compressibility of these materials may affect the performance of the liner and underdrain system. As a result, it is recommended that further investigations be performed as part of the subsequent design phases. These investigations should include undisturbed sampling of these finer grained soils, and laboratory measurement of density and consolidation parameters on the undisturbed samples. Penetration testing (SPT of CPT) is also recommended as part of the field investigations.

If additional detailed investigations do confirm that the finer grained layers are in a loose, highly compressible state, remedial measures such as over excavation and compaction of the fine-grained layers, or removal and replacement with less compressible fill may be required in these areas. The necessity for implementation of foundation mitigation measures should be further evaluated as part of detailed design.

7. REFERENCES

Bowles, Joseph E. (Bowles) 1998. *Foundation Analysis and Design, Fifth Edition*, McGraw-Hill Press, Carter, M. and Bentley, S.P., 1991. *Correlation of Soil Properties*, Pentech Press.

SRK Consulting (SRK) 2016, *2015 Geotechnical Field Investigation, Coffee Gold Project, Yukon Territory, Canada*.

Tetra Tech, 2016. *Technical Memorandum, Permafrost and Related Geohazard Mapping within the Coffee Mine Area*.

Tetra Tech, 2017. *Summer 2017 Geotechnical Investigation Data Report, Coffee Mine Site, Coffee Gold Project.*

The Mines Group, Inc. (Mines), 2016. *Feasibility Design Report for Coffee Gold Heap Leach Facility, Yukon Territory, Canada*.

ATTACHMENT A: SETTLEMENT RESULTS

120 Commerce Drive., Unit 3 Fort Collins, CO 80524

Table 7-1: Parameters and Results for the Deepest Section Over Bedrock

Location of 1 D Profile: Deepest Section Over Bedrock					
Heap Thickness for Stress Calc. (m):	95				
Assumed Ore Density for Stress Calc (kN/m^3):	17.3				
Layer	Thickness (m)	Young's Modulus (kPa)	Poisson's Ratio	Stress Increment (kPa)	Layer Deformation (m)
Weathered Bedrock	6	100000	0.375	1643.5	0.054
Unweathered Bedrock	n/a	infinite	n/a	n/a	0
Total Estimated Liner Settlement (m):					**0.05**

Table 7-2: Parameters and Results for the Thinnest Section Over Bedrock

Location of 1 D Profile: Thinnest Section Over Bedrock					
Heap Thickness for stress calc. (m):	30				
Assumed Ore Density for stress calc (kN/m^3):	17.3				
Layer	Thickness (m)	Young's Modulus (kPa)	Poisson's Ratio	Stress Increment (kPa)	Layer Deformation (m)
Weathered Bedrock	6	100000	0.375	519	0.017
Unweathered bedrock	n/a	infinite	n/a	n/a	0
Total Estimated Liner Settlement (m):					**0.02**

Table 7-3: Parameters and Results for the Thickest Silt Pocket

Location of 1 D Profile: Thickest Silt Pocket					
Heap Thickness for stress calc. (m):	61				
Assumed Ore Density for stress calc (kN/m^3):	17.3				
Layer	Thickness (m)	Young's Modulus (kPa)	Poisson's Ratio	Stress Increment (kPa)	Layer Deformation (m)
Silty Sand (ML)	7	4800	0.3	1055.3	1.14
Weathered Bedrock	6	100000	0.375	1055.3	0.03
Unweathered bedrock	n/a	infinite	n/a	n/a	0
Total Estimated Liner Settlement (m):					**1.18**

Table 7-4: Parameters and Results for the Thinnest Silt Pocket

Location of 1 D Profile: Thinnest Silt Pocket					
Heap Thickness for stress calc. (m):	60				
Assumed Ore Density for stress calc (kN/m^3):	17.3				
Layer	Thickness (m)	Young's Modulus (kPa)	Poisson's Ratio	Stress Increment (kPa)	Layer Deformation (m)
Silty Sand (ML)	2	4800	0.3	1038	0.32
Weathered Bedrock	6	100000	0.375	1038	0.03
Unweathered bedrock	n/a	infinite	n/a	n/a	0
Total Estimated Liner Settlement (m):					**0.36**

APPENDIX H: ENGINEERING CALCULATIONS

APPENDIX H. 1: PIPE CALCULATIONS

APPENDIX H.1. 1: PIPE SPACING CALCULATIONS

Project: Coffee HLP Engineering for Licensing
Date: June 13, 2025
Engineer: K. Swetala
Project No.: 123022
Rev: A

Highlighting Legend
=Input parameter
=Equation
=Calculated value to be used for design purposes

$ORIGIN := 1$ Allows row matrix counting start from 1 rather than 0 (Do not delete)

Calculation of Perforated Collection Pipe Spacing

$W_{app} := 10 \cdot \frac{L}{hr \cdot m^2}$ Application Rate of solution to the heap

$h_0 := 50\ mm$ Height of the solution in drain pipe (assume that 100 mm corrugated perforated pipe is used remains about halfway full as a minimum drainage requirement

$h_{max} := 0.6\ m$ Maximum height of phreatic surface above line

$K := 1.0 \cdot 10^{-2}\ \frac{cm}{s}$ Minimum Acceptable Permeability of the overliner material (typically between .001 and 1 cm/s)

$DF := 1.3382$ Factor of safety from the PMP Rainfall event

$W := DF \cdot W_{app} = 13.382\ \frac{L}{hr \cdot m^2}$

Phase Slope (perpendicular to 100mm pipes)

$$S := \begin{bmatrix} .08 \\ .05 \\ .07 \\ .046 \\ .044 \\ .085 \\ .08 \\ .09 \\ .05 \\ .05 \end{bmatrix}$$ 1N, 1S, 2N, 2S, 3N, 3S, 4N, 4S, 5N, 5S %/100

Pad Angle

$$\beta := \operatorname{atan}(S) = \begin{bmatrix} 4.574 \\ 2.862 \\ 4.004 \\ 2.634 \\ 2.519 \\ 4.858 \\ 4.574 \\ 5.143 \\ 2.862 \\ 2.862 \end{bmatrix}\ deg$$

East, Haile, and Beck Equation for Underdrain Pipe Spacing (Gold Hill Phase 4)

The height (h) of the phreatic surface above the impermeable liner can be expressed as a function of the horizontal distance (x) from the centerline between drain piping as written above (East, Haile, and Beck *Optimization Technology for Leach Pad Liner Selection,* Geotechnical Aspects of Heap Leach Design, Dirk VanZyl 1987).

$$h = \left[{h_0}^2 - \frac{W}{K}\left(x^2 - \left(\frac{L}{2}\right)^2\right) - L \cdot h_0 \cdot tan(\beta) + x^2 \cdot tan^2\ (\beta) \right]^{\frac{1}{2}} - x \cdot tan(\beta)$$

$$L^2 \left(\frac{W}{4\,K}\right) - L\left(h_0 \cdot tan(\beta)\right) + \left({h_0}^2 - {h_{max}}^2\right) = 0$$

Rewriting the equation in the form of a quadratic in terms of L as x: ax^2+bx+c=0

$$L = \frac{h_0 \cdot tan(\beta) + \sqrt{\left(-h_0 \cdot tan(\beta)\right)^2 - \left(\frac{W}{K}\right) \cdot \left({h_0}^2 - {h_{max}}^2\right)}}{\frac{W}{2 \cdot K}}$$

Equation for Pipe Spacing

Giroud Equation for Underdrain Pipe Spacing

$$h_{max} = \frac{\sqrt{tan(\beta)^2 + \frac{4 \cdot W}{K}} - tan(\beta)}{2 \cdot cos(\beta)} \cdot L$$

Equation written to solve for maximum solution head on liner

$$L = \frac{h_{max} \cdot 2 \cdot \cos(\beta)}{\left(\tan(\beta)^2 + \frac{4 \cdot W}{K}\right)^{0.5} - \tan(\beta)}$$

Equation for Pipe Spacing

Required Pipe Spacing by Collection Pipes

$$L := \frac{h_0 \cdot S + \sqrt{(-h_0 \cdot S)^2 - \left(\frac{W}{K}\right) \cdot \left({h_0}^2 - {h_{max}}^2\right)}}{\frac{W}{2 \cdot K}} = \begin{bmatrix} 6.4 \\ 6.3 \\ 6.4 \\ 6.3 \\ 6.3 \\ 6.4 \\ 6.4 \\ 6.4 \\ 6.3 \\ 6.3 \end{bmatrix} m$$

Horizontal distance between pipes per East, Haile, and Beck

$$EHB_{spacing} := \frac{L}{\cos(\beta)} = \begin{bmatrix} 6.442 \\ 6.346 \\ 6.409 \\ 6.334 \\ 6.328 \\ 6.458 \\ 6.442 \\ 6.475 \\ 6.346 \\ 6.346 \end{bmatrix} m$$

Maximum allowable drain pipe spacing per East, Haile, and Beck

$$L := \frac{h_{max} \cdot 2 \cdot \cos(\beta)}{\left(\tan(\beta)^2 + \frac{4 \cdot W}{K}\right)^{0.5} - \tan(\beta)} = \begin{bmatrix} 3.812 \\ 3.537 \\ 3.719 \\ 3.502 \\ 3.484 \\ 3.859 \\ 3.812 \\ 3.906 \\ 3.537 \\ 3.537 \end{bmatrix} m$$

Horizontal distance between pipes per Giroud

$$Giroud_{spacing} := \frac{L}{\cos(\beta)} = \begin{bmatrix} 3.824 \\ 3.542 \\ 3.728 \\ 3.505 \\ 3.487 \\ 3.873 \\ 3.824 \\ 3.922 \\ 3.542 \\ 3.542 \end{bmatrix} m$$

Maximum allowable drain pipe spacing per Giroud

Collection Pipe Spacing Summary

Phase 1

North

Slope

$\beta_1 = 4.574\ deg \quad S_1 = 0.08$ 8%

Pipe Spacing

$EHB_{spacing_1} = 6.442\ m$

$Giroud_{spacing_1} = 12.546\ ft$

South

Slope

$\beta_2 = 2.862\ deg \quad S_2 = 0.05$ 5%

Pipe Spacing

$EHB_{spacing_2} = 6.346\ m$

$Giroud_{spacing_2} = 3.542\ m$

Phase 2

North

Slope

$\beta_3 = 4.004\ deg \quad S_3 = 0.07$ 7%

Pipe Spacing

$EHB_{spacing_3} = 6.409\ m$

$Giroud_{spacing_3} = 3.728\ m$

South

Slope

$\beta_4 = 2.634\ deg \quad S_4 = 0.046$ 4.6%

Pipe Spacing

$EHB_{spacing_4} = 6.334\ m$

$Giroud_{spacing_4} = 3.505\ m$

Phase 3

North

Slope

$\beta_5 = 2.519\ deg \quad S_5 = 0.044$ 4.4%

Pipe Spacing

$EHB_{spacing_5} = 6.328\ m$

$Giroud_{spacing_5} = 3.487\ m$

South

Slope

$\beta_6 = 4.858\ deg \quad S_6 = 0.085$ 8.5%

Pipe Spacing

$EHB_{spacing_6} = 6.458\ m$

$Giroud_{spacing_6} = 3.873\ m$

Phase 4

North

Slope

$\beta_7 = 4.574\ deg \quad S_7 = 0.08$ 8%

Pipe Spacing

$EHB_{spacing_7} = 6.442\ m$

$Giroud_{spacing_7} = 3.824\ m$

South

Slope

$\beta_8 = 5.143\ deg \quad S_8 = 0.09$ 9%

Pipe Spacing

$EHB_{spacing_8} = 6.475\ m$

$Giroud_{spacing_8} = 3.922\ m$

Phase 5

North

Slope

$\beta_9 = 2.862\ deg \quad S_9 = 0.05$ x%

Pipe Spacing

$EHB_{spacing_9} = 6.346\ m$

$Giroud_{spacing_9} = 3.542\ m$

South

Slope

$\beta_{10} = 2.862\ deg \quad S_{10} = 0.05$ x%

Pipe Spacing

$EHB_{spacing_{10}} = 6.346\ m$

$Giroud_{spacing_{10}} = 3.542\ m$

APPENDIX H.1. 2: BURIED HEADER COLLECTION PIPE CALCULATIONS

Heap Leach Solution Collection System Calculations

Project: Coffee HLP Engineering
Date: June 13, 2025
Engineer: K. Swetala
Doc. No.: 123022
Rev.: A

Highlighting Legend:
=User defined input
=Equation
=Calculated value to be used for design purposes
=Calculated value to be used for reference

Use this calculation sheet to aid in the design of underdrain collection piping systems for heap leach pads as well as in the design of open channel collection systems. Take note of the assumptions made for the determination of the input parameters and calculations.

$ORIGIN := 1$ Allows row matrix counting start from 1 rather than 0 (Do not delete)

Solving for Minimum Buried ADS Header Collection Pipe Size

Phase Slope	Cell	Pad Angle
.08	1NA	4.574
.08	1NB	4.574
.08	1NC	4.574
.05	1SA	2.862
.05	1SB	2.862
.05	1SC	2.862
.07	2NA	4.004
.07	2NB	4.004
.046	2SA	2.634
.046	2SB	2.634
.044	3NA	2.519
.044	3NB	2.519
.044	3NC	2.519
.085	3SA	4.858
.085	3SB	4.858
.08	4NA	4.574
.08	4NB	4.574
.09	4SA	5.143
.09	4SB	5.143
.05	5NA	2.862
.05	5SA	2.862
.05	5SB	2.862

$S :=$ (Phase Slope) % slope /100

$\beta := \operatorname{atan}(S) =$ (Pad Angle) deg

$Q_{PLS} := 1400 \frac{m^3}{hr}$ Nominal PLS Flowrate

$DF := 1.2$ PLS Flowrate Design Factor

$W := 10 \cdot \frac{L}{hr \cdot m^2}$

$W = 10 \frac{mm}{hr}$

Application Rate of solution to the heap

Heap Leach Solution Collection System Calculations

Area	Cell
62090	1NA
30900	1NB
46635	1NC
33380	1SA
29320	1SB
43230	1SC
40015	2NA
46330	2NB
43990	2SA
42095	2SB
38655	3NA
47165	3NB
47110	3NC
59765	3SA
76305	3SB
55665	4NA
41415	4NB
57875	4SA
66180	4SB
50290	5NA
23975	5SA
56070	5SB

$A := \quad m^2$

Areas for each cell size

Flow	Cell
745.08	1NA
370.8	1NB
559.62	1NC
400.56	1SA
351.84	1SB
518.76	1SC
480.18	2NA
555.96	2NB
527.88	2SA
505.14	2SB
463.86	3NA
565.98	3NB
565.32	3NC
717.18	3SA
915.66	3SB
667.98	4NA
496.98	4NB
694.5	4SA
794.16	4SB
603.48	5NA
287.7	5SA
672.84	5SB

$Q_{app} := W \cdot A \cdot DF = \quad \frac{m^3}{hr}$

Flow for application rate per cell

Heap Leach Solution Collection System Calculations

$$P_{PMP} := 283 \ \frac{mm}{day} = 11.142 \ \frac{in}{day}$$

Amount of Rainfall for a Probable Maximum Precipitation Event

$$CN_{ore} := 75$$

$$S_{ore} := \left(\frac{1000}{CN_{ore}} - 10\right) \frac{in}{day}$$

Potential Maximum Retention Equation multiplied by Initial abstraction

$$RO_{ore} := \frac{\left(P_{PMP} - .2 \cdot S_{ore}\right)^2}{P_{PMP} + .8 \cdot S_{ore}} = 201.838 \ \frac{mm}{day}$$

Precipitation Excess (Runoff) Equation

$$P_{ore} := P_{PMP} - RO_{ore}$$

Adjusting total Precipitation for infiltration rate $P_{ore} = 81.162 \ \frac{mm}{day}$

$$Q_{storm} := P_{ore} \cdot A = \begin{bmatrix} 209.972 \\ 104.496 \\ 157.707 \\ 112.882 \\ 99.152 \\ 146.192 \\ 135.32 \\ 156.676 \\ 148.762 \\ 142.354 \\ 130.721 \\ 159.499 \\ 159.313 \\ 202.109 \\ 258.043 \\ 188.244 \\ 140.054 \\ 195.718 \\ 223.803 \\ 170.067 \\ 81.077 \\ 189.614 \end{bmatrix} \frac{m^3}{hr}$$

Cell
1NA
1NB
1NC
1SA
1SB
1SC
2NA
2NB
2SA
2SB
3NA
3NB
3NC
3SA
3SB
4NA
4NB
4SA
4SB
5NA
5SA
5SB

Design storm flow for each section of the pad

Heap Leach Solution Collection System Calculations

$$Q_{total} := Q_{app} + Q_{storm} = \begin{bmatrix} 955.052 \\ 475.296 \\ 717.327 \\ 513.442 \\ 450.992 \\ 664.952 \\ 615.5 \\ 712.636 \\ 676.642 \\ 647.494 \\ 594.581 \\ 725.479 \\ 724.633 \\ 919.289 \\ 1.174 \cdot 10^3 \\ 856.224 \\ 637.034 \\ 890.218 \\ 1.018 \cdot 10^3 \\ 773.547 \\ 368.777 \\ 862.454 \end{bmatrix} \frac{m^3}{hr}$$

Cell
1NA
1NB
1NC
1SA
1SB
1SC
2NA
2NB
2SA
2SB
3NA
3NB
3NC
3SA
3SB
4NA
4NB
4SA
4SB
5NA
5SA
5SB

$$n := 0.012 \frac{s}{ft^{\frac{1}{3}}} = 0.018 \frac{s}{m^{\frac{1}{3}}}$$

Manning's roughness coefficient

$$C_{buried} := 55\%$$

Percentage that buried collection pipe can be filled with solution

Heap Leach Solution Collection System Calculations

Deriving Design Equations for Finding Required Radius for Open Channel Flow in Pipe

$h = 2\,r - depth$ circular segment height (assume pipe is >50% full)

$h = 2\,r - 2\,r \cdot C$ Re-write depth as a function of the fill percentage of the pipe

$h = 2\,r\,(1 - C)$ Simplify and isolate r

$\theta = 2\,arccos\left(\frac{r - 2\,r\,(1 - C)}{r}\right)$ Sub. in h in terms of r

$\theta = 2\,arccos(2\,C - 1)$ Simplify (now the central angle is a function of the fill percentage of the pipe)

$A = \pi \cdot r^2 - \frac{r^2\,(\theta - sin(\theta))}{2}$ Sub. in K in terms of r for flow area

$A = r^2\left(\pi - \frac{\theta - sin(\theta)}{2}\right)$ Simplify and isolate r terms

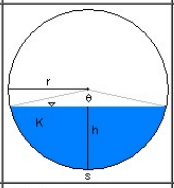
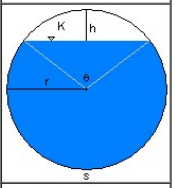
$P_w = 2\,\pi \cdot r - r \cdot \theta$ Sub. in s in terms of r for wetted perimeter

$P_w = r\,(2\,\pi - \theta)$ Simplify and isolate r terms

$Q = \left(\frac{1}{n}\right) \cdot A \cdot R_h^{\frac{2}{3}} \cdot \sqrt{S}$ Manning's Equation for open channel flow in a pipe using SI units

$Q = \left(\frac{1}{n}\right) \cdot \frac{A^{\frac{5}{3}}}{P_w^{\frac{2}{3}}} \cdot \sqrt{S}$ Re-write Manning's Equation to combine A terms

$Q = \left(\frac{1}{n}\right) \cdot \frac{\left(r^2\left(\pi - \frac{\theta - sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{(r\,(2\,\pi - \theta))^{\frac{2}{3}}} \cdot \sqrt{S}$ Sub. in A and P_w in terms of r

step	solve for	*if flow depth < radius*	*if flow depth ≥ radius*
			
1	circular segment height	$h = d$	$h = 2r - d$
2	central angle	$\theta = 2\arccos\left(\frac{r-h}{r}\right)$	$\theta = 2\arccos\left(\frac{r-h}{r}\right)$
3	circular segment area	$K = \frac{r^2(\theta - \sin\theta)}{2}$	$K = \frac{r^2(\theta - \sin\theta)}{2}$
4	arc length	$s = r \times \theta$	$s = r \times \theta$
5	flow area	$A = K$	$A = \pi r^2 - K$
6	wetted perimeter	$P_W = s$	$P_W = 2\pi r - s$
7	hydraulic radius	$R_h = \frac{A}{P_W}$	$R_h = \frac{A}{P_W}$

Heap Leach Solution Collection System Calculations

$$Q = r^{\frac{8}{3}} \cdot \left(\frac{1}{n}\right) \cdot \frac{\left(\pi - \frac{\theta - sin(\theta)}{2}\right)^{\frac{5}{3}}}{(2\,\pi - \theta)^{\frac{2}{3}}} \cdot \sqrt{S}$$

Simplify and combine r terms

$$r = \left(\left(\frac{Q \cdot n}{1 \cdot \sqrt{S}}\right) \cdot \frac{(2\,\pi - \theta)^{\frac{2}{3}}}{\left(\pi - \frac{\theta - sin(\theta)}{2}\right)^{\frac{5}{3}}} \right)^{\frac{3}{8}}$$

Re-write such that r can be solved for

Solving for Minimum Buried ADS Header Collection Pipe Size

$\theta := 2 \cdot \text{acos}\left(2 \cdot C_{buried} - 1\right) = 2.941$ Central angle in terms of radians (unitless)

$$r := \left(\left(\frac{Q_{total} \cdot n}{\sqrt{S}}\right) \cdot \frac{(2\,\pi - \theta)^{\frac{2}{3}}}{\left(\pi - \frac{\theta - \sin(\theta)}{2}\right)^{\frac{5}{3}}} \right)^{\frac{3}{8}} = \begin{bmatrix} 204.034 \\ 157.056 \\ 183.268 \\ 176.563 \\ 168.182 \\ 194.541 \\ 177.43 \\ 187.453 \\ 198.903 \\ 195.645 \\ 191.075 \\ 205.878 \\ 205.788 \\ 198.862 \\ 217.942 \\ 195.846 \\ 175.289 \\ 194.385 \\ 204.41 \\ 205.896 \\ 155.956 \\ 214.47 \end{bmatrix} mm$$

Cell
1NA
1NB
1NC
1SA
1SB
1SC
2NA
2NB
2SA
2SB
3NA
3NB
3NC
3SA
3SB
4NA
4NB
4SA
4SB
5NA
5SA
5SB

Radius of the collection pipe (note that for a flat pad, this equation is unsolvable due to division by zero. Practically speaking, this would also mean that no drainage could occur).

Heap Leach Solution Collection System Calculations

$$ID_{min} := 2 \cdot r = \begin{bmatrix} 408.069 \\ 314.112 \\ 366.537 \\ 353.126 \\ 336.364 \\ 389.083 \\ 354.86 \\ 374.906 \\ 397.805 \\ 391.29 \\ 382.15 \\ 411.756 \\ 411.576 \\ 397.723 \\ 435.884 \\ 391.691 \\ 350.578 \\ 388.771 \\ 408.82 \\ 411.792 \\ 311.912 \\ 428.94 \end{bmatrix} mm \quad ID_{min} = \begin{bmatrix} 16.066 \\ 12.367 \\ 14.431 \\ 13.903 \\ 13.243 \\ 15.318 \\ 13.971 \\ 14.76 \\ 15.662 \\ 15.405 \\ 15.045 \\ 16.211 \\ 16.204 \\ 15.658 \\ 17.161 \\ 15.421 \\ 13.802 \\ 15.306 \\ 16.095 \\ 16.212 \\ 12.28 \\ 16.887 \end{bmatrix} in$$

Cell
1NA
1NB
1NC
1SA
1SB
1SC
2NA
2NB
2SA
2SB
3NA
3NB
3NC
3SA
3SB
4NA
4NB
4SA
4SB
5NA
5SA
5SB

Minimum inside diameter of the buried header collection pipes needed

$ID_{selected} := 450\ mm$

Use ID_min to find manufactured size of ADS pipe that meets the minimum diameter requirement. Enter the actual inner diameter of manufactured size chosen.

$ID_{actual} := 18.07\ in = 458.978\ mm$

Actual inside diameter of ADS 18" N-12 pipe

$$r_{actual} := \frac{ID_{actual}}{2} = 229.489\ mm$$

Actual inside radius

Heap Leach Solution Collection System Calculations

Cell 1NA Maximum Velocities

$\theta := [.9623] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total}^{1}} = [955.052] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{1}}}\right) = [955.169] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{1}}} = [1.228 \cdot 10^{3}] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [955.169] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.468 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.983 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1NA Application Rate Velocities

$\theta := [.9062] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{app}} = [745.08] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S}}\right) = [745.299] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S}} = [1.397 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [745.299] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.075 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.11 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1NB Maximum Velocities

$\theta := [.8155] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total^2}} = [475.296] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\,2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^2}}\right) = [475.031] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\,2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^2}} = [1.661 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [475.031] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\,2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.488 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\,2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.174 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1NB Application Rate Velocities

$\theta := [.7705] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{app}^{2}} = [370.8] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^2}}\right) = [370.208] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^2}} = \left[1.784 \cdot 10^{3}\right] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [370.208] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.218 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 0.863 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1NC Maximum Velocities

$\theta := [.898] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total}^{3}} = [717.327] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{3}}}\right) = [717.432] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{3}}} = [1.421 \cdot 10^{3}] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [717.432] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.02 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.004 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1NC Application Rate Velocities

$\theta := [.847] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{app}^{3}} = [559.62] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^3}}\right) = [559.626] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^3}} = [1.571 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [559.626] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.685 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.445 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1SA Maximum Velocities

$\theta := [.877] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total}^{4}} = [513.442] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{4}}}\right) = [513.278] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{4}}} = [1.173 \cdot 10^{3}] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [513.278] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.277 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.387 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1SA Application Rate Velocities

$\theta := [.8276] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{app}^{4}} = [400.56] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{4}}}\right) = [400.344] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{4}}} = [1.286 \cdot 10^{3}] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [400.344] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.026 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.006 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1SB Maximum Velocities

$\theta := [.8507] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total}^{5}} = [450.992] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{5}}}\right) = [450.778] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{5}}} = [1.234 \cdot 10^{3}] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [450.778] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.141 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.17 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1SB Application Rate Velocities

$\theta := [.8032] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}\overset{\widehat{5}}{\smile} = [351.84]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\overset{\widehat{5}}{\smile}}\right) = [351.449]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\overset{\widehat{5}}{\smile}} = [1.34 \cdot 10^3]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [351.449]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 1.907\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 0.854\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1SC Maximum Velocities

$\theta := [.9328] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total}^{6}} = [664.952] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{6}}}\right) = [664.544] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{6}}} = [1.041 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [664.544] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.576 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.968 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 1SC Application Rate Velocities

$\theta := [.879] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{6}} = [518.76] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{6}}}\right) = [518.257] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{6}}} = [1.168 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [518.257] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.287 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.404 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2NA Maximum Velocities

$\theta := [.8798] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}\widehat{\ } = [615.5]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\widehat{\ }}\right) = [615.577]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\widehat{\ }} = [1.38 \cdot 10^3]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [615.577]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.711\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.67\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2NA Application Rate Velocities

$\theta := [.8302] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{7}} = [480.18] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{7}}}\right) = [480.169] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{7}}} = [1.515 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [480.169] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.412 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.211 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2NB Maximum Velocities

$\theta := [.911] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{total}} = [712.636] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{8}}}\right) = [712.729] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{8}}} = [1.293 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [712.729] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.907 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.034 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2NB Application Rate Velocities

$\theta := [.8588] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{app}^{8}} = [555.96] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S^{8}}}\right) = [555.452] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S^{8}}} = [1.438 \cdot 10^{3}] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [555.452] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.583 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.46 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2SA Maximum Velocities

$\theta := [.9465] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}\widehat{{}^{9}} = [676.642]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\widehat{{}^{9}}}\right) = [676.867]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\widehat{{}^{9}}} = [967.45]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [676.867]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.544\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.054\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2SA Application Rate Velocities

$\theta := [.8914] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$\widehat{Q_{app}} = [527.88] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\overrightarrow{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{\widehat{S}}\right) = [527.399] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\overrightarrow{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{\widehat{S}} = [1.093 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [527.399] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.256 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.457 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2SB Maximum Velocities

$\theta := [.9364] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{10}} = [647.494] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{10}}}\right) = [647.628] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{10}}} = [990.486] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [647.628] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.49 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.93 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 2SB Application Rate Velocities

$\theta := [.8823] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{10}} = [505.14] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{10}}}\right) = [505.042] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{10}}} = [1.113 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [505.042] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.21 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.376 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3NA Maximum Velocities

$\theta := [.9222] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{11}} = [594.581] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{11}}}\right) = [594.567] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{11}}} = [1 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [594.567] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.362 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.729 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3NA Application Rate Velocities

$\theta := [.869] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{11}} = [463.86] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{11}}}\right) = [463.117] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{11}}} = [1.118 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [463.117] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.097 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.236 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3NB Maximum Velocities

$\theta := [.968] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}\overset{\widehat{12}}{\smile} = [725.479]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\overset{\widehat{12}}{\smile}}\right) = [725.603]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\overset{\widehat{12}}{\smile}} = [898.25]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [725.603]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.603\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.29\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3NB Application Rate Velocities

$\theta := [.9113] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{12}} = [565.98] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{12}}}\right) = [565.847] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{12}}} = [1.025 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [565.847] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.307 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.615 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3NC Maximum Velocities

$\theta := [.9677] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{13}} = [724.633] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{13}}}\right) = [724.69] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{13}}} = [898.918] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [724.69] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.601 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.286 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3NC Application Rate Velocities

$\theta := [.9111] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{13}} = [565.32] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{13}}}\right) = [565.328] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{13}}} = [1.025 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [565.328] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.306 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.613 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3SA Maximum Velocities

$\theta := [.9463] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{14}} = [919.289] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{14}}}\right) = [919.299] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{14}}} = [1.316 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [919.299] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.457 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.788 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3SA Application Rate Velocities

$\theta := [.8915] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{14}} = [717.18] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{14}}}\right) = [717.257] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{14}}} = [1.485 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [717.257] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.068 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.982 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3SB Maximum Velocities

$\theta := [.992] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{15}} = [1.174 \cdot 10^3] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\,2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{15}}}\right) = [1.113 \cdot 10^3] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\,2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{15}}} = [1.174 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{more_than_half_full} = [1.174 \cdot 10^3] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\,2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 4.008 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\,2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 3.881 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 3SB Application Rate Velocities

$\theta := [.9453] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{15}} = [915.66] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{15}}}\right) = [915.316] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{15}}} = [1.319 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [915.316] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.45 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.771 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4NA Maximum Velocities

$\theta := [.937] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{16}} = [856.224] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{16}}}\right) = [856.327] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{16}}} = [1.304 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [856.327] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.288 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.555 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4NA Application Rate Velocities

$\theta := [.8828] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{16}} = [667.98] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{16}}}\right) = [667.628] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{16}}} = [1.466 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [667.628] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.918 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.82 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4NB Maximum Velocities

$\theta := [.8733] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{17}} = [637.034] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{17}}}\right) = [637.707] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{17}}} = [1.494 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [637.707] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.855 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.713 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4NB Application Rate Velocities

$\theta := [.824] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{17}} = [496.98] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{17}}}\right) = [496.922] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{17}}} = [1.637 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [496.922] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.54 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.242 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4SA Maximum Velocities

$\theta := [.9325] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{18}} = [890.218] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{18}}}\right) = [890.395] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{18}}} = [1.398 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [890.395] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.454 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.635 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4SA Application Rate Velocities

$\theta := [.8787] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{18}} = [694.5] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{18}}}\right) = [694.31] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{18}}} = [1.568 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [694.31] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.066 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.881 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4SB Maximum Velocities

$\theta := [.9635] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}^{\widehat{19}} = [1.018 \cdot 10^3] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\,2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{19}}}\right) = [1.018 \cdot 10^3] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\,2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{19}}} = [1.299 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [1.018 \cdot 10^3] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\,2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.688 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\,2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 3.187 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 4SB Application Rate Velocities

$\theta := [.9072] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{19}} = [794.16] \ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{19}}}\right) = [794.165] \ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{19}}} = [1.478 \cdot 10^3] \ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [794.165] \ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 3.269 \ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.252 \ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 5NA Maximum Velocities

$\theta := [.968] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}\overset{\widehat{20}}{\smile} = [773.547]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\overset{\widehat{20}}{\smile}}\right) = [773.495]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\overset{\widehat{20}}{\smile}} = [957.537]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [773.495]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.775\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.441\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 5NA Application Rate Velocities

$\theta := [.9114] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}\overset{\frown}{20} = [603.48]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\overset{\frown}{20}}\right) = [603.471]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\overset{\frown}{20}} = [1.092 \cdot 10^3]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [603.471]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.459\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 1.723\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 5SA Maximum Velocities

$\theta := [.812] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$$Q_{total}\overset{\widehat{21}}{\smile} = [368.777]\ \frac{m^3}{hr}$$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\overset{\widehat{21}}{\smile}}\right) = [368.575]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\overset{\widehat{21}}{\smile}} = [1.321 \cdot 10^3]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [368.575]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 1.95\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 0.906\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 5SA Application Rate Velocities

$\theta := [.7675] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}\overset{\widehat{21}}{\smile} = [287.7]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\overset{\widehat{21}}{\smile}}\right) = [287.657]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\overset{\widehat{21}}{\smile}} = [1.417 \cdot 10^3]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [287.657]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 1.74\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 0.668\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 5SB Maximum Velocities

$\theta := [.9945] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{total}\widehat{\underset{\smile}{22}} = [862.454]\ \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S\widehat{\underset{\smile}{22}}}\right) = [862.612]\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\ \pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S\widehat{\underset{\smile}{22}}} = [894.828]\ \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [862.612]\ \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.929\ \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.865\ \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

Heap Leach Solution Collection System Calculations

Cell 5SB Application Rate Velocities

$\theta := [.9355] \cdot \pi$

Iterate the actual central angle for the fluid in the pipe until the flow rate in the pipe equals the flowrate to the pad (Q). The purpose is to find the lowest continuous scouring velocity in the pipe to determine is sediment buildup will occur over time.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$Q_{app}^{\widehat{22}} = [672.84] \frac{m^3}{hr}$

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \cdot \left(\frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \left(\sqrt{S^{\widehat{22}}}\right) = [672.525] \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)\right)^{\frac{5}{3}}}{\left(r_{actual} \cdot (2\,\pi - \theta)\right)^{\frac{2}{3}}} \cdot \sqrt{S^{\widehat{22}}} = [1.035 \cdot 10^3] \frac{m^3}{hr}$$

$Q_{actual} := Q_{less_than_half_full} = [672.525] \frac{m^3}{hr}$

Enter the row number and the flow level ("less" for less than half full and "more" for more than half full) found

$$v_{less_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\frac{\theta - \sin(\theta)}{2}\right)} = 2.591 \frac{m}{s}$$

$$v_{more_than_half} := \frac{Q_{actual}}{r_{actual}^{\ 2} \left(\pi - \frac{\theta - \sin(\theta)}{2}\right)} = 2.001 \frac{m}{s}$$

"Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <2ft/s (.61m/s) will allow sediment buildup and >10ft/s (3 m/s) will cause undue wear on the pipe and fittings, in a process that is ran 24hrs/7days a week and is used for a caution in this design). Due to the infrequency of peak flows, lack of fittings/bends, a maximum of 4.8 m/s is utilized in this design. Use the actual inside diameter of the piping selected to check the scouring velocity, not the minimum necessary diameter."

APPENDIX H.1. 3: BURIED HEADER COLLECTION PIPE CALCULATIONS

Project: Coffee HLP Engineering for Licensing
Date: June 13, 2025
Engineer: K. Swetala
Doc. No.: 123022
Rev.: A

Highlighting Legend

=Input parameter that must be entered for each specific case
=Intermediate calculation necessary for use in critical calculations
=Calculated value to be used for design purposes
=Calulated value for reference

$Q_{PLS} := 1400 \cdot \frac{m^3}{hr} = 0.389 \frac{m^3}{s}$ Nominal PLS Flowrate

$P_{PMP} := 283 \frac{mm}{day} = 11.142 \frac{in}{day}$ Amount of Rainfall for a Probable Maximum Precipitation Event

$Ia := 20\%$ Initial Abstraction Rate

$CN_{ore} := 75$ Curve Number for ore

$S_{ore} := \left(\frac{1000}{CN_{ore}} - 10\right) \cdot Ia \frac{in}{day}$ Potential Maximum Retention Equation multiplied by Initial abstraction

$RO_{ore} := \frac{\left(P_{PMP} - .2 \cdot S_{ore}\right)^2}{P_{PMP} + .8 \cdot S_{ore}} = 263.647 \frac{mm}{day}$ Precipitation Excess (Runoff) Equation

$P_{ore} := P_{PMP} - RO_{ore}$ Adjusting total Precipitation for infiltration rate $P_{ore} = 19.353 \frac{mm}{day}$

$CN_{liner} := 99$ Curve Number for liner

$S_{liner} := \left(\frac{1000}{CN_{liner}} - 10\right) \cdot Ia \frac{in}{day}$ Potential Maximum Retention Equation

$RO_{liner} := \frac{\left(P_{PMP} - .2 \cdot S_{liner}\right)^2}{P_{PMP} + .8 \cdot S_{liner}} = 282.385 \frac{mm}{day}$ Precipitation Excess (Runoff) Equation

$P_{liner} := P_{PMP} - RO_{liner}$ Adjusting total Precipitation for infiltration rate $P_{liner} = 0.615 \frac{mm}{day}$

$A_1 := 245125\ m^2$

$A_2 := 180830\ m^2$

$A_3 := 268835\ m^2$

$A_4 := 171440\ m^2$

$A_5 := 130331\ m^2$

Areas of each phase

$$Q_{Storm} := (A_1 + A_2 + A_3 + A_4) \cdot \langle P_{ore} \rangle + A_5 \cdot P_{liner} = 701.848\ \frac{m^3}{hr}$$

Estimated Precipitation that would infiltrate the heap leach pad, PMP Event (Phase 1-4 Ore and Phase 5 Liner)

$$Q_{Total} := 1.2 \cdot Q_{PLS} + \frac{Q_{Storm}}{2} = \langle 2.031 \cdot 10^3 \rangle\ \frac{m^3}{hr}$$

Design PLS Flow reporting to Heap Trunklines (North and South) and Preg Return Line/ Standby Return Line (Nothe and South)

$C := 93\%$

Maximum Flow is acheived at about 93% of full pipe flow.

$\theta := 2 \cdot \operatorname{acos}(2 \cdot C - 1) = 1.071$

Central angle in radians (unitless)

$$n := .009 \cdot \frac{s}{ft^{\frac{1}{3}}} = 0.013\ \frac{s}{m^{\frac{1}{3}}}$$

Manning's roughness coefficient for HDPE pipe

$S_{A_Pad} := 0.03$

Minimum Slope of North Heap Trunkline

$S_{A_Channel} := 0.01$

Minimum Slope of North Preg Return Line/ Standby Line

$S_{B_Pad} := 0.04$

Minimum Slope of South Heap Trunkline

$S_{B_Channel} := 0.01$

Minimum Slope of South Preg Return Line/ Standby Line

Minimum Inner Diameter and Max Velocities for the North A Pad

$$r_{A_Pad} := \left(\left(\frac{Q_{Total} \cdot n}{1 \cdot \sqrt{S_{A_Pad}}} \right) \cdot \frac{(2\pi - \theta)^{\frac{2}{3}}}{\left(\pi - \frac{\theta - \sin(\theta)}{2} \right)^{\frac{5}{3}}} \right)^{\frac{3}{8}} = 232.632\ mm$$

Min. Radius of North Heap Trunkline

$ID_{A_Pad} := 2 \cdot r_{A_Pad} = 465.26\ mm$ Min. Inner Diameter of North Heap Trunkline

$ID_{A_Pad_actual} := 515.6\ mm$ $OD_{A_Pad_actual} := 630\ mm$

Pipe Size for North Heap Trunkline= using HDPE SDR 11 pipe sizes

$$r_{A_Pad_actual} := \frac{ID_{A_Pad_actual}}{2} = 257.8\ mm$$

$$Q_{min} := 28\ \frac{m^3}{hr} = \left(7.778 \cdot 10^{-3}\right)\ \frac{m^3}{s}$$

Iterate the Minimum flow until a velocity of .61 m/s is found. This is the minimum flow that can go through the pad's trunkline in order to scour it .

$\theta_{A_Pad} := .4394 \cdot \pi$ Iterate the actual central angle for the fluid in the pipe until the total flow rate in the pipe equals the minimum flow rate that will likely occur in the pipe during continuous operation.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{A_Pad_actual}^{\ 2} \left(\frac{\theta_{A_Pad} - \sin(\theta_{A_Pad})}{2} \right) \right)^{\frac{5}{3}}}{\left(r_{A_Pad_actual} \cdot (2\pi - \theta_{A_Pad}) \right)^{\frac{2}{3}}} \cdot \sqrt{S_{A_Pad}} = 29.561\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{A_Pad_actual}^{\ 2} \left(\pi - \frac{\theta_{A_Pad} - \sin(\theta_{A_Pad})}{2} \right) \right)^{\frac{5}{3}}}{\left(r_{A_Pad_actual} \cdot (2\pi - \theta_{A_Pad}) \right)^{\frac{2}{3}}} \cdot \sqrt{S_{A_Pad}} = 2627.704\ \frac{m^3}{hr}$$

$$v := \frac{Q_{less_than_half_full}}{r_{A_Pad_actual}^{\ 2} \left(\frac{\theta_{A_Pad} - \sin(\theta_{A_Pad})}{2} \right)} = 0.62\ \frac{m}{s}$$

Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <0.61 m/s will allow sediment buildup)

Minimum Inner Diameter and Max Velocities for the Channels (Slope A=B)

$$r_{Channel} := \left(\left(\frac{Q_{Total} \cdot n}{1 \cdot \sqrt{S_{A_Channel}}} \right) \cdot \frac{(2\,\pi - \theta)^{\frac{2}{3}}}{\left(\pi - \frac{\theta - \sin(\theta)}{2} \right)^{\frac{5}{3}}} \right)^{\frac{3}{8}} = 285.844\ mm$$

Min. Radius of Preg Return Line/ Standby Return Line

$$ID_{Channel} := 2 \cdot r_{Channel} = 571.69\ mm$$

Min. Inner Diameter of Preg Return Line/Standby Return Line

$$ID_{Channel_actual} := 642.2\ mm \qquad OD_{Channel_actual} := 710\ mm$$

Pipe Size for Preg Return Line/Standby Return Line= using HDPE SDR 21 pipe sizes

$$r_{Channel_actual} := \frac{ID_{Channel_actual}}{2} = 321.1\ mm$$

$$Q_{min} := 76\ \frac{m^3}{hr} = 0.021\ \frac{m^3}{s}$$

Iterate the Minimum flow until a velocity of .61 m/s is found. This is the minimum flow that can go through the pad's trunkline in order to scour it .

$$\theta_{Chann} := 0.5312 \cdot \pi$$

Iterate the actual central angle for the fluid in the pipe until the total flow rate in the pipe equals the minimum flow rate that will likely occur in the pipe during continuous operation.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$$Q_{less_than_half_full} := \left(\frac{1}{n} \right) \cdot \frac{\left(r_{Channel_actual}^{\,2} \left(\frac{\theta_{Chann} - \sin(\theta_{Chann})}{2} \right) \right)^{\frac{5}{3}}}{\left(r_{Channel_actual} \cdot (2\,\pi - \theta_{Chann}) \right)^{\frac{2}{3}}} \cdot \sqrt{S_{A_Channel}} = 76.56\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n} \right) \cdot \frac{\left(r_{Channel_actual}^{\,2} \left(\pi - \frac{\theta_{Chann} - \sin(\theta_{Chann})}{2} \right) \right)^{\frac{5}{3}}}{\left(r_{Channel_actual} \cdot (2\,\pi - \theta_{Chann}) \right)^{\frac{2}{3}}} \cdot \sqrt{S_{A_Channel}} = 2619.37\ \frac{m^3}{hr}$$

$$v := \frac{Q_{less_than_half_full}}{r_{Channel_actual}^{\,2} \left(\frac{\theta_{Chann} - \sin(\theta_{Chann})}{2} \right)} = 0.612\ \frac{m}{s}$$

Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <0.61 m/s will allow sediment buildup)

Minimum Inner Diameter and Max Velocities for the South Pad

$$r_{B_Pad} := \left(\left(\frac{Q_{Total} \cdot n}{1 \cdot \sqrt{S_{B_Pad}}} \right) \cdot \frac{(2\pi - \theta)^{\frac{2}{3}}}{\left(\pi - \frac{\theta - \sin(\theta)}{2} \right)^{\frac{5}{3}}} \right)^{\frac{3}{8}} = 220.416\ mm$$

Min. Radius of South Heap Trunkline

$$ID_{B_Pad} := 2 \cdot r_{B_Pad} = 440.83\ mm$$

Min. Inner Diameter of South Heap Trunkline

$$ID_{B_Pad_actual} := 515.6\ mm \qquad OD_{B_Pad_actual} := 630$$

Pipe Size for South Heap Trunkline= using HDPE SDR 11 pipe sizes

$$r_{B_Pad_actual} := \frac{ID_{B_Pad_actual}}{2} = 10.15\ in$$

$$Q_{min} := 35\ \frac{m^3}{hr} = \left(9.722 \cdot 10^{-3}\right)\ \frac{m^3}{s}$$

Iterate the Minimum flow until a velocity of .61 m/s is found. This is the minimum flow that can go through the pad's trunkline in order to scour it .

$$\theta_{B_Pad} := 0.4755 \cdot \pi$$

Iterate the actual central angle for the fluid in the pipe until the total flow rate in the pipe equals the minimum flow rate that will likely occur in the pipe during continuous operation.

Since the fluid level in the pipe is not known, the formulas for more and for less than half full pipes are necessary to check:

$$Q_{less_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{B_Pad_actual}^{\ 2} \left(\frac{\theta_{B_Pad} - \sin\left(\theta_{B_Pad}\right)}{2} \right) \right)^{\frac{5}{3}}}{\left(r_{B_Pad_actual} \cdot \left(2\pi - \theta_{B_Pad}\right) \right)^{\frac{2}{3}}} \cdot \sqrt{S_{B_Pad}} = 50.069\ \frac{m^3}{hr}$$

$$Q_{more_than_half_full} := \left(\frac{1}{n}\right) \cdot \frac{\left(r_{B_Pad_actual}^{\ 2} \left(\pi - \frac{\theta_{B_Pad} - \sin\left(\theta_{B_Pad}\right)}{2} \right) \right)^{\frac{5}{3}}}{\left(r_{B_Pad_actual} \cdot \left(2\pi - \theta_{B_Pad}\right) \right)^{\frac{2}{3}}} \cdot \sqrt{S_{B_Pad}} = 2996.597\ \frac{m^3}{hr}$$

$$v := \frac{Q_{less_than_half_full}}{r_{A_Pad_actual}^{\ 2} \left(\frac{\theta_{B_Pad} - \sin\left(\theta_{B_Pad}\right)}{2} \right)} = 0.842\ \frac{m}{s}$$

Check that the velocity in the buried piping is within the acceptable range for scouring velocities (typically <0.61 m/s will allow sediment buildup)

APPENDIX H. 2: HEAT LOSS CALCULATIONS

Title:	Insulated Pipe Heat Loss - Flowing
Revision Date:	5/18/2022
Generated by:	Jesse White

Insulation Thermal Conductivity	0.035	W/m K
Insulation Thickness	25	mm
External Radius of Pipe	305	mm
Internal Radius of Pipe	295	mm
Flow Rate	1100	m^3/h
Fluid Temp @ inlet	10	°C
Air Temp	-40	°C
Fluid Velocity	1.12	m/s
Pipe Length	2500	m
C_p of fluid	4.2	KJ/Kg °K
SG of Fluid	1	
Fluid Mass/ 1 m of length	273	kg
Residence Time	2237	sec
Heat Loss/ 1 m of length	0.14	KW
Fluid Temp @ Outlet	9.73	°C

Constants	
mm/m	1000
sec/hr	3600
0°C->°K	273
kg/m^3	1000
W/KW	1000

Assumptions:
- Fluid is well mixed
- Pipe has negligible insulating value
- Cp of the fluid is independent of temperature
- Solution is water at 10°C
- Heat loss is based on the largest differential temperature

Title:	Insulated Pipe Heat Loss - Flowing
Revision Date:	5/18/2022
Generated by:	Jesse White

Insulation Thermal Conductivity	0.035	W/m K
Insulation Thickness	25	mm
External Radius of Pipe	162	mm
Internal Radius of Pipe	131	mm
Flow Rate	550	m^3/h
Fluid Temp @ inlet	9.73	°C
Air Temp	-40	°C
Fluid Velocity	2.83	m/s
Pipe Length	1100	m
C_p of fluid	4.2	KJ/Kg °K
SG of Fluid	1	
Fluid Mass/ 1 m of length	54	kg
Residence Time	388	sec
Heat Loss/ 1 m of length	0.08	KW
Fluid Temp @ Outlet	9.60	°C

Constants	
mm/m	1000
sec/hr	3600
0°C->°K	273
kg/m^3	1000
W/KW	1000

Assumptions:
- Fluid is well mixed
- Pipe has negligible insulating value
- Cp of the fluid is independent of temperature
- Solution is water at 10°C
- Heat loss is based on the largest differential temperature

Title:	Insulated Pipe Heat Loss - Static
Revision Date:	5/18/2022
Generated by:	Jesse White

Insulation Thermal Conductivity	0.035	W/m K
Insulation Thickness	25	mm
External Radius of Pipe	305	mm
Internal Radius of Pipe	295	mm
Flow Rate	0	m^3/h
Fluid Temp @ inlet	10	°C
Air Temp	-40	°C
Fluid Velocity	0.00	m/s
Pipe Length	2500	m
C_p of fluid	4.2	KJ/Kg °K
SG of Fluid	1	
Fluid Mass/ 1 m of length	273	kg
Heat Loss/ 1 m of length @ max dT	0.14	KW
Time to 0°C	22.9	hr
Latent Heat of Solidification	334	KJ/kg
Time to Solidification from 0°C	182	hr

Constants	
mm/m	1000
sec/hr	3600
0°C->°K	273
kg/m^3	1000
W/KW	1000

Assumptions:
- Fluid is well mixed
- Pipe has negligible insulating value
- Cp of the fluid is independent of temperature
- Solution is water at 10°C
- Heat loss is based on the largest differential temperature

Title:	Insulated Pipe Heat Loss - Static
Revision Date:	5/18/2022
Generated by:	Jesse White

Insulation Thermal Conductivity	0.035	W/m K
Insulation Thickness	25	mm
External Radius of Pipe	162	mm
Internal Radius of Pipe	131	mm
Flow Rate	0	m^3/h
Fluid Temp @ inlet	10	°C
Air Temp	-40	°C
Fluid Velocity	0.00	m/s
Pipe Length	1100	m
C_p of fluid	4.2	KJ/Kg °K
SG of Fluid	1	
Fluid Mass/ 1 m of length	54	kg
Heat Loss/ 1 m of length @ max dT	0.08	KW
Time to 0°C	8.2	hr
Latent Heat of Solidification	334	KJ/kg
Time to Solidification from 0°C	65	hr

Constants	
mm/m	1000
sec/hr	3600
0°C->°K	273
kg/m^3	1000
W/KW	1000

Assumptions:
- Fluid is well mixed
- Pipe has negligible insulating value
- Cp of the fluid is independent of temperature
- Solution is water at 10°C
- Heat loss is based on the largest differential temperature

APPENDIX H. 3: PLS COLLECTION PIPE HYDRAULIC CALCULATIONS

Project: Coffee HLP Engineering for Licensing
Document Title: Hydraulic Analysis for Coffee PLS Collection Pipe - Route C
Date: 22-Feb-22
Engineer: W. Reinhardt
Project No.: 123017
Document No.: N/A
Revision: A

Legend
- Input Required
- Pressure in Pipeline
- Pump Discharge
- Riser Locations

Flowrate	7450	gpm
	16.599	cfs
Darcy -Weisbach e steel	1.50E-04	ft
Darcy -Weisbach e plastic	7.00E-05	ft
Kinematic Viscosity	1.23E-05	ft^2/s
Specific Gravity	1.02	
Temperature	50	°F
Pump Soln. Surface Elev.	6123	ft. msl
	3.2808	m/ft
CS1 Pressure Rating	270	psig
HDPE SDR 21 Rating	100	psig
Hazen Coeff. - Steel	147	
Hazen Coeff. - Plastic	150	

ANALYSIS SUMMARY

	Station	Elevation	Intake Press. (psi)	TDH (ft)	Discharge Pressure (psi)
Vertical Turbines	0	0.00	0.00	0	0.00
# of Pumps in Parallel	0				
Flow per pump (gpm)	0				

End Pressure (psi) 4.18

Station	Elevation	Pipe Type	Pipe ID (in.)	Relative Rough.	Length (ft.)	Cummulative Length (ft.)	Velocity (ft/s)	Re	A	B	Fric. Factor	Friction Loss (ft.)	Fittings Loss (ft.)	Pump TDH (ft.)	Pressure Head (ft.)	Line Pressure (psi)	Check- Hazen Line Pressure	Dynamic Grade Line (ft. msl)	Static Grade Line (ft. msl)	Pipe Pressure Rating (psi.)	Pipe Pressure Rating (ft.)	Comments
328	3993.2	24 HDPE SDR 21	NA	NA	NA	NA	NA	NA	NA	NA	*NA*	0	0	0	0.00	0.00		3993.20	3993.20	100.00	4224.00	
350	3992.4	24 HDPE SDR 21	21.58	3.89E-05	21	21.49	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.09942537	0	0	0.72	0.31	0.31	3993.10	3993.20	100.00	4223.18	
361	3991.9	24 HDPE SDR 21	21.58	3.89E-05	11	32.81	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.05236909	0	0	1.10	0.48	0.48	3993.05	3993.10	100.00	4222.75	
394	3990.7	24 HDPE SDR 21	21.58	3.89E-05	33	65.62	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	2.21	0.96	0.96	3992.90	3993.05	100.00	4221.49	
427	3989.4	24 HDPE SDR 21	21.58	3.89E-05	33	98.42	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	3.31	1.43	1.43	3992.75	3992.90	100.00	4220.24	
437	3989.0	24 HDPE SDR 21	21.58	3.89E-05	10	108.82	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.04811885	0	0	3.66	1.58	1.58	3992.70	3992.75	100.00	4219.84	
459	3988.2	24 HDPE SDR 21	21.58	3.89E-05	22	131.23	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.10367562	0	0	4.41	1.91	1.91	3992.60	3992.70	100.00	4218.99	
492	3986.9	24 HDPE SDR 21	21.58	3.89E-05	33	164.04	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	5.51	2.39	2.39	3992.44	3992.60	100.00	4217.73	
525	3985.7	24 HDPE SDR 21	21.58	3.89E-05	33	196.85	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	6.62	2.87	2.87	3992.29	3992.44	100.00	4216.48	
558	3984.4	24 HDPE SDR 21	21.58	3.89E-05	33	229.66	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	7.72	3.34	3.34	3992.14	3992.29	100.00	4215.22	
591	3983.2	24 HDPE SDR 21	21.58	3.89E-05	33	262.46	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	8.82	3.82	3.82	3991.99	3992.14	100.00	4213.97	
610	3982.4	24 HDPE SDR 21	21.58	3.89E-05	19	281.72	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.08910335	0	0	9.47	4.10	4.10	3991.90	3991.99	100.00	4213.23	
623	3981.9	24 HDPE SDR 21	21.58	3.89E-05	14	295.27	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.06269111	0	0	9.92	4.30	4.30	3991.84	3991.90	100.00	4212.71	
656	3980.7	24 HDPE SDR 21	21.58	3.89E-05	33	328.08	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	11.02	4.78	4.78	3991.68	3991.84	100.00	4211.46	
689	3979.4	24 HDPE SDR 21	21.58	3.89E-05	33	360.89	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	12.13	5.25	5.25	3991.53	3991.68	100.00	4210.21	
722	3978.2	24 HDPE SDR 21	21.58	3.89E-05	33	393.70	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	13.23	5.73	5.73	3991.38	3991.53	100.00	4208.95	
755	3976.9	24 HDPE SDR 21	21.58	3.89E-05	33	426.50	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	14.33	6.21	6.21	3991.23	3991.38	100.00	4207.70	
785	3975.9	24 HDPE SDR 21	21.58	3.89E-05	30	456.56	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.13904373	0	0	15.19	6.58	6.58	3991.09	3991.23	100.00	4206.70	
787	3975.8	24 HDPE SDR 21	21.58	3.89E-05	3	459.31	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.01275074	0	0	15.26	6.61	6.61	3991.08	3991.09	100.00	4206.62	
820	3975.6	24 HDPE SDR 21	21.58	3.89E-05	33	492.12	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.34	6.65	6.65	3990.93	3991.08	100.00	4206.38	
853	3975.4	24 HDPE SDR 21	21.58	3.89E-05	33	524.93	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.40	6.67	6.67	3990.77	3990.93	100.00	4206.17	
886	3975.2	24 HDPE SDR 21	21.58	3.89E-05	33	557.74	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.47	6.70	6.70	3990.62	3990.77	100.00	4205.96	
904	3975.0	24 HDPE SDR 21	21.58	3.89E-05	18	575.62	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.08272798	0	0	15.50	6.72	6.72	3990.54	3990.62	100.00	4205.84	
919	3974.9	24 HDPE SDR 21	21.58	3.89E-05	15	590.54	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.06906648	0	0	15.54	6.73	6.73	3990.47	3990.54	100.00	4205.74	
951	3974.7	24 HDPE SDR 21	21.58	3.89E-05	33	623.35	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.59	6.76	6.76	3990.32	3990.47	100.00	4205.53	
984	3974.5	24 HDPE SDR 21	21.58	3.89E-05	33	656.16	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.65	6.78	6.78	3990.17	3990.32	100.00	4205.31	
1017	3974.3	24 HDPE SDR 21	21.58	3.89E-05	33	688.97	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.72	6.81	6.81	3990.02	3990.17	100.00	4205.10	
1050	3974.1	24 HDPE SDR 21	21.58	3.89E-05	33	721.78	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.78	6.84	6.84	3989.86	3990.02	100.00	4204.89	
1083	3973.9	24 HDPE SDR 21	21.58	3.89E-05	33	754.58	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.84	6.86	6.86	3989.71	3989.86	100.00	4204.68	
1115	3973.7	24 HDPE SDR 21	21.58	3.89E-05	33	787.39	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.90	6.89	6.89	3989.56	3989.71	100.00	4204.46	
1148	3973.4	24 HDPE SDR 21	21.58	3.89E-05	33	820.20	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.96	6.91	6.91	3989.41	3989.56	100.00	4204.25	
1181	3973.2	24 HDPE SDR 21	21.58	3.89E-05	33	853.01	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.02	6.94	6.94	3989.26	3989.41	100.00	4204.04	
1214	3973.0	24 HDPE SDR 21	21.58	3.89E-05	33	885.82	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.08	6.97	6.97	3989.10	3989.26	100.00	4203.83	
1247	3972.8	24 HDPE SDR 21	21.58	3.89E-05	33	918.62	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.14	6.99	6.99	3988.95	3989.10	100.00	4203.61	
1280	3972.6	24 HDPE SDR 21	21.58	3.89E-05	33	951.43	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.20	7.02	7.02	3988.80	3988.95	100.00	4203.40	
1312	3972.4	24 HDPE SDR 21	21.58	3.89E-05	33	984.24	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.26	7.04	7.04	3988.65	3988.80	100.00	4203.19	
1345	3972.2	24 HDPE SDR 21	21.58	3.89E-05	33	1017.05	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.32	7.07	7.07	3988.50	3988.65	100.00	4202.98	
1363	3972.1	24 HDPE SDR 21	21.58	3.89E-05	18	1035.39	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.08485311	0	0	16.35	7.08	7.08	3988.41	3988.50	100.00	4202.86	
1378	3972.0	24 HDPE SDR 21	21.58	3.89E-05	14	1049.86	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.06694136	0	0	16.37	7.09	7.09	3988.35	3988.41	100.00	4202.78	
1411	3971.8	24 HDPE SDR 21	21.58	3.89E-05	33	1082.66	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.43	7.12	7.12	3988.19	3988.35	100.00	4202.56	
1444	3971.5	24 HDPE SDR 21	21.58	3.89E-05	33	1115.47	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.49	7.15	7.15	3988.04	3988.19	100.00	4202.35	
1476	3971.4	24 HDPE SDR 21	21.58	3.89E-05	33	1148.28	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.48	7.14	7.14	3987.89	3988.04	100.00	4202.21	
1509	3971.5	24 HDPE SDR 21	21.58	3.89E-05	33	1181.09	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	16.26	7.04	7.04	3987.74	3987.89	100.00	4202.28	
1542	3971.7	24 HDPE SDR 21	21.58	3.89E-05	33	1213.90	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.89	6.89	6.89	3987.59	3987.74	100.00	4202.49	
1575	3971.9	24 HDPE SDR 21	21.58	3.89E-05	33	1246.70	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	0	15.53	6.73	6.73	3987.43	3987.59	100.00	4202.71	
1600	3972.1	24 HDPE SDR 21	21.58	3.89E-05	25	1272.00	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.11703353	0	0	15.25	6.61	6.61	3987.32	3987.43	100.00	4202.87	

1608	3972.1	24	HDPE	SDR 21	21.58	3.89E-05	8	1279.51	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.03476093	0	15.17	6.57	6.57	3987.28	3987.32	100.00	4202.91
1620	3972.2	24	HDPE	SDR 21	21.58	3.89E-05	12	1292.01	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.05783369	0	15.03	6.51	6.51	3987.22	3987.28	100.00	4203.00
1626	3973.0	24	HDPE	SDR 21	21.58	3.89E-05	6	1298.02	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.02777839	0	14.15	6.13	6.13	3987.20	3987.22	100.00	4203.85
1659	3976.6	24	HDPE	SDR 21	21.58	3.89E-05	33	1330.82	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	10.48	4.54	4.54	3987.05	3987.20	100.00	4207.36
1692	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1363.63	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	10.56	4.58	4.58	3986.89	3987.05	100.00	4207.13
1725	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1396.44	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	10.41	4.51	4.51	3986.74	3986.89	100.00	4207.13
1757	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1429.25	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	10.26	4.45	4.45	3986.59	3986.74	100.00	4207.13
1790	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1462.06	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	10.11	4.38	4.38	3986.44	3986.59	100.00	4207.13
1823	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1494.86	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.96	4.31	4.31	3986.29	3986.44	100.00	4207.13
1856	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1527.67	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.80	4.25	4.25	3986.13	3986.29	100.00	4207.13
1889	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1560.48	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.65	4.18	4.18	3985.98	3986.13	100.00	4207.13
1921	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1593.29	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.50	4.12	4.12	3985.83	3985.98	100.00	4207.13
1954	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1626.10	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.35	4.05	4.05	3985.68	3985.83	100.00	4207.13
1987	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1658.90	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.20	3.99	3.98	3985.53	3985.68	100.00	4207.13
2020	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1691.71	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	9.05	3.92	3.92	3985.38	3985.53	100.00	4207.13
2053	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1724.52	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	8.89	3.85	3.85	3985.22	3985.38	100.00	4207.13
2085	3976.3	24	HDPE	SDR 21	21.58	3.89E-05	33	1757.33	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	8.74	3.79	3.79	3985.07	3985.22	100.00	4207.13
2118	3972.4	24	HDPE	SDR 21	21.58	3.89E-05	33	1790.14	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	12.53	5.43	5.43	3984.92	3985.07	100.00	4203.19
2151	3961.5	24	HDPE	SDR 21	21.58	3.89E-05	33	1822.94	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	23.31	10.10	10.10	3984.77	3984.92	100.00	4192.25
2184	3950.6	24	HDPE	SDR 21	21.58	3.89E-05	33	1855.75	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	34.02	14.74	14.74	3984.62	3984.77	100.00	4181.39
2217	3943.5	24	HDPE	SDR 21	21.58	3.89E-05	33	1888.56	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	40.94	17.74	17.74	3984.46	3984.62	100.00	4174.32
2249	3943.5	24	HDPE	SDR 21	21.58	3.89E-05	33	1921.37	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.15179447	0	40.79	17.67	17.67	3984.31	3984.46	100.00	4174.32
2271	3943.5	24	HDPE	SDR 21	21.58	3.89E-05	22	1943.28	6.535	9.55E+05	2.73186E+22	3E-23	**0.012547**	0.1013987	0	40.69	17.63	17.63	3984.21	3984.31	100.00	4174.32

APPENDIX H. 4: BARREN PIPE HYDRAULIC CALCULATIONS

Project: Coffee - Barren Solution Line
Document Title: Hydraulic Analysis
Date: 30-May-25
Engineer: C.Green
Project No.: 123017
Document No.: N/A
Revision: 0

Flowrate	6150	gpm
	1407	m3/h
	13.7	cfs
Darcy -Weisbach e steel	1.50E-04	ft
Darcy -Weisbach e plastic	7.00E-05	ft
Kinematic Viscosity	1.23E-05	ft^2/s
Specific Gravity	1.02	
Temperature	50	^{0}F
Pump Soln. Surface Elev.	3942.56	ft. msl
CS Sch 80 Pressure Rating	749	psig
CS Std Pressure Rating	270	psig
HDPE SDR 11 Rating	200	psig
Hazen Coeff. - Steel	147	
Hazen Coeff. - Plastic	150	

ANALYSIS SUMMARY

	Station	Elevation	Intake Press. (psi)	TDH (ft)	Discharge Pressure (psi)
Vertical Turbines	2+260.07	3942.56	0.00	773.85	335.00
# of Pumps in Parallel	1				
Flow per pump (gpm)	6150				

Legend
- Input Required
- Pressure in Pipeline
- Pump Discharge
- Riser Locations

End Pressure (psi) 42.61

Station	Elevation	Pipe Type	Pipe ID (in.)	Relative Rough.	Length (ft.)	Cummulative Length (ft.)	Velocity (ft/s)	Re	A	B	Fric. Factor	Friction Loss (ft.)	Fittings Loss (ft.)	Pump TDH (ft.)	Pressure Head (ft.)	Line Pressure (psi)	Check- Hazen Line Pressure	Dynamic Grade Line (ft. msl)	Static Grade Line (ft. msl)	Pipe Pressure Rating (psi.)	Pipe Pressure Rating (ft.)	Comments
		Barren Tank Soln. Surface	NA	NA	NA	NA	NA	NA	NA	NA	*NA*	0	0	0	0.00							Start at Elevation of Barren Solution Surface
	3942.56															0.00		3950.64	3950.64	749.00	5679.33	
2+260.07	3942.56	**PUMP DISCHARGE**	9.4	1.91E-04	0	0	28.432	1.81E+06	9.79283E+21	1E-27	**0.014264**	0	0	773.85	773.85	335.29	335.25	4724.57	4724.57	749.00	5679.41	Discharge from Barren Vertical Turbine(s)
2+236.78	3945.84	**24" Sch 80-DN 600**	21.56	8.35E-05	76.3912	76.3912	5.405	7.89E+05	6.92618E+21	7E-22	**0.014895**	0.28725383	0		773.48	335.13	-0.04	4724.20	3950.64	749.00	5679.41	
2+231.58	3950.63864	**24" Sch 80-DN 600**	21.56	8.35E-05	17.056	93.4472	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.05839505	0		772.89	334.88	335.01	4724.14	4724.57	749.00	5679.94	
2+230.00	3950.72064	**24" Sch 80-DN 600**	21.56	8.35E-05	5.1824	98.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.01774311	0		772.35	334.64	334.85	4724.13	3950.64	749.00	5680.47	
2+220.00	3951.24872	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	131.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		772.84	334.85	335.01	4724.09	4724.57	749.00	5679.94	
2+210.00	3951.77352	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	164.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		772.20	334.58	334.58	4723.98	4724.57	749.00	5680.47	
2+200.00	3952.29832	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	197.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		771.57	334.30	334.30	4723.86	4724.57	749.00	5680.99	
2+190.00	3952.82312	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	229.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		770.93	334.02	334.02	4723.75	4724.57	749.00	5681.52	
2+180.00	3953.3512	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	262.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		770.29	333.75	333.75	4723.64	4724.57	749.00	5682.04	
2+170.00	3953.876	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	295.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		769.65	333.47	333.47	4723.53	4724.57	749.00	5682.57	
2+160.00	3954.4008	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	328.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		769.01	333.20	333.20	4723.42	4724.57	749.00	5683.09	
2+150.00	3954.9256	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	361.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		768.38	332.92	332.92	4723.30	4724.57	749.00	5683.62	
2+140.00	3955.45368	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	393.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		767.74	332.64	332.64	4723.19	4724.57	749.00	5684.15	
2+130.00	3955.97848	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	426.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		767.10	332.37	332.37	4723.08	4724.57	749.00	5684.67	
2+120.00	3956.50328	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	459.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		766.46	332.09	332.09	4722.97	4724.57	749.00	5685.20	
2+110.00	3957.02808	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	492.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		765.83	331.81	331.81	4722.85	4724.57	749.00	5685.72	
2+100.00	3957.55288	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	525.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		765.19	331.54	331.54	4722.74	4724.57	749.00	5686.24	
2+090.00	3958.08096	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	557.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		764.55	331.26	331.26	4722.63	4724.57	749.00	5686.77	
2+080.00	3958.60576	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	590.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		763.91	330.98	330.98	4722.52	4724.57	749.00	5687.30	
2+070.00	3959.13056	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	623.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		763.27	330.71	330.71	4722.40	4724.57	749.00	5687.82	
2+069.97	3959.11416	**24" Sch 80-DN 600**	21.56	8.35E-05	0.0984	623.528	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.00033689	0		763.29	330.71	330.71	4722.40	4724.57	749.00	5687.81	
2+060.00	3960.8952	**24" Sch 80-DN 600**	21.56	8.35E-05	32.7016	656.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11196128	0		761.40	329.89	329.89	4722.29	4724.57	749.00	5689.59	
2+052.20	3962.14816	**24" Sch 80-DN 600**	21.56	8.35E-05	25.584	681.8136	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.08759258	0		760.06	329.31	329.31	4722.20	4724.57	749.00	5690.84	
2+050.00	3962.21704	**24" Sch 80-DN 600**	21.56	8.35E-05	7.216	689.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.0247056	0		759.96	329.27	329.27	4722.18	4724.57	749.00	5690.91	
2+040.00	3962.51552	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	721.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		759.55	329.10	329.10	4722.07	4724.57	749.00	5691.21	
2+030.00	3962.81072	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	754.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		759.14	328.92	328.92	4721.96	4724.57	749.00	5691.50	
2+020.00	3963.10592	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	787.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		758.74	328.74	328.74	4721.84	4724.57	749.00	5691.80	
2+010.00	3963.4044	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	820.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		758.33	328.56	328.56	4721.73	4724.57	749.00	5692.10	
2+000.00	3963.6996	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	853.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		757.92	328.39	328.39	4721.62	4724.57	749.00	5692.39	
1+990.00	3963.99808	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	885.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		757.51	328.21	328.21	4721.51	4724.57	749.00	5692.69	
1+980.00	3964.29328	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	918.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		757.10	328.03	328.03	4721.39	4724.57	749.00	5692.99	
1+970.00	3964.58848	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	951.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		756.69	327.86	327.86	4721.28	4724.57	749.00	5693.28	
1+960.00	3964.88696	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	984.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		756.28	327.68	327.68	4721.17	4724.57	749.00	5693.58	
1+950.00	3965.18216	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1017.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		755.87	327.50	327.50	4721.06	4724.57	749.00	5693.87	
1+940.00	3965.48064	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1049.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		755.46	327.32	327.32	4720.94	4724.57	749.00	5694.17	
1+930.00	3965.77584	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1082.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		755.06	327.15	327.15	4720.83	4724.57	749.00	5694.47	
1+920.00	3966.07104	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1115.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		754.65	326.97	326.97	4720.72	4724.57	749.00	5694.76	
1+910.00	3966.36952	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1148.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		754.24	326.79	326.79	4720.61	4724.57	749.00	5695.06	
1+900.00	3966.66472	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1181.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		753.83	326.62	326.62	4720.50	4720.61	749.00	5695.36	
1+890.00	3966.9632	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1213.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0		753.42	326.44	326.44	4720.38	4720.61	749.00	5695.66	

1+880.00	3967.2584	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1246.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	753.01	326.26	326.26	4720.27	4720.61	749.00	5695.95
1+870.00	3967.5536	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1279.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	752.61	326.09	326.09	4720.16	4720.61	749.00	5696.25
1+860.00	3967.85208	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1312.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	752.19	325.91	325.91	4720.05	4720.61	749.00	5696.54
1+850.00	3968.14728	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1345.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	751.79	325.73	325.73	4719.93	4720.61	749.00	5696.84
1+847.35	3968.15056	**24" Sch 80-DN 600**	21.56	8.35E-05	8.692	1353.7216	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.02975902	0	751.75	325.72	325.72	4719.90	4720.61	749.00	5696.84
1+843.04	3969.67248	**24" Sch 80-DN 600**	21.56	8.35E-05	14.1368	1367.8584	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.04840051	0	750.18	325.04	325.04	4719.86	4720.61	749.00	5698.36
1+840.00	3970.15136	**24" Sch 80-DN 600**	21.56	8.35E-05	9.9712	1377.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.03413865	0	749.67	324.81	324.81	4719.82	4720.61	749.00	5698.84
1+830.00	3971.72576	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1410.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	747.98	324.08	324.08	4719.71	4720.61	749.00	5700.42
1+820.00	3973.29688	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1443.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	746.30	323.35	323.35	4719.60	4720.61	749.00	5701.99
1+810.00	3975.196	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1476.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	744.29	322.48	322.48	4719.48	4720.61	749.00	5703.89
1+808.53	3975.51088	**24" Sch 80-DN 600**	21.56	8.35E-05	4.8216	1481.0512	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.01650783	0	743.96	322.34	322.34	4719.47	4720.61	749.00	5704.20
1+800.00	3976.55064	**24" Sch 80-DN 600**	21.56	8.35E-05	27.9784	1509.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.09579035	0	742.82	321.85	321.85	4719.37	4720.61	749.00	5705.24
1+790.00	3977.7708	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1541.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	741.49	321.27	321.27	4719.26	4720.61	749.00	5706.46
1+780.00	3978.99752	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1574.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	740.15	320.69	320.69	4719.15	4720.61	749.00	5707.69
1+770.00	3980.2308	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1607.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	738.80	320.11	320.11	4719.04	4720.61	749.00	5708.92
1+760.00	3981.48704	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1640.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	737.44	319.51	319.51	4718.92	4720.61	749.00	5710.18
1+750.00	3982.74	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1673.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	736.07	318.92	318.92	4718.81	4720.61	749.00	5711.43
1+749.83	3982.75968	**24" Sch 80-DN 600**	21.56	8.35E-05	0.5576	1673.5872	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.00190907	0	736.05	318.91	318.91	4718.81	4720.61	749.00	5711.45
1+740.00	3983.99296	**24" Sch 80-DN 600**	21.56	8.35E-05	32.2424	1705.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11038911	0	734.71	318.33	318.33	4718.70	4720.61	749.00	5712.68
1+730.00	3985.24592	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1738.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	733.34	317.74	317.74	4718.59	4720.61	749.00	5713.94
1+720.00	3986.50216	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1771.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	731.97	317.15	317.15	4718.47	4720.61	749.00	5715.19
1+710.00	3987.75512	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1804.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	730.61	316.55	316.55	4718.36	4720.61	749.00	5716.45
1+700.00	3989.00808	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1837.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	729.24	315.96	315.96	4718.25	4720.61	749.00	5717.70
1+690.00	3990.26104	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1869.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	727.88	315.37	315.37	4718.14	4720.61	749.00	5718.95
1+680.00	3991.514	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1902.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	726.51	314.78	314.78	4718.02	4720.61	749.00	5720.21
1+674.87	3992.16016	**24" Sch 80-DN 600**	21.56	8.35E-05	16.8264	1919.456	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.05760897	0	725.81	314.47	314.47	4717.97	4720.61	749.00	5720.85
1+670.00	3992.77024	**24" Sch 80-DN 600**	21.56	8.35E-05	15.9736	1935.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.05468921	0	725.14	314.19	314.19	4717.91	4720.61	749.00	5721.46
1+660.00	3994.0232	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	1968.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	723.78	313.59	313.60	4717.80	4720.61	749.00	5722.72
1+650.00	3995.27616	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2001.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	722.41	313.00	313.00	4717.69	4720.61	749.00	5723.97
1+640.00	3996.52912	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2033.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	721.05	312.41	312.41	4717.58	4720.61	749.00	5725.22
1+630.00	3997.78536	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2066.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	719.68	311.82	311.82	4717.46	4720.61	749.00	5726.48
1+620.00	3998.61848	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2099.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	718.73	311.41	311.41	4717.35	4720.61	749.00	5727.31
1+616.84	3998.80872	**24" Sch 80-DN 600**	21.56	8.35E-05	10.3648	2109.7944	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.03548622	0	718.51	311.31	311.31	4717.32	4720.61	749.00	5727.50
1+610.00	3999.44504	**24" Sch 80-DN 600**	21.56	8.35E-05	22.4352	2132.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.07681195	0	717.79	311.00	311.00	4717.24	4720.61	749.00	5728.14
1+600.00	4000.40936	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2165.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	716.72	310.54	310.54	4717.13	4720.61	749.00	5729.10
1+590.00	4001.5508	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2197.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	715.46	309.99	309.99	4717.01	4720.61	749.00	5730.24
1+580.00	4002.82344	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2230.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	714.08	309.39	309.39	4716.90	4720.61	749.00	5731.52
1+575.94	4003.32856	**24" Sch 80-DN 600**	21.56	8.35E-05	13.3168	2243.9464	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.04559306	0	713.53	309.15	309.15	4716.86	4720.61	749.00	5732.02
1+570.00	4004.24368	**24" Sch 80-DN 600**	21.56	8.35E-05	19.4832	2263.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.06670512	0	712.55	308.73	308.73	4716.79	4720.61	749.00	5732.94
1+560.00	4005.23752	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2296.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	711.44	308.25	308.25	4716.68	4720.61	749.00	5733.93
1+550.00	4006.22808	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2329.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	710.34	307.77	307.77	4716.57	4720.61	749.00	5734.92
1+540.00	4007.21864	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2361.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	709.23	307.29	307.30	4716.45	4720.61	749.00	5735.91
1+531.66	4008.04192	**24" Sch 80-DN 600**	21.56	8.35E-05	27.3552	2389.1848	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.09365668	0	708.32	306.90	306.90	4716.36	4720.61	749.00	5736.73
1+530.00	4008.18952	**24" Sch 80-DN 600**	21.56	8.35E-05	5.4448	2394.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.0186415	0	708.15	306.82	306.82	4716.34	4720.61	749.00	5736.88
1+520.00	4009.08824	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2427.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	707.14	306.39	306.39	4716.23	4720.61	749.00	5737.78
1+510.00	4009.99024	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2460.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	706.13	305.95	305.95	4716.12	4720.61	749.00	5738.68
1+500.00	4010.88896	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2493.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	705.11	305.51	305.51	4716.00	4720.61	749.00	5739.58
1+490.00	4011.79096	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2525.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	704.10	305.07	305.07	4715.89	4720.61	749.00	5740.48
1+480.00	4012.68968	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2558.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	703.09	304.63	304.63	4715.78	4720.61	749.00	5741.38
1+470.00	4013.5884	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2591.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	702.08	304.19	304.20	4715.67	4720.61	749.00	5742.28
1+460.00	4014.4904	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2624.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	701.06	303.75	303.76	4715.55	4720.61	749.00	5743.18
1+458.57	4014.61832	**24" Sch 80-DN 600**	21.56	8.35E-05	4.6904	2628.92	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.01605864	0	700.92	303.69	303.69	4715.54	4720.61	749.00	5743.31
1+450.00	4015.38256	**24" Sch 80-DN 600**	21.56	8.35E-05	28.1096	2657.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.09623954	0	700.06	303.32	303.32	4715.44	4720.61	749.00	5744.07
1+440.00	4016.278	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2689.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	699.05	302.88	302.88	4715.33	4720.61	749.00	5744.97
1+430.00	4017.17344	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2722.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	698.04	302.45	302.45	4715.22	4720.61	749.00	5745.87
1+420.00	4018.0656	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2755.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	697.04	302.01	302.01	4715.11	4720.61	749.00	5746.76
1+410.00	4019.148	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2788.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	695.84	301.49	301.49	4714.99	4720.61	749.00	5747.84
1+403.04	4020.99792	**24" Sch 80-DN 600**	21.56	8.35E-05	22.8288	2811.0584	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.07815953	0	693.92	300.66	300.66	4714.91	4720.61	749.00	5749.69
1+400.00	4021.79496	**24" Sch 80-DN 600**	21.56	8.35E-05	9.9712	2821.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.03413865	0	693.09	300.30	300.30	4714.88	4720.61	749.00	5750.49
1+390.00	4024.41896	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2853.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	690.35	299.11	299.11	4714.77	4720.61	749.00	5753.11
1+380.00	4027.04296	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2886.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	687.61	297.93	297.93	4714.66	4720.61	749.00	5755.73
1+370.00	4029.67024	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2919.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	684.87	296.74	296.74	4714.54	4720.61	749.00	5758.36
1+360.00	4032.29424	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2952.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	682.14	295.55	295.56	4714.43	4720.61	749.00	5760.99
1+350.00	4034.91824	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	2985.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	679.40	294.37	294.37	4714.32	4720.61	749.00	5763.61
1+340.00	4037.54224	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3017.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	676.66	293.18	293.18	4714.21	4720.61	749.00	5766.23
1+330.00	4040.16624	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3050.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	673.93	292.00	292.00	4714.09	4720.61	749.00	5768.86
1+320.00	4042.79352	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3083.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	671.19	290.81	290.81	4713.98	4720.61	749.00	5771.49
1+310.00	4045.41752	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3116.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	668.45	289.62	289.63	4713.87	4720.61	749.00	5774.11
1+305.14	4046.69344	**24" Sch 80-DN 600**	21.56	8.35E-05	15.9408	3132.1704	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.05457691	0	667.12	289.05	289.05	4713.82	4720.61	749.00	5775.39

1+300.00	4048.04152	**24" Sch 80-DN 600**	21.56	8.35E-05	16.8592	3149.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.05772126	0	665.72	288.44	288.44	4713.76	4720.61	749.00	5776.73	
1+290.00	4050.6688	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3181.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	662.98	287.25	287.25	4713.65	4720.61	749.00	5779.36	
1+280.00	4053.29608	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3214.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	660.24	286.06	286.07	4713.53	4720.61	749.00	5781.99	
1+270.00	4055.92008	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3247.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	657.50	284.88	284.88	4713.42	4720.61	749.00	5784.61	
1+260.00	4058.54736	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3280.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	654.76	283.69	283.69	4713.31	4720.61	749.00	5787.24	
1+250.00	4061.17464	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3313.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	652.02	282.50	282.51	4713.20	4720.61	749.00	5789.87	
1+249.07	4061.41736	**24" Sch 80-DN 600**	21.56	8.35E-05	3.0504	3316.08	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.01044373	0	651.77	282.40	282.40	4713.19	4720.61	749.00	5790.11	
1+240.00	4063.8052	**24" Sch 80-DN 600**	21.56	8.35E-05	29.7496	3345.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.10185445	0	649.28	281.32	281.32	4713.08	4720.61	749.00	5792.50	
1+230.00	4066.34392	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3378.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	646.63	280.17	280.17	4712.97	4720.61	749.00	5795.04	
1+220.41	4068.66616	**24" Sch 80-DN 600**	21.56	8.35E-05	31.4552	3410.0848	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.10769395	0	644.20	279.12	279.12	4712.86	4720.61	749.00	5797.36	
1+220.00	4068.7744	**24" Sch 80-DN 600**	21.56	8.35E-05	1.3448	3411.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.00460423	0	644.08	279.07	279.07	4712.86	4720.61	749.00	5797.47	
1+210.00	4071.3984	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3444.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	641.35	277.88	277.88	4712.75	4720.61	749.00	5800.09	
1+202.43	4073.38608	**24" Sch 80-DN 600**	21.56	8.35E-05	24.8296	3469.0592	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.08500972	0	639.28	276.98	276.98	4712.66	4720.61	749.00	5802.08	
1+201.98	4073.48776	**24" Sch 80-DN 600**	21.56	8.35E-05	1.476	3470.5352	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.00505342	0	639.17	276.94	276.94	4712.66	4720.61	749.00	5802.18	
1+200.00	4073.94368	**24" Sch 80-DN 600**	21.56	8.35E-05	6.4944	3477.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.02223504	0	638.69	276.73	276.73	4712.63	4720.61	749.00	5802.64	
1+190.00	4076.23968	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3509.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	636.28	275.69	275.69	4712.52	4720.61	749.00	5804.93	
1+180.00	4078.53568	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3542.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	633.87	274.64	274.64	4712.41	4720.61	749.00	5807.23	
1+170.00	4080.83168	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3575.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	631.47	273.60	273.60	4712.30	4720.61	749.00	5809.52	
1+160.00	4083.12768	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3608.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	629.06	272.56	272.56	4712.19	4720.61	749.00	5811.82	
1+150.00	4085.42368	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3641.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	626.65	271.51	271.51	4712.07	4720.61	749.00	5814.12	
1+140.00	4087.71968	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3673.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	624.24	270.47	270.47	4711.96	4720.61	749.00	5816.41	
1+130.00	4090.01568	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3706.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	621.83	269.43	269.43	4711.85	4720.61	749.00	5818.71	
1+120.00	4092.31168	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3739.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	619.42	268.38	268.38	4711.74	4720.61	749.00	5821.00	
1+113.04	4093.90904	**24" Sch 80-DN 600**	21.56	8.35E-05	22.8288	3762.2584	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.07815953	0	617.75	267.66	267.66	4711.66	4720.61	749.00	5822.60	
1+110.00	4094.60768	**24" Sch 80-DN 600**	21.56	8.35E-05	9.9712	3772.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.03413865	0	617.02	267.34	267.34	4711.62	4720.61	749.00	5823.30	
1+100.00	4096.90368	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3805.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	614.61	266.29	266.30	4711.51	4720.61	749.00	5825.60	
1+090.00	4099.19968	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3837.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	612.20	265.25	265.25	4711.40	4720.61	749.00	5827.89	
1+080.00	4101.49568	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3870.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	609.79	264.21	264.21	4711.29	4720.61	749.00	5830.19	
1+070.00	4103.79168	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3903.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	607.38	263.16	263.17	4711.17	4720.61	749.00	5832.48	
1+060.00	4106.08768	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3936.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	604.97	262.12	262.12	4711.06	4720.61	749.00	5834.78	
1+050.00	4108.38696	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	3969.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	602.56	261.08	261.08	4710.95	4720.61	749.00	5837.08	
1+040.00	4110.68296	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4001.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	600.15	260.03	260.03	4710.84	4720.61	749.00	5839.37	
1+030.00	4112.97896	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4034.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	597.75	258.99	258.99	4710.73	4720.61	749.00	5841.67	
1+020.00	4115.27496	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4067.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	595.34	257.95	257.95	4710.61	4720.61	749.00	5843.97	
1+010.00	4117.57096	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4100.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	592.93	256.90	256.90	4710.50	4720.61	749.00	5846.26	
1+002.72	4119.24048	**24" Sch 80-DN 600**	21.56	8.35E-05	23.8784	4124.108	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.08175307	0	591.18	256.14	256.14	4710.42	4720.61	749.00	5847.93	
1+000.00	4119.86696	**24" Sch 80-DN 600**	21.56	8.35E-05	8.9216	4133.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.0305451	0	590.52	255.86	255.86	4710.39	4720.61	749.00	5848.56	
0+990.00	4122.16296	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4165.8296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	588.11	254.82	254.82	4710.28	4720.61	749.00	5850.85	
0+980.00	4124.45896	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4198.6296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	585.71	253.77	253.77	4710.16	4720.61	749.00	5853.15	
0+970.00	4126.75496	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4231.4296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	583.30	252.73	252.73	4710.05	4720.61	749.00	5855.45	
0+960.00	4129.05096	**24" Sch 80-DN 600**	21.56	8.35E-05	32.8	4264.2296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.11229818	0	580.89	251.68	251.69	4709.94	4720.61	749.00	5857.74	
0+959.26	4129.21824	**24" Sch 80-DN 600**	21.56	8.35E-05	2.4272	4266.6568	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.00831007	0	580.71	251.61	251.61	4709.93	4720.61	749.00	5857.91	
0+950.00	4131.34696	**24" Sch 80-DN 600**	21.56	8.35E-05	30.3728	4297.0296	5.405	7.89E+05	1.46651E+22	7E-22	**0.013562**	0.10398811	0	578.48	250.64	250.64	4709.83	4720.61	749.00	5860.04	
0+940.00	4133.64296	24" Std-DN 600	23.25	7.74E-05	32.8	4329.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	576.11	249.61	249.61	4709.75	4720.61	749.00	5862.33	Transistion from CS2 to CS1
0+930.00	4135.93896	24" Std-DN 600	23.25	7.74E-05	32.8	4362.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	573.73	248.58	248.59	4709.67	4720.61	270.00	4759.10	
0+920.00	4138.23496	24" Std-DN 600	23.25	7.74E-05	32.8	4395.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	571.36	247.56	247.56	4709.60	4720.61	270.00	4761.39	
0+910.00	4140.53096	24" Std-DN 600	23.25	7.74E-05	32.8	4428.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	568.99	246.53	246.53	4709.52	4720.61	270.00	4763.69	
0+900.00	4142.82696	24" Std-DN 600	23.25	7.74E-05	32.8	4461.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	566.61	245.50	245.50	4709.44	4720.61	270.00	4765.99	
0+890.00	4145.12296	24" Std-DN 600	23.25	7.74E-05	32.8	4493.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	564.24	244.47	244.47	4709.36	4720.61	270.00	4768.28	
0+880.00	4147.41896	24" Std-DN 600	23.25	7.74E-05	32.8	4526.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	561.87	243.44	243.44	4709.29	4720.61	270.00	4770.58	
0+870.50	4149.60016	24" Std-DN 600	23.25	7.74E-05	31.16	4557.7896	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07325504	0	559.61	242.47	242.47	4709.21	4720.61	270.00	4772.76	
0+870.00	4149.71496	24" Std-DN 600	23.25	7.74E-05	1.64	4559.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00385553	0	559.50	242.42	242.42	4709.21	4720.61	270.00	4772.87	
0+860.00	4152.01096	24" Std-DN 600	23.25	7.74E-05	32.8	4592.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	557.12	241.39	241.39	4709.13	4720.61	270.00	4775.17	
0+850.00	4154.30696	24" Std-DN 600	23.25	7.74E-05	32.8	4625.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	554.75	240.36	240.36	4709.06	4720.61	270.00	4777.47	
0+840.00	4156.60624	24" Std-DN 600	23.25	7.74E-05	32.8	4657.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	552.37	239.33	239.33	4708.98	4720.61	270.00	4779.77	
0+830.00	4158.90224	24" Std-DN 600	23.25	7.74E-05	32.8	4690.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	550.00	238.30	238.30	4708.90	4720.61	270.00	4782.06	
0+820.00	4161.20152	24" Std-DN 600	23.25	7.74E-05	32.8	4723.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	547.62	237.27	237.27	4708.82	4720.61	270.00	4784.36	
0+810.00	4163.49752	24" Std-DN 600	23.25	7.74E-05	32.8	4756.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	545.25	236.24	236.24	4708.75	4720.61	270.00	4786.66	
0+800.00	4165.79352	24" Std-DN 600	23.25	7.74E-05	32.8	4789.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	542.88	235.22	235.22	4708.67	4720.61	270.00	4788.95	
0+796.57	4166.58072	24" Std-DN 600	23.25	7.74E-05	11.2504	4800.28	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.02644892	0	542.06	234.86	234.86	4708.64	4720.61	270.00	4789.74	
0+790.00	4167.44336	24" Std-DN 600	23.25	7.74E-05	21.5496	4821.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.05066164	0	541.15	234.47	234.47	4708.59	4720.61	270.00	4790.60	
0+780.00	4168.75536	24" Std-DN 600	23.25	7.74E-05	32.8	4854.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	539.76	233.87	233.87	4708.52	4720.61	270.00	4791.92	
0+770.00	4170.06736	24" Std-DN 600	23.25	7.74E-05	32.8	4887.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	538.37	233.26	233.26	4708.44	4720.61	270.00	4793.23	
0+760.00	4171.37936	24" Std-DN 600	23.25	7.74E-05	32.8	4920.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	536.98	232.66	232.66	4708.36	4720.61	270.00	4794.54	
0+750.00	4172.69136	24" Std-DN 600	23.25	7.74E-05	32.8	4953.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	535.59	232.06	232.06	4708.29	4720.61	270.00	4795.85	
0+740.00	4174.00336	24" Std-DN 600	23.25	7.74E-05	32.8	4985.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	534.20	231.46	231.46	4708.21	4720.61	270.00	4797.16	
0+730.00	4175.31536	24" Std-DN 600	23.25	7.74E-05	32.8	5018.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	532.82	230.86	230.86	4708.13	4720.61	270.00	4798.48	
0+720.00	4176.62736	24" Std-DN 600	23.25	7.74E-05	32.8	5051.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	531.43	230.25	230.26	4708.05	4720.61	270.00	4799.79	
0+715.08	4177.27352	24" Std-DN 600	23.25	7.74E-05	16.1376	5067.5672	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0379384	0	530.74	229.96	229.96	4708.02	4720.61	270.00	4800.43	

0+710.00	4177.93936	24" Std-DN 600	23.25	7.74E-05	16.6624	5084.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03917217	0	530.04	229.65	229.65	4707.98	4720.61	270.00	4801.10
0+700.00	4179.25136	24" Std-DN 600	23.25	7.74E-05	32.8	5117.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	528.65	229.05	229.05	4707.90	4720.61	270.00	4802.41
0+690.00	4180.56336	24" Std-DN 600	23.25	7.74E-05	32.8	5149.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	527.26	228.45	228.45	4707.82	4720.61	270.00	4803.72
0+680.00	4181.87536	24" Std-DN 600	23.25	7.74E-05	32.8	5182.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	525.87	227.85	227.85	4707.75	4720.61	270.00	4805.04
0+670.00	4183.18736	24" Std-DN 600	23.25	7.74E-05	32.8	5215.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	524.48	227.24	227.25	4707.67	4720.61	270.00	4806.35
0+660.00	4184.49936	24" Std-DN 600	23.25	7.74E-05	32.8	5248.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	523.09	226.64	226.64	4707.59	4720.61	270.00	4807.66
0+650.00	4185.81136	24" Std-DN 600	23.25	7.74E-05	32.8	5281.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	521.70	226.04	226.04	4707.51	4720.61	270.00	4808.97
0+640.00	4187.12336	24" Std-DN 600	23.25	7.74E-05	32.8	5313.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	520.31	225.44	225.44	4707.44	4720.61	270.00	4810.28
0+630.29	4188.39928	24" Std-DN 600	23.25	7.74E-05	31.8488	5345.6784	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07487436	0	518.96	224.85	224.85	4707.36	4720.61	270.00	4811.56
0+630.00	4188.43536	24" Std-DN 600	23.25	7.74E-05	0.9512	5346.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00223621	0	518.92	224.84	224.84	4707.36	4720.61	270.00	4811.60
0+620.00	4189.74736	24" Std-DN 600	23.25	7.74E-05	32.8	5379.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	517.54	224.24	224.24	4707.28	4720.61	270.00	4812.91
0+610.00	4191.05936	24" Std-DN 600	23.25	7.74E-05	32.8	5412.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	516.15	223.63	223.63	4707.21	4720.61	270.00	4814.22
0+600.00	4192.37136	24" Std-DN 600	23.25	7.74E-05	32.8	5445.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	514.76	223.03	223.03	4707.13	4720.61	270.00	4815.53
0+590.00	4193.68336	24" Std-DN 600	23.25	7.74E-05	32.8	5477.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	513.37	222.43	222.43	4707.05	4720.61	270.00	4816.84
0+580.00	4194.99536	24" Std-DN 600	23.25	7.74E-05	32.8	5510.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	511.98	221.83	221.83	4706.97	4720.61	270.00	4818.16
0+570.00	4196.30736	24" Std-DN 600	23.25	7.74E-05	32.8	5543.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	510.59	221.23	221.23	4706.90	4720.61	270.00	4819.47
0+560.00	4197.61936	24" Std-DN 600	23.25	7.74E-05	32.8	5576.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	509.20	220.62	220.63	4706.82	4720.61	270.00	4820.78
0+555.76	4198.17696	24" Std-DN 600	23.25	7.74E-05	13.9072	5590.1368	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03269488	0	508.61	220.37	220.37	4706.79	4720.61	270.00	4821.34
0+554.82	4198.29176	24" Std-DN 600	23.25	7.74E-05	3.0832	5593.22	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00724839	0	508.49	220.32	220.32	4706.78	4720.61	270.00	4821.45
0+550.00	4198.90512	24" Std-DN 600	23.25	7.74E-05	15.8096	5609.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03716729	0	507.84	220.03	220.03	4706.74	4720.61	270.00	4822.07
0+540.00	4200.1712	24" Std-DN 600	23.25	7.74E-05	32.8	5641.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	506.49	219.45	219.45	4706.67	4720.61	270.00	4823.33
0+530.00	4201.44056	24" Std-DN 600	23.25	7.74E-05	32.8	5674.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	505.15	218.87	218.87	4706.59	4720.61	270.00	4824.60
0+520.00	4202.70992	24" Std-DN 600	23.25	7.74E-05	32.8	5707.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	503.80	218.28	218.29	4706.51	4720.61	270.00	4825.87
0+510.00	4203.97928	24" Std-DN 600	23.25	7.74E-05	32.8	5740.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	502.46	217.70	217.70	4706.43	4720.61	270.00	4827.14
0+500.00	4205.24864	24" Std-DN 600	23.25	7.74E-05	32.8	5773.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	501.11	217.12	217.12	4706.36	4720.61	270.00	4828.41
0+490.00	4206.518	24" Std-DN 600	23.25	7.74E-05	32.8	5805.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	499.76	216.53	216.53	4706.28	4720.61	270.00	4829.68
0+483.03	4207.40032	24" Std-DN 600	23.25	7.74E-05	22.8616	5828.6912	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.05374606	0	498.83	216.13	216.13	4706.23	4720.61	270.00	4830.56
0+480.00	4207.78736	24" Std-DN 600	23.25	7.74E-05	9.9384	5838.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0233645	0	498.42	215.95	215.95	4706.20	4720.61	270.00	4830.95
0+470.00	4209.05344	24" Std-DN 600	23.25	7.74E-05	32.8	5871.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	497.07	215.37	215.37	4706.13	4720.61	270.00	4832.21
0+460.00	4210.3228	24" Std-DN 600	23.25	7.74E-05	32.8	5904.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	495.73	214.79	214.79	4706.05	4720.61	270.00	4833.48
0+450.00	4211.59216	24" Std-DN 600	23.25	7.74E-05	32.8	5937.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	494.38	214.20	214.20	4705.97	4720.61	270.00	4834.75
0+440.00	4212.86152	24" Std-DN 600	23.25	7.74E-05	32.8	5969.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	493.03	213.62	213.62	4705.89	4720.61	270.00	4836.02
0+430.00	4214.13088	24" Std-DN 600	23.25	7.74E-05	32.8	6002.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	491.69	213.04	213.04	4705.82	4720.61	270.00	4837.29
0+420.00	4215.40024	24" Std-DN 600	23.25	7.74E-05	32.8	6035.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	490.34	212.45	212.45	4705.74	4720.61	270.00	4838.56
0+410.00	4216.6696	24" Std-DN 600	23.25	7.74E-05	32.8	6068.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	488.99	211.87	211.87	4705.66	4720.61	270.00	4839.83
0+400.00	4217.93568	24" Std-DN 600	23.25	7.74E-05	32.8	6101.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	487.65	211.29	211.29	4705.59	4720.61	270.00	4841.10
0+390.00	4219.20504	24" Std-DN 600	23.25	7.74E-05	32.8	6133.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	486.30	210.70	210.70	4705.51	4720.61	270.00	4842.37
0+380.07	4220.46456	24" Std-DN 600	23.25	7.74E-05	32.5704	6166.4	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07657079	0	484.97	210.12	210.12	4705.43	4720.61	270.00	4843.62
0+380.00	4220.4744	24" Std-DN 600	23.25	7.74E-05	0.2296	6166.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00053977	0	484.96	210.12	210.12	4705.43	4720.61	270.00	4843.63
0+370.00	4221.74376	24" Std-DN 600	23.25	7.74E-05	32.8	6199.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	483.61	209.54	209.54	4705.35	4720.61	270.00	4844.90
0+360.00	4223.01312	24" Std-DN 600	23.25	7.74E-05	32.8	6232.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	482.26	208.95	208.95	4705.28	4720.61	270.00	4846.17
0+350.00	4224.28248	24" Std-DN 600	23.25	7.74E-05	32.8	6265.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	480.92	208.37	208.37	4705.20	4720.61	270.00	4847.44
0+340.00	4225.55184	24" Std-DN 600	23.25	7.74E-05	32.8	6297.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	479.57	207.79	207.79	4705.12	4720.61	270.00	4848.71
0+330.00	4226.8212	24" Std-DN 600	23.25	7.74E-05	32.8	6330.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	478.23	207.20	207.20	4705.05	4720.61	270.00	4849.98
0+320.00	4228.09056	24" Std-DN 600	23.25	7.74E-05	32.8	6363.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	476.88	206.62	206.62	4704.97	4720.61	270.00	4851.25
0+310.00	4229.3632	24" Std-DN 600	23.25	7.74E-05	32.8	6396.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	475.53	206.04	206.03	4704.89	4720.61	270.00	4852.52
0+304.70	4230.08152	24" Std-DN 600	23.25	7.74E-05	17.384	6413.6136	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0408686	0	474.77	205.71	205.71	4704.85	4720.61	270.00	4853.24
0+300.00	4231.96096	24" Std-DN 600	23.25	7.74E-05	15.416	6429.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03624197	0	472.85	204.88	204.88	4704.82	4720.61	270.00	4855.12
0+292.45	4235.14912	24" Std-DN 600	23.25	7.74E-05	24.764	6453.7936	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.05821848	0	469.61	203.47	203.47	4704.76	4720.61	270.00	4858.31
0+290.00	4236.09704	24" Std-DN 600	23.25	7.74E-05	8.036	6461.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01889209	0	468.64	203.05	203.05	4704.74	4720.61	270.00	4859.26
0+280.46	4240.0888	24" Std-DN 600	23.25	7.74E-05	31.2912	6493.1208	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07356348	0	464.58	201.29	201.29	4704.66	4720.61	270.00	4863.25
0+280.00	4240.25936	24" Std-DN 600	23.25	7.74E-05	1.5088	6494.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00354709	0	464.40	201.21	201.21	4704.66	4720.61	270.00	4863.42
0+270.00	4244.32656	24" Std-DN 600	23.25	7.74E-05	32.8	6527.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	460.26	199.42	199.42	4704.58	4720.61	270.00	4867.49
0+268.47	4244.98584	24" Std-DN 600	23.25	7.74E-05	5.0184	6532.448	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01179792	0	459.59	199.13	199.13	4704.57	4720.61	270.00	4868.15
0+260.00	4248.3872	24" Std-DN 600	23.25	7.74E-05	27.7816	6560.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06531265	0	456.12	197.63	197.63	4704.51	4720.61	270.00	4871.55
0+256.48	4249.85664	24" Std-DN 600	23.25	7.74E-05	11.5456	6571.7752	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.02714292	0	454.62	196.98	196.98	4704.48	4720.61	270.00	4873.02
0+250.00	4252.48064	24" Std-DN 600	23.25	7.74E-05	21.2544	6593.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.04996765	0	451.95	195.82	195.82	4704.43	4720.61	270.00	4875.64
0+244.88	4254.66512	24" Std-DN 600	23.25	7.74E-05	16.7936	6609.8232	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03948061	0	449.72	194.85	194.85	4704.39	4720.61	270.00	4877.83
0+240.00	4256.57736	24" Std-DN 600	23.25	7.74E-05	16.0064	6625.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03762996	0	447.78	194.01	194.01	4704.35	4720.61	270.00	4879.74
0+233.28	4259.45064	24" Std-DN 600	23.25	7.74E-05	22.0416	6647.8712	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0518183	0	444.85	192.74	192.74	4704.30	4720.61	270.00	4882.61
0+230.00	4260.70032	24" Std-DN 600	23.25	7.74E-05	10.7584	6658.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.02529227	0	443.57	192.19	192.19	4704.28	4720.61	270.00	4883.86
0+221.67	4264.20992	24" Std-DN 600	23.25	7.74E-05	27.3224	6685.952	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0642331	0	440.00	190.64	190.64	4704.21	4720.61	270.00	4887.37
0+220.00	4264.82984	24" Std-DN 600	23.25	7.74E-05	5.4776	6691.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01287746	0	439.37	190.37	190.37	4704.20	4720.61	270.00	4887.99
0+210.07	4268.94952	24" Std-DN 600	23.25	7.74E-05	32.5704	6724	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07657079	0	435.17	188.55	188.55	4704.12	4720.61	270.00	4892.11
0+210.00	4268.97576	24" Std-DN 600	23.25	7.74E-05	0.2296	6724.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00053977	0	435.15	188.54	188.54	4704.12	4720.61	270.00	4892.14
0+200.00	4273.02984	24" Std-DN 600	23.25	7.74E-05	32.8	6757.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	431.01	186.75	186.75	4704.04	4720.61	270.00	4896.19
0+198.46	4273.67272	24" Std-DN 600	23.25	7.74E-05	5.0512	6762.0808	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01187503	0	430.36	186.46	186.46	4704.03	4720.61	270.00	4896.83
0+190.00	4277.0544	24" Std-DN 600	23.25	7.74E-05	27.7488	6789.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06523554	0	426.91	184.97	184.97	4703.97	4720.61	270.00	4900.21
0+185.27	4279.15032	24" Std-DN 600	23.25	7.74E-05	15.5144	6805.344	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0364733	0	424.78	184.05	184.05	4703.93	4720.61	270.00	4902.31

0+180.00	4281.15112	24" Std-DN 600	23.25	7.74E-05	17.2856	6822.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.04063727	0	422.74	183.16	183.16	4703.89	4720.61	270.00	4904.31	
0+172.06	4284.57216	24" Std-DN 600	23.25	7.74E-05	26.0432	6848.6728	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06122579	0	419.26	181.65	181.65	4703.83	4720.61	270.00	4907.73	
0+170.00	4285.31344	24" Std-DN 600	23.25	7.74E-05	6.7568	6855.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01588478	0	418.50	181.33	181.33	4703.81	4720.61	270.00	4908.47	
0+160.00	4289.44624	24" Std-DN 600	23.25	7.74E-05	32.8	6888.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	414.29	179.50	179.50	4703.74	4720.61	270.00	4912.61	
0+158.90	4289.90872	24" Std-DN 600	23.25	7.74E-05	3.608	6891.8376	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00848216	0	413.82	179.30	179.30	4703.73	4720.61	270.00	4913.07	
0+150.77	4293.24776	24" Std-DN 600	23.25	7.74E-05	26.6664	6918.504	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06269089	0	410.42	177.82	177.82	4703.66	4720.61	270.00	4916.41	
0+150.00	4293.53968	24" Std-DN 600	23.25	7.74E-05	2.5256	6921.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00593751	0	410.12	177.69	177.69	4703.66	4720.61	270.00	4916.70	
0+140.00	4297.62984	24" Std-DN 600	23.25	7.74E-05	32.8	6953.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	405.95	175.89	175.89	4703.58	4720.61	270.00	4920.79	
0+137.72	4298.65648	24" Std-DN 600	23.25	7.74E-05	7.4784	6961.308	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01758121	0	404.91	175.44	175.44	4703.56	4720.61	270.00	4921.82	
0+130.00	4301.70032	24" Std-DN 600	23.25	7.74E-05	25.3216	6986.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.05952936	0	401.80	174.09	174.09	4703.50	4720.61	270.00	4924.86	
0+124.64	4303.97992	24" Std-DN 600	23.25	7.74E-05	17.5808	7004.2104	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.04133126	0	399.48	173.09	173.09	4703.46	4720.61	270.00	4927.14	
0+120.00	4305.81344	24" Std-DN 600	23.25	7.74E-05	15.2192	7019.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0357793	0	397.61	172.28	172.28	4703.43	4720.61	270.00	4928.97	
0+111.55	4309.39848	24" Std-DN 600	23.25	7.74E-05	27.716	7047.1456	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06515843	0	393.96	170.69	170.69	4703.36	4720.61	270.00	4932.56	
0+110.00	4309.97576	24" Std-DN 600	23.25	7.74E-05	5.084	7052.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01195214	0	393.37	170.44	170.44	4703.35	4720.61	270.00	4933.14	
0+100.00	4314.06264	24" Std-DN 600	23.25	7.74E-05	32.8	7085.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	389.21	168.64	168.64	4703.27	4720.61	270.00	4937.22	
0+098.48	4314.7088	24" Std-DN 600	23.25	7.74E-05	4.9856	7090.0152	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01172081	0	388.55	168.35	168.35	4703.26	4720.61	270.00	4937.87	
0+090.00	4318.11344	24" Std-DN 600	23.25	7.74E-05	27.8144	7117.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06538976	0	385.08	166.85	166.85	4703.20	4720.61	270.00	4941.27	
0+086.80	4319.55008	24" Std-DN 600	23.25	7.74E-05	10.496	7128.3256	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.02467538	0	383.62	166.21	166.21	4703.17	4720.61	270.00	4942.71	
0+080.00	4322.22	24" Std-DN 600	23.25	7.74E-05	22.304	7150.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.05243518	0	380.90	165.03	165.03	4703.12	4720.61	270.00	4945.38	
0+075.13	4324.34216	24" Std-DN 600	23.25	7.74E-05	15.9736	7166.6032	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03755285	0	378.74	164.10	164.10	4703.08	4720.61	270.00	4947.50	
0+070.00	4326.33968	24" Std-DN 600	23.25	7.74E-05	16.8264	7183.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03955772	0	376.70	163.22	163.22	4703.04	4720.61	270.00	4949.50	
0+063.47	4329.07848	24" Std-DN 600	23.25	7.74E-05	21.4184	7204.848	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0503532	0	373.91	162.01	162.01	4702.99	4720.61	270.00	4952.24	
0+060.00	4330.47248	24" Std-DN 600	23.25	7.74E-05	11.3816	7216.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.02675737	0	372.49	161.39	161.39	4702.96	4720.61	270.00	4953.63	
0+051.46	4334.05752	24" Std-DN 600	23.25	7.74E-05	28.0112	7244.2408	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.06585242	0	368.84	159.81	159.81	4702.90	4720.61	270.00	4957.22	
0+050.00	4334.6184	24" Std-DN 600	23.25	7.74E-05	4.7888	7249.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01125814	0	368.27	159.56	159.56	4702.89	4720.61	270.00	4957.78	
0+040.00	4338.7512	24" Std-DN 600	23.25	7.74E-05	32.8	7281.8296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.07711057	0	364.06	157.74	157.74	4702.81	4720.61	270.00	4961.91	
0+039.46	4338.98736	24" Std-DN 600	23.25	7.74E-05	1.7712	7283.6008	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.00416397	0	363.82	157.63	157.63	4702.81	4720.61	270.00	4962.15	
0+030.00	4342.78888	24" Std-DN 600	23.25	7.74E-05	31.0288	7314.6296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.0729466	0	359.94	155.96	155.95	4702.73	4720.61	270.00	4965.95	
0+027.45	4343.85816	24" Std-DN 600	23.25	7.74E-05	8.364	7322.9936	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.01966319	0	358.86	155.48	155.48	4702.71	4720.61	270.00	4967.02	
0+020.00	4346.87904	24" Std-DN 600	23.25	7.74E-05	24.436	7347.4296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.05744737	0	355.78	154.15	154.15	4702.66	4720.61	270.00	4970.04	
0+015.82	4348.6732	24" Std-DN 600	23.25	7.74E-05	13.7104	7361.14	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03223222	0	353.95	153.36	153.36	4702.62	4720.61	270.00	4971.83	
0+010.00	4350.97248	24" Std-DN 600	23.25	7.74E-05	19.0896	7380.2296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.04487835	0	351.61	152.34	152.34	4702.58	4720.61	270.00	4974.13	
0+004.20	4353.46856	24" Std-DN 600	23.25	7.74E-05	19.024	7399.2536	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.04472413	0	349.07	151.24	151.24	4702.53	4720.61	270.00	4976.63	
0+000.00	4355.0856	24" Std-DN 600	23.25	7.74E-05	13.776	7413.0296	4.648	7.32E+05	1.45006E+22	2E-21	**0.013581**	0.03238644	0	347.42	150.53	150.53	4702.50	4720.61	270.00	4978.25	
Top Of Pad	4592.00	16" HDPE 4710 D	12.915	6.50E-05	1095.52	8508.5496	7.531	6.59E+05	1.46507E+22	1E-20	**0.013563**	12.1586148	0	98.34	42.61	28.28	4690.34	4720.61	200.00	5053.60	16" HDPE 4710 DR11-Riser



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APPENDIX C
HLF Construction QA/QC Plan

Coffee Mine Project

Coffee 2025 Licensing Support

HLF Construction QAQC Plan

Project No. 123022



Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
REV 0	01/26/2026	Issued for Licensing	L. Burnett	A. Reiman	C. Green

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Appendix A: RFI Template

1. INTRODUCTION

This Quality Assurance Plan is provided as a guide to field and laboratory personnel conducting inspections and testing for the Coffee Mine Project in West-Central, Yukon. This document is intended to assist and aid personnel in aspects of inspection, testing, and reporting on site during all HLF construction activities. Standard procedures will be used for all activities, and in general, these will be adopted from recognized organizations, such as the American Society of Testing and Materials (ASTM), the American Concrete Institute (ACI) and the American Association of State Highway and Transportation Officials (AASHTO). This manual is a guide for procedures and sets out frequencies for the various work being tested. The Technical Specifications, together with the latest issue of the Drawings and this manual, are an integrated set of documents. This manual is to be used in conjunction with the Technical Specifications, relevant standards and codes, the design report, and the Drawings. QA and QC measures regarding permafrost identification and mitigation are pending further site investigations and will be captured in the QAQC Plan that is issued for construction.

1.1 Relevant Documents

The Technical Specifications referenced in this manual are in Revision 0. The Drawings referenced in this manual are Issued for Construction (IFC) as Revision 0. The Technical specifications are included in Appendix C of the 2025 HLP Engineering Report for Licensing ("Design Report") (123022-51010-CV-EDR-2001) from Forte Dynamics. The Drawings are included in Appendix B of the Design Report. If the drawings or technical specifications are revised before construction begins this document should be modified to include these revisions. Table 1-1 includes a list of all relevant documents and their current status, for reference.

Table 1-1: Document and Drawing Revisions

Document	Rev	Date	Issuance
01 - Summary of Work - 01 11 00	0	01/26/2026	Issued for Licensing
02 - Project Management & Coordination – 01 31 00	0	01/26/2026	Issued for Licensing
03 - Construction Progress Documentation – 01 32 00	0	01/26/2026	Issued for Licensing
04 - Submittal Procedures – 01 33 00	0	01/26/2026	Issued for Licensing
05 - Regulatory Requirements – 01 41 00	0	01/26/2026	Issued for Licensing
06 - Reference Standards – 01 42 19	0	01/26/2026	Issued for Licensing
07 - Quality Assurance – 01 43 00	0	01/26/2026	Issued for Licensing
08 - Quality Control – 01 45 00	0	01/26/2026	Issued for Licensing
09 - Product Storage & Handling Requirements – 01 66 00	0	01/26/2026	Issued for Licensing
10 - Mobilization and Demobilization – 01 71 13	0	01/26/2026	Issued for Licensing
11 - Field Engineering – 01 71 23	0	01/26/2026	Issued for Licensing
12 - Cast in Place Concrete – 03 38 00	0	01/26/2026	Issued for Licensing
13 - Soils for Earthworks – 31 05 13	0	01/26/2026	Issued for Licensing
14 - Aggregate for Earthworks – 31 05 16	0	01/26/2026	Issued for Licensing
15 - Construction Progress Documentation – 31 05 19.13	0	01/26/2026	Issued for Licensing
16 - GCL for Earthworks – 31 05 19.14	0	01/26/2026	Issued for Licensing
17 - Geomembrane for Earthworks – 31 05 19.16	0	01/26/2026	Issued for Licensing
18 - Excavation – 31 23 16	0	01/26/2026	Issued for Licensing
19 - Fill – 31 23 23	0	01/26/2026	Issued for Licensing
20 - Rubble-Stone Riprap – 31 37 16.13	0	01/26/2026	Issued for Licensing
21 - Rough Grading – 31 22 13	0	01/26/2026	Issued for Licensing
22 - Subgrading Piping – 33 46 16	0	01/26/2026	Issued for Licensing
23 - Drainage Layers – 33 46 23	0	01/26/2026	Issued for Licensing
Cover Sheet and Drawing Index	0	01/26/2026	Issued for Licensing
Notes and Legend	0	01/26/2026	Issued for Licensing

Document	Rev	Date	Issuance
Heap Leach Facilities General Arrangement	0	01/26/2026	Issued for Licensing
Heap Leach Pad Stage 1 General Arrangement	0	01/26/2026	Issued for Licensing
Ponds Grading	0	01/26/2026	Issued for Licensing
Subgrade and Liner Plan	0	01/26/2026	Issued for Licensing
Heap Leach Pad Overview	0	01/26/2026	Issued for Licensing
Heap Leach Pad Piping Collection Plan	0	01/26/2026	Issued for Licensing
Heap Leach Pad Over Liner Plan	0	01/26/2026	Issued for Licensing
Process Plant Pad	0	01/26/2026	Issued for Licensing
Event Pond 1 North, 1 South, and Rain Water Pond	0	01/26/2026	Issued for Licensing
Event Pond 2	0	01/26/2026	Issued for Licensing
Ponds and Pad Sections Page 1 of 4	0	01/26/2026	Issued for Licensing
Ponds and Pad Sections Page 2 of 4	0	01/26/2026	Issued for Licensing
Ponds and Pad Sections Page 3 of 4	0	01/26/2026	Issued for Licensing
Ponds and Pad Sections Page 4 of 4	0	01/26/2026	Issued for Licensing
Typical Detail Page 1 of 6	0	01/26/2026	Issued for Licensing
Typical Detail Page 2 of 6	0	01/26/2026	Issued for Licensing
Typical Detail Page 3 of 6	0	01/26/2026	Issued for Licensing
Typical Detail Page 4 of 6	0	01/26/2026	Issued for Licensing
Typical Detail Page 5 of 6	0	01/26/2026	Issued for Licensing
Typical Detail Page 6 of 6	0	01/26/2026	Issued for Licensing

1.2 Definition of Key Terms

Owner — Primary stakeholder accountable for the project or any of its authorized representative(s) and or agent(s).

Construction Contractor (CC) — Representative contracted by the Owner to manage the construction work.

Engineer/ Engineer of Record (EoR) — Forte Dynamics (Forte) or any of its authorized representative(s) or agent(s).

Contractor — The construction firm that has executed the contract agreement for the specified Work with the Owner or its authorized representative(s) or agent(s).

Surveyor — The person or entity contracted by through the Construction Contractor or any of its representative(s)/agent(s) responsible for providing surveying services not required to be provided by the Contractor.

Specifications — The approved Technical Specifications, all supplemental addenda and any modification furnished by the Engineer that apply to the Work.

Drawings — The approved Construction Drawings furnished by the Engineer, or others that apply to the Work.

Quality Assurance Plan (QAP) — The minimum acceptance requirements prepared by the Engineer that apply to the construction. These requirements are recommended implementation without unnecessary revision.

Quality Control (QC)	Includes those inspection tasks performed by the Contractor to ensure that the material and workmanship performed by that Contractor meet the quality requirements for the project. Routine QC inspection tasks include items such as personnel control, material control and construction procedures. **The QC is typically managed by the CC.**
Quality Assurance (QA)	Includes those inspection tasks performed by an agency or firm other that the Contractor. QA may include duplicating specific inspection tasks that may be similarly included in the Contractor's QC program. QA includes monitoring the performance of the Contractor in implementing their QC program and ensuring the designed QC tasks are preformed properly. QA also includes the responsibility of ensuring all testing included in the Construction Documents, including this Section , are conducted and documented. **The QA will be performed by EoR or EoR Representative.**
Site	Coffee Project site owned by the Owner where the Work is to be completed as described in the Technical Specifications and Detailed on the Drawings.
Contract	The document executed by the Owner or its authorized representative(s) and or agent(s) with the Contractor to complete specified portions of the Work.
Work	The entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.
Modification	Changes made to the Specifications or the Drawings that are approved by the Construction Contractor and Engineer in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.
Units	All units for the project should be metric.

2. ORGANIZATION AND RESPONSIBILITIES

The Owner and all parties shall be under the overall direction of the Owner or its designated Representative. The Contractor and its subcontractors are responsible for performing the work. Forte Dynamics is the EoR for the Coffee Project's Heap Leach Facility (HLF).

The CC is appointed by the Owner to perform the Construction Contractor functions and ensure that the project is built in accordance with the project documents. Any questions with regard to the associated Design or Technical Specifications associated with the project shall be addressed to the EoR for clarifications in accordance with the established project protocol. All changes to the Design or Technical Specifications shall be approved by the Owner or their appointed representative prior to implementing the change.

QA/QC functions entail witnessing and recording (as detailed herein) all field inspection and control and record testing for the project as well as daily construction activity reports. Daily reports and completed field inspection control and record test results are to be submitted to the CC for inclusion in the Record of Construction report.

Testing of the work does not relieve the Contractor of liability for substandard work. The Contractor is responsible for setting out the correct lines and grades to ensure that the work is constructed accordingly. The project Surveyor will check lines and grades and will verify all grades, quantity measurements and calculations.

Table 2-1: Key Project Personnel

Role	Responsibility
Mine General Manager	Overall responsibility for Mine Site management.
Operations Manager	Responsible for mine planning and production, mine technical monitoring, and mine regulatory compliance.
Health & Safety (H&S) Manager	Responsible for conducting regular safety site inspections and implementing the appropriate controls in a timely manner. The H&S Manager shall maintain records of all safety inspections as well as any actions taken because of these inspections throughout the life of the Project. Where safety inspections show the potential for environmental effects, the H&S Manager will work in collaboration with the Environment Department.
Sustainability and External Relations (SER) Department	Responsible for recording and addressing any complaints received from nearby land users, or other interested parties regarding Project-related impacts off-site. The SER department shall maintain records of all complaints received as well as any actions taken because of these complaints.
Environmental Manager	Responsible for permitting, environmental monitoring, and regulatory compliance.
Engineer of Record (EoR)	The EoR developed the design, specifications, and detailed drawings. The EoR will be responsible for reviewing the QA and QC documentation to ensure it complies with the design requirements. The EoR also assesses changes to the design to determine their impact on HLF's performance and safety. The EoR issues guidance, clarification, and revisions to the design during construction as needed.
QA Representative	The QA Representative will be responsible for all construction duplicate testing and documentation of construction per the technical specifications, to verify that there are no issues with the QC. This role is typically performed by a representative of the EoR or a third party.
QC Representative	The QC Representative will be responsible for all construction verification testing and documentation. This role is typically performed by a representative of the Construction Contractor or a third party.
Construction Contractor	The Construction Contractor is responsible for completing the construction of the HLF per the detailed design and technical specifications.

3. DOCUMENTATION REQUIREMENTS

This section summarizes the tools that will be used to comprehensively document the construction activities performed. Technical specifications within this section provide procedures for collection as well as communicating information throughout the duration of the project.

The below technical specifications provide direction on QA/QC documentation:

Table 3-1: Section 3 – Applicable Technical Specifications

Document	Rev	Date	Issuance
01 - Summary of Work - 01 11 00	0	01/26/2026	Issued for Licensing
02 - Project Management & Coordination – 01 31 00	0	01/26/2026	Issued for Licensing
03 - Construction Progress Documentation – 01 32 00	0	01/26/2026	Issued for Licensing
04 - Submittal Procedures – 01 33 00	0	01/26/2026	Issued for Licensing
07 - Quality Assurance – 01 43 00	0	01/26/2026	Issued for Licensing
08 - Quality Control – 01 45 00	0	01/26/2026	Issued for Licensing
09 - Product Storage & Handling Requirements – 01 66 00	0	01/26/2026	Issued for Licensing
11 - Field Engineering – 01 71 23	0	01/26/2026	Issued for Licensing

3.1 Engineering, Field Sampling, and Testing Documentation

Standard procedures for sampling include proper sample identification, collection, custody and documentation. All sampling procedures shall be completed in accordance with ASTM and AASHTO standards. Deviations from sampling procedures shall be approved by the Engineer.

3.1.1 Sample Collection Documentation

A record of all tests performed shall be maintained by the QA and QC Representatives and the Construction Contractor. Individual test data and results will be recorded on a standard form applicable to the test being performed. The location of all tests will be recorded and accurately described. The location description will include a physical description in relation to the project site (e.g. Prepared Sub grade, Engineer Fill) so that the test location can be readily identified. Where possible this description should include such information as Northing, Easting, and elevation. A plan indicating the positions of all tests and “Work Acceptance Report” detailing inspection of specific areas shall be maintained by the Project Manager and the Construction Contractor.

At a minimum the following information is to be recorded on the designated sample reporting forms when taking samples:

- Project Number
- Project Name
- Material Type/ Name
- Material Volume and Number of Containers
- Sample Number
- Sample Location
- Date Sampled
- Off-site Laboratory Used (Laboratory Name and Analysis)
- On-site Laboratory Used (Analysis Performed on Site)

3.1.2 Field Testing Documentation

Through the course of construction, various field tests may be performed. The types of field testing required are detailed with their applicable ASTM standard in the Technical Specifications. Documentation for each test is also detailed in each ASTM standard and should be followed. At a minimum the following information should be collected as field testing documentation:

- Project Number
- Project Name
- Test Number/Name
- Test location relative to construction as well as testing depth, if applicable.
- Date of Test
- Equipment used and applicable calibration information, if applicable.
- Test results.
- Tester identification.

3.1.3 Work Approval Documentation

As circumstances require, the Owner and/or Construction Contractor shall provide written acceptance of the quality and/or condition of work before subsequent work by the Contractor can take place. For these cases, the following general procedures will be used:

- QA shall perform any required or optional testing for the Contractor.
- The Contractor will notify the Owner and the Construction Contractor in writing of the area or work requiring approval.
- The QA/QC Representatives will perform all necessary inspections and tests in such a manner that will cause the least delay to the work.
- The QA/QC Representatives will submit documentation to the Construction Contractor who will inform the Contractor of the test results, in writing (if required) on the “Work Acceptance Report.” The written approval will contain a clear description and plan of the work approved. If the work is rejected the reasons for doing so will be clearly set out.
- The Contractor will perform any tasks required to bring the work within the required testing limits as defined by the Technical Specifications and approved by the Construction Contractor. This procedure will continue until the work meets the required specification.

3.2 Engineering Documentation

Standard procedures for sampling include proper sample identification, collection, custody and documentation. All sampling procedures shall be completed in accordance with ASTM and AASHTO standards. Deviations from sampling procedures shall be approved by the Engineer.

3.2.1 Requests for Information (RFIs)

In the event that clarification to the design or a design change is needed, the Contractor shall inform the EoR or Owner using a Request for Information (RFI). The form in Appendix A should be used for RFIs. The EoR will respond in a timely manner to the request and gather necessary information to allow the Contractor to proceed with the work. Additionally, any party that requires clarification or information,

including the EoR should request this information using an RFI to allow for tracking of information throughout the projects life.

3.2.2 Internal Non-Conformance

When materials or workmanship does not conform to any part of the Technical Specifications, Drawings, or good craftsmanship, a 'Non-Conformance Form' will be issued to the Contractor or Supplier. This form is to be signed by the EoR or Owner. This document will describe the material or work which is not in conformance, the nature of the non-conformance and the required corrective action. Non-conforming materials shall be clearly marked, identified and segregated from conforming materials to prevent unauthorized use. A copy of the signed Non-Conformance document shall be issued to the Contractor/Supplier.

3.2.3 Product Certification

Manufacturer's specifications should be met for all products including but not limited to piping, liner, and geofabric used for the work. Material quality sheets that declare that the product has met these specifications and specifying that the product has undergone quality testing should be provided to the owner and the engineer.

3.2.4 Daily Reports

The QC Representative shall prepare a daily report summarizing work inspected, tests performed and other relevant items. The daily report will indicate any failed inspections or tests and the actions taken. The CC will prepare a one page daily report that will be submitted to the Contractor and the Owner no later than the following day. Included with the daily reports will be any laboratory reporting that has been completed.

3.2.5 Monthly Summary Reports

The Construction Contractor shall prepare a monthly summary report. The purpose for this report is to provide reference for monthly invoicing and scope of work tracking. This report will:

- Summarize all construction activities completed.
- Summarize all QC/QA activities completed that month.
- Summarize all failed testing results completed that month and the remediation actions taken.
- Summarize volumes of materials stockpiled, moved, and placed as well as the method for performing this work.
- Provide the status of material stockpiles including month end volume.
- Provide a list of billable equipment used on site that month.
- Indicate problems encountered.
- Indicate potential difficulties.
- Provide an updated construction schedule based on work completed that month.

The Construction Contractor may include such other items, drawings, photos, figures and tables as are necessary to clearly present the work performed and planned.

3.2.6 Health and Safety and Incident Reporting

All personnel on site are required to follow the guidance and guidelines provided by the Owner regarding health and safety. A copy of the Owner guidelines will be provided to all personnel prior to starting work. Issues observed and incidents should be reported to the Owner Health and Safety department promptly using the forms and methods required in this plan as well as those stated in the Heap Leach Facilities Emergency Response Plan.

3.2.7 Record of Construction Report

Upon completion of the work, the CC will prepare a Record of Construction Report. The purpose of this report is to document the construction activities, changes to the design, and final configuration of the HLF. This report will include:

- A summary of Construction Methods and Materials.
- A summary of Any Problems Encountered and the Solutions to Them.
- Results of All Tests.
- A copy of all construction documents including RFIs, material and procedure submittals, field memorandums, and material certifications.
- As-Built Drawings

The Record of Construction Report will be submitted to the Owner for review and final acceptance.

3.3 QA/QC Document Submittal Procedures

Proper documentation shall be maintained for testing activities and shall be in accordance with the procedures described below. The following procedures do not preclude other requirements that may be outlined in the specific standards for that test.

3.3.1 Field and Field Laboratory Records

Once the field test documentation has been compiled into a Work Acceptance Report, it must be properly named and numbered in accordance with the project's document control procedures. Each report should be assigned a unique document number that includes relevant information such as the project code, test type, and date of testing. The document name should be descriptive enough to allow for easy identification in the project’s document management system.

The test report, along with any associated forms or logs, should be submitted electronically through the project's designated document management system or portal. Upon submittal, the QA/QC Representatives are responsible for ensuring that all relevant stakeholders are notified, including the EoR Field Supervisor, and any other designated team members. This notification should include the document number, a brief description of the content, and a link or reference to the location of the document within the system.

Any feedback or required actions should be communicated promptly to the QA/QC Representatives and Construction Contractor, and the document status (e.g., "Pending Review," "Approved," "Requires Revision") should be updated in the document management system accordingly. All final, approved documents should be archived in the project’s QA/QC records, accessible for future reference, audits, and compliance verification. All feedback and required actions regarding the work stated within this report should be promptly reported to the QA/QC Representatives, Construction Contractor, and EoR. If the action requires extensive change then a plan of action to mitigate the change must be proposed.

3.3.2 Corrections to Documentation

Entries on all documents are to be in indelible ink and/or marked as final if in digital form. If an error is made on a document assigned to one individual, that individual may make corrections by crossing a single line through the error and entering the correct information. The erroneous information must not be obliterated. The correction is to be dated and initialed.

If an error is made on a general document or another person makes a change on an assigned document submitted by another, the above procedure is to be used and the entry dated and initialed by the person making the correction or entry. No documents are to be destroyed or thrown away, even if they are illegible, contain inaccuracies or are replaced by another document.

4. INSPECTIONS AND APPROVALS

QA/QC inspections for the Coffee Project HLF construction shall be performed according to the general guidelines outlined in the following sections. The following requirements do not preclude other guidelines that may be outlined elsewhere or be required to ensure proper documentation for a record of construction.

Table 4-1: Section 4 - Applicable Technical Specifications

Document	Rev	Date	Issuance
07 - Quality Assurance – 01 43 00	0	01/26/2026	Issued for Licensing
08 - Quality Control – 01 45 00	0	01/26/2026	Issued for Licensing
09 - Product Storage & Handling Requirements – 01 66 00	0	01/26/2026	Issued for Licensing
11 - Field Engineering – 01 71 23	0	01/26/2026	Issued for Licensing
12 - Cast in Place Concrete – 03 38 00	0	01/26/2026	Issued for Licensing
13 - Soils for Earthworks – 31 05 13	0	01/26/2026	Issued for Licensing
14 - Aggregate for Earthworks – 31 05 16	0	01/26/2026	Issued for Licensing
15 - Construction Progress Documentation – 31 05 19.13	0	01/26/2026	Issued for Licensing
16 - GCL for Earthworks – 31 05 19.14	0	01/26/2026	Issued for Licensing
17 - Geomembrane for Earthworks – 31 05 19.16	0	01/26/2026	Issued for Licensing
18 - Excavation – 31 23 16	0	01/26/2026	Issued for Licensing
19 - Fill – 31 23 23	0	01/26/2026	Issued for Licensing
20 - Rubble-Stone Riprap – 31 37 16.13	0	01/26/2026	Issued for Licensing
21 - Rough Grading – 31 22 13	0	01/26/2026	Issued for Licensing
22 - Subgrading Piping – 33 46 16	0	01/26/2026	Issued for Licensing
23 - Drainage Layers – 33 46 23	0	01/26/2026	Issued for Licensing

4.1 Definitions for Inspection Points and Frequencies

Inspection points and frequencies of QC and QA tasks and documentation shall be as provided in the Work Acceptance Reports as stated in the tables under their appropriate sections below. The CC will be performing QC and the EoR will be performing QA regarding task and documentation.

The following entries are used in the tables:

- **Observe (O)** – The inspector shall observe these functions on a random or daily basis.
- **Continuous Observation (C)** – The inspector shall observe these functions on a continuous basis.
- **Certificate of Compliance (CoC)** – The manufacturer shall submit a certificate of compliance confirming that the equipment meets seismic requirements for the project and shall submit standard calculations or test results.

- **Perform (P)** – These inspections shall be performed prior to the final acceptance of the item. Where a task is noted to be performed by both QC and QA Representatives, it is permitted to coordinate the inspection functions between QC and QA Representatives so the inspection may be performed by only one party. Where the QA Representative is to rely upon inspection functions performed by the QC Representative, the approval of the EoR and the Owner is required.
- **Document (D)** – The QA/QC Representatives shall include details in the Daily Reports indicating that the work has been performed in accordance with the technical specifications and the Contractor documents.
- **Ongoing Testing (T) –** This activity will require ongoing testing in the field or lab that requires documentation as necessary.

4.2 Earthworks

All required QA earthworks testing shall be done in strict accordance with the associated ASTM or AASHTO procedures. All relevant ASTM procedures for earthworks referenced in this section can be found in the Technical Specification (TS-0013, TS-0014).

All foundation base areas are to be stripped and cleared of topsoil. Any sub-soils beneath the topsoil that are soft, contain organics, or for other reasons are not suitable for foundation material shall be removed. All foundations shall be clear of debris and should be compacted in a neat and smooth manner to the lines and grades shown on the drawings and to the requirements of the Specifications.

The cleared and/or stripped area along with the completed fill area shall be accepted in writing by the Construction Contractor and acknowledged by the Contractor prior to further work taking place. The acceptance form shall identify the limits of the area that have been inspected and approved. If the approval is contingent on repairs (exceptions) that have been completed, then the next sequence of work can proceed thereafter.

General fills will be used for the construction of general fill zones. General fills will most likely be generated from areas within the project limits or other material that can be uniformly compacted and is satisfactory to the Construction Contractor.

In general, inspections are required for, but not limited to, the following activities:

Table 4-2: General Earthworks Inspections

Activity	CC (QC)		EoR (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Excavated and Stripped Areas	O	-	O	-	O	-
Stripping, Stock Piles, and Rough Grading	O	-	O	-	O	-
Correct Lines and Grades	C	D	O	-	O	-
Locations & Areas Requiring Over Excavation	O	D	O	-	O	-
Foundation Areas of Engineered Fill	T	D	T	D	O	-
General Fill	T	D	T	D	O	-
Prepared Sub Grade**	T	D	T	D	O	-
Underdrain Construction	O	D	O	-	O	-

***Requires acceptance from the Engineer*

Table 4-3: General Fill Related Field Observations

Activity	CC (QC)		EoR (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Fill Gradation	T	D	T	D	O	-
Atterberg Limits	T	D	T	D	O	-
Moisture Content	T	D	T	D	O	-
Lift Placement	C	D	C	D	O	-
Compaction	C/T	D	C/T	D	O	-
Absence of Organic Materials	O	-	O	-	O	-
Absence of Rutting	O	-	O	-	O	-
Regular, Consistent Mixing of Particles to Eliminate Segregation	O	-	O	-	O	-

For material production, QA/QC will inspect concurrently with construction to insure further construction is done in adherence to the technical specifications.

In general, inspections are required for, but not limited to, the following activities for material production:

Table 4-4: Material Production Activities

Activity	CC (QC)		EoR (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Rock Fill	O	D	O	D	O	-
Structural Fill	T	D	T	D	O	-
Drain Fill	T	D	T	D	O	-
ODF	T	D	T	D	O	-
Rip Rap	O	D	O	D	O	-

4.2.1 Fill Density Testing

The density of soil and aggregate materials is determined using the methods and equipment according to ASTM D6938. Nuclear density testing is useful as a rapid, nondestructive technique for the in-place determination of soil and aggregate at or near the surface. This equipment must only be used, calibrated, and maintained by those staff specifically trained and designated for this work. Before a nuclear density testing result will be accepted, the nuclear gauge needs to be correlated in the field with sand cone tests. A correlation will be developed by testing the soil in the same direct area by both the nuclear gauge and the sand cone test. A minimum of five (5) trials shall be run and the results graphically plotted to develop a correlation between the different testing methods. If needed, the nuclear gauge can then be calibrated to match the results of the sand cone test.

For coarser grained fills, such as rockfill, a method test specification may be developed because in-situ testing may not be possible or practical. Once densities have been determined to be acceptable through the method specification, material conditions, placement methods, and compaction methods must replicate that which was performed in the method specification. If material, equipment, or field conditions changes significantly, then a new method specification or a return to confirmation density testing will be required.

Density testing for fill material placed inspection requirements are included in the table below.

Table 4-5: Fill Density Testing

Activity	CC (QC)		Engineer (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Nuclear Density Test	T	D	C	D	O	-
Method Spec Tracking	C	D	C	D	O	-

Sand cone density testing can be performed per ASTM Standard ASTM D1556/D1556M. Inspection and documentation for sand cone testing is included in the table below.

Table 4-6: Sand Cone Test

Activity	CC (QC)		EoR (QA)		Owner	
	Doc	Task	Task	Doc	Task	Doc
Sand Cone Test	T	D	O	D	O	D

The material being tested must be sufficiently cohesive to maintain stable sides during testing. It must not deform or slough while digging the hole or pouring the sand. In general, these test methods are limited to materials in an unsaturated condition and are not recommended for soft, friable or seeping materials.

4.3 Concrete

QA/QC will inspect all concrete placement per recommended inspections called out in the Technical Specification (TS-0013) and witness the testing on all concrete placements. The CC representative will give approval on the “Work Acceptance Report” prior to the pouring of concrete in excavated areas. In the event that concrete construction fails to meet the requirements specified in the specifications, the Contractor may be required to repair or remove and replace the affected concrete in a manner that is satisfactory to the engineer. In general, inspections are required for, but not limited to, the following activities:

Table 4-7: Concrete Activities

Activity	CC (QC)		EoR (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Concrete Mix Design	O	CoC	O	D	O	-
Concrete Formwork Placement	O	-	O	-	O	-
Reinforcing Steel Mill Certs/Test Reports	O	CoC	O	-	O	-
Reinforcing Steel Placement	O	-	O/P	D	O/P	D
Structural Concrete Placement	O	-	C/P	D	C/P	D
Structural Concrete Samples and Testing	O	CoC	P	D	O	D
Fresh Concrete Sampling	O	-	C	D	-	-
Grout Sampling	O	-	C	D*	O	-
Grout Placement	O	-	C	-	C	-

**Omit for pre-packaged mixes.*

4.4 Piping

QA/QC will inspect all pipe delivered, storage and handling, welding, bolting, placement and touch up painting per the technical specifications. The following requirements do not preclude other guidelines that may be outlined elsewhere or be required to ensure proper documentation for a record of construction. In general, inspections are required for, but not limited to, the following activities:

Table 4-8: Piping Activities

Activity	CC (QC)		EoR (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Pipe Mill Certs/Test Reports	O	CoC	O	D	O	-
Receive & Inspect Pipe Upon Delivery	O	CoC	O	D	O	D
Pipe Welder(s) Certification(s)	O	CoC	O	D	O	D
Pipe Welding Map with Weld Numbers	O	CoC	O	D	O	-
Welding Procedure	O	D	O	-	O	D
Welder Site Mandatory Pre-qualification Test	P	D	O	-	O	-
Touch Up Painting	O	-	O	-	O	D
Collection Piping Installation	O	D	O	D	O	D

Certificates of Compliance are to be supplied by Contractor for each material for all pipe and pipe components. Contractor shall provide receiving inspections to verify that all pipe and pipe components are of the types and quantity required for the pipe work and are not damaged or exhibit other unsatisfactory characteristics.

Contractor shall provide access for the Owner at all times to all facilities concerned with the fabrication and installation of piping.

Weld Certification: All welding performed on process and utility piping is to be performed using weld procedures qualified in accordance with ASME B31.3. Welders and welding operators are to be qualified in accordance with ASME B31.3. Contractor shall provide traceability for all welding via permanent marking or weld maps. Fabricator or Erector shall submit welder certifications for each type of weld they are to perform to Owner for approval.

Contractor shall submit qualified welding procedures and performance qualification records.

All welders must be prequalified and shall perform a mandatory test weld on site. The weld shall be tested by a certified inspector by means of radiographic test and will meet the requirements of a Normal Fluid Service per ASME B 31.3. The pipe size and schedule shall be determined by the Project Manager and QC Manager.

Sections of HDPE pipe having been discovered with cuts or gouges in excess of 10% of the pipe wall thickness shall be cut out and removed. The undamaged portions of the pipe shall be rejoined by butt fusion.

4.5 Liner

In general, inspections are required for, but not limited to, the following liner activities:

Table 4-9: Liner Activities

Activity	CC (QC)		EoR (QA)		Owner	
	Task	Doc	Task	Doc	Task	Doc
Liner Certifications	O	CoC	O	D	O	-
Liner Installation	T	D	O	D	O	-
Overliner Drain Fill Installation	O	D	O	D	O	D

- Inspection: The surface upon which the liner material will be installed shall be inspected by the **Quality Assurance Consultant** and certified by the **Contractor** to be in accordance with the requirements of this specification.

- Compaction: Site specific compaction requirements should be followed in accordance with the project Drawings and Specifications. At a minimum, the level of compaction should be such that no rutting is caused by installation equipment or other construction vehicles which traffic the area of deployment.

- Clearing: The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials larger than one inch as well as free of any voids, large cracks or standing water or ice.

- Grading: Directly prior to deployment of the **liner**, the subgrade shall be final graded to fill remaining voids or desiccation cracks, and smooth drum rolled to eliminate sharp irregularities or abrupt elevation changes. The surfaces to be lined shall be maintained in this smooth condition.

4.6 Permafrost Identification and Mitigation *(Pending Additional Site Investigations)*

Once further investigations have been completed at Site, an updated QAQC Plan that will be Issued for Construction (IFC) will be submitted that details a permafrost identification and mitigation plan.

5. REQUIRED TESTING AND FREQUENCIES

Content-appropriate forms are to be used for the tests described in this section are located in Appendix C of the Design Report. When reference is made to an external test procedure, i.e. ASTM, ACI, etc., the relevant test procedure documentation is considered an integral part of this manual. If these external test procedures reference or require other additional external procedures, they also are considered an integral part of this document. The majority of the relevant ASTM procedures for Earthworks testing are provided in the Technical Specifications. The tests required are divided into two categories:

- Quality Assurance Testing
- Quality Control Testing

Control tests are used to determine that materials comply with the specifications prior to placement and to determine other parameters, such as optimum moisture content and maximum dry density, so that the requirements of the Technical Specifications are achieved. The frequency of control tests can be reduced when material characteristics are relatively constant and consistent.

Generally, record tests are performed after placement of the materials to determine that the materials meet the requirements as set forth in the below Technical Specifications. Testing frequencies in this document are provided as reference. The required frequencies may change as construction progresses. If discrepancies exist between the technical specifications and this document the Technical Specifications should prevail. All materials need to be reviewed and approved by the EoR.

Table 5-1: Section 5 - Applicable Technical Specifications

Document	Rev	Date	Issuance
06 - Reference Standards – 01 42 19	0	01/26/2026	Issued for Licensing
07 - Quality Assurance – 01 43 00	0	01/26/2026	Issued for Licensing
08 - Quality Control – 01 45 00	0	01/26/2026	Issued for Licensing
11 - Field Engineering – 01 71 23	0	01/26/2026	Issued for Licensing
12 - Cast in Place Concrete – 03 38 00	0	01/26/2026	Issued for Licensing

Document	Rev	Date	Issuance
13 - Soils for Earthworks – 31 05 13	0	01/26/2026	Issued for Licensing
14 - Aggregate for Earthworks – 31 05 16	0	01/26/2026	Issued for Licensing
18 - Excavation – 31 23 16	0	01/26/2026	Issued for Licensing
19 - Fill – 31 23 23	0	01/26/2026	Issued for Licensing
20 - Rubble-Stone Riprap – 31 37 16.13	0	01/26/2026	Issued for Licensing
21 - Rough Grading – 31 22 13	0	01/26/2026	Issued for Licensing
22 - Subgrading Piping – 33 46 16	0	01/26/2026	Issued for Licensing
23 - Drainage Layers – 33 46 23	0	01/26/2026	Issued for Licensing

5.1 Fill Placement and Ground Preparation

Material production will be in stalled in adherence to the technical specifications and design criteria for the project, unless noted as best practice.

The source material should be as follows:

5.1.1 Buildings

The frequency for testing for buildings shall be conducted as stated in the below table:

Table 5-2: Building Test Frequency

Location	Frequency
Buildings	1 Test Group for Every 5,000 ft^2

*Best Practice

5.1.2 Roads and Parking Lots

Table 5-3 states the testing frequency for roads and parking lots.

Table 5-3: Roads and Parking Lots Test Frequency

Location	Frequency
Road	1 Test Group for Every 300 ft of Road
Parking Lots	1 Test Group for Every 10,000 ft^2

*Best Practice

5.1.3 Unpaved Areas

Testing frequencies for unpaved areas are given in the table below:

Table 5-4: Unpaved Areas Test Frequency

Location	Frequency
Unpaved Areas	1 Test Group for Every 20,000 ft^2

*Best Practice

5.1.4 Pipe Trenches

Table 5-5 states the testing frequency for pipe trenches:

Table 5-5: Pipe Trench Test Frequency

Location	Frequency
Pipe Trench	1 Test Group for Every 300 ft

*Best Practice

5.1.5 Prepared Subgrade

Testing is not required for prepared subgrade. However, this activity does require a proof roll to ensure quality assurance and quality control measures.

Table 5-6: Subgrade Test Frequency

Location	Frequency
Subgrade	Testing Not Required – Proof Roll Required Instead

5.2 Material Production

Material production will be in stalled in adherence to the technical specifications and design criteria for the project. The source material should be as follows:

5.2.1 Rockfill

Rock fill shall be soil material derived form the excavated cut or other approved sources as shown in the Project Drawings and should be free of vegetation or other deleterious materials. Unsuitable materials shall be disposed of as directed by the Owner.

The rockfill material shall be no larger than 2/3 of the construction lift thickness determined by a test fill. Less than 30% material must pass 19 mm and must be well graded. Gap graded material will not be accepted. Rockfill should be durable and hard as determined by the Engineer in the field using field tests such as scratch testing and hammer blow tests. The Engineer may also collect samples for laboratory durability testing, such as slake durability, LA abrasion, and sulfate soundness. Due to the maximum size in rockfill moisture and gradation testing is typically not possible or practical and visual inspections of the material may be used.

Table 5-7: Rockfill Production Test Frequency

Observations	Frequency
Visual Gradation and Moisture Based on Method Spec	Method and Frequency to be Determined by Test Fill
Durability Field Testing	Method and Frequency to be Determined by Test Fill

5.2.2 Structural Fill

Structural fill shall be soil material derived form the excavated cut or other approved sources as shown in the Project Drawings and should be free of vegetation or other deleterious materials. Unsuitable materials shall be disposed of as directed by the Owner.

The structural fill material should 100% pass 150mm, with less than 30% material passing 19mm. Gap graded material will not be accepted, as all material should be well graded. The material should have a plasticity index of less than 7 and a liquid limit of less than 30.

Table 5-8: Structural Fill Testing Frequency

Testing	Frequency
Gradation	1 Test per 5,000 m^3
Moisture	1 Test per 5,000 m^3
Durability	1 Test per 5,000 m^3
Plasticity Index	1 Test per 5,000 m^3

5.2.3 Drain Fill

Select drain fill shall be free draining material that is non-calcareous round or river run stone. This material shall be durable material that is full of clay and debris, as well as durable by that specified by Los Angeles Abrasion Testing (ASTM C535). A loss of less than 45% is required.

Table 5-9: Drain Fill Testing Frequency

Testing	Frequency
Gradation	1 Test per 5,000 m^3
Permeability	1 Test per 50,000 m^3
Durability	1 Test per 50,000 m^3

5.2.4 Overliner Drain Fill

Overliner drain fill shall be free draining with a minimum operation permeability of 1.0 x 10^{-2} cm/s as determined by ASTM D 2434 or ASTM D 3385. This material shall also be non-calcareous, durable material that is free of clay and debris. Durability expectations are as determined by Los Angeles Abrasion Testing (ASTM C535). A loss of less than 45% is required.

An ODF placement procedure will be developed based construction material characterization and final design to ensure placement is consistent and at the designed thickness to protect the geomembrane.

Table 5-10: ODF Testing Frequency

Testing	Frequency
Gradation	1 Test per 5,000 m^3
Permeability	1 Test per 50,000 m^3
Durability	1 Test per 50,000 m^3

5.2.5 Rip-Rap

Rip-rap shall consist of hard, dense, durable stone that is resistant to weathering and consists of in organic, non-plastic, screened, crushed, ROM aggregate that is free of clay, friable material, and debris. The stone should have a specific gravity of at least 2.4 as well as a mean particle size that conforms to the gradation requirements shown on the drawings. The material used for rip-rap shall be visually approved by the quality assurance consultant and if the material does not meet the below requirements, engineer approval is necessary.

Table 5-11: Rip-Rap Production Test Frequency

Observations	Frequency
Visual Gradation and Moisture Based on Method Spec	Weekly Composite
Durability Field Testing	Per Engineer

5.3 Use of other Construction Materials

Other procured construction materials will be required and must be approved by the EoR. These material include, but may not be limited to items such as piping, steel, and concrete. The following testing requirements are needed.

5.4 Concrete

The items checked with an “X” in the “Special inspection Schedule” shall be inspected in accordance with IBC chapter 17 by a certified special inspector. A certified testing agency shall complete material sampling and testing requirements, refer to project specification, the structural notes and the notes below. The special inspector and testing agency shall furnish reports to the engineer/architect of record and Contractor, for each test or inspection. All discrepancies shall be brought to the immediate attention of the Contractor for correction. Any discrepancies shall be clearly shown on the report, with a record of the uncorrected items.

This report shall be immediately furnished to the engineer/architect of record and Contractor after each test result or inspection. Special inspection testing requirements apply equally to all bidder designed components. The special inspector shall be employed by the owner, the engineer/architect of record, or an agent of the owner, but not the Contractor or any other person responsible for the work. The Contractor shall be responsible for contacting the special inspector and scheduling any special inspection, within the scheduling requirements of the testing agency or special inspector.

Table 5-12: Concrete Inspection Frequencies

Item	Continuous Inspection	Periodic Inspection
Inspection of Reinforcing Steel Placement		X
Verifying Use of Design Mix		X
At the Time of Fresh Concrete and Grout Sampling to Fabricate Test Specimens	X	
Inspection of Concrete and Grout Placement	X	
Inspection of Post Installed Anchors	X	

Continuous special inspection means that the special inspector is on the site at all times observing the work requiring inspection (IBC 1702). Periodic special inspection means that the special inspector is on site at time intervals necessary to confirm that all work required special inspection is in compliance.

Inspection of concrete shall be in accordance with IBC section 1704.4. The concrete construction shall be inspected for compliance with approved construction documents.

Make one set of four cylinders of mixed and placed concrete. As a minimum, one set shall be taken at least once in the field for each day, for every 150 cubic yards of concrete, or for every 5000 ft2 of surface area of slabs or walls, whichever is less. Samples for strength tests shall be taken in accordance with ASTM C172.

Non-shrink grout: Make three sets of three cubes in the field for each batch of grout mixed and placed. Test cylinders shall be in accordance to ASTM C109.

Installation of post installed anchors should be done by trained personnel.

Sand cement dry pack grout: Make three sets of three test cylinders or cubed in the field for each batch of grout mixed and placed. Test cylinder shall be in accordance to ASTM C387

Perform slump testing per ASTM C143 and air contents per ASTM C233 each time strength test cylinders are taken.

Construct and cure the cylinders in accordance with ASTM C31.

Perform compressive strength test on cylinders in accordance with the provisions of ASTM C39. Per set, test one cylinder at seven days and two at twenty-eight days. The fourth cylinder shall be tested at the discretion of the Contractor.

A complete record of tests of materials and of concrete shall be retained by the inspector for two (2) years after completion of the project and made available for inspection during the progress of work.

5.5 Piping

Contractor shall coordinate and perform pressure, radiographic, and visual tests and document all testing after erection. Tests are to fulfill the requirements of ASME B31.3. Pressure testing for HDPE pipe shall be conducted in accordance with the ASTM F 2164, Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure.

Hydrostatic pressure testing shall not be required for lines that have had 100% Radiographic testing.

The following equipment shall not be subjected to piping test pressure:

- Pumps, turbines, compressors, and centrifuges.
- Rupture discs, relief valves, flame arrestors, filters, self-contained pressure regulating valves, sealed control valves, rotometers, and all other inline instruments.
- Equipment or components that do not have a specified test pressure.

Before testing, the Contractor shall remove non-pressure parts of traps, instruments, and specialties.

Long runs of piping may be tested in segments to facilitate supply and disposal of test media. Test lengths to be pre-approved by the Owner.

All flanges or threaded joints and all welds shall be left unpainted and uninsulated, and underground pipe joints shall be left exposed, until testing is completed and accepted by the Owner.

Contractor shall furnish all tools, instruments, and equipment necessary to carry out the tests and repair of all leaks.

Testing gauges used shall be certified for accuracy prior to testing.

Any leaks shall be repaired and retested. Changes to piping after testing shall be retested.

No piping shall be tested at metal temperature below 35°F.

Vents and other high point connections shall be open during filling so that air in the pipeline is vented prior to applying pressure to a system.

After hydrostatic testing of a system is complete and approved by Owner, all lines and equipment shall be completely drained. System shall be vented during draining to avoid excessive vacuum.

The Contractor shall ensure that adequate temporary pipe restraining precautions are taken during pressure testing.

Tests are to be performed by the Contractor. Accurate test records shall be kept by Contractor on each line or system tested and shall include the following:

- Identification of Piping System by Line Number and Segment
- Testing Medium
- Testing Pressure

- Time of Test, Start Time with Pressure Reading and Ambient Temperature, Finish Time with Pressure Reading And Ambient Temperature
- Date of Test Approval
- Signature of Test Supervisor

5.5.1 Hydrostatic Testing

In the event that hydrostatic testing is needed, a procedure will be developed by the engineer to employ for the project.

5.5.2 Radiographic Testing

Radiographic and visual tests are to fulfill the requirements of ASME B31.3-2010. All testing shall be to the requirements called out in the piping line list schedule (Design Report - Appendix B) and will be tested in accordance to the ASME B31.3 Fluid Service Category which is designated in Specification BGM-LOMD-113-1ES-5231 Pipe and Valve material Classification.

Table 5-13: Radiographic Testing

Activity	CM - QC		Engineer - QA		Owner	
	Task	Doc	Task	Doc	Task	Doc
Radiographic Testing	O	D	C	P/D	O	D
Visual Testing	O	-	C	P/D	O	D

A minimum of 5% of all welds will be required to have radiographic examination by an Examiner that shall have training and experience commensurate with the needs of the specified examinations. The employer shall certify records of the examiners employed, showing dates and results of personnel qualifications, and shall maintain them and make them available to the Inspector.

The fluid service categories are defined as follows:

- **Category D Fluid Service:** A fluid service in which all the following apply:
  - The fluid handled is nonflammable, nontoxic, and not damaging to human tissues as defined by “a fluid service in which exposure to the fluid, caused by leakage under expected operating conditions, can harm skin, eyes, or exposed mucous membranes so that irreversible damage may result unless prompt restorative measures are taken. (Restorative measures may include flushing with water, administration of antidotes, or medication.)
  - The design gage pressure does not exceed 1035 kPa (150 psi) 3. the design temperature is from −29°C (−20°F) through 186°C (366°F)
- **Category M Fluid Service:** A fluid service in which the potential for personnel exposure is judged to be significant and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons on breathing or bodily contact, even when prompt restorative measures are taken.
- **Elevated Temperature Fluid Service:** A fluid service in which the piping metal temperature has a design or sustained operating temperature equal to or greater than Tcr as defined in Table 302.3.5, General Note (b).
- **High Pressure Fluid Service:** A fluid service for which the owner specifies the use of Chapter IX for piping design and construction; see also para. K300.

- **Normal Fluid Service:** A fluid service pertaining to most piping covered by this Code, i.e., not subject to the rules for Category D, Category M, elevated temperature, or High Pressure Fluid Service

- **High Purity Fluid Service:** A fluid service that requires alternative methods of fabrication, inspection, examination, and testing not covered elsewhere in the Code, with the intent to produce a controlled level of cleanness. The term thus applies to piping systems defined for other purposes as high purity, ultra-high purity, hygienic, or aseptic.

The acceptance criteria for radiographic testing for limits on weld imperfections shall conform to ASME B31.3 Chapter VI section 341.3.2 as indicated in the tables below.

When the required or spot or random examination reveals a defect two (2) additional samples of the same kind, by the same welder shall be given the same type of examination and the defective items shall be repaired or replaced and reexamined by the same radiographic procedure. This procedure is further explained in ASME B 31.3 Section 341.4.

Table 5-14: Welding Requirements

Criteria (A to M) for Types of Welds and for Service Conditions[1]											Examination Methods			
Normal and Category M Fluid Service				Severe Cyclic Conditions			Category D – Fluid Service							
Type of Weld				Type of Weld			Type of Weld			Weld Imperfection				
Girth, Miter Groove, & Branch Connection [2]	Longitudinal Groove [3]	Fillet [4]	Girth, Miter Groove, & Branch Connection [2]	Longitudinal Groove [3]	Fillet [4]	Girth, Miter Groove,	Longitudinal Groove [3]	Fillet [4]	Branch Connection [2]		Visual	Radiography	Magnetic Particle	Liquid Penetrant
A	A	A	A	A	A	A	A	A	A	Crack	☒	☒	☒	☒
A	A	A	A	A	A	C	A	N/A	A	Lack of Fusion	☒	☒	☐	☐
B	A	N/A	A	A	N/A	C	A	N/A	B	Incomplete Penetration	☐	☒	☐	☐
E	E	N/A	D	D	N/A	N/A	N/A	N/A	N/A	Internal Porosity	☐	☒	☐	☐
G	G	N/A	F	F	N/A	N/A	N/A	N/A	N/A	Internal Slag Inclusion, Tungsten – Inclusion, or Elongated Indication	☐	☒	☐	☐
H	A	H	A	A	A	I	A	H	H	Undercutting	☒	☒	☐	☐
A	A	A	A	A	A	A	A	A	A	Surface Porosity or Exposed Slag Inclusion[5]	☒	☐	☐	☐
N/A	N/A	N/A	J	J	J	N/A	N/A	N/A	N/A	Surface Finish	☒	☐	☐	☐
K	K	N/A	K	K	N/A	K	K	N/A	K	Concave Root Surface (Suck Up)	☐	☒	☐	☐
L	L	L	L	L	L	M	M	M	M	Weld Reinforcement or Internal Protrusion	☒	☐	☐	☐

Notes:

1. *Weld imperfections are evaluated by one or more of the types of examination methods given, as specified in paras. 341.4.1, 341.4.2, 341.4.3, and M341.4, or by the engineering design.*
2. *N/A indicated the Code does not establish acceptance criteria or does not require evaluation of this kind of imperfection for this type of weld.*
3. ☒Indicates examination method generally used for evaluating this kind of weld imperfection.
4. ☐Indicates examination method not generally used for evaluating this type of weld imperfection.

Table 5-15: Legend for Welding Specifications

Symbol	Measure	Acceptable Value Limits[6]	
A	Extent of Imperfection	Zero – No Evident Imperfection	
B	Depth of Incomplete Penetration Cumulative Length of Incomplete Penetration	≤ 1mm (1/32 in.) and ≤ 0.2 T_w ≤ 38mm (1.5 in.) in any 150mm (6in) weld length	
C	Depth of Lack of Fusion and Incomplete Penetration Cumulative Length of Lack of Fusion and Incomplete Penetration[7]	≤ 0.2 T_w ≤ 38mm (1.5 in.) in any 150mm (6in) weld length	
D	Size and Distribution of Internal Porosity	See BPV Code, Section VIII, Division 1, Appendix 4	
E	Size and Distribution of Internal Porosity	For T_w ≤ 6 mm (1/4 in.), limit same as D. For T_w > 6 mm (1/4 in.), limit is 1.5 x D.	
F	Stag Inclusion, Tungsten Inclusion, or Elongated Indication Individual Lenth Individual Width Cumulative Length	 ≤ T_w/3 ≤ 2.5 mm (3/32 in.) and ≤ T_w/3 ≤ T_w in any 12 T_w weld length	
G	Stag Inclusion, Tungsten Inclusion, or Elongated Indication Individual Lenth Individual Width Cumulative Length	 ≤ 2 T_w ≤ 3 mm (1/8 in.) and ≤ T_w/2 ≤ 4T_w in any 150 mm (6 in.) weld length	
H	Depth of Undercut	≤ 1 mm (1/32 in.) and ≤ T_w/4	
I	Depth of Undercut	≤ 1.5 mm (1/16 in.) and ≤ (T_w/4 or 1 mm (1/32 in)	
J	Surface Roughness	≤ 500 min R_a in accordance with ASME B46.1	
K	Depth of Root Surface Concavity	Total joint thickness, incl weld reinf. ≥ T_w	
L	Height of Reinforcement or Internal Protrusion[8] in any plane through the weld shall be within limits of the applicable height value in the tabulation to the right, except as provided in Note 9. Weld metal shall merge smoothly into the component surfaces.	For T_w mm (in) ≤ 6 (1/4) > 6 (1/4), ≤ 13 (1/2) > 13 (1/2) ≤ 25 (1) > 25 (1)	Height, mm (in.) ≤ 1.5 (1/16) ≤ 3)1/8) ≤ 4 (5/32) ≤ 5 (3/16)
M	Height of Reinforcement or Internal Protrusion[8] as described in L Note 9 does not apply.	Limit is twice the value applicable for L Above	

Notes:

1. *Criteria given are for required examination. More stringent criteria may be specified in the engineering design. See also paras. 341.5 and 341.5.3.*
2. *Branch connection weld includes pressure containing welds in branches and fabricated laps.*
3. *Longitudinal groove weld includes straight and spiral stream. Criteria are not intended to apply to welds made in accordance with a standard listed in Table A-1 or Table 326.1. Alternative Leak Test requires examination of these welds. See Para. 345.9.*
4. *Fillet Weld includes socket and seal welds, and attachment welds for slip-on flanges, branch reinforcement, and support.*
5. *These imperfections are evaluated only for welds* ≤ 5 mm (3/16 in.) in nominal thickness.
6. *Where two limiting values are separated by "and", the lesser of the values determines acceptance. Where two sets of values are separated by an "or", the larger value is acceptable. Tw is the nominal wall thickness of the thinner of two components joined by a butt weld. Tightly butted unfused root faces are unacceptable.*

APPENDIX A: RFI TEMPLATE

REQUEST FOR INFORMATION			
		Forte RFI:	
		Contractor RFI:	
		Site Location:	
		Date Submitted:	
Subject:		**Project Zone/Area:**	
Contractor:		**Station/Location:**	
Attention:		**Discipline:**	
Request			
Related Drawings:		**Other Related Documents:**	
Information Request:			
Proposed Corrective Action:			
Type of Change:	☐ Owner Change ☐ Vendor Change	☐ Clarification/Information ☐ Design Change	☐ Field Change ☐ Other
Cost Impact:			
Schedule Impact:			
Requested By:		**Date:**	
Response			
☐ Approved	☐ Approved as Noted	☐ Rejected as Noted	
Response:			
Answered By:		**Date:**	
Signature:			

Note: Response to this RFI does not constitute authorization to perform a change to any Contract. The Requestor may proceed with the response only on the basis that the Requestor agrees that it is not a contract change. If the Requestor believes that the response does constitute a contract change, the Requestor shall immediately notify Forte Dynamics. Work undertaken without Forte's written authorization is a the Contractor's risk and expense.



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APPENDIX D

HLF Operation, Maintenance and Surveillance Manual

REPORT

Heap Leach Facility Operations, Maintenance, and Surveillance Manual

Coffee Gold Mine

Submitted By:

Kaminak Gold Ltd.
201-166 Titanium Way
Whitehorse, YT, Y1A 0G1

January 27, 2026

REVISION TRACKING LOG

Revision Tracking Log			
Version	**Date**	**Section Updated**	**Description of Update**
0	November 2023	-	First submission of Heap Leach Facility Operations, Maintenance, and Surveillance Manual
1	January 2026	Various	Updated based on the Third-party Review and review of Independent Review Board Recommendations.
2			

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
ADR	Adsorption, Desorption, Regeneration
DoR	Designer of Record
EoR	Engineer of Record
ESR	Event Storage Requirement
GCL	Geosynthetic Clay Liner
H&S	Health & Safety
HDPE	High Density Polyethylene
HLF	Heap Leach Facility
HLP	Heap Leach Pad
H:V	Horizontal to Vertical Slope Angle
LDRS	Leak Detection and Recovery System
LLDPE	Linear Low Density Polyethylene
LOM	Life Of Mine
MAP	Mean annual precipitation
MDMER	Metal and Diamond Mining Effluent Regulations
NaCN	Sodium Cyanide
NAR	Northern Access Route
ODF	Overliner Drain Fill
OMS	Operations, Maintenance, and Surveillance
PLS	Pregnant Leach Solution
PMP	Probable Maximum Precipitation
QA/QC	Quality Assurance/Quality Control
QML	Quartz Mining License
RHLFE	Responsible Heap Leach Facility Engineer
ROM	Run of Mine
SER	Sustainability and External Relations
SOP	Standard Operating Procedure
SWE	Snow Water Equivalent
WMP	Water Management Plan
WRSF	Waste Rock Storage Area
WUL	Water Use License
YWB	Yukon Water Board

LIST OF SYMBOLS AND UNITS OF MEASURE

Symbol / Unit of Measure	Definition
%	percent
ºC	degrees Celsius
d	day
d/y	days per year

Symbol / Unit of Measure	Definition
g	gram
g/t Au	grams of gold per tonne
ha	hectare
hr	hour
hr/d	hours per day
H:V	Horizontal to Vertical ratio
km	kilometer
km^2	square kilometer
kN/m^2	kiloNewton per square metre
kN/m^3	kiloNewton per cubic metre
koz	thousand ounces
kg	kilogram
km	kilometre
km^2	square kilometres
kt	kilotonne
L	litre
$L/hr/m^2/$	litres per hour per square metre
$l/m^2/hr$	liters per square meter per hour
m	metre
mm	millimetre
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
Mt	million metric tonnes
Mt/a	million tonnes per annum
pH	hydrogen potential
t/d	tonnes per day
yr	year

1.0 INTRODUCTION

1.1 Project Summary

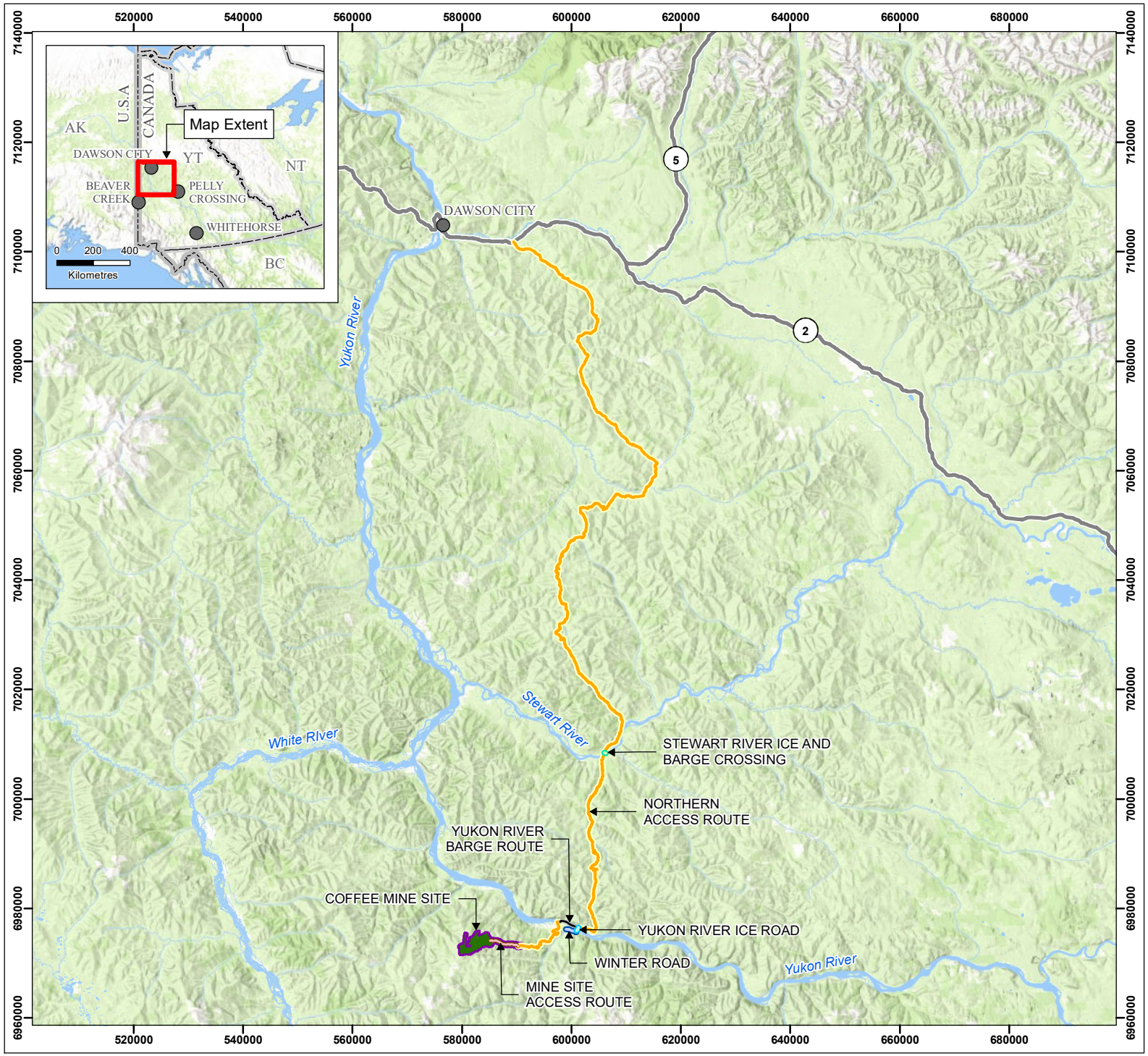
The proposed Coffee Gold Mine (the Project) is an open-pit gold mine owned by Kaminak Gold Ltd. (Kaminak Gold), a subsidiary of Fuerte Metals, located on the south side of the Yukon River in the White Gold District of west-central Yukon. The Project site is approximately 130 km south of the City of Dawson, 140 km west of Pelly Crossing, 95 km north-east of Beaver Creek, and 340 km northwest of Whitehorse. The Project is located wholly within the traditional territory of Tr'ondëk Hwëch'in, partially within the traditional territory of Selkirk First Nation and First Nation of Na-cho Nyäk Dun, and partially within the asserted territory of White River First Nation. The Project contains several gold occurrences within an exploration concession covering an area of more than 600 km2. The Mine Site will be accessed by road from Dawson via a 16-km stretch of Klondike Highway and 192-km all-season road, referred to as the Northern Access Route (NAR) (Figure 1-1). The NAR includes seasonal barge crossings on both the Stewart and Yukon rivers, with ice bridges and a seasonal winter road in the winter months.

The Project is comprised of four open pits: Supremo, Latte, Double Double, and Kona. Waste rock is proposed to be permanently stored in the Alpha Waste Rock Storage Facility (WRSF). The ore production rate is proposed to be up to approximately 9.0 million tonnes (Mt) per year, producing an estimated total of 67 Mt of heap leach feed over the 10-year Operation Phase. The conceptual-level estimate for waste material to be moved over the life of mine (LOM) is up to approximately 330 Mt based on an average strip ratio of 5.0:1. The ore will be crushed and transported to the Heap Leach Facility (HLF) via overland conveyor or trucks for nine months of the year. During the three coldest months of winter, run-of-mine (ROM) ore will be stockpiled in the ROM stockpile. Gold will be extracted from gold-bearing leach solution by a six tonnes per day (t/d) adsorption, desorption, recovery carbon plant with mercury retorting to produce a final gold doré product. A total of 2.6 million ounces of gold is planned to be recovered over a 10-year mine life.

The Project phases are defined as follows:

- Construction Phase: Q2 Year –3 to end of Year –1 (30 months)
- Operation Phase: Year –1 to end of Year 9 (10 years)
- Reclamation and Closure Phase: Year 10 to end of Year 21, including a 6-year Post-Mining Closure Stage and a 5-year Active Closure Stage (11 years)
- Post-Closure Phase: Year 21 onwards as determined to be required.

These phases broadly describe the activities occurring within a particular time period; however, some activities will continue from one phase to another as mine site development advances with operational activities (e.g., Open Pits, WRSF). When areas that support mine operations are no longer required, they will be progressively reclaimed. The overall Project schedule is the general expected scenario for mine construction and operation; detailed activities are subject to change depending on detailed mine planning and the timing of receipt of authorizations.



COFFEE GOLD MINE

Coffee Project Location and Northern Access Route

Legend

- Stewart River Ice and Barge Crossing
- Yukon River Barge Route
- Yukon River Ice Road
- Winter Road
- Mine Site Access Route
- Northern Access Route
- Project Area
- Project Footprint
- Highway
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
2. Contains information licensed under the Open Government Licence - Yukon Territory
3. Basemap: ESRI World Topographic Map
4. Inset Basemap: ESRI World Topographic Map

N

1:1,000,000

0 5 10 15 20 25

Kilometres

NAD 1983 UTM Zone 7N

Page Size: 8 ½" x 11"

Figure 1.1	Date: Mar 2, 2023	Drawn by: AS	Reviewed: KP

Path: S:\Geomatics\Projects\1038620\1mxd\Fig1_1_1038620_03_CoffeeProjectLoc_NorthernAccessRoute_230302.mxd

1.2 Scope and Objectives

This Operations, Maintenance, and Surveillance (OMS) Plan will be used in the development of training material and guidance for key operators and maintenance personnel with responsibilities related to the HLF. It also provides guidance on emergency response procedures and is intended to be utilized in conjunction with the following documents:

- Heap Leach and Process Facilities Plan
- Water Management Plan
- Cyanide Management Plan
- Site Emergency Response Plan
    - Heap Leach Facility Emergency Response Plan.

The OMS Plan provides a framework for actions and a basis for measuring performance for the HLF operations. Key items and activities covered in the plan include:

- Roles and responsibilities of personnel assigned to OMS activities for the HLF.
- Description of the HLF including site conditions, key components, regulatory requirements, and design criteria.
- Facility operations including ore stacking, leaching, heap solution management, solution processing, environmental protection, and documentation and reporting.
- Facilities maintenance including routine and event-driven maintenance, and documentation and reporting.
- Facility surveillance including routine, event-driven and annual inspections, and documentation and reporting.
- Emergency planning and response.

This OMS Plan introduces procedures that will be implemented by mine personnel for the operation, maintenance, and surveillance of the HLF to ensure that it is functioning as designed while meeting regulatory and company environmental policy obligations.

1.3 Synergies with Other Project Documents

While this Plan can be reviewed in isolation to inform a review of the specific actions for operations, maintenance, and surveillance, this plan should be viewed in concert with the following additional management plans in order to attain a holistic understanding of the Project:

- Access Route Construction Management Plan
- Access Route Operational Management Plan
- Reclamation and Closure Plan
- Explosives Management Plan
- Emergency Response Plan
- Spill Contingency Plan
- Water Management Plan
- Wildlife Protection Plan.

2.0 MANAGEMENT OF DOCUMENT REVISION

The HLF OMS Plan will be reviewed and updated annually, or as necessary by the Process Manager, and in accordance with the permit and licence requirements.

Manual revisions will incorporate relevant changes in facility performance, capacity, operational requirements, closure requirements, site management, roles and responsibilities, or regulations or reporting procedures.

Previous versions of the Manual are accessible to all relevant persons operating the facility, the Engineer of Record (EoR), and regulatory authorities. The version control tables at the top of this document summarize the revision history. Table 2-1 details revisions to the OMS Plan and provides a summary and rationale for those modifications.

The list of Manual holders for the HLF is provided in Table 2-2. The Owner will maintain a record of the location of each copy of the plan and will ensure that all copies are updated when required.

Table 2-1 Revision History

Section	Date	Revision and Rationale
All	June, 2023	Initial Issuance
All	January 2026	Revision 1

Table 2-2 List of Manual Holders and Contact Information

Organization and Title
Owner; Process Manager
Forte Dynamics, Inc; Engineer of Record (EoR).

3.0 ROLES AND RESPONSIBILITIES OF KEY PERSONNEL

The Proponent has committed to providing the necessary human, material, and financial resources to implement and maintain the OMS Plan. The Mine General Manager and Process Manager will be responsible for implementation of the monitoring components outlined in the Plan. Key Project personnel responsible for being familiar with the contents of this Plan are shown in Table 3-1.

Table 3-1 Key Project Personnel

Role	Responsibility
Mine General Manager	Overall responsibility for Mine Site management.
Process Manager	Responsible for all the HLF, adsorption, desorption, and recovery (ADR) Plant, and Crushing Operation at the Facility. This includes making decisions regarding the procedures to be carried out during an emergency.

Role	Responsibility
H&S Manager	Responsible for conducting regular safety site inspections and implementing the appropriate controls in a timely manner. The H&S Manager shall maintain records of all safety inspections as well as any actions taken because of these inspections throughout the life of the Project. Where safety inspections show the potential for environmental effects, the Health & Safety (H&S) Manager will work in collaboration with the Environment Department.
Sustainability and External Relations (SER)	Responsible for recording and addressing any complaints received from nearby land users, or other interested parties regarding operation-related impacts off-site. The SER department shall maintain records of all complaints received as well as any actions taken because of these complaints.
Environmental Manager	Responsible for permitting, environmental monitoring, and regulatory compliance.
Accountable Executive Officer	One or more executive(s) directly answerable to the CEO and who is accountable for the safety of the HLF. The Accountable Executive(s) may delegate responsibilities but not accountability.
Independent Technical Reviewers	An individual or group of technical experts that perform an independent third-party review of key technical, management, operational and governance aspects of the HLF.
Responsible Heap Leach Facility Engineer	An engineer appointed by the Operator to be responsible for the heap leach facility. The RHLFE must be available at all times during construction, operations, and closure. The RHLFE has clearly defined, delegated responsibility for management of the heap leach facility and has appropriate qualifications and experience compatible with the level of complexity of the heap leach facility. The RHLFE may delegate specific tasks and responsibilities for aspects of heap leach management to qualified personnel but not accountability.
Designer of Record (DoR)	Engineering firm responsible for the design of the HLF, meeting applicable regulations, statutes, guidelines, codes, and standards. For the purpose of this project, the EoR is the DoR
Engineer of Record (EoR)	Engineering firm responsible for confirming that the HLF is designed, constructed, and decommissioned with appropriate concern for integrity of the facility, and that it aligns with and meets applicable regulations, statutes, guidelines, codes, and standards. The Engineer of Record may delegate responsibility but not accountability.

3.1 Assignment of Responsibilities

The Process Manager and the Mine General Manager are the main individuals responsible for implementation and management of the procedures outlined within the OMS Plan. Other individuals have a role in supporting them with certain aspects within the plan. These roles range from having responsibility (R) for performing the tasks, being Accountable (A) for managing the tasks, being Consulted (C) on the performance and results of the tasks or being informed (I) of the tasks. Table 3-2 presents this RACI Matrix of key individuals and their respective roles as it relates to operation of the HLF.

Table 3-2 HLF Operations RACI Matrix

Title	Operations	Maintenance	Surveillance	Emergency Preparedness	Training	Change Management
Accountable Executive	A	I	I	I	I	I
Mine General Manager	A	A	A	A	A	A
DOR						
EOR	C	C	C	C	C	C
RHLFE	C	C	R	C	C	C
Process Manager	R	R	R	R	R	R
Process Operations Superintendent	R	R	R	R	R	R
Process General Foreman	R	R	R	R	R	
Process Supervisor	R	R	R	C	I	C
Crushing and Conveying General Foreman	R	R	R	R	R	C
Crushing and Conveying General Superintendents	R	R	R	C	I	C
Chief Metallurgist	R		R	C	I	C
Maintenance Manager		R	I	R	I	R
Maintenance Foreman		R	R	C	I	R
Maintenance Supervisors		R	R	C	I	C
Senior Maintenance Planner		R	R		I	R
Maintenance Planners		R	R		I	
Environmental Manager			I	C	I	I
Environmental Superintendent			R	C	I	I
Environmental Coordinators			I	I	I	
Health & Safety Manager			I	R	R	R
Health & Safety Coordinator			I	R	R	
Engineer of Record	I	I	I	I	I	I

3.2 Training

The Process Manager will ensure routine training workshops for all personnel with OMS responsibilities for the HLF are provided. The workshops will focus on operations, surveillance, inspection, monitoring, cyanide management, emergency response, and regulatory reporting requirements for the HLF. Engineering consultants who are familiar with the HLF design and operations may assist in the training program as necessary.

4.0 PROJECT OVERVIEW

4.1 HLF Overview

The Project will operate as a conventional, multi-lift, free-draining ridge-top heap leach pad with an ultimate pad area of approximately 1.1M m^2. The HLP will be constructed in 5 stages (Table 4-1) expanding to the design capacity of approximately 67 Mt.

Table 4-1 HLP Staging

Heap Leach Pad Stage	Construction Year	Cumulative Pad Stage Area (m^2)1*	Pad Cumulative Capacity (Mt)	Heap Crest Elevation (masl)
1	Year -1	247,000	4	1324
2	Year 1	429,000	15	1350
3	Year 2	699,000	32	1388
4	Year 4	921,000	50	1392
5	*Year 7*	*1,053,000*	*69*	*1392*

*Leach pad area within the HLF containment system. Does not include lined pond area.

Ore will be stacked with trucks and conveyor/stackers on a lined leach pad in nominal 10 m thick lifts. Barren solution containing sodium cyanide will be irrigated onto the ore using drip irrigation. As the barren solution percolates through the heap, gold will react with the cyanide and dissolve into the solution. Pregnant (gold-bearing) solution will be collected into the piping network at the base of the HLP above the liner system and will be transported by pipe to an on-site adsorption, desorption, and recovery (ADR) plant where it will be processed via conventional gold recovery methods. Barren solution will be heated and pumped back up to the top of the heap leach pad at a nominal rate of 1,100 m^3/hr (design 1,400 m^3/hr) after adding cyanide (estimated 0.2 kg cyanide per tonne of ore), anti-scalant, and makeup water to the barren tank as needed to maintain nominal flows.

The HLF will include the following:

- Heap leach pad
- Three event ponds (EP-1N, EP-1S, EP-2) and one rainwater pond
- Conveying system
- Conventional process plant for gold recovery
- Various access roads
- Required utilities, reagents, and infrastructure.

Figure 4-1 shows the general arrangement for key HLF components.

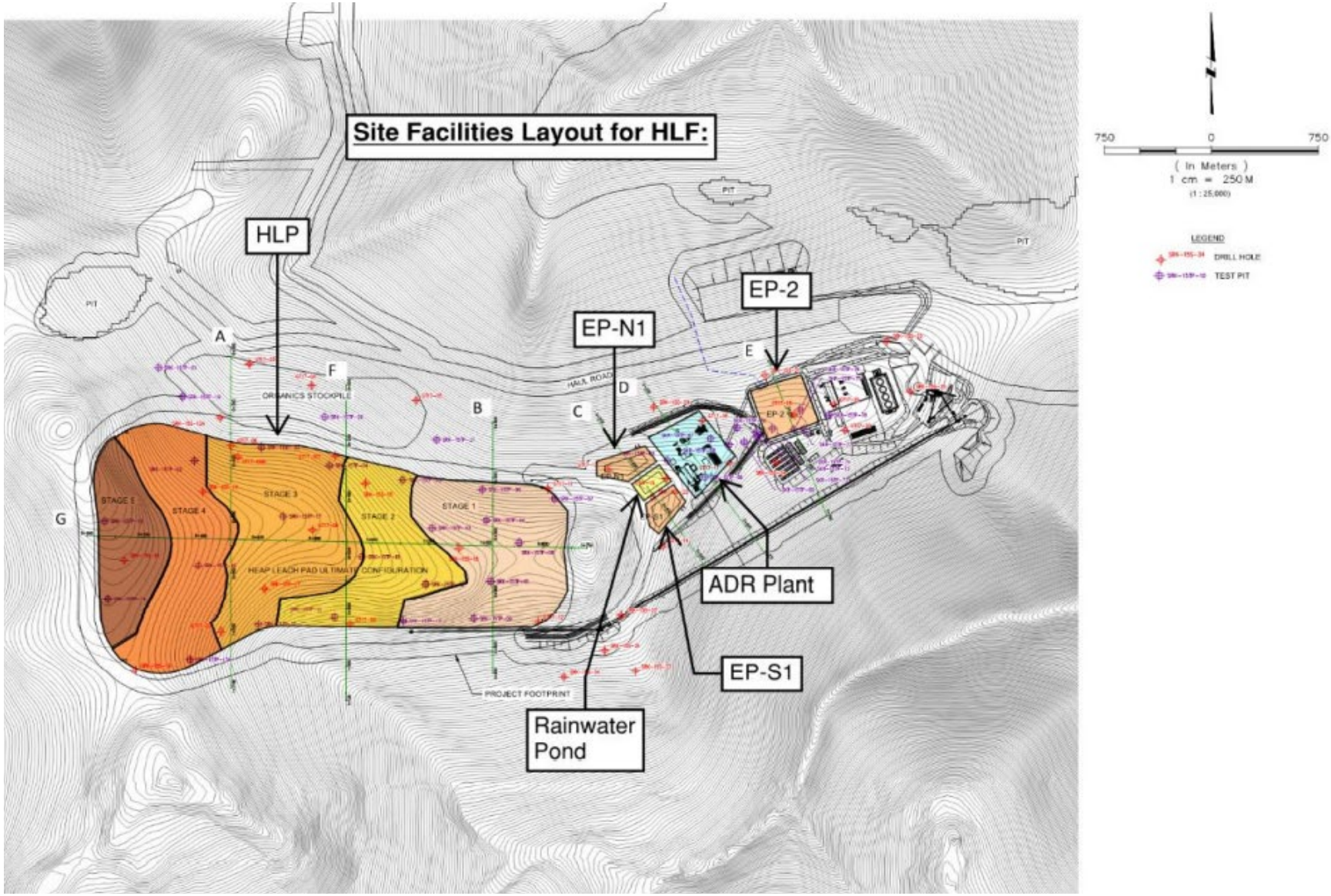


Figure 4-1 Site General Arrangement and HLF Phases

4.2 Site Conditions

4.2.1 Location and Setting

The Coffee Gold Project is approximately 130 km south of Dawson City, and 340 km northwest of the Yukon capital of Whitehorse (Figure 1-1). Dawson City is the closest town to the project having a population of about 1,400. The Mine Site will be accessible via the NAR spanning from Dawson City to the Yukon River. Crossing the Stewart and Yukon River to the Mine Site is restricted to ice road or barge route. A 1,220 m all-weather airstrip will be constructed approximately 7 km east of the Coffee Mine Project process plant, which will be primarily used for personnel transportation. Climate and Vegetation

The Coffee Gold Project is situated along a ridge in west-central Yukon, Canada at an average elevation of approximately 1,300 masl. The mean annual precipitation at the Project is estimated to be 504 mm, occurring as snowfall and rainfall. Precipitation occurs as snowfall in winter months and comprises approximately 33% of the annual total. The mean air temperature is below 0°C from October through April, and most of the precipitation that occurs during this period falls as snow and accumulates, until the snowpack melts in spring (typically occurs over a one- to two-week period between late March and late April). Precipitation occurs as rainfall in summer months, from May through September, and comprises approximately 67% of the annual total. This ratio shifts toward the valley bottoms, with a higher proportion of mean annual precipitation (MAP) falling as rain. The largest daily precipitation events have been attributed to over-land convective events that occur frequently in summer. On average, there are 20 to 30 days of appreciable precipitation (>5mm/day) in summer.

The terrain at higher elevations is dominated by sparse, deciduous shrubs. Mature pine forests dominate the steeply incised valleys and the Yukon River valley.

4.2.2 Surface Drainage

A number of small watercourses originate on the Project ridge and flow into the Yukon River. Latte Creek drains the south face of this ridge and has a catchment area of approximately 70 km^2. Latte Creek flows eastward to its confluence with Coffee Creek. Coffee Creek has a total catchment area of approximately 487 km^2 and drains an area to the south and east of the Project, generally flowing from south to north to the Yukon River. The north face of the ridge is drained by Yukon Tributary 24 (YT-24), on the eastern side of the Mine Site. YT-24 has a total catchment area of approximately 12 km^2. Halfway Creek drains the western side and has a total catchment area of approximately 27 km^2. Both YT-24 and Halfway Creek flow northeast to their confluences with the Yukon River.

The general slope of the ridgetop Project is from west to east. Management of surface water is facilitated through diversion channels, sedimentation ponds and pumping systems. Surface water ultimately drains to Halfway Creek, Latte, Creek, and YT-24 depending on the Project facility.

4.2.3 Subsurface Conditions

The Project site generally contains a thin, active overburden veneer consisting of soil and organics that is subject to freeze-thaw cycles. Soils in this active layer are typically silty, light to dark brown in color and loosely compacted with high amounts of gravel and ice. The typical depth of active layer soils in the HLF footprint is about 1.2 to 3.3 meters, underlain by bedrock. Soils are generally of low permeability and exhibit high surficial runoff characteristics (Tetra Tech, 2016b). Discontinuous permafrost of varying depth is

present on site. Frozen soils are predominately on the north and west-facing slopes, and valley floors; however, isolated areas of frozen soils may be present in other areas. Bedrock within the footprint of the HLF pile is composed of granite. Both granite and metamorphic rock are present within the footprint of the ADR Plant and the Event Ponds.

4.2.4 Ground Ice

The Project is located in a zone of extensive discontinuous permafrost. It extends to depth on the ridge, and is thickest on higher elevation, north-facing slopes. It is estimated to be 165 m deep on the north side of the ridge at the top of the YT-24 catchment, for example. It is generally thinner on south-facing slopes, and appears to become thinner at lower elevations, based on the hydrogeological assessment completed to date. The Coffee Gold Project area is located in a zone of extensive discontinuous permafrost. The overall site contains a thin, active overburden veneer consisting of soil and organics that is subject to freeze-thaw cycles. It is estimated that 50% to 90% of the HLF footprint is perennially frozen.

5.0 REGULATORY REQUIREMENTS

Regulations and permitting requirements for heap leach facilities in the Yukon Territory are not expressly stated; but rather, they have historically relied on regulations from other regions and on precedence established from other successful projects. Permitting considerations for the HLF either remain consistent with those proposed during the regulatory approvals process or will be revised to meet the conditions imposed by the Type A Water Use License (WUL).

The Heap Leach Facility design standards adopted for the project include:

- The regulatory requirements of Yukon and Canada
- The Yukon Water Board (YWB) Licensing Guidelines (2012)
- The requirements specified in the Project's WUL
- Permitting requirements of the State of Nevada, NAC 445A. These are not regulatory requirements in the Yukon but are considered standards for best practice.

6.0 BASIS OF HLF DESIGN AND DESIGN CRITERIA

6.1.1 Design Basis

The design basis is in accordance with all obligations given by the YWB Licensing Guidelines for Type A Quartz Mining Undertakings. In addition to adhering these guidelines, the design will meet all requirements given by the WUL.

6.1.2 Design Criteria

Key design criteria for the HLF are as follows, and are summarized in Table 6-1:

- During Stage 1, the pad is designed to accommodate in excess of 5 M tonnes. The current mine plan has loading and leaching of 4 Mt of crushed ore during Stage 1, leaving an additional 1 M tonnes of capacity. An ore average stacked density of 1.6 dry tonnes per cubic meter was used to determine the capacity. Ore will be truck and/or conveyor stacked in 10-meter lifts to an elevation of 1390 m.

- A sufficient depth of stacked ore material, toe to crest, will be maintained going into the winter period to maintain thermal capacity of the heap with the assistance of heated barren solution.
- The final pad is planned to accommodate 67 Mt of ore, with a max capacity of 69 Mt and will be constructed in 5 Stages, expanding in a westerly direction, with each Stage having separate cells for solution collection. Stages 2, 3,4, and 5 will be constructed to process cumulative amounts of 15, 32, 50 and 69 Mt of ore, respectively. The HLP footprint expansions allow ore to be stacked higher on previous Stages.
- 2.5H:1V (horizontal to vertical) overall heap side slopes have been used for the heap to ensure physical stability and facilitation heap closure and capping.
- The ore will be leached at an average solution application rate of 10 liters per square meter per hour (l/m^2/hr).
- All pregnant solutions will gravity drain to the pregnant solution tanks at the process plant.
- The process plant will have a maximum operating capacity of 1,250 m^3/hour. Normal operating capacity for the process plant will be 1,100 m^3/hr. Barren solution after gold extraction will be returned to a barren tank for recycling to the heap after the necessary addition of cyanide and NaOH or lime.
- Event ponds are sized to contain the following cumulative volume:
  a) the runoff from a PMP event.
  b) full heap drainage during a 72-hour power outage or pump failure; and
  c) seasonal water accumulation.
- The PMP storage volume is of sufficient volume to contain the runoff from the 283 mm event over a 24-hr duration. Full heap drainage has been estimated by applying the nominal barren pumping rate of 1,100 m^3/hr over a 72-hr period.
- Storm flows from the terrain surrounding the pad and pond, resulting from the 100-year, 24-hour storm, will be diverted around the facility.
- During the operating life of the plant, the leach pad facility will be a closed system to the greatest extents possible. Treatment and discharge will be required during operations as this is a net surplus climate, however stored volumes for treatment and discharge will be selectively discharged based on water quality, with priorities for direct precipitation in lined ponds over solution coming from the HLP or Process Plant.

The following considerations were made for the layout of the proposed heap leach pad facility:

- The permafrost zone active layer will be stripped to acceptable foundation material for all stages of heap leach construction.
- Earthwork construction requirements (cuts and fills) will be minimized based upon grading requirements. The majority of fill material required will be obtained from grading within the leach pad area, or where additional fill is required, from suitable materials from overburden stripping in the open pits.
- Solution collection infrastructure, Event ponds and process facilities will be located on the down gradient and east of the of the heap leach pad, and EP-2 will be located down gradient of the Pregnant Tanks and Process Plant providing for gravity flow of all solutions, including upset conditions.

- The toe grades for the liner for the heap leach facility will be designed to minimize grading and earthwork volumes, and while ensuring long-term physical stability of the heap.

6.1.3 Engineering Design Criteria

The parameters and criteria presented in Table 6-1 below form the basis of design for the HLF. The design for the HLP incorporates a single-sided textured 2.0 mm (80 mil) linear low-density, polyethylene (LLDPE) liner. A geosynthetic clay liner (GCL) will be used in lieu of a layer of compacted low-permeability material. The GCL will be placed underneath the geomembrane and will have a saturated hydraulic conductivity of no greater than $5x10^{-9}$ cm/sec.

A minimum 0.6 m thick layer of overline drain fill (ODF) material will be placed over the LLDPE geomembrane in a single lift based on a designed maximum allowable phreatic surface thickness over the liner. The pad is designed to contain a network of pipes that will be distributed throughout the limits of the facility and will collect and convey pregnant leach solution (PLS) in addition to stormwater. Areas requiring ore stacking via trucks will require additional overliner thickness depending on the specific equipment utilized in stacking the ore. The ODF will be placed in bulk onto the liner using suitable haulage equipment or conveyors and spread by dozers in a uniform layer.

Solution collection pipes will be placed within the ODF to convey PLS flows to the processing plant via gravity. The barren leach solution and pregnant leach solution nominal flowrate is 1,100 m^3/hr (1,400 m^3/hr design flowrate). The permeability of the ODF along with the slope of the lined surface and the maximum phreatic head on the geosynthetic liner will drive the particle size distribution and collection piping spacing criteria in future design phases.

The HLP is designed to accommodate an anticipated maximum capacity of approximately 69M m^3 of ore (current mineplan has 67M m^3) on an ultimate footprint (exclusive of solution collection channels and perimeter berm) of approximately 1.1M m^2 with a maximum thickness of 115 m. The pad will be stacked between the months of April and December. Ore will be ripped and cross-ripped to improve solution infiltration. The HLF water balance models take into account consolidation of ore that is stacked on the pad as it effects ore density and hydraulic conductivity properties.

Table 6-1 Summary of HLF Design Criteria

SITE CONDITIONS			
Description	Unit	Value	Resource
Annual Precipitation	mm	504	Lorax
Min Air Temperature	°C	-37.6	Lorax
Max Air Temperature	°C	29.7	Lorax
Average Air Temperature	°C	-2.0	Lorax
Annual Evapotranspiration	mm	190	Lorax
Average Relative Humidity	%	69	Lorax
Average Solar Radiation	kW/m^2	0.113	Lorax
Average Wind Speed	m/s	2.1	Lorax

ORE CHARACTERISTICS			
Description	Unit	Value	Resource
Specific Gravity[1]	SG	2.7	Owner
Ore Bulk Density[1]	t/m^3	1.6	Owner
Angle of Repose	°	34	Owner
LEACH PAD HYDRODYNAMIC PROPERTIES			
Description	Unit	Value	Resource
Initial Moisture Content[1]	%	4.5 by weight	Measured
Residual Moisture Content[1]	%	6.5 by weight	Calibration
Target P80	mm	50	Owner
Saturated Hydraulic Conductivity[1]	cm/s	0.004	Measured
[1] – Ore characteristics listed, which are currently being used in modeling, are subject to change with additional testing and data collection, processing optimizations, and field conditions during processing.			
GENERAL HLP PARAMETERS			
Description	Unit	Value	Resource
Heap Ore Capacity, Ultimate	m^3	48,250,000 (approx.)	Forte
Heap Ore Capacity, Current Mine Plan	m^3	41,900,000 (approx.)	Forte
Total Footprint1	m^2	1,010,000	Forte
Heap Elevation, Design Maximum	m	1,400	Forte
Heap Elevation, Current Mine Plan	m	1,390	Forte
Stacking Method	-	Conveyor with Radial Stacker and Haul Trucks	Owner
Overall slope angle of stacked ore during operations	-	2.5:1 (H:V)	Owner
Overall slope angle for reclamation and Closure	-	2.5:1 (H:V)	Owner
Maximum Height Above Liner	m	110	Owner
Lift Height	m	10	Owner
Liner CN (SCS)	-	99	TMG
Ore CN (SCS) Unleached	-	70	TMG
Ore CN (SCS) Leached	-	75	TMG
Raincoat CN (SCS)	-	99	TMG
Reclaimed Surface CN (SCS)	-	95	TMG
SCS Method Initial Abstraction	%	20	Forte
Evaporation Loss on Drip Emitters	%	0-0.5	Forte
PMP Event	mm	283	Lorax
P100 of ODF	mm	50	Forte
Haul Road Min Width	m	46	Forte
Haul Road Max Slope	%	10	Forte
Conveyor Min Width	m	23	Forte
Conveyor Max Slope	%	10	Forte

STABILITY PARAMETERS			
Description	Unit	Value	Resource
Static-Short Term FOS	-	1.3	Owner
Static-Long Term FOS	-	1.5	Owner
Post-Earthquake	-	1.2	Forte
Pseudo Static	-	1.0	Forte
Material Strengths (Pseudo Analysis)	-	Peak	Forte
Horizontal Coefficient	-	2/3	Forte
MCE Return Period	-	2% in 50 years	Forte
Liner Interface Strength (Post-EQ Analysis)	-	Residual	Forte
PGA (2% in 50 years)	g	0.246	Forte
Horizontal Coefficient (kh)		2/3	Forte
Vertical Coefficient (vh)		0	Forte
BARREN SOLUTION APPLICATION			
Description	Unit	Value	Resource
Solution Application Method	-	Drip Emitter	Owner
Leach Schedule	days/ year	365	Owner
Nominal Barren Solution Application Rate2	$(L/h)/m^2$	10	Owner
Target Barren Solution pH		9-10.5	Forte
Nominal Barren Solution Flow Rate	m^3/h	1,100	Owner
Nominal Preg Solution Flow Rate	m^3/h	1,100	Owner
Primary Leach Cycle2	d	45	Owner
Area Under Leach2	m^2	110,000	Calculation
Note 1-Footprint is the stacked footprint excluding setback and berms Note 2 – Leaching process is subject to change and naturally varies somewhat throughout heap leach pad development; nominal values listed are based on application rates and the nominal pumping rate was used in modeling work.			

PREGNANT LEACH SOLUTION		
Description	Quantity/Criteria	Resource
Solution Collection and recovery system	A system to collect PLS and convey it by gravity. System to comprise overliner drain fill and a network of collection pipes to convey solution to the processing plant.	Owner/YESAB

LEAK DETECTION SYSTEM		
Description	Quantity/Criteria	Resource
Leak detection system	System to consist of monitoring wells installed away from the heap leach pad, unsaturated or vadose zone monitoring under the leach pad using an adaptation of lysimeter technology (i.e., wick drains), and electrical leak location surveys performed after construction of each stage of the leach pad.	Owner/YESAB
PAD LINER SYSTEM		
Description	Quantity/Criteria	Resource
Geosynthetic Liner	2.0mm Linear Low Density polyethylene (LLDPE) liner material to provide required puncture resistance, elastic strain range and resistance to solution attack and chemical breakdown along with cold weather performance for the project's climate conditions.	Owner/YESAB
Geosynthetic Clay Liner	Geosynthetic clay liner below the geosynthetic liner to provide a composite liner to minimize leakage. Objective maximum permeability of $5x10^{-9}$ cm/s	Owner/YESAB
Overliner Drain Fill (ODF)	Crushed clean rock to provide a free draining layer under the placed ore and to protect the lining system from damage by ore placement while not impacting the conveyance of solution to the recovery wells.	Forte
PAD RINSING SYSTEM		
Description	Quantity/Criteria	Resource
Recirculation/Rinsing Collection System	A redundant collection system can be used for recirculation.	Owner/YESAB

7.0 HEAP LEACH FACILITY OPERATIONS

The HLF will be progressively developed in 5 stages. Each stage will progress through construction and operations as summarized in Table 7-1. During operational phases, ore will be mined and delivered to the heap leach pad via trucks or conveyors and stacked at a nominal rate of approximately 27,000 t/d based on 275 d/y of operation. The actual rates will vary year to year based on progression of the mine plan. The heap leach pad will be constructed in 10 m lifts with approximate areas and capacities shown in Table 7-1. Barren solution will be delivered to the pad at a nominal rate of 1,100 m^3/hr. The application rate will be approximately 10 (L/hr)/m^2, which varies based on the area being irrigated.

Table 7-1 HLF Stages

Heap Leach Pad Stage	Construction Year	Pad Phase Stage Area (m^2)	Pad Capacity @ 1.6 t/m^3 (Mt)	Heap Crest Elevation (masl)	Stage Stacking Completion Date
1	Year-1	247,000	4	1,324	7/1/2032 (Yr 6)
2	Year 1	182,000	11	1,350	4/1/2033 (Yr 7)
3	Year 2	270,000	17	1,388	7/1/2035 (Yr 9)
4	Year 4	222,000	18	1,392	10/1/2035 (Yr 9)
5	Year 7	132,000	19	1,392	10/1/2035 (Yr 9)

7.1 Pad Loading

The pad will be stacked utilizing a conveyor and radial stacker system and/or by mine haul trucks, on a 275 d/y schedule from approximately April through November. During the colder months of winter, ROM ore will be stockpiled in the ROM Stockpile. The period planned without stacking is an operational buffer for cold weather, and if it is deemed technically advisable, year-round stacking may be implemented. The planned heap stacking system may include:

- Overland Conveyors
- Grasshopper mobile conveyors
- Mobile bridge conveyor
- Radial stacking conveyor
- A fleet of trucks and dozers.

The feed conveyors will be installed along the south side of the HLF. The grasshopper conveyors transport the ore from the overland conveyors to the bridge conveyor. Ore is placed on the pad in lifts via a radial stacker and/or using a fleet of trucks and dozers. Benches are 10 m wide and are included between lifts to produce a maximum overall slope of 2.5:1 H:V. Ore will be placed such that:

- Ore is not placed outside the limits of the liner
- Ore will occur in an upslope direction to the extent possible
- The maximum slope will not exceed the design slope of 2.5:1
- Ore placement on the overliner is not damaging to the ODF, underlying solution collection pipework, or liner system
- Ore being placed meets the characteristics of used on the basis of design
- New ore is not placed on snow with excessive accumulation; excess snow will be pushed to a designated snow collection area to allow continuation of ore placement. This will be free of vegetation and include a sediment trap to capture any ore entrained in the snow.

For the areas of the heap that are under leach in the winter months, the leach lines will be “ripped in” to the ore and covered to prevent freezing. To insulate larger piping, an additional insulation cover and crushed ore may be placed in stockpiles on the heap and spread by dozers to facilitate rapid placement and spreading of the ore.

7.2 Ore Stacking Plan

The current heap leach stacking plan was designed in coordination with the mining plan to efficiently schedule ore stacking and leaching over the LOM. The stacking plan is based on a loading rate of approximately 27,000 t/d based on 275 days per year of stacking.

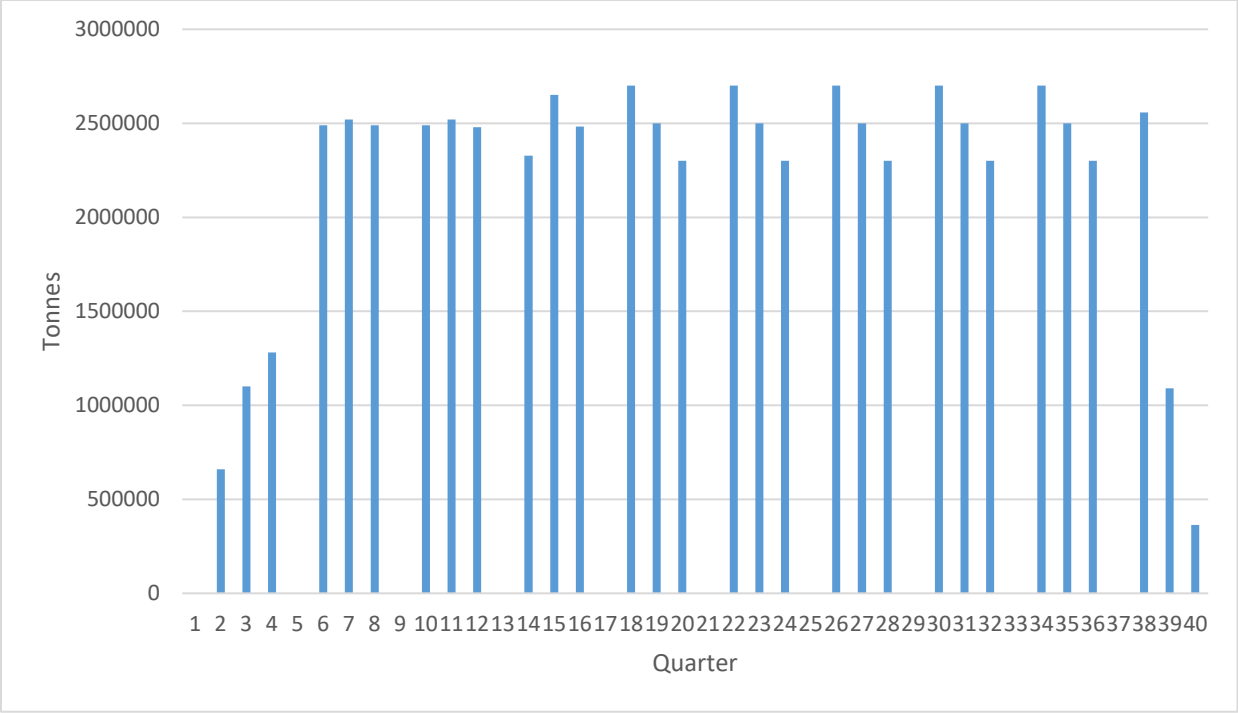


Figure 7-1 Current HLF Mine Plan (67 Million Tonnes Total), Q1 is the Start of Year -1

7.3 Solution Delivery and Leaching

The barren cyanide solution will be applied to the ore stacked on the HLF at a nominal flow rate of 1,100 m^3/hr to extract the gold. After passing through the stacked ore, the gold-bearing pregnant solution drains via a network of pipes, flows to the Pregnant Solution Tank, and is pumped to the ADR facility for processing.

7.3.1 Barren Solution Delivery

A barren solution tank will be located indoors in the ADR facility. Fresh sodium cyanide (NaCN) solution is added to maintain a target NaCN concentration in the barren solution tank. Anti-scalant is also added as needed after the barren solution tank and before the inlet to the barren solution pumps. A series of barren solution pumps located in the ADR facility pump solution from the barren solution tank to the heap leach pad. The barren solution piping to the pad will run along both the north and south sides of the pad with risers branching off at selected intervals to direct solution to the top of the pad for leaching. The barren line will always be contained by either a secondary pipe or by having the pipe run over liner.

7.3.2 Leaching

A series of pipe headers further distribute the barren solution at the top of the pad from the risers. These headers in turn feed subheaders until ultimately leading to drip emitters through which solution is applied to the ore at approximately 10 (L/hr)/m^2. Based on the current leaching plan, the design leach cycle is equal to approximately 45 days. During the summer months, drip emitters will be placed on the surface of the pad. During winter months, when freezing is of concern, the drip emitters will be buried to a depth of approximately 1 m to minimize the risk of solution freezing. Leach operations are to be conducted such that:

- Pipe crossings are positioned to prevent the crushing of pipes
- Solution distribution lines work properly
- Ponding of leach solution on the pad is minimized
- The pH of the barren solution is maintained at a target of 10.5
- Major leaks in pipe are to be repaired in a timely manner.

7.4 Leach Solution Collection System

Pregnant solution will be collected at the base of the heap leach pad via the overliner layer and drainage pipes. The solution will be routed to collector pipes along the north and south edges of the leach pad. Two to three pipes are provided on each edge to allow segregation of solution. The leach pad is divided into cells with a divider berm or ditch approximately every 100 m (east to west), and a valve box is provided at each location. Because the pregnant solution will flow by gravity to the ponds or process plant, there are no pumping risers or wells.

A free draining gravel layer (ODF) and drainage piping will be placed over a composite liner system. This liner system consists of an HDPE liner overtop of a geosynthetic clay liner. Above the HDPE liner are corrugated double wall, perforated PE pipes. The collection pipes are buried in an overliner drainage fill that serves to efficiently transmit the PLS to the collection system and protect the primary liner from damage by rocks and/or equipment which might come in contact with the liner. A series of primary collector pipes are spaced to control the phreatic heap pressure to be below the limits set forth in the Design Criteria. Where slope lengths dictate, secondary collector pipes are installed to convey flows from the primary pipes to the header pipes. The header pipes will consolidate the solution into a pipeline that will carry the solution to the ADR.

7.5 Event Ponds

The HLF will include three lined Event Ponds and one Rainwater Pond located downstream of the HLF (Figure 4-1). The ponds will be constructed to temporarily store direct precipitation, process makeup water, and excess process water that may accumulate during upset conditions. Solution draining from the heap can be directed to any event pond at any time, providing flexibility in solution management. The water and solution contained in the Event Ponds will typically be recirculated to the heap to meet leaching makeup water demands. Per the Water Management Plan, pond solution may be distributed to other site facilities. During upset conditions, excess process solution will be pumped to the process plant. The combined volume of the four ponds satisfies the event storage requirements of adequate volume to accommodate a PMP storm event from the ultimate HLF footprint, plus a 72-hr heap draindown; in addition to seasonal

water accumulation. A leak detection sump will be installed in the low corner of each pond. Further details of the leak detection and recovery systems are described in Section 7.6 and Section 9.2.3.1.

7.6 Leak Detection and Recovery System

A leak detection and recovery system (LDRS) is installed between the upper and lower geomembranes of event ponds EP-1N, EP-1S, and a process segregation sump within EP-2. The LDRS consists of three synthetic layers installed over prepared foundation and the subgrade (Figure 7-2). The primary (top) liner will be a 2.0mm thick LLDPE. The leak detection and recovery layer will consist of HDPE (or other suitable material). The secondary liner will be a 1.5 mm LLDPE. These geomembranes will be underlain by a GCL to form a composite bottom system liner. Any fluid that reports to the LDRS will drain to a monitoring sump equipped with a fluid level activated pump. The pump is sized to adequately remove fluids to minimize the head on the secondary liner.

The LDRS allows for detection, containment, and recovery of any leakage. The sump monitoring instruments provide early alerts to the presence of flow. The collected solution will then be returned to the pad or sent to the Water Treatment Plant. Additional information on the monitoring of solution levels in the LDRS, as well as response is included in Section 9.2.3.

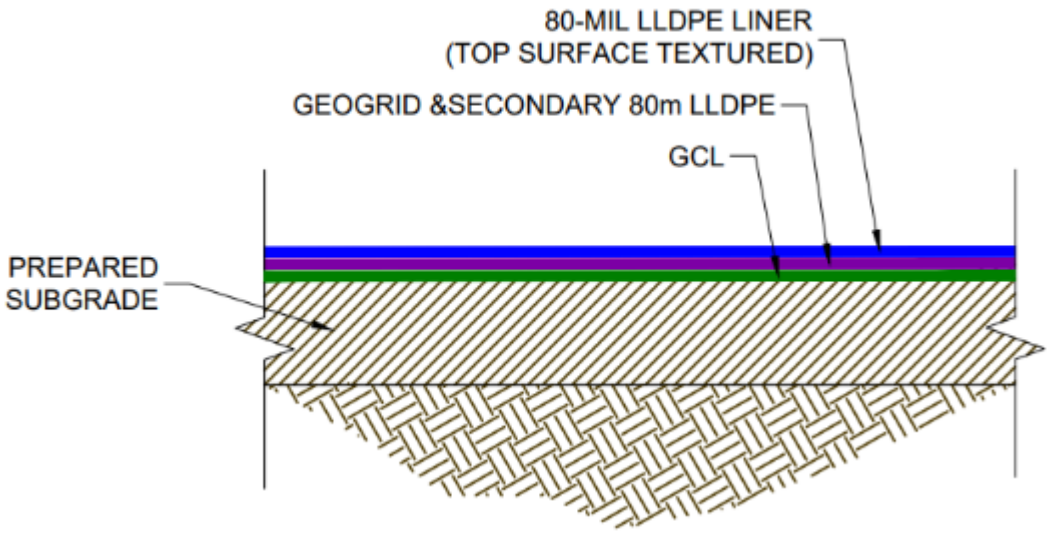


Figure 7-2 LDRS for EP-1N, EP-1S, and Process Segregation within EP-2

7.7 Cold Weather Considerations

The following parameters have been incorporated into the HLF:

- Ore stacking on the pad during the warm months (275 d/y)
- Sizing of the fine ore crushing operation to allow increased production in the warmer months
- Storing ore on the ROM stockpile during the winter months
- Ore stacking on the heap leach pad is planned to ensure that a minimum of two lifts (20 m) will be stacked in any newly started sections prior to the winter months to provide thermal mass.

The process pumping and solution delivery system includes pumps, pipelines, valves, and associated controls to move solution between the ADR and the HLF. The system includes the following provisions for year-round operation:

- Emitters will be buried in the winter months to a depth of approximately 1 m
- Pregnant and Barren solution tanks are located inside the ADR
- Pipelines are heat-traced, insulated, and/or buried where necessary
- Barren and Pregnant solution temperatures are monitored
- Generators are in place as a backup power supply to pumps and emergency process equipment as described in the Water Management Plan (WMP) and the HLF Emergency Response Plan.

As an additional cold weather consideration, throughout the winter, the snow water equivalent (SWE) on the HLF will be measured on a monthly basis to establish the volume of water that may enter the HLF during a melt event. In accordance with the WMP, this volume of water may be actively managed if the solution levels within the HLF indicate that the definitive Events Pond triggers would be reached. This management strategy is discussed further in the WMP and will benefit the water balance for the facility and enhance leaching efficiency. During excess snow accumulation years, and prior to melting or freshet conditions, snowpack accumulated on the flat surfaces of the heap leach may be pushed via dozer off to the sides and ends of the facility into larger piles that cover less area, which will delay the melt due to thermal process in larger snowpacks. Additional snow management may be determined by the Process Manager based on Event Pond trigger levels discussed in Section 9.2, to include snow removal by dozer out of the HLF catchment to adjacent designated snow storage locations that are free of vegetation. The designated snow storage locations must include a sediment trap to capture any ore entrained in the snow. In some cases, and depending on the volume of snowpack, temporary interceptor ditches may be developed that report to exfiltration sumps or exfiltration areas as necessary to minimize effects from runoff.

7.8 Operational Heap Leach Water Balance Model

An operational heap leach water balance model will be used to assist in managing solution storage and operation of the HLF. The model will be used to evaluate HLF pad performance by tracking and predicting makeup water demands and ensuring that the volume of storage required to be maintained for events is available. The heap leach water balance model will be updated annually.

The Process Manager is responsible for the operational heap leach water balance model, determining makeup water demand, ensuring a safe allocation of storage within the Events Ponds, as well as allocating water transfers from outside the system to meet makeup water demands, to allow for determination of the monthly volume of solution within the HLF (including the Events Ponds), and determining when solution needs to be removed from the HLF to water treatment or to fulfill other site water demand per the Water Management Plan. Water transfers into the HLF (exclusive of potable water and water for gold elution) are not permitted when the Desired Available Storage volume is not available in the Events Ponds.

To ensure the Event Storage Requirement is retained in the Events Ponds, protocols or event pond triggers are defined as described in the Heap Leach and Process Facilities Plan. To prevent exceeding the triggers, any meteoric water from the Events Pond will be the first source utilized in the ADR Plant as makeup water. Use of the Events Pond for temporary storage of makeup water will be a tool available to the Process Manager, while following the appropriate protocols for each stage of operations.

8.0 HEAP LEACH FACILITY MAINTENANCE

The purpose of the HLF Maintenance Program is to ensure the individual facility components, and the entire facility, are operating as designed. Proper HLF maintenance will provide a safe working environment for employees; maximize precious metals recovery; and minimize the potential for events that would contribute to the requirement for the institution of contingency water management measures as considered in the Heap Leach and Process Facilities Plan. Maintenance of the HLF is the responsibility of the Maintenance Manager or designate with support from the Process Manager or designate. The Process and Maintenance Department includes personnel with the required qualifications to understand operating and maintenance manuals, assess conformance with HLF design or performance standards, complete routine, or predictive maintenance tasks, and to adequately respond to event-driven maintenance requirements. Figure 8-1 presents a flowchart for a basic maintenance management process that will be applied to individual components to ensure the facility is operating as designed.

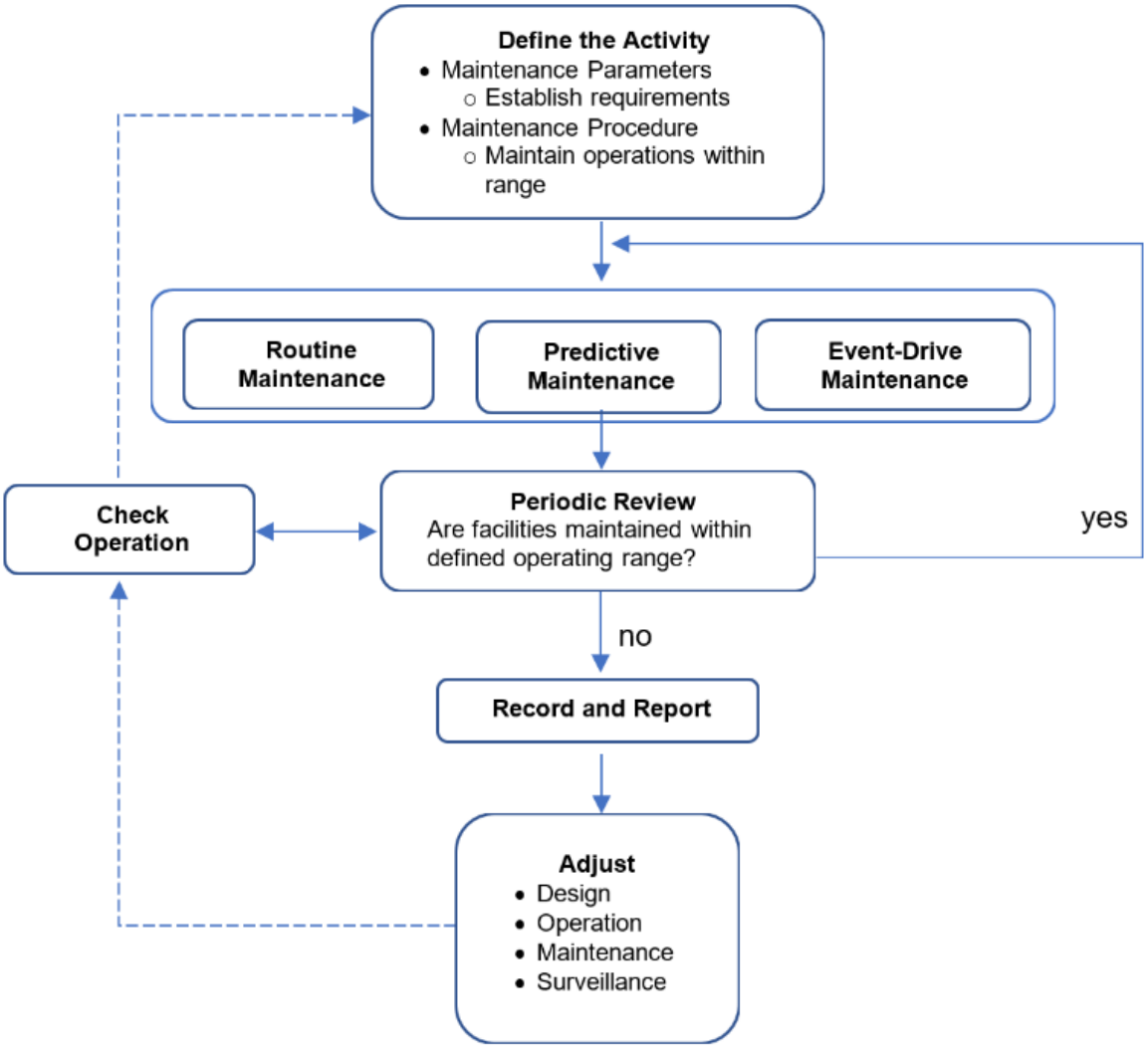


Figure 8-1 Maintenance Flow Chart

8.1 Routine Maintenance

HLF components to be routinely assessed to determine maintenance requirements include:

- Heap leach pad
- ROM stockpile (prior to crusher feed)
- Pregnant solution pumps
- Solution delivery and collection system to include pipelines, drip emitters, pumps, tanks, pipeline corridors, and support facilities where accessible
- Conveyors
- Instrumentation
- Event Ponds
- Rainwater Pond.

Routine maintenance details the inspection and monitoring of different components of the HLF that must be performed as part of a regular procedure, rather than for a specific reason. Inspections and routine maintenance for mechanical equipment will be carried out per the manufacturer's recommendations. The following routine maintenance procedures act as a guide for the procedures that must be carried out per the areas defined in Table 9-1:

- Weekly inspection of interceptor ditches and solution channels for accumulation of debris or sediment and remove as appropriate.
- Weekly monitoring of pipeline corridors for flows indicating leaks from pipes. Pipes will be repaired, as needed.
- Weekly visual inspection of the pad for signs of slope movement. Report all signs of slope movement to a qualified geotechnical engineer as appropriate.
- Weekly visual inspection of the heap ore stockpile for signs of sliding, tension cracks, erosion, excessive or unexpected moisture, or other signs of instability. Repair as appropriate. Slope maintenance includes any activities required to maintain the slope of the ore and preserve the integrity of structure along the toe of the slope. Report all signs of heap instability to a qualified geotechnical engineer as appropriate.
- Conduct routine inspections and maintenance of all pumps per manufacturer guidelines.
- Conduct routine inspections and maintenance of all instrumentation per manufacturer guidelines.
- Conduct routine inspections and maintenance of the conveyor systems and radial stacker per manufacturer guidelines.
- Weekly visual inspection of the visible portions of the HLF and Events Pond liners and make repairs to damaged sections as appropriate.
- Conduct a weekly visual inspection of the Events Ponds. Remove any accumulated debris as appropriate. Make repairs to pond liners as appropriate. Remove any accumulated solutions, including stormwater runoff, within the specified timeframes as specified in the HLF WMP to maintain required pond storage capacities.
- Conduct routine inspections of accessible portions of the solution delivery and collection system including pipelines, drip emitters, pumps, and tanks per manufacturer guidelines.

- Perform routine non-destructive testing, as required by the manufacturer's guidelines, appropriate for components of the system including periodic measurement of pipeline thickness to identify areas of wear and to schedule pipeline replacement if necessary. Replace pipe work, bends and fitting components as required. Remove accumulated debris from valves, reducers and off takes. Carry out maintenance as recommended by fitting and valve suppliers and regularly inspect major wear components.

8.2 Predictive Maintenance

Predicative maintenance goes hand in hand with Surveillance as described in Section 9.0. Surveillance of the HLF is required to determine if the facilities are operating within expected parameters. Deviations from expected performance may require maintenance to facilitate ongoing safe and efficient operation of the facilities. Prior to performing any maintenance, the instrumentation from which the data is being collected from should be checked to ensure that data being collected is accurate. Potential maintenance items that may arise from the surveillance of data, specifically the trends of data, include but are not limited to:

- Maintenance of pumps (based on trends of declining performance):
  - The maintenance manual provided by the manufacturer shall be followed when performing maintenance on a pump.
- Maintenance of piping networks (based on trends of flow and pressure instrumentation):
  - Inspect the pipeline in the general area of where data indicates declining operational performance; and
  - Repair or replace affected components.

8.3 Event Driven Maintenance

Potential event-driven maintenance items arising from pipeline leaks or breaks, earthquakes and floods are listed below.

8.3.1 Solution Collection and Delivery System Pipeline Leaks or Breaks

- Inspect entire pipeline
- Repair or replace affected components
- Perform opportune and scheduled maintenance
- Repair any collateral damage caused by a leak or break
- Collect any released or spilled solutions and return them to the HLF fluid management system
- If the failure results in loss of containment, refer to the Spill Contingency Plan and Cyanide Management Plan and report to appropriate parties per Section 9.7
- Reclaim any disturbed areas as appropriate.

8.3.2 Earthquake Occurrence

- Inspect Heap Leach pad for signs of movement
- Inspect ore stockpile for signs of movement
- Check LDRS leakage rates to determine if liner integrity has been compromised

- Inspect Event Pond embankments for signs of deformation, slope failure, or containment failure.

8.3.3 Flood Event

- Monitor Event Ponds and Rainwater Pond volumes
- Measure freeboard in the Events Ponds and Rainwater Pond for compliance with design requirements and the HLF WMP
- Inspect Event Ponds and Rainwater Pond embankments, solution ditches, and diversion ditches for signs of excessive erosion and repair if required
- Inspect solution collection and delivery system for operational adequacy.

8.4 Maintenance Schedule and Spare Parts

All electrical and mechanical components will be inspected and maintained as per manufacturer's recommendation. A spare parts inventory will be maintained as recommended by equipment manufacturers and as required by the Owner.

8.5 Documentation

Maintenance records of each component will be kept by the Process Manager or designate and will include:

- Up-to-date logs of in-service equipment and facilities
- Maintenance schedules
- Maintenance history
- Inspection logs
- Repair reports including cost
- Quality control records
- Photographs, videos of repair issues
- Inventory of spares, materials, tools, and equipment
- Critical spares list.

8.6 Reporting

A Maintenance Report will be prepared monthly, or as required, by the Maintenance Manager or designate and will include:

- Completed work
- Updated maintenance log and schedule
- Progress on partially completed work that has been halted for some reason
- Items not requiring maintenance and reason why
- New items or conditions requiring maintenance
- Cause of any neglected or late maintenance.

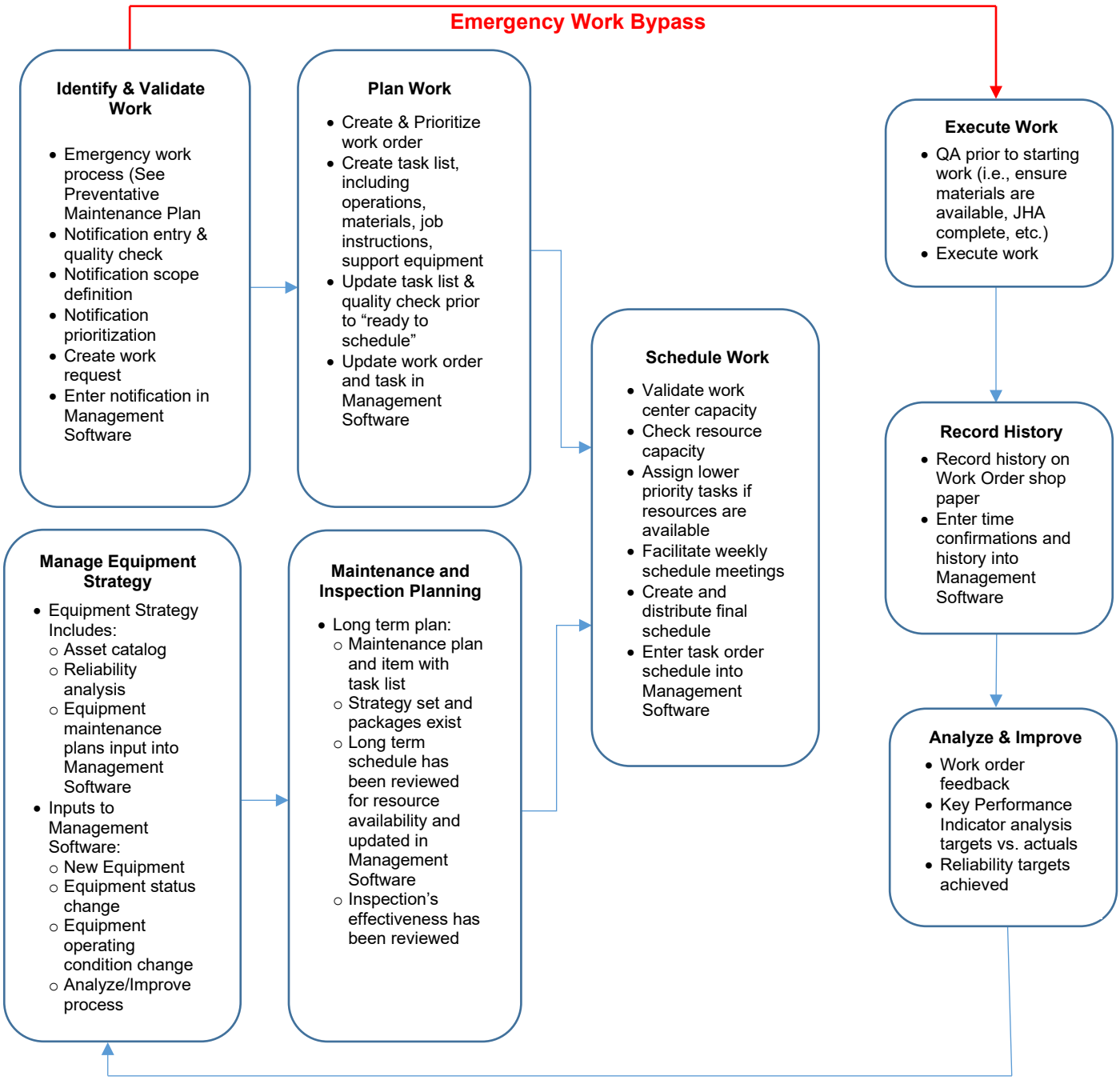


Figure 8-2 Heap Leach Facility Basic Maintenance Work Management Process

9.0 HEAP LEACH FACILITY SURVEILLANCE AND RESPONSE

Surveillance of the HLF is required to determine if the facilities are operating within expected parameters. Deviations from expected performance may require adjustments to operation, maintenance, or design to facilitate ongoing safe and efficient operation of the facilities. Regular surveillance is essential to ensure ongoing safety of the HLF and to identify areas requiring maintenance before problems and safety concerns develop. Behavior and performance of the facility are assessed visually and through monitoring of instrumentation.

A responsible person will be designated to coordinate sufficiently thorough communication among design, construction, operation, surveillance teams, and the EoR. The EoR will confirm the operation aligns with the design intent and meets regulatory requirements. Deviations from the design intent and regulatory requirements will be communicated to the EoR. Routine risk assessments will be conducted due to material changes to the HLF, or at a minimum of every three years.

A flow chart of the Surveillance process is shown in Figure 9-1. The flowchart describes a surveillance review procedure, including an inspection program, to help ensure safe and continued operation of the HLF.

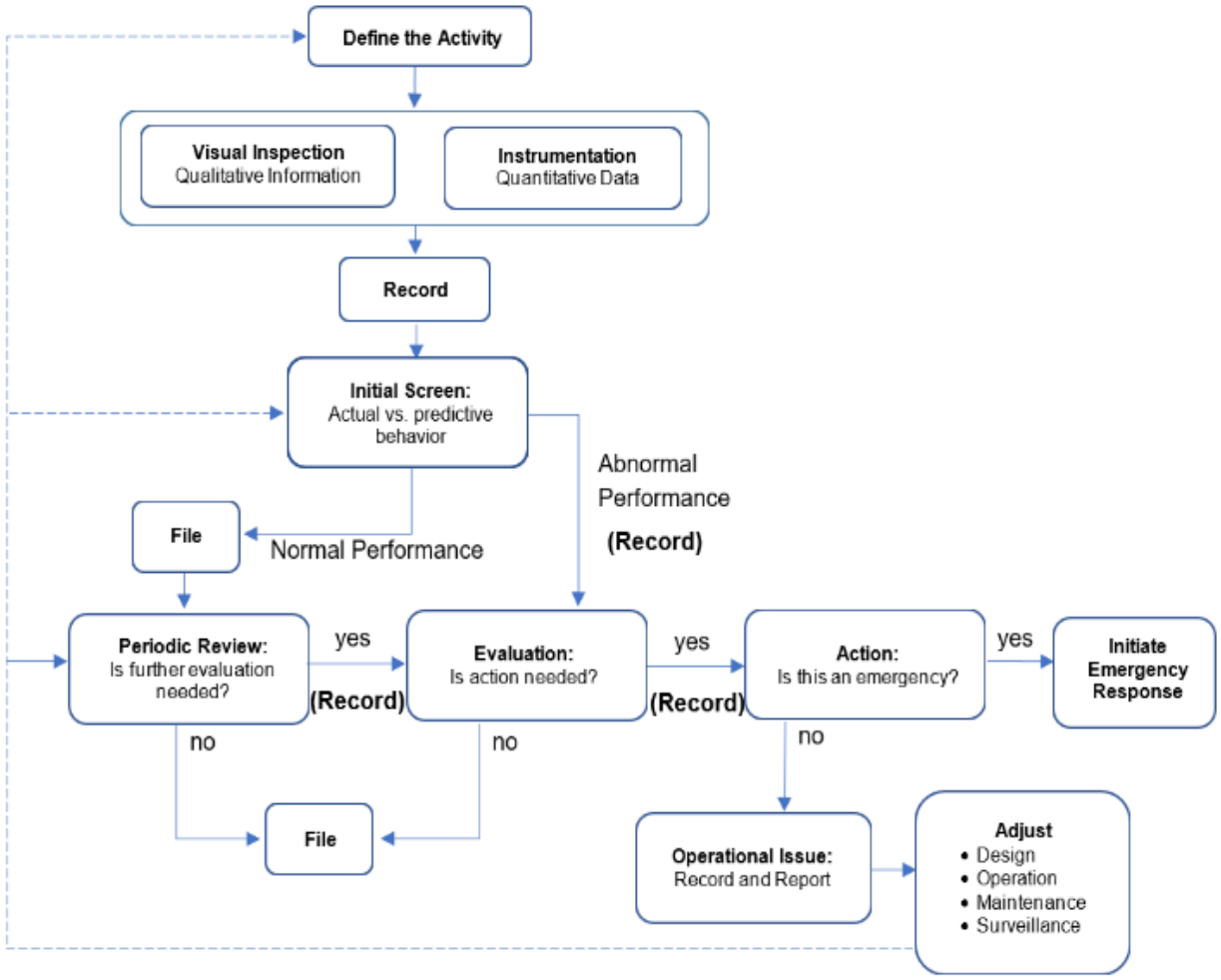


Figure 9-1 Surveillance Flowchart

Surveillance is undertaken in two primary methods – visual inspection and reading of instruments. Results of these qualitative and quantitative observations are compared to the expected performance of the HLF. If observations are within the expected range or performance, the results of the surveillance are simply recorded. If observations are outside the expected range, further evaluation is completed to determine if remedial action is necessary. If necessary, remedial action may range from a minor adjustment, implementing the HLF WMP operational procedures, or potentially the initiation of Emergency Response Plan procedures, depending on the severity and nature of the deviation from expected performance.

Signs of potential or actual hazards can generally be observed by a combination of visual inspection and instrumentation readings before hazards become significant. Mine personal can identify the need for maintenance based on observations of changes to the HLF such as erosion, cracking, bulging, seeps, or changes in vegetation. Additionally, changes in instrumentation readings can also indicate potential hazards.

The purpose of an inspection program is to identify problems and/or unsafe conditions that are visually evident. Visual inspections are an integral part of proper maintenance and performance of monitoring programs for the HLF. Failure to correctly identified maintenance and repair items, or potential adverse behavior, could result in unsafe conditions or lead to a failure of operating systems or cause an adverse environmental effect. Table 9-1 summarizes the routine surveillance requirements for the HLF.

Table 9-1 Surveillance Requirements for the HLF

Surveillance	Frequency	Responsibility
Pad Liner	Weekly	Process General Foreman or alternate
Stacked Leach Ore	Weekly	Process General Foreman or alternate
Solution Collection and Recovery System	Weekly	Process General Foreman or alternate
Leak Detection and Recovery System Monitoring Ports	Daily	Environmental Superintendent
Heap Leach Pad Vibrating Wire Piezometers	Daily during freshet or when unequal inflow and outflow is present, weekly otherwise	Environmental Superintendent
Monitoring Vault	Weekly	Environmental Superintendent
Event Pond Fluid Levels	Daily if desired storage has been reached and weekly otherwise	Environmental Superintendent
Event Pond Liners	Weekly	Environmental Superintendent
Conveyors and Radial Stacker	Monthly	Crushing and Conveying Supervisor
Geochemical Sampling of Pregnant and Barren Solution	Quarterly	Metallurgist
HLF Inspection by Engineer	Annually	Engineer of Record
Independent Third-Party Physical Stability Inspection	Annually	Engineering Consultant
Event Driven Inspection	Following unusual events (e.g., Freshet, heavy precipitation, earthquake)	Process, Maintenance, Health, Safety, and Environmental Managers

Surveillance	Frequency	Responsibility
Comprehensive Review	Within 5 years after construction and prior to decommissioning	Engineering Consultant
Instrumentation	Monthly or per Manufacturer Guidelines	Instrumentation Technician
General Visual Inspection of the HLF Components and Event Ponds	Daily during the completion of standard work procedures	Environmental Superintendent and Coordinators and Health, Safety and Security Manager and Coordinator

If any unusual occurrences are observed during the completion of the routine surveillance activities, they will be immediately reported to the Process Manager and the Process General Foreman for assessment and development of an appropriate course of action. The Process Manager will immediately notify the Engineer of Record of any observation that has the potential to impact the stability of the HLF. If deemed necessary, appropriate procedures will be implemented as outlined in the HLF WMP, Emergency Response Plan, or as directed by the EoR.

9.1 Routine Inspections

Routine and/or regular visual inspections of the HLF components listed in Table 9-1 are completed in accordance with required frequencies. During high water times (e.g., spring freshet, high rainfall, and flood events), daily or more frequent surveillance is undertaken to ensure the safe operation of pumping systems and/or spillway operations.

Ideally the inspections are performed and recorded by the same responsible party/position on each shift with direct shift to shift communication through the Process Manager to ensure that relevant incremental changes are observed between each inspection. The visual inspections are done for all components of the HLF, including the visible portions of the leach pad liner; leach pad embankment; stacked ore pile; accessible portions of the solution delivery and collection system including pipelines, drip emitters, pumps, tanks, and other support facilities; conveyors, radial stacker; the Events Ponds, Rainwater Pond, and instrumentation as appropriate.

The LDRS monitoring sumps are checked daily for the presence of solution. If solutions are present, they are sampled and analyzed for the presence of constituents as determined by the Process Manager and Environmental Superintendent. Contained solutions in any of the monitoring ports will be evacuated and measured for volume. All information is recorded for comparison with follow-up measurements, and for comparison with the alert levels for Event Ponds.

Visual inspections of the event pond embankments. The following are items are examined during these inspections:

- evidence of settlement or subsidence on the embankment crest or slope
- evidence of cracks or erosion on the embankment slope
- bulging on the downstream slope which could indicate leakage
- evidence of animal burrows or unusual vegetation patterns on the dam.

At a minimum, monthly snowpack measurements are made on approximately five flat and sloped surfaces (or benches/lifts) of the heap leach facility, and by aspect. Each snow survey consists of a flat (leaching) surface and the adjacent slope, and each bench/slope is measured at a minimum of ten locations evenly spaced across each bench, with an average snowpack calculated for each area. The two on-site weather stations, one located 5 km to the east of the main Project infrastructure (KM 11 climate station), and the other located adjacent to the proposed heap leach pad footprint (Kona climate station), are used to measure any and all rainfall, including snowfall with respective density (water content).

All observations will be documented.

9.2 Instrumentation, Monitoring, and Response

9.2.1 Heap Leach Pad

Construction and operational monitoring requirements for the HLF includes instrumentation for measuring phreatic levels and pore pressures within the heap, foundation. Monitoring is used to verify the facility components are performing as expected and to provide early warning of problematic conditions. Observations on the performance of the initial stages may provide useful information for optimizing subsequent stages of development.

Horizontal piezometers are installed in the ODF to monitor phreatic head on the liner. The HLF was designed to maintain a phreatic head above the liner of no more than 0.6 meters. Perimeter weirs at the low point of each cell direct any solution that exceeds 0.6 meters to the lined perimeter channel to further prevent any solution build-up above the ODF.

9.2.2 Pond Water Volumes

A level gauge will be installed in each of the Event Ponds and the Rainwater Pond to allow weekly monitoring of solution volumes, measured as the cumulative volume of all Event Ponds (EP-1S, EP-1N, and EP-2) and the Rainwater Pond. The frequency of pond level monitoring will increase to daily whenever the total solution or direct precipitation contained in the Event Ponds and Rainwater Pond has reached the Cumulative Pond Volume Trigger as defined in Table 9-2. The Event Storage Requirement (ESR) increases with the HLF footprint as operations progress, corresponding to varying Cumulative Pond Volume Triggers by Stage.

Table 9-2 Definitive Event Ponds and Rainwater Cumulative Pond Volume Triggers

Stage	72 Hour Draindown Volume (m^3)	Potential Maximum Precipitation Event Volume (m^3)	Event Storage Requirement (m^3)	Cumulative Pond Volume Trigger (m^3)	Percentage Full of Total HLF Storage Capacity
1	**79,200**	**70,000**	**149,200**	**446,700**	**75%**
2	**79,200**	**121,500**	**200,700**	**395,300**	**66%**
3	**79,200**	**197,900**	**277,100**	**318,900**	**54%**
4	**79,200**	**260,800**	**340,000**	**255,900**	**43%**
5	**79,200**	**298,000**	**377,200**	**218,700**	**37%**

The storage available for operations is the HLF storage volume below the Cumulative Pond Volume Trigger. The HLF storage volume above the trigger is the Event Storage Requirement as illustrated in Figure 9-2.

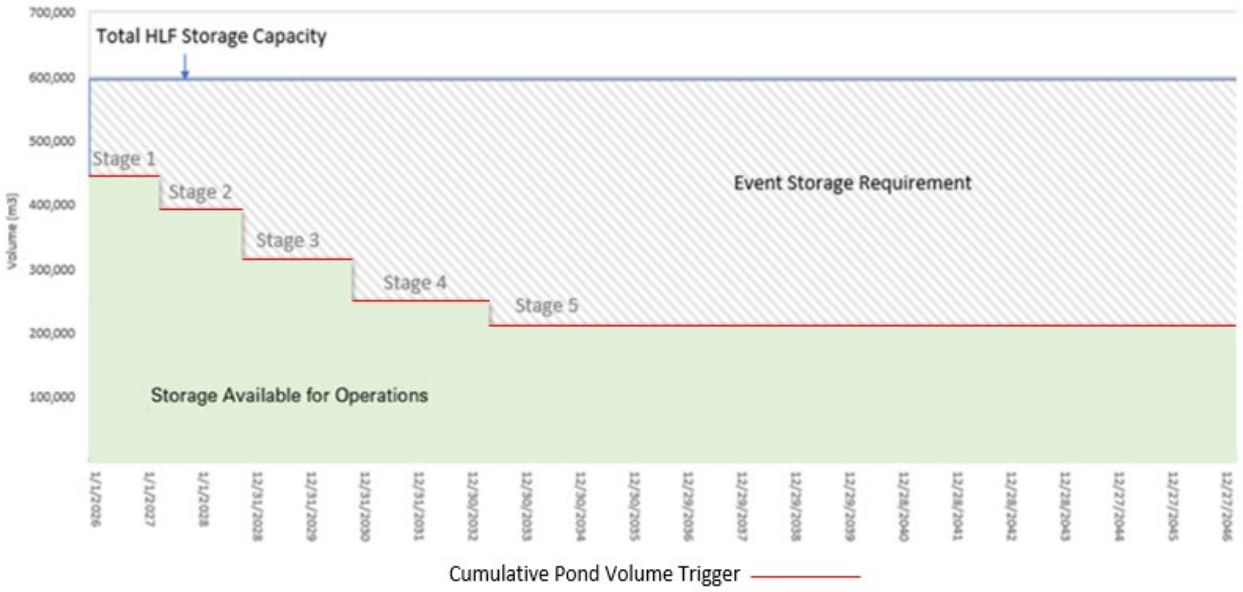


Figure 9-2 HLF Solution Storage Volumes

Specific volume conditions are defined as green, orange, and red based on the total solution in the Event Ponds and Rainwater Pond for each stage of the HLF as stated in Table 9-3.

Table 9-3 Cumulative HLF Pond Volume Conditions

Stage	Condition Green	Condition Orange	Condition Red
1	Below 402,100 m^3	Between 402,100 m^3 and 466,700 m^3	Above 466,700 m^3
2	Below 355,700 m^3	Between 355,700 m^3 and 395,300 m^3	Above 395,300 m^3
3	Below 287,000 m^3	Between 287,000 m^3 and 318,900 m^3	Above 318,900 m^3
4	Below 230,300 m^3	Between 230,300 m^3 and 255,900 m^3	Above 255,900 m^3
5	Below 196,800 m^3	Between 196,800 m^3 and 218,700 m^3	Above 218,700 m^3

The Event Ponds and Rainwater Pond will ordinarily be occupied by precipitation and/or process makeup water. Any accumulation of water in the ponds will be pumped into the process circuit to reduce make up water withdrawals from other sources. To allow the Process Manager to permit the accumulation of water in the Event Ponds, the HLF solution condition must be green and under no circumstances can planned accumulation be above the definitive Cumulative Pond Volume Triggers shown in Table 9-2. Additionally, planned accumulation cannot be permitted in the month prior to freshet. Typically, no transfers into the HLF, other than potable water and water required for gold elution, are permitted if the Cumulative Pond Volume Triggers for the Event Ponds and Rainwater Pond have been reached.

Trigger levels and required actions have been established for the cumulative volume of the Event Ponds and Rainwater Pond to ensure that the ESR is maintained at all times.

9.2.2.1 Event Ponds Water Level Response

To ensure that normal operating conditions are maintained, appropriate mitigative responses to specific fluid volumes have been developed as shown in Table 9-4. The Process Manager or designate is ultimately responsible for the institution of these responses.

Table 9-4 Cumulative HLF Pond Volume Condition Responses

Condition	Response
Green	• Continue monitoring HLF pond levels on a weekly basis • Event Ponds and Rainwater Pond have capacity to store full PMP + 72-hr draindown without release.
Orange	• Monitor fluid levels on a daily basis when temperatures are above freezing or on a weekly basis when freezing conditions persist to ensure solution volumes remain within threshold. • Consult with the Environmental Manager regarding precipitation events either experienced or predicted. This may include out of schedule snow water equivalent measurements as necessary. • Inspect HLF solution application logs to confirm no increased application rates have been utilized for the lifts under active leach. • Inspect the spillways of all Event Ponds and the Rainwater Pond on a daily basis to confirm that there are no blockages. • Inspect solution application pumping system (both operational and redundant) to ensure that increased pumping can be utilized to utilize dynamic storage as necessary. • Inspect dedicated pond pumps to ensure that pumping fluids out of and/or between all Event Ponds and the Rainwater Pond can be undertaken if necessary. • Consider solution application to inactive areas as necessary and as directed by Process Manager (i.e., confirm dynamic storage capability is available and utilize as necessary). • Confirm with the General Manager that heavy equipment is operable and available for the excavation of an emergency downgradient events pond.
Red	• Activate HLF WMP procedures as determined by the Process Manager. • Active the Emergency Response Plan as determined by the Process Manager. • Cease all water transfers into the HLF ponds (potable water for consumption by personnel and water for gold elution are the only exceptions). • Measure HLF pond volumes on an hourly basis to ensure that the Event Storage Requirement is available at a minimum. • Increase the solution applicate rate at the current leach area. • Initiate solution application to dry, non-active leaching portions of the pad. • Inspect all HLF pond spillways on an hourly basis to confirm that there are no blockages. • Inspect CN destruct equipment and the Water Treatment Plant to ensure operability and capacity. • Begin pumping solution from the ponds to the Water Treatment Plant, if capacity is available • Inspect all backup power generation and pumping equipment on a daily basis to ensure operability. • Consult with the Environmental Manager regarding precipitation events either experienced or predicted. This may include out of schedule snow water equivalent measurements as necessary. • If loss of containment is expected, discontinue addition of cyanide to barren solution.

9.2.3 LDRS Levels

A Leak Detection and Recovery System (LDRS) has been constructed within each Event Pond (EP-1S, EP-1N, and the process solution segregation within EP-2), consisting of a monitoring sump equipped with an automatic, fluid-level activated pump equipped with a flow meter located between the top and bottom liners. The pumps are sized to sufficiently remove fluids to minimize head on the bottom liner and collection of any potential leaks in the top liner. The pressure transducer utilized to activate the pumping system within the LDRS sump and inline flow meter will be connected via a remote link to the ADR.

The ADR Plant control room will have real time data on pumping rates and pumping duration, which will allow for the determination of volume of fluids evacuated from the sump. The Event Ponds' LDRS monitoring sumps are to be checked daily for the presence of solution. If solutions are present, they will be sampled and analyzed for the presence of Metal and Diamond Mining Effluent Regulations (MDMER) Schedule 4 constituents, or as determined by the Process Manager and Environmental Manager. Two alert levels were established for the design and operation of the Event Ponds. Alert Level 1 provides a benchmark for liner performance in a double-lined pond under typical operating conditions based on industry standard rates for expected leakage from "normal" defects in the liner. AL1, as measured by the amount of fluid pumped by the pond's LDRS, is a low-level trigger that may indicate the presence of a small hole or defect in the top geomembrane. Alert Level 2 provides a high-level trigger that indicates serious malfunction of the liner system.

9.2.3.1 Event Ponds LDRS

Contained solutions in the Event Ponds' LDRS monitoring port are to be evacuated and measured for volume by inline flow meters. The Event Ponds LDRS sump is to be inspected on a daily basis to monitor fluid levels and the pumping rate of the fluid activated pump, if it has been activated. The pumping rate is then compared to the fluid levels of the Event Ponds measured by the level gauge and if an alert level has been reached, the mitigation measures described in the HLF Emergency Response Plan are to be followed.

All information is to be recorded for comparison with follow-up measurements, and for comparison with alert levels established for the Event Ponds. The presence of solution in any of the ports is expected but excess volume is a potential indication of a leak in the liner.

Table 9-5 LDRS Alert & Response Levels: Event Pond 1 South

Event Pond 1 South			Response Level 1	Response Level 2		Response Level 3		Response Level 4
Elevation	Calculated Alert Level 1	Calculated Alert Level 2	Maximum Collection Rate	Collection Rate Minimum Range	Collection Rate Maximum Range	Collection Rate Minimum Range	Collection Rate Maximum Range	Minimum Collection Rate
(masl)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)
1203	Bottom of Pond (Pond Empty)							
1204	2,000	86,000	1,600	1,601	2,000	2,001	86,000	86,001
1205	4,000	137,000	2,000	2,001	4,000	4,001	137,000	137,001
1206	5,000	188,000	4,000	4,001	5,000	5,001	188,000	188,001
1207	7,000	241,000	5,000	5,001	7,000	7,001	241,000	241,001
1208	9,000	297,000	7,000	7,001	9,000	9,001	297,000	297,001
1209	11,000	357,000	9,000	9,001	11,000	11,001	357,000	357,001
1210	13,000	422,000	11,000	11,001	13,000	13,001	422,000	422,001
1211	15,000	501,000	13,000	13,001	15,000	15,001	501,000	501,001
1212	18,000	593,000	15,000	15,001	18,000	18,001	593,000	593,001

Table 9-6 LDRS Alert & Response Levels: Event Pond 1 North

Event Pond 1 North			Response Level 1	Response Level 2		Response Level 3		Response Level 4
Elevation	Calculated Alert Level 1	Calculated Alert Level 2	Maximum Collection Rate	Collection Rate Minimum Range	Collection Rate Maximum Range	Collection Rate Minimum Range	Collection Rate Maximum Range	Minimum Collection Rate
(masl)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)
1203	Bottom of Pond (Pond Empty)							
1204	3,000	111,000	2,400	2,401	3,000	3,001	111,000	111,001
1205	5,000	175,000	3,000	3,001	5,000	5,001	175,000	175,001
1206	7,000	238,000	5,000	5,001	7,000	7,001	238,000	238,001
1207	9,000	303,000	7,000	7,001	9,000	9,001	303,000	303,001
1208	11,000	371,000	9,000	9,001	11,000	11,001	371,000	371,001
1209	13,000	444,000	11,000	11,001	13,000	13,001	444,000	444,001
1210	16,000	521,000	13,000	13,001	16,000	16,001	521,000	521,001
1211	19,000	610,000	16,000	16,001	19,000	19,001	610,000	610,001
1212	22,000	707,000	19,000	19,001	22,000	22,001	707,000	707,001

Table 9-7 LDRS Alert & Response Levels: Process Solution Segregation Within Event Pond 2

Process Solution Segregation Within Event Pond 2			Response Level 1	Response Level 2		Response Level 3		Response Level 4
Elevation	Calculated Alert Level 1	Calculated Alert Level 2	Maximum Collection Rate	Collection Rate Minimum Range	Collection Rate Maximum Range	Collection Rate Minimum Range	Collection Rate Maximum Range	Minimum Collection Rate
(masl)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)	(L/day)
1157	Bottom of Pond (Pond Empty)							
1158	3,000	108,000	2,400	2,401	3,000	3,001	108,000	108,001
1159	5,000	182,000	3,000	3,001	5,000	5,001	182,000	182,001
1160	7,000	248,000	5,000	5,001	7,000	7,001	248,000	248,001
1161	9,000	317,000	7,000	7,001	9,000	9,001	317,000	317,001
1162	12,000	391,000	9,000	9,001	12,000	12,001	391,000	391,001
1163	14,000	470,000	12,000	12,001	14,000	14,001	470,000	470,001
1164	17,000	555,000	14,000	14,001	17,000	17,001	555,000	555,001
1165	20,000	646,000	17,000	17,001	20,000	20,001	646,000	646,001
1166	23,000	744,000	20,000	20,001	23,000	23,001	744,000	744,001
1167	26,000	848,000	23,000	23,001	26,000	26,001	848,000	848,001
1168	30,000	959,000	26,000	26,001	30,000	30,001	959,000	959,001
1169	33,000	1,078,000	30,000	30,001	33,000	33,001	1,078,000	1,078,001
1170	37,000	1,204,000	33,000	33,001	37,000	37,001	1,204,000	1,204,001
1171	42,000	1,337,000	37,000	37,001	42,000	42,001	1,337,000	1,337,001
1172	46,000	1,478,000	42,000	42,001	46,000	46,001	1,478,000	1,478,001
1173	51,000	1,627,000	46,000	46,001	51,000	51,001	1,627,000	1,627,001
1174	56,000	1,784,000	51,000	51,001	56,000	56,001	1,784,000	1,784,001

The associated response activities that are to be considered, and instituted as deemed necessary by the Process Manager, for each response level are provided below. If at any time the LDRS collection rate rises above those stated for Response Level 1, the following actions must be taken:

- Owner to conduct a Study of Cause and Effect of the excess LDRS collection rate
- Perform corrective actions as determined by the Study of Cause and Effect.

Potential actions from the Cause and Effect Study are outlined below.

Potential Actions for Response Level 1

- Rates considered within normal range and standard activities related to the HLF may continue
- Conduct routine monitoring and testing as considered in this Manual.

Potential Actions for Response Level 2

- Increase visual monitoring frequency as directed by the Process Manager.
- Lower Events Pond fluid levels to allow for determination of potentially impacted elevation range and to reduce overall leakage volume.
- Electrical leak detection and repair of damaged location.
- Increase sampling frequency of down gradient monitoring wells to monthly.
- Take inventory of available HDPE pipe to determine if sufficient length is available for pump out or gravity drain of solution to downgradient emergency pond location. If insufficient length in inventory, contact supplier to determine availability and delivery timeline.
- Take inventory of available LLDPE (or HDPE) liner to determine if sufficient material is available for lining of downgradient emergency pond. If insufficient material in inventory, contact supplier to determine availability and delivery timeline.

Potential Actions for Response Level 3

- Increase visual monitoring frequency as directed by the Process Manager
- Lower Events Pond fluid levels to allow for determination of potentially impacted fluid elevation range and to reduce overall leakage volume
- Return fluids within Events Pond into dynamic storage
- Increase sampling frequency of down gradient monitoring wells to weekly
- Increase sampling frequency of surface water quality stations to weekly
- Isolate leak if possible
- Electrical leak detection and repair of damaged location
- Ready heavy equipment for excavation of downgradient emergency pond
- If insufficient length of HDPE pipe available for drainage to downgradient emergency pond location, procure sufficient supply
- If insufficient supply of LLDPE/HDPE liner available for lining downgradient emergency pond location, procure sufficient supply.

Potential Actions for Response Level 4

- Increase visual monitoring frequency as directed by the Process Manager
- Lower Events Pond fluid levels to allow for determination of potentially impacted fluid elevation range and to reduce overall leakage volume
- Return fluids within Event Pond into dynamic storage
- Isolate leak if possible
- Electrical leak detection and repair of damaged location
- Construct lined downgradient emergency pond. Once constructed, transfer any excess fluids to downgradient emergency pond
- Remove and replace liner system in Event Pond
- Increase sampling frequency of down gradient monitoring wells to daily
- Increase sampling frequency of surface water quality stations to daily.

9.2.4 Event Pond Embankment Deformation

The Event Pond embankments were designed and construction to tolerate some movement without significantly impacting the liner or stability. Deformation of the Event Pond embankments is monitored with survey monuments and inclinometers. Survey monuments are located along the crests of the Event Pond embankments to allow monitoring of potential vertical settlement and/or surficial horizontal movement. Survey pins are constructed with rebar embedded at least 0.8 meters into the embankment surface, as needed. Since the soft material in the foundation was sub excavated and the dam fill is compacted, significant settlement or lateral movement is not expected.

Table 9-8 Monitoring Frequency

Task	Frequency
Inspect overall HLF	Weekly
Inspect Event Ponds	Weekly
Measure LDRS in Event Ponds	Daily
Measure pumped seepage at monitoring vault	Weekly

9.3 Annual Inspection-Engineer of Record or Designate

Annual inspections are intended to be part of a more thorough review of the condition of the facility, and are carried out by a qualified engineer, experienced with the design and maintenance of the HLF. The annual inspections will be conducted between May and July, as weather permits, and will include the following main items:

- Visual inspection of the HLF by the engineer, including taking appropriate photographs of the observed conditions.
- Review of routine inspection records prepared by operating personnel in the past year.
- Review whether or not recommendations from previous year's inspection(s) have been addressed, and any incidents or actions arising from those previous recommendations.

- Review of instrumentation and monitoring data.
- Review of the previous year's operations including reports of any incidents (and remedial measures) that may have occurred.
- An evaluation and interpretation of the structural performance of the embankment and related components and identify any potential safety deficiencies or recommended items that need to be addressed in the coming year.
- Review construction records, Quality Assurance/Quality Control (QA/QC) data and as-built information.
- Evaluation of the OMS Manual to assess the need for updating.
- Review of the Water Balance Report and associated records.
- Review and approval of an ongoing Ore Monitoring Plan that includes surveillance of slopes, moisture content, and ore geotechnical properties including shear strength and permeability. The data records associated with the Ore Monitoring Plan will be reviewed.

This annual inspection will be conducted jointly with a third party, independent engineer (Section 9.4). Results of the inspection and review will be documented in a written report that will be provided to the Yukon Government Department of Energy, Mines and Resources within 90 days of completion of the inspection as required per the Quartz Mining License (QML).

9.4 Annual Physical Stability Inspection-Independent Engineer

Annual inspections of the physical stability of all engineered structures, including the HLF and the Event Ponds, will be conducted jointly with the EoR or designate in accordance with licence requirements by an independent engineer. The annual inspections will be documented in a written report and provided to the Yukon Government Department of Energy, Mines and Resources within 90 days of completion of the inspection. Each annual report will include a summary of the stability, integrity, and status of the inspected structures, works, and installation and provide recommendations for remedial actions, if required, as a result of the inspection.

Based on the recommendations, in consultation with the Engineer of Record, the Owner is to then take appropriate (sometimes immediate) steps to implement the recommendations for remedial action made as a result of the inspection.

9.5 Event Driven Inspections

Special inspections are to be carried out if any of the following events occur:

- Unusual events such as an earthquake or large precipitation event
- Unusual operating events such as rupture of a pipeline or a power loss that lasts longer than 8 hours
- Slide of the stacked ore
- Unusual observations such as cracks, excessive settlements, sinkholes, large slope, or foundation deformations in any Event Pond embankments
- Instrument readings that deviate from historical trends or are within site specific designated "alert" action levels
- Overtopping events, use of spillways, or general loss of containment.

Special inspections after unusual events are necessary to evaluate whether there has been any damage requiring correction, any safety measures or special operating procedures that need to be implemented, or if there is a need to initiate procedures as outlined in the HLF WMP or the Emergency Response Plan.

9.6 Data Interpretation and Documentation

Documentation of surveillance activities are maintained by the Process Manager and Environmental Manager and include recording of:

- Routine visual observations (departures from normal conditions)
- Instrumentation monitoring and testing
- Reviews.

Documentation includes, as a minimum, the following:

- Routine inspection log
- Surveillance network monitoring report
- Quarterly instrumentation reports
- Annual engineering inspection reports
- Biannual review of data and annual environmental monitoring and surveillance report.

Documentation includes a hard copy (paper) and electronic filing system for inspection reports, photographic and video records, incident reports, instrumentation readings, instrumentation plots, annual inspections, and third-party reviews, so that they can be quickly retrieved for review and in case of an emergency.

9.7 Reporting

The Process Manager is to review collected data records from facility monitoring and assess the need for maintenance activities or response. The reporting procedures for various levels of surveillance are summarized below.

a. Performance meets design expectations

Data will continue to be plotted as recorded and documented in the monthly and annual reports.

b. Conditions may require adjustment to design, operation, maintenance, or surveillance

The results of the routine maintenance and surveillance programs may result in a caution warning that requires action. At that time, the Process Manager will formally notify the Engineer of Record and request assessment of the data and to advise any remedial actions or potential modification to HLF components to bring the facility back into design expectations. The frequency of monitoring should be increased to confirm the measurements and to assess if the rate of change is increasing, stabilizing, or decreasing.

c. Potential Emergency Response Alert

Certain unexpected or unplanned events may trigger an emergency response alert. Examples of these events include earthquakes or large precipitation events that exceed the design storm event. The Process Manager will immediately inform the following personnel, who will determine what

immediate action should be taken and whether the Emergency Response Plan should be implemented:

- Site Management including the General Manager, Environmental Manager, Health, Safety and Security Manager
- Chief Operating Officer
- Engineer of Record
- Yukon Government Departments (EMR, Water Resources, Environment, etc.), Environment Canada, and First Nations.

d. Environmental Monitoring and Reporting

The Environmental Manager is responsible for overseeing sample and data collection and analysis and reporting as per WUL requirements to the YWB and Inspector. This reporting will include the collection of all data required to allow for the monthly reporting of the following items:

- Daily average available storage volume.
- Month end volume of water stored in the HLF, inclusive of the snow water equivalent of any snow cover on the pad, Event Ponds, and the Event Pond watershed below the ADR Plant.
- The total monthly volume and the average pumping rate of HLF solution pumped for irrigation or rinsing of the ore.
- The total monthly volume and the average rate of HLF solution from the Pad to the ADR Plant.
- The total monthly volume of water flowing or pumped from the Pregnant Solution Tanks to the Event Pond 2.
- The total monthly volume of water pumped from the Event Ponds to the ADR Plant.
- The total monthly volume of precipitation (in SWE if snow) falling on the HLF and the Event Ponds watershed.
- The total monthly volume of water transfers into the HLF.
- The total monthly volume and average treatment rate of any HLF solution treated in the mine water treatment plant and released to the environment.
- The daily average moisture content of ore delivered to the HLF.
- The monthly volume of water added to the HLF as ore moisture content.

Data acquired from all environmental programs is to be compiled bi-annually and included in the annual report in accordance with licence requirements.

9.8 Backup Generators and Pumps

Backup power generation and pumping equipment and supplies are available to operators in the event of routine or event driven maintenance, in the event of a power outage, or in the event of an emergency. This redundancy enables continuous management of solution in these circumstances.

9.8.1 Backup Power

As an additional designed contingency, backup power is available for all phases of the project. Generators are on site to provide backup power to the pumping system in the event of a power loss or failure from the

gridline, with sufficient fuel for at least two weeks of operation. The HLF water balance evaluated the power loss scenario of the PMP event concurrent with a 72-hr draindown of the heap. Although the facility solution storage provides sufficient capacity, additional contingency tools are in place to further mitigate the risk associated with a power failure. Therefore, the Project incorporates a backup generator system that is capable of supplying power to the pumping stations. These generators are able to provide sufficient power to all of the pumps so that they can continue to operate in the event of a gridline power failure, with sufficient fuel for two weeks of operation. This allows for solution to continue to be circulated through the pad so that the Event Ponds are effectively managed during power failure events.

Standard Operating Procedures (SOPs) will be developed that describe backup power generation as well as the process for using backup generators in the event of temporary loss of grid power. The procedure is to ensure that power is provided for essential facilities and equipment (e.g., solution circulation pumping stations and critical camp facilities) in the event of disruption to electrical supplies, as well as ensuring backup generators are properly maintained and available for emergency use as necessary.

9.8.2 Pump Redundancy

The HLF solution management systems include redundancy in the various pumping systems associated with the HLF. Barren pumps installed at the barren pumping station will service the life of the pad, including an installed redundant pump. It is planned by the end of ramp up that there will ultimately be a sufficient number of installed pumps at the barren pumping station during the life of the facility and during operations to handle operations (1,250 m^3/hr), plus one pump for maintenance and one pump on standby. The N+1+1 redundancy in the system allows for continuing operation in the event that a pump requires maintenance or if the pump breaks.

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APPENDIX E

Coffee Gold Mine Water Treatment – Preliminary Design

Technical Assessment

Preliminary Design

Coffee Gold Mine – Water Treatment

Yukon, Canada

Engineer
WesTech Engineering, LLC
Salt Lake City, UT

Owner
Newmont
P.O. No.: CW2242356
Project No.: M-100898

Revisions

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Technical Assessment – Water Treatment

Work with Documents: N/A, all reference documents included as Appendices

1.0 Objective

The objective of this document is to present a Preliminary Design for permitting purposes and a feasibility assessment for the treatment of the water at the proposed Coffee Gold Mine located in the Yukon, Canada.

This includes a technical assessment and detailed description of the treatment processes for removal of target constituents in the mine wastewater streams. Also, to include general design principles, integration with surrounding infrastructure, risk mitigation, and adaptive management planning as applicable for typical water treatment plants, particularly in mining applications, and their supporting systems. Due to the lack of actual mine wastewater for evaluation, the design elements outlined are conceptual only, while they are intended to be specifically applicable to this site, they are only based on lab-produced simulated streams and predictive conditions from other similar applications as outlined herein.

2.0 Definitions

Owner – The owner requesting design services and testing for the feasibility of the treatment plant, for purposes of this document the Owner refers to Newmont Corporation.

Engineer – The design engineering firm responsible to provide preliminary design services for the treatment plant. In this document it refers to WesTech Engineering, LLC

Contractor – The Owner's installing contractor responsible for construction of the treatment plant, integration of the supplied equipment, and interconnecting systems on the treatment plant site.

Registered Professional – The registered engineer or architect that holds responsibility for the design decisions, recommendations, and final sealed documents for the project within their area of expertise or engineering discipline. Generally, all design professionals providing stamped and sealed documents on the project shall be registered in the province where the project is being constructed in accordance with local regulations (in this case, Yukon, CA). The registered design professional(s) shall be employees of the firm acting as project engineer of record or its supporting consultants, unless otherwise approved by the Owner.

Jurisdiction Having Authority, JHA (AJH) – An agency, organization, office, or individual responsible for enforcing the requirements of local building codes or standards, within a specific area of the country, in this case: Yukon, CA.

Vendor/Supplier/Manufacturer – Third party entity providing equipment, materials, or products in conformance with the engineer's applicable design specifications and drawings that is unaffiliated with the prime contract between the Owner and engineer. They may be selling equipment to the contractor, engineer, or directly to the Owner.

2.1 Units of Measure

The following units of measure are used throughout the document, secondary units are in brackets (where applicable).

Measure / Meaning	Unit / Abbreviation
Temperature	°C [°F]
Mass and Force	kg [lb]
Concentration (in water)	mg/L or ppm
Volume, Liquid	L or m^3 [gal]
Volume, Material	m^3 [ft^3]
Density	kg/m^3 [lb/ft^3]
Flowrate, Liquid	L/s [gpm], L/hr [gph]
Flowrate, Mass	kg/hr [lb/hr]
Flow, Gas	m^3/hr [cfm]
Power	HP (Horsepower)
Specific Heat	BTU/°C
Velocity (Fluid)	m/s [ft/s]
Velocity (Wind)	km/h [mph]
Equipment Dimensions	m, mm [X'-XX"]
Length, Distance	m [ft]
Pipe Diameter (NPS)	Inch
Voltage	V
Current (Amperes)	A
Pumping Head	m [ft]
NPSH (Pump suction)	m [ft]
Area	m^2 [ft^2]
Acceleration	m/s^2 [ft/s^2]
Time	hr:min:sec

2.2 Referenced Codes and Standards

Code / Industry Reference	Abbreviation
National Building Code of Canada	NBCC
Towards Sustainable Mining, Mining Association of Canada	TSM
The Occupational Safety and Health Administration	OSHA
Accessible Canada Act	ACA
Canadian Standards Association (multiple codes as referenced)	CSA
Canadian Electrical Code (CSA C22.1)	CE Code
National Plumbing Code of Canada	NPC
Canadian Institute of Steel Construction	CISC
American Institute of Steel Construction (for select steel members)	AISC
American Society for Testing and Materials International (for material selection/specification)	ASTM
American Society of Mechanical Engineers (centrifugal pumps only)	ASME

Code / Industry Reference	Abbreviation
Precast/Prestressed Concrete Institute	PCI

2.3 Abbreviations and Symbols

Common industry abbreviations are used throughout the report to simplify readability and flow of the document. A summary of those abbreviations is included here for reference. In addition, the first time each abbreviation is used within the document, the common term or definition is included immediately preceding it.

Industry Terms	Abbreviation	Industry Terms	Abbreviation
Heap Leach Facility	HLF	Equalization (Flow)	EQ
Process Flow Diagram	PFD	Safety-in-Design	SID
Process and Instrumentation Diagram	P&ID	Safety Data Sheet	SDS
Zero Liquid Discharge	ZLD	Fiber-Reinforced Polymer	FRP
Piping Material Specification	PMS	Hot-Dipped Galvanized	HDG
High-Density Polyethylene	HDPE	Balance-of-Plant	BOP
Chlorinated Polyvinyl Chloride	CPVC	Top of Concrete	TOC
Nominal Pipe Size	NPS	Precast Concrete	PCC
Outside Diameter (piping systems)	O.D.	Controlled Low-Strength Material	CLSM
Specific Gravity (material/fluid)	SG	Digging, Ditching, and Trenching (civil work)	DDT
Vendor Data and Document Register	VDDR	Motor Control Center	MCC
Process Performance Guarantee	PPG	Variable Frequency (Speed) Drive	VFD/VSD
Total Suspended Solids	TSS	Programmable Logic Controller	PLC
Total Dissolved Solids	TDS	Human-Machine Interface (touchscreen)	HMI
Nephelometric Turbidity Unit	NTU	Hand-Off-Auto (switch)	HOA
Polyfluoroalkyl Substances	PFAS	Light-emitting Diode	LED
Reverse Osmosis	RO	Lock-out, Tag-out	LOTO
Ultrafiltration	UF	Underwriters Laboratory	UL
Electro-Biochemical Reactor	EBR	Heating, Ventilation and Air Conditioning	HVAC
Oxidation-Reduction Potential	ORP	Minimum Efficiency Reporting Value	MERV
Silt Density Index	SDI		
Pressure Decay Test (Membrane systems)	PDT		

Industry Terms	Abbreviation	Industry Terms	Abbreviation
Maintenance Clean (membrane systems)	MC		
Chemically Enhanced Backwash (membrane systems)	CEB		
Clean-in-Place (membrane and filter systems)	CIP		

2.4 Chemicals

Chemical usage in water treatment facilities is essential for removal of target constituents and pH balancing; this report includes references to the various chemical compounds proposed for use in the plant using their chemical formulas and common representations. In addition, the target constituents for removal are represented using the common elemental formulas or chemical symbols both in the water quality tables and the context of the report. A summary of those chemical compounds, symbols, and representations are included here for reference.

Chemical References	Formula	Chemical References	Formula
Ammonia	NH_3	Chromium	Cr
Nitrate	NO_3	Copper	Cu
Nitrogen Dioxide	NO_2	Cobalt	Co
Chlorine (free)	Cl	Iron	Fe
Ferric Chloride	$FeCl_3$	Mercury	Hg
Sulfate	SO_4	Manganese	Mn
Barium Sulfate	$BaSO_4$	Molybdenum	Mo
Copper Sulfate	$CuSO_4$	Nickel	Ni
Calcium Hydroxide	$Ca(OH)_2$	Lead	Pb
Sodium Hypochlorite	NaOCl	Antimony	Sb
Carbon Dioxide	CO_2	Selenium	Se
Aluminum	Al	Uranium	U
Silver	Ag	Zinc	Zn
Arsenic	As	Weak-acid Dissociable – Cyanide	WAD-CN
Cadmium	Cd		

3.0 Basis of Design

The Basis of Design outlines the philosophies and approaches used during the development of the treatment plant system design, drawings, project specifications, and supporting documentation for the Coffee Gold Mine. In addition, design progression beyond the feasibility level would be in conformance to WesTech standard specifications, including the Minimum Technical Requirements 01 10 DC, which is available upon request.

Apparent conflict within the Basis of Design, Owner specifications, regulatory requirements and any other relevant document, shall be brought to the engineer's attention. Unless otherwise agreed, the following descending order of precedence shall apply:

- Local governmental and statutory regulations and laws
- Owner's Purchase Order / Contract
- Project Specifications, Data Sheets, and Drawings
- Referenced Documents, Codes and Industry Standards

3.1 Background

WesTech (formerly Inotec) was contracted to develop a conceptual water treatment system for the water from the proposed Coffee Mine. The purpose was to increase confidence in the proposed treatment, reduce uncertainty and risks, and develop an approach specific for the treatment of the water anticipated at the Coffee Gold mine site; the testing was designed in three phases. Conceptual (Phase I), Bench-scale (Phase II), and Optimization (Phase III), all of which have been completed at this time.

The conceptual design documents were shared with the stakeholders (Newmont, First Nations, and the Canadian regulatory agencies), and the obtained feedback was included in the testing program and this document.

For Phase I, the initial test work was performed on recirculated leach waters in order to try and mimic site water chemistry in the later years of the mine's operation. Phase I testing successfully demonstrated the removal of nitrate, arsenic, and uranium from the simulated Coffee Gold leach waters.

Next, additional bench-scale testing was completed (Phase II) to further the design and account for the anticipated barren solution treatment and evolving water quality over the life cycle of the mine. This was done to validate that the proposed treatment solution would be viable throughout the life cycle of the mine. The Phase II bench-scale testing successfully removed the initial target contaminants to below their respective discharge limits.

Upon completion of the Phase II testing, WesTech and the client sought feedback from the stakeholders through a series of water-treatment-focused workshops. The consultations yielded positive feedback, identified additional contaminants of interest, and resulted in the addition of several analytical parameters to the monitoring list, strengthening the testing design and outcomes. Sulfate and antimony were identified as potential additional contaminants of interest.

The jar test optimization program (Phase III) was then initiated which tailored the treatment design to the changing water quality expected during the mine lifecycle and the additional contaminants. As a result, the best approach for the Coffee Gold water treatment was confirmed to be a multi-stage treatment train, consisting of the following systems:

- Cyanide destruction and ammonia oxidation
- Physical-chemical treatment for arsenic and sulfate precipitation, and biological denitrification

- Membrane Filtration, including Reverse Osmosis (RO) treatment

In Phase III testing, all contaminants of interest (including the additional target contaminants) were removed to below their respective discharge limit using the first (2) steps, except for cobalt. Due to the strong complexes that cobalt forms with cyanide, the metal remained in solution throughout the cyanide destruction and phys-chem treatment steps. To achieve removal of cobalt, the third stage (Reverse Osmosis) was added to the proposed water treatment flow.

3.2 Site Information

The Coffee Gold Mine water treatment plant is proposed to be located near the open pit mine site in central western Yukon, Canada. The exact location of the treatment plant is yet to be determined and will be located based on proposed mining activities, excavations, and the location of the heap leach facility (HLF) feeding the plant.

Developing a conceptual water treatment design for a prospective mine is challenging. No heap leach waters exist for treatment evaluations without an operational mine. Predicting water quality generated by the heap leach facility is crucial for identifying the parameters of concern and developing a treatment system with appropriate unit processes.

Water quality modeling was performed by Lorax Environmental Services (See Influent Criteria). The treatment targets were based on a back-calculation approach to arrive at allowable concentrations in the discharge to achieve Use-Protection water quality objectives in Halfway Creek (discharge point).

The conceptual water treatment plant outlined is based on removal of the target constituents outlined in the water quality predictions to achieve those treatment targets.

3.3 Scope Summary

The engineer will provide a comprehensive technical assessment of the feasibility of the water treatment plant comprised by this report which is prepared to address the feasibility of treating water for the target constituents and concentrations as simulated in previously performed lab tests (summarized above) and does not reflect actual water from the mine site, nor does it consider scaling for flows larger than those illustrated on the Mass Balance calculation summary. This report reflects a preliminary level of design with supporting design documents attached as Appendices, these documents and their purpose are summarized below:

- Mass Balance, Appendix A: Flowrate and mass balance calculation summary tracing the introduced water (influent) through to the resulting produced water (effluent) and splitting out the associated waste streams resulting from the capture, separation, removal, and any further processing of all target contaminants. It demonstrates conservation of mass throughout the system allowing the reviewer to identify each process step and associated feed streams (untreated feed water, chemical, polymer, dilution addition) through to the resulting discharge streams (treated water for discharge, recycled waste, backwash, solids capture, etc.).
- Process Flow Diagram (PFD), Appendix B: A diagrammatic layout of the major process equipment and interconnecting piping required to accomplish the (3)

treatment stages outlined above. It visually illustrates how the water treatment objectives will be achieved in the same order of progression as illustrated in the Mass Balance calculations.

- Chemical Consumption List, Appendix C: A proposed list of the chemicals and reagents that were tested and proved to aid in removal of the target contaminants during the treatment process. These are external additives injected or mixed into the process water at different stages of the process (locations of chemical injection/mixing are indicated on the PFD) to adjust pH levels and aid in precipitation, agglomeration and/or consolidation of solids. Also included are the recommended chemicals for cleaning or purging any membrane or filtration systems.
- Equipment List, Appendix D: The proposed equipment list is a consolidated table format listing all the pieces of equipment shown on the PFD. This list will also include the equipment type, approximate size/capacity, weight, and electrical demand for each item.
- Preliminary Mechanical Plan, Appendix E: The Mechanical plan drawing is a schematic physical representation of the potential treatment plant layout illustrating a general proposed overall footprint, equipment locations, piping corridors, personnel and drive access ways, etc. It is not intended to represent an actual layout at any specific location in or around the mine site, at this stage of the project there has not been any location designated for the treatment plant.
- Utility List, Appendix F: The utility list indicates external services required for operation of the treatment plant, including the general purpose, estimated consumption, and expected delivery method.

The comprehensive set of deliverables are included as a single package for the Owner to review and use as required and are not intended to be considered individually. In addition to the Preliminary Design documentation and process/design summaries below, this report shall also address the minimum technical design requirements, the technical feasibility of the treatment plant and application specific for the Coffee Mine, a general risk assessment and mitigation recommendations for the treatment plant, and an adaptive management plan for mitigating unknown factors that could impact the effectiveness of the current proposed design.

Excluded from the scope are any final design engineering, infrastructure, equipment, installation, or operational cost estimates; design and construction scheduling; civil design or site investigation (including geotechnical, site survey or other on-site analysis); or any other detailed engineering activities. Also excluded are any process performance guarantees (PPG) related to the specific mine water.

3.4 Feed Water Analysis

Influent/feed water quality is based on the water quality modeling described earlier in this report. The Coffee Gold Mine is projected to generate a positive water balance with variable water chemistry throughout the project lifecycle. Water generated through the infiltration of the heap will contain cyanide, metals, and other dissolved inorganics. The mine water balance estimates the design flow to the water treatment facility as 25 – 35 L/s (396 – 555 gpm).

If the owner intends to inject/add any chemicals, bleach or acids into the process fluid upstream of the treatment plant tie point, the engineer shall be provided with dosages and frequency of application to ensure they will not interfere with the treatment plant's processes. WesTech sampling skids will be provided in addition to flow meters to measure influent and effluent TSS, pH, and flow to validate that process requirements are being met. Grab samples of effluent water may be collected by the Owner from the discharge line in accordance with the Owner's independent testing requirements for other constituents as needed.

Table 3.4. Influent Water Quality (simulated predictions of HLF solutions).

Parameter [mg/L]	Early Phase	Post-Recirculation
pH	9 - 10	8.4
NH_3-N	72	0.06
NO_3-N	50	307
NO_2-N	1	1.9
Cl	300	123
SO_4	1100	2516
WAD-CN	130	0.2
Al	0.09	0.2
Ag	0.00045	0.00125
As	5.0	2.0
Cd	0.0036	0.00013
Cr	0.008	0.014
Cu	2.0	0.014
Co	0.5	0.25
Fe	2.3	0.5
Hg	0.005	0.00026
Mn	0.27	0.06
Mo	0.125	0.105
Ni	0.019	0.006
Pb	0.0002	0.0013
Sb	0.09	0.5
Se	0.007	0.005
U	0.1	0.685
Zn	0.7	0.052

3.5 Performance Predictions

The actual discharge flow rate to the Halfway Creek is anticipated to be lower than the treatment plant influent, this is illustrated in the PFD and mass balance calculations (and summarized in the following section). The anticipated actual discharge flow rate will be 20 – 26L/s (317 – 412 gpm) to Halfway Creek and is anticipated to have concentrations below the target limits based on the treatment processes, simulated predictions, and lab testing performed.

Table 3.5. Target Treated Water Quality.

Parameter [mg/L]	Treatment Target
pH	<9.0
NH_3-N	16
NO_3-N	79
NO_2-N	0.15
Cl	1300
SO_4	1100
WAD-CN	0.046
Al	3.4
Ag	0.0027
As	0.043
Cd	0.002
Cr	0.05
Cu	0.029
Co	0.03
Fe	10
Hg	0.00019
Mn	3.0
Mo	0.77
Ni	0.8
Pb	0.02
Sb	0.08
Se	0.021
U	0.7
Zn	0.2

3.6 Water Balance

The treatment plant is targeting a process that doesn't produce any liquid waste streams leaving the mine site; this requires a comprehensive water balance analysis to validate sufficient capture and treatment of solids and dewatering processes. To achieve this objective, the Coffee Gold mine will maintain non-compliant water on-site by recirculating a portion of the flow back to the HLF. In addition, all other liquid waste streams are recirculated within the plant. This practice of recirculation to the HLF requires further treatment in the plant (producing additional waste streams) as described in the Process Description below to prevent the buildup of residuals and other reject contaminants in the HLF, these additional liquid waste streams are also recirculated within the plant and solids are consolidated with the solids generated in the primary treatment steps for disposal.

The overall plant Mass Balance calculation traces the water balance through the plant, primarily consisting of (3) streams: (1) feed stream, (2) discharge to Halfway Creek, and (3) HLF recirculation with a small amount of additional water encapsulated in the final solids consolidation (filter press cake). In short, the feed stream from the HLF is

equal to the sum of the discharge to Halfway Creek plus the recycled stream back to the HLF.

It is anticipated that all other streams required within the treatment plant, indicated as service water (for chemical make-down, push/carrier water, CIP cleaning, etc.), are pulled from the treated stream before it leaves the plant and the resulting dilution or waste stream is recirculated through the plant via the process sump or directly back to a point within the primary treatment stream. This results in a net zero increase/decrease in total water entering and leaving the treatment plant. In cases where large volumes of service water are consumed (for washing, CIP activities, etc.), the instantaneous discharge to Halfway Creek or the HLF recirculate may be slightly reduced while a portion of that treated water is diverted to replenish the service water storage volume in the plant.

Chemicals injected as concentration in water do contribute a minimal amount of additional net water to the process, however due to the extraction of dissolved solids by precipitation out of the liquid volume, the net balance is still anticipated to be maintained.

Additionally, an upstream water balance evaluation was performed for the HLF pond that feeds the treatment plant. This illustrated the upstream storage volume available for short term use when implementation of risk management mitigation or adaptive management processes are required. Allowing the mine to retain contaminated water on-site until the treatment plant is available for continuous forward flow to be treated and discharged as outlined in the Process Description below.

3.7 Process Description

The water treatment plant is designed to receive untreated influent water at the flow rate(s), temperatures, and pH levels summarized in section 3.4 with the contaminants as listed at the indicated maximum expected concentrations outlined in the same table. The plant will then discharge effluent (treated) water that reflects the minimum quality, pH, and temperature ranges as outlined in section 3.5 in addition to consolidating contaminants into dry solids or recirculated waste streams. To accomplish this the plant will employ multiple processes, systems, and various types of equipment to target and remove different contaminants, balance flows, and ensure sufficient monitoring and consistent performance.

Each step in the process is generally represented graphically on the Process Flow Diagram (PFD) included in the Appendix of this document.

As noted in the background and testing there are (3) primary treatment systems that make up the Coffee Gold mine water treatment plant, including:

- Cyanide destruction and ammonia oxidation
- Physical-chemical treatment and biological denitrification
- Reverse Osmosis (RO) treatment.

Other supporting systems or processes are also outlined in the detailed descriptions below that contribute to and are required for the overall performance of the plant and those primary systems.

3.7.1 Flow Equalization

The initial steps of the treatment plant processes rely on continuous and consistent forward flow to ensure more predictable treatment and removal of the target contaminants. The treatment plant will rely on flow equalization (EQ) to improve efficiency, reliability, and control; the EQ system shall allow for collection and natural mixing of various feed waters from the mine site and prevent swings in flowrates, temperatures, and water chemistry going into primary treatment plant processes.

Sizing and distribution of flows to and from the EQ system is dependent on the final water balance and quality modelling of the upstream contributors. The required volume for the EQ system will account for the maximum feed water flow variations, anticipated surge flows (storm events, flush, or other sequences), etc. outlined by the Owner as part of the final design contract. Depending on the volume and subsequent residence time of the influent water in the EQ tank/basin aeration systems may be required to encourage mixing and maintain constituents in suspension. The EQ system will target a consistent "average" forward flow to the treatment plant.

Feed pumps are provided near the EQ tank to feed the initial treatment step. Small or gradual variations in flow to increase or decrease plant throughput within the defined operating ranges of the plant are controlled by flow control valves or variable speed feed pumps within the EQ system.

3.7.2 Cyanide Destruction

The first treatment step in the plant is cyanide destruction by chemical cyanide oxidation. The Owner is responsible to ensure that the pH of contaminated influent water fed to the plant is maintained between 9 – 9.5 to prevent hydrogen cyanide gas formation upstream of the cyanide destruction step. The process of cyanide destruction itself is also highly pH dependent, and the influent pH will be monitored continuously.

As demonstrated by the lab testing of a couple different chemical oxidation processes, hydrogen peroxide was proven the most effective agent for cyanide destruction in barren solutions and post-recirculation waters that are anticipated from the Coffee Gold project. Other processes were shown to be ineffective or produced other residuals that required more treatment.

Due to the potential for varying levels of cyanide in the feed water, the plant will also use Oxidation-reduction monitoring (using ORP instrumentation in the process) to control the amount of hydrogen peroxide. This has been demonstrated during laboratory testing as a more reliable approach for controlling hydrogen peroxide dosing than using set reagent:contaminant ratios.

Copper is a required catalyst to initiate the reaction, copper ions are introduced to the solution by injecting copper sulfate ($CuSO_4$) into the initial mix tank(s) along with the hydrogen peroxide. The total sulfate added to the treatment stream with this process is minimal and would be removed with the other pre-existing sulfates later in the process (refer to secondary treatment of RO concentrate outlined below).

This is a critical first step in the treatment process and requires thorough mixing and extensive reaction time to achieve the required chemical reactions. Rather than employ a single large mix tank, the design will improve both the efficacy and efficiency of the process with the use of multiple sets of mix tanks in series. Different chemicals are

injected at different stages (before or at the beginning of each set of tanks) based on the next required reaction step. The tanks will use crossflow design principles and continuous mechanical mixing to prevent short-circuiting and ensure positive interaction between the contaminants, reagents, and catalysts to ensure removal downstream.

3.7.3 Breakpoint Chlorination

Following the cyanide destruction step, pH is lowered to between 8.0 – 8.5 to oxidize any ammonia in the influent water using a metered sodium hypochlorite (chlorine) addition and continuous mixing. This step is commonly referred to as breakpoint chlorination.

The chemical ammonia oxidation step is a recommended approach for the water treatment plant at the Coffee Gold project because of the anticipated gradually decreasing ammonia loading in the Heap Leach Facility (HLF) waters. The hypochlorite dose shall be automatically adjusted within the plant control system and programming based on the measured incoming ammonia levels to meet the treatment objective and limit free chlorine and chlorides downstream. This step does produce acid compounds in the water, these are subsequently neutralized by the addition of calcium hydroxide ($Ca(OH)_2$) which is critical to the Physical-Chemical treatment step.

Citric Acid for pH control is to be used when ammonia levels are low and the subsequent use of sodium hypochlorite is reduced.

3.7.4 Physical-Chemical Treatment

The next step of treatment processes, commonly referred to as the physical-chemical or “phys-chem”, relies on chemical reactions followed by solids coagulation, flocculation, sedimentation, and separation of precipitated constituents and other suspended solids.

Phys-chem processes are some of the most widely used and accepted treatment methods across all industries, applied in treatment plants for all applications from drinking water to municipal wastewater to industrial and mining water. In general, a phys-chem system includes reaction time for the chemical reaction of suspended and dissolved solids (both existing in the primary stream and injected as outlined in the previous section) to mix to agglomerate, precipitate, or flocculate and then physically settle, float, or otherwise separate into a thickened waste stream that can be segregated from the clarified primary water.

Following the series of mechanically mixed reaction tanks (where cyanide destruction, breakpoint chlorination, and chemical conditioning occur) the influent stream will be pumped into clarifiers and media filters where the physical separation occurs and consolidated solids can be removed in a waste stream.

WesTech’s understanding of the wholistic treatment processes allows for design flexibility in the initial treatment plant that can accommodate changes to chemical types and mix requirements due to the natural evolution of the influent water (and associated contaminants) over time.

3.7.4.1 Chemical Conditioning

Chemical conditioning is the first step to initiate the required ionization and precipitation reactions. Most of the required chemical conditioning will occur

simultaneously or in the same reaction/mixing tank as some of the previous processes outlined above, this allows the design to limit the number of mix tanks, motors, and hydraulic losses between systems thus increasing the overall mechanical, chemical, and process efficiency of the plant.

Ferric chloride will be added to the reaction tanks to precipitate and coagulate arsenic. This method is widely used across the mining industry (as well as other treatment applications) and was demonstrated to be effective for the simulated waters used during bench-scale testing for this site. Ferric chloride ($FeCl_3$) hydrolyzes in water to form positively charged ferric hydroxide ($Fe(OH)_3$). The dissolved arsenic oxyanions (target contaminant) are negatively charged and readily sorb to the positively charged ferric hydroxide particles.

The process is sensitive to the oxidative state of arsenic. If any reduced arsenic oxyanions, such as arsenite, are present, they must be oxidized to arsenate first for the ferric coagulation step to be effective. Understanding this potential challenge and the common presence of arsenite in mine waters, WesTech has designed the complete system using as many synergies as possible to tackle the removal of various contaminants (and variations of the contaminants) from a holistic perspective. Thus, the first step, which includes oxidation for cyanide detoxification, will also ensure that all arsenic is present as arsenate (As(V)). Ferric chloride is also an excellent coagulant for any other suspended solids and may aid in precipitation of other constituents present in the influent stream.

Removal of some of the other dissolved metal ions as required within the phys-chem system is achieved using targeted pH adjustment and the addition of calcium hydroxide (Ca(OH)2 a process also known as lime softening. In addition, organosulfide is used to bind other heavy metal ions, such as mercury that may not precipitate as easily. The metal hydroxides (precipitate) and other insoluble compounds (formed by the organosulfide) generated through these reactions can then be flocculated and settled in the physical-chemical process.

There will be multiple locations for calcium hydroxide injection along the chemical conditioning mixing process, allowing for plant operations to modify concentration/location as required to target optimal precipitation (or to avoid precipitation or settling too early in the process) of the heavy metals present at various stages of the mine operations. Organosulfide shall only be added in the final stage of mixing tanks and after an in-line injection of sodium bisulfite (to be dosed as required to quench any residual chlorine left in the system from the breakpoint chlorination step).

3.7.4.2 Clarification



Traditional WesTech Clarifier w/radial collection launders – Installed

For the Coffee Mine water treatment plant, a WesTech traditional gravity Clarifier/Thickener is a viable and efficient option. Other options that may reduce overall footprint include high-rate ballasted flocculation clarifiers (WesTech RapiSand) or other clarification equipment proven effective in similar applications. The engineer will develop final recommendations during the detailed design with input from the Owner.

In a traditional clarifier flocculant is added to the clarifier feedwell as a settling aid for the coagulated suspended solids. Flocculants are high density polymers that can generate long chains to which suspended particles in the influent stream can attach, creating much larger, faster settling particles. The gentle mixing as the water distributes through the clarifier feedwell allows for rapid development of these polymer chains without causing shearing or breaking and encourages interaction between these developed chains and the solids suspended in the fluid, creating larger particles that will settle more rapidly in the clarification zone.

Solids are collected at the bottom of the clarifier tank with a slow rotating, centrally driven rake that directs solids to a central hopper to be removed for further processing. The rake mechanism consists of a central shaft mounted to the drive unit, rake arms, and cone scraper. The sloped tank floor and the angled scraper blades on the rotating rack direct solids along the sloped tank floor to the central hopper where they are pumped out by the sludge pumps.

The rake drive torque is continuously monitored by a device mounted to the drive unit that provides a continuous local readout of 0-100% of design torque and a minimum of (3) limit switches set to indicate alarm, lift, and cutout functions. The limit switch for lift shall automatically activate an integral rake lift motor. The limit switch for cutout shall be wired to directly cut power to the rake drive motor when the maximum design torque is reached (or at the manufacturer's recommended torque level). Setpoints for all limit switch functions shall be preset and factory tested by the clarifier manufacturer.

The lift device shall be integral to the drive unit and include a worm gear and lift screw assembly connected to the upper portion of the rake shaft.

The settled sludge (which may be up to ~20% solids by weight) that has been conveyed to the central hopper by the rake arms is pumped out to a sludge storage tank. The "waste" rate of solids being discharged to the sludge tank is intermittent depending on the rate of solids separation and consolidation in the clarifier, the duration and frequency may be adjusted accordingly. A minimum sludge draw off is required to provide continuous recirculation to the mix tanks, this recirculation is important to promoted additional precipitation, flocculation, and coagulation of solid particles.

The clarified water will overflow the clarifier into a perimeter launder where it is channeled to a clearwell tank.

3.7.4.3 pH Neutralization

Due to elevated pH levels that will be present in the Clarifier, carbon dioxide (CO_2) will be injected into the treated water to lower the pH and prevent scaling in the downstream media filter. In general, conventional acids (e.g. hydrochloric, sulfuric, or nitric) are typically used to lower pH, and several options were considered; however, to minimize loading of target constituents such as chloride, nitrate, and/or sulfate, WesTech elected to pursue alternatives. Direct injection carbon dioxide (CO_2) was selected as the neutralization option, leaving no restricted dissolved species behind. The CO_2 is injected as a gas and dissolves forming carbonic acid that will lower the pH within the system prior to entering the membrane filtration step.

Compressed CO_2 gas will be injected into the main process stream in the pipe directly downstream of the clarifier (using carrier water pulled from the clearwell) and will be primarily dispersed in the pipeline prior to arrival at the clearwell tank. Instrumentation located downstream in the clearwell tank will monitor the pH of the process water and control the amount of CO_2 being injected.

3.7.4.4 Media Filtration



Image 2: Media Filter Train – Installed

Following pH adjustment, forwarding pumps will transfer the clarified water from the clearwell into media (silica sand) filters to remove residual solids. The WesTech SuperSand™ is an up-flow, moving bed filter that is constructed with various media depths for different applications and configurations. The clarified and neutralized water will be pumped up to the top of the filter, where the feed pipe extends down the middle to near the bottom of the tank. The suspended solids will be filtered out as the water

flows up through the filter media bed. As the filtrate reaches the top of the filter, it will pass over the effluent weir and will be discharged.

The SuperSand filter employs a backwash rinse that is performed continuously while the tank is processing water. An airlift pump draws the media from the bottom of the filter up into the wash box. As the media is released into the wash box, it falls into the sand scrubber, where the filtered solids (waste) are separated from the media and carried by a small portion of the filtrate (backwash) to the mix tanks ahead of the clarifier. The washed sand falls down onto the base media bed for continued use, this also encourages self-circulating of the media within the bed.

Filtrate coming off the top of the filter is collected in the feed tank for the biological removal of nitrates.

3.7.5 Biological (denitrification)



Electro-Biochemical Reactor (WesTech stock image)

The biological process requires a specific pH range to foster an environment where microorganisms can thrive. This requires the injection of phosphoric acid and organic carbon following the feed tank and pH monitoring downstream for verification and dosing adjustment.

Biological denitrification is a process that relies on microorganisms to convert nitrate to nitrogen gas under anoxic conditions. It is commonly used in the tertiary treatment of wastewater, in mining and industrial water treatment, and – in recent years – even in drinking water applications.

In biological systems, microbes facilitate nitrate removal through electron transfer (redox processes). In conventional biological treatments, those electrons are supplied from excess organic carbon. This typically results in excess biological growth and frequent backwashing.

Contrary to conventional biological systems, the Electro-Biochemical Reactor (EBR) technology supplies the needed electrons directly to the reactor. The electrons supplement those supplied from a carbon source, significantly reducing operating costs and lower biomass production. The directly supplied electrons are readily available to the microbes in a consistent, controllable manner, making the system less susceptible to low temperatures and changes in water conditions.

The EBRs will be supplied with organic carbon and supplemented with a direct current to maintain high electron availability. The by-product of denitrification is nitrogen gas, which is degassed to the atmosphere. Nitrogen is harmless and constitutes 78% of the air. Based on the preliminary bench-scale testing, the biological denitrification system is also expected to remove up to 60% of cobalt.

The size and number of the denitrifying bioreactors are sensitive to the nitrate loading rate (flowrate and nitrate concentration). Further, if the heat transfer inside the treatment building is not sufficient to keep consistently warm water for the biological treatment, heaters will be required. Sizing for the denitrifying bioreactors will be adjusted based on the most current water quality information prior to detailed engineering.

WesTech has an extensive experience with denitrifying filters, with several dozen installations in the municipal wastewater and power markets over the past 12 years. The EBR process represents an improved process over our conventional denite filters.

Nitrate concentrations in the barren solutions are expected to be significantly lower than in the later years of the mine's life cycle. The EBR bioreactors will be designed and constructed in a modular fashion. The control philosophy will bring the reactors online based on nitrate load, as dictated by the flowrate and nitrate concentrations measured by an in-line nitrate analyzing instrument.

Intermittent, low-flow backwashes are still required to carry any biological waste out of the reactors, the backwash water is supplied from the downstream process.

3.7.6 pH Neutralization

After the biological system the treated stream from the EBR is collected in a UF feed tank for pH neutralization. A byproduct of the denitrification process is an elevated pH in the process stream; to lower the pH, carbonic acid is introduced system being used upstream with a dedicated skid but using the same CO_2 storage. Similar to the previous application, the carbonic acid approach is recommended to avoid undesired residual ions from being introduced into the stream that would result from the use of other common acids.

3.7.7 Ultrafiltration (UF)



Ultrafiltration Skid - Installed

The Ultrafiltration (UF) system is fed by clarified water from the UF feed tank using VFD-controlled feed pumps. Prior to entering the filters, the water first passes through a 200 µm pre-strainer for removal of any residual larger debris/suspended solids. From the strainer, the feed travels to the ultrafiltration system, which consists of a series membrane filtration units fed from a single header.

The filtration process is an outside/in, pressure-driven process to remove suspended solids and turbidity, and to achieve 4-log reduction of pathogens like Giardia and Cryptosporidium.

Clean water is sent to the UF filtrate tank, this tank supplies water to the downstream Reverse-Osmosis process and water used for backwashing, flushing, and makeup/push water for chemicals throughout the plant. Backwashing of the UF system itself is required to remove accumulated foulants by reversed inside/out flow at an interval of 20 - 60 minutes with air scour for increased agitation. A drain or filter-to-waste step is used to remove any additional accumulated material. WesTech UF membrane systems automatically conduct an integrity testing once every 24 hours. This automated and monitored pressure decay test (PDT) is capable of detecting a single fibre break in the system.

The backwash sequence and flush-to-waste streams are recirculated back to one of the reaction mix tanks ahead of the Clarifier to be reprocessed through the phys-chem system where the eventual removal of solids and foulants will occur with the settled sludge in that system.

Maintenance cleans (MCs)/chemically enhanced backwashes (CEBs), and clean-in-place (CIP) procedures are automated chemical cleaning processes used to recover membrane permeability and prolong the life of the filter. MCs/CEBs are typically performed with Sodium Hypochlorite (NaOCl) or citric acid hourly. The automated clean-in-place procedure is designed to occur no more frequently than once per month and is conducted with either NaOCl or acid, and is initiated when membrane permeability decreases to a specified value.

Following chemical cleaning procedures, the membrane units are drained by gravity or a pressurized drain-to-waste, and waste is subsequently returned to the last reaction

tank of the phys-chem system to neutralize it and permanently remove the solids from the process. A rinse step and backwashing are used to remove residual chemical prior to resuming production.

3.7.8 Reverse Osmosis (RO)



Reverse Osmosis Skid (WesTech stock image)

The Reverse Osmosis (RO) system accepts the filtrate from the UF process out of the filtrate tank. The feed goes to the reverse osmosis system. The RO system required is a single pass RO designed to remove dissolved contaminants from the inlet water source with a consistent silt density index (SDI) < 5 and a turbidity < 1 NTU.

The recovery of the system is preliminarily designed as 75% but may be improved or hampered by changes in the water quality and fluctuations in dissolved constituent concentrations, like TDS. The RO system has a nominal rejection rate of 95 – 99% of dissolved materials including those contributing to hardness and TDS.

Reverse osmosis technology uses semi-permeable membranes for removal of dissolved contaminants. The basic principle of RO involves application of high pressure to counteract natural osmotic pressure to drive water from a more concentrated, feed solution to a pure water permeate. Dissolved impurities are removed during this process.

The process utilizes crossflow filtration to remove dissolved contaminants from the feed stream, producing a purified water stream (permeate) and a high-solute waste stream (concentrate). The desired recovery level is typically determined by the scaling characteristics of the feed water. A high-pressure pump boosts the feed pressure provided by the feed pump(s) and drives water through the membranes.

Similar to the UF system, Clean-in-place (CIP) procedures are chemical cleaning processes used to recover membrane permeability. The clean-in-place procedure is conducted with either a high pH/alkaline or low pH/acid solution, depending on the foulant. A CIP is automatically initiated when normalized permeate flow decreases by ≥ 10%, normalized salt passage increases by ≥ 10%, or normalized differential pressure increases by ≥ 15%.

The RO will remove any residual metals and byproducts from other processes (including cyanate, the primary byproduct of the cyanide destruction step) to acceptable levels. As a result, the permeate stream from the RO system will meet the treated effluent targets outlined earlier in this document and is ready to be discharged to the environment (at Halfway Creek).

3.7.9 Discharge to Environment

The RO system constitutes the final step in treating water to a level that meets all the targets required for discharge to the environment. Thus, the permeate stream from the RO system is discharged directly to Halfway Creek. Remineralization may be required prior to discharge; remineralization is not included as part of the treatment plant design and if it is required is the responsibility of the Owner.

To ensure no contaminated liquid waste streams require processing off-site, the produced concentrate from the RO system is further treated within the plant and then recirculated to the HLF. This results in a discharge flow rate (to Halfway Creek) that is lower than the design incoming flow rate. Cobalt is one of the constituents that will be recirculated through the treatment system by being sent back to the HLF until the cyanide levels in the HLF drop, at which point, free cobalt will be readily precipitated in the phys-chem tanks. Some cobalt removal is also expected in the biological denitrification step (described above) before the waste stream return to the HLF.

3.7.10 HLF recirculation water production

The management of the RO concentrate (and additional treatment steps) prior to recirculation to the HLF are outlined below and are included as part of the overall treatment plant. The concentrate from the RO system is directly fed to a smaller scale phys-chem treatment system very similar to the primary treatment stream's initial step outlined above. This system will target sulfate removal by gypsum desaturation and additional barium sulfate precipitation as needed.

3.7.10.1 Chemical Conditioning

Similar to the primary phys-chem system, chemical conditioning of the waste stream is required to facilitate coagulation and precipitation. The primary driver for gypsum precipitation is calcium hydroxide ($Ca(OH)_2$ which will be added in the initial mix tank.

Since gypsum solubility is high (2,000 – 2,200 mg/L), the addition of barium salts might be needed to further enhance sulfate precipitation as $BaSO_4$. Barium sulfate has very low solubility in water (2.5 mg/L), with the final sulfate concentration limited only by the amount of barium added and reaction time.

3.7.10.2 Clarification



Traditional Clarifier/Thickener – Overflow Weir

The solids from the sulfate precipitation step will be captured in an additional, smaller secondary clarifier, identical in design and function again recommended for this process. A comprehensive description of that process can be found above in the primary clarifier description.

Additionally, polymers can be added directly to the feedwell at the center of the clarifier to increase the rate of solids settling within the clarifiers clarification zone. Sludge collection from the bottom of the clarifier is accomplished by an identical setup as the primary clarifier, sending a portion of the solids back to the mix tanks to increase interaction and settling efficiency.

The treated water leaving the secondary clarifier treatment system is collected in a clearwell tank and is then pumped back to the HLF.

3.7.11 Solids Handling

Slurry waste streams from both clarifiers require further consolidation and dewatering prior to disposal. The water extracted in these processes is re-circulated back to the front of the treatment plant to contribute to the produced water, reducing total waste and loss of water.

The waste streams generated from the physical-chemical treatment steps carrying the precipitated and consolidated solids are all combined in the sludge storage tank. The sludge storage tank is equipped with a mixer and serves to collect and homogenize the slurry(s) prior to dewatering in the filter press. Because dewatering with a filter press is a batch operation, the volume of the tank is determined based on the required storage capacity to accommodate the batch process.

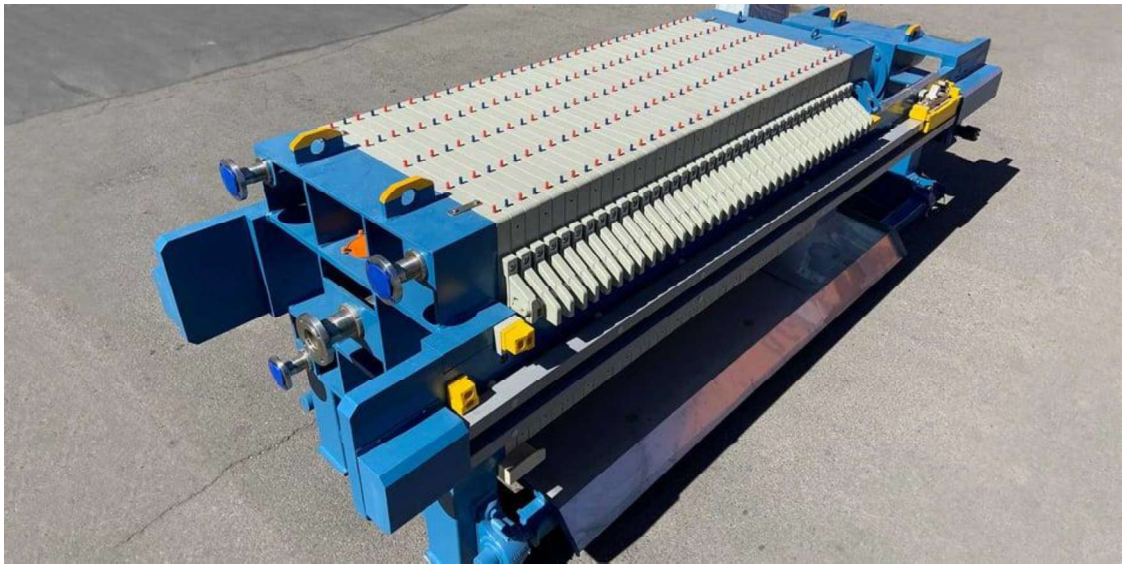


Plate and Frame Filter Press (WesTech stock image)

The filter presses are used to separate solids from water using plate and fabric pressure filtration. The filter press is comprised of a steel framework with a hydraulic closing cylinder that locks packs of polypropylene plates in place. The filter plates have an internal recess with a feed inlet and a filtrate drainage grid covered in filter cloth. Feed slurry is introduced under high pressure. As the chambers fill under pressure, filtrate moves through the filter fabric and exits via the plate drainage grid. The solids are trapped in the chamber and formed into a solid cake. At the end of the cycle, the plates are separated, and the cake falls to a solids collection hopper, dumpster, or similar transportation device for disposal.

Dewatered solids will be sent to an on-site lined pit for disposal; processing and transport of dry solids to the pit is not included in the treatment plant design scope and will be the responsibility of the Owner. The filtrate produced from the filter presses will be collected and pumped back to the front of the plant.

3.8 Operation Philosophy and Automation

The treatment plant is designed to be in continuous 24 hr/day operation during the annual period of April to October. Due to the nature of some of the equipment and processes, recirculating the effluent flow at a minimum rate within the plant is preferred for short-term consideration when there is no available untreated influent to provide forward flow rather than performing a temporary shut-down of the entire plant. Long-term shut down, layup and storage procedures are prepared as part of the detailed design activities. Bypass or recirculation of some individual systems within the plant may be required during certain startup sequences prior to bringing additional downstream equipment online.

Operations personnel are required to be at the plant whenever any of the systems are receiving or discharging forward flow.

3.8.1 Operator Controls and Monitoring

The treatment facility will be equipped with a semi-automated control system. A series of programmable logic controllers (PLC) will monitor and operate all unit processes based on feedback from field instrumentation, which may include flow rate, pressure, tank levels, and water pH and quality parameters. A local human-machine interface (HMI) panel will be provided at unit PLC's as required to provide operators with local indication, observation, and limited control of certain processes. All individual unit PLC's will provide comprehensive feedback to a master PLC panel located in a control room or centralized location within the plant for operator. Master PLC shall have an HMI panel for operator interface and direct observation of all unit PLC's and auxiliary equipment as applicable. Multiple interface screens, including simulated screens from the unit PLC panels (where applicable) shall be provided at the master PLC HMI.

All critical controls for adjustment of flow, chemical addition, motor speed (where VFD controlled), on/off control valves, instrumentation feedback, recirculation of off-spec treated water are maintained at the master PLC

The treatment plant systems will be equipped with instruments that will communicate with the PLC, including flow transmitters, flow control valves, level transmitters and switches, solenoid valves, pressure transmitters, etc. Each unit process will be equipped with relevant water quality analyzers. For instance, the clarifier unit will have an integrated turbidimeter and a pH probe, while the denitrifying bioreactors will be equipped with an in-line nitrate analyzer.

The water quality monitoring provided will allow the operators to assess the plant's performance in real time. The human-machine interface (HMI) will display the current plant conditions, trends, and alarms for the operators, notifying them of improper operations or out-of-spec conditions. Automated adjustment, initiation, or shut-down of chemical feeds, system flow rates, backwash/cleaning/batch processes shall be implemented to the extent possible using established and proven programming logic integrated between individual unit PLC's and monitored by the master PLC.

An operating Control Narrative and Alarm List shall be provided outlining controls, alarms, and interlocks. The programmer shall provide a comprehensive Project Book with details about the final design program and user interface.

The status of the plant and any subsystems may also be transmitted to the Owner allowing for the transmission of any common alarms, shutdown sequences, or other data to a centralized location. This integration or interface with the Owner's existing controls/monitoring systems shall be limited to a single output data connection (fiber optic patch) at a tie point located inside the master PLC. Any required inputs from the Owner or other external sources for operation of the plant shall be provided by the Owner and delivered to the same tie-point.

3.8.2 Transfer Pump Skids

All WesTech transfer pumps required within the primary Process flow shall be supplied on pre-assembled on skids to minimize field piping and fit up, installation time, and ensure fast mobilization. Pump skids shall include installed spares as outlined in this document, including all necessary isolation valving, instrumentation, etc. on-skid, plumbed and tested ready for placement. Skid frames shall be welded steel fabrication and include integral lifting/anchor lugs w/ minimum (4) anchor bolts.

3.8.3 Chemical Feed Systems

All chemical additions will be automated and controlled by the PLC. Chemical dosing pumps are supplied pre-assembled on individual skids for each reagent; each skid will include one operating and one standby motorized diaphragm pump with automatic stroke control and local HOA switches. The PLC will define which pump is designated for regular operation (Duty) and which is redundant (standby).

3.8.4 Chemical Storage

Storage tank sizing for process chemicals shall be performed upon completion of the final chemical consumption table during the detailed engineering phase of the project. The chemical type, recommended dosage, and maximum anticipated consumption rate will be determined by based on lab testing data and the Design flow value; the simulated lab testing is used for this project.

Where multiple chemicals and their associated storage tanks are provided for a plant or system, they shall be consolidated where possible, while still segregated by firewall or other means as required by local building codes or regulations. Preferably, they shall be filled from a centralized fill station equipped with high/overflow level control alarms, shut-off valves, and hose connections for filling via bulk transport tanker trucks. Day tanks (permanent totes) shall have provisions for a vertically stacked replaceable fill tote or permanent fill station near the tote. Individual replaceable tote storage is permitted for low or intermittent use chemicals and where the tote replacement activities will not interrupt continuous operation of the plant. All individual totes requiring removal and/or replacement shall be accessible via forklift.

3.8.5 Redundancy

Critical controlling instrumentation shall include sparing and bypass considerations as outlined:

- Equipment mounted instrumentation shall include installed spares (N+1) permanently wired to the PLC and may be used for validation of primary controlling instrument.
- In-line flow-through instrumentation (flow meters, control valves, orifice) shall include manual bypass and isolation piping system for maintenance or replacement without interruption of forward flow.
- In-line insertion instrumentation (probes, sensors) shall be selected and installed such that they can be removed and replaced without interrupting forward flow where possible. Otherwise, redundant installed spares will be provided (N+1).

Rotating mechanical equipment (pumps, compressors, etc), excluding tank mixers/flocculators, shall include spares (N+1) permanently wired, plumbed, and installed on the same skid as the duty equipment. All appropriate cross-over piping, isolation valving, instrumentation, etc. shall be included to ensure continuous operation of the system and allowing the Operator to change the designated “duty” equipment at any time.

Other equipment, non-critical instrumentation, and electrical devices shall include installed spares (N+1) if they meet the following criteria:

- Failure is expected to occur within the first year of operation AND
- Failure cannot reasonably be identified and mitigated by the operations staff within 2 hours

Non-redundant equipment, instrumentation, and electrical devices shall include a shelf spare (supplied with the initial shipment) if it meets all the following criteria:

- Failure is expected to occur within the first 5 years of operations

  AND
- Failure results in the inability to output treated process water for 48 hours OR
- Failure cannot reasonably be identified and mitigated by the operations staff within 2 working days.

Provisions in the overall plant design for storage and management of shelf spares is not considered within the plant boundaries except as specifically noted.

4.0 Minimum Technical Design Requirements

4.1 Battery Limits

Proposed battery limits, external services, and tie points for the treatment plant are outlined below. Where property lines or other local record data is used for identifying site boundary limits or tie points, development plans and government records shall be provided by the Owner for review and incorporation in the design. Upon selection of a site for the treatment plant, a tie point drawing shall be prepared to illustrate exact location, pressure, and connection type of each process tie point.

All plant facilities, equipment, conveyance, and permanent storage shall be maintained within the project battery limits. Construction lay-down, staging, and storage areas may be developed outside of the battery limits where permitted. Such areas shall be limited to the extent possible and are subject to the Owner's approval. Land, property, or other nearby areas that are not owned by the Owner shall not be used for any storage, staging, trailers, parking or any other similar construction activities related to the project without express, written, and documented permission of that respective property's owner and the approval of the plant Owner.

4.1.1 Process Tie Points

Process tie points are shown on the PFD with "TP-X" tag designations. All process piping tie points and shall be consolidated to a single area located at the geographical battery limits of the treatment plant site. The consolidation, transportation, and disposal of solids produced by the plant are not included in the treatment plant design unless specifically noted.

Process treatment chemicals are stored within the treatment plant footprint in storage tanks and require periodic delivery via tanker truck or individual tote (dependent on consumption) to replenish storage volumes. On-going chemical delivery and management is the responsibility of the Owner. Site layout shall include space for truck delivery to chemical fill station for distribution to the individual chemical storage tanks.

4.1.2 Plant Utilities

Supporting utilities as required (potable water, compressed air, sanitary sewer, etc.) shall be supplied to the treatment plant by the Owner at tie points located at the geographic battery limits of the site unless noted otherwise.

Potable water supply shall be provided to the treatment plant site by the Owner as required for safety showers, eye wash stations, and other personnel services as required by local codes and regulations. Potable water systems shall be maintained separately and independent from all process water systems.

Compressed air shall be provided by the Owner to a supply header near the Process Tie Points, unless specifically noted otherwise.

4.1.3 Service Water System

Service water for treatment plant operations activities, such as wash down, flushing, backwash, dilution etc. shall be generated by effluent water re-use during permanent plant operation. A dedicated service water tank shall collect a portion of the effluent for plant use as required and shall be accounted for in the water balance. Hose stations shall be provided at various locations throughout the plant as needed for equipment maintenance and personnel safety considerations.

Safety showers and eyewash stations shall not be plumbed into the Service Water system (refer to Plant Utilities).

A Potable water tie-in to the service water tank may be required to provide adequate water for the plant during startup, commissioning or upset flow conditions. Potable water tie-ins shall be provided with appropriate backflow prevention measures as required by the local jurisdiction to prevent treated effluent from entering the balance of the potable water system

4.1.4 Geographic Battery Limits

At this stage of the project, no geographic battery limits have been defined for the treatment plant.

4.2 Site Investigation

All existing data, drawings, and reference documentation for subsurface structures, utilities, and other conditions shall be provided by the Owner where such data are available. Additional investigation shall be performed as outlined below where current or accurate data cannot be verified otherwise.

4.2.1 General Site Conditions

Existing site conditions, surface contours, landscaping, and other features shall be verified prior to completing site design activities and drawings. This shall be accomplished using topographic survey data collected and compiled during the preliminary phases of the project. Survey data shall be incorporated into the design documents and considerations for the development of the project.

Where a recent topographic survey has been performed by the Owner or other party the data may be used upon verification that the information given in the survey is sufficiently comprehensive to support the project design activities. Verification of data

contained in existing survey and validation of control points and benchmarks shall be performed during a visit to the site by the design engineer prior to starting design activities.

4.2.2 Geotechnical Information

A geotechnical investigation shall be conducted for any site where new development and/or construction of permanent structures, equipment, buildings, and supporting systems will be performed. The geotechnical investigation work shall be performed, and a certified report provided by an engineer registered (registered professional) in the state where the project is located. Preliminary locations for major structures (buildings, large tanks, heavy equipment/machinery) shall be identified on a preliminary site plan after selection of the actual site for the treatment plant, this is to aid the investigation of soils in specific high load-bearing areas as required.

The Owner shall be responsible to coordinate the investigation activities and procure the final report as required unless otherwise noted in the contract documents. Upon receipt and validation by the Owner, the geotechnical report shall become a contractual part of the project documentation and design packages (including IFC drawings and documentation used for construction).

4.2.3 Existing Roadways and Structures

Consideration of nearby existing structures, roadways, etc. shall be included in the design and layout of the new site. This includes usage of existing or planned roadways for mine activities around the treatment plant site (if any) rather than relocating or modifying pre-designed traffic patterns to the extent possible. Site access (both construction and permanent) shall consider minimum impact to the surrounding areas and roadways. Any proposed modifications to existing roadways or structures shall be closely coordinated with the Owner. Existing structures both on the site and nearby on adjacent sites shall be protected against accidental impact during construction and permanent operation activities. Temporary measures (concrete or water-filled traffic barricades, cones, etc.) may be used during construction and shall be shown on the drawings. Permanent protection above and below grade (bollards, curbs, DOT barricades, pipe sleeves, concrete encasement, etc.) shall be provided and installed where required for plant life-cycle considerations and operations.

4.3 Engineering Documentation

All engineering documentation prepared for review by the Owner shall be properly prepared and presented per industry standard practices and the specifications outlined herein. Each document shall bear the initials or other unique identifier for the designer/preparer, reviewer/checker, and approver (as applicable). Revision tracking is required for any documentation that requires multiple reviews, submittals, or requires updating at any stage of the project.

Where required by local law and/or the Jurisdiction Having Authority (JHA or AHJ), design of the plant and associated systems shall be performed under the direction and review of a registered professional who is licensed in the state where it will be constructed. Where this requirement applies, all design drawings and supporting documentation shall be stamped and sealed by the registered professional responsible for the same.

4.3.1 Document and Tag Numbering

All documents and drawings provided for a project are assigned specific document numbers aligned with the documentation database maintained by WesTech document management. An Owner document numbering system may be adopted in addition to the WesTech number where required in the contract documents. The WesTech document number shall be applied to all documents for internal alignment and organization independent of the Owner's document numbering or organization requirements.

Cross-referencing between affiliated project documents shall use the WesTech assigned document number only. Where an Owner document numbering system is applicable, the project documentation database shall be provided to the Owner for their use in aligning the WesTech document numbers to the associated Owner document numbers.

4.3.1.1 Drawing Numbers

The drawing numbers assigned to engineering review and construction drawings shall follow WesTech standard convention per internal Document Management procedures and the drawing preparation specification: 01 30 10 – Drawing Requirements.

For large sets of identical drawing types, such as P&ID's, the drawing numerical designation and organization shall be progressive through the primary treatment processes and systems with ancillary and supporting systems occupying secondary or latter number sets in the drawing chronology.

Drawing organization shall follow industry standards of practice for design and detailing. Compilation of drawings into drawing "sets" shall include appropriate cover, index, and legend sheets to aid in organization and navigation by the user.

4.3.1.2 Specification Documents

Project specifications for equipment, materials, piping components (valves, specialty items and instruments), construction and commissioning activities, among others shall be assigned a designated project specific number aligned with the project documentation numbering system as required.

Piping Material Specifications (PMS) shall be generated from the native database in AutoCAD Plant 3D. Standard PMS are pre-established in the application, any modification, customization, or updates required to meet project-specific requirements shall be approved by the mechanical engineer responsible.

4.3.1.3 Lists, Calculations, Data Sheets, and Other Miscellaneous Documents

All other documents, including but not limited to data sheets, lists, calculations, vendor packages, etc., that are submitted for project review or information may be given a project specific number in accordance with WesTech document control standards and the project documentation database.

4.3.2 Tagging

All individual pieces of equipment, valves, electrical panels, junction boxes, instruments, and specialty items represented on the P&ID drawings or within the controls logic and programming shall be assigned a unique tag number per the

engineer's standard convention. Packaged or standalone equipment (with standalone, non-integrated controls systems) may be assigned a single "package" or "skid" tag number where applicable; in these cases, the tagging of individual valves or instruments within the package shall be by the package manufacturer (if applicable). Owner assigned tag numbers (or tag prefixes) may be included as a secondary identifier where required by contract documents.

Assigned tag numbers shall be carried throughout the project on all associated lists, data sheets, drawings, and other documentation (as applicable). Controls, programming, and operations data logging systems shall use the WesTech assigned tag number unless specifically noted otherwise.

4.3.3 Project Deliverables

All engineering and design documentation is prepared for either internal use or external distribution. Documentation to be prepared for external distribution shall be outlined in a Vendor Drawing and Data Requirements (VDDR) as deliverables to the Owner or contractor. In general, external distribution of deliverables will use PDF file formats; this distribution is managed and controlled by the WesTech document control team.

It is expected that an external deliverable or document set is complete, comprehensive, and acceptable upon being issued by the Engineer to the Owner for review. In some cases, a submittal drawing or document is only as developed as is reasonably expected at a specific design phase but will still be submitted in the un-finished state to illustrate design development and solicit feedback. In such cases, all information pertinent to that design phase shall be included with the expectation that additional details will be added as the design progresses and subsequent submittals are completed (this may include multiple subsequent deliverables that support or replace a single original document).

4.4 Design Limits and Emissions

4.4.1 System Design Size and Capacity

The treatment plant and supporting systems shall be designed for the conditions outlined in the project Basis of Design. Site, equipment, instrumentation, fluid handling, solids handling, chemicals, electrical, controls, and utility loads shall not consider any reserve space, additional expansion area/volume, or operating capacity unless explicitly outlined in the contract documents or as otherwise stated herein.

4.4.2 Noise Emissions

Individual pieces of equipment shall not produce noise levels above 85 dBA time-weighted average (TWA) in accordance with NIOSH 98-126 based on continuous operation. Sound enclosures shall be provided for all equipment that exceeds this limit sufficient to reduce exposure below the permitted level.

Environmental impact of overall plant noise emissions is not estimated, measured, nor mitigated in the design of the project.

4.4.3 Gas Emissions

Limits for gas emissions (if any) shall be provided by the Owner as part of the contract documents, otherwise, gas emissions due to chemical or treatment processes are not

measured, contained, or otherwise limited unless quantities and/or constituents exceed the allowable limits restricted by local codes and regulations. Instrumentation and monitoring of actual off-gas production is not included in WesTech scope unless specifically noted.

Off-gassing of other chemical vapors or produced gases may occur as a by-product of chemical storage ventilation, treatment processes, or other plant operations. These gas emissions are considered negligible in nature and are not calculated nor reported in project deliverables unless specifically noted. Any potentially noxious, toxic, or harmful vapors produced shall be vented to outdoor areas away from building clean air intakes or personnel walkways in accordance with the Personnel Protection Systems outlined herein.

Note: The engineer is not responsible for obtaining new or expanded gas emissions permits under any circumstance. Where treatment plant gas emissions result in or contribute to an overall gas emission in excess of the Owner's current permit for their comprehensive operations, the Owner shall be responsible for permit modification or renewal.

4.5 Design Considerations

Facility and plant design shall consider all facets of engineering design and development in addition to operations and maintenance for the projected lifetime of the project with primary emphasis on personnel safety and following principles of sustainability. Integration and coordination of all design aspects is critical to ensure a safe, fully operable, and sustainable project execution.

4.5.1 Secondary Containment

There are (2) types of Secondary Containment area designations within the treatment plant: (1) Permanent sealed containment areas and (2) Temporary collection and containment areas. Containment area minimum design requirements are outlined in the Civil section of this document.

Consideration for dual-contained process piping, leak/rupture detection systems, etc. are not included unless specifically noted.

Storm water management within containment areas shall be as outlined in the Civil section of this document. Treatment or mitigation of storm water collected within the site battery limits is not considered as part of the plant design.

Refer to Civil Design requirements for design requirements applicable to secondary containment areas.

4.5.1.1 Type I: Permanent Sealed Containment

Areas designated for permanent sealed secondary containment shall be impervious with consistent height perimeter walls/berms and shall be sealed/coated as required to ensure complete collection and retention of fluids. All such areas shall have provisions for holding the required minimum containment volume, defined as either 110% of the largest single tank within the containment area or the full design stormwater event (if containment area is unsheltered), whichever is larger with sufficient freeboard over the maximum anticipated liquid level within the containment. In addition, all sealed secondary containment areas shall have collection sumps or low point basins for

neutralization and discharge of the treated fluid. Permanently installed neutralization system(s), pumps, and piping/tubing to separate discharge points are not required, however provisions shall be made in the design to accommodate temporary systems.

The areas requiring permanent sealed secondary containment include the following (unless otherwise exempted by the Owner in the contract documents):

1. Chemical/Reagent Storage Areas
2. Chemical/Reagent Fill Stations
3. Chemical Pumps/Feed Skids
4. Additional areas as required by the contract or project specifications

Leak detection within sealed secondary containment systems shall be dictated by the type of secondary containment system employed (operator observation, local indication, electronic signal, etc.). Automated electronic leak detection systems are not considered unless specifically noted.

Chemical distribution lines throughout the plant are not required to have sealed secondary containment except where required for personnel protection as outlined in this document or otherwise specifically indicated in contract documents.

4.5.1.2 Type II: Temporary Collection and Containment

Where required by contract, the collection of potential spill, overflow, or drainage of Process water within the plant, in addition to washdown and maintenance wastewater shall be provided. This may include any paved or floor slab area within the plant (inside or outside of buildings) containing process treatment equipment, tanks, pumps, piping corridors, or maintenance/laydown spaces for the same.

Temporary collection and containment areas are not intended to permanently retain fluids (except in the destination: i.e. process sump or similar) and shall have sloped continuous paths to designated collection point(s), such as trench drains, floor drains, and/or sumps. Sumps collecting process water shall be sealed and are permanently equipped with automatic, level-controlled pumps for the discharge/handling of the collected fluid back to the front of the treatment system or plant (or as otherwise designated in the contract documents). Areas provided with collection sumps and automatic sump pumps, are not required to have a minimum design containment/retention volume, unless noted otherwise; sump pumps shall be sized for the maximum anticipated flow rate collected by the drainage system (or the maximum influent flow rate of the plant).

Overflow and drain lines for equipment and tanks shall terminate at grade directly adjacent to equipment/tank unless specifically noted otherwise. Surfaces around drain lines shall be sloped to nearby collection trench drains, floor drains, or sumps.

To the extent possible flanges, threaded/compression fittings, couplings, or other discontinuities in the process piping systems shall be placed within the temporary collection and containment area. Pipe racks and general conveyance lines are not required to be placed within the containment area unless specifically noted.

4.5.2 Chemical and Reagent Storage

Storage tank sizing for process chemicals shall be performed upon completion of the final chemical consumption table during the engineering design phase of the project.

This chemical type, recommended dosage, and maximum anticipated consumption rate is estimated based on lab testing data and the Design flow value; experience at similar sites or with similar processes may be used if the specific project treatment stream is unavailable for testing.

Where multiple chemicals and their associated storage tanks are provided for a plant or system, they shall be consolidated where possible, while still segregated by firewall or other means where required by local building codes. Preferably, chemical storage tanks shall be filled from a centralized fill station equipped with high/overflow level control alarms, shut-off valves, and hose connections for filling via bulk transport tanker trucks. Day tanks (permanent totes) shall have provisions for a vertically stacked replaceable fill tote or permanent fill station near the tote. Individual replaceable tote storage is permitted for low or intermittent use chemicals and where the tote replacement activities will not interrupt continuous operation of the plant. All individual totes requiring removal and/or replacement shall be accessible via forklift.

4.5.3 Protective Coatings

Protective coatings shall be provided for all exposed, exterior, non-stainless, non-galvanized, uninsulated carbon steel or cast/ductile iron materials (with the exception of machined or polished surfaces, mating flange faces, or as otherwise noted). Protective coatings may also be applied to other surfaces (including Aluminum, FRP, concrete, etc.) as dictated by field or process-specific conditions; any such coating requirements shall be outlined in the project Basis of Design or contract documents. Field touch-up of shop-applied coatings shall comply with the original coating system. Alternate materials of construction (not requiring additional coating) may be considered based on sustainability and life-cycle impacts for the Owner of any applied coating systems.

The manufacturer of packaged or industry standard equipment shall validate their standard shop coatings are suitable for the applicable service conditions or provide an adequate alternative. All such coating systems are still subject to review and approval by the engineer. Manufacturers shall provide field touch-up coating kits and instructions as part of the equipment supply package unless otherwise directed.

4.5.4 Maintenance and Operability

Permanent ladders and platforms with permanent guardrail systems shall be provided for all elevated equipment, valves, and instrumentation requiring access for start-up/shut-down, routine maintenance and/or inspection. Equipment requiring routine operator observation and access shall have permanent stair access unless specifically noted otherwise. Stairs, ladders, and guardrail systems shall be designed in accordance with OSHA standards and the referenced SID specifications. Where possible, interconnecting walkways shall be provided for equipment at similar elevations to avoid operations or maintenance personnel having to descend and then re-ascend ladders/stairs for adjacent pieces of equipment.

Where permanent guarded access is not feasible as described above for equipment, valves, or instrumentation requiring access for maintenance/startup operations the equipment supplier shall provide permanent attachment locations for lifeline/tie-off systems. The attachment shall be designed per OSHA 1910.140 and compatible with industry standard PFAS (personal fall-arrest system). Removable guardrail systems shall also be provided where possible at these locations to allow personnel access. In

all cases the PFAS attachment point, or lifeline shall be accessible from a properly guarded or safe location by the plant personnel.

Fork truck access shall be provided throughout the plant, designated drive aisles shall be shown on the plan drawings. Temporary laydown areas or "drop zones" shall be placed within crane reach (where applicable) shall be kept clear of permanent equipment/fixtures and are permitted to overlap drive aisles where required.

Mechanical equipment located inside of buildings which will require vertical lift of components weighing 23kg [50 lb] or more for maintenance and/or servicing shall be positioned within the direct reach of a permanent lift mechanism (JIB crane, monorail, etc.) or direct access by forklift where possible. Vertical clearance shall be sufficient to allow overhead transportation of the component to an open laydown space on the building floor (grade level).

Additional considerations for personnel access, ergonomics, and clearances are included in section 4.10.4 and applicable Safety-in-Design (SID) specifications, which include:

- WesTech SID specifications/standards:
    - Railings – Ladders – Stairs
    - Ergonomics and Equipment Access.
    - Walkways – Ramps – Platforms.
    - Equipment Guarding and Maintenance.
    - Electrical Hazards and Protections
    - Workplace Safety and Chemical Hazards.
    - Lock-out Tag-out (LOTO) Review
- Piping Design Criteria.
- Instrumentation and Controls Design Criteria

TSM Safety and Health Protocol requirements may be adopted where required by contract documents but have not been considered applicable to the water treatment plant at this time.

Except where more stringent requirements apply from the contract documents or local codes/regulations, the following minimum requirements shall be used:

- Personnel Walkway Clearances and Access:
    - Primary personnel access width: 914mm [3'-0"] minimum (1000mm [3'-6"] preferred).
    - Secondary personnel access width (max 6m [20'] dead end from primary access): 762mm [2'-6"] minimum.
    - Overhead clearance, personnel access: 2286mm [7'-6"] minimum.
    - Stair width: 762mm [2'-6"] minimum clear width at grab/handrail.
    - Stair Landings: 914mm [3'-0"] length minimum x Stair Width.
    - Secondary means of egress (ladder or additional stairs) required for elevated walkways or platforms extending >15m [50'] (straight-line) from Primary egress/access point.

    - Building egress and exit requirements as per local building codes and OSHA
- Equipment Clearance:
    - As required by manufacturer for operation and maintenance access but not less than 600mm [2’-0”] minimum on one end and one side unless specifically noted otherwise.
- Interior Drive Aisle (Forklift) Clearances:
    - 3m [10’-0”] minimum width, 1.5m [5’] inside turn radius.
    - 3.7m [12’-0”] minimum preferred overhead (2.5m [8’-0”] permitted where necessary); overhead clearance less than 3.7m [12’-0”] in drive aisles shall be specifically noted as “Low Clearance” with black/yellow striped caution marking tape/paint and actual clearance clearly indicated with bumper or knock bar set in the pathway (from primary direction of travel) toward the low clearance area to prevent permanent damage to structure, equipment or piping systems.
    - Overhead rollup doors: 3m [10’-0”] width x 3.7m [12’-0”] high minimum
- Exterior access roadways/driveways:
    - One-way traffic: 3.7m [12’-0”] minimum width, w/ 1m [3’-0”] wide shoulders each side. (16’-0” pavement width)
    - Two-way traffic: 6m [20’-0”] minimum width, w/ 1m [3’-0”] wide shoulders each side. (24’-0” pavement width)
    - Turning radius: AASHTO Intermediate, 40’ WB minimum.
    - 4.9m [16’] minimum overhead clearance; all overhead clearances for roadways passing beneath bridges, piping, platforms, etc. shall be clearly indicated using DOT standard signage or similar.
    - Pavement load rating: HS-20; 32,000 lb axle weight (AASHTO) minimum.

4.5.5 Physical Traffic Barriers

Physical traffic barriers shall be provided to protect equipment, personnel, critical structures, etc. from vehicular traffic as required. In general, concrete-filled pipe bollards shall be used as permanent traffic barriers. Pipe bollards shall be provided at the following outdoor locations minimum (where applicable):

- Each building rollup door location on both sides of the door in the approach driveway
- Minimum (2) at fire hydrants located within 3m [10’] of a paved roadway without concrete curbing. Bollard shall be located between the roadway and hydrant and shall not interfere with hydrant operation
- Minimum (2) at each side of electrical transformer pads exposed to vehicular traffic (including for raised/curbed pads), bollards shall not interfere with transformer maintenance and/or access
- Corners of containment area curbing or equipment mounting pads adjacent to roadways or parking areas.
- Building corners less than 10’ from roadways

Pipe bollards shall be provided at the following indoor locations, minimum (where applicable):

- All interior corners of designated forklift drive aisles
- Drive aisle discontinuities due to obstructions from equipment, structure or other permanent fixture into the primary path.
- Prevention of access to areas where forklift traffic shall be restricted; removable bollards may be used if infrequent, temporary access to an area is required but should be restricted otherwise. Removable bollards shall have a latching or locking mechanism to prevent accidental removal.

Pipe bollards shall be concrete filled and painted safety yellow or provided with full height safety yellow plastic bollard covers secured to the pipe. Refer to typical bollard details for different mounting locations and arrangements. Other permanent barrier types (jersey barriers, traffic-rated guardrail systems, etc.) may be used upon approval. Bollards and permanent barriers shall provide sufficient protection for equipment and personnel without compromising access to or serviceability of the equipment.

Bollards shall be designed to withstand a direct impact load of not less than 2250kg [5,000 lbs] at the mid-section of the bollard or 900kg [2,000 lbs] at the top (whichever results in greater moment load at the base).

4.6 Process Design

In general, the process design shall account for the most efficient use and selection of equipment, processes, chemicals, and controls to meet the minimum performance and operability requirements of the plant.

Equipment and chemicals are selected based on expected influent and required effluent water characteristics. Systems will be designed for level of control and automation as outlined in this document. Minimum considerations include isolation for Lock-Out /Tag-Out of major equipment and other necessary maintenance considerations, safe operations, and controllable process parameters.

4.6.1 Hydraulic Evaluation

4.6.1.1 Equipment Hydraulic Flow Design

Individual equipment design flows within the system will be considered as the maximum operating flow rate needed to meet the effluent requirements. These flows are defined in the mass balance calculation which is provided by WesTech with engineering review package. If there is an intermittent flow rate greater than the system design (max) flow rate required for an individual piece of equipment or portion of the system in order to maintain continuous forward flow within the overall system, then this peak intermittent flow rate shall be used for the design of that piece of equipment or portion of the system. Regularly occurring intermittent flowrates shall also be adequately detailed in the mass balance; multiple mass balance calculations may be performed during detailed design activities to accurately illustrate variable flows and intermittent flow requirements for proper sizing of pumps and buffer tanks.

In all cases, both the individual turndown capacity of the equipment and the instantaneous peak flow of the equipment shall be considered in the overall hydraulic evaluation of the system.

4.6.1.2 Pipe Flow Hydraulics

- Model type: Network model
- Piping pressure drop mode: Hazen – Williams and Darcy-Weisbach. Whichever is more conservative for the specific calculation.
- Gravity lines will have a full fitting-by-fitting hydraulic calculation after final equipment and piping layout is complete to ensure proper water flow and validate adequate upstream head requirements.
- Pressurized lines shall initially be evaluated for conservative headloss based on fluid velocity as part of the pump sizing, these calculations are then validated using detailed friction and minor loss calculations based on the final equipment and piping layout.
- Required pressure(s) and associated flow rate at all downstream tie points shall be provided by the Owner and recorded in the project Tie Point Package for use in the hydraulic evaluation of the comprehensive plant.
- Supply pressure(s) and associated flow rates for all lines feeding the plant shall be provided by the Owner and recorded in the project Tie Point Package. WesTech shall provide a minimum initial pressure/elevation head required at the feed tie point(s) which shall be accommodated by the Owner unless otherwise noted in the contract documents.

4.6.1.3 Pipe Flow Velocity

Pipe flow velocity as a basis for fluid line sizing shall always consider all the fluid properties (solids concentration, viscocity, etc.). Sloped or open-ended gravity lines must be evaluated for open-channel flow conditions and sized accordingly. In all cases, the line sizing shall also consider the full range of operating flow conditions (min/max flow rate, solids concentrations, etc.) for the service, including the possibility of transitional flow (from full pipe to open channel) where applicable. Where the full range of flows required by the project cannot be accommodated within a single line, engineering judgement shall be used to determine splits in flow, separate treatment trains, pumping systems or approval of temporary flow velocities during short durations or upset conditions that may fall outside the typical ranges.

Engineer shall provide a line sizing criteria or specification for design considerations as part of the design package to demonstrate adequate consideration of the factors and variables present in the project fluid streams.

4.6.2 Piping Material Selection

Piping material shall be selected based on the process water constituents. Applicable piping material(s) per service is outlined in the Piping Service Index within the project Basis of Design.

Process water properties considered during material compatibility evaluation include chlorine, sulfates, pH, temperature, material location (indoor/outdoor), and process service (chemical).

Piping Service Index will consider corrosion and chemical compatibility. Metal applications will refer to NACE Corrosion Engineer's Reference Guide. Selection of elastomers and plastics will be based on selected manufacturers chemical compatibility information.

4.6.3 Chemical Distribution Systems

4.6.3.1 Chemical Pumps and Storage

All chemical distribution systems shall have sufficient personnel protection measures as required, including, but not limited to:

- Skid frames with integral secondary drip containment.
- Plexiglass or similar (transparent) hinged safety shields.
- Lockable isolation valves at storage, distribution skids (pumps), and injection/dispersion locations.
- Safety shower accessible near chemical distribution systems.
- Local manual pump/skid shutoff (E-stop or similar)

4.6.3.2 Chemical Routing

All chemical piping/tubing in areas overhead or exposed to personnel shall use secondary containment measures for personnel protection where the routing is overhead or in an area with direct exposure to personnel walkways or access. Secondary containment shall consist of either double wall piping or a covered chemical tray of compatible material. Secondary containment collection and discharge shall be sloped and piped where possible to drain any leaking chemicals to a safe location away from personnel walkways, drive aisles, or other areas where the chemical could pose additional hazard. The drain shall daylight above the drain/sump destination for visual indication of any leaking chemicals being collected in the secondary containment. Alternately, leak detection systems may be provided in the secondary containment system.

Where chemical trays are used for secondary containment, the trays shall have a solid bottom and sides; tray joints in the bottom and sides shall be sealed, including any attachment/splice holes and fasteners. Sealants shall be compatible with the chemicals being carried. Removable tray covers are required for any trays crossing or adjacent to personnel or drive access ways (covers shall be solid but are not required to be leak-proof/sealed). If multiple chemicals are routed together within a single tray, a compatibility analysis will be conducted with the following requirements for chemical intended for the same dual containment:

- Reactivity of 2 or less between all chemicals
- No exothermic reactions between chemicals
- No creation of toxic gas if chemicals mix
- No creation of toxic solutions if chemicals mix

Where the criteria above are not met, dedicated separate trays shall be provided for the chemical(s) that are not compatible.

4.6.3.3 Chemical Injection

- Chemical injection points shall enter the feed pipe on the top 90-degree quadrant of the pipe.
- A thorough review of injection distances between chemical additions shall be performed if multiple chemicals are added in a single line or location. This is to ensure proper reaction and mixing time for each chemical as well as to avoid any unintended chemical inaction. Spacing of injection points shall be indicated on the P&ID's if required.
- The use of chemical injection quills for the addition of chemicals into feed piping is preferred.
- Chemical injection points shall be accessible for inspection and isolation.
- Chemical injection lines will have an air lock in tubing/piping by injection point to prevent chemical from escaping into process when chemical pump is turned off. This may be avoided when injection quills with an appropriate minimum opening pressure are used.
- Where possible, a portion of clear tubing/piping or air gap shall be added near the injection point so that operators can visually inspect that chemical is present.
- Control for chemical injection and chemical dosage will be considered during PID creation. Chemicals that require precise dosages will require a flowmeter to flow pace off.
- Chemical injection additions into tanks shall be designed to maximize mixing intensity at the injection point. Inject ahead of the tank or at the feed nozzle to the tank. If adding chemicals to a mix tank, injection piping shall extend to a location in the mix tank that minimizes short circuiting.
- Chemical injection additions into process piping shall be designed for appropriate mixing down stream of chemical injection point depending on chemical mixing requirements.
- Avoid addition of flocculants into long retention time mix tanks such as sludge holding tanks ahead of dewatering equipment.

4.6.4 Heat Trace and Insulation

Heat Tracing and insulation shall be provided where required by the Owner and based on fluid service, application, and ambient temperature ranges.

Where freeze protection is required for outdoor piping systems, the following apply unless specifically noted otherwise:

- Gas piping does not require freeze protection.
- Chemical lines requiring freeze protection may be routed in a common duct where possible with shared heat trace and insulation.
- Drain, vent, and intermittent use (including non-fluid or normally empty) lines do not require heat trace/insulation considerations unless specifically noted.

Insulation for personnel protection will be considered when there is potential of personnel exposure to an external piping surface temperature that exceeds 60°C [140°F] or is less than (or potentially less than) 0°C [32°F] (compressed gas service).

Insulation for heat conservation will be used when operating temperature exceeds 60°C [140°F].

4.6.5 Manual Valve Selection

Manual valve types shall be selected using the engineer's standard valve selection matrix or criteria, considering items such as function and service using best engineering practice. Available valves based on service shall be clearly outlined in the project Piping Specifications for a given service/line size. Valve materials (internal/wetted) and ratings selected will be compatible with process conditions as defined in the Pipe Specifications for each line designation.

On/Off Control valves shall be selected based on the same criteria as the manual valves in the same service/line with respect to valve type, materials, and rating unless specifically noted otherwise.

4.6.6 Pump Selection

Considerations for pump selection include hydraulics (available suction head, required discharge pressure and flow rate), solids percent and type, fluid viscosity, temperature, and any minimum applicable specification requirements (API, ASME). Refer to Mechanical section of the minimum technical requirements for additional pump selection, sizing, and design considerations.

4.6.6.1 Pump Type

In general, conveyance of low-solids process water shall be accomplished using horizontal, end-suction pumps complying with ASME B73.1 unless noted otherwise. All other pumping systems shall be evaluated based on the criteria outlined in this section.

In all cases, the pump type shall be selected to provide the most efficient service, solids handling capability (where applicable), and longevity for the fluid being pumped based on the process conditions and performance required.

4.6.6.2 Material Selection

Pump wetted parts shall be compatible with the fluid being pumped, including consideration for durability, corrosion resistance, and operating conditions as applicable.

In general, wetted pump components shall not be coated. Replaceable liners in pump casings are permitted where required and alternative, compatible casing materials are not commercially available.

4.6.6.3 Pump Driver

In general, pump drivers shall be variable speed controlled to provide flexibility in the design application. Variable frequency drives (VFD) shall be used for electric motor driven pumps; for air or hydraulic driven pumps, control of the supplied fluid pressure (pressure regulator) shall be used to modulate pump speed as required.

4.6.7 Equipment Sizing

4.6.7.1 Process Equipment

The major process equipment shall be sized based on the minimum capacity required at each stage of the process as determined by the Mass Balance calculations for the project and the requirements for redundancy or expansion outlined in the Basis of Design and/or contract documents.

Wherever possible, equipment sizing shall be based on standard manufacturer offerings capable of providing the minimum performance required, custom-sized or one-off equipment shall be avoided. Where additional capacity is required, multiple standard or modular pieces of identical equipment are preferred in parallel with split stream influent rather than specifying a customized single larger piece of equipment.

The final sizing and actual capacity of process equipment shall be provided by the manufacturer prior to production.

4.6.7.2 Mix Tanks

Mix tanks in the process are used for various reasons, including but not limited to:

- Initiate or complete a chemical reaction between reagents and the process stream.
- Produce a homogenous mixture of multiple fluids.
- Allow for development of flocculation particles and/or promote interaction between flocculants and solid particulates in the process stream.
- Maintain solids suspension (non-process and not considered herein)

All process mix tanks shall be sized volumetrically according to the required retention time to achieve the desired result (chemical reaction, mixing, or flocculated particles/interaction). Other sizing parameters, including freeboard, baffling, minimum depth, and Diameter:Height ratio may be partially dictated by the type of mixer selected, hydraulics of the system, and the engineer's standard design criteria. The mixer manufacturer shall be consulted in determining a final tank design compatible with the mixer type, orientation, and energy input being provided.

4.6.7.3 Transfer / Buffer Tanks

Process buffer and/or transfer tanks are typically in-line with the treatment process between pieces of process equipment. These tanks support a continuous forward flow within the overall plant while allowing individual pieces of equipment within the system to operate in their optimum flow state.

A buffer tank shall be used anywhere a downstream piece of equipment requires continuous forward flow, but the upstream equipment only has intermittent discharge (for example a sludge blow-down of a thickener). Alternately, where the upstream process requires a continuous discharge, but the downstream equipment operates on a batch or intermittent feed (for example a filter with intermittent backwash). The tank shall be sized with sufficient working volume to provide adequate buffer time between intermittent operations and the continuous demand/feed in addition to contingency. All buffer tanks shall be provided with level controls/monitoring as applicable.

A transfer tank may be required upstream of a pressurized/pumped system where a specific suction head or intermediate volume is required to achieve pump desired operation, and the requirement cannot be adequately met within the upstream equipment's design. Other scenarios that merit the use of transfer tanks may include a requirement for non-mixed retention time or a non-mechanical mixing transition between individual pieces of equipment.

4.6.7.4 Process Storage Tanks

The sizing of process water storage tanks is based upon having a working volume capacity sufficient for a minimum specified retention time or volumetric parameters required for their service.

Storage tanks typically have a pumped discharge which may limit the actual working volume of the tank. The minimum operating level of the with a pumped discharge (and determination of the associated "dead volume") shall be determined to limit vortex formation and provide sufficient net positive suction head (NPSH) for the pump, whichever is greater.

Other storage tanks, including those used for storage of on-site chemicals, utility water, or other auxiliary services within the plant shall be sized according to the parameters set forth in this document for each type of tank, respectively. In-line process storage tanks are classified as either transfer or buffer tanks (see previous section).

4.6.8 Instrument Air System Design

Instrument air system capacity will be based on the developed Utility Consumption List for the project with at least a 20% contingency. Dew point of air at dryer outlet will be 10° C below lowest expected ambient air temperature.

Outlet pressure of system will be at minimum 700kPa [100 psi]. Design for air piping will allow for a minimum of 550kPa [80 psi] at instrument.

Where a single, plantwide compressed air system is provided, a separate dedicated instrument air distribution system shall be provided meeting the requirements outlined above. Otherwise, the air quality of the entire plant air system shall comply.

4.6.9 Service Water System Design

The service water system shall use treated plant effluent as illustrated in the PFD; the service water system shall provide water for backwashing, rinsing, clean-in-place, utility stations, and other applications. In cases where the effluent is not of sufficient quality, pH, or may be inconsistent for critical/sensitive services (polymer make-down, chemical dilution, etc.), a separate potable water system may be used to feed the service water system or for distribution to those specific services requiring different water quality.

The service water system storage tank shall be provided with working volume capacity based on the anticipated water volume requirement developed Utility Consumption List for project plus 20% contingency on average continuous flow. Service water pump(s) shall be provided to deliver service water to the terminals at the maximum anticipated combined flow rate and pressure with 10% design contingency on both. Where minimum flow is less than the stable operating point of the service water pump, a recirculation loop may be used.

Minimum accessories on the service water feed system include a pressure transmitter, an expansion tank, flow transmitter, and pressure regulator(s) where required. Minimum pressure of the system shall be sufficient to service the highest pressure requirement within the system, but not less than 40 psi at the furthest service station from the pump.

Safety showers and eyewash stations are not permitted to be plumbed into the service water system.

A potable water tie-in to the service water storage tank may be provided for startup, commissioning, or upset flow conditions. Potable water tie-ins shall be provided with appropriate backflow prevention as required by the local jurisdiction to prevent treated effluent from entering the potable water system.

4.7 Civil Design

General Civil design and sitework are performed to develop functional layout and locations for buildings, equipment, tanks, pipe racks, raceways, and utilities including foundations and other subsurface components. The site layout is developed to consider vehicle and personnel accessibility as required to install, operate, maintain, and support plant operations (see clearances and requirements outlined in this document). A preliminary site layout and development plan has been developed for the purposes of this report.

4.7.1 Initial Preparation

Grubbing, vegetation removal and rough grading of the site is required prior to excavations or finish surface grading. Demolition of existing structures (above or below the ground surface), utility lines and/or relocation of the same are excluded unless specifically noted on the drawings.

Trenching or excavations of native soils shall be braced or cut at a maximum slope/depth as directed in the Geotechnical evaluation.

4.7.2 Site/Plant Access

Access to the site shall be provided from (2) separate entrances from existing roadway(s) unless otherwise indicated in the contract documents. All new access driveways or intersections with an existing right-of-way shall be coordinated with the Owner. Strict compliance with any local right-of-way regulations and design considerations is required.

Where only a single entrance/exit to the site is provided, the site shall provide sufficient space for complete turnaround of a standard tractor trailer (single trailer) within the site boundaries, this may be accomplished by wrapping around the building, or tanks/equipment if necessary. Ensure all minimum roadway clearances outlined in this document are maintained.

4.7.3 Utilities (Balance of Plant)

Balance of Plant (BOP) utility services shall be provided for all systems as required, these may include but are not limited to potable water, sanitary sewer, natural gas, storm water, etc. All externally supplied utilities shall be provided and installed in compliance with local codes and regulations for any occupied spaces.

Medium voltage electrical power supply is generally provided as part of the treatment system package design. BOP electrical demands are typically low by comparison, however electrical demand for lighting, fire detection, HVAC, general service, etc. shall be reported as part of the overall plant electrical load. Accommodation for any necessary transformers and distribution for low voltage as required shall be considered in the plant layout and design. Primary power supply equipment (transformer or switchgear) shall be provided by the Owner unless otherwise specified.

All trenching, shoring, excavation, and spoils handling for underground utility work shall be accounted for on-site. Coordinate utility tie-in timing with site schedule, the Owner, and the utility provider. Downtime of existing utilities shall be minimized.

All existing underground utility locations shall be confirmed by the installing contractor prior to commencing any digging, ditching, or trenching (DDT) work on-site. Locations of utility lines shown on the drawings are approximate and may be incomplete, local 811 services shall be utilized in addition to GPR as required. The contractor is responsible for procuring appropriate utility locating services and safe DDT practices.

Utility permitting (including contractor trade permits, if required) is the responsibility of the Owner.

Any pressure testing, cleaning/disinfection, and verification of utilities for beneficial use as required shall be provided per local codes and regulator standards prior to service.

4.7.4 Storm Water Management

Permanent storm water surface collection and discharge shall be designed to reduce ponding and allow for efficient conveyance to the point of discharge or storage. Finish impervious surfaces (building roofs, flexible/rigid pavements, driveways, access walkways, etc.) shall be designed to drain away from the building/process treatment areas and sheet flow onto surrounding native soils where possible. Where required, basin drop inlets and buried storm water piping shall be provided to convey collected stormwater to the existing storm drain system or the pre-developed stormwater discharge location (where permitted). Downspouts (from roof areas) shall be provided with energy and flow dissipation systems at the discharge point, including but not limited to splash blocks and riprap or similar material. Surface drainage swales may be used where they do not interfere with regular operational and maintenance traffic. Drainage swales shall use slopes and materials optimized to avoid erosion concerns. If required, at pipe outfall locations for storm water discharge into ponds or existing drainage swales, riprap shall be used as required for energy and flow dissipation.

4.7.5 Fluid Collection and Containment Systems

Requirements for the design of secondary fluid containment systems are outlined in this section, the determination and application of secondary containment systems within the site shall be in accordance with the process requirements outlined above.

4.7.5.1 Permanent Sealed Secondary Containment – Concrete

Where secondary containment is achieved using concrete basins or curbed areas, the concrete shall be sealed and coated with a coating resistant to the process fluids or chemicals within the containment area. Continuous hydrophobic expansive waterstop shall be used at all construction (cold) joints in concrete containment areas. Ribbed flexible bulb waterstop and greased slip-dowels shall be used at all concrete expansion

joints, bulb size as required to accommodate the anticipated expansion/contraction movement of the slab joint.

Where containment is exposed to outdoor weather conditions, storm water collection and discharge within the containment area shall conform to Part 4.7.5.3 below.

4.7.5.2 Temporary Washdown and Overflow Containment

Containment areas for temporary process fluid discharge, washdown, and/or overflow are not considered a sealed secondary containment area and are intended only to collect and direct process fluids to a general collection sump. This type of containment may generally be applied to paved or floor slab areas within the plant boundaries unless noted otherwise. All such areas shall conform to the following requirements:

- General Considerations
    - Equipment housekeeping pads shall be provided to prevent standing water against the base of equipment, skids, tanks, etc. All drains, overflow pipes, etc. shall discharge beyond the edge of the housekeeping pad and onto the sloped floor. Housekeeping pads shall be discontinuous when placed crosswise with the primary floor slope to allow proper drainage between adjacent pads to drains/sumps.
    - Trench drains, floor drains, and collection basins shall be provided with removable HDG steel grating. All surface grating for trenches and basins shall have a minimum Light Duty or Class A load rating (75 psi) in all areas regardless of use; minimum Class E load rating (620 psi) shall be used in vehicular/forklift traffic areas. Permanent or fixed grating shall not be permitted over drainage channels/basins unless otherwise noted. Other grating materials may be permitted for chemical compatibility or corrosion resistance in areas where vehicular traffic is restricted.
    - Where treatment plant process flows, due to filter backwashes, rinses, cleaning, or other automated process activities are discharged into the plant drainage system (trench/floor drains) the trench, basins, and piping shall be sized for 120% of the largest anticipated process flow without overflowing. The discharge piping from the equipment shall be piped directly into the trench/drain location by cutting a hole slightly larger than the pipe O.D. in the grating/cover and extending the pipe vertically down through the opening minimum 75mm [3”] below the top of grate/cover (alternately pipe may terminate above the grate with a rubber boot extension that penetrates the opening a minimum of 75mm [3”] below the top of grate). Design flow velocity at the discharge shall be less than 1.0 m/s and gravity head pressure only.
- In addition to the above, areas that are inside buildings or under sheltered canopies shall conform to the following:
    - Continuous perimeter curb or foundation wall that extends a minimum of 6” above the finish floor (permitted to be discontinuous at overhead doors, personnel doors, etc. where such instances occur at the finish floor HP (high point).
    - Slab-on-grade shall be sloped to collection trench drains, floor drains, or surface sump (slope minimum 1%, maximum 2%). Exceptions to the slope requirement permitted for primary forklift drive aisles away from

equipment or piping systems. Perimeter of building floor slab shall be set at the HP (high point) elevation where possible (drainage of collected fluid away from building walls). Any construction and/or expansion joints bisecting trench drain paths shall have continuous waterstop installed per the manufacturer's recommendations. Where possible, trench drain runs shall not cross through major floor slab expansion joints.

  - Preferred elevation difference from HP (high point) of slab to top of drain grate (low point) shall not exceed 150mm [6"].
  - Collection basin(s) within the building shall be piped directly to the process sump, unless noted otherwise (for specific containment areas). Floor drains shall be 4" NPS pipe minimum and discharge into the nearest trench drain or the collection basin inside the building.
  - Piping from the collection basin to the process sump shall be sized for open-channel gravity flow from the basin to the sump at the maximum anticipated flow rate in the trench drain system, but not less than 12" NPS. Pipe shall be sloped at not less than 1:250 (0.4%) and not more than 1:50 (2%) toward the sump.

- Areas that are outdoors/non-sheltered shall conform to the General considerations of this section in addition to the following:
  - Continuous perimeter curb, minimum 150mm [6"] high with consistent TOC (top of concrete) elevation; use of foundation or curb walls of adjacent buildings is permitted provided the wall is at the containment high point (HP)
  - Access to outdoor containment areas shall be provided via ramps for crossover of (not through) the curb.
  - Continuous slope of concrete slabs (0.5% minimum, 2% maximum) to collection basins or trench drains shall be provided to prevent standing water.

4.7.5.3 Stormwater Collection within Containment Areas

Where required by local environmental regulations or as specified in the contract documents all outdoor sealed containment areas (or other areas as specified) shall include design considerations for collection and retention of stormwater that falls directly onto or could be discharged into the containment area. In addition to compliance with all other containment area requirements, these areas shall conform to the following unless otherwise specified:

- The containment area/volume determined per the process/chemical fluid containment requirements shall be evaluated and compared against the required stormwater volume retention per the design storm event at the site. The containment volume shall be based on the larger of the (2) scenarios.
- Where permitted by the Owner and/or local jurisdiction, the stormwater may be collected and then discharged into the overall site stormwater collection system. A dual-outlet from a low-point collection catch basin with an isolation compliance valve on the discharge line to the storm drain system, may be used (valve is normally closed until compliance is confirmed). Where permanent piping to the process sump is provided as the secondary outlet appropriate level controls and setpoints in the process sump are required to ensure process

fluid cannot backflow into the storm drain basin/piping. Alternatively, the collection basin shall be designed to accommodate a temporary pumping system for non-compliance situations.

- In cases where the Owner or local jurisdiction requires all collected stormwater within a site or containment area to be considered "contact water" and requires treatment, it shall be collected in a retention sump or wet well with provisions to pump the collected stormwater to either the process sump or directly to the front of the plant for processing prior to discharge as plant effluent. The stormwater retention basin or sump shall be sized to accommodate the design stormwater volume.

4.7.6 Structural Concrete

The design of all concrete shall conform with the current edition of CSA A23.3, normal-weight concrete. Loads and load combinations applied to concrete foundations, slabs, walls, or other structures shall be according to the current edition of the NBCC.

Concrete foundations shall be designed for all buildings, tanks, and equipment for soil bearing of loads based on the recommendations from the project specific Geotechnical report. Structural concrete for spread or strip footings and slab-on-grade concrete with associated reinforcing steel shall be designed per CSA A23.3 using loads as determined from the structural design parameters outlined for the site in the Basis of Design. Structural concrete work shall be per CSA A23.3 with a minimum compressive strength of 35 MPa [5000 psi] (28 day f'c). General usage concrete, including any equipment pads, containment areas, building slabs and curbs shall have a minimum compressive strength of 27.5 MPa [4000 psi] (28 day f'c).

Concrete in potential continuous contact with water (sumps, basins, tanks, etc.) shall have a minimum compressive strength of 35 MPa [5000 psi] (28 day f'c).

Independent foundations (for heavy equipment), building column piers (extending from buried foundations) and similar concrete structures penetrating concrete floor slabs inside the building or outdoor containment areas shall extend not less than 100mm [4"] above the finish floor. Expansion joints shall be considered between all independent equipment foundations, building column piers, and the surrounding floor slab.

All mechanical, electrical, miscellaneous columns (for access platforms, pipe racks, etc.) that do not require independent foundations shall be mounted on elevated concrete equipment pads or piers (min. 100mm [4"] above finish floor). Equipment pads shall be anchored to the floor slab below using post-drilled or cast-in reinforcing as required. Equipment pads shall be flat and level ±5mm [¼"] per 2.5m [8'] of width unless otherwise specified. Equipment pads and misc. column piers shall be sized such that the edge of concrete extends past the skid/equipment base not less than 80mm [3"] in all directions.

Entire building floor shall be finished concrete slab, 150mm [6"] thick minimum; 200mm [8"] thick minimum in Process Equipment areas and drive aisles. Slab within the treatment or other wetted areas shall be sloped to centrally located trench drain(s) (away from building exterior) in accordance with containment requirements outlined in section 9.6 of this document. Where applicable, the process building perimeter shall have a minimum 150mm [6"] high concrete curb; curb width shall match the building exterior wall width (for termination of wall panels). Curb shall be discontinuous through doorways unless specified otherwise.

Concrete admixtures, release agents, and sealants shall be Chloride-free.

Deformed steel bars (rebar) and wire fabric/mesh used for reinforcement in structural concrete shall conform to the requirements of CSA, material specifications shall be provided with the structural design specifications for the project. Minimum reinforcing steel quantity, placement, clear spacing, and cover shall be in accordance with the guidelines set forth in the current edition of CSA A23.3, minimum. Welded wire fabric/mesh shall only be used for temperature (expansion/contraction) crack control, all structural concrete requiring tension reinforcement shall use #4 bars minimum.

Smooth steel dowels with sleeves, minimum 25mm [1”] diameter, shall be used where necessary to prevent differential settlement between adjacent slabs at expansion joint locations. Dowel size, spacing, and placement shall be designed such to be capable of complete transfer of vertical loads across the joint.

4.7.6.1 Cementitious Grout

Cementitious grout, where required for leveling or infill, shall have minimum compressive strength of 35 MPa [5000 psi] (28 day f’c).

4.7.6.2 Precast Concrete (PCC)

Precast concrete (PCC) structures shall be designed and fabricated in accordance with the current edition of the PCI Design Handbook. All precast concrete design calculation and drawing packages shall be provided to the engineer for review.

Load bearing joints in PCC shall be designed to adequately transfer 1.5x the design load. Openings in PCC structures larger than Ø150mm [6”] or 100mm [4”] square shall be pre-formed and reinforced as required where possible.

4.7.6.3 Housekeeping Pads

Housekeeping pads for miscellaneous components (electrical panels, HVAC, plumbing components), stair landings, duct banks, etc. require a minimum concrete compressive strength of 17 MPa [2500 psi] (28 day f’c) with welded wire fabric (WWF) reinforcing, minimum. These pads are not required to follow the other structural concrete requirements outlined herein.

All permanently exposed corners of concrete shall be finished with 19mm [¾”] chamfer.

4.7.7 Miscellaneous Concrete and CLSM

Miscellaneous concrete and the use of controlled low-strength material (CLSM) for backfill, mud mats, or similar shall be limited to non-structural, non-reinforced applications. Minimum compressive strength of CLSM shall be 500 psi.

4.7.8 Flatwork Concrete

Interior exposed concrete finishes shall be trowel finish minimum, broom finish as required in personnel traffic areas where specified. Visible pocketing or rough surfaces of exposed formed concrete shall be repaired and finished to match surrounding concrete surface after formwork removal. Exterior exposed concrete in containment areas shall be trowel finish with appropriate sealant and/or coatings applied as necessary for potential continuous exposure to chemical/process fluids.

Expansion joints in concrete flatwork shall be placed to minimize buckling of both interior and exterior concrete. Expansion joints shall be full slab depth and filled with backer rod and sealant compatible with the operating environment. Reinforcing shall be discontinuous at all expansion joints, smooth dowels/sleeves shall be used to transfer shear loads as required. Control joints shall be placed to limit surface cracking of slabs, joint cuts shall be early-entry dry-cut unless otherwise specified; control joint depth shall be limited to 0.75x the depth to the top reinforcing (where applicable). Construction joints shall be back-cut (saw-cut) to the same depth as the control joints after placement of the second pour. Reinforcing shall be continuous through all construction joints.

Expansion and construction joints in slabs or structures that may be in continuous contact with process fluids or chemicals (sumps, chemical containment, trench drains) shall have continuous waterstop. In expansion joints an embedded PVC waterstop with flexible bulb centered in the joint shall be used. For construction joints a continuous hydrophilic adhesive waterstop shall be used and placed directly to the first pour concrete after formwork is removed and prior to placement of the second pour.

Concrete floors, ramps and curbs in chemical storage and distribution areas shall have an epoxy coating finish compatible with the chemicals being used; epoxy coating on floor slabs shall be provided with grit additive (for traction).

Exterior pavement surface slopes (including parking areas) shall be finished at 1% minimum (for drainage) away from buildings. Slopes of 6% maximum permitted for primary access routes (including parking areas), with up to 8% allowed for limited distances. Primary access routes with slopes exceeding 8% shall have stairs or ramp with guardrails.

4.8 Structural Design

Structures used for buildings, canopies, pipe/utility racks, elevated bridges/walkways, elevated equipment platforms, etc. shall use structural steel materials unless specifically noted otherwise. Structural steel design shall be per the latest edition of the NBCC and CISC steel construction manual.

4.8.1 Structural Steel

Material selection and minimum specification for structural elements shall be as outlined below:

Structural Shape/Element	Material Specification	Application
WF Shapes	ASTM A992, Gr 50	Steel structures
M, C, L, S Shapes	ASTM A572, Gr 50	Steel structures
Steel Plate	ASTM A572, Gr 50, up to 2" thick	Tank shell, gussets, baseplates, structural plate, built-up members, etc.
Hollow Structural Steel (HSS)	ASTM A500, Gr C	Steel Structures
Pipe (non-process)[a] (Sch 40 min)	ASTM A53, Gr. B	Guardrail, handrail, bollards

Structural Shape/Element	Material Specification	Application
Channel Strut	ASTM A1011 SS, GR. 33	Pipe/Panel/Signage/Cable tray/misc support systems
Structural Fasteners	ASTM F3125, Gr. A325 (ZP)	Structural connections
Misc. Fasteners[b]	ASTM A307, Gr. A (ZP)	Non-structural conn. (guardrail, grating, etc.)
Anchor Bolts (Cast-in-Place)	ASTM A1554, Gr 55 (min)	Anchorage to concrete
Anchor Bolts (Post-installed)	ASTM A1554, Gr 36 (min)	Anchorage to concrete or masonry
Heavy Hex Nuts	ASTM A563	For use with all anchor bolts and structural fasteners
Reinforcing Steel #3 thru #10 deformed bars	ASTM A615, Grade 60 (ASTM A706, Grade 60, as required)	Structural concrete and masonry reinforcement

[a] Refer to the project mechanical piping specifications for process pipe material and fasteners requirements

[b] Materials for fasteners that are part of mechanical equipment assemblies shall be per the equipment manufacturer standard supply as appropriate for the service, environment, and application.

All structural steel shall conform to ASTM standards outlined above and be designed in accordance with the applicable codes and standards listed herein. Minimum thickness of steel shapes, plates, and fasteners used in structural steel assemblies and weldments shall be as listed:

- Primary framing, open steel shapes (WF, C, MC, etc.): 6.35mm [¼"] min
- Primary framing, closed steel shapes (HSS, Pipe): 5mm [3/16"] min
- Bracing, struts: 5mm [3/16"] min
- Gussets, shear tabs, stiffener, misc. plates: 10mm [3/8"] min., 50mm [2"] max
- Fasteners: Ø16mm [5/8"] min, Ø25mm [1"] (max preferred)
- Welds: 3/16" min
- Column base plate thickness: 19mm [¾"] min., 50mm [2"] max (U.N.O.)
- Column anchors: Ø16mm [5/8"] min, (4) anchors per column minimum (exception: misc. platforms/walkways with 4-bolt column base plates are permitted to be Ø12mm [½"]), post-installed anchors shall be limited to Ø25mm [1"] max.

4.8.2 Pre-engineered Shelter Building

A pre-engineered shelter building with fabric exoskeleton (Arctic Structures, Norseman Structures, or equivalent) shall be provided for the treatment plant. The building shall be steel framed, and the materials shall be per the manufacturer standard. The main span framing shall consist of open trusses designed by the building manufacturer to withstand and adequately transfer all external, building, and surcharge loads to the exterior columns. Primary columns shall be designed to maintain stability of the building including lateral loading and anchorage without requiring additional bracing in the direction of the clear span. Intermediate framing shall consist of manufacturer standard steel members providing adequate intermediate stiffness to the overall structure and support for all required wall/roof openings (for doors, louvers, etc.).

Diagonal bracing (where required) shall be located such that it does not interfere with access pathways during operation and maintenance activities. Diagonal bracing is not permitted in the clear span direction. Openings for overhead doors, louvers, fans, etc. shall be adequately framed and braced to support the attached component and transfer all loads to the main building frame structure as required. Shelter buildings using fabric or membrane shell materials shall be taught and secured to the building framing per the manufacturer standard. The fabric or membrane material strength and attachment design and shall account for all applicable snow, ice, and wind loads in addition to anticipated exposure conditions at the site.

Minimum clear span and lean-to sections shall be as illustrated in the drawings. The building manufacturer shall provide a modular frame design such that potential future expansion of the building perpendicular to the clear span does not require significant modifications to the existing structure.

All building structure calculations, drawings, and design documents shall be stamped and sealed by a Professional Engineer registered in the state/province where the building will be constructed. This stamp/seal shall be provided by the building manufacturer or their delegated designer.

4.8.3 Utility Racks

Overhead utility racks for supporting piping and cable raceways shall be constructed of structural steel. Steel frame dimensions shall extend beyond the pipe/cable tray extents on the sides and bottom of the rack where possible. Cantilever members off the sides of the rack are not permitted except at columns and for supporting vertical drops directly adjacent to the rack to/from the main piping corridor. Steel framing shall be the lowest extent of the utility rack over personnel and vehicular traffic corridors.

Utility racks shall be prefabricated in modular sections to the extent possible using bolted assemblies in the field. Modular sections shall not exceed standard shipping dimensions for ease of handling. Field welding on utility racks shall be limited to the extent possible. Refer to WesTech standard pipe support detail S-DT-01, “Pipe Racks” for typical configurations.

The utility rack lateral force resisting system (LFRS) shall consist of struts and diagonal steel bracing for the longitudinal direction. LFRS for the transverse frames are to be diagonally braced where possible, transverse moment frames may be used where diagonal bracing will interfere with access or clearance requirements. Longitudinal lateral force resisting systems shall be braced frames. Piping and cable tray shall not be considered as part of the structural frame or LFRS.

4.8.4 Elevated equipment and access platforms/walkways

Structural steel frames shall be used to accomplish any elevated equipment support structures as required, in addition to any personnel access platforms and walkways. Concentrically braced frames shall be used for design of LFRS for platforms and walkways unless otherwise approved by the engineer. Bolted assemblies of shop-welded components shall be used to the extent possible for all platforms and walkways.

4.8.5 Ladders and Stairs

Ladder and stair design shall conform to WesTech standard detail S-DT-10, "Guardrail, Ladders, Stairs & Grating" unless noted otherwise.

Stair stringers shall be AISC MC shapes (300mm [12"] deep min.) or standard AISC C shapes (250mm [10"] deep min.). Maximum stair height shall be limited to 3.7m [12'] without intermediate landing.

All ladders over 3.7m [12'] shall be provided with a personal fall arrest system (PFAS) that does not interfere with use of or access onto or off the ladder. Single ladders shall not exceed 7.3m [24'] in height, access to platforms exceeding 7.3m [24'] shall use multiple ladders with intermediate landing/resting platform(s) as required. Self-closing safety gates shall be used at the top of all permanent ladders. Cages on ladders are not permitted.

4.8.6 Grating/Floor Plate/Stair Treads

All elevated walking surfaces (grating, floor plate, stair treads) in general plant areas shall be HDG steel unless specifically noted otherwise or as required due to nearby process/environmental conditions. Grating used in chemical storage, handling, and distribution areas shall be fiber-reinforced plastic (FRP). FRP grating shall not be used where forklift or vehicular traffic is expected without prior approval by the engineer.

Grating/floor plate and stair treads for elevated steel platforms/walkways shall not be considered as adding any stiffness to the structural design of the steel frame nor be included as part of the lateral restraint system.

Elevated platforms shall use open grating, maximum deflection shall be limited to ¼" per panel width or L/300 under the design loads whichever is lower. Floor plate shall not be used without prior approval. All floor plate shall be diamond pattern checkered plate, ASTM A786, min. ¼" thick with raised grid pattern.

Grating and stair treads shall conform to WesTech standard detail S-DT-10, "Guardrail, Ladders, Stairs & Grating" unless noted otherwise.

4.8.7 Corrosion Protection (Steel)

Corrosion protection for mild carbon steel exposed to atmospheric conditions shall conform to the following unless otherwise specified:

- Building Structural: Shop-primed or as provided by the building manufacturer.
- Misc. Structural: Hot-dipped galvanized or finish coated per manufacturer's recommendations.
- Tanks, equipment, and other misc.: The manufacturer's standard coating system properly applied per the manufacturer's requirements and the coating manufacturer's specifications unless otherwise indicated in project requirements.
- Fastener assemblies: Zinc-plating or shop galvanized.

Corrosion protection for submerged exposure of mild carbon steel shall minimally conform to the following:

- Tanks, equipment, and other misc. metals: Manufacturer's recommended multi-coat paint system suitable for the fluid service and vapor conditions anticipated. Coatings shall be properly applied per the manufacturer's requirements and the coating manufacturer's specifications.
- Fastener assemblies: AISI Type 304 or higher grade stainless steel (stainless grade and corrosion resistance shall be compatible with the fluid and vapor conditions of the application).

Note: Galvanized or Zinc-plated carbon steel assemblies, including fasteners shall not be used in submerged applications.

Corrosion protection and other considerations may be required based on the process fluid conditions for submerged applications. Design engineer shall review all applicable conditions and determine additional protective measures as needed to minimize corrosion or galvanic action.

4.8.8 Dissimilar Metals Isolation

Evaluation of dissimilar metals in direct contact (or indirect contact via conductive media such as water) shall be considered in the design of tanks, equipment, and other conditions where galvanic action is likely.

The rate of galvanic corrosion is also directly proportional to the exposed surface areas of the cathode (contact) material and anode (corroding) material. The larger the cathode material surface area compared to the anode material surface area the more severe the corrosion of the anode material will be.

Consideration shall be given to all such conditions and any dissimilar metals with high probability of galvanic action shall be properly isolated. Isolation may vary based on the application and conditions of the risk. In general, industry standard methods shall be used where possible, including bolt/flange sleeve kits, non-metallic isolation pads/gaskets (rigid: UHMW, Nylon, etc.; non-rigid: Neoprene, natural rubber, etc.), approved coating systems. Non-standard methods of isolation shall be subject to review and approval by the engineer. Isolation systems shall not negatively impact the structural or mechanical integrity of the connection or interface between the dissimilar metals.

4.8.9 Structural Finishes

Exposed building structural steel framing shall be shop-primed minimum. Miscellaneous structural frames, platforms, access walkways, ladders, grating, and guardrail shall be Hot-Dip Galvanized (HDG) in accordance with ASTM A123 (base material specifications as listed above) unless otherwise noted, galvanized steel shall not be painted. HDG structures shall have adequate vent holes in all closed sections; all welded assemblies shall have adequate drain and weep holes at locations where galvanizing material could pool during the application process.

Closed sections (HSS, pipe) shall have low-point weep holes as required to drain condensation from within the section regardless of finish.

Structural steel permanently integral to equipment shall be coated to match the equipment by the equipment manufacturer.

The building assembly fasteners shall be per the building manufacturer standard supply. All other structural fasteners shall be Zinc Plated or HDG surface finish unless specifically noted otherwise. Equipment assembly fastener materials shall be equipment manufacturer standard as required for the exposure, environmental and application conditions. Isolation of dissimilar metals is required to prevent galvanic action where required. Piping fasteners shall be per the Mechanical pipe specification.

4.8.10 Structural Welding

Welding of carbon steel shall conform to the latest edition of CSA W59, using E480XX electrodes for all welding applications. Welding electrodes shall "match" base metal in accordance with CSA W59 when welding any material in all cases. Field welding of structures shall be limited to the extent possible. Shop-welded assemblies in excess of 900kg [2000 lbs] shall be provided with lifting plans and/or recommended lift points for transportation, handling and field erection. The use of stainless steels or other non-ferrous metals for structural components is subject to review and approval by the engineer. All structural welding of those materials shall be subject to the applicable industry codes and standards.

Welding of tanks, equipment, and mechanical components associated with the equipment shall conform to the weld requirements outlined in the WesTech Workmanship Standard per the associated base material specifications unless noted otherwise.

4.8.11 Anchor Bolts

All permanent equipment, structures, and skids shall be anchored to concrete piers/pedestals, housekeeping pads, foundations, footings, or slab-on-grade unless otherwise noted in the contract documents.

Large Process or storage tanks may be exempt where the supplier can justify a self-anchored tank configuration. In these cases, the supplier shall provide calculations stamped and sealed by a professional engineer illustrating all conditions (empty and full) under the design parameters and site conditions set forth in the Basis of Design; calculations shall adequately demonstrate the self-anchored configuration.

4.8.11.1 Cast-in Place (CIP) Anchors

The primary building column anchorage into concrete footings shall be accomplished using cast-in place anchor bolts w/ embedded heavy hex nut and washer. Anchors shall be designed to adequately transfer and support the load conditions provided by the building manufacturer or building designer into the concrete foundation. Oversized holes and structural plate washers shall be used for CIP anchors where possible to aid in base plate alignment and installation.

Major structures with cantilever, overhung load conditions, or requiring larger than Ø1" anchors, including cranes (JIB, cantilever hoists, etc.), canopies, or other similar configurations that are directly mounted to concrete shall also be anchored using cast-in place anchors unless specifically noted otherwise.

Cast-in place anchors shall not be used for process or auxiliary equipment, pipe supports, platforms, walkways, or other misc. structures except where post-installed anchors are not practical due to calculated loads, excessive embedment depth or in other specific applications.

4.8.11.2 Post-installed Adhesive Anchors

Post-installed anchors for all other major equipment, misc. structures, anchors on vertical or overhead surfaces shall be post-installed, adhesive-type (epoxy) anchors, Hilti HY-200 minimum or equivalent, International Code Council Evaluation Service (ICC-ES) report req'd for all post-installed anchor adhesive manufacturers. Where required by local codes and based on the project seismic design category, seismic load-rated adhesives and anchor assemblies may be required, refer to the Basis of Design for seismic design requirements. **Where possible, equipment suppliers shall provide additional anchor locations on equipment (for additional post-installed adhesive anchors) for extreme loading situations rather than requiring cast-in place anchors.**

4.8.11.3 Post-installed Expansion-type Anchors

Misc. concrete anchors for auxiliary systems, individual pipe stands (<1.5m [5'] above grade), and channel strut structures shall be post-installed expansion type anchors, Hilti Kwik-Bolt or similar.

For all post-installed anchors, the equipment and tank anchor tabs/chairs or column baseplates shall have holes sufficiently oversized to accommodate a through-set anchor installation, including the associated drill bit per the table below. Sufficient clearance shall be provided around the anchor tab or chair to allow drilling/cleaning of anchor holes in the concrete pad/slab after equipment placement including vertical clearance of not less than 1m [36"] directly above the anchor bolt hole. All post-installed anchors shall use double washers minimum beneath the securing heavy hex nut; where significant uplift/pullout loads are anticipated oversized plate washers shall be used to distribute load from the anchor tab/chair into the anchor.

Material and finish specifications for anchors shall be as outlined in this section. Exceptions to the above requirements shall be specifically submitted for review by the engineer.

4.8.12 Design Loads

Structural design loading conditions for equipment, structures, non-structural elements, etc. shall be in accordance with the current edition of the NBCC. This includes all site-specific loading conditions for wind, seismic, snow, ice, etc. The site-specific structural design criteria shall be outlined by the Owner based on the final treatment plant location. In addition, the following load conditions shall be applied to all structures, equipment, and non-structural components supported by structures in accordance with the NBCC and local codes, as applicable.

The applicable combination of loads for strength design according to the NBCC shall be applied to determine the critical design state of the structure. Load combinations shall consider all applicable load states in their most extreme condition, unless specifically noted otherwise.

4.8.12.1 Design Dead Loads

Dead Loads refer to all static, permanent, at-rest weight of materials included in an assembly and shall be applied to supporting structures in accordance with the current edition of the NBCC.

4.8.12.2 Design Live Loads

Minimum live loads shall be in accordance with the current edition of the NBCC, but not less than those values listed below for specific applications:

- Elevated catwalks, stairways, landings equipment platforms: 300 kgf/m^2 [60 psf].
- Operating floors/forklift drive aisles: 1220 kgf/m^2 [250 psf].
- Elevated slab floors (non-driving access): 610 kgf/m^2 [125 psf].
- Roof Live: 100 kgf/m^2 [20 psf].
- Deflection Limits (Serviceability) under applied Live Load: L/360 max (where L is the unsupported beam span length between end supports), L/240 max for cantilever ends. In all cases, the serviceability limits for a structure shall not negatively impact the performance of equipment, accessories, or other systems mounted to the structure. More stringent deflection limits may apply for structures supporting sensitive mechanical equipment, piping systems, or architectural elements as required.

4.8.12.3 Design Operating Loads (Static)

All static from mechanical equipment shall be applied as part of the dead loads on the support structure (as outlined above), unless the load is part of a temporary condition and will not be present when other load types could be applied.

4.8.12.4 Design Operating Loads (Dynamic)

Equipment that generates rotational (torque), lateral, oscillating dynamic, braking, or other vibratory loading conditions during operation shall be considered using the dead load factors when generating load combinations. All such loads shall be included as part of the manufacturer's design of their equipment and anchorage. Dampening/isolation of vibratory loads is required within the equipment where applicable. Other considerations for loading of nearby structures (such as heavy components that may be placed on adjacent platforms or walkways during maintenance or operations activities) shall be considered or communicated to the design engineer as applicable.

Operating dynamic loads for structures supporting piping systems shall include consideration of the following where applicable: thermal loading (due to fluid temperature variations in piping, tanks, etc.), pressure induced loads, fluid acceleration/deceleration, hydrostatic testing

Structures supporting the equipment, piping, or other systems shall be adequately designed to transfer all dynamic equipment loads into an appropriately designed foundation. Attachment of dynamically loaded equipment or piping to a supporting steel structure shall be bolted, clamped or similar; welding of dynamically loaded elements to the supporting structural steel frame is not permitted.

4.8.12.5 Design Operating Loads (Fluid)

Operating conditions of equipment, piping, and accessories shall be considered where process liquids, chemicals, bulk solids, or similar materials are contained or conveyed within the same. Operating loads due to materials storage/conveyance shall be applied

to structures using the dead load modification factors when generating load combinations.

- Loads for tanks containing process or other liquids shall be considered for the liquid level at the overflow or upset condition using the maximum expected density of the fluid contained. Sloshing loads (under seismic conditions) shall be considered in the design of tanks and their anchorage systems.
- Loads for piping/conveyance systems shall be considered at 100% capacity (pipe full) at the maximum expected density of the material conveyed.
- Bulk storage tanks/silos for solids shall be considered at the highest storage level permitted by the tank and the maximum density anticipated.

Where a liquid has a specific gravity (SG) less than 1.0 (density less than water), a minimum liquid density equal to 1.0 SG shall be used.

Operating fluid loads shall not be considered when evaluating equipment or structures for overturning or uplift except where they potentially increase uplift/overturning probability such as during seismic or rotational load conditions (where lateral acceleration and/or sloshing loads are being applied to the structure).

4.8.12.6 Transportation / Lifting Loads

Loading conditions of equipment and prefabricated structures during transit, lifting, and placement on-site shall be considered where applicable. Any applicable dynamic or impact loading and shall be combined with the total weight (Dead Load) of the element or structure and applied based on the design support locations during each applicable load condition (lifting lugs, tailing lugs, shipping braces, etc.).

4.9 Architectural Design

4.9.1 Pre-Engineered Shelter Buildings

The use of pre-Engineered shelter buildings is preferred for this application to provide shelter and protection for the equipment and operators. This type of semi-permanent building installation shall be designed and provided in compliance with applicable project specifications and applicable local codes and regulations.

Building eave height and clear span width shall be sufficient to provide both overhead clearance and floor space to stage, place, and maneuver equipment within those areas and throughout the building using forklifts or similar ground-based equipment during construction and maintenance activities. In addition, there shall be adequate overhead clearance to provide working space for routing process piping, utilities, and cable raceways in addition to access, operations, and maintenance activities above or around all equipment and utility racks without interfering with lighting, fire sprinklers, HVAC, insulation, or other ceiling mounted equipment.

The building structural frame design shall also consider a minimum surcharge dead load of 24.4 kgf/m^2 [5 PSF] and a single point live load capacity of 136 kgf [300 lb] at any single point on the structural and intermediate framing.

The wall/roof fabric, doors, louvers, windows, and miscellaneous components shall be similar to those described in the other architectural systems of this subsection. Interior building slabs in process and fluid handling areas shall be sloped to drains to prevent free-standing liquids from accumulating at building walls.

- Fire Rating in compliance with applicable code requirements shall apply where required to wall and roof fabric/membrane
- The fabric/membrane fasteners shall be manufacturer standard. Fasteners shall be installed according to the manufacturer's guidelines. All splices, penetrations, other closures, and sealants in the wall and roof fabric/membrane shall be per manufacturer's guidelines.
- All openings and penetrations shall be framed and sealed per manufacturer's recommendations.
- Roof slope shall be 1:2.5 minimum and designed to shed excess snow. Rooftop structures and equipment are not permitted except where approved by the building manufacturer.
- All handling, storage and erection sequencing procedures shall follow the building manufacturer's recommendations.

4.9.2 Insulation

Insulation materials shall be added to the walls and roof where necessary to help maintain the inside building temperatures as required by the contract documents or local codes for the time periods when the plant will be occupied/operating. Insulation shall be included in interior walls where required to reduce heating/cooling load on conditioned spaces separate from the main non-conditioned building area. Energy calculations shall be performed in accordance with the NBCC to balance fenestrations and penetrations with overall roof and wall thermal efficiency. Additional insulation may be required to comply with energy performance requirements. Insulation shall be noncombustible listed as Class I or Class A in accordance with Factory Mutual Guide or UL Listing.

4.9.3 Building Security

Building security system integration is by the Owner if required. Rough-in requirements and specific frame/lockset considerations shall be provided by the Owner where required.

4.9.4 Personnel Doors

Exterior personnel doors shall be the hollow metal type, flush, insulated, with formed hollow metal frames. Minimum dimensions: 91cm [36"] Wide x 214cm [84"] High. The doors shall be constructed with 14 ga. steel with an internally reinforced, insulated core. Frames shall be hollow metal type, constructed of 14 ga steel, with all joints mitered, welded, and ground smooth. Both doors and frames shall be factory primed and then field painted by the installing contractor. All exterior personnel doors shall have locks, door locks to common areas shall be keyed the same. Exterior personnel doors lever lockset with cores not installed. No sidelights or windows, except where required by code. Exterior doors shall open outward with interior crash bar, automatic closers and vandal-resistant HD hardware. Exterior doors shall exit at-grade onto concrete landings (sloped away from the building at 2%), landing size shall be not less than 1.2m x 1.2m [4'x4'] and 150mm [6"] thick minimum.

Interior personnel doors shall be hollow metal type, 18 ga steel, flush, non-insulated (except where the door separates a conditioned area from a non-conditioned area). Minimum dimensions: 81cm [32"] Wide x 214cm [84"] High. Frames shall be hollow metal type, 16 ga steel, all joints mitered, welded and ground smooth. Keyed

locksets/cores are not required, restroom doors shall be provided with standard privacy locks where applicable. Interior doors to occupied spaces shall have glazed sidelight (vision panel), glazing shall consist of tempered safety glass or wired glass.

4.9.5 Equipment Access (Overhead Rollup) Doors

Large exterior doors shall be provided for access where large items of equipment or material may have to be removed and replaced for maintenance or other purposes. Access doors shall be the overhead coiling metal type with weather seals and wind locks and shall be sized to allow passage of the largest component to be placed in the enclosed building/space when transported on a commonly available carriage or dolly's plus at least a minimum of 150mm [6"] additional clearance at the top and on each side. Door components shall be formed from galvanized steel and factory primed and shall be field painted by the installing contractor. Coiling doors shall be motor-operated, equipped with provisions that will allow emergency manual operation, and shall be minimum 3m [10'] wide and minimum 3.5m [12'] high.

Doors shall be interior mounted, heavy-duty, high-frequency use (100,0000 cycle) electrically operated type consisting of motors, drives, sheaves, helical assist coils, door panel, safety enclosures, interior push-button actuation and 3-remotes per door; equip door(s) with manual over-ride open/close device, reversing edge, and safety beams. Fabricate doors of all decay resistance metals or metals treated for decay resistance with insulated-cores; rails, glides, rollers, brackets, hoods, etc. Door panel shall be galvanized and factory-finished with baked-enamel or epoxy with polyurethane top coat. Doors in wet and/or hazardous use locations shall have appropriately rated electrical controls and enclosures; hoods and enclosures constructed of stainless-steel.

4.9.6 Windows

Rigid windows shall be provided for the control room, offices and in other locations as specified; frames shall be made of extruded aluminum. Window frames shall be finished with a polyvinylidene fluoride coating in a color selected by the Owner or match the exterior wall panel color.

Windows shall be designed for inside glazing secured by continuous extruded aluminum beads. Double paned windows shall be included in all HVAC conditioned areas.

4.9.7 Louvers

Ventilation openings shall be provided with vertical storm proof louvers. Vertical storm louvers shall be tested and certified according to AMCA Standard 500-L-99. Vertical storm proof louvers shall have a Class A classification, with an effectiveness of 1 to 0.99 at 200 mm [8"] rainfall and 22 m/s [50 mph] wind velocity. Vertical storm proof blades shall be provided complete with bird screens. Operating damper blades shall be provided behind fixed louvers wherever necessary to allow closing the related opening. Louvers shall be fabricated from extruded aluminum with a polyvinylidene fluoride finish in a color selected by the Owner.

4.10 Mechanical Design

4.10.1 Process Piping

Piping systems shall be designed in accordance with the engineer's standard specifications and criteria, client specifications, and any applicable local and/or national codes and regulations. The application of the criteria and engineering best practices shall assist in delivering the following project objectives:

- Safe operations.
- Uniformity of piping components and materials.
- Uniformity of design documentation.
- Compliance with statutory requirements.
- Compliance with specified process performance parameters and local operating conditions.

The piping systems shall be designed such that forces transmitted to the equipment do not exceed maximum allowable values permitted by the equipment manufacturers, applicable codes, or design standards, whichever is more stringent.

Piping shall be routed with adequate flexibility and shall allow access for maintenance (e.g., crane, forklifts, trucks). Removal and replacement of equipment shall be made with a minimum disruption of piping, including the support of freestanding pipe when disconnected from equipment.

Piping systems shall be designed for internal or external pressure representing the most severe service condition of coincident pressure, including the combination of fluid head and temperature expected during normal maximum operation.

Piping design shall develop standard dimension spools for maintaining piping systems subject to wear and corrosion. Design shall consider removable spools around pump suction and discharge sections, heat exchanger piping and control valve manifolds.

Except for lines in which velocities are of critical importance and for connections at equipment, the following pipe sizes shall generally be avoided: NPS 1¼", 2½", 3½", and 5".

Minimum pipe size of a line to be run on utility racks shall generally be NPS 2" to avoid special methods of support. In the event smaller diameter piping, tubing, or similar needs to be run on the utility racks adequate support (e.g., trays) should be provided.

Flanges and blanks for sizes up to NPS 24" shall be in accordance with ASME B16.5 or shall be drilled to ASME B16.5, unless otherwise directed by selected equipment's special requirement.

4.10.1.1 Vents and Drains

Piping shall be designed with designated high and low points for venting and draining. Where air entrainment is possible during normal operation, the piping shall be provided with automatic air vent or combination air/vacuum valves as indicated on the P&IDs. Other considerations shall include:

- Vent connections shall be provided at all high points in liquid piping, and all high points in other piping which shall be pressure tested.

- Drain connections shall be provided at all non-self-draining low points in liquid piping and all other piping which requires pressure testing.
- Vents and drains shall have manual isolation valves located as close as possible to the high or low point in the piping (except for automatic vent or combination valve locations). Where no additional piping is provided, the isolation valve shall be FNPT (threaded) at the open end to allow for temporary hose attachment during use.
- Vent and drain connections subject frequent operation shall be piped to the ground away from equipment/personnel walkways and/or directly to a trench, floor drain, or sump. Permanent drain piping shall not run across walkways (tripping hazard).
- All operational vents shall be directed or piped away from equipment and personnel traffic areas.
- Appropriate pipe slope, sizing, and venting shall be determined for draining of gravity flow piping is required. Slope requirements shall be indicated on the P&ID drawings.

4.10.1.2 Slurry Piping

Slurry fluid properties shall be clearly defined for proper piping design. In general slurry piping shall be designed with the minimum number of direction changes to reduce the chance of plugging and abrasion of the internal pipe wall. Pipe material selection will be made with respect to the latter (in addition to all other typical considerations).

Transitions or variations of the inner diameter (such as changing material, line size, or hose sections) shall have a smooth transition to reduce the potential of scouring. Hose internal diameter shall match the internal diameter of the equipment or piping it is connected to.

Slurry piping shall be arranged and supported to facilitate dismantling, flushing, and rotating of straight runs including the use of mechanical joints. High and low points, other than those at the pump suctions or tanks shall be avoided. Slurry piping routing shall be designed for self-draining, preferably back to a tank or vessel and shall minimize dead legs or pockets. Flush connections and cleanout tees shall be provided as required.

Full-bore, straight-thru valves (ball, knife-gate, plug, or similar) shall be used for normal shut-off service and other valve locations to the extent possible. Butterfly valves may be considered for light slurry service and large flows. In such cases, butterfly valves shall have stems set horizontal, with the lower half of the disc following the direction of flow while closing. Where throttling of the flow is required, rubber-lined diaphragm valves shall be used based on manufacturer recommendations.

4.10.1.3 Piping for Corrosive and Hazardous Fluids Service

Design of piping carrying acid and other hazardous fluids shall incorporate all safety considerations in accordance with the SID specifications referenced herein.

4.10.1.4 Compressed/Blower Air Piping

Piping shall be designed to avoid instantaneous or rapid pressure drops within the line and maintain even distribution of air flow at consistent pressure throughout the piping system to the extent possible.

Horizontal piping runs shall be sloped at 0.5% to a low point for condensation trap / drain and shall use eccentric reducers flat on bottom (where required), to permit proper drainage. All low points shall be provided with condensate drain valves.

Install piping in a manner that prevents stresses and strains from being imposed upon connected equipment.

Personnel protection insulation shall be provided and accounted for in the design where required.

4.10.1.5 Instrument Air Piping

Instrument air piping shall include a lockable isolation valve per user or device and ahead of any distribution manifolds, as indicated in applicable P&ID. A header isolation valve is preferred within 5m [15'] of each service. Automated condensate removal drains are required on all instrument air headers.

4.10.1.6 Buried Piping

Process piping is not permitted to be underground except where specifically noted (drain lines to sumps or similar). Underground piping shall be non-metallic (CPVC, HDPE, or similar) where possible. If required, buried steel or iron pipe (including in covered trenches) shall be protected from external corrosion. Buried steel piping shall also have cathodic protection.

Process piping systems that are underground where leaking of the fluid is considered hazardous or harmful to the environment shall use dual containment piping with leak detection, unless otherwise permitted.

4.10.1.7 Pipe Supports

Pipe and pipe support locations will be designed with adequate flexibility for thermal expansion or contraction without causing any overstress condition in the pipe.

Piping around control valves and in-line instrumentation shall be adequately supported to minimize vibration and to reduce stress at these devices. Valve actuators shall be provided with auxiliary support where necessary.

Lines for corrosive liquids that operate intermittently and require draining shall be sloped from end to end. Piping supports shall be spaced to prevent sag pockets between them.

Shoes, sleeves saddles or other adequate means of protecting insulation shall be provided at all pipe supports on horizontal runs of insulated piping.

Alloy pipe, galvanized pipe and pipelines with non-metals, which cannot be welded to carbon steel members and stress-relieved piping, shall be supported by clamped shoes.

Piping sections requiring frequent dismantling for maintenance, such as for the installation of blinds, shall be provided with permanent supports for the dismantled condition.

In general, polyethylene or other plastic pipes NPS 2"and smaller shall be continuously supported using cable trays or structural supports.

Where stress analysis calculations are not performed, pipe support spacing for metallic pipe shall be in accordance with Table 121.5-1 of ASME B31.1 code. However, suggested pipe support spacing for plastic piping shall be calculated based on the ambient and operating temperatures, wall thickness, and fluid contents.

Supports detailed in "Mechanical Standard Details" are supports commonly used in general service and shall be used as the basis for pipe support selection. Further standard pipe support details shall be developed and added as required during the project. Standard pipe supports shall only be used when they meet the geometry and load conditions defined on the standard drawing. Supports that do not meet such criteria shall be referred to the Structural Discipline.

Engineered pipe supports structures, where required, shall be numbered, listed, and controlled by area. Each special pipe support shall be allocated an individual reference and sequentially numbered. The use of unique reference numbers is to assist in the control of the supports during design, procurement, and construction.

4.10.2 Process Equipment

The design of the equipment shall be based on proven equipment design for the specified requirements or similar industrial equipment applications.

The equipment supplied shall be new; used equipment is not permitted.

The requirements set out in this document shall not be construed to eliminate consideration of the Manufacturer's standard design. The Manufacturer's standard design will be accepted, if found to be equivalent or superior to the requirements of these specifications.

The Vendor shall furnish all components and auxiliary equipment(s) necessary to meet the requirements of data sheets and specifications to make a complete, operable, safe, maintainable and dependable unit.

Arrangement of piping, instruments and structures, shall provide adequate clearance areas and safe access for operation and maintenance. Spacing for valve actuation, equipment maintenance, and other component functionality shall be considered in accordance with SID specifications for ergonomics.

All equipment and materials purchased overseas which meet European Design Standards or other design standards, shall be checked for compatibility with U.S. Design Standards such as ASME B31.1 "Power Piping" or ASME B31.3 "Process Piping". Interface points between equipment and materials manufactured to other standards must "fit-up" to U.S. Design Standard equipment and materials.

Adequate information about process equipment is required for incorporation into the design, including but not limited to:

- Operational and Maintenance safety requirements, clearances, and protections
- Availability and lead time of spare parts. In addition to compatibility with other equipment or assets within the overall plant, especially for rotating or wear assemblies.
- Proven history of operation in similar applications.
- Lifetime capital investment, operating, and maintenance costs.

Refer to the Mechanical and Process Equipment Design Criteria for additional details. General considerations are outlined below:

4.10.2.1 Load Data

Design loads for mechanical equipment shall be the most adverse combination of loads that can reasonably be expected to occur concurrently. Load states to be considered include but are not limited to those listed in the structural design section.

In addition, the Vendor shall determine the maximum allowable loads on equipment nozzles, battery limit flanges, and any external attachments.

Load values for each applicable design state shall be shown on the equipment GA drawings.

4.10.2.2 Limits and Fits

Geometric tolerances, limits and fits shall be in accordance with the applicable standards. Fit between proprietary mechanical components and custom designed components supplied by the Vendor (e.g., bearings mounted on shafting) shall be in accordance with the component manufacturer's recommendations.

4.10.2.3 Materials of Construction

Materials of construction for wetted components shall be compatible with the process fluid, exposed non-wetted components shall be compatible with operating environment of the equipment/system. All materials of construction shall be verified for corrosion and abrasion resistance by the engineer and/or Vendor.

No asbestos material and/or fibers harmful to health shall be used. All materials potentially presenting a health hazard must be identified by the Vendor, all accompanied by Safety Data Sheets (SDS). Their use shall be subject to engineer's approval.

4.10.2.4 Lifting Devices

All equipment or materials requiring regular maintenance and inspection that weigh more than 22.5kg [50 lbs] including high wear items shall be accessible for maintenance or replacement using forklifts, mobile cranes, manlifts, or portable lifting devices. Where such access is blocked or impeded, or where space limitations would cause the lifting procedure to be risky to personnel or nearby equipment, monorails, hoists, lift points, or other means of safely handling and/or replacing the items requiring maintenance shall be provided. Where lifting lugs are provided, both the lug and the structure to which it is attached shall be evaluated for adequate load bearing capability and impact loading. Any integral hoists, cranes, or monorails shall be tested to 125 percent of rated capacity after installation and certified by installing contractor.

4.10.2.5 Safety Guarding

Personnel protection guards shall be provided around all exposed moving and rotating machine parts and hot surfaces. The design shall fully comply with all applicable local codes, regulations, and the engineer's SID specifications.

Guards shall be designed for easy removal and access to the guarded component for inspections, lubrication, and maintenance.

Guards for V-belt and chain drives shall be large enough to accommodate one size larger sheave or sprocket change (2" on radius minimum).

4.10.2.6 Standardization

The standardization of parts shall be a priority in the design to the extent possible. The implications on the process will be given primary consideration during any attempt at parts standardization.

4.10.2.7 Thermal Protection

Thermal protection shall be by thermal insulation, heat shield, cage or another protective device and shall be removable for servicing of the equipment where required.

4.10.2.8 Internal Access

Manholes and circular openings for inspection or access shall be included for interior access of equipment where required for installation, commissioning, or maintenance activities.

Manways shall not interfere with other mechanical equipment or block access ways when open.

4.10.2.9 Equipment Labels and Nameplates

All equipment shall have permanent nameplates. Nameplates shall be masked during painting to ensure that they remain legible.

Process equipment and steel/FRP tankage shall be clearly identified with a securely attached or welded stainless steel, nameplate. Lettering will be etched or stamped with all information to be provided by the vendor, required by the Owner, engineer.

Where components are to be separated for shipment, each separable component shall be provided with a clearly stamped stainless steel temporary label to clearly identify the component and will be matched marked for assembly at site. The temporary label shall be securely attached to each separate item by suitable stainless-steel tie to allow clear identification of the component.

4.10.2.10 Packaged Equipment

If a piece of equipment is classified as a packaged equipment and/or unit, all materials and documentation necessary for complete system evaluation, installation, and operation shall be provided including all applicable subsystems. Refer to the Packaged Equipment specification.

The supplier shall be responsible for ensuring that the completed packaged system or unit is functionally tested and can be integrated into the plant with limited interface within the package (except for clearly indicated tie and termination points). Single lift, rigid structural steel skid frames with designated lifting lugs shall be used with all equipment, hardware, electrical panels, instrumentation, etc. installed and connected. Lifting and transport of the skid, shall not permanently distort or otherwise damage the skid, attached equipment, or machinery mounting surfaces.

Placement of packaged equipment in the plant shall provide adequate clearance for all interconnecting, installation, and maintenance activities in accordance with the supplier's recommendations.

Piping tie-points for process, flush, and services connections shall be located at the edge of the skid and centralized to the extent possible. Unless otherwise specified, the installing contractor shall provide all the interconnecting piping required between individual skids or separate equipment items provided in the packaged system. If the supplier provides any interconnecting piping pre-spooled, the piping shall be match-marked for easy installation. Support of interconnecting piping shall be coordinated with the engineer.

4.10.3 Mechanical Equipment Sizing and Selection

General considerations and requirements for the sizing of mechanical equipment within the treatment plant are as outlined below:

4.10.3.1 Centrifugal Pumps

Pumps shall be designed and constructed for a minimum service life of and least 3 years of uninterrupted operation and capable of operation at the normal and rated operating points and any other anticipated operating conditions specified in the equipment data sheet.

Pumps shall be capable of a minimum 5% head increase at rated conditions by increasing impeller(s) size, different hydraulic design, or variable-speed capability (without over-speed). This is to prevent a change in pump frame size due to refinement of hydraulic requirements after the pump has been purchased. It does not replace any project-specific requirements to accommodate future expansion if specified elsewhere.

Pumps shall be capable of operating at least up to the maximum continuous speed of the driver. Variable-speed pumps shall be designed for excursions to trip speed without damage.

The Operating NPSH required shall have a safety margin of 3 ft or ratio of 1.2 (whichever yields a higher value) applied to ensure stable operating conditions for all specified flows. This margin should be increased if variables exist that could increase the NPSHR of the pump.

Pumps shall have a preferred operating region of 70% to 120% of best efficiency flowrate of the pump as furnished. Rated flow shall be within the region of 80% to 110% of best efficiency flowrate of the pump as furnished.

Any needs for seal water, cooling considerations, etc. shall be determined by the vendor, and the method shall be agreed upon by the engineer.

Pressure and temperature limitations shall be stated by the pump manufacturer and shall exceed the maximum/minimum design conditions of the project site and service.

4.10.3.2 Positive Displacement Pumps

The pump Vendor shall advise in the proposal any component designed for finite life. Pump shall be provided with all auxiliary equipment required for operation of the same.

Equipment shall be designed to run at the maximum rated input speed and relief valve settings simultaneously without damage. Rated flow capacity shall be at least 110 % of the maximum capacity specified.

Unless otherwise specified, the vendor shall recommend the pump speed for the specified service, considering such factors as net positive suction head (NPSH) or net positive inlet pressure (NPIP) available and required, maximum fluid viscosity, solids and abrasives content, and wear allowance if required. The pump manufacturer shall recommend a NPSH/NPIP margin with enough contingency to guarantee the mechanical integrity of the proposed equipment.

Pressure and temperature limitations shall be stated by the pump manufacturer and shall exceed the maximum/minimum design conditions of the project site and service.

The pumps shall be designed to permit rapid and economical maintenance, particularly regarding packing and valves. Major parts or components shall be designed and manufactured to ensure accurate alignment on reassembly.

4.10.3.3 Tank Mixers

Mixers for process mixing applications shall be in accordance with the applicable specifications, data sheets, and process requirements.

The selected impeller type shall be suitable for the process conditions specified in the applicable data sheet and shall be recommended by the Vendor and/or Manufacturer based on their expertise. The assembly shall be made up of an impeller hub with bolted-on blades. The impeller shall have a hub(s) with no less than three (3) blades evenly spaced on the hub(s) having a minimum outside blade diameter per the manufacturer's recommendation for the service.

Speed reducer shall be designed for mixer service and shall be temperature rated such that it does not require a cooling system. Speed reducer shall be designed to withstand all torsional, bending, and thrust loads.

The shaft shall be designed to resist torsional loads and bending moments for all specified operating conditions, including cold startup. Shaft assemblies that operate at 300 RPM or higher shall be dynamically balanced to G40 tolerance or better in accordance with ISO 1940.

Bolts on the rotating assembly shall be secured by positive locking methods.

Unless otherwise specified, mixers shall be equipped with a through-bolted connection flange for direct mounting to steel framing or a tank nozzle.

4.10.3.4 Metallic (welded) Storage Tanks

Tanks shall be furnished complete including all interior coatings, supports, saddles, ladders, covers, manholes, handholes, gaskets, bolts, vents, standpipes, interior piping, overflows, skirts, wear plates, nozzles, hanger lugs, piping connections, drip pans, lifting lugs, and other appurtenances as specified.

Design conforms to WesTech standards and design principles based on the application of sections of multiple standards including API 650/620/12B, AWWA, AISC, etc. and common practices in the industry. The resulting design, fabrication, quality criteria, standards, practices, methods and tolerances for tankage design and erection activities used by WesTech are summarized below:

- Specific gravity used for design shall be applicable to worst case conditions of the item being stored; in no case shall the specific gravity be considered less than 1.0.
- Tank material shall be chosen suitable for the material being stored, and the surrounding environment.
- Tanks not designed for flooded condition shall be protected by the provision of an overflow pipe.
- Enclosed tanks shall be positively vented or equipped with a pressure / vacuum relief valve to prevent vacuum damage or pressurization due to temperature changes and/or liquid movement into or out of the tanks.
- Tank shell thickness shall be calculated by the "one-foot" method except where prohibited by API STD 650 or specifically defined on the Data Sheet.
- Manufacturers may additionally propose an alternate shell thickness calculated by the "variable design point" method or "elastic analysis" method if a more economical design results.
- Acceptable plates shall conform to the ASTM specifications within the stated limitation per API STD 650, Section 4.2.2.
- Unless otherwise specified, pipe and pipe couplings and forgings shall conform to the specifications listed in API STD 650, Section 4.5.1.
- The tanks having connections for top mounted mixers shall be provided with internal support steel for the mixer. The tanks shall be designed and constructed for the static and dynamic loads associated with the mixer.
- Flanges (for NPS ≤24") shall conform to the material requirements of ASME B16.5. For nominal pipe sizes greater than NPS 24", flanges shall conform to ASME B16.47, Series A.
- Unless otherwise specified, the design liquid level for calculating shell thicknesses for non-floating roof tanks shall be to the top of the shell, irrespective of operating liquid levels.
- Reinforcing plates (if required) for manholes, nozzles, and other attachments shall be of the same nominal composition as the tank part to which they are attached.
- Nozzles and manholes shall not be placed in shell weld seams and reinforcement pads for nozzles and manholes shall not overlap plate seams, exceptions shall be approved by the engineer
- Shell nozzle covers weighing 50 pounds or less shall have two handles for removal. Nozzle covers weighing more than 50 pounds and all manways shall be equipped with either a hinge or davit to facilitate the handling of the manhole cover plate.
- The davit support arm for nozzle covers/manways shall be welded to a structural member. If the structural member is of the same weld group as the shell, it may be welded directly to the shell. Whenever the structural member is not of the same weld group as the shell plate, an attachment plate of the same weld group as the shell shall be welded to the shell, and the structural member in turn welded to the attachment plate.
- Bolt holes shall straddle the vertical centerline of the flange.

- Open vent roof nozzles shall be turned horizontal or vertical downward (gooseneck) and include bird screens.

4.10.3.5 Polyethylene Storage Tanks

All the requirements and criteria for the design, manufacturing, testing and inspection, preparation for shipment and delivery of the Polyethylene Tanks, shall be in accordance with WesTech standard specification.

The polyethylene tanks shall be rotationally molded, vertical, high density cross-linked polyethylene, one-piece seamless construction, cylindrical in cross-section and vertical with flat bottoms (unless otherwise specified).

For double wall tanks, the assembly consists concentrically aligned primary (inner) and containment (outer) tanks. Each tank is a rotationally molded one-piece seamless constructed tank. The containment tank shall be sealed to/around the primary tank to prevent rainwater or other foreign debris from entering the containment tank. The bottom head shall be integrally molded with the cylindrical wall.

Tank working volume, venting requirements, nozzle sizing, orientation, access, etc. shall be per the applicable tank sizing criteria. Tanks shall be designed for above-ground, vertical installation and approved to store fluids and/or chemicals at atmospheric pressure.

Wall thickness for a given hoop stress shall be calculated in accordance with ASTM D1998. In NO case shall the tank thickness be less than design requirements per ASTM D1998.

Larger tanks (>2000 gal) shall be provided with lifting lugs for lifting and placement when the tank is empty. Lifting lugs shall be molded or permanently affixed at the top of the tank shell. The tank shall also have an anchorage/restraint system to prevent sliding and overturning, where required.

If specified in the data sheet, the high-density polyethylene tank shall be provided with bottom molded flanged drain nozzle, to allow for full drain capability. Where tanks are mounted to concrete the pad shall be notched around the drain nozzle as required.

The tank manufacturer shall define expansion joint requirements, based on the quantities, sizes and locations of nozzles specified in the data sheet.

Access to enclosed tanks shall be as outlined below:

- Less than 7500L [2000] gallons: 430mm [17”] manway cover of polyethylene material with a coarse thread on the top of the tank.
- 7500L [2000] gallons or more: 600mm [24”] diameter manways or greater on the top of the tank and equipped with and integral emergency pressure relief device.

4.10.3.6 Compressed Air Package

The Compressed Air Package shall be supplied with all accessories according to the applicable data sheet and P&ID and shall be designed to provide adequate and uninterrupted supply of compressed air to the entire plant per the Utility Consumption List with an additional 20% capacity for expansion in both continuous air flow delivery and storage capacity in the receiver tank.

The Vendor shall furnish all components and auxiliary equipment(s) necessary to meet the requirements of data sheets and specifications to make a complete, operable, safe, maintainable and dependable unit.

The actual flow capacity and discharge pressure of the air compressor(s) shall account for actual pressure drops/losses expected inside skid boundaries. Minimum capacity and discharge pressure (after all internal losses) shall not be less than the minimum values required on the data sheet.

The manufacturer must participate in the Compressed Air & Gas Institute (CAGI) Performance Verification program.

4.10.4 Site Layout

The purpose of a good site layout is to provide a safe and economical flow of materials and people around a plant which is socially acceptable to operators, maintenance personnel, and potential vendors/visitors to reliably and cost-effectively treat and discharge the specified product (clean water).

The plant layout shall be approached, with a large emphasis placed on reduction of up-front capital and on-going operating costs. Considerations for ease of operation, maintenance and construction activities as these are all key drivers for those costs on the project.

4.10.4.1 Safety

Sufficient space shall be reserved in the design to ensure:

- All personnel can evacuate the plant and individual buildings in an emergency situation in accordance with local building codes and OSHA regulations.
- All personnel can move around the plant and within individual buildings.
- Maintenance activities can be undertaken throughout the plant and inside individual buildings.
- Vehicles can move around the plant and inside individual buildings, where required.
- Construction activities can be undertaken, including transportation, craneage and laydown.
- Chemical containment, management, and segregation.

Safety issues related to enclosed areas shall have special considerations prior to the development of the plant layout. Creation of areas considered as confined spaces shall be avoided wherever practical.

Consideration shall be given to a safe and logical flow of people, material, and mobile equipment through the plant to minimize in plant traffic congestion. Compliance with all applicable Safety In Design (SID) specifications is required.

The layout design shall make provisions for:

- Protecting operators from such hazards as tripping, bumping their heads or coming into contact with hot surfaces.
- Containing and channeling liquid spillages to safe recovery points, directing vents to safe locations, and installing adequate ventilation.

- Allowing equipment and pipework to be completely and safely drained.
- Reducing pipe and equipment failures due to vibration, heat stress, and impact.
- Separating flammable materials from ignition sources and adopting electrical classification schemes.
- Protecting plot equipment and adjacent plots from the spread of fire.
- Planning appropriate firefighting and emergency escape procedures.

4.10.4.2 Services and Utilities

Services and utilities for all areas, including buildings, to be laid out and designed with dedicated service corridors or runs. Access shall be provided to any and all operable or maintainable components such as control valves, dampers, air filters, instruments, and emergency stops. Floors or walkways accessed by stairs can be considered for this purpose.

Automatic on-off valves may, in certain conditions, have no permanent access but be accessed by scissor lift or scaffold. These conditions will be evaluated in a case-by-case basis. All effort will be made to minimize designing valves with no permanent access.

4.10.4.3 Service Corridors and Utility Racks

Services, process piping, cable ways, etc. shall be brought to and run in designated corridors throughout the treatment plant on utility racks, ground sleepers, or grouped supports, laid out in clear cardinal directions. Multi-level arrangements shall be used to facilitate entrance, exit and crossing the designated corridors.

Utility racks are preferred for routing of services, piping, and cables and shall be sufficiently elevated overhead to allow full access to all plant areas. Where required, any ground level sleepers or pipe/cable routing shall not block operations and/or maintenance access (vehicular or pedestrian) within the plant or around the equipment.

Piping and electrical cable corridors shall be on separate levels of utility racks where possible. Consider running slurry piping to the outside of the utility rack (on out riggers) or along the perimeter of the rack for accessibility and clean out.

In general, process piping shall be routed at the outside of rack keeping utility and service piping in the center of the rack. Where multi-tiered utility racks are used, the placement shall be as follows (per level): cable trays at the top level(s), utility and chemical distribution lines in the middle tiers and process lines on the lower level(s); with slurry and gravity lines on out riggers.

Under no circumstances shall any fluid process/service piping be allowed to run at a utility rack level above an electrical cable tray level. Cable tray runs shall be placed at the topmost levels of all utility racks, including any crossings or junctions. Where fluid piping is required to cross over above a cable tray run (perpendicular), adequate protection shall be provided over the tray (covers) or under the piping (catch trays, sleeves, dual containment) to route any leaking fluids away from the cables.

Tray (cable/chemical) spacing on the rack shall be sufficient to allow access into the tray from above to route tubing or cables. Horizontal spacing shall be sufficient to allow for securing the tray to the structure according to the manufacturer's recommended clamp/fastener design.

Depending on quantity and width of trays on the racks and with consideration to constructability issues, cable trays on top of racks can be stacked vertically with a central access aisle, alternately adequate access from both sides of the utility rack shall be provided. This will allow safe access during construction. Cable trays located in service corridors/utility racks shall run with flat turns in both directions where possible.

Lines running in perpendicular directions to each other shall be routed in specific predetermined elevations to facilitate crisscrossing of lines running north/south direction from lines running east/west. North/south and east/west utility racks shall intersect midway between deck levels. Piping level shall be raised/lowered wherever there is change in direction of travel.

Vertical rack clear spacing between levels shall be 800mm [2'-0"] minimum but not less than 2.5x the largest pipe O.D. contained within the rack.

Horizontal pipe spacing on a utility rack shall be based on a clearance of 1 inch between the outside edge of the piping attachment considered to secure the pipe against the metallic structure. When the pipes or flanges are insulated, the insulation thickness is added to the spacing dimension. The spacing shall be increased where orifice plate flanges are installed. A minimum clearance of 4 inches shall be provided between valve hand wheel and another hand wheel/structure/obstruction.

4.10.4.4 Maintenance and Housekeeping Areas

Access aisles shall be wide enough for forklifts, small mobile cranes and mobile cleaning equipment wherever possible. All parts of the process areas and buildings shall be easily accessible for maintenance and housekeeping.

Priority must be given to ensure that the plant can be operated to meet the process requirements for which it was intended without compromise, including maintenance of that equipment.

The process should be compartmented whenever possible to prevent interferences with adjacent processes and operations. Sufficient room should be provided to allow for construction and preparation for maintenance of a given process or operation without interfering with the process or operation of the adjacent equipment.

Equipment shall be provided with suitable access and workspace to allow for the free movement of personnel and equipment required for maintenance and housekeeping. Consideration will be given to space requirements for all manways, piping and valves associated with each piece of equipment.

Catwalks are to be provided for servicing cranes and hoists.

Equipment, structures, and piping shall be arranged to permit maintenance and service by means of mobile equipment. Permanent facilities shall be provided, as indicated on the plot plan, where maintenance by mobile equipment is impractical.

Valve hand wheels and stems shall not obstruct operating aisles, walkways, or platforms. Valves shall be easily accessible for operation and shall be operated from grade or platform accessed by stairs or ladders.

Manually operated control valves shall be located such that the operator can adjust valves while reading adjacent instruments.

Wherever practical, instruments and level indicators showing the process variables shall be placed in sight of the control valve. The valve positioner on control valves shall be placed so that it is visible from the operating aisle.

4.10.4.5 Pumps

Process pumps within a given process area shall be isolated from all other areas as required to prevent any cross contamination in the event of leakages and spills. Adequate access shall be provided around each pump for maintenance and service purposes.

Equipment overflows will be located such that they do not spill onto the pumps, motors, or other process equipment.

4.10.4.6 Agitators

Where overhead clearance is limited, split shafts with solid couplings shall be provided to allow shaft removal in sections.

4.10.4.7 Sumps / Trench Drains

Sump pump bases shall be higher than the containment wall to allow access to mounting bolt holes in the event the area is flooded.

In slurry areas, trench drains shall have removable grating sections and sumps shall be located as close to the slurry pumps as possible and be provided with adequate access from outside bunded area.

In non-slurry areas, sumps shall be located close to any curbed edges and trench drains shall be placed in line of sight of tank overflows and drains.

4.10.4.8 Blowers

When locating blowers, considerations shall be given to determine if the equipment needs to be placed in a separate enclosure or room, or requires silencers, to minimize overall plant noise. Where possible blowers shall be located outside of buildings to reduce the noise levels inside.

4.10.4.9 Storage Tanks

Tanks shall be located to the high point of any sloped area, where possible.

Open tanks shall be provided with access to view the level of solution in the tank or sight glasses for visual indication of the level from grade.

All metallic or FRP tanks shall be provided with a permanently affixed nameplate. Polyethylene or similar storage tanks where permanently affixed nameplates are not reasonable due to tank construction shall have permanently affixed adhesive labels.

4.10.4.10 Vents, Drains, and Overflows

Vents and drainage lines for hazardous or valuable process chemicals shall be accessible for inspection and maintenance. Unless otherwise specified drainage from such equipment shall be individually piped to a sump, tank, or other safe area.

Overflow lines from equipment shall be extended to grade and directed towards a collection sump or drain trench.

4.10.4.11 Utility Stations

Utility Service hose stations shall be located as needed in process areas, so that equipment requirements at grade or on operating floor levels can be reached using a 15m hose. Utility stations shall have both compressed are and pressurized service water available.

4.10.4.12 Personnel Service Facilities

Major personnel and service facility room requirements, including control rooms, electrical rooms, mechanical rooms and maintenance rooms are to be located such that:

- Control rooms are centrally located with a good view into the main process areas.
- Electrical, mechanical and maintenance rooms are located adjacent to main work areas.
- Areas in front of control rooms and offices shall be kept clear of equipment, piping, cable trays, hoist wells, etc.
- Containerized and prefabricated rooms shall be provided where possible.
- Where possible, rooms shall have a vestibule area for removal and storage of dirty outerwear.
- Washroom and toilet facilities shall be provided for operator use.

4.10.4.13 Equipment Placement

The arrangement of the equipment, including piping and auxiliaries, shall provide adequate clearance areas and safe access for operation and maintenance.

Normally, the starting point for layout of equipment within a plot is to follow the order of the Process Flow Diagram (PFD). This initial layout will then be modified to reflect the desirability of grouping certain equipment, such as tanks or pumps, or isolating hazardous operations. Equipment may also be grouped such that a common crane or trolley beam can be used for removing equipment and materials handling.

As a general rule, equipment should be located at ground level on housekeeping pads, additional elevation is only considered when ground space is limited or where gravity flow of materials is desired for safety, economic, or reliability reasons.

Considering whether the equipment may be safely installed in open areas, buildings offer advantages like security, protection of people, loose assets (spare equipment, parts, tools, etc.) and equipment against the weather, vandalism, theft, in addition to providing greater long-term reliability. Use of a building should be considered against their disadvantages, such as impeding firefighting (or requirements for fire suppression systems) and the tendency to collect rather than disperse toxic or explosive vapors and other code-compliance requirements.

Bumpers (bollards or permanent barricade systems) shall be used to protect skids and other equipment installed near traffic areas and access ways.

Layout and design of the physical plant shall consider:

4.10.4.14 Process Considerations

- The desirability of gravity flow.
- Limitations of pressure or temperature drop in transfer lines and heat exchangers.
- Sufficiency of head for orifices, reflux returns, control valves, and pump suctions, particularly for liquids near their boiling points.
- Positioning of flow meters.
- Length of instrument transmission lines.
- Requirements for operation, particularly for manual materials handling operations.

4.10.4.15 Economic Considerations

- Economical plant layout is concerned mainly with minimizing the costs of steelwork, concrete, piping, and electric cables.
- Tall structures with their deep foundations can be greatly reduced by placing most equipment on the ground. Where structures have to be used, they should support more than one item. To minimize piling costs, the heaviest equipment should ideally be located over the best load-bearing soil.
- Equipment should be located to avoid excessive pipe and cable runs. Long runs increase the amount of tray-work and ductwork, conduit and insulation, bracketry and fittings. They also have greater energy losses, and consequently increased running costs.

4.10.4.16 Operational Considerations

Operational convenience is very important to achieving safe and reliable operation, by reducing the chances of making mistakes and increasing the probability of a malfunction being detected early.

- Equipment requiring frequent attendance should be reached by the shortest and most direct routes from the control room, which must itself be in a safe location.
- Valves and instrument dials should be at a suitable height so that they can be easily used or read.
- All plots may require emergency escape routes and firefighting measures.

All these considerations shall be reviewed during design by 3D Model review meetings.

4.10.4.17 Maintenance Considerations

The layout shall be designed through the arrangement of equipment to facilitate safe maintenance. Space maintenance requirements and routines shall be outlined at the initial stages of design.

Multiple 3D model review meetings shall be considered for the checking of maintenance clearances during the design process.

For equipment that is to be maintained in situ, space must be left for maintenance staff and their tools, access to equipment for inspection and repair, lifting gear (to carry parts, fittings, and possibly maintenance staff), and laying down of new and used parts.

Where equipment is to be repaired in the workshop, space is required for maintenance staff and their tools to reach the equipment (for inspection, disconnection, and reconnection of pipework and electrics), removal and replacement of equipment, and moving equipment to and from workshop transport.

In all cases the layout should provide a safe place of work with regard to access, lifting equipment, entry into vessels or tanks, electrical and mechanical isolation, draining and washing.

A reasonable distance (depending on the degree of hazard) from plant areas is needed for safe welding unless special precautions are to be taken.

4.10.4.18 Construction Considerations

- The plot should be designed so that adequate access is available to lift large pieces of equipment into place.
- Access space planning for operation and maintenance should be utilized during construction, but additional space may be needed for scaffolding and rigging, and for dismantling and removing construction equipment.
- High or heavy equipment should be located near the construction access allocated to the plot at the site-layout stage. Heavy equipment in a structure should be near main stanchions.
- When interfacing with plants under operation, care should be taken to ensure that constructional work interferes as little as possible with the running of operational processes.
- Elements of “Modular Construction” (in which the object is to complete as much construction and erection work as possible in the workshop) will be desirable, as possible.

4.10.4.19 Contingency Space

Definition for future expansion of structures, equipment, and pipework shall be communicated by the Owner during the bidding phase, so that any additions can be erected and tested with the minimum interference to plant operation.

The positioning of potential extensions should not involve excessive runs of pipework to link up with the existing plant. On primary utility racks, 20% of the pipe rack will be considered as an allowance for future piping (where possible).

4.11 Electrical Design

4.11.1 Electrical Motor Control Center (MCC)

All motor starters and drivers for the treatment plant equipment and systems are required to be installed in a centralized motor control center (MCC). The MCC shall be constructed within the plant but isolated from any wetted, washdown, overflow, or drainage areas. A minimum of 25% spare space shall be accounted for in the MCC space for future expansion or use. The interior MCC and panel design shall allow for

top entry/exit of cabling in overhead trays to be carried out the end or sidewalls of the PDC building for distribution to the plant.

The interior of the room shall maintain clear access for removal of the largest piece of equipment and either double or roll-up access doors for removal from the MCC room. Access, egress, and clearances for the MCC room shall be according to the MCC manufacturer standard and comply with applicable building and electrical codes. Personnel doors shall be per the requirements outlined in this document. Fire doors, if required, shall conform to hollow metal door requirements and shall be provided with fillers adequate to meet the required fire rating. The door, frame, and hardware shall bear a certification label of Underwriters' Laboratories (UL) for the class of opening and rating.

Distribution of motor control wiring to individual motors shall be accomplished overhead using cable trays throughout the treatment plant.

4.11.2 Power Supply and Grounding

The Owner shall provide electrical power to the designated electrical tie point location(s) as outlined in Section 9. The design engineer will then distribute power within the project battery limits throughout the treatment system via outdoor rated cable with CE Code disconnect compliance. The engineer will determine a "not to exceed" power supply service requirement with the engineering review package which will be relayed on the Electrical Load List.

WesTech will provide a Grounding Plan based on final equipment location and loads with the engineering review package which the Owner may use to incorporate into their overall plant grounding grid to ensure a proper level of protection. Electrical load requirements will be specified by WesTech in the Electrical Load List.

4.11.3 Distribution Voltages

- 480VAC Delta, 3-Phase, 3-Wire
- 480Y/277VAC, 3-Phase, 4-Wire
- 208Y/120VAC, 3-Phase, 4-Wire
- 120/240VAC, 1-Phase, 3-Wire
- 120VAC, 1-Phase, 2-Wire

4.11.4 Equipment Utilization Voltages

WesTech standard voltages used per service are listed in the table below:

Equipment Classification	Voltage and Phase
Interior Lighting	120V, 1-Phase
Site Lighting (LED)	120V, 1-Phase
Heat Tracing	120V, 1-Phase
Convenience Outlets	120V, 1-Phase
Motors, < 0.5 HP	120V, 1-Phase
Motors, >= 0.5 HP	480V, 3-Phase
Operations/Service	240V, 1-Phase
Major Electrical Equipment (i.e., Local Control Panel)	480V, 3-Phase

Equipment Classification	Voltage and Phase
Remote I/O Panels	24 VDC, 1-Phase

4.11.5 Raceway Systems

Cable Tray shall be used as the primary raceway throughout the plant. In areas with fewer cables, cable tray should still be used where multiple voltage levels are present. Conduit shall be used as necessary for congested areas and for short runs from cable tray to individual devices. Cable tray and conduit material shall be selected appropriately for the site and area conditions and sized per industry standard guidelines regarding fill percentage.

For indoor facilities, conduit shall be preferred where cables are routed beneath concrete unless otherwise specified in the contract. Cable tray can be used where not buried (i.e., hanging from ceiling).

4.11.6 Wire and Cable

Below are commonly used cables for typical applications:

Service	Conductor Size	Insulation	Cable Type	Description
480 VAC	#12 minimum, 600 kcmil maximum	THHN	Tray Cable (outdoor)	Power Distribution
120/240 VAC	#12 minimum	THHN	Building Wire (Indoor)	Power Distribution
120 VAC / 24 VDC	#14 minimum	THHN	Tray Cable (outdoor)	Control Power and Discrete Signals
24 VDC Analog	#16 minimum	THHN	Building Wire (Indoor)	Analog Control Signals
Data	#24 minimum	TFFN	Tray Cable (outdoor)	Ethernet/Data

4.11.7 Interior Lighting and Power Distribution

Interior lighting systems shall be 120 VAC, 1-phase in accordance with the local building code

Building power distribution and receptacles shall be 120 VAC, 1-phase; distributed throughout the building per project requirements. Building receptacles and lighting systems shall be maintained in a separate panel from process treatment equipment and instrumentation controls.

4.11.8 Lightning Protection

Lightning protection systems are designed to protect operations personnel and equipment from lightning strikes during extreme weather events. These systems shall be designed according to the local code requirements or client specifications.

4.11.9 Heat Tracing System Design

Where heat trace systems are required, it shall include an outdoor adjustable thermostat that will be wired to contactors for automatic powering of the heat trace

system. Local lighted end kit indicators will be placed in convenient, highly visible locations for direct indication of heat trace activation at the furthest extend of the circuit as is feasible. A relay shall also be provided to indicate back to the control system when the heat trace system has been activated.

Heat trace circuits shall be designed such that overall circuit start-up current load does not exceed 80% of the breaker size. Cables shall be self-regulating, 3, 5, 8, or 10 W/ft. Unless otherwise required by project specifications, heat trace circuits to be 120 VAC, 1-Phase on 30A GFCI-EPD breakers.

Insulation thickness and material to be determined based on ambient site conditions. Design values for site conditions shall be defined by the historical temperature averages for the area equal to the number of anticipated years of project life or the most recent 5-year averages (whichever is greater) if not otherwise specified in the contract.

4.11.10 Area Classification Requirements

In general, all areas of the treatment plant within the battery limits are considered non-classified per CEC unless specifically noted.

During detailed design, specific areas of the plant may be determined to be CEC Class I, Zone 2, shall comply with the associated requirements outlined in the CEC for all electrical components, enclosures, instrumentation and wiring within that designated area. It is not anticipated that any areas will be Class I, Zone 1.

4.11.11 Site Lighting System Design

Site Lighting shall be provided where specified in the contract, or where regular operation outside of regular daylight hours requires it. Light locations shall be determined to ensure adequate lighting is provided to all critical areas including all walkways, platforms, stairways, ladders, panels, motors, chemical areas, as well as any critical instruments and valves.

Lighting circuits shall be designed on 20A circuits, 120VAC, 1-Phase, with circuits powered out of a contactor panel containing a photocell that will govern system operation based on ambient light set points, unless otherwise specified in the contract. Voltage drop calculations shall be performed to ensure that all lighting circuits are sufficiently designed and an appropriate conductor size selected.

4.12 Instrumentation & Controls Design

4.12.1 Instrumentation – General

Instrument selections shall be made in accordance with the engineer's standard design criteria. All process transmitters shall be electronic, smart transmitters with 4 to 20 mA DC signal ranges and with accuracy suitable for the application. In no case shall the accuracy be worse than ±0.5% for controlling instruments. All process transmitters shall be two-wire devices except where a two-wire device is impractical or not available. No transmitter shall be selected for use where the anticipated operating range is at an extreme of its available calibration range (below 20 percent or above 80 percent of the range). All transmitters shall be capable of driving a load up to 750 ohms and shall be designed with provisions for zero and span adjustments. All transmitters shall be furnished with HART communication capabilities. Instruments installed in lines

containing suspended solids, high chlorides, corrosive or otherwise harmful fluids shall be provided with diaphragm seals.

Basic design principles include:

- Instrument performance/accuracy shall be sufficient to fulfill process/unit performance requirements.
- Variation of instrument types and ranges shall be kept to a minimum.
- Analog instruments shall be used for switch functions.
- Field instruments not specifically addressed within this standard shall be designed based on recognized industry standards where applicable.
- Local audible alarms shall be provided for remote independent systems when warranted for system and personnel safety or system troubleshooting.

4.12.1.1 Flow Instruments

Magnetic flow meters provide a cost-effective and accurate flow measurement solution up to 12" NPS, has low pressure drop, no moving parts. For slurry service magnetic flow meters shall be preferred.

For clean process waters an orifice flow meter is an option. Non-intrusive and clamp-on sonar type flow meters may be considered for slurry service in large diameter pipes where the use of magnetic flow meters is not practical or cost effective.

Flow meters shall have proper orientation with upstream and downstream pipe length requirements as recommended by the Vendor.

4.12.1.2 Level Instruments

Liquid level transmitters and gauges or gauge glasses on tanks will be used to monitor tank levels. The preferred hierarchy for common applications is listed below:

- Static pressure sensing devices for vessels exposed to atmospheric pressure mounted at the lowest reasonable nozzle elevation in the tank.
- Wave-guided radar sensing devices for enclosed vessels. (May use stilling wells)
- Open-path radar sensing devices for bulk material levels.
- Top-mounted noncontact open-path radar level transmitters for measurement of storage tank levels in applications containing suspended solid material. Mounting flanges shall be located to avoid influence and false detections caused by operation of agitators and materials entering the vessels.
- Stilling-well with magnetic float-type level gauge with conductance or similar switches
- Radio frequency admittance, ultrasonic, or radar type for specialized applications (with prior Purchaser approval).

4.12.1.3 Pressure Instruments

Pressure Transmitters and/or gauges will be on the inlet and outlet of all flow processes where differential pressure is an indication of performance. Pressure instruments shall have individual block and bleed valves.

Pressure instruments in slurry service, high temperature, highly pulsating, toxic or corrosive services shall be installed with diaphragm seals. For high solids applications where pressure feedback is critical to the service (pump/feed shutoff, by-pass release, etc) wafer isolation rings shall be considered.

4.12.1.4 Temperature Instruments

Thermocouples and/or thermometers on inlet and outlet of all flow processes where differential temperature is an indication of performance or temperature needs to be monitored.

Temperature elements shall preferably be thermocouples. Thermocouples shall be ISA type E chromel-constantan (preferred) with type EX extension cable or ISA type K chromel-alumel with type KX extension cable. When used for temperature elements, resistance temperature detectors (RTDs) shall be of the 3-wire, 100-ohm platinum type with an alpha characteristic of 0.00385. All RTDs for measurement of fluid system temperature shall be suitable for the design temperature of the fluid system.

Temperature elements shall preferably not be grounded at the point of measurement (ungrounded elements). Thermocouples and RTDs shall have sheathed elements spring-loaded to provide good thermal contact with the thermowell or protection tube. The sheath shall be made of stainless steel and have magnesium oxide insulation. All connection heads shall be weatherproof, made of cast iron (or other Purchaser approved material) with screwed covers, and supported from the well by a stainless-steel extension nipple. Stainless steel nipple-union-nipple extensions shall be used when the temperature element must be removed for equipment maintenance purposes.

4.12.1.5 Analyzers

Analytical instruments shall be mounted in easily accessible locations. Critical controlling instruments shall be installed such that they can be removed from, or inserted into, the process safely without requiring process isolation or pressure relief.

4.12.2 Control Valves

Control valve selection (including valve and actuator type) shall be made in accordance with the engineer's standard design criteria. All wetted materials and body type for control valves shall follow the same selection criteria as manual valves in accordance with the applicable Pipe Specification. Pneumatic actuators shall be preferred wherever instrument air is available.

Valve position switches (with input to the DCS for display) shall be provided for open/close (non-modulating) valves. Valve position feedback signals shall be provided to DCS for display and control for all modulating valves via HART discrete communications (preferred) or via position transmitters.

Control valve body size shall not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping. Control valves in 600 class service and below shall be flanged where economical (except for steam service).

Solenoid coils shall be class H high-temperature construction and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be CSA rated for the environment. Solenoid valves utilized on isolation, drain, and wash valves shall be equipped with manual override capability.

4.13 Misc. Balance of Plant Systems

4.13.1 HVAC Systems

HVAC systems shall be designed to maintain indoor conditions communicated by the Owner and in accordance with applicable codes for any occupied spaces.

Use of air conditioning in the plant control and electrical equipment rooms shall be designed to meet the filtration levels listed. Tabulated filtration efficiency and Minimum Efficiency Reporting Value (MERV) levels shall be as indicated in the table below and in accordance with ASHRAE Standard 52.1, "Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter":

Dust Spot Efficiency (percent)	MERV
80 to 90	13
20 to 60	7 to 11
Less than 20	N/A

4.13.2 Ventilation Systems

Ventilation shall be provided in areas considered to be normally continuously occupied in accordance with local codes. Ventilation, heating, and cooling equipment shall be located to ensure a generally uniform temperature distribution throughout the space.

For areas with high noise environments (above 85 dBA), the HVAC equipment and components shall be designed such that the overall HVAC noise contribution is no more than 2 dB higher than the overall room noise at 1.5m [5’] above the floor with normal Facility Materials and Equipment in operation.

Ventilation of non-air-conditioned areas shall be sized to achieve a minimum of five (5) air changes per hour (ACH) for heat removal/ventilation during warm seasons. A minimum of one (1) air change per hour shall be considered for all occupied spaces throughout the balance of the year. Minimum ventilation rates (1 ACH) shall be used for design infiltration when determining heating requirements for non-air-conditioned areas. Ventilation fans shall be VFD controlled to allow for variance in total ventilation requirements throughout the year.

Climate controlled spaces for personnel comfort or other critical equipment support shall provide recirculation air or fresh air intake for effective mixing a minimum of five (5) air changes per hour during air conditioning and one (1) air change per hour throughout the year.

Minimum design ventilation rates are based on gross volumes. The volume of equipment inside the space shall not be deducted from the total volume when calculating air change rates. Air circulation may be achieved by either timed intervals or continuous operation of fans with variable speed control.

Indoor chemical handling and storage areas shall have continuous ventilation as required by local codes but not less than 5(L/s)/m^2 [1 CFM/ft^2] of space. Where chemical storage areas cannot be segregated from the balance of the building a design value of 7.5(L/s)/m^2 [1.5 CFM/ft^2] for the chemical handling area shall be used for sizing a dedicated fan and intake louver, both fan and louver shall be located within the chemical storage space and properly spaced to provide consistent air flow.

For ventilated areas, the airflow rate based on internal load (for air-conditioned spaces) or other design parameters shall be compared to the minimum total volumetric air change rate to determine the controlling airflow requirement. The higher value of the two airflow rates shall be selected.

All other rooms within the building that may have offensive or hazardous gases shall have dedicated ventilation/exhaust fans to outside the building (examples include rooms containing toilets or lab processing equipment). In addition, all chemical storage tanks/totes maintained inside of buildings shall have permanent off-gas vent piping outside of the building. Vent locations for these gases/fumes shall be placed 3m [10’] minimum away from any fresh air intake louver to ensure contaminated air does not enter the building.

4.13.3 Climate Control Systems (Heating/Air Conditioning)

Interior non-conditioned spaces within the treatment plant shall have unit heaters as required to maintain the minimum temperatures set forth in Section 2.1 of this document. Unit heaters shall be arranged to provide circulatory air movement along the perimeter of the space being heated. The distance between unit heaters shall not be less than the throw of one unit heater nor more than twice the throw of one unit heater. Heater throw lengths shall correspond to a terminal velocity of 15m [50’] per minute. Heating calculations shall include a 10 percent margin on capacity.

Interior conditioned spaces shall consider a 15 percent margin on capacity for the heating and air-conditioning systems (including airflow) to account for future equipment heat loads or changes in occupancy.

Where possible exterior wall-mounted HVAC systems shall be used, if indoor HVAC units are required in which moisture may condense or otherwise are connected to a water source, the unit shall include suitable drain pans or other provisions for catching and collecting condensation and/or water leaks. Water collected from such equipment shall be drained to an acceptable outdoor location. All HVAC equipment shall be oriented and arranged to provide for maximum efficiency of operation and to provide easy access for performing routine maintenance.

The HVAC systems shall interface with fire protection systems in accordance with NFPA and other applicable codes. Interfaces shall include, but not be limited to, furnishing and installing duct mounted smoke detectors and fire/smoke dampers, de-energizing HVAC equipment, and automatic closing dampers upon detection of a fire.

4.13.4 Potable Water Systems

Potable water systems for occupied buildings shall comply with the NPC, latest edition. Minimum requirements may include a single unisex restroom with a toilet, lavatory and mop sink (if required by local code) including all associated accessories as required by the code. Restroom shall be sized for ACA accessibility with required grab bars per standard ACA guidelines.

Potable water shall be supplied to the Chemical treatment area for dilution, polymer make-down or other use in that area as required where the service water system does not meet minimum quality requirements for the service. Potable water tie-in to the plant service water tank to support initial startup or upset conditions may be provided.

Potable water distribution within the process treatment plant (to safety shower/eyewash stations, chemical dilution, etc.) shall follow the process piping utility racks for distribution where possible.

Tempered/Hot water for lavatories and safety shower/eyewash stations (where required) shall be provided by individual instantaneous electric water heaters located near the lavatory and/or safety shower/eyewash unless otherwise specified. Pumped, heated, and insulated loop systems for tempered/hot water are not recommended unless otherwise specified. Tempered water temperature delivered to safety shower/eyewash stations shall be in accordance with OSHA regulations.

4.13.5 Sanitary Sewer Systems

Sanitary sewer design and piping shall be provided in accordance with the current NPC, gravity drain systems to existing sewer tie-in as described in the Civil design basis. Each restroom shall be provided with floor drains that tie into the building sanitary sewer system.

4.13.6 Fire Protection, Suppression, and Detection

Fire protection systems shall be provided in accordance with local codes and regulations.

A local junction box in or near the building shall be provided to tie into the plant's existing fire detection and notification systems where required by the Owner. Tie-in of the new building and systems to any existing systems is not part of the project scope.

There will be no active fire suppression system for the process building unless specifically directed by the local building codes or local fire marshal.

4.13.7 Personnel Protection Systems

4.13.7.1 Emergency Evacuation

Fire detection systems shall provide audio and visual indication of alarm, evacuation plans shall be provided showing clear direct paths to building or area exit/egress.

Evacuation plans shall have clearly marked pathways from occupied spaces and shall be kept clear of equipment, laydown, or other obstructions. All egress pathways shall conform to all requirements of the NBCC.

4.13.7.2 Chemical Containment and Handling

Chemical handling, storage, and containment measures shall conform to the SID specification for Workplace Safety and Chemical Hazards in addition to the provisions outlined in other sections of this document.

4.13.7.3 Safety Shower / Eyewash Stations

Safety showers shall be provided at a minimum in all areas where handling or exposure to hazardous fluid, chemicals, or other substances may occur, Showers shall be provided within the minimum distance and accessibility requirements from the potential exposure point as outlined by OSHA. Additional safety showers may be required as outlined in the Process design section of this document.

4.13.7.4 Ventilation and Confined Spaces

Confined spaces during normal operations activities are prohibited. Where confined spaces exist or potentially exist within equipment or enclosed areas of the plant, sufficient openings (size and location) shall be provided to accommodate temporary measures for continuous airflow in the entire space during maintenance activities.

All personnel occupied spaces inside buildings shall have sufficient ventilation as outlined above.

4.13.7.5 Plant Security Systems

Security systems for restricting unauthorized personnel access to the physical and electronic access to plant systems and equipment shall be implemented at the Owner's discretion and following the overall mine or site standard products, design and integration of these systems is not performed by the treatment plant design engineer.

5.0 Technical Feasibility

5.1 Comprehensive Treatment Plant Scope

The scope of comprehensive design services and equipment supply for final design of the treatment plant for Coffee Gold Mine shall be as outlined in this section. Engineering and Procurement services shall be provided by the engineer offering specialized expertise in water treatment equipment, interconnecting systems, and treatment plant design.

The scope matrix below generally outlines responsibilities for design and construction activities.

Table 5.1: Scope Matrix.

Work Category	FEED / Input	Detailed Design	Supply	Install / Perform	Commissioning
Site Investigation	WesTech	N/A	Owner	Owner	N/A
Earthwork	WesTech	WesTech	Contractor	Contractor	N/A
Utilities*	WesTech	WesTech	Contractor	Contractor	Contractor
Utilities**	Owner	Owner	Contractor	Contractor	N/A
Footings/Foundations	WesTech	WesTech	Contractor	Contractor	N/A
Slab-on-Grade	WesTech	WesTech	Contractor	Contractor	N/A
Building(s)	WesTech	WesTech	WesTech	Contractor	Contractor
JIB Cranes / Lifting Devices	WesTech	WesTech	Contractor	Contractor	Contractor
Misc. Steel	WesTech	WesTech	WesTech	Contractor	N/A
Process Equipment	WesTech	WesTech	WesTech	Contractor	WesTech
Interconnecting Piping (plant)*	WesTech	WesTech	WesTech / Contractor	Contractor	WesTech

Work Category	FEED / Input	Detailed Design	Supply	Install / Perform	Commissioning
Interconnecting Piping (to plant)**	Owner	Owner	Contractor	Contractor	Contractor
Misc. Mechanical Equipment	WesTech	WesTech	WesTech / Contractor	Contractor	Contractor
MV Transformer and Power Supply	Owner	Owner	Owner	Contractor	Contractor
MV/LV Power distribution*	WesTech	WesTech	Contractor	Contractor	Contractor
Interconnecting Wiring (plant)*	WesTech	WesTech	Contractor	Contractor	WesTech
Interconnecting wiring (to plant)**	Owner	Owner	Contractor	Contractor	Owner
Lighting	WesTech	WesTech	Contractor	Contractor	Contractor
Motor Control Center (MCC)	WesTech	WesTech	WesTech	Contractor	WesTech
Programmable Logic Controller(s)	WesTech	WesTech	WesTech	Contractor	WesTech
Temporary Structures	WesTech	WesTech / Contractor	Contractor	Contractor	N/A
Permitting	WesTech	WesTech	Owner	Owner	N/A
* Within site boundary limits ** Outside site boundary limits					

5.2 Case Studies and Process Experience

WesTech has extensive experience designing mine water treatment systems with multiple unit processes, and we understand the nuanced differences in site chemistry and treatment needs. Although no two mine sites are the same, below are a few examples of our installations that include the same or similar processes and equipment proposed for the Coffee Gold site for applications requiring removal of similar contaminants.

5.2.1 Newmont Pamour Water Treatment

Newmont has chosen WesTech to be the preferred technology provider for the Pamour pit dewatering project in Canada. WesTech recently designed the water treatment plant (WTP) for Newmont's Porcupine operation, where the Pamour pit is to be dewatered to extend the life of the mine. The Pamour WTP flow sheet (Figure 8) closely resembles the conceptual design proposed for the Coffee Gold mine. Two notable differences are 1) the lack of reverse osmosis (RO) filtration due to the lack of complexed cobalt cyanide species, and 2) the lack of biological denitrification system due to low nitrate levels.

The Pamour open pit contains over 32 million m^3 of water that must be treated prior to its utilization. The WTP is designed to treat the water and remove metal contaminants consisting primarily of arsenic, copper, cobalt, and nickel. The treatment method consists of various steps for the precipitation of the metals, followed by clarification.

To meet the low effluent compliance standards, ultrafiltration is used to polish the clarified water and remove trace precipitants. Finally, the thickened precipitated solids are collected and further dewatered with a filter press.

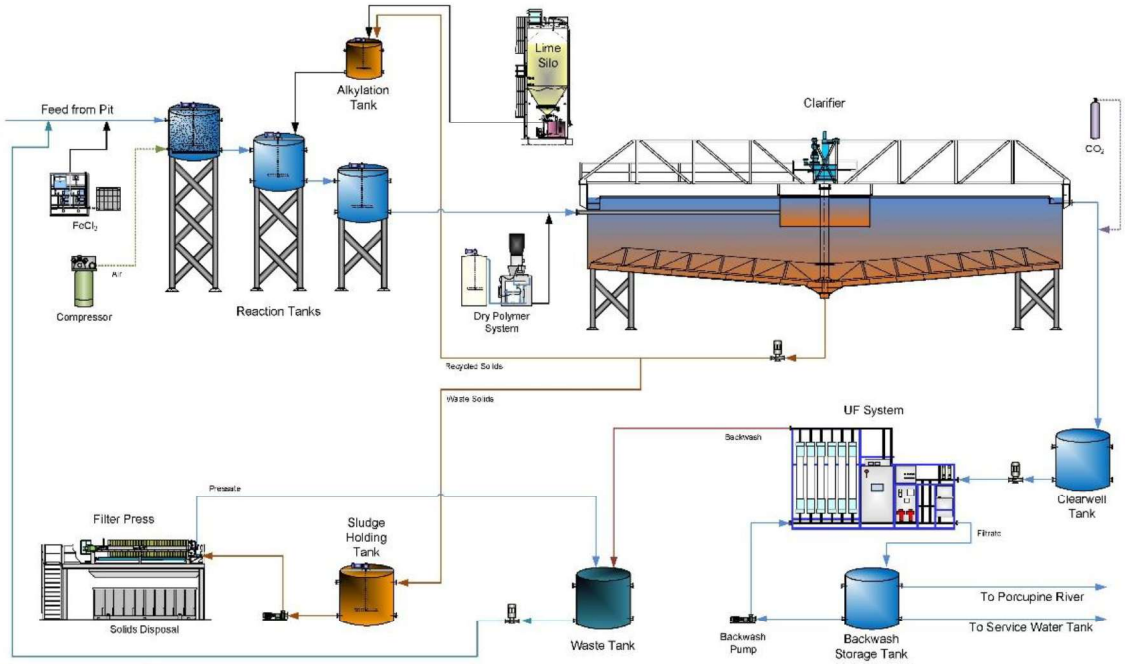


***Figure 1**. Newmont Pamour Flow Sheet*

Metals precipitation involves several treatment steps and reagent additions. First, oxidation is used to drive arsenic to its arsenate oxidation state. Ferric chloride is then added to allow for arsenic co-precipitation. The addition of the feed from the alkylation tank elevates the pH, causing calcium carbonate formation. After sufficient mixing and reaction time, a polymer is added before the clarifier.

Pamour WTP is designed to collect and treat the ultrafiltration backwash, filter press filtrate, and filter press cloth wash so that the only waste disposal required is the dewatered filter cake from the filter press. The filter press cake consists of mainly calcium carbonate/calcium hydroxide with trace metal solids and some iron hydroxide solids generated with co-precipitated arsenic solids. Since there is no RO membrane or ion exchange in the treatment system, no offsite liquid disposal is required for concentrated brine or regenerant waste.

5.2.2 Combination Physical-Chemical and Biological Treatment

WesTech also has extensive experience in the combination physical-chemical and biological treatment plant design and operation. Of particular consideration are flue-gas desulfurization (FGD) waste streams from coal-fired power generation. Flue gas desulfurization removes sulfur dioxide from fossil fuel flue gases. Wet scrubbing of the flue gas transfers the pollutants to a liquid waste stream that is treated before discharge to local waterways. These waste streams contain many of the same contaminants (e.g. Arsenic, Mercury, Nitrate/Nitrite, etc.) that are targeted and successfully removed by the same processes that have been outlined for the Coffee Mine.

A typical flow sheet, shown in Figure 2, resembles the treatment train proposed for the Coffee Gold project.

WesTech's FGD treatment relies on robust sedimentation and filtration equipment, supported by biological denitrification and metals removal steps, proven to treat complex wastewater streams successfully.

FGD wastewater can be a combination of multiple waste streams. An equalization tank allows for peak-flow attenuation and stream homogenization via mixing. Desaturation is performed by raising the wastewater stream pH to between 8.2-9.2 using lime ($Ca(OH)_2$) or sodium hydroxide (NaOH). Dissolved metals precipitate as hydroxides and sulfates, settling in the clarifier.

Reaction tanks are used to precipitate and coagulate metals, such as mercury and arsenic. Metal precipitates are removed from the waste stream by a flocculating clarifier. The pH of the clarified overflow is neutralized using hydrochloric acid prior to filtration and anaerobic biological treatment. WesTech's conventional denite filters are applied to reduce the nitrate loading to the biological selenium removal.

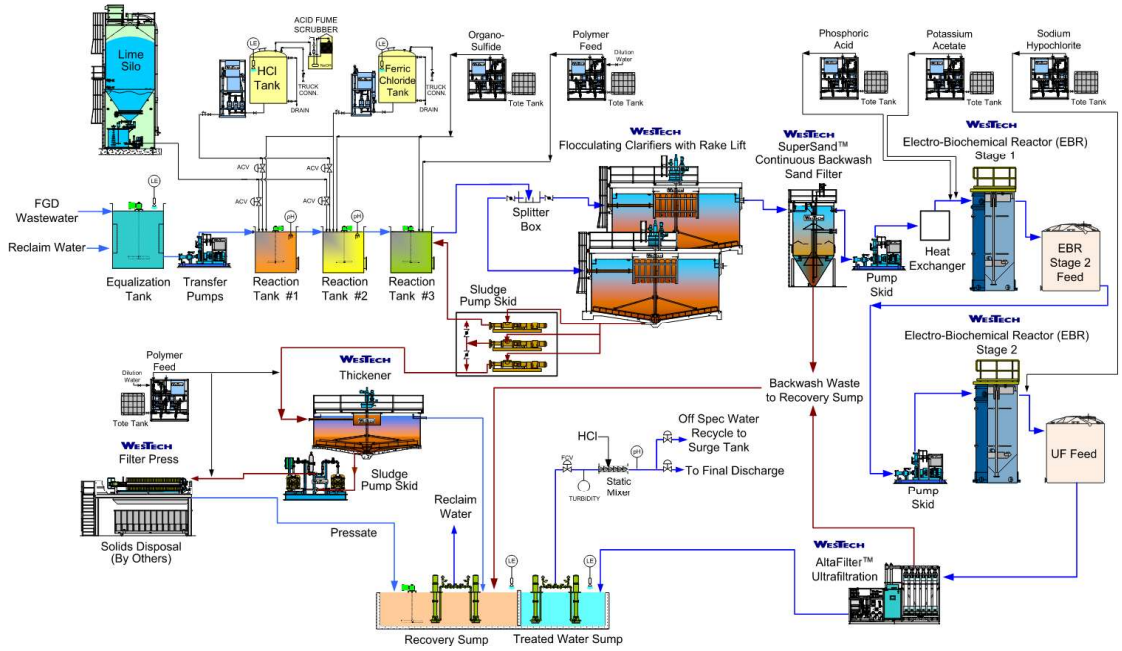


***Figure 2**. Typical FGD Process w/ Biological Treatment*

With many FGD treatment plant installations scattered across North America currently in operation, the combination of physical-chemical processes and biological treatment is proven to be highly effective. In addition, recent regulation updates in the United States have resulted in stricter criteria and ZLD targets for FGD treatment processes. WesTech has continued to adapt and is providing the market with ZLD options to meet the demand.

6.0 Technical Risk Assessment

The risk assessment for the Coffee Gold mine water treatment plant will target the risks that would result in prolonged inability to treat the HLF stream, these include construction delay (plant not ready before water is being produced), major equipment

failures, tank/equipment overflow, water contamination (beyond anticipated influent levels), and chemical spills inside the plant. These major events and failures are addressed on a conceptual level and may require further assessment and consideration after a specific site for the treatment plant is selected. This is due to factors that cannot be determined at this stage, including method and source location of the feed water with respect to the treatment plant, distance to the discharge point, geographic factors, final site arrangement and exposure.

Mitigation plans for common wear part failures, critical instrumentation, or typical maintenance activities are outlined in the Design Basis section addressing redundancy (part 3.9.4). Temporary shut-down (up to 48 hours), may be required to address the failure or replace an item being stored on-site (shelf spare) in accordance with the redundancy plan. Process fluid (HLF barren solution) is required to be stored in the source pond for this period of time at any point during the plant's operational life.

6.1 Construction or Installation Risks

A common situation in large scale greenfield operations is the misalignment of construction finalization and substantial completion; especially for downstream systems that require extensive commissioning and testing prior to coming on-line. The water treatment plant is the last step in processing and handling of water used in mining operations and thus requires critical attention during planning and staging of construction activities in order to be operational and performing at capacity to discharge treated water to the environment. Where scheduling or equipment delivery delays are anticipated to extend beyond the storage capacity of the upstream pond(s), a mitigation plan to allow on-going mine activities until completion of the treatment plant shall include temporary treatment solutions.

Modular, temporary, rental treatment systems are available for fast deployment from WesTech's rental fleet of treatment equipment; the equipment available in the rental fleet can handle the flow rate and are able to remove the target constituents outlined for this site. The only requirement being that enough open space is provided for the placement of the temporary systems on-site. In addition to providing the rental equipment, WesTech offers full-service hook-up and operational support for all rental systems. The process has been highly successful in Ash Pond remediation at power generation facilities, with the equipment requiring minimal site preparation and leaving little permanent impact after completion and removal of the temporary services.

6.2 Mechanical Risks

6.2.1 Major Equipment Failure

A major equipment failure is defined as the complete loss of use of a primary treatment piece of equipment, this includes all items depicted on the PFD and/or listed on the Major Equipment List. In the event of a non-redundant major equipment failure during regular operational activities, the plant would require immediate shut down and forward flow would be stopped, including discontinuing the discharge of water to Halfway Creek downstream. This would result in back-filling to the HLF pond until the equipment is repaired or replaced. Drainage of equipment, tanks, and pipelines to the Process Sump for areas surrounding the failure is required; the process sump recirculates water to the HLF, or plant feed tank as required.

Modular rental treatment systems are available from WesTech's rental fleet for temporary replacement of failed equipment. In some cases, multiple pieces of mobile equipment may be required to replace the full capacity of the treatment plant and additional pumps may be required to transport water mid-stream to the temporary system then back to the plant for further processing. WesTech offers a full-service layout, design, integration and operational support for all rental systems in addition to in-place retrofit and repair aftermarket services for many major pieces of WesTech supplied equipment.

6.2.2 Piping or Interconnecting System Failure

Interconnecting systems are susceptible to wearing failures of items such as gaskets, expansion joints, in-line instruments, valves, or other components that would require an entire section of piping to be isolated. These situations would result in partial or total plant shutdown to address the failure. As the common failures related to interconnected piping and systems are failures of spared or easily replaced components, those items shall be maintained as shelf-spares where applicable.

Containment of the process fluid (environmental protection) in the event of a piping or interconnecting system failure is achieved by the building floor slab and utility rack design. The entire treatment plant floor shall be concrete, which is sloped inward (away from exterior building walls) toward a trench and/or floor drain system that collects spills, drainage, washdown water, overflows, etc. channeling them to the process sump where they are recirculated to the HLF or feed tank for the plant. The building is also designed with a 150mm high (minimum) perimeter curb (discontinuous at doorways), both to protect the structure from corrosion and containment of splashing, draining, or overflowing process fluids.

Utility racks and equipment located outside the building are placed in a curbed area with centralized drainage to a collection sump or piped back to the process sump.

Catastrophic failure of a pipeline requiring long-term shut down for re-fabrication or modification of existing piping spools or components may result in mitigation action similar to a major equipment failure outlined above.

6.2.3 Containment System Failure

The plant is designed to have full containment of process fluids and chemicals as outlined in the Minimum Technical Design requirements (included in this document). In general, the use of sloped concrete to sealed sumps, trench drains, or isolated collection boxes shall mitigate the environmental impact or loss of contaminated fluids from within the plant boundaries. However, in cases where a natural disaster or other situation creates a failure of the containment area(s) mitigation and repair shall be implemented. In most cases, the containment systems are already a secondary protection for management of a primary equipment, tank, or piping failure. Thus, periodic inspection of containment systems and areas by plant operations personnel to maintain containment systems in good working order shall mitigate the potential of a primary failure that could also produce a secondary issue by lack of containment.

6.3 Chemical Risks

Water treatment systems are inherently reliant on chemical reactions to neutralize, precipitate, coagulate constituents for removal and therefore require on-site storage of various chemicals. While some chemicals are inert or not harmful in small doses, many

chemicals used in water treatment systems do pose various risks to either personnel or environment in the event of exposure. While various methods are employed to ensure protection from chemical hazards, the specific mitigation for each chemical exposure shall follow the published safety data sheets applicable to that chemical.

6.3.1 Chemical Spill (Storage)

The chemical storage area is situated outside the building and behind properly designed fire barriers in accordance with local building codes and industry practices. The area shall include fully sealed secondary containment for all chemical storage tanks as outlined in this document. In addition, any non-compatible chemical storage tanks shall be placed in independent, sealed containment areas to prevent the possibility of mixing and potentially volatile or otherwise hazardous reactions between two chemicals. The containment areas are designed with a low point sump for proper neutralization and removal of the spilled chemical.

Chemicals that are considered inert, non-toxic, and/or non-hazardous are still maintained within the designated chemical storage area and secondary containment to simplify cleanup in the event of leaks, spills, or tank failure. In some cases, inert or low consumption chemicals may be stored indoors, storage of these substances is still maintained within a sealed and isolated secondary containment area (typically shared with the indoor chemical distribution pump skids).

Refer to other design considerations in the minimum technical requirements section of this document.

6.3.2 Chemical Spill (Distribution)

The various chemicals are injected and different locations throughout the entire plant, including in mixing tanks, directly in the pipeline and into various process equipment as illustrated on the PFD. This requires distribution piping/tubing to be run throughout the plant and feed pumps to deliver chemical to the injection points.

Each injection point typically requires its own dedicated chemical feed pump; each pump shall be housed in a skid frame with associated valves, calibration columns, flow meters, etc. as required. The chemical skid shall be provided with catchment trays and spray shields to prevent exposure due to fitting, valve, or pump failure within the skid. All of the chemical skids shall be placed in a centralized location (to the extent possible), inside the building, within permanently sealed secondary containment. The containment shall be concrete with a continuous curb, waterstop, and a grit-infused chemically resistant coating system.

Design considerations for chemical distribution to limit risk of exposure are outlined in the minimum technical requirements section of this document.

6.4 Environmental Risks

Environmental risks due to natural disasters are generally accounted for in the design requirements of the local jurisdiction via building design codes and construction practices. While the intent of the design code is to maintain safety and integrity of the plant, building(s), and associated structures for personnel, it may not comprehensively protect against certain mechanical failures (pipe/tank rupture, containment/sealant cracking/failure, electrical fault, etc.). Refer to the Mechanical Risks above for

mitigation of mechanical failures. Other environmental factors or events may result in excess water (hydraulic overload) or foreign contaminants upstream.

6.4.1 Foreign Contaminants

The treatment plant is designed to target specific constituents present in common mine waters at the predicted concentrations outlined in this document. The presence of additional foreign contaminants that were not part of the initial design and water analysis may result in fouling, scaling, failure to treat or remove the foreign contaminants (leaving them to be passed through to Halfway Creek) or even failure to remove target constituents due to chemical or biological reactions from the foreign contaminants. In some cases, foreign contaminants may also contribute to eventual/premature failure of equipment, piping, or instrumentation systems within the plant. If the new contaminants are the result of changing mine chemistry not accounted for in the Adaptive Management Plan (see below) and are expected to be present in the HLF stream for an extended period, a long-term solution shall be pursued. Temporary or semi-permanent modular treatment systems that target specific constituents are generally available on the market, including rapid-deployment rental systems where mitigation plans must be implemented quickly.

Slip-stream sampling stations are recommended at the front of the plant to monitor incoming water quality and contaminant levels, in addition to identifying new or different constituents that could negatively impact the process equipment. Not all constituents can be tested and identified live (at the sampling station instrumentation) and a periodic lab analysis of the slip-stream would also be recommended. The instrumentation included in the sampling station would be recommended by the detailed engineering team based on final design targets.

In cases where the foreign contaminants are temporary (due to an upstream spill, leak, or system upset) and the contaminated water is localized or minimal volume, the use of trailered storage tanks (commonly referred to as frac tanks) for temporary storage may allow for isolation and remediation of the contaminants. With extensive experience in removal of a high variety of contaminants from waste streams, WesTech is positioned to offer solutions, including temporary rental systems that can target any range of applications.

After treatment for the foreign contaminants, the process water would be recirculated to the HLF or mixed into the feed tank at the front of the plant for regular processing.

6.4.2 Excess Target Constituents

Concentrations exceeding the maximum values listed may result in equipment overload or potential failure. Operators shall have the ability to measure and adjust chemical addition through the plant controls system and potentially be able to account concentration levels that are higher than anticipated in the design, thus managing a minor or temporary situation within the provided equipment capacity. Where the need is for additional capacity of existing equipment due consistently higher concentrations, other mitigation options shall be pursued which may include the following:

Where equipment is determined to be undersized for the higher constituent load, the overall plant influent flow rate may be reduced temporarily until further analysis is performed. A permanent retrofit to the plant may be required to increase overall capacity if the elevated concentrations are expected to remain. The resulting temporary decrease of flow through the plant will require the HLF pond to hold a larger

volume temporarily until the mitigation system is in place. Alternatively, a temporary or rental solution may be provided by suppliers, such as WesTech Engineering, capable of handling side-stream flows or treating specific targeted constituents temporarily during time periods where additional capacity is required. These systems may also be employed during the construction of a permanent retrofit that may require a long-term shutdown or reduced capacity of the existing plant.

6.4.3 Storm Events (Hydraulic Loading)

Surge flows of stormwater (rain, snowmelt, etc.) are not anticipated to impact the treatment plant which is primarily housed inside of a building. Where stormwater impacts the upstream HLF pond, the pond's size will manage the influx of water from any storm events with the only effect potentially being a slightly diluted feed to the plant for a period of time. Excess sediment carried into the plant from stormwater runoff is generally expected to be easily managed in the primary clarifier with the flocculation and sedimentation of other solids. In some rare case where stormwater introduces a non-targeted constituent that is not easily removed using the existing technology, a potential short-term solution may be required (refer to "Foreign Contaminants" mitigation in this section).

6.5 Regulatory Compliance Risks

The on-going evolution of regulatory requirements, specifically regarding maximum allowable effluent concentrations of target constituents based on the Water Quality Objectives (WQO), may require future adaptations and mitigation of the incoming HLF stream. If lower limits on those constituents in the effluent are adopted as part of future WQO's the plant's capacity to achieve those limits may be limited as presently designed. Where the capacity of the existing equipment is the limiting factor, the mitigation shall follow the same as outlined for situations where higher than expected concentrations of the target constituents are found in the influent (see above).

Where technology capability is the limiting factor or new constituents are added to a future WQO that is dependent on specific newly developed treatment technologies, the same must be evaluated and proven effective with the specific Coffee Gold Mine HLF stream.

7.0 Adaptive Management Plan

The water quality at the Coffee Gold Mine is anticipated to evolve with time, this requires that the treatment plant account for these changes to the extent possible. The original design should incorporate sufficient expansion, flexibility and/or capacity to achieve treatment targets throughout the design life. The plant shall also include instrumentation and data monitoring systems to help identify trends that would reveal evolving waste streams.

In the case of the Coffee Gold mine, the primary variations anticipated are related to specific target contaminants and their concentration levels in the feed water from the HLF.

7.1 Baseline Assessment

This technical assessment report includes the information used for the treatment plant's baseline design parameters, equipment selection, and process treatment steps

using the lab-produced simulated HLF stream. The goal of the lab testing was to size equipment and identify chemical conditioning and mixing parameters for a simulated stream that would be reflective of the worst-case feed water to the treatment plant. This is due to the lack of actual water available from the mine (which does not yet exist) in addition to understanding that the HLF water would evolve over the lifetime of the project.

7.2 Monitoring and Data Collection

Upon completion and commissioning of the treatment plant, the controls system shall monitor various live parameters using a variety of instruments, including flowmeters, pH probes, conductivity probes, turbidity meters, etc. Much of this data is used in real time to automatically adjust chemical dosing, initiate backwash or cleaning sequences, or manage other on-going operations and parameters. Data mapping within the master PLC allows operators and engineers to review conditions, follow trends, and make other manual adjustments within the process to optimize performance.

In addition, periodic sampling and lab testing of various streams within the plant will allow for observation of specific contaminant load, concentrations, and effectiveness of the various treatment stages at the targeted removal rates. On-going observation of the feed water coming into the treatment plant from the HLF is critical to recognizing the trends and evolution of that stream in order to make plans for long-term adjustments or adaptations if necessary.

7.3 Decision Triggers

The on-going trend mapping of in-line and lab test data shall be maintained to trigger the implementation or initiation of permanent or temporary adaptations within the treatment plant. Some of the triggers for within the treatment process may include, but are not limited to:

- Excess use of pH control chemicals (carbon dioxide, citric acid, etc.)
- Higher than permitted target constituents in the effluent
- Underperforming equipment or premature equipment failure
- Premature or frequent fouling of membrane, filter media, etc.
- High turbidity (in effluent)
- Scaling in equipment or piping
- High membrane/filter reject flows

Other outside variables may also act as triggers, including regulatory updates for discharge constituents, climate events, or technological advancements.

7.4 Flexible Treatment Strategies

The conceptual treatment plant includes several design features that create flexibility for future adaptation and adjustment. This includes the following:

- The use of modular and multi-stage mixing prior to the phys-chem treatment steps.

- Chemical injection locations are often duplicated and may be relocated to different mixing stages based on the needs of the process and the constituents present.
- The placement of equipment in parallel allows for optimization of those pieces of equipment based on whether hydraulic or solids loading conditions control.
- Phys-chem clarifiers have adjustable rake speed and sludge draw-off rates, in addition to the recirculated flow rate of solids back to the 3rd stage mixing.

In some cases, lab testing may not be feasible for certain pieces of equipment, until actual water is available for testing the conservative sizing of that equipment, such as the Reverse Osmosis (RO) membrane systems, is incorporated into the design and layout.

The availability of temporary rental treatment systems, including trailerized mix tanks, ballasted flocculating clarifiers, UF, and RO units, creates additional flexibility for the plant in situations where a temporary spike of targeted constituents or flow is anticipated or required to maintain mine operations.

7.5 Stakeholder Engagement

Proper engagement of the stakeholders (Newmont, First Nations, and the Canadian regulatory agencies) is critical, especially if evolving concentrations or types/species of contaminants will compromise the ability of the treatment plant to achieve the removal targets and regulatory minimums. Modifications, detailed mitigation plans, temporary treatment systems, testing, and evaluation of technologies and processes shall be reviewed and agreed upon prior to initiation of the same.

7.6 Periodic Review and Adjustment

Adaptive management plans are inherently subject to change, this may be due to unforeseen variables or parameters that could not be predicted in the lab environment or fully accounted for with reasonable contingency. In addition, regulations and advances in technology may justify a different approach or dictate a change in the adaptive management plans.

8.0 Conclusion

In summary, it is the Owner's responsibility to provide adequate management of the water being used and/or produced from the HLF activities, this report has been compiled by the engineer to aid in producing an acceptable treatment plant design complete with final recommendations.

Key findings include the identification of critical chemical addition, mixing, and liquid-solids separation validated by lab testing as an effective way to remove the target constituents and produce a clean discharge stream to Halfway Creek compliant with the current regulations. The critical removal of cyanide, the primary target constituent, by way of chemical oxidation has been proven effective in lab testing to produce compounds that can be coagulated, precipitated, and removed in the physical-chemical treatment portion of the plant. Another primary target is the removal of nitrates for which an electro-biochemical reactor is recommended for biological denitrification. Finally, due to the presence of cobalt the Reverse Osmosis step was introduced to polish the water before discharge. Other steps in the process are

supporting those primary targets in addition to ensuring the removal of other heavy metals and residuals from those primary target processes that may be present throughout the lifetime of the plant. While not all processes could be proven or tested in the lab environment, historic reliability of technologies (such as Reverse Osmosis or Ultrafiltration) in similar processes have shown the viability of the engineer's recommendation.

Appropriate plans for comprehensive risk management of the plant and protection of the operations personnel and surrounding environment shall consider the engineer's recommendations. In addition, it is critical to understand the evolving nature of the HLF feed stream and how adaptability of the process and availability of supporting systems may influence up-front design decisions.

The proactive design of both flexible and adaptable processes and robust treatment equipment capable of withstanding the varying conditions and continuous operation is critical to achieve a consistent discharge of clean water to the environment.

Appendix A: Mass Balance

Client:	Newmont	REVISION	BY	CHECKED	REASON	DATE
Project Title:	COFFEE GOLD	A	SJARD	JFREE	INITIAL SUBMITTAL	2025-05-20
Project ID:	CW2242356					
Project Number:	M-100898					
Document Name:	Mass Balance					
Document Number:	100898-PR-MB-01					
Client Document Number:						

Stream ID **PFD Sheet-01**	**1. Influent feed water to EQ Tank (by customer)**	**2. Reaction Tank 1 feed Cyanide destruction**	**3. Reaction Tank 2 feed BP chlorination**	**4. Reaction Tank 3 feed Calcium Precipitaiton**	**5. Reaction Tank 3 to Clarifier 1 feed**	**6. Clarifier 1 overflow to Supersand**	**7. Clarifier 1 Recylce to Reaction Tank 3**	**8. Clarifier 1 Sludge to Sludge Tank**	**9. Supersand overflow/EBR feed**	**10. Supersand backwash waste to Sump**
Design (Max) Flow rate, Continuous (L/s)	35.00	35.00	35.74	36.10	44.71	41.02	3.33	0.36	39.79	2.10
Maximum TSS (mg/L)	By client	0.00	79.62	461.80	18856.19	17.61	228070.18	228070.18		344.37
Maximum Solids Load, continuous (kg/hr)	By client	0.00	10.24	60.01	3034.98	2.60	2736.84	295.53		2.60
Solids SG	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6		2.6
Liquid SG	1	1	1	1	1	1	1	1		1
pH									7.50	7.50
Typical % Solids	By client	0.00%	0.01%	0.05%	1.86%	0.00%	20.00%	20.00%		0.03%
NOTES	TP 1									

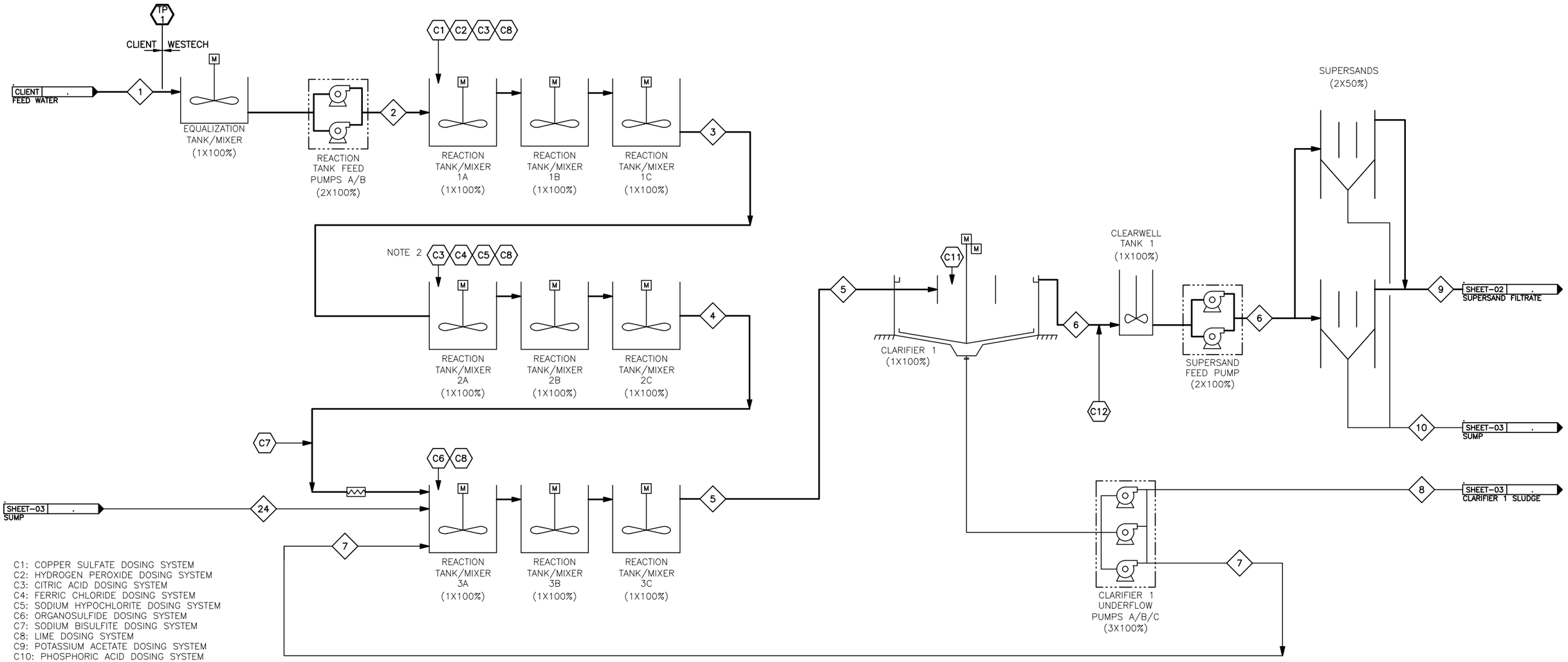
Stream ID **PFD Sheet-02**	**11. EBR treated water to UF Skid**	**12. UF filtrate to Filtrate/Service Water Tank**	**13. UF backwash waste to Sump**	**14. RO Skid feed**	**15. RO Peremate, treated water stream**	**16. RO concentrate/ Reaction Tank 4 feed (SO4 removal)**
Design (Max) Flow rate, Continuous (L/s)	40.60	40.60	60.90 Intermittent	35.64	26.73	8.91
Maximum TSS (mg/L)			N/A		0.00	
Maximum Solids Load, continuous (kg/hr)			N/A		N/A	
Solids SG			2.6		N/A	2.6
Liquid SG	1	1	1	1	1	1
pH	8.0-8.5	7.0-7.5				
Typical % Solids			0.00%		N/A	
NOTES	Note 1	Note 1	Note 1	Note 1	TP 2/ Note 1	Note 1

Stream ID **PFD Sheet-03**	**17. Clarifier 2 feed**	**18. Clarifier 2 sludge to Sludge Tank**	**19. Clarifier 2 underflow recycle**	**20. Clarifer 2 overflow to HLF**	**21. Sludge Tank to Filter Press**	**22. Filter Press filtrate to Sump**	**23. Filter Press cake to disposal**	**24. Sump return to Reaction Tank 3**
Design (Max) Flow rate, Continuous (L/s)	10.43	0.21	1.34	9.01	0.57	0.33	0.25	4.65
Maximum TSS (mg/L)	33916.21	228070.18	228070.18	18.50	228070.18	848.57	530612.24	215.20
Maximum Solids Load, continuous (kg/hr)	1273.00	175.09	1097.30	0.60	470.63	1.00	1174.07 (total slurry)	3.60
Solids SG	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Liquid SG	1	1	1	1	1	1	1	1
pH								
Typical % Solids	3.32%	20.00%	20.00%	0.00%	20.00%	0.08%	40.00%	0.02%
NOTES	Note 1	Note 1	Note 1	TP 3/ Note 1	Note 1		TP 4	

Stream ID **Service water** Note 2	**S1. Balance of Plant Service Water**	**S2. Lime makeup water**	**S3. Sodium Bisfulfite makeup water**	**S4. Polymer day tank, makeup water**	**S5. Polymer to Clarifier 1 push water**	**S6. Polymer to Clarifier 2 push water**	**S7. UF backwash**	**S8. EBR backwash (for 1 units)**	**S9. CO2 carrier water to 2 injection sites**
Continuous (L/s)	2.74	0.52	0.00	0.02	0.44	0.13	2.22	0.13	1.62
Continuous (L/hr)	9852.23	1878.66	7.43	87.00	1600.00	450.00	8000.00	454.33	5829.15
Intermittent (L/s)							60.90	1.89	
Intermittent (L/hr)							219228.55	6815.00	
Duration (for instantaneaous)							~3.5 minute backwash	1 minute per EBR every 15 minutes	

Note 1: Flow rates may vary to makeup for UF maintenance cleans, downstream UF will pause for daily cleans, and increase throughput after clean has finished. Balance shows average throughput over 24 hours.
Note 2: Continuous streams could be broken down into the whole draw from the tank in a 24 hour period, not the actual instantaneous required flow for makedown, backwash, etc

Appendix B: Process Flow Diagram



C1: COPPER SULFATE DOSING SYSTEM
C2: HYDROGEN PEROXIDE DOSING SYSTEM
C3: CITRIC ACID DOSING SYSTEM
C4: FERRIC CHLORIDE DOSING SYSTEM
C5: SODIUM HYPOCHLORITE DOSING SYSTEM
C6: ORGANOSULFIDE DOSING SYSTEM
C7: SODIUM BISULFITE DOSING SYSTEM
C8: LIME DOSING SYSTEM
C9: POTASSIUM ACETATE DOSING SYSTEM
C10: PHOSPHORIC ACID DOSING SYSTEM
C11: POLYMER DOSING SYSTEM
C12: CARBONIC ACID DOSING SYSTEM

CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION

NOTE:
1. FOLLOW THE LISTED WESTECH REFERENCE DOCUMENTS EXCEPT AS NOTED ON THIS DRAWING.
2. OPTIONAL CITRIC ACID ADDITION LINE INTO REACTION TANK 2.

PROFESSIONAL ENGINEER YUKON MARK SOMERS TERRITORY 26/11/2025

PROFESSIONAL ENGINEER YUKON E. H. DONALDSON TERRITORY ED 26/11/25

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE	REFERENCE DOCUMENTS
A	ISSUED FOR REVIEW	–	SJARD	BCALL	2025-05-01	100898-MB-01

PREPARED FOR GOLDCORP KAMINAK LTD.
VANCOUVER, BC

ENGINEER WESTECH ENGINEERING, LLC
SALT LAKE CITY, UT

CONTRACTOR

PO/CONTRACT NUMBER CW224356

WESTECH®

TITLE
PROCESS FLOW DIAGRAM
PHYSICO-CHEMICAL

CLIENT DOCUMENT NUMBER				
DESIGNER	CHECKER	APPROVER	DATE	DOCUMENT UNIQUE ID
SJARD	JFREE	BCALL	2025-05-01	
JOB NUMBER	DOCUMENT NUMBER		SHEET	REV
M-100898	PR-PFD-01		1 OF 3	A

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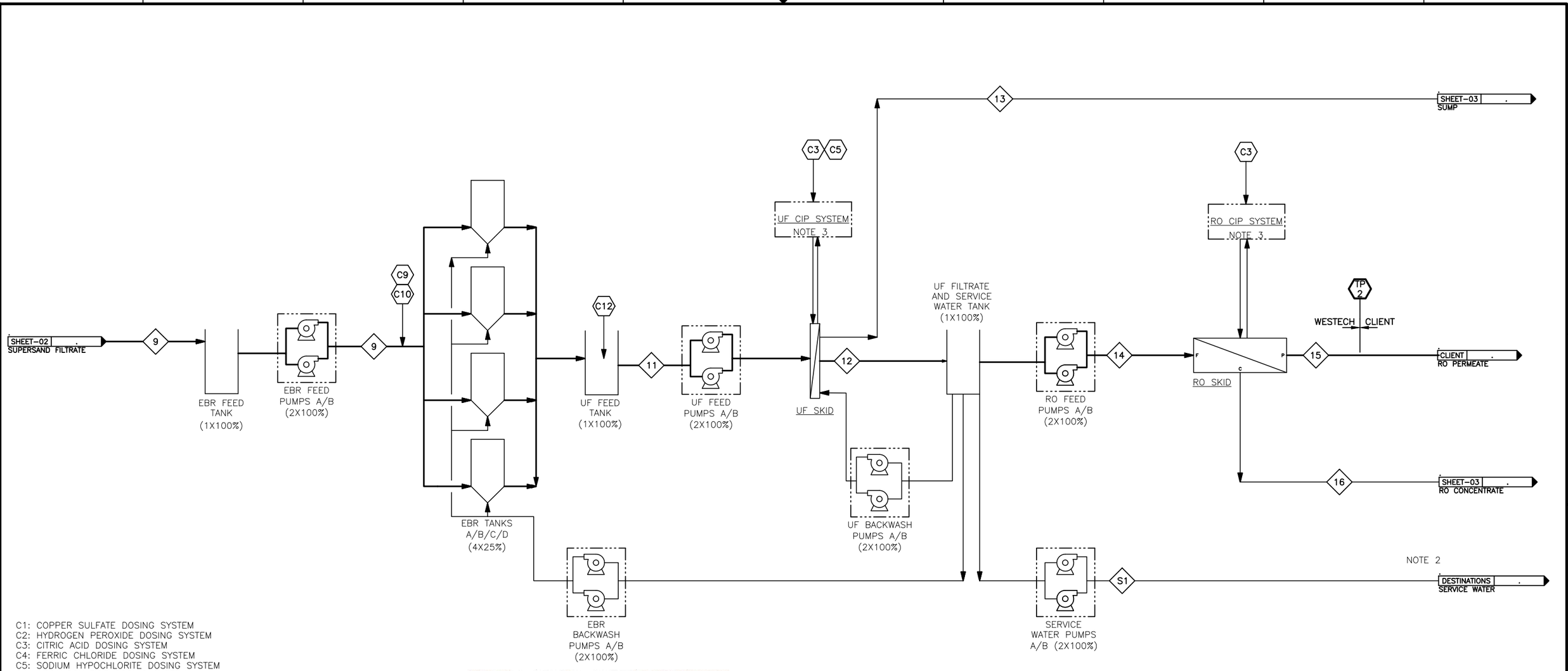

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**CONCEPTUAL DESIGN
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PROFESSIONAL ENGINEER YUKON MARK SOMERS TERRITORY 26/11/2025

PROFESSIONAL ENGINEER YUKON E.H. DONALDSON TERRITORY ED 26/11/25

NOTE:
1. FOLLOW THE LISTED WESTECH REFERENCE DOCUMENTS EXCEPT AS NOTED ON THIS DRAWING.
2. SERVICE WATER TO DESTINATIONS REQUIRED TO MAKEUP CHEMICAL SLURRIES, SERVE AS PUSHWATER TO APPLICABLE CHEMICAL SYSTEMS, FILL CIP TANKS, AND GENERAL PLANT SERVICES.
3. CIP SYSTEM CONSISTS OF CIP TANK, PUMP, CHEMICAL HOOKUPS, ON SKID PIPING. CIP FLOWPATHS ARE CLOSED LOOP RECIRCULATION CLEANINGS, AND DO NOT REQUIRE A STREAM NUMBER.

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE
A	ISSUED FOR REVIEW	–	SJARD	BCALL	2025-05-01

100898-MB-01
REFERENCE DOCUMENTS

PREPARED FOR GOLDCORP KAMINAK LTD.
VANCOUVER, BC

ENGINEER WESTECH ENGINEERING, LLC
SALT LAKE CITY, UT

CONTRACTOR

PO/CONTRACT NUMBER CW224356

WESTECH®

TITLE
PROCESS FLOW DIAGRAM
BIOLOGICAL/MEMBRANE

CLIENT DOCUMENT NUMBER				
DESIGNER	**CHECKER**	**APPROVER**	**DATE**	**DOCUMENT UNIQUE ID**
SJARD	JFREE	BCALL	2025-05-01	
JOB NUMBER	**DOCUMENT NUMBER**		**SHEET**	**REV**
M-100898	**PR-PFD-01**		2 OF 3	A

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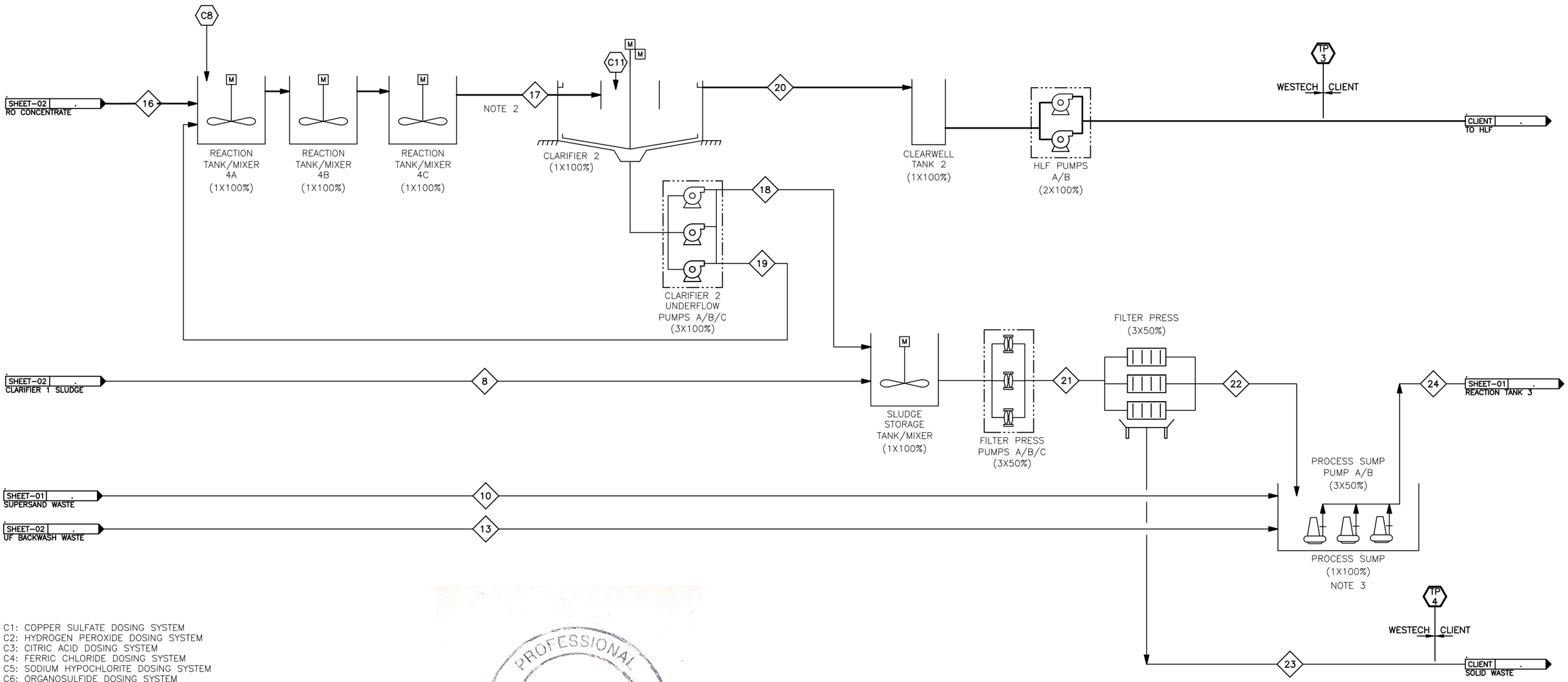

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C10: PHOSPHORIC ACID DOSING SYSTEM
C11: POLYMER DOSING SYSTEM
C12: CARBONIC ACID DOSING SYSTEM

CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION

NOTE:
1. FOLLOW THE LISTED WESTECH REFERENCE DOCUMENTS EXCEPT AS NOTED ON THIS DRAWING.
2. ADDITIONAL SULFATE PRECIPITATION USING BARIUM (BACO3) MAY BE INCLUDED AT THIS POINT. FURTHER ENGINEERING REQUIRED TO ASSESS THE NECESSITY.
3. CIP WASTE TO SUMP.

PROFESSIONAL ENGINEER YUKON E.H. DONALDSON TERRITORY 26/11/25

PROFESSIONAL ENGINEER YUKON MARK SOMERS TERRITORY 26/11/2025

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE	REFERENCE DOCUMENTS
A	ISSUED FOR REVIEW	–	SJARD	BCALL	2025-05-01	100898-MB-01

PREPARED FOR GOLDCORP KAMINAK LTD.
VANCOUVER, BC

ENGINEER WESTECH ENGINEERING, LLC
SALT LAKE CITY, UT

CONTRACTOR

PO/CONTRACT NUMBER CW224356

WESTECH®

TITLE
PROCESS FLOW DIAGRAM
SECONDARY TREATMENT

CLIENT DOCUMENT NUMBER				
DESIGNER	CHECKER	APPROVER	DATE	DOCUMENT UNIQUE ID
SJARD	JFREE	BCALL	2025-05-01	
JOB NUMBER	DOCUMENT NUMBER		SHEET	REV
M-100898	PR-PFD-01		3 OF 3	A

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Appendix C: Chemical Consumption List

Client:	Newmont	REVISION	BY	CHECKED	REASON	DATE
Project Title:	COFFEE GOLD	A	SJARD	JFREE	INITIAL SUBITTAL	2025-05-16
Project ID:	CW242356					
Project Number:	M-100898					
Document Name:	Chemical Consumption list					
Document Number:	100898-PR-MB-02					
Client Document Number:						

Stream ID	C1. Copper Sulfate	C2. Hydrogen Peroxide	C3. Citric Acid	C4. Ferric Chloride	C5. Sodium Hypochlorite	C6. Organosulfide	C7. Sodium Bisulfite	C8. Lime	C9. Potassium Acetate	C10. Phosphoric acid	C11. Dry Polymer	C12. Carbon Dioxide (Carbonic Acid)
Chemical Concentration	25%	34%	50%	40%	14.5%	100%	10%	10%	60%	75%	N/A	100%
SG	1.18	1.13	1.26	1.43	1.16	1.05	1.05	1.10	1.34	1.572	N/A	1.50
Dosing streams	1	1	1	1	1	1	1	4	1	1	2	2
Total Dosage (mg/L)	185	7684	100	600	756.9	30	6	3295	1200	11.79	5.41	5284.02
Total Flow rate (L/hr)	79.02	2520.00	20.00	132.17	567.00	3.60	7.43	1878.66	213.77	1.43	90.30	5829.15
Total Mass flow rate (kg/hr)	23.31	968.18	12.60	75.60	95.37	3.90	0.78	206.65	172.13	1.69	0.45	15.40

Appendix D: Equipment List

Client:	NEWMONT	**Revision**	**By**	**Checked**	**Reason**	**Date**
Project Title:	COFFEE GOLD	A	SJARD	JFREE	INITIAL SUBMITTAL	2025-05-16
Project ID:	CC2242356					
Project Number:	M-100898					
Document Name:	MAJOR EQUIPMENT LIST					
WesTech Document Number:	M-100898-PR-LST-01					
Client Document Number:						

Line No.	Line Item Revision	Equipment Designation	Tag No.	PFD SHEET NO.	Equipment/Name	Qty	Size	Material	Working Capacity	Comments / Other Information	Equipment Provided By	Equipment Skidded (Y/N)
1	A	TANK	EQ-001	SHEET-01	EQUALIZATION TANK	1	7.5 M DIAMETER X 7.2 M SWH	STEEL	252 M^3	OPEN TOP TANK W/ 60 HP MIXER (480VAC/3-PHASE)	WESTECH	N
2	A	PUMP	PU-001A/B	SHEET-01	REACTION TANK FEED PUMPS A/B	2	15 HP PER PUMP	STEEL	35 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	Y
3	A	TANK	TK-001A/B/C	SHEET-01	REACTION TANK 1 A/B/C	3	6 M DIAMETER X 7.2 M SWH	STEEL	172 M^3	OPEN TOP TANK W/ 60 HP MIXER PER TANK (480VAC/3-PHASE)	WESTECH	N
4	A	TANK	TK-002A/B/C	SHEET-01	REACTION TANK 2 A/B/C	3	5 M DIAMETER X 5.4 M SWH	STEEL	87 M^3	OPEN TOP TANK W/ 60 HP MIXER PER TANK (480VAC/3-PHASE)	WESTECH	N
5	A	TANK	TK-003A/B/C	SHEET-01	REACTION TANK 3 A/B/C	3	4 M DIAMETER X 5.4 M SWH	STEEL	44 M^3	OPEN TOP TANK W/ 60 HP MIXER PER TANK (480VAC/3-PHASE)	WESTECH	N
6	A	MIXER	MX-004	SHEET-01	INLINE MIXER	1	8-10 INCH LINE	TBD	36.5 L/s FLOW	STATIC MIXER (IN-LINE)	WESTECH	N
7	A	CLARIFIER	CF-001	SHEET-01	CLARIFIER 1	1	15.25 M DIAMETER X 4.5 M SWH	STEEL	141 M^2 CLARFICIATION AREA	2 MOTORS, 5 HP EACH (480VAC/3-PHASE)	WESTECH	N
8	A	PUMP	PU-002A/B/C	SHEET-01	CLARIFIER 1 UNDERFLOW PUMPS A/B/C	3	5 HP PER PUMP	TBD	3.7 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	Y
9	A	TANK	TK-004	SHEET-01	CLEARWELL TANK 1	1	3 M DIAMETER X 5.4 M SWH	STEEL	12.3 M^3	OPEN TOP TANK W/ 60 HP MIXER (480VAC/3-PHASE)	WESTECH	N
10	A	PUMP	PU-003	SHEET-01	CARRIER PUMP	1	2 HP PER PUMP	TBD	1.6 L/s @ 20 METERS TDH	CARBONIC ACID CARRIER WATER	WESTECH	Y
11	A	PUMP	PU-004A/B	SHEET-01	SUPERSAND FEED PUMPS A/B	2	25 HP PER PUMP	TBD	41 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	N
12	A	FILTER	FL-001A/B	SHEET-01	SUPERSAND A/B	2	3 M DIAMETER X 7.7 M HEIGHT	STEEL	0.27 L/s PER 7 M^2 LOAD RATE	10 AMPS @ 120V PER UNIT	WESTECH	N
13	A	TANK	TK-005	SHEET-02	EBR FEED TANK	1	3 M DIAMETER X 5.4 M SWH	STEEL	23.4 M^3	OPEN TOP TANK	WESTECH	N
14	A	PUMP	PU-005A/B	SHEET-02	EBR FEED PUMPS A/B	2	20 HP PER PUMP	TBD	40 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	Y
15	A	EBR	EBR-001A/B/C/D	SHEET-02	EBR TANKS A/B/C/D	4	2.15 M DIAMETER X 6.1 M HEIGHT	STEEL	18000 GALLONS PER UNIT	30 AMPS @ 120V PER UNIT	WESTECH	N
16	A	TANK	TK-006	SHEET-02	UF FEED TANK	1	6 M DIAMETER X 5.4 M HEIGHT	STEEL	94 M^3	OPEN TOP TANK	WESTECH	N
17	A	PUMP	PU-006A/B	SHEET-02	UF FEED PUMPS A/B	2	10 HP PER PUMP	TBD	40.6 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	Y
18	A	FILTER	FL-002	SHEET-02	ULTRAFILTRATION SKID	1	6.1 M LENGTH X 1.93 M WIDTH	TBD	40.6 L/s		WESTECH	Y
19	A	TANK	TK-007	SHEET-02	UF FILTRATE AND SERVICE WATER TANK	1	5 M DIAMETER X 5.4 M SWH	STEEL	77 M^3	OPEN TOP TANK	WESTECH	N

Client:	NEWMONT	**Revision**	**By**	**Checked**	**Reason**	**Date**
Project Title:	COFFEE GOLD	A	SJARD	JFREE	INITIAL SUBMITTAL	2025-05-16
Project ID:	CC2242356					
Project Number:	M-100898					
Document Name:	MAJOR EQUIPMENT LIST					
WesTech Document Number:	M-100898-PR-LST-01					
Client Document Number:						

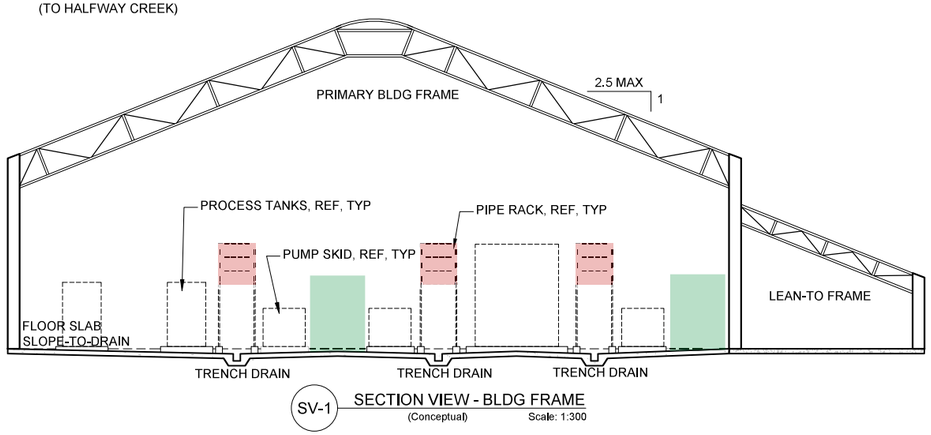
Line No.	Line Item Revision	Equipment Designation	Tag No.	PFD SHEET NO.	Equipment/Name	Qty	Size	Material	Working Capacity	Comments / Other Information	Equipment Provided By	Equipment Skidded (Y/N)
20	A	PUMP	PU-007A/B	SHEET-02	UF BACKWASH PUMPS A/B	2	30 HP PER PUMP	TBD	60.9 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	Y
21	A	PUMP	PU-008A/B	SHEET-02	EBR BACKWASH PUMPS A/B	2	1.5 HP PER PUMP	TBD	1.9 L/s @ 20 METERS TDH	480VAC/3-PHASE	WESTECH	Y
22	A	PUMP	PU-009A/B	SHEET-02	SERVICE WATER PUMPS A/B	2	3 HP PER PUMP	TBD	2.7 L/s @ 20 METERS TDH	480VAC/3-PHASE	WESTECH	Y
23	A	PUMP	PU-0010A/B	SHEET-02	RO FEED PUMPS A/B	2	20 HP PER PUMP	TBD	35.6 L/s @ 10 METERS TDH	480VAC/3-PHASE	WESTECH	Y
24	A	FILTER	FL-003	SHEET-02	REVERSE OSMOSIS SKID	1	8.25 M LENGTH X 2.6 M WIDTH X 2.75 M HEIGHT	TBD	35.6 L/s		WESTECH	N
25	A	SYSTEM	SD-100	SHEET-02	UF CIP SYSTEM	1	4 M LENGTH X 2 M WIDTH	VARIES	N/A	1 CIP WASH PER MONTH	WESTECH	N
26	A	SYSTEM	SD-110	SHEET-02	RO CIP SYSTEM	1	4 M LENGTH X 2 M WIDTH	VARIES	N/A	1 CIP WASH PER MONTH	WESTECH	N
27	A	TANK	TK-008A/B/C	SHEET-03	REACTION TANK 4 A/B/C	3	3 M DIAMETER X 5.4 M SWH	STEEL	25 M^3	OPEN TOP TANK W/ 60 HP MIXER PER TANK (480VAC/3-PHASE)	WESTECH	N
28	A	CLARIFIER	CF-002	SHEET-03	CLARIFIER 2	1	9.15 M DIAMETER X 4.5 M SWH	STEEL	63 M^2 CLARFICIATION AREA	2 MOTORS, 5 HP EACH (480VAC/3-PHASE)	WESTECH	N
29	A	PUMP	PU-011A/B/C	SHEET-03	CLARIFIER 2 UNDERFLOW PUMPS A/B/C	3	5 HP PER PUMP	TBD	1.6 L/s @ 20 METERS TDH	480VAC/3-PHASE	WESTECH	Y
30	A	TANK	TK-009	SHEET-03	CLEARWELL TANK 2	1	2 M DIAMETER X 3.6 M SWH	STEEL	5.4 M^3	OPEN TOP TANK W/ 15 HP MIXER (480VAC/3-PHASE)	WESTECH	N
31	A	PUMP	PU-012A/B	SHEET-03	HLF FEED PUMPS A/B	2	20 HP PER PUMP	TBD	9 L/s @ 35 METERS TDH	480VAC/3-PHASE	WESTECH	Y
32	A	TANK	TK-010	SHEET-03	SLUDGE STORAGE TANK	1	2 M DIAMETER X 3.6 M SWH	STEEL	8.2 M^3	OPEN TOP TANK W/ 15 HP MIXER (480VAC/3-PHASE)	WESTECH	N
33	A	PUMP	PU-013A/B/C	SHEET-03	FILTER PRESS PUMPS A/B/C	3	3.7 LENGTH X 2.6 FT WIDTH X 2.6 FT HEIGHT (SINGLE SKID CONTAINING ALL 3 PUMPS)	TBD	5 L/s @ 35 METERS TDH	AIR-OPERATED DOUBLE DIAPHRAGM PUMPS	WESTECH	Y
34	A	FILTER	FL-004A/B/C	SHEET-03	FILTER PRESS A/B/C	3	7.5 M LENGTH X 2.2 M WIDTH X 2.2 M HEIGHT	TBD	1.5 M^3, 20 HP HYDRAULIC UNIT (480VAC/3-PHASE)	ON ELEVATED STRUCTURE W/ PERIMETER WALKWAY	WESTECH	N
35	A	SUMP	TK-011	SHEET-03	SUMP	1	3.35 M LENGTH X 2.74 M WIDTH X 2.13 M HEIGHT OUTER DIMENSIONS	REINFORCED CONCRETE	11.7 M^3	PRECAST CONCRETE CONSTRUCTION	WESTECH	N
36	A	PUMP	PU-014A/B/C	SHEET-03	SUMP PUMPS A/B	3	25 HP PER PUMP	TBD	23 L/s @ 20 METERS TDH	BOTH PUMPS RUN DURING UF BACKWASH	WESTECH	N

Appendix E: Site Layout (Preliminary)

PLANT NORTH (NOTE 4)



PV-1 PLAN VIEW
Scale: 1:300



SV-1 SECTION VIEW - BLDG FRAME
(Conceptual) Scale: 1:300

MAJOR EQUIPMENT SCHEDULE	
NO.	DESCRIPTION
1	EQUALIZATION TANK
2	REACTION TANK FEED PUMPS A/B
3	REACTION TANK 1 A/B/C
4	REACTION TANK 2 A/B/C
5	REACTION TANK 3 A/B/C
6	SUMP
7	CLARIFIER 1
8	CLARIFIER 1 UNDERFLOW PUMPS A/B/C
9	CLEARWELL TANK 1
10	SUPERSAND FEED PUMPS A/B
11	SUPERSAND A/B
12	EBR FEED TANK
13	EBR FEED PUMPS A/B
14	EBR TANKS A/B/C/D
15	UF FEED TANK
16	UF FEED PUMPS A/B
17	ULTRAFILTRATION SKID
18	UF FILTRATE AND SERVICE WATER TANK
19	UF BACKWASH PUMPS A/B
20	EBR BACKWASH PUMPS A/B
21	SERVICE WATER PUMPS A/B
22	RO FEED PUMPS A/B
23	REVERSE OSMOSIS SKID
24	UF CIP SYSTEM
25	RO CIP SYSTEM
26	REACTION TANK 4 A/B/C
27	CLARIFIER 2
28	CLARIFIER 2 UNDERFLOW PUMPS A/B/C
29	CLEARWELL TANK 2
30	HLF FEED PUMPS A/B
31	SLUDGE STORAGE TANK
32	FILTER PRESS PUMPS A/B/C
33	FILTER PRESS A/B/C

CONCEPTUAL DESIGN NOT FOR CONSTRUCTION

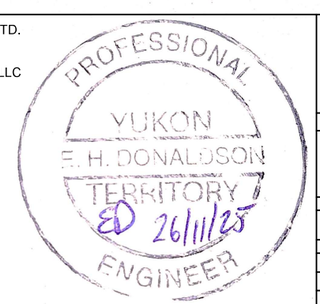
LEGEND:
- PRIMARY PIPE ROUTING
- PIPING CORRIDOR/PIPE RACK
- FORKLIFT/MAINTENANCE ACCESS
- ELEVATED SERVICE PLATFORM
- OVERHEAD SERVICE DOOR

GENERAL NOTES:
1. ALL DIMENSIONS ARE IN METERS U.N.O.
2. SECTION VIEW FOR REFERENCE ONLY, ACTUAL BUILDING HEIGHT TBD.
3. LAYOUT IS CONCEPTUAL ONLY, NOT FOR CONSTRUCTION.
4. SITE ORIENTATION IS FOR REFERENCE ONLY, ACTUAL SITE HAS NOT BEEN SELECTED.

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE
B	PRELIMINARY DESIGN	-	BCALL	-	2025-06-26
A	ISSUED FOR APPROVAL	-	LRAYF	BCALL	2025-05-01

REFERENCE DOCUMENTS
M-100898-PR-LST-01
M-100898-PR-PFD-01

PREPARED FOR: GOLDCORP KAMINAK LTD. VANCOUVER, BC
ENGINEER: WESTECH ENGINEERING, LLC SALT LAKE CITY, UT
CONTRACTOR:
PO/CONTRACT NUMBER: CW2242356



WESTECH
SWIRE WATER

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TITLE **EQUIPMENT LOCATION PLAN**
NEWMONT COFFEE GOLD MINE

CLIENT DOCUMENT NUMBER: -

DESIGNER	CHECKER	APPROVER	DATE	DOCUMENT UNIQUE ID
LRAYF	DZORR	BCALL	05-01-2025	-

JOB NUMBER	DOCUMENT NUMBER	SHEET	REV
M-100898	M-PL-01	1 OF 1	A

G:\ACTVPROP\221 PROPS\2210138 NEWMONT YUKON COFFEE MINE WTP CAN\7-WESTECH DRAWINGS\NEWMONT YUKON COFFEE MINE NEW\PLANT 3D MODELS\GENERAL\M-100898-M-PL-01

Appendix F: Utility List (Preliminary)

WESTECH®

SWIRE WATER

Client:	Newmont	**Revision**	**By**	**Checked**	**Reason**	**Date**
Project Title:	Coffee Gold	A	SJARD	JFREE	INITIAL SUBMITTAL	05/15/25
Project ID:	CC242356					
Project Number:	M-100898					
Document Name:	Utility Consumption List					
Document Number:	100898-PR-LST-03					

SERVICE/POTABLE WATER CONSUMPTION

Line No.	Equipment	Service Water L/hr	Potable Water L/hr	Description of Service	Continuous/ Intermittent	Line Item Revision
1	LIME DOSING SYSTEM - SLURRY TANK	1880		Service water to make Lime slurry for chemical dosing	Intermittent	A
2	CARBONIC ACID DOSING SYSTEM	5830		Carrier water for carbonic acid system	Continuous	A
3	POLYMER DOSING SYSTEM - DAY TANK	87		Service water for polymer day tank makeup	Intermittent	A
4	POLYMER SYSTEM - FEED SKID TO CLARIFIER 1	1600		Push water for flocculant to clarifier 1	Continuous	A
5	POLYMER SYSTEM - FEED SKID TO CLARIFIER 2	450		Push water for flocculant to clarifier 2	Continuous	A
6	UF CIP SYSTEM - TANK	5678 L total		Makeup water for CIP cleans for UF once per month. CIP Tank to be filled each CIP cycle	Intermittent	A
7	RO CIP SYSTEM - TANK	7570 L total		Makeup water for CIP cleans for RO once per month. CIP Tank to be filled each CIP cycle	Intermittent	A
8	EBR 1A	6815		1 minute backwash every 15 minutes	Intermittent	A
9	EBR 1B	6815		1 minute backwash every 15 minutes	Intermittent	A
10	EBR 1C	6815		1 minute backwash every 15 minutes	Intermittent	A
11	EBR 1D	6815		1 minute backwash every 15 minutes	Intermittent	A
12	UF SKID	8000		UF Backwash for 20-60 minutes with air scour	Intermittent	A
13	SAFETY SHOWERS		4500	Assuming 1 stations, for 5 minutes	Intermittent	A

INSTRUMENT/PLANT AIR CONSUMPTION

Line No.	Equipment	Instrument Air SCFM	Plant Air SCFM	Description of Service	Continuous/ Intermittent	Line Item Revision
1	LIME DOSING SYSTEM - ASH SILO		20	20 SCFM @ 100 psi	Intermittent	A
2	SUPERSAND A/B - AIR PANEL		4	Continuous air use for air panel - air lift pump	Continuous	A
3	SUPERSAND - AIR PANEL		5	Used for startup of supersand (bursting) per unit	Intermittent	A
4	UF FILTER		5	30 second air scour during backwash	Continuous	A
5	DOUBLE DIAPHRAM PUMPS A/B		120	Assumes 10-15 minute fill cycle at 100 psi	Intermittent	A
6	FILTER PRESS UNIT		300	Batch operation, 100 psi per unit per cycle	Intermittent	A
7	CONTROL VALVES ~ 150	2		Assumes 150 control valves changing positions	Intermittent	A

APPENDIX F
Contingency Water Treatment Plan



Contingency Water Treatment Plan

Coffee Gold Mine Project, Yukon, Canada

Owner

Newmont™ COFFEE

Vancouver, Canada

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WESTECH®

Friday, April 28, 2023

SYSTEM CERTIFICATION ISO 9001 SGS

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- Introduction
- Temporary Closure Water Management
- Contingency Treatment Desciption
- Management of Water Treatment Residuals
- Economic and Technical Feasibility
- Contingency Deployment Schedule
- Potential Triggers for Deployment

Contingency Water Treatment Plan

Introduction

The current HLF Water Balance Model shows that the HLF event pond volumes will maintain the Event Storage Requirement (ESR) throughout the life and beyond the final reclamation of the HLF. The facility will maintain the capability to manage solution between ponds to maintain the ESR during any unforeseen events. The model indicates that solution removal will need to commence in Year 2 to maintain ESR; therefore, the proposed schedule includes a commissioned water treatment plant on site for Year 2 of mine operation. The model assumes that zero solution removal will occur prior to the availability of the active water treatment plant. In the event, however, that heap leach solution accumulates in greater volumes than assumed within the model and solution removal is required prior to Year 2, an active contingency water treatment system would be implemented. This memo describes the contingency water treatment system, as well as the strategy and schedule for implementation. This memo also outlines the economic and technical feasibility of implementing the contingency water treatment plan and describes a potential temporary closure scenario prior to Year 2.

Contingency Treatment Description

The plan for Contingency Water Treatment would be implemented in the event of a need to treat and discharge water prior to the time when the proposed capital water treatment plant becomes operational. To provide a flexible and effective treatment option, we propose to use a temporary reverse osmosis (RO) unit.

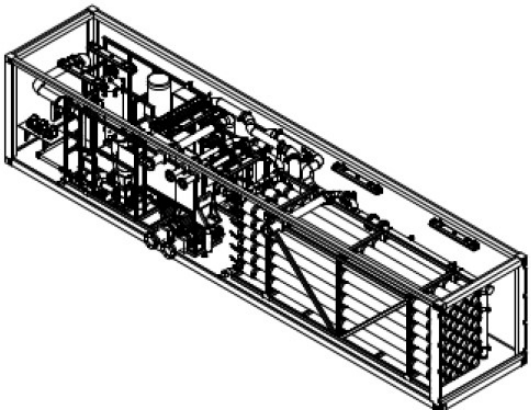


Figure 1. A graphic representation of a mobile RO unit.

The Containerized Reverse Osmosis System is a pre-packaged solution with quick piping and electrical connections (Figure 1). Major equipment and valves are pre-configured for fully automated operations. The closed-circuit reverse osmosis (CCRO) design allows for process flexibility for flow and recovery rates.

Temporary mobile water treatment equipment provides a quick-response solution in case of unforeseen problems with the capital equipment, water balance, or schedule. Mobile units require a smaller commitment of resources and offer easier installation and a lower footprint.

Multiple vendors offer containerized RO systems. Some can also provide operations support, allowing fast deployment and operations by a professional team.

Reverse osmosis technology uses semi-permeable membranes for the removal of dissolved contaminants, such as TDS, metals, and inorganics from water. The basic principle of RO involves the application of high pressure to counteract natural osmotic pressure to drive water from a more concentrated feed solution to a pure water permeate. Dissolved impurities are removed during this process.

The process utilizes cross-flow filtration to remove dissolved contaminants from the feed stream, producing a purified water stream (permeate) and a high-solute waste stream (concentrate). Feed water quality will determine the amount of permeate capable of being recovered from feed water.

VFD-controlled feed pumps direct the source water to a 5-µm cartridge filter for the removal of larger debris. Depending on water-quality parameters, the RO might require additional pre-treatment. For example, elevated total suspended solids (TSS) might have to be removed with an ultra-filtration (UF) membrane pre-treatment prior to RO. VFD-controlled high-pressure pumps boost the feed pressure provided by the feed pumps and drive water through the membranes.

Clean-in-place (CIP) procedures are chemical cleaning processes used to recover membrane permeability. The semi-automated clean-in-place procedure is conducted with either a high pH/alkaline or low pH/acid solution, depending on the foulant. A CIP is initiated when normalized permeate flow decreases by ≥ 10%, normalized salt passage increases by ≥ 10%, or normalized differential pressure increases by ≥ 15%.

Following chemical cleaning procedures, the membrane units are flushed to remove residual chemicals prior to resuming production. If desired, chemical cleaning waste can be captured and neutralized prior to discharge (Figure 2).

The temporary RO systems will vary between vendors. They generally include all the required pumps (feed buster pump, high-pressure pump, circulation pump, chemical addition pumps), air compressor, pre-filter strainer, pressure and conductivity transmitters, and a master control panel with human-machine interface (HMI.) As an example, Table 1 below shows systems details of a unit suitable for the Coffee Gold project.

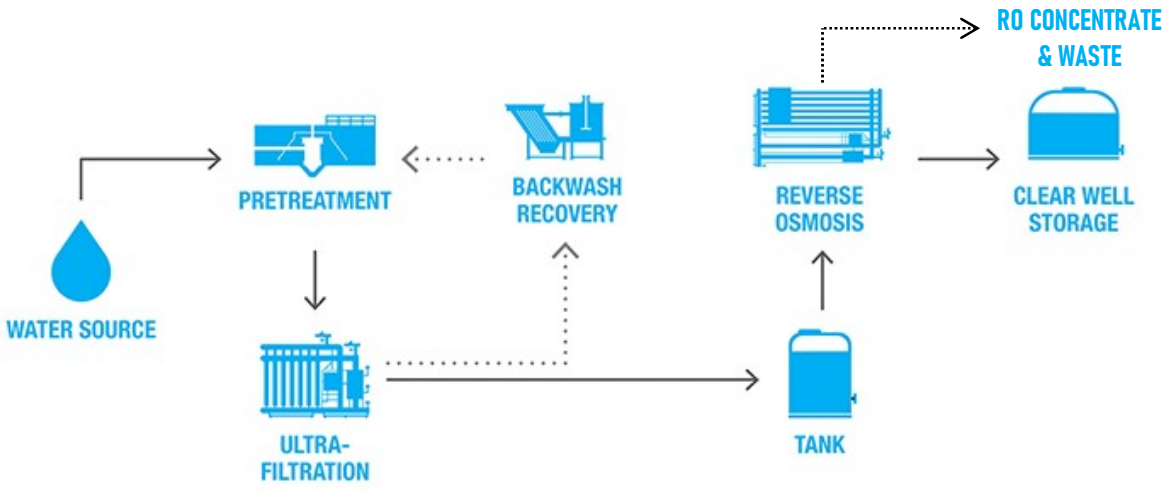


Figure 2. Typical RO treatment flowsheet.

Table 1. Containerized Reverse Osmosis System Details

Description	Unit	Dimension/Capacity
Max Permeate Flow Rate per Container	gpm	700
Min Permeate Flow Rate per Container	gpm	350
Design Permeate Flow Rate per Container	gpm	500
Total Element Capacity per Container	-	140
Min Feed Pressure (Flooded Suction)	psi	0 - 75
Max System Pressure	psi	450
Recovery Rates*	-	75% – 98%
Container Dimensions	ft.-in.	40' L x 8' W x 9'-6" H
Container Weight		
Shipping	lbs.	25,000
Operating	lbs.	33,000
Connection Sizes	150# ANSI RF Flanges	8" Feed 6" Permeate Outlet 6" Brine/Reject Outlet 8" RO Feed CIP 6" RO Permeate CIP 6" RO Brine CIP 2" Drains
Material of Construction		
Container	-	Painted Carbon Steel
Piping	-	PVC / Stainless Steel
Power Requirement per Container	Volts/Hertz/Phase/Amps	480/60/3/250

*Recovery rates are dependent on influent water quality.

Management of Water Treatment Residuals

RO efficiency and recovery rates depend on the influent water quality. Because of the projected presence of monovalent ions that will require treatment, such as nitrates, we assume recovery rates of 80%. For a 25 L/s temporary treatment, such a system would produce 5 L/s of concentrate waste. Additional processes can be deployed to lower the waste stream volume.

Water treatment employing RO results in the generation of retentate that is more concentrated with respect to parameters of concern. This retentate would be of much higher TDS concentrations (e.g., higher salinity and density) than source waters. Management of retentate would occur via discharge to a mine-out pit void that has no groundwater discharge potential and where the density of the retentate would ensure permanent stratification of the ultimate pit lake (or pit pore waters) and no surface discharge. Meteoric waters entering the pit lake or pit porewaters would not mix with the higher density retentate and ensure any surface water discharges do not contain retentate water.

Economic and Technical Feasibility

Reverse Osmosis systems are widely used across municipal, mining, and industrial markets. Many RO membrane elements have been developed to target specific parameters of interest. Temporary RO systems are able to accept elements from different vendors, broadening the technical feasibility.

Once the Contingency Plan is triggered, the membrane vendors would specify the required RO elements to target the constituents in the Coffee Mine water and define the rejection percentages based on the water chemistry, pH, etc. Additionally, any pre-treatment requirements would also be defined based on water quality parameters, such as total suspended solids.

The economic feasibility of the proposed Contingency solution will depend on the deployment duration and required commissioning and operational support. Most vendors generally require a minimum rental period and provide discounts for longer operation. For example, a containerized unit's monthly rental fee may vary between $30,000 to $60,000 depending on the rental duration. If additional equipment or support, such as UF filtration or operations, are needed, the monthly rental cost will increase. Additionally, vendors will charge a one-time fee for RO elements. A typical mobile RO system able to treat 25 – 35 L/sec would require a one-time element cost of about $80,000 - $100,000.

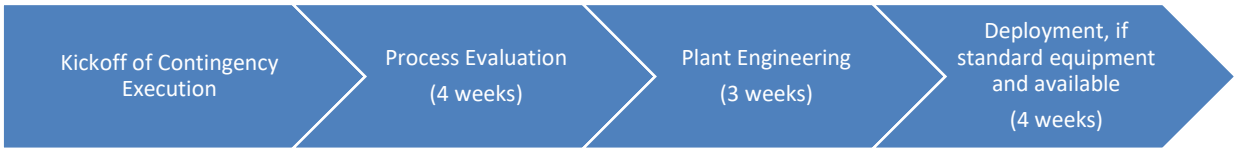
Overall, a short-term temporary system deployment costs significantly less than a capital equipment plant and can be designed and commissioned within a relatively short schedule.

Contingency Deployment Schedule

The general deployment schedule will depend on the availability of rental units at the time of contingency execution and the engineering design results. The figure below shows an example timeline for the deployment of a standard containerized RO unit.

After contingency water treatment deployment is triggered, Newmont will contact mobile equipment vendors, who will complete a detailed process evaluation. During this stage, water quality will be well-defined, and additional sampling can be completed to aid the vendor, who will also evaluate the need for site-specific pre-treatment steps. Specific membrane elements will be selected to meet the required treatment goals.

After process evaluations are completed, plant engineering will take up to three weeks to define the required system design, including hydraulics, pumps, tank sizes, etc. If temporary RO equipment of the required design is readily available, it will be deployed and commissioned within weeks. However, in the event that none of the rental equipment vendors have a mobile RO system available at the time of the contingency trigger, constructing a new unit typically takes about a year.



Potential Triggers for Contingency Deployment

The contingency water treatment will be deployed under four scenarios – delay or failure to install the proposed WTP, exceedance in the predicted mine water volumes, water treatment requirements prior to installation of the active water treatment plant in Year 2, or WTP failure.

The water treatment facility is planned to be installed by the end of Year 2 of mine operations. Additional two years will be granted as a contingency. Should the proposed WTP not be functional by the end of Year 4 of mine operations, the contingency RO system will be deployed.

Moreover, the capital equipment will be designed for up to 35 L/s flowrate. Since the WTP will be installed over two years of mine construction period, the actual water volumes needed treatment will not be known at the time of detailed engineering. However unlikely, should the mine water flowrates exceed the predicted 35 L/s, the contingency RO system will be deployed to manage the excess water.

Similarly, should the solution accumulation be faster than projected, or should the mine water require treatment for other reasons prior to Year 2, the contingency RO system will be mobilized.

Finally, a WTP failure to treat the Coffee Mine water to below the discharge targets will also trigger the contingency solution. Short-term WTP effluent exceedances can be expected over the life of the plant due to system upsets or operator errors. However, those upset conditions can be corrected. The contingency RO plant will be deployed if the installed WTP fails to meet the discharge targets for an extended period, while troubleshooting and process adjustment do not correct the issue.

Table 2 summarizes proposed trigger concentrations in the WTP effluent that would indicate the need for the RO contingency water treatment process. While it is not anticipated that there will be challenges to meeting metal removal requirements, parameters such as sulphate, chloride, ammonia, and CN-WAD could be challenging. The proposed trigger concentrations would need to be observed over an extended period and a minimum of 30 consecutive days with commensurate observed exceedances of Alpha Pond EQS values to prompt contingency deployment.

Table 2. Trigger concentrations for Contingency Treatment Deployment.

Parameter	Units	Back-calculated Allowable in Effluent	WTP Effluent Target	Effluent Trigger Values
$N\text{-}NH_3$	mg/L	16	15	>15
$N\text{-}NO_3$	mg/L	79	<5[a]	>100
$N\text{-}NO_2$	mg/L	0.15	0.1	>0.2
Cl	mg/L	1300		>2000
Sulphate	mg/L	1100	1100	>2000
TDS	mg/L		3000	>4000
WAD-CN	mg/L	0.046	0.04	>0.1
As-D	mg/L	0.043	0.04	>0.08
Cd-D	mg/L	0.002	0.002	>0.005
Cu-D	mg/L	0.029	0.02	>0.05
Co-D	mg/L	0.03	0.04	>0.08
Hg-D	mg/L	0.00019	0.0001	>0.0002
Sb-D	mg/L	0.08	0.08	>0.1
Se-D	mg/L	0.021		>0.02
U-D	mg/L	0.7	0.7	>0.8
Zn-D	mg/L	0.2	0.2	>0.5

a: lower nitrate values are "targeted" during denitrification step to allow other microbially mediated electron transfer reductions to proceed uninhibited

Temporary Closure Water Management

A temporary closure scenario was evaluated through the HLF Water Balance Model to assess heap solution buildup within the event ponds and potential water treatment needs should temporary closure occur prior to when the water treatment plant would be commissioned in Year 2. The temporary closure scenario applies the following assumptions:

- The temporary closure scenario would commence at the end of Year 1 of the mine life.
- Raincoats would be deployed over the entire stacked ore portion, and that water shed from raincoats would not require treatment.
- Continuous circulation of heap leach solutions would occur during temporary closure to maintain a "zero discharge" facility.
- Solution would be recirculated at the same rate as it is seeping out of the heap.
- The temporary closure period would range anywhere from at least 6 months to no more than five years; however, the scenario was modelled out to Year 21.

The outcome of the water balance model predicts that, for the period of temporary closure prior to when the water treatment plant is available, the ponds would contain approximately 160,000m^3 of solution, which is within the pond storage volume available for operations. In this scenario, the pond volume infringes upon the ESR in Year 10, and overflows in Year 18, at which time the water treatment plant would be available. The graph in Figure 3 shows filling of the ponds over time in the temporary closure scenario.

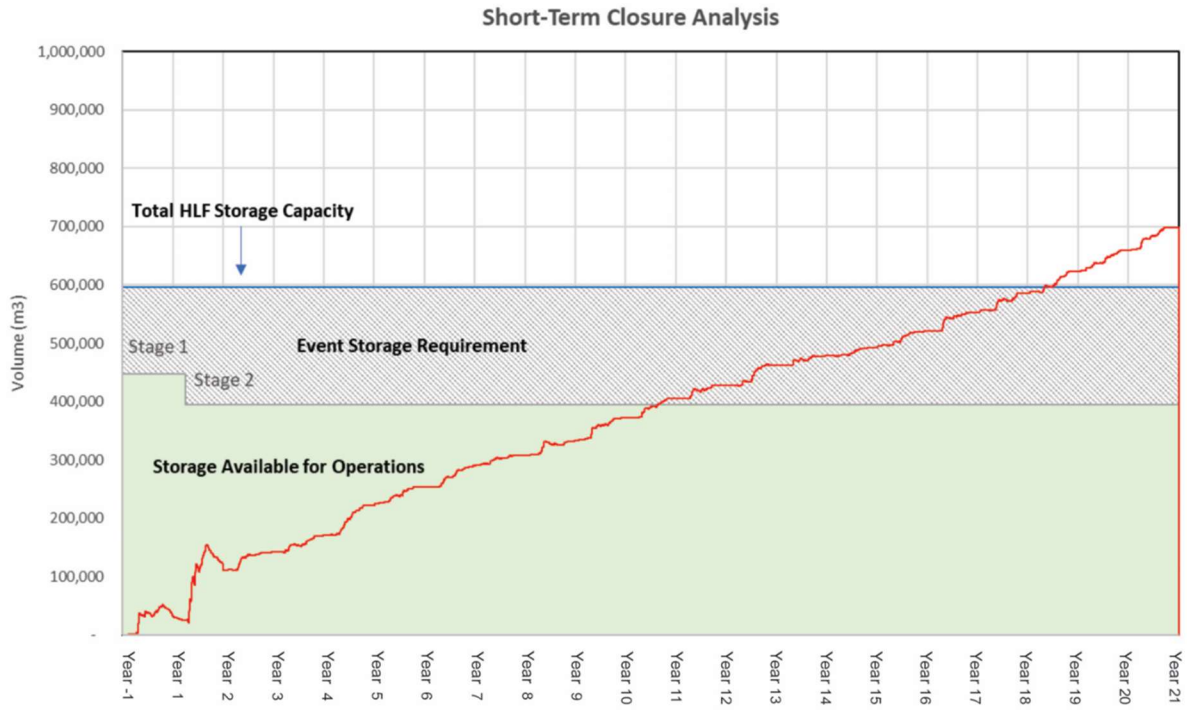


Figure 3. Water accumulation in the temporary closure scenario.