CLOSURE SPILLWAY FOR THE PLANTSITE TAILINGS DAM, QUINTETTE OPERATING CORPORATION

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ABSTRACT

The Quintette mine was a large open pit coal mine in Northeastern BC which produced 65 million tonnes of high quality metallurgical coal from 1983 until its closure in 2000. The tailings dam at the mine is up to 50 meters high, and retains approximately 11 million cubic meters of tailings.

A spillway was required to allow storm water management at closure. Further, for long term dam stability, it was desirable to minimize the amount of ponded water. Numerous design options were examined, including a notch in the dam crest with a rip rap-lined channel on the downstream face. Since this was to be a closure spillway, long term, no maintenance performance was essential.

The design option chosen was a wide, low gradient geomorphic spillway, sized to pass the 1000 year return period rain event. As the design flow velocities are low due to the low gradient, no rip rap was required in the design. Construction of the spillway meant excavating tailings so that the spillway floor would be either in native till or competent fill. This was accomplished by dumping a causeway of rock along the spillway alignment which squeezed tailings ahead of it. The channel was then cut to grade, and a low flow meandering channel was built to carry normal flows.

Revegetation of the channel side slopes was enhanced with erosion control mats and the addition of annual barley to the standard seed mix for coarse refuse and tailings. Willow cuttings were planted in a wide swath around the spillway inlet. The net result was a practical, long term solution for a closure spillway.

INTRODUCTION

The Quintette mine was a large open pit coal mine in Northeastern BC which produced 65 million tonnes of high quality metallurgical coal from 1983 until its closure in 2000. The tailings dam at the mine is up to 50 meters high, and is constructed of coarse coal refuse with an impermeable till core. Figure 1 is an aerial photograph of the dam.

The dam retains approximately 11 million cubic meters of tailings. It was designed as an impermeable structure. During operation of the tailings facility, reclaim water was pumped from the dam and recirculated to the plant. Once the design capacity of the dam was reached in 1996, a decision was made to develop a new tailings dam in one of the mined out pits rather than to raise the height of the original dam. This meant that the original dam would be decommissioned, and a permanent spillway would be needed.

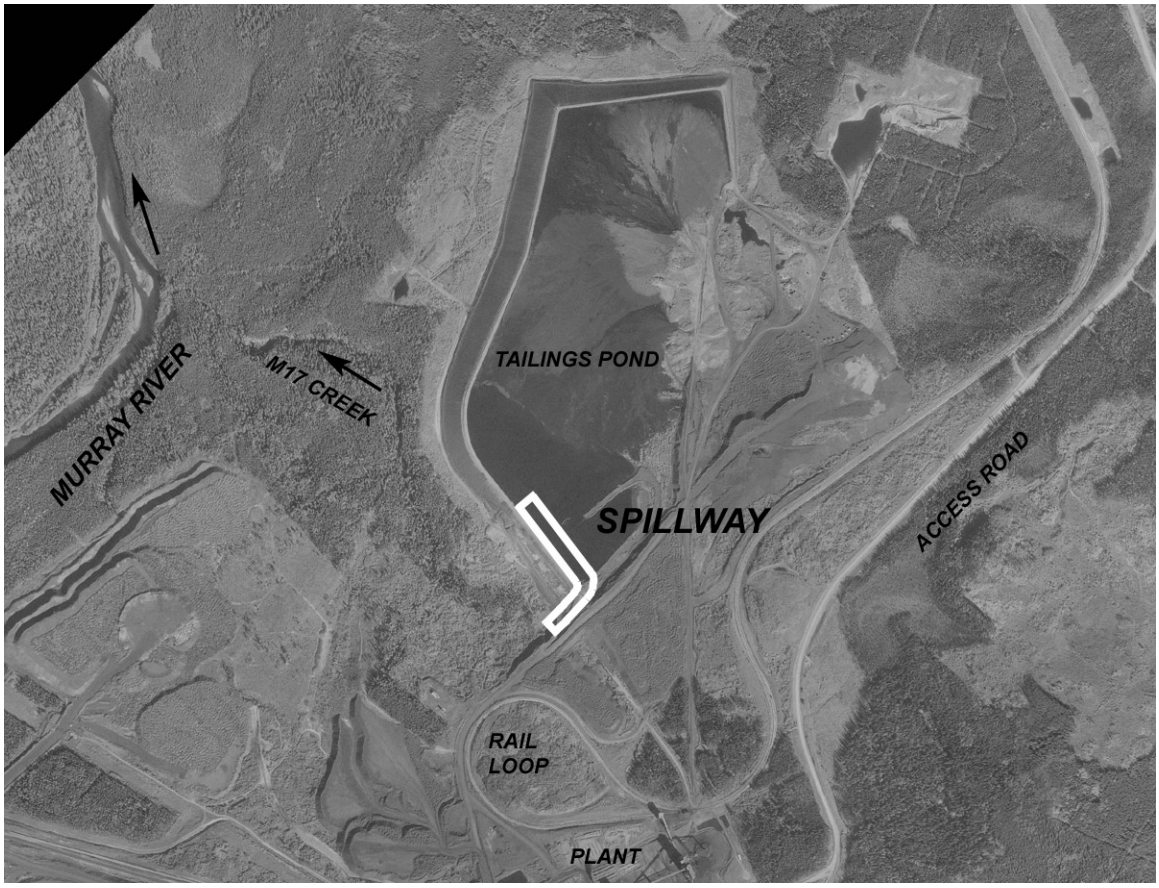

Figure 1 – Aerial Photograph of Tailings Dam Area, Showing Spillway

SPILLWAY DESIGN

The first step in the spillway design process was a hydrology study to determine the flows that a spillway would be required to pass. The design storm chosen was a 1:1000 year rain event, with a maximum instantaneous flow of 9.7 cubic metres per second.

Possible post-closure designs were examined by Golder Associates, who categorized them into two classes: rigid and geomorphic. Rigid designs typically incorporate reinforced concrete, riprap or gabion-lined spillway channels. These can be regarded as semi-permanent, requiring periodic maintenance. Ultimately, these are incompatible with natural processes of landscape change over time. Also, most of the sedimentary rock that is available for riprap at Quintette is not particularly durable in the long term.

Geomorphic structures are designed to become more stable over time. They do this by mimicking the natural landscapes, with features such as low gradients, meandering low flow channels, and vegetated banks.

Based on the above considerations, the design option chosen was a 20 meter wide spillway channel to convey tailings pond runoff to M17 Creek. The spillway design was a low gradient (0.5%) with a 2 meter wide meandering low flow channel for the normal flows. Figure 2 shows a cross section of the channel design.

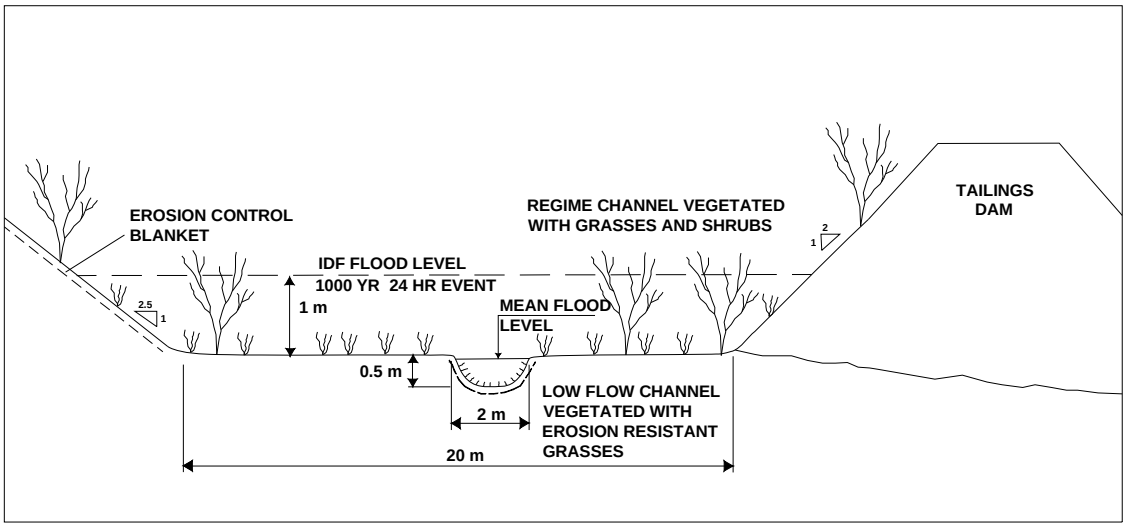

Figure 2 – Schematic Diagram of Spillway

SPILLWAY CONSTRUCTION

The first step in construction of the spillway was to lower the water level in the pond. This was accomplished by pumping into the seepage collection ditch which flowed to a sedimentation pond. There are no acid rock drainage or metal leaching concerns with the tailings, so the pond water is suitable for discharge to the environment. Water quality from the pond is shown in Table 1.

The floor of the pond in the footprint of the spillway consisted of glacial till with a variable thickness of tailings. Since the spillway could not be constructed in tailings, it needed to be cut into the till (where the till elevation was higher than the spillway grade) or material would need to be placed (where the floor of the pond was lower than the spillway grade). The construction method adopted was to dump a causeway of waste rock and coarse refuse along the spillway footprint. The weight of this material squeezed the tailings ahead of it, allowing the causeway to contact the till surface. The causeway material was then dug down to the spillway grade. The excavated material was cast to the side to form the next section of the causeway.

PARAMETER	AVERAGE VALUE (MG/L)
pH	8.05
SULPHATE	205
CONDUCTIVITY	626
NITRATE	2.2
NITRITE	0.45
AMMONIA	0.29
TOTAL DISS. PHOSPHORUS	0.004

Table 1 – Average Tailings Water Quality

Design sideslope angles for the spillway channel were 2.5:1. It was decided to use the upstream face of the dam (2:1 slope) for one sideslope. The other sideslope coincided with the confining dyke for a decommissioned sewage lagoon. This was graded to 2.5:1 or less.

Construction on the spillway progressed intermittently over three years. The portion outside the dam was completed first, in conjunction with the removal of culverts on M17 Creek. Next, the portion immediately inside the dam was completed. In the third season, the remainder of the spillway was completed, and the dam was breached.

REVEGETATION

The design for the spillway specified erosion control blankets for the sideslopes and floor of the channel. It was decided to place blankets on the constructed sideslope and in the low flow channel only. The blankets used for the sideslopes were 4.9 meter wide, 29 meter long straw blankets. Before placing the blankets, the area was seeded with Quintette's standard mix for coarse refuse (listed in Table 2) with the addition of barley. Barley was chosen for quick growth and stabilization of the area in the first growing season. Fertilizer (26-10-10 granular) was added as well. The blankets provided ideal growing conditions, allowing fast green-up. The low flow channel had 2 meter wide blankets placed along its length to allow vegetation establishment. The remainder of the spillway and the tailings exposed by the drop in water level were seeded with the coarse refuse mix and barley as well.

Willow cuttings were placed on the sideslopes and along the regime channel. These will stabilize the material over time and baffle the flow in flood conditions.

Common Name	% By Weight
Alfalfa (c.v. Peace)	34%
Barley	25%
Slender Wheatgrass (c.v. Revenue)	10%
Creeping Red Fescue (c.v. Boreal)	9%
Hard Fescue (c.v. Aurora)	3%
Canada Bluegrass	3%
Timothy (c.v. Alma or Climax)	3%
Alsike Clover	3%

Table 2 – Seed Mixture Used on Spillway and Adjacent Tailings

WILDLIFE HABITAT

Quintette's reclamation philosophy is to achieve post-mining land capability that is equivalent to or better than the pre-mining capability on a property wide basis. The tailings pond and spillway area contribute to this. The seed mixes chosen contain a mix of grasses and legumes which is self-sustaining. Native ingress by shrubs and trees has already begun, and this has been supplemented by planting of spruce, pine, and larch on the tailings surface, as well as willow cuttings in wetter areas and along the spillway.

CONCLUSION

The permanent spillway for the Plantsite tailings dam at Quintette incorporates a "new school" design philosophy of a self-sustaining, no maintenance structure. The completed spillway contributes to sound water management as well as fitting in to the overall reclamation plan for the site.