Wolverine Mine
OMS Manual - Tailings Facility

DEFINITIONS AND ABBREVIATIONS

Acid Rock Drainage (ARD)	Drainage of Acid water containing dissolved metals as a result of natural oxidation of sulfides found in waste rock, ore and tailings exposed to air and water.
Appurtenances	Structures and equipment within a tailings facility other than the dam itself. They include, but are not limited to, such facilities as pipelines, spillways, drains, intake towers, canals, low-level outlets and water treatment, control and release facilities. Also included are mechanical and electrical control and standby power supply equipment.
As-Build Drawings	Engineering drawings portraying the tailings facility and CCR dump as constructed, including all changes from the original engineering drawings implemented during construction of a facility.
Aspect	Elements of an organization’s activities, products or services that can interact with the environment.
Coarse Coal Rejects (CCR)	50mm x 1mm size fraction of waste product from the coal processing, hauled as construction material to the tailings embankment or to the CCR dump.
Continual Improvement	The process of enhancing the tailings and CCR management system to achieve improvement in overall coal refuge disposal performance.
Emergency	A situation which endangers life, property, the environment or the integrity of as tailings facility, and requires immediate action.
Environmental Impact	Change to the environment, adverse or beneficial, wholly or partially resulting from activities, projects and development.
Fine Tailings	1mm (100 mesh) x 0 size fraction of waste product from the coal processing, pumped as a slurry to the tailings impoundment.
Life Cycle	The continuum form initial conceptual design through construction and operation to closure of a tailings facility and CCR dump.

Owner	The person, company, organization or entity which is responsible for control, operation, and maintenance of the coal refuge facilities.
Risk	The combination of the probability of occurrence and the adverse consequences of a specified event which would be detrimental to operations, the public or environmental health and safety.
Starter Dyke	An engineered, earth-filled embankment built to contain the initial fine tailings produced from the processing plant. The starter dyke is within the footprint area of the final tailings embankment and is designed to contain about 0.65 million m^3 of fine tailings.
Significant Aspect	An aspect that has or can have a significant environmental impact.
Tailings Facility (TF)	All structures, components and facilities functionally to tailings impoundment, including but not limited to dams, spillways, decant structures, other water control and treatment structures and tailings pipelines.

OBJECTIVE

The purpose of this manual is to provide a system of operation, maintenance, and surveillance for the Tailings Facility. In addition, the manual contains an emergency preparedness and response plan to identify potential for accidents, to respond in emergency situations and to prevent and mitigate environmental and safety impacts. Specifically, this Operation, Maintenance and Surveillance (OMS) manual defines and describes the following:

- Roles and responsibilities of personnel assigned to the tailings facility.
- Procedures and processes for managing change.
- The key components of the facility.
- Procedures required for operating, monitoring the performance of, and maintaining the facility to ensure that it functions in accordance with its design, meeting regulatory and corporate policy obligations, and links to emergency planning and response.
- Requirements for analysis and documentation of the performance of the facilities.

Feedback shall be used to formally test and validate design assumptions and make improvements over time. The OMS manual provides details of this work. This manual shall be updated periodically as required following important events occurring at the tailings facility.

The main sections of this OMS manual pertain to management plans and procedures designed to ensure safe, efficient, and compliant operation of the Tailings Facility. There are six management plans that provide guidance for managing these facilities. Current versions of these plans should be considered preliminary as they need to be periodically updated based on operations experience, particularly for the experiences and learning that will occur during the start-up production period and continuous building of the dam structure.

Operations/ Construction	Maintenance	Surveillance/ Monitoring
• Water Balance • Filling Factors • Design Capacity • CCR Placement Plan – Tailings Facility • CCR Placement Plan – Dump • Tailings Placement Plan • Water Management Plan	• Standard Operating Procedure	• Monitoring and Surveillance Plan • Emergency Preparedness and Response Plan

This manual has been created to meet permitting requirements from the BC Ministry of Energy and Mines (conditions 4(c)(ii) and 4(d)(iv) of Permit C-223) and to provide Walter Energy Western (the Company) with a manual for implementation at the mine and as a base document to update as required.

This OMS Manual is complemented by the permit-level geotechnical designs for the Tailings Facility and Coarse Coal Rejects Pile and the Tailings Facility As-Built Report (prepared by Norwest Corporation in 2005 and 2006). Both, information in this manual, and the Geotechnical Design reports are needed to meet regulations and to construct the landforms efficiently and safely.

SCOPE

This manual applies to all Company employees and all contractors involved in the construction, operations, maintenance and surveillance of the tailings facility. Collectively the tailings facility refers to:

- The Starter Dyke,
- The Tailings Embankment (built with coarse coal rejects as an outward and upward extension to the starter dyke),
- The Tailings Pipeline and Spigots, used to deliver (by pumping from the thickener) a slurry of tailings to designated points within the impoundment area,
- The Process Water Reclaim system, used to pump and deliver process make-up water from the impoundment pond back to the processing plant,
- The Seepage and Drainage control systems, including the upstream drain, the downstream blanket, the seepage interception ditch and downstream toe drain and,
- The instrumentation, including vibrating wire piezometers, slope inclinometer, and magnetic extensometer settlement gauges.

RESPONSIBILITIES

Walter Energy Western Coal is responsible for the safe construction, operation, reclamation, and closure of the Tailings Facility. This section of the OMS Manual defines the specific individuals and their respective responsibilities.

OMS Manual Preparation, Updating and Document Control

The initial preparation and review of this manual was completed by personnel from the Company and Norwest Corporation. Specifically the manual development team consisted of:

Walter Energy Western Coal:

Al Kangas	Mine Manager
Kresho Galovich	Technical Services Manager
John Moberg	Mine Manager
Dan Mcneil	Chief of Engineering and Geology
Leke Fadiya	Senior Mine Engineer
Darren Cowan	Environmental Superintendent
Romeo Cabanayan	Project/Geotechnical Engineer

Norwest Corporation:

Richard Dawson	VP, Geotechnical
Michael Graham	Senior Geotechnical Engineer
Walter Rathbun	Geotechnical Engineer

This OMS manual is a controlled document through the Company's guidelines for policy and procedure development. Controlled activities include updating and reviewing, distribution and filing, and removing and archiving. Each copy of the manual shall be numbered to ensure proper control and updating.

The Company's Chief of Engineering and Geology is responsible for controlling the manual and ensuring all reports listed as references are readily available at the mine site and at Vancouver office. Printed copies of this manual shall be filed at the following offices:

1. WEWC Vancouver office:
    - VP Operations
    - VP, Environmental and Regulatory
2. Wolverine mine site:
    - General Manager
    - Mine Manger
    - Technical Services Manager
    - Chief of Engineering and Geology
    - Plant Manager
    - Principal contractor(s) involved with construction
3. BC Ministry of Energy and Mines

The manual shall be updated from time-to-time, as events dictate or through a process of continuous improvement. Examples of events that may trigger updates include:

- Completion of construction milestones.
- Changes in regulations or approvals.
- Following significant incidents.
- Following performance reviews.
- Following or along with design changes.
- Following changes in corporate policy.

The reporting documentation generated by the monitoring and surveillance described in this manual shall be formally filed in a document management system. For each monitoring and surveillance event, action plans shall be drawn up and implemented if required and a record of repairs or maintenance documented.

This manual and its implementation shall be reviewed annually.

Organization Structure

The specific roles and responsibilities for the operations, maintenance and surveillance of tailings facility at the Wolverine Mine are described in the attached section and based on the following organization structure as presented below.

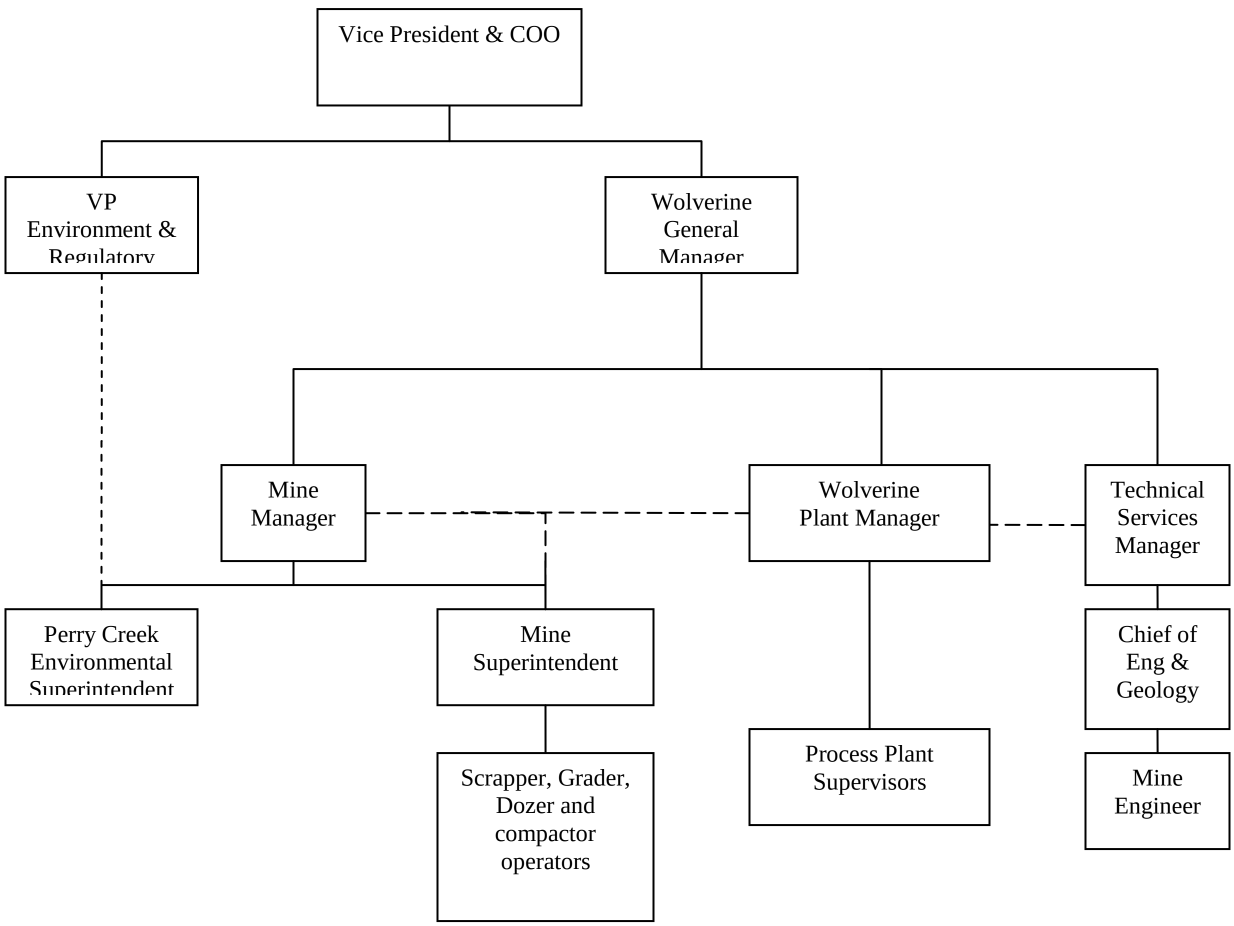

Figure 1 - Wolverine Mine Organization Chart

Responsibilities

1. The General Manager is responsible for:
   i. Providing the resources needed for the ongoing visual monitoring, instrumentation, analysis and review, documentation, updating and general administration of the manual and its prescribed activities.
   ii. The safe construction, operation, reclamation and closure of the tailings facility.
   iii. Ensuring that all tailings embankment failures are investigated.
   iv. Notifying the District Mines Inspector within 16 hours of a dangerous occurrence (example: tailings embankment failure).

2. The Wolverine Mine Plant Manager is responsible for:
   i. Overseeing the activities of plant personnel involved in handling CCR from the CCR loadout bin and the maintenance of tailings line, decant/reclaim water source and spigot system.
   ii. Periodic and documented inspections of the tailings pipeline, spigot points and process water reclaim system

3. The Technical Services Manager/Mine Manager is responsible for:
   i. Overseeing the activities of employees and contractors involved in the placement and compaction of CCR used to construct the tailings dam embankment.
   ii. Ensuring compaction meets the 95% SPD requirement.
   iii. ARD characterization of CCR placed in the embankment and tailings placed in the impoundment.
   iv. Conducting periodic and documented inspections of the embankment and water seepage and drainage systems.
   v. Collecting and reviewing information from the instrumentation systems.
   vi. Arranging third party engineering reviews.

4. The Environmental Superintendent is responsible for:
   i. Conducting periodic inspections of the surface water diversion structures.
   ii. Reviewing the geochemical characterization of CCR and tailings in conjunction with surface and ground water monitoring results.

5. All employees working on the tailing facility are responsible for ongoing visual inspections of the Tailings Facilities and reporting abnormal conditions to the Plant or Technical Services Manager.

Competency and Training

For the ongoing safe and reliable operation of this facility, it is critical that the people assigned to shoulder the responsibility are competent to perform their role by way of training, experience and character. They must be supported with adequate resources including time, qualified staff, and budget.

All participants must have a working knowledge of this Manual.

In particular, a training manual for the installation, maintenance, reading, and interpretation of geotechnical instrumentation and visual observations shall be developed and implemented (refer to the Instrumentation section of this manual).

As well, the site orientation for all staff and others working on the site shall include a brief chapter on what to look out for visually and who to contact in case of concerns when operating around these landforms. In particular, there are some landforms with restricted uses / access – this should be periodically communicated to workers.

Managing Change

One of the key features of this manual is that it must be updated whenever a significant change occurs to the design, operation, monitoring, or maintenance of the facility. This responsibility lies with the Technical Services Manager.

The importance of adequate management of change cannot be overstated. Changes to any components can affect the performance of this landform as a whole – there are many interdependencies and there are certain complexities inherent in the system. Change management systems are most successful when the following exist:

- There is a holistic approach to the design, construction, operation, and surveillance and that consideration of the sum of these is considered whenever a change to any one is being planned.
- Clear responsibility for the management of change process is identified.
- There are adequate resources allotted.
- There is effective communication of changes.
- There is periodic review.

The manual is to be reviewed, updated, and improved in response to the following kinds of changes (Mining Association of Canada’s 2010 guide):

- “Evolution of design through capacity changes, operational efficiencies, closure requirements, performance feedback and life-cycle changes;
- Incorporation of as-built records of construction;
- Variation of performance from design, temporary changes made to approved designs and plans;
- Changes in site management personnel, organization, facility description, roles and responsibilities, and operating and reporting procedures;
- Suggestions for improvement;
- Succession planning / training; and
- Responding to regulatory changes.”

GENERAL INFORMATION

Overview

The Wolverine Mine is located approximately 725 km north of Vancouver, British Columbia and 25 km from Tumbler Ridge, B.C. Refer to Figure 2 (Regional Map). Key landform features constructed through the twelve year operating period of the mine include:

- Wolverine pit
  - Phase 1 - Mined-out
  - Phase 2 - Mined-out
  - Phase 3/3B - Mined-out
  - Phase 4A - Idled

- Three external waste dumps
  - South Dump
  - North Dump and
  - East Dump (and W6 Rock Drain)

- The Coarse Coal Reject (CCR) Dump

- The Tailings Embankment and contained tailings storage

- Six water management settling ponds
  - SP18
  - SP14
  - SP12
  - SP6
  - SP4
  - Exp. Pond

- Three major diversions
  - CCR dump Diversion
  - Upper Diversion and
  - North Diversion

Refer to Figure 3: Wolverine Mine Site Layout on the tailing facility section for location and footprint. Other infrastructure includes the raw and clean coal handling system, coal preparation plant, thermal dryer, shop/warehouse/office complex and explosives storage site.

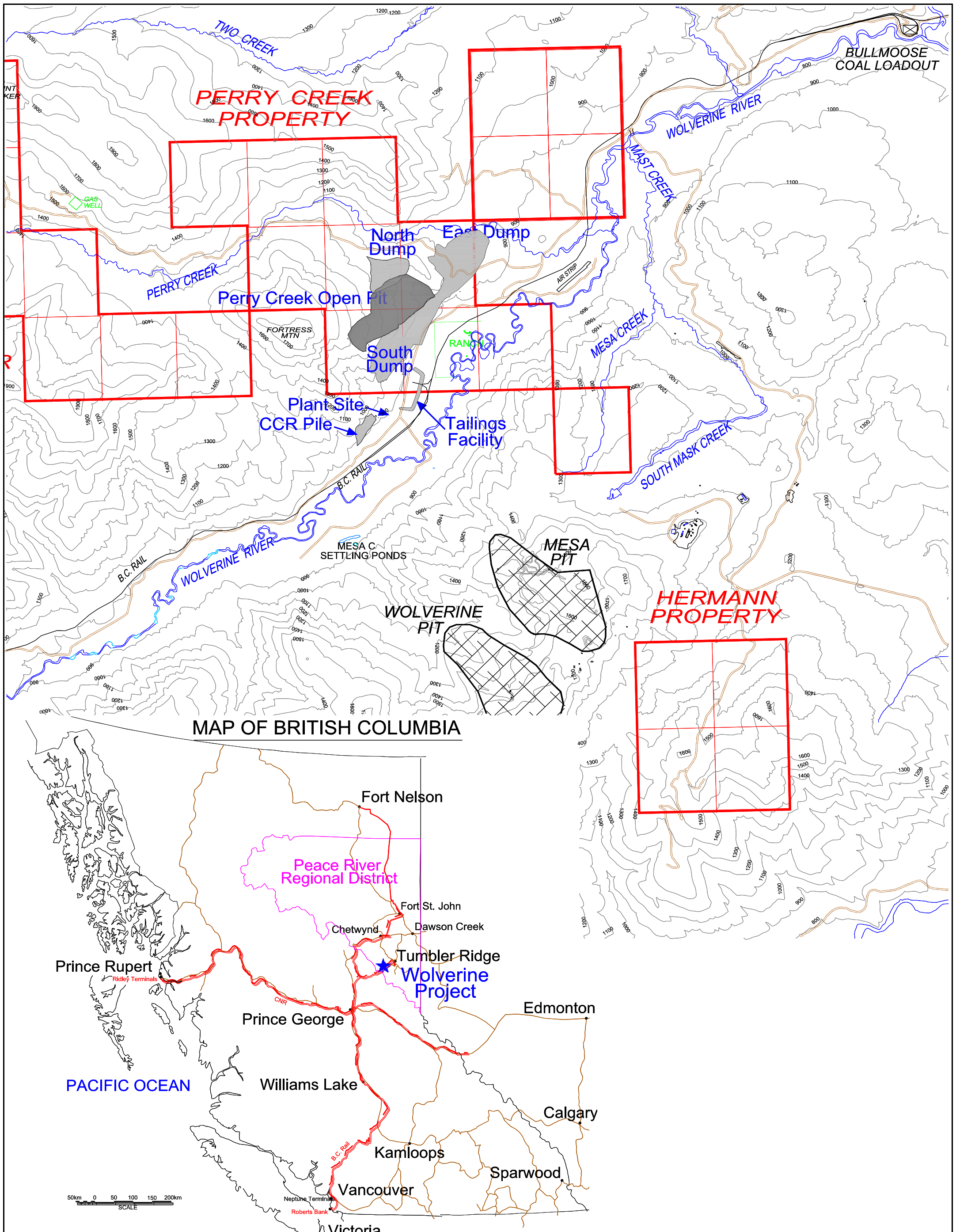

Figure 2 - Regional Map

Site Conditions

Climate

The Wolverine Mine site is located in the Eastern Rocky Mountains at elevations between 850 and 1750 masl. The following account is adapted from Western's Additional Information Report (Western Canada Coal Corp, 2004).

Mean daily temperatures range from about 15º C in summer to about -10º C in winter and are generally above freezing between April and October. Freezing conditions are practical throughout the year at higher elevations. Maximum temperatures recorded at nearby weather stations range from 27 to 32º C. Very cold weather (less than -30°C) frequently occurs during cold spells in January and February.

Based on extrapolation from nearby weather stations, total annual precipitation (rain and snow) of 580 millimeters is predicted for the Wolverine site. Weather has an important impact on material placement, water management, and long-term landscape performance. Geotechnical designs take into account the present climate of this region.

Table 1 - Wolverine Weather Data: 5 Year Average (2008 - 2012)

Month	Min. Temp. (°C)	Max. Temp. (°C)	Ave. Temp. (°C)	Max. Wind Speed (km/h)	Ave. Wind Speed (Km/h)	Ave. Wind Direction (degrees)	Total Rainfall (mm)
Jan	-32.35	8.35	-8.16	59.16	14.97	172.71	3.64
Feb	-27.33	9.83	-5.6	55.28	13.78	177.15	0.76
Mar	-25.59	7.22	-4.04	52.4	10.99	146.35	1.26
Apr	-11.38	15.78	1.48	46.5	11.44	170.24	3.8
May	-5.49	21.63	6.89	44.5	11.55	176.83	5.24
Jun	-0.73	24.37	11.29	44.68	12.8	191.31	8.11
Jul	2.82	27.57	14.85	45.41	12.3	188.21	16.77
Aug	0.37	29.04	14.15	49.58	11.47	180.86	10.1
Sep	-2.73	26.17	10.54	50.13	11.36	188.49	7.75
Oct	-11.38	19.19	2.77	48.12	12.21	168.17	9.56
Nov	-24.32	11.13	-3.84	53.45	12.83	168.93	8.62
Dec	-33.07	7.45	-10.88	55.93	11.16	148.91	1.92

Surface Water Hydrology

The Wolverine River flows in a north-easterly direction adjacent to the site and extends approximately 45 kilometers from its headwaters to its discharge point into the Murray River, approximately three kilometers west of Tumbler Ridge.

There are several tributaries that drain seasonally through the site into the Wolverine River. These types of steep mountain streams can be subject to large flows during spring freshet. Surface water diversions (shown in Figure 2) shall route surface water away from the three dump footprints. Runoff and seepage from the three dumps shall be routed into watercourses below each dump and through sediment control structures. Management of water and snow on the dumps is an important aspect of design, and in particular, the operation of these dumps.

All the creeks that affect the dumps are ephemeral (they do not flow all year round) with the exception of the lower reach of the W6 tributary. A rock drain (between the South and East Dumps) shall pass the W6 tributary. An ephemeral tributary of W6 shall be largely buried by the North Dump. To accommodate seepage flows from this creek, a pervious zone shall be constructed along the axis of the creek. The design hydrology for the W6 Rockdrain is presented with East Dump.

Topography and Landforms

The pre-mining landforms (see Norwest 2004) include the following:

- Foothills: rolling mountains/hills of 600 to 1000 meters height comprised of Cretaceous sedimentary bedrock.
- Wolverine River floodplain: flat, swampy, valley-fill sediments of clays, silts, and gravels.
- Glaciofluvial terrace: sand and gravel terrace along the flanks of the East Dump and part of South Dump.
- Alluvial fans at the base of the larger ephemeral streams.

Geology and Geochemistry

The bedrock on the Wolverine Property ranges in age from Late Jurassic to Early Cretaceous and consists primarily of inter-tonguing clastic lithologies of both marine and continental origin, with most of the coal-bearing strata reflecting a deltaic depositional environment (Western Canada Coal Corp, 2004).

The Wolverine pit is the trough of a broadly shaped syncline between the Wolverine and Perry Creek Valleys (Norwest Corporation, 2003). The coal is contained within the Gates Formation with a total thickness of about six to eight meters.

The surficial geology includes glacial and post-glacial sediments that include a thin mantle of glacial till, glaciolacustrine sediments that fill the valley floors, a glaciofluvial sand and gravel terraces, active river alluvium (silts and clays) and alluvial / debris fans from the mountain watercourses. The Geotechnical Design provides additional information and characterization of these deposits.

In terms of dump operation the key elements that relate to the geology are as follows:

- The dumps are generally underlain by zero to four meters of glacial till and colluvium. The failure mode considered is a foundation failure along these materials (though this is unlikely).
- The East Dump is founded on a broad glaciofluvial terrace which shall provide good foundation conditions.

Natural Hazards

The following table provides information on natural hazards in the region.

Table 2 - Natural Hazards in the Wolverine Permit Area

Category	Hazard	Comment	Potential impact
Meteorological	Snowstorms, cold wave	Normal component of winter operations in region	• Need for slow clearing • Productivity • Avoid burying layers of snow in dump
	Rainstorm	Control of surface water is important to safety and stability	• Monitoring of roads and dumps for washouts and ponded water
	Flood	Concern for Wolverine tributaries and diversion system	• Washouts monitoring roads and diversion system
	Fog	Mainly a concern for traffic on roads and dumps	• Adjust traffic patterns and speeds.
	Lightning	Uncommon	• Adjust field operations during periods of lightning
	Forest fire	Uncommon	• Develop procedures for avoiding triggering fires and reacting to forest or brush fires
Geomorphic	Snow avalanche	Not usually a concern	• Productivity • Need for slow clearing
	Earthquake	Very low seismic area	• Factored into design, inspection of facilities if earthquake occurs
	Landslide / debris flows	Concern for Wolverine tributaries. Some landslide scars at high elevation west of mine site	• Covered under Watercourses OMS (Piteau Associates Ltd, 2004)

Land Tenure

The following information is summarized from (Western Canada Coal Corp, 2004). The project area is 25 kilometers from the nearest town, in an area that is unsettled except for one nearby privately owned ranch. There are, however, a variety of land uses and facilities taking place presently which include:

- Traditional use by First Nations people
- BC Rail Line
- Wolverine Forest Service Road (FSR) and other forestry roads including the Perry Creek Road (a non-status road). Forest harvesting has occurred in parts of the region
- Oil and gas exploration
- Hunting, guiding, trapping, and winter recreation
- Fishing - fisheries values in lower Perry Creek and the Wolverine River are high
- Wildlife species of management interest include grizzly bear, mountain goat, and caribou

Tenure holders whose interests overlap the project area include twelve PNG leaseholders including Talisman Energy, Shell Canada, and Koch Petroleum, as well as Canfor, BC Rail, BC Hydro, one trapper, one guide-outfitter, and owners of one private property (Terry Ranch).

Vegetation and Ecosystems

Aside from subalpine areas at higher elevation, the site is forested predominantly with fir and spruce. The dominant ecosystems are the ESSFmv2 (Engelmann Spruce Subalpine Fir) found at upper elevations and SBSwk2 (Sub-Boreal Spruce) found at lower elevation. Additional ecosystems include variants of the above and non-forested units in the subalpine parkland or subalpine transition.

Forest productivity ranges from non-existent in the subalpine to moderate on the lower slopes to high-productivity units in the wetter SBSwk2 site series. For more information, see Western's Additional Information Report (Western Canada Coal Corp, 2004) from which the above is adapted.

Numerous species important to traditional land use are present at the site. None are regionally rare (Keystone Wildlife Research, 2004).

Tailings Facility

The following are salient features of the tailing dam appurtenances with related brief description on their importance, use and other specifications.

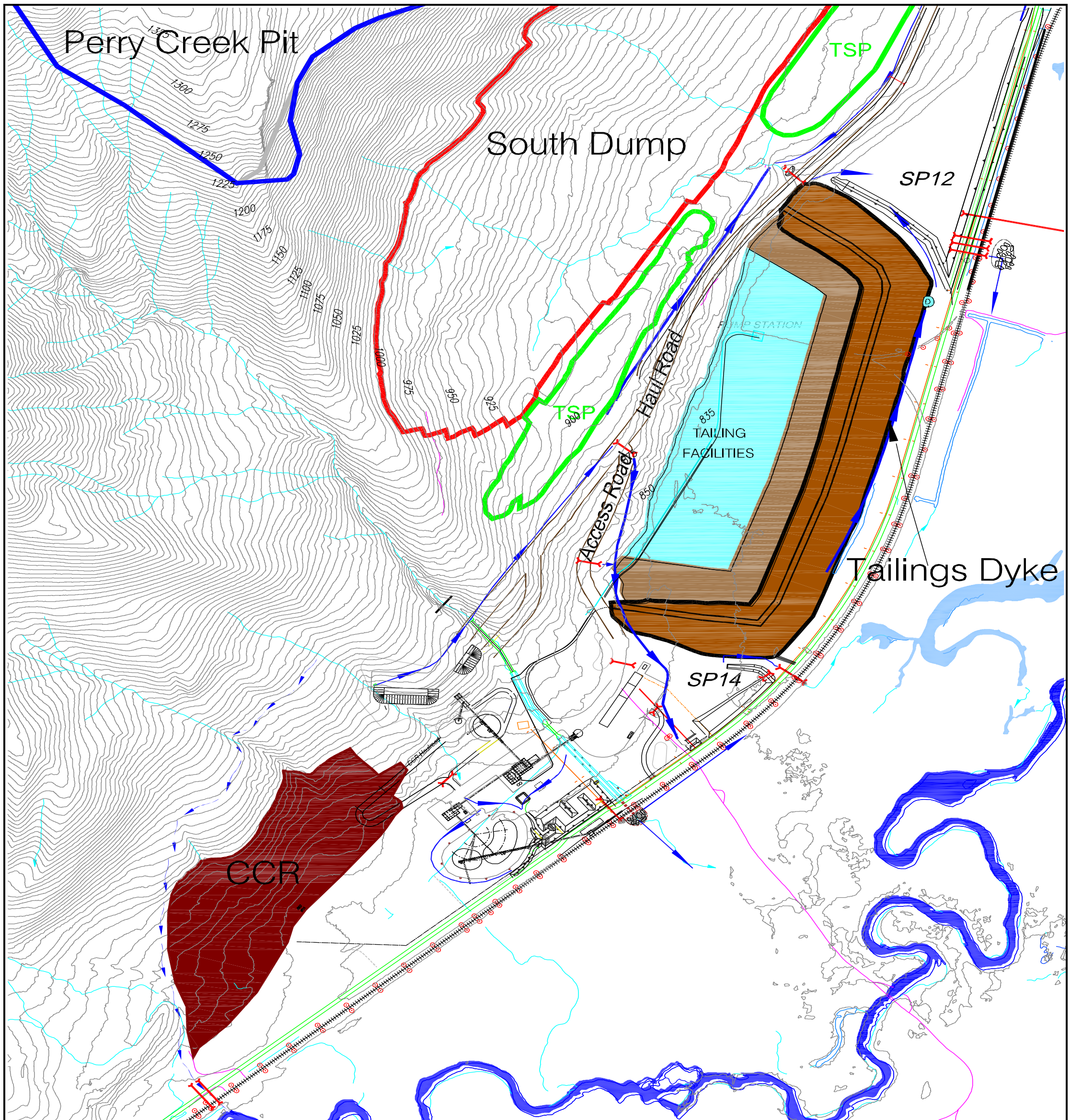

Figure 3- Tailings Facility and CCR Pile Locations.

Design

The ultimate tailings dyke was previously designed to be a 12-17m high engineered dyke founded on the Wolverine River floodplain sediments constructed from borrow fill (starter dyke) and compacted CCR material. The completed starter dyke is a 5-9m high structure built from engineered fill. For a complete record of the starter dyke construction see Tailings Facility Starter Dyke As-Built Report (Norwest, 2006). Fine tailings will be pumped out to the dam and deposited as slurry. The solids settle out as a beach and the free water runs off into the pond to be recycled back to the process plant.

This dyke structure was raised by 5 meters to 852 masl from the original design of 847 masl. The downstream toe footprint of the tailings dam was completely expanded September 30, 2010 prior to the planned increase in crest elevation to 852 masl.

Infrastructure

Various infrastructures are integral to the operations of the Tailings Facility including the equipment access road, Wolverine FSR, BC Rail line, power supply and transmission lines.

Access to the tailings dyke crest will be provided by a ramp that was constructed as part of the starter dyke at the south abutment. The ramp allowed traffic to drive from the equipment access road on to the crest of the tailings dyke in order to facilitate placement of the CCR material and perform periodic inspections of the facility.

Currently, the mode of access going into the tailings facility is through the main crest elevation of the dam embankment. Most of the dam crest has been constructed to the ultimate elevation of 852 masl. About 300 meters of crest at the north side of the facility still requires to be raised to its ultimate elevation.

The Wolverine FSR and BC Rail line run parallel to the downstream toe of the tailings dyke. The Wolverine FSR provides access to the mine site from Tumbler Ridge. The rail line will facilitate the shipment of coal to either the Ridley Terminals in Prince Rupert, BC or the Neptune Terminals in Roberts Bank, BC.

There are two power transmission lines (25 kV and 4.16 kV) that run parallel to the downstream toe of the Tailings Facility. The 25 kV line is the main power supply brought in from the Tumbler Ridge sub-station to the mine site. The 4.16 kV power line provides power to the pumping systems (reclaim water, upstream toe drain, down-stream toe interceptor ditch and future interceptor wells associated with the tailings facility).

In April 2009, the 4.16 kV power line was re-routed along the Perry Creek Road at the east side of the tailings dam upstream.

Three (3)-30 hp submersible pumps in the decant tower reclaim water at the tailings dam are energized by the 4.16 kV line along with the necessary heaters to preclude freezing on the pumps during winter. These heaters have a rated capacity of 15 kW each.

The existing decant tower was completely extended to 847 masl on November 2010 allowing better pumping of reclaim water from the tailings facility back to the process plant especially during the winter season.

About 1,400 meters of 10-inch diameter polyethylene (PE) pipelines were laid along the upstream perimeter of the tailings embankment where tailings is discharged into the tailings facility through spigots. There are also thirteen (13) spigots installed in series at equal interval that aide even distribution of tailings into the dam to develop a 100-meter tailings beach from the upstream toe of the tailings dyke. The spigots are spaced about 90-100 meters apart.

Supporting Documentation and Reports

- Wolverine Coal Project – Environmental Assessment – Addendum Report, May, 2004
- Wolverine Coal Project – Environmental Assessment – Addendum Report, July, 2004
- Wolverine Coal Project – Application for a Mines Act Permit Approving the Mine Plan and Reclamation Program, December 8, 2004.
- Wolverine Coal Project – Technical Assessment Report, Part 7 of the Effluent Permit Application (PE-17756), March 2005.
- Wolverine Coal Project: Permit-Level Geotechnical Designs for the Tailings Facility and Coarse Coal Reject Pile, January, 2005 (prepared by Norwest Corporation).
- Wolverine Coal Project – Environmental Assessment Certificate and Mine Permit Amendments, 2.4mtpa, May, 2005.
- Western Canadian Coal – Environmental Management System, June 2006.
- Wolverine Tailings Facility Starter Dyke As-Built Report, June 2006 (prepared by Norwest Corporation).
- Wolverine Coal Project – Mine Permit Amendment: Tailings and CCR Management Plan, April 2007 (prepared by Norwest Corporation).

Design / Reference Documents

Document	Drawing #
Permit-Level Geotechnical Designs for the Tailings Facility and Coarse Coal Reject Pile (Norwest, 2005)	1
	2
	3
	4
	5
	6
Starter Dyke IFC Drawings rev.01 & 02 (Norwest, 2005 & 2006)	1
	2
	3
	4
Tailings Facility Starter Dyke As-Built Report (Norwest, 2006)	1
	2
Water Management Facility Design Report (Piteau Associates Ltd. and KWL, 2004)	1140-220-1-201
	1140-220-1-202
	1140-220-1-203
	1140-220-1-204
	1140-220-1-205
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OPERATION

Standard Operating Procedures

Fine tailings and coarse coal reject (CCR) are produced as mine waste from the processing of ROM (run-of-mine) coal. A simplified diagram of the coal process is shown below. The coarse coal reject is produced as a "dry" product and it is trucked to the tailings dyke as construction material or to the CCR pile for dry storage. The fine tailings are produced as slurry and pumped to the Tailings Facility for "wet" storage. The proportions of dry coarse and wet fine materials, the placement densities and the capacities of the storage areas define the filling rates and ultimate containment capacities.

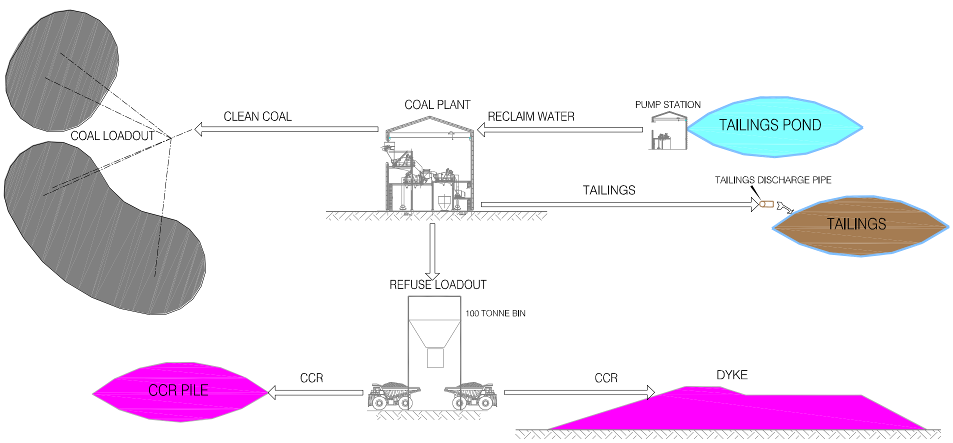

Figure 4 - Simplified Coal Process Diagram

CCR and Tailings Placement Plan

CCR production and placement into the tailings embankment began end of July, 2006. A program of handling and compaction trials was undertaken by Norwest Corporation and Peace Country Technical Services Ltd. Results of those trials have been used to develop the following placement, compaction and quality control procedures and the initial placement plan. Ongoing testing and trials will be compiled. This OMS manual may contain some updates and changes to the CCR Placement Plan for the Tailings Facility as experience and practical knowledge arises during the operation period.

The Manager of Engineering and Geology ensures guidelines are provided to all personnel responsible for CCR placement and compaction on the tailings facility. These guidelines will address placement area, placement practices and compaction requirements.

The Chief of Engineering and Geology and Environmental Superintendent will designate technical personnel to conduct sampling and testing on the CCR for ARD characterization and compaction density.

Table 3 - Placement, Compaction, and Contingency Guidelines for CCR Placement on the Tailings Facility

Particulars	Summer	Winter
Placement	• Remove/scrape standing water before placement. • End-dumped piles (from haul trucks) should be spread and graded in 30cm (12") thick, 8m (25') wide lifts immediately after dumping. • Keep lifts as long as possible, working from upstream (starter dyke or crest) to downstream. • Scrapper trucks should spread the specified CCR lifts (max. 6") for CCR placement. • Prior to compaction, lifts should be graded to provide a -4% cross-slope towards the upstream side.	• Remove all snow and ice prior to placing CCR. Scarify the receiving surface to ensure a bond between layers. • End-dumped piles (from haul trucks) should be spread in 15cm (6") thick, 8m (25') wide lifts immediately after dumping. Keep lifts as long as possible, working from upstream (starter dyke or crest) to downstream. • Scrapper trucks should spread the specified CCR lifts (max. 6") for CCR placement. • Prior to compaction, lifts should be graded to provide a -4% cross-slope towards the upstream side.
Compaction	• Should immediately start within 10 minutes after scrapper spread CCR. • Compaction should be made with a minimum of 4 passes. • Do compaction tests with an annually calibrated TROXLER Surface Moisture-Density Gauge. • Compaction shall have at least 95% SPD. In case the compaction result is below 95% SPD, compaction should be repeated in that particular area of the dam.	• Start compaction immediately after the CCR is spread: - Minimum of 12 to 16 passes (back and forth) in a staggered pattern, with a haul truck - Minimum of 8 passes with the vibratory roller packer • CCR should not be allowed to freeze before compaction is achieved. • If the above placement and/or compaction guidelines (95% SPD) cannot be met the CCR will be hauled to the winter stockpile.
Contingency	• Grading of high spot and filling at the low spot with a grader will be done to prevent ponding of water at the dam crest. • All CCR spread on the dam should be compacted before end of the shift.	• CCR placement should never be attempted on the dam when the outside temperature is below minus 12 degree centigrade. • Scrapping of snow accumulation should be periodically done towards the downstream slope to preclude thickening of snow on the crest.

Tailings Deposition Plan

The tailings deposition plan is developed for the expected life of the mine. Deposition plan can allow for the staging of dam lifts over the life of the mine to accommodate long-term storage of tailings solids, maintain adequate solid storage capacity, and allow adequate polishing of supernatant during operation of the mine.

The deposition plan development includes the gathering of information on tailings slurry quantity and density and production every month. This would provide the total volume contained in the dam and use these parameters on the future level of solid to be placed in this impoundment facility.

To ensure the stability of the Tailings Facility, the following three elements of operational freeboard must be maintained at all times:

- The tailings beach shall be no higher than one meter below the crest elevation
- The tailings pond shall be no higher than two meters below the dyke crest elevation
- The tailings pond shall be no closer than 100 meters (horizontally) from the upstream crest of the tailings dyke

The two meter freeboard and the 100 meter minimum beach width are designed to keep the dyke geotechnically stable even as it undergoes considerable foundation consolidation settlement. The dyke crest is defined as the lowest point of the dyke crest at any given time.

The decant system should be operated and maintained in accordance with these criteria, although during early stages of deposition water will impound directly against the face of the starter dike until sufficient tailings beach has formed to control the pond location and level. Norwest has prepared an “initial tailings placement plan” for placing tailings in a north to south manner during the early stages of production; the plan is contained at the end of this section and is an important operational plan for early tailings placement during the first year of production. Subsequent tailings placement will require additional plans based on updated operational data.

In order to control the phreatic surface within the dam during tailings placement there must be an upstream drain pipe with risers for pumping. This system will be especially useful to control ponding of water near the dam face during early operations and afterwards as the steady state seepage conditions develop. As an initial operating basis, water in the riser pipes should be maintained at an elevation 833-834m elevation.

Tailings and CCR Filling factors

The table below shows the design filling factors derived from the ratio of fine/coarse plant feed, the specific gravity of the particles and estimated dry density; expressed as ROM tonne and clean tonne basis. At full production rates of 3 million clean tonnes per year, the filling factors predict annual deposit volumes of 0.425 million m^3 wet fine tailings and 0.730 million m^3 "dry" coarse coal reject (CCR). Expressed in terms of percentages, the tailings deposits consist of about 37% fines needing engineered containment and up to 63% CCR which can be used to construct the containment. The relatively large proportion of CCR provides an abundant source of construction material for raising the dam.

Table 4 - Tailings and CCR Filling Factors

Particulars	Process/Deposition Parameters		Filling Factors	
			m^3/ROM tonne	m^3/clean tonne @ 67% yield
Fine Tailings	Fines/Total Tails (dry)	26%	0.09	0.13
	Specific Gravity (Gs)	2.0 (65% ash)		
	Dry Density	0.9 t/m^3		
Coarse Coal Reject (CCR)	Coarse/Total Tails (dry)	74%	0.16	0.24
	Specific Gravity (Gs)	2.0 (65% ash)		
	Dry Density (t/m^3)	1.5 t/m^3		

Tailings Production Rate

The figure below shows the tailings production rate (in terms of deposit volumes) based on a clean coal production profile of 2 mta for the first 16 months and 3 mta thereafter. This figure shows that it will take about 2 years to fill up the starter dyke impoundment and about 5.5 years to fill the final impoundment up to the 847m level. The figure also shows that once the starter dyke is complete there will have been about 1.2 million m^3 of CCR produced. There is only about 1 million m^3 required to complete the dam up to 847m elevation beyond the starter dyke. The filling curves require regular updating with pond surveys and production measurements to ensure that containment is adequately staged ahead of tailings storage.

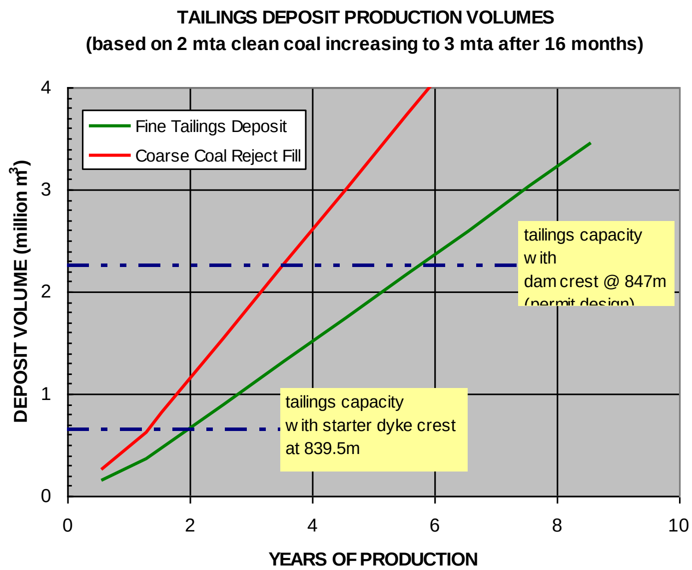

Figure 5 - Tailings Production Volumes

Design Capacity

The figure below shows the filling curve for the tailings facility based on a 1% deposit beach slope. The starter dike (crest at 839.5m) and the first lift (crest at 847.0m) can store 0.65 million m^3 and 2.26 million m^3 respectively. There is about 0.22-0.26 million m^3 of tailings storage for each 1m of dike height. As of the idle of the Wolverine Mine in 2014, the remaining tailings capacity was determined to be approximately 1,732,000 m^3 upon completion of the northern abutment to 852.0m.

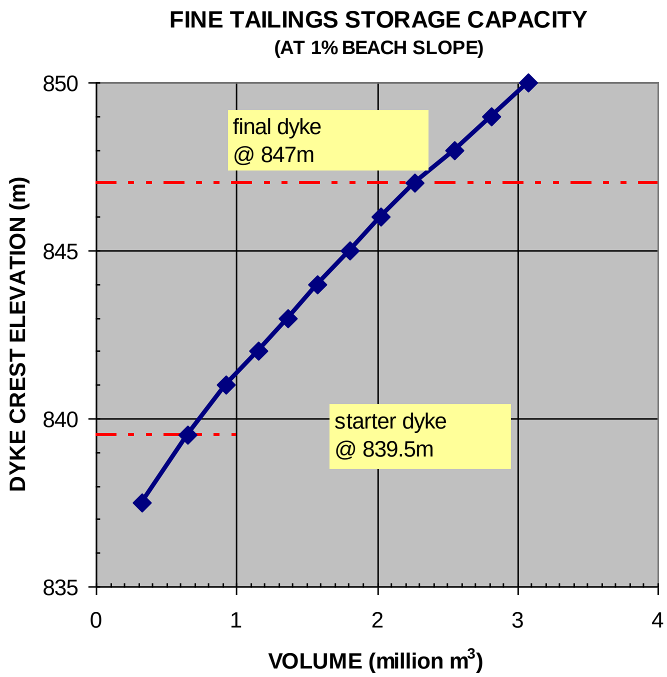

Figure 6 - Fine Tailings Storage Capacity

Water Management Plan

All potential sources of water run-off diverting into the tailings site catchment area should be identified, measured and recorded. Determine the maximum water inflow going into the dam as this will establish an actual experience data and compare and understand the variance from the design parameter established during the course of the feasibility study. Catchment ditches are constructed to divert water inflow into the dam.

Water Balance

The table below shows the water balance derived from the Mine Permit Amendment Application (WCC, July, 2006). The water balance shows that up to 50% of the process water requirements will be derived as recycle from the tailings water recovery system. The water balance should be regularly updated with measurements of losses and storage in the Tailings Facility.

Table 5 - Water Balance

Particulars	Moisture % (total weight)	Dry Solids t/h (db)	Water t/h	Total t/h (arb)
Plant Feed	6.0	550	35	585
Coarse Plant Refuse (CCR)	13 to 15	84 to 196	14 to 84	98 to 230
Tailings (as it leaves plant)	60 to 70	30.3 to 60.7	91 to 107	123
Clean Coal Dryer Feed	10 to 12	297 to 430	35.8 to 50.2	3337 to 430
Clean Coal Product	6.0	289 to 420	18.4 to 26.8	307 to 447
Plant Make-up Water annual avg. (before tailings recycle)			124	
Peak Plant Make-up Water			200	
Tailings Water Recovery			0 to 124 (avg. 59)	

Tailings Seepage Interception Ditch and Sump Pump

The toe drain ditch along the outside toe of the downstream toe drain of the tailings dyke is intended to act as an interception trench, and collect any seepage from the tailings impoundment that remains above the layer of silty clay that confines the valley bottom aquifer. It will also induce a small amount of upward seepage from the valley bottom aquifer into the trench. In order to do this, the water level in the trench should be maintained within 300 mm of the trench base.

The Flygt BS 2125 dewatering pump is therefore placed in a sump at an elevation that will allow it to operate at up to its nominal capacity of 35 to 40 L/s when the water level in the immediately adjacent interception channel is at 831.2 masl elevation. A staff gauge shall also be placed in the sump to monitor the rise of water level in this sump. The pump will run continuously and equipped with an automatic shut-off device when the water level in the sump subsides and run when water level rises again. Typically, there should be two units of submersible pumps stationed at this sump as one serving as back-up unit.

The discharge line from the toe drain dewatering pump will be pumped directly to the process plant via the reclaim water lines or pumped back to the supernatant pond in the tailings impoundment pond. The discharge pipeline will be laid passing to the north end of the dam and joined with the reclaim discharge pipeline of the tailings pond. In the event of a power outage, the line should be designed to drain automatically to prevent freezing during the winter months. Ideally, the sump should also have a heater, so that the pump will not freeze in the event of a pump malfunction or temporary power outage.

The pump operation will be checked daily, and pump repairs or replacements made as required. Flows should be monitored with a cumulating flow meter.

Until an initial lift of coarse coal reject (CCR) has been placed over the stripped area between the starter dyke and the downstream toe drain, it will be necessary to dewater in this area to place the CCR. The dewatering capacity for the seepage interception trench will probably have to be reserved for the CCR placement dewatering operation during most of the first year of tailings operations. This initial operation period is discussed in the following section.

Dewatering for CCR Placement

The area of CCR placement is dewatered at the time the CCR is actually placed. The Flygt BS 2125, and possibly a second pump, will have to be deployed to achieve the necessary dewatering. All dewatering flows must be returned to the tailings impoundment after tailings discharge has started, as this pump will be intercepting tailings seepage. Flows should be monitored with a cumulating flow meter.

The water table in the CCR placement area will fluctuate seasonally and will be highest in the late spring and early summer months. Ideally, CCR should be placed in the low area north of the 'wye' by the start of the 2007 freshet, so that groundwater in the underlying aquifer will be confined by the CCR when the higher water table condition occurs. In order to achieve this, CCR should be placed as far north as possible, based on the level of groundwater control that can be attained. This would allow CCR to be placed in the more southerly, higher elevation areas during periods of high water table, when it may be difficult to adequately dewater the lower lying northerly areas. If placement starts at the south and works to the north in a straight progression, filling may reach the lower lying areas when the water table is highest.

The dewatering pump capacity may limit the level of drawdown that can be maintained between the starter dyke and the toe drain berm. It is important to maintain sufficient drawdown to prevent flow from this area exiting out through the culverts on either end of the 'wye'. If pumping capacity is not sufficient to maintain adequate drawdown, it will be necessary to divert some of the valley bottom alluvial aquifer groundwater that is discharging up into the starter dyke foundation, to reduce the demand on the dewatering pump(s). This can be achieved by the method described below in the Modifications to Culvert Inlets and Ditching section.

Monitoring Wells

Water levels in monitoring wells TMW-1, TMW-2, TMW-3, TMW-4 and TMW-5, and interception wells ITW-A, ITW-G and ITW-C are measured monthly and entered into the customized spreadsheet. Plots are to be produced quarterly (i.e. three hydraulic gradient profiles per plot).

The hydraulic grade line determined from the monitoring wells and interception wells should be a minimum of 300 mm above the ditch invert. In the winter months, this hydraulic grade line may fall below the minimum level. In the freshet, the hydraulic grade line could be as much as 1.5 m, or possibly more, above the ditch invert.

In this situation, the operating level in the seepage collection channel could potentially rise above the desired level, and it may rise to the point that the dewatering pump cannot keep up with the flow, and containment is lost. For both cases where the hydraulic grade line in the underlying aquifer is outside of the desired threshold, modifications may be required to the inlets to the two culverts that pass beneath the Wolverine FSR and BC Rail embankment, as discussed in the following section.

The monitoring wells, seepage return flow and tailings supernatant should be sampled on a regular basis, as stipulated in Effluent Permit PE 17756.

Modifications to Culvert Inlets and Ditching

Hydraulic grade lines in the aquifer beneath the site can be controlled to some extent by sandbagging the inlets to the 1200 mm culverts located on the north and south side of the railway 'wye'. The northern culvert should be permanently sandbagged to an elevation 0.6 m above its invert, nominally 831.7 masl. Water would only decant into this culvert under extreme freshet conditions. The southern culvert should only be sandbagged if the hydraulic grade line in the monitoring wells falls within 300 mm of the ditch invert. This is only likely to occur in the late fall to early spring, hence sand bags may have to be placed late in the year, and removed in the early freshet period.

Following the downstream toe drain construction along the toe of the tailings dyke, very limited ditching remains tributary to the two culverts. If the hydraulic gradeline in the underlying aquifer is more than 1 m above the seepage interception trench, and inflows to the seepage interception trench exceed the capacity of the sump pump, it may be necessary to construct more ditching to increase the flow from the valley bottom aquifer to the BC Rail ditch. Ideally, this should only be done for the south culvert (working in an upstream direction), or possibly on the northeast side of the railway embankment, to release groundwater that will not have been impacted by tailings seepage. In the event that additional ditching is required, all monitoring data collected to the time that the need for additional ditching is recognized will be reviewed prior to the installation of any new ditches.

Closure Plan

A closure plan and performance criteria was developed in the early stages of the tailings facility and verified and updated periodically throughout the operating life of the facility in preparation for decommissioning and closure.

This plan must require a thorough re-assessment of the tailings facility and dam stability under closure condition. All aspects of the facility and dam stability must be reviewed. Structural monitoring and inspections should be continued for all facilities and dams until they are decommissioned and thereafter as appropriate. Identify those requirements for continuous inspection and or monitoring for the remaining structure after closure.

Ensure continuing availability of design, construction and operating records after closure for structures remaining in place.

MAINTENANCE

The objective of a maintenance program is to ensure that the individual components of the facility are maintained in accordance with performance criteria, manufacturer and company standards, legislative requirements and sound operating practices. Refer to the tables below for a summary of maintenance issues as they relate to the various components.

Tailings Dyke

Table 6 - Tailings Dyke Maintenance Issues, Schedule and Responsibility

Particulars	Component	Maintenance Issue(s)	Maintenance Schedule	Responsibility
Fill	Crest	• Maintain crown for drainage • Cracks	Daily (during construction); Weekly (after construction); Following storm event	Operations
	Slopes	• Maintain slopes for stability and drainage • Cracks • Bulging	Daily (during construction); Weekly (after construction); Following storm event	Operations
Instrumentation	Instrumentation Stations	• Ensure that instrumentation quads are clearly visible at all times	Weekly	Engineering
	Data Collectors	• Store piezometer data read-out box and slope inclinometer probe according to manufacturer specifications	Following each usage regularly	Engineering

Seepage/ Drainage Control	Upstream Drain	• Maintain integrity of filter cloth (covers drain rock material)	Prior to tailings discharge	Plant Personnel
	Downstream Blanket	• Design including rock drain specs should be followed	During construction	Operations/ Contractors
	Seepage Interception Ditch	• Maintain sump pump (Flygt BS 2125) • Maintain return line to supernatant pond in Tailings Facility	As required	Maintenance Personnel
	Upslope Diversion	• Ensure that diversion ditch remains clear of debris	Weekly and following storm event	Operations

Tailings Management

The tailings slurry will be discharged into the dam at 32 to 37 wet metric tons per hour at approximately 30% solids. There are 13 discharge points called spigots arrayed along the upstream crest of the dyke that will maintain a beach along the toe. The tailings solid will then settle to form a beach about 1% slope and process water together with some fines will flow to the tailings pond which later pumped back into the process plant.

A tailings disposal procedure is hereby included in this OMS manual which can be modified for improvement as more data and experience are gained on site.

Tailings Disposal Procedure

1. The 13 spigots are equally spaced about 90-100 meters apart and designated spigot 1 to 13 starting from the south abutment going to the north end.

2. Tailings discharge from each spigot will commence from north to south direction to develop an even beach on the upstream toe footprint. At some point, spigot is opened to where water pond inside the tailings facility is coming close to the upstream toe of the dam.

3. Tailings discharge from each spigot will be limited for 15 operating days to ensure a maintained level of beach. This could be adjusted to suit plant operations need especially during winter.

4. The plants maintenance supervisor or foreman will maintain a record log book on the operating schedule of spigots and input data in an accessible drive in the computer accessible to the Engineering Department for data recording and verification purposes. An operating log spreadsheet will be generated for beach spigot monitoring.

5. A daily visual inspection on the actual beach build-up will be done. Pre-mature decommissioning of current running spigot shall be done once abnormal flow of beach and slime in the pond is detected. Opening another spigot will be carried-out to divert proper flow of tailings and water to the reclaim decant tower.

6. When necessary, a survey on the beach will be done during summer when the process plant is not operational and the beach is hard and dry. This is to confirm the actual slope angle on the beach surface and would allow reliable basis in projecting the beach slope formation.

7. The operating time of each spigot will be adjusted based from the result in item 6.

Table 7 - Tailings Disposal Maintenance, Schedule and Responsibility

Particulars	Component	Maintenance Issue(s)	Maintenance Schedule	Responsibility
Slurry Handling / Deposition	Tailings Pipeline	• Clogging/Freezing of pipelines	Daily	Plant
	Tailings Spigots	• Spigot pipe's invert close to the toe of the dam	Daily	Plant
Reclaim System	Barge / Decant Structure	• Siltation • Rising of tailings beach	Daily	Plant
	Pump	• Spare parts • Power Outage	Daily	Plant
	Pipeline	• Freezing of pipelines	Daily	Plant

Documentation

Relevant information, recording and data management which are part and parcel of the tailings facility maintenance will be collected. Checklist and reports will include among others;

- Daily equipment (Scrappers, Graders, Compactors) operation data sheet.
- Work History on Daily CCR placement.
- Frequency and cause of problems
- Component reliability
- Quality control records such as compaction test
- Daily diary entries
- Communications and activity records covered in weekly update reports
- Photographic summaries and /or videos
- Inventory of spares, materials, tools and equipment
- Critical spares list
- Schedules
- Change orders
- Memorandums
- Reports including blast vibration reports

Reporting

Tracking of activities on the tailings facility is recorded on a daily basis and all information are inputted on a modified spreadsheet. This includes the recording of load-volumes of CCR dumped either on the dam, CCR pile and or to other areas of the mine. Basically, the total CCR from the process plant have to be monitored for other government regulation compliances. Other important information is incorporated to have a historical data on climate conditions and outside temperature which is essentially relevant in dictating the progress of CCR placement and compaction in the tailings facility especially during winter. The equipment running hours operating on the dam, the location of tailings discharge, the type of CCR produced and other observations are essential part of the daily report.

A weekly update report on the dam building shall be prepared and disseminated to all concerned, highlighting over-all accomplishment of the dam activities. This will also include other continual improvement plans to enhance the tailings management system of the dam appurtenances, and significant observations that may be instrumental in identifying and dealing with changed conditions at the facility.

SURVEILLANCE

The objective of a surveillance program is to identify the key surveillance parameters and procedures for monitoring the operation, safety and environmental performance of the tailings dyke. Any deviations from expected behavior that affect operational safety, structural integrity and environmental performance should be promptly identified, reported, and evaluated by appropriate personnel. Refer to the tables below for a summary of surveillance and monitoring issues as they relate to the various components.

Potential Failure Mechanisms

Potential failure mechanisms for the tailings dyke are discussed in the Permit-Level Geotechnical Designs for the Tailings Facility and Coarse Coal Reject Pile (Norwest, 2005). See Emergency Planning and Response section of this manual for a summary of failure modes and potential warning signs.

Surveillance Procedures

Surveillance consists of both routine and event-driven procedures. Visual inspections, instrument readings and surveys are the integral parts of surveillance procedures. All personnel working at the Tailings Facility should be involved in surveillance and monitoring as a routine part of daily activities.

The alert levels and trigger response criteria for instrumentation related to all geotechnical stations installed at the tailings dam structure are listed below. These alert levels were based from design parameters and actual results from previous instrumentations during the past 6 year period of construction and operation of the tailings facility.

Table 8 - Tailing Facility Monitoring Equipment Surveillance Procedure

Particulars	Component	Frequency/ Threshold Level	Trigger Response	Responsibility
Magnetic Extensometer Settlement Gauge	Foundation settlement	Once per quarter First 15 years: 1.4 m. Beyond 15 years: 2.7m	• Stop process plant operation.	Plant
			• Conduct instrumentation at all stations around the TF.	Engineering
			• Conduct visual inspection.	Plant/ Engineering
			• Backfill and compact cracks manifested from settlement, if any.	Operations
			• Move operating spigot away from location of cracks.	Plant
			• Inform Management and 3rd party consultant (Norwest).	Engineering Manager
			• Warn personnel and company working at the downstream of the tailings facility, if necessary.	Engineering Manager
Slope Inclinometers	Horizontal ground movement	Once per quarter Accumulated total displacement of 0.1m or 4 inches in a month.	• Stop process plant operation.	Plant
			• Conduct instrumentation at all stations around the TF.	Engineering
			• Review and analyze all data gathered.	Engineering
			• Conduct visual inspection.	Plant/ Engineering
			• Backfill cracks manifested from ground displacement, if any.	Operations
			• Move operating spigot away from visible cracks.	Plant
			• Inform Management and 3rd party consultant (Norwest).	Engineering Manager.
			• Warn personnel and company working at the downstream of the tailings facility, if necessary.	Engineering Manager

VW Piezometers	Pore water pressure	Twice per month Upper VW Piezometer: 834.5 masl. Middle VW Piezometer: 844.5 masl. Lower VW Piezometer: 852 masl.	• Stop process plant operation.	Plant
			• Conduct instrumentation at all stations around the TF.	Engineering
			• Review, correlate and analyze all data gathered.	Engineering
			• Conduct visual inspection taking into consideration the condition of the d/s ditch, beach configuration and surface run-off diverting at the tailings facility.	Plant/ Engineering
			• Clear downstream ditch and culvert to discharge water away from the toe of the TF and precluding the raising of water table that would saturate the foundation of the dam.	Operations
			• Move operating spigot away from piezometer stations with high water level readings.	Plant
			• Inform Management and 3rd party consultant (Norwest).	Engineering Manager
			• Warn personnel and company working at the downstream of the tailings facility, if necessary.	Engineering Manager

Visual Monitoring

Site personnel should be routinely aware of the appearance of cracks, bulging, seepage and slumping behavior on the tailings dyke and slopes. The presence of abnormal deep fissures at the tailings beach shall be considered that may result in piping or leak in the dam embankment.

The tables below show the frequency of visual surveillance and monitoring through visual inspection. A standard form or checklist shall be provided during inspections. The alert level ranges from 3 to 1 describing the severity of damage that would affect the entire operation, level 3 being the most critical level and 1 as the less serious. The responsibility in the conduct of these inspections is given to department or groups who are the champions about the vital components of some appurtenance of the dam as shown in the table.

Table 9 - Tailing Facility Dyke Visual Surveillance Responsibility

Particulars	Component	Surveillance and Monitoring Criteria/Issues	Surveillance/ Monitoring Frequency	Alert Level	Responsibility
Fill	Crest	• Visual: cracks, erosion, sinkhole • Survey: bench, crest and water pond elevations	Each shift, daily and as required	3	Operations/ Engineering
	Slopes	• Visual: cracks, erosion, bulging of slopes and toes, seepage • Survey: Location of instability such as tension cracks	Each shift, daily and as required	3	Operations/ Engineering
Instrumentation	Foundation Piezometers	• Pore water pressure readings	Weekly following normal readings; Daily after sudden change (as per Norwest)	3	Engineering
	Slope Inclinometers	• Foundation movement readings	Monthly following normal readings; Bi-weekly after significant change (as per Norwest)	3	Engineering
Seepage / Drainage Control	Upstream Drain	• Visual: filter cloth integrity	Each shift, daily	2	Operations
	Upstream Drain Piezometers	• Pore water pressure readings	Weekly	2	Engineering
	Downstream Blanket	• Visual monitoring of flow into seepage interception ditch	Daily	1	Environmental
	Seepage Interception Ditch	• Water quality monitoring, invert depth	Daily	1	Environmental
	Upslope Diversion	• Visual: erosion and debris	Weekly; Daily following storm event	3	Operations/ Engineering/ Environmental

Table 10 - Tailing Facility System Visual Surveillance Responsibility

Particulars	Component	Surveillance and Monitoring Issue(s)	Surveillance/ Monitoring Frequency	Alert Level	Responsibility
Slurry Handling/ Deposition	Tailings Pipeline	• Erosion of upstream dyke/dam slope	Shift, daily	1	Plant
	Tailings Spigots	• Erosion of upstream dyke/dam slope	Shift, daily	1	Plant
	Pond	• Visual: Freeboard (minimum 2 m)	Shift, daily	3	Plant/ Engineering
		• Survey: Water level elevation	Monthly	2	Plant/ Engineering
	Beach	• Visual: Freeboard (minimum 1m)	Shift, daily	3	Plant/ Engineering
		• Survey: Beach width (minimum 100 m)	As required	3	Engineering
		• Survey: Bathymetric/	Annually	1	Engineering
Reclaim System	Barge/Decant Structure	• Clogging on the perforations of the decant culvert	Weekly	2	Plant
	Pump	• Defective submersible pump	Daily	2	Plant
	Pipeline	• Clogged, leaking and busted pipe	Daily	2	Plant

The frequency of visual inspection would depend on the day-to-day operation requirement of the construction and maintenance of the tailings dam.

During occurrences of unwanted events such as decrease in freeboard, increased rate of seepage, crest drops and unexplained slumping and cracking of dam slope, a specific incident report must be made. This report should include the observations, the risk assessments and recommendation to be undertaken to avert greater damage at the dam.

Periodic Inspection and Review

A monthly facility inspection and review shall be done by key personnel from the operations, Engineering, Process Plant and Environmental Groups that will consider site and operating characteristics, jurisdiction and consequence classification. With this inspection, respective groups should be informed of their responsibility and obligation with respect to the operation and maintenance of this facility. Each group will also plan their activities needed based on the outcome of the inspection.

Annual dam inspections of the Tailings Facility and audit of the surveillance program by a qualified Professional Engineer who is familiar with the Operation, Maintenance and Surveillance of Tailings Facility should be adopted.

In cases of isolated catastrophic events such as earthquakes, floods, typhoons, hurricanes, fires or any other significant operational upsets, an independent second party inspection on the tailings facility is required from the company. It is essential to put in place a surveillance program and other recommendations to effectively manage the aftermath arising from any of these events.

A separate comprehensive review on the facility every five years as per failure consequence classification or by regulation must also be adhered to and provide independent verification of the safety and environmental performance of the facility, the adequacy of the surveillance program, and the adequacy of delivery of OMS within the management framework, plus review and analysis of the facility design with respect to current standards and possible failure modes.

Tailings Facility Instrumentation and Monitoring

Foundation Piezometers

As of February 2010, there are six foundation VW piezometers already installed at the tailing facility due to additional installation of three stations at the main dam structure, one station was installed at 4+00, 7+00 and 9+00. Three (3) piezometer stations were previously installed at the starter dyke prior to the tailing facility was ushered into operation. Each piezometer stations consist of three vibrating wire piezometers, the lower two tips are in the Lower Clay while the upper tip is in the Bouldery Gravel. The foundation piezometers should be read every week with a VW data recorder. The data will then be entered into the Tailings Facility Piezometers spreadsheet and the resulting graph will be plotted for review. Any significant changes should be immediately reported to the Chief of Engineering and Geology prior to consultation with Norwest, if further required.

Slope Inclinometers

There are four (4) slope inclinometer stations to monitor ground displacement on the tailings dam since February 2012. Three (3) SI instrumentations were installed near the downstream toe along the FSR at station 4+00, 7+00 and 9+00. Another SI was installed at the mid-crest of the dam structure at station 7+00 coupled with a magnetic extensometer settlement gauge.

These slope inclinometer stations were installed at depth ranging from 145-120 meters extended at the bottom of lower clay and anchoring into bedrock. All of these slope inclinometer instrumentations are read every two weeks with the digital slope inclinometer probe at 0.5 meter interval. The data will then be downloaded into an Inclinalysis software to generate displacement graphs and stored at the main server for data storage. Any significant changes in the graphs will be immediately reported to the Chief of Engineering and Geology for proper action.

Magnetic Extensometer

A magnetic extensometer settlement gauge was coupled inside the slope inclinometer station at mid-section 7+00 of the dam. This instrumentation is read every month to determine any settlement progressing at the foundation of the tailings dyke.

Instantel "Minimate Plus Vibration Monitor

A ground vibration monitoring was started April 2009. The purpose of this monitoring program is to examine any ground vibration or movement during open cast blasting activities in the pit approximately 3 km from the tailings dam. Another scenario being considered for vibration monitoring is during train hauling of coal at the BC rail. The existing BC rail is about 50 meters from the dam structure.

The Instantel Vibration monitoring device is assembled at an area of the dam nearest to the blasting area and the BC railway. Data gathered from the device are downloaded into the blastware software which will generate a graph to determine the severity of vibration from the blast. The resulting graphs are also stored in the main server and printed for dissemination.

During this initial vibration monitoring, it was found-out that there are no noticeable vibration effect during a major blast in the pit and also when coal hauling at the BC rail is in progress.

Collation and Analysis of Data

Data from visual inspections and instrumentation measurement should be screened, documented, and collated by competent personnel. Instrumentation data should be immediately compared to previous readings to establish if there are changes or if abnormal trend is occurring. Once the results have been reviewed and compared against performance criteria, appropriate personnel are informed for appropriate actions.

VW Peizometer and Slope Inclinometer Data

Check the workability of instruments and take Slope Inclinometer and VW Peizometer readings at established geotechnical stations on the tailings dam. Download all the gathered data into the customized spreadsheets and Inclinanalysis application software (for SI readings). Print-out resultant graph or copy into the main PC folder for the information all concerned personnel.

When normal mode reflects from collated data, meaning the peak level of previous measurement readings is not reached, the frequency of monitoring would still be followed. However, once an abnormal trend manifest on the current data as reflected by sudden change compare to previous graphs, then readings will be taken daily until readings normalize. At the first instance that abnormal trends on the graph is noticed, reviewed and analyze then the Chief of Engineering and Geology, the Technical Services Manager and the Mine Manager shall be informed immediately for proper action before relaying the information to Norwest.

Surface Moisture-Density Compaction Test

Density test locations are to be surveyed during CCR placement on the dam during construction. Compaction tests will be conducted and moisture samples will be collected from each test. Sample will be delivered to the plant laboratory for moisture analysis. All data gathered from compaction test including the result of moisture analysis must be input into the customized spreadsheet to determine compaction result.

Compaction test results are placed on the weekly compaction drawings to update compaction test results. Results will also be part of the weekly update report for the information of all concerned personnel.

All areas tested lower than the 95% SPD shall be re-compacted to obtain the required 95% SPD compaction criteria for the tailing facility.

In some cases, when design criteria have been modified, then Norwest Corporation should be contacted for consultation. A schedule should be established for periodic review by Norwest Corporation of collated visual observations, inspection reports and instrumentation measurements, to analyze data and facility performance trends.

Vibration Monitor

The vibration created from open cast blasting in the pit along with the ground pulsation produced from passing coal trains are previously being monitored. This surveillance procedure will detect any surface movement at the tailings facility attributed from blasting and coal hauling by train.

Critical consideration of this vibration monitoring is the distance of bench location of the blast in the pit to the tailing dam. Likewise, the total number of cars (usually around 100 cars) per train is being accounted in every vibration monitoring for coal hauling at the tailings facility.

Since there is no apparent vibration effect during a major blast in the pit and during coal hauling at the BC rail, this ground vibration monitoring was temporarily deferred.

Documentation

All pertinent data, document, reports, drawings and other relevant information concerning the operation, maintenance and surveillance of the tailing facility are digitally stored in a distinct folder. Documents shall be maintained, periodically reviewed and revised and kept the current versions of all document at identified location. Promptly remove or archive in a separate location documents which are considered obsolete.

Another documentation of standards for surveillance shall be documented, including the recording of:

- Observations from routine visual observation (departures from or exceptions to normal conditions)
- Instrumentation monitoring and testing
- Evaluations
- Inspections
- Reviews

Standard hard copy forms and checklists will be provided for simplified manner of recording and separately scanned for electronic filing.

A hard copy and digital filing system for all inspection reports, photographic and video records, incident reports, instrumentation readings, instrumentation plots, annual inspections and third-party reviews shall also be established. This will expedite retrieval of documents for review and in cases of an emergency.

Reporting

This is the part of the surveillance program to disseminate information from documented data gathered from inspections, collated data from geotechnical instrumentation (SI and VW peizometer), Surface Moisture-Density Compaction Test and Vibration Monitoring.

Furthermore, the details of all data, records and documents are stored in a distinct folder at the main computer server particularly drive X. Every personnel shall have access into this folder for all the information concerning the tailings facility. Similarly, retrieval of information for regulatory report can be done as the need arises.

EMERGENCY RESPONSE PLAN

It is important to be ready for emergencies and have the appropriate contingency and emergency preparedness and response plans in place. Emergency Preparedness includes preparation both for on-site incidents and for incidents having off-site implications, including dam breach. Contingency and Emergency Preparedness and Response Plans should be reviewed on a periodic basis, tested and widely distributed within the organization and to potentially affected external stakeholders.

The tailings facility response plan refers to the over-all minesite's emergency preparedness and response plan.

Failure modes and Warning Signs

It is important to be aware of the warning signs associated with a potential tailings facility failure mode or emergency. Refer to table below for a summary of failure modes and potential warning signs.

Tailings Dyke

<table>
<tr><th>Failure Mode</th><th>Description</th><th>Warning Sign(s)</th><th>Action Plan</th></tr>
<tr><td>Overtopping</td><td>Tailings pond overtops dyke crest</td><td>• Loss of freeboard
• Gully erosion</td><td rowspan="7">• Notify shift supervisor immediately.
• Stop process plant operation.
• Ocular inspection by concerned personnel.
• Initiate emergency planning and response activities
• Observe result and ensure failure was totally eradicated.
• Report/document the incident.</td></tr>
<tr><td>Piping (seepage)</td><td>Internal erosion due to migration of fines</td><td>• Dirty water discharging from d/s drain into seepage interception ditch
• Formation of salts on d/s slope
• Lush vegetative growth on d/s slope
• Sinkholes and/or depressions on crest or tailings beach
• Clogging of seepage control system (rising phreatic surface in dyke)
• Surge in seepage flux
• Sudden change in d/s monitoring well levels</td></tr>
<tr><td>Fill Failure</td><td>Planar or circular rotation through the d/s main dyke (CCR) fill that daylights on the face or at the toe</td><td rowspan="5">• Cracks
• Settlement
• Scarps
• Toe heave / bulging
• SI movements
• Loss of instrumentation (shearing of wire leads)</td></tr>
<tr><td>Downstream Slope</td><td>Foundation sliding - non-circular rotation or wedge failure surface that slides along the horizontal Upper Clay</td></tr>
<tr><td>Sliding Translation</td><td>Planar failure along the Upper Clay that involves the entire dyke and is driven by hydrostatic reservoir force</td></tr>
<tr><td>Deep-Seated</td><td>Circular or non-circular rotation through the Lower Clay that may or may not involve a liquefied silt layer</td></tr>
<tr><td>Excessive Settlement</td><td>Significant settlement and/or differential settlement due to consolidation of Lower Clay</td></tr>
</table>

CCR Pile

Failure Mode	Description	Warning Sign(s)	Action
Fill Failure	Circular rotational failure through the CCR fill – does not extend into the foundation	• Cracks • Settlement • Scarps • Toe heave / bulging • SI movements • Loss of instrumentation (shearing of wire leads)	• Notify shift supervisor immediately • Temporary suspension of dumping at CCR pile. • Ocular inspection by concerned personnel. • Initiate emergency planning and response activities • Observe result and ensure failure was totally eradicated. • Report/document the incident.
Foundation Failure	Circular rotational failure through CCR and involving granular foundation materials		
Base Translation	Failure surface that slides along the foundation soils at or near the bedrock contact and incorporating the entire pile		
Bedrock Slip	Non-circular rotation or wedge failure along a weak carbonaceous plane in the bedrock		

"Call-out" Process

A call-out process is a well-defined process by which an emergency condition can be analyzed, requirement assessed, an incident command structure established and personnel re-assigned in a deliberate and efficient manner. Call-out processes are integral components of emergency preparedness plan and operation's protocol.

This call-out process should be integrated into the over-all call-out process of the mine based on the mine site ERP. The mine shall initiate a call-out process as appropriate in the event of an accident occurring within the jurisdiction of the mine, be it on the pit or on the tailing facility. An effective line of communication should be developed within the facility site. This will include the dissemination of updated telephone directory of management, all employees, contractors and suppliers.

Affected individuals will include external stakeholders, municipal officials, government agencies, local organizations, service departments such as fire marshal, first aid, hospital facilities should be contacted immediately through phone after an emergency has been reported. Hence, updated contact information (telephone directory, Fax numbers and electronic mailing addresses) of the aforementioned personnel and agencies shall be kept by the Safety Department.

A system of verification confirming the recipient of the call should be insured. This will be done by identifying and recording the name, address and position of the recipient of the call. This gives assurance that the call has been correctly forwarded and effectively received.

A continuous improvement call-out process has to be developed through-out the operation of the mine. It is also necessary to conduct dry runs to test the effectiveness of the current call-out process and determine the needed enhancement practices.

Contacts

In addition to the Wolverine Mine ERP and call-out procedure, it is crucial to inform the ministry of any emergency situations.

Potential Inundation Area

This section is an excerpt from the permit. The mostly plausible loss-of-contents event is a through-going vertical transverse crack that penetrates the beach and causes a flow-slide of saturated (beach) tailings to erode a channel through the dyke, spilling tailings into a fan at the toe of the dyke. The geometry of such a failure was estimated using the following steps:

- A 10 meter deep crack with a one percent base slope starts at the toe of the dyke.
- The crack causes a liquefaction flow-slide of tailings material with an inverted cone with a 10% side slope angle.
- The flowing tailings erode the dyke so that it creates a gully that has a five meter wide base with 1H:1V side slopes.
- The resulting volume (tailings + eroded dyke) flows out forming a one percent slope radiating out from the apex of the fan.
- This fan interacts with the natural topography (including the railway embankment, the dyke toe, and the floodplain).
- The limit of this fan defines the inundation distance from the toe of the dyke.
- Several locations on the dyke were examined, the inundation distance plotted for each, allowing the delineation of a potential inundation zone when the dyke is at full height. The inundation zone will be smaller when the dyke is less than full height.

Using this methodology, the following conclusions were reached:

- The maximum volume of tailings lost is 50,000 cubic meters (plus there is an additional 8,000 cubic meters of dyke material).
- The four meter high railway embankment captures or deflects the vast majority of the flow-slide material (see inundation area below).
- The potential inundation zone remains west of the railway and in a zone about 400m north of the dyke toe at the north end of the facility and 300m south of the south end of the facility (see inundation area below).
- Most of the inundation zone is covered by less than four meters of tailings; such is less than one to two meters.

The monitoring program is designed to detect early warning signs of potential failure.

The failure geometry does not extend to the ponded water behind the embankment (though repair of the breach would be of the highest priority to re-establish the design freeboard and maintain the integrity of the pond).

At closure, a spillway will be established that removes the pond and the potential for overtopping. The combination of the cover soil on the tailings and the underdrain will keep the tailings largely unsaturated near the dyke crest, so the failure mode and inundation described above are only active during operation of the tailings facility.

REFERENCES AND RELATED DOCUMENTS

The following pertinent documents and related drawings are properly kept by the Engineering Department. Any reproduction or request to borrow or to use as reference for reasons that has significant use in the mine operation shall be requested for approval to the Mine Manager, Chief Engineer or the Senior Mine Engineer office.

1. Perry Creek Mine: Mines Act Permit Application, WCC, December, 2004
    a. Volume 1: Application and Figures

    b. Volume 2: Technical Appendices Part 1
        i. Permit-Level Geotechnical Designs for North, South and East Waste Rock Dumps
        ii. Observation, Surveillance, & Maintenance Manual for Waste Rock Dumps (Table of Contents)
        iii. Geotechnical Pit Slope Design

    c. Volume 3: Technical Appendices Part 2
        iv. Water Management Facility Design Report
        v. Wolverine Project Kinetic Test Update
        vi. Baseline Vegetation Metals
        vii. Wolverine Project – Wildlife Management Plan Framework
        viii. Forest Site Index Evaluation for Reclamation Branch
        ix. Traditional Plant Use Survey
        x. Rare Plants Reconnaissance
        xi. Wildlife Studies Update
        xii. Waterfowl Survey Summary
        xiii. Wolverine Mine Flow Monitoring
        xiv. Baseline Groundwater Quality Sampling – Update Report
        xv. Assessment of Fisheries Habitat Potential at “Oxbow 1” & “B.C. Rail Ditch”

    d. Addendum: Permit-Level Geotechnical Designs for the Tailings Facility and Coarse Coal Reject Pile (Norwest Corporation: January, 2005)
2. Permit C-223 – Perry Creek Mine: issued by British Columbia Ministry of Energy, issued February 2005.

3. Wolverine Coal Project: Environmental Assessment – Additional Information Report: May, 2004
    a. Volume 1: Main Document
    b. Volume 2: Figures
    c. Volume 3: Appendices Part 1
    d. Volume 4: Appendices part 2
    e. Addendum Report: Acid Rock Drainage and Metal Leaching

4. Environmental Certificate M04-01, issued January 13, 2005

5. Health, Safety and Reclamation Code for Mines in British Columbia, 2008

6. Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities, The Mining Association of Canada

7. A Guide to the Management of Tailings Facilities, The Mining Association of Canada, 1998