



EAGLE GOLD PROJECT

CONSTRUCTION AND OPERATIONS WATER MANAGEMENT PLAN

Version 2017-01

JULY 2017

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DOCUMENT CONTROL

Version 2017-01 of the Construction and Operations Water Management Plan (the Plan) for the Project has been revised in July 2017 to update the version dated February 24, 2015. The table below is intended to identify modifications to the Plan and provide the rationale for such modifications.

Version 2017-01 Revisions

Section	Revision/Rationale
1 Introduction	Updates to better describe the Project optimizations to comply with licence conditions.
Figure 1.1-1 Project Location	Update of figure to be consistent with other plans.
Figure 1.1-2 General Arrangement	Updates to site general arrangement.
Table 1.2-1 Project Schedule Controls on Water Management Strategies	Updates to the overall Project schedule to reflect current assumptions.
1.4 Scope of Plan	Updated to text to reflect current status of the Project with respect to regulatory approvals.
3 Baseline Conditions	Complete revision to incorporate updated baseline information collected since the completion of the version dated February 24, 2015.
Table 4.1-1 Design Criteria	Updated to included criteria for armouring of water management infrastructure.
Figure 4.1-1 Overview Plan Watershed Areas	Updates to watershed areas based on optimized site general arrangement.
4.2.2.10 Flocculants	Updates to include additional details on product types and reference to new appendix (Flocculant Use Plan)
4.2.2.12 Collection Ditches	Revision of text to ensure consistency with design criteria.
4.2.2.13 Diversion Ditches	Revisions of text to ensure consistency with design criteria.
4.2.2.14 Culverts	Revisions of text to ensure consistency with design criteria.
4.3 Discharge Protocols	Inclusion of new section to comply with requirements of the Type A Water Use Licence QZ14-041.
5 Water Balance, Storm Water and Groundwater	Complete revision to incorporate updated modelling and baseline information collected since the completion of the version dated February 24, 2015.

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Construction and Operations Water Management Plan

Section	Revision/Rationale
6 Construction Water Management	Complete revision to water management routing based on optimized site general arrangement.
7 Operations Water Management	Complete revision to water management routing based on optimized site general arrangement.
8 Water Distribution	Complete revision to water management routing based on optimized site general arrangement.

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Appendix A	IFC Design Specifications and Drawing Package
Appendix B	Flocculent Use Plan

List of Acronyms and Abbreviations

%	percent
<	less than
>	greater than
ADR	adsorption, desorption and recovery
AMC	antecedent moisture content
BC	British Columbia
BGC	BGC Engineering Ltd.
BMP	Best Management Practice
CHP	corrugated metal half-pipe
cm	centimetre
cm/s	centimetres per second
CN	curve number
°C	degrees Celsius
EQS	effluent quality standards
GCL	geosynthetic clay liner
ha	hectare
hr	hour
HLF	Heap leach facility
IROSA	ice-rich overburden storage area
km	kilometres
km ²	square kilometres
L	litres
L/min	litres per minute
LDSP	Lower Dublin South Pond
LLDPE	linear low-density polyethylene
m	metres
masl	metres above sea level
m ²	square metres

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m ³	cubic metres
m/s	metres per second
MF	microfiltration
mg/L	milligrams per litre
min	minutes
MIW	mine-influence water
mm	millimetre
Mt	megatonnes (million tonnes)
Mt/y	megatonnes per year
MWTP	mine water treatment plan
pH	potential of hydrogen (measure of acidity)
PLS	pregnant leach solution
Project	Eagle Gold Project
PTS	passive treatment systems
QML	quartz mining licence
RECP	rolled erosion control products
SCP	sediment control pond
SGC	StrataGold Corporation
WAD CN	weak acid-dissociable cyanide
WBM	water balance model
WMP	water management plan
WQM	water quality model
WQO	water quality objectives
WRSA	waste rock storage area
WUL	Water Use License

1 INTRODUCTION

The Eagle Gold Project (the “Project”) is located about 85 kilometres (km) from Mayo, Yukon using existing highway and access roads (Figure 1.1-1). The Project will involve open pit mining at a production rate of approximately 10.7 million tonnes per year (Mt/y) ore. The open pit will be developed using standard drill and blast technology. Ore will be removed from the open pit by haul truck and delivered to the first stage crushing plant (the primary crusher), situated on the north side of the open pit, passed through three crushing stages and then delivered to the heap leach facility (HLF) via conveyor belt. Gold will be extracted using heap leaching, and a carbon Adsorption, Desorption, and Recovery (ADR) system over life of mine. Waste rock will be removed from the open pit by haul truck and delivered to one of two waste rock storage areas (Platinum Gulch or Eagle Pup Waste Rock Storage Area [WRSAs]).

Additional water-related planned infrastructure includes a control pond, interceptor ditches, an ice-rich overburden storage area (IROSA), a mine water treatment plant (MWTP), and event ponds. The proposed general layout of the mine and infrastructure components of the Project are presented in Figure 1.1-2.

The open pit will be located to the south of the Dublin Gulch valley in the headwater areas of Suttles Gulch and Platinum Gulch. Mined rock that does not contain economic ore or cannot be used for construction will be placed in the WRSAs.

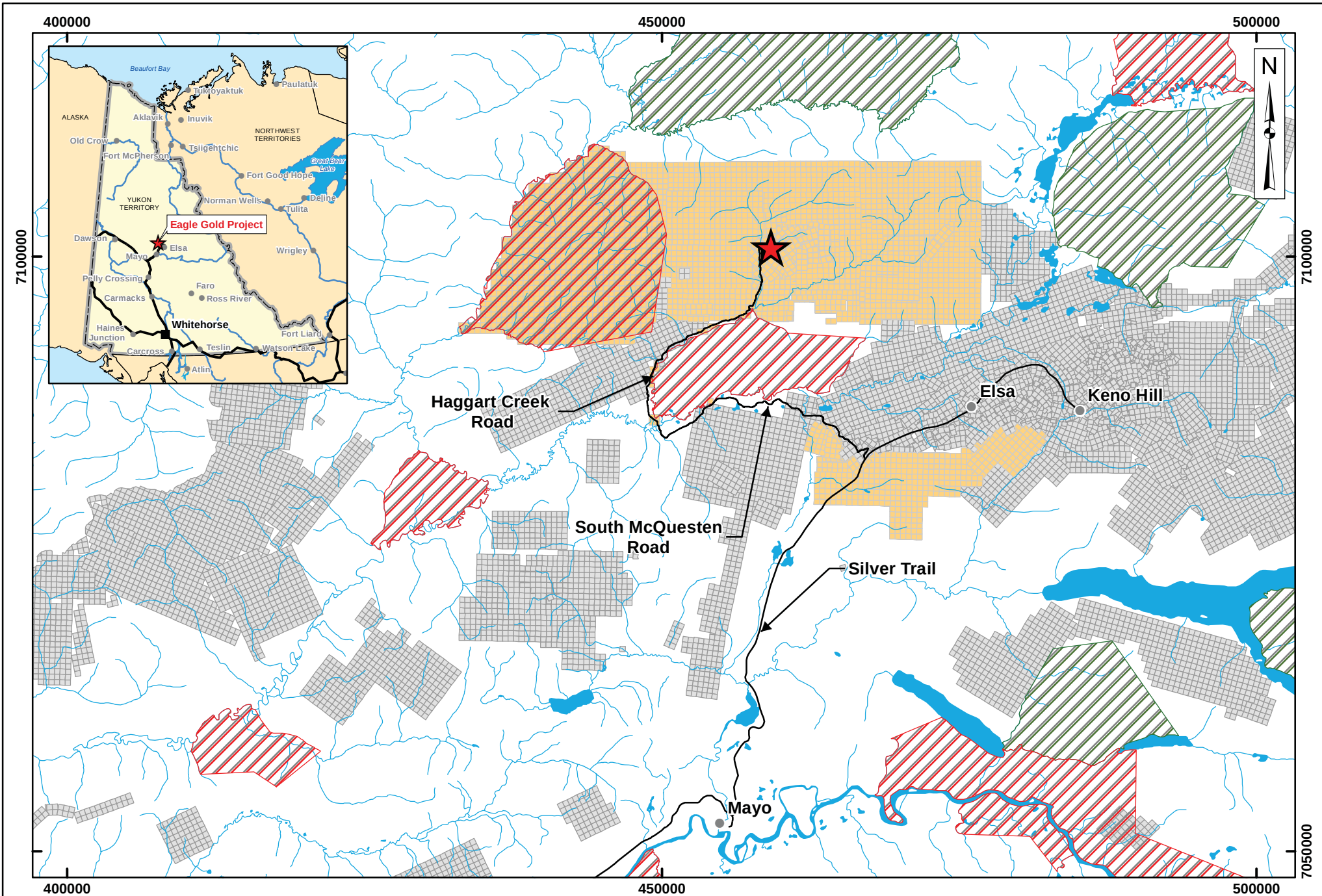
Historically, the Project site has been impacted by extensive placer mining in the Haggart Creek and Dublin Gulch watersheds. The valley floor has been significantly re-worked in the lower Dublin Gulch catchment, which has resulted in the re-routing of smaller streams within the system.

During the construction phase, a single water management pond, referred to as the Lower Dublin South Pond (LDSP), will be constructed to use as a sediment control pond (SCP) and the IROSA will be constructed to manage frozen materials that are thaw unstable. Non-contact water will be diverted, as feasible, around disturbed areas before discharging into receiving waters (i.e., Haggart Creek, Dublin Gulch and Eagle Creek). During operations the LDSP will be used to retain water for HLF process make-up solution. A MWTP will be constructed during operations downstream of the HLF and adjacent to the LDSP to treat contact water when not needed for process make-up, and will discharge treated water into Haggart Creek. During closure, infrastructure will be decommissioned, covers will be placed on the WRSAs and the HLF, passive treatment systems will be established and active water treatment systems will be phased out and then no longer utilized.

1.1 PROJECT LOCATION AND BACKGROUND

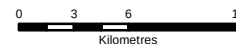
The majority of the Project site lies within the Dublin Gulch watershed. Dublin Gulch is a second order stream that is a tributary to Haggart Creek which flows to the South McQuesten River. Elevations in the vicinity of the Project range from 730 metres above sea level (masl) in the Haggart Creek valley to 1,540 masl at the summit of Potato Hills (which forms the eastern boundary of the Dublin Gulch watershed).

Access to the Project site is from the Silver Trail (Highway 11) onto the existing South McQuesten Road and Haggart Creek Road. Together, the two roads comprise a 45 km road divided by the South McQuesten River.



Legend:

- | | | | | | |
|--|--------------------|--|----------------|--|----------------------------|
| | Eagle Gold Project | | Town / Village | | Category A Settlement Land |
| | StrataGold Claims | | Road | | Category B Settlement Land |
| | Other Claims | | Watercourse | | |



Projection:

NAD 83 Zone 8N

Date: 2017/03/15

Drawn By:

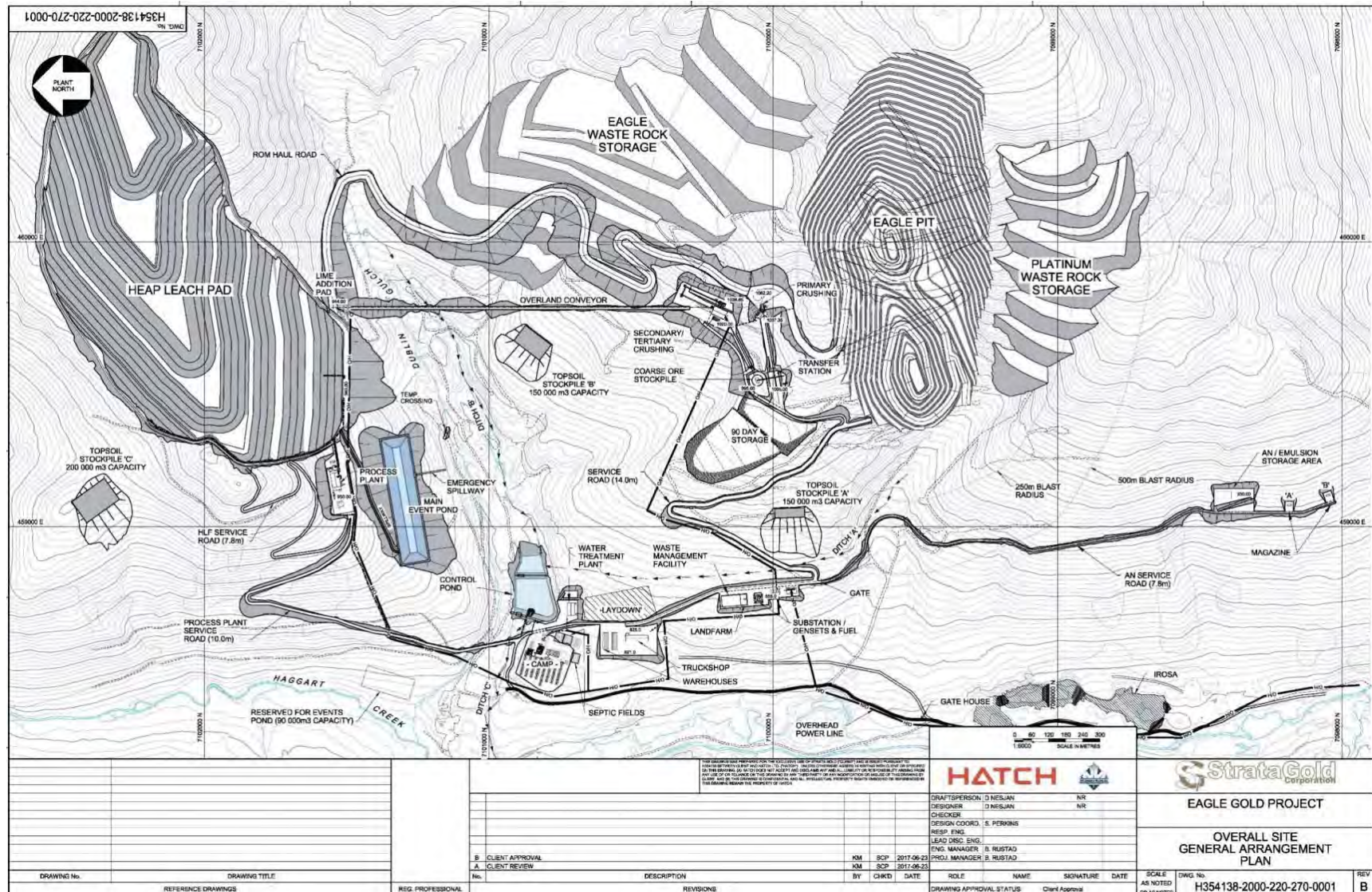
HC

Figure: 1.1-1

**EAGLE GOLD PROJECT
YUKON TERRITORY**

Project Location

Figure 1.1-2: General Arrangement



1.2 PROJECT SCHEDULE

A summary of the project schedule is provided in Table 1.2-1. The schedule is conceptual and dependent upon receipt of regulatory approvals, project financing, contractor availability and seasonal limitations.

Table 1.2-1: Project Schedule Controls on Water Management Strategies

Project Phase	Assumed Dates	Duration (yrs)	Controls on Water Management Strategies
Construction	2017 - 2019	2	End of baseline, site development including construction of water management structures, ADR plant, site infrastructure, and Phase 1 HLF including the spillway and events pond
Phase 1	2019 - 2022	3	Start-up and complete Phase 1 of Heap; contact water managed based on process make-up requirements, through adaptive water management strategies and continued development of future active treatment system based on operational monitoring data
Phase 2	2023 - 2025	2.5	Northward expansion of the HLF footprint and continued stacking; active treatment of contact water from the LDSP; progressive reclamation of PG WRSA; development of the PG PTS
Phase 3	2025 - 2027	2	Eastward expansion of the HLF footprint and continued stacking until the HLF reaches capacity; continued active treatment and development of the PG WRSA cover and PG PTS
Phase 4	2027 - 2028	1.0	Termination of mining and ore production, but continued irrigation of the ore stack for gold production; managed pumpback of heap drain-down solution; open pit begins to fill
Phase 5	2028-2030	2.0	Termination of gold production and period of rinsing and cyanide destruction; managed pumpback of heap drain-down solution – some heap discharge to treatment; PTS discharge to Haggart Creek; open pit still filling
Phase 6	2030 – April 2035	5.0	Controlled drain-down of heap (drain-down solution split into two flows: managed pumpback to heap and proportion sent to active treatment); begin conversion of Event Pond into HLF PTS; when flows and concentration criteria are met - change from active treatment to passive treatment of the heap seepage; open pit fills– flow allowed to drain to Haggart Creek (via PTS as necessary)
Phase 7	May 2035 – TBD	NA	Uncontrolled drainage of heap – seepage rate will ultimately meet rate of meteoric input; all passive treatment systems in place and meeting objectives and monitoring in effect
Phase 8	Post Phase 8	NA	Post-closure. Monitoring if required

Source: JDS (2017)

1.3 DEFINITIONS

The term “sediment-laden water” is used to describe water that originates from disturbed areas (e.g., roads, foundation pads, etc.) and only needs treatment for sedimentation, which is done through the management practices described in this Plan. “Contact water” is used to describe water that will come into contact with the open pit, waste rock storage areas, or the heap leach facility. 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 Project facilities.

1.4 SCOPE OF PLAN

This Construction and Operations Water Management Plan (the “Plan”) has been developed to proactively manage sediment-laden, contact and non-contact water throughout the construction and operation phases of the Project. Construction of the mine is planned to occur over a twenty-four month period.

The Plan has several functional components, each developed from specific design basis and criteria, and supported by the integration of baseline studies and various water-related modeling exercises. This plan covers construction and operations water management and sediment and erosion control.

The construction water management section describes the capability of the site water management infrastructure to contain, control and convey short duration extreme rainfall events. Water management facilities are designed with two specific operating modes: 1) service conditions, which include day-to-day operations and 2) ultimate limit conditions, which include provisions for safely handling extreme peak runoff events.

The sediment and erosion control plan section describes the best management practices (BMPs) that will be implemented on site and detailed site-specific plans that address the construction objectives of the Project, and provides strategies and design objectives with appropriate flexibility to allow the design elements to be field-fit to suit the conditions encountered during construction (i.e., adaptive management approach).

The operations water management plan section describes water routing and key management facilities built during construction (e.g., in-heap and events pond), and in addition to those facilities maintained for use into the operations phase. Closure and post-closure water management is described in the Reclamation and Closure Plan.

2 WATER MANAGEMENT PLANNING

2.1 OBJECTIVES

The primary objective of this Plan is to protect and conserve water resources (including the water quality, water quantity, and the aquatic ecosystem) from impairment caused by the planned operation. Other objectives considered when developing design criteria include the following:

- Protect and prevent surface and ground water resources from potential contamination caused by the activities throughout the Project.
- Protect infrastructure from damage, to maintain safety and minimize financial costs for repair or replacement.
- Maximize water reuse and avoid contaminated water discharges.
- Maximize clean water runoff.
- Minimize the need for additional make-up water use.
- Prevent the discharge of sediment-laden water to surface water streams.
- Minimize the impact on the receiving environment.
- Encourage stabilization and regrowth of vegetation.

2.2 STRATEGIES

The primary strategies for means of achieving the objectives listed above include:

- Separating waters of different quality, so that water quality deterioration is minimized. (i.e., diverting non-contact water away from disturbed areas).
- Minimizing the contact between water and potential contaminants, such as chemicals, petroleum products, or waste products.
- Erosion and pollution source control (i.e., minimizing total suspended solid levels in runoff from disturbed areas),
- Capture of contact water so that it can be treated, as necessary, prior to reuse or discharge back into the environment.

Management of non-contact water during construction and operations is best done by the redirecting of surface runoff away from disturbed areas. This process can be done by constructing small channels, swales, or ponds to capture as much of the surface runoff as possible, or by constructing small obstacles such as berms or other barriers, that will redirect the flow around a specific area.

Management of sediment-laden water during construction and operations is best done by reducing the velocity of water thus allowing sediments to settle. This process can be done by constructing channels with check dams, SCPs, sediment basins, exfiltration ponds, and sediment traps, as well as through the

stabilization of disturbed land surfaces, and re-establishment of vegetative cover. Where final slopes are created, indigenous vegetation will be planted.

Management of contact water during operations is best done by capturing as much of the water as possible in water management ponds, using this water for various mine operations (e.g., process water, dust control) and/or pumping the water to a treatment facility, where it can then be treated, as necessary, prior to recirculation/re-use or discharged back to the environment.

In summary, all water will need to be controlled in such a manner that minimizes erosion in areas disturbed by construction or operational activities and which prevents the release of contact water, which could adversely affect the quality of receiving waters (e.g., Dublin Gulch, Haggart Creek, and Eagle Creek).

3 BASELINE CONDITIONS

A Hydrometeorology Report (Lorax, 2017a) was completed for the Project to provide long-term estimates for various meteorological and hydrological parameters that act as the basis for assembly of hydro-meteorological inputs to be used in the design of water management structures and water balance models for the Project area.

The long-term estimates provided in this report are based on regional datasets and available site data from 2007 to 2016. Lorax (2017a) summarizes, integrates, and analyses data collected at the Project site as well as regional data from Environment Canada and Yukon Environment. The results of this report supersede those from previous studies completed by Knight Piesold (2013c) and Stantec (2011g). The baseline conditions summarized in this Plan also relied on the following previous baseline reports:

1996

- Initial Environmental Evaluation (Hallam Knight Piesold 1996)

2008

- Climate and Hydrology Environmental Baseline Report (Jacques Whitford 2008)

2009

- Snow Survey Environmental Baseline Report (Jacques Whitford 2009)

2010

- Environmental Baseline Report: Climate (Stantec 2010a).
- Environmental Baseline Report: Hydrology (Stantec 2010b).
- Aquifer Test for Camp Water Supply. Technical Memorandum (Stantec 2010c).

2011

- Environmental Data Summary Report: Climate 2011 Update (Stantec 2011b).
- Environmental Baseline Report: Surficial Geology, Terrain and Soils (Stantec 2011c).
- Environmental Data Summary Report: Hydrology 2011 Update (Stantec 2011d).
- Environmental Baseline Report: Hydrogeology (Stantec 2011e).
- Environmental Baseline Report: Water Quality and Aquatic Biota (Stantec 2011f).
- Surface Water Balance Model Report (Stantec 2011g)

2012

- Environmental Baseline Report: Climate (Stantec 2012a).
- Environmental Baseline Report: Water Quality and Aquatic Biota (Stantec 2012b).
- Environmental Baseline Report: Hydrology 2011 Update (Stantec 2012c).

- Environmental Baseline Data Report: Hydrogeology 2011 – 2012 Update (Stantec 2012d).
- Lower Dublin Gulch Valley Aquifer Tests (BGC 2012e).
- Open Pit Pumping Tests (BGC 2012f).

2013

- Groundwater Data Report (BGC 2013a).
- Production Well Completion Report for PW-BGC12-04 (BGC 2013b).
- Climate Baseline Data Summary (Knight Piésold 2013a).
- Hydrology Baseline Data Summary (Knight Piésold 2013b).
- 2013 Baseline Water Quality Report (Lorax 2013)
- Hydrometeorology Report (Knight Piésold 2013c)

2014

- Site Water Balance Model Report Knight Piésold (2014)

2016

- Climate Baseline Report (Lorax 2016a)
- Hydrology Baseline Report (Lorax 2016b)
- Groundwater Quality Characterization Report (CoreGeo/Watterson 2017)

2017

- Hydrometeorology Report (Lorax 2017a)
- Water Quality Model Update (Lorax 2017b)

3.1 REGIONAL SETTING

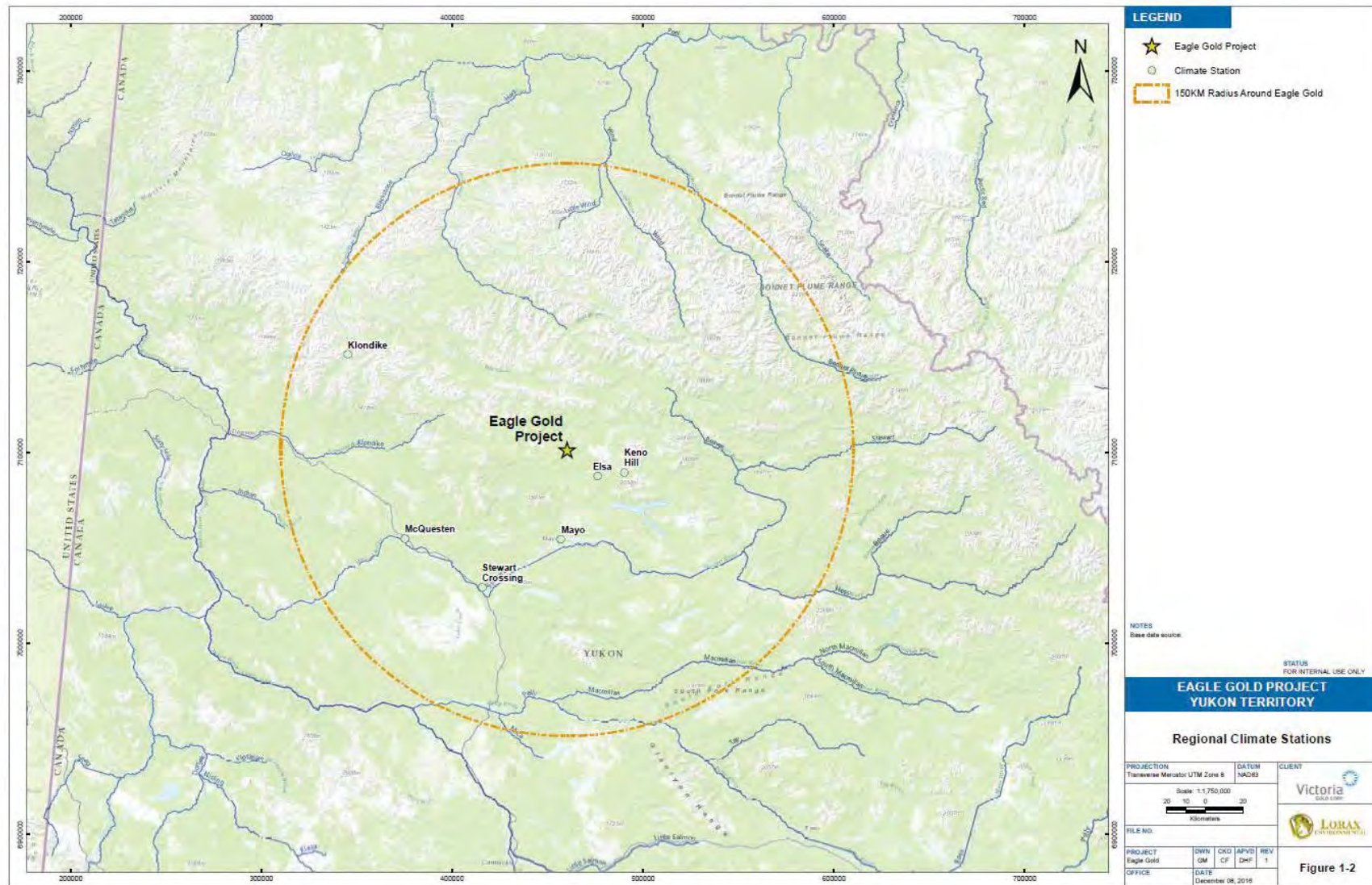
The Project is located within the Boreal Cordillera ecozone, which comprises much of the southern Yukon and a large portion of northern British Columbia, and more specifically within the Yukon Plateau-North ecoregion. The Boreal Cordillera ecozone is broadly characterized by the presence of several mountain ranges that trend in the northwesterly direction and include extensive plateau regions. The plateaus consist of flat or gently rolling upland terrain separated by broad valleys and lowlands.

The climate is characterized by long, cold, dry winters and short, warm, periodically wet summers, with conditions varying according to altitude and aspect. Streamflow in the region is typically highest in May due to melting of the winter snowpack. Annual peak instantaneous flows commonly occur in this freshet period on larger rivers, but on smaller streams they may also occur in summer or early autumn due to intense rain or rain on snow events. Flows decrease throughout the winter and minimum flows typically occur in March or April.

The locations of regional climate stations, snow monitoring stations, and hydrometric stations operated by the Meteorological Service of Canada (MSC), Yukon Department of Environment (Yukon Environment),

and the Water Survey of Canada (WSC), respectively, are shown in Figure 3.1-1, Figure 3.1-2 and Figure 3.1-3.

Figure 3.1-1: Regional Climate Stations



Eagle Gold Project

Construction and Operations Water Management Plan

Section 3 Baseline Conditions

Figure 3.1-2: Regional Snow Monitoring Stations

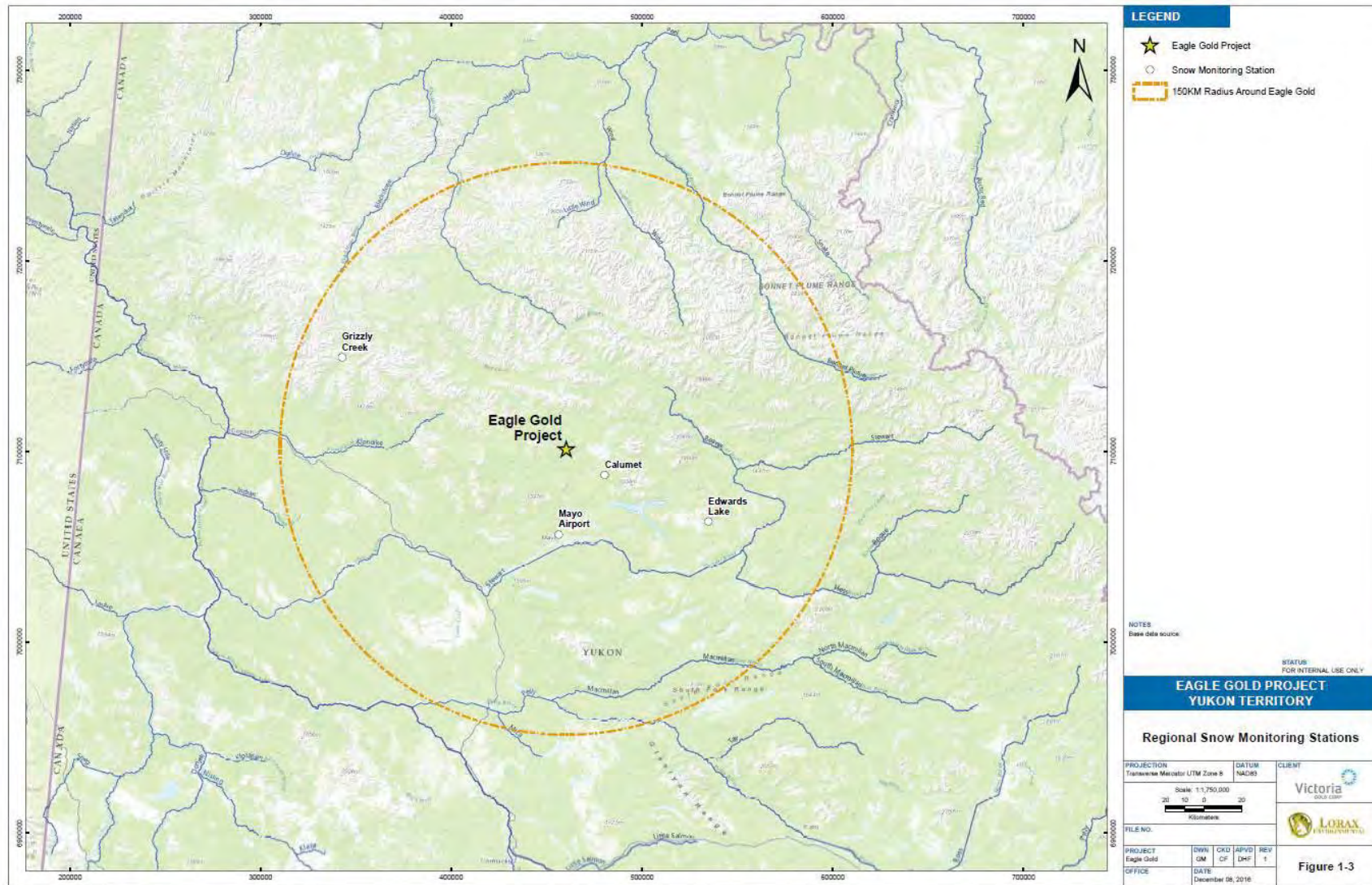
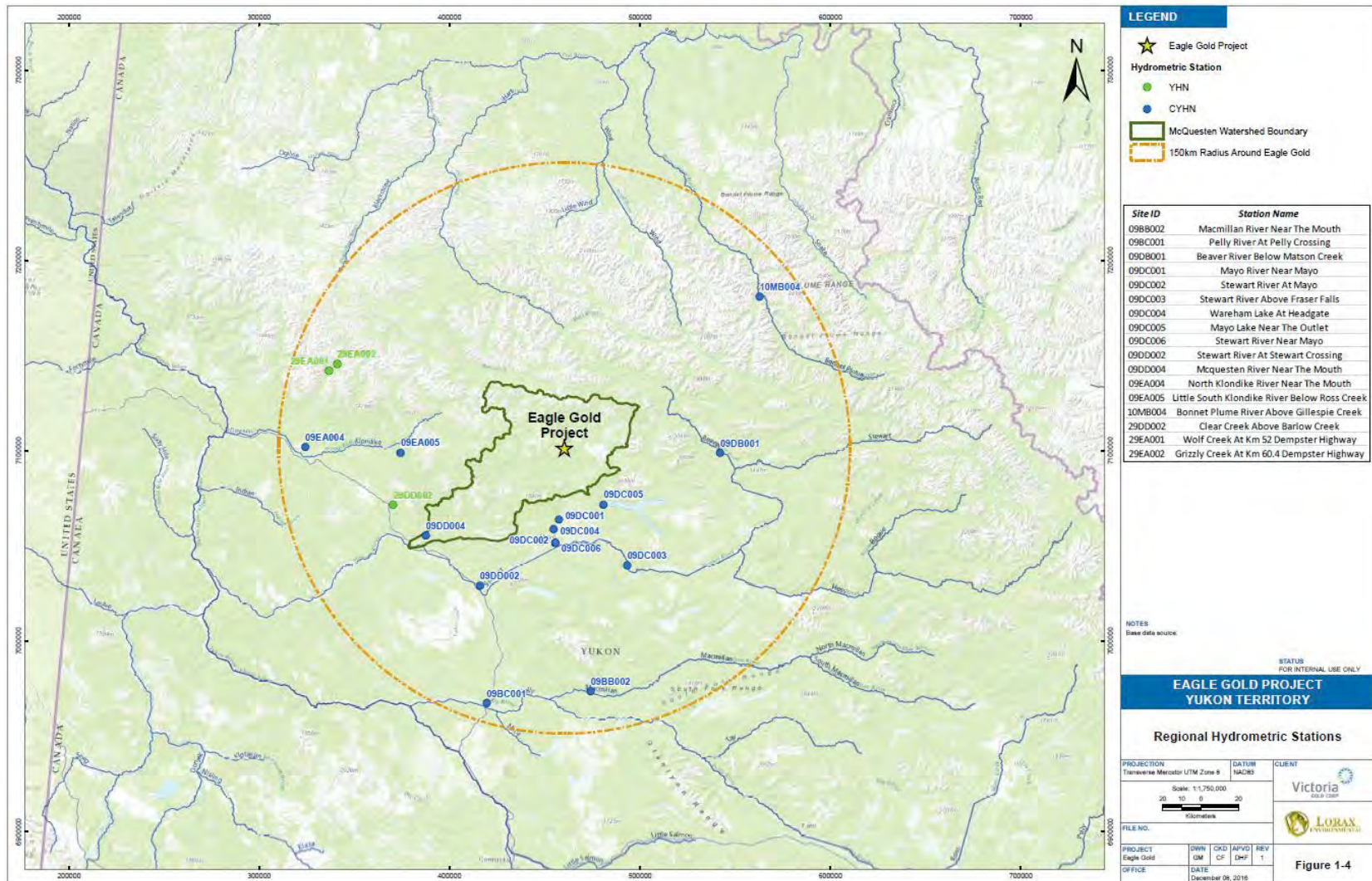


Figure 3.1-3: Regional Hydrometric Stations



3.2 CLIMATE

3.2.1 Regional Stations

Regional climate stations relevant to this assessment are shown in Figure 3.1-1, Figure 3.1-2, and Figure 3.1-3. Station information for relevant climate, snow course, and hydrometric stations are also summarized by the information presented in Table 3.2-1 and Table 3.2-2.

Regional climate stations considered in this assessment meet the two main requirements of being: 1) within a 150-km radius of the Project site; and 2) show at least five years of usable climate information.

Table 3.2-1: Regional Climate Stations in Proximity to the Eagle Gold Project

Station	Station ID	Latitude (dec degrees)	Longitude (dec. degrees)	Elevation (m asl)	Start Year	End Year
Keno Hill	2100677	63.93	-135.20	1,473	1974	1982
Klondike	2100679	64.45	-138.22	973	1966	2010
Elsa	2100500	63.92	-135.48	814	1948	1989
Mayo A	2100700	62.62	-135.87	504	1953	Current
McQuesten	2100719	63.60	-137.52	457	1986	2014
Stewart Crossing	2101030	63.38	-136.68	480	1963	2008

Source: Lorax (2017a)

Table 3.2-2: Yukon Snow Course Stations near the Eagle Gold Project

Station	Station ID	Latitude (dec degrees)	Longitude (dec. degrees)	Elevation (m asl)	Start Year	End Year
Mayo Airport A	90DC-SC01A	63.63	-135.88	540	1968	Active
Mayo Airport B	09DC-SC01B	63.63	-135.88	540	1987	Active
Edwards Lake	09DC-SC02	63.70	-134.30	830	1987	Active
Calumet	09DD-SC01	63.92	-135.40	1,310	1975	Active
King Solomon Dome	09EA-SC01	63.87	-138.93	1,080	1975	Active
Grizzly Creek	09EA-SC02	64.43	-138.27	975	1975	Active

Source: Lorax (2017a)

3.2.2 Project Site Location

The information on the Project climate stations and snow survey stations is presented in Table 3.2-3 and Table 3.2-4, and the locations are shown in Figure 3.2-1. Climatic parameters are measured at the Project site by two weather stations that were originally installed by Stantec (formerly Jacques Whitford AXYS). The Potato Hills station is situated near the eastern basin divide (1,420 m), and was installed in August 2007. The second station was originally installed near the camp at 823 m in August 2009, and subsequently moved to its current location in September 2010 at 782 m due to construction of new camp facilities.

Table 3.2-3: Climate Stations at the Eagle Gold Project

Station	Elevation (m asl)	UTM E	UTM N	Record Period
Camp Station	782	458 164	7 101 036	2009-present
Potato Hills Station	1,420	463 544	7 100 833	2007-present

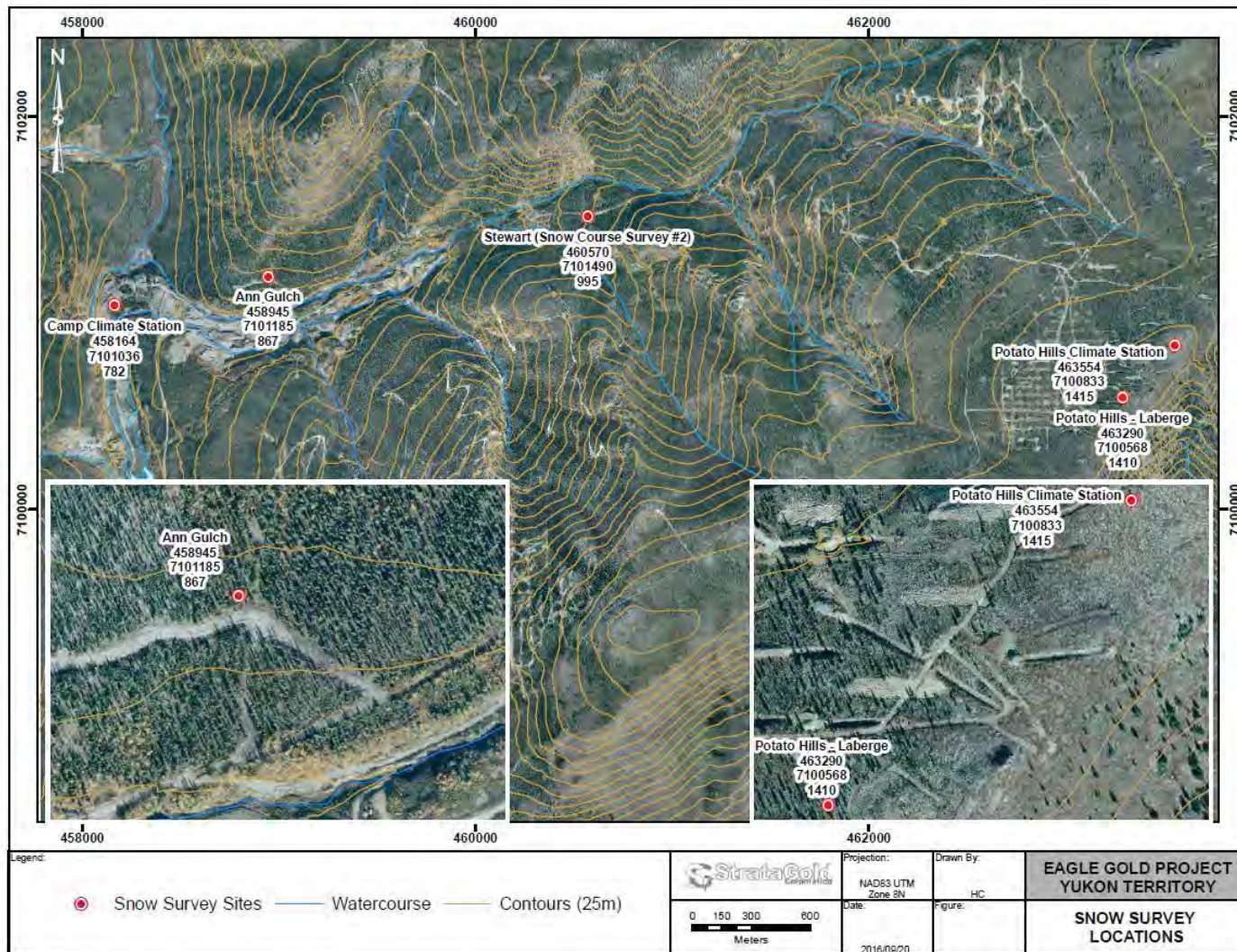
Source: Lorax (2017a)

Since snow sensor installation, the continuous snow depth data for the Potato Hills station has not been reliable and so this data are not presented in this report. Continuous snow depth data are provided herein for the Camp station, as are records of snow survey measurements for three local stations (Camp, Ann Gulch, Potato Hills) up through spring 2016.

Table 3.2-4: Snow Survey Stations at the Eagle Gold Project

Station	Elevation (m asl)	UTM E	UTM N	Record Period
Camp Snow Survey	782	458 164	7 101 036	2009-present
Ann Gulch Snow Survey	875	458 945	7 101 185	2012-present
Stewart (Snow Survey #2)	995	460 570	7 101 490	Mar 2012 only
Potato Hills Snow Survey	1,420	463 290	7 100 568	2009-present

Figure 3.1-3: Eagle Gold Project - Snow Survey Locations



Source: Lorax (2017a)

3.2.3 Temperature

3.2.3.1 Regional

Monthly average air temperature data is shown for nearest regional climate station in Table 3.2-5. The reported data for these six Environment Canada weather stations are based on their entire periods of record. Results for these stations are typical for Yukon Territory. Mean annual air temperature estimates range from -5.6°C to -1.9°C, with higher mean annual air temperature values occurring at stations showing lower elevation – and vice versa.

Overall, these data show that during the months of March to October inclusive, a standard lapse rate applies, with temperatures decreasing with rising elevation, and are cooler at the upper station, on average. However, during the winter months of November to February, temperature inversions are common in the region, with temperatures being cooler on average in the valley bottom than at the height of land.

The spring/summer lapse rate returned by regional data is consistent with the saturated adiabatic lapse rate of -5.0°C/1,000 m. Such cooling temperatures with elevation are likely drivers for the increased frequency of precipitation at higher elevations during the summer months, when a larger portion of the annual precipitation falls. The winter lapse rate for the region shows variability by month but consistency overall with the general approximation reported by Wahl et al. (1987), which suggest winter temperature inversion lapse rates on the order of 3-5°C/1,000 m of elevation gain.

Table 3.2-5: Regional Monthly and Mean Annual Temperatures

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Keno Hill	-16.7	-14.2	-11.5	-4.8	2.1	7.8	10.4	9.1	2.9	-5.3	-11.0	-16.2	-4.0
Klondike	-22.6	-18.2	-14.4	-5.9	3.4	9.9	11.6	8.4	2.3	-6.7	-15.9	-18.9	-5.6
Elsa	-20.9	-18.0	-11.7	-2.6	6.1	12.5	14.6	11.3	4.8	-4.7	-14.2	-19.4	-4.1
Mayo A	-24.9	-19.1	-10.6	0.0	8.2	13.7	15.4	12.6	6.6	-2.0	-15.3	-22.0	-3.1
McQuesten	-22.8	-19.1	-12.8	0.1	8.5	13.7	15.0	12.4	6.4	-2.9	-16.4	-24.4	-2.9
Stewart Crossing	-21.9	-16.8	-11.5	0.0	8.3	14.0	15.6	12.6	6.4	-2.5	-14.7	-18.6	-1.9

Source: Lorax (2017a)

3.2.3.2 Project Site

Air temperatures at the Project site are consistent with those throughout the Yukon interior. As indicated in Table 2-5 below, mean annual air temperature at site is -3.6°C at the Camp station (782 m) and -3.9 °C at the Potato Hills station (1,420 m) over their respective periods of record. At the Camp station, monthly average temperature ranges from -20.2°C in January to 13.1°C in July, and -16.1°C to 10.7°C at the Potato Hills station, for the same months. The minimum (maximum) recorded daily average temperatures were -43.8°C (22.0°C) and -36.6°C (22.8°C) at the Camp and Potato Hills stations, respectively. The minimum (maximum) recorded 15-minute temperatures were -46.4°C (31.6°C) and -37.6°C (28.5°C) at the Camp and Potato Hills stations, respectively.

The monthly mean temperatures signatures for both climate stations are shown in Table 3.2-6, and the pattern is consistent with the larger regional picture. During the months of March to October inclusive, the standard lapse rate applies, with temperatures decreasing with rising elevation, and are approximately 3°C cooler at the upper station, on average. However, during the winter months of November to February, temperature inversions are common at the Project site as per the broader region, with temperatures roughly 2.5°C cooler on average in the valley bottom than at the height of land.

Table 3.2-6: Project (Site) Monthly and Mean Annual Temperatures

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Camp	-20.2	-16.5	-12.9	-2.0	7.3	12.2	13.1	10.6	4.7	-2.7	-17.4	-20.8	-3.6
Potato Hills	-16.1	-14.3	-12.5	-4.4	4.8	9.6	10.7	8.0	2.2	-5.7	-13.9	-15.6	-3.9

Source: Lorax (2017a)

3.2.4 Potential Evaporation

As described in Lorax (2016a) 15-minute potential evaporation rates were computed for the Camp station using available climate and the Ref-ET calculator - a compiled, standalone computer program that calculates reference evapotranspiration (ASCE 2005). For the period of available record (Jan 2013 to Apr 2016), a 15-minute climate input file was prepared for the Eagle Gold site. The input variables required by Ref-ET are: maximum air temperature, minimum air temperature, relative humidity, incoming solar radiation, atmospheric pressure and wind speed.

From the assembled climate inputs, Ref-ET returned potential evaporation (PE) computations for an array of evaporation models (e.g., Penman-Monteith model, Priestley- Taylor formulation), which were aggregated to daily time-step. Presented in Table 3.2-7 (monthly tabulations) are resulting outputs from Ref-ET for months March to October.

May to end-September PE estimates for the Camp station are also reported in Table 3.2-7 and are estimated to total 380 mm over this period. In terms of monthly magnitudes of PE, highest monthly rates of PE are expected in May, June, July and August of each year. These estimates were used as the basis for the time-series of evaporation estimates that were developed for the synthetic climate record contained in Appendix A of Lorax (2017a).

Table 3.2-7: Potential Evaporation (PE) Estimates for the Camp Site

Period	Method	Potential Evaporation (mm)				
		2012	2013	2014	2015	Average (2012-2015)
Mar	PM	-	17	21	17	18
	P-T	-	16	19	16	17
Apr	PM	-	40	47	47	45
	P-T	-	40	46	46	44
May	PM	-	78	91	113	94
	P-T	-	82	85	108	92
June	PM	-	114	98	97	103
	P-T	-	116	96	97	103
July	PM	87	102	91	80	90
	P-T	93	102	90	86	93
August	PM	69	74	55	61	65
	P-T	70	73	56	63	65
Sep	PM	36	30	33	27	31
	P-T	26	24	28	23	25
Oct	PM	6	3	10	10	7
	P-T	4	3	4	5	4
Total (Mar-Oct)	PM	-	456	445	453	453
	P-T	-	456	423	445	453
Total (May-Sep)	PM	-	397	367	378	382
	P-T	-	397	354	378	378

Notes: PM and P-T Indicate potential evaporation (PE) estimates based on Penman–Monteith and Priestley–Taylor approaches respectively. 2. PE Estimates computed using Eagle camp/lower 15-min climate data (I.E, air, temperature, relative humidity, wind speed, precipitation solar radiation, atmospheric pressure) and Ref-Et software.

3.2.5 Precipitation

3.2.5.1 Regional

Key features relating to the precipitation signatures for regional climate stations are summarized by information presented in Table 3.2-8. The table summarizes monthly and annual precipitation data for six regional climate stations for rainfall, snowfall, and total precipitation.

For regional climate stations surrounding the Project site, MAP varies appreciably with elevation. For example, MAP ranges from 324 mm at the Mayo A station (504 m; situated approximately 50 km to the south of the Eagle Gold Project) to 572 mm at the Keno Hill station (1,473 m; ~30 km southeast of the Project). An inspection of available data from regional climate stations indicates both precipitation phases exhibit increases with elevation, with the regional gradients averaging 5%/100 m of elevation gain for rainfall, 10%/100 m for snowfall, and an average MAP gradient of 7%/100 m (Lorax 2016a). On an annual basis, total precipitation in the region is comprised of roughly 60% rainfall and 40% snowfall, noting proportions vary to some degree from station to station, but notably by elevation. Across the Yukon the proportion of annual precipitation falling as snow increases with elevation, resulting in a reversal of the rain/snow proportions. Further, for the component of annual precipitation realized as rainfall – roughly half of annual rainfall may be expected in June and July at the Project site.

Data from regional snow courses were included to aid in the evaluation of elevational gradients in winter precipitation totals and to provide context in terms of long-term pattern and variability in snow accumulation near the Project Site. In Table 3.2-9, April 1 snow water equivalent (SWE) data are summarized for nearest regional snow courses to the Project site. April 1 SWE is of interest in this assessment as data for this time period (i.e., snow sampling during the last week of March) typically represent maximum SWE on an annual basis, as well as provide an indication of the freshet volume that is likely to report following melt.

Table 3.2-8: Precipitation Summary for Regional Climate Stations near the Eagle Gold Project

Climate Station	Elevation (m)	Description	Measured Precipitation (mm)												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Keno Hill (1974-1982)	1473	Total Rainfall	0	0	0	0	15	80	88	45	45	3	0	0	275
		% monthly precipitation	0%	0%	0%	0%	75%	100%	100%	98%	68%	5%	0%	0%	48%
		Total Snowfall	39	27	42	37	5	0	0	1	21	57	34	33	297
		% monthly precipitation	100%	100%	100%	100%	25%	0%	0%	2%	32%	95%	100%	100%	52%
		Total Precipitation	39	27	42	37	20	80	88	46	66	60	34	33	572
		% annual	7%	5%	7%	6%	3%	14%	15%	8%	12%	10%	6%	6%	100%
Klondike (1966-2010)	973	Total Rainfall	0	0	0	0	14	51	67	64	41	6	0	0	243
		% monthly precipitation	0%	0%	0%	0%	70%	64%	76%	139%	62%	10%	0%	0%	52%
		Total Snowfall	28	26	28	23	6	0	0	0	7	35	35	40	227
		% monthly precipitation	100%	100%	100%	100%	30%	0%	0%	0%	15%	85%	100%	100%	48%
		Total Precipitation	28	26	28	23	20	51	67	64	48	41	35	40	470
		% annual	6%	6%	6%	5%	4%	11%	14%	14%	10%	9%	7%	9%	100%
Elsa (1948-1989)	814	Total Rainfall	0	0	0	1	28	51	63	53	50	14	0	1	262
		% monthly precipitation	0%	0%	0%	7%	90%	100%	100%	98%	96%	32%	0%	3%	59%
		Total Snowfall	27	23	19	13	3	0	0	1	2	30	29	34	181
		% monthly precipitation	100%	100%	100%	93%	10%	0%	0%	2%	4%	68%	100%	97%	41%
		Total Precipitation	27	23	19	14	31	51	63	54	52	44	29	35	443
		% annual	6%	5%	4%	3%	7%	12%	14%	12%	12%	10%	7%	8%	100%
Mayo A (1925-2016)	504	Total Rainfall	0	0	0	3	20	37	49	44	30	9	0	0	191
		% monthly precipitation	0%	0%	0%	30%	95%	100%	100%	100%	91%	31%	0%	0%	59%
		Total Snowfall	22	17	12	7	1	0	0	0	3	20	26	25	133
		% monthly precipitation	100%	100%	100%	70%	5%	0%	0%	0%	9%	69%	100%	100%	41%
		Total Precipitation	22	17	12	10	21	37	49	44	33	29	26	25	324
		% annual	7%	5%	4%	3%	6%	11%	15%	14%	10%	9%	8%	8%	100%
Stewart Crossing (1963-2007)	480	Total Rainfall	0	0	0	2	26	40	53	46	32	10	0	0	209
		% monthly precipitation	0%	0%	1%	21%	99%	100%	100%	99%	97%	42%	1%	0%	63%
		Total Snowfall	22	13	10	8	0	0	0	0	1	14	28	24	121
		% monthly precipitation	100%	100%	99%	79%	1%	0%	0%	1%	3%	58%	99%	100%	37%
		Total Precipitation	22	13	10	10	26	40	53	46	34	25	28	24	330
		% annual	7%	4%	3%	3%	8%	12%	16%	14%	10%	7%	9%	7%	100%
McQuesten (1986-2014)	457	Total Rainfall	0	0	0	5	26	39	59	42	34	8	0	0	212
		% monthly precipitation	0%	0%	0%	50%	100%	100%	100%	100%	89%	32%	0%	0%	61%
		Total Snowfall	23	14	14	5	0	0	0	0	4	17	31	28	136
		% monthly precipitation	100%	100%	100%	50%	0%	0%	0%	0%	11%	68%	100%	100%	39%
		Total Precipitation	23	14	14	10	26	39	59	42	38	25	31	28	348
		% annual	7%	4%	4%	3%	7%	11%	17%	12%	11%	7%	9%	8%	100%

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Table 3.2-9: Regional April SWE Snowfall Values

Snow Survey	Station ID	Elevation (m)	Apr. 1 SWE (mm) Period of Record	Apr. 1 SWE (mm) (2009-14, 2016)
Mayo A	09DC-SC01A	540	97	109
Mayo B	09DC-SC01B	540	105	103
Edwards Lake	09DC-SC02	830	164	164
Calumet	09DD-SC01	1310	197	185
King Solomon Dome	09EA-SC01	1080	162	175
Grizzly Creek	09EA-SC02	975	179	179

Source: Lorax (2017a)

3.2.5.2 Project Site

The precipitation data is collected at the Project site using tipping bucket rain gauges, which have not been adapted to measure snowfall. Therefore, the precipitation data presented in Table 3.2-10 for rainfall only, collected between the months of March and October, inclusive. Generally, precipitation falls as snow from November through March, with precipitation falling as a mix of rain and snow in April and October. Rainfall data for March is included in the table below, where the temperature record indicates that precipitation would have fallen as rain (i.e., daily average air temperature was above zero).

Table 3.2-10: Project Site Monthly Rainfall Data

Climate Station	Elevation (masl)	Rainfall (mm)															
		Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
Camp Station	782	2009		-	-	-	-	-	-	-	-	-	35.0	8.0	S	S	-
		2010		S	S	5.0	9.0	20.0	62.0	34.0	28.0	25.0	12.0	S	S	195.0	
		2011		S	S	11.0	10.0	16.0	31.0	75.0	44.0	40.0	9.0	S	S	236.0	
		2012		S	S	13.0	1.0	22.0	18.0	74.6	29.8	24.0	4.8	S	S	187.2	
		2013		S	S	8.6	10.4	34.6	25.6	28.4	35.2	58.6	25.2	S	S	226.6	
		2014		S	S	5.4	8.8	9.2	52.8	43.2	70.4	28.8	23.2	S	S	241.8	
		2015		S	S	20.8	13.0	8.2	28.8	64.0	62.0	38.6	13.4	S	S	248.8	
		All Years	Mean	S	S	10.6	8.7	18.3	36.4	53.2	44.9	35.7	13.7	S	S	222.6	
			Max	S	S	20.8	13.0	34.6	62.0	75.0	70.4	58.6	25.2	S	S	248.8	
			Min	S	S	5.0	1.0	8.2	18.0	28.4	28.0	24.0	4.8	S	S	187.2	
Potato Hills Station	1420	2007		-	-	-	-	-	-	-	24.0	100.8	2.0	S	S	-	
		2008		S	S	3.4	4.8	58.4	52.0	201.2	130.0	11.2	1.2	S	S	462.2	
		2009		S	S	S	3.0	-	50.8	12.6	75.4	44.4	1.2	S	S	-	
		2010		S	S	1.0	6.2	16.4	77.2	45.8	39.4	4.2	5.4	S	S	195.6	
		2011		S	S	0.2	7.2	21.2	38.0	92.8	83.8	34.4	0.4	S	S	278.0	
		2012		S	S	S	0.6	9.6	24.2	64.8	37.8	21.0	4.6	S	S	162.6	
		2013		S	S	2.2	0.2	29.6	33.2	18.0	18.2	63.8	10.0	S	S	175.2	
		2014		S	S	S	M	M	M	M	M	M	M	S	S	-	

Climate Station	Elevation (masl)	Rainfall (mm)														
		Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
		2015		S	S	M	M	M	M	M	48.5	27.1	10.0	S	S	-
		All Years	Mean	S	S	S	3.7	27.0	45.9	72.5	57.1	38.4	4.4	S	S	254.7
			Max	S	S	S	7.2	58.4	77.2	201.2	130.0	100.8	10.0	S	S	462.2
			Min	S	S	S	0.2	9.6	24.2	12.6	18.2	4.2	0.4	S	S	162.6

3.2.6 Snow Accumulation and Snowmelt

Snow data have been collected at three snow courses at the Project site since 2009. Furthermore, the annual maximum snow water equivalent (SWE) value generally occurs in late-March or early-April at the Project site. Field measurements from site show that snow density is generally lower earlier in the season, corresponding to colder temperatures, but increases through winter as the snow pack deepens, weathers and as snow melt progresses.

Project site snow survey data is summarized in Table 3.2-11 for period of record 2009 to 2016. Annual maximum SWE values range from 93 mm to 160 mm at the Camp snow course, 98 mm to 117 mm (shorter record) at the Ann Gulch snow course, and vary from 190 mm to 410 mm at the Potato Hills snow course.

The Potato Hills snow survey was conducted in the immediate vicinity of the weather station from 2009 to 2011. However, due to the exposed location, snow redistribution resulted in variable measurements, and therefore the survey was moved to its current and more sheltered location in 2012, several hundred metres to the south-east (Figure 3.1-2). Note that high snowpacks did not allow access to the Potato Hills snow course in March 2012, and therefore the survey was conducted at Stewart Gulch (Snow Survey #2; Figure 3.1-2).

Table 3.2-11: Project Site Snow Survey Data

Year	Camp Station				Ann Gulch (Snow Survey #2)				Potato Hills Station			
	Survey Date	Depth (cm)	SWE (mm)	Density (%)	Survey Date	Depth (cm)	SWE (mm)	Density (%)	Survey Date	Depth (cm)	SWE (mm)	Density (%)
2009	2009-04-21	69	112	16%	-	-	-	-	2009-04-21	126	410	33%
2010	2010-03-31	50	99	20%	-	-	-	-	2010-03-31	103	278	27%
	2010-04-21	69	112	16%	-	-	-	-	2010-04-21	126	405	32%
2011	2011-03-28	55	93	17%	-	-	-	-	2011-03-28	105	251	24%
2012	2012-03-20	78	161	21%	-	-	-	-	-	-	-	-
	2012-04-20	56	79	14%	-	-	-	-	2012-04-22	117	262	22%
2013	-	-	-	-	2013-02-20	70	97	14%	2013-02-28	96	185	19%
	2013-03-02	61	108	18%	2013-03-02	67	115	17%	-	-	-	-
	2013-04-02	59	108	18%	2013-04-02	62	117	19%	2013-04-03	90	190	21%
					2013-04-16	62	85	14%	-	-	-	-
	2013-05-05	58	106	18%	2013-05-03	58	105	18%	2013-05-05	117	167	14%

2014	2014-03-12	57	126	22%	2014-03-12	51	94	18%	2014-03-11	98	276	28%
	2014-04-02	55	100	18%	2014-04-02	46	98	21%	2014-04-02	96	275	29%
	-	-	-	-	-	-	-	-	2014-05-08	70	258	37%
2016	2016-03-02	53	118	22%	2016-03-02	53	117	22%	2016-03-02	95	214	22%
	2016-04-09	38	140	37%	2016-04-09	22	115	52%	2016-04-10	107	257	24%
	-	-	-	-	-	-	-	-	2016-05-03	95	226	24%

3.2.7 Extreme Rainfall/Snowmelt

Estimates of the 24-hour rainfall for various return periods were computed in three ways: The first method used the rainfall Intensity-Duration-Frequency (IDF) curves published by Environment Canada for the Mayo A climate station, and the second method used the longer daily rainfall record from the Mayo A station. For comparison with the estimated rainfall values, the monthly maximum 24-hour rainfall totals are presented in Table 3.2-12 and Table 3.2-13, for the Camp and Potato Hills climate stations, respectively.

Previous work by Knight Piésold (2013a) based the rainfall recurrence interval estimates on the Rainfall Frequency Atlas of Canada (Hogg and Carr 1985). While the Atlas is a useful reference, a significant amount of rainfall data has become available since its publication. Environment Canada publishes rainfall IDF curves for the Mayo A station, based on 24-hour rainfall accumulations recorded from 1979 to 2010 (n = 25 years). These estimates were included, and scaled by 4%/100 m to account for the orographic gradients at site.

The IDF curve for the Mayo A climate station is based on 25 samples of annual 24-hour rainfall, however, this station has a record of maximum annual daily rainfall spanning the period of 1925 to 2015, resulting in a sample size of 92. This longer daily record allows for a more robust analysis to be conducted on the expected frequency and magnitude of rainfall events. These daily data were adjusted by a factor of 1.14 (the Herschfield factor) to account for the fact that the maximum 24-hour precipitation does not necessarily fall within the standard day (midnight to midnight; Herschfield 1961). An analysis was conducted using the site rainfall data to confirm the Herschfield factor, and on average, the 24-hour totals were 1.18 and 1.16 times higher than the daily totals, for the Camp and Potato Hills stations, respectively. Therefore, the higher ratio of 1.18 was carried forward as a scalar for the Mayo A daily totals. Recurrence interval estimates were derived by fitting the Extreme Value Type I (Gumbel) distribution to these data – the same distribution used for both the IDF curve derivation. The IDF estimates and daily rainfall values were scaled by 4%/100 m to account for the orographic gradients at site (Table 3.2-14).

Knight Piesold (2014) provided estimates for the project site using a frequency factor approach, as presented in the Rainfall Frequency Atlas for Canada (Hogg and Carr, 1985). This approach also involved using frequency factors based on the Extreme Value Type I (Gumbel) distribution derived directly from the Atlas. In this case, though a more conservative factor of 1.5 was applied, as recommended in the Atlas, in recognition of potential orographic effects and the fact that the Atlas values are largely based on data from valley stations. The resulting mean and standard deviation values for the annual 24-hour rainfall are 22 mm and 8.2 mm, respectively. The estimated 24-hour 100-year, 200-year and PMP estimates for the site of 71.6 mm, 78.3 mm, and 255.6 mm, respectively (Table 3.2-14).

The values based on the Mayo A daily rainfall totals range from 24% to 57% higher than those derived from the Mayo A 24-hour IDF curve, for the 1:100 year event. The values derived from the scaled Mayo A daily data (highlighted in grey) reported in Table 3.2-14 are recommended for use in engineering design.

From Table 3.2-12 and Table 3.2-13, the maximum 24-hour rainfall totals recorded at the Project site are 22 mm (July 2012; Camp station) and 38.2 mm (August 2008; Potato Hills station). With over six years of data collection, these totals approximately represent only the median 2-yr storm for Camp and the Potato Hills stations. This indicates that all three methods (Mayo A, Mayo IDF and the ARFA) likely overestimate the 24-hour rainfall for every recurrence interval.

Table 3.2-12: Maximum Monthly 24-hour Rainfall for the Camp Station (mm)

Month	2009	2010	2011	2012	2013	2014	2015	Max
May	--	9.6	5.6	7.6	6.6	4.0	3.8	9.6
Jun	--	15.2	8.4	6.6	4.6	14.0	7.2	15.2
Jul	--	8.0	17.8	22.0	9.4	11.2	14.0	22.0
Aug	11.2	15.4	14.0	14.0	19.8	13.2	16.8	19.8
Sep	8.6	8.4	8.2	8.8	15.8	8.6	15.4	15.8
Max	11.2	15.4	17.8	22.0	19.8	14.0	16.8	22.0

Source: Lorax (2017a)

Table 3.2-13: Maximum Monthly 24-hour Rainfall for the Potato Hills Station (mm)

Month	2007	2008	2009	2010	2011	2012	2013	Max
May	--	14.8	0.0	7.8	6.2	2.4	7.0	14.8
Jun	--	16.4	14.4	20.4	13.4	7.2	8.0	20.4
Jul	--	27.0	5.0	16.2	17.2	17.0	3.6	27.0
Aug	14.2	38.2	12.6	20.2	19.8	16.2	6.2	38.2
Sep	35.8	4.0	9.2	1.8	12.8	6.8	10.0	35.8
Max	35.8	38.2	14.4	20.4	19.8	17.0	10.0	38.2

Source: Lorax (2017a)

Table 3.2-14: Recurrence Interval Estimates of 24-hour Storm Rainfall Depths (mm)

Exceedance Probability	Return Period	Mayo A	Camp		Project			Potato Hills	
		504 m	782 m		1125 m			1420 m	
		IDF	Daily ¹	IDF ²	Daily ¹	IDF ²	ARFA ³	Daily ¹	IDF ²
0.5	1:2	18	22	20	25	23	31	36	26
0.1	1:10	25	33	28	38	32	49	54	36
0.04	1:25	29	39	32	44	37	58	63	42
0.02	1:50	31	43	35	49	40	65	70	44
0.01	1:100	34	47	38	54	43	72	77	49
0.005	1:200	39 ⁴	51	44	58	50	78	83	56
0.001	1:1000	43 ⁴	60	48	69	55	94	99	62
PMP	PMP	--	--	--	--	--	256	--	--

Source: Lorax (2017a)

Notes:

¹Based on the Mayo A annual maximum daily rainfall, multiplied by 1.18, and scaled by elevation.²Based on the Mayo A 24-hour IDF curve estimates, and scaled by elevation.³Based on the Adjusted Rainfall Frequency Atlas method (Knight Piésold 2014).⁴IDF curve values not provided for these recurrence intervals – values in table based on extrapolation.

3.3 PHYSIOGRAPHY

The project is located within the Mayo Lake-Ross River Ecoregion, which encompasses the Stewart, Macmillan, and Pelly plateaus, a subdivision of the Yukon Plateau physiographic subdivision. Terrain consists of rolling upland plateaus and small mountain groups with nearly level tablelands dissected by deep and broad U-shaped valleys. Most of the terrain in the region lies between 500 and 1,700 m asl, while most of the slopes in the project area are between 15 to 30%. The local study area lies in the upper regions of the Haggart Creek drainage basin, including the Dublin Gulch and Eagle Creek sub-basins. Haggart Creek flows generally southwestward and into the South McQuesten River which ultimately eventually flows to the Stewart River. Further details of the surficial geology and physiography of the project area are found Stantec (2010b and 2011c).

Placer mining has been conducted in both Haggart Creek and the Dublin Gulch basins over the past century. The outcome of these operations has resulted in large placer deposits which have altered the natural drainage character of Dublin Gulch, including channel diversions and some changes to sub-basin divides. The most notable changes have affected Eagle Pup and Suttles Gulch. These water courses formerly entered into Dublin Gulch in the lower part of the valley. However, as a result of the placer mining activities, these drainages now flow into Eagle Creek. After leaving the Dublin Gulch valley, Eagle Creek turns southward and flows parallel to Haggart Creek for several kilometres through placer deposits including several ponds before draining to Haggart Creek downstream of the mouth of Gil Gulch. Lynx Creek, the largest tributary to Haggart Creek, meets Haggart Creek about 3 km downstream of the Eagle Creek-Haggart confluence.

3.4 SURFACE WATER

3.4.1 Regional Streamflow

The availability of long-term, reliable hydrometric data is relatively sparse in the region. The active and historic hydrometric stations in the regional area are listed in Table 3.4-1.

Table 3.4-1: Regional Hydrometric Stations near the Eagle Gold Project

Site ID	Station Name	Latitude (dec.deg.)	Longitude (dec.deg.)	Drainage Area (km ²)	Period of Record
09DB001	Beaver River Below Matson Creek	64.01	-134.14	4,770	1995-present (21 years)
10MB004	Bonnet Plume River Above Gillespie Creek	64.75	-133.68	3,760	1981-1994 (14 years), 2016-present (0 years)
29DD002	Clear Creek Above Barlow Creek	63.75	-137.63	340	1980-present (36 years)
29EA002	Grizzly Creek at km 60.4 Dempster Highway	64.40	-138.30	34	1975-1982 (8 years)
09EA005	Little South Klondike River Below Ross Creek	64.00	-137.57	860	1981-1981 (1 years), 1983-1994 (12 years), 2015-present (1 years)
09BB002	Macmillan River Near the Mouth	62.89	-135.51	13,800	1984-1998 (15 years)
09DC005	Mayo Lake Near the Outlet	63.77	-135.39		1979-present (37 years)
09DC001	Mayo River Near Mayo	63.70	-135.86	2,260	1945-1947 (3 years), 1949-1950 (2 years)
09DD004	Mcquesten River Near the Mouth	63.61	-137.27	4,750	1979-present (37 years)
09EA004	North Klondike River Near the Mouth	64.00	-138.60	1,090	1974-present (42 years)
09BC001	Pelly River at Pelly Crossing	62.83	-136.58	48,900	1952-present (64 years)
09DC003	Stewart River Above Fraser Falls	63.49	-135.13	30,600	1980-1998 (19 years)
09DC002	Stewart River at Mayo	63.59	-135.90	31,600	1949-1979 (31 years)
09DD002	Stewart River at Stewart Crossing	63.38	-136.68	35,000	1958-1958 (1 years), 1960-1973 (14 years)
09DC006	Stewart River Near Mayo	63.59	-135.90	na	1980-present (36 years)
09DC004	Wareham Lake at Headgate	63.66	-135.92	na	1979-2000 (22 years)
29EA001	Wolf Creek at km 52 Dempster Highway	64.37	-138.38	69	1975-1982 (8 years)

Source: Lorax (2017a)

Monthly and annual streamflow data for the McQuesten River (used as the predictor station for Project streams) are presented in Table 3.4-2.

The hydrology of the region is characterized by a dominant snowmelt driven freshet signature, which typically occurs between early May and early June. The recession limb of the freshet tapers to a lower summer low-flow

regime reflective of primarily groundwater, which is punctuated by periodic rainfall driven runoff events, typically one to four days in duration. Base flows are lowest in the winter and flow sub-ice; in the smaller creeks groundwater is depleted and there is no flow under the ice. Air temperatures begin to drop below zero in the autumn months, and many of the smaller tributaries experience zero-flow conditions for the majority of the winter season.

Table 3.4-2: Monthly Hydrometric Summaries for the McQuesten River Station

Station	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
McQuesten River (Drainage area 4,750 km ² ; 1979-2015) Period of Record = 38 years	Mean (m ³ /s)	8.8	7.5	7.1	11.5	122.0	104.0	53.7	43.6	45.8	30.5	16.8	11.6	38.4
	Max (m ³ /s)	13.6	11.9	10.3	23.7	224.0	214.0	109.0	86.5	83.7	63.0	33.2	19.9	55.5
	Min (m ³ /s)	5.1	4.4	4.2	5.7	75.9	42.0	24.4	17.2	18.2	13.0	8.3	6.3	23.6
	Mean (L/s/km ²)	1.9	1.6	1.5	2.4	25.7	21.9	11.3	9.2	9.6	6.4	3.5	2.4	8.1
	Max (L/s/km ²)	2.9	2.5	2.2	5.0	47.2	45.1	22.9	18.2	17.6	13.3	7.0	4.2	11.7
	Min (L/s/km ²)	1.1	0.9	0.9	1.2	16.0	8.8	5.1	3.6	3.8	2.7	1.7	1.3	5.0

Source: Lorax (2016b)

3.4.2 Project Area Streamflow

The number of continuously recording hydrometric stations at the Project has varied over the period of record. Eight currently operating stations with the most complete records are described in Lorax (2016b) [Eagle Gold Baseline Hydrology Study] and include streamflow monitoring stations in Dublin Gulch, Haggart Creek, Lynx Creek, Stewart Gulch and Eagle Creek. Station locations and the associated metadata are presented in Figure 3.4-1 and Table 3.4-3, respectively,

Lorax (2016b) provides a recent summary of all hydrometric data, and includes a summary of discharge measurement techniques, stage measurements and corrections, QA/QC of field data, approach and methods for hydrometric record assembly, and rating curve development and error. Over time, manual discharge measurements have been conducted using the following methods: velocity area techniques using a current meter; salt dilution; calibrated V-notch weir; calibrated Parshall flume; bucket/bag; and float-area method.

All hydrometric stations at the Eagle Gold Project were instrumented with metric staff gauges, mounted to vertical angle iron in the stream channel, and regularly surveyed to nearby benchmarks. Continuously recording HOB0 pressure transducers were installed in stilling wells, and set to record water level every 15 minutes. These readings were corrected for fluctuations in barometric pressure in a post-processing step. During each site visit, the water level was noted on the staff gauge. These readings formed the basis for the continuous water level records, which were adjusted to match the manual stage readings. Regular surveys were conducted to determine the staff gauge zero datum and water level, and these measurements were used to correct the station records for changes due to shifts in the channel bed (i.e., aggradation or scour), frost-jacking or station relocation following a high-magnitude flood event.

To develop continuous time-series of discharge for the Project streams, spot measurements of stage and discharge were combined with continuous water level records collected by the pressure transducers. Rating curves were derived to describe the relationship between water level and discharge unique and specific to each monitoring station, and then applied to the continuous water level records to estimate discharge.

Table 3.4-4 provides a summary of monthly average discharge, unit yield and runoff for Project site hydrometric stations listed in Table 3.4-3. Flow records for all stations are presented in this format and as unit yield plots in Lorax (2016b).

Available site data confirm streamflow patterns seen in the regional record. The characteristic snowmelt driven freshet signature, which typically occurs between early May and early June is evident at site hydrology stations. The peak of snowmelt is short-duration, lasting days to weeks, but streamflow yields in the range 50-150 L/s/km² are possible at this time of the year. On a monthly basis, average flows are expected to be higher on average in May (25-40 L/s/km²) than in June (12-16 L/s/km²).

The recession limb of the freshet tapers to a summer low-flow regime reflective of primarily groundwater, which is punctuated by periodic rainfall driven runoff events, typically one to four days in duration. The low-flow regime at the Project site is defined by streamflow yields of approximately 10-15 L/s/km², with rainfall driven runoff reaching yields of 40-60 L/s/km² – but for short periods of time and peaks being short-lived.

Air temperatures at the Project site begin to drop below zero in September. Accordingly, many of the smaller tributaries experience low- or zero-flow conditions for the majority of the winter season. Lorax (2016b) provides a summary of winter spot-flow measurements recorded at the Project site. At W4 (76.9 km²) and W5 (97.5 km²) hydrometric stations, winter spot flows typically reach minima 2 to 3 L/s/km². In contrast at the smaller W1 basin (6.8 km²), winter minima are slightly lower and approximately 1.5 to 2 L/s/km².

Table 3.4-3: Eagle Gold Project Hydrometric Stations

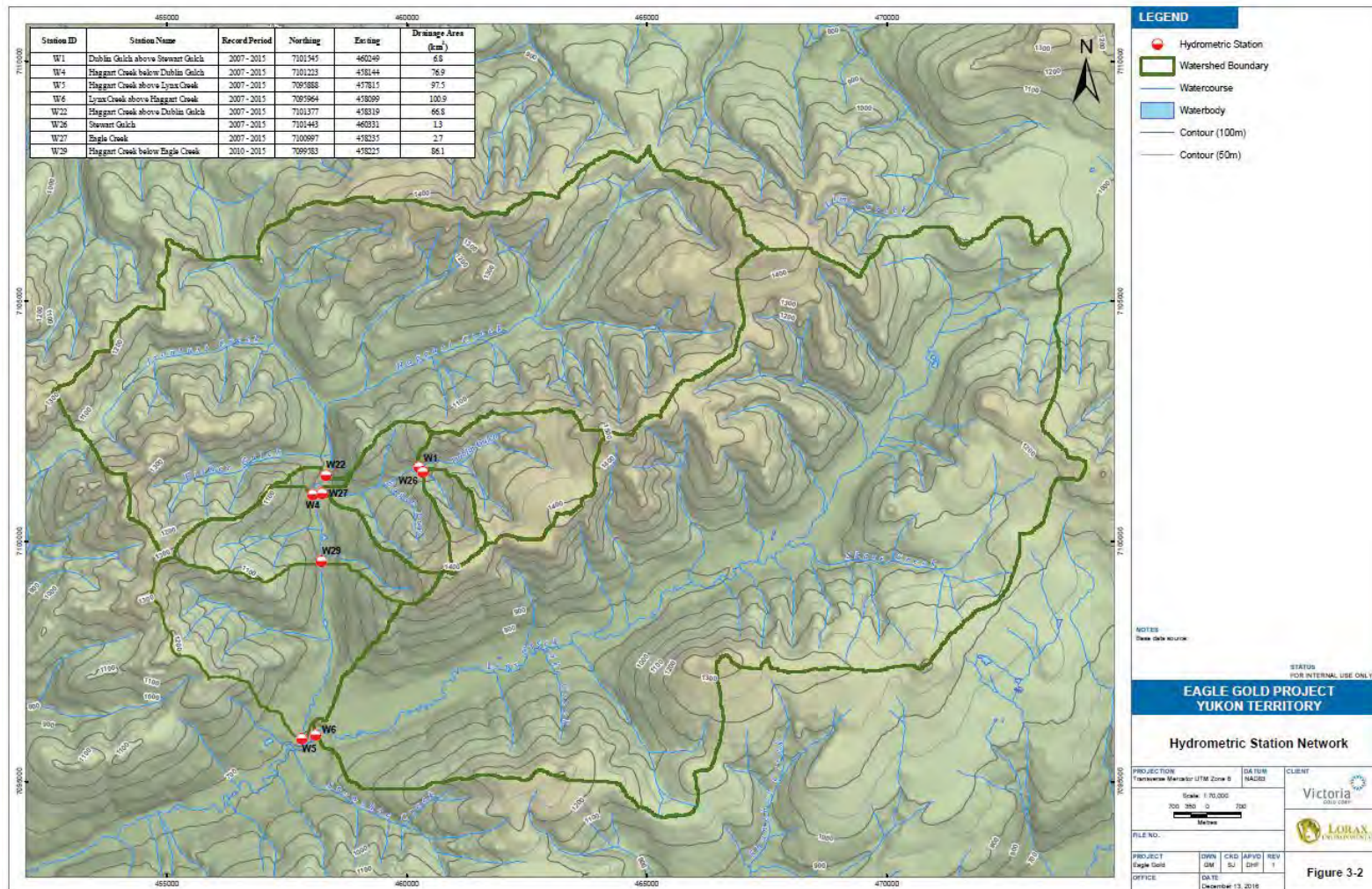
Station ID	Station Name	Record Period	Northing	Easting	Drainage Area (km ²)	Median Basin Elevation (m)	Notes
W1	Dublin Gulch above Stewart Gulch	2007 - 2015	7,101,545	460,249	6.8	1,303	Continuous discharge time-series
W4	Haggart Creek below Dublin Gulch	2007 - 2015	7,101,223	458,144	76.9	1,125	Continuous discharge time-series
W5	Haggart Creek above Lynx Creek	2007 - 2015	7,095,888	457,815	97.5	1,091	Continuous discharge time-series
W6	Lynx Creek above Haggart Creek	2007 - 2015	7,095,964	458,099	100.9	1,049	Continuous discharge time-series
W22	Haggart Creek above Dublin Gulch	2007 - 2015	7,101,377	458,319	66.8	1,113	Continuous discharge time-series
W26	Stewart Gulch	2007 - 2015	7,101,443	460,331	1.3	1,183	Continuous discharge time-series, manual data only for 2007 - 2009, 2011.
W27	Eagle Creek	2007 - 2015	7,100,997	458,235	2.7	1,037	Continuous discharge time-series, manual data only for 2007
W29	Haggart Creek below Eagle Creek	2010 - 2015	7,099,583	458,225	86.1	1,112	Manual measurements for 2010, continuous data thereafter

Source: Lorax (2016b)

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Figure 3.4-1: Hydrometric Stations at the Eagle Gold Project



Source: Lorax (2017)

Table 3.4-4: Summary of Monthly Average Discharge, Unit Yield and Runoff for Project Site

Station (Discharge Area)	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average/ Total
W1 (6.8 km²)	Average Discharge (m ³ /s)	--	--	--	0.02	0.25	0.08	0.09	0.08	0.10	0.08	0.07	--	0.098
	Average Yield (L/s/km ²)	--	--	--	3.38	37.36	12.44	12.69	12.40	14.49	12.35	10.10	--	14.4
	Runoff (mm)	--	--	--	3.5	79.1	26.2	33.3	28.6	37.5	22.6	4.4	--	235
W4 (76.9 km²)	Average Discharge (m ³ /s)	--	--	--	--	2.03	1.02	0.85	0.89	0.91	0.81	1.03	--	1.076
	Average Yield (L/s/km ²)	--	--	--	--	26.38	13.27	11.11	11.53	11.80	10.48	13.34	--	14.0
	Runoff (mm)	--	--	--	--	50.5	31.5	29.8	29.4	30.6	19.0	24.2	--	215
W5 (97.5 km²)	Average Discharge (m ³ /s)	--	--	--	--	2.68	1.30	1.09	0.99	0.96	0.97	--	--	1.332
	Average Yield (L/s/km ²)	--	--	--	--	27.54	13.33	11.15	10.17	9.89	9.92	--	--	13.7
	Runoff (mm)	--	--	--	--	56.5	29.5	29.9	25.6	25.6	15.6	--	--	183
W6 (100.9 km²)	Average Discharge (m ³ /s)	--	--	--	--	3.24	1.27	0.98	1.09	1.19	0.94	0.90	--	1.430
	Average Yield (L/s/km ²)	--	--	--	--	32.11	12.63	9.74	10.81	11.77	9.28	1.79	--	14.2
	Runoff (mm)	--	--	--	--	62.4	24.3	26.1	27.6	30.5	15.8	0.39	--	202
W22 (66.8 km²)	Average Discharge (m ³ /s)	--	--	--	0.27	1.97	0.81	0.66	0.81	0.78	0.68	0.94	--	0.864
	Average Yield (L/s/km ²)	--	--	--	3.98	29.44	12.15	9.91	12.12	11.73	10.16	14.02	--	12.9
	Runoff (mm)	--	--	--	4.1	60.2	30.1	24.0	30.8	30.4	18.5	14.5	--	213
W26 (1.3 km²)	Average Discharge (m ³ /s)	--	--	--	--	--	0.02	0.02	0.01	0.01	0.01	--	--	0.015
	Average Yield (L/s/km ²)	--	--	--	--	--	16.54	12.52	11.15	10.13	7.42	--	--	11.5
	Runoff (mm)	--	--	--	--	--	28.2	28.3	29.9	24.7	7.3	--	--	118
W27 (2.7 km²)	Average Discharge (m ³ /s)	--	--	--	--	0.09	0.04	0.03	0.02	0.02	0.02	--	--	0.040
	Average Yield (L/s/km ²)	--	--	--	--	34.24	16.28	12.75	9.16	8.47	8.82	--	--	15.0
	Runoff (mm)	--	--	--	--	57.4	39.7	25.6	23.0	21.9	13.2	--	--	181
W29 (8 km²)	Average Discharge (m ³ /s)	--	--	--	--	2.51	1.20	1.21	1.06	1.11	0.87	--	--	1.325
	Average Yield (L/s/km ²)	--	--	--	--	29.13	13.94	14.09	12.25	12.88	10.05	--	--	15.4
	Runoff (mm)	--	--	--	--	44.0	26.1	37.7	31.3	33.4	16.3	--	--	189

3.4.3 Surface Water Quality

The current water quality and aquatic biota baseline program began in 2007. Stantec (2011f and 2012b), Lorax (2013), and Lorax (2017b) provide details on sample locations, sampling methods and frequency, and detailed summaries of results. Water quality characterization has occurred every year since 2007 and is still ongoing. The study area includes the Haggart Creek, Dublin Gulch, Eagle Creek basins, which have been subject to historical placer mining and will be affected by further development activities and Lynx Creek basin, which has not been subject to placer mining and will be unaffected by development activities. For the period of 2007 to 2016, a total of 21 monitoring stations were sampled within the study area.

Portions of Haggart Creek, Dublin Gulch, and Eagle Creek drainage basins have the potential to be affected by the proposed Project and thus, sites located upstream and downstream of the Project footprint were selected within these basins, where possible. Lynx Creek drains a large catchment to the south of the Project area that will be unaffected by development activities and will serve as reference monitoring location, but because it will be unaffected it is not summarized in this management plan.

3.4.3.1 Dublin Gulch Drainage

The major ion chemistry of Dublin Gulch is assessed with respect to conductivity, hardness, alkalinity, sulphate and pH. Dublin Gulch is characterized by soft to moderately hard waters, with monthly mean hardness values ranging from 28 to 66 mg/L at station W1 (downstream) and 47 mg/L to 145 mg/L at station W21 (upstream). Values for conductivity, hardness, and alkalinity demonstrate pronounced seasonal fluctuations, with minima coinciding with freshet periods in May and June. Conductivity, hardness and alkalinity at both sites exhibit an approximate two- to three-fold increase in concentration between freshet and other times of the year.

Overall, such trends in stream salinity reflect varying proportions of snow-melt driven surface runoff (lower ionic strength) and groundwater inputs (higher ionic strength) as driven by the seasonal water balance. Values upstream are typically higher than values downstream, and may reflect the contribution from groundwater discharges at lower elevations in the catchment.

The pH in Dublin Gulch remains relatively uniform throughout the year with values generally ranging between 7.0 and 8.0. The neutral to slightly basic pH conditions can be linked to bicarbonate alkalinity. All pH values reported to date have remained within the BC freshwater chronic criterion range for pH of 6.5 to 8.5.

Baseline concentrations for sulphate in Dublin Gulch are generally low, and exhibit a pronounced seasonal signature as observed for other salinity proxies. Sulphate minima during high flow can be attributed to the influence of low ionic strength melt waters, while higher values during the low-flow periods likely reflect an increased proportion of groundwater inputs.

Mean monthly sulphate values range from freshet minima of approximately 6.0 mg/L and 17 mg/L, respectively to maximum mean values observed during winter low flows of 20 mg/L and 65 mg/L, respectively.).

Unlike the dissolved ions, elevated TSS concentrations in Dublin Gulch generally coincide with the peak snowmelt month of May or during intense rainfall events. At most other flow periods of the year, TSS

values in Dublin Gulch were generally below the analytical detection limit of 3.0 mg/L. Peak TSS values measured for the period of 2007 to 2016 were 103 mg/L (May 2014) and 37 mg/L (May 2011), respectively.

Nutrients quantified in Dublin Gulch include nitrate (NO₃-), nitrite (NO₂-), ammonia (NH₃), total phosphate (T-PO₄3-), and dissolved orthophosphate (D-o-PO₄3-). In overview, nutrient parameters show low values in Dublin Gulch. Ammonia-N concentrations in Dublin Gulch are low with mean monthly values ranging from <0.005 mg/L to 0.028 mg/L.

Ammonia-N concentrations are expected to remain low in Dublin Gulch due to the low persistence of ammonia in fully oxygenated freshwaters at neutral pH. Similar to ammonia, the majority of nitrite-N values have occurred near or below the detection limit value. Baseline nitrate-N concentrations in Dublin Gulch are also low, with mean monthly values ranging from approximately 0.006 to 0.2 mg/L. Minima are evident during high flow periods, reflecting melt water influences. During lower flow periods, Dublin Gulch is characterized by higher nitrate-N concentrations, again likely reflective of a greater proportion of groundwater derived flow.

Primary productivity in freshwaters is typically limited by available phosphorus. Accordingly, measurements of phosphorus compounds in surface waters can provide an indication of trophic status (i.e., productivity regime). Baseline concentrations for dissolved orthophosphate in Dublin Gulch are low, ranging from approximately <0.0020 to 0.005 mg/L.

Total organic carbon (TOC) reflects a combination of dissolved organic carbon (DOC) and particulate phases associated with both aquatic and terrestrial organic matter. Highest values of TOC and DOC are typically observed during high flow periods, likely reflecting contributions of particulate carbon associated with terrestrial runoff and within-stream re-suspension. In contrast, low and uniform values prevail during low flow conditions, during which time TOC is predicted to be present primarily as dissolved phases. Mean monthly baseflow TOC levels in Dublin Gulch are lowest at W1 (1.0 mg/L) and slightly higher at W21 (1.4 mg/L). Freshet flow TOC levels are higher and typically exceed 10 mg/L.

Baseline trace element concentrations in Dublin Gulch were derived from data collected from August 2007 to July 2016. In general, mean monthly concentrations of total and dissolved trace elements are low (e.g., Sb, Cu, Co, Cr, Pb, Hg, Se, Tl and Zn). However, Dublin Gulch is characterized by elevated total and dissolved As concentrations throughout its reaches with generally low variability in measured concentrations throughout all flow conditions.

Total Al and total Cd are also observed to be elevated during peak flow months; higher total concentrations are associated with elevated TSS levels. Total and dissolved Al values correlate positively with flow and elevated TSS, with dissolved Al reaching a mean monthly maximum of 0.15 mg/L at W1 to 0.17 mg/L at W21 in May. The correlation between dissolved and total fractions strongly suggests that the dissolved Al fraction is governed by colloidal Al hydroxides that are able to pass through a 0.45 µm filter membrane. During non-peak flow periods, dissolved Al concentrations in Dublin Gulch are typically an order of magnitude lower than total concentrations.

It has been speculated that elevated As concentrations in Dublin Gulch are, in part, attributable to historical placer mining disturbance within the Dublin Gulch valley. The current As monitoring data do not support this posit. Station W21 is located at the mouth of Dublin Gulch and downstream of all placer disturbances in the valley. Conversely, station W1 is much further upstream in Dublin Gulch, and while

some minor placer disturbance is noted upstream of W1, by far the majority of placer disturbance is between W1 and W21 at the mouth. Despite the historical placer activity, As concentrations do not increase with increasing distance downstream in Dublin Gulch, suggesting that existing disturbances do not contribute additional As loadings to Dublin Gulch.

3.4.3.2 Eagle Creek Drainage

The major ion chemistry of Eagle Pup and Eagle Creek is described with respect to conductivity, hardness, alkalinity, sulphate and pH. Eagle Pup is characterized by moderately hard to hard waters, with monthly mean hardness values ranging from 94 to 285 mg/L. Hardness values in lower Eagle Creek are slightly lower but are characterized as moderately hard to hard with monthly mean hardness ranging from 83 mg/L to 212 mg/L at station.

Like the other project area streams, values for conductivity, hardness, and alkalinity demonstrate pronounced seasonal fluctuations, with minima coinciding with freshet periods in May and June during peak periods of snowmelt runoff. The pH in Eagle Creek remains relatively uniform throughout the year with values generally ranging between 7.5 and 8.4. Alkalinity values in excess of 150 mg/L are typical and represent significant buffering capacity and dissolution of carbonate mineral phases in the catchment.

Baseline concentrations for sulphate in Eagle Creek are notably higher (e.g., ~60 mg/L during nonfreshet flow conditions) than observed in Dublin Gulch (~20 mg/L) for corresponding flow periods. The higher sulphate concentrations in the Eagle Creek drainage likely reflect the presence and weathering of the low-sulphide Eagle Gold deposit.

TSS concentrations observed in the Eagle Creek drainage were highly variable depending upon location in the catchment. The seasonal TSS signature was similar to that observed in Dublin Gulch, exhibiting higher concentrations in peak freshet months (e.g. 20 mg/L) and much lower concentrations during lower flow periods. Conversely, the highest mean monthly TSS concentrations corresponded to freshet (April/May) as well as summer (e.g. July and August) flow periods. Elevated TSS measurements were documented in Suttles Gulch during 2010 and 2011, and were related to meltwater that originated from the disturbance of permafrost (associated with geotechnical and exploration activities). The meltwater initially developed during summer 2010 and became more extensive during summer 2011. The elevated TSS concentrations in Eagle Creek at station W27 had a significant influence on total trace element concentrations as described below.

Nutrient parameters show low values in the Eagle Creek drainage. Ammonia-N concentrations are low with mean monthly values ranging from <0.005 mg/L to 0.011 mg/L at W9 and <0.005 mg/L to 0.059 mg/L at W27. The majority of nitrite-N values have occurred near or below the detection limit value. Baseline nitrate-N concentrations during low flows in Eagle Creek are higher (e.g. ~0.02 to 0.30 mg/L) than observed in Dublin Gulch (e.g. 0.1 mg/L).

Baseline concentrations for dissolved orthophosphate in Eagle Creek are low, ranging from approximately <0.0020 to 0.005 mg/L. Mean monthly baseflow TOC levels in Eagle Creek are typically 1.0 mg/L to 2.0 mg/L, while freshet flow TOC levels are on the order of 15 to 20 mg/L.

Baseline trace element concentrations in upper Eagle Creek were derived from data collected from July 2009 to May 2013. Characterization of baseline water quality in lower Eagle Creek was developed using

data collected from August 2007 to October 2014. Because of the influence of disturbance in Suttles Gulch, the data from W9 and W27 will be described initially individually below.

Eagle Pup W9

In general, mean monthly concentrations of total and dissolved trace elements in the upper Eagle Creek basin are low, with concentrations of key parameters of interest (e.g. Cd, Cu, Co, Cr, Pb, Hg, Ni, Se, Tl and Zn) measured at, or below, their respective analytical detection limit. However, total and dissolved arsenic concentrations are naturally elevated in the head waters of Eagle Creek. During low flow conditions, total and dissolved As concentrations are similar and typically range between 0.018 mg/L and 0.022 mg/L with dissolved As accounting for over 95% of total As.

Episodic periods of higher flow and elevated TSS values result in elevated total As values that have been observed to range from approximately 0.033 mg/L to values approaching 0.06 mg/L. These brief periods of elevated total As do not translate into higher dissolved As concentrations which show decreased dissolved As concentrations during freshet months (e.g. 0.012 mg/L) and near consistent low flow dissolved concentrations of approximately 0.02 mg/L. The dissolved data suggest that solid-phase As associated with higher TSS is primarily responsible for peak concentrations observed. Although not graphically presented, the periods of elevated TSS also result in higher concentrations of trace elements, namely Al, Cd, Mn and Ag).

Eagle Creek W27

Lower Eagle Creek has experienced periods of very elevated TSS since mid-2010 to present. These periods of elevated TSS result in elevated concentrations of total trace elements, in particular Al, As, Cd, Cu, Pb, Hg, Mn, Ni, Ag and Zn. Total As concentrations during these elevated TSS events can exceed 0.450 mg/L (and is directly attributable to solid-phase As in suspended sediments).

Conversely, dissolved As concentrations, while higher than observed in the upper reaches of Eagle Creek at W9, remain consistently between 0.025 mg/L and 0.036 mg/L (e.g. during winter low flow) and 0.03 and 0.049 mg/L during summer flow periods. Based on these results, baseflow As concentrations in upper Eagle Creek basin are approximately 0.02 mg/L and increase further down the catchment to roughly 0.028 mg/L.

3.4.3.3 Haggart Creek Drainage

Upper Haggart Creek above Dublin Gulch

The major ion chemistry of upper Haggart Creek is described with respect to conductivity, hardness, alkalinity, sulphate and pH. Upper Haggart Creek is characterized by moderately hard to hard waters, with monthly mean hardness values ranging from approximately 63 to 216 mg/L. Like the other project area streams, values for conductivity, hardness, and alkalinity demonstrate pronounced seasonal fluctuations, with minima coinciding with freshet periods in May and June during peak periods of snowmelt-driven runoff. The pH in upper Haggart Creek remains relatively uniform throughout the year with mean values generally ranging between 7.3 and 8.0. Alkalinity values are typically in excess of 85 mg/L suggesting a well-buffered system. Lower alkalinity values are only experienced during freshet periods.

Section 3 Baseline Conditions

Baseline concentrations for sulphate in upper Haggart Creek are notably higher (e.g., ~60 to 93 mg/L) during non-freshet flow conditions as compared to peak snowmelt periods where values typically less than 25 mg/L sulphate are observed. TSS concentrations in upper Haggart Creek exhibit freshet maxima, generally coinciding with the peak snowmelt month of May. At most other flow periods of the year, TSS values in upper Haggart Creek were generally below the analytical detection limit of 3.0 mg/L. The peak TSS value measured for the period of 2007 to 2016 was approximately 80 mg/L.

Nutrient parameters show low values in upper Haggart Creek. Ammonia-N concentrations are low with mean monthly values ranging from <0.005 mg/L to 0.022 mg/L at W22. Similar to ammonia, the majority of nitrite-N values have occurred near or below the detection limit value. Baseline nitrate-N concentrations in upper Haggart Creek are also low, with mean monthly values ranging from approximately 0.03 to 0.16 mg/L. Minima are evident during high flow periods, reflecting melt water influences.

Like other project area streams, baseline concentrations for dissolved orthophosphate in upper Haggart Creek are low, ranging from approximately <0.0010 to 0.0013 mg/L. Mean monthly baseflow TOC levels in upper Haggart Creek are low and generally less than 1.5 mg/L. Freshet flow TOC levels are much higher at approximately 25 mg/L, reflecting the addition of terrestrial-derived runoff and organic detritus.

In general, mean monthly concentrations of total and dissolved trace elements are low for all parameters monitored with the exception of Al, Mn and to a lesser extent Cd during the peak freshet month of May. Most parameters are present at concentrations at or below their respective analytical detection limit. Unlike Dublin Gulch and Eagle Creek drainages, arsenic concentrations in upper Haggart Creek at W22 are low; mean monthly concentrations range from a high of 0.004 mg/L during freshet periods to values typically less than 0.0008 mg/L for the remaining flow periods.

Upper Haggart Creek below Dublin Gulch

The major ion chemistry of Haggart Creek downstream of Dublin Gulch is similar to that observed at above Dublin Gulch with waters characterized as moderately hard to hard. Monthly mean hardness values range from approximately 56 to 209 mg/L with minima coinciding with freshet periods in May and June during snowmelt runoff. The pH is well buffered and relatively uniform throughout the year with values ranging between 7.3 and 8.0. Alkalinity values are lowest in the high flow periods (e.g. approximately 35 mg/L) and greatest in low flow periods (e.g. approximately 120 mg/L).

Sulphate concentrations are slightly lower than observed above Dublin Gulch as a result of the addition of low sulphate loadings from Dublin Gulch. The lowest sulphate concentrations are observed during May and June (e.g. 20 mg/L to 45 mg/L); higher sulphate concentrations are measured during non-freshet flow conditions (e.g. ~60 mg/L to ~90 mg/L).

TSS concentrations are similar to those observed above Dublin Gulch with the exception that higher TSS values below DG occur as a result of suspended solids loadings from Dublin Gulch during peak snowmelt months of May and June. At most other flow periods of the year, TSS values are generally below the analytical detection limit of 3.0 mg/L, with the exception of episodic summer rainfall events that increase suspended sediments loads in the Eagle Creek drainage and to a lesser extent in the Haggart Creek drainage.

Not surprisingly, nutrient parameters in Haggart Creek below Dublin Gulch are low with ammonia-N, nitrate-N and orthophosphate values being very similar in concentration to those observed in Haggart Creek above Dublin Gulch.

Trace element concentrations are very similar to those observed above Dublin Gulch with the sole exception of As. Specifically, mean monthly concentrations of total and dissolved trace elements are low for all parameters monitored with the exception of Al, Mn and to a lesser extent Cd during the peak freshet month of May. Arsenic concentrations are roughly four times that observed above Dublin Gulch. The reason for the increased As concentrations is due to significant natural As loadings entering from Dublin Gulch. Winter low flow mean monthly As concentrations range from 0.0013 mg/L to 0.0018 mg/L (December to March) to summer flow concentrations of approximately 0.0042 mg/L. 95th percentile values for total As for the same winter low flow and summer low flow conditions range from 0.0015 mg/L to 0.0025 mg/L and from 0.0044 mg/L to 0.0061 mg/L, respectively.

Haggart Creek below Eagle Creek

Haggart Creek below Eagle Creek is characterized as moderately hard to hard water. Monthly mean hardness values range from approximately 67 to 232 mg/L with minima coinciding with freshet periods in May and June during snowmelt runoff. Hardness values and alkalinity are slightly higher in this location relative upstream in Haggart Creek; the greater alkalinity and hardness in the section below Eagle Creek is a result of Ca, Mg inputs from Eagle Creek. The pH in Haggart Creek at below Eagle Creek is well buffered and relatively uniform throughout the year with values ranging between 7.4 and 8.1. Alkalinity values are lowest in the high flow periods (e.g. approximately 40 mg/L) and greatest during low flow periods (e.g. approximately 130 mg/L).

Sulphate concentrations are slightly higher than observed at the Haggart Creek segment below Dublin Gulch for the low flow months (e.g. January to April) and reflect higher sulphate loadings from Eagle Creek. During peak flow periods, sulphate concentrations in Haggart Creek from are not significantly different moving downstream and typically range from approximately 20 mg/L to 60 mg/L.

TSS concentrations are higher than those observed upstream during the peak flow periods and likely reflect the higher TSS loadings associated with Eagle Creek, particularly since 2010 (Appendix A2 of Lorax 2017b). At most other flow periods of the year, TSS values are generally below the analytical detection limit of 3.0 mg/L with the exception of episodic summer rainfall events that increase suspended sediments loads in the Eagle Creek drainage and to a lesser extent in the Haggart Creek drainage.

Nutrient parameters are low with ammonia-N, nitrate-N and orthophosphate values being very similar in concentration to those observed in Haggart Creek above Dublin Gulch.

Water quality in Eagle Creek has a notable influence on water quality conditions in Haggart Creek below Eagle Creek. The high TSS loadings occurring in Eagle Creek, particularly during freshet conditions, result in elevated concentrations of total trace elements, in particular Al, As, Cd, Cu, Pb, and Mn. The most significant trace metal increases are associated with total arsenic. Total As concentrations are typically greater below Eagle Creek as compared to above Dublin Gulch during most flow periods of the year and can be particularly elevated during peak flow events. As with the other trace metal parameters, the elevated total As concentrations can be associated with the increased TSS loadings derived from Eagle Creek.

Mean As concentrations were calculated using all monitoring results for each station. Mean arsenic concentrations in Haggart Creek above Dublin Gulch (0.0009 mg/L) increase to values of approximately 0.0038 mg/L downstream following inputs from Dublin Gulch. Below Eagle Creek, mean arsenic concentrations in Haggart Creek increase to values of approximately 0.006 mg/L. Farther downstream,

mean arsenic concentrations decrease to values of roughly 0.0045 mg/L. Although Lynx Creek is an undisturbed catchment, arsenic is also naturally elevated in drainage waters with a mean arsenic concentration of 0.0064 mg/L and as a result, arsenic concentrations below the confluence with Lynx Creek, are observed to increase to 0.0056 mg/L.

3.5 GROUNDWATER

Hydrogeologic baseline characterization studies conducted from 2009 to 2012 and previous investigations conducted in 1995 and 1996 (GeoViro 1996 and Knight Piésold 1996a, b, c) are summarized in Stantec (2011e and 2012d) and BGC (2013a). Material property data available for the Project comprises results of packer tests, slug tests and pumping tests from drilled bore holes and wells at site. Hydraulic head data (instantaneous and continuous) has been collected from 104 monitoring wells, standpipe piezometers, vibrating wire piezometers, and aquifer test wells (Stantec 2010c, BGC 2012e, BGC 2012f and BGC 2013b), located across eight different sub-basins that include Bawn Boy Gulch, Olive Gulch, Stewart Gulch, Eagle Pup, Suttles Gulch, Platinum Gulch, Dublin Gulch, and Ann Gulch. In addition, since 2009 water quality data has been collected on a regular basis from 18 of the site monitoring wells in these same sub-basins. The groundwater level and groundwater quality data collection program that began in 2009 is still on-going. The data obtained has been used to identify local groundwater recharge and discharge zones, groundwater flow patterns, characterize groundwater quality and to develop a numerical hydrogeological model (BGC 2014).

3.5.1 Hydrogeologic Setting

There are two principal water-bearing units in the project area: deeper relatively low permeability bedrock and the near-surface moderately permeable surficial deposits. Surficial material at the Project site consists of a thin veneer of organic soils underlain by colluvium (i.e., a loose heterogeneous mass of soil material), glaciofluvial deposits (i.e., originating from rivers associated with glaciers), or till (a glacial deposit). Below these clastic (i.e., transported broken fragments of rock) units are either metasedimentary or granodiorite bedrock, which is deeply weathered in places. The elongated granodiorite stock (ore bearing unit) has intruded the surrounding host metasediment. The surficial material thickness and physical properties varies significantly throughout the area.

The Dublin Gulch valley contains large amounts of fluvial materials that were considerably reworked by placer mining operations. Extensive stockpiles of placer deposits comprised of sub-rounded metasediment and granodiorite clasts, ranging in size from sands to boulders, and fine-grained material (i.e., that are located in former placer settling ponds) are present adjacent to the Dublin Gulch and Eagle Creek watercourses. A till blanket covered with a colluvial veneer is located along the south valley wall in Dublin Gulch valley and extends southward in the Haggart Creek valley. A recent alluvial fan is present where Dublin Gulch meets Haggart Creek. Discontinuous permafrost is also present, especially on the north-facing slopes and affects the connectivity between the deep and shallow water-bearing zones in places. Further details of the spatial distribution and characteristics of surficial materials are found in Stantec (2011b).

3.5.2 Groundwater Occurrence

Generally groundwater has been observed deeper (approximately >6 m below ground) at higher elevations and shallow to artesian in lower elevations and in valley bottoms. Springs and seeps have

been observed in a few locations where valley bottoms have narrowed. These are typically associated with the re-emergence of a stream from channel deposits (i.e., a gaining reach). In these instances (e.g., Eagle Pup, Stewart Gulch), thin alluvium overlying shallow bedrock is the likely cause of the emergence. The interpreted piezometric surface appears to generally mimic the surface topography (see Figures 3 and 4 in BGC 2013a). Groundwater elevation data from the 2009-2013 exhibit common seasonal trends in all monitored locations, characterized by relatively high water levels corresponding to spring freshet and fall precipitation events, and relatively low water levels related to dry summer and frozen winter conditions. Small but discernible responses to precipitation events were observed in the wells with continuously recording dataloggers.

3.5.3 Groundwater Flow

Groundwater flow in the bedrock occurs in fractures and fault zones, while preferentially flowing through more permeable (and porous) sediments within the surficial deposits. General orientation of groundwater flow contours mimic the topography of the site as groundwater flows from the highest to lowest areas. Throughout most of the project area the groundwater divides of each sub-basin approximately coincide with the surface water divides. In the lower Dublin Gulch valley the groundwater divide between the Eagle Creek and Dublin Gulch basins in the placer tailings is not clearly defined. Field observations suggest that at times the divide migrates across the valley so that groundwater from the Dublin Gulch basin may flow towards Eagle Creek or vice versa. This shifting is seasonal and also due in part to the variability in the timing of the freshet and/or rainfall events across the entire watershed.

Groundwater recharge occurs at higher elevations throughout the Dublin Gulch-Eagle Creek drainage basin and ultimately discharges to surface water (in some cases as seeps and springs) at lower elevations in the valley or directly to surface streams, or ultimately into Haggart Creek. The main groundwater flow in conjunction with the highest groundwater elevations is expected to occur during the snowmelt in late spring (i.e., May to June) after thawing of the shallow sediment.

Data from nested well pairs or vibrating wire piezometer nests indicate upward or near neutral gradients in the lower Dublin Gulch valley and a mix of near neutral, downward and upward gradients in the upper reaches of Bawn Boy or in the Open Pit area. In some cases, gradient plots indicate both positive and negative gradients exist within the same profile, which may be due to anisotropy within the bedrock, and/or possible fracture controls on groundwater flow.

3.5.4 Surface Water - Groundwater Connectivity

Streamflow is generally composed of rainfall runoff and groundwater base flow. Groundwater contributes to stream flows where the groundwater table elevation intersects the ground surface. Typically these intersections are located in stream channel inverts (e.g., Eagle Pup appears in mid-valley where the valley is well confined by bedrock); however, they also appear as seepage from slopes within the placer deposits of the lower Dublin Gulch valley. Groundwater from the lower Dublin Gulch valley likely contributes a measureable portion of the baseflow to Haggart Creek. The baseflow contributions to the streams maintain flow in the larger creeks during the drier months of the year (including winter flows). The connectivity between surface water and groundwater is described and evaluated in detail in the numerical hydrogeologic model (BGC 2014).

3.5.5 Groundwater Flow Properties

Estimates of hydraulic conductivity in the overburden materials are based on 12 recovery tests carried out in colluvium, till, placer, and fluvial materials and three pumping tests conducted in the lower Dublin Gulch valley aquifer. Results for all testing range from 4×10^{-7} to 4×10^{-3} metres per second (m/s) at depths less than 35 m below ground. The hydraulic conductivity of the colluvial, alluvial, and till deposits was generally higher than that of the placer material, and also higher than the bedrock.

The bedrock hydraulic conductivity dataset includes over 80 packer tests and recovery tests conducted in over 50 boreholes and six pumping tests. Results of the pumping tests are typically considered to be more representative of the larger scale (bulk) hydraulic conductivity of the rock mass. Results of the 1996 pumping tests conducted at depths less than 55 m yielded hydraulic conductivity values ranging from 3×10^{-7} m/s to 5×10^{-7} m/s. Mean results of the two pumping tests conducted in bedrock in 2011 were 8×10^{-6} m/s in the lower valley and 9×10^{-8} m/s in the Open Pit area at depths up to 100 m and 140 m below ground, respectively. Results from the 2012 testing in the lower Dublin Gulch valley bedrock aquifer are about an order of magnitude higher (9.0×10^{-5} m/s) than results from 2011 testing; however, these results are specific to an 18 m thick zone targeted by the well, whereas the 2011 well was tested over a thicker (37 m) zone.

Generally, the hydraulic conductivity of the intrusive units and metasediments is similar and tends to decrease with depth, although considerable variation in results is apparent for each unit at any given depth. The general trend of decreasing hydraulic conductivity is common in bedrock settings as described by Rutqvist and Stephansson (2003).

3.5.6 Groundwater Quality

3.5.6.1 General Characterization

Groundwater quality data has been previously summarized in Stantec (2012d), which includes the most comprehensive data summary of 1996-2011 data, and BGC (2013a) which provides an update through 2012. The data suggests that the chemical composition of groundwater in the project area depends on the local and up-gradient rock-types. Groundwater quality data have been collected for many areas of the site including in Eagle Pup, Dublin, Suttles, Ann, Stewart, Olive, Bawn Boy and Platinum Gulches. The parameters analyzed included dissolved and total metals, nutrients, anions and other general parameters.

The groundwater samples were classified based on their major ion chemical composition, taking into account the major anions and cations. Calcium is the dominating cation in most groundwater samples from the site; however, in some sampling locations magnesium concentrations exceeded calcium. Carbonate was the dominating anion in all samples, and was particularly high in some samples.

The following parameters exceeded the Canadian Council of Ministers for the Environment (CCME) and/or Contaminated Sites Regulation (CSR) guidance parameters in the Project area: aluminum, arsenic, cadmium, copper, iron, lead, molybdenum, nickel, selenium, silver, and/or zinc. The CSR guideline values apply to both surface and groundwater, whereas the CCME guidelines only apply to surface water. However, as groundwater ultimately discharges to surface water bodies, the CCME guideline values are included here for reference.

Comparison of groundwater quality data to current Yukon CSR AW standards (for protection of freshwater aquatic life) identified dissolved arsenic exceedances in all Project sub basins. Arsenic concentrations in Ann Gulch, Suttles Gulch and Eagle Pup were 3 to 70 times higher than the CSR AW standard; whereas, arsenic concentrations in Platinum Gulch were 160 to 200 times higher than the CSR AW standard.

The highest dissolved arsenic concentrations reported in the project area occurred consistently in Platinum Gulch and ranged between 8 and 10 mg/L. These concentrations were approximately two times higher than dissolved arsenic values reported in a well in Dublin Gulch and approximately ten to one hundred times higher than concentrations reported in all other project sub-basins. No discernible correlations were interpreted between dissolved metals and geological strata. CSR AW dissolved arsenic exceedances were reported in monitoring wells screened in both unconsolidated sediments and bedrock.

The exceedances do not imply that the groundwater at the site is currently contaminated; only that background concentrations of these parameters are higher than typically found in other natural sites in Canada and merely reflect the natural geologic and hydrogeologic conditions within these specific areas of the project area.

Comparison of the multiple years of groundwater data indicated that groundwater quality parameters were generally in the same range and that seasonal trends were not apparent over the years sampled.

3.5.6.2 Statistical Characterization

A comprehensive characterization of background groundwater quality was completed by CoreGeo/Watterson (2017) in accordance with Clause 158 of Victoria's Water License QZ14-041. The assessment included a statistical analysis of all available groundwater quality data from the Eagle Gold project area up through 2015. In keeping with the rationale described within the Reasons for Decision document, and the methods described within CSR Protocol No. 10, background groundwater quality values at the 95th percentile were determined. Also, to help characterize the data across the site, groundwater quality data are presented and described by sub-basin and on a site-wide basis.

The following points summarize the results and conclusions of the statistical characterization:

- The quality and character of groundwater data (in terms of spatial coverage, multiple sampling events over a range of seasons and times of the year, consistency in sampling technique and analytical laboratory) meets or exceeds the requirements established in Protocol No. 10, where applicable.
- Stantec (2012d) and BGC (2013a) concluded that, in general, there were no discernible effects from well completion zone or seasonality in the data.
- Background concentration calculation and presentation methods are intended to illustrate groundwater quality variation at the site and to provide a baseline for future evaluation of groundwater data.
- Background POI concentrations (95th percentiles) demonstrated a high degree of spatial variability at the sub-basin and site-wide scales.

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- Except for cyanide during the 1995-96 sampling events, the site-wide background concentrations of all general chemistry parameters did not exceed applicable CCME-FAL guideline values for these parameters.
- Although site-wide background calculations may provide a useful overall reference, significant variation in background concentrations between sub-basins for some elements indicates that the site-wide background values may not be the best representative value in all situations.
- A comparison between total and dissolved background concentrations demonstrated the role that turbidity and TSS has on the overall sample results, especially when TSS is greater than 100 NTU for the common rock forming elements (i.e., aluminum, iron). For the most part, total water chemistry data was suitable to support background parameter calculations; however, where wells produce samples with elevated turbidity or TSS, dissolved parameters may provide a better comparison with guidelines especially with respect to toxicity for aquatic life.

4 DESIGN BASIS AND CRITERIA

4.1 STORM WATER DESIGN CRITERIA

For the purpose of this Plan, the Project area has been subdivided into a number of hydrologic watersheds and sub-watersheds, as shown on Figure 4.1-1. These watershed boundaries shown in the figure are based on the proposed end of mine topography. During construction and particularly prior to installation of collection ditches, some of the watershed areas are larger than the areas shown on Figure 4.1-1. Therefore, to ensure that the corresponding conveyance and storage structures are capable of routing runoff during the entire life of the Project, they were sized to their largest respective contributing area.

A risk-based approach is used to select appropriate design storm events for water management facilities. This approach weighs the likelihood of failure, versus the consequence of failure, on a case-specific basis. Design storm events are developed by assessing the annual recurrence of precipitation events of a given magnitude, as described in Section 3.

Design storm events are used as input parameters in most rainfall-runoff type storm water models (e.g., HEC-HMS, PCSWMM and, TR-55). Design criteria for various design elements are listed in Table 4.1-1.

Table 4.1-1: Design Criteria

Infrastructure Element	Design Element	Design Basis Criteria
Unlined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Maximum Depth (mm): Type 1 or 2	300
	Minimum Width (mm): Type 2	500
	Minimum Grade (%): Type 1 or 2	1.00
	Maximum Grade (%): Type 1 or 2	1.70
	Maximum Side Slopes: Type 1 or 2	3H:1V
	Maximum Velocity (m/s): Type 1 or 2	1.5
Lined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Design Storm Event (above major infrastructure)	1 in 100-year
	Maximum Depth (mm)	500
	Minimum Grade (%): Type 3 / Type 4	1.00 / 0.50

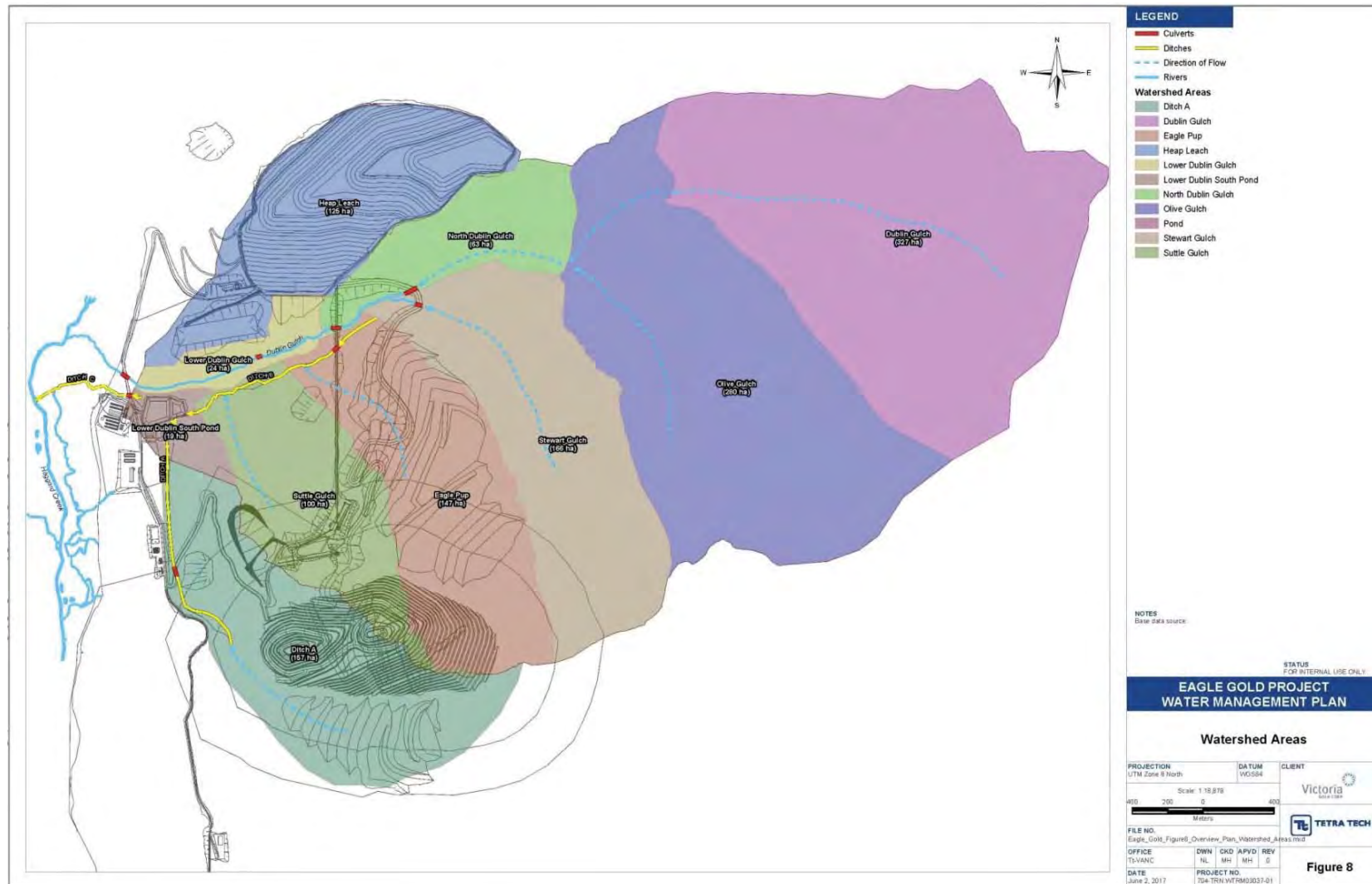
Section 4 Design Basis and Criteria

Infrastructure Element	Design Element	Design Basis Criteria
	Maximum Grade (%): Type 3 / Type 4	4.5 / 15
	Maximum Side Slopes: Type 3 / Type 4	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): Type 3 / Type 4	2.33 / 4.0
Culverts	Minimum Diameter (mm)	750
	Design Storm Event (Areas < 1 ha)	1 in 10-year, 24-hour
	Design Storm Event (Areas > 1 ha)	1 in 100-year, 24-hour
	Design Storm Event (at stream conveyances)	1 in 200-year, 24-hour
	Design Storm Event (downstream of the Lower Dublin South Pond)	1 in 1000-year, 24-hour
	Maximum HW/Diameter Ratio	2.0 for less than 1.0 m 1.5 for greater than 1.0 m
	Minimum Grade (%)	0.5
	Minimum Velocity (m/s)	1.0
	Maximum Velocity (m/s)	4.0
Temporary Sediment Control Ponds and Exfiltration Areas	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 100-year, 24-hour
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (100-year event)	0.5
Permanent Sediment Control Ponds	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 200-year, 24-hour
	Design Storm Event (overflow)	1 in 1000-year, 24-hour

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Infrastructure Element	Design Element	Design Basis Criteria
	spillway – dam)	
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (200-year event)	0.5
	Dewatering (pumping capability)	Full Dewater in 24 hours

Figure 4.1-1: Overview Plan Watershed Areas



Source: EBA (2017)

4.2 SEDIMENT AND CONTROL EROSION

Sediment and erosion control measures will be implemented and maintained to prevent the discharge of sediment-laden water to the receiving environment. The BMPs described below are shown on Figure 4.2-1 to Figure 4.2-3 and will be required during construction as well as during operations. Implementation of BMPs is described in Section 6.

4.2.1 Sediment and Erosion Sources

Construction and operation activities that have the potential to result in erosion and sedimentation include the following.

- Vegetation clearing and topsoil stripping.
- Excavation, grading and filling.
- Stockpiling of topsoil and waste rock.
- Management of ice-rich material.
- Construction and maintenance of roads and infrastructure.

Potential effects from the above activities in the absence of planned mitigation measures include:

- Increased surface erosion from disturbed and rehabilitated areas
- Increased sediment load entering the natural water system
- Siltation or erosion of ditches, culverts, and watercourses
- Damage to existing roadways and embankments, i.e. rutting, scouring, or potholing

The Plan addresses the above potential hazards to ensure effective management of surface water and sediment-laden runoff during construction and operational stages. Sediment mobilization and erosion can best be minimized by using the following measures.

- Limiting the extent of land disturbance to the practical minimum
 - Reducing water velocities across the ground using soil bioengineering, surface roughening, sediment logs, and re-contouring, particularly on exposed surfaces and in areas where water concentrates
 - Concurrently reseeding disturbed land and constructing drainage controls to improve the stability of rehabilitated land
 - Protecting natural drainages and watercourses by constructing appropriate sediment control devices such as collection and diversion ditches, sediment traps, in-channel energy dissipaters, and sediment basins
 - Installing rock riprap, channel lining, sediment filters or other suitable measures in ditches on steep gradients, as required
 - Restricting access to re-vegetated and stabilized areas
-

- Constructing collection and diversion ditches to intercept surface runoff
- Directing all sediment-laden runoff to the appropriate sediment control measure
- Constructing appropriate temporary BMP measures (e.g., silt fences, hay bales) downslope of disturbed sites (where more permanent sediment control measures are not appropriate, or in combination with more permanent measures)
- Implementing soil bioengineering techniques to contain sediment and enable disturbed surfaces to recover.

Installation of temporary erosion and sediment control features or “BMPs” will be the first step towards controlling erosion and sedimentation during construction. All temporary sediment and erosion control features will require regular maintenance and inspection after each significant rainfall. These temporary features will be removed after achieving soil and sediment stabilization. Typical sediment and erosion design elements and BMPs are described in the following section.

4.2.2 Best Management Practices

Erosion control BMPs reduce erosion by stabilizing exposed soil or reducing surface runoff flow velocity. There are generally two types of erosion control BMPs:

- Source control BMPs for protection of exposed surfaces, and
- Conveyance BMPs for control of runoff and reduction/capture of sediment.

Erosion control BMPs will be implemented prior to and during construction to minimize erosion and sediment discharge into surrounding areas.

Descriptions of the planned BMPs are provided below.

4.2.2.1 Vegetation Management

Natural vegetation is one of the best and most cost effective methods of reducing the potential for erosion and sedimentation. Vegetation keeps soil secure, and leaves and ground cover absorb raindrop velocities. In order to preserve vegetation, it is recommended to maintain “no-entry” vegetation buffers to prevent excess clearing, particularly around water bodies, prior to clearing vegetation from surrounding areas. If preserving natural vegetation is not a viable option, cleared areas that will not include infrastructure will be re-seeded as soon as practical after construction activities have ended in the area accounting for seasonal constraints.

4.2.2.2 Soil Bioengineering

Soil bioengineering is the use of plant materials to perform engineering functions such as bank protection, erosion protection, drainage, and slope stabilization (Polster 2002). Some typical techniques include:

- Sediment log fences
- Live bank protection
- Live palisades

Sediment log fences are used on over-steepened slopes where the incline prevents successful growth of vegetation. Sediment logs are placed on the slopes to create terraces, which slows the velocity of water, and holds the soil in place in order to encourage vegetation growth.

Live bank protection is generally used in streams for habitat restoration, but the technique can be transferred to constructed ditches. Sediment log fences using cut plugs and live cuttings are installed on the banks of the ditch, which become stabilized once the live cuttings sprout and grow.

The live palisades technique involves installing large cottonwood (poplar) posts in trenches adjacent to eroding stream beds where the natural vegetation has been compromised. The cottonwood will root along its entire buried length producing a dense cylinder of roots.

These techniques prevent the creation of smooth, hard surfaces, which tend to encourage increased velocities and thus increased erosion potential. USDA (1992) provides useful application and construction guidelines for various bioengineering techniques.

4.2.2.3 Mulching

Mulching is the application of a uniform protective layer of straw, wood fiber, wood chips, or other acceptable material on, or incorporated into, the soil surface of a seeded area to allow for the immediate protection of the seed bed. The purpose of mulching is to protect the soil surface from the forces of raindrop impact and overland flow, foster the growth of vegetation, increase infiltration, reduce evaporation, insulate the soil, and suppress weed growth. Mulching also helps hold fertilizer, seed, and topsoil in place in the presence of wind, rain, and runoff, while reducing the need for watering.

Mulching may be utilized in areas that have been seeded either for temporary or permanent covers. There are two basic types of mulches: organic mulches and chemical mulches. Organic mulches may include straw, hay, wood fiber, wood chips and bark chips. This type of mulch is usually spread by hand or by machine (mulch blower) after seed, water, and fertilizer have been applied. Chemical mulches, also known as soil binders or tackifiers, are composed of a variety of synthetic materials, including emulsions or dispersions of vinyl compounds, rubber, asphalt, or plastics mixed with water. Chemical mulches are usually mixed with organic mulches as a tacking agent to aid in the stabilization process, and are not used as stand-alone mulch, except in cases where temporary dust and/or erosion control is required.

Hydroseeding, sometimes referred to as hydromulching, consists of mixing a tackifier, specified organic mulch, seed, water, and fertilizer together in a hydroslurry and spraying a layer of the mixture onto a surface or slope with hydraulic application equipment. The choice of materials for mulching will be based on soil conditions, season, type of vegetation, and the size of the area.

4.2.2.4 Rolled Erosion Control Products

Roller erosion control products (RECP) are geosynthetic or organic materials composed of two layers of coarse mesh that contain a central layer of permeable fibers in between. These products take the form of flexible sheet materials that are often composed of organic materials that decompose over time. When intended for long-term use, RECPs are made from UV-stable synthetics such as polypropylene. RECPs may be used to cover un-vegetated cut or fill slopes in order to provide erosion control when seeding or mulching alone is unsuccessful. RECP sheets must be anchored with special stakes or rocks and must be in direct, tight contact with the soil surface in order to perform effectively.

4.2.2.5 Surface Roughening

Cut and fill slopes will be roughened with tracked machinery or by other means, to reduce runoff velocity, increase infiltration, reduce erosion, and to aid in the establishment of vegetative cover. Roughening will typically be carried out by a tracked machine moving up and down the slope, creating undulations on the soil surface parallel to the contour. This procedure is simple, inexpensive and provides immediate short-term erosion control for bare soil, where vegetative cover is not yet established. Compared to hard, compacted smooth surfaces a rough soil surface provides more favorable moisture conditions, which will aid in seed germination. Surface roughening works best on flat and moderately sloped areas.

4.2.2.6 Re-contouring

Re-contouring the soil surface can also reduce the effect of erosion by shortening the length of the accumulation and movement of water as well as decreasing its slope. Creating undulations or troughs will also reduce overland water movement velocity. These types of improvements are beneficial as they are easily planned and constructed on site. However, both surface roughening and re-contouring are only semi-permanent erosion control methods and more permanent structures may be needed over time.

4.2.2.7 Silt Fencing

Silt fencing is a perimeter control used to intercept sheet flow runoff and used in conjunction with other BMPs. Typical silt fencing comprises a geotextile fabric anchored to posts driven into the ground. Silt fencing promotes sediment control by filtering water that passes through the fabric and increases short term detention time, allowing suspended sediments to settle. A typical silt fence installation is shown on Figure 4.2-1.

Silt fences will be placed parallel to slope contours in order to maximize ponding efficiency. Barrier locations are informally chosen based on site features and conditions (e.g., soil types, terrain features, and sensitive areas), design plans, existing and anticipated drainage courses, and other available erosion and sediment controls. Typical barrier sites are catch points beyond the toe of fill or on side slopes above waterways or drainage channels. Silt fences are not recommended for wide low-flow, low-velocity drainage ways, for concentrated flows, in continuous flow streams, for flow diversion, or as check dams. Silt fencing will be installed per the manufacturer's specifications and as detailed on Figure 4.2-1.

All silt fences shall be inspected and maintained following major rainfall events. Proper installation and frequent maintenance is required for effective sediment control.

4.2.2.8 Temporary Sediment Traps and Sediment Basins

A sediment trap/basin is a temporary structure that is used to detain runoff from small drainage areas (generally less than 2 hectares [ha]) to allow sediment to settle out. Sediment traps/basins will be located in areas where access can be maintained for sediment removal and proper disposal. A sediment trap/basin can be created by excavating a basin, utilizing an existing depression, or constructing a dam on a slight slope downward from the work area. Sediment-laden runoff from the disturbed site is conveyed to the trap/basin via ditches, slope drains, or diversion dikes. The trap/basin is a temporary measure, and is to be maintained until the site is permanently protected against erosion by vegetation and/or structures.

Temporary sediment traps and sediment basins will be constructed at the end of smaller collection ditches to detain sediment-laden runoff long enough to allow sediment to settle out. The size of the temporary sediment trap/basin is dependent on the ditch design flows. The exact locations and final geometry of each trap will be field fitted to integrate with the terrain to minimize disturbance. The engineer of record or construction manager shall review and approve the sizing and location of these basins prior to construction. The sediment traps/basins will be inspected regularly, if the sediment trap/basin has accumulated sediment and/or debris, the trap will be cleaned to restore design capacity.

Two sizes of sediment basins designated SB1 and SB2 have been developed for the site and will be used for different size drainage areas. The sizing and dimensions of the two sediment basins are summarized Table 4.2-1.

Table 4.2-1: Temporary Sediment Basin Design Specifications

	Sediment Basin size 1	Sediment Basin size 2
Drainage Area (hectares)	<1	1 - 2
Width (m)	10	12
Length (m)	20	25
Depth of Wet Storage (m)	1	1
Minimum Spillway Weir Length (m)	2	4

The width and length dimensions correspond to the top of the wet storage area, at the base of the outlet structure.

4.2.2.9 Filter Bags and Geotubes

Filter bags are generally constructed from a sturdy non-woven geotextile capable of filtering particles larger than 150 microns. Filter bags are typically installed at the discharge end of pumped diversions, via fabric flange fittings, to remove fine grained materials before discharging to the environment.

If necessary for fine grained materials, filter bags shall be installed on flat, stable, non-erodible foundations, or in well vegetated areas. The pumping rate shall be no greater than specified by the manufacturer. Discharge from filter bags will be routed to lined areas (i.e., rock aprons, riprap, etc.) to reduce water velocity and minimize erosion.

A smaller variety of filter bags, referred to as filter socks, can be installed on the discharge ends of gravity flow pipes, such as slope drains, to filter silt particles before discharging to the environment.

Filter bags shall be maintained in the following manner.

- Inspected daily for defects, rips, tears, sediment accumulation, and erosion of the surrounding area.
- When sediment fills one half of the volume of the filter bag, the filter bag shall be removed from service and replaced.

Spare bags shall be kept nearby to minimize time required to recommence pumping activities. Once the used bag is fully drained, the bag and its contents can be deposited in the reclamation material storage areas for use as cover materials during mine closure, or disposed of in the on-site landfill.

Geotubes can be used as part of a dewatering system to separate and contain solids in sediment-laden water. The system is composed of a geosynthetic tube, which is available in various sizes, and an injection port. The sediment-laden water is pumped or directed via gravity into the geotube until full. Clean water drains through the pores of the engineered textile, which allows the solids to consolidate inside the geotube. Once the apparatus is full of solids, it can be disposed of at a landfill or the solids can be removed and used on site.

4.2.2.10 Flocculants

The term flocculation is used to describe the aggregation of small particles clumping together and settling out of suspension. In sediment and erosion control applications, flocculation is achieved with the use of chemical or natural additives (e.g., corn starch, chitosan, guar gum). A flocculant dosing system is typically installed at the inlet to a sedimentation pond, which allows the flocculation process to begin immediately upon discharge to the pond. The flocculants accelerate the natural settling process as the sediment-laden water flows through the pond, and therefore the required pond detention time is reduced. Additionally, flocculants can be added at specific points along collection ditches to initiate the settling process prior to arrival at the water management pond. This system may be beneficial in steep topographic areas where:

- The calculated surface area for the design particle size is not practical
- Where the clay component is high, as clay soil types have a lower settling velocity than other particles.

If site conditions necessitate the use of flocculants, SGC intends to use only products from the high molecular weight anionic polyacrylamides (or PAMs) group of flocculants, and that are non-toxic to fish to settle sediment in sediment control ponds or sediment basins subject to conditions identified in this licence. There is a wide range of anionic PAMs available for water clarification and erosion control. The methods used to identify the flocculants to be used for this project are described in the Flocculant Use Plan (Appendix B).

4.2.2.11 Ditches

Strategically placed ditches and runoff collection structures can help direct water movement, which in turn limits erosion. Large collection ditches (i.e., Ditches A, B and C) are placed at the downslope perimeter of development activities, while smaller collection and diversion ditches are used to direct flow to the main catchment ditches. Cut and fill slopes created during construction leave long runs of exposed soils that are prone to erosion. A ditch placed above the cut slope will intercept water and direct it to less erosion prone areas. Coarse rock to build ditches and dams is easily obtained on site, and require little further maintenance, making them effective improvements. Typical collection and diversion ditches (two types) are shown on Figure 4.2-2. A corrugated metal half-pipe (CHP) will be used in terrain that is steeper than 15%, as the velocities at such slopes are too high for practical riprap channel protection. Minimum diameter of CHP is 1.0 m, as shown Figure 4.2-2.

4.2.2.12 Collection Ditches

A collection ditch intercepts sediment-laden water runoff from disturbed areas and diverts it to a stabilized area where it can be effectively managed. Collection ditches are used within construction areas to collect

runoff and convey it to the appropriate sediment control measures. General locations and conditions may include the following.

- Below disturbed existing slopes to divert sediment-laden water to control facilities.
- At or near the perimeter of a construction area to prevent sediment-laden runoff from leaving the site.
- Below disturbed areas before stabilization to prevent erosion.

The ditch designs will be based on steady, uniform flow analysis.

4.2.2.13 Diversion Ditches

Diversion ditches will be constructed up-gradient of disturbed areas to intercept clean surface water runoff. A diversion ditch is a channel lined with vegetation, riprap, or other flexible, erosion resistant material. The main design considerations are the design flow and velocity of the water expected in the channel. All diversion ditches have been designed to carry the appropriate peak flow. All diversion ditches will discharge through a stabilized outlet designed to handle the expected runoff velocities and flows from the ditch without scouring. The selection of a type of lining will be based upon the design flow velocities.

4.2.2.14 Culverts

In general, while variations may occur due to site-specific conditions, it is assumed that culverts will be installed at a slope of 2% with an inflow along a smooth headwall. A small energy dissipater or stilling basin will be constructed upstream of each culvert to reduce sedimentation. The culvert will consist of corrugated metal pipe or corrugated polyethylene tubing installed according to the manufacturer's specifications to accommodate the anticipated vehicle loading and to prevent crushing. Standard culvert details can be seen in Figure 4.2-1 and Figure 4.2-2.

4.2.2.15 Exfiltration Areas

An exfiltration area is used to treat sediment-laden water by detention in an area that is not lined, and which allows the water to filter through the natural ground surface leaving the sediment behind. This process provides complete capture of the sediment as it filters the water only and does not allow for any additional outflows such as riser pipes and/or spillways, which are commonly used in sediment ponds/basins.

Where feasible, exfiltration areas will be designed to detain the 10-year 24-hour storm event. The hydraulic conductivity of surficial material on site ranges from 10^{-3} to 10^{-7} m/s. A value of 10^{-7} m/s is used for the design of the exfiltration areas.

Section 4 Design Basis and Criteria

Figure 4.2-1: Culvert Sections and Details

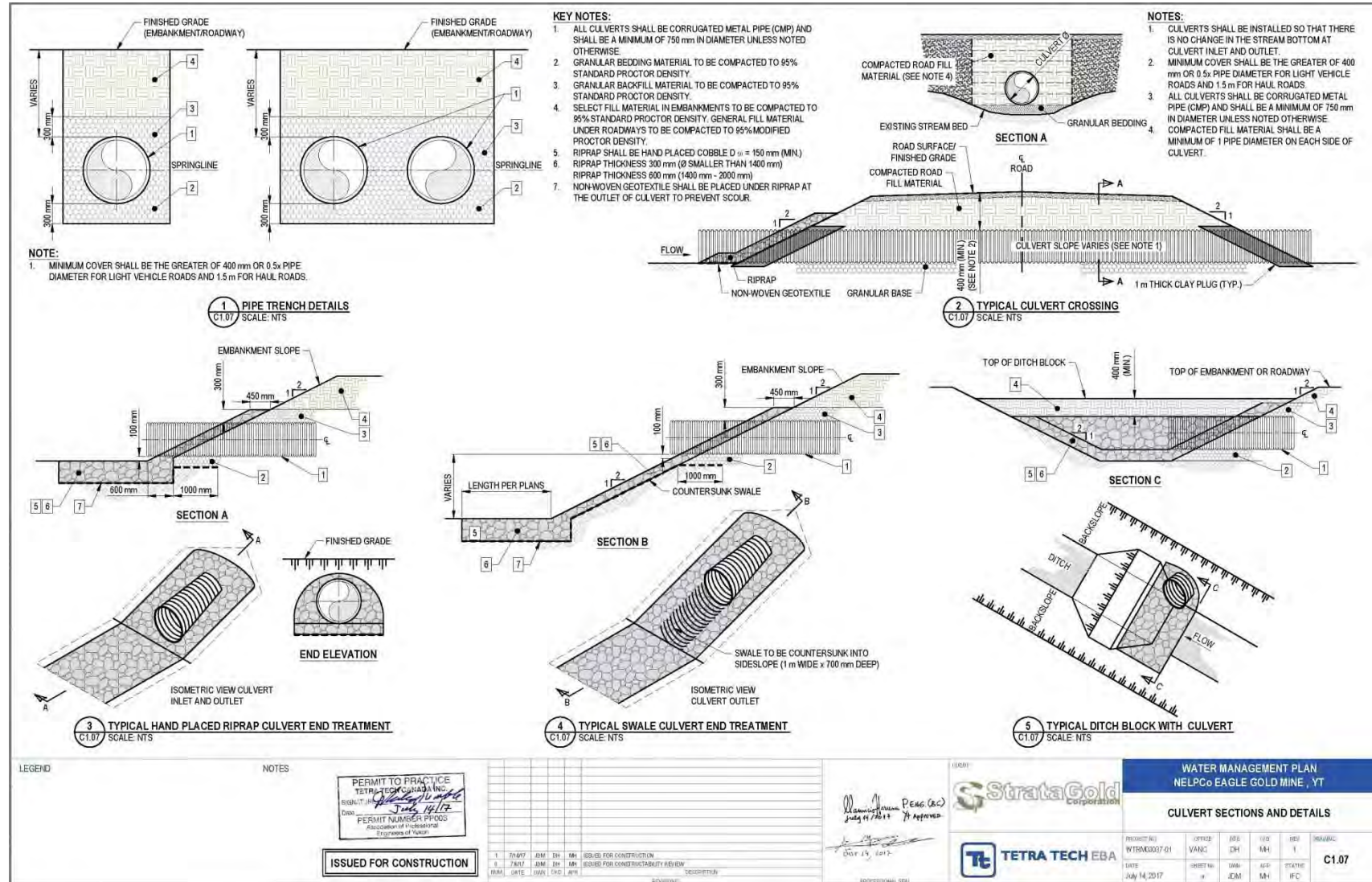
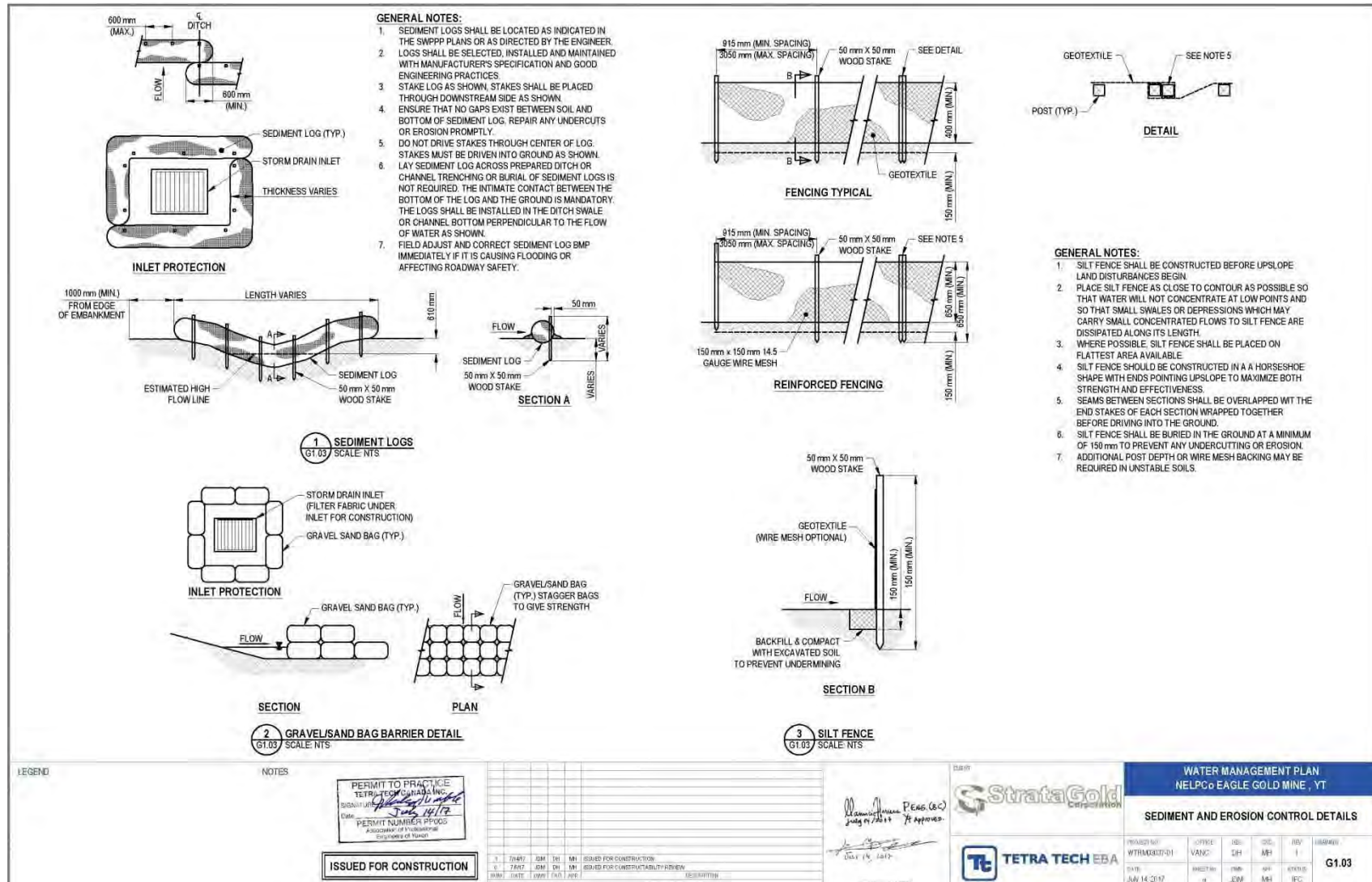


Figure 4.2-2: Erosion Control BMP - Sections and Details - Sheet 1 of 2



TYPE 2 - UNLINED DITCH

TYPE 3 - RIPRAP DITCH

DITCH TYPE	RIPRAP CLASS	RIPRAP THICKNESS	D _{max}
TYPE 3A	10 kg	350 mm	195 mm
TYPE 3B	25 kg	450 mm	290 mm
TYPE 3C	50 kg	550 mm	330 mm
TYPE 3D	250 kg	1000 mm	565 mm
TYPE 3E	500 kg	1200 mm	715 mm

NOTES:

- FOR DITCH 'A' AND 'B' DITCH BOTTOM WIDTH SHALL BE 1 m AND FOR DITCH 'C' BOTTOM WIDTH SHALL BE 2 m.
- 300 mm FREEBOARD SHALL BE INCLUDED FOR ALL DITCH SECTIONS WHERE WATER DEPTH EXCEEDS 700 mm.

(1) DIVERSION AND COLLECTION DITCHES SCALE: NTS

CULVERT LINED DITCH (SEE DETAIL 3/C1.08)

LLO PIPE

350 mm THICK 10 kg CLASS RIPRAP

NILEX 4553 NON-WOVEN GEOTEXTILE (OR APPROVED EQUIVALENT)

DITCH A & B

LLO OUTLET

(2) ROCK ENERGY DISSIPATOR SCALE: NTS

SECTION B

(3) CULVERT LINED DITCH SCALE: NTS

LEGEND

NOTES

PERMIT TO PRACTICE
TETRA TECH EBA INC.
NEW YORK
Date: July 14/17
PERMIT NUMBER PHOOS
(Insignia of Yukon)

ISSUED FOR CONSTRUCTION

PROJECT NO. WTRM0037-01

DATE July 14, 2017

SHEET NO. JCM

TETRA TECH EBA

WATER MANAGEMENT PLAN NELPCCo EAGLE GOLD MINE, YT

DITCH DETAILS

DESIGNED BY	CHECKED BY	DATE	APP'D BY	DATE
JCM	MH	July 14, 2017	JCM	July 14, 2017

C1.08

4.3 DISCHARGE PROTOCOLS

During operations, when the sample results are below the adaptive management threshold of a specific effluent quality criteria, monitoring frequency (of both flow rate and water quality) will continue at the specified rates provided in Tables 3.4-1 (Construction), 3.5-1 (Operations and Active Closure) and 3.7-1 (Late Closure and Post Closure) of the EMSAMP. When sample results exceed the adaptive management thresholds listed in Tables 3.8-1 (Construction) and 3.8-2 (Operations, Closure and Post Closure) of the EMSAMP, the sampling frequency will increase accordingly (to the next higher order) to better characterize any trends. For example, monitoring frequencies will be increased from monthly to weekly, or weekly to daily, or daily to four times a day, until the source of the trends have been identified and mitigated.

5 WATER BALANCE, STORM WATER & GROUNDWATER

Several detailed water-related models were developed and/or used specifically for the Project to simulate the effect of land use changes due to the project within the Project study area (Haggart Creek, Dublin Gulch and Eagle Creek drainage basins). These include the:

- Site Surface Water Balance Model;
- Heap Leach Facility Water Balance Model;
- Water Quality Model;
- Storm Water Model; and
- Numerical Groundwater Model.

These models are structured to provide dynamic spatial and temporal modeling frameworks to represent various physical conditions and simulate changes to the hydrologic regime over the course of the life of the Project. The modeling results provide input to the development and implementation of water management planning for all facets of the project. This section describes each model and summarizes relevant results that informed the development of the integrated site water management plan described herein.

5.1 SURFACE WATER BALANCE MODEL

A surface water balance model (WBM) was created in support of the Eagle Gold Project (Knight Piésold, 2014) and was used to simulate the availability and usage of water for operating the Eagle Gold Mine, including the HLF. The WBM simulates the supply and demand for water on a month-by-month basis, from the initiation of mine operations through mine closure and post-closure. The WBM was created using GoldSim®, a dynamic probabilistic simulation model used extensively for mine site water management applications. GoldSim® permits inputs to be entered as probability distributions (rather than discrete values), performs Monte Carlo simulations, tracks outputs from those simulations, and provides a graphic interface to facilitate the review and identification of interactions between components.

5.1.1 Model Updates

The WBM was updated by Lorax (2017a, b) for the 2017 Annual Report to reflect updates to the climate and hydrology databases to 2016. Overall, the incorporation of additional baseline climate data and updated synthetic precipitation and runoff estimates resulted in minimal changes to the understanding of the Project site water balance. As in the previous WBM, annual runoff at the W4 hydrometric station is assumed to represent the effective precipitation at the Project site, and forms the primary driver of the WBM. The summary of the changes relevant to the WBM parameterization is as follows:

- Mean annual precipitation (MAP) at the 1,125 masl decreased by 6%, from 500 mm to 472 mm;
- Mean annual runoff (MAR) for W4 increased by 7% from 230 mm to 247 mm;
- The annual orographic precipitation gradient decreased from +10%/100 m for to +7%/100 m; and

- The monthly distribution of annual runoff used to distribute the MAR value for W4 changed slightly, as outlined in Table 5.1-1

Table 5.1-1: Comparison of 2014 and Updated Monthly Runoff Distributions for the Eagle Gold Project

Month	2014 values		2017 values	
	Distribution	Precipitation (mm)	Distribution	Precipitation (mm)
JAN	2%	3.6	3%	6.5
FEB	1%	2.8	2%	5.4
MAR	1%	3.0	2%	5.7
APR	2%	4.8	3%	8.4
MAY	30%	69.6	24%	60.5
JUN	21%	48.0	17%	41.1
JUL	12%	27.3	11%	28.4
AUG	10%	23.9	10%	23.9
SEP	10%	23.2	10%	24.2
OCT	6%	13.1	8%	20.7
NOV	3%	6.9	6%	14.0
DEC	2%	4.9	3%	8.2
Total		231		247

Overall, the changes listed above result in minor alterations to the WBM inputs. Winter flows in the larger drainages tend to be higher than previous estimates, and freshet magnitudes are slightly lower. Annual runoff volumes are higher overall, with the increases ranging from 2% to 11% above the values used in the 2014 WBM.

5.1.2 Model Results

The WBM assumes the eight phases of the project described in Table 1.2-1. The model results indicate that the system is able to supply enough water to meet the process water requirements for the HLF and dust control throughout operations (Phases 1-3), under all runoff scenarios. During other months the WBM indicates that the system will operate in an excess condition and site water that is not needed for makeup to the HLF and dust control for roads will be discharged to Haggart Creek at W4, via treatment as necessary.

The supplemental gold recovery phase (Phase 4) lasts for approximately one year, followed by the cyanide destruction and rinsing phase (Phase 5) for approximately two years. During these phases, the model shows that HLF will be in a surplus condition during most months, in which net precipitation inputs to the heap exceed the moisture losses to the ore, thereby creating an increase in the overall moisture content in the heap.

Following Phase 5, the heap drain-down process commences, and drain-down water will be discharged to the environment via active and passive treatment systems. The heap drain-down phase has two parts (Phase 6 and 7), with the duration of each part a function of the moisture contents of both the ore under active leach and the unirrigated portions of the heap. The first part of drain-down will be the “managed” phase (Phase 6) in which drain-down water is bled from the system and pumped to active treatment until passive systems are in place.

Additional water management strategies are modeled for water quality modeling purposes so that the managed phase yields a bleed rate more in synchronization with the natural hydrograph of the receiving waters (i.e., Haggart Creek).

Over time, the recycle rate to the heap will decrease since the ore under irrigation (recycling), given its higher moisture content, will drain at a faster rate than the unirrigated ore portions of the heap until similar moisture content in both is reached. At some time (5 to 10 years based on managed treatment rates), all the heap ore is assumed to be at the same moisture content and the second part of drain-down commences (Phase 7). During this phase, all the ore in the heap drains at approximately the same rate and the drain-down water will be allowed to drain freely, with no recycled pumpback. The will then be directed to passive treatment (although the passive treatment system may have already received some input by this time) at an assumed constant rate of approximately 10 L/s or less, depending on the moisture content in the heap until the heap ore reaches a meta-stable equilibrium with incoming infiltration, after which it will continue to drain to the environment on a seasonal basis in perpetuity.

5.1.3 Model Sensitivity

The WBM results show that the system (without active management and continued recycling) would result in a surplus condition (until meta-stable equilibrium is achieved) where the seepage, depending on water quality and effluent discharge criteria, could require treatment (active or passive) prior to discharge to Haggart Creek. Therefore, to assess the sensitivity of the WBM results to the rate and duration at which excess water is sent to treatment, the model was rerun with an increased pumping rate of 20 L/s for drain-down water that is pumped to treatment. Using this rate, as opposed to 10 L/s, the duration of drain-down dropped from 73 months (~6.1 years) to 22 months (~1.8 years), which illustrates that the results of the model are very sensitive to the assumed HLF bleed rate. The duration of drain-down is also sensitive to the variable inputs of runoff included in the stochastic version of the model, although less so.

5.1.4 Climate Change

The potential implications of climate change on the WBM were assessed by increasing the input of annual runoff in the model by 11% based on a review of historical streamflow patterns for the McQuesten River. Overall, the climate change scenario resulted in larger accumulated water volumes; however, the modelled changes are well within the range of flows due to the inherent climatic variability of the base case model. Therefore, since the water management systems for the project will be designed to accommodate the range of flows indicated by the base case model, it can be concluded that the systems have adequate flexibility to also accommodate flows associated with future projected changes in climate.

5.2 HEAP LEACH WATER BALANCE MODEL

An operational heap leach water balance model was developed by The Mines Group (2017) with the primary objectives of evaluating HLF pad performance in terms of predicting: 1) makeup water demands, and 2) the potential for maintaining an adequate level of emergency pond storage volume. Two (2) different types of water balance models were used: a deterministic model (using a chain of single valued input parameters to produce a series of single valued results) and a stochastic model (probability based).

5.2.1 Deterministic Model

For the deterministic model, a 68-year site synthetic meteoric record (Lorax 2017a) was used for the modeling of an assumed 12 year operational facility life, which included ore stacking at approximately 39,154 tonnes per day for 275 days of the year, an assumed 2 years of extended gold extraction after the cessation of ore stacking, and an additional 1 to 2 years to represent the initiation of draindown and closure. The actual duration of extended gold extraction will depend on when the level of gold recovery becomes uneconomic, and similarly, the actual duration of draindown and closure will depend on the pace of reclamation activities and the rate of pumping of solution to treatment. The draindown process was further examined using a separate but linked spreadsheet based model that simulated the unsaturated flow conditions in the heap.

A three (3) year dry period and a three (3) year wet period, taken from the 68-year synthetic record was included within the 12 year mine life. Inclusion of these wet and dry periods in the deterministic record assure that the potential impact of historically observed variations in precipitation will be represented by the model and included in the expected operating range. As a check on the expected performance of the HLF during normal operations, two (2) additional meteoric records were extracted from the full site synthetic weather record. Meteoric Record Number 2 represents a period of average precipitation with moderate variance. Meteoric Record Number 3 represents a wetter period with high variance.

Air temperature was also included in the site synthetic meteoric record, as it is a major factor in the climate of the site influencing the fluctuations and phases of meteoric water. Given the far north latitude of the site and the predominance of sub-freezing temperatures from October through April each year, a very large percentage of the precipitation at site occurs as snow. The accumulation of water as the snow water equivalent (SWE) in a growing snowpack over the winter months has a major impact on the hydrology of the site by storing water from October through early April, then rapidly releasing that stored water over the months of April and May. The water balance model controls the accumulation of SWE in the snowpack as a function of precipitation and temperature using a monthly series of snowpack factors. Similarly, the evaporation data provided in the Lorax (2017a) site synthetic record was included; for the coldest months with mean monthly temperatures below freezing, the potential evaporative loss was replaced with a sublimation loss assumed to be 20% of the monthly precipitation (Lorax 2017a).

The deterministic model uses the synthetic precipitation record, number of days of precipitation, temperature, and the synthetic evaporation time history for the same time period to track system storage and makeup water demand on a monthly basis, compute a single value for all variables and provide results for each month in the record.

The first deterministic scenario examines the dry/wet meteoric record with no mitigation of seasonal accumulation of water in the pond system. The adsorption of solution by new ore prevents any excessive accumulation of water in the pond system during normal leaching operations. However, once ore stacking ends in operational year 8, the substantial ore wetting loss component is no longer a factor and solution begins to accumulate within the pond system in response to the addition of meteoric water. Without implementing any solution management, the accumulation would continue until the available room for emergency storage is depleted by operational year 10, so that by operational year 11 the events pond could experience an uncontrolled discharge of solution.

However, the model demonstrates that by pumping solution at a rate of 4 l/s to treatment beginning in operational year 8 at the end of ore stacking was sufficient to control the seasonal accumulation of water in the ponds and maintain an adequate emergency storage volume with no expected uncontrolled discharge from the

pond system. Substituting the Average Precipitation with Moderate Variance meteoric record also showed no tendency for significant seasonal accumulation within ponds, maintenance of an adequate emergency storage volume, and no uncontrolled discharge from the pond system. Similarly, substituting the Wetter Precipitation with High Variance meteoric record also showed no tendency for significant seasonal accumulation within ponds, maintenance of an adequate emergency storage volume, and no uncontrolled discharge from the pond system.

Therefore, the final deterministic water balance model configuration for the HLF includes pumping of solution to treatment at a rate of 4 l/s beginning in June of operational year 8 once ore stacking operations have ceased. This configuration was also used as the base configuration for the stochastic modeling.

Deterministic results show that normal operating volumes in the in-heap pond and events pond remain low during normal operations due to the dominance of ore wetting in system losses. Once ore stacking ceases and the ore wetting loss component is lost, the system continues to recruit meteoric water such that some solution management is required (e.g., pumping to treatment) to prevent excessive seasonal accumulation of water. The pond levels peak during Phase 4 as irrigation for gold production continues, while no additional ore is being delivered and soaks up water. The pond levels during normal operations maintain an adequate amount of emergency storage and when any water is in the events pond, the levels are substantially below the emergency spillway.

Makeup water demand declines over the operating life of the facility having a typical demand of about 60,000 m³ to 70,000 m³ per month and maximums of about 90,000 m³ +/- per month during Phase 1. There is a modest decrease in Phase 2 as the lined footprint increases and water begins to accumulate in the system. Typical values fall to between 30,000 m³ and 50,000 m³ and maximums are on the order of 70,000 m³ +/- . Makeup water demand continues to decline into Phase 3. Typical values fall to about 30,000 m³ to 40,000 m³ and maximums are on the order of 60,000 m³ +/- . The percentage of time that the makeup water demand is zero increases with later phases as the lined footprint increases and more captured meteoric water is available.

5.2.2 Stochastic Model

For use in stochastic modeling, descriptive statistics were developed for the compiled monthly values from the 68-year synthetic meteoric record. Rather than singular climate inputs (i.e., the synthetic record), the stochastic model substitutes probability distributions for the discrete monthly rainfall, temperature, and evaporation values and samples the distributions based on the observed statistical parameters (monthly mean and standard deviation). Then the model compiles new probability distributions for the results of interest.

Stochastic modeling results show that makeup water demand during Phase 1 will typically range from about 65,000 m³ to 80,000 m³ per month during the warmer months and about 50,000 m³ to 60,000 m³ during the cooler months. The exception is the spring freshet period, typically occurring in the month of May, where a sudden influx of water from snowmelt substantially reduces the outside makeup water demand. The reduction in makeup water demand steadily increases with each phase due to the associated increase in the lined footprint of the HLF. Outside makeup water demand drops to zero during Phase 4 and Phase 5 due to the accumulation of water in the system following the termination of ore stacking and the elimination of ore wetting losses and the expectation that no fresh water from outside the system will be used in the rinsing process.

The other matter of interest in stochastic modeling involves the volume of water stored within the pond system and the ability to maintain an adequate level of emergency storage capacity. As mentioned in the section on

deterministic modeling, the required level of emergency storage varies as a function of the lined footprint of the heap leach pad and therefore varies by phase.

The available emergency storage volume is defined as the total pond capacity minus the volume of water in storage within the pond system at any given point in time. The results show there is essentially no risk of encroaching on the required minimum emergency storage volume during Phase 1, Phase 2, or Phase 3 (normal operations). There is a small risk of encroachment (1.9%) during the freshet month (May) in Phase 3. Phase 1 through Phase 3 are similar in that the strong ore wetting demand keep ponds relatively empty and facilitate a quick recovery even from strong freshet inflows. During Phase 4 ore stacking ends and the water demand associated with the wetting of fresh ore is lost. The strong annual influx of water associated with the freshet in May is now slow to recover and water begins to accumulate in the system. Pumping to treatment is now the dominant mechanism for controlling seasonal accumulation of water. On average the month of May maintains an emergency storage volume of about 203,000 m³ and the most common value (the mode) is on the order of 210,000 m³, well above the required minimum of 130,031 m³. However, there are circumstances that could occur which would encroach upon the minimum required emergency storage volume and those circumstances would occur about 5.7% of the time without any mitigation (e.g., pumping to treatment, increase the volume in dynamic storage, etc.). Assuming pumping to treatment at a rate of 4 L/s from June through December, the accumulated water volume would steadily decrease and reduce the associated probability of a shortfall in the minimum required emergency storage from a probability of 2.5% in June to a probability of 0.5% in September climbing back slightly to 1.7% in December.

5.2.3 Risk Management – HLF Water Management Contingencies

The risks addressed by the pond design criteria are not the same as the risks characterized by a stochastic analysis. Whether the empty pond systems have the capacity to store a 24 hr PMP event or a 100 yr 24 hr (1% probability) storm plus 24 hrs of draindown from an associated power outage, these are all short duration, 24 hr events that present no practical option other than to “catch” the volume of the event within the pond system without overtopping and spilling. However, the risk characterized by the stochastic analysis addresses a combination or sequence of events that occur over an extended period of time. Most of the time they will not simply appear without warning, but will be seen developing over time allowing the effects of these event sequences to be mitigated either before they encroach upon the minimum required emergency storage or shortly after a shortfall becomes evident. This is particularly true of a climate environment like that of the Eagle Mine where the greatest risk is associated with the spring snowmelt or freshet event. The snowpack responsible for this event can be seen developing over a period of at least four (4) or five (5) months. The SWE of the snowpack can be measured and monitored over the period from October through April so that the subsequent snowmelt event in May can be predicted with a high degree of certainty and prepared for well ahead of time.

Of interest is not simply the probability of experiencing a shortfall in emergency storage, but also the ability to manage the risk and recover from the shortfall in a reasonable amount of time (typically within 30 days). There are multiple ways of managing the overtopping risk and emergency storage volume. In some cases increasing the rate of solution pumped to treatment can eliminate the shortfall. In other cases, an increase in the application pumping rate and associated area under leach can empty ponds very quickly by putting more water into dynamic storage. The stochastic model was designed to evaluate mitigation options for correcting a shortfall in emergency storage. When a shortfall is triggered the model computes the treatment rate required to eliminate the shortfall over a 30 day period, and also computes the required increase in pumping rate/area under leach as a percentage of the base pumping rate/area under leach required to eliminate the shortfall over a 30 day period.

5.2.4 Heap Draindown

Once all gold production has ceased and the proposed cyanide neutralization and rinsing of the HLF is finished, the post closure heap will be allowed to dewater and drain. The draindown process is an unsaturated flow process that is controlled by the soil water retention characteristics of the ore. The rate of flow during draindown is a function of the unsaturated hydraulic conductivity which is in turn a function of the moisture content of the ore. As the ore drains, the moisture content decreases and the effective unsaturated hydraulic conductivity declines as well leading to an exponentially declining flow rate curve. There are two (2) distinctly different areas of the HLF that will behave differently during the draindown period. The first area is the column of ore below the area under leach, which will have elevated moisture contents relative to the adjacent unirrigated ore. The elevated moisture allows the leach column to drain at a faster rate than the unirrigated ore. At some point in time the moisture content of the leach column will essentially equal the moisture content of the unirrigated ore and there will be no measureable difference in the draindown rate anywhere across the heap.

It is not practical nor advantageous to simply turn off the pumps and allow the heap to just drain as a very large volume of water would report quickly to the ponds, filling and overtopping them. Therefore, the model assumes that pumping of process solution will continue at a declining rate until such time as the water content in the active leach column approaches the water content in the unirrigated ore, or the potential draindown volume remaining would not fill the ponds but would be captured in the pond system and still provide sufficient capacity to capture and store the design events (i.e., 1% probability (100 yr) 24 hr storm and a short-term drain-down). At that point the pumps could be turned off while allowing the heap to continue to drain until it reaches a meta-stable equilibrium with the level of meteoric water that continues to enter the pad year after year. The rate at which the water is diverted to treatment will control the time required for the leach column to reach the moisture content of the unirrigated ore and also the time required to reach equilibrium with the meteoric precipitation regime. The draindown model predicts that continuing the treatment rate of a nominal 4 L/s would result in an elapsed time of over ten years before pumping could be stopped and over 12 years before the leach column fully dewateres. It is more likely however, due to cost considerations, that a higher treatment pumping rate (i.e., on the order of 10 to 20 L/s) would be used to minimize the duration of the draindown period (i.e., to less than 3 or 4 years). For example, while the actual pumping rate would be determined based on several factors, doubling the treatment rate would approximately halve the time until when pumping was not necessary.

5.3 WATER QUALITY MODEL

The Eagle Gold Project water quality model (WQM) is a mass-conserving mixing model that predicts water quality for 38 parameters at key monitoring and compliance points in the receiving waters affected by mine activity. The model was designed on the GoldSim® platform and utilizes a GoldSim® water balance model (WBM). As described in Section 5.1, the WBM was updated to reflect additional data collected in 2013 to 2016. Both the WBM and the WQM use a monthly time-step for 50 years, spanning the construction phase, operations, closure and several years into post-closure. Model inputs include seepage contact water source terms, Mine Water Treatment Plant (MWTP) and Passive Treatment Systems (PTS) effluent discharge requirements and background water quality for non-contact flows.

5.3.1 Model Inputs

The model assumes that contact water comes from the following sources:

- Waste rock storage facilities in Eagle Pup and Platinum Gulch;

- Pit wall runoff and pit-wall depressurization wells that report to pit;
- Heap leach facility (during post-operations and drain-down only); and
- Runoff-seepage from developed and undeveloped portions of the project footprint

Input source concentrations for all contact waters were the same as described in Eagle Gold Geochemical Source Term Predictions – Model Description and Results (Lorax 2014b) and in Eagle Gold Project – Water Quality Model (Lorax 2014a). As part of the WQM update, the geochemical source terms used as inputs in Lorax (2014a) were assessed in light of the updated data collection. The geochemistry of field bin leachates collected throughout 2016 were reviewed, and the potential effect on the additional data on the source term model was assessed. Upon completion of this review it was determined that the source term model results prepared for the Eagle Gold WUL in 2014 (Lorax 2014b) are still valid and do not currently require updating as a result of more recent field bin data collected in 2016.

Effluent quality standards were developed during the Water Use License application process for the MWTP during operations and PTS for the closure phase. The effluent quality standards listed in Table 34 for each component are utilized in the model. Background flows and water quality from runoff (e.g., non-contact water) and background receiving environment water chemistry are fully characterized and included in the model. Baseline water quality data collected from project area streams from 2013 to 2016 were incorporated into the water quality baseline dataset (Lorax 2017b).

Flows from background sources and mine facilities are taken directly from the WBM with the exception of the seepage from the waste rock facilities. Infiltration through the waste rock is provided to the WQM; the model then uses a function that attenuates the flow within the waste rock pile in a manner consistent with observed waste rock seepage hydrographs from other sites.

Each parameter is treated as a conservative tracer which is mixed at model nodes (confluences) by the following equation:

$$C_r = \frac{\sum_i Q_i C_i}{\sum_i Q_i}$$

where:

C_r is the resultant concentration

Q_i are the source flows into the mixing point

C_i are the concentrations associated with the source flows

The only exceptions to this flow-weighted instantaneous mixing scheme are for the Lower Dublin South Pond (LDSP) and for the open pit pond which are represented by constituent transport flow cells in GoldSim®.

5.3.2 Model Results

The results of the WQM update are presented in downstream order for the three receiving environment stations (W4, W29 and W23), for the main parameters of interest, namely As and Se. Results for all other modeled parameters are provided in Lorax (2017b).

5.3.2.1 Haggart Creek at W4

The updated model predicts lower peak As concentrations at W4 as compared to the previous 2014 model. The driver for this predicted decrease is the increase in MAR (+7%) as discussed in Section 5.2.1, which provides additional dilution at W4. Also of influence is the slight decrease in the orographic gradient at the Project site, that effectively reduces the volume of water reporting to the mine components, which tend to be located at the higher elevations, relative to the lower elevations. In the updated 2017 WQM, As concentrations are predicted to remain well below the water quality guideline of 0.0085 mg/L at W4. Similar results are observed for Se at W4. During early operations, Se concentrations are driven by the background concentrations in Haggart Creek and hence model predictions do not diverge significantly. The primary source of Se is associated with the HLF. Once HLF flows begin to contribute, Se concentrations increase at station W4. However, with the slightly increased flows, a similar dilution effect is observed at W4, and 17WQM predictions for Se are generally lower than 14WQM predictions. Updated predictions indicate that Se concentrations throughout the life of mine are well below water quality objectives at W4. In general, all parameters are predicted to be below their respective water quality objective. No suggested changes to proposed site water management strategies at the site are therefore warranted as a result of the modeling updates.

5.3.2.2 Haggart Creek at W29

A comparison of 17WQM predictions for total As at W29 to 14WQM output indicates that the peak As concentrations at W29 are predicted to be slightly higher in 17WQM as a result of higher background concentrations calculated for Dublin Gulch following incorporation of baseline surface water quality monitoring data in 2013 to 2016. Predicted peak As concentrations occur in May of each model year. Revised background total As concentrations assumed for Dublin Gulch are based on the mean of measured As concentrations at W1 for the period of 2007 to 2016. Monthly mean total As concentration for May increased from 0.028 mg/L to 0.040 mg/L. As such, changes to the predicted peak As concentrations at W29 in 17WQM are driven solely by revised background As concentrations in Dublin Gulch.

Unlike As, the predicted total Se concentrations at W29 are similar to what was observed at station W4 in Haggart Creek. The primary reason for this is that background Se in all catchments at the project site is very low (less than 0.0003 mg/L) including Dublin Gulch (see Lorax 2017b). As such, the slightly higher predicted background flows in the 2017 WBM result in greater dilution and therefore lower predicted total Se concentrations.

5.3.2.3 Haggart Creek at W23 (Far-field)

Consistent with predictions at W29 for total As, peak As concentrations at W23 are predicted to be slightly higher in 17WQM as a result of higher background concentrations calculated for Dublin Gulch. Predicted peak As concentrations occur in May of each model year and approach 0.008 mg/L. Changes to the predicted peak As concentrations at W23 in 17WQM are driven solely by revised background As concentrations in Dublin Gulch.

As predicted for the other upstream locations in Haggart Creek, the revised 17WQM predictions for total Se are lower as compared to 14WQM results. The slightly higher 17WBM flows, coupled with naturally low background Se concentrations results in lower predicted peak Se concentrations at W23.

5.4 STORM WATER MODEL

A series of hydrological models using HEC-HMS and PCSWMM software were run to estimate the Inflow design flood for Ditch A, Ditch B, Ditch C, Lower Dublin South Pond and various culverts throughout the project site, and to size them based on the corresponding design events. The design specifications and drawing package is included as Appendix A.

The more conservative adjusted rainfall frequency atlas values for extreme precipitation were used as input to the rainfall runoff hydrologic models. The general basin model developed using the HEC-HMS software is shown in Figure 5.4-1. The catchment physical characteristics for the model were adopted from those summarized in Tetra Tech (2014), the previous operations water management Plan (StrataGold 2015) and BGC (2017) and are summarized in Table 5.4-1. The results of the rainfall runoff analysis for the 10 Year are summarized in Table 5.4-2.

Table 5.4-1: Catchment Areas Used in the Model

Catchment ID	Area (km ²)	Curve Number (CN)	Lag Time (min)
Dublin Gulch	3.27	60	42
Olive Gulch	2.80	60	38
Stewart	1.66	60	27
North Dublin Gulch	0.63	60	14
Lower Dublin Gulch	0.24	60	6.8
Eagle Pup	1.47	82	41
Suttles Gulch	1.00	82	32
Ditch A	1.57	82	48
Lower Eagle Creek	0.19	82	10

Sources: Tetra Tech 2014, StrataGold 2015 and BGC 2017

Table 5.4-2: Flood Volume and Peak Runoff Values Estimated from the Rainfall Runoff Analysis

Catchment ID	Flood Volumes (1000 m ³)				Peak Flow (m ³ /s)			
	10 Year	100 Year	200 Year	1000 Year	10 Year	100 Year	200 Year	1000 Year
Dublin Gulch	3.73	21.28	28.6	48.9	3.73	1.12	1.65	3.25
Olive Gulch	3.23	18.36	28.6	42.13	3.23	1.01	1.65	2.98
Stewart	1.95	11.00	28.46	25.19	1.95	0.65	1.64	2.00
North Dublin Gulch	0.77	4.27	24.66	9.75	0.77	0.31	1.49	1.01
Lower Dublin Gulch	0.30	1.66	53.12	3.78	0.30	0.14	3.12	0.48
Eagle Pup	22.09	45.33	52.78	71.13	22.09	5.25	3.09	8.39
Suttles Gulch	15.09	30.94	14.76	48.54	15.09	3.90	0.99	6.27
Ditch A	23.82	48.85	67.54	76.64	23.82	6.16	3.95	9.91
Lower Eagle Creek	2.83	5.8	67.49	9.09	2.83	1.13	3.94	1.79
Total (Eagle Pup, Suttles Gulch and Ditch A)	61.0	125.1	135.1	196.3	61.0	15.3	8.0	24.6

Using the model, a total runoff volume of 61,000 m³ was estimated from the Eagle Pup, Suttles Gulch and Ditch A catchments during the 10 year event. This volume will be conveyed to and stored in the LDSP. The pond was designed to accommodate more than the 10 year storm event, with a total storage capacity of 74,450 m³. The Lower Dublin South Pond is shown in Figure 5.4-2. The pond includes a rock-fill forebay to slow down the flow and promote additional settlement for coarser material just before entering the main pond. The stage storage area curves for the pond and forebay are shown in Figure 5.4-3 and Figure 5.4-4, respectively. During the 10-year 24-hour event, the maximum water level will be less than 811.5 m leaving a freeboard of 2.0 m. The pond was designed to have a detention time of a minimum of 24 hours. Water outflow will be discharged if water is not needed for other purposes (i.e., dust suppression, make-up water) and if effluent quality criteria are met. During normal operating conditions the pond and outflow levels will be controlled through a riser and a low level outlet, which consists of a perforated stand-pipe with a control gate. A submersible pump will be installed in the riser; pump outflow will be sent to a pipe junction that can direct water to the ADR for make-up water; if make-up water is not needed, water flow will be conveyed to the MWTP for treatment prior to discharge.

The LDSP also includes a liner system with a design similar to the HLF liner to protect the dam face from seepage. The liner covers the upstream face of the dam from the crest to about 20 m inboard within the pond; the upslope extent of the liner will be anchored 0.5 m below the pond bottom. Because the pond will be constructed into the Eagle Creek channel, groundwater will be encountered; due to the seasonal fluctuation of groundwater in the Dublin Gulch valley, and the likelihood of positive hydrostatic pressures in the eastern half of the pond footprint, the pond will not be lined over most of the area, as it is anticipated that groundwater will seep into the pond.

According to the Canadian Dam Safety Guidelines (CDA 2007) the LDSP currently meets the criteria as a dam, which according to the CDA is “A barrier constructed for the retention of water, water containing any other substance, fluid waste, or tailings, provided the barrier is capable of impounding at least 30,000m³ of liquid and is at least 2.5m high”. Table 5.4-3 summarizes LDSP specifications.

Table 5.4-3: Water Management Pond Design Specifications

Pond	Surface Area at Maximum Operating Elevation (m ²)	Height of Embankment (m)	Live Pond Storage Capacity (m ³)	Primary Outflow		Secondary Outflow	
				Type	Depth Below Embankment Crest (m)	Type	Specification
Lower Dublin South Pond	62,750	6.5	62,000	600 mm Riser Pipe	1.5	Emergency Spillway	15 m wide 2:1 side slope Invert at El = 812 m
Lower Dublin South Forebay	11,700	3.0	11,700	-	-	Spillway	20 m wide 2:1 side slope Invert at El = 811 m

Source: EBA (2017)

With regards to Canadian dam safety considerations it can be stated that:

- there will be no permanent population at risk downstream of the embankment, only the occasional worker on the mine access road;
- in case of a dam break, no significant loss or deterioration of fish or wildlife habitat would be expected;
- any environmental loss would be of marginal habitat only, and restoration is highly possible; and

- there will be no mine or public infrastructure downgradient of the dam, such that economic losses would be low and affect the mine only.

Thus, the embankment can be classified to have a “Significant” consequence. Accordingly, the spillway was sized to safely route the 1000 year flood during the Inflow Design Flood (IDF). Based on the spillway design specifications summarized in Table 5.4-3, during the IDF event, the flood level would be 1 m above the spillway invert. Considering the relatively short fetch length of the reservoir, a 0.5 m freeboard allowance during the IDF was considered to account for the wind setup and wave run-up. Figure 18 shows a rendering of the water level during the 1000-year event.

The spillway chute channel will be a 15 m wide, 2:1 side slope trapezoidal channel with a bottom grade of 25% slope. The spillway chute enters a stilling basin with mounted rock baffles for further energy dissipation. A riprap class of 100 kg with nominal riprap thickness of 700 mm and approximate average dimension of an angular rock of 450 mm shall be used for the spillway chute channel. The forebay spillway was designed in north side of the pond to increase the retention time within the fore-bay.

Eagle Gold Project

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Figure 5.4-1: Eagle Gold Basin Model



Figure 5.4-2: Lower Dublin South Pond

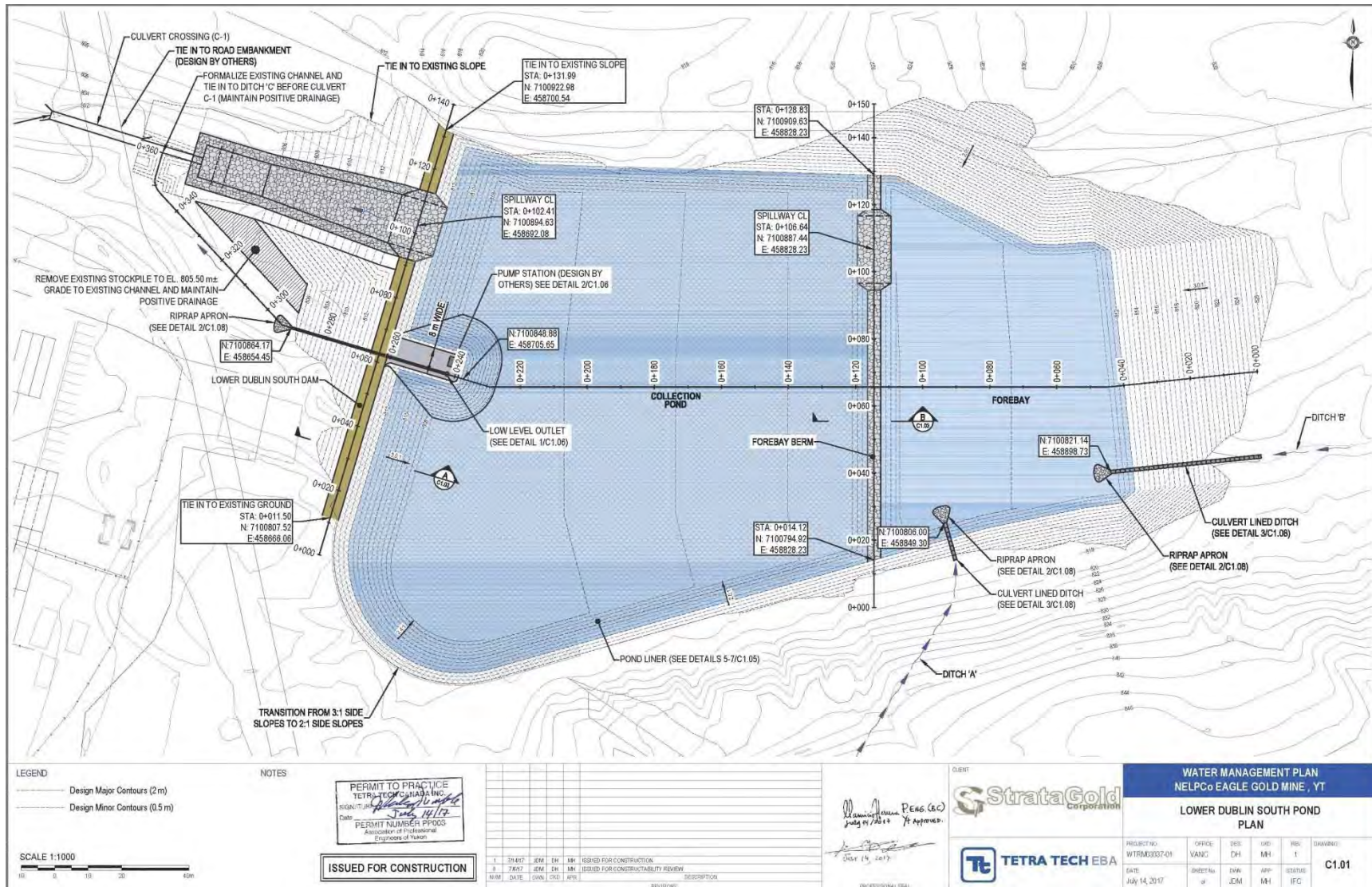


Figure 5.4-3: Stage Storage Area Curve - Lower Dublin South Pond

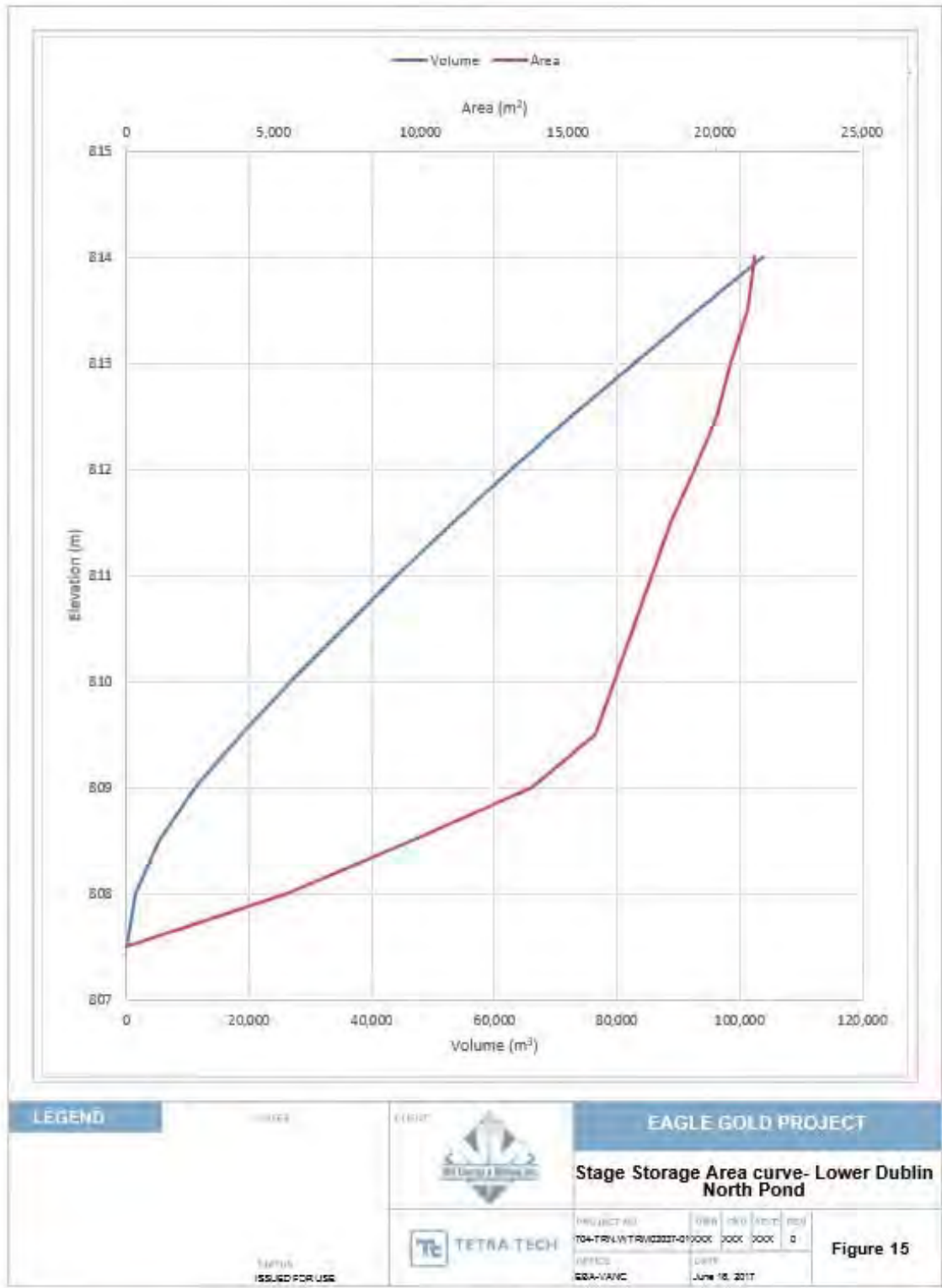


Figure 16 is a graph showing the Stage Storage Area curve for the Forebay. The Y-axis represents Elevation (m) ranging from 809.5 to 812.5. The X-axis represents Volume (m³) ranging from 0 to 14,000. The graph includes two curves: Volume (blue line) and Area (red line). The Volume curve starts at (0, 809.5) and rises to (12,000, 812.0). The Area curve starts at (2,000, 810.0) and rises to (10,000, 812.0).

Figure 5.4-5: 2D Hydraulic Modelling of Lower Dublin South Pond During 10 Year Storm Event - Maximum Water Depth



Figure 5.4-6: 2D Hydraulic Modelling of Lower Dublin South Pond During 1000 Year Storm Event - Maximum Water Depth



5.5 GROUNDWATER MODEL

With respect to site water management, a three dimensional (3-D) finite difference numerical groundwater flow model for the site was developed by BGC (2014) to:

- quantify groundwater inflows to the proposed open pits,
- predict changes to the project area groundwater flow regime due to mining activities, including groundwater extraction for water supply.
- evaluate the range of potential impact of changes to the groundwater regime from mining on surface water flows, and
- evaluate post-closure groundwater flow conditions.

5.5.1 Conceptual Hydrogeologic Model

Measured groundwater elevations suggest that the water table is a subdued replica of topography, with depths to groundwater typically being greater in the uplands relative to the valley bottom. Groundwater enters the flow system from infiltration of precipitation and snowmelt, as well as by surface water infiltration in creeks and gullies. Groundwater discharge occurs primarily to creeks and breaks in slope within gullies. Groundwater elevations are observed to slowly decline through the winter and spring (i.e. November to April), rise relatively rapidly during spring melt and are highest during the summer (i.e. June to September). The seasonal variation in groundwater levels is consistent with the seasonal precipitation and temperature trends.

Surficial materials at the site comprise a thin layer of overburden (typically less than 10 m thick) that is generally composed of a thin veneer of colluvium in the uplands; while alluvium and reworked placer tailings dominate in the valley bottoms. Deposits along Dublin Gulch generally vary from 0 to 30 m thick between Eagle Pup and Haggart Creek. Discontinuous, relatively warm (typically 0° to -1° Celsius) permafrost is present primarily along northeast to northwest-facing slopes with sporadic distribution in the general area. Because of its discontinuous nature it is assumed to have limited regional control on the groundwater flow system.

The bedrock of the project area can be broadly divided into the Hyland Group metasediments and intrusive rocks of the Dublin Gulch Stock. Results from hydrogeologic tests conducted in the bedrock to date show that the hydraulic conductivity of the intrusive and metasediment units is generally similar and associated with fractures, although considerable variation in results is apparent for each unit at any given depth (i.e., 2 to 4 orders of magnitude). A general trend of decreasing permeability with depth is discernible from the data, with geometric mean hydraulic conductivities of 2×10^{-6} m/s from 0 m to 50 m below ground surface, 1×10^{-7} m/s from 50 m to 100 m below ground surface, and 2×10^{-8} m/s at depths greater than 100 m for all bedrock tests. Measured hydraulic conductivity within the main overburden materials ranges from 3×10^{-5} to 4×10^{-3} m/s in placer and fluvial materials, and 4×10^{-7} to 3×10^{-5} m/s for colluvium.

5.5.2 Groundwater Model Development

Groundwater Vistas (Version 6.22; ESI, 2010), a graphical user interface, was used to develop the MODFLOW-SURFACT (Version 3.0) groundwater flow model for the site. The groundwater flow model domain extends beyond the project footprint and local topographic divides to the north and south to major streams and to the east and west to the major topographic divides. The model consists of 260 rows and 226 columns covering an approximate area of 82.5 square kilometers (km²), 65.3 km² of which is within the active model domain. Eight model layers were used to discretize the domain in the vertical dimension for a total of approximately 470,080 grid blocks. Uniform 20 m by 20 m grid blocks were defined in the project footprint. Initially, the model was calibrated using both steady state and transient conditions.

Continuous, semi-continuous and single groundwater elevation data were used with average annual and mean estimated monthly flows from gauging stations on Stewart Gulch, Dublin Gulch, Eagle Creek and Haggart Creek were used to help calibrate the groundwater flow model to both static and transient conditions. In addition, the model was then calibrated using data from pumping tests conducted in bedrock and alluvial aquifer wells. Comparison of simulated versus observed drawdowns suggested that the calibrated hydraulic conductivity values were reasonable for the project scale of the modeling.

5.5.3 Model Results

5.5.3.1 Open Pit Advance and Mine Dewatering

Due to the relatively low hydraulic conductivity of the rock mass in the open pit area, pumping wells are not likely to provide a practical or economically efficient means of depressurizing the open pit slopes. Approximately 41 horizontal drains are recommended over the life of the mine for depressurization to maintain stability of the pit walls and to manage pit wall seepage and most of the inflows. The number and location of the horizontal drains will need to be adapted in the field to match conditions observed in the open pit as it is excavated. These drains could be supplemented with vertical pumping wells in areas of relatively high hydraulic conductivity.

5.5.3.2 Groundwater Supply Extraction

Model results indicate that one to two groundwater supply wells installed in the bedrock of the lower Dublin Gulch valley will be able to sustain the estimated groundwater supply demands (i.e., for process make-up water when the LDSP water supply is limited) as estimated by the site-wide surface water balance model. An additional well may be needed on standby to accommodate well maintenance and pump service needs.

5.5.3.3 Flow in Haggart Creek

As a result of the open pit advance, groundwater supply demands, and reduced recharge from the HLF and WRSA footprints, the model predicted lower hydraulic heads (i.e., drawdown) in the project footprint. During operations this translated to a slight decrease in stream baseflow and a slight increase in stream leakage to the aquifer which resulted in stream flow reductions at W5 of generally less than 1% from May through October to 3% to 6% from December to April. During active, passive, and post closure, these changes were estimated to reduce stream flow at W5 by less than 1% to 2% from May through November, and by 2% to 5% from December to April.

6 CONSTRUCTION WATER MANAGEMENT

The water management objective during construction is to safely convey and/or detain the respective design storm event at each facility, while keeping clean water clean (i.e., maintaining water quality at background levels) and by meeting water quality standards in the receiving environment.

The primary means of achieving the water management objective during construction will require erosion source control (i.e., minimizing total suspended solid levels in runoff from disturbed areas) and the diversion of non-contact water away from construction activities to reduce the total volume of sediment-laden water needing to be managed..

Management of sediment-laden water during construction is best done by reducing the velocity of water, thus allowing sediments to settle. This process is generally accomplished by constructing channels with check dams, sediment control ponds (SCPs), sediment basins, exfiltration ponds, and sediment traps, as well as through the stabilization of disturbed land surfaces, and the re-establishment of vegetative cover. This section describes the specific mitigation measures that will be implemented to meet the objectives.

Water will be controlled in a manner that minimizes erosion in areas disturbed by construction activities to minimize the release of construction-impacted to receiving waters (e.g., Dublin Gulch, Haggart Creek, and Eagle Creek).

6.1 WATER MANAGEMENT PLAN IMPLEMENTATION

The first step in site water management will be the construction of a water management control pond and the associated ditches that will be situated to intercept runoff from the construction area, and also separates construction-impacted runoff from areas not under development.

6.1.1 Lower Dublin South Sediment Control Pond

One SCP, the Lower Dublin South Pond (LDSP), will be constructed to manage sediment-laden water during construction. The LDSP will also serve as the contact water management pond throughout operations. It will be located just upstream of the Camp within the existing Eagle Creek valley as shown on Figure 1.1-2. This pond has been designed using Methods 1 and 3 of the guidelines established by BC MOELP (2001). The pond has been designed to store the 10-year, 24hr storm event while at the same time providing a detention time of at least 24 hours for any sediment particles sized 0.005 mm (and larger) to settle out. The spillway of the pond is designed to pass the 1000-year, 24-hour storm while still maintaining at least 0.5 m of freeboard. If it is observed that the TSS in the pond discharge could exceed the maximum permitted or regulated discharge quality, then settling aids (e.g., flocculants) would need to be added upstream of the pond. The procedures for addressing elevated TSS are described in the Flocculant Use Plan (Appendix B). Effluent quality criteria (as per Water License QZ14-041) for discharge to receiving waters from the LDSP (and any other water management facility) are listed in Table 6.1-1

Table 6.1-1: Construction Effluent Quality Criteria

Parameter ¹	Maximum Monthly Mean Concentration	Maximum Concentration in a Grab Sample
Arsenic	-	0.50 mg/L
Copper	-	0.30 mg/L
Lead	-	0.20 mg/L
Nickel	-	0.50 mg/L
Zinc	-	0.50 mg/L
Total Suspended Solids (TSS)	15.00 mg/L	30.00 mg/L
¹ All Concentrations are total values		

The LDSP (Figure 5.4-2) will be constructed during the initial stage of construction, and will be used to manage sediment-laden water for the Project throughout construction and operations. This water will be released pending demonstration of meeting EQC, during most of the construction period, via the controlled outlet pipe from the pond into ditch C. During Stage 1, ditch C is essentially still Eagle Creek and would flow southward in its present watercourse through former placer ponds and finally to Haggart Creek. During Stage 2, ditch C is constructed and the flow is diverted into Haggart Creek about 200 m downstream from the mouth of Dublin Gulch (Figure 6.1-1).

6.1.2 Ditches and Culverts

6.1.2.1 Culverts

Figure 6.1-1 depicts eight watercourse crossings along site roads. Culverts were sized to convey the 1 in 10-year 24-hour storm event for temporary crossings, the 1 in 100-year 24-hour storm event for crossings with a catchment area larger than 1 ha, and the 1 in 200-year 24-hour storm event for stream crossings (i.e., Dublin Gulch and Eagle Creek). The culverts will consist of corrugated metal pipe installed according to the manufacturer's specifications and are sized as shown in Table 6.1-2. Culverts will be embedded in gravel for those crossings where fish passage will occur.

The hydrologic model described in Section 5.4 was used to predict the design flows for each crossing. The culverts were sized using standard culvert nomographs and the PCSWMM modelling software.

Table 6.1-2: Culvert Specifications

Culvert ID	Catchment Area (Ha)	Design Criteria	Total Rainfall Depth (mm)	Rainfall Distribution	Peak Intensity (mm/h)	Design Flow (m ³ /s)	Length (m)	Slope	Diameter (mm)	# of pipes
1	422.2	IDF from Emergency Spillway	94.0	Type 2	104.3	24.0	28	2.4%	2200	2
2	860.9	1 in 200-year, 24-hour	78.2	Type 2	86.8	4.3	49	5.7%	1200	2
3	846.7	1 in 10-year, 24-hour	49.1	Type 2	54.5	0.3	30	8.7%	750	1
4	836	1 in 200-year, 24-hour	78.2	Type 2	86.8	4.2	58	2.7%	1200	2

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Culvert ID	Catchment Area (Ha)	Design Criteria	Total Rainfall Depth (mm)	Rainfall Distribution	Peak Intensity (mm/h)	Design Flow (m ³ /s)	Length (m)	Slope	Diameter (mm)	# of pipes
5	11.2	1 in 200-year, 24-hour	78.2	Type 2	86.8	1.2	44	7.1%	800	1
6	166.2	1 in 200-year, 24-hour	78.2	Type 2	86.8	1.0	40	7.1%	750	1
7	653.2	1 in 200-year, 24-hour	78.2	Type 2	86.8	3.1	78	7.1%	900	2
8	133.8	1 in 100-year, 2-hour	71.6	Type 2	79.4	5.3	56	3.0%	1200	2
9	na	IDF from Emergency Spillway	94.0	Type 2	104.3	24.0	28	2.4%	2200	2

Source: EBA

6.1.2.2 Ditches

Non-contact and sediment-laden water will be conveyed via trapezoidal ditches lined with riprap and/or CHPs during the construction stages. The large collection ditches were sized to convey the 100-year 24-hour storm.

There are three main ditches planned for construction, shown on Figure 6.1-2 and described below:

Ditch A is located downslope from the Eagle Pit, the Platinum Gulch WRSA, the 90 day stockpile and the Mine service road. Ditch A will run north from the drainage basin of the Platinum Gulch WRSA across the site and into Lower Dublin South Pond;

Ditch B follows the natural Eagle Creek watercourse, downslope from the Eagle Pup WRSA, the crusher installations and part of the Eagle Pit. Ditch B flows west across site from the northern end of the Eagle Pup WRSA to Eagle SCP; and

Ditch C is downslope of the Lower Dublin South Pond, and conveys the outflow from the pond to Haggart Creek. Ditch C flows west following the natural course of the current Eagle Creek until it reaches the Haggart Creek valley. At that point ditch C will divert the flow into a remnant Dublin Gulch channel and follow a more direct route into Haggart Creek.

The hydrologic model described in Section 5.4 was used to predict the design flows for each ditch. The design criteria and design flows are presented in Table 6.1-3.

Table 6.1-2: Water Management Ditch Design Specifications

Ditch	Design Criteria	Rainfall Depth (mm)	Rainfall Distribution	Peak Intensity (mm/h)	Catchment Area (ha)	Design Flow (m ³ /s)
Ditch A - Upstream of Culvert 8	1 in 100-yr, 24-hour	71.6	Type 2	79.48	133.8	5.3
Ditch A - Downstream of Culvert 8	1 in 100-yr, 24-hour	71.6	Type 2	79.48	157.4	6.2
Ditch B	1 in 100-yr, 24-hour	71.6	Type 2	79.48	246.3	8.9

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Ditch	Design Criteria	Rainfall Depth (mm)	Rainfall Distribution	Peak Intensity (mm/h)	Catchment Area (ha)	Design Flow (m ³ /s)
Ditch C	IDF from Emergency Spillway	-	-	-	422.2	24

Source: EBA

A PCSWMM hydraulic model was implemented as part of the design process to predict velocity and water depth along the ditches.

The design of diversion and collection ditches is based on the gradient and volume of flow anticipated.

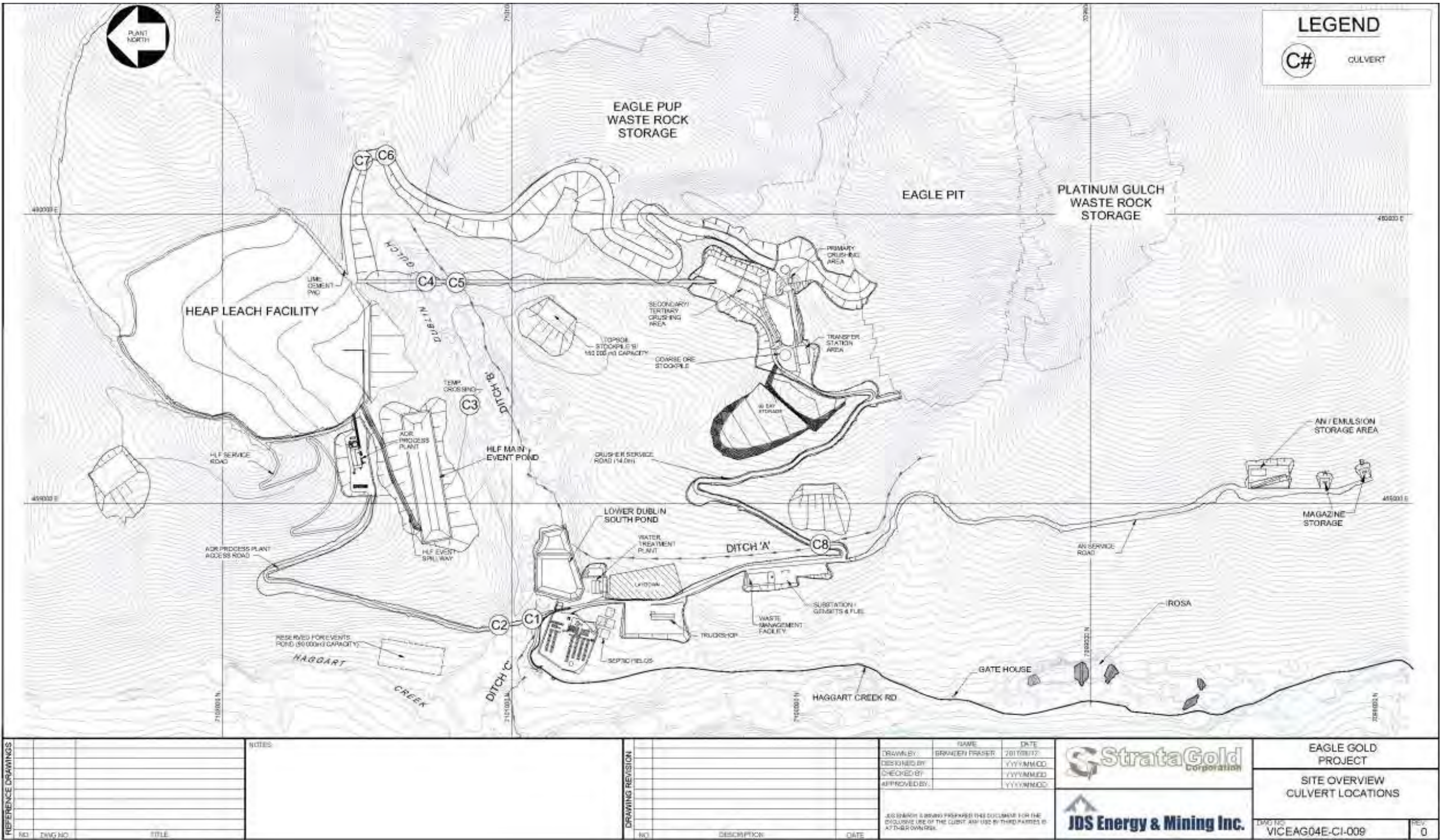
- For small watersheds limited to channel slopes of 1% to 2%, two types of ditches will be constructed (Type 1 and 2).
- For larger watersheds with channel slopes of 2% to 15%, a Type 3 ditch will be constructed that includes geotextile liner and a riprap lining with a D50 of 150 mm minimum, and a riprap thickness of at least two times the D50 of the riprap in the channel. The median grain size, D50, refers to the grain diameter for which 50% of the sample mass is smaller than and 50% is larger than the specified diameter (i.e., D50 of 200 mm means that 50% of the sample has a diameter greater than 200 mm and 50% has a diameter less than 200 mm). The riprap class for each reach of ditch was design as per the Ministry of Transportation BC Supplement to TAC Geometric Design Guide, 2007.
- CHPs will be used in terrain that is steeper than 15%, as the velocities at such slopes are too high for practical riprap channel protection. Minimum diameter of CHPs is 1.0 m.
- In the cases of ditch B and C, which for the most part follows the natural watercourse of Eagle Creek, a field assessment of slope stability and erosion potential will be conducted of the streambanks along the established vegetated riparian corridor, to evaluate the suitability of leaving certain reaches intact, while considering the conservatism in the design flows.

Table 6.1-3 presents the ditch characteristics and specifications for riprap protections. The stationing increases in the downstream direction. The ditch locations are shown on Figure 6.1-3.

Table 6.1-3: Collection Ditch Specifications

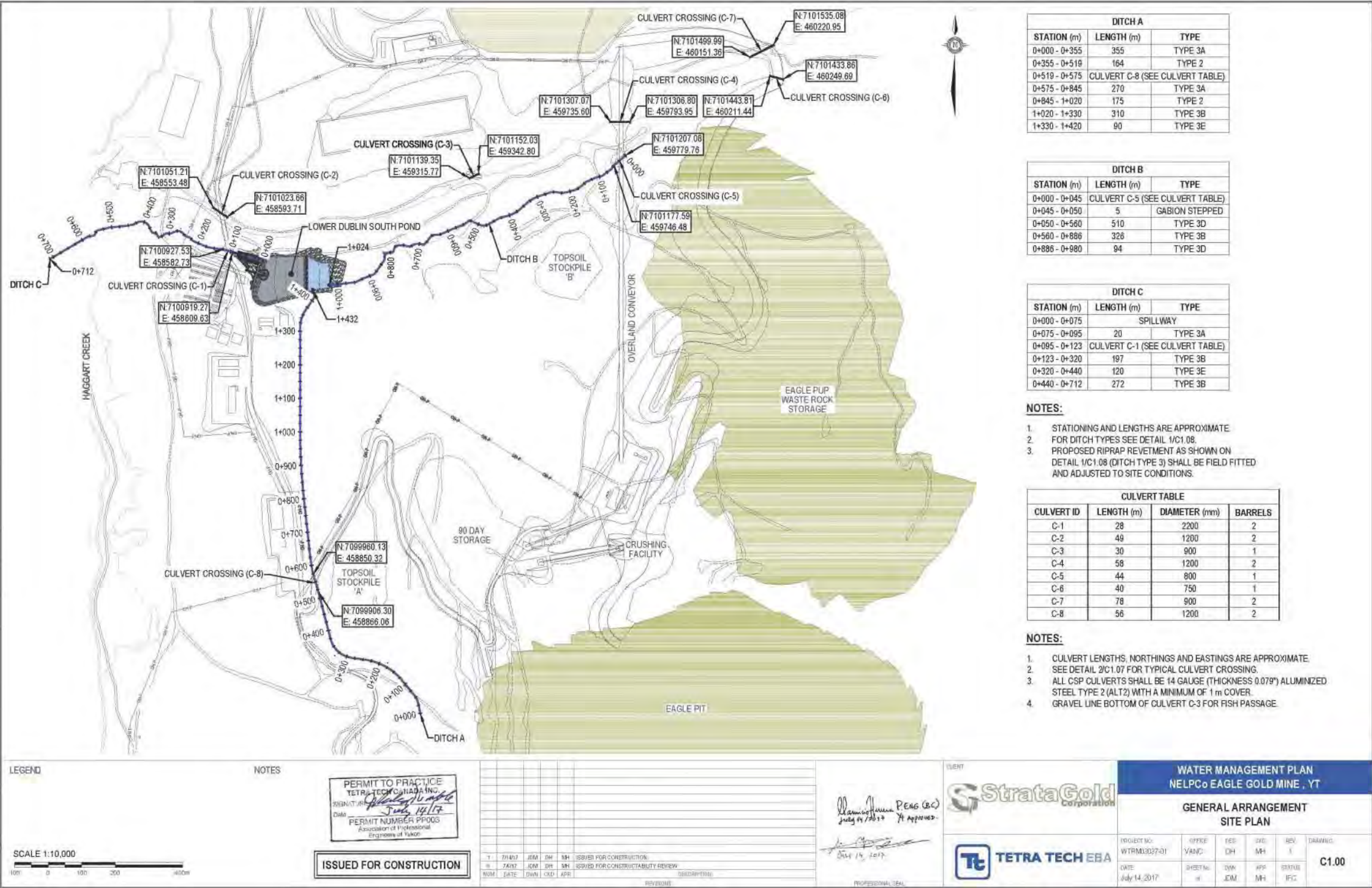
Proposed DITCH A Specifications												
ID	From Station (m)	To Station (m)	Length (m)	Slope (%)	Velocity (m/s)	Max. Depth (m)	Bottom Width (m)	Side Slopes (XH:1V)	Class of Riprap (kg)	D50 (mm)		
1	0	355	355	2 - 5	1.3 - 2.0	1.4	1	2	10	195		
2	355	519	164	1 - 2	1.0 - 2.8	1.6	1	2	No riprap required			
3	519	575	56	Culvert 8								
4	575	845	270	2 - 5	1.6 - 2.2	1.2	1	2	10	195		
5	845	1020	175	1 - 2	2.4 - 2.9	1	1	2	No riprap required			
6	1020	1195	175	2 - 5	2.0 - 3.0	1	1	2	25	260		
7	1195	1155	135	6 - 15	3.7 - 4.6	0.8	1	2	25	260		
8	1155	1240	45	6 - 15	6.9	0.6	1	2	500	715		
9	1240	1200	45	> 15	10.4	0.4	1	2	Culvert Lined			
Proposed DITCH B Specifications												
ID	From Station (m)	To Station (m)	Length (m)	Slope (%)	Velocity (m/s)	Max. Depth (m)	Bottom Width (m)	Side Slopes (XH:1V)	Class of Riprap (kg)	D50 (mm)		
1	0	45	45	Culvert 5								
2	45	50	5	Gabion steps – 3 meter drop								
3	50	560	510	6 - 15	3.4 - 6.2	1.1	1	2	250	565		
4	560	1026	466	2 - 5	2.0 - 2.9	1.3	1	2	25	260		
5	1026	1120	94	6 - 15	5.0 - 5.4	1	1	2	250	565		
Proposed DITCH C Specifications												
ID	From Station (m)	To Station (m)	Length (m)	Slope (%)	Velocity (m/s)	Max. Depth (m)	Bottom Width (m)	Side Slopes (XH:1V)	Class of Riprap (kg)	D50 (mm)		
1	0	20	20	6 - 15	3.7	1.9	2	2	50	330		
2	20	57	37	2 - 5	1.3 - 2.0	2.9	2	2	10	195		
3	57	90	33	Culvert 1								
4	90	287	197	2 - 5	2.3 - 3.9	1.8	2	2	25	260		
5	287	407	120	6 - 15	5.9 - 7.4	1.5	2	2	500	715		
6	407	624	217	2 - 5	2.9 – 3.1	1.6	2	2	25	260		
7	624	657	33	Culvert 9								
8	657	687	30	2 – 5	2.9 – 3.1	1.6	2	2	25	260		

Figure 6.1-1: Ditch and Culvert Locations



Source: JDS

Figure 6.1-2: Collection Ditches General Arrangement



6.2 EROSION AND SEDIMENT CONTROL PLAN IMPLEMENTATION

This section provides an overview of the construction activities for each year during the construction phase of the project. The overall construction sequencing, and the erosion and sediment control measures based on the BMPs described in Section 4.2 (Sediment and Erosion Control Measures) to be implemented are described below.

For the purpose of this Plan, the following BMPs will be conducted site wide for construction.

- Proper staging of construction activities and BMP installations to mitigate erosion and the potential entrainment of sediment.
- Install berms or sediment logs at the top of fill slopes to protect the newly formed slopes from erosion.
- Apply bioengineering techniques for slope stabilization and channel protection as necessary in the sediment basins, ditches, and on any unstable and/or disturbed slopes and surfaces.
- Apply additional BMPs for slope stabilization and channel protection as necessary in the sediment basins, ditches, and on any unstable and/or disturbed slopes and surfaces.
- Install silt fences or sediment logs around the downslope perimeter of all material stockpiles during construction to prevent sediment migration downslope.
- Monitor, maintain, repair, or replace the mitigating measures listed above throughout Stage 1 construction to ensure BMP effectiveness and efficiency.

6.2.1 Stage 1 Construction

Stage 1 construction refers to the activities taking place in the first year of construction (Table 6.2-1). The scope and sequencing of the Stage 1 Construction activities include the following:

- Upgrade the Haggart Creek Road (Site Access) that include minor realignments, construction of pull outs, grading, resurfacing, and drainage improvements.
- Build water management structures, diversion ditches and the LDSP
- Upgrade existing site access roads by widening and grading to access areas for project construction
- Establish new temporary construction access trails
- Expand the camp including the enlargement to the septic system and drainfield.
- Construct the mine service road to the crusher, stockpile area, and open pit
- Conduct earthworks to establish pads for the topsoil stockpiles, laydown area, crushing installations, truck shop, waste facility, fuel storage, site substation, and 90 day stockpile.
- Clear and excavate the HLF embankment area
- Clear, grub and grade roads, infrastructure and facilities designated in Table 6.2-1
- Excavate and conduct bulk earthworks for the facilities designated in Table 6.2-1

- Construct the initial phases of the IROSA facility, as necessary.

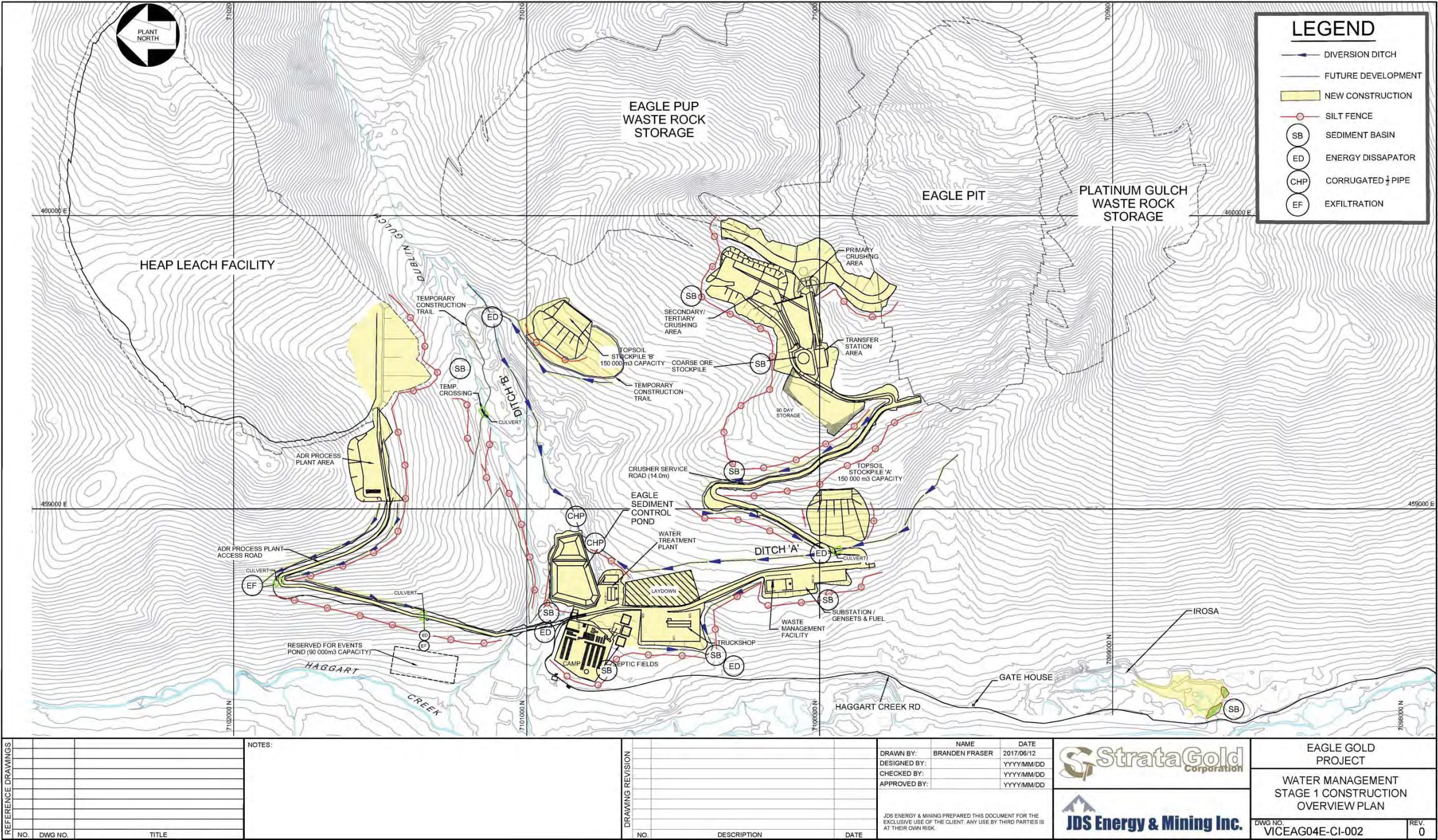
Table 6.2-1: Stage 1 Activities for Roads, Infrastructure and Facilities

Facility	Clear	Excavate
Eagle SCP	X	X
Diversion and collection ditches and sediment and erosion control facilities	X	X
Camp expansion and septic system upgrade	X	X
Laydown area	X	X
Waste Management Facility	X	X
Permanent and temporary crushing and screening plants	X	X
Ice-rich overburden storage area (IROSA)		X
HLF embankment and spillway	X	X
HLF main event pond	X	X
Process plant area	X	X
Truck shop	X	X
Fuel storage	X	X
Topsoil Stockpiles	X	X
Sub-station	X	X

Source: JDS (2017)

Figure 6.2-1 depicts the areas (highlighted in yellow) where earthworks activities are proposed. Note that, except for the Camp area work and the construction of the LDSP and some ditching, no other structures will be built during Stage 1. The following section describes the erosion and sediment control measures to be implemented during Stage 1 Construction.

Figure 6.2-1: Stage 1 Construction Plan



Source: JDS (2017)

6.2.1.1 Stage 1 Construction Water Management Facilities

The following measures will be implemented during Stage 1 to stabilize the Project areas:

- Install silt fences, prior to construction, downslope of proposed collection ditches and mining infrastructure including:
 - o Security entrance
 - o Site water management ditches A and B
 - o Lower Dublin South Pond
 - o Temporary construction access trails
 - o Crusher Service Road
 - o ADR Process Plant Access Road
 - o ADR Process plant pad
 - o Substation, gensets, and fuel storage area
 - o Waste management facility
 - o Camp area
 - o Truck shop pad
 - o Crushing and screening areas
 - o Topsoil stockpiles A and B
 - o Coarse ore stockpile
 - o Initial area of 90 day stockpile
 - o HLF embankment area.
- Construct the LDSP to collect and settle construction generated sediment-laden water;
- Construct site water management ditches A and B, to convey site contact water to the LDSP;
- Install culvert lined ditch sections on ditches A and B where they approach the LDSP;
- Install culverts as necessary under the Crusher Service Road;
- Install culverts as necessary under the ADR Process Plant Access Road;
- Install the culvert on Dublin Gulch for the temporary construction access trail to the HLF area;
- Construct sediment basins in topographical low points downslope of the following facilities/ areas:
 - o One SB West of the LDSP, at the lowest end of the construction area;
 - o One SB South of the HLF embankment area (water collected and pumped to ditch B), at lowest point of construction activity;
 - o One SB at the North end of the Secondary Tertiary crushing area, and grade the area to allow runoff to flow into the basin;
 - o One SB at the North end of the Coarse Ore Stockpile area, and grade the area to allow runoff to flow into the basin;
 - o One SB in the southwest portion of the truck shop pad and grade the area to allow runoff to flow into the basin;
 - o Construct SB's where required to collect from areas generating runoff and as determined by the engineer in the field.
- Construct two exfiltration areas downslope of the following facilities/areas:

- o Northwest of the first bend in the Process Plant Access Road, to handle the water flow from uphill of the process plant access road and plant area;
 - o At the discharge end of the Process Plant Access Road ditch.
- Construct diversion ditches on site to channel non-contact water away from the construction areas. These will be sized as required as a Type 1, Type 2 or Type 3 ditch, by a field engineer when in construction:
 - o One ditch downhill of the Process Plant Access Road to divert water to an energy dissipater and then to the exfiltration area;
 - o One ditch uphill (North) of the Process Plant Access Road to divert non-contact water away from site into an exfiltration area;
- Construct diversion ditches to channel contact water to the main site sediment control ditches A and B, the LDSP, or to a suitable SB. These will be sized as required as a Type 1, Type 2 or Type 3 ditch, by a field engineer when in construction:
 - o Downhill of the of the topsoil stockpile B;
 - o Alongside the Crusher Service Road;
 - o Downhill of the waste management facility and truck shop pads.
- Install rock energy dissipation structures at the end of the diversion ditches where the ditches tie into the natural drainage. This protects the natural drainage from higher velocity flows released from the diversion ditch. Vegetation management will be implemented downslope of the diversion ditch to ensure the flow does not erode natural ground.
- Install rock energy dissipation structures at the outlet end of culverts to reduce the higher velocity flows.

6.2.2 Stage 2 Construction

The following sections describe water management measures for the areas depicted on Figure 6.2-2 and to be implemented during Stage 2 Construction, which refers to the second year of construction. Table 6.2-2 lists the areas of construction with respect to clearing, excavating and foundations for Stage 2. As the Project progresses into Stage 2 construction, some of the temporary sediment and erosion control measures can be decommissioned and reclaimed. Periodic monitoring and maintenance of the erosion and sediment control measures established during Stage 1 of construction will continue throughout Stage 2, as well as the additional structures completed for Stage 2.

Table 6.2-2: Stage 2 Activities for Roads, Infrastructure and Facilities

Facility	Clear	Excavate	Foundation
Sub-station	X	X	X
Concrete batch plant area	X	X	
Waste Management Facility	X	X	X
Transmission line Right-of-Way	X		
Crushing and screening plants		X	X

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Facility	Clear	Excavate	Foundation
Overland conveying system	X	X	X
Ice-rich overburden storage area (IROS)		X	
HLF Phase I	X	X	
HLF embankment and spillway		X	X
HLF main event pond	X	X	
Process plant area including ADR plant refinery and laboratory	X	X	X
Truck shop, mine offices and fuel storage	X	X	X
Magazine and AN / emulsion (explosives) storage areas and access road	X	X	
Lime and cement silo addition area	X	X	X

Source: JDS (2017)

The scope and sequencing of the Stage 2 Construction activities include:

- Construct the HLF service road;
- Construct the HLF Phase 1 upper diversion ditch, sediment basin and exfiltration area;
- Construct the HLF Phase 1 strip;
- Excavate and construct the HLF Phase 1;
- Clear, excavate and construct the HLF main event pond and spillway;
- Excavate and construct the overland conveyor strip;
- Construct filter berms, as required, in the IROS;
- Set up and operate the concrete batch plant;
- Erect the ADR plant, metallurgical laboratories, administration office and reagent storage buildings;
- Build the sub-station;
- Construct the access road and erect the magazine and explosives storage facilities;
- Develop the lime and cement addition area;
- Complete unfinished earthworks started in Stage 1 for the:
 - o Coarse ore stockpile and 90 day storage;
 - o Crushing and screening plants;
 - o Truck shop, mine offices and fuel storage areas; and
 - o HLF embankment completion;

The following section describes the erosion and sediment control measures to be implemented during Stage 2 construction.

6.2.2.1 Stage 2 Construction Water Management Facilities

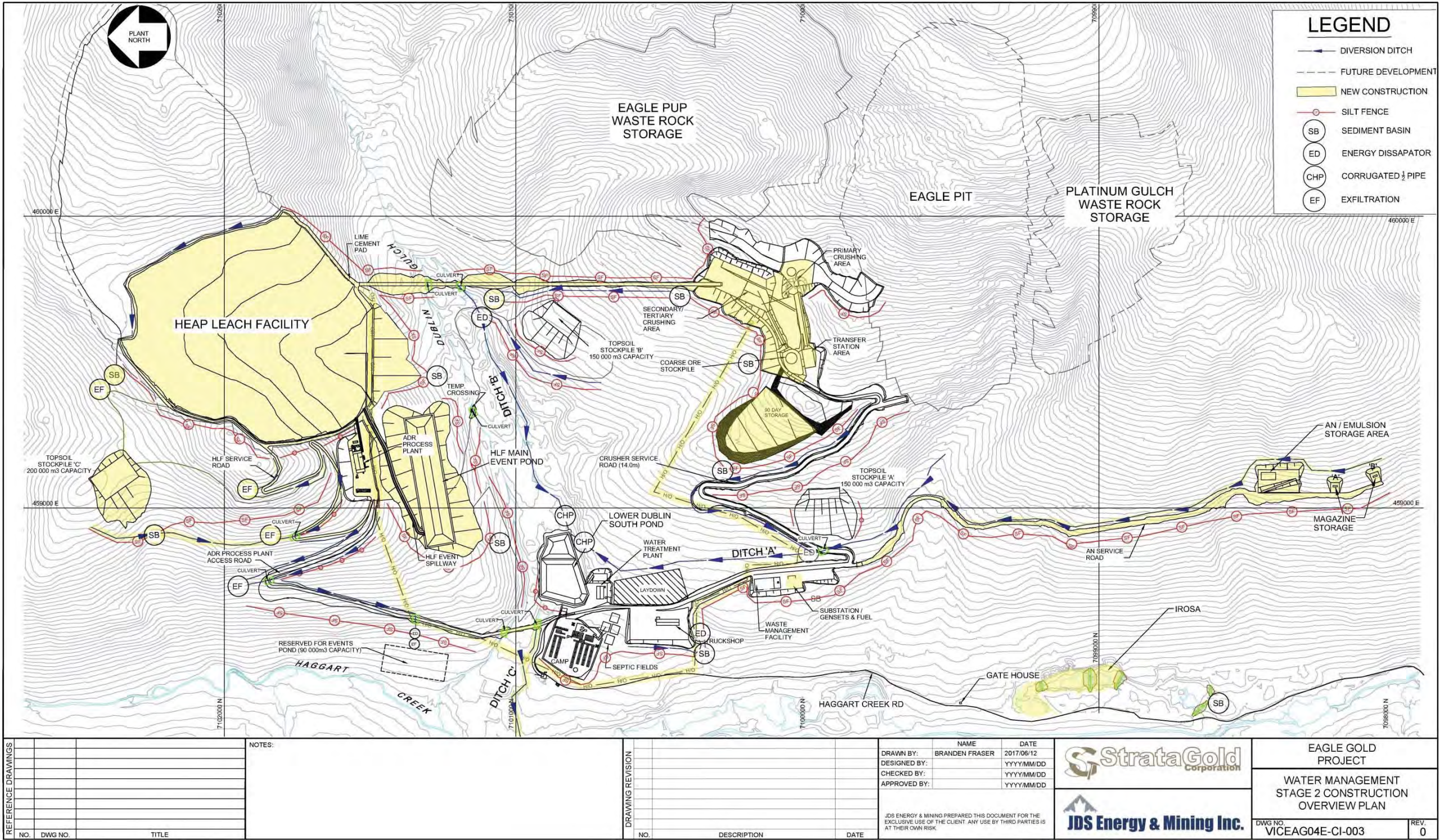
The following measures will be implemented in Stage 2 to stabilize the Project areas:

- Install silt fences, prior to construction, downslope of proposed collection ditches and mining infrastructure including:
 - o HLF;
 - o Site water management ditch C;
 - o HLF service road;
 - o HLF spillway and main event pond;
 - o AN service road
 - o Magazine and AN / emulsion (explosives) storage area
 - o Crushing and screening areas;
 - o Topsoil stockpile C;
 - o 90 day stockpile area;
 - o Overland conveyor right of way (ROW).
- Install the culverts in the Dublin Gulch and Eagle Creek crossings for the ADR process plant service road;
- Install the culverts in the Dublin Gulch and Eagle Creek crossings for the overland conveyor ROW;
- Install culverts as necessary for the HLF service road;
- Construct site water management ditch C, from the LDSP to Haggart Creek;
- Construct diversion ditches on site to channel non-contact water away from the construction areas. These will be sized as required as Type 1, Type 2 or Type 3 ditches by a field engineer when in construction:
 - o One ditch on the north uphill side of the HLF (phase 1) that channels water away from the construction area to the west of the HLF;
 - o One ditch uphill of the AN / emulsion and magazine storage areas, and their access road.
- Construct diversion ditches to channel contact water to the main site sediment control ditches A and B, the LDSP, or to a suitable SB. These will be sized as required as Type 1, Type 2 or Type 3 ditches by a field engineer when in construction:
 - o Downhill of the of the topsoil stockpile C;
 - o Alongside the HLF Service Road;
 - o One ditch along overland conveyor ROW, on the south portion between the crusher plants and ditch B, downhill on the west side;
- Construct sediment basins in topographical low points downslope of the following facilities/ areas:
 - o One SB at the west discharge end of the HLF upper diversion ditch;
 - o One SB southwest of the topsoil stockpile C, at the lowest end of the construction area;
 - o One SB at the north end of the 90 day stockpile area, and grade the area to allow runoff to flow into the basin;

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- o One SB west of the overland conveyor ROW, uphill of the diversion ditch B;
 - o Construct SB's where required to capture runoff as determined by the engineer in the field.
- Construct three exfiltration areas downslope of the following facilities/areas:
 - o At the discharge of the upper HLF diversion ditch, at the west end;
 - o One at the first switchback of the HLF service road;
 - o One at the third switchback of the HLF service road.
- Install rock energy dissipation structures at the end of the diversion ditches where the ditches tie into the natural drainage. This protects the natural drainage from higher velocity flows released from the diversion ditch. Vegetation management will be implemented downslope of the diversion ditch to ensure the flow does not erode natural ground.
- Install rock energy dissipation structures at the outlet end of culverts to reduce the higher velocity flows.

Figure 6.2-2: Stage 2 Construction Plan



Source: JDS (2017)

6.3 SANITARY WASTEWATER MANAGEMENT

The existing 100-person camp at the site uses a mechanical wastewater treatment plant with a absorption field 28.6 m wide x 31.5 m long (area of 900 m²). A 400-person camp is projected for the construction phase. The septic field design, however, has been completed for a 450-person camp, to allow for potential future contingency.

EBA's (2013) report, On-Site Sewage Disposal System Design and Construction Recommendation, summarizes the test pitting and percolation testing program, and the EBA (2017) report, 2017 Review and Revisions of the 2013 On-Site Sewage Disposal System Design Camp Expansion – Dublin Gulch Property (Eagle Gold Project), YT presents an on-site sewage disposal system design.

The absorption field expansion required for a 450-person camp from a 100 person camp is 3,217.5 m² (EBA 2017). The design percolation rate is 16 minutes per 25 mm from percolation testing in the vicinity of the proposed absorption fields. The 450-person camp requires an absorption field that can handle 85,500 L per day, which equals 4,117.5 m². Three additional fields 31.5 m by 34 m totaling 3,217.5 m² are planned in addition to the existing 900 m² field to accommodate the 450-person camp. Three additional absorption fields are planned north of the existing field.

Each absorption field is equipped with two trickle septic tanks, one with a B2500S Series 11,350 L compartment with baffle and effluent filter, and one H2000 Series with a 9,092 L working capacity, yielding a capacity of 20,442 L per field for a total of 61,326 L of additional capacity to the existing field. The total calculated volume requirement is 69,225 L. A 50 mm layer of insulation is recommended for each tank to protect it from freezing and add to the strength of the tank during shipping and installation. An effluent filter is required in the lead trickle tank to prevent solids from entering the rest of the system.

Each set of septic tanks discharges to a pumping chamber to feed its dedicated absorption field. The size of the pumping chamber is designed to fill the piping in the absorption field to 80 percent of the aggregate pipe volume. Each pumping chamber is equipped with a submersible pump to feed the force main from pumping chamber to the distribution manhole for its absorption field.

The three additional absorption fields consist of four quadrants of perforated pipe connected by 100 mm pipe manifolds to the distribution manhole. Each quadrant contains 14 runs of 100 mm perforated pipe. The pipe is laid on a scarified ground surface covered with 75 to 300 mm of leveling sand with less than 3 percent fines. Each pipe is covered with an infiltrator chamber, surrounded by free draining sand, and covered with up to 1,800 mm of minimally compacted native backfill.

6.4 CONSTRUCTION WATER USES

Construction water uses for the project include potable water, dust suppression, wash water, and construction uses involved primarily in making concrete. Estimated water usage varies with season and construction activity throughout the construction period from approximately 1910 m³/month to 29,242 m³/month. A breakdown of the projected water use by month is noted in Table 6.3-1

Table 6.3-1: Project Construction Water Usage by Month (m³/month)

	Potable	Concrete	Wash Water	Dust Suppression	Totals

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First Year of Construction					
August	930	0	250	8392	9572
September	1860	0	250	16783	18893
October	2325	0	250	1134	3709
November	2325	0	150	0	2475
December	1860	0	150	0	2010
January	1860	0	100	0	1960
February	1860	0	50	0	1910
Second Year of Construction					
March	2325	0	50	0	2375
April	2790	0	50	1134	3974
May	3255	200	125	16783	20363
June	3720	400	125	24797	29042
July	3720	600	125	24797	29242
August	3720	600	125	24797	29242
September	3720	600	100	16783	21203
October	3255	200	50	1134	4639
November	2790	150	50	0	2990
December	2790	0	50	0	2840
January	2325	0	50	0	2375
February	1860	0	50	0	1910

Source: JDS

Potable water consumption is estimated in accordance with the projected population of the camp. Consumption rates range from 930 m³/month to 3,720 m³/month, with the more consumptive months occurring during the ice-free season.

Dust suppression is estimated on the basis of season and number of dry days per month for a typical year. Water for dust suppression water will come from a number of sources, including: 1) the Lower Dublin South Pond, 2) Dublin Gulch, 3) Haggart Creek and/or groundwater as needed. Monthly usage ranges from 0 m³/month in November through March to approximately 24,800 m³/month in the months of June, July, and August. Estimates are calculated from the area of roads to be treated and the average number of dry days per month, reaching a maximum of 20 days/month in dry months.

Wash water includes water to wash trucks and equipment and varies with seasonal activity. Estimated wash water consumption varies from 50 m³/month to 250 m³/month, with highest projected usage in the summer months with intensive construction activities.

Construction uses include making concrete and washing the aggregate necessary to make concrete and other uses that required sizing of aggregates. These uses are projected to be confined to the months of May through October when the weather is favorable for these activities. No construction uses for concrete are projected for the months of November through April. A maximum usage of 600 m³/ month is projected for months for which aggregate sizing and concrete-making activities are planned.

6.5 FROZEN MATERIAL MANAGEMENT

Earthworks construction and some operational activities of the Project will result in the excavation and exposure of frozen overburden soils, identified as either permafrost or from within the active zone that freezes seasonally. Frozen soils at the project site consist of:

- fine and/or coarse-grained colluvial/alluvial soils or weathered bedrock with little or no ice content,
- coarse-grained sands and gravels with zones of variable ice content,
- fine-grained soils with relatively thin zones (lenses) and low proportions of “excess ice”, and
- fine-grained silty and clayey soils with relatively thick lenses of highly visible “excess ice”.

The term “excess ice” is used to describe ice that occupies a larger pore space in the soil than water in an unfrozen state. When this ice thaws, the resulting water exceeds the water holding capacity of the soil and excess water will be present. Some of the frozen soil with excess ice, hereafter called “ice rich”, may become unstable upon thawing, particularly if it is fine-grained and excess pore water pressure cannot drain readily. Some of these materials, which could potentially be useful in closure activities (e.g., as cover for reclamation) while thawing and draining, may require temporary containment during construction and operation of the mine.

The Frozen Materials Management Plan (FMMP) describes the management of frozen materials, and includes:

- descriptions of existing site conditions pertinent to materials management;
- protocols for characterizing the nature and extent (lateral and vertical) of frozen materials encountered during construction activities including characterizing the presence and extent of excess ice;
- protocols for determining whether encountered frozen material is thaw stable or thaw unstable;
- estimated quantities of frozen materials to be handled during construction distinguishing between material types and different approaches for their management;
- descriptions of appropriate handling requirements for each frozen material type, including protocols for excavation and removal of thaw unstable material from drainage channels, valley walls, etc.;
- design criteria and preliminary engineering for an ice rich overburden storage area;
- construction quality assurance and quality control planning for the ice rich overburden storage area;
- protocols for recording and reporting on the characterization and management of frozen soils (including thaw stable and unstable materials), and
- monitoring plans for stability and associated water management.

Because of the nature of thawing frozen material and the potential for generation of sediment-laden water, the activities associated with the FMMP have been integrated into the overall site WMP. The While the FMMP addresses the identification, field practices and overall management of all frozen materials,

including permafrost and ice-rich soils, this WMP describes best management practices for containing and controlling sediment laden runoff from areas developed in permafrost terrain.

The Ice Rich Overburden Storage Area (IROSAs) will serve as a dewatering area for any ice-rich material that is excavated during construction and operations. The design (Appendix A in the FMMP) is based on the concept of flow-through berms that permit the exfiltration of excess water to the subsurface while filtering out sediments suspended in the excess pore water. The design consists of five berms to create four storage cells for containing the thawing ice-rich materials.

6.6 CONCRETE WATER MANAGEMENT

A batch plant will be used during construction to provide the concrete necessary for foundations, channels, and other structures. Placer tailings, natural gravels, crushed bedrock, and other sources may be processed in this area to provide aggregate for concrete, bedding materials for liners, and a variety of other uses.

Water used for washing gravels and cleaning equipment will be captured in a small basin to capture sediment-laden water. The sediment basin will be designed in accordance with BMPs to contain the sediment and also to allow water to infiltrate into the subsurface. The optimum location for the batch plant is still being evaluated, however, it will be situated somewhere within the catchment area of the LDSP that drains to Ditch A, such that any excess water generated during washing will be intercepted by Ditch A and conveyed to the LDSP.

6.7 CONSTRUCTION DEWATERING

Several areas of the site may require dewatering during construction, most notably the foundation area for the HLF embankment. In general, excavations in saturated materials including placer tailings, natural alluvium, colluvium, and weathered bedrock may result in sediment-laden waters flowing from the cut face. These waters will be diverted into a sediment basin to prevent the discharge of sediments into the natural streams on the site. HLF dewatering will be collected in the SB and then pumped to Ditch B, where it will be conveyed to the LDSP. In general, temporary channels will be constructed, as needed to contain the sediment-laden runoff prior to discharge or pumping to a controlled water conveyance facility, or exfiltration to the subsurface.

6.8 MAINTENANCE AND MONITORING STRATEGIES

Regular monitoring of implemented BMPs is essential to the success of the Plan. The contractor will inspect all erosion control measures periodically and after each major runoff-producing rainfall event. Frequent and proper maintenance will allow for prolonged use instead of allowing the facilities to degrade and in need of full replacement.

Silt fences, sediment traps/basins, ditches, culverts, exfiltration areas, and water management basins/ponds will be visually inspected for the following:

- excess sediment build-up;
- structural/physical integrity,
- anticipated wear and tear, and

- snow/ice build-up.

Where certain structures are found to have permafrost or saturated backslopes on the cut slopes, the maintenance of suitable equipment access corridors will be included in the design to allow for maintenance of those cut slopes.

Water storage and conveyance structures will be designed to allow for suitable access to undertake maintenance activities. Maintenance, of the LDSP, sediment basins and other water management structures will be performed as required and would include:

- work required to physically stabilize structures;
- the removal ice or snow to minimize the accumulation within basins/ponds, culverts and water conveyance channels;
- the removal of sediment from ditches, SBs and the LDSP;
- the stabilization and development of adequate drainage from any saturated or permafrost cut slopes
- the repair any damaged liner, armouring materials or installed erosion control products; and
- the repair or replacement of any damaged or faulty monitoring or control instrumentation or equipment.

For the LDSP, the potential for seepage and settlement need to be considered. Thus, survey monuments will be located along the crest and possibly on the discharge structures. Further, piezometers will be installed through the embankment and equipped with transducers to monitor evolving hydrostatic pressures. Further, flow from the LDSP to ditch C will be monitored with a V-notch weir installed at the downgradient end of the outflow pipe that discharges to ditch C. These monitoring locations will be in addition to the routine visual inspections that would need to be conducted and documented as part of periodic CDA-related inspections. LDSP monitoring protocols will be included in the overall Environmental Monitoring, Surveillance and Adaptive Management Plan.

7 OPERATIONS WATER MANAGEMENT

The effluent quality standards that must be met during operations as identified in Water License QZ14-041 are listed in Table 7.1-1

Table 7.1-1: Effluent Quality Standards during Operations

Parameter ¹	Maximum Concentration in a Grab Sample
pH	6.5 – 8
Total Suspended Solids (TSS)	15.00 mg/L
Sulphate	1850 mg/L
Chloride	250 mg/L
Nitrate-N	19.5 mg/L
Nitrite-N	0.12 mg/L
Ammonia-N	7.5 mg/L
Total Cyanide	1.0 mg/L
WAD Cyanide	0.03 mg/L
Aluminum (Dissolved)	0.4 mg/L
Antimony	0.13 mg/L
Arsenic	0.053 mg/L
Cadmium	0.00125 mg/L
Copper	0.026 mg/L
Cobalt	0.026 mg/L
Iron	6.4 mg/L
Lead	0.05 mg/L
Mercury	0.00008 mg/L
Manganese	7.7 mg/L
Molybdenum	0.45 mg/L
Nickel	0.50 mg/L
Selenium	0.025 mg/L
Silver	0.01 mg/L
Uranium	0.09 mg/L
Zinc	0.23 mg/L

. 1 – All concentrations are total values

For the purpose of this Plan, the project area is defined as the area of disturbance encompassing the entire site, including the Eagle Pit, Platinum Gulch WRSA, Eagle Pup WRSA, the HLF, haul roads, crushing and screening plants, overland conveyor, ADR Plant, the camp and administration areas, the AN / emulsion and magazine storage, all the site roads and all the support facilities as shown on Figure 1.1-2. Water management of the site is focused primarily around the Lower Dublin South Pond, and the conveyance there by Ditch A and Ditch B. Sediment-laden runoff from cleared areas as well as water from the open pit depressurization and dewatering operations will be directed to the LDSP where

possible. No contact water will report to the environment outside of this facility. Any other potentially sediment-laden water will be controlled in supplemental sediment basins or exfiltration ponds, as necessary, to meet discharge criteria for TSS.

Once operations begin, construction of additional water management infrastructure is not anticipated as most of the ditches and sediment control devices should have already been established during the construction stages of the Project. However, proper maintenance of these devices and structures is critical in their performance and ability to control surface water and sediments. These devices and structures will be routinely checked periodically and replaced or repaired if needed.

7.1 SURFACE WATER ROUTING

Clean surface water is anticipated to have been diverted around key infrastructure prior to operations. However, additional ditches may need to be implemented and will be evaluated at that time. Sediment-laden water will be collected and managed to prevent sediments from migrating into Dublin Gulch or Haggart Creek. See Figure 6.2-1 and Figure 6.2-2 for proposed sediment control devices and locations.

7.2 KEY WATER MANAGEMENT FACILITIES

See Figure 7.2-1 for location of proposed water management facilities.

7.2.1 Open Pit

During operations, water management will begin in and around the open pit due to the importance of maintaining the integrity of pit slope stability. As summarized above in Section 5.5 and described by BGC (2014), due to the relatively low hydraulic conductivity of the rock mass in the open pit area, dewatering wells are not likely to provide a practical or economically efficient means of depressurizing the open pit slopes. Horizontal drains are anticipated to be the primary method for depressurizing the pit slopes over the life of the mine to maintain stability of the pit walls and to manage pit wall seepage and most of the inflows. The number and location of the horizontal drains will be adapted in the field to match conditions observed in the open pit as it is excavated and monitored. These drains could be supplemented with vertical pumping wells in areas of relatively high hydraulic conductivity. The water captured from here will be pumped to Ditch A where it will flow to the LDSP.

7.2.2 Lower Dublin South Pond

The LDSP (Figure 5.4-2) will serve two purposes throughout the mine life. During construction it will serve as a sediment control pond, collecting sediment-laden water from various areas around the Project via ditches. During operations the LDSP will serve as an operational storage pond that accumulates runoff and mine water routed from Eagle Pup WRSA, Platinum Gulch WRSA, and the open pit. This water can then be dispatched to the HLF as makeup water, routed to treatment, or discharged provided that the water meets discharge requirements. Excess water from the LDSP above the assumed process make-up requirements, will be sent to Haggart Creek via the mine water treatment system (as necessary).

Prior to the operations phase, any additional pond lining requirements will be established.

7.2.3 Heap Leach Facility

The HLF valley fill design incorporates a rock filled embankment (dam) that will provide stability to the base of the heap and the stacked ore. The dam also creates an In-Heap Pond leaching configuration that provides storage of pregnant solution within the pore spaces of the ore. The major design components for the HLF, which are incorporated primarily for solution management purposes, include the following:

- a rock filled embankment (dam) and the In-Heap Pond;
- a composite liner system;
- solution recovery wells;
- associated piping network for solution collection and distribution;
- a leak detection and recovery system (LDRS); and
- a down-stream Events Pond.

The heap leach pad will consist of two liner systems: an up-gradient liner system and the In-Heap Pond liner system. The single composite liner system in the upper portion of the pad (above the in-heap solution storage area) will be comprised of a double-side textured 60 mil linear low-density, polyethylene (LLDPE) liner over a geosynthetic clay liner (GCL) system. The double composite liner system in the lower portion of the pad (forming the in-heap solution storage area) will be composed of two discrete layers of LLDPE liner, separated by a layer of geonet material to form the LDRS, over a GCL system.

Process (barren) solution containing cyanide will be applied to the ore via a drip irrigation system (buried during winter). The resultant pregnant leach solution (PLS) will be captured in the solution collection system and flow to the In-Heap Pond. The PLS will be recovered via a sump and using pumps and standpipes. The PLS will be transferred to the ADR plant for gold recovery.

The heap leach pad is designed to contain a network of pipes that will be distributed throughout the limits of the facility at the base of the ore pile. This pipe network will collect and convey PLS and an infiltrated stormwater to the In-Heap Pond where it will be pumped to the process plant via the solution collection wells.

The downstream Events Pond will serve as an overflow containment area that provides additional solution storage in case the In-Heap Pond capacity is exceeded. Any water collected in the events pond will be pumped back to the ADR plant for use as make up water for the barren solution. Prior to construction of the MWTP, the ADR plant will be equipped to function as a cyanide destruct circuit in the extreme case that there is excess cyanide solution that needs to be treated.

7.2.4 Mine Water Treatment Plant

Based on the WBM and the WQM, the HLF system is predicted to be in a negative balance during Phase 1, such that the initial water management strategies during start-up through the end of Phase 1 of the HLF, indicate that any additional volume and rate of contact water delivered to the LDSP can be controlled through general water management strategies (e.g., using water for process make-up water) and additional adaptive water management strategies (e.g., use of evaporators and/or snowmakers

depending on season, use of events ponds for temporary storage for process make-up water). Thus, a mine-water treatment plant is not anticipated for Phase 1.

A MWTP is proposed to treat a varying combination of site contact water originating from the open pit and WRSAs during phases 2 to 5, as well serving as a back-up to treat excess water from the HLF primarily during the initial drain-down (Phase 6) (Linkan 2014a). The proposed MWTP will be constructed adjacent to the LDSP and just east of the Camp. This site provides good access for chemical delivery trucks and minimizes major pipe runs. The MWTP raw water feed during Phases 2-5 from the LDSP to the plant will be an insulated and heat traced HDPE pipeline. Phase 6 feed water will also be transferred from the ADR to the plant through a heat traced and insulated HDPE pipeline approximately. The MWTP will be designed to be flexible and expandable to accommodate a wide range in flows.

Contact water quality, MWTP EQSs, and anticipated flow rates from the LDSP to the MWTP were simulated by the WQM (Section 5.3). During the Phases 2 to 5, the MWTP will treat arsenic (As) and antimony (Sb). Water quality modeling also indicated that during closure Phase 6 (i.e., primarily drain-down of the HLF) 11 parameters may require treatment. These parameters include pH, TSS, nitrate, nitrite, WAD CN, As, Sb, Pb, Hg, Se, and U. Detailed bench testing (Linkan 2014b) for these parameters provided the basis of the MWTP design. Water management strategies during closure are described in the Reclamation and Closure Plan.

Based on the WQM, the total annual treatment volume during Phases 2-5 is 865,000 m³/yr (or 98.7 m³/hr), and the maximum estimated MWTP daily average influent flow rate primarily during freshet seasons is 160 L/s (or 576 m³/hr). This works out to an instantaneous influent flow of 188 L/s assuming 20.4 hrs/day of continuous treatment operations to achieve the daily average influent flow of 160 L/s. Thus, 3.6 hrs/day will be dedicated to backwashing the microfiltration (MF) units and cleaning. Based on simulated flows and water chemistry the water treatment process to meet the treatment needs is represented in Figure 1 of Linkan (2014a).

During Phases 2-5, the MWTP will treat excess water from the LDSP that exceeds site specific water quality criteria for As and Sb. Raw water from the LDSP will be transferred to the MWTP through an HDPE pipeline to the reaction tank where chemicals will be added to create iron floc for As and Sb adsorption and pH adjustment. The floc will then be pumped to inline plate clarifiers for settling. The decanted water will feed the MF units where any remaining unsettled solids will be removed. Settled solids from the clarifiers will be pumped to the thickener. Thickened solids will be pressed in a plate and frame filter press and sent to the low pH repository. The press filtrate and thickener decant will be returned to the reaction tank. Captured suspended solids from the MF will also be returned to the reaction tank to be settled in the clarifiers. MF filtrate water will then be pH-adjusted and dechlorinated as needed to meet discharge standards and sent to the permeate tank. Treated water in the permeate tank will then be discharged to Haggart Creek in accordance with site specific water quality criteria. Technical specifications for the MWTP are described in detail in Linkan (2014a).

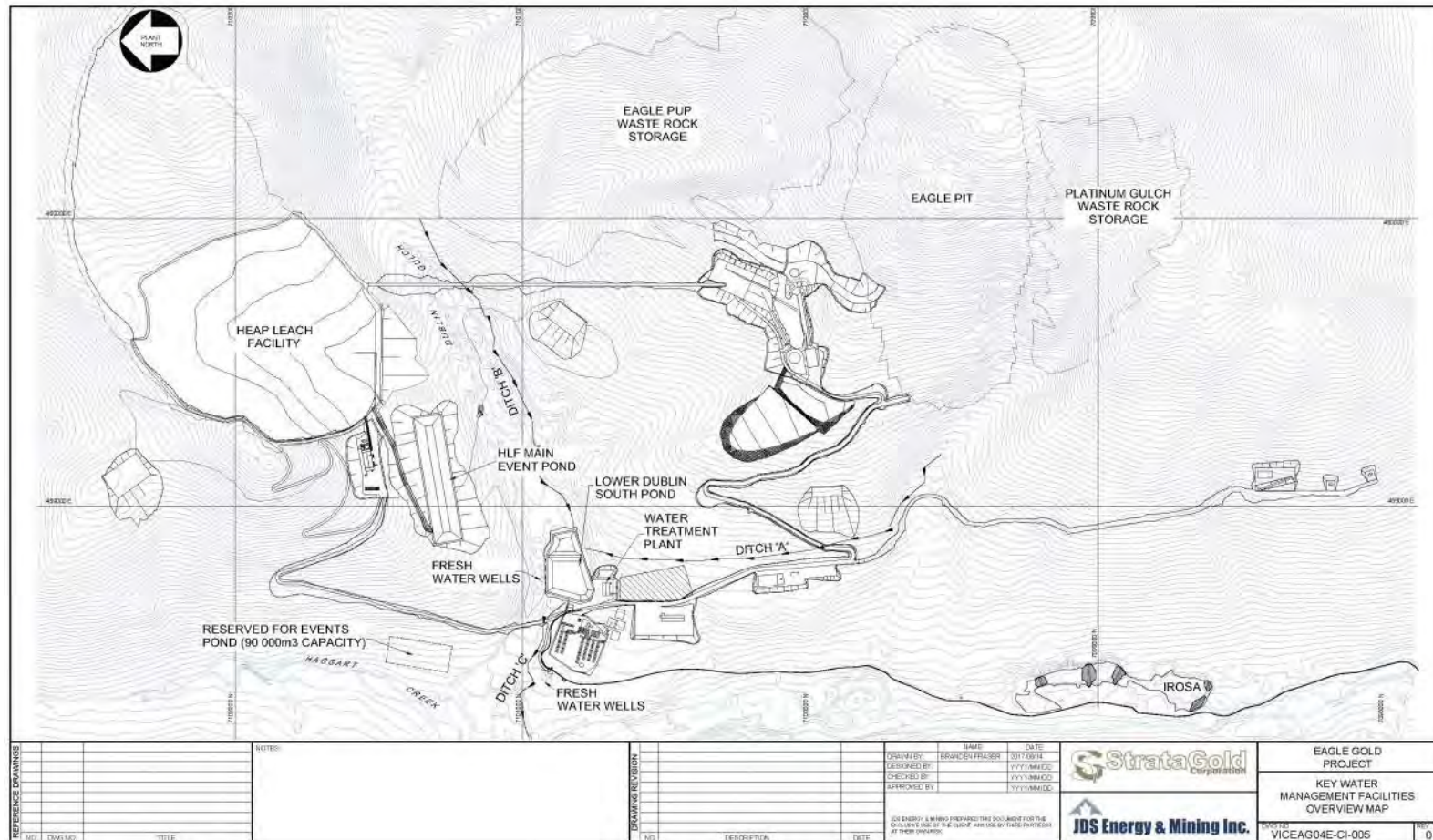
The MWTP will produce two types of solids during its life of service: low pH solids, and high pH solids. Low pH solids will be generated during both the operational Phases 2-5 and closure Phase 6. These solids consist of the ferric chloride coagulation treatment process solids. The low pH solids will be pressed with a plate and frame filter press and disposed of in a lined repository as described by Engineering Analytics (2014) and situated just southeast and uphill from the MWTP. High pH solids will only be generated during the early closure (Phase 6). This treatment process targets the removal of

mercury and other heavy metals. These solids will be pressed with a plate and frame filter press and disposed of within the cover of the HLF.

7.2.5 Maintenance and Monitoring Strategies

All the maintenance and monitoring activities described in Section 6.8 for construction will be continued into and through operations. As surface conditions stabilize, the focus will be less on sediment and erosion control and more on the regular monitoring and maintenance of the stability and condition of water management structures including the main collection ditches, the LDSP and events pond, the ditching and collection of seepage from the WRSAs, the downslope monitoring of the temporary ore stockpile, the reclamation stockpiles and the IROSA. As during construction, monitoring frequencies will be both periodic (as a routine inspection through the year), and after major runoff producing events.

Figure 7.2-1: Key Water Management Facilities Overview Plan



Source: JDS (2017)

8 WATER DISTRIBUTION

Water distribution systems for the Project include fresh water, potable water, process water, and firewater systems. Included in the process water systems are the facilities to contain, transport, and distribute mine-influenced water (MIW). The arrangement of water distribution facilities on the site is depicted in Figure 8.1-1. The figure also shows the general routing of water flows coded by color.

Section 8 Water Distribution

Figure 8.1-1: Mine Site Water Distribution Plan



8.1 FRESH WATER

The freshwater system provides water for freshwater process needs, reagent mixing, wash down water, process make-up, truck washing, fire suppression, and potable water use. Fresh/fire water infrastructure includes a fresh water booster tank and pumps at the well field, water supply pipeline, fresh/fire water tank, and freshwater distribution piping.

The source of freshwater will be wells constructed in the alluvial valley fill near the confluence of Haggart Creek and Dublin Gulch, and to the West of the Lower Dublin South Pond. The well pumps feed discharge into a booster tank and pumps that feed the freshwater/firewater tank at the ADR Process Plant, and to the potable water treatment system, the camp firewater tank, and the truckshop firewater tank. The booster tank also feeds trucks for the mine site dust control and wash water. Design criteria for the freshwater system are presented in Table 8.1-1.

Table 8.1-1: Fresh Water Design Criteria

Factor	Criterion	Source
Peak freshwater demand	127,000 m ³ per month	KP, 2014
Fire suppression needs – ADR Plant	250 m ³ /hr for 2 hrs	Hatch
Fire water storage requirement – ADR Plant	500 m ³	Calculated
Fresh water storage – ADR Plant	75 m ³ /hr x 2 hrs = 150 m ³	Hatch
Fresh/Fire water tank capacity – ADR Plant	650 m ³	Calculated
Fire suppression needs – Camp	125 m ³ /hr for 2 hrs	Estimate 1 standpipe
Fire water storage – Camp	250 m ³	Calculated
Fire suppression needs – Truckshop	125 m ³ /hr for 2 hrs	Estimate 1 standpipe
Fire water storage – Truckshop	250 m ³	Calculated

8.2 PROCESS WATER

Process water requirements are primarily associated with make-up water to the Barren Solution Tank and for reagent mixing. MIW from Lower Dublin South Pond will be a significant source of make-up water to the Barren Solution Tank, supplemented by fresh water when MIW is not available in sufficient quantity. Make-up water demand is expected to peak at start-up, as shown in Table 8.1-1. Water for reagent mixing will be supplied by the fresh water tank.

8.3 POTABLE

The potable water system is supplied from wells in the alluvial valley to the potable water treatment system at the camp area. The water is treated by ultraviolet radiation or chlorination to eliminate bacterial concerns and stored in a potable water tank (Figure 8.1-1). Potable water will be distributed by booster pumps and piping to

the administration building, camp, change house/mine dry, and Mine Water Treatment Plant. Potable water will be distributed by truck to the two main working buildings on site, including the truck shop and ADR building. The design criteria for the potable water system are presented in Table 8.3-1.

Table 8.1-1: Potable Water Design Criteria

Factor	Criterion	Source
Projected mine population	400	JDS
Potable water needs, per person per day	300 L	JDS
Potable water storage requirement	24-hr supply	JDS
Potable Water Storage Capacity	110 m ³	JDS

8.4 FIRE SUPPRESSION

Fire suppression water will be provided by fire water tanks located at the ADR Process Plant, at the camp site, and at the truckshop. The ADR Process Plant tank will be for the plant's fresh water and firewater needs, with the bottom 500 m³ storage dedicated to the plant and laboratory firewater system. It will feed to hydrant standpipes, and be equipped with jockey pumps and back up diesel jockey pump in case of power failure. The camp and administrative buildings will have a dedicated firewater system, also with pump and back up diesel generator power supply in case of power failure. The truck shop will also have a stand alone firewater tank with pump and back up diesel generator jockey pump. Capacities are listed in Table 8.1-1.

8.5 DUST CONTROL

During operations, most of the water for dust suppression will be pumped into water trucks from the water management LDSP. Peak dust suppression demand is projected to occur in the months of June, July, and August and is estimated to be 960 m³ per day (Knight Piésold 2014). Supplemental water for dust control will be sourced from groundwater wells and stored in the Fresh/Fire Water head tank, as needed. Dust control demand is variable throughout the year, with the winter months requiring no dust control.

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APPENDIX A

IFC Design Specifications and Drawing Package

WATER MANAGEMENT PLAN

NELPCo EAGLE GOLD MINE, YT



SITE LOCATION
SCALE: NTS

ISSUED FOR CONSTRUCTION

CLIENT		PROJECT NO. WTRM03037-01	OFFICE VANC	DES	CKD	REV	DRAWING
				DH	MH	1	
DATE July 14, 2017			SHEET No. of	DWN	APP	STATUS	G1.00
				JDM	MH	IFC	

INDEX OF DRAWINGS	
DWG No.	DESCRIPTION
G1.00	COVER SHEET
G1.01	DRAWING INDEX, GENERAL NOTES, SPECIFICATIONS AND QUANTITIES
G1.02	GEOTECHNICAL SPECIFICATIONS AND NOTES
G1.03	SEDIMENT AND EROSION CONTROL DETAILS
G1.04	BOREHOLE LOCATION PLAN
C1.00	GENERAL ARRANGEMENT - SITE PLAN
C1.01	LOWER DUBLIN SOUTH POND - PLAN
C1.02	LOWER DUBLIN SOUTH POND - PROFILES
C1.03	LOWER DUBLIN SOUTH POND - TYPICAL SECTIONS
C1.04	LOWER DUBLIN SOUTH POND - SPILLWAY PLAN AND PROFILE
C1.05	LOWER DUBLIN SOUTH POND - SECTIONS AND DETAILS
C1.06	LOWER DUBLIN SOUTH POND - LOW LEVEL OUTLET AND PUMPHOUSE
C1.07	CULVERT SECTIONS AND DETAILS
C1.08	DITCH DETAILS

GENERAL NOTES:

1. THIS PROJECT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE CONTRACT PLANS AND SPECIFICATIONS AND ANY RULES, REGULATIONS, STANDARDS OR SPECIFICATIONS REFERENCED THEREIN.
2. THE CONTRACTOR SHALL COMPLY WITH ALL LOCAL, TERRITORIAL AND FEDERAL LAWS THAT ARE PERTINENT TO THIS WORK.
3. AVAILABLE DOCUMENTATION OF EXISTING OR RECENTLY CONSTRUCTED UTILITIES HAS BEEN INDICATED ON DRAWINGS. CONTRACTOR IS RESPONSIBLE FOR AVOIDING ALL UTILITIES WHETHER SHOWN ON THE DRAWINGS OR NOT.
4. CONTRACTOR SHALL EXAMINE SITE FIRST HAND WITH OWNER'S REPRESENTATIVE TO DETERMINE THE NATURE AND TYPE OF MATERIALS TO BE CLEARED, EXCAVATED OR REMOVED PRIOR TO THE BIDDING OF WORK.

DESIGN CRITERIA

1. DAM CLASSIFICATION: SIGNIFICANT
2. LOWER DUBLIN SOUTH POND CAPACITY (MINIMUM 24 HOUR RETENTION TIME): 1 IN 10 YEAR FLOOD.
3. MAIN DAM SPILLWAY: 1 IN 1000 YEAR FLOOD
4. COLLECTION DITCHES: 1 IN 10 YEAR FLOOD FOR CAPACITY, 1 IN 100 YEAR FLOOD FOR EROSION
5. CULVERT DOWNSTREAM OF THE DAM ($H_w/D=1.5$): 1 IN 1000 YEAR FLOOD
6. REST OF CULVERTS ($H_w/D=1.5$): 1 IN 200 YEAR FLOOD

HYDROLOGY:

1. RECENT PRECIPITATION DATA HAS BEEN REVIEWED AS PART OF THE DESIGN AND FOUND TO BE WITHIN THE NATURAL VARIABILITY.

LEGEND

NOTES



ISSUED FOR CONSTRUCTION

[illegible]

00
 Planning
 July 14, 2017
 PENG, CBO
 Approved
 July 14, 2017
 PROFESSIONAL SEAL

CLIENT

 **StrataGold**
Corporation

 **TETRA TECH** EBA

**WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE , YT**

DRAWING INDEX, GENERAL NOTES
SPECIFICATIONS AND QUANTITIES

PROJECT NO. WTRM03037-01	OFFICE VANC	DES DH	CKD MH	REV 1	DRAWING G1.01
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

GEOTECHNICAL INVESTIGATION:

1. A GEOTECHNICAL INVESTIGATION WAS CONDUCTED FROM JUNE 10-13, 2017. APPENDIX A INCLUDES LAB RESULTS FROM THE INVESTIGATION.

GEOTECHNICAL NOTES:

- ## PREPARATION
1. REMOVE DEBRIS, SNOW, ICE, WATER, AND LOOSE MATERIAL PRIOR TO STARTING FILL PLACEMENT.
 2. DO NOT PLACE FILL MATERIAL WHEN THE MATERIAL, THE FOUNDATION, OR THE RECEIVING SURFACE IS FROZEN.
 3. DO NOT PLACE FILL MATERIAL ON ANY SURFACE UNTIL THE PREPARED SURFACE HAS BEEN INSPECTED BY THE OWNER'S REPRESENTATIVE AND ANY DEFECTS IDENTIFIED BY THE OWNER'S REPRESENTATIVE HAVE BEEN RECTIFIED.
 4. PROTECT SURFACES PREPARED TO RECEIVE FILL FROM FREEZING.
 5.
BOND PRIOR TO PLACING THE FIRST LIFT OF FILL. SCARIFICATION OF BEDROCK AND RIPRAP SURFACES IS NOT REQUIRED.
 6. GRADE AND COMPACT THE SCARIFIED FOUNDATION SURFACE TO THE SAME DENSITY.
 7. CAREFULLY INSPECT ALL EXCAVATIONS BEFORE DOING ANY WORK IN THE EXCAVATIONS. LOOK FOR SIGNS OF CRACKS ABOVE SLOPES, SEEPAGE, AND ANY OTHER SIGNS OF SLOPE INSTABILITY OR POTENTIAL FOR LOOSE MATERIAL TO BECOME DISLODGED.
 8. MAINTAIN SIDES AND SLOPES OF EXCAVATIONS IN SAFE CONDITION BY APPROPRIATE METHODS AND IN
.....
ACT FOR THE PROVINCE OF ALBERTA.
 9. REMOVE SOIL BLOCKS, BOULDERS, LOOSE ROCK AND OTHER FRAGMENTS THAT MAY SLIDE OR ROLL INTO THE EXCAVATED AREAS AND ANY ACCUMULATIONS OF SUCH MATERIALS FROM THE BASE OF EXCAVATIONS.
 10. WHERE CONDITIONS ARE UNSTABLE, CONTRACTOR'S ENGINEER TO DEVELOP A PLAN TO ALLOW SAFE ACCESS.
 11. EXCAVATE TO LINES, GRADES, ELEVATIONS AND DIMENSIONS AS INDICATED ON CONSTRUCTION DRAWINGS.

- DEWATERING AND HEAVE PREVENTION

1. KEEP EXCAVATIONS FREE OF WATER WHILE WORK IS IN PROGRESS.
2. THE DEWATERED CONSTRUCTION AREA SHOULD BE SUFFICIENT TO ALLOW FULL RECONSTRUCTION OF THE EMBANKMENT AS SHOWN IN THE CONSTRUCTION DRAWINGS.
3. AVOID EXCAVATION BELOW GROUNDWATER TABLE IF QUICK CONDITION OR HEAVE IS LIKELY TO OCCUR.
 - a. PREVENT PIPING OR BOTTOM HEAVE OF EXCAVATIONS BY GROUNDWATER LOWERING, SHEET PILE CUT-OFFS, OR OTHER MEANS.
4. PROTECT OPEN EXCAVATIONS AGAINST FLOODING AND DAMAGE DUE TO SURFACE RUN-OFF.

- FILL TYPES AND COMPACTION

1. DO NOT PLACE ORGANIC MATERIALS IN THE FILL.
2. COORDINATE EXCAVATION AND FILL PLACEMENT OPERATIONS, WHERE PRACTICAL, TO ESTABLISH EFFICIENT CONSTRUCTION EFFORT AND MAKE EFFICIENT USE OF EXCAVATED MATERIALS.
3. PLACE FILL AT THE LOCATIONS, AND TO THE LINES, GRADES, AND ELEVATIONS SHOWN ON THE CONSTRUCTION DRAWINGS OR AS ESTABLISHED BY THE OWNER'S REPRESENTATIVE, USING SPECIFIED FILL MATERIALS PLACED, CONDITIONED AND COMPACTED TO THE SPECIFIED REQUIREMENTS.
4. OVERBUILD FINAL FILL SLOPES AND THEN TRIM THEM TO THE LINES, GRADES, AND ELEVATIONS SHOWN ON THE CONSTRUCTION DRAWINGS, OR AS ESTABLISHED BY THE OWNER'S REPRESENTATIVE.
5. MAINTAIN THE TOP SURFACE OF FILL ZONES APPROXIMATELY HORIZONTAL. DURING SPREADING AND COMPACTION, PROVIDE THE SURFACE OF THE FILL ZONE WITH A GENTLE TRANSVERSE GRADIENT OF 3% TO 5% SO THAT WATER FROM PRECIPITATION WILL DRAIN FREELY TOWARD THE EXTREMITIES OF THE FILL ZONE, BUT AWAY FROM ANY FILTER MATERIALS. IMMEDIATELY PRIOR TO ANY SUSPENSION IN FILL OPERATIONS, SLOPE THE FILL SURFACE AT THE ABOVE GRADIENT AND ROLL WITH A SMOOTH CYLINDRICAL ROLLER SO AS TO LEAVE THE SURFACE AREA IN A SMOOTH, EVEN CONDITION FOR DRAINAGE.
6. PLACE AND SPREAD FILL MATERIALS IN CONTINUOUS AND APPROXIMATELY HORIZONTAL LAYERS OF UNIFORM THICKNESS AS PER SECTION 3.10 - COMPACTION IN SUCH A MANNER AS TO PREVENT SEGREGATION AND STRATIFICATION AND TO OBTAIN A HOMOGENEOUS MASS.

7. PLACE AND SPREAD EMBANKMENT DAM MATERIALS IN A DIRECTION PARALLEL TO THE DAM AXIS TO MINIMIZE THE POTENTIAL FORMATION OF PREFERENTIAL SEEPAGE PATHS.
8. USE DISCS AS NECESSARY DURING FILL PLACEMENT TO MIX OR BLEND AS REQUIRED, TO OBTAIN A CONSISTENT FILL MATERIAL, AND TO SCARIFY, BLEND, AND BREAK UP MATERIALS TO THE FULL DEPTH OF THE UNCOMPACTED LIFT.
9. COMMENCE PLACEMENT OF FILL MATERIALS AT THE LOWEST ELEVATION OF THE FOUNDATION OR EXCAVATION AND PROGRESS IN AN UPSLOPE DIRECTION.
10. MOISTEN EACH PREVIOUSLY PLACED LIFT, IF NECESSARY, AND WORK WITH DISCS TO A MINIMUM DEPTH OF 50 mm TO PROVIDE A BONDING SURFACE, PRIOR TO PLACING THE OVERLYING LIFT OF FILL MATERIAL EXCEPT WHEN, IN THE OPINION OF THE OWNER'S REPRESENTATIVE, SUCH WORK CANNOT BE PERFORMED BECAUSE OF COLD WEATHER.
11. JOIN NEW FILL ONTO ALL NATURAL, EXCAVATED, OR FILL SLOPES BY TERRACING OR STEPPING INTO THE SLOPES A MINIMUM OF 1.5 m WIDE. STAGGER FILL JOINTS TO MINIMIZE THE POTENTIAL FOR PREFERRED SEEPAGE PATHS IN ANY DIRECTION.

- MOISTURE CONTROL

1. MOISTURE CONTENT EXCEPT FOR RIPRAP MATERIALS, SHALL BE WITHIN ~~...~~ OF THE OPTIMUM MOISTURE CONTENT DETERMINED IN ACCORDANCE WITH ASTM D698.
2. THE MOISTURE CONTENT OF FILL MATERIALS SHALL BE DETERMINED IN ACCORDANCE WITH ASTM D2216.
3. ADD WATER TO THE FILL MATERIAL WHEN ITS MOISTURE CONTENT IS BELOW THAT SPECIFIED. USE METHODS THAT PERMIT WATER TO BE ADDED, IN CONTROLLED AMOUNTS, AND WHICH DO NOT CAUSE ~~...~~ FINER MATERIALS TO BE WASHED OUT. WORK THE WATER INTO THE FILL MATERIAL UNTIL THE SPECIFIED MOISTURE CONTENT IS UNIFORMLY OBTAINED THROUGHOUT THE MATERIAL.
4. WHEN THE MOISTURE CONTENT OF THE FILL MATERIAL EXCEEDS THE SPECIFIED LIMITS, DRY THE FILL MATERIAL, PRIOR TO COMPACTION, BY SPREADING, DISCING, AND HARROWING THE FILL MATERIAL UNTIL THE SPECIFIED MOISTURE CONTENT IS UNIFORMLY OBTAINED THROUGHOUT THE MATERIAL.

- COMPACTION

LIFT THICKNESS, COMPACTION REQUIREMENTS, AND DENSITIES SHALL CONFORM TO THE FOLLOWING UNLESS SPECIFIED OTHERWISE:

EMBANKMENT FILL	200 mm LOOSE LIFT THICKNESS	≥ 98% SPMD
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1. COMPACTED DENSITY LIMITS, IN CLAUSE 3.9.1, SHALL BE TO STANDARD PROCTOR MAXIMUM DRY DENSITY (SPMDD) AS DETERMINED BY ASTM D698, OR MAXIMUM VIBRATED DENSITY (MVD) AS DETERMINED BY ASTM D4253.
2. USE COMPACTION EQUIPMENT OF THE TYPE, SIZE, AND EFFICIENCY CAPABLE OF ACHIEVING THE SPECIFIED DENSITIES AND COMMENSURATE WITH THE NATURE OF THE FILL PLACEMENT OPERATION.
3. UNLESS OTHERWISE AUTHORIZED BY THE OWNER'S REPRESENTATIVE, USE A SUITABLY-SIZED VIBRATORY SMOOTH-DRUM ROLLERS FOR GRANULAR MATERIALS.
4. IN AREAS THAT ARE NOT ACCESSIBLE TO LARGER COMPACTION EQUIPMENT, OR WHICH ARE WITHIN 1000 mm OF STRUCTURES OR 600 mm FROM PIPES, OR OTHER ITEMS SUSCEPTIBLE TO COMPACTION INDUCED DAMAGE, REDUCE THE LIFT THICKNESS AND COMPACT FILL MATERIALS WITH HAND OPERATED PNEUMATIC OR MECHANICAL TAMPING EQUIPMENT.
5. APPLY COMPACTION EFFORT FOR A MINIMUM HORIZONTAL DISTANCE OF 600 mm BEYOND THE EDGE OF THE FILL ZONES.
6. COMPACTION REQUIREMENTS FOR MATERIAL THAT CANNOT PRACTICALLY BE TESTED AND COMPARED TO STANDARD PROCTOR DENSITIES, COMPACTION EFFORT SHOULD BE APPROVED BY THE OWNER'S REPRESENTATIVE.
7.
EMBANKMENT CREST SHALL BE + 100 mm / 0 mm.

[illegible]


 P.ENG. (BC)
 July 14, 2017 ☒ APPROVED.

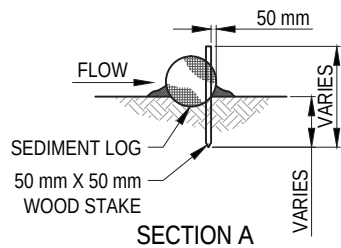
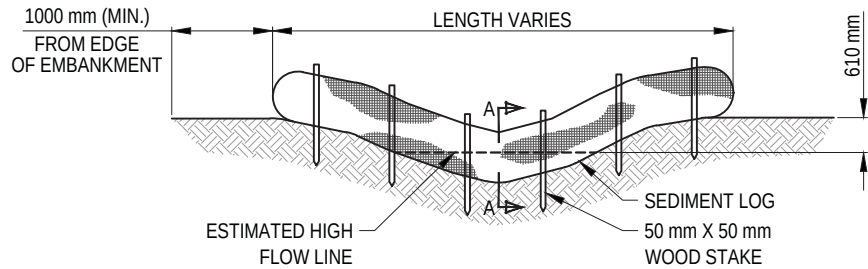
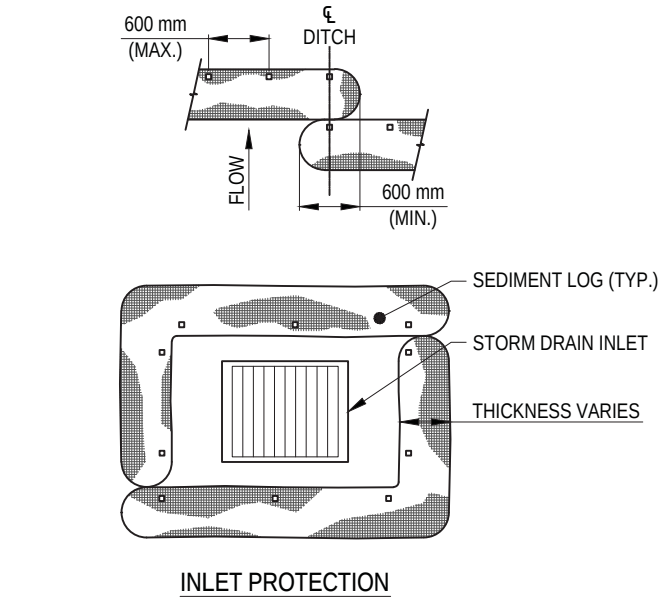
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 **Strata Gold**
Corporation

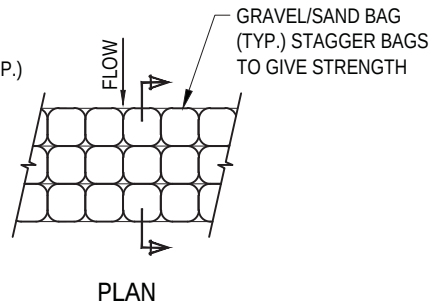
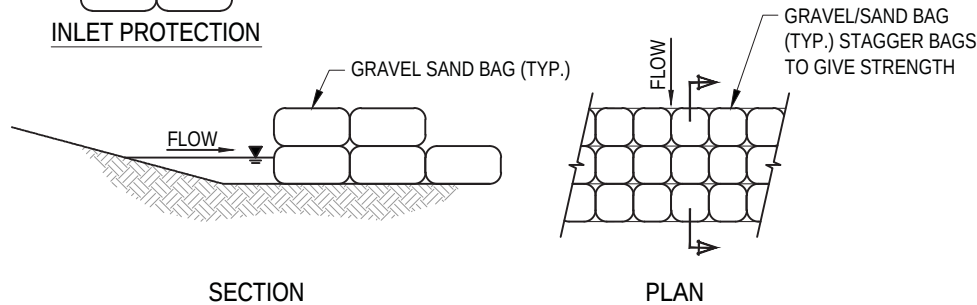
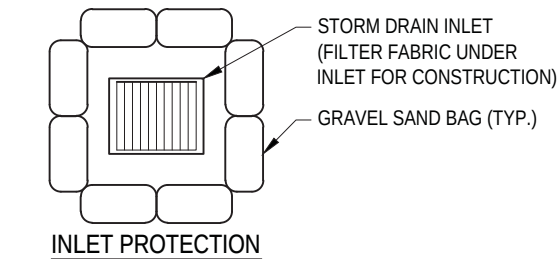
 **TETRA TECH EBA**

WATER MANAGEMENT PLAN NELPCo EAGLE GOLD MINE , YT					
GEOTECHNICAL SPECIFICATIONS AND NOTES					
PROJECT NO. WTRM03037-01	OFFICE VANC	DES JS	CKD MH	REV 1	DRAWING G1.02
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

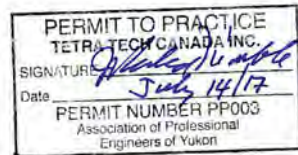
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1 SEDIMENT LOGS
G1.03 SCALE: NTS



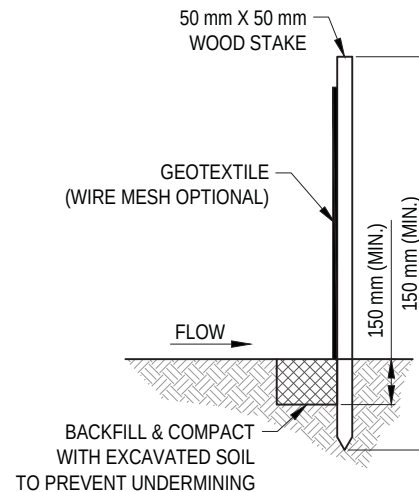
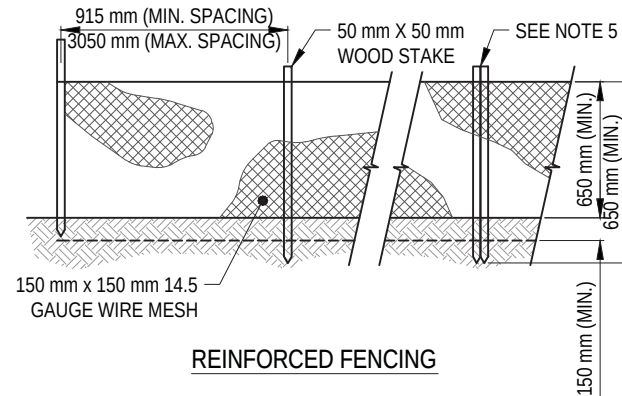
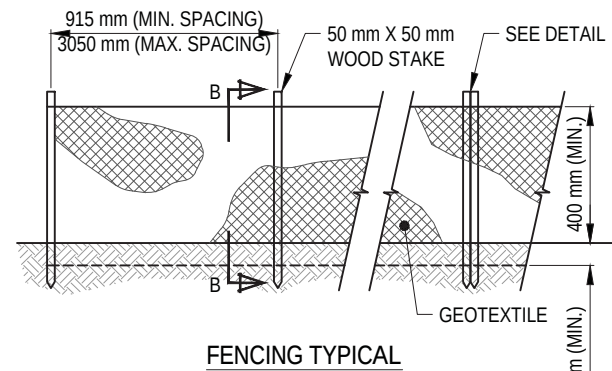
2 GRAVEL/SAND BAG BARRIER DETAIL
G1.03 SCALE: NTS



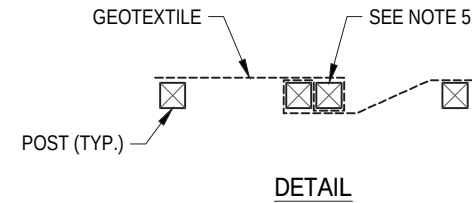
ISSUED FOR CONSTRUCTION

GENERAL NOTES:

1. SEDIMENT LOGS SHALL BE LOCATED AS INDICATED IN THE SWPPP PLANS OR AS DIRECTED BY THE ENGINEER.
2. LOGS SHALL BE SELECTED, INSTALLED AND MAINTAINED WITH MANUFACTURER'S SPECIFICATION AND GOOD ENGINEERING PRACTICES.
3. STAKE LOG AS SHOWN, STAKES SHALL BE PLACED THROUGH DOWNSTREAM SIDE AS SHOWN.
4. ENSURE THAT NO GAPS EXIST BETWEEN SOIL AND BOTTOM OF SEDIMENT LOG. REPAIR ANY UNDERCUTS OR EROSION PROMPTLY.
5. DO NOT DRIVE STAKES THROUGH CENTER OF LOG. STAKES MUST BE DRIVEN INTO GROUND AS SHOWN.
6. LAY SEDIMENT LOG ACROSS PREPARED DITCH OR CHANNEL TRENCHING OR BURIAL OF SEDIMENT LOGS IS NOT REQUIRED. THE INTIMATE CONTACT BETWEEN THE BOTTOM OF THE LOG AND THE GROUND IS MANDATORY. THE LOGS SHALL BE INSTALLED IN THE DITCH SWALE OR CHANNEL BOTTOM PERPENDICULAR TO THE FLOW OF WATER AS SHOWN.
7. FIELD ADJUST AND CORRECT SEDIMENT LOG BMP IMMEDIATELY IF IT IS CAUSING FLOODING OR AFFECTING ROADWAY SAFETY.



3 SILT FENCE
G1.03 SCALE: NTS



GENERAL NOTES:

1. SILT FENCE SHALL BE CONSTRUCTED BEFORE UPSLOPE LAND DISTURBANCES BEGIN.
2. PLACE SILT FENCE AS CLOSE TO CONTOUR AS POSSIBLE SO THAT WATER WILL NOT CONCENTRATE AT LOW POINTS AND SO THAT SMALL SWALES OR DEPRESSIONS WHICH MAY CARRY SMALL CONCENTRATED FLOWS TO SILT FENCE ARE DISSIPATED ALONG ITS LENGTH.
3. WHERE POSSIBLE, SILT FENCE SHALL BE PLACED ON FLATTEST AREA AVAILABLE.
4. SILT FENCE SHOULD BE CONSTRUCTED IN A A HORSESHOE SHAPE WITH ENDS POINTING UPSLOPE TO MAXIMIZE BOTH STRENGTH AND EFFECTIVENESS.
5. SEAMS BETWEEN SECTIONS SHALL BE OVERLAPPED WIT THE END STAKES OF EACH SECTION WRAPPED TOGETHER BEFORE DRIVING INTO THE GROUND.
6. SILT FENCE SHALL BE BURIED IN THE GROUND AT A MINIMUM OF 150 mm TO PREVENT ANY UNDERCUTTING OR EROSION.
7. ADDITIONAL POST DEPTH OR WIRE MESH BACKING MAY BE REQUIRED IN UNSTABLE SOILS.

LEGEND

NOTES

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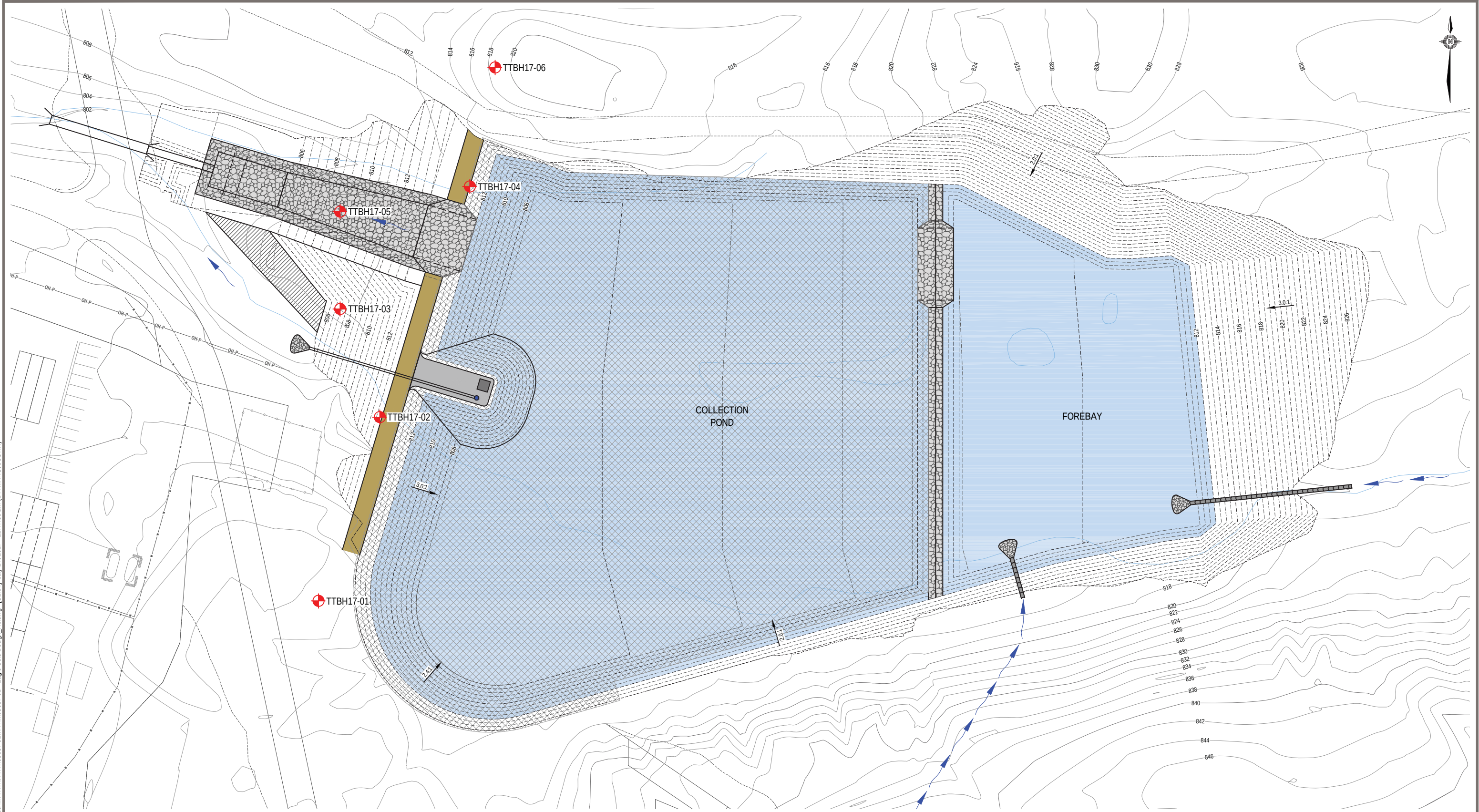
**WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE , YT**

SEDIMENT AND EROSION CONTROL DETAILS

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03037-01	VANC	DH	MH	1	G1.03
DATE	SHEET No.	DWN	APP	STATUS	
July 14, 2017	of	JDM	MH	IFC	

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW
REVISIONS					

PROFESSIONAL SEAL



LEGEND

----- Design Major Contours (2 m)

----- Design Minor Contours (0.5 m)

SCALE 1:1000

NOTES

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE: *[Signature]*
Date: *July 14/17*
PERMIT NUMBER PP003
Association of Professional Engineers of Yukon

ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	DESCRIPTION
0	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION

REVISIONS

CLIENT

[Signature] P.ENG (B.C.)
July 14/2017
It Approved.

StrataGold Corporation

TETRA TECH EBA

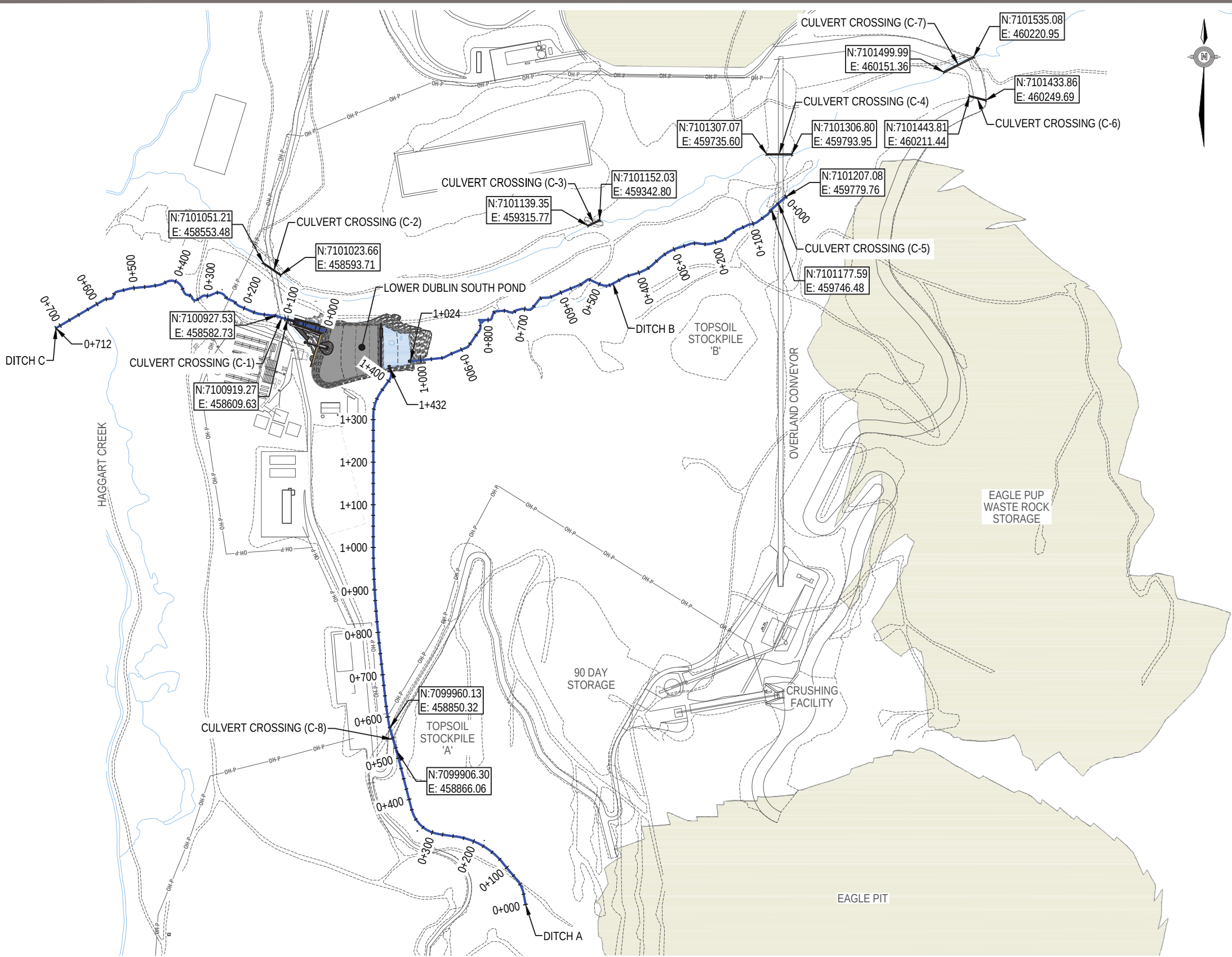
**WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE , YT**

BOREHOLE LOCATION PLAN

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03037-01	VANC	DH	MH	0	G1.04

DATE	SHEET No.	DWN	APP	STATUS
July 14, 2017	of	JDM	MH	IFC

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DITCH A		
STATION (m)	LENGTH (m)	TYPE
0+000 - 0+355	355	TYPE 3A
0+355 - 0+519	164	TYPE 2
0+519 - 0+575	CULVERT C-8 (SEE CULVERT TABLE)	
0+575 - 0+845	270	TYPE 3A
0+845 - 1+020	175	TYPE 2
1+020 - 1+330	310	TYPE 3B
1+330 - 1+420	90	TYPE 3E

DITCH B		
STATION (m)	LENGTH (m)	TYPE
0+000 - 0+045	CULVERT C-5 (SEE CULVERT TABLE)	
0+045 - 0+050	5	GABION STEPPED
0+050 - 0+560	510	TYPE 3D
0+560 - 0+886	326	TYPE 3B
0+886 - 0+980	94	TYPE 3D

DITCH C		
STATION (m)	LENGTH (m)	TYPE
0+000 - 0+075	SPILLWAY	
0+075 - 0+095	20	TYPE 3A
0+095 - 0+123	CULVERT C-1 (SEE CULVERT TABLE)	
0+123 - 0+320	197	TYPE 3B
0+320 - 0+440	120	TYPE 3E
0+440 - 0+712	272	TYPE 3B

NOTES:

- STATIONING AND LENGTHS ARE APPROXIMATE.
- FOR DITCH TYPES SEE DETAIL 1/C1.08.
- PROPOSED RIPRAP REVETMENT AS SHOWN ON DETAIL 1/C1.08 (DITCH TYPE 3) SHALL BE FIELD FITTED AND ADJUSTED TO SITE CONDITIONS.

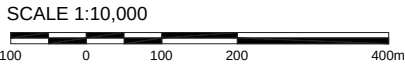
CULVERT TABLE			
CULVERT ID	LENGTH (m)	DIAMETER (mm)	BARRELS
C-1	28	2200	2
C-2	49	1200	2
C-3	30	900	1
C-4	58	1200	2
C-5	44	800	1
C-6	40	750	1
C-7	78	900	2
C-8	56	1200	2

NOTES:

- CULVERT LENGTHS, NORTHINGS AND EASTINGS ARE APPROXIMATE.
- SEE DETAIL 2/C1.07 FOR TYPICAL CULVERT CROSSING.
- ALL CSP CULVERTS SHALL BE 14 GAUGE (THICKNESS 0.079") ALUMINIZED STEEL TYPE 2 (ALT2) WITH A MINIMUM OF 1 m COVER.
- GRAVEL LINE BOTTOM OF CULVERT C-3 FOR FISH PASSAGE.

LEGEND

NOTES



ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW

Professional Engineer's Seal and Signature. The seal is for Manning P. Eng. (B.C.) and the signature is dated July 14, 2017.

CLIENT

StrataGold Corporation

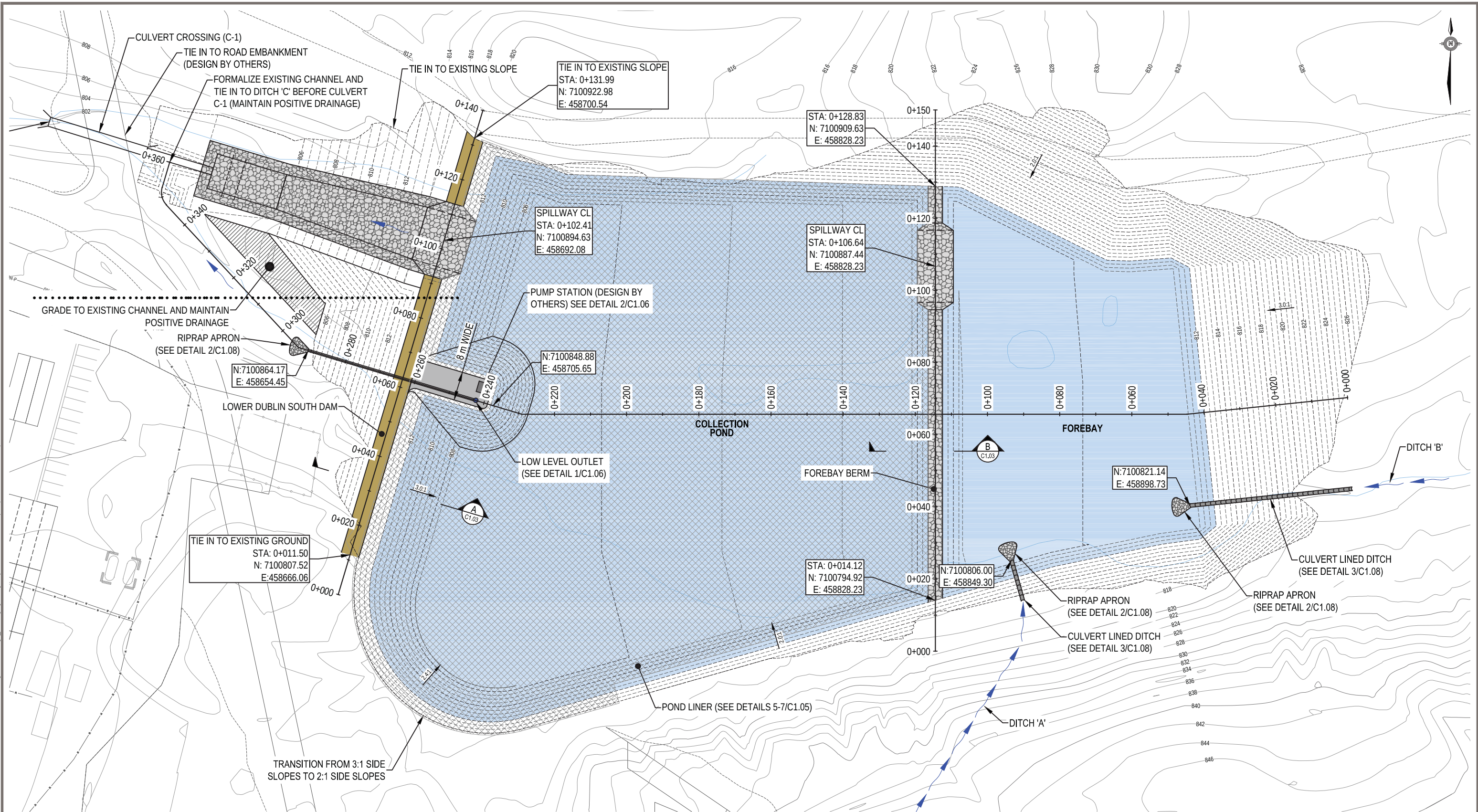
TETRA TECH EBA

WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE , YT

GENERAL ARRANGEMENT
SITE PLAN

PROJECT NO. WTRM03037-01	OFFICE VANC	DES DH	CKD MH	REV 1	DRAWING C1.00
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

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LEGEND

----- Design Major Contours (2 m)

----- Design Minor Contours (0.5 m)

SCALE 1:1000

0 10 20 40m

NOTES

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE: *[Signature]*
Date: *July 14/17*
PERMIT NUMBER PP003
Association of Professional Engineers of Yukon

ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	REVISIONS	DESCRIPTION
1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION	
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW	

[Signature] P.ENG. (B.C.)
July 14, 2017
It Approved.

PROFESSIONAL SEAL

CLIENT

StrataGold Corporation

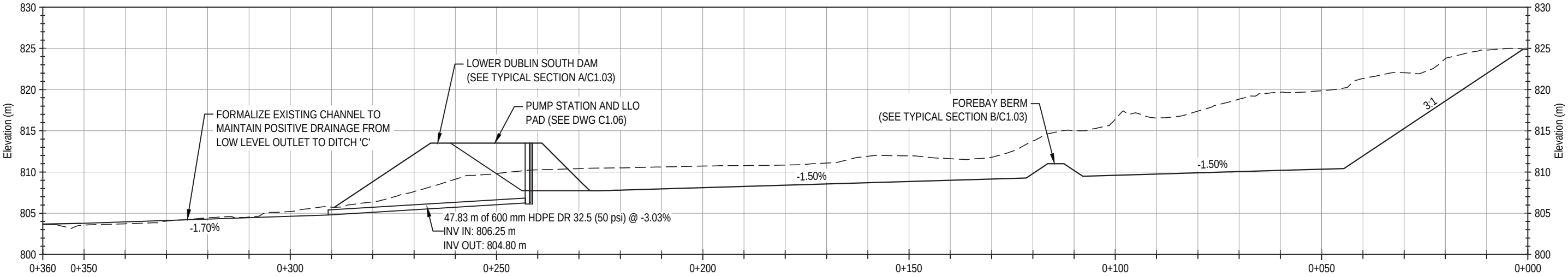
TETRA TECH EBA

**WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE, YT**

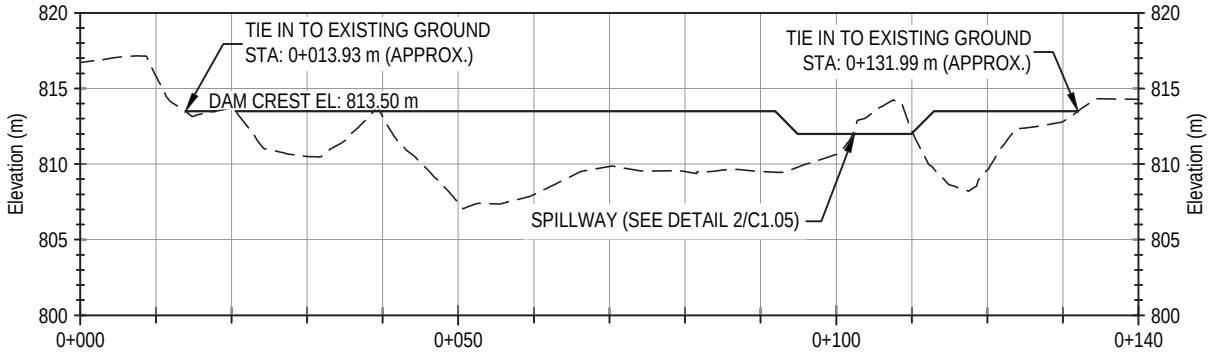
**LOWER DUBLIN SOUTH POND
PLAN**

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03037-01	VANC	DH	MH	1	C1.01
DATE	SHEET No.	DWN	APP	STATUS	
July 14, 2017	of	JDM	MH	IFC	

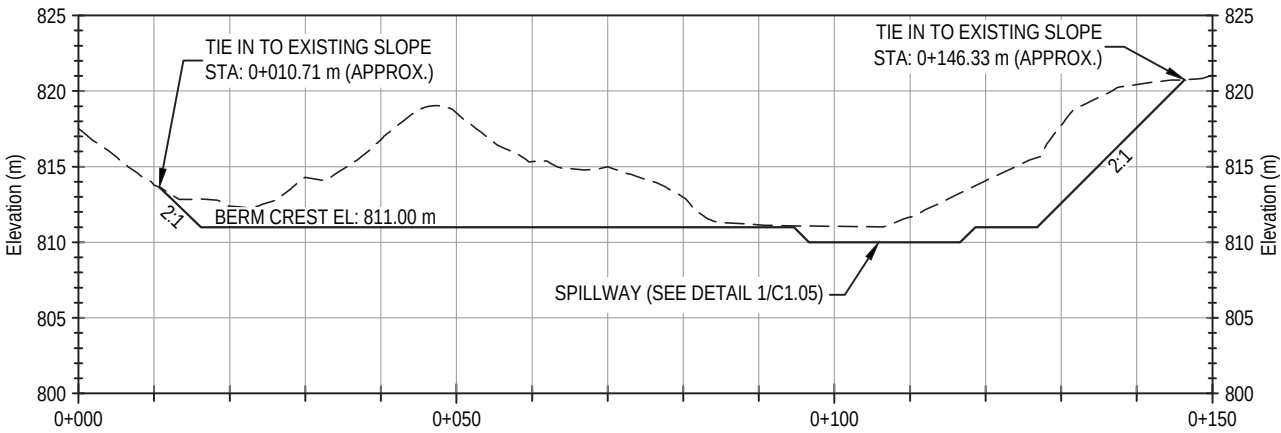
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1 POND CENTERLINE PROFILE
C1.02 SCALE: 1:1000 (HORIZ.) 1:500 (VERT)



2 DAM CENTERLINE PROFILE
C1.02 SCALE: 1:1000 (HORIZ.) 1:500 (VERT)



3 BERM CENTERLINE PROFILE
C1.02 SCALE: 1:1000 (HORIZ.) 1:500 (VERT)

NOTE:

1. PROFILE VIEWS ARE EXAGGERATED BY TWO TIMES VERTICALLY.

LEGEND

- Existing Ground
— Proposed Ground

NOTES



ISSUED FOR CONSTRUCTION

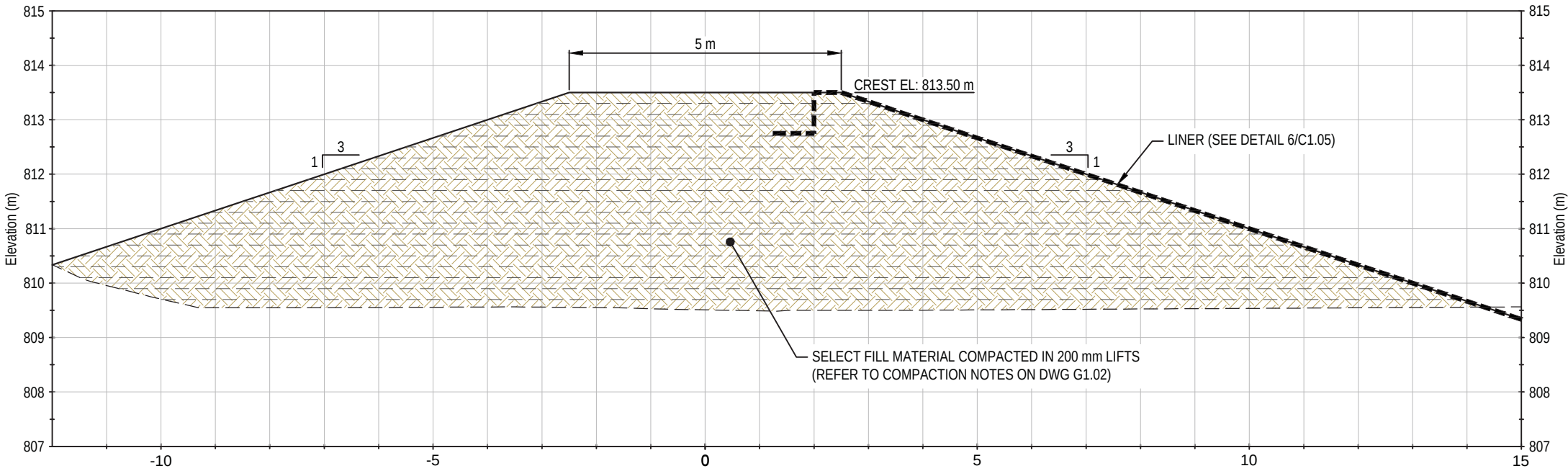
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1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW
					DESCRIPTION

Professional Engineer Seal
Signature: [Signature] P.ENG. (B.C.)
Date: July 14, 2017
Text: It Approved.

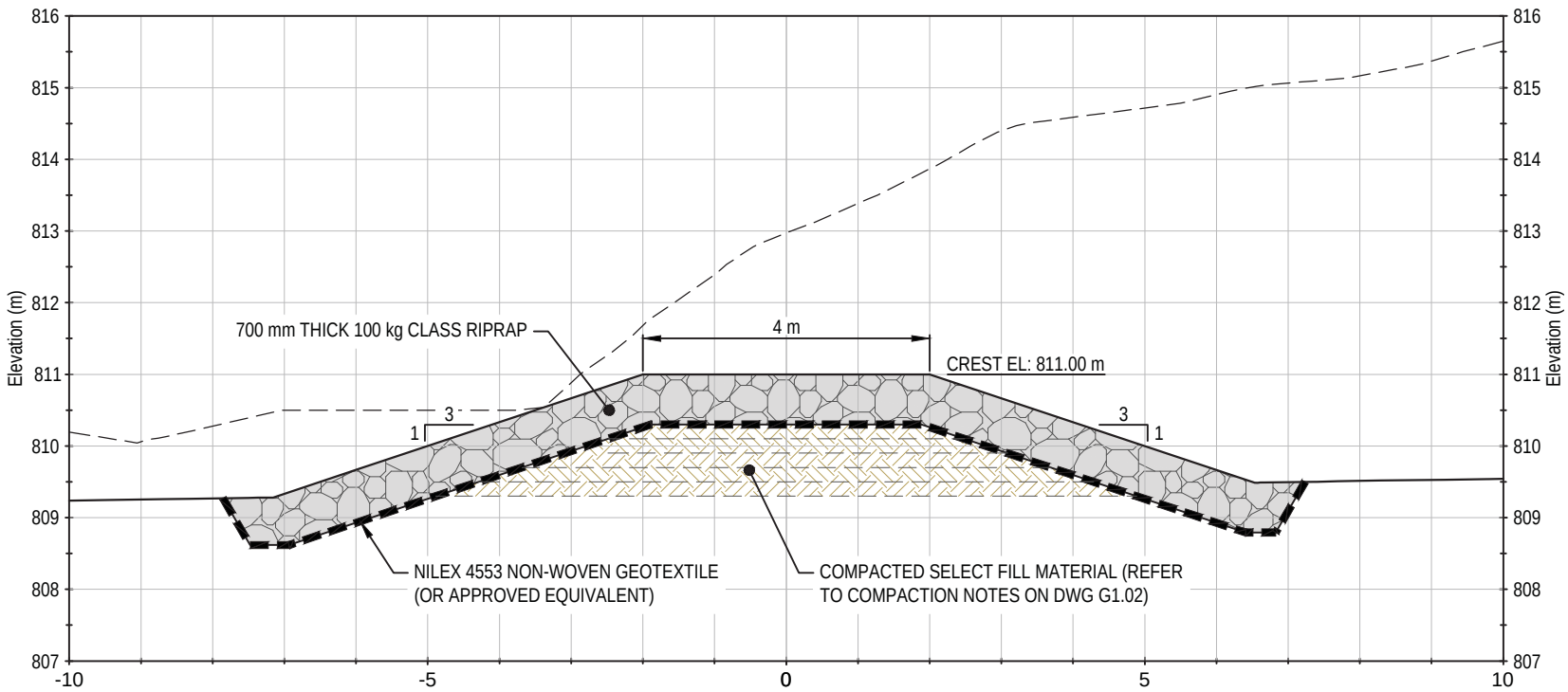


WATER MANAGEMENT PLAN NELPCo EAGLE GOLD MINE , YT					
LOWER DUBLIN SOUTH POND PROFILES					
PROJECT NO. WTRM03037-01	OFFICE VANC	DES DH	CKD MH	REV 1	DRAWING C1.02
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

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A TYPICAL DAM SECTION
C1.03 SCALE: 1:100



B TYPICAL FOREBAY EMBANKMENT SECTION
C1.03 SCALE: 1:100

LEGEND
--- Existing Ground
— Proposed Ground

NOTES



ISSUED FOR CONSTRUCTION

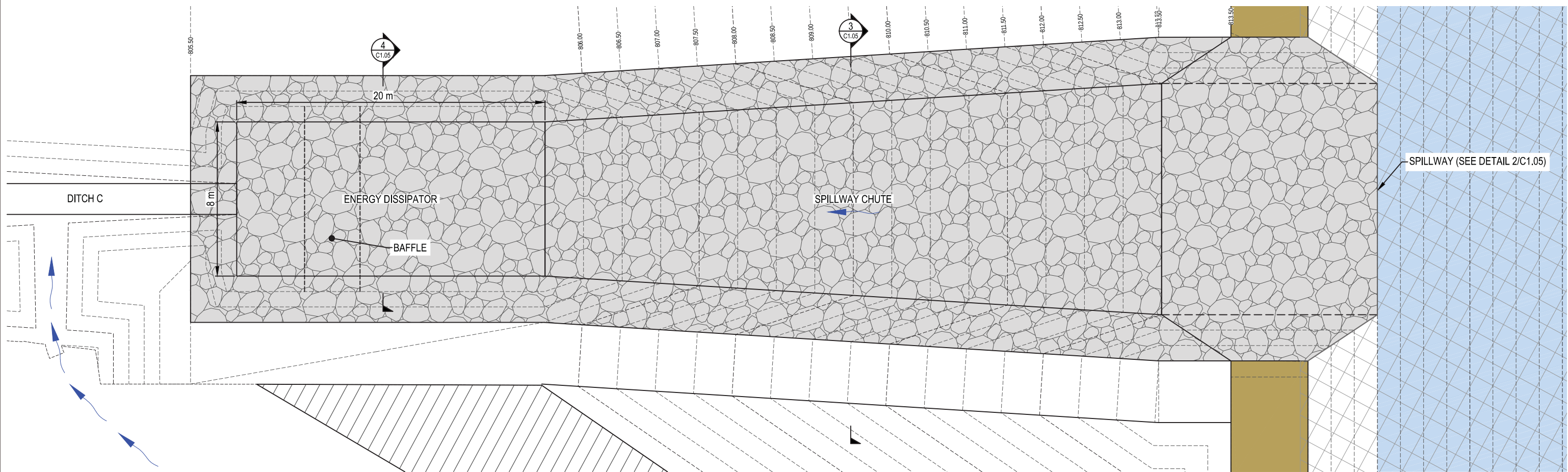
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1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW

Professional Seal of Justin Mang, P.Eng. (B.C.), dated July 14, 2017.

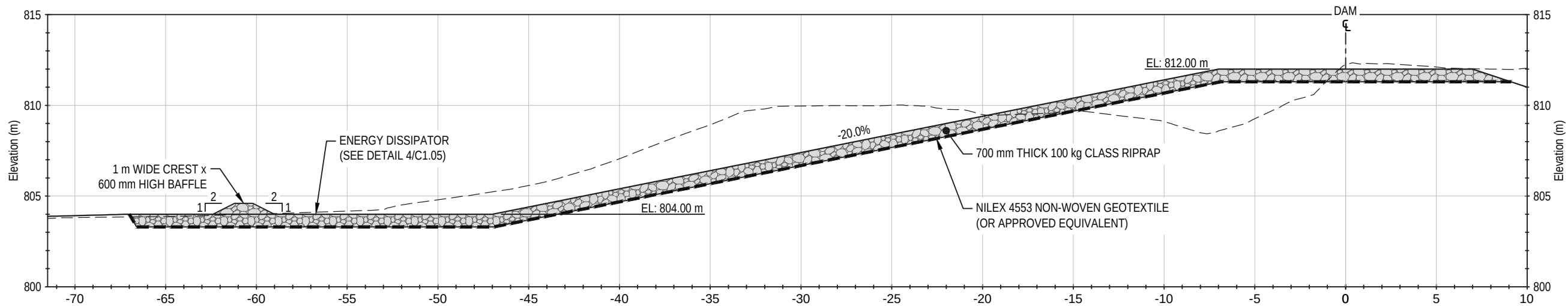


WATER MANAGEMENT PLAN NELPCo EAGLE GOLD MINE , YT					
LOWER DUBLIN SOUTH POND TYPICAL SECTIONS					
PROJECT NO. WTRM03037-01	OFFICE VANC	DES DH	CKD MH	REV 1	DRAWING C1.03
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

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PLAN
SCALE: 1:250



1
C1.04 BERM CENTERLINE PROFILE
SCALE: 1:250

LEGEND

- Existing Ground
- Proposed Ground

NOTES



ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW

REVISIONS

Mani Hossain P.ENG (B.C.)
July 14, 2017
It approved.

PROFESSIONAL SEAL

CLIENT

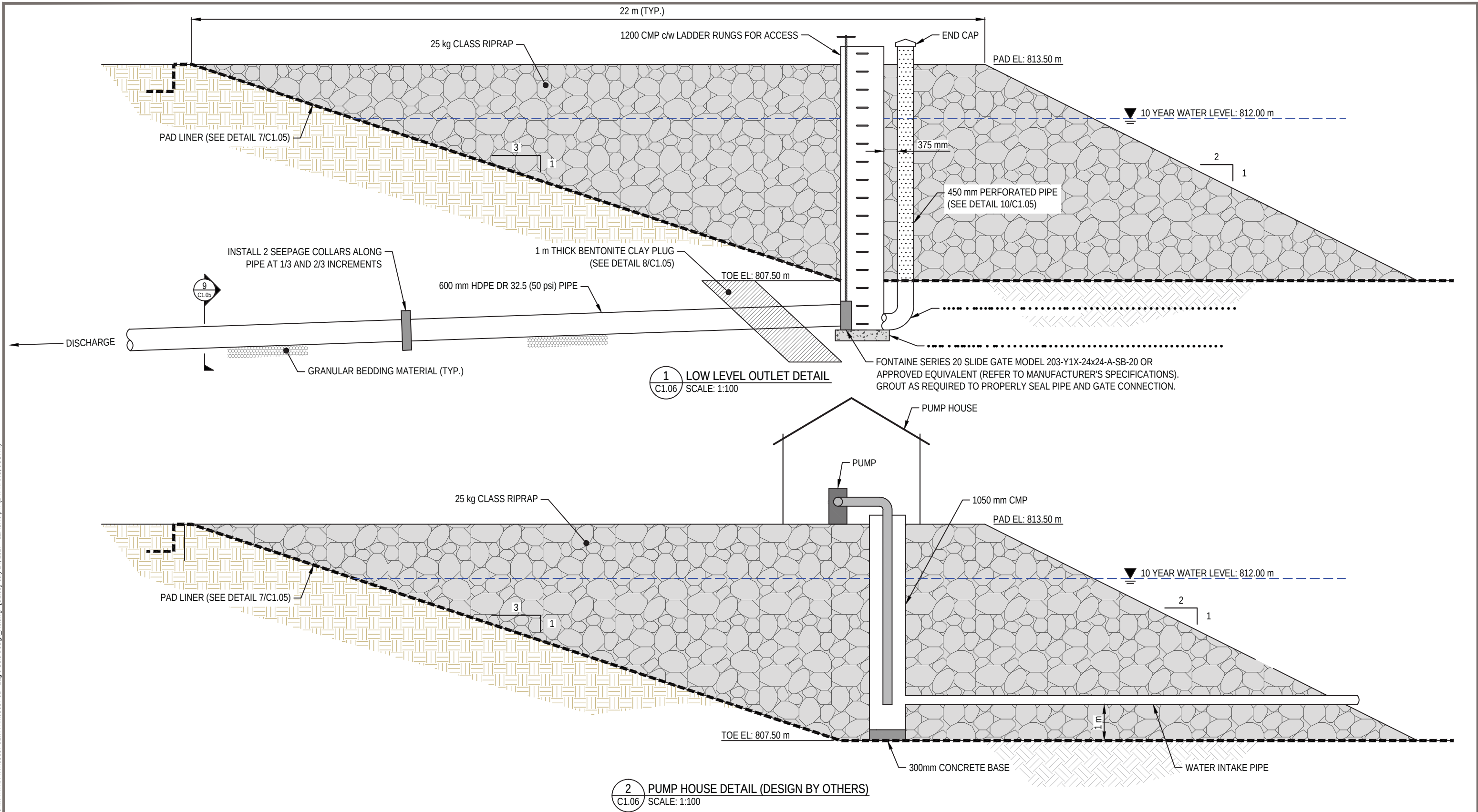


WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE, YT

LOWER DUBLIN SOUTH POND
SPILLWAY PLAN AND PROFILE

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03037-01	VANC	DH	MH	1	C1.04
DATE	SHEET No.	DWN	APP	STATUS	
July 14, 2017	of	JDM	MH	IFC	

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LEGEND

SCALE 1:100

1 0 1 2 4m

NOTES

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE: *[Signature]*
Date: *July 14/17*
PERMIT NUMBER PP003
Association of Professional Engineers of Yukon

ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW

REVISIONS

PROFESSIONAL SEAL

[Signature] P.ENG (B.C.)
July 14, 2017

CLIENT

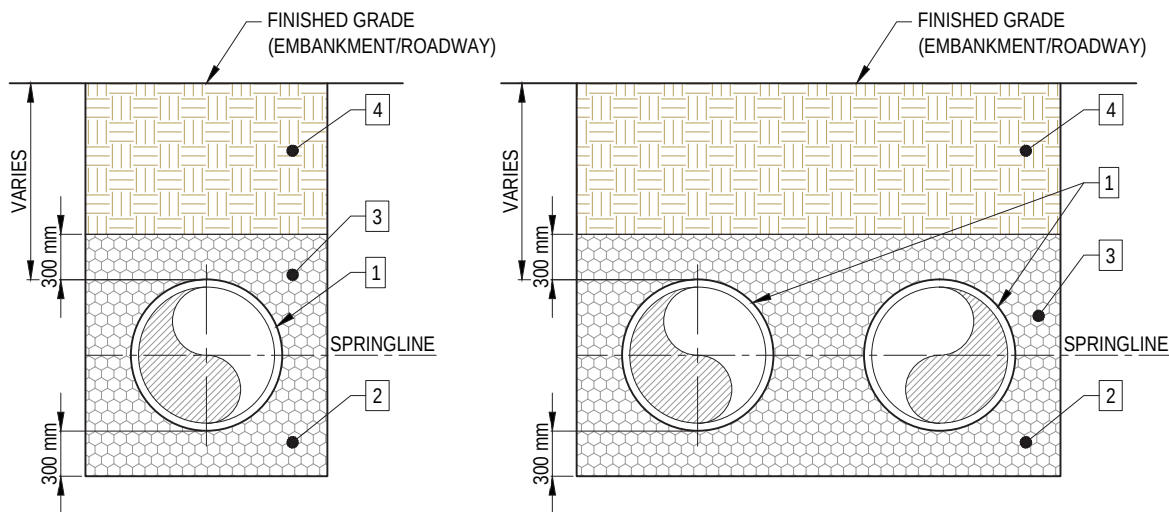
StrataGold Corporation

TETRA TECH EBA

WATER MANAGEMENT PLAN
NELPCo EAGLE GOLD MINE, YT

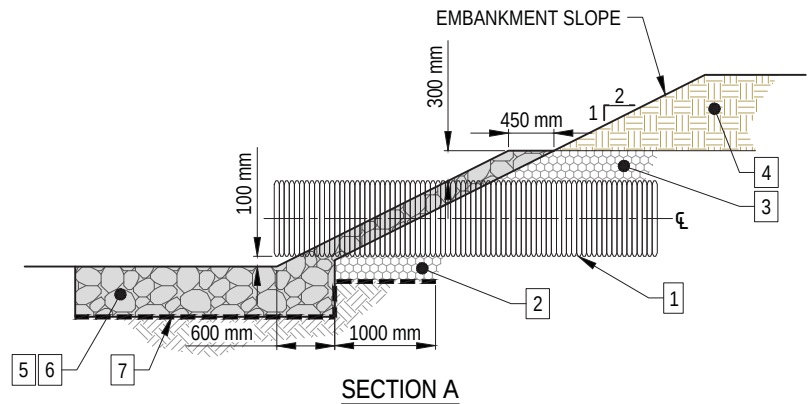
LOWER DUBLIN SOUTH POND
LOW LEVEL OUTLET AND PUMP HOUSE

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03037-01	VANC	DH	MH	1	C1.06
DATE	SHEET No.	DWN	APP	STATUS	
July 14, 2017	of	JDM	MH	IFC	

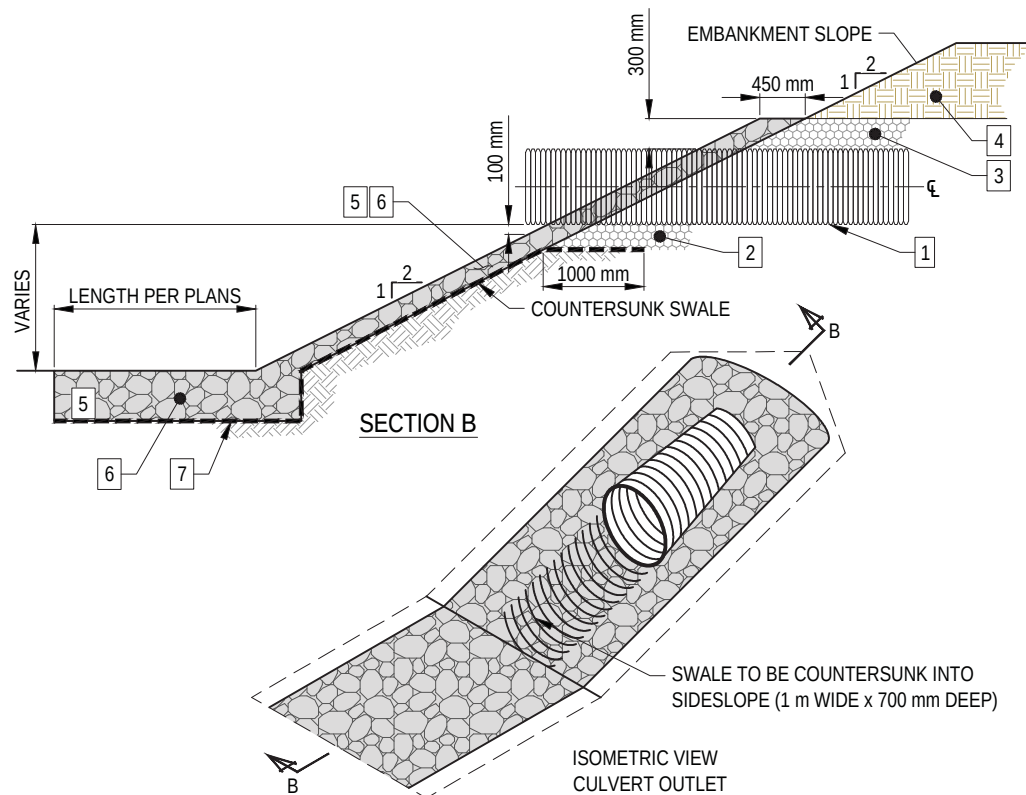


NOTE:
1. MINIMUM COVER SHALL BE THE GREATER OF 400 mm OR 0.5x PIPE DIAMETER FOR LIGHT VEHICLE ROADS AND 1.5 m FOR HAUL ROADS.

1 PIPE TRENCH DETAILS
C1.07 SCALE: NTS

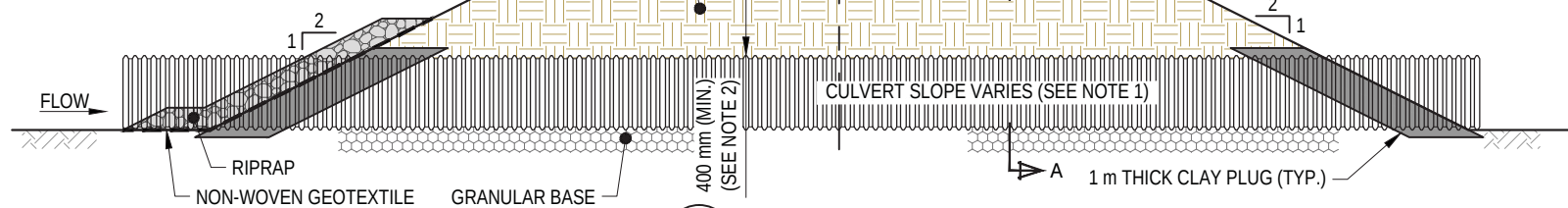


3 TYPICAL HAND PLACED RIPRAP CULVERT END TREATMENT
C1.07 SCALE: NTS

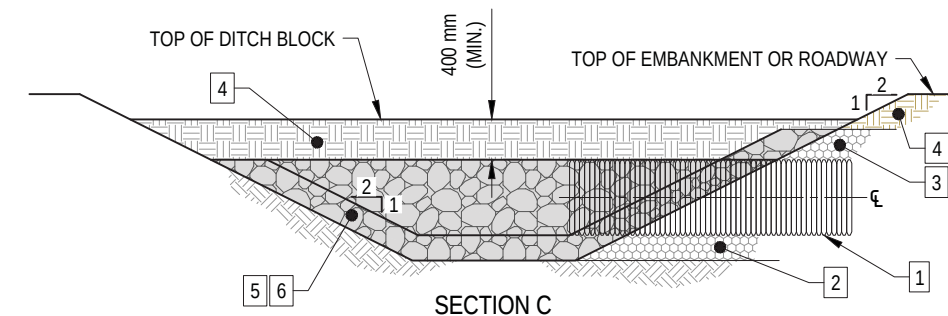


4 TYPICAL SWALE CULVERT END TREATMENT
C1.07 SCALE: NTS

- KEY NOTES:**
1. ALL CULVERTS SHALL BE CORRUGATED METAL PIPE (CMP) AND SHALL BE A MINIMUM OF 750 mm IN DIAMETER UNLESS NOTED OTHERWISE.
 2. GRANULAR BEDDING MATERIAL TO BE COMPACTED TO 95% STANDARD PROCTOR DENSITY.
 3. GRANULAR BACKFILL MATERIAL TO BE COMPACTED TO 95% STANDARD PROCTOR DENSITY.
 4. SELECT FILL MATERIAL IN EMBANKMENTS TO BE COMPACTED TO 95% STANDARD PROCTOR DENSITY. GENERAL FILL MATERIAL UNDER ROADWAYS TO BE COMPACTED TO 95% MODIFIED PROCTOR DENSITY.
 5. RIPRAP SHALL BE HAND PLACED COBBLE $D_{50} = 150$ mm (MIN.)
 6. RIPRAP THICKNESS 600 mm (1400 mm - 2000 mm)
 7. NON-WOVEN GEOTEXTILE SHALL BE PLACED UNDER RIPRAP AT THE OUTLET OF CULVERT TO PREVENT SCOUR.



2 TYPICAL CULVERT CROSSING
C1.07 SCALE: NTS

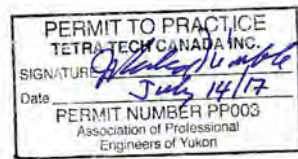


5 TYPICAL DITCH BLOCK WITH CULVERT
C1.07 SCALE: NTS

- NOTES:**
1. CULVERTS SHALL BE INSTALLED SO THAT THERE IS NO CHANGE IN THE STREAM BOTTOM AT CULVERT INLET AND OUTLET.
 2. MINIMUM COVER SHALL BE THE GREATER OF 400 mm OR 0.5x PIPE DIAMETER FOR LIGHT VEHICLE ROADS AND 1.5 m FOR HAUL ROADS.
 3. ALL CULVERTS SHALL BE CORRUGATED METAL PIPE (CMP) AND SHALL BE A MINIMUM OF 750 mm IN DIAMETER UNLESS NOTED OTHERWISE.
 4. COMPACTED FILL MATERIAL SHALL BE A MINIMUM OF 1 PIPE DIAMETER ON EACH SIDE OF CULVERT.

LEGEND

NOTES



ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	REVISIONS
1	7/14/17	JDM	DH	MH	ISSUED FOR CONSTRUCTION
0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW
DESCRIPTION					

PROFESSIONAL SEAL

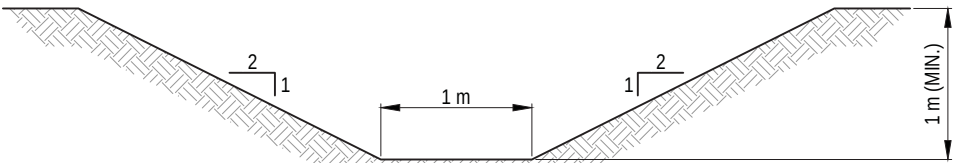
 Approved:

 July 14, 2017

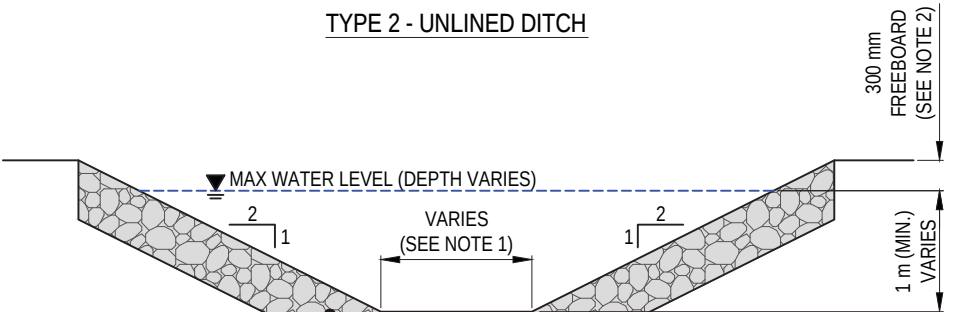
CLIENT

WATER MANAGEMENT PLAN NELPCo EAGLE GOLD MINE, YT					
CULVERT SECTIONS AND DETAILS					
PROJECT NO. WTRM03037-01	OFFICE VANC	DES DH	CKD MH	REV 1	DRAWING C1.07
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

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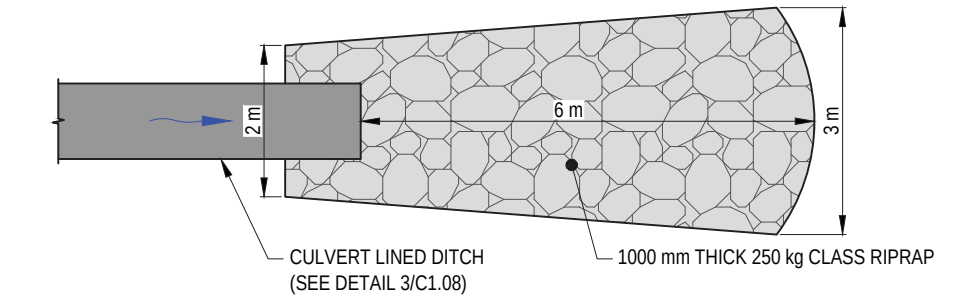
TYPE 2 - UNLINED DITCH



RIPRAP (SEE TABLE FOR SIZE AND THICKNESS)

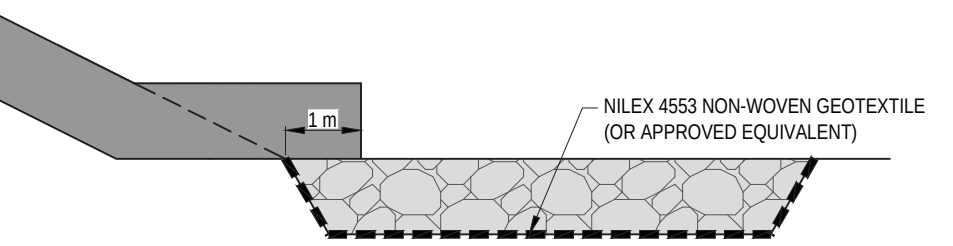
TYPE 3 - RIPRAP DITCH

1 DIVERSION AND COLLECTION DITCHES
C1.08 SCALE: NTS

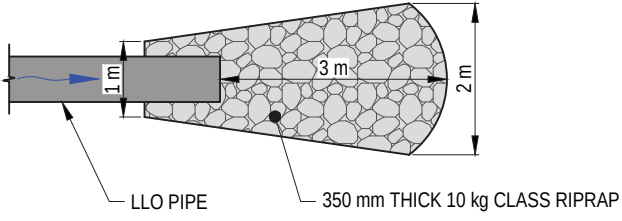


CULVERT LINED DITCH
(SEE DETAIL 3/C1.08)

1000 mm THICK 250 kg CLASS RIPRAP

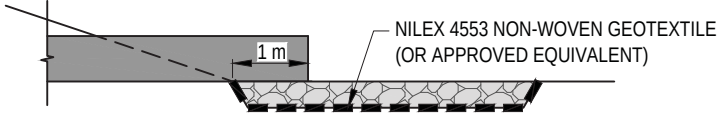


DITCH A & B



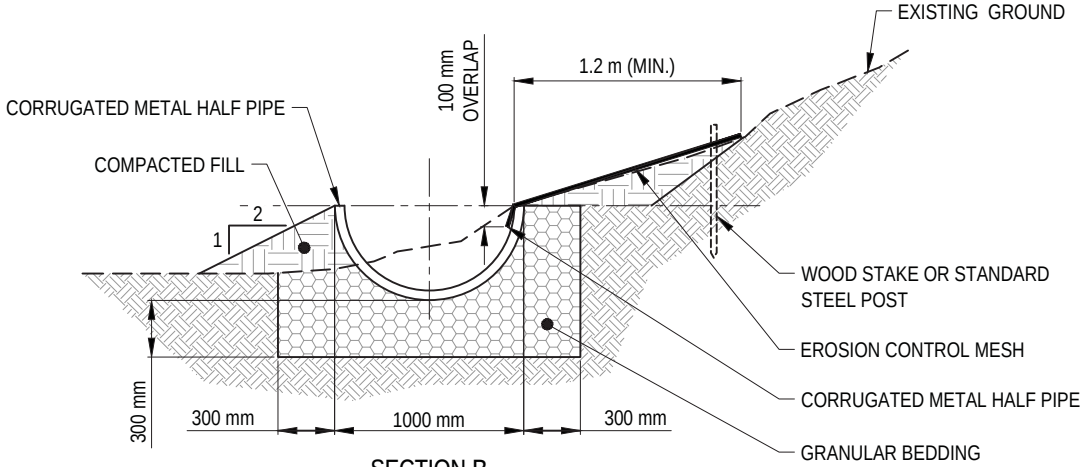
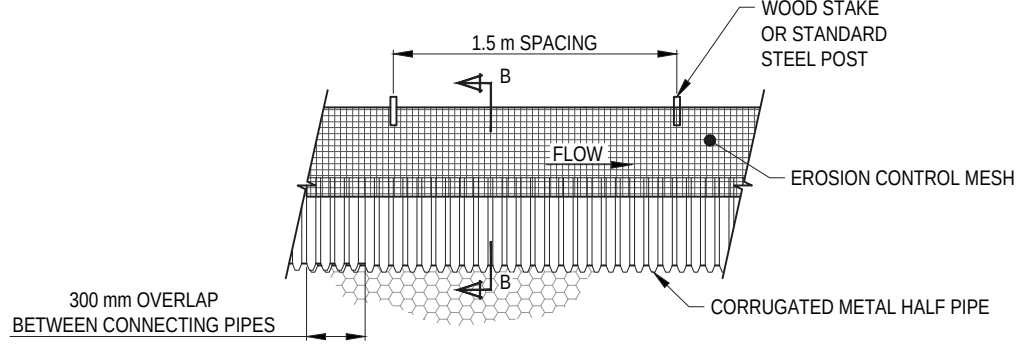
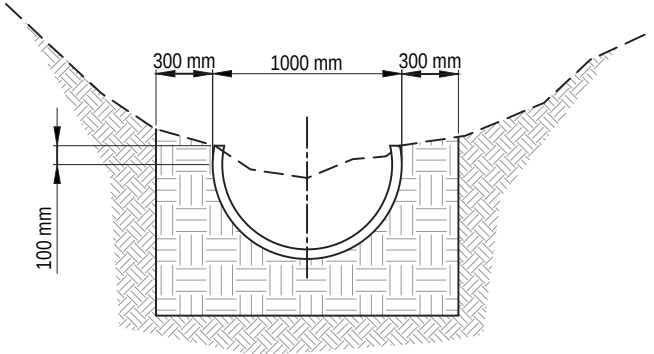
LLO PIPE

350 mm THICK 10 kg CLASS RIPRAP



LLO OUTLET

2 ROCK ENERGY DISSIPATOR
C1.08 SCALE: NTS



SECTION B

3 CULVERT LINED DITCH
C1.08 SCALE: NTS

RIPRAP TABLE			
DITCH TYPE	RIPRAP CLASS	RIPRAP THICKNESS	D ₅₀
TYPE 3A	10 kg	350 mm	195 mm
TYPE 3B	25 kg	450 mm	260 mm
TYPE 3C	50 kg	550 mm	330 mm
TYPE 3D	250 kg	1000 mm	565 mm
TYPE 3E	500 kg	1200 mm	715 mm

NOTES:

- FOR DITCH 'A' AND 'B' DITCH BOTTOM WIDTH SHALL BE 1 m AND FOR DITCH 'C' BOTTOM WIDTH SHALL BE 2 m.
- 300 mm FREEBOARD SHALL BE INCLUDED FOR ALL DITCH SECTIONS WHERE WATER DEPTH EXCEEDS 700 mm.

LEGEND

NOTES



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0	7/6/17	JDM	DH	MH	ISSUED FOR CONSTRUCTABILITY REVIEW

Professional Engineer Seal for M. Peng (B.C.) dated July 14, 2017.



WATER MANAGEMENT PLAN NELPCo EAGLE GOLD MINE , YT					
DITCH DETAILS					
PROJECT NO. WTRM03037-01	OFFICE VANC	DES DH	CKD MH	REV 1	DRAWING C1.08
DATE July 14, 2017	SHEET No. of	DWN JDM	APP MH	STATUS IFC	

APPENDIX B

Flocculent Use Plan

1. General

This document provides a basic description of a flocculant use plan that will be implemented, if required, at the SGC Eagle Project. SGC will only use only products from the high molecular weight anionic polyacrylamides (or PAMs) group of flocculants that are non-toxic to fish to settle sediment in the Lower Dublin South Pond (LDSP), sediment control pond.

2. Identification and Testing of Appropriate Flocculant(s)

There is a wide range of anionic PAM flocculants available for water clarification however the selection of a specific product is generally informed by site specific soil and water conditions. To ensure that an appropriate product is selected for use on the Project site, a test program will be developed with the earthworks contractor and flocculant suppliers. The test program will commence upon the initial construction of the Lower Dublin South Pond (LDSP) sediment control pond. The testing program will be used to determine the optimal flocculent to meet the discharge criteria for Total Suspended Solids (TSS) (i.e., maximum monthly mean of 15.00 mg/l, and a maximum grab sample of 30.00 mg/L). The test program will specifically be conducted to determine:

- a. The identification of suitable PAM flocculant products that meet the ANSI/NSF Standard 60 for drinking water treatment and is linear (non-cross-linked or resistant to forming complex polymer chains or bonding between adjacent short polymer chains);
- b. An identified maximum dosage for the identified product;
- c. Toxicity testing results for a proposed maximum dosage of the identified PAM product;
- d. A protocol for determining the appropriate dosage rate, which may often be less than the maximum dosage, for the identified product. The protocol will be based on monitoring data (i.e., flow rate, TSS, turbidity) collected routinely and periodically (i.e., likely several times a day during initial establishment to daily once established) from incoming streams (i.e., Ditches A and B).
- e. The Scope of the Testing Program in development is described in Section 2.1

Once the test program is completed, and a suitable PAM flocculant(s) has been determined, a design will be prepared for dosing the flocculant(s) into the feed water going into the LDSP. Material Safety Data Sheets (MSDSs) will be submitted with the design once the PAM products have been identified and tested for performance. Appendix A provides the MSDS for a range of anionic PAM products that may be used to reduce sediment loads in contact water on the Project site.

2.1 Scope of Required Testing for Flocculant Determination

Initial testing will be conducted by a selected Flocculant vendor, or third party testing service. The testing will be a standard Laboratory Jar test. The following guidelines will be followed

- Test a minimum of 3 separate polymers covering the tester's recommended polymer formulations for the raw water. The candidate polymers should include as many permutations as practical for the following general polymer characteristics.
- A minimum of five different levels of turbidity will be conducted with equal spacing between the minimum allowable level of 15 mg/l and 1000 mg/l.
- The Jar tests will be conducted for each product at different dosages with the tests run side-by-side, and the results compared to an untreated jar. A minimum of 10 different doses will be conducted for each products.

3. Operational Plan for Flocculant System

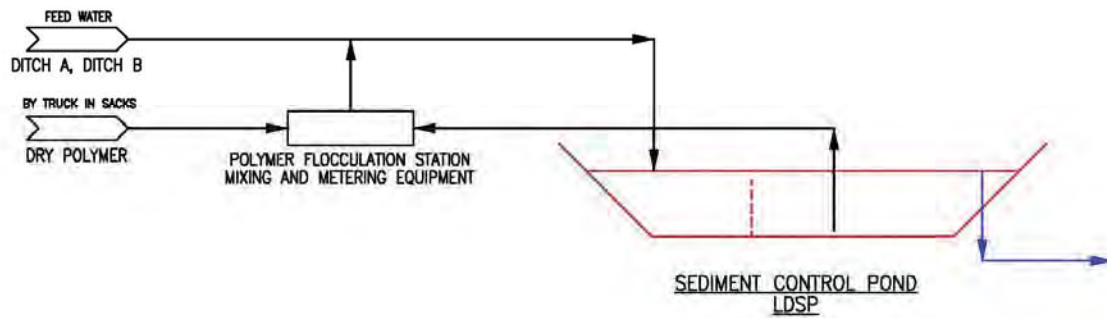
Should flocculants be required on site to manage elevated TSS concentrations in the discharge from the LDSP or sediment basins, a flocculation system as shown in Figure 1 (assuming the LDSP) will be used. This concept is summarized as follows:

- A centralized flocculation station will prepare a polymer solution from dry polymer powder for in-line injection into Ditch A and Ditch B feeding the LDSP. The maximum batching capacity is expected to be determined during testing;
- The flocculation station and batching and storage tanks will have secondary containment for the expected working volumes of stored liquid;
- It is anticipated that the flocculant storage, station, batching and storage tanks will be assembled into a 40' x8' Sea container converted into mix plant for this application. The plant (if required) will be stationed to the East of the LDSP, before the fore bay;
- Turbidity testing will be conducted daily at regular intervals to determine flocculant addition dosage requirements when there is water to be discharged from the LDSP. Water will be tested at the discharge well of the LDSP, to determine turbidity of the water at the point where it will be released, at the edge of the still well/pump house location of the pond, in the entrance to the main pond, and in the forebay, so that differences in turbidity can be monitored from the entrance to the exit of the water holding area;
- Make-up water for the polymer is expected to be drawn from the secondary portion of the LSDP or from a sediment basin, because the inflow will under most conditions be ephemeral and relatively low. Alternatively, make-up water will be drawn from either a water tank or a nearby water course;
- Protocols for determining the appropriate dosing rates will be prepared from the original testing based on the chosen product. The protocols will be reviewed once in operation to determine the effectiveness and make adjustments to dosing
- The flocculation system will be complete with metering and controls for the mixing and pumping to injection locations; and
- The dry polymer will be shipped to site in 1.0 m³ super sacks and will be stored indoors.

A standard operating procedure will be developed for the efficient, effective, and controlled addition of the flocculant. The procedure will include, at a minimum, the following:

- Monitoring Requirements (frequency and locations for TSS, turbidity and flow rate);
- Monitoring Methods (sampling and analyses);
- Polymer Handling, Storage and Maintenance;
- Batch Plant Operations and Maintenance (includes make-up water system);
- Periodic Performance Testing to ensure appropriate dosing and uses of identified flocculants; and
- Reporting Protocols and Requirements (for each of the above procedures).

Figure 1 Block Flow Diagram of Flocculation Concept



END OF SECTION



MATERIAL SAFETY DATA SHEET

PAM A Series

Section 01 - Product And Company Information

Product Identifier PAM A-03, PAM A-103, PAM A-303, PAM A-403, PAM A-503, PAM A-502, PAM A-702, PAM A-703, PAM A-903, PAM A-1003, PAM A-1002, PAM A-1503, PAM A-1803, PAM A-2003

Product Use Anionic water treatment polymer.

Supplier Name ClearTech Industries Inc.
1500 Quebec Avenue
Saskatoon, SK. Canada
S7K 1V7

Prepared By ClearTech Industries Inc. Technical Department
Phone: (306)664-2522

24-Hour Emergency Phone 306-664-2522

Section 02 - Composition / Information on Ingredients

Hazardous Ingredients Contains no hazardous ingredients

CAS Number Not applicable

Synonym (s) Not available

Section 03 - Hazard Identification

Inhalation Not available

Skin Contact / Absorption Irritating to skin

Eye Contact Irritating to eyes

Ingestion Not available



Exposure Limits..... Nuisance dust: 15mg/m³

Section 04 - First Aid Measures

Inhalation..... Remove victim to fresh air. Give artificial respiration only if breathing has stopped. If breathing is difficult, give oxygen. Seek immediate medical attention.

Skin Contact / Absorption..... Remove contaminated clothing. Wash affected area with soap and water. Seek medical attention if irritation occurs or persists

Eye Contact..... Flush immediately with water for at least 20 minutes. Forcibly hold eyelids apart to ensure complete irrigation of eye tissue. Seek immediate medical attention

Ingestion..... Do not induce vomiting. Consult a physician.

Additional Information..... Not available

Section 05 - Fire Fighting Measures

Conditions of Flammability..... Not available

Means of Extinction..... Foam, carbon dioxide, dry powder

Flash Point..... Not available

Auto-ignition Temperature..... Not available

Upper Flammable Limit Not available

Lower Flammable Limit..... Not available

Hazardous Combustible Products... Nitrogen oxides, carbon monoxide and carbon dioxide.

Special Fire Fighting Procedures..... Wear NIOSH-approved self-contained breathing apparatus and protective clothing. When this product comes in contact with water, surfaces become very slippery.



Explosion Hazards..... Not available

Section 06 - Accidental Release Measures

Leak / Spill..... Wear appropriate personal protective equipment. Ventilate area. Stop or reduce leak if safe to do so. Prevent material from entering sewers. Do not flush with water. Clean up promptly by sweeping or vacuum. After cleaning, flush away traces with water.

Deactivating Materials..... Not available

Section 07 - Handling and Storage

Handling Procedures..... Use proper equipment for lifting and transporting all containers. Use sensible industrial hygiene and housekeeping practices. For good industrial hygiene, avoid contact with skin and eyes, avoid forming dust, and wash hands before breaks and at the end of the workday. Avoid all situations that could lead to harmful exposure.

Storage Requirements..... Keep in a dry, cool place with the container well sealed.

Section 08 - Personal Protection and Exposure Controls

Protective Equipment

Eyes..... Chemical goggles, full-face shield, or a full-face respirator is to be worn at all times when product is handled. Contact lenses should not be worn; they may contribute to severe eye injury.

Respiratory..... Use dust masks where dust exceeds 15mg/m³

Gloves..... Impervious gloves of chemically resistant material (rubber or PVC) should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse.

Clothing..... Body suits, aprons, and/or coveralls of chemical resistant material should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse.

Footwear..... No special footwear is required other than what is mandated at place of work.

**Engineering Controls**

- Ventilation Requirements**..... Mechanical ventilation (dilution or local exhaust), process or personnel enclosure and control of process conditions must be provided in accordance with all fire codes and regulatory requirements. Supply sufficient replacement air to make up for air removed by exhaust systems.
- Other**..... Emergency shower and eyewash must be available and tested in accordance with regulations and be in close proximity.

Section 09 - Physical and Chemical Properties

- Physical State**..... Granular solid
- Odor and Appearance**..... Virtually no odor, off white
- Odor Threshold**..... Not available
- Specific Gravity (Water=1)**..... Not available
- Vapor Pressure (mm Hg, 20C)**..... Not available
- Vapor Density (Air=1)**..... Not available
- Evaporation Rate**..... Not available
- Boiling Point**..... Not available
- Freeze/Melting Point**..... Not available
- pH**..... 4-6 @ 5g/L
- Water/Oil Distribution Coefficient**.... Not available
- Bulk Density**..... Not available
- % Volatiles by Volume**..... Not available
- Solubility in Water**..... Complete
- Molecular Formula**..... Not available
- Molecular Weight**..... Not available

Section 10 - Stability and Reactivity



Stability..... Product is stable

Incompatibility..... Oxidizing agents, galvanized metals, mild steel, copper and brass.

Hazardous Products of Decomposition.. Thermal decomposition may produce nitrogen oxides.

Polymerization..... Will not occur

Section 11 - Toxicological Information

Irritancy..... Draize tests showed material produces no corneal or iridial effects only slight transitory conjunctival effects similar to those which all granular materials have on conjunctivae.

Sensitization..... Testing on guinea pigs showed this material to be non-sensitizing.

Chronic/Acute Effects..... A two-year feeding study on rats did not reveal adverse health effects.

Synergistic Materials..... Not available

Animal Toxicity Data..... LD₅₀(oral, rat)= >5000mg/kg

Carcinogenicity..... Not considered to be carcinogenic by NTP, IARC, and OSHA.

Reproductive Toxicity..... Not available

Teratogenicity..... Not available

Mutagenicity..... Not available

Section 12 - Ecological Information

Fish Toxicity..... LC₅₀(96 hrs, Fathead minnows)= >1000mg/L

Biodegradability..... Not readily biodegradable, this product is not expected to bioaccumulate.

Environmental Effects..... The product is not considered toxic to aquatic organisms or harmful to the aquatic environment.

Section 13 - Disposal Consideration



Waste Disposal..... Dispose in accordance with all federal, provincial, and/or local regulations including the Canadian Environmental Protection Act.

Section 14 - Transportation Information

TDG Classification

Class..... Not regulated

Group..... Not regulated

PIN Number..... Not regulated

Other..... Secure containers (full and/or empty) with suitable hold down devices during shipment and ensure all caps, valves, or closures are secured in the closed position.

Section 15 - Regulatory Information

WHMIS Classification.....Not a controlled product

NOTE: THE PRODUCT LISTED ON THIS MSDS HAS BEEN CLASSIFIED IN ACCORDANCE WITH THE HAZARD CRITERIA OF THE CANADIAN CONTROLLED PRODUCTS REGULATIONS. THIS MSDS CONTAINS ALL INFORMATION REQUIRED BY THOSE REGULATIONS.

NSF Certification.....PAM A-503 is certified under ANSI/NSF Standard 60 for coagulation and flocculation at a maximum dosage of 1mg/L.

Section 16 - Other Information

Note: The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment. The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations.

Attention: Receiver of the chemical goods / MSDS coordinator

As part of our commitment to the Canadian Association of Chemical Distributors (CACD) Responsible Distribution® initiative, ClearTech Industries Inc. and its associated companies require, as a condition of sale, that you forward the attached Material Safety Data Sheet(s) to all affected employees, customers, and end-users. ClearTech will send any available supplementary handling, health, and safety information to you at your request.

If you have any questions or concerns please call our customer service or technical service department.



Preparation Date.....January 21, 2015

ClearTech Industries Inc. - Locations

Corporate Head Office: 1500 Quebec Avenue, Saskatoon, SK, S7K 1V7

Phone: 800-387-7503

Fax: 888-281-8109

www.ClearTech.ca

Location	Address	Postal Code	Phone Number	Fax Number
Richmond, B.C.	12431 Horseshoe Way	V7A 4X6	800-387-7503	888-281-8109
Port Coquitlam	2023 Kingsway Avenue	V3C 1S9	800-387-7503	888-281-8109
Calgary, AB.	5516E - 40 th St. S.E.	T2C 2A1	800-387-7503	888-281-8109
Edmonton, AB.	12020 - 142 nd Street	T5L 2G8	800-387-7503	888-281-8109
Saskatoon, SK.	North Corman Industrial Park	S7K 1V7	800-387-7503	888-281-8109
Regina, SK.	555 Henderson Drive	S42 5X2	800-387-7503	888-281-8109
Winnipeg, MB.	340 Saulteaux Crescent	R3J 3T2	800-387-7503	888-281-8109
Mississauga, ON.	355 Admiral Blvd Unit #1	L5T 2N1	800-387-7503	888-281-8109

24 Hour Emergency Number - All Locations – 1(306) 664-2522
Alternative - 1(800) 387-7503