8. Environmental Management and Mitigation Measures

8.1 Introduction

The following chapter outlines an Environmental Management System (EMS) dealing with the construction and operations phases of the Galore Creek Project. The EMS proposed within this EA is designed to form the basis for a more detailed management system to be developed concurrent with project permitting and associated construction and commissioning phases. The EMS comprises a series of written plans that outline the scope of environmental management pertaining to compliance with both regulatory requirements as well as NovaGold environmental policy.

Environmental management and mitigation measures are provided for each of the following areas:

- Air Emissions and Fugitive Dust
- Water Management
- Tailings and Waste Rock
- Pipelines
- Filter Plant and Concentrate Loadout
- ML/ARD Prediction and Prevention
- Access Corridor Preliminary ARD
- Materials Management
- Erosion Control and Sediment
- Spill Contingency and Emergency Response
- Fish and Fish Habitat
- Wildlife Management
- Domestic and Industrial Waste
- Access Road
- Aerodrome and Aircraft Operations
- Archaeological and Heritage Site Protection

NovaGold Environmental Policy

NovaGold recognizes environmental management as a corporate priority as part of its Environmental Policy. NovaGold cares about preserving our environment for future generations, while also providing for safe, responsible and profitable operations by developing our natural resources for the benefit of our employees, shareholders and the wider community.

In adopting the following Statement of Principles throughout all stages of exploration, development, mining and closure, NovaGold intends to set and maintain standards of excellence for environmental performance at all of its operations.

- NovaGold will communicate its commitment to excellence in environmental performance to their subsidiaries, employees, contractors, other agents and the community.
- All new activities and operations will be managed to ensure compliance with applicable laws and regulations. In the absence of regulation, best management practices will be applied to minimize environmental risk.
- Remediation and mitigation of historic mining impacts at Galore Creek will be managed through the cooperative involvement of NovaGold with previous owners, government agencies and the community.
- To achieve its commitment to environmental excellence, NovaGold will utilize an environmental management system that ensures prioritization, planning, implementation, monitoring, and honest reporting.
- NovaGold will strive to minimize releases to the air, land, or water and will ensure appropriate treatment and disposal of waste consistent with associated permits.
- NovaGold will allocate the necessary resources to meet its reclamation and environmental obligations for the Galore Creek Project.
- NovaGold will continuously seek opportunities to improve its environmental performance through adherence to these principles. NovaGold will regularly report progress to its employees, shareholders and the community.

Commitment to Continual Improvement

Consistent with the above Environmental Policy statement, NovaGold is committed to the implementation of an EMS that is based on the principles set out by the International Organization for Standardization known as ISO. Through the implementation of various ISO standards, companies and government organizations around the world are able to ensure that quality levels are consistently met in the areas of product manufacture and delivery while ensuring environmental protection goals are also met and/or exceeded. The ISO 14000 series of standards deals specifically with requirements for environmental management and provides a framework for the development of both the management system and supporting audit program. The *14001 Environmental Management System* standard includes a requirement for continual improvement.

Within the context of the Galore Creek EMS, continual improvement refers to an ongoing process of performance enhancement. This means that NovaGold will endeavour to enhance the overall environmental performance of the mining operation by continuously enhancing its EMS and by improving its ability to manage the environmental aspects of its activities, products and services. Continual improvement to the EMS will be achieved by carrying out internal/external audits, regularly meeting with regulators and project stakeholders, performing management reviews, analyzing data and implementing corrective and preventive actions.

Agency Reporting and Plans for Environmental Monitoring

NovaGold will develop a reporting schedule for both Federal and Provincial agencies during the project permitting phase. The reporting schedule will detail the requirements for both meeting with regulatory agencies as well as the provision of written reports detailing compliance with permit stipulations and any other areas requiring such attention.

Plans for environmental monitoring are provided within Chapter 10 of this EA. NovaGold will modify these monitoring programs as required during the project permitting phase so as to ensure the monitoring program fully reflects permit requirements.

8.2 Air Emissions and Fugitive Dust Management Plan

The main objective of the air emissions and fugitive dust management plan is to ensure that the levels of air emissions and fugitive dust generated by project activities are at or lower than the regulatory requirements of the Canada and British Columbia Ambient Air Quality Objectives to ensure the protection of biological receptors such as vegetation, fish, wildlife and human health.

Potentially negative effects from air emissions and fugitive dust will be minimized through the implementation of mitigation measures such as:

- use of clean, high-efficiency technologies for diesel mining equipment
- use of appropriate emissions control equipment such as scrubbers
- use of low-sulphur diesel fuel when practical
- use of a vehicle fleet powered by diesel engines with low emissions of nitrous oxide and hydrocarbons (greenhouse gases)
- use of preventative maintenance to ensure optimum performance of light-duty vehicles, the diesel mining equipment and the incinerator, thereby reducing air emissions
- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination
- use of appropriate control methods such as road watering and vehicle speed regulations to minimize the generation of fugitive dust
- use of monitoring programs to ensure healthy work environments and protection of other biological receptors
- use of pipelines for moving concentrate and diesel fuel to reduce the number of haul truck trips and the consequent amount of diesel emissions and fugitive dust
- implementation of a recycling program to reduce the amount of incinerated wastes and hence CO_2 emissions
- segregation of waste prior to incineration to minimize toxic air emissions.

All employees, contractors and subcontractors will be made aware of the project policies for management of air quality. For example, trucking contractors will be informed of the requirements for speed limits and no idling.

Management and mitigation measures to protect ambient air quality during the construction and operations phases of the project are discussed separately below.

8.2.1 Construction Phase

The two main sources of air pollutants during the construction phase of the project will be diesel exhaust and fugitive dust generated from the unpaved roads and at the construction sites. Table 8.2-1 summarizes the anticipated pollutant sources and analogous mitigative policies to be implemented during the construction phase.

Table 8.2-1
Construction Phase Air Emissions and Fugitive Dust Mitigative Policies

Source of Pollution	Mitigative Policies
Diesel Emissions	• **regular vehicle maintenance** • **no-idling policy** • **speed limits** • **avoiding spills**
Waste Incineration	• **recycling program** • **waste segregation**
Fugitive Dust	• **using water for a dust suppressant** • **speed limits**

During the construction phase, diesel emissions will be produced primarily by light- and heavy-duty vehicles, stationary construction equipment and haul trucks carrying loads to and from the camp. Diesel emissions will include carbon monoxide/dioxide, nitrogen oxides, sulphur dioxide, particulate matter (PM) and residual unburned fuel vapours. Air emissions will also be produced by the incineration of inorganic and organic wastes. Depending on atmospheric stability and other meteorological conditions, the contaminants will disperse into the surrounding air mass and be quickly and efficiently diluted by the prevailing winds.

Air emissions will be mitigated and managed by:

- minimizing diesel emissions through regular maintenance of all generators and mobile equipment
- reducing vehicle emissions by not allowing vehicles to idle, except when necessary, and by imposing speed limits
- avoiding spills during the refuelling of vehicles and stationary power equipment to minimize the release of hydrocarbons to the atmosphere
- implementing waste segregation and recycling programs to reduce the quantity of inorganic wastes incinerated, thereby decreasing CO_2 emissions.

During construction, fugitive dust will be generated from vehicles travelling on unpaved roads, construction of the access corridor (including blasting in quarry pits) and other construction activities, including clearing, earthworks, topsoil removal and stockpiling. Fugitive dust can be exacerbated by dry climatic conditions and winds, although the regular precipitation that typically occurs at the Galore Creek site can be expected to provide natural mitigation for a certain amount of fugitive dust.

Dust control is an important aspect of the project environmental management system. During construction, fugitive dust will be managed by applying water as a dust suppressant to unpaved roads and active earthworks areas during dry weather and the summer season, especially June and July, the driest months. In addition, speed limits will be imposed to limit the amount of fugitive dust generated by vehicles.

8.2.2 Operations Phase

Operations phase air emissions and fugitive dust will be controlled and monitored throughout the life of the project. The main pollutants will include particulate matter (PM) of various sizes, greenhouse gases (mainly carbon dioxide, carbon monoxide and nitrous oxide), sulphur oxides (SOx), nitrogen oxides (NOx) and volatile organic compounds (VOCs).

Activities that will produce gaseous air emissions and fugitive dust during operations include mining (blasting, earthworks, excavation), ore processing, tailings and waste rock disposal/storage, and the transportation of personnel and materials to and from the mine site by means of the access road and aerodrome.

Table 8.2-2 summarizes the anticipated pollutant sources and analogous mitigative policies to be implemented during the operations phase

Table 8.2-2
Operations Phase Air Emissions and Fugitive Dust Mitigative Policies

Source of Pollution	Mitigative Policies
Diesel Emissions	• regular vehicle maintenance • no-idling policy • speed limits • avoiding spills • using pressure valves on fuel storage tanks • where applicable, using electric drills and shovels/loaders
Gaseous Emissions from Blasting	• limiting number of blast holes • blast hole stemming • adjusting hole firing sequences
Waste Incineration	• recycling program • waste segregation
Fugitive Dust	• using water for a dust suppressant • speed limits • upgrading road surface materials • limiting number of blast sites • dust suppression system at the primary crusher • enclosing the ore stockpile in a building • using covered conveyors and ore transfer points • reducing vehicular traffic by using the concentrate and diesel pipelines

8.2.2.1 Mining Activities

Mining activities that result in air emissions include blasting and the operation of diesel-powered mining equipment and haul trucks for transporting waste and ore. Emissions include SOx, NOx, CO and PM. To reduce diesel emissions, equipment engines will not be left to idle except when necessary, and speed limits will be imposed.

Fugitive dust can be created by vehicle traffic on unpaved roads, ore transfer, truck loading and unloading, and blasting. To mitigate fugitive dust around the open pits, water will be sprayed on the haul roads, vehicle speeds will be enforced, the number of blast sites will be limited, hole firing sequences will be adjusted and blast hole stemming will be conducted carefully.

8.2.2.2 Ore Processing Area

The primary air emissions from the ore processing areas will be PM. Different mitigation measures will be used for indoor and outdoor sources of air emissions. The indoor ore processing activities will include ore stockpiling, ore conveying, two-stage grinding, copper flotation, rougher concentrate regrinding, concentrate thickening and pumping, concentrate filtration, concentrate storage, tailings handling and water reclaim. The only source of dust will be the ore stockpile, which will be partially enclosed in an A-frame building; to reduce fugitive dust, the two open ends of the building will be oriented at 90º to the prevailing wind direction. The other indoor ore processes are wet and hence PM emissions will be negligible.

More-active measures of dust suppression will be implemented at the outdoor facilities associated with the process plant. A dust suppression system will be used at the primary crusher, and water will be sprayed around the crusher, the ore stockpile pad and the process plant itself to minimize fugitive dust from ore handling and local traffic on unpaved roads.

8.2.2.3 Access Corridor and Transportation

Traffic on the unpaved access corridor will contribute to air emissions through diesel exhaust and the generation of fugitive dust. Mitigative measures include the enforcement of speed limits and no-idling policies, road watering and upgrading the road-surfacing materials with coarse local aggregates.

The use of pipelines to transport concentrate and diesel fuel will help minimize vehicle emissions and fugitive dust by significantly reducing the amount of traffic along the access road. The road will therefore be used primarily for the delivery of consumables such as non-diesel fuels, steel balls, reagents and supplies to the mine. On backhaul, the trucks would leave the mine either empty or loaded with materials to be disposed of or recycled in licensed facilities. A traffic study suggests that a maximum of about 19 vehicles will travel over the road every day.

8.2.2.4 Filter Plant and Porcupine Aerodrome

Operation of the filter plant and Porcupine aerodrome will result in air emissions in the form of exhaust produced by vehicles and by fixed- and rotary-wing aircraft. The amount of exhaust produced will be minimized by enforcing no-idling policies and speed limits for vehicles and by limiting the amount of air traffic (see Section 8.16 for more information on the Airstrip and Aircraft Operations Management Plan).

Light-duty vehicles and haul trucks being loaded with concentrate will produce fugitive dust around the filter plant, and aircraft landings and departures will produce fugitive dust at the aerodrome. These areas will be sprayed with water for dust control, particularly during June and July, the two driest summer months.

8.2.2.5 Tailings and Waste Rock Disposal/Storage

Fugitive dust caused by wind erosion on the tailings and PAG waste rock storage areas will be limited by maintaining a water cover over the deposited materials Fugitive dust caused by wind erosion on the non-PAG waste rock piles will be mitigated by progressive reclamation. Each lift will be layered with just enough organic matter to allow native seed propagation, thus providing a long-term vegetative cover.

8.2.2.6 Miscellaneous Items

Other mitigative measures will be incorporated for the management of air emissions and fugitive dust at the project: a vegetation cover will be established on stripped surface areas, the waste incinerator will have a built-in emission control system, and the fuel storage tanks will be equipped with pressure valves to control fuel vapour air emissions.

8.2.3 Workplace Air Quality Control

The workplace is generally defined as an indoor setting where air quality control is required to provide an environment that protects the health and safety of workers. Indoor air quality control measures will be established during both the construction and operations phases of the project. Workers in outdoor settings may also be exposed to air contaminants, but the effects of dilution and dispersal into the volume of the air mass reduce the need for protective measures. The main air contaminants that can affect the health and safety of workers are PM, CO and diesel exhaust. The major project locations where workplace air quality will be of concern are the process plant and open pit mining areas.

The workplace air quality guidelines for the Galore Creek Project will include provisions for:

- conducting periodic monitoring of workplace air quality for air contaminants relevant to employee tasks and equipment operations
- providing good ventilation systems
- providing air pollution control equipment such as scrubbers
- maintaining protective respiratory equipment and air quality monitoring equipment in good working order
- ensuring that employees use protective respiratory equipment when the exposure levels for various contaminants, including welding fumes, solvents and other materials present in the workplace, exceed local or internationally accepted standards.

8.2.3.1 Ore Processing Areas and Indoor Operations

Dust generation related to ore processing will occur when dry materials are being handled. Most of the dust created at the primary crusher, conveyors and ore transfer points will be captured by dust collectors. The relatively high moisture content of the Galore Creek ore to be processed, 5%, will help reduce the amount of PM to be captured. According to the United States Environmental Protection Agency, ores with a moisture content of more than 1.5% are considered “wet.” Process plants that maintain relatively high ore moisture content can effectively control PM emissions throughout the process (US EPA 1995).

Other indoor areas of concern include any building where CO can be generated from the operation of diesel equipment, such as the truck repair shop and diesel genset (emergency back-up power) areas. CO monitors will be installed in these areas, and appropriate ventilation systems will be activated when concentrations are high.

8.2.3.2 Mining Activities

Fugitive dust is usually prevalent in open pits, especially during the drier summer months. Heavy equipment operators will normally remain in their vehicles, and the cabs will be fitted with a filtered supply of fresh air. This will minimize worker exposure to fugitive dust.

8.2.4 Monitoring and Implementation

A dust deposition monitoring program will be established to measure dust/chemical deposition from mining activities. The monitoring program will:

- identify the total PM deposition rates at various distances from the project footprint
- identify the physical and chemical characteristics of particulate material that may be deposited into the surrounding area from mining activities, especially metals but also sulphate and nitrate that may be associated with acid deposition.

The monitoring program will be used to identify any locations of high air emission concentrations or particulate dust deposition. If a particular area becomes a problem, then adaptive management policies, such as increased road watering or reducing diesel exhaust, will be implemented. The physical and chemical characteristics of the PM will also be measured to ensure that parameters are at or below the regulatory requirements. The main monitoring parameters will be determined by the conditions set out in NovaGold's licences and permits.

8.3 Water Management Plan

Water is a key component in the mining process in that it is both required for, and affected by, mining activity. In the process of mining, waterbodies can be temporarily diverted, created or drawn upon to allow mining activity to occur. As well, water acts as a transport medium for potential contaminants to be introduced into the receiving environment. Therefore, water must be managed for a variety of reasons including compliance with operating permits; smooth and uninterrupted operation of the mine; and control of effects to water quality and quantity in the receiving environment.

As such, NovaGold Canada Inc. (NovaGold) is committed to a comprehensive water management plan that applies to all mining activities undertaken during all phases of the Galore Creek Project. The main objective of this water management plan is to regulate the movement of water in and around the mine site to ensure long term environmental protection.

The goals of this management plan are to:

- provide a basis for management of the freshwater on the site, especially with the changes to flow pathways and drainage areas
- protect ecologically sensitive sites and resources and avoid harmful impacts on fish and wildlife habitat
- provide and retain water for mine operations
- define required environmental control structures
- manage water to ensure that any discharges meet and/or exceed the permitted water quality levels and guidelines.

This management plan is organized to reflect the principal issues surrounding water management planning, which include:

- management philosophy
- planning and design criteria
- changes to flow pathways and drainage areas
- water balance
- water management within the:
    - tailings and waste rock impoundment
    - open pits
    - plant site
    - filter plant
    - waste rock dumps
    - access corridor.

Material contained in this section is closely related to material appearing elsewhere in the report, and thus the reader is referred to the following sections for further detail pertaining to certain areas:

- Section 8.4 on Tailings Management for information on water quality management within the tailings and waste impoundment
- Chapter 5 on Project Description describes the dam engineering in section 5.9, and mine area water management in section 5.10
- Chapter 6 on Environmental Setting describes the baseline data on water quality and quantity for surface and ground water in sections 6.4 and 6.5, respectively.
- Chapter 7 on Environmental Effects Assessment describes surfacewater and groundwater in Sections 7.8 and 7.9, respectively.

8.3.1 Water Management Philosophy

The Galore Creek Project site will experience high annual precipitation of approximately 1,650 to 2,300 mm throughout the mine life. Rain and snow, as well as water discharged from nearby icefields and glaciers, have been incorporated into the design of the proposed mine. The catchment area around the Galore Creek site is large (125 km^2), which means that large volumes of freshwater require diversion to facilitate mining and minimize environmental impacts. Therefore, the Galore Creek Project will result in localized changes to quantity.

Permanent changes will occur to Galore Creek from the construction of a tailings and waste rock impoundment. For the life of the mine, normal flow of Galore Creek will be diverted into a diversion channel and directed around the tailings and waste rock impoundment to empty back into the creek channel below the dam. At closure of the mine all the freshwater diversions will be breached allowing water to flow into the tailings and waste rock impoundment. Any excess water in the tailings and waste rock impoundment will exit into the Galore Creek below the dam through a spillway on the right abutment.

Figure 8.3-1 depicts the water management structures that will be employed in the Galore Creek Valley, including structures required for construction as well as operation.

8.3.2 Changes to Flow Pathways and Drainage Areas

The following section provides a brief summary on the changes to flow pathways and drainage areas within the project area. For further details the reader is referred to Section 8.4, Tailings Management Plan, and Section 7.9, Groundwater Effects Assessment.

The construction of mine site infrastructure for the Galore Creek Project will alter the natural flow paths within Galore Creek Valley. Flow pathways and drainage areas for baseline conditions, Year 1 of operations, Years 2 – 20 of operations and closure are shown in Figures 8.3-2 to 8.3-5.

During the construction period water will be diverted around the main construction sites (*e.g.*, plant site, dam, pre-stripping of pit areas). There will be local changes to flow pathways within Galore Creek Valley. Flow and sediment controls are outlined in Section 8.10, Erosion and Sediment Control.

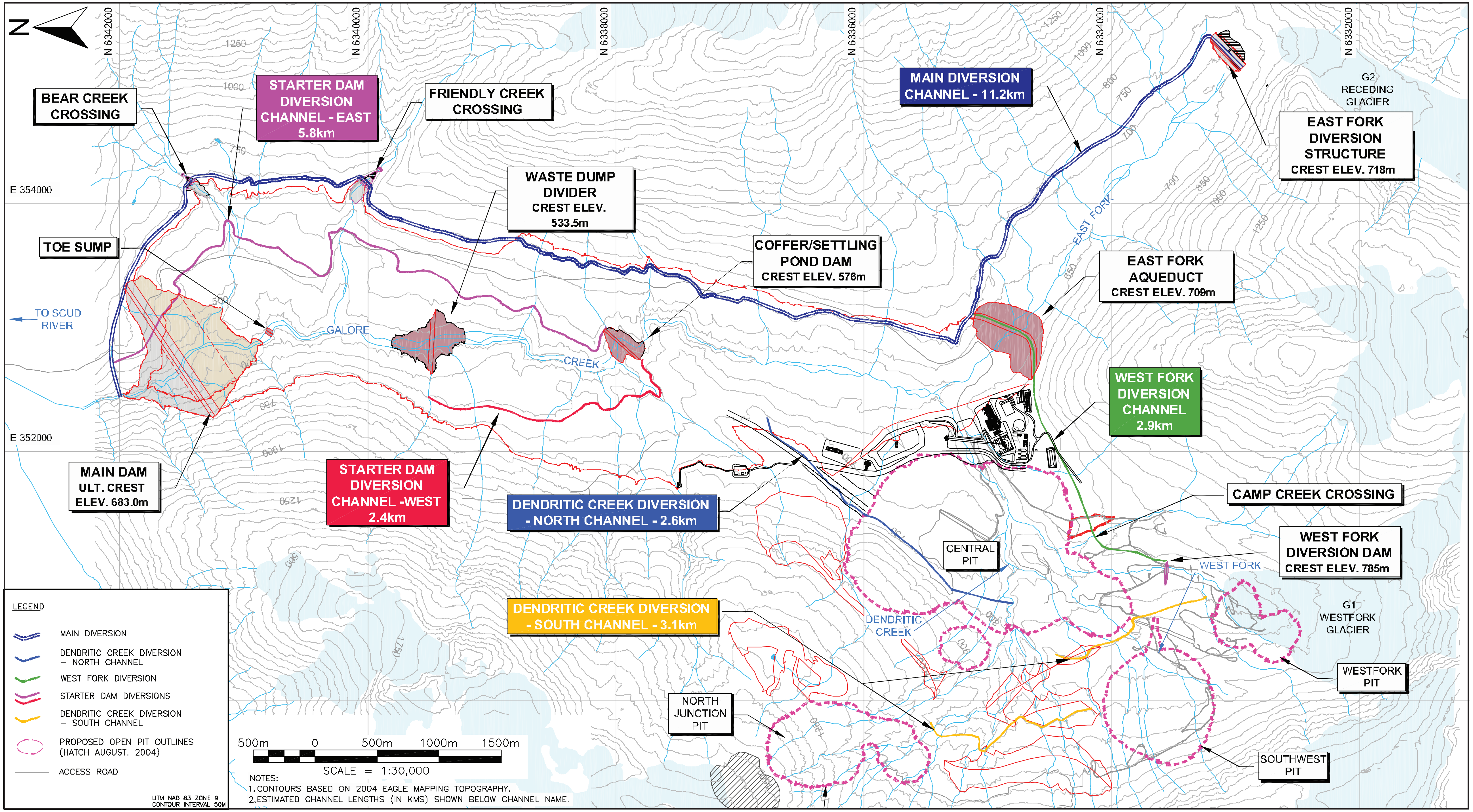
During mine operations much of the main stem of Galore Creek Valley will be flooded under the tailings and waste rock impoundment. Diversion channels will capture water from non-disturbed areas of the watershed and direct these flows away from the tailings and waste rock impoundment, finally discharging into Galore Creek, downstream of the main tailings dam. Runoff from disturbed watersheds and non-disturbed watersheds on the west side of Galore Creek Valley will discharge into the impoundment.

In the first year of operations a coffer dam located upstream of the waste rock / tailings divider will capture all of the runoff from the upstream watersheds and divert flows into a temporary diversion channel. During this time only a small watershed area will report to the tailings storage area and be retained behind the starter dam.

The main diversion channel will divert water from 85.6 km^2 of the original watershed of Galore Creek, away from the tailings and waste rock impoundment. Water draining from the East Fork of Galore Creek will flow into the main diversion channel at the East Fork Diversion Structure. The drainage area flowing into the diversion channel at the East Fork Diversion Structure will be 46.2 km^2. Within the main diversion channel flows originating from the East Fork will be joined by flow from a secondary diversion channel that drains water from the West Fork of Galore Creek and which crosses the waste rock storage area on an aqueduct.

Other diversion channels and ditches within the mine site footprint will divert water away from the pits and control drainage at the camp, process plant and along roads. Runoff from disturbed areas will report to the tailings and waste rock impoundment. After Year 5 of operations the Dendritic Creek drainage in the West Fork of Galore Creek will be diverted to the main diversion channel and runoff from this area will no longer enter the tailings and waste rock impoundment. At closure all diversion structures will be decommissioned and all runoff will enter the impoundment, where it will flow over the spillway of the main dam into Galore Creek.

A 3.8 km long tunnel will allow access from Scotsimpson Creek drainage into Galore Creek Valley. The tunnel will drain toward Galore Creek. It will intercept groundwater that would have originally drained into the Scotsimpson watershed. Groundwater intercepted from the tunnel will flow into the headwaters of Galore Creek and be directed into the West Fork Pit. Based on estimated groundwater inflow rates, the tunnel will contribute 0.05 m^3/s of additional flow into the Galore Creek Valley. For a detailed discussion of groundwater inflow from the tunnel, see Section 7.9.



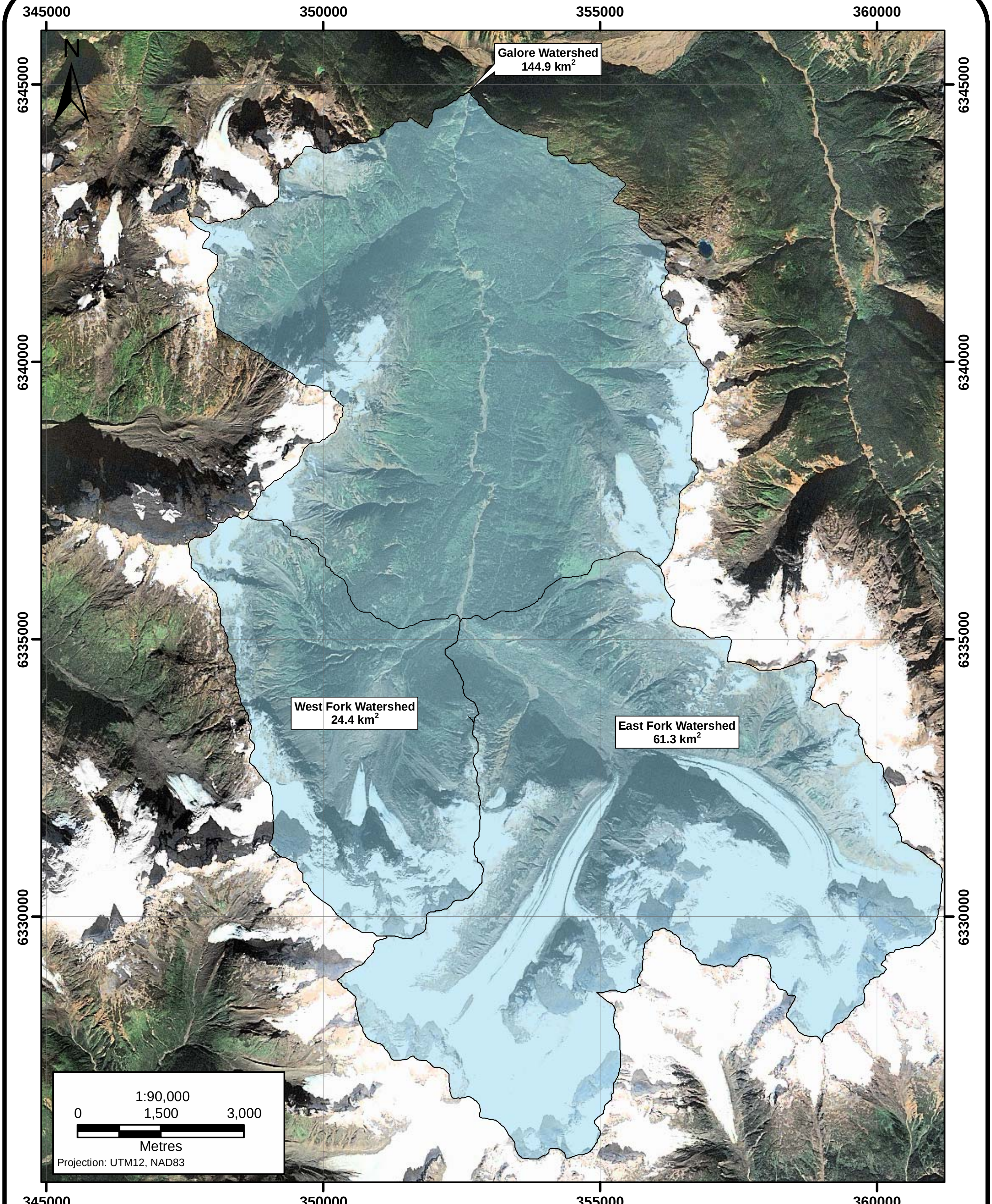
Source: BGC Enineering Inc.

NovaGold Canada Inc.

Water Management Structures in the Galore Creek Valley for both Construction and Operation Phases of the Project

FIGURE 8.3-1

Rescan™



Minesite Drainage Areas - Pre-development

FIGURE 8.3-2

NovaGold Canada Inc.

Rescan™

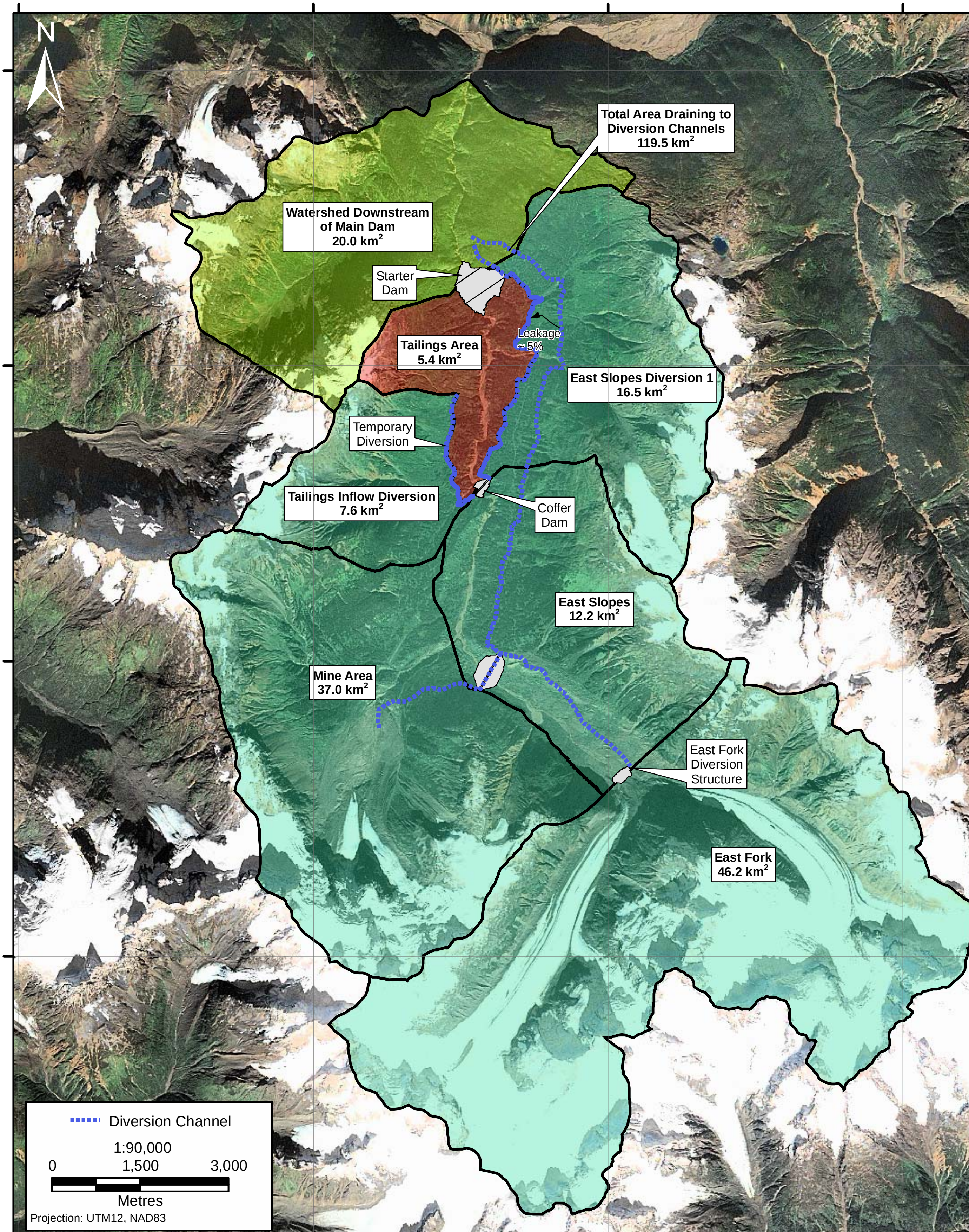


FIGURE 8.3-3

NovaGold Canada Inc.

Minesite Drainage Areas - Year 1

Rescan™

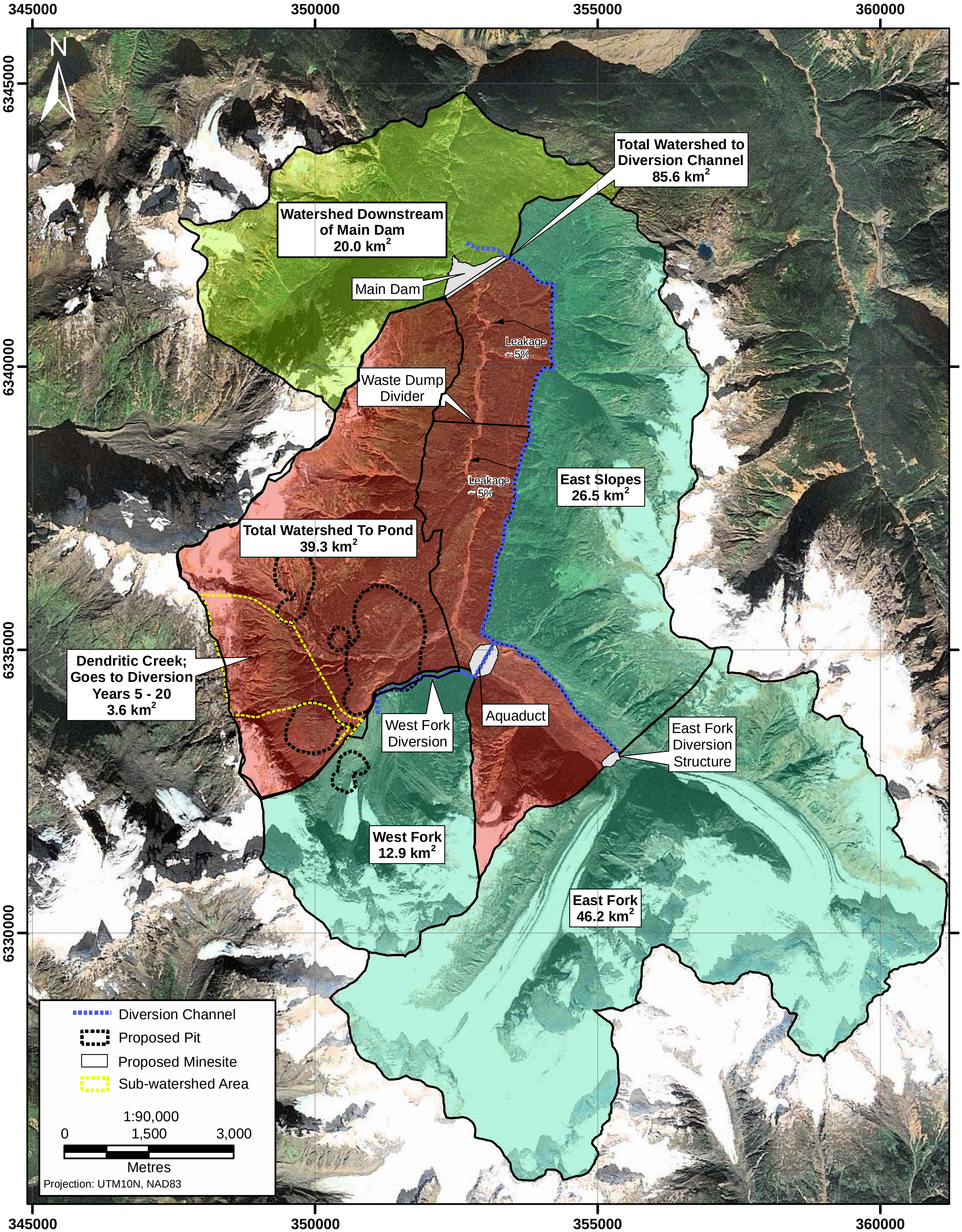


FIGURE 8.3-4

NovaGold Canada Inc.

Minesite Drainage Areas, Year 2 to 20

Rescan

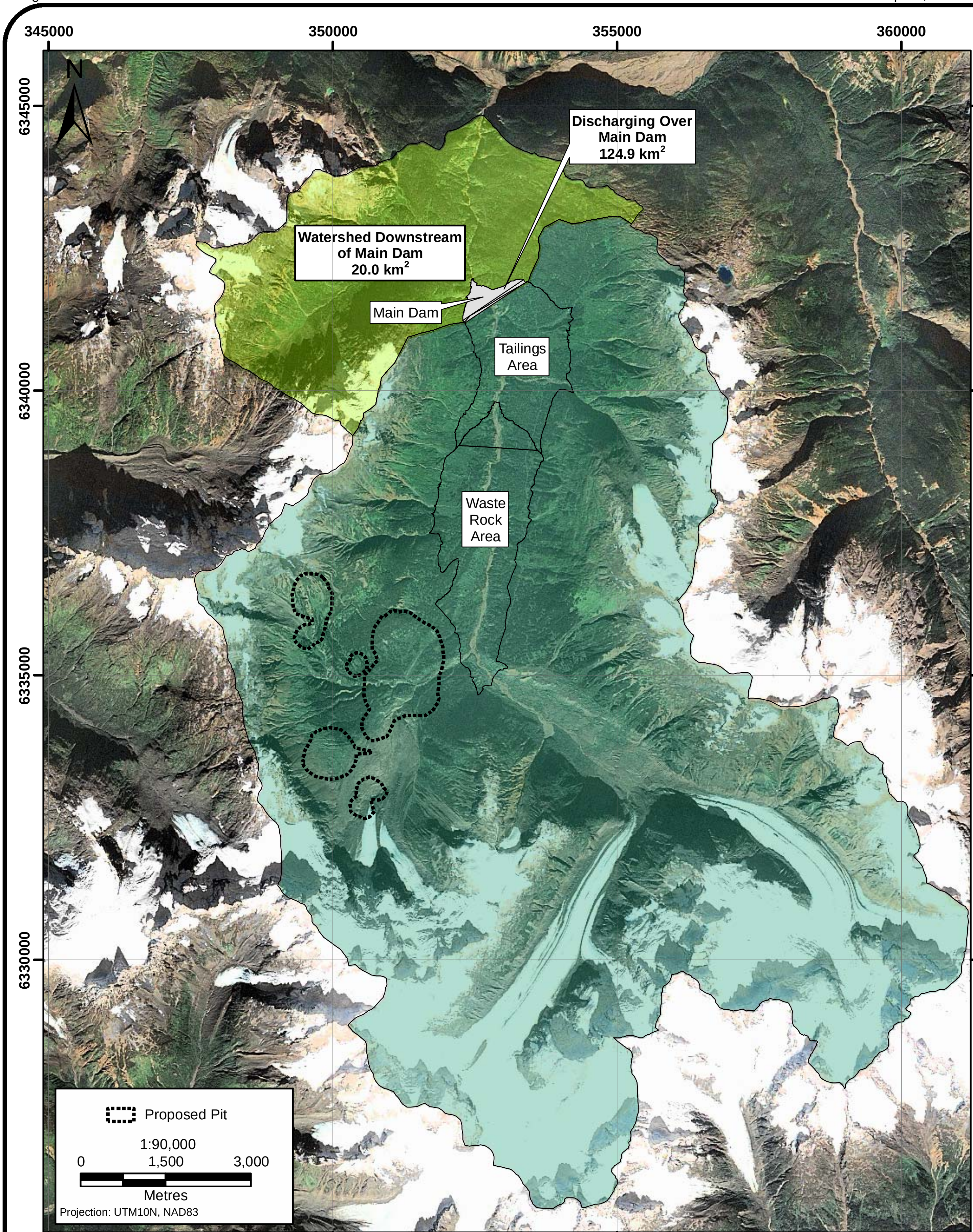


FIGURE 8.3-5

NovaGold Canada Inc.

Minesite Drainage Areas - Closure

Rescan™

In summary, the development of mine site infrastructure will dramatically alter the flow paths and drainage areas within Galore Creek Valley. However, downstream of the main tailings dam where the pumped outflow from the storage facility has mixed with flow from the main diversion channel, the mine site will not change the natural flow paths and drainage areas in the lower reaches of Galore Creek or in the Scud River. At closure the diversion channels within Galore Creek Valley will be decommissioned and all runoff will enter the flooded tailings and waste rock impoundment. The tailings and waste rock impoundment will operate as a freely overflowing reservoir or lake. In West Fork the pits will be allowed to fill and will overflow into the impoundment.

Table 8.3-1 provides the summary of the catchment areas within the Galore Creek area.

Table 8.3-1
Summary of Catchment Areas in Galore Creek (km^2)

	Pre-Development	Operation Yr 1-2	Operation Yr 2-4	Operation Yr 4-20	Closure
West Diversion Channel	-	44.6	12.9	16.5	-
East Diversion Channel	-	74.9	72.7	72.7	-
Open Pits and Pit Catchments	-	-	13.7	13.7	-
Tailings Impoundment and Catchment	-	5.4	22.0	22.0	124.9
Downstream of Tailings Dam	-	20.0	20.0	20.0	20.0
Galore Creek (Total)	145.0	144.9	144.9	144.9	144.9

8.3.3 Water Balance

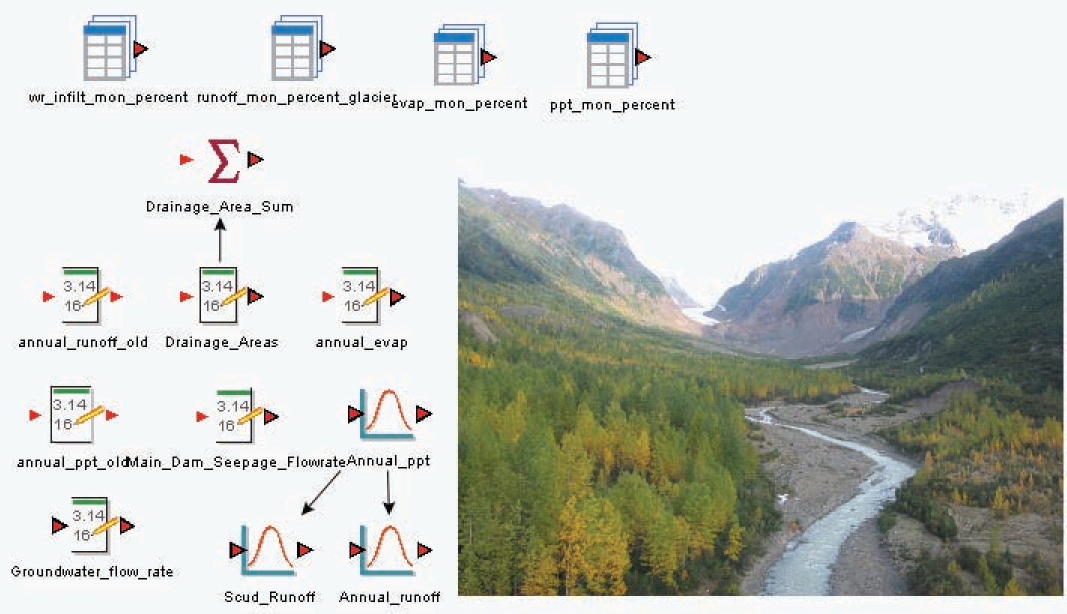
A thorough understanding of water movement, including flow patterns, flow volumes and occurrence, throughout the project site is essential to water management planning.

The water balance sub-component of the Galore Creek water quality model (see Appendix 7-E, Galore Creek Storage Facility Water Quality Prediction Model) was used to compute the annual water balance and produce water management strategies within the tailings and waste rock storage facility. Within the model natural runoff, diversion channels, groundwater from pit de-watering wells, process plant flows, sump water, and pumped outflows from the storage facility are all considered. Figure 8.3-6 shows screenshots of the organization of hydrological inputs, outputs, and processes within the water balance model. A schematic illustrating how Galore Creek Valley is represented in the model is shown in Figure 8.3-7.

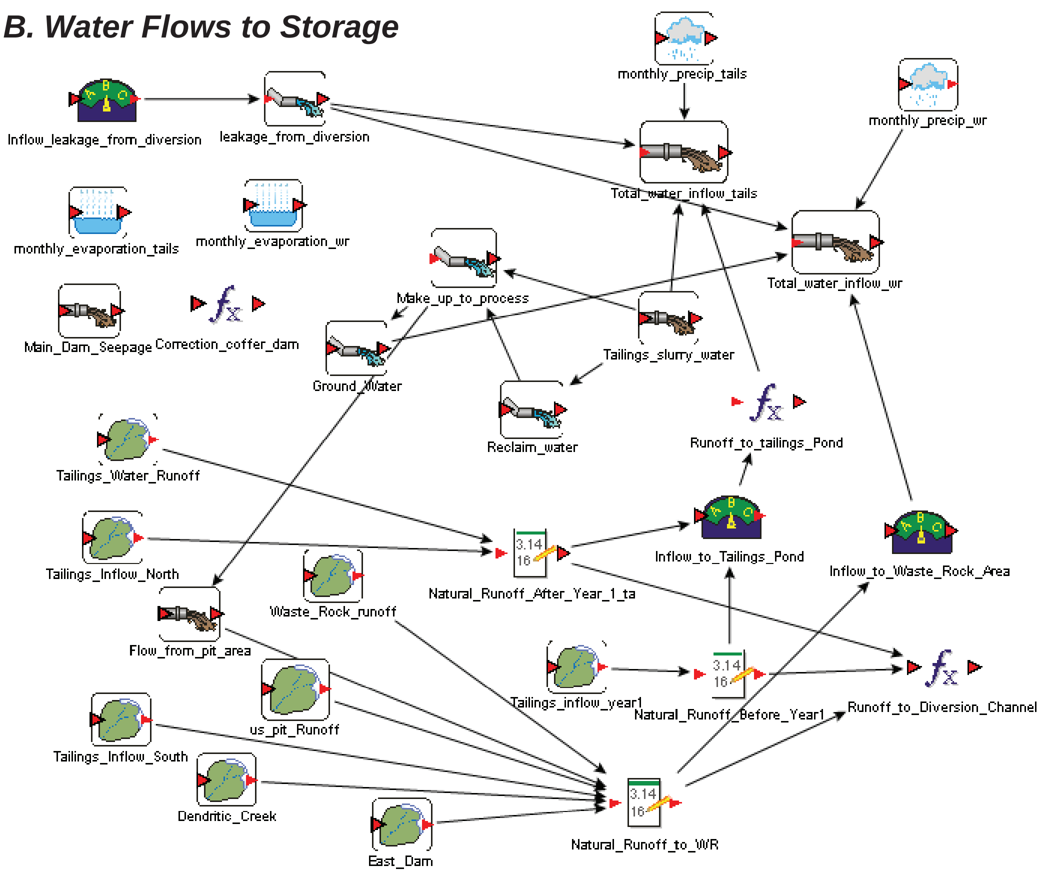
The water balance model for the Galore Creek site was based on storage-elevation curves of the storage facility, mine plans for the various project phases, as well as baseline hydrological and meteorological conditions. The water balance sub-component of the water quality model was used to project;

- annual excess volume of water stored in the tailings and waste rock storage facility;

A. Hydrology Input Data



B. Water Flows to Storage



Hydrological Inputs and Water Flow Calculations within the Water Balance Sub-component of the Water Quality Model

FIGURE 8.3-6

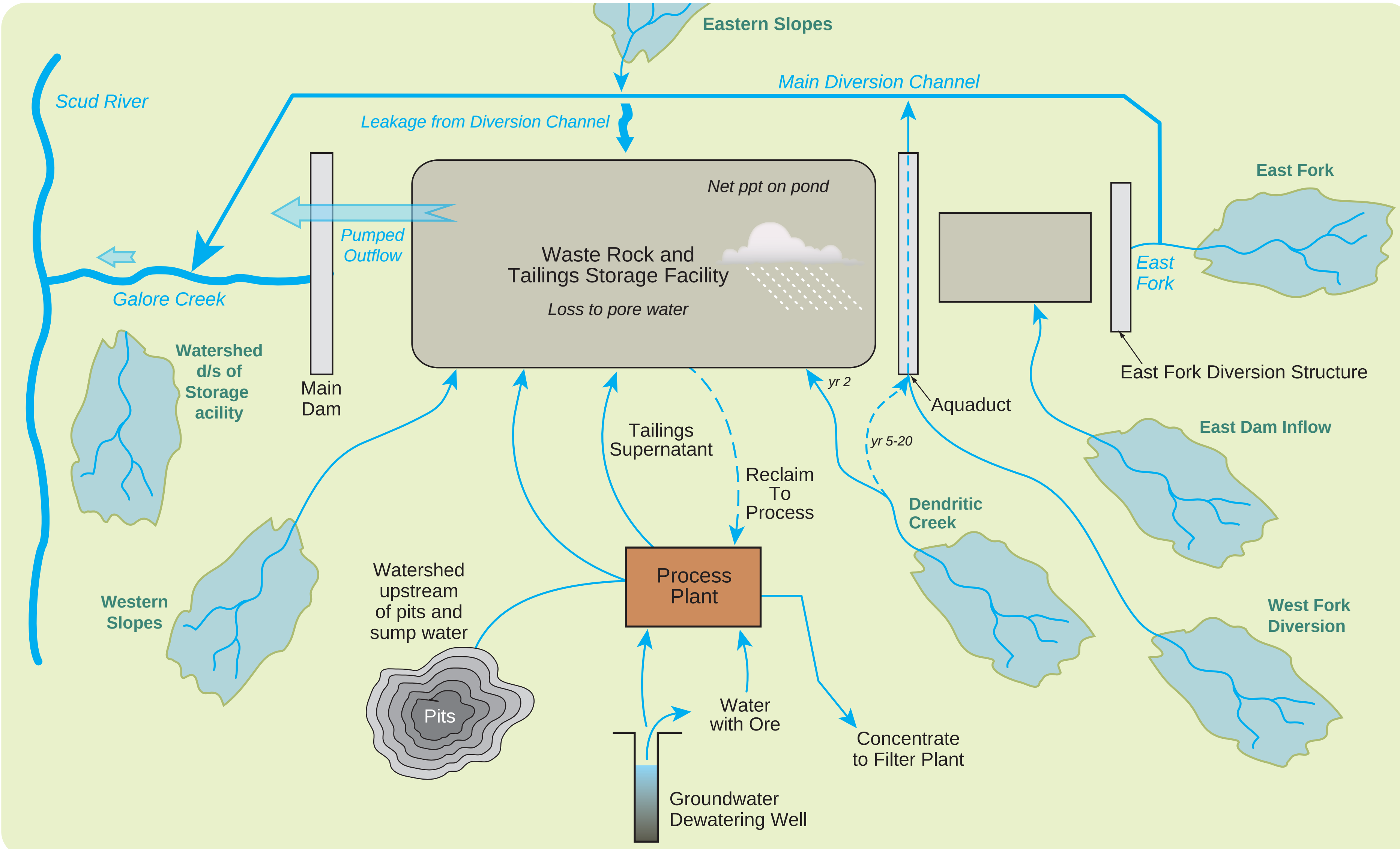


FIGURE 8.3-7

NovaGold Canada Inc.

Galore Valley Water Balance - Schematic

Rescan™

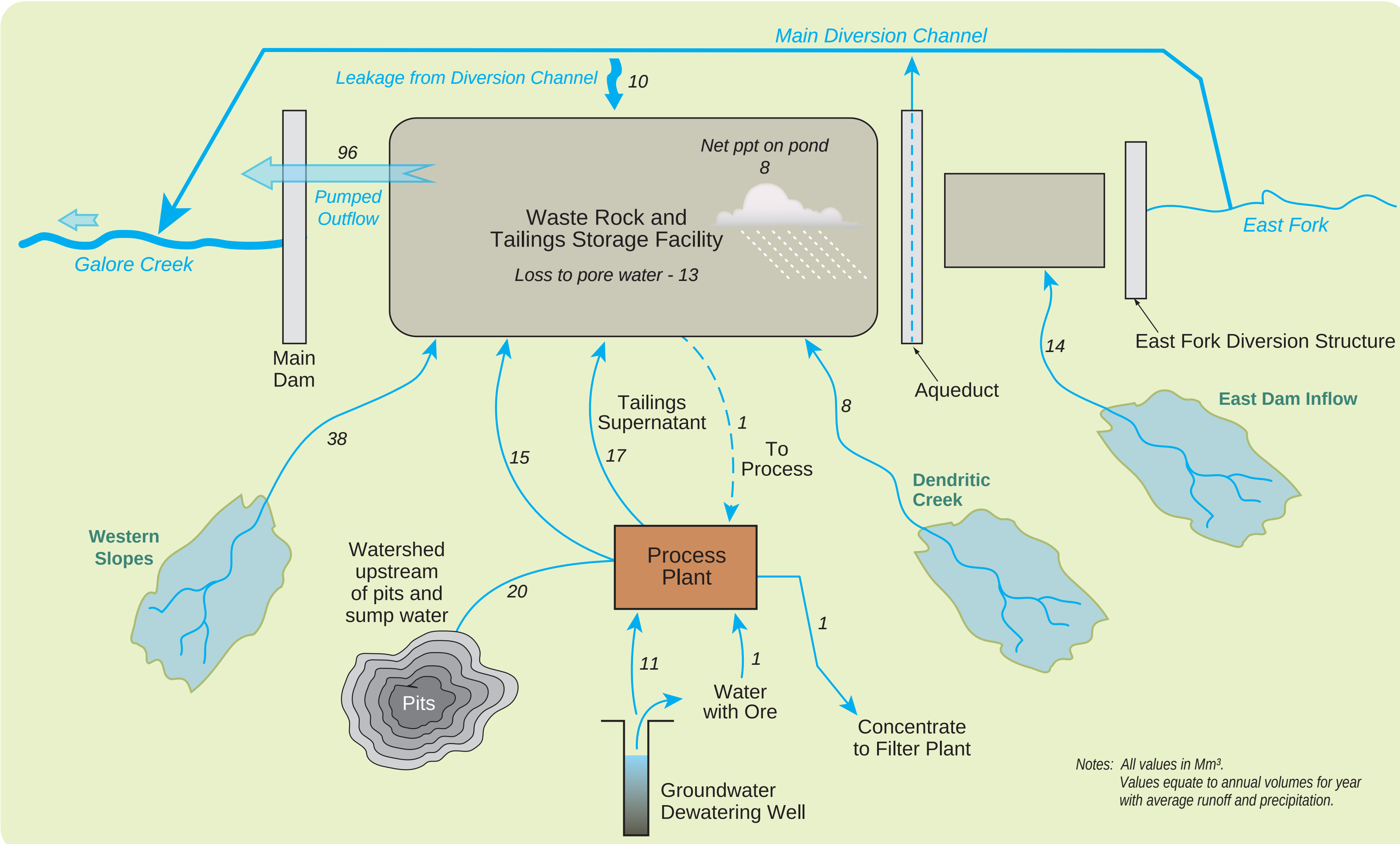


FIGURE 8.3-8

Galore Valley Water Balance – Inflows and Outflows to the Tailings and Waste Rock Impoundment

NovaGold Canada Inc.

Rescan™

- bi-weekly pumped discharges from the storage facility during the spring and summer open-water period; and
- water levels within the storage facility under average conditions as well as 1 in 200 dry and 1 in 200 wet conditions.

8.3.3.1 Predicted Water Volumes

Table 8.3-2 provides a summary of predicted annual water volumes for key sources and sinks within the water balance model. Schematics showing water volumes for a year with average runoff conditions are provided in Figures 8.3-8 and 8.3-9.

8.3.3.2 Pumped Flows and Downstream Flow Rates

Pumped flow rates and flows at the mouth of Galore Creek were estimated for different climatic conditions. Estimates were made of average flow rates for each two-week period during the pumping season, typically May 15th to October 15th under normal operating conditions.

Estimates were also made considering extreme conditions where there are no releases from the pond from May 15th to July 15th and then the full annual volume has to be pumped from the impoundment from July 16th to October 15th. Results are provided in Figures 8.3-10 to 8.3-12.

Estimates of the impact of pumping on flow rates in the Scud River downstream of Galore Creek are provided in Figures 8.3-13 to 8.3-15.

Table 8.3-2
Predicted Annual Water Volumes within the Water Balance Model

	Average Year (Mm^3)	1 in 200 wet (Mm^3)	1 in 200 dry (Mm^3)
Inflows to the Pond			
[a]Natural Runoff	60	82	39
Sump and watersheds upstream of pits	20	28	13
Groundwater Dewatering	11	11	11
Net precipitation	8	11	5
Leakage from Diversion Channel	10	14	6
Others	2	2	2
Losses from the pond			
Pore Water	13	13	13
Reclaim	1	1	1
With concentrate	1	1	1
Pumped outflow	***96***	***133***	***61***
Diversion Channel	190	259	122
Watersheds downstream of main dam	47	64	30
At mouth of Galore Creek	***333***	***456***	***213***

[a]Assumes Dendritic Creek watershed flows to the storage area . This will occur from Years 2 to 4 and represents the period with highest inflows to the facility and highest pumped volumes

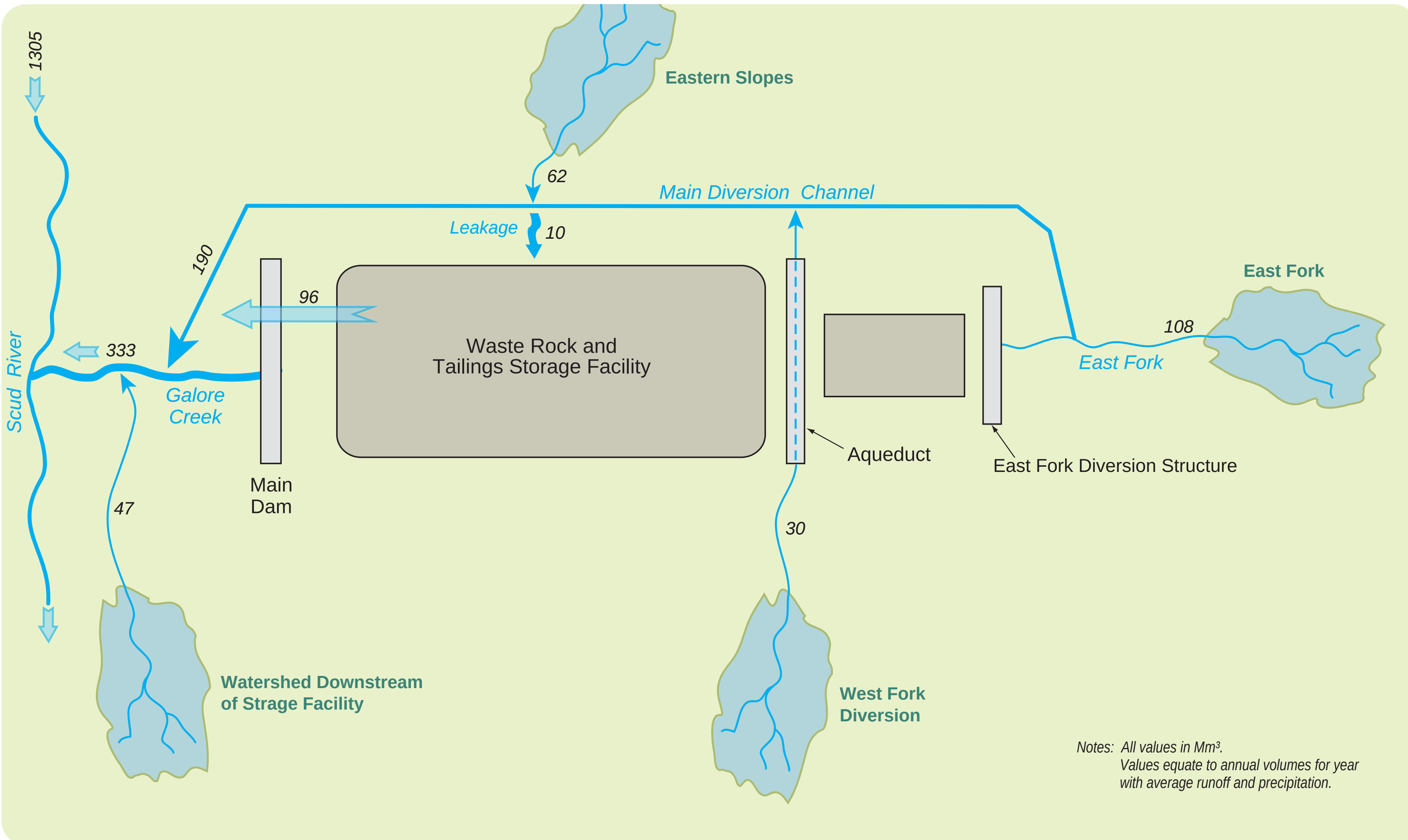
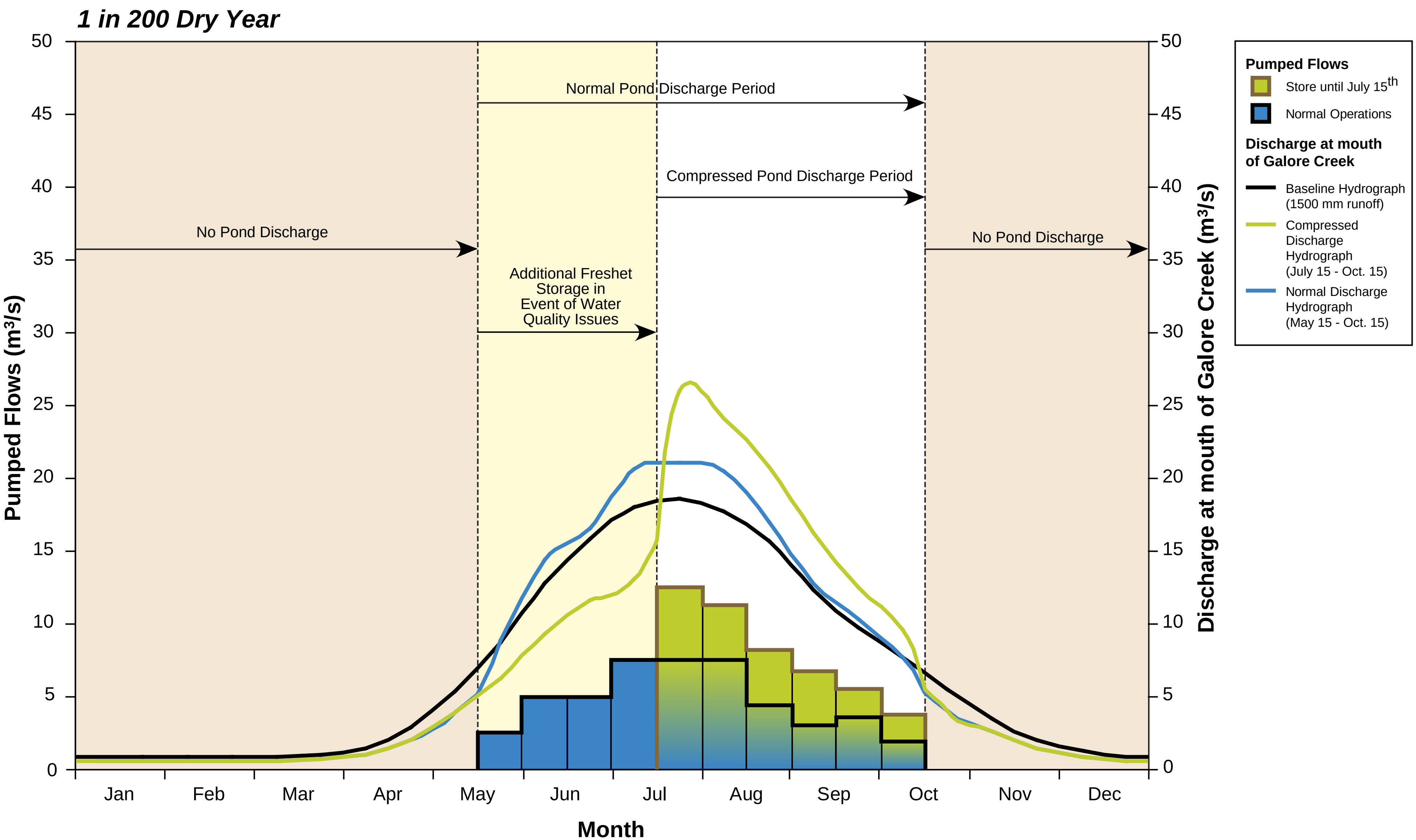


FIGURE 8.3-9

Galore Valley Water Balance - Diverted Flows

NovaGold Canada Inc.

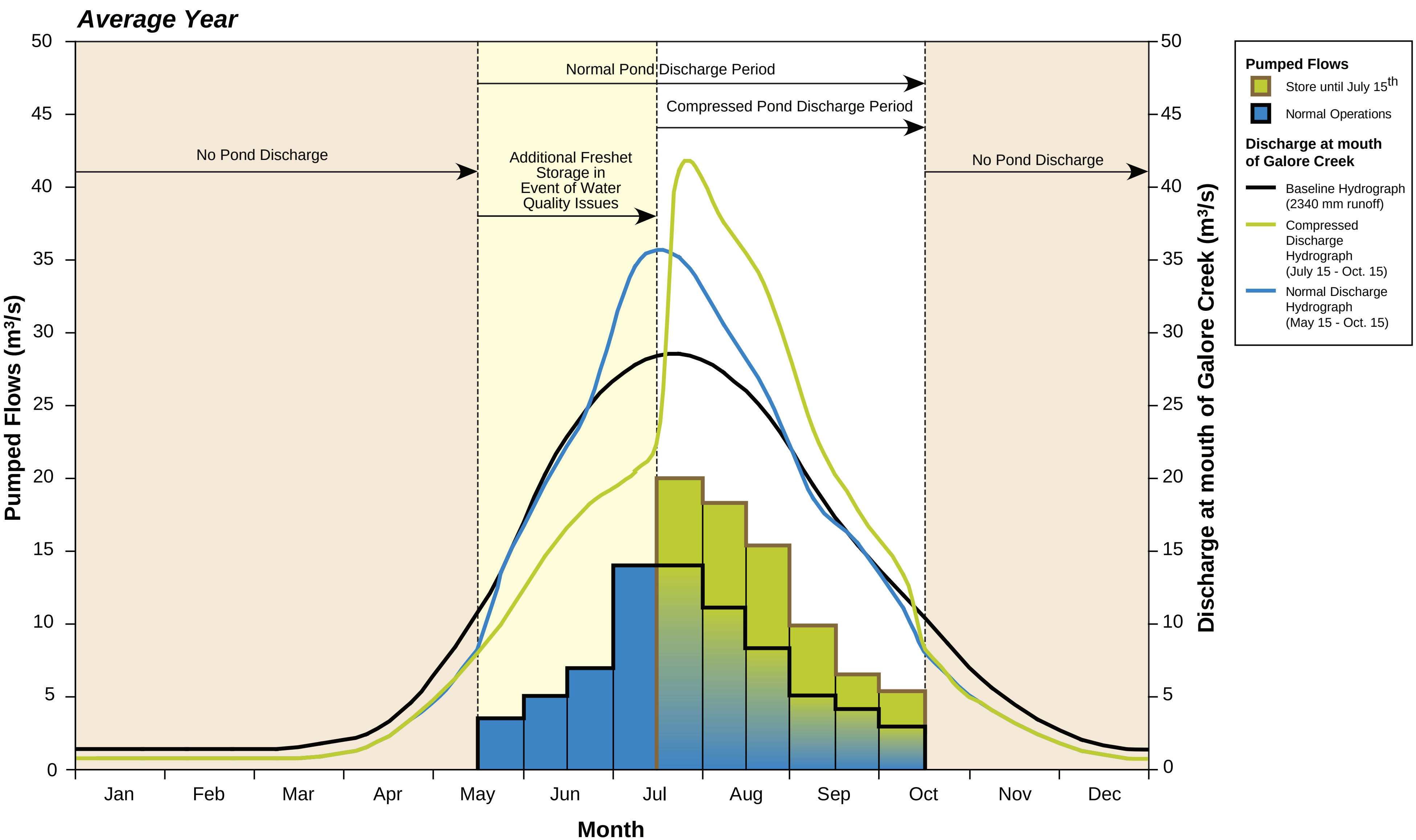


Note: For operation years 2 to 5

FIGURE 8.3-10

Proposed Annual Paced Discharge Schedule (May 15 - Oct. 15) for 1 in 200 Dry Year and Compressed Paced Discharge (July 15 - Oct. 15)

NovaGold Canada Inc. Rescan™



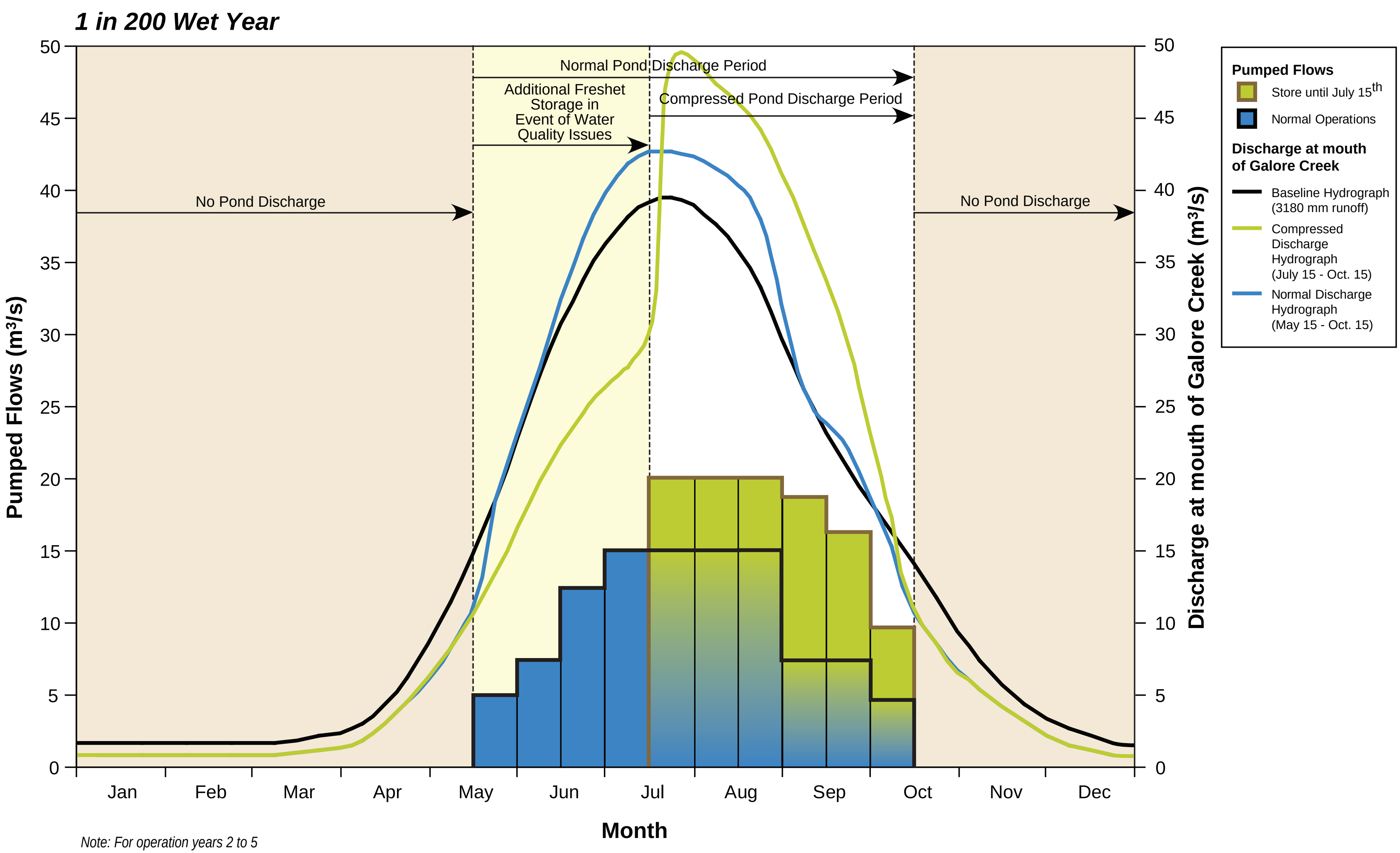
Note: For operation years 2 to 5

NovaGold Canada Inc.

Proposed Annual Paced Discharge Schedule (May 15 - Oct. 15) for Average Year and Compressed Paced Discharge (July 15 - Oct. 15)

FIGURE 8.3-11

Rescan™



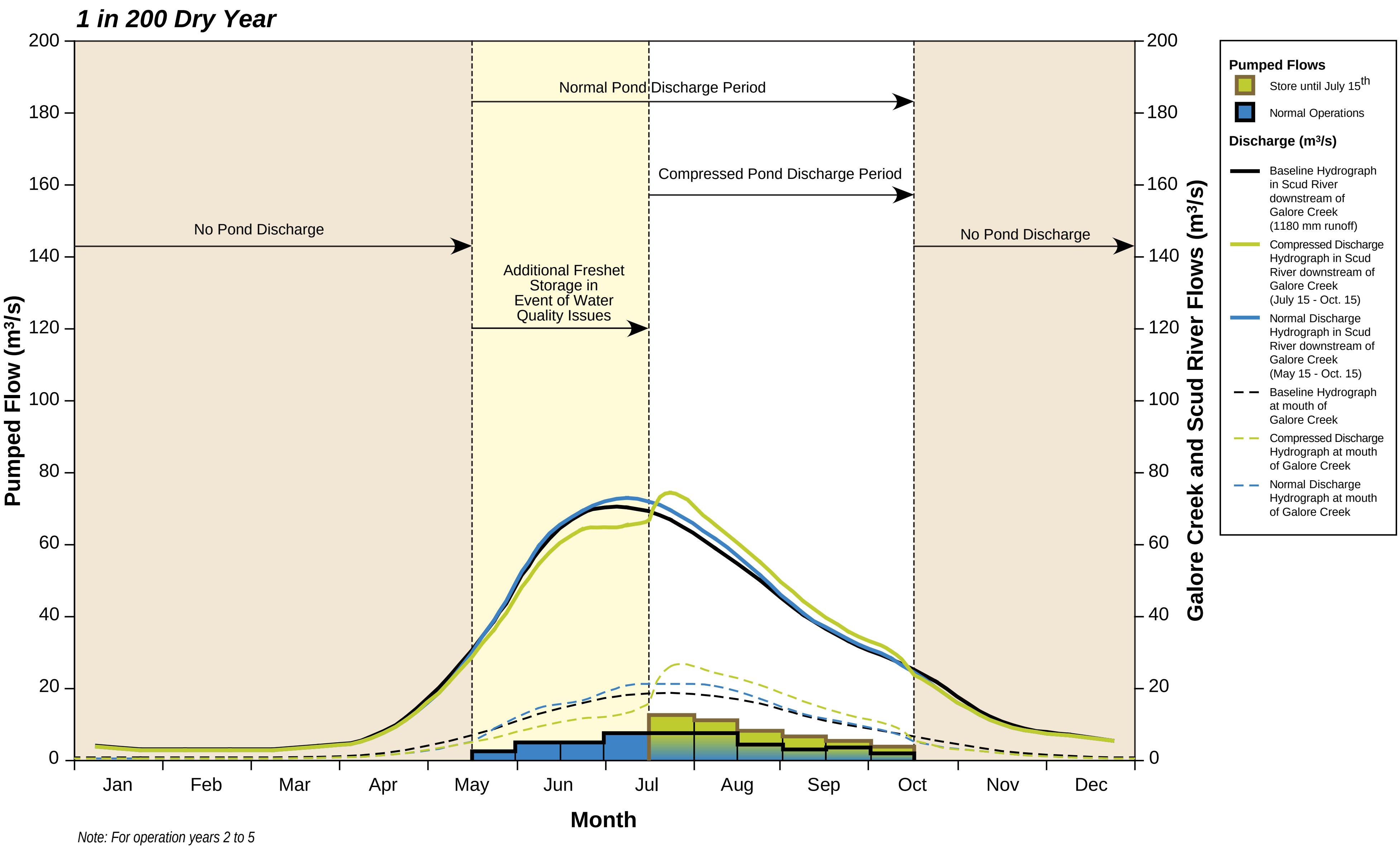
Note: For operation years 2 to 5

FIGURE 8.3-12

NovaGold Canada Inc.

Proposed Annual Paced Discharge Schedule (May 15 - Oct. 15) for 1 in 200 Wet Year and Compressed Paced Discharge (July 15 - Oct. 15)

Rescan™



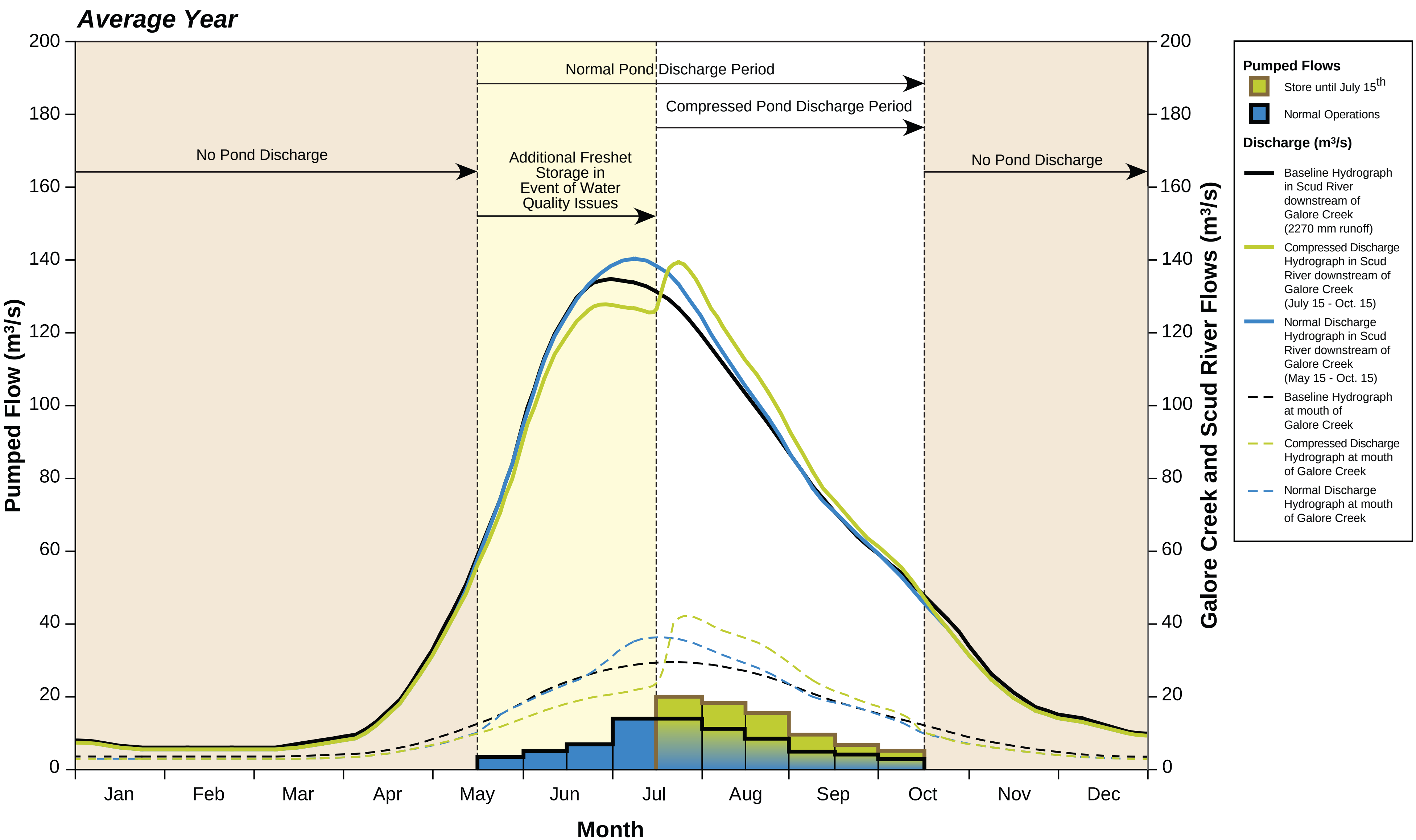
Note: For operation years 2 to 5

NovaGold Canada Inc.

Baseline and Predicted Flows within the Scud River Downstream of Galore Creek for a 1 in 200 Dry Year

FIGURE 8.3-13

Rescan™



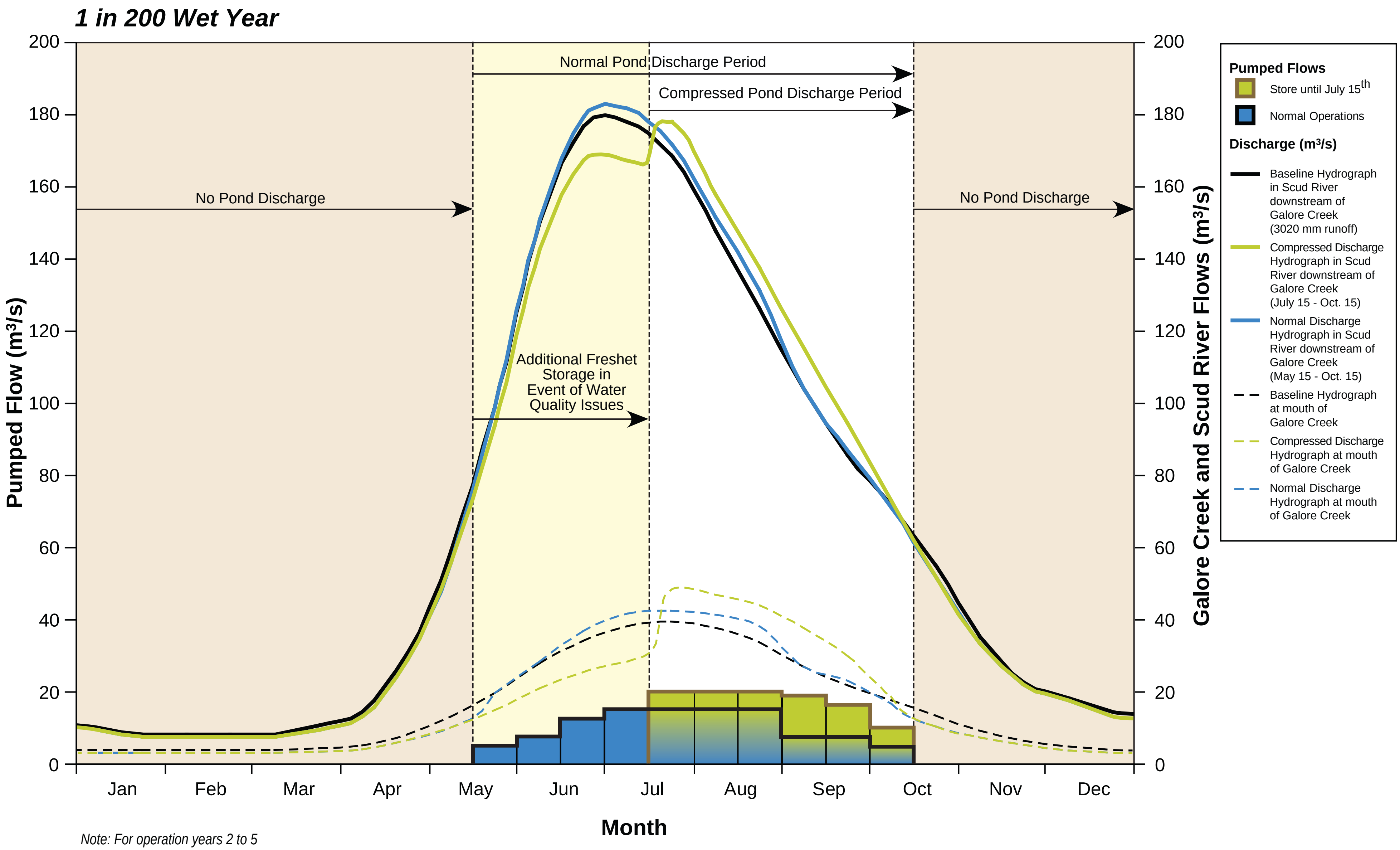
Note: For operation years 2 to 5

NovaGold Canada Inc.

Baseline and Predicted Flows within the Scud River Downstream of Galore Creek for an Average Year

FIGURE 8.3-14

Rescan™



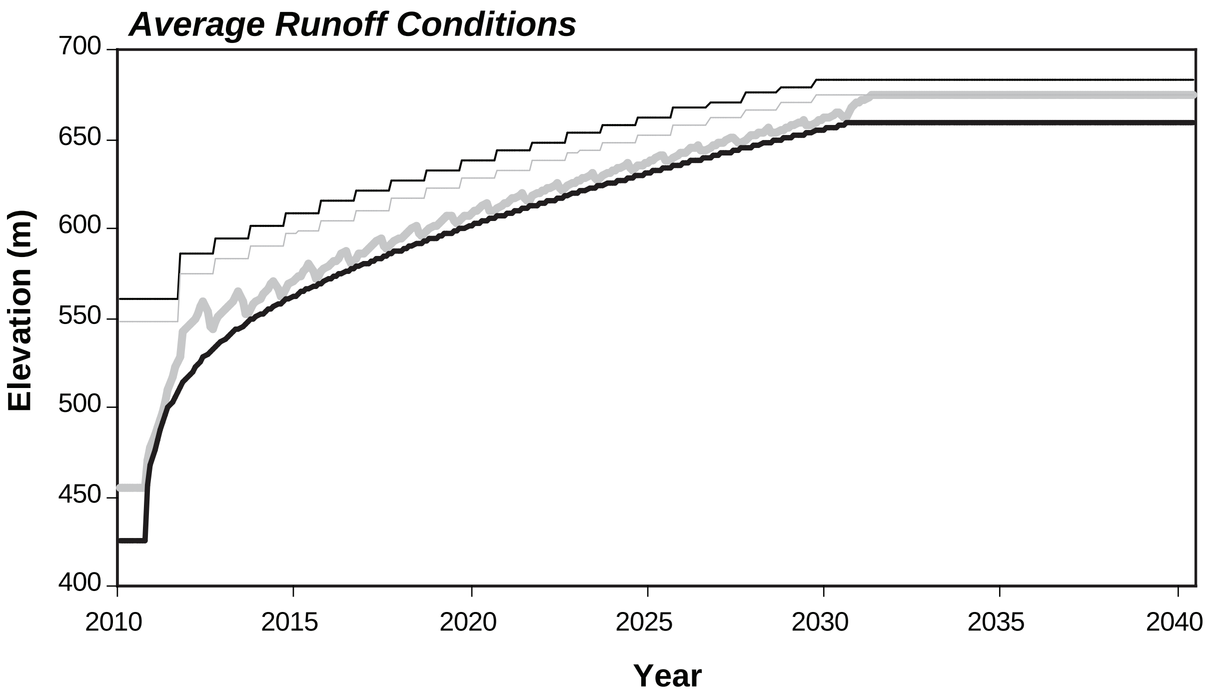
Note: For operation years 2 to 5

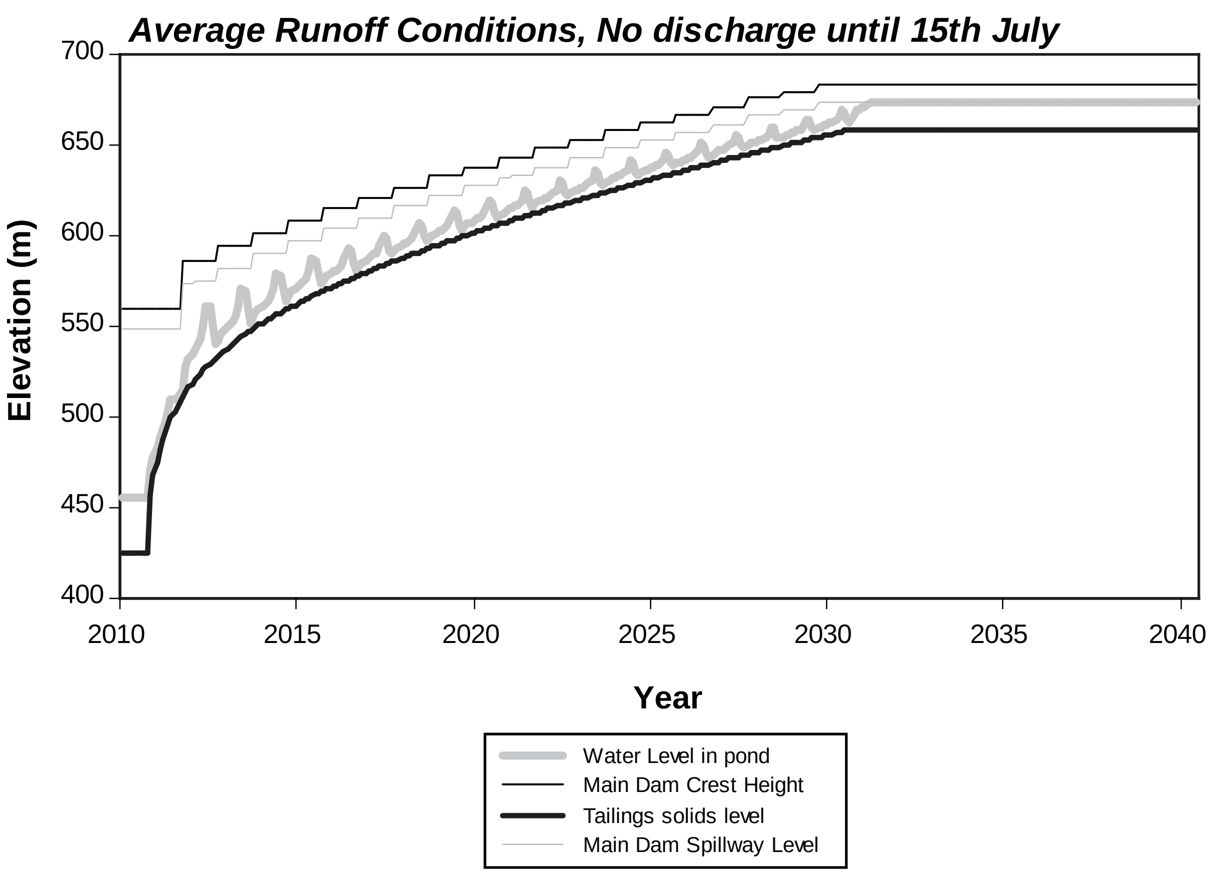
NovaGold Canada Inc.

Baseline and Predicted Flows within the Scud River Downstream of Galore Creek for a 1 in 200 Wet Year

FIGURE 8.3-15

Rescan™



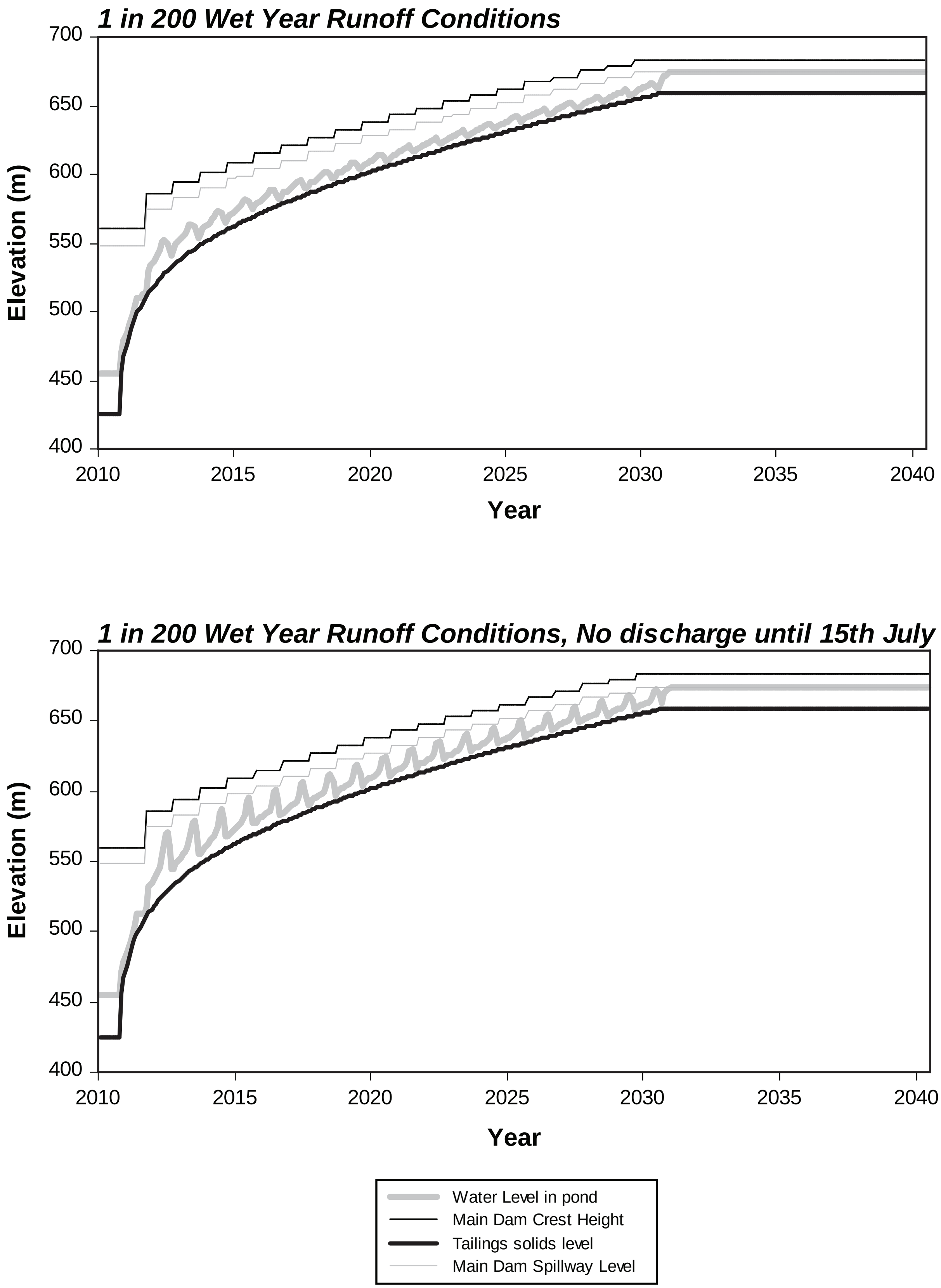


Predicted Pond Water Level Over Lifetime of the Mine; Average Runoff Conditions With and Without Discharge until 15th July

FIGURE 8.3-16

NovaGold Canada Inc.

Rescan™



Predicted Pond Water Level Over Lifetime of the Mine; 1 in 200 Wet Year With and Without Discharge until 15th July

FIGURE 8.3-17

NovaGold Canada Inc.

Rescan™

8.3.3.3 Predicted Water Levels

Figures 8.3-16 and 8.3-17 illustrate the evolution of water levels within the impoundment under a range of climatic and operational conditions. Also shown on the figures are the dam crest elevation, spillway elevation and the tailings solids elevation. Under normal operating conditions, pumping is able to hold the water level within the pond well below the spillway elevation. The design condition for the pond is the ability to store water for a 1 in 200 wet year runoff condition until July 15th.

8.3.4 Water Management Structures

The total potential undiverted catchment area of the proposed tailings and waste rock impoundment and the open pit area is estimated to be 125 km^2. The construction of the main tailings dam across the Galore Creek Valley the regular flow of Galore Creek by creating a 7 km x 1.3 km impoundment to contain the tailings, potentially acid generating (PAG) waste rock, a portion of not-PAG waste rock and a water cover. Thus it is imperative to implement water management in this area.

Diversions are necessary to minimize the amount of water entering the tailings and waste rock impoundment and the open pits. These diversions will consist of diversion structures and diversion channels that will reduce the total catchment area to 39.3 km^2 for operation years 2 to 4 and to 35.7 km^2 for years 5 to 20. Additional diversions will be built for the tailings dam construction period to further reduce the catchment reporting to the dam area. The reader is referred to the Tailings Management Plan, Section 8.4 of this report, for a detailed description of the main tailings dam and the operation, maintenance and surveillance plan for the water management structures.

8.3.4.1 Planning and Design Criteria

All of the water management structures are designed to reflect both regulatory requirements and engineering standards. Overall criteria for planning and design of the water management structures are as follows:

- The main tailings dam has been designed for maximum credible earthquake or the 1:10,000 year return period earthquake, with a minimum Factor of Safety of 1.5 under steady-state seepage and maximum water level for the downstream slope.
- During the construction period of the starter dam (Yr -3 to -1) and the first year of operation (Yr +1), all freshwater except approximately 5 km^2 of catchment area above the starter dam will be diverted past the tailings dam construction area (with the starter dam diversion channels and cofferdam).
- Immediately prior to the start of tailings deposition into the pond, all water will be pumped out of the pond.
- The starter dam has been sized to store water for a 1 in 100 wet year for the first 18.5 months of production (assumed from November 2010 to May 2012) in addition to tailings solids.

From year +2 to year +20:

- The main, West Fork and Dendritic Creek diversions will divert runoff from all except about 35 km^2 of catchment area, which includes pit and waste dump areas.
- A 1 in 200 wet year runoff volume can be stored.
- The required elevation of the spillway invert is determined each year by the requirement to store the cumulative deposited tailings solids at the end of the year, plus a minimum operating pond, plus the 1 in 200 wet year runoff inflow.
- The total freeboard from the spillway invert to the dam crest will constitute the surcharge storage determined by flood routing to pass the probable maximum precipitation flood event plus 3 m emergency freeboard above maximum pond levels. Total freeboard varies from 12 m initially to 9 m at the end of operations.

8.3.4.2 Diversion Structures

Table 8.3-3 summarizes the diversion structures used for the management of water within the Galore Creek drainage.

East Fork Diversion Structure

The East Fork diversion structure is located in the upper East Fork valley, approximately 3.5 km southeast of the confluence of the East and West Forks of Galore Creek. A 17 m earthfill crossing is required at the upstream end of the Galore Creek East Fork drainage to divert water into the main diversion channel. The East Fork diversion structure will cross the East Fork of Galore Creek, at the base of two recently merging glaciers.

Table 8.3-3
Summary of Major Diversion Structures

Diversion Structure	Height (m)	Purpose of Diversion	Operational Period
East Fork Diversion Structure	17	Divert freshwater from East Fork area into main diversion channel	20 years (mine life)
East Fork Aqueduct	84	Divert freshwater from West Fork diversion into main diversion channel	Yr +1 to Yr +20
West Fork Diversion Dam	10	Divert freshwater from West Fork area past Central pit and plant site area	20 years (mine life)
West Fork Dissipator	-	Carries water down the slope from the West Fork Diversion Channel into the East Fork of Galore Creek prior to construction of the East Fork Aqueduct	Yr -3 to Yr +1
Primary Cofferdam	71	Divert water into Starter Dam diversion channel	Spring 2008 (Yr -2) to Nov 2010 (Yr +1)
Temporary Cofferdam	15	Pond water to allow pumping of winter flows past the primary cofferdam works	Fall and Winter 2008

The East Fork diversion structure will be constructed of local overburden and riprap. It is intended that less than 2 m of water will be retained by this structure at any time and water will be directed immediately into the main diversion channel on the northern slope. The height of the crossing is controlled by the invert elevation of the main diversion channel. For the channel location shown in Figure 8.3-1, the crossing crest elevation is 718 m, or 4.5 m above the inlet main channel invert.

The East Fork diversion structure will be operational only after the main channel has been completed. The East Fork diversion structure will be in operation for the life of the mine. At closure the structure will be breached and revegetated.

East Fork Aqueduct

The East Fork aqueduct is located in the lower East Fork valley, approximately 750 m southeast of the confluence of the East and West forks of Galore Creek. An 84 m high waste rock aqueduct is required across the East Fork near the confluence of the East and West forks (Figure 8.3-1). The purpose of the aqueduct is to move water from the West Fork diversion channel across the waste dump and into the main diversion channel. The area between the aqueduct and the upstream East Fork diversion structure provides room for future waste storage if required. Runoff from a 6.0 km^2 catchment area will report to the upstream toe of the aqueduct; however, this water will either seep through the waste rock and into the dump area or can be pumped up into the tailings and waste rock impoundment.

Downstream of the aqueduct a short channel will be excavated to ensure seepage from the East Fork area is directed north and away from the West Fork till stockpile pad.

At closure the East Fork aqueduct will be breached to allow flows from the East Fork to enter the tailings and waste rock impoundment.

West Fork Diversion Dam

The West Fork diversion dam is located between the Central and West Fork pits, below the toe of the West Fork glacier. It is required in the Galore West Fork drainage to divert water into the West Fork diversion channel, and will be a 10 m high waste rock structure with a bituminous liner. Figure 8.3-1 shows the diversion dam located approximately 500 m downstream of the northern edge of the West Fork open pit.

A small volume of water will pond behind the structure as it passes water through the channel and out of the system. Sediment from the natural glacial water will likely collect behind this structure, so periodic cleaning of the sediment out of the pond area may be required. It will be in operation for the life of the mine.

The West Fork diversion dam will be constructed during the first 12 months of construction, after the West Fork diversion channel is complete. It will be operation for the life of the mine. At closure, the dam will be breached.

Cofferdam

A 71 m high waste rock cofferdam is required across Galore Creek, approximately 3.5 km upstream of the main tailings dam as shown in Figure 8.3-1. The cofferdam is required during the construction phase of the project to divert Galore Creek into the eastern starter dam diversion channel. The crest elevation (576 m) of the cofferdam is controlled by the invert elevation of the eastern starter dam diversion channel. For this crest elevation, a narrow section of the valley was selected to locate the cofferdam to minimize earthworks volumes. The cofferdam will be a water-retaining structure constructed of waste rock with a bituminous geomembrane liner on the upstream face.

To facilitate easier construction of the cofferdam out of the valley bottom, a 10 to 15 m high secondary earthfill dam will be constructed 1.5 km upstream of the primary cofferdam. Water collected behind this small structure will be pumped up to the eastern starter dam diversion channel.

The primary cofferdam must be constructed during a low flow winter period to pump winter flows of 1 to 2 m^3. Once the starter dam diversion channels and cofferdam are completed, water will fill behind the cofferdam and flow into the eastern starter dam diversion channel. After completion of the main starter dam, the cofferdam and the starter diversions will be maintained until the diversion channel is flooded due to a raise in the pond level, a raise in the waste dump and/or a raise of the tailings dam in Year +1. Eventually waste rock will fill in around the cofferdam during operations.

Toe Sump

A toe sump is required immediately upstream of the main tailings dam to collect water between it and the upstream cofferdam. The toe sump is a temporary structure that will be operational for less than 2 years. Assuming the sump is designed for a 20 year return period event with runoff from a 4 km^2 catchment area, a combination of pumping capacity and water storage volume will be required.

8.3.4.3 Diversion Channels

Table 8.3-4 summarizes the diversion channels that will be used for the management of water within the Galore Creek watershed.

Main Diversion Channel

The 12.3 km long main diversion channel will be constructed along the eastern slopes above the tailings/waste impoundment extending from the East Fork of Galore Creek to the main tailings dam. Combined with the West Fork diversion channel, the main diversion channel will divert runoff around the proposed waste facility from an 87 km^2 catchment area. Runoff from the eastern slopes above the impoundment will also be captured and diverted around the facility.

The channel will be 10 m wide at its base and the flow section will be 4.5 to 5.5 m deep. Between the East Fork diversion structure and the main tailings dam, the channel will be approximately 11.3 km long. With a longitudinal slope of 0.3%, the channel invert will vary from elevation 712 at the East Fork diversion structure to 678 m at the main tailings dam alignment. At closure this channel will be decommissioned and reclaimed.

Table 8.3-4
Summary of Diversion Channels

Diversion Channel	Length (km)	Purpose	Operational Period
Main	12.3	Divert freshwater around waste facility.	20 years (mine life)
		Open Pit Diversion Channels	
West Fork	2.0	Divert freshwater away from Central Pit, plant site and around waste facility.	20 years (mine life)
Dendritic Creek – North	2.6	Divert water away from Central pit.	Yr -1 to Yr 5 +/-
Dendritic Creek – South	3.1	Divert water away from Central pit.	+/- Yr 5 to Yr 20
		Construction Diversion Channels	
Starter Dam – East	5.3	Divert freshwater around main dam construction area.	Yr -2 to Yr +1
Starter Dam – West	2.4	Divert freshwater around main dam construction area.	Yr -2 to Yr +1

Along most of the channel section in the East Fork valley, the natural slopes are steep and will be buttressed with not-PAG waste rock or quarried rock**.**

Near the main tailings dam, the channel will connect with the emergency spillway outlet channel down to Galore Creek. This outlet channel section is approximately 0.8 km long. The channel invert will vary from approximately 678 m elevation at the main tailings dam alignment to 390 m at the valley bottom, which corresponds to a steep slope of 36%.

Five designated emergency overflow structures (or fuse plug spillways) will be constructed along the main diversion channel so that any blockages along the channel will direct flow through these reinforced spillways into the waste impoundment area. These fuse plug spillways will be designed to be pervious enough to allow flow through the channel during normal conditions but will erode during extreme events. These plugs may comprise rockfill with lean grout such that they will be washed away during a large avalanche or debris flow event.

Open Pit Diversion Channels

In addition to the main diversion channel, channels will be required to divert water around the open pits past the waste dump and tailings and waste rock impoundment. These channels will be relocated depending on the areas of active mining.

Dendritic Creek Diversion South Channel

With time, as the West pit wall is advanced, the initial Dendritic Creek north channel will be mined out. In addition, access roads to North Junction will disrupt drainage of Dendritic Creek such that water can be more easily diverted south around the main pits and then east to join the original West Fork channel. This secondary diversion, referred to as the Dendritic Creek diversion south channel, will be constructed to divert water south from Dendritic Creek around the Central pit, into the West Fork diversion and ultimately into the main diversion channel. In the event that the proposed Central and Southwest pits merge, a waste rock aqueduct can be used to transport Dendritic Creek over the south end of the Central pit, where mining is completed early in the project life.

Dendritic Creek Diversion North Channel

A channel will be constructed to divert water north from Dendritic Creek away from the Central pit for the first five years of operation. As shown in Figure 8.3-1, this 2.6 km long channel will capture water in the Dendritic Creek area, transport it north above the high wall of the Central pit and divert it into the waste dump. Depending on the location of the crossing(s) in Dendritic Creek, this channel may divert runoff from a catchment area of up to 8.2 km^2.

West Fork Diversion Channel

The West Fork diversion channel is a 2.0 km long channel constructed immediately south of the Central pit, across Camp Creek, behind the plant site to connect with the original Galore Creek channel (Figure 8.3-1). The purpose of the channel is to divert runoff from the West Fork area. For the first five years of operation (before the West Fork pit is mined), this channel will divert runoff from an 11.9 km^2 catchment area south of the Central pit. However, once the West Fork pit is opened in Year +5, the diversion inlet will have to be relocated upstream of the pit. Prior to construction of the East Fork aqueduct, the West Fork dissipater will carry water down slope from the bottom of the West Fork Channel into the original Galore Creek channel.

Construction Diversion Channels

To facilitate construction of the tailings starter dam in the dry, water will be ponded behind a 71 m high cofferdam and diverted into the main starter dam diversion channel. Runoff from the west side of Galore Creek will be diverted south behind the dam. These construction diversions will be capable of diverting runoff from the entire 125 km^2 catchment area. A minor amount of precipitation will remain undiverted (4 km^2); this water will be contained behind a small sump, to clarify by settling, then pumped out to the diversion channel.

- *Starter Dam Diversion – East Channel*: This channel will be approximately 5.3 km long and will transport water north from behind the cofferdam around the starter dam construction area. The invert of the eastern channel will vary from 555 m at the Starter Dam alignment to 571 m at the cofferdam alignment. This channel will be sized to pass the entire catchment area.
- *Starter Dam Diversion – West Channel*: This channel will be approximately 2.4 km long and will be constructed along a portion of the western slope between the cofferdam (for the main tailings dam) and the toe sump. The channel does not extend up to the main

tailings dam alignment due to the steep natural topography. The channel invert varies from 607 m elevation at its northern end to 571 m at the cofferdam.

The starter dam diversion channels are temporary structures and may be operational for less than two years; however, they will still be designed for peak flows from a 200-year return period event (similar to the Main Channel). The east channel will be 20 m wide and 5 m deep, while the west channel will be 10 m wide and 3 m deep.

Soil and rock excavated from the channels will be used to construct a maintenance access road on the downslope side. Both channels will be excavated in the first 12 months of construction. The operating period is currently assumed be from spring 2008 to fall 2011 during starter dam construction through to the end of Year +1. The channels will be flooded once the starter dam is raised above 560 m elevation in Year +2.

The channels will be locally lined with riprap or a geomembrane liner to minimize erosion of and seepage through the higher conductivity soils.

Channel Crossings

Where the diversion channels intercept other streams or gullies, energy dissipation structures and sediment traps will be required. Three major crossings have been identified: Bear Creek, Friendly Creek and Camp Creek. In these areas, the creeks have eroded, steeply incised gullies. Crossings are required to pass the main diversion channel across these gullies at the required elevation while allowing water from the tributary creeks to be directed into the main channel in a controlled manner. Bear and Friendly creeks are also susceptible to rockfall, debris flows and snow avalanches.

The crossing structures have been designed to pass water while retaining solids that may pass down the creek during high flows or even debris floods. Debris flow barriers consisting of a gabion rockfill structure with a spillway overlying a base of slush-grouted riprap with culverts are proposed. The upper gabion portion will be designed to pass water for a 100 year flood event. The culverts will allow water to pass through the barrier but will prevent debris from entering the main diversion channel. The upstream and downstream face of the barrier is protected with a layer of shotcrete. The exact location of the barrier as well as dimensions and flow through the barrier will be designed at the next phase of design once geohazard assessments are complete.

Depending on the location of the Dendritic Creek open pit channel(s), crossings in the Dendritic Creek drainage may either be a single major crossing or multiple small crossings. The Dendritic Creek crossing(s) are also described below. Debris flow mitigation will be required at specific locations within the Dendritic Creek drainage.

Energy dissipation structures and coarse sediment traps will be required at various locations where there is a large change in channel slope. Regular inspections and ongoing maintenance will be required to ensure proper operation of the diversion system.

The settling pond and the debris barriers will require regular inspections and periodic cleaning and maintenance.

Minor Crossings

Where diversion channels intercept minor streams or gullies, additional fill will be required to maintain the channel elevation. Additional excavation of the natural channel will be required to create a small settling pond to capture coarser sediment transported by the creek. Suitable erosion control such as riprap will be installed as required. As with all components of the runoff diversion system, these ponds will need to be monitored and cleaned out on a regular basis in order to maintain the freshwater channel flow.

Diversion Channel Management/Maintenance

To mitigate for and to manage issues such as avalanches, probable maximum floods (PMFs), sedimentation, interception by larger creeks and channel maintenance, the main diversion channel and the open pit diversion channels will both include the following design features:

- Channels will be designed for average flows from a 200-year return period 24 hour event with some allowance for snowmelt.
- Unlined channel longitudinal slopes will be about 0.3% to minimize erosion potential. Steeper slopes will require erosion-resistant linings depending on the resistance of the local materials.
- In areas of impervious soils and sound rock, the channel will not be lined. In areas of pervious soil and broken rock the channel will be lined with a geomembrane, then covered with riprap to protect the liner.
- Channel depths will typically range from 3 m to 5 m.
- For purposes of channel maintenance (*i.e.*, snow clearing), a 10 m wide running surface or access road was assumed alongside each channel. This surface will be constructed of fill from the channel excavation.
- Bed protection / stabilization and energy dissipation structures will be required in areas where diversion channels discharge into the downstream creek.

Regular channel inspections and maintenance will be required to keep the channels operational year-round. Blockage of the diversion channels could occur due to soil and rockfalls from the upper slopes and snow avalanches. Periodic overflows to the tailings/waste basin should therefore be anticipated.

Any pervious channel sections will be lined along the base and extend up the slopes to a vertical height of 3 to 5 m. The synthetic liner will be anchored on both slopes. A layer of riprap will be placed over top of the liner (in the channel bottom and up the slopes) to protect it from damage during channel maintenance. To prevent uplift of the geomembrane as a result of groundwater flowing beneath and up against the lined channel, a perforated drain pip system is proposed along the upstream side of the ditch. The pipe will be built with T cross-drains to draw down the phreatic surface and allow uplift pressures to be dissipated by gravity flow into the pond.

8.3.5 Tailings and Waste Rock Impoundment Water Management

This component of water management, including surplus water discharge, water quality monitoring, seepage management and discharge from the tailings and waste rock impoundment, is dealt with in Section 8.4, Tailings Impoundment Management.

8.3.6 Open Pit Water Management

The five open pits (Central, Southwest, Middle Creek, West Fork, Junction) will all lie within the West Fork of the Galore Creek watershed. As explained above, freshwater diversions will capture runoff from hillslopes upstream of the pits. Groundwater inflow to the open pits will be managed by several dewatering wells, keeping the water inflow to a minimum. Details on groundwater are provided in Section 7.9.

The rate of unmitigated groundwater inflow to the open pits is expected to increase with time as the pits are advanced, reaching a relatively constant total inflow rate for all pits of approximately 20,000 m^3/d after six years. Sustainable unmitigated inflow rates to the individual open pits are predicted to be approximately 2,400 m^3/d (Southwest pit), 3,800 m^3/d (North Junction pit), 8,100 m^3/d (West Fork pit) and 14,000 m^3/d (Central pit).

During the early life of the mine, the total water to be handled by the pit dewatering system, excluding flow into the pits, will be approximately 50,000 m^3/d, but will decrease to a relatively constant flow of 25,000 to 29,000 m^3/d after five years. Vertical perimeter wells alone will be insufficient to dewater all of the open pits; therefore, a combination of deep vertical perimeter and in-pit wells can be used to dewater all but the deepest portion of the Central pit. Horizontal wells will be required to create dewatered conditions in the deeper parts of the Central pit (*i.e.*, below a depth of approximately 380 m elevation). Any pit dewatering system will be required to handle a minimum of 29,000 m^3/d, although greater flow rates of up to 50,000 m^3/d may be expected initially. Groundwater will be used in the process plant before being discharged into the tailings and waste rock impoundment along with the tailings slurry.

Water that is not captured by the freshwater diversions or the dewatering pumps, as well as precipitation falling directly on the pit surface, will accumulate at the bottom of the pits. This sump water will be pumped to a settling pond and will either be used in the process plant or discharged directly into the storage pond.

8.3.7 Plant Site Water Management

The water balance for the plant site can be divided into three components: process water, reclaim water and site drainage.

Process Water

Process water will be made up of water pumped from the pit perimeter and in-pit dewatering wells and from concentrate and tailings thickener overflow (Figure 8.3-16). Tailings impoundment water will be recycled to the process where required for make up. Process water will be stored in a 17 m diameter x 19 m high steel tank and supplied to the distribution points by pumps. In addition, a small process water reservoir will be constructed near the mill and equipped with a reclaim pump.

Reclaim Water

Concentrate and tailings thickener overflow will be recycled within the plant as process water via the process water tank. Tailings water will be reclaimed as required for process water makeup. Two barge-mounted vertical turbine pumps will be maintained in the tailings pond for this purpose, and will pump to a reclaim transfer pump and process water pump via a high density polyethylene return pipe to the mill.

Site Drainage

Direct precipitation and runoff from the surrounding catchment that is not diverted by the diversion structures will be routed to the tailings and waste rock impoundment.

8.3.8 Filter Plant Water Management

The treated clean water from the filter plant will be pumped through a 15 cm diameter pipe to the Iskut River where it will be discharged through a pipeline and diffuser system. There will be two operating conditions: one where the pipeline flush water is discharged at 90 m^3/h (25 L/s) and the other where treated filtrate water will be discharged at an average rate of approximately 59 m^3/h (16.5 L/s). The more critical condition for dilution is the discharge of treated filtrate water when the total copper concentration is projected to be between 0.17 and 0.25 mg/L.

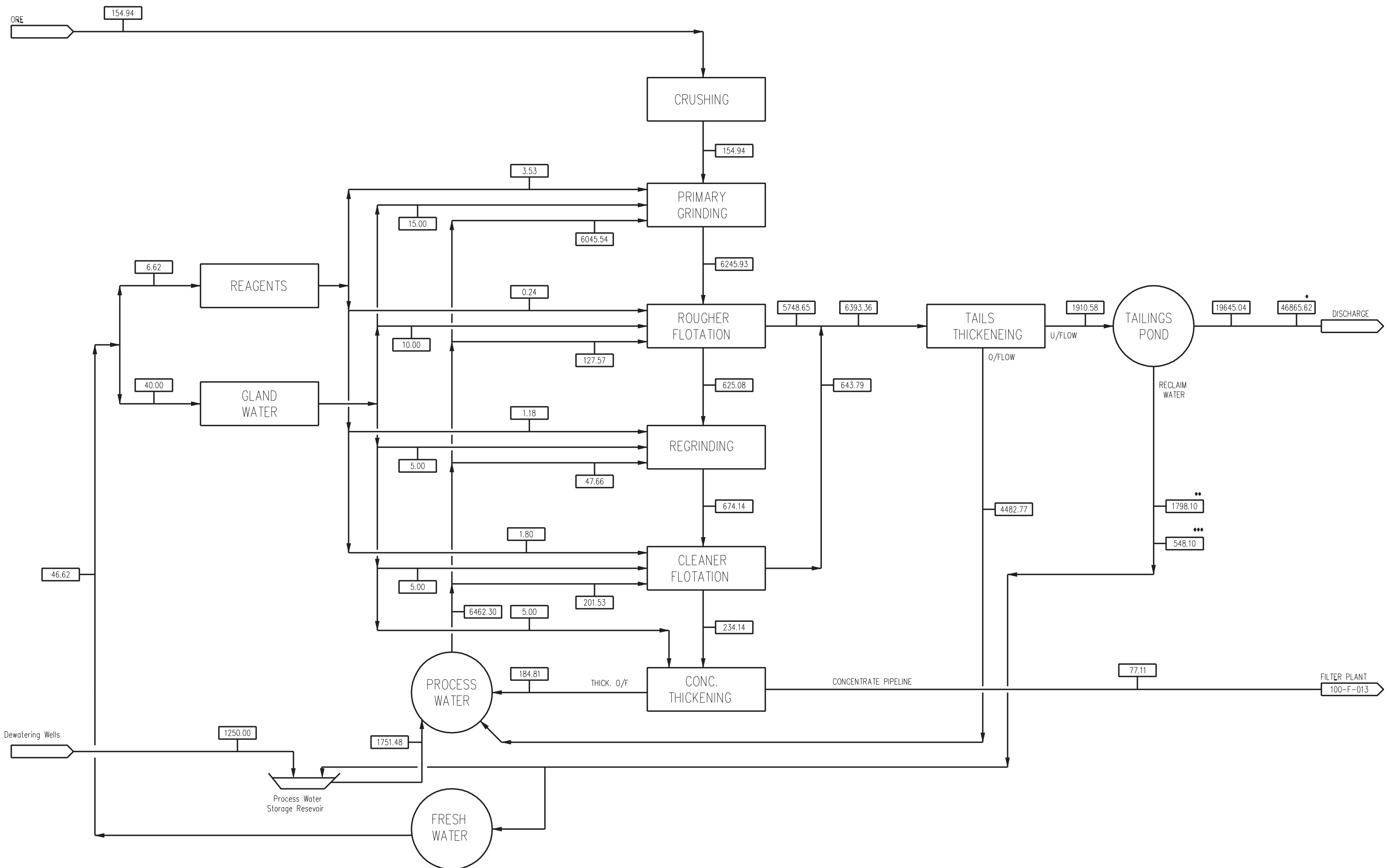
The Iskut River above More Creek has an annual predicted seven-day low flow of about 15 m^3/s with a mean of 110 m^3/s and a maximum of 330 m^3/s. Therefore, a potential overall dilution of 910:1 is available at low flow. Average flow conditions provide a dilution of 6,600:1.

A site for the diffuser has been identified at a relatively straight and narrow reach of the river approximately 5 km upstream of the confluence of the Iskut River and More Creek and 2 km downstream of the Iskut River Hot Springs. This point is advantageous because it is:

- a relatively high-velocity reach providing good mixing
- less important fish habitat than areas downstream because the bottom materials are less suitable for spawning
- located in closer proximity to the filter plant, requiring a shorter pipeline
- relatively easy access, providing a feasible route for the pipeline and access road.

8.3.9 Waste Rock Dumps Water Management

Water inputs to the waste rock dumps include direct precipitation and waste rock moisture transferred from the open pits. Runoff from the dumps will be minimal, with the water percolating into the dumps following pathways of least hydraulic resistance downward into the rock mass. The majority of this water will be taken into permanent storage in the pores of the waste rock, while the remainder will seep out at the toe of the dumps. Any water that seeps out of the waste rock dumps will report to the tailings and waste rock impoundment.



Source: Hatch & Associates

FIGURE 8.3-18

Process Water Balance Flowsheet

NovaGold Canada Inc.

Rescan™

8.3.10 Access Corridor Water Management

To manage water along the access corridor culverts will be designed for a 50-year life and to pass the 100-year instantaneous flood flow. To reduce the risk of blockage from infilling, snow and ice, culverts will be at least 600 mm diameter in size. The inlet and outlet to all culverts will be protected from scouring with appropriately sized riprap. Ditch blocks will be installed immediately downslope from cross-drain culverts.

Major bridges will be designed for the 200 year instantaneous flood plus a minimum of 1.5 m debris clearance to the underside of the bridge girders unless additional clearance is required for navigable waters or geotechnical requirements. Most bridges will be simple clear spans ranging from 12 to 40 m in length. Multiple-span structures will be required for the Iskut (107 m) and Porcupine (79 m) river crossings and for the Muskwie (98 m) and one of the More Creek (90 m) crossings. Major single-span bridges will be required to cross More Creek (200 m), Eros Creek (110 m), Yurie Creek (80 m) and two crossings over Sphaler Creek (35 m and 31 m).

Further details are provided in Section 8.15, Access Road Management, and Section 8.9, Erosion and Sediment Control Management.

8.4 Tailings and Waste Rock Management Plan

The mining process produces two types of mined waste materials that require disposal. Improper disposal or treatment of these mined waste materials can lead to impacts on the surrounding environment. The mined waste materials that will be produced at the Galore Creek Project include:

- tailings: residual material from the processing plant after the valuable ore minerals have been extracted; and
- waste rock: any rock other than ore that is moved in the mining process, including potentially acid generating (PAG) and not potentially acid generating (not-PAG, sometimes also called NPAG) wastes.

It is estimated that approximately 1,500 million tonnes of tailings and waste rock will be produced over the 20 - year mine life of the Galore Creek Project. Management of these wastes is required to provide protection to the receiving environment, compliance with licence and permit conditions, and smooth operation of the mine.

The purpose of this Management Plan is to describe how the tailings and waste rock produced at the Galore Creek Project can be managed to minimize the adverse impacts on surrounding areas in perpetuity. The main factors that were used to determine the placement and hence the management of the tailings include:

- nature of the material (potentially acid generating (PAG), water content, *etc.*);
- options for disposal sites (taking into effect the geotechnical considerations, cost and environmental management implications); and
- volume and production schedule.

The goals of this management plan are to:

- provide a guide or framework to manage the tailings and waste rock impoundment structures in a safe and environmentally responsible manner throughout all stages of the Galore Creek Project
- provide a means to manage the tailings impoundment itself (managing substances going into the impoundment and out of the impoundment)
- manage the discharge from the tailings and waste impoundment to ensure that all effluent meets and/or exceeds the permitted water quality levels and guidelines
- provide continual improvement in the environmental safety and operational performance of the tailings management structures
- provide environmental and performance monitoring and reporting
- provide an organizational structure to ensure accountability and responsibility to manage the implementation and maintenance of obligations under NovaGold's environmental policy.

Throughout the life cycle of the mine NovaGold will implement the principles stated in this framework and management plan through the commitment and actions of their employees to ensure proper tailings management.

All structures to support tailings management are designed and will be constructed in compliance with this management plan, NovaGold's environmental policy and the regulatory conditions of NovaGold's license's and permits.

8.4.1 Classification of the Tailings

Over the 20-year life of the Galore Creek Project, it is estimated 475 Mt of tailings will be produced. Tailings will be generated from a conventional copper flotation process, and will be comprised of the tailings from rougher flotation and the first cleaner scavenger flotation cells.

The distinctive characteristics of the rougher and cleaner tailings indicate that only the pyritic PAG cleaner tailings will need subaqueous disposal to address acid rock drainage (ARD) potential. Rougher tailings are expected to have lower reactivity and could be disposed sub-aerially. All tailings will be treated as though they were acid generating, therefore they will be disposed subaqueously. From an operational standpoint, the primary effect from temporarily beached tailings will be draindown of process water. Minimal oxidation and leaching effects are expected.

The estimated grain size distribution from the metallurgical test work tailings indicates that 80% of the tailings will be finer than 100 to 120 µm and 50% finer than 60 microns. This distribution indicates the tailings will likely be 50% sand and 50% silt/clay with the dry settled density of the tailings at 1.35 t/m^3 and a water content of 37% by weight. However, the tailings density will increase with time so a consolidation model for the entire impoundment will be developed at the next stage of design. The specific gravity for the tailings will be 2.7. Given the low sulphur content of the ore, it is assumed that lime will not be added to the tailings line prior to release into the impoundment.

All of these considerations have been factored into the tailings management plans discussed below.

8.4.2 Tailings Management Structures

The tailings impoundment (tailings and waste rock impoundment) is situated in a large catchment area; therefore to successfully manage the tailings produced at the Galore Creek Project and prevent ARD the following key tailings management structures are required:

- tailings and waste rock impoundment
- main tailings dam
- freshwater diversions
- seepage recovery system (downstream of tailings dam).

The solid mined wastes, including tailings, waste rock and pre-stripped overburden from the pits, will be entirely contained within the Galore Creek valley north and east of the proposed open pits. In order to minimize the amount of freshwater that will come into contact with the wastes, diversion structures and channels will be used to carry water around the operation, including the pits and plant site. Figure 8.4-1 shows a conceptual layout of the proposed tailings management structures and other mine facilities.

Management of PAG and not-PAG waste is described in the Acid Rock Drainage and Metal Leaching Prediction and Prevention Plan in Section 8.7. The site conditions and the field investigations for the tailings and waste rock impoundment, and its main components are presented in Section 5.9, and the cross sections of the structures are presented in Section 6.5 of this application report. Thus the reader is referred to these sections for additional detail.

8.4.2.1 Overall Design Criteria for Tailings Management Structures

Table 8.4-1 describes the general design criteria and assumptions for the tailings management structures.

- Tailings will be stored in a cross-valley impoundment.
- Tailings will be retained behind a tailings dam to be built using the downstream method of construction.
- The tailings dam will be a rockfill dam with a central impervious core and filters. The dam shells will be built of waste rock hauled and placed by the mine fleet.
- The starter dam will provide sufficient storage capacity for two years (or 24 months) of tailings production
- At the end of the mine life, the tailings impoundment is sized to store all of the tailings and PAG waste rock such that this waste will be flooded at the end of the mine life.
- Total freeboard consists of surcharge freeboard to pass a probable maximum flood (PMF) through the spillway plus emergency freeboard.

Additional general assumptions are as follows:

- The PAG and not-PAG can be separated for the purpose of using not-PAG for dam construction.
- All not-PAG waste rock is placed on top of the PAG waste rock or in separate dumps higher up the valley slopes.
- Volume elevation curves for the tailings impoundment area, waste dump area and the entire tailing/waste impoundment area were based on a 5 m contour interval map based on 2004 Eagle Mapping topography.
- Tailings dam crest elevations were determined assuming no beaching losses but elevations are generally controlled by water levels.
- The hydrological design criteria are based primarily on the Canadian Dam Safety Association (CDSA) Guidelines for water storage facilities, the CDSA (1999) Guidelines and the Province of BC regulatory requirements.

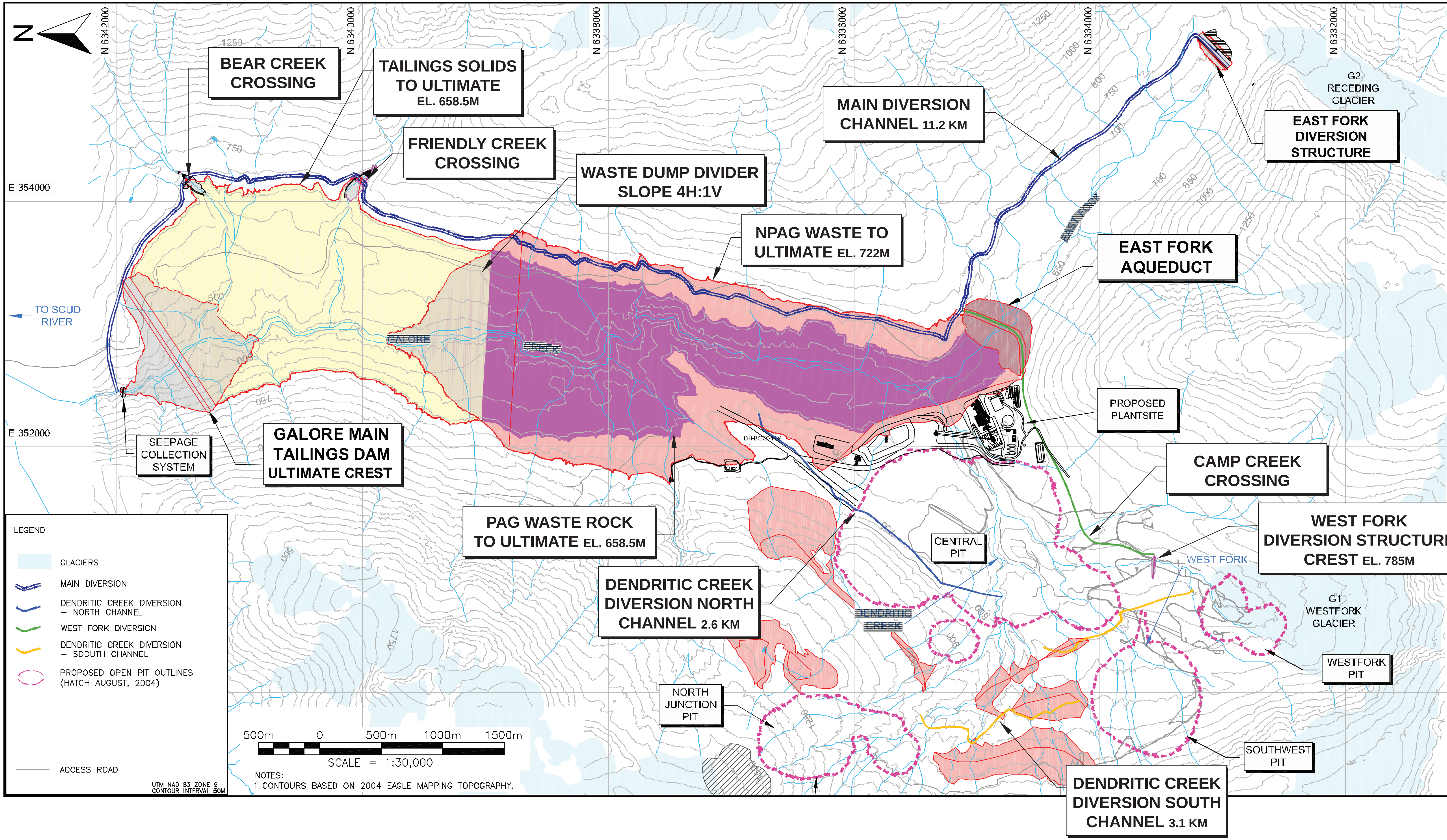
- The design of the main tailings dam was therefore based on an estimate of the Maximum Credible Earthquake.
- Tailings and Waste Rock Impoundment

Table 8.4-1
General Design Criteria and Assumptions for Feasibility Level Geotechnical Design

	Feasibility Level Design Criteria & Assumptions
Total Mineral Resource	475 million tonnes
Mill Throughput	65,000 tonnes per day
Mine Life	20 years
Processing	conventional copper flotation (no cyanide)
Waste	1,016 Million tonnes (including overburden pre-stripping)
Overburden Pre-stripping vs. Waste Rock	166 million tonnes of Overburden; 850 Million tonnes of Waste rock
Tailings	475 million tonnes
Mining Method	conventional open pit mining methods using truck and shovel units
Product	copper concentrate transported as slurry to Bob Quinn, then dewatered and transported by truck to Stewart, BC
Operation	year-round (12 months)
Settled Dry Density	1.35 t/m^3
Waste Rock Density	2.05 t/ m^3
Solids Specific Gravity	2.7
Primary Grind Grain Size	Non-plastic Silt and Sand, trace clay (Percentages by weight: 49% silt; 47% sand, 4% clay)

The generation of ARD requires both water and oxygen; therefore underwater storage is generally the most effective means of preventing ARD and reducing metal leaching. Underwater storage relies on the low solubility of oxygen in water to reduce sulphide oxidation, acid generation and metal leaching to levels that generally do not pose an environmental concern.

It is estimated that over a billion tonnes of waste rock will be produced over the life of the Galore Creek Project. Based on preliminary analyses of ARD potential it has been conservatively assumed that half of the waste rock will be acid generating and will require flooding in perpetuity. It has further been assumed that ARD will not develop for up to twenty three years, allowing flooding of the waste rock to be delayed without correcting acidity. The reader is referred Section 5.3.7 of the project description, for a more detailed description of ARD at the Galore Creek Project, as well as Section 8.7 for information on the Acid Rock Drainage and Metal Leaching Prediction and Prevention Plan for the management of PAG and not-PAG waste.



Source: BGC Engineering Inc.

NovaGold Canada Inc.

FIGURE 8.4-1

Proposed Tailings and Waste Rock Impoundment Management Structures

Rescan

Location

The tailings and waste rock impoundment will be created upstream of the main tailings dam in a cross-valley impoundment located in the Galore Creek Valley, 7 km north of the Central pit.

Design

To prevent ARD at the Galore Creek Project, submergence of both the tailings and PAG waste rock will be required. Therefore, the tailings and waste rock impoundment is designed to store both the tailings and PAG waste rock. At the end of the mine life, the tailings and waste rock impoundment will be approximately 7 km long, 1.3 km wide and 200 m above the existing valley bottom.

The intent will be to leave all the PAG waste in a flooded condition for perpetuity, while at the same time providing a water cover deep enough to prevent tailings re-suspension due to wave erosion.

The main tailings dam will be constructed in stages to an ultimate crest elevation of approximately 683 m within ultimate dam height of approximately 275 m.

Tailings will be transported hydraulically to the northern part of the impoundment where they will be spigotted off the crest of the dam and/or nearby valley slopes. During operations, an operating impoundment (and settling basin) will be created to allow suspended solids to settle and water to be reclaimed to the plant. The tails will be flooded during operations and for perpetuity at closure.

The majority of the waste rock will be trucked and dumped in lifts in the southern portion of the impoundment. The PAG waste rock will be placed in lifts at lower elevations in the valley. Throughout the mine life, the elevation of the PAG must remain higher that the tailings solids elevation to allow controlled placement. At the end of the life mine, the impoundment has been designed such that PAG waste rock will be flooded in perpetuity.

The majority of the not-PAG waste rock will be placed as a cover the PAG waste. The not-PAG waste dumps on the western and eastern slopes will likely vary in elevation from 710 m to 900 m at the end of the mine life.

To prevent tailings from migrating into the designated waste dump area, a waste dump divider will be constructed before the initiation of tailings deposition. The divider is constructed of PAG rock up to elevation 658.5 m and with not-PAG waste rock above this elevation. Throughout the mine life, the divider will be raised such that its crest is always higher than the tailings solids elevation to provide separation of the two mining waste products. The waste rock divider will also be used as a valley crossing to give haul trucks access to the tailing dam during construction.

Pre-stripped overburden from the pits will either be used for dam construction or stockpiled behind the active rock waste dumps so that the material can be used for reclamation upon closure. Material that is over wet will be contained in cells built of waste rock. Over the mine life, the tailings dam will be raised as will the impoundment and water level in the waste dump.

To minimize the amount of seepage reporting to this impoundment and the Central pit, a water retaining dam (open pit diversion dam) is required in the West Fork of Galore Creek (near the confluence of the East and West forks). In this same area, a small winter run of mine ore stockpile will be located to the west of the dam, near the proposed truck shop. Downstream of the Open Pit Diversion Dam, there will be a separate cell for over wet pre-stripped overburden. A snow dump will be located upstream of the dam and separate from the over-wet overburden cell to facilitate melting of the snow pack.

The tailings and waste rock impoundment is located within a large natural catchment area with a high annual precipitation of approximately 1,650 to 2,300 mm. The anticipated volumes of rain, snow, avalanches and water discharged from nearby ice fields and glaciers were incorporated into the design of the tailings and waste rock impoundment. The storage capacity and design criteria for the impoundment allow for storing tailings, PAG waste rock, and a portion of the not-PAG waste rock, while at the same time allowing for extreme precipitation and avalanche events with a 200 year flood design.

The emergency spillways will be designed to pass the routed flow from a PMF. The PMF could result from a probable maximum snowmelt, a probable maximum precipitation, or a combined rain-on-snow event. The design for the PMF assumes failure of all runoff diversion channels except those that discharge directly into the open pits. The PMF is assumed to result from a Probable Maximum Precipitation (PMP) estimated to be 535 mm of rainfall in 24 hours with 375 mm occurring in the maximum 6 hour period. The inflow hydrograph derivation assumed wet antecedent conditions and included an allowance for snowmelt. A minimum 3 m emergency freeboard above the maximum calculated reservoir level will be required during the PMP.

8.4.2.2 Main Tailings Dam

Dam engineering details including complete construction particulars are explained in Section 5.9; therefore, only a summary of the main tailings dam design, East Fork and West Fork diversion structures, and the East Fork aqueduct will be provided in this section.

Location

The main tailings dam will be located in a steep valley downstream of the Galore Creek mine with a cross-valley placement. This location, upstream of a deposit of lower Permian limestone, has been optimized to achieve the maximum storage capacity with the least amount of embankment fill material. Figure 8.4-1 depicts the main tailings dam in relation to the rest of the tailing impoundment components.

Design

The main tailings dam is designed to contain all of the tailings, PAG waste, part of the not-PAG waste and a water cover within a 7 km long, 1.3 km wide storage area. It is also designed to allow some deformations and prevent overtopping under the maximum credible earthquake, thus preventing loss of freeboard.

The main tailings dam will be a rock-fill dam, built with an impervious till core to ensure minimal seepage. A main starter dam sized to contain the first two years of tailings production will be constructed first, of not-PAG materials. The main tailings dam will be built progressively on the downstream side of the main starter dam. The final dam will be 160 m wide at the crest and the base will be 1.1 km wide.

The management of tailings dam crest height will require analysis to be undertaken on a regular basis, taking into consideration all variables effecting required crest height. Some of these variables will include seasonal fluctuations in precipitation and infiltration rates, effluent release volumes, plant recirculation water volumes, actual tailings and PAG volumes placed in the reservoir, tailings beach formation and submerged PAG geometry, and others. The projected ultimate dam height of 275 m is sized to contain the tailings, a PMF, 3m of freeboard, and also flood all PAG waste rock at mine closure. The height of the main tailings dam over time is shown in Table 8.4-2.

The starter dam must be constructed to a crest elevation of 560.0 m (or dam height of 152.0m) prior to tailings deposition, assumed to be November 2010. A dam raise of 26 m is required in the first 12 months of production (or Year +1) so that the dam can store to an elevation of 586 m by the end of Year +1 (Nov 2011). Every year the tailings dam is raised to the crest elevation shown in Table 8.4-2. Figure 8.4-2 shows the main tailings dam crest elevation and tailings solids elevation over the life of the mine.

Spillways

To protect the integrity of the tailings dam, a series of emergency spillways will be constructed on the right abutment during the mine life. All spillways have been designed to pass the routed flow from a PMF. Spillways constructed on the right abutment are intended to intersect the main diversion channel so that only one outlet to Galore Creek is needed. Spillways have not been considered in the left abutment because of steep topography (slopes up to 45°).

New spillway channels will be excavated approximately every two to three years as the tailings dam is raised. In order to use a spillway for more than one year, the spillway invert must be raised incrementally until the next (higher elevation) channel is constructed. Grouted gabion mats will be used to raise the spillway invert for the spillway section that lies within the footprint of the impervious central core of the dam. Remaining sections of the spillway which fall under the dam shells can be in filled with waste rock.

8.4.2.3 Freshwater Diversions

The total potential un-diverted catchment area of the proposed tailings and waste rock impoundment and open pits is estimated to be 125 km^2. Diversions around these facilities are necessary to minimize the quantity of water entering the impoundment and the open pits. The reader is referred to the water management plan in Section 8.3 for a description on the freshwater diversions and water balance.

8.4.2.4 Seepage Recovery Dams

A seepage recovery dam will be constructed downstream of the main tailings dam to collect any seepage immediately downstream of the dam. Recovery wells may also be considered for deeper seepage recovery. The seepage recovery dam will be designed to the same seismic criteria as the tailings dam.

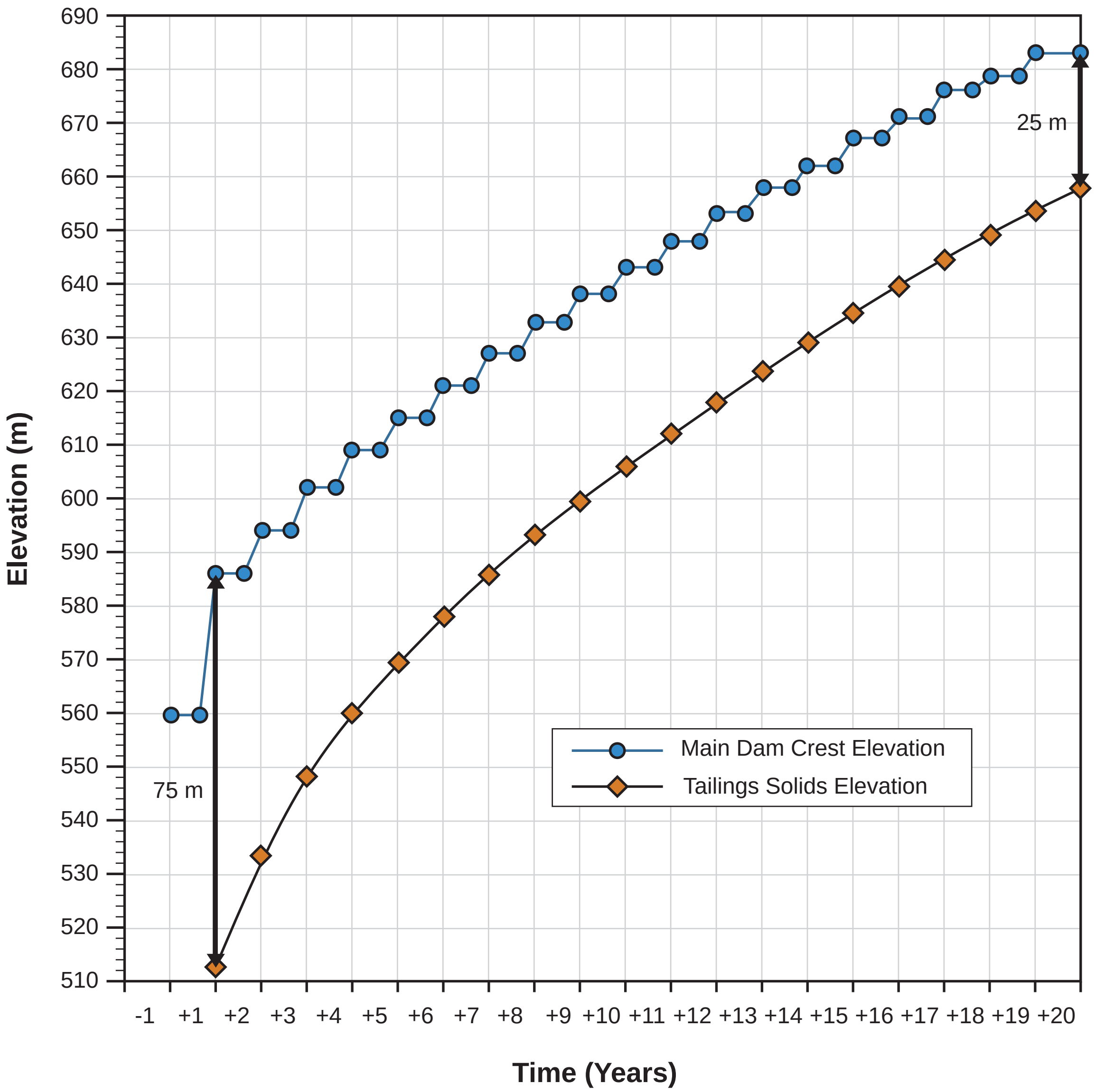


FIGURE 8.4-2

Main Dam Crest Elevation and Tailings Solids Elevation

Table 8.4-2
Required Crest Elevation and Maximum Dam Height for the Main Tailings Dam

End of Mine Year	Date (Approx.)	Dam Crest Elevation at End of Year (m)	Valley Bottom Elevation (m)	Dam Height (m)
Yr -1	16-Oct-10	560	408	152
Yr +1	16-Oct-11	586	408	178
Yr +2	16-Oct-12	594	408	186
Yr +3	16-Oct-13	602	408	194
Yr +4	16-Oct-14	609	408	201
Yr +5	16-Oct-15	615	408	207
Yr +6	16-Oct-16	621	408	213
Yr +7	16-Oct-17	627	408	219
Yr +8	16-Oct-18	633	408	225
Yr +9	16-Oct-19	638	408	230
Yr +10	16-Oct-20	643	408	235
Yr +11	16-Oct-21	648	408	240
Yr +12	16-Oct-22	653	408	245
Yr +13	16-Oct-23	658	408	250
Yr +14	16-Oct-24	662	408	254
Yr +15	16-Oct-25	667	408	259
Yr +16	16-Oct-26	671	408	263
Yr +17	16-Oct-27	676	408	268
Yr +18	16-Oct-28	679	408	271
Yr +19	16-Oct-29	683	408	275
Yr +20	16-Oct-30	683	408	275

Total water storage behind the seepage recovery dam will be designed for the same hydrologic criteria as the tailings impoundment. The spillway for the seepage recovery dam will be designed to pass an inflow event consistent with CDSA criteria. Depending on the size of the seepage recovery dam and reservoir the design event may range up to a PMF. The reader is referred to the Ground Water Effects Assessment in Section 7.9 for more details on the seepage recovery dam.

8.4.3 Surveillance of the Tailings Management Structures and Dam Safety

The purpose of surveillance is to identify potential problems or unsafe conditions in all of the tailings management structures and to ensure dam safety. Surveillance is fundamental for a proper maintenance program. Failure to address problems identified on an inspection can mean failure of any of the tailings management structures.

NovaGold's tailings management plan incorporates responsibilities, policies, plans and procedures, documentation, training, review and correction of deficiencies and non-conformances into their operation, maintenance and surveillance (OM&S) plan.

8.4.3.1 Operation Maintenance and Surveillance Plan

The objective of the OM&S plan is to ensure continuous operation of the tailings management structures and safety of the dams, as well as provide a process for follow-up and correction of deficiencies and non-conformances in a reasonable time. A key factor of the OM&S plan is ensuring that it contains adequate information and instruction to allow a qualified engineer to perform all the required actions to operate the tailings management structures and dam safely, and in the case of an emergency situation, provide protection and notification to the public downstream.

The dam safety management system should be reviewed regularly and reported to senior management representatives.

The OM&S plan will include relevant information on the structures, operating instructions, surveillance, monitoring instructions, maintenance instructions, documentation, communication, responsibility assignment and an emergency preparedness plan.

Information

The OM&S plan will include substantial information to provide a detailed picture of the location, make-up and function of each tailings management structure, and each part of the dams, including maps, plans, detailed information on the dams, records of past inspections monitoring, repairs and operating problems, as well as photographs for comparison and reference.

Operating Instructions

Instructions on the general operating procedures for the spillway and tailings and waste rock impoundment will be drawn up, including regulation of the spillway, addressing maximum storage elevations, maximum and/or minimum permissible spillway releases, and maximum and/or minimum storage of the tailings and waste rock impoundment.

Inspections

As part of the tailings management structures and dam safety maintenance program, inspections are necessary on all the structures to determine any maintenance that may be required before major problems develop. Detailed inspections will be carried out on the main tailings dam as well as the tailings management structures to ensure dam safety as well as efficient operations.

Monitoring Instructions

Monitoring observations will be recorded and maintained so they can be used as a performance record of the dams and other tailings management structures. A site plan identifying each monitoring point on the structures will be created and the points will be clearly marked so they can easily be found during surveillance. Instruction on how to record each measurement or observation will be provided as well.

Maintenance Instructions

All maintenance work will be identified, listed and carried out in a timely manner to avoid potential problems. Instructions for providing maintenance to all the structures will be provided to allow a qualified engineer to direct all work relating to the dam and carry out the maintenance.

Documentation

Documentation will be maintained up-to-date so that a permanent record will exist of the design, construction, operation and performance of the tailings management structures, and the management of the dam safety. These documents will include design documents, instrumentation readings, inspection and testing reports, dam safety inspections, dam safety review reports, operational records, investigation studies, current closure plans and other technical data.

Communication

The OM&S plan will include all the persons involved in the construction, operation and administration of the tailings management structures including their involvement and define their roles.

Responsibility Assignment

Individuals will be assigned with certain tasks involving the tailings management structures and dam safety, and they will be responsible for assuring the tasks are carried out suitably. This approach evokes a sense of ownership which will help to minimize small factors that may be overlooked. All individuals with responsibilities for tailings management structure maintenance, dam safety and monitoring activities will be adequately qualified and trained and under the direction of a qualified engineer. The content and frequency of the training programs will allow competency to be maintained. All of the training records will be maintained as well.

Emergency Response Plan

The emergency response plan addresses issues such as: what can be done at the tailings management site to manage an emergency and what equipment is available and where it is located, people and organizations that should be notified, *etc.*, and will be updated regularly. The emergency response plan is discussed in Section 8.11 of this report and should be referred to for further information.

8.4.3.2 Types of surveillance

The type of surveillance include: inspection/monitoring, safety inspection and safety review.

Routine Inspections/Monitoring

Daily inspections of the dam and other tailings management structures will be conducted by the dam operators. Daily inspections will include visual inspections of the dams, spillway, and open diversion channel as a part of the routine dam and structure maintenance. Daily inspections may be reduced to suit seasonal conditions (snow cover). Visual inspections will record seepage readings (or any condition that is subject to change), reservoir levels, operational conditions, blockages in channel, and spillway releases. Daily records of the volumes and types of waste placed in the tailings and waste rock impoundment will be kept.

Water quality will be tested monthly at seepage areas from the main tailings dam, from the surface water in the open water diversion systems, and surface water in the tailings and waste rock impoundment.

Daily observations in conjunction with monthly and special inspections will be used to check for cracks, bulging, settling, blockage, seepage, slumping, erosion and water quality changes. These or other abnormal conditions may trigger additional technical safety inspection(s) or initiate the development of alternative inspection protocols.

Safety Inspections

Safety inspections include formal annual reviews to be conducted on the tailings management structures, with the inspection of dams conducted by a qualified Professional Engineer. Safety inspections include a more thorough inspection of the structures which will be recorded in a formal inspection report. In addition to annual reviews, safety inspections will take place after severe events such as flooding, windstorms, severe icing, extreme rainfall, seismic events, *etc.*, to assess the stability of the structures.

Safety Reviews

Safety reviews will be conducted every 5 years on all the tailings management structures while the main tailings dam is still receiving lifts, and up to every 15 years after it is completed, by a qualified professional engineer. A safety review will encompass all hydrotechnical, seismic, geotechnical, structural, geochemical (environmental) and flow control equipment (pumps) of the tailings management structures. The review includes:

- consequences of structure failure
- operation, maintenance and surveillance documentation and practices
- emergency response plans and procedures
- previous Dam Safety Reviews
- up-to-date dam closure plan for the tailings dam
- failure modes (physical and geochemical)
- inflow design flood
- seismic loads and other loads and load combinations
- stability and performance
- reliability and functionality of the spillway and diversion channels
- overall effectiveness of safety management at the dam.

8.4.4 In-Impoundment Water Quality Monitoring

It is expected that the water quality from the tailings and waste rock impoundment will be suitable for direct discharge to the receiving environment without treatment. However, as part of NovaGold's proactive Environmental Policy and OM&S plan monthly water samples of the in-impoundment water will be collected to monitor the water quality. Samples will be collected from defined collection points, and submitted to the lab for analytical testing. All results will be recorded and reported to the regulatory officials. This monitoring will ensure a track record of the in-impoundment water quality, and advise of any changes to the water quality.

8.4.5 Seepage Reduction, Control Measures and Water Quality Monitoring

The main tailings dam will be constructed over a mixed sedimentary layer that is estimated to be between 0-50 m in thickness and to have variable permeability. This layer represents the overburden, which confines groundwater in the fractured rock layer directly below it, causing artesian conditions to prevail in some areas. The fractured rock layer is composed of fragmented, weathered and fractured rocks between 150 and 200 m thick. Permeability of this layer is expected to be relatively high, and it houses the main confined aquifer (for a detailed description of the hydrostratigraphy and groundwater seepage, refer to Section 6.5 of the EA). Seepage from the tailings and waste rock impoundment will be reduced by constructing the main tailings dam with an impermeable compacted till core and a bituminous geotextile membrane on the upstream facing side of the dam.

Seepage Management

Seepage from the tailings and waste rock impoundment will be reduced by beaching the tailings on the upstream facing side of the dam, using a geomembrane liner, a grout curtain and shallow consolidation grouting, and constructing recovery dams and wells below the main tailings dam.

Tailings and the presence of overburden upgradient of the dam minimize seepage through the fractured bedrock, in addition to reducing gradients around the base of the liner for the starter dam.

A geomembrane liner will be used to minimize seepage during the early years of construction when till placement may be difficult. The addition of a grout curtain will further reduce the seepage through the highly fractured bedrock. Because a liner will not be present above 560 m elevation, the grout curtain will be placed below the till core to be effective for later stages of the tailings dam life.

Shallow consolidation grouting below the till core will minimize the potential of “piping” phenomenon in this area.

Recovery dams will be constructed downstream of the main tailings dam to capture any seepage and local runoff for the purpose of pumping the water back to the tailings and waste rock impoundment. The recovery dams will be built to the same seismic standards as the main tailings dam to ensure longevity. Recovery wells may also be considered for deeper seepage recovery.

As part of the OM&S plan, the daily inspections of the dam and other tailings management structures will include visual inspections for any seepage, record seepage levels, and to ensure that the pumps are operating efficiently to pump the seepage back to the tailings and waste rock impoundment. As well, monthly water samples will be taken from all seeps and be submitted to a laboratory for analytical tests. All results will be recorded and submitted to regulatory officials along with the water quality report for the in-impoundment water quality.

8.4.6 Tailings Beach Development and Dust Management

The tailings distribution will evolve through the life of the project. During operations, tailings will be piped from the plant site - approximately 5.6 km - to the designated tailings impoundment area. The tailings pipeline(s) will be placed along a road excavated in the eastern slopes above the waste facility. Tailings will be primarily spigotted from the north end of the impoundment area, off of the main dam crest, thus creating a tailings beach on the upstream slope of the main tailings dam. However, tailings slurry will also be spigotted off the western facing slopes to optimize filling of the basin.

With deposition off the main dam, water will be forced south against the waste dump, creating a beach on the upstream slope of the main dam. However, it is recognized that there will likely be water against the main dam, most of the time. Any beaches that do form will slope to the south at an inclination of less than 1%, depending upon the impoundment water level and final tailings grain size.

After the first five years of operation the tailings will be covered with water and there will be no appreciable tailings beach. At closure any tailings beach will be fully covered with the closure tailings lake.

Any potential tailings dust will be managed by continuously keeping the tailings submersed.

8.4.7 Waste and Water Storage in the Tailings and Waste Rock Impoundment

A series of volume elevation curves have been prepared for the Galore Creek valley to determine dam heights required to contain tailings and potential acid rock drainage. These curves have been developed for the dam alignments and waste dump outlines shown in Figure 8.4-3 the separation line between waste rock and tailings was varied until a balance was reached which had the final elevation of tailings solids and PAG waste rock at the same elevation.

8.4.7.1 Tailings and Waste Rock Production

An average mill throughput of 65,000 t/d was used to develop filling schedules and dam raises over the mine life. It has been assumed that the total tonnage of tailings is evenly distributed over the life of the mine. Material volumes were calculated assuming the following densities:

- tailings settled dry density = 1.35 t/m^3
- waste rock density = 2.05 t/ m^3
- overburden density = 1.67 t/ m^3.

At the end of the mine life, the impoundment will be storing approximately 352 Mm^3 of tailings solids and 513 Mm^3 of pit waste (rock and overburden) for a total of 865 Mm^3 of solids. A total of 590 Mm^3 of mine waste (tailings + PAG waste rock) must be flooded at the end of the mine life. The remaining 275 Mm^3 of not-PAG can be placed above the PAG or in separate dumps on the valley slopes.

8.4.7.2 Water Storage in Impoundment

In addition to solids, the tailings impoundment must store water. Water reporting to the tailings and waste rock impoundment will be derived from tailings transport water, and non-diverted runoff. Transport water reporting to the tailings and waste rock impoundment will be managed by thickening the tailings prior to transport. Remaining water not lost to the voids will be reclaimed and returned to the mill. It has been estimated that 85% of the initial transport water will be recovered from the circuit either from the thickener or from the impoundment.

In order to maintain water balance in the tailings impoundment excess water must be released from the impoundment every year. This release will be controlled by pumping. Pumped outflows from the facility will follow a paced discharge, simulating the natural flow hydrograph of Galore Creek. It is anticipated that pumping will only occur from 15th May to 15th October in each year; however, the pumping period will be extended if hydrological conditions allow. There will be no pumped outflow from the tailings and waste rock impoundment during low flow periods during winter months.

For every year of operation contingency will be provided to allow storage, with zero discharge, of mine discharge, winter flows and freshet runoff up to 15th July, if required. This storage will allow monitoring of water quality within the tailings and waste rock impoundment before release.

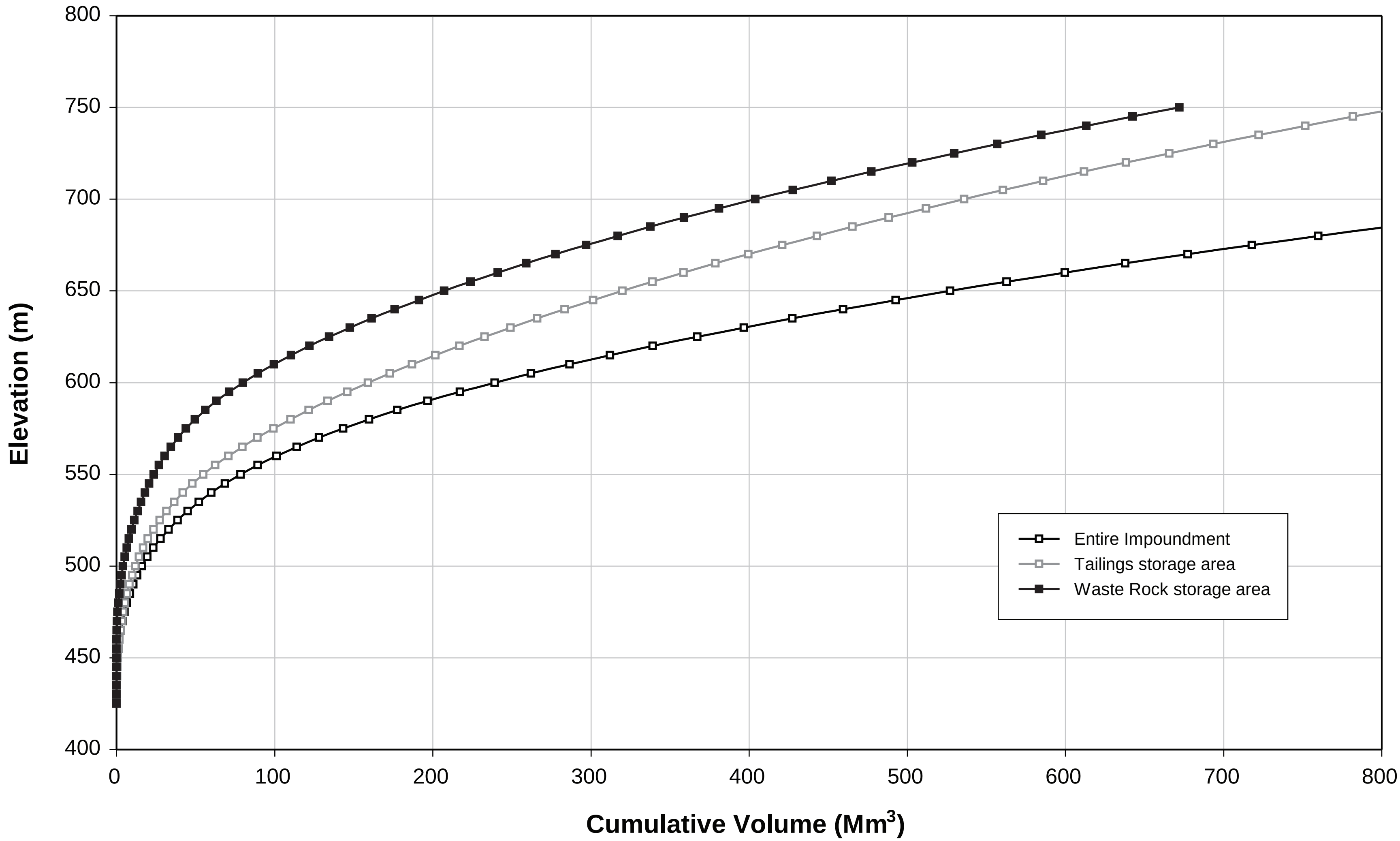
Hence, in every year of operation the dam will be able to store all inflows (runoff, tailings inputs, sump water) for a 9 month period (16th October to 15th July). Runoff volumes are designed for 1 in 200 wet year conditions. However, if water quality in the impoundment is good, pumping will commence as soon as flow conditions in the Galore Valley allow (anticipated to be around 15th May).

During the first year of operations additional storage will be provided to allow extra time for ongoing monitoring of the impoundment water quality. During the first year of operations the starter dam will be designed to provide the capacity to store all inflows for a 19 month period (*i.e.* storage from start-up of the mill on 1st November 2010 until 12th May 2012), covering two winter periods and summer flow season. Runoff volumes are designed for a 1 in 200 wet year condition.

The water balance for the project has been determined based on water quality modelling of the tailings and waste dump facilities. Table 8.4-3 summarizes the available data and assumptions used in their modelling.

To determine the water storage requirements of the tailings and waste rock impoundment during the early years of production (Yr +1) and size the starter dam, the following assumptions were made:

- During the construction period of the starter dam (Yr -3 to -1) and first year of operation (Yr +1), all freshwater, except runoff from approximately 5 km^2 of catchment area above the starter dam, will be diverted past the tailings dam construction area (with the starter dam diversion channels and cofferdam).



Curves provided by BGC Engineering

FIGURE 8.4-3

NovaGold Canada Inc.

Galore Creek Waste Rock and Tailings Storage Facility Volume-Elevation Curves

Rescan™

Table 8.4-3
Water Quality/Water Balance Model Assumptions

Mine Layout and Production	
Tailings	Production rate = 65,500 t/d (Hatch 2006) Density (dry)= 1.35 t/m^3 (from BGC 2006) Water content of settled tails = 37 % by weight
Waste Rock	Production rate; WR areas; WR height; PAG/NPAG split = calculated from schedule provided by NovaGold, March 2006 Fraction of NPAG *never* submerged = 0.46; Average NPAG exposure time = 70 months. Fraction of PAG *never* submerged = 0; Average PAG exposure time = 36 months For water balance and water quality calculations, Density = 1.95 t/m^3; S.G = 2.67; pore water = 14 % by weight (from BGC pers comm..).
Struck Curves	From BGC (2006)
Mine Life	20 years with two years for construction
Dam Lift Schedule	From BGC (2006)
Tailings Height	Calculated internally within model. Confirmed consistent with estimates in BGC (2006).
Tailings discharge	Tailings with 55 % solids
Process Plant water	Estimated 20 % reclaim from sedimentation basin; 80 % from other sources (*i.e.* pit water and groundwater if required). Based on Hatch (2006)
Maximum Pump rate	20 m^3/s; but 10 – 14 m^3/s under normal operating conditions
Pond above tailings	4 m
Water Balance	
Hydrology	Based on analysis in Surface Water Hydrology Baseline Report
Pumping Schedule	Assume discharge during half of May until mid-October under normal operating conditions
Diversion Channel	5 % leakage to sedimentation basin.
Chemistry	
Natural Water	Data from Rescan 2004 and 2005 baseline programs
Pit Water	Assuming that precipitation on the open pits infiltrate through 1 m of NPAG rock per bench of each open pit (SRK 2006). However, pit water load is passed through Process Plant and is considered within tailings supernatant discharge.
Tailings Supernatant	Years 1 to 5, mix of data from pilot plant and analysis of oxide layer. Years 6 to 20 use maximum values for water quality parameters in the final tailings supernatant produced in the pilot plant study.
Waste Rock	Values for Seepage through exposed PAG and NPAG and Submersion/inundation of PAG and NPAG prepared by SRK (2006)
Loss of dissolved metals in reclaim water	Assumed zero removal of dissolved metals from the reclaim water as it passes through the process plant.
Metal Loadings associated with suspended solids	Calculated using average values for metal content from tailings solids and natural sediment analysis (assumed that discharge from pond is 50:50 tails solids to natural sediment). Assumed a constant TSS content in the tailings facility discharge of 15 ppm.
Pore Water	Pore Water assumed to be tailings supernatant water
Seepage	All seepage water pumped back into pond

- Immediately prior to the start of tailings deposition into the impoundment, all water will be pumped out of the impoundment.

- The starter dam has been sized to store water for a 1 in 200 wet year for the first 19 months of production (assumed from November 2010 to May 2012) in addition to tailings solids.

To determine the water storage requirements of the tailings and waste rock impoundment during the remainder of the mine life (Yr +2 to Yr +20) and to size the tailings dam raises over the mine life, the following assumptions were made:

- The main, West Fork and Dendritic Creek diversions will be in operation, diverting runoff from all except about 35 km^2 of catchment area, which includes pit and waste dump areas.
- Water storage volumes assume storage in the designated tailings impoundment area, but includes the waste dump area.
- A 1 in 200 wet year runoff volume can be stored.
- A tailings dam raise will be completed during the construction season preceding the year of operation.

The required elevation of the spillway invert will be determined each year by the requirement to store the cumulative deposited tailings solids at the end of the year, plus a minimum operating impoundment, plus the 1 in 200 wet year runoff inflow.

The total freeboard from the spillway invert to the dam crest will comprise the surcharge storage determined by flood routing to pass the PMP design flood event plus 3 m emergency freeboard above maximum impoundment levels. Total freeboard will vary from 12 m initially to 9 m at the end of operations.

In addition to the flood storage described above, an allowance has been made for an operating impoundment to facilitate the reclaim of water. Test work and modelling will be ongoing throughout the life of the mine to continuously improve the definition and prediction of effluent water quality. Results of the test work and models to date show that the tailings water will not require treatment.

Water will be drawn from the tailings and waste rock impoundment as reclaim water for use in the process plant. The reclaim water will make up 10% of the process water, and is conservatively assumed to have zero removal of dissolved metals from the reclaim water as it passes through the process plant.

8.4.8 Surplus Water Discharge

With the possible exception of the first 19 months of production, tailings water will be pumped out of the impoundment from mid-May to mid-October. This mine water will be pumped from the reclaim barge and sent to the emergency spillway location for discharge. Ongoing monitoring will confirm that the water pumped to the spillway for discharge meets or exceeds design criteria. This criterion is defined by the Metal Mining Effluent Regulations under the *Fisheries Act*, Environment Canada LC_{50} standard toxicity testing protocols and the regulatory and permits conditions. The base case operating conditions assume that releases of excess water will be made every year between mid-May and mid-October. Release rates will be paced to mimic as much as possible the natural receiving water hydrograph.

For feasibility design, it has been assumed that the tailings impoundment water does not require treatment prior to discharge to the environment, with the exception of managing the total suspended solids. Runoff from Yr +1 spring freshet will be stored to ensure the water quality is as predicted. To keep the starter dam low and still have the required storage volume for the anticipated solids and water volumes, water will be pumped from behind the starter dam during construction. Immediately prior to tailings deposition (assumed to be November 2010), the impoundment will be drawn down by pumping to ensure the largest possible storage in the impoundment.

Flood events larger than the 1 in 200 wet year will be passed with a combination of pumping and direct discharge through the emergency spillways. The emergency spillways are designed to safely pass the PMP, assuming that the impoundment is full to the spillway invert and assuming none of the freshwater diversions are operational (*i.e.* diversions are not relied upon so runoff is from the entire 125 km^2 catchment area).

8.4.9 Construction Considerations

Ensuring key management objectives for environmental protection and capital stewardship are met while applying a “common sense” approach to mine construction are overriding principles guiding the development of the startup plan.

The construction of the tailings management structures require significant earthmoving operations, which will be integrated into the startup of the mining operation, after the development of the supporting infrastructure such as mine access, power and communication structures, equipment erection and maintenance facilities (fuel, service, repair).

The main physical construction considerations for the tailings management structures involve the management and control of the Galore Creek while building the structures of the tailings and waste rock impoundment, as well as natural hazards. Temporary coffer dams, water diversion channels and other structures will be employed to divert the Galore Creek around the construction sites. The proposed waste containment area lies in steep terrain in an area prone to landslides and avalanches.

Landslides

Instability in the form of debris avalanches, debris flows, debris floods, rockfalls, rockslides, rock avalanches and deep-seated slope sagging all pose a problem for the following areas:

- main tailings dam
- upper eastern slopes above the tailings and waste rock impoundment and diversion channels (Bear and Friendly Creeks)
- upper western slopes above the tailings and waste rock impoundment and starter diversion channel.

The main tailings dam is located in a steep canyon and, the abutment slopes are susceptible to shallow rock fall during dam construction and during operations. Once the dam is at its final height, these slopes will be covered and the risk of rockfalls from above will be minimal to none. Care will be required during construction to mitigate rockfalls.

The downstream left abutment (northwest side of the dam) is potentially subject to debris flows in a gully extending to 1,200 m elevation. This gully could generate debris flows with the potential to cause scour on the northwest side of the dam. Once the downstream shell encroaches on this small creek, scour protection measures may be necessary.

Two creeks (Bear Creek and Friendly Creek) on the upper eastern slopes above the tailings and waste impoundment are subject to sporadic rock fall, debris flows and debris floods. Bear Creek enters Galore Creek approximately 200 m south of the proposed dam alignment. This creek is potentially subject to debris flows above approximately 550 m elevation and to debris floods in its lower reaches. Debris flow and debris flood events are considered to have very low likelihood of damaging the tailings dam, but could represent a safety hazard during dam construction and could interrupt the main diversion channel or main dam access road. Construction activities planned at the confluence of Bear Creek and Galore Creek must take into account the potential for debris flood activity, including facility site selection and the design of stream crossings.

Freshwater diversions will cross Bear Creek at approximately 1 km south of the dam. Debris flow barriers have been planned upstream of the main channel to minimize the risk of debris reaching the diversion channels. Once this barrier is in operation, there will be minimal debris entering the impoundment due to debris flows and floods.

Friendly Creek enters Galore Creek approximately 1.3 km south of the proposed dam alignment. This creek is also subject to debris flows at high elevations and debris floods at lower elevations. Similar to Bear Creek, a debris flow interceptor structure will be built upstream of the main channel to minimize the risk of debris reaching the diversion channel crossing and entering the impoundment.

The upper western slopes above the tailings and waste impoundment are subject to rockfall and debris flows. Several channels exist 1 to 4 km south of the proposed dam alignment where debris flows could run out into the impoundment during the early years of operation. Debris flow events occurring in this area are considered to be very low hazard to the main tailings dam, but may have to be diverted around active waste dump areas and waste dump access roads.

Snow Avalanches

A snow avalanche hazard exists on both sides of the valley, with the potential to run out into the footprint of the proposed tailings and waste impoundment, and intersect and to possibly block the main diversion channel. A snow avalanche management program will be instituted during construction and operations (as outlined in BGC, 2006a).

Avalanche Hazards to the Tailings and Waste Rock Impoundment

BGC identified the potential of snow avalanches impacting the tailings and waste rock impoundment and conducted an assessment to determine whether a snow avalanche-generated wave could cause dam overtopping. This assessment is described in detail in the feasibility geohazards report (BGC, 2006a). In the event a very large and rare (1:100 frequency) snow avalanche affects the impoundment during the early years of mine operation, snow avalanche-generated waves are unlikely to reach the crest of the dam. Any waves generated by avalanche will be contained within the 12 m of freeboard above the spillway invert. No additional mitigation measures are needed until mine closure, when the depth of water in the impoundment will be limited and the emergency freeboard and spillway will be capable of handling smaller waves.

8.4.10 Summary of Closure Concepts

In concept, all the tailings and PAG waste rock within the impoundment will be flooded as well as the open pits below the pit lower lip in Galore valley. The approximate elevation of the flooded surface is 674 m, equivalent to the spillway invert elevation at closure. All not-PAG waste rock, located above the PAG waste will be exposed at the surface.

All freshwater diversions (including pit dewatering wells) will be decommissioned. The East Fork diversion structure and West Fork diversion dam, as well as any major energy dissipater structures along the diversion channels, will be breached. The structures will be revegetated or the material can be used for reclamation in other areas. To facilitate flow through the waste dump, a channel through the not-PAG waste between the East Fork aqueduct and the waste dump divider location will be provided. Similarly, in the area of the pits, water from the upper pits will be controlled and channelized to allow water to cascade down from the higher elevation pits down to the lower elevation pits.

To protect the integrity of the main tailings dam (by controlling the impoundment level), an emergency spillway on the right abutment will be excavated into rock. This spillway will be designed to handle the PMP and must remain in operation for as long as the dam exists. The spillway must be kept clean via regular maintenance to ensure water can pass through year round. It assumed that the impoundment water chemistry will be suitable for direct discharge to the environment after mining has been completed so all water exiting the spillway will be released without collection and treatment.

8.4.11 Contingency for Non-Compliant Effluent

The effluent water quality from the tailings and waste rock impoundment is expected to be meet the quality criteria of the MMER regulation discharge limits; therefore, treatment of the effluent is not required. However, throughout the life of the mine, should the discharge exceed the MMER discharge limits, NovaGold will take immediate action to ensure the effluent does not enter the receiving environment. This will involve whatever combination of measures necessary for containment (accelerated dam construction, construction of containment berms, emergency containment impoundments, decreasing the water inflow to the tailings and waste rock impoundment, decreasing water inflow from the process plant) and treatment of the primary tailings and waste impoundment water.

8.5 Pipelines Environmental Management Plan

8.5.1 Introduction

The remote location of the proposed Galore Creek Project site and the need to construct a 140 km access road to the site has prompted the incorporation of buried pipelines to transfer the two largest-volume liquid materials by pipeline rather than by heavy trucks along the access road. These two materials are slurried copper concentrate from the Galore Valley processing plant and diesel fuel required for site operations equipment. Copper concentrate will be pumped via buried pipeline from the Galore Creek valley processing plant to the concentrate filter plant and truck-loading facility located near the Highway 37 mine access road junction. Diesel fuel will be delivered by transport truck from Highway 37 to an unloading facility at the filter plant site, from where it will be transferred to the Galore mine site via a buried diesel pipeline. A third, shorter pipeline will transfer treated water (effluent) from the filter plant to a permitted discharge point on the Iskut River.

Installing the two main pipelines will significantly reduce the potential for diesel and concentrate spills due to possible motor vehicle accidents along the mine access route. This will also improve overall project safety and associated reliability. Pipeline transport has historically proven to be a highly reliable delivery method with lower risk of spills and/or incidents than traditional methods.

As in other project areas, NovaGold has made a commitment to incorporating Best Management Practices in the design, construction, operation, maintenance, monitoring and decommissioning of the pipelines consistent with those utilized in currently operating slurry and fuel pipeline systems.

8.5.2 Pipeline Design Criteria

Pipeline Systems Inc. (PSI) was engaged by NovaGold to perform a conceptual study of the slurry and diesel fuel pipeline transportation systems to assess technical feasibility and to develop order-of-magnitude cost estimates for the system. The design of the of the system from a safety and operability standpoint is based on the latest American Society of Mechanical Engineers (ASME) codes for slurry and liquid hydrocarbon materials.

The alignment of the pipelines leading from the filter plant to the mine site along the access road is shown in Figure 8.5-1. Also shown is a pipeline low-point drain planned to be installed adjacent to Porcupine River.

A key factor in developing the pipeline design is the route engineering. The pipelines will be installed within the mine access road corridor to facilitate access during all phases of the project. This will require careful coordination during construction but will greatly facilitate system inspections during operations.

In general, the pipelines will be buried over the major portion of the route, and above-ground pipeline sections will be minimized. The above-ground sections will be insulated, but buried sections will not. A fibre-optic communications cable will be installed alongside the pipes. In compliance with ASME Codes, burial depths will range from 1.6 to 3.0 m depending on the geotechnical risks along each section, with deeper burial in areas such as at potential debris flow channels that are at higher risk. The alignment will generally be under the access road roadside ditch, but minor diversions will be required to maintain appropriate grades and thereby avoid the settlement of solids in the slurry line in low points during shutdowns.

In potential washout zones, the top of the pipeline will be a minimum of 1.5 m below the fill surface for the complete length of the area identified as a potential washout zone. The pipe will be appropriately protected with either concrete pipe saddles or concrete coating.

At Muskwie River and adjacent fish-bearing creeks (not named) and at Swamp Creek the pipelines will be installed in directionally drilled holes that will allow the pipelines to remain buried down the two banks and below the full width of the stream or riverbed. Buried crossings have the advantage of additional protection against accidental or malicious damage. The pipes will be buried sufficiently deep to eliminate any concerns with exposure of the pipe due to scour of the stream or changes in alignment of the channel. For typical minor water crossings there will be a minimum of 1.2 m between top of pipe and river bottom bed in rock material and 2.0 m below grade in earth material. At installations undertaken using an excavated trench across the watercourse, the pipeline will be bedded in select fine material and covered with riverbed material and riprap. The pipelines will be covered with a concrete coating for the complete crossing width. For special situations, more extensive engineering and installation efforts may be required.

Drilled installations have several additional benefits, including greater flexibility of installation by not having to work in or around the stream, no bank restoration costs, no concerns for habitat enhancement after construction and being almost maintenance-free for the life of the pipeline.

Where directional drilling is not deemed possible, such as where the road crosses steep canyons on high bridges, the two pipelines will cross the watercourse on the bridge structure, suspended from an I-beam adjacent to the bridge deck. The pipelines will not be suspended below the bridge deck, as is often the practise, to prevent jeopardizing the clearance between the pipes and the water surface below. The pipelines on the crossings will be insulated. A 2" diameter conduit will be provided alongside for the fibre optic communications cable. The pipes and conduit will be covered by an A-frame snow roof.

Pipeline designs are based on work by PSI supplemented by additional mitigation measures as proposed by BGC Engineering in its geohazards assessment report , which identifies hazards such as potential landslide, avalanche and rockslide locations along the selected road route. Pipeline design features (deep burial, armouring, *etc.*) have been included in conceptual plans and cost estimates. During detailed engineering, specific designs and construction procedures will be developed for each site to ensure protection of the pipelines and compliance with relevant permit requirements.

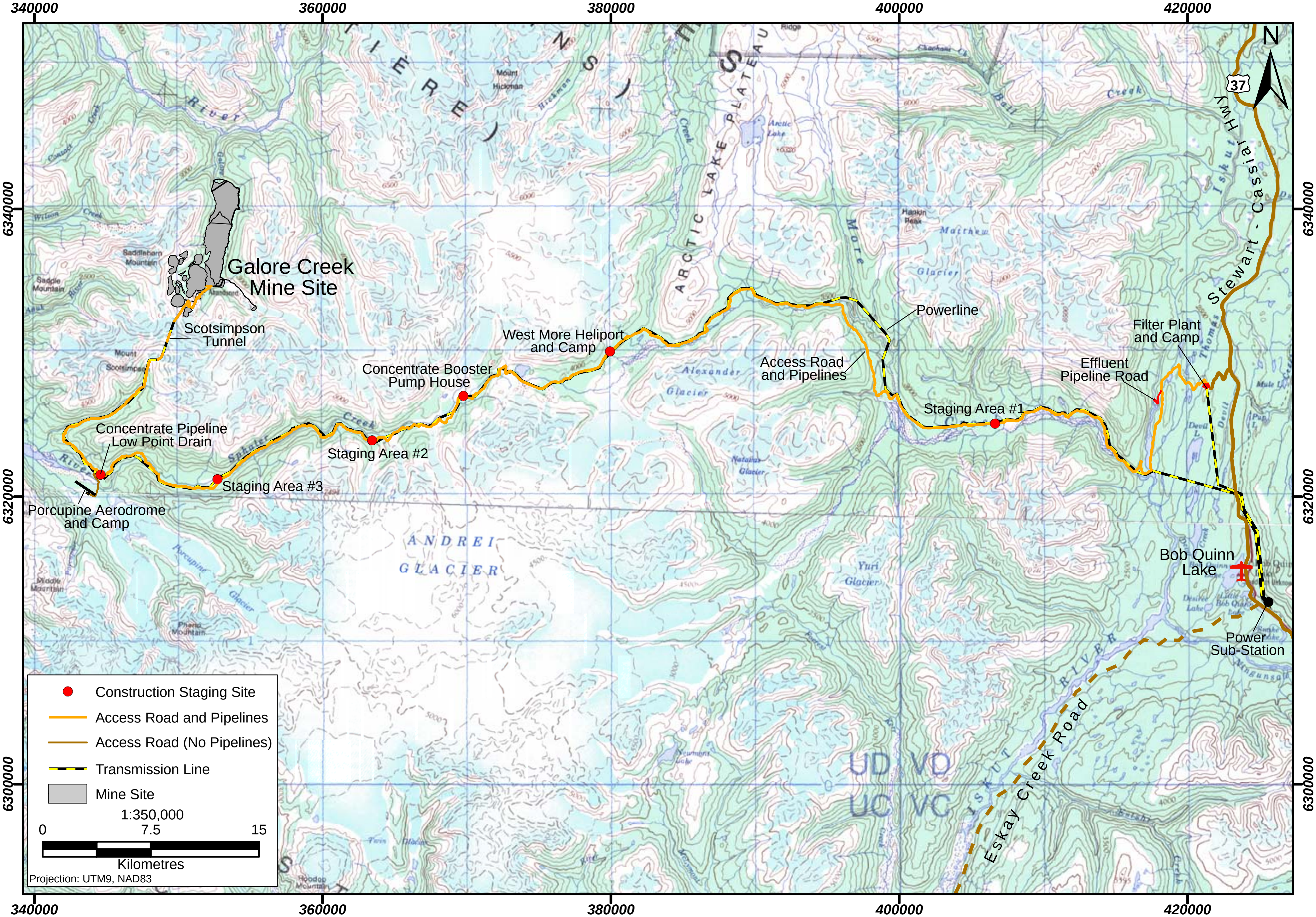


FIGURE 8.5-1

NovaGold Canada Inc.

Project Pipeline Alignments - Overall Plan

Rescan

Table 8.5-1
Pipeline Design Criteria

Component	Pipelines: Concentrate	Pipelines: Diesel Fuel
Product	Copper Concentrate • Specific gravity 4.2 • Solids concentration 52-58%; • pH 10 Slurry temperature 15°C at pipeline inlet and 5°C in the pipe	Diesel Fuel
Throughput	2,000 dry t/d peak and 25,000 t/m, 87.7 t/h at 95% availability	11 million litres per year estimated fuel requirement
Power Requirement	900 kW for two pump stations	HP requirement omitted
Input Method	From mill concentrate stock tank	From Super B trailers – 500 per year
Feed End Storage Tank(s)	10 m diameter by 10 m high agitated stock tank	40 m^3 (10,000 gallon) capacity tank
Pipe Details	7.625" outside diameter thick walled welded carbon steel; varying thickness HDPE liner inside pipe along length to compensate for wear, especially in first 20 km	3.5" carbon steel line (PSIa)
Design Codes and Standards	ASME B31.11-02 Slurry Transportation Piping Systems	ASME B31.4-02 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids; ANSI/CSA Z662S1-05 Supplement No. 1 to CAN/CSA-Z662-03, Oil and Gas Pipeline Systems
Line Pressure	14,340 kPa at the pump stations to 14,150 kPa at the discharge point	N/A
Discharge End Storage Tank(s)	Storage tank at filter plant	two 12 m (D) x 11 m (H) storage tanks at main fuel farm on site

8.5.3 Pipeline System Considerations

8.5.3.1 Pipeline Integrity

Three aspects of pipeline integrity are critical in the management of pipeline systems: prevention, detection, and response in the event of a loss. The pipeline systems at Galore Creek will be designed to the highest standards realizing the challenging terrain, geohazards, importance of the pipelines to the project operation and natural environment along the access corridor.

The focus of the management systems will be to develop a comprehensive program of inspections, monitoring and maintenance to prevent structural integrity problems, especially those that may jeopardize public safety, environmental compliance and/or mine operations.

Ensuring integrity of the pipelines is the most effective physical method for minimizing risks of failures.

The diesel and concentrate pipelines will be controlled and monitored from the mine site central control room, where all system controls and operating information will be available. The treated water discharge pipeline from the filter plant will have similar monitoring systems to ensure design operability and compliance reporting. The treated water discharge pipeline will share the same excavated and backfilled trench along the road corridor before it deviates down to the Iskut River diffuser system.

Response plans in the event of a release of material from the pipelines are outlined in Section 8.11, Spill Contingency and Emergency Response Plan. This plan will continue to be refined and updated as detailed engineering is completed and management systems are detailed and then implemented.

8.5.3.2 Construction Phase

Pipeline construction will begin shortly after the roadway is completed. The pipelines will be installed in an excavated trench, typically located beneath the roadside ditch. The trench will be excavated or blasted and will have been opened up during road construction but then refilled until installation. Best management practices will be employed during the construction period, with environmental protection and safety of the workers being paramount.

Erosion control and sediment management concerns will be highest during the construction phase when excavation and earthmoving work is being undertaken. Construction procedures will be supplemented with a comprehensive environmental monitoring program to ensure environmental protection.

8.5.3.3 Operations Phase

During operation of the pipelines, ongoing monitoring systems will be supplemented with a program of regular inspections and preventive maintenance to minimize the potential for pipeline failures.

Operating manuals will be prepared for both pipelines. Elements to be included are listed below:

- description of components and processes
- pipeline alignments
- design criteria and specifications
- operating plans including staffing and responsibilities
- detailed operating procedures
- detailed inspections procedures
- schedule for undertaking integrity testing of pipelines
- maintenance procedures

- security
- contingency and emergency response plans
- details of products including MSDS sheets for both products, as well as for any products used in the maintenance of the system

The operating manuals will be prepared before the pipelines are commissioned or any materials are pumped through them.

8.5.3.4 Risk Assessment

A qualitative and quantitative, or probabilistic, risk assessment (RA) system for the pipeline systems will be an important management tool. It will include hazard identification and evaluation as well as specific preventive and mitigation measures to manage the risks.

An initial identification of a number of pipeline risks, suggested monitoring and mitigation measures is presented in Table 8.5-2.

Ongoing performance monitoring and evaluation of the RA process will be undertaken through periodic reviews of the management system.

Table 8.5-2
Typical Pipeline Risks

Cause of Leak	How to Monitor	Mitigation
Third-party damage	Patrol the route	Restricted access on access road
Pipeline corrosion	Ultrasonic wall thickness measurements (diesel line only)	Treat the lines to keep corrosion rate within design limits. Incorporate cathodic protection
Slack flow	Monitor pressures near high points	Use chokes to prevent slack flow
Geohazards	Identify hazard areas	Deep burial, pipe armour, directional drilling
Operator error	Expert Advisor System	Operator training
Freezing (not an issue for diesel pipeline)	Expert Advisor System	Bury pipe below frost line Maintain minimum flow rate to prevent freezing when pipe is above frost depth

8.5.3.5 Contingency Plans

During construction and operation of the pipelines, strategies and procedures will be developed relating to:

- containment and clean-up of spills of materials being pumped
- repair of pipeline failures, system malfunctions or potential malfunctions arising from occurrences such as landslides, avalanches, slope failures, washouts, floods, forest fires or seismic activity
- salvage of fish stranded or trapped as a result of construction activities.

Contingency plans for the above will also contain information regarding:

- pipeline repairs that will require immediate deployment of heavy equipment
- timing of fish migrations and wildlife movements that could be at risk due to pipeline activities
- pipeline flaws that could be temporarily repaired during sensitive periods using low-impact procedures, with more-permanent repairs to be made later during non-sensitive times.

Careful monitoring, inspection and maintenance programs greatly reduce the risk of failures that could have significant adverse consequences to human life, the environment and business operations. Ensuring that risks are "as low as reasonably practicable" will be the guiding principle in the construction and operation of the proposed pipelines at the Galore Creek Project.

8.5.4 Environmental Management

The Pipelines Environmental Management Plan is one component of a comprehensive management system for the Galore Creek Project. Diligence in managing the pipelines is essential due to the challenging terrain, the sensitivity of the natural environment along the access corridor and the importance of the pipelines to project operation.

A Supervisory Control and Data Acquisition (SCADA) system will support pipeline operation and control as well as advanced functions such as leak detection, leak location and batch tracking. A fibre-optic communication line will link all the intermediate stations and the mine site to the filter plant.

Because the pipelines will be buried along most of their length, specific plans will be prepared for managing the environmental aspects of breaches in particular areas. For example, exposed sections will have different management approaches than buried sections.

Where the pipelines are attached to bridges over water crossings, many aspects of routine pipeline maintenance will become more important, particularly with regard to environmental concerns. Any material released from a bridge will disperse much more rapidly than it would underground. Even though the pipeline itself may not be threatened, release control may be required to prevent the erosion of soils and bank materials, especially where environmental resources such as fish habitat may be threatened. A careful program of inspection and maintenance along with well-prepared contingency plans for early detection and correction of developing problems will reduce environmental consequences and help prevent environmentally disruptive emergency repairs and future restoration work.

These considerations are incorporated in the operations-phase spill response plans for the pipelines discussed in some detail in the Spill Contingency and Emergency Response Plan.

8.5.4.1 Concentrate Pipeline

The concentrate slurry pipeline will be more vulnerable to plugging than the other two lines carrying more homogenous liquids such as diesel fuel or treated effluent water. Significant variations in line pressure can be expected owing to the length of the line, the topography along the route and the batch process (low production) to be used in pumping the concentrate through the pipeline to the filter plant.

Pipeline slopes will normally be limited to the adjacent road grade. This will minimize the settlement of solids at low points that could accumulate to form a partial plug or potentially an almost full cross-section plug as the materials flow to the low point after a shutdown. However, commercial operating experience indicates that slopes less than 15% do not present a risk to pipeline plugging during shutdowns.

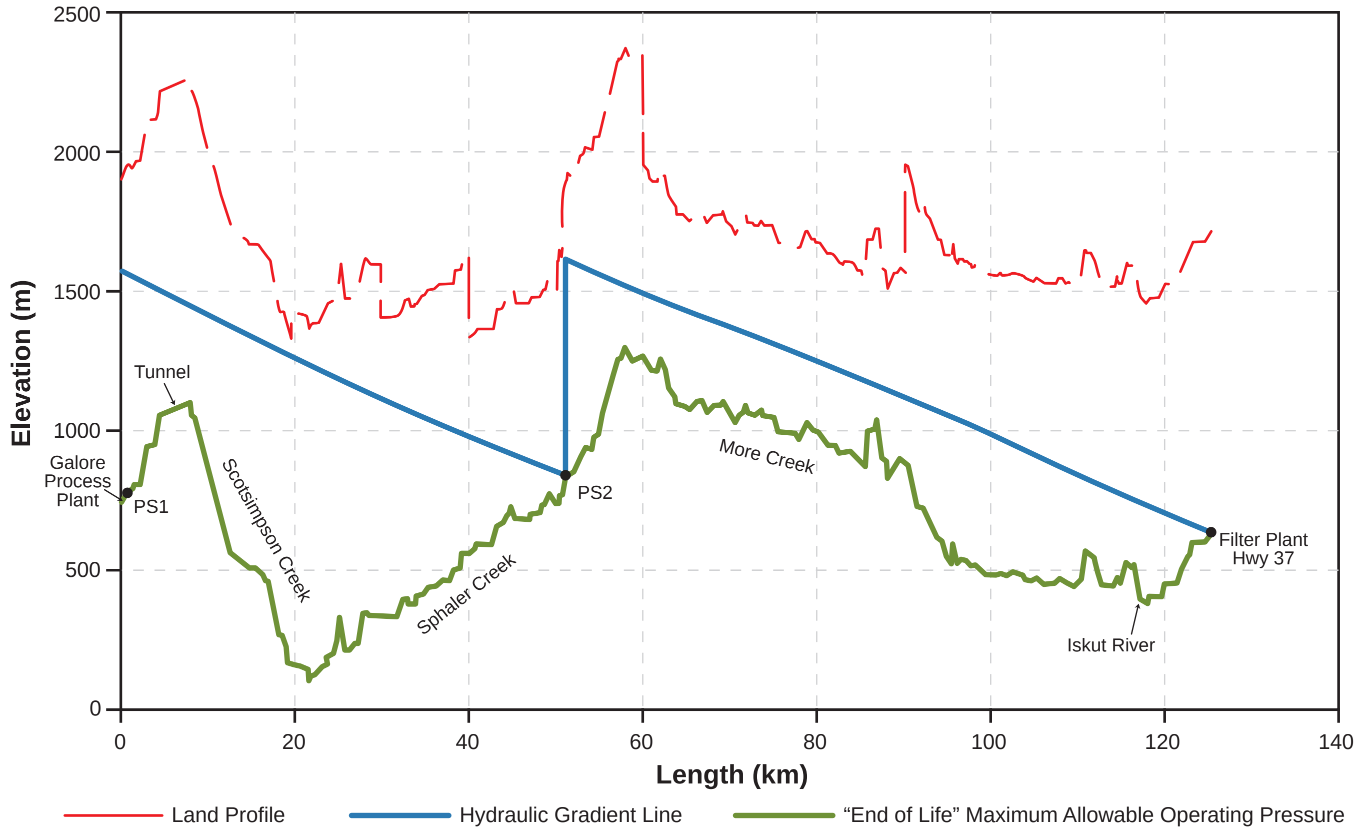
Large piston diaphragm pumps will be used to pump the slurry. There will be two pump stations, one at the Galore plant site plus a booster station near the headwaters of Sphaler Creek; these pump stations are shown as PS1 and PS2 in Figure 8.5-2. The figure also illustrates the results of a hydraulic model showing land profile, hydraulic gradient line and operating pressure along the pipeline route.

Under normal operating conditions, heat from the concentrate slurry and heat generated by pipeline friction will warm the surrounding soil. This soil will also provide an insulating layer to mitigate heat losses during cold weather, thereby preventing freezing. Modelling predicts no risk of freezing after more than 96 hours after a shutdown.

Operating Procedures

Operating procedures for the pipeline will be outlined in the operations manual that will be prepared during detailed design work. Main operating considerations include the following:

- Control of the system will be automatic in the steady-state mode with operator intervention required during process upsets.
- A batch process will likely be utilized. There will typically be three batches in the pipeline at any one time. After this, flush water will be pumped down the line to the filter plant (shutdown condition only).
- Each year, over 660,000 m^3 of water will be used in the slurry and as batch water and will be discharged, after treatment, from the filter plant site.
- The pipeline system will be designed to be shut down full of slurry. This may occur during upset conditions, in which case the pumps will be stopped and the terminal valve closed. The shutdown sequence will be implemented by the SCADA system software, so that the emergency stop can be implemented quickly and safely.
- In a planned long-term shutdown, solids will be displaced from the pipeline through an orderly introduction of flush water. Following evacuation of solids in the pipeline (estimated to take 27 hours), the flow will be stopped with the valve closed and pumps shut down. Prior to an extended planned shutdown, anticipated to be an infrequent event, water flushing will be required.
- If a long-term shutdown is required in the winter, displacing the water in the pipeline with air or nitrogen may be required to eliminate the risk of freezing.



Slurry Characteristics	
Solids S.G.	4.2
Temp (°C)	5
B'	2.92
Von Karman	0.9
Durand	150
Roughness (inches)	0.002
Slurry SG	1.74

Particle Size Distribution	
P% 65	99.98
P% 100	99.91
P% 150	99.42
P% 200	96.74
P% 325	81.35
P% 400	76.29

Pipeline Characteristics		
OD (inch)	6.625	
Average Wall (inch)	0.242	
Liner (inch)	0.000	
ID (inch)	6.140	
Wear Rate KP 0-20	8	(mpy)
Wear Rate KP 20-125	4	(mpy)

Length Pipe	125.18	km
Steel tonnage	3,229.98	
API5L X	65.00	

Pipeline Throughput		
Flowrate	89.79	m³/h
Cw%	56%	
Throughput	87.70	tph

Line Velocity	
Minimum	**1.31** m/s
Maximum	**1.40** m/s

MAOP Clearance	
Minimum	**62.6** m
Maximum	**1,076.0** m

Pumping Requirements	*PS 1*	*PS 2*	
Location	**0.0**	**50,677.2**	KP
TDH	**834.6**	**823.5**	m
Number of pump	**1op + 1stb**	**1op + 1stb**	
Discharge Pressure	**2,080.2**	**2,052.8**	psig
	143.46	**141.57**	BAR
Pump Efficiency (%)	**85%**	**85%**	
Motor HP	**597.5**	**589.6**	HP
Motor kW	**445.5**	**439.7**	kW

Hydraulic Gradient	
Minimum	**12.37** m/km
Maximum	**15.85** m/km

Profile Clearance	
Minimum	**0.0** m
Maximum	**1,132.3** m

Choking	
Head Loss	**0.00** m

Minimum Operating Safe Velocity	1.28
Safety on Flow	1.06
Length Factor	1.05

Source: PSI Engineering

FIGURE 8.5-2

NovaGold Canada Inc.

Galore Creek Project: Slurry Pipeline Hydraulic Model

Rescan™

Protection System

Risks will be minimized through the application of best management practices during construction and subsequent operation, maintenance and surveillance of the pipelines.

All pipelines will slowly degenerate with time as a result of corrosion, wear-and-tear and other factors. Scheduled inspections and maintenance will require periodic uncovering of the pipeline. However, most of the monitoring will be done using remote systems that will be implemented from within the pipeline and do not involve the line being uncovered.

Pressure monitoring stations will be distributed along the pipelines to support pipeline operations and for leak protection. The monitoring stations will be powered by small, stand-alone propane-fuelled generators. The leak detection system will issue a warning and predict the location of a leak. The leak detection system will warn within 2 to 15 minutes of an occurrence. The principles of leak detection involve a comparison of flow rates, line pressures and densities along the pipeline based on a flow regime in the line and position of the pipeline valves.

Isolation valves will not be installed along the concentrate line. Experience elsewhere has shown that isolation valves in concentrate slurry pipelines disturb the flow pattern of the slurry, causing extensive scouring and abrasion and leading to pipe failures.

The pipeline will be equipped with a full cathode protection system supplementing the external corrosion protection pipe coating. The system will consist of rectifiers at each pump station and at the terminus of the line. Sacrificial anodes will be used to supplement the anti-corrosion system. The pipeline will be insulated at creek and river crossings. Buried sections of the line will not require insulation.

The SCADA system software will provide monitoring status of the pipeline and pumping systems and will enable rapid controlled shutdowns in the event of a line break.

A drain-out (approximately 1,200 m^3 internally supported) covered tank will be constructed at the low point of the pipeline near km 116 of the access road to provide an emergency drain point in case the concentrate pipeline must be shut down. The tank will be capable of containing the drainable capacity of the pipeline between the Scotsimpson Creek and Sphaler/More creeks divide. In an emergency, NovaGold will tap into the pipeline with a tie-in isolated by a high-pressure ball valve to drain the pipeline into the tank. Any concentrate drained to the sump will be recovered by vacuum pumping at a later date. Figure 8.5-3 shows the conceptual concentrate low-point drain in both plan and sectional views.

A number of methods are currently utilized to check the integrity of buried pipelines. One involves an internal pipeline inspection system that uses “intelligent pigs” with specific functions such as geometric surveys to measure metal loss and detect cracks or leaks. New technologies include GPS tracking systems to identify precise locations.

“Pigs” have traditionally been used to clean the insides of pipelines by forcing an appropriately sized, rough-surfaced ball down the pipeline to remove any accumulated scale from the inside pipe wall. They could be used in the concentrate slurry pipeline to ensure no buildup of material along the pipeline.

A number of risks and environmental considerations for the concentrate pipeline are listed in Table 8.5-3.

8.5.4.2 Diesel Fuel Pipeline

An ongoing supply of diesel fuel is required for the operation of the mine. Due to concerns about possible interruptions to incoming supplies, and to reduce safety and environmental concerns in transporting large quantities of diesel fuel by truck along the access road, the fuel will be pumped to site. The pumping system from the filter plant will typically transfer two deliveries of tanker trucks in B-train configurations daily.

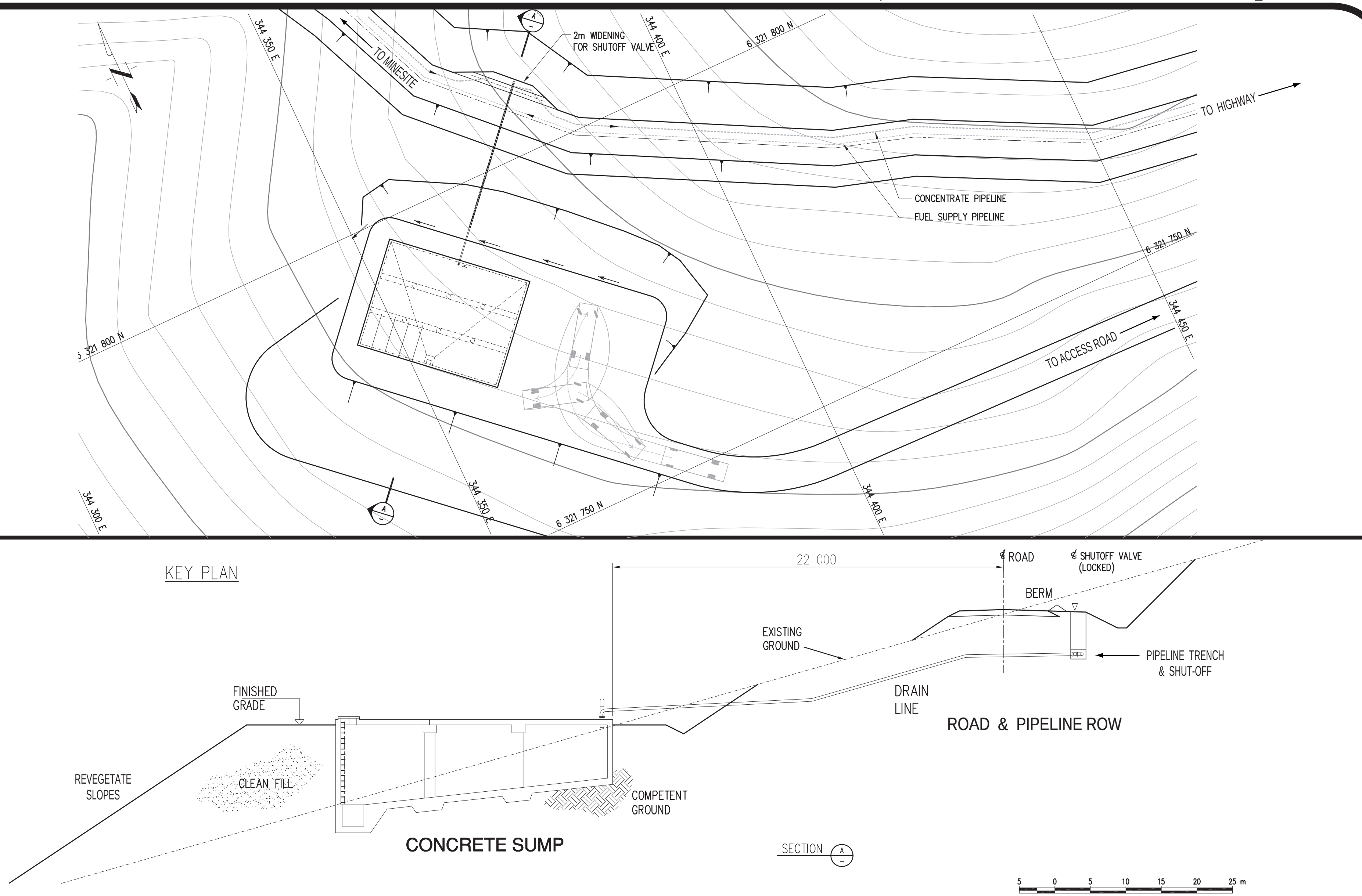
In addition, a sizable inventory of fuel will be stored on site to maintain uninterrupted operation. The size of the tanks in the main fuel farm should provide for approximately two weeks' supply of diesel fuel.

The diesel fuel pipeline has slightly different environmental management concerns than the concentrate slurry pipeline because of the higher mobility and toxic nature of the product. The primary environmental risks and considerations for the diesel pipeline are listed in Table 18.5-4.

Table 8.5-3
Concentrate Pipeline Failure Methods, Causes and Preventive Measures

Failure Method	Likely Causes	Preventive Measures
Breach along an above-grade (bridge and abutments) section with possible release to a watercourse	Failure due to failure of pipeline integrity by excess line pressure or pressure fluctuations including wear of pipeline;	Following established operating procedures that prevent excessive pressures and pressure fluctuations
		Maintenance and surveillance program
	Failure due to impact accident (hitting or puncturing pipeline)	Removing any large upstream debris to ensure no impact possible
		Well protected and labelled sections above grade in abutment areas to help avoid run-ins by vehicles including snowplows
Break along a buried section	Failure due to failure of pipeline integrity by excess line pressure or pressure fluctuations including wear of pipeline	Following established operating procedures that prevent excessive pressures or pressure fluctuations
		Maintenance and surveillance program
Plugged Line	Poor operating procedure (*e.g.*, off-spec material)	Keeping material feeding pipeline on-spec (continual monitoring)
	Extended shutdown without line drainage	Following established operating and shutdown procedures including procedures during power interruptions
	Not having cleaned out line with pig	Maintenance and surveillance program
Freezing	Extended shutdown, without line drainage	Following established operating and shutdown procedures including procedures during power interruptions

Rapid confirmation of a suspected release will be vital to enable shutting down the system, stopping the leak, containing any spilled material and minimizing any potential environmental damage. Spill response details are described in the Spill Contingency and Emergency Response Plan.



Source: Hatch & Associates

FIGURE 8.5-3

NovaGold Canada Inc.

Concentrate Pipeline Low Point Drain

Rescan™

Table 8.5-4
Diesel Pipeline Failure Methods, Causes and Preventive Measures

Failure Method	Likely Causes	Possible Preventive Measures
Breach along an above-grade (bridge and abutments) section with possible release to a watercourse	Failure due to failure of pipeline integrity by excess line pressure or pressure fluctuations including wear and tear of pipeline	Following established operating procedures that prevent excessive pressures and pressure fluctuations Maintenance and surveillance program
	Failure due to accident (hitting or puncturing pipeline)	Removing any large upstream debris to ensure no impact possible Well-protected and labelled sections above grade in abutment areas to help avoid run-ins by vehicles including snowplows
Break along a buried section	Failure due to failure of pipeline integrity by excess line pressure or pressure fluctuations including wear and tear of pipeline	Following established operating procedures that prevent excessive pressures or pressure fluctuations Maintenance and surveillance program

In British Columbia, oil and gas pipelines are regulated by the Oil and Gas Commission. Companies are required to have an Integrity Management Plan (IMP) to identify and assess activities that prevent or reduce the likelihood of incidents, as well as activities that mitigate consequences of incidents, should they occur. NovaGold will be responsible for maintaining the pipeline in a safe and reliable manner. An IMP will be prepared that is specific to the diesel pipeline. NovaGold's responsibilities will include:

- maintaining integrity and managing risks associated with pipeline systems and facility operations
- establishing procedures for informing and educating communities, government agencies and first responders in the event of an incident
- establishing procedures critical to incident investigations and/or notifications.

8.5.4.3 Filter Plant Discharge Water Pipeline

Dewatering of the concentrate slurry at the filter plant will produce an effluent that will be treated within the facility before release. Details of the water treatment process, pipeline and diffuser system are currently being finalized and will be provided as part of the project permitting phase.

Discharge from the water treatment process will be piped in a buried 15 cm diameter HDPE pipeline alongside the access road for several kilometres from the filter plant site. The discharge water pipeline will then follow an access road grading down to the Iskut River shoreline at a depth of approximately 1 m. A diffuser system at the discharge point into the Iskut River will maximize the mixing of the discharge water with flow coming down the river. The anticipated discharge rate is 16.5 to 25 L/s depending on whether the discharge consists of pipeline flush water or treated filtrate from the slurry. A site for the discharge has been identified in a relatively straight and narrow reach of the river approximately 5 km upstream of the confluence of the Iskut River and More Creek and 2 km downtream of the Iskut River Hot Springs.

The treated effluent pipeline, access road and discharge location are shown in Figure 8.5-4. The treated filter plant effluent discharge point is advantageous from several perspectives:

- It is a relatively high-velocity reach of the river and thus provides good mixing. There is no need to extend the pipeline downstream of the junction with More Creek because the flows in the Iskut River are always sufficient to mix with the incoming treated effluent water.
- The narrow reach of the Iskut River is less important for fish than areas downstream because the bottom materials are less suitable for spawning.
- The proposed discharge location is closer to the filter plant and requires a shorter pipeline.
- Access is relatively easy, providing a feasible route for the pipeline and access road.

The selected diffuser design achieves maximum dilution in close proximity to the discharge ports and will provide dilution in excess of that required to meet water quality criteria. The diffuser will be constructed of steel and will be installed below the streambed. It will be situated within the low-flow channel width and span less than one-half the low flow channel width. A single-port diffuser (a simple pipe) will achieve dilutions in excess of the required 120:1 within about 22 m of the discharge point at low-flow conditions in the river.

Pipeline operation, maintenance and surveillance programs for the system will be developed during detailed design and as part of the permitting process.

General spill response considerations are provided in the Spill Contingency and Emergency Response Plan. This plan will continue to be refined and updated through all phases of the project.

8.5.5 Environmental Training and Awareness

Having adequately trained personnel is vital for the successful operation of the pipelines in the long term. NovaGold will develop a comprehensive environmental training and awareness program for the Galore Creek Project that will include pipeline operation and maintenance. As part of this program, detailed site-specific training will be provided to all employees, contractors and others using the access road during the construction and operation phases. Additional training will be provided for all persons working along the pipeline. This will include details of the pipelines operating and maintenance manuals and components such as wildlife management, materials management, contingency plans, spill protection, avalanche control, emergency response, fire and rescue. Some of these plans will be covered in greater detail in other management plans as part of the operations-phase environmental management system.

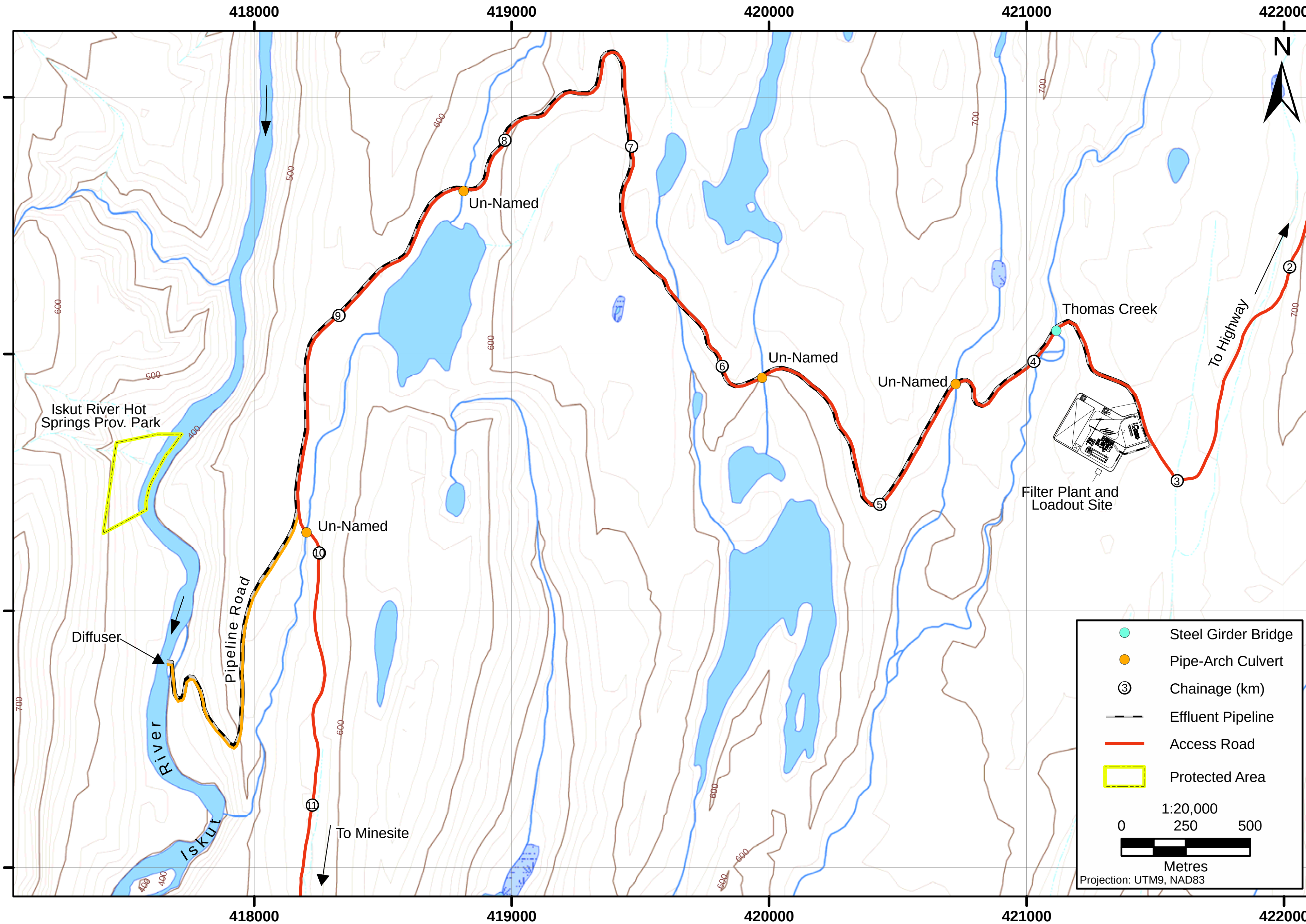


FIGURE 8.5-4

NovaGold Canada Inc.

Effluent Pipeline Route and Discharge Location

Rescan™

8.6 Filter Plant and Concentrate Loadout Environmental Management Plan

8.6.1 Introduction

The concentrate pipeline from the process plant will terminate at a filter plant where the concentrate slurry will be dewatered to produce a concentrate with 8% to 10% water ready for shipment to the port at Stewart by truck. The filter plant and truck loadout site will be located approximately 3 km from Highway 37 on the mine access road, about 135 km from the mine. It will consist of the following facilities:

- filter plant building housing equipment for dewatering the concentrate from the pipeline, a system to treat slurry and flush water from the pipeline prior to release, and equipment to provide required services
- covered concentrate storage area with truck loadout and weighing facilities
- diesel fuel unloading, storage and pumping system
- an accommodations complex for about 30 plant workers and related personnel.

This environmental management plan (EMP) deals with the filter plant and truck loadout site. Associated plans include:

- Pipelines EMP for concentrate and fuel pipelines
- Access Road EMP for the access corridor.

8.6.2 Regulatory Considerations

The filter plant component was an addition to the overall project scope under the B.C. Environmental Assessment process after NovaGold decided to construct a concentrate pipeline from the mine site along the access road to a location close to the highway. The scope was modified again after it was decided to also construct a diesel fuel pipeline along the same pipeline corridor.

Water removed from the concentrate slurry must be treated to remove suspended solids and dissolved metals prior to being discharged into the nearby Iskut River. Water quality for this discharge will meet Canadian Council of Ministers of the Environment (CCME) criteria in the receiving environment. The receiving environment will be at a prescribed location in the Iskut River downstream of the diffuser where plant effluent will enter the river.

Any alteration of fish habitat will require authorizations from Department of Fisheries and Oceans under Section 35(2) of the *Fisheries Act*. This authorization will include development of the plant site if construction in some areas may cause a harmful alteration, disruption or destruction (HADD) of fish habitat. The project will follow the decision framework developed by DFO for the determination and authorization of HADD of fish habitat. Compensation "in kind" for the loss of fish habitat will be a last-resort measure after all design modifications and mitigation measures have been demonstrated to be "not possible." The EA and support documents will provide a significant amount of information to assist in the preparation of any authorizations that may be required.

8.6.3 Filter Plant Considerations in the LRMP

The project lies within the asserted traditional territory of the Tahltan Nation.

The Cassiar Iskut-Stikine Land and Resource Management Plan (LRMP) was prepared to address management of the lands, which include the project area. The LRMP specifically permits mining activities and related infrastructure in all areas excluding protected areas. The area selected for the filter plant is not a protected area.

Land uses in the project area are described in various sections of the Environmental Impact Assessment Report and support documents.

8.6.4 Site Description

Access to the filter plant site from the east will be along the upgraded Devil Creek Forest Road from Highway 37. The rest of the mine access road will be to the west of the filter plant site, continuing on to the mine area and other facilities along the road corridor. The filter plant site will be immediately adjacent to the access road and will cover an area of approximately 27 ha (net of road). Main features at the site will include:

- a facility to dewater concentrate slurry delivered by pipeline from the mine site. This facility will include a concentrate stock tank, two pressure filters, conveyors, concentrate loadout bin and covered concentrate stockpile.
- equipment to treat concentrate slurry and flush water, including a filtrate thickener, reactor clarifier, sand filters, cartridge filters, carbon filters, pH control, effluent tank and associated reagent systems. The treated effluent will be pumped via a buried pipeline for discharge into the Iskut River utilizing a diffuser buried below the riverbed.
- diesel fuel unloading, storage and pumping system for transferring fuel from incoming tanker trucks into the pipeline to the mine site. This facility includes an above-ground fuel storage tank, fuel pumphouse and containment area.
- laydown area (80 m x 180 m)
- accommodation complex including vehicle parking area
- maintenance yard with road service equipment
- jet fuel storage tank
- snow-clearing area (25 m x 25 m)
- electrical components, including transmission line from Bob Quinn substation, electrical substation adjacent to the filter plant site and a diesel-powered emergency generator
- access control to filter plant site and mine access road from an adjoining gatehouse. A truck weigh scale will be located immediately inside the site gate

The entire site will be fenced for security purposes and for wildlife management. Access to the site will be through a manned gate. A gatehouse at the plant site will control traffic on and off the filter plant site as well as onto the mine access road.

A conceptual layout drawing of the site is provided in Figure 8.6-1.

8.6.5 Design Basis and Design Criteria

8.6.5.1 Filter Plant

The filter plant has been designed to dewater the concentrate slurry and treat all water received at the plant site through the slurry pipeline, producing concentrate for trucking to a deep-water port and a clean effluent for discharge. The peak throughput will be about 2,000 dry t/d with normal operations processing about 25,000 tonnes per month. The slurry will arrive at the plant at about 56% solids by weight. Flush water will be pumped through the pipeline between batches of concentrate slurry to keep the line charged and any contained solids moving.

8.6.5.2 Loadout Plant

The truck loading system will be designed to enable the transfer of concentrate from the loadout hopper into the truck trailers with the minimum amount of loss due to spillage and dusting. The flowsheet accommodates surges in production (or delays in trucking concentrate) by allowing the loadout bin to be fed directly from the filter presses or by front-end loader from the covered stockpile area.

8.6.5.3 Water Treatment Plant

Design criteria for the water treatment process are provided in a report proposing a conceptual process (Appendix 5-H).

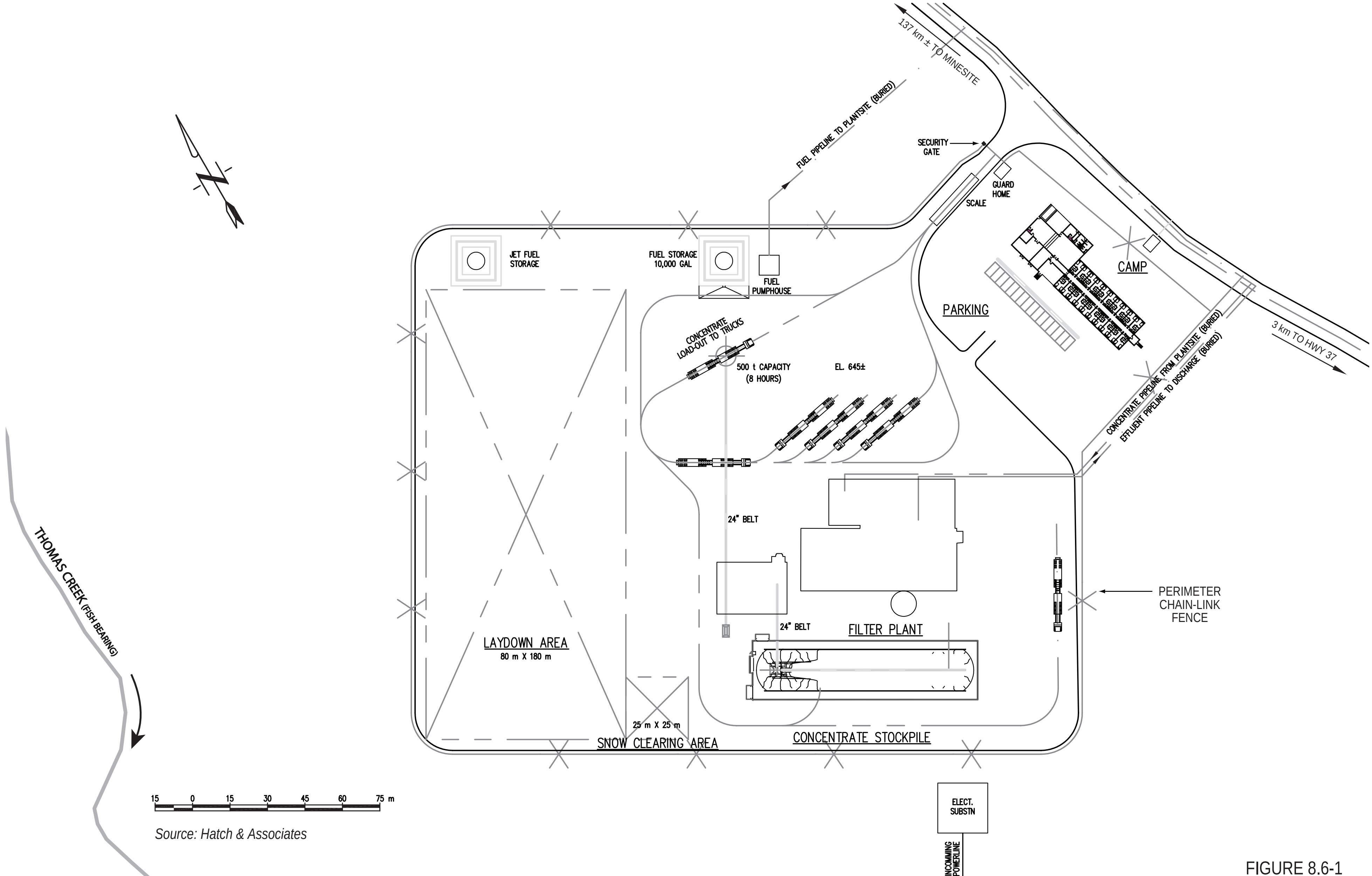
The process will remove solids and dissolved metals to comply with Provincial and Federal environmental regulations. Provincial and federal (Canadian Council of Ministers of Environment) guidelines set a limit of 0.002 mg/L total copper concentration in the receiving water downstream of the discharge point. The federal Metal Mine Effluent Regulation (MMER) limit for discharge water quality is 0.3 mg/L total copper, whereas the Provincial objectives require that the discharge water dissolved copper concentration must not exceed 0.05 mg/L.

The design flow rate of slurry arriving at the filter plant will be just under 90 m^3/h, of which about 70 m^3/h is the liquid fraction. The concentrate solids are 80% finer than 35 μm and have a specific gravity of 4.2.

8.6.5.4 Risk Management

A number of risks with possible adverse environmental effects have been identified. These risks include:

- a break in one or more of the pipelines causing material release



Source: Hatch & Associates

FIGURE 8.6-1

NovaGold Canada Inc.

Filter Plant and Loadout Facility – Conceptual Site Layout

Rescan™

- the need for additional concentrate storage due to lack of downstream capacity (at Stewart bulk terminal and off-shore)
- effluent water quality not meeting discharge or downstream criteria

Additional risks related to winter operation are discussed later in this plan, in Section 8.6.5.7.

8.6.6 Main Features and Environmental Considerations

8.6.6.1 Overview

The plant site is 3 km from Highway 37 along the Devil Creek Forest Road, which will become the beginning of the Galore Creek access road. This location close to the highway will enable the filter plant site to become rapidly established as the first base of operations for subsequent construction of the access road. Major earthworks and road building equipment will be mobilized from this site. The site area is relatively flat, especially compared to other areas of the access corridor. However, there are nearby streams, flora and fauna that must be protected.

During operations, the site will be the gateway to the access road and the main Galore Creek mine site. The vast majority of freight and materials for the project will travel through the filter plant site. Where significant volumes of material will be loaded (concentrate) and unloaded (diesel fuel).

8.6.6.2 Construction Phase

The area will be stripped of vegetation and trees for construction of the facilities required to establish the site as a major staging and construction camp site for development of the access road. Fill materials will be sourced from borrow sources nearby.

Construction Schedule Overview

Basic facilities will be established immediately at the site to enable road construction beyond the end of the current forest road. Construction of the mine access road will initially be from a limited number of staging areas because of the lack of access for bringing in heavy equipment and materials.

The following sequence of construction tasks at the filter plant site is envisioned:

- upgrading the forest road to filter plant site
- clearing the filter plant site
- constructing facilities at the filter plant site, especially those required for access road construction activities west of the filter plant, including camp facilities, temporary power supply, appropriately lined laydown and storage areas, *etc.*
- establishing the filter plant site as a major staging area for access road construction work
- constructing the filter plant, loadout system, fuel unloading and water treatment facilities required for mine operations phase.

Construction Methodology

The final design of the site will attempt to balance material requirements to minimize new excavation and wasting of construction materials. All excavated surface soils and organic matter will be retained for reclamation purposes. Any wetland soils may also be considered for recovery (while frozen, if necessary).

Site Clearing

Preparation of the site will involve felling trees and grubbing and stripping stumps, roots and downed logs. These materials will be removed to strategically located spoil/waste piles. Salvageable organic material will be set aside for later use in reclamation.

Development as a Major Staging Area

The site will initially be developed as a staging area for construction of the access road. Some borrow and rock sources may be required for site preparation and later facility construction. A borrow area has been identified along the access road just over a kilometre away (at km 2.1). A closer source may be found during detailed site reconnaissance. The access road construction is discussed in Section 8.15, Access Road Environmental Management Plan.

Wildlife Considerations

The presence of work camps and human activity could cause wildlife disruption during construction. To reduce the effects on wildlife, access to the construction area will be restricted and controlled from a manned gate at the filter plant. Detailed plans for minimizing the effects of construction on area wildlife are discussed in Section 8.13, Wildlife and Wildlife Habitat Management Plan.

Filter Plant Site Construction

The filter plant will not treat concentrate slurry until the mine and mill are operational. However, the diesel fuel unloading system will be required sooner to permit the use of diesel-powered equipment during mine development work.

The filter plant and loadout facilities will be constructed during the overall project construction phase. An itemized timeline for construction of the components will be developed during detailed design.

Water Management

The site is located a short distance away from Thomas Creek, which has been identified as a fish-bearing stream based on environmental baseline sampling in 2004 and 2005 (Rescan 2005). The following measures will be employed for environmental protection during site construction:

- silt fencing around perimeter of site during entire construction phase
- silt traps at inlets to any culverts discharging into fish-bearing streams
- straw or coconut matting placed on slopes susceptible to surface erosion

- geotextile fabric and clean shot-rock placed in bottom of ditches and on potentially unstable cut banks
- French drains to intercept any subsurface flow
- environmental monitoring of runoff from the site area
- additional measures based on site-specific conditions and as prescribed by supervising professional or environmental coordinator.

Transmission Line

An electrical transmission line will be constructed to the filter plant site. A separate line will follow the access corridor west of the plant site to supply the mine, with a spur line to supply the Porcupine aerodrome.

The transmission line to the filter plant site will likely be constructed first to reduce the dependency of the camp and staging area on a diesel-powered electrical supply. This section sis also relatively short and only partially follows the highway corridor, whereas the bulk of the transmission line to the mine will parallel the access road and will therefore be constructed along with (but slightly behind) the road.

Tree removal will be required along the transmission line right-of-way to ensure falling trees cannot damage the line conductors. Generally, this requirement results in clearing widths falling outside the right-of-way boundaries. Appropriate permitting and permissions from the Ministry of Forests in the form of a “Licence to Cut” will be required prior to removal of any trees.

Clearing of the right-of-way will probably involve both machinery and handheld equipment. Environmental considerations may dictate the method used. The clearing of vegetation along the transmission line and nearby road rights-of-way will cause habitat alteration and/or loss, and wildlife will have increased interaction with the human activities. Clearing the vegetation in winter when the ground is frozen could reduce rutting and damage to the land surface, and the snow cover could also minimize impact on low-growing vegetation.

Section 8.15, the Access Road Environmental Management Plan, provides additional information on the environmental management plans for facilities along the access corridor, including the transmission line.

8.6.6.3 Operations Phase

The main features of the operating filter plant and loadout site will include a concentrate stock tank, pressure filters, covered concentrate storage area and loadout system, several unit operations for the treatment of the water produced during concentrate dewatering, and facilities for the unloading of diesel fuel trucks and pumping fuel to the mine site. The site will also contain a large laydown area for materials being readied for transport to and received from the mine site along the access road.

Some of the environmental considerations during operation of the filter plant site include:

- wildlife disruption from the presence of plant facilities and human activity, including camp, noise from trucks, traffic and process equipment
- spillage of dangerous materials, especially concentrate or diesel fuel, from trucks and fixed facilities including pipelines and site facilities
- runoff from snow-clearing area being contaminated with road salt and fines that could leave the site and enter the adjacent environment.

Effectiveness of the mitigation measures will be monitored according to an ongoing program, with the provision for additional mitigation strategies to be adapted where appropriate.

Concentrate Filtration

The filter plant will dewater the concentrate slurry received in the pipeline from the mine site. The process will involve several unit operations, including pressure filters that will effectively squeeze the water out of the slurry and produce a "filter cake" of 8% to 10% moisture. Unlike conventional driers used elsewhere to dry mineral concentrates, the filter process involves no stack discharge and possible airborne emissions. The basic process steps for dewatering the concentrate and placing it into the stockpiles for truck-loading are shown in Figure 8.6-2.

Water Treatment and Discharge

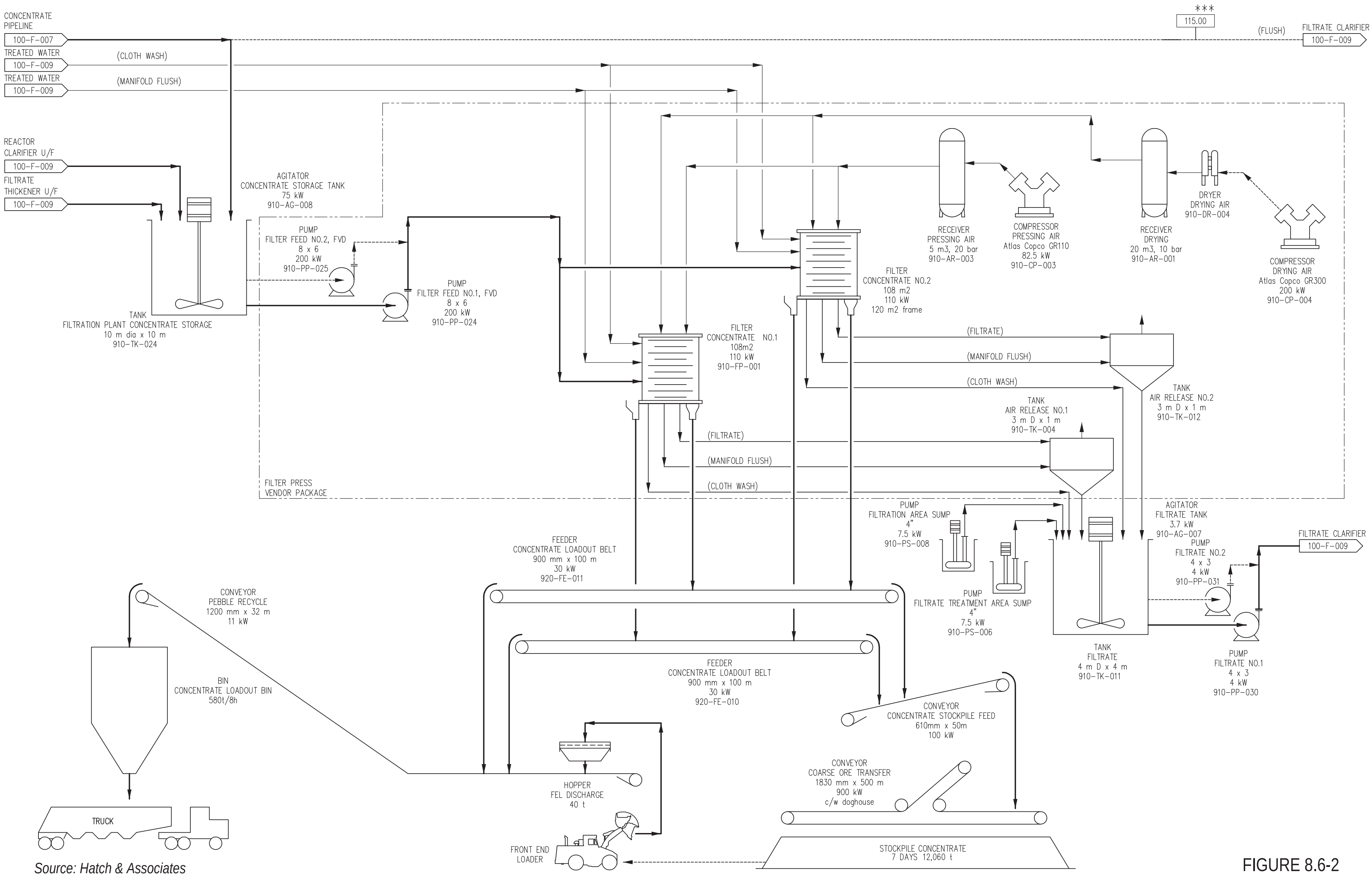
The water treatment process will be required to capture the vast majority of solids from the liquid. Even minute amounts (~0.5 to 1.0 mg/L) of suspended concentrate solids (containing ~30% copper) will result in 0.15 to 0.30 mg/L total copper concentration in the effluent. Effluent water quality will be required to meet two environmental criteria, one regarding receiving water quality in the Iskut River and the other regarding discharge "end of pipe" water quality. Federal MMER limits for discharge water quality are for total copper, whereas provincial objectives are for dissolved copper. The final water treatment design will model both total and dissolved copper to ensure all water quality requirements are fulfilled.

Typically, 55% of the discharged water will have originated from the liquid fraction of the treated concentrate slurry and 45% from freshwater flushing of the line between concentrate slurry batches. For process design, it was assumed that 100% of the concentrate slurry would be treated as a safety provision. The process will therefore involve several stages of progressively finer filtration of the effluent water to remove particulate matter. The filtrate from the pressure filters will be pumped to a clarifier thickener, then a sand filter and finally through a cartridge filter. Figure 8.6-3 provides a flowsheet of the water treatment process.

The filtrate will be neutralized to meet the Provincial discharge water quality pH criteria. This will involve the use of sulphuric acid and a metering pump controlled by a feedback pH control system. Residual organic compounds from mill flotation reagents will be removed with activated carbon filtration. Depending on loadings, carbon may be regenerated on site.

The treated effluent will be transferred from the filter plant site through a buried 15 cm diameter HDPE pipeline to a diffuser at the Iskut River. The pipeline will initially parallel the other two pipelines along the access road and then branch off to the discharge location.

ai no. a12113w-ch11 Job No. 762-1 04/01/2006-11:00am Res_AP

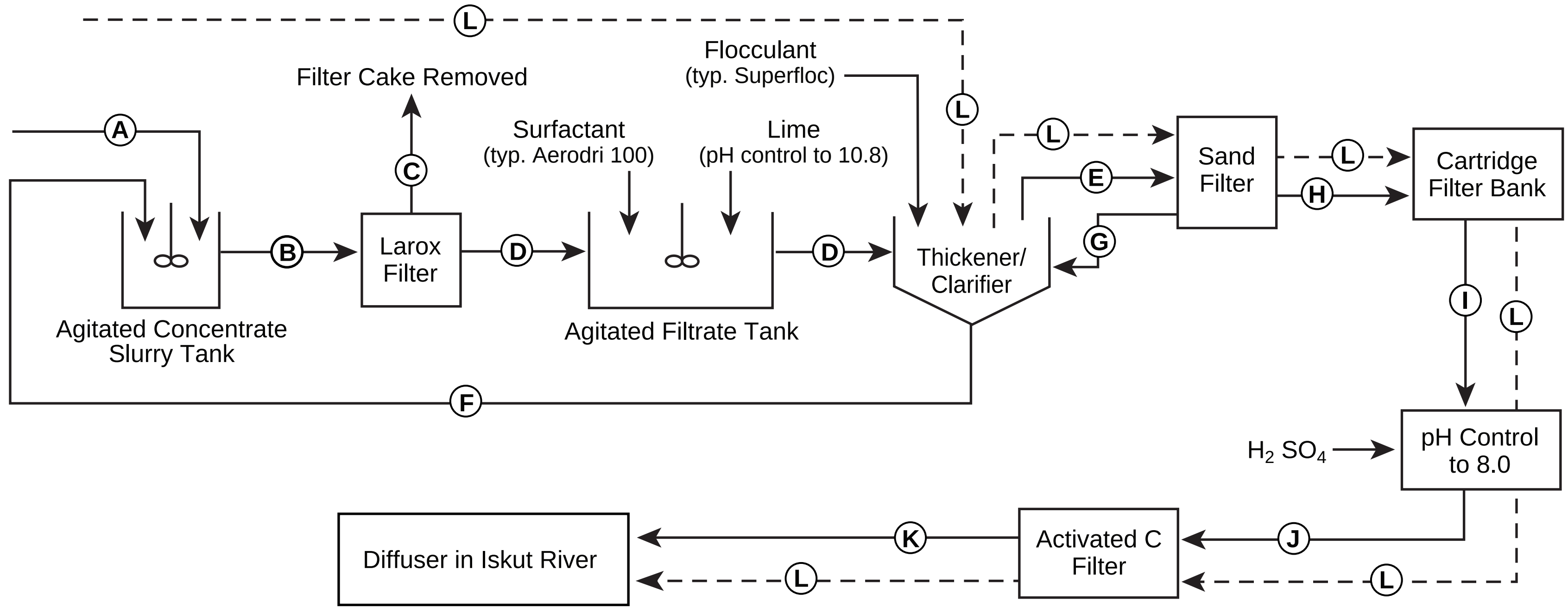


Source: Hatch & Associates

FIGURE 8.6-2

NovaGold Canada Inc.

Concentrate Filtration Flowsheet



Galore Filtrate Water Treatment Circuit

Stream	A	B	C	D	E	F	G	H	I	J	K	L (Clear Water)
Solids (tph)	***87.69***	94.89	87.69	***7.20***	0.00296	7.20	0.00296	0.000296	0	0	0	0
Liquid (m^3/h)	68.97	74.63	9.75	64.88	59.24	5.66	***0.03***	59.22	59.22	59.22	59.22	89.85
Solids w/w	***56%***	56%	***90%***	***10%***	***0.005%***	56%	***10%***	***0.0005%***	0	0	0	0
Pulp tph	156.59	169.45	97.43	72.01	59.18	12.86	0.030	59.16	0	0	0	0
Pulp m^3/h	89.85	97.22	30.63	66.59	59.24	7.38	0.027	59.22				
Pulp SG	1.743	1.743	3.181	1.081	0.999	1.743	1.081	0.999	0.999			
Solids SG	4.2											

FIGURE 8.6-3

Filter Plant Process Flow Diagram

NovaGold Canada Inc.

Rescan™

The diffuser system will enable very rapid mixing of the plant effluent with river water flowing past it. The location of the effluent pipeline and the discharge point into the Iskut River are shown in Figure 8.6-4. The site is approximately 5 km upstream of the confluence of the Iskut River and More Creek and 2 km downstream of the Iskut River Hot Springs. The site selected for the diffuser system was found to have the following advantages:

- high velocity at this section of the river, providing good vertical mixing
- less important location for fish habitat than further downstream
- close proximity to filter plant, requiring a shorter pipeline
- relatively easy access, enabling a feasible route for the pipeline and related access road.

The steel diffuser will extend across one-half of the low-flow river width. The length, number and size of ports provide the required dilution within the specified distance at low-flow condition.

The flow rate through the system will be approximately 90 m^3/h during slurry pipeline flushing and 59 m^3/h during periods when treated effluent from the concentrate slurry is being discharged. The treated effluent will need to be diluted by approximately 85:1 to 125:1 with pure water to achieve the receiving water quality criteria of 0.002 mg/L total copper. However, natural Iskut River total copper concentrations vary between 0.0006 mg/L in February and a high of 0.018 mg/L during freshet (*i.e.*, above criteria). Typical dilution will be 256:1 within 25 m of the diffuser in average flow conditions. A dilution of 144:1 will be attained within 7 m of the diffuser at annual low flow conditions, in excess of the 120:1 target. The target dilution (120:1) is based on the effluent containing 0.17 mg/L total copper. A dilution level of 175:1 is required for an effluent at 0.25 mg/L.

8.6.6.4 Pipeline Management Plan

The three pipelines connected to the plant will require routine monitoring and maintenance. A documented and comprehensive program will be prepared during detailed design, prior to construction. Additional details on the pipelines and proposed management issues can be found in Pipelines Environmental Management Plan.

8.6.6.5 Erosion Control

The filter plant site will be flat and will have minimal erosion potential apart from runoff. The site will be largely unpaved, and there is some potential for minor erosion of material from the plant site pad bank, which will be slightly above the adjacent natural topography. Therefore, the perimeter bank will be stabilized using appropriate methods.

8.6.6.6 Sediment and Dust Control

The nearest watercourse, Thomas Creek, is approximately 120 m west of the site. Primary sources for dust and the potential for it to enter local waters include:

- conveyor discharge into the covered outside stockpile gis no. 762-1-109 Job No. 762-1 March 21, 2006

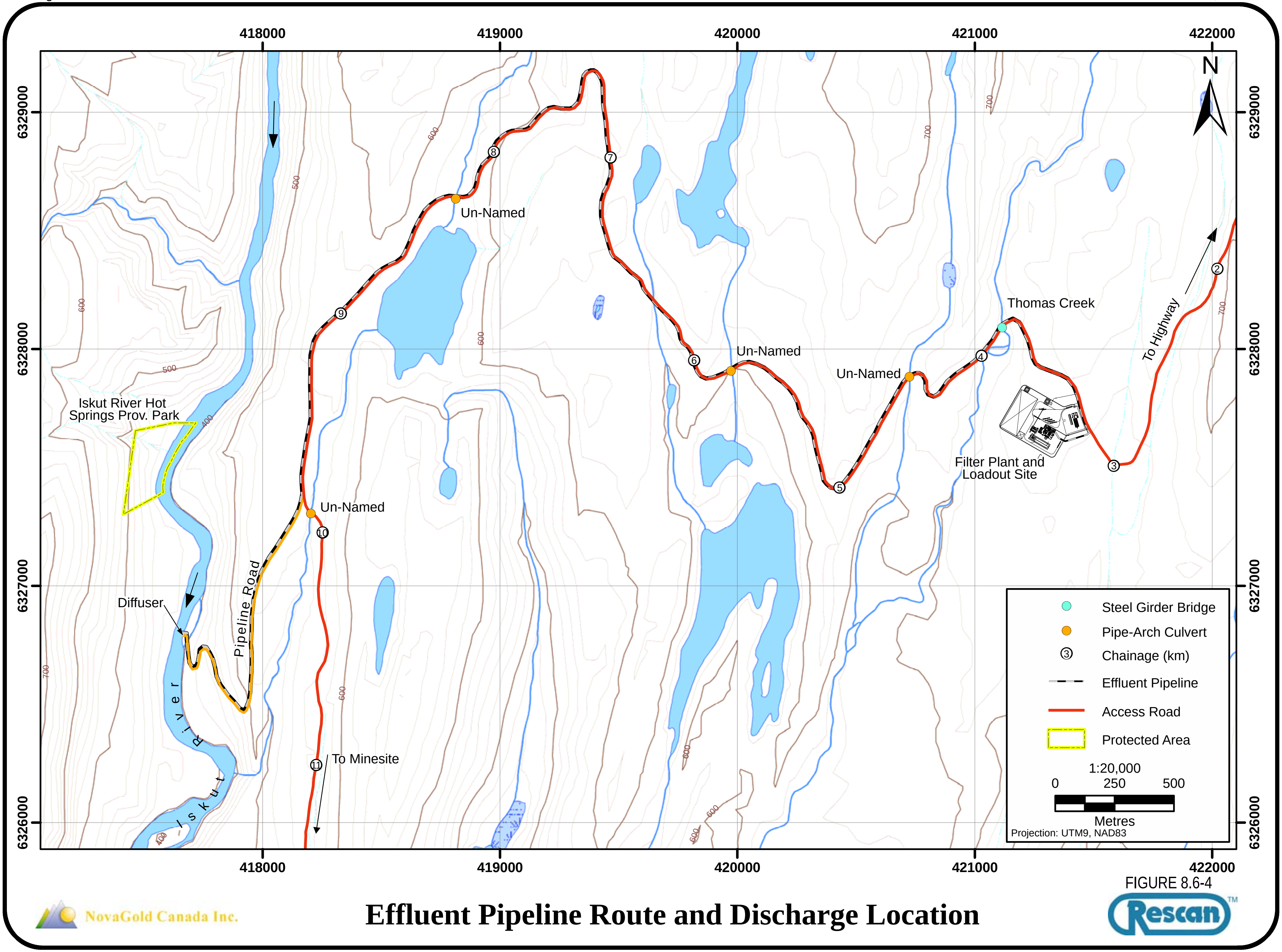


FIGURE 8.6-4

Effluent Pipeline Route and Discharge Location

- loadout bin discharge into highway trucks
- heavy equipment (*i.e.*, front-end loader) moving concentrate from the stockpile area into the loadout hopper, which will then be conveyed into the truck loadout bin
- spillage of material falling off the trucks onto the pad area during loading.

Runoff from Plant Site Surface

The site will be flat, and any runoff from ground surface will be managed through design and ongoing operating procedures. The design includes containment of facilities and paving the areas most vulnerable to being sources of surface water contamination. The perimeter slopes of the pad area will be stabilized, and plant site runoff will be collected and passed through a small sedimentation pond system to trap any fine materials prior to release to the environment.

Facility containments will include pumpback systems. Containments will be provided for the filter plant and concentrate handling systems and the diesel fuel handling and storage facilities. Any other hazardous goods stored in the storage area will have appropriate containment systems.

Any watercourses passing nearby the toe of the plant site pad will be evaluated for installation of additional sediment retention measures (*e.g.*, silt fencing, check dams, *etc*.).

Concentrate Loadout Facility Dust Management

The dried concentrate at the filter plant site is vulnerable to dusting. Dust control measures will include:

- enclosure (roof and partial walls) over main concentrate stockpile
- use of a flexible fabric tube to minimize dusting during discharging material from conveyor discharges onto the stockpile into the concentrate trucks
- a truck wash station for concentrate trucks after loading and prior to entering the roadway
- a concrete pad complete with truck wash and a sump system for the truck load out area, with recycle of sump waters back to the filter plant
- a truck wash station to clean concentrate trucks of any surface dust and dirt prior to being released on the road leading to the highway and the trip to Stewart to unload concentrates. Such systems have been found effective in limiting the spread of concentrate fines beyond a loadout facility. A similar facility will be in place at the Stewart shiploading facility, so that trucks can be cleaned after unloading the concentrate and before to making the return trip.
- tarpaulin or composite covers on concentrate trucks and trailers to reduce loss of concentrate due to dusting while underway.

Road Dust Suppression

Dust generated by moving vehicles will be managed by enforcing speed limits and the use of dust suppressants such as water. Dust suppression will include non-paved areas where vehicles will be loaded, unloaded and parked. The filter plant site will have a low speed limit consistent with it being a work area.

A road dust suppression plan will be prepared to describe the procedures to ensure minimal dusting from the roads and other non-paved areas. It will include watering and other dust reduction technologies to be used on the access road and all site roads, including haul roads. At this time, water is envisioned to be the primary dust suppressant.

8.6.6.7 Winter Operation

Freezing temperatures could increase the likelihood of several failure mechanisms, with possible adverse effects including:

- increased risk of material spillage due to higher motor vehicle accident rates. Accidents should not be an issue at the plant site due to the small area and prescribed slow speeds through the site area.
- risk of frozen slurry pipeline causing pipe failure and release of material. This risk will be reduced by the design of the installed system and through appropriate management plans (see Section 8.5, Pipelines Environmental Management Plan).
- spills of products used at the plant site, including dewatering and water treatment reagents handled outdoors. These risks will be managed by following appropriate procedures.

Environmental management plans associated with the access road are provided in the Access Road EMP. The risk of winter road travel can be significantly reduced through diligent maintenance of road surfaces, including the timely removal of snow and the appropriate placement of traction aids. However, the use of traction aids on roads (especially salt and sand) can lead to resultant environmental concerns, including:

- potential impacts of road salt and siltation on water quality and the environment
- snow-dumping procedures needing to consider environmentally sensitive areas
- Possible animal-vehicle contact as a result of animal attraction to the salt-laden snow along the roadside.

These concerns will be managed through the control of runoff from areas used by vehicles such as the filter plant site, roads and roadside ditches by means of buffer zones and sediment control measures.

A winter road maintenance management plan will be prepared to document procedures to be used on roads and vehicle areas in the winter. It will include a section on snow removal and designated sites for snow disposal. These sites will be strategically located; selection criteria will include any possible adverse effects of melting snow on adjacent watercourses and salt acting as a wildlife attractant. A designated part of the filter plant site will likely be established as a snow storage area.

NovaGold will employ best management practices including appropriate material selection, application and cleanup procedures. For example, use of road salt will involve careful placement of salt at variable application rates depending on conditions and locations, pre-wetting, use of more sanding and ploughing, advanced equipment, *etc*. Updated procedures, traction aid alternatives and other components will be considered as they become available and will be incorporated in the winter road maintenance management plan.

8.6.6.8 Wildlife Considerations

Some of the potential adverse wildlife effects of the filter plant site include:

- habitat alteration and loss from increased interaction with human activities
- bird collisions
- bird electrocutions.

Detailed plans for minimizing the effects of the operation on area wildlife are discussed in Section 8.13, Wildlife and Wildlife Habitat Management Plan.

8.6.7 Closure and Post-Closure Phases

The facilities at the filter plant site will be required during site closure and decommissioning. Once the work is completed and only long-term monitoring and maintenance remain, the road will be removed and the tunnel closed. Road closure will include removal of all associated structures such as bridges and culverts as well as the transmission line. As a minimum, buried pipelines will be flushed and the ends capped. It is anticipated that the access road and tunnel will be required for post-closure activities to enable completion of the closure and decommissioning plan. Subsequent travel to the site will be by helicopter.

The water treatment process will continue until untreated water can be discharged directly. Ultimately there will be no effluent requiring discharge.

The site will be cleaned of any contaminated soils due to spillage of concentrate, fuels or other materials.

Long-term natural drainage will be restored by contouring the site, removing culverts and ditches and grading to match the local topography wherever possible.

The site will be reseeded with vegetation to establish an early seral stage that mimics a natural disturbance, especially in areas where structure removal leaves bare soils and in areas prone to soil erosion. Natural succession will then be allowed to re-establish habitats. Monitoring will be undertaken for invasive species at the filter plant site, along with other areas of the access road, transmission line and other facilities.

8.6.8 Access Control

Access to the filter plant site will be controlled from a manned gatehouse. The gatehouse will be constructed early in the construction phase and will remain in operation through the life of the mine and into the post-closure period. The gatehouse will be manned 24 hours per day, 7 days per week.

Access to the mine access road beyond the filter plant site will be controlled with a gate. Controlled access has a number of benefits, including security, safety for road users and protection of the natural environment along the access road.

The entire length of the mine access road beyond the filter plant site will be considered to be a single-lane road. All vehicular traffic using the road will be controlled using two-way radio communications coordinated by gatehouse/site security at the filter plant.

8.7 ML/ARD Prediction and Prevention Management Plan

8.7.1 Prediction Program

The objectives of the ML/ARD Prediction and Prevention Plan (ML/ARD PPP) will be to:

- collect data to provide ongoing evaluation of the criteria used for waste management planning prior to mining
- direct management of waste materials during mining
- maintain an inventory of waste materials for future evaluation of performance of the various waste facilities
- specify monitoring to evaluate water quality predictions, update the overall water and load balance for the site and provide input into considerations of long term water quality effects.

The ML/ARD PPP covers all types of geological materials and wastes that will be produced during construction and mining. These materials include:

- waste rock produced by access tunnel excavation
- waste rock developed prior to mining to provide fill materials for facilities, particularly the impoundment dam
- mine area overburden
- oxide waste
- waste rock
- tailings.

Section 8.7-2 describes general methods used to monitor and manage wastes. The subsequent sections describe the program for each component.

8.7.2 Methods

8.7.2.1 Waste Delineation and Segregation

Delineation and segregation of waste types will be a central requirement for waste management at the Galore Creek Project. The methods used to segregate waste types are essentially the same as those in used at open pits throughout the world for segregation of ore and waste but with an additional degree of conservatism built in to ensure that "low reactivity" waste does not contain "high reactivity" waste. In the following sections, the definition of high and low reactivity varies depending on the facility, but all can be reduced to measures of either acid rock drainage (ARD) or metal leaching (ML) potential.

The Galore Creek Project will use state-of-the-art information technology that has been proven for more than 20 years at different mine sites worldwide. This technology is a combination of radio control systems and High Precision GPS (Global Position Systems), both linked to a central computer controlled by a dispatch operator. Accurate and timely information permits mine operators to make confident decisions by monitoring, controlling and managing mining equipment in real-time.

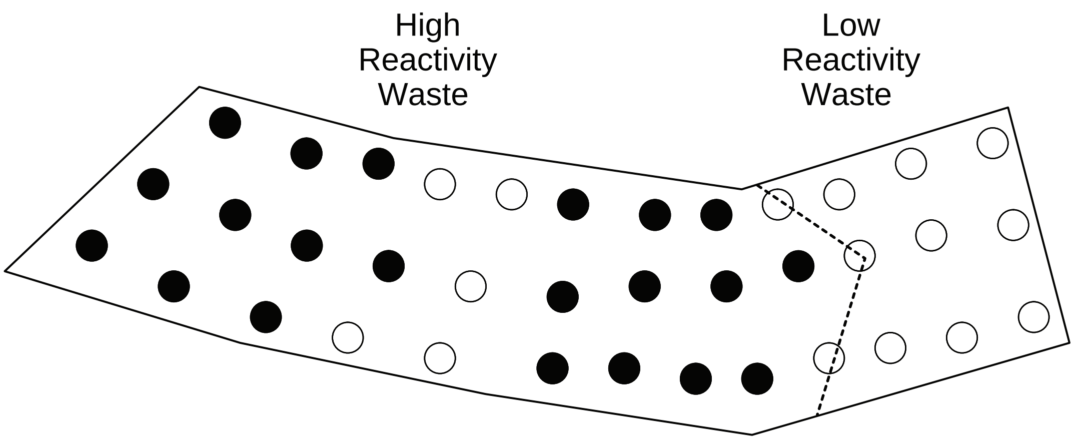
In general, the following steps will be followed to segregate waste at an operational scale:

- Blast holes will be drilled in preparation for blasting. Locations of the blast holes will be surveyed by GPS.
- Blast hole chips will be collected using the same sampling techniques used to obtain representative samples for ore assays.
- The blast hole samples will be tested on-site for the parameters indicated for each facility in the following sections.
- The results obtained will be used to calculate dig limits.
- The dig limits will be communicated to pit operations.
- The blast will be fired.
- Daily mine plans will be transferred to shovel operators via radio. The digging ore boundaries will be displayed to the operator on a full-color, GPS-driven graphic display. The system eliminates the use of field stakes, which are sometimes hard for the shovel operators to see. This also eliminates mis-directed loads and insures that the right material is loaded every time.
- Waste rock will be loaded into waiting haul trucks. Truck-dispatching systems will optimize haul truck assignments to increase the productivity and efficiency of the haul fleet. These systems have proven to be a key part of mine operations because they monitor material movement and type and alert operators and planners of any mis-routing to ensure that material is moved to the proper location.
- Disposal locations will be monitored to ensure that wastes are appropriately dumped.

While ore dilution is an accepted practice during open pit mining, dilution of low reactivity waste with high reactivity waste will be minimized because of the possible deleterious effects of mis-classification on the overall geochemical performance of low reactivity waste disposal areas.

In blasts showing both high and low reactivity, conservative dig limits will be established. The general principle is illustrated in Figure 8.7-1. The figure shows results of analysis of blast holes indicating both high reactivity (black dots) and low reactivity (circles). The area of low reactivity on the right-hand side can be segregated, and the dig limits are established along the edge of the holes showing low reactivity (*i.e.*, not between the high and low reactivity holes). The five low reactivity holes in the centre of the blast cannot be safely segregated without potentially including low reactivity material.

Any adjacent blast hole results are used in the design of dig limits. For example, in Figure 8.7-1, the results from a previous blast on either side of the blast shown would be used.



Note: The black dots are blast holes showing high reactivity, and the circles are blast holes showing low reactivity.

Source: SRK Consulting

General Principle Used to Establish Dig Limits in a Blast Containing High and Low Reactivity Waste

FIGURE 8.7-1

8.7.2.2 Analytical Methods

Analytical methods include routine procedures for on-site testing for waste management, off-site confirmatory analyses and non-routine procedures.

Routine On-Site Procedures and Off-Site Confirmatory Analysis

The following procedures will form part of the routine analyses:

- rinse pH (Price, 1998)
- sulphur as sulphide determined by Leco furnace on a rock firstly leached with hydrochloric acid to remove sulphate (MEND, 1991)
- modified neutralization potential (MEND, 1991)
- net acid generation (NAG) test.

During the start-up phase of the laboratory, all samples will be re-analyzed off-site to confirm that the on-site laboratory is providing reliable analytical results. Once the off-site testing confirms that the on-site laboratory is achieving acceptable levels of precision and accuracy, the frequency of off-site analysis will decrease to 5% of samples. Further reductions may be possible depending on the performance of the on-site laboratory.

Special Procedures

The following sections include special procedures that will be performed on a less frequent or occasional basis either on-site or off-site. These procedures include:

- total sulphur by Leco furnace
- total carbon by Leco furnace
- sulphur as sulphate by HCl extraction (MEND, 1991)
- metals scan on solids
- total and sulphide copper analysis on solids
- Rietveld XRD analysis for determination of carbonate forms
- microprobe analyses of carbonate mineral grains
- optical mineralogy on thin sections
- carbonate analysis (MEND, 1991)
- water analyses: standard methods to determine pH, acidity, alkalinity, major anions and cations and regulated parameters on filtered and unfiltered samples
- shake flask extraction (Price, 1997).

The specific application of these procedures is described below.

Site-Specific Procedures

Experience at other open pit mines shows that standard methods can be performed reliably by trained analysts operating in site laboratories. In addition, it is expected that site-specific adaptations of standard methods will be developed to allow rapid turnaround of analyses to direct mine operations.

8.7.2.3 Management Criteria

In the following sections, several parameters are used to monitor potential for ARD and/or metal leaching (ML). The application of these criteria is described in the following sections, but additional general commentary is provided below.

Classification of Unweathered Materials Using NP/AP

Criteria for Materials within Impoundment Area

Potential for ARD would generally be determined by the measurement of NP/AP (or surrogates). Appendix 5-A describes development of a site-specific NP/AP criterion (1.3) based on calcium and magnesium carbonate NP. Actual permit conditions will specify the operational criterion. This criterion will apply to the bulk of the waste rock and will be used to segregate rock for subaqueous and subaerial disposal within the contained areas of the impoundment.

Criteria for Materials located outside of Impoundment Area

Early in the mine life, rock will be generated that may need to be placed outside the impoundment (for example, the south portal of the access tunnel, and in the downstream shell of the impoundment). Since drainage from these areas will not be contained to the same degree as operational waste rock, a higher NP/AP criterion of 3 has been proposed to account for uncertainties in distribution of minerals in size fractions and uncertainties about availability and type of NP. This criterion provides additional certainty that rock placed in these areas will have low potential to generate ARD.

Classification of Weathered Materials Using pH

Paste and rinse pH are used to classify the immediate potential of rock and overburden to release metals. For fresh rock, a paste pH criterion of 6 is used. If the paste pH is above this level, then it is very likely that the rock contains no acidity and that metal leaching will not be significant. For oxidized materials (oxide waste rock and overburden), rinse pH is used. For these materials, a classification criterion of 7 has been used to separate rocks based on copper leaching potential. Zinc leaching, which can be significant at pH greater than 7, does not appear to be a concern for these materials based on testing conducted to date.

8.7.3 Access Tunnel Waste Rock

8.7.3.1 Summary of Proposed Development and Disposal Method

The access tunnel will be developed simultaneously from the north and the south. All rock will be tested during development to allow for segregation of the rock in terms of potential for ML/ARD generation. Potentially ARD generating (PAG) rock, or rock with elevated metal leaching (ML) potential, removed from the south end of the development will be stockpiled and transported to the Galore Creek Valley for disposal in the tailings and waste rock impoundment once the tunnel is complete to ensure that rock remaining at the south portal has low ML and ARD potential. At the north portal, the main requirement is to manage PAG rock rather than ML potential, since mine development in the Galore Creek Valley will result in subaerial not-PAG waste rock dumps with ML leaching potential. PAG rock removed from the north portal will eventually be transported to the impoundment to allow for subsequent flooding. Rock from the south end with low ARD potential will be used as rock fill at the south end of the tunnel. Rock with low ARD potential from the north end will be disposed near the north portal.

8.7.3.2 Existing Data

Surface mapping has been used to predict the geological units expected to be intersected during development of the tunnel. Six to seven major rock types are expected (from north to south):

- pseudo-leucite-bearing volcanic flows with syenite sills and dykes
- pseudo-leucite-bearing volcanic flows with volcanic fragmental lenses
- latite-basalt and latite-andesite volcanics and volcaniclastics
- trachyandesite flow
- volcanic fragementals and basaltic flows
- fine-grained intrusive volcanic fragmentals and basalt flows
- monzo-diorite intrusive.

No geochemical data are available for rock along the alignment. Limited surface testing indicates that ML/ARD should be addressed for rock removed from the tunnel.

8.7.3.3 Sampling and Testing During Development

For the first five blast rounds in each major rock types listed above, a sampling program will be completed to evaluate the performance of simple ABA screening methods to ensure that subsequent data from testing are provided in a timely fashion to avoid delays in sampling. Two samples for testing from each round will be obtained from a composite of the blast hole samples. Each sample will be analyzed at the on-site laboratory as follows:

- paste pH
- total S
- total C
- carbonate
- modified neutralization potential.

Each sample will also be sent off-site for a metal analysis scan.

Based on the result of testing of these ten samples, a monitoring program specifying an appropriate level of testing will be designed. For example:

- If total C is equivalent to carbonate, and less than neutralization potential, then total C will be used as a surrogate for NP.
- If metals are within two times crustal levels, then no further metals testing will be needed. A geological technician will be responsible for ongoing visual monitoring to check for indications of sulphides other than pyrite. If metals are elevated, then metals analysis will be continued on subsequent rounds to establish metal content.

Subsequent sampling will include total S, a measure of carbonate to indicate NP and paste pH on every round.

8.7.3.4 Management Criteria

Disposal will be determined using the criteria shown in Table 8.7-1.

Table 8.7-1
Management of Tunnel Waste Rock

Production Heading	Temporary Stockpile	Permanent Disposal Location	NP/AP		Paste pH		Metal Content
From South Portal		**South portal permanent disposal as rock fill**	**>3**	**and**	**>6**	**and**	**<2 times crustal average for rock type**
From South Portal	**South portal stockpile A**	**Underwater in Galore Creek valley impoundment**	**<3, or no data available**	**or**	**<6, or no data available**	**or**	**>2 times crustal average or no data available**
From South Portal	**South portal stockpile B**	**North portal fill**	**>3**	**and**	**>6**		
From North Portal		**North portal fill**	**>3**	**and**	**>6**		
From North Portal		**Underwater in Galore Creek valley impoundment**	**<3**	**or**	**<6**		

8.7.3.5 Performance Monitoring and Additional Testing

An annual seepage survey for the south portal permanent rock disposal area will be performed to evaluate drainage chemistry.

8.7.4 Waste Rock for Construction

8.7.4.1 Summary of Proposed Development and Disposal Method

Waste rock fill will be required during the development phase for construction of the impoundment dam, site roads and other facilities. This rock will be obtained from the highwall area of the open pit as part of pre-stripping of the ore deposit. Four categories of rock will be produced:

- not-PAG rock with low ML potential suitable for placement on the downstream slope of the impoundment where drainage will not be contained with the impoundment (except by pumpback)
- general not-PAG rock placed within the overall contained area of the impoundment
- PAG rock requiring permanent subaqueous disposal in the impoundment
- ore.

8.7.4.2 Existing Data

Geochemical data on pre-strip rock is provided in Appendix 5-A. In summary, the pre-strip rock from the highwall area of the pit contains weak sulphide mineralization and is generally classified as not-PAG due to high levels of carbonate mineralization (mainly calcite). NP/AP varies from 1 to 612. Sulphide mineralization is a mixture of pyrite, chalcopyrite and bornite. Copper sulphides may form a high percentage of the overall sulphide content; hence, the potential for copper leaching at near-neutral pH is a factor to be considered in the use of pre-strip rock.

Elevated concentrations of other parameters such as zinc were not indicated by the pre-mining testwork in the areas proposed for construction rock.

8.7.4.3 Routine Sampling and Testing During Development

Due to the requirement for reliable classification of ARD and ML potential for construction rock, all blast holes in the pre-strip areas will be sampled to define dig limits until sufficient data are available to reduce sampling.

Blast hole chips from the pre-strip areas will be analyzed at the on-site laboratory in the following sequence:

- copper
- paste pH
- sulphur as sulphide
- carbonate.

Carbonate is a surrogate for NP based on pre-mining testwork. The data obtained will be used to model dig limits.

The possibility of using total carbon as a surrogate for carbonate will be evaluated and would be considered as a permit amendment. Samples of the initial blast muck samples will be screened to obtain samples of blast rock size fractions. These samples will be analyzed for the same parameters to determine if partitioning of sulphide or carbonate minerals into the fines is occurring. This may lead to adjustment of management criteria.

8.7.4.4 Management Criteria

Management and disposal will be determined using the criteria shown in Table 8.7-2.

The value of "y" in Table 8.7-2 is being evaluated by leach column tests.

Table 8.7-2
Management Criteria for Dam Construction Rock

Use or Disposal Location	Cu		NP/AP		Paste pH		Cu/S
Temporary ore stockpile	>Ore cutoff						
Permanent underwater disposal in impoundment	<Ore cutoff	and	<3	or	<6		
Upland disposal within containment area above final flood level	<Ore cutoff	and	>3	and	>6	and	>y
Dam construction rock	<Ore cutoff	and	>3	and	>6	and	<y

8.7.4.5 Performance Monitoring and Additional Testing

Performance monitoring and additional testing will consist of:

- maintaining a database of analytical results, truck counts and disposal locations to provide an inventory of rock management
- continuing the existing column tests on pre-strip material initiated during the EA phase
- conducting bi-annual seep surveys to check for seepage from upland disposal areas and the dams
- quarterly sampling and analysis of rock size fractions to evaluate partitioning of carbonate and sulphide minerals in dam construction materials
- conducting bi-annual evaluation of mineralogy using optical and Rietveld methods
- annual auditing of management practices.

8.7.5 Mine Area Overburden

8.7.5.1 Summary of Proposed Disposal Method

Overburden consists of transported unconsolidated surficial materials such as glacio-fluvial deposits and glacial till. Overburden may be used for construction purposes or stockpiled for future reclamation. Overburden does not include oxidized bedrock, which is a separate material type.

8.7.5.2 Existing Data

Testing of five overburden samples from the mine area indicates that these materials may contain residual sulphide minerals and elevated copper concentrations. The samples obtained were non-acidic. Leached copper concentrations from shake flask extraction were about 0.01 mg/L. It is possible that overburden near the mineralized area will be acid generating or PAG.

8.7.5.3 Routine Sampling and Testing

The objective of sampling and testing is primarily to identify overburden that is suitable for use outside the impoundment containment area. For overburden placed inside the containment area, the issue is mainly whether the material is acidic and could leach metals.

For borrow required for use as fill outside the containment area, samples will be collected from the proposed borrow area by drill or excavator. Each sample will represent no more than 10,000 m^3. The sampling program will be designed to evaluate variations in characteristics indicated by the logs obtained during the delineation program. The samples will be tested for:

- rinse pH
- acid-base account
- metal scan
- shake flask extraction for metals.

For overburden stripped for disposal in the containment area, samples will be collected at the rate of one sample to represent every 10,000 m^3. Samples will be tested for:

- sulphur as sulphide
- modified neutralization potential.

8.7.5.4 Management Criteria

For overburden used outside the containment area, the results will be interpreted to determine if the material is suitable for disposal without containment of runoff. In general, overburden used outside the containment area will meet all of the following characteristics:

- NP/AP>3 (conservative for acid potential)
- rinse pH>7 (limited copper leaching).

For overburden disposed of within the containment area, the following criteria will be used:

- Overburden placed in upland dumps will have NP/AP>3 and rinse pH>7.
- All other overburden will be placed so that it is submerged in the impoundment.

Placement of acidic overburden in the flooded impoundment may affect the water quality of the impoundment. This effect may be reduced by adding lime directly to the impoundment as part of the mill process or by adding lime to the overburden before disposal. The required lime dosage will need to be determined by shake flask extractions to measure acidity.

8.7.5.5 Performance Monitoring and Additional Testing

Bi-annual seep surveys will be performed in overburden disposal areas to determine water chemistry and the need to modify the management approach.

A database of analytical results, truck counts and disposal locations will be maintained to provide an inventory of overburden management.

8.7.6 Oxide Waste Rock

8.7.6.1 Summary of Proposed Development and Disposal Method

Oxide waste rock refers to the oxidized bedrock overlying the mineralized zone and surrounding host rocks. It includes the gossan, which grades down into unoxidized gypsum leached bedrock. Since the characteristics of this material are expected to be highly variable, all disposal will be in the contained area.

8.7.6.2 Existing Data

Surface samples of the exposed gossan and seeps draining from gossan were characterized as part of the EA. The rock varies from acidic to non-acidic, and PAG to not-PAG. Seeps and extraction tests showed that copper is the main leachable metal. Significant neutral pH copper leaching was apparent in both extraction tests and seeps. Comparatively, leachable copper from fresh bedrock is negligible (<0.01 mg/L).

8.7.6.3 Routine Sampling and Testing

The objective of sampling and testing will be to define when the degree of oxidation becomes negligible to the point that the rock is considered fresh. All oxidized waste potentially leaches copper at a level that represents an unacceptable long-term impact on water quality in the impoundment. Samples will be collected from blast hole chips. The following testing will be performed in sequence:

- sulphide copper
- rinse pH
- leachable copper by shake flask extraction.

Testing of rock will continue to depths at which the criteria indicated in Section 8.7.5.4 for waste rock are achieved.

8.7.6.4 Management Criteria

Materials will be classified as shown in Table 8.7-3.

Table 8.7-3
Management Criteria for Oxide Waste Rock

Use or Disposal Location	Sulphide Cu		Rinse pH		Leachable Cu
Temporary ore stockpile	>Ore cutoff				
Permanent underwater disposal in impoundment	<Ore cutoff	and	<7	or	>0.005 mg/L
Managed as unoxidized waste rock (see Table 8.7-4)	<Ore cutoff	and	>7	and	<0.005 mg/L

The concentration value for leachable copper of 0.005 mg/L was defined based on the typical leachable copper concentration shown by rock core tested in 2005. This value will be refined through ongoing testing.

As with overburden, placement of acidic oxide waste in the flooded impoundment may affect the water quality of the impoundment. This effect may be reduced by adding lime directly to the impoundment as part of the mill process or by adding lime to the overburden before disposal. The required lime dosage will need to be determined by shake flask extractions to measure acidity.

8.7.6.5 Performance Monitoring and Additional Testing

Because the oxide waste rock will be placed in the impoundment, the only performance monitoring will be of the overall impoundment water chemistry.

8.7.7 Unoxidized Waste Rock

8.7.7.1 Summary of Proposed Development and Disposal Method

Unoxidized waste rock (or "waste rock") will be the major geological waste product. The rock will be segregated during mining based primarily on potential to produce ARD. Rock defined as PAG will be placed in the impoundment for permanent underwater disposal. Rock classified as not-PAG will be placed in upland dumps. All waste rock will be placed within the catchment area of the impoundment.

8.7.7.2 Existing Data

An extensive static and kinetic geochemical testing program was completed to provide input into the ML/ARD prediction and prevention plan. In summary, findings included:

- Rock varies from PAG to not-PAG and segregation can be achieved using conventional mining methods.
- Neutralization potential is significant and will result in decades to onset of ARD. Sampling of the gossan indicates that ARD will be produced eventually from PAG rock.
- Rock and alteration types are not useful variables for segregation. Segregation will be based on determination of site-specific NP/AP.

8.7.7.3 Routine Sampling and Testing

Routine samples for waste classification will be obtained from blast hole cuttings. In the initial stages of mining, all blast hole samples will be analyzed. As mining progresses and knowledge of the distribution of ARD potential increases, the sampling frequency may decrease.

Testing on blast hole cuttings will be involve the following analyses, in sequence:

- net acid generation (NAG) test
- if NAG pH is provisionally between 5.7 and 6.4, perform sulphide sulphur and modified neutralization potential determinations.

The modified neutralization potential is converted to equivalent carbonate content representing magnesium and calcium carbonates ($IC_{Ca,Mg}$) by subtracting 10, *i.e.*, IC($_{Ca,Mg}$) = NP – 10.

The NAG pH limits were estimated from scoping level evaluations of NAG pH compared to ABA (Figure 8.7-2). For rock with NAG pH below 5.7, $IC_{Ca,Mg}$/AP is consistently below the recommended site-specific value threshold of 1.3 recommended for PAG rock. For rock with NAG pH above 6.3, $IC_{Ca,Mg}$/AP is greater than the site-specific value. Between these values, NAG pH and ABA show uncertain relationships, hence the need to perform the ABA analysis.

Following testing, results will be used to model dig limits and direct pit operations. Dig limits will be specified to ensure that PAG rock does not become incorporated into not-PAG waste rock. The reverse situation (not-PAG in PAG) is acceptable.

8.7.7.4 Management Criteria

Classification of waste rock will therefore be according to the criteria shown in Table 8.7-4:

Table 8.7-4
Classification of Waste Rock

Classification	Disposal Location	NAG pH		$IC_{Ca,Mg}$/AP
Not PAG	In containment area	>6.3	or	>2
PAG	Flooded in impoundment	<5.7	or	<2

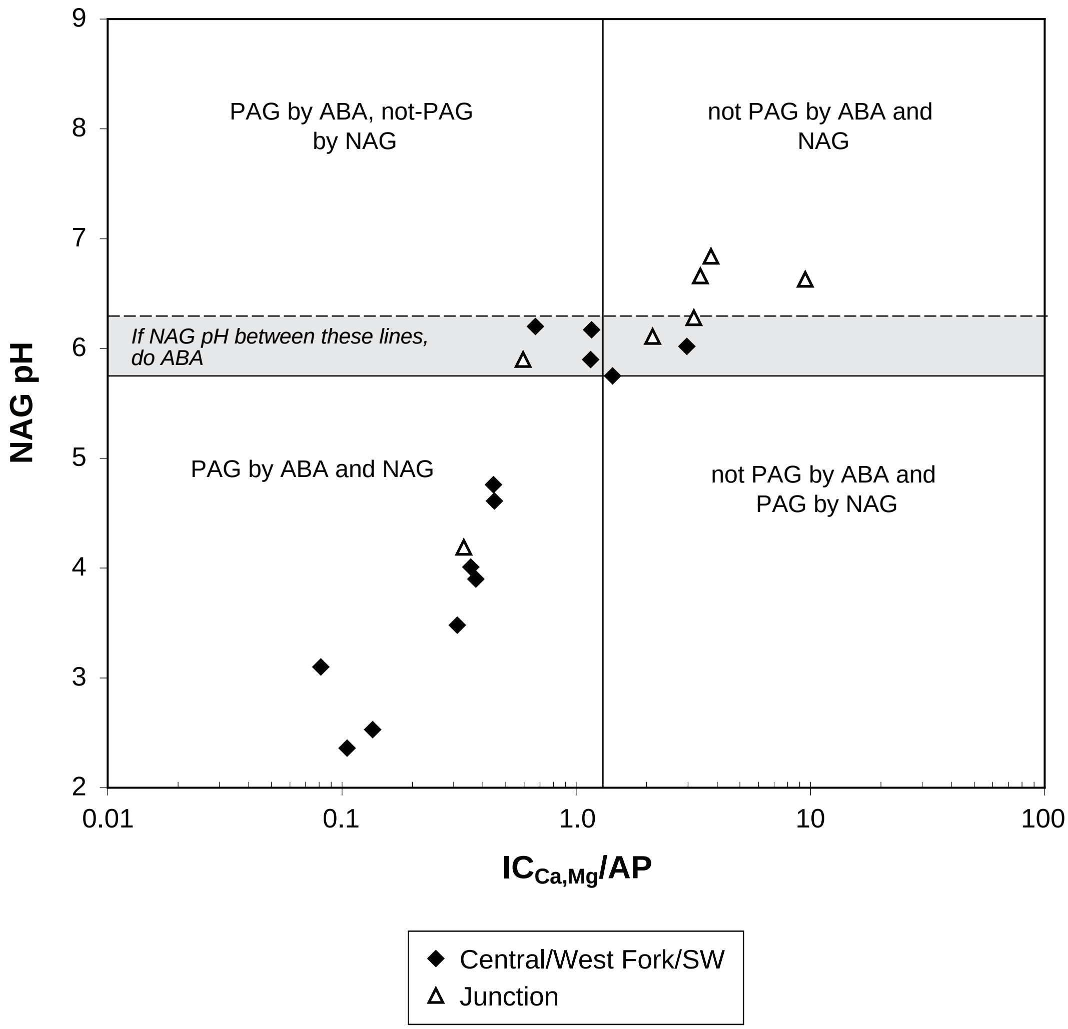
8.7.7.5 Performance Monitoring and Additional Testing

Further testing will be needed prior to and after start-up to refine the criteria used to manage waste rock. This will include:

- Initial waste rock blasts will be treated as PAG and tested to evaluate the possible preferential enrichment of sulphide minerals in the fine fraction of blasted rock. Whole rock and the -2 mm fraction will be analyzed to determine whether adjustment to the $IC_{Ca,Mg}$/AP is needed. An annual program will be designed to continually re-evaluate this distribution.
- Further additional comparative testing of NAG and ABA will be needed to refine the NAG pH boundaries and ensure that there are no biases related to rock type and mineralogy. This is most likely achieved early in the mine operation by testing additional core or blast hole cuttings.
- Additional testing will be needed prior to mining to refine the adjustment of NP to estimate $IC_{Ca,Mg}$. This additional testing will use the same methods used in the EA, which were Rietveld XRD, carbonate analyses and microprobe testing on mineral particles. This program should be repeated annually.

Performance monitoring should include:

- maintaining a database of analytical results, truck counts and disposal locations to provide an inventory of rock management



Source: SRK Consulting

FIGURE 8.7-2

Comparison of NAG and ABA Methods

- continuing some of the humidity cell tests started during the EA process to monitor the progress of NP depletion
- continuing on-site barrel tests
- bi-annual monitoring of toe seeps from upland dumps
- maintaining an overall up-to-date site water and load balance to compare predictions of metal loadings with actual conditions
- annual auditing of management practices.

8.7.8 Tailings

8.7.8.1 Summary of Proposed Development and Disposal Method

Whole tailings will be discharged to the impoundment where they will remain saturated and eventually become submerged.

8.7.8.2 Existing Data

Existing data show that tailings may vary from PAG to not-PAG, probably depending on variations in ore composition. Neutralization potential is significant, indicating that brief exposure of tailings during deposition will not result in ARD runoff or significant ML.

8.7.8.3 Routine Sampling and Testing

A quarterly composite will be prepared for analysis of:

- sulphide sulphur
- neutralization potential
- metal scan.

8.7.8.4 Management Criteria

No specific management criteria are needed for tailings because they will be disposed of subaqueously.

8.7.8.5 Performance Monitoring and Additional Testing

Tailings performance monitoring will be part of the overall monitoring of water chemistry in the impoundment.

An annual composite of the quarterly samples will be submitted for mineralogical analysis using optical and XRD methods.

Seepage from the impoundment will be sampled bi-annually and analyzed for pH and major and trace cations and anions.

8.7.9 Post-Closure Monitoring

The post-closure monitoring program will be designed to continue the sampling of seeps monitored during operations. Monitoring will be relatively infrequent, possibly every five years, immediately after mine closure. Depending on possible indications of accelerating oxidation and potential ARD onset, such as increased metal leaching, monitoring may be done more often, perhaps yearly. This program would be combined with the overall monitoring program for the tailings and waste rock impoundment following closure.

8.7.10 Summary of Monitoring Program

Table 8.7-5 provides an overall summary of four main material disposal or management facilities and the types of material destined for each. All materials in this table are below ore grade. In addition to these facilities, a temporary low-grade ore stockpile will be developed during the construction phase for material from the pre-stripping areas that is unsuitable for construction but contains elevated copper concentrations.

Table 8.7-5
Summary of Management Facilities, Source Materials and Criteria

Facility	Material	Criteria
Galore Creek Valley Impoundment (underwater disposal)	Access tunnel waste rock	Unclassified waste rock, or
		NP/AP<3 or paste pH<6 or metals>2 times crustal average for rock type
	Unsuitable construction rock	NP/AP<3 or paste pH<6
	Overburden	NP/AP<3 or rinse pH<7
	Oxide waste rock	Rinse pH<7 or leachable Cu>0.005 mg/L
	Waste rock	NAG pH<5.7 or $IC_{Ca,Mg}$/AP<2
	Tailings	All
Sub-aerial disposal areas in impoundment containment	Access tunnel waste rock	NP/AP>3 and paste pH>6
	Unsuitable construction rock	NP/AP>3 and paste pH>6 and Cu/S>y
	Overburden	NP/AP>3 and rinse pH>7
	Waste rock	NAG pH>6.3 or $IC_{Ca,Mg}$/AP>2
Impoundment dam or other fill outside of dam containment area	Construction rock	NP/AP>3 and paste pH>6 and Cu/S<y
South Portal Fill	Access tunnel waste rock	NP/AP>3 and paste pH>6 and metals<2 times crustal

y – molar ratio of copper to sulphur being estimated by leach column tests.

8.8 Access Corridor Preliminary ARD Management Plan

8.8.1 Introduction

The Galore Creek Project will require the construction of about 118 km of new road to access the mine, a 1.5 km spur road for the filter plant discharge pipeline access to Iskut River and a 3 km spur road to access the Porcupine aerodrome. The new road will start from an existing forestry road that connects with Highway 37 north of Bob Quinn Lake, follow More Creek upstream from its junction with the Iskut River to the pass at the head of More and Sphaler creeks, descend the Sphaler Creek Canyon near the Porcupine River, then ascend Scotsimpson Creek to a 3.8 km tunnel at the headwaters. The tunnel will create access from Scotsimpson Creek Valley to the Galore Creek Valley. The distance from Highway 37 to the south tunnel portal will be 129 km. Section 5.11 of this report presents a comprehensive discussion of the road.

Much of the road will traverse rugged terrain with geohazard and snow avalanche hazards. Considerable engineering has been required to define a route that adequately balances safety, environmental and economic considerations. Despite design specifications that permit a narrow width of 5 to 6 m, almost 1.5 Mm^3 of rock excavation will be required for construction. Additional volumes of colluvium will be excavated. Wherever possible the road designers will balance cuts and fills to use excavated rock and colluvium near their source. Some waste storage areas will be required in zones of high-volume rock excavations.

The road will travel westwards across the generally north-south trend of the regional geology, thereby intersecting a wide range of rock types. This area of the Coast Range Mountains hosts a number of mineral deposits and many smaller mineral occurrences. Sulphide minerals are relatively common in some rock types.

When exposed to oxygen and water, fresh rock will naturally weather, oxidize and leach. Where sulphide minerals such as pyrite are present, their oxidation can create acid rock drainage (ARD) unless sufficient quantities of neutralizing minerals are available. In the event acidic drainage is formed, its lower pH can lead to higher rates of metal leaching (ML). However, metal leaching can also occur at sites of neutral and alkaline drainage. It has been conservatively estimated that about 50 % of the billion tonnes of waste rock that will be moved to extract ore at the Galore Creek mine will be potentially ARD generating.

Compared to the volume of rock proposed to be excavated at the Galore Creek mine site, the rock excavations related to the access road are relatively small. Nonetheless, care must be taken to avoid water quality degradation due to ML/ARD originating from rock used for fills at stream crossings and elsewhere. While ML/ARD effects related to road construction are rare, it is important to assess the ARD impacts, to identify potentially problematic rocks that may be avoided by minor alignment modifications, to identify alternative sources of borrow materials if necessary to replace ARD generating rocks and to facilitate preliminary management approaches for potentially ARD generating rock.

Drainages over 75 km of the 118 km of the proposed new road construction are not fish bearing. Fish barriers exist in More Creek near km 44, at about km 115 near the mouth of Sphaler Creek and below the canyon on Scotsimpson Creek.

The road will be constructed under the authority of a Special Use Permit (SUP) issued by the Ministry of Forests. It is expected that the SUP for the road will require a plan to implement ARD monitoring and management of ARD generating rock from cuts, borrow sources and tunnels. There is no precedent for ARD management under a SUP.

NovaGold has completed a preliminary assessment of ARD potential for the road based on geological reconnaissance field work completed by the B.C. Ministry of Energy, Mines and Petroleum Resources. The elevated mineral potential of the region has stimulated the production of a significant database of geological and geochemical information by government and industry groups that, when combined with engineering information on the current road design, allowed a comprehensive preliminary assessment.

The data were compiled and assessed to produce a map ranking sections of the corridor relative to the potential to intersect ARD generating rock. The ranking system (SRK, 2006) that was used is described below.

- Extreme – The road corridor passes through a rock unit with nearby known mineralization (indicated by MINFILE and Assessment Reports).
- High – The road corridor intersects a rock unit with indicated regional potential for economic (*e.g.* gold, silver, copper, zinc) mineralization;
- Moderate – The road corridor intersects a rock unit that may have regionally elevated levels of iron sulphide mineralization (*e.g.* black shales, gossans);
- Low – The road corridor will intersect a rock unit with good buffering capacity (limestone) or regionally low mineralization;
- None – The road will excavate regionally-transported surficial materials (*e.g.* glacial till, sands and gravels).

In this ranking scheme, any bedrock or colluvium is considered to represent a potential for the generation of ARD, and only coarse mixed unconsolidated surficial materials are immediately ranked as "none". Surficial materials that are locally derived (talus and colluvium) are given the same classification as the likely source bedrock.

The ranking system formed the basis for the assessment but other factors were also qualitatively factored into the ranking. For example, small cuts in potentially reactive rock distant from surface watercourses do not raise the same level of concern as large cut-and-fills located near watercourses.

The ARD potential ranking system was used to identify 200 m segments of the proposed 129 km access road as having no, low, moderate, high or extreme potential for exposure of ARD generating rocks (Table 8.8-1 and Figure 8.8-1).

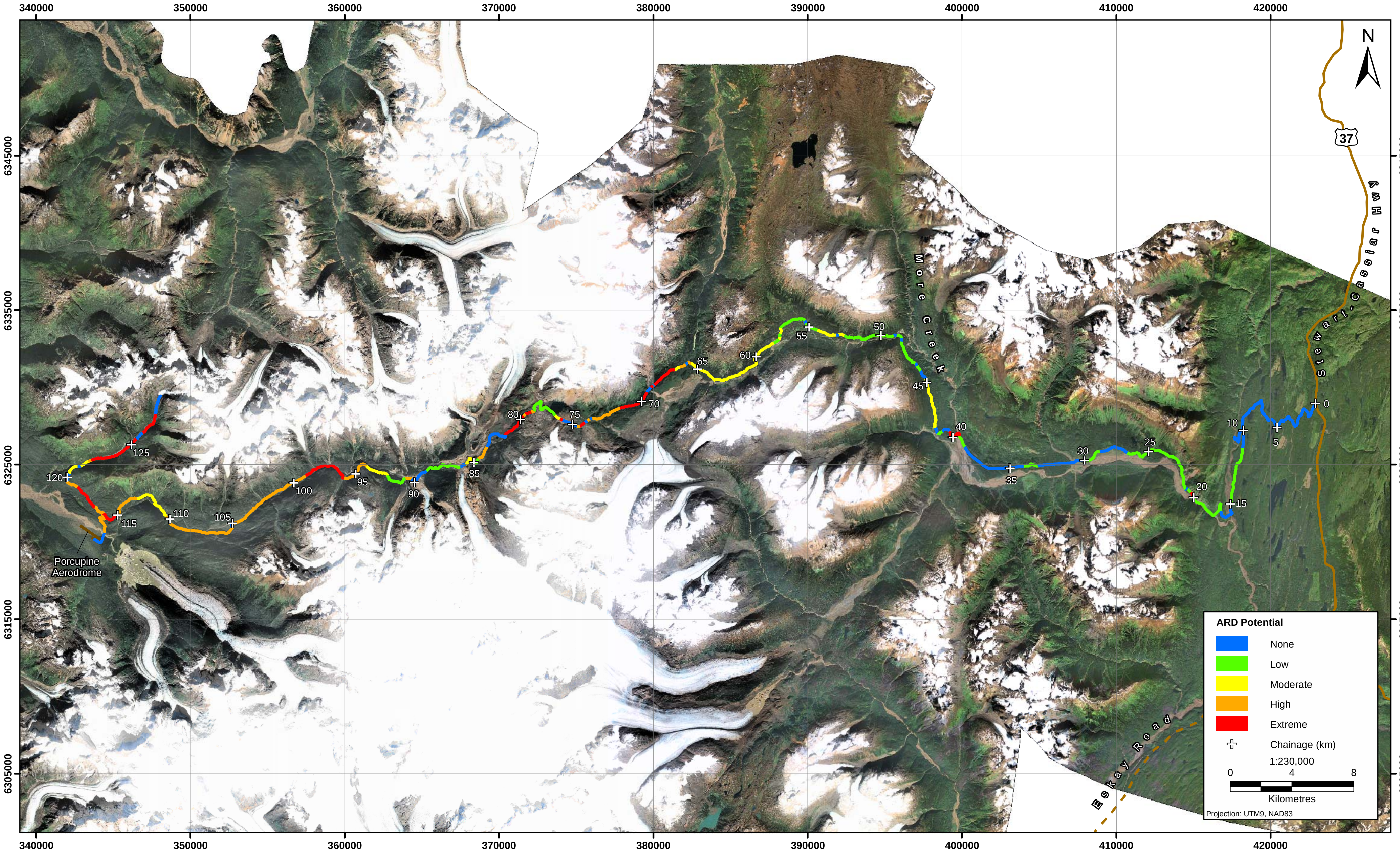


FIGURE 8.8-1

NovaGold Canada Inc.

Preliminary Acid Rock Drainage Potential Assessment of the Galore Creek Access Corridor

Rescan

Table 8.8-1
Distribution of Road Corridor* Segments
Based on ARD Potential Ranking

Ranking	# of Segments	km	%
Extreme	102	19	15
High	131	25	19
Moderate	106	20	15
Low	167	32	24
None	183	36	27
Total	689	132	100

*** Includes 3 km spur road to access the proposed Porcupine Aerodrome, does not include 1.5 km spur road for the filter plant discharge pipeline access to Iskut River.**

NovaGold will implement a reconnaissance level field program in 2006 to spot check the potential ranking and collect data to fine tune the preliminary management plan to a level ready for construction.

8.8.2 Purpose of the Preliminary Management Plan

This document presents a preliminary plan for the management of potentially ARD generating rocks during construction of the access road. The plan will be revised prior to construction to incorporate new information and concepts from the 2006 reconnaissance ARD potential field program. The plan is intended to allow adaptive management as knowledge of the occurrence and distribution of ARD generating rocks is gathered before and during the construction process.

The pace of construction of the access road will be affected by the availability of information on the presence of ARD generating rock. NovaGold proposes a limited program of assessment of ARD management options in advance of construction. This approach will generate sufficient information to allow the use of adaptive management to effectively and efficiently construct the road with minimal adverse effects from any ARD generating rock that may be encountered.

The results of the 2006 field program will be used to establish criteria for additional rock sampling in key areas in order to further define the boundaries of known or expected ARD generating rocks. There will be several opportunities for further and more detailed sampling as the road is developed. The 2006 program will also help to establish procedures for assessment and management of new exposures resulting from earthmoving operations.

8.8.3 Modifications to Road Design

8.8.3.1 Consideration of Alignment Modifications

McElhanney Consulting Services Ltd. (McElhanney) has produced a feasibility level design for the access road. This design attempts to balance the known engineering, geotechnical and environmental issues for the construction of a safe and cost-effective industrial road through the rugged terrain of the More, Sphaler and Scotsimpson drainages.

Where significant ARD concerns are identified from the results of the 2006 reconnaissance field work or subsequent pre-construction follow-up assessment, McElhanney will investigate minor alignment alternatives to reduce their effects and implement feasible alignments where the alternatives have less overall adverse effects. Once construction has commenced, only minor modifications to the overall alignment will be considered owing to the complexity of the required engineering in this rugged area with major geohazard and snow avalanche hazards.

8.8.3.2 Revision of Cut-and-Fill Schedules

Small areas of potential ARD generating rock may be avoided by revising cut schedules to reduce the frequency and volume of cuts in ARD generating rock. Cuts may be avoided or reduced on moderate slopes by increasing the volume of fill supporting the downhill side of the road prism. Fill schedules can also be revised to avoid using or disposing of potential ARD generating wastes in sensitive areas. Sources of not potentially ARD generating rock fill to replace ARD generating waste and offset ARD generating cuts should be readily available within short haul distances over most of the alignment.

8.8.4 Field Laboratory

ARD analyses required during the construction phase will be performed in a mobile field laboratory trailer located within the project area. The field laboratory will provide 24-hour, and in certain circumstances shorter, turnaround for samples. The field laboratory will expedite management decisions with respect to ARD characterization and management of rock. The laboratory will be equipped to perform the following analyses:

- paste pH, rinse pH and conductivity
- total sulphur by Leco furnace
- carbon by Leco furnace
- modified neutralization potential (Lawrence *et al.*, 1989).

Paste and rinse pH tests will be conducted to determine the current pH of rock samples. Electrical conductivity measurements will be taken to determine relative total dissolved solids. If the paste pH tests result in a value greater than or equal to 6, then the rocks will be considered net neutralizing. If the paste pH is less than 5, then the rock will be considered net acidic. If the paste pH is between 5 and 6, then the result will be compared with the pH of the distilled water used in the paste pH test. If the paste pH is less than the pH of the distilled water, then the rock will be considered net acidic (paste pH < 5). Otherwise it will be considered net neutralizing (paste pH > 6).

Electrical conductivity (EC) measurements are a surrogate for total dissolved solids. Where pH values are inconclusive, higher EC values may be indicative of ARD. Criteria for use of EC values will be developed prior to commencement of construction and may be amended over time as experience is gained with ARD characterization methodologies.

A laboratory technician and a helper will be required to operate the field laboratory and manage the anticipated flow of samples. For quality assurance and quality control (QA/QC) selected sample splits will be sent off site to an accredited laboratory for ABA analyses.

8.8.5 Construction

8.8.5.1 Roles and Responsibilities

The ARD management plan will require the coordination of concurrent activities over a 128 km length of road. A range of responsibilities will be assigned to individuals to ensure orderly and consistent implementation. These individuals and their roles and responsibilities are described below.

Geoscientist

A registered professional geoscientist will be charged with overall responsibility for the ongoing assessment of ARD potential and the management of ARD generating and potentially ARD generating rock during the construction program. The geoscientist will inspect construction spreads and meet with environmental monitors and construction supervisors as required to ensure consistent quality and detail of assessment and management.

The geoscientist will determine sampling criteria and oversee rock sample intervals for each broad construction segment to characterize ARD potential. These criteria will apply to borrow areas as well as excavations on the alignment. The geoscientist will also monitor the application of the guidelines for disposal of ARD generating rock and may authorize modification of the guidelines in a process of adaptive management over the course of the construction project.

Environmental Monitors

Environmental monitors, under the direction of the geoscientist, will be employed to oversee the environmental performance of the construction of the road and will be key players in the ARD management plan. Individual environmental monitors will be responsible for day-to-day ARD management of specific construction segments. They will receive comprehensive pre-employment training in the visual indicators of ARD (*e.g.*, iron staining, sulphides, carbonates), identification of sulphides and carbonates, sampling procedures for natural seeps to predict source rock quality and sampling of rock for ARD characterization. They will be trained in appropriate rock sampling methodology, marking of sample sites and recording of pertinent sample data for submission of samples to the field laboratory.

Environmental monitors will inspect all rock excavation areas at every stage of construction. Their role in areas ranked as having no or low potential for ARD will be to visually inspect to confirm that no visual indicators are present. Rock sampling and analysis for NP/AP and paste pH will be required in all areas where visual indicators are noted. In areas with higher ARD potential ranking, environmental monitors will inspect rock after every blast. They will also collect rock samples for analysis in higher-ranked areas regardless of whether visual indicators are present, following the criteria developed by the geologist.

Construction Supervisors

Construction supervisors will be trained to identify potentially ARD generating rocks visually, based on iron staining and presence of sulphides, and from laboratory analyses. They will be required to work with environmental monitors to review and respond appropriately to daily laboratory reports on neutralization potential to acid potential (NP/AP) ratios and paste pH tests from rock sampling conducted in advance of excavation. Construction supervisors will be provided with instructions regarding the classification of rock using laboratory results and the use or disposal of rock within each classification.

Equipment Operators

Equipment operators will be trained in the identification of ARD indicators such as iron oxide staining and sulphides. There is a strong likelihood that small, structurally controlled zones of gossan or sulphide will be found during excavations; the cooperation of equipment operators will be essential for the management of such zones. Equipment operators will be responsible for inspecting rock after every blast in areas of low ARD potential to ensure that no new occurrences of iron oxides or sulphides have been exposed. Where visual indicators are noted, equipment operators will inform the environmental monitor to allow sampling and analysis before rock is permanently disposed of.

8.8.5.2 Grubbing and Stripping

The early stages of construction will include felling timber, clearing/grubbing stumps and debris and stripping organics and unsuitable materials before subgrade construction begins. The grubbing and stripping stages will require the use of heavy equipment and will provide an opportunity to access bedrock that may not have been accessible during the 2006 field season. There could be a period of up to a few weeks between the initial grubbing and the commencement of significant rock excavations, allowing time for ARD characterization.

Drilling and blasting will precede major rock excavations, except where bedrock can be excavated by ripping, during the subgrade construction stage. Where there is ARD potential, drill cuttings will be collected for analysis at the field laboratory and the results returned in time to guide in the management of the blasted rock.

8.8.5.3 Rock Excavation

Despite the ARD prediction program based on rock types and formations, it is possible that unexpected areas of potential ARD will be encountered along the access road. Proper training and ongoing monitoring and assessment will minimize the potential for mismanagement of such rock.

Environmental monitors will collect rock samples at regular intervals in advance of excavation in all areas ranked as having high or extreme potential for ARD. Daily sample collections will be delivered to the field laboratory by helicopter for timely ARD characterization.

Guidelines for Construction Supervisors

Construction supervisors will be provided with guidelines for disposal of ARD generating rock based on NP/AP and paste pH values. Preliminary guidelines and disposal options are provided in Table 8.8-2. These guidelines will be reviewed and revised if necessary after the results of the 2006 field program have been assessed. They may be expanded to include parameters for electrical conductivity to supplement pH and NP/AP ratios. Disposal options for highly reactive ARD rock include:

- transportation to the mine site for permanent disposal in the waste rock facility

- storage in excavations in limestone units that occur near Round Lake
- storage in compacted or sealed piles along the alignment or encapsulated in limestone colluvium. Depleted borrow pits in till materials may offer excellent sites for disposal. The rock would be layered, compacted and covered with till to minimize air and water penetration.

Waste rock that cannot be immediately transported to permanent disposal sites may be temporarily stored in managed sites along the road. Stockpiles with a NP/AP ratio of less than 2 should have a paste pH test before being moved to determine whether the paste pH has changed during storage, and potential implications on subsequent management approaches should be assessed.

It is likely that very small zones of potentially ARD generating rock, or ARD generating rock, associated with faults and shear zones will be uncovered during excavations. Recognizing that these small volumes are unlikely to have significant adverse effects, a rule of thumb will be developed for their disposal. It is suggested that where waste from these zones is less than 10 m^3, it may be disposed of with not potentially ARD generating rock, provided that the disposal location is greater than 50 m from a watercourse and not within 100 m of a fish-bearing stream. Locations of disposal sites for potentially ARD generating and net ARD generating rock will be marked to avoid the accidental re-use of that rock for future road maintenance or repair.

Table 8.8-2
Preliminary Guidelines for Management of ARD Generating Rock

NP/AP		Paste pH	If paste pH between 5 & 6	Management Approach
≥ 2	and	> 6	n/a	No disposal constraints, can be used as rock fill.
≥ 2	and	5 to 6	pH of distilled water < paste pH	No disposal constraints, can be used as rock fill.
1 to 2	and	> 6	n/a	Potentially ARD generating. Cannot be used as rock fill. Requires disposal by compaction in till or burial in limestone matrix.
1 to 2	and	5 to 6	pH of distilled water < paste pH	Potentially ARD generating. Cannot be used as rock fill. Requires disposal by compaction in till or burial in limestone matrix.
Any		< 6	pH of distilled water > paste pH	Net acidic. Cannot be used as rock fill. Requires temporary capped storage prior to subaqueous disposal at mine or burial in limestone formation near Round Lake.
≤ 1		Any		Potentially ARD generating. Cannot be used as rock fill. Requires temporary capped storage prior to subaqueous disposal at mine or burial in limestone formation near Round Lake.

Natural Seeps

If there is natural seepage from areas of iron oxidation, environmental monitors will measure the seepage pH, conductivity and sulphate content of the seep water to provide a preliminary indication of the ARD conditions of the rock. These preliminary indications will be used to support short-term management decisions such as temporary storage requirements pending receipt of more definitive ARD characterization assessments.

Table 8.8-3 provides an initial matrix of seep characteristics and management direction for discussion. It will be revised as needed during on-site testing of natural seeps.

Table 8.8-3
Testing of Natural Seeps for Indicators of ARD

pH	Conductivity	Sulphate	Indicator	Action
< 6	>150	> 50	net acidic due to ARD	submit source rock for analysis
< 6	< 150	< 50	net acidic not due to ARD	None
> 6	-	-	not net acidic	None

Sulphides

Usually any rock with more than trace amounts of visible sulphide will be considered to be ARD generating. Exceptions include sulphides in calcareous volcanics or limestones where the neutralization potential of the host rock reduces the likelihood of ARD generation. Where possible sulphide bearing rock areas will be avoided by making minor alignment revisions, but where avoidance is not an option other approaches will be taken. This could include reducing the width of the road to minimize excavated volumes, importing not potentially ARD generating rock as fill material and disposing of sulphide-bearing rock in the most appropriate manner. Disposal options will depend on the ARD characterization (NP/AP and paste pH), the volume of reactive rock and the sensitivity of the receiving environment. Where construction scheduling does not permit waiting for ARD characterization, the sulphide-bearing rock will be treated as if it were highly reactive.

Cuts in Potentially ARD Generating Rock

Cuts in potentially ARD generating rock will be avoided where possible. Where they cannot be avoided they will be minimized to avoid producing highwalls of potentially ARD generating rock and potentially ARD generating waste, both of which must be managed. Where creation of highwalls in potentially ARD generating rock cannot be avoided, diversions will be excavated up-slope to divert surface water away from the exposed slope. Water quality in ditches below the highwalls will initially be monitored, and if water quality degrades, then crushed limestone will be added to the bed of the ditches as a mitigation control strategy.

Cuts in ARD Generating Rock

Cuts in rock that is already generating ARD, such as gossan, will be avoided where possible. Where they cannot be avoided they will be minimized to avoid producing highwalls of ARD generating rock and ARD generating waste, both of which must be managed. Where creation of highwalls in ARD generating rock cannot be avoided, diversions will be excavated up-slope to divert surface water from the exposed faces. Ditches below the highwalls and at the mouths of diversion ditches will be lined with crushed limestone to control the pH of runoff waters. Water quality from these ditches will initially be monitored to assess the effectiveness of the limestone treatment.

8.8.6 Operations and Monitoring

Management of ARD generating rock along the access road during mine operations will be the responsibility of the mine environmental manager.

Road maintenance during mine operations will include scaling of loose rock, removal of debris from rock falls and debris flows, grading, ditch clearing, maintenance of stream armouring and resurfacing from time to time.

The environmental staff at the Galore Creek mine site will be trained to test for and recognize potentially ARD generating rock. The mine site laboratory will be fully equipped for ARD characterization for segregation of waste rock at the mine and will be capable of quick turnaround times for road maintenance test samples. Mine site geologists will be available to guide the selection of rock for sensitive applications such as armouring of stream-crossing structures. Waste rock volumes from large scaling sites or alignment upgrades will be subjected to ARD characterization prior to disposal to ensure appropriate disposal methods.

The mine environmental staff will be responsible for monitoring the effectiveness of ARD management approaches along the road corridor. They will carry out annual water quality monitoring of ditch water in the area of potentially ARD and not potentially ARD and major waste disposal areas. Water samples will be submitted for a suite of analyses such as pH, sulphate, acidity, alkalinity and total and dissolved metals.

Where annual sampling detects water quality degradation, remedial action will be taken. The type of action will depend upon the options available and may range from application of limestone to excavation and replacement of the source waste rock.

8.8.7 Closure and Reclamation

The access road will be closed and deactivated once it is no longer required. Where recontouring is possible at sites with reactive highwall faces, attempts will be made to isolate those faces, perhaps with clay rich till, to minimize exposure to air and water. The isolation will compensate for the gradual loss of capacity of diversion ditches over time due to natural sloughing and infilling.

Slopes will be stabilized and culverts and structures will be removed.

8.9 Materials Management Plan

8.9.1 Purpose and Overview

The purpose of a materials management plan is to provide a description of proposed movement and storage of various materials on the site including materials brought into the site such as hazardous materials, dangerous goods including explosives and petroleum products. This plan deals with the handling, storage and use of the various materials. The plan focuses on the operations phase of the project. However, the construction phase will involve similar considerations and is included.

Management of ore, concentrate, waste rock, overburden and borrow materials and related materials are covered under separate management plans, and are therefore not included in this plan.

The plan will be expanded in detail as part of the detailed design work prior to bringing any materials to the site. The management plan will be implemented during project construction and commissioning. The Environmental Management System (EMS) presented in the Galore Creek EA is designed to outline the principles for environmental management that will be expanded upon in greater detail as part of the project permitting process. It will detail operational and systems procedures based on international standards including the ISO 14000 Environmental Management System protocol.

Management of waste materials is not discussed in this plan. They are described in the Waste Management Plan. It includes domestic and industrial, and hazardous and non-hazardous materials. Hazardous wastes will include materials such as waste oil, concentrator reagents, laboratory chemicals and solvents, lead acid batteries, antifreezes and oil filters. Non-hazardous wastes will include materials such as domestic garbage, and industrial wastes such as plastics, tires, conveyor belts, scrap metals, waste lumber, vehicle parts, *etc.*

8.9.2 Design Considerations

Considerations in the design of materials management systems include:

- Incorporation of best management practices in design, construction and operation of installed facilities to protect human health and safety and the environment;
- Protect facilities including pipelines and storage areas from wildlife, especially when certain materials are attractants to animals (*e.g.* hydrocarbons, sewage, food in camp area, etc);
- Consider ultimate closure and decommissioning of facilities during design of facilities and management systems.

NovaGold is committed to the safety and sustainability for its Galore Creek project. In the addition to conformance with all regulatory requirements, the project will utilize best management practices in material management systems at Galore Creek valley and associated facilities off-site.

The material management systems will consider protection of materials from animals, especially when they are attractants to animals. This may include design of facilities (*e.g.* avoidance of locations relative to known wildlife areas, enclosing or fencing areas, *etc.*), and management plans (*e.g.* personal awareness of wildlife, avoidance of known wildlife areas, minimizing presence of attractants through housekeeping, efficient garbage collection and landfilling).

Considerations of long-term plans for the site will be included in the initial development and subsequent operations phase of the project. Also, remaining materials will be consumed, returned to suppliers or removed from site for use or removed to licensed recycling/disposal facilities. Material storage and handling systems will be decontaminated and de-constructed. Steel structures will be removed for either off-site salvage or on-site landfilling. All concrete structures will be de-constructed and landfilled at approved on-site facilities. Foundations will be levelled to surrounding topography datum and covered.

8.9.3 Materials Management Components

There are three areas of the Galore Creek Project where materials management will require the implementation of site-specific procedures.

1. Filter Plant;
2. Porcupine Aerodrome; and
3. Galore Creek Mine and Mill Processing Facilities.

The site layout of the Mill Processing Facilities involves an area between the mining area and tailings/waste rock storage facility as shown in Figure 8.9-1. Most of the surface facilities are located within this area. The truckshop and fuel station will be located about 1km north of there, and the explosives facility will be another 1 km further north in a more isolated location.

Further optimizing of the plant site and concentrator facilities is currently underway, incorporating results of geo-technical drilling of the plant site during the 2005 field program. Final designs and detailed layouts will be provided as part of the project permitting process.

Materials management facilities will be designed, constructed and operated using best management practices. Preliminary descriptions of the materials management components are outlined in the section, below.

8.9.3.1 Transportation to Site

Construction Phase

Before the access road to the site is completed, all transportation of construction equipment and materials to the work areas west of the staging area near Highway 37 will be by air.

The only section of pre-existing road along the selected road route is an 11 km long forestry access road known as the Devil Creek forestry road that leads west from Highway 37 approximately 8 km north of the hamlet of Bob Quinn Lake. The forestry road will be upgraded and a large staging area will be built within the area containing the filter plant facility.

Access to camps and materials staging areas for the road construction will be with rotary-winged aircraft until the Porcupine River Aerodrome is completed and fixed wing aircraft can deliver equipment and materials closer to the west end of the access road and the site. As sections of the road are completed and connected with other sections, less air transport will be required. Once the road is completed, major construction work for the project facilities will commence.

Operations Phase

The access road will be a single lane 140 kilometer long resource development road with limits on speed and traffic due to difficult terrain and hazards. The road will be designed for carrying the legal load limit for trucks on British Columbia highways on a year-round basis. The interior dimensions of the 3.8 km long Scotsimpson Creek tunnel will determine the maximum size of equipment that can be transported to the site. A separate management plan has been developed for the access road. A number of detailed procedures will be developed and utilized during operation to ensure safety and environmental protection along the access road to the site.

During operation, the vast majority of the materials will be transported to the mine site using the access road with a small amount of materials brought to site by air. Use of the Porcupine Aerodrome will be primarily for transport of mine personnel, rush freight and emergency supplies and for emergency medical evacuation.

8.9.3.2 Logistics/Freight

The majority of material requirements for the construction and ongoing maintenance/upgrade of mine facilities will be sourced nationally. The provincial highway system connects the site access road with major supply sources in the various centres in northern British Columbia and Alberta as well as larger centres in the south. Northern deep-water ports are available in Stewart and Prince Rupert. No laydown areas for materials are planned for any of the supply areas. However, laydown areas will be utilized for incoming materials at the filter plant site as well as a site at the Porcupine Aerodrome.

Once the access road is completed, and during construction of the mine facilities, there will be a significant number of round trips per day for construction materials to be transported to the site.

During operations, traffic along Highway 37 and the Galore Creek access road will include mining consumables, process plant operating and maintenance supplies and consumables, concentrate and diesel fuel (Highway 37 only), as well as operations and maintenance personnel and supplies (although most staff will access site via the Porcupine aerodrome).

Traffic frequency during operations is estimated at:

- Highway 37 to the Filter Plant - 71 maximum trips/day
- Mine Access Road – 21 maximum trips/day

The traffic frequency along the access road including the maximum daily trips is summarized below in Table 8.9-1.

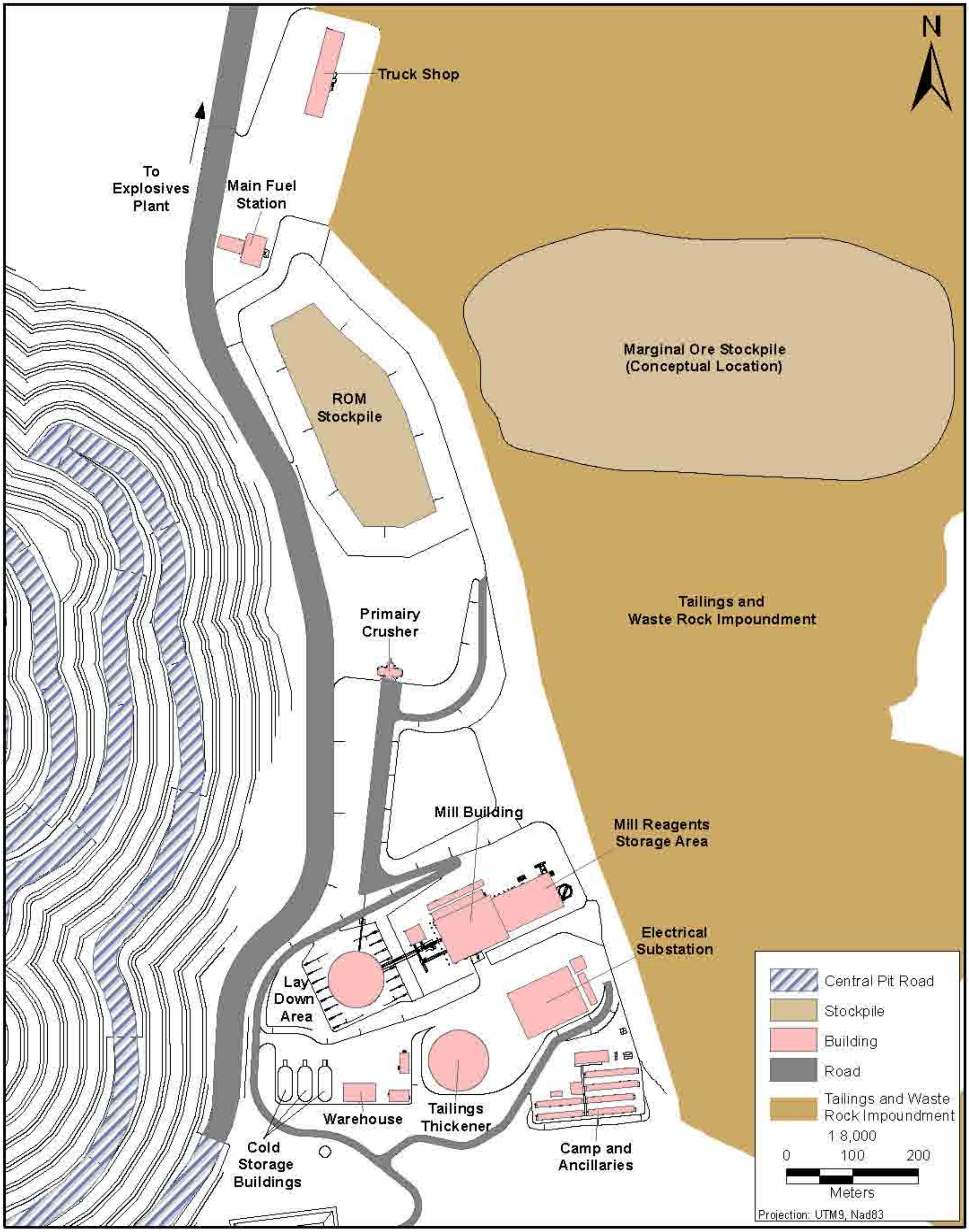


FIGURE 8.9-1

Material Storage Areas at Main Plant Site

NovaGold Canada Inc.

Rescan

Table 8.9-1
Traffic Frequency Estimate

Truck Type	Load	Delivery Frequency		Total Annual Trips	Maximum Daily Trips
20,000 L tanker	MIBC (methyl-isobutyl-carbinol)	1	Two weeks	26	1
40 tonne Flat Deck Trucks	PAX (potassium amyl xanthate), Flocculant, Maintenance Supplies	1	Two weeks	26	1
40 tonne Tandem Trucks	Lime	5	Week	260	1
	Grinding Balls	10	Week	520	2
	Explosive	2	Day	500	2
	Concentrate	30	Day	7,500	50
40 ft Trailers	Food	3	Week	156	1
Super B Train	Diesel	2	Day	500	2
50-person Buses	People	2	Week	104	1
Small Vehicles	People	7	Day	2,500	10
Total Highway 37				12,100	71
Total Mine Access Road				4,620	21

Due to the remoteness of the mine site, and the fact that intermittent road closures can be expected due to blizzards, un-mitigated snow avalanches and other geo-hazards, the mine plan includes provisions for substantial covered storage and warehouse space for operating supplies. Provisioning campaigns will be considered prior to the onset of winter in order to ensure adequate supplies are on hand at the site to continue normal operations if the road was closed for up to two weeks.

Transportation of materials to site will be by the various suppliers, depending on the source of the load. In some cases, equipment suppliers will provide their own truck. In other cases, NovaGold will contract freight services to local companies on a competitive basis. All drivers will be advised of NovaGold's rules of the road concerning safety and the environment before they will be permitted to travel the road beyond the gatehouse at the filter plant. Traffic on the access road will be relatively light due to the pumping of diesel fuel and product concentrate in buried pipelines. Most vehicles leaving the mine will be travelling empty.

Table 8.9-2 provides a summary listing of consumable materials used during operation at the Galore Creek project.

8.9.3.3 Site Storage Facilities

The majority of storage requirements for materials being utilized by the operation will be met with facilities on site.

Table 8.9-2
Listing of Major Materials (Consumables) at the Galore Creek Project

Construction Phase	
On-site	
Road and Facilities Construction	
Explosives	ANFO-based emulsion, ANFO, blasting caps, detonating cord
Fuels and Lubricants	Diesel fuel, gasoline, antifreeze, propane, oils and greases
Maintenance Services	Solvents, cleaners, resins, glues
Camp	Food, propane, cleaning supplies
Road Maintenance	Liquid calcium chloride for chemical dust suppression, salt and sand for winter traction assistance
Off-site	
Porcupine Aerodrome	Jet fuel, de-icing fluids, various materials required for periods of emergency road closure (*eg*., fuel, consumables)
Heliport and Helipads	Jet fuel
Staging Areas and Camps	Food, propane, cleaning supplies
Operations Phase	
On-site	
Mining explosives	ANFO-based emulsion, ANFO, blasting caps, detonating cord
Mill Materials	Crusher and grinding mill wear plates, grinding balls
Mill Reagents	Potassium Amyl Xanthate (PAX), Methyl Isobutyl Carbinol (MIBC), flocculent, lime, Guar Gum (PE 26), Promoter 3418A
Fuels and Lubricants	Diesel fuel, gasoline, antifreeze, propane, oils and greases
Maintenance Services	Solvents, cleaners, resins, glues
Assay Laboratory	Various laboratory chemicals and products
Camp	Food, propane, cleaning supplies
Road Maintenance	Liquid calcium chloride for chemical dust suppression, salt and sand for winter traction assistance
Off-site	
Porcupine Aerodrome	Jet fuel, de-icing fluids, various materials required for periods of emergency road closure (fuel, consumables, *etc.*)
Filter Plant	Sulphuric acid, flocculent, surfactant

Storage locations for materials at the site will include:

- Several sites at the mine site including the main warehouse area, fuel station, mill area, truck shop, explosives plant site and a number of the individual user areas;
- Porcupine Aerodrome and storage area (at km 116 of access road) for emergency supplies including diesel fuel and provisions for the operation in the event of an extended access road blockage;
- Filter Plant (at km 3 of access road) where some materials will be unloaded and/or stored including:
    - Diesel fuel to be unloaded and transferred into holding tanks for pumping to the minesite through the diesel fuel pipeline;

- Supplies required for the filter plant and associated facilities;
- Certain materials will be off-loaded to be then transported to the minesite using company vehicles along the access road;
- Concentrate storage and management is described in the Filter Plant and Loadout Management Plan. It will include a covered concentrate storage area and loadout bin for loading trucks for haulage of product to a deep-water port in Stewart, B.C.

Figure 8.9-1 provided an overview of the site and preliminary material storage locations.

The storage facilities will be installed with appropriate environmental protection and health and safety features consistent with best management practices and regulatory requirements.

Warehouse Area

The main indoor and heated materials storage area will be within a heated, pre-engineered steel building that will house maintenance shops, offices and storage space.

Three un-heated, pre-engineered, fabric covered buildings will provide bulk, covered storage for winter operations (cold storage). These structures could also be utilized for maintenance and laydown of large components during winter operations.

Warehouse yards will be secured with perimeter fencing and locked gates.

Fuel Station

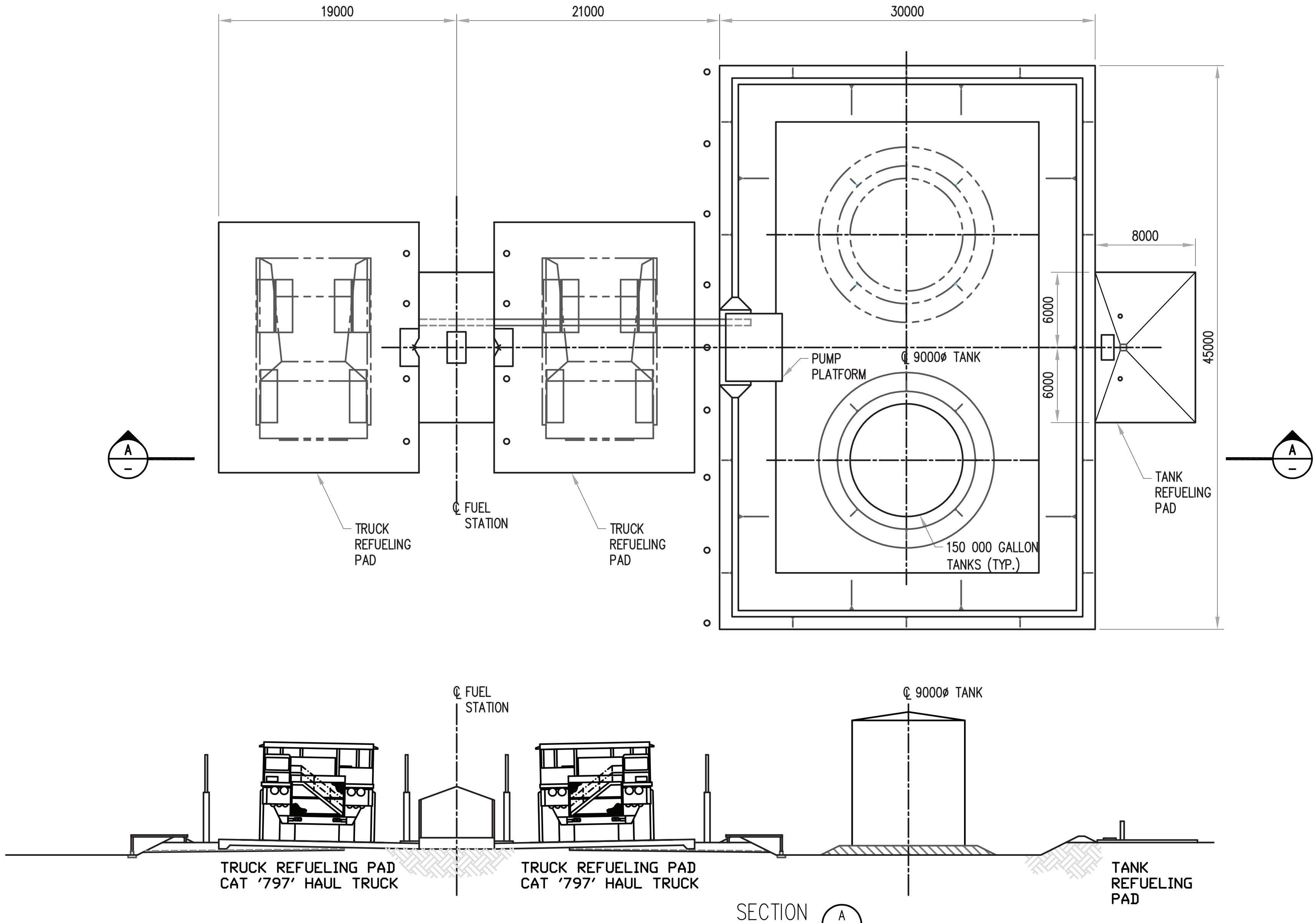
The main fuel station will include a farm containing diesel fuel storage tanks and an adjacent fuelling pad area. It will consist of two large diesel fuel tanks. The tanks will be built within an appropriate containment system. On-loading and off-loading will be undertaken within separate contained concrete pad areas supported with an oil/water separator system. Figure 8.9-2 provides a plan and sectional view of the proposed main fuel station and tank farm.

Mill Storage Area

A storage area will be required for reagents, and other consumables such as crusher and grinding mill liners, various spare parts, *etc.* This will likely consist of enclosed, heated and un-heated (cold) storage facilities as well as an outside laydown area adjacent to the concentrator building.

Assay Laboratory

The assay laboratory will be housed in a pre-fabricated building. Capabilities will include mining, metallurgical and environmental analytical services. Laboratory supplies will include an assortment of chemicals and materials used for assaying. Most of these will be in small, laboratory-sized bottles or pails that will be stored in separate secure areas based on compatibility. Compressed gas cylinders required for various analytical processes will be stored in their own secure area.



Source: Hatch & Associates

FIGURE 8.9-2

Fuel Station and Tank Farm

NovaGold Canada Inc.

Rescan™

Explosives Facility

A contracted explosives manufacturer will operate an explosives manufacturing plant at the Galore Creek site for mining operations. The fully contained plant will be contained within a 4 ha fenced compound located approximately 1 km north of the Truck Shop and Fuel Station, remote from site activities. The site was selected in consultation with potential explosives suppliers/manufacturers as well as plant operators. This area provides a location in reasonable proximity to the mining areas and will ensure ease of use and access under extreme weather conditions. The facility will include a number of buildings and structures including a manufacturing plant to produce the bulk emulsion, office trailer, truck storage/wash bay, Boiler and Electrical Room, Gasser Facility, and one magazine. Three other explosives magazines will be located at strategic locations within the Galore Creek valley.

Locations of the explosives plant and magazine locations are provided in Figure 8.9-3.

Storage facilities for materials used to manufacture explosives in the compound will include a number of tanks and silos either in the manufacturing plant building or immediately outside.

NovaGold will contract a third party for the provision of explosives, including operation of the emulsion manufacturing facility and explosives storage magazines. Explosives will be delivered by the contractor to the boreholes.

Additional information on the handling, storage and use of explosives on the minesite is provided in a management plan in Section 8.9.8 of this plan.

8.9.3.4 Off-Site Facilities

Porcupine Aerodrome Storage Area

The aerodrome facilities will include an area on the apron for storage of required aircraft supplies including de-icing fluids, emergency fuel cache as well as laydown area for emergency freight coming or going by air.

Outside of the main aerodrome apron area and away from the terminal building there will be a larger laydown area that will include a fuel farm for the construction and operations phases (for road maintenance and emergency site cache). The fuel storage facilities will consist of above-ground double walled portable “Enviro-Safe” tanks.

The Aerodrome and its associated camp will be the primary staging area during construction of the access corridor facilities, as it will be the only location where heavy-life aircraft can fly into until the road is completed. The area will be very busy and there will be an extensive laydown area for construction materials. Upon completion of access corridor construction work, the majority of the movable aerodrome camp and laydown facilities will be relocated to the minesite, as on-going construction efforts will be focused there.

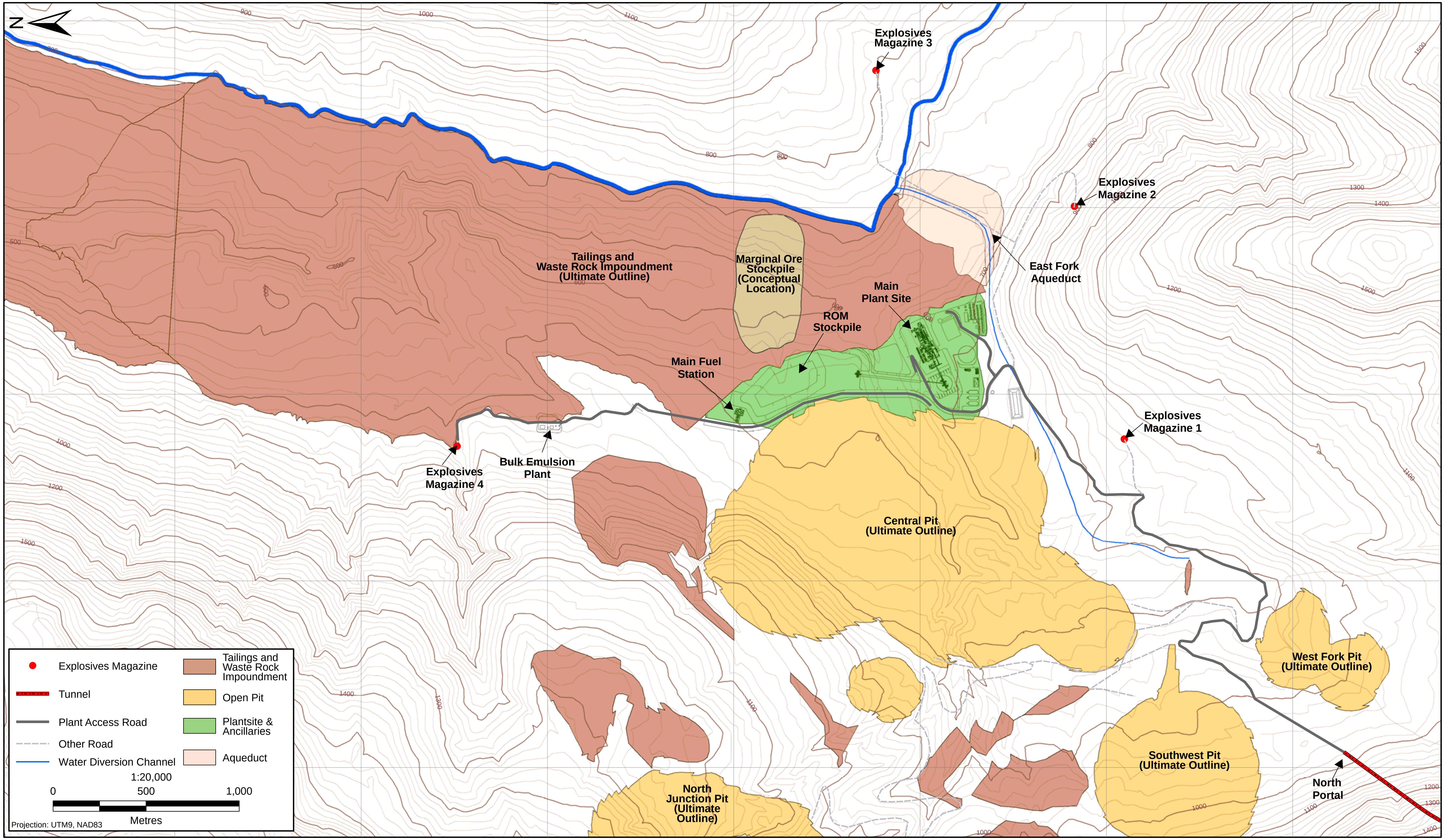


FIGURE 8.9-3

Explosives Plant and Magazine Locations (Ultimate Footprint Areas - Year 20)

NovaGold Canada Inc.

Rescan™

All storage areas will have spill containment and environmental protection components consistent with best management practices. For example, fuel storage facilities will have containment with external pumping/load-out facilities located within a concrete pad with appropriate spill collection and buried oil/water separator components.

A layout drawing of the Aerodrome with the main facilities including the fuel storage tank and apron storage area is provided in Figure 8.9-4.

Filter Plant Site

The site of the filter plant will be developed early so as to permit construction of a major staging area for construction of the access road. This will likely include a camp and warehouse facilities. There will also be a jet fuel storage tank at the site for re-fuelling rotary-winged aircraft lifting equipment and materials to the various staging areas along the access corridor and to the minesite.

During operations, the warehouse facility and laydown areas will store materials required for operation of the filter plant and associated process. This will include the operations of concentrate dewatering, truck load-out, and treatment of water removed from concentrate. It will include flocculent, surfactant and sulphuric acid addition systems.

The site will also include a fuel receiving and pumping system for transferring diesel fuel unloaded from tanker trucks to the pipeline for pumping to the minesite fuel farm tanks for use by the mine. Concentrate will also be stored in a covered storage area prior to being loaded out by conveyor onto trucks for transport to the town of Stewart and a deep-water shiploading facility located there.

The site layout for the filter plant and loadout facility is provided in Figure 8.9-5.

8.9.4 Hazardous Materials Management Plan

8.9.4.1 Introduction

The construction and subsequent operation of the Galore Creek project will involve the use of a number of hazardous materials and dangerous goods.

A hazardous material is one which, as a result of its physical, chemical or other properties, poses a hazard to human health or the environment when it is improperly handled, used, treated, stored, disposed of or otherwise managed. NovaGold is committed to the adoption of best management practices for hazardous materials at its Galore Creek Operation.

This section provides an outline of a comprehensive management plan that will be prepared by NovaGold as part of the permitting phase and will continue to evolve in time to meet the needs of mine operations.

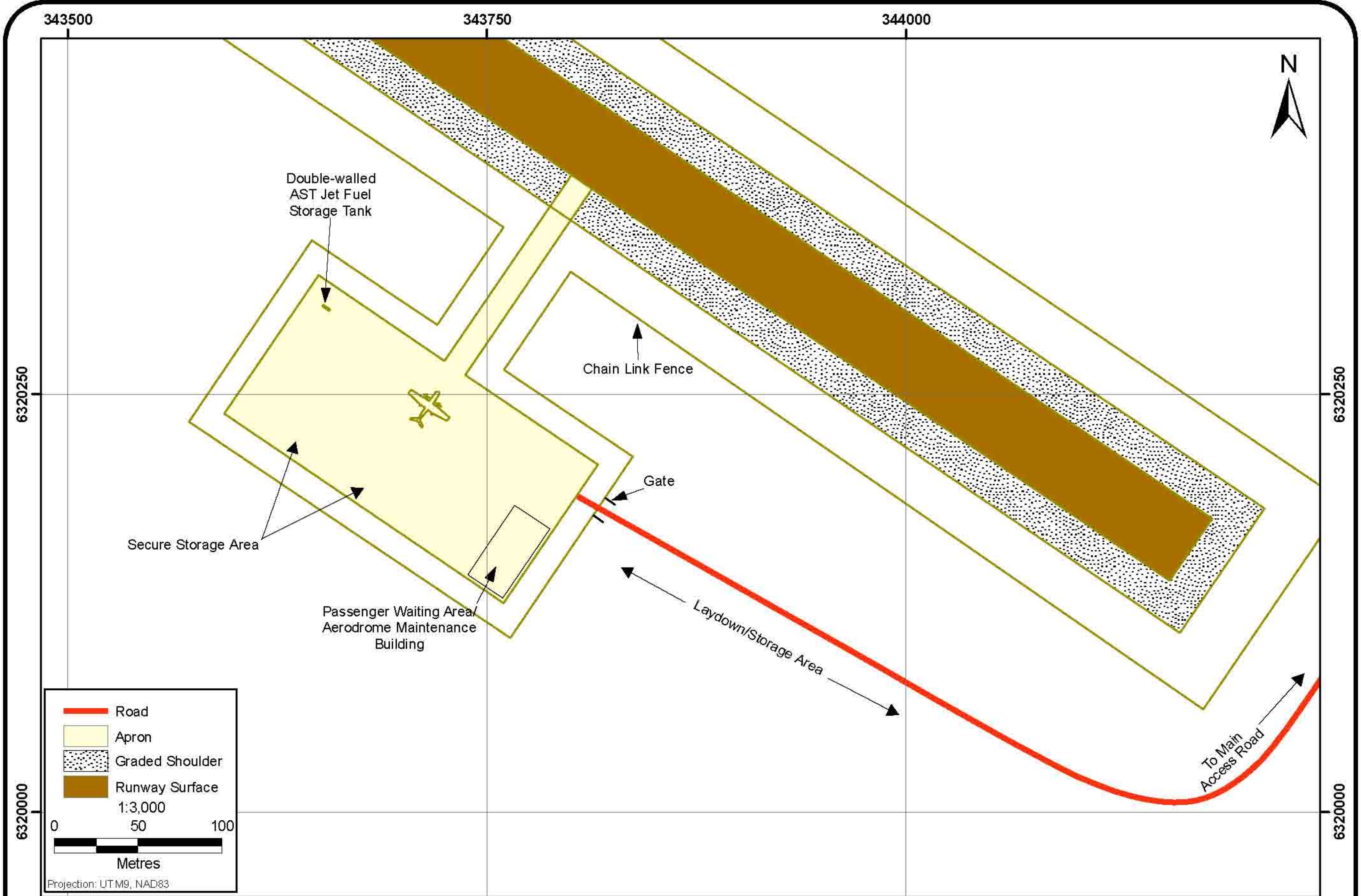
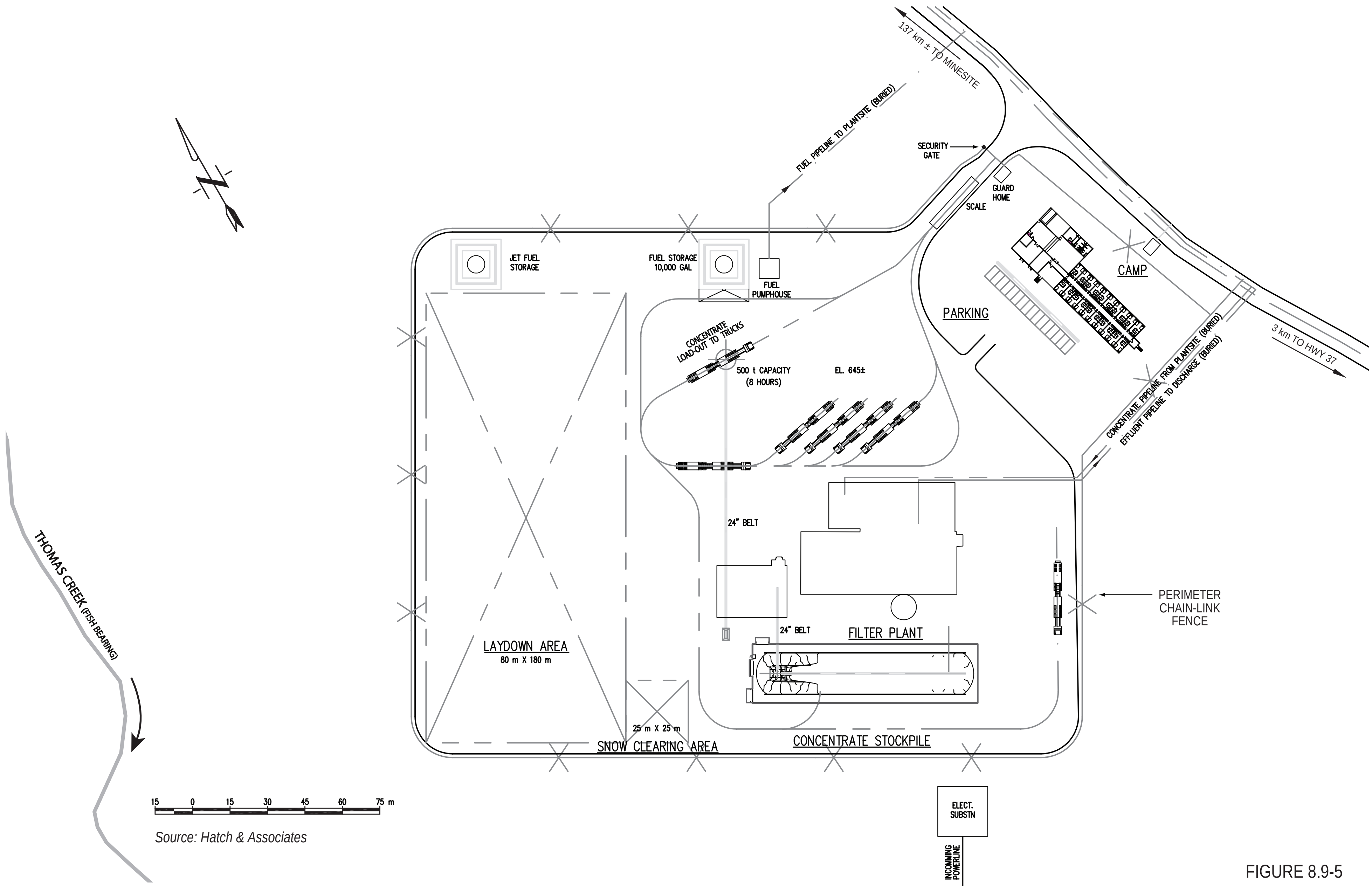


FIGURE 8.9-4

Porcupine Aerodrome Facility - Conceptual Layout

NovaGold Canada Inc.

Rescan



Source: Hatch & Associates

FIGURE 8.9-5

NovaGold Canada Inc.

Filter Plant and Loadout Facility-Conceptual Site Layout

Rescan™

8.9.4.2 Purpose and Scope

The Hazardous Materials Management Plan (HMMP) includes hazardous materials and dangerous goods that will be utilized by the project. It covers the entire life cycle of the product while it is on site. This includes storage, handling and use of the product from when it arrives on the site to when it is finally disposed of at a licensed and secure off-site disposal facility. All components of the Plan will be in compliance with regulatory requirements and will utilize best management practices as an additional guiding principle.

The HMMP should complement, and be integrated with, other plans and management system at Galore Creek, including the overall Environmental Management System.

8.9.4.3 Hazardous Substances Inventory

To implement best management practices in materials management at the site, an accurate and detailed inventory of the hazardous materials and dangerous goods is required.

The inventory register will include all the chemicals and raw materials on site including chemicals brought onsite by contractors.

Before any chemical is brought on site (for full-scale use or for a first plant trial), the supplier or contractor will supply a Material Safety Data Sheet (MSDS) for the product. The MSDS provides information primarily aimed at worker health and safety with some secondary information typically provided related to environmental impacts and remedial action in the event of spillage.

The hazardous substances inventory will list all chemicals on the site, and include additional information on the products applicable for use by mine personnel including specific spill response considerations and procedures.

An initial listing of hazardous substances to be utilized at the mine site during operations is provided in Table 8.9-3.

Table 8.9-3
Hazardous Substances at Galore Creek

Substance (by user area)	Use	Delivered Form, Typical Volume in Site Storage	Storage vessels	Additional Details
Warehouse				
Ozone	Potable water treatment	200 cylinders, by transport truck	Potable water storage tank: 5m x 5m	
Chlorine	Potable water treatment	200 cylinders, by transport truck	Potable water storage tank	
Mill Area				
PAX	Flotation-conditioner	800 kg bulk bags, by 40 tonne flat bed transport truck;	Mix tank: 4.5m D x 5.0m H sized for 1 week supply; Day tank: 2.2 m D x 2.5m H, located in flotation area	Made up to 10% strength & distributed to addition points using metering pumps

(continued)

Table 8.9-3
Hazardous Substances at Galore Creek (continued)

Substance (by user area)	Use	Delivered Form, Typical Volume in Site Storage	Storage vessels	Additional Details
MIBC	Flotation-frother	Liquid in 20,000L Tanker truck	Storage tank: 4.5 m D x 5.0 m H sized for 1 week supply; Day tank: 1.8 m D x 2.3 m H located in flotation area;	Made up to 10% strength and distributed to addition points using metering pumps
3418A Promoter	Flotation-promoter	Liquid in Bulk tanker	Storage tank: 2.0 m D x 2.5 m H	Used at 100% strength and distributed to addition points with metering pumps No special hazard classifications
Lime	pH adjustment: grinding, re-grind, flotation circuit conditioner cells	Tanker truck (pneumatically unloaded)	60 tonne storage silo; Slaker; Holding tank: 4.5 m D x 5.0 m H;	Made up to 20% solution and pumped continuously in a closed loop with take-offs to addition points Has a Health Hazard Rating of 3-HIGH
Flocculent	Settling aid in concentrate and tailings thickeners	700 kg bulk bag (Magnafloc 351), by 40 tonne flat bed transport truck;	Mixing tank; Storage tank: 5.0 m D x 5.5m H	Dissolved into water using eductor; No special hazard classifications
Guar Gum (PE 26)	Used in conditioning cells prior to flotation	Starch like powder in 800 kg bulk bags, by flat bed transport truck	Made up in 6.0m D x 6.5 m H Mixing tank; 7.0 m D x 7.5 m H Holding tank	Use metering pump to add to Rougher conditioner Not a US DOT controlled material
<u>Assay Lab</u>				
Laboratory chemicals	For environmental and production laboratory	In 1-5 L/kg containers	In dedicated storage area	
<u>Mine Area</u>				
<u>Camp</u>				
Propane	Fuel for camp kitchen, space heaters	Bulk tanker truck	Bulk tank adjacent to camp facilities	
Domestic Products	For cleaning camp rooms and kitchen facilities	Freight truck		
Maintenance & Truck Shops				
Ethylene glycol	Engine antifreeze	205L barrels, by transport truck		
Lubricating Oil	For lubricating machinery and equipment	Stored in 4 m D x 12 m H tank located near truck shop Delivered to site by bulk oil tanker truck		Tank will be located within lined containment area
Miscellaneous Lubricants	For lubricating machine parts	205L barrels, by transport truck	Drums in secure area; Distribution using barrel pumps and hose reels	

(continued)

Table 18.9-3
Hazardous Substances at Galore Creek (completed)

Substance (by user area)	Use	Delivered Form, Typical Volume in Site Storage	Storage vessels	Additional Details
Hydraulic Oil/Fluids	For machine hydraulics	205L barrels, by transport truck	Drums in secure area; Distribution using barrel pumps and hose reels	
Solvents	Degreaser	205L barrels, by transport truck	Drums in secure area; Distribution using barrel pumps and hose reels	
Liquid Calcium Chloride	Road dust suppressant	205L barrels, by transport truck	Drums in secure area; Transferring into dedicated truck using barrel pump and hose reel	
Road Salt	Traction aid for road surfaces	Bulk, by tandem dumper truck	Covered storage sheds	
Tailings/Waste Impoundment				
Site – Other				
Diesel Fuel	Mobile equipment, Emergency generators,	Pumped to site in buried pipeline alongside access road from Filter Plant unloading facility.	Two 12m D x 11m H (1244 m3) storage tanks on site in main fuel farm as shown in Figures 11.9-1 and 11.9-2.	Located within a HDPE-lined containment area sized to contain at least 110% of the capacity of one tank
Explosives-ANFO	Mining-open pit	Bulk AN prill, on 40 tonne tandem trucks; Bulk AN solution, on heated 40 tonne tandem trucks; Fuel oil deliveries, by tanker truck	ANFO & emulsion production facility at remote location with a 1,000 tonne storage capacity. Three other explosives magazines in remote locations around the site as shown in Figure 8.9-3.	
Explosives-Ammonium nitrate (AN) based emulsion	Mining-open pit	By 40 tonne tandem truck	Emulsion explosives manufactured at plant located in remote location on site, stored in dedicated magazine	
Explosives-Ignition Systems-Cordtex AP Detonating Cord, Pentex AP 16 boosters, Exel MS detonators, Exel MS connectors	Mining-open pit	Explosives truck	Stored in several caps and explosives magazines located in isolated sites situated in proximity to the mine areas, a shown in Figure 8.9-3.	
Tailings/Waste Impoundment				
Aerodrome				
De-icer	Aircraft operations			Stored within lined containment area; Used within designated area of apron with collection system and containment
Filter Plant-plant				
Flocculent	For filter plant thickener	Bulk bags, by 40 tonne flat bed transport truck;		
Sulphuric Acid	For discharge water treatment, pH adjustment	205L barrels, by transport truck		Use metering pump and inline mixer
Surfactant	For discharge water treatment, to aid settling in clarifier/thickner	205L barrels, by transport truck		

The anticipated consumptions of selected hazardous substances are provided in tabular form in Table 8.9-4.

8.9.4.4 Handling and Storage of Hazardous Materials

All hazardous materials and dangerous goods will be stored in clearly labelled containers or vessels and handled in accordance with local regulations and appropriate to their hazard characteristics.

Table 8.9-4
Anticipated Consumptions of Selected Hazardous Substances

Material	Area of Use	Consumption (estimate only)
Diesel Fuel	Mobile and other equipment	481K-881K L/wk.
Gasoline	Smaller mobile equipment, vehicles	N/A
Explosives	Mining	4-15 M kg/yr over mine life
Lime (CaO)	Mill	37.5 t/d
PAX	Mill	0.97 t/d
MIBC	Mill	2.7 t/d
3418a Promoter	Mill	0.975 t/d
Flocculent (Magnafloc 351)	Mill	0.48 t/d
Guar Gum (PE 26)	Mill	N/A

Minimizing the risk of safety infractions and/or environmental damage from accidental releases of hazardous materials includes the following practices:

- Knowing which hazardous materials are on site through the maintenance of an inventory system;
- Allocating clear responsibility for managing hazardous materials;
- Understanding the actual or potential hazards and environmental impacts associated with the storage and handling of these materials;
- Minimizing the use and/or generation of hazardous materials;
- Constructing storage facilities that safely contain the materials in all foreseeable circumstances;
- Implementing physical controls and procedures to ensure that no materials escape during routine operations as well upset conditions;
- Having emergency response plans in place to ensure immediate action to minimize the environmental effects should accidental or unplanned releases occur;
- Monitoring all discharges and also the receiving environment as stipulated in an approved monitoring program to detect and escapes of the materials and measure any potential impacts; and

- Keeping adequate records and reviewing them regularly so future environmental problems are anticipated and avoided.

Materials will be stored in appropriate containers within suitably contained areas. The majority of the process reagents will be stored in the reagent warehouse and several other main storage areas. This will allow for easy visual identification of any leakage from the containers (*e.g.* drums, totes, bags).

NovaGold will ensure that:

- Manufacturers provide safe packaging and labelling for packaged materials, as a condition of entering purchase agreements with them;
- Storage areas are climate-controlled, dry and well ventilated;
- Containers holding the materials remain sealed to prevent accidental leakage and/or spillage;
- Incompatible chemicals are stored separately in order to prevent deleterious chemical reactions and cross contamination;
- Chemical storage areas are designated as non-smoking areas and are located away from food storage areas;
- All personnel handling dangerous goods are trained and provided with appropriate personal protective equipment; and
- All bulk chemical storage sites are provided with concrete or lined floors and walls capable of containing 110% of the volume of largest vessel in the area or as stipulated by appropriate legislation or permits.

Hazardous substances will be segregated from incompatible substances, as well as from other non-hazardous materials. Storage areas will be designed to prevent liquid and/or dry chemical releases to the environment. Controls will include impervious pads, secondary containment berms or sumps. Primary containment will also be built around mill areas with a secondary containment system for site drainage from the entire plant site area.

Adequate ventilation, fire and safety protection and MSDS stations will be provided at strategic locations at the various facilities.

Waste hazardous materials will be stored in appropriate containers within designated areas including a waste transfer building before being shipped off site to an authorized receiver.

The Spill Contingency and Emergency Response Plan (SCERP) provides additional information on response plans in the event of any spills of hazardous materials. A site-wide communication system (including access road corridor) will ensure rapid notification of any observed spills. The site will have a trained Emergency Response Team with resources to contain and recover spills so as to reduce the size of any spill and thus reduce any potential adverse environmental impact. Locations of storage areas and transfer stations will have appropriate spill kits. On-site equipment will include absorbent pads and booms, skimmers, dike materials, etc as part of a comprehensive spill recovery kit that will be contained on a truck for rapid deployment to any spill scene. The kit will be easily transferable so as to enable pick up and delivery by helicopter if required.

8.9.5 Nuclear Equipment Handling and Disposal Plan

Radioactive sources are commonly used in the mining and mineral processing industry for tasks such as process monitoring (*e.g.*, density gauges), exploration (*e.g.*, down-hole logging), monitoring (*e.g.*, neutron moisture gauges), geo-technical (*e.g.*, Troxler soil compaction meters) and research (*e.g.*, for tracer studies).

All aspects relating to the purchase, handling, use, storage and disposal of nuclear equipment is regulated in Canada under the Atomic Energy Control Regulations.

The presence of radioactive materials at industrial facilities raises issues including the potential human health hazard (both occupational and public). Radioactive contamination may not be detected in conventional occupational, environmental or process stream monitoring.

Periodic checks of radioactive sources will be undertaken to ensure there has been no significant loss of integrity of the source container that could result in leakage or contamination. All radioactive materials will be appropriately labelled and always be visible.

Out of service sources will be stored in appropriate containers in secure storage buildings on site.

Whenever possible, purchase agreements will be established with suppliers to take back units being taken out of service.

8.9.6 Petroleum Products Management Plan

The materials with the highest risk potential for a spill or accidental release are petroleum products. The quantities of mill reagents and shop materials are significantly smaller, and with the exception of several alkali products (such as quick lime) their individual hazard ratings are also lower.

Diesel fuel will arrive at the unloading facility at the Filter Plant site by tanker truck in B-train configurations, averaging two deliveries per day. It will be loaded into a 40 m3 capacity (40,000 litre) tank. From there it will be pumped through a 140 km long pipeline to the minesite and into the main fuel station storage tanks. Storage tanks will consist of two 12m D by 11m H tanks (1,244m3 each).

Due to the risk of diesel fuel delivery interruptions resulting from pump or pipeline maintenance or malfunctions, closures of Highway 37 or electrical power transmission failures, the project will require substantial storage capacity to maintain uninterrupted operations.

The diesel fuel pipeline will be laid in the same trench as the concentrate slurry pipeline and will be equipped with leak detection systems similar to the slurry pipeline and automatic shut-off valves. Safety provisions will be consistent with regulations governing petroleum products pipelines, which will use conventional and proven technologies.

Additional information on the diesel fuel pipeline system is provided in the Pipelines Environmental Management Plan.

All fuel storage vessels will include secondary containment with a sump, and all transfer stations will have concrete spill pads complete with oil/water separators. Tanks and sumps will have high-level alarms. All transfers from tank trucks to tanks at the Filter Plant site or Fuel Farm areas will be done using enclosed lines, hoses and pumps. All storage and transfer locations will also be equipped with appropriate spill kits.

Fuel transfer procedures will include best management steps to ensure no overtopping of tanks or spillage. In addition, inventories will be tracked regularly to check on any possible losses.

Most mobile equipment including mine haul trucks will be fuelled from the fuel farm tanks. Mobile equipment such as tracked dozers will be serviced by a fleet of fuel/lube trucks. These vehicles will be equipped with spill kits.

Hydrocarbon spills will be collected and contaminated soils and overburden materials will be hauled to an on-site land farm for bioremediation.

Oils, lubricants degreasers, solvents and other petroleum-based products will be delivered to site in drums by truck (the drums will often be palletized). These will be unloaded using a forklift and then be stored in a secure area. The lubricants will be dispensed using hose reels and barrel pumps in the truckshop service bays and maintenance shop areas.

8.9.7 Process Reagents Management Plan

The mill process involves the following basic unit operations: crushing, grinding, flotation, thickening and filtration.

Materials management will involve the use of best management practices so as to provide maximum environmental and safety protection.

Most liquid materials including mill reagents will be shipped to site in 205L drums. Initial assessments indicate that only Methyl Iso-Butyl Carbinol (MIBC), a mill flotation process reagent, will be trucked to site in a 20,000L tanker truck. It will be unloaded on a concrete pad with a spill collection system.

Lime will be received by tanker truck and unloaded pneumatically. It will be unloaded pneumatically. Lime requires handling and safety precautions due to its serious health hazard because of its caustic nature, risk of burns and potential to cause irreversible injuries to the eye. It is not generally regulated as a hazardous chemical during transport. Small spills may be cleaned up dry and returned to the process stream. Larger spills may require neutralization with a weak acid.

Without appropriate spill response measures outlined in the SCREP, larger spills could reach a nearby watercourse or into the groundwater regime, and reach one of the creeks or rivers.

Possible downstream effects depend on the exact location and volume entering that watercourse and specific receptors in the area.

Dry products such as flocculent and flotation conditioner are packaged in large bulk bags that may weigh in the order of 1 tonne. They will be trucked to site in conventional transport trucks and unloaded at the mill into a reagent storage and makeup area. The bags are then emptied into mix tanks for subsequent pumping and distribution to the appropriate area in the mill.

The majority of the mill process reagents will be stored in the area adjacent to the reagents makeup area in the north-east corner of the mill building whose location was shown in Figure 8.9-1.

8.9.8 Explosives Management Plan

This plan will provide the basis of a management plan for the safe handling, storage and use of explosives at the Galore Creek project.

During the construction phase, the use of explosives will be required as part of bedrock excavation associated with the road alignment, borrow source development and tunnel construction. For the road alignment and borrow sources, explosives containers known as "day-boxes" will be used in the field in support of bedrock excavation. The day-boxes will be stored during non-working hours in secure areas accessible by authorized staff only. Required explosives quantities will be brought into the field each day from these central locations and kept in secure areas throughout the workday. Development of the access tunnel connecting Scotsimpson and Galore Creek will require the stationing of an explosives magazine near the development headings.

The mining process requires the use of explosives to break apart the rock in the open pits for recovery of the ore for processing and separation from the surrounding waste rock. Due to the large volumes of explosive required and the remote location of the minesite, explosives will be manufactured at the mine site.

A fenced compound will be the site of contracted explosives manufacturing plant. The site will include a number of buildings including a fully contained manufacturing plant, storage tanks and silos, plant services and one magazine for the storage of explosives. The plant building will meet the bulk guidelines published by the Explosives Regulatory Division (ERD) of Natural Resources Canada as well as local, provincial and federal regulations. A sump in the building will collect any water for eventual emulsion/oil/water separation and disposal.

The final configuration of the structures on the compound site is under detailed design as part of the permitting process. The general layout of the site will be designed to allow for ample turning space for B-trains and bulk transport trucks for the raw prilled ammonium nitrate (ANP) used in the manufacture of the bulk emulsion explosives.

ANP will be unloaded pneumatically into one of two 80 tonne overhead storage bins adjacent to the main building. It will be transferred to two 100 tonne stainless steel heating tanks in the manufacturing plant to produce AN solution (ANS). Off-loaded ANS will be unloaded into a storage tank.

Diesel fuel will be used in the manufacture of the emulsion-based explosive. It will be stored in a diesel fuel storage tank, located at least 25 m away from the manufacturing plan and will likely be re-supplied by tanker truck from the mine's central fuel farm.

A surfactant is required in the process. The material will be trucked to site in B-train tankers and pneumatically unloaded into a 35,000 L storage tank located inside the manufacturing plant.

Sodium nitrate and ethylene glycol are required for the emulsion production process and will be stored in a separate building in the compound.

The manufacturing process will also require some 10,000 L/d of clean water, to be sourced from the site water distribution system.

The truck storage/wash bay facility in the compound will have a sump and evaporation system for collecting wash water and wastes. The resulting residue will either be recycled into the manufacturing process or disposed of on site.

There will be four other explosives storage magazines located in strategic locations on the minesite. These will also be operated by the contractor. A 2.4m by 3.7m (8' x 12') magazine for boosters and occasional case powder and a 1.8 m x 2.4 m (6'x8') magazine for detonators will be required. The magazines will conform to standards set by the Department of Energy, Mines and Resources Canada. This includes each magazine being bullet-proof, fire resistant, theft-resistant, weather proof, and well ventilated. The magazines will be located a safe distance away from both the main site and any main structures or roads.

Emulsion explosive will be delivered to the appropriate pit for offloading into the pre-drilled blast holes using a vehicle specially designed for this purpose. Blasting will typically be done once per day. The explosives delivery vehicles will typically be able to load 20-25 holes per trip. An average pattern size of 90-100 holes will be completed and shot (blasted) the same day. In the winter months, the amount of snow at the minesite may dictate loading and shooting the same day.

During the filling of each hole with explosives, a Galore Creek employee will load the hole with a blasting cap and run detonating cord connecting the holes together for subsequent blasting.

Locations of the Explosives plant and the magazines were provided in Figure 8.9-3.

8.9.8.1 Regulatory Setting

Natural Resources Canada (NRCan) is responsible for regulating the use of explosives under the *Explosives Act*. Section 7(1)(a) of the *Explosives Act* states that the Minister of Natural Resources Canada must issue a license for an explosives factory (manufacture) and magazine (storage).

The following information must be provided to meet NRCan requirements:

- The type and volume of explosives that will be used on the Galore Creek Project;
- How the explosives will be transported, stored and used at the site;
- Safety measures that will be used to reduce the frequency of misfires and other potential incidents involving explosives; and
- An explosives monitoring program and safety/accident reporting program.

There are a number of other regulatory considerations in the design, construction and ultimate operation of the facility and use of explosives on the site. Several selected ones include:

- NRCan *Explosives Act*; Ammonium Nitrate Storage Facilities Regulations;
- Transportation of Dangerous Goods (TDG) Regulations;
- Explosives production building to meet Bulk Guidelines published by the ERD and local and federal regulations.

The Galore Creek project explosives facilities will comply with all regulatory requirements throughout the construction, operations and closure phases of the project.

8.9.8.2 Safety Considerations

NovaGold will be responsible for the safe management of explosives on the Galore Creek site. This will include the tasks contracted out to a third party. The Spill Contingency and Emergency Response Plan will be developed further as part of permitting will include details on the procedures to deal with any incidents involving explosives.

8.9.8.3 In-Pit Explosives Handling Plan

The explosives contractor will be responsible to supply and load the explosives materials to the mine boreholes. NovaGold employees will drill and dewater the mine boreholes and then prime, stem, tie-in and detonate the explosives.

Additional details of the plans for explosives use at Galore Creek will be determined during detailed design and mine permitting.

As per requirements of NRCan *Explosives Act*, the completed In-Pit Explosives Handling Plan will include the following elements:

- Estimate of quantities of various materials to be generated;
- Consideration of over-break and other reasons for likely adjustments to quantities of materials to be produced;
- Consideration of background information concerning ground control and water ingress problems;

- Segregation of ore, and of Potentially Acid Generating (PAG), Non Potentially Acid Generating (NPAG) and Acid Generating (AG) rock materials;
- Any plans for blending of waste materials for possible storage on surface if they cannot be relocated to the underground mine for long-term impoundment;
- Plans for backfilling mine workings;
- Final location of all mined materials.

8.9.8.4 Additional Considerations

Additional components in the final Explosives Management Plan will include:

- Detailed plans of the explosives plant site and individual facilities on the site. It will include detailed locations of various explosive materials and products and typical quantities within the compound. It will also include locations and description of various services and connections to the site (*e.g.* water, fuel, communications, etc); and
- Linkage to the Galore Creek Spill Contingency and Emergency Response Plan. This will include specific information concerning compatibility groups, emergency plans for various classes of explosive materials, criteria for initiation of emergency and evacuation plans, resources, detailed contact lists, review and testing plans, *etc.*