Klohn Crippen Berger

# COBRE PANAMA SPILLWAY TOWER

## COLON PROVINCE, PANAMA

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CANADIAN CONSULTING ENGINEERING AWARDS 2020

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| PROJECT NAME | Cobre Panama Spillway Tower |
| LOCATION OF PROJECT | Colon Province, Panama |
| YEAR COMPLETED | 2019 |
| CATEGORY OF ENTRY | E. Natural Resources, Mining, Industry, Energy |
| ROLE IN PROJECT | Prime Consultant |
| PROJECT OWNER / CLIENT | First Quantum Minerals Ltd. |
| GENERAL CONTRACTORS | Bluebird Contracting Services |
| PROJECT SUMMARY | First Quantum Minerals Ltd. (FQML) engaged Klohn Crippen Berger (KCB) to develop a spillway tower with an intake and discharge tunnel for the Cobre Panama Tailings Management Facility (TMF). FQML's objective was to maintain a controlled discharge of the catchment inflow water as tailings deposition increases. KCB's innovative design incorporated elements common on hydro-electric intakes to regulate discharge flows. The solution is a gravity-based system which achieves the project objectives while reducing the need for pumping infrastructure. |


Concrete stoplog installation

# INNOVATION

The Cobre Panama mine site is located about 215 km west of Panama City. The Cobre Panama Tailings Management Facility (TMF) footprint covers an area of approximately 20 km$^2$ and lies within the Rio del Medio and Rio Jujuka catchments. The TMF is impounded by the 3.5 km long North Dam, the 4 km long East Dam, and several smaller saddle dams on the west side. FQML's objective was to maintain a controlled discharge of the catchment inflow water into the TMF.

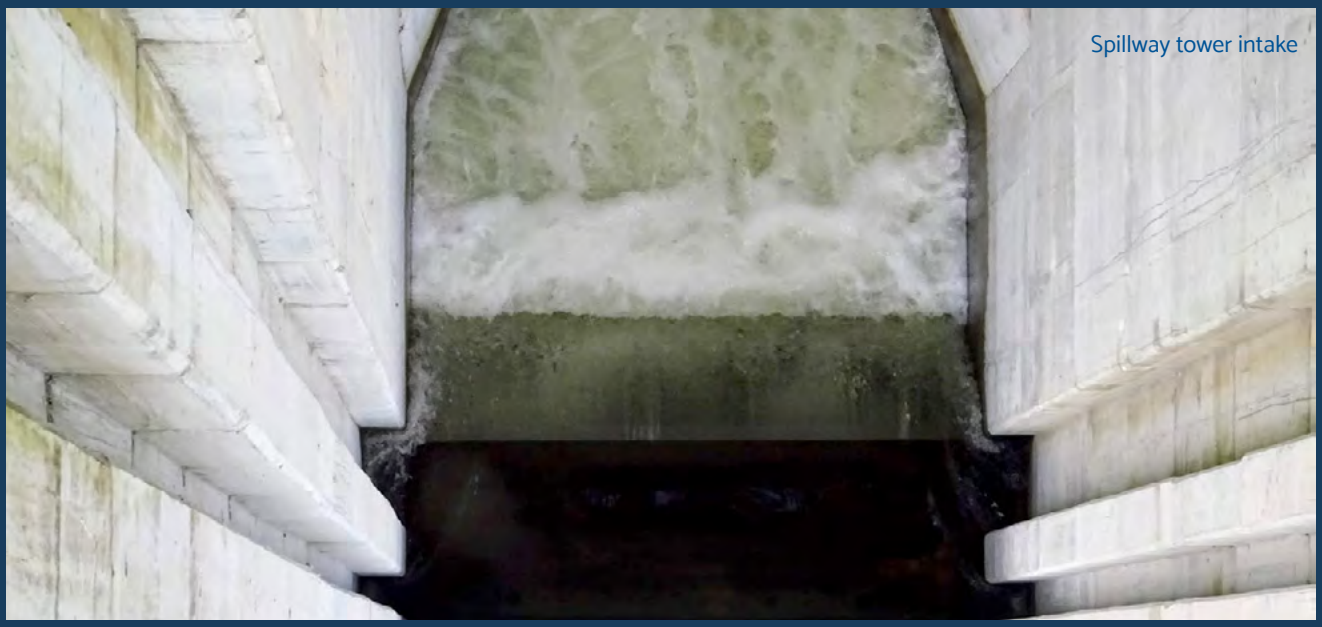
KCB's spillway tower design incorporated concepts and elements common on hydro-electric intakes to regulate discharge flows. As tailings deposition increases, a permanent barrier must be built on the spillway tower's upstream face to prevent tailings from entering the tunnel, while allowing water to naturally decant. The barrier is formed by stacking concrete stoplogs and concrete formwork panels at regular intervals, then pouring tremie concrete in between to form the permanent isolation barrier. The unique design included the mechanical and civil infrastructure to handle and place the stoplogs and formwork panels in a safe and controlled manner.

The concrete stoplogs form the main flow control weir for the spillway tower. The reinforced concrete stoplogs are 0.6 m (W) x 4.5 m (L) x 1.0 m (H) and are gradually installed over time with rising level of water and tailings during TMF operations. The sealing integrity of the stoplogs is achieved by embedded rubber seals on the sides and bottom of each stoplog.

The formwork panels lag in height below the concrete stoplogs. The space between them is filled with tremie concrete to further prevent tailings and suspended solids seeping past the concrete stoplogs into the spillway tunnel and downstream water course.

A floating debris screen is installed across the upstream face of the spillway tower to accommodate the continually rising pond level. The debris screen is also used as a working platform during placement of the tremie concrete.

The spillway also has a fixed-wheel, vertical-lift operating gate. The gate is normally intended for closure under open channel flow in order to shut-off the flow to the spillway tunnel for installation of the tunnel plug during decommissioning. A permanent deck-mounted cable hoist lifts and lowers the gate during normal operation. In an emergency, the gate is designed to close by gravity under full flow conditions to terminate the flow through the tunnel.



Spillway tower intake

# COMPLEXITY

Operating pond levels during the life of the TMF vary from El. 65.0 m in Year 1 to approximately El. 135.5 m in Year 22. This range of water level would require a single spillway tower in excess of 70 m, which would be very challenging to design given the high seismicity of the region and problematic for accessing the tower crest from the surrounding topography. KCB's design comprised two 48 m spillway tower-and-tunnel arrangements (Phases 1 and 2), in order to make the structural design of the spillway intakes manageable.

Light vehicle access to the spillway tower deck is via a single span girder bridge. The access presented challenges for installing the heavy stoplog and formwork panels. A monorail was incorporated from the land side of the spillway tower bridge to the top of the spillway tower to facilitate handling the stoplogs using a dedicated underhung hoist and trolley. Due to space limitation on the top of the spillway tower deck, the monorail was designed with a 180-degree bend to allow the stoplogs to be brought across the deck and directly aligned over the top of the slot. The stoplogs and formwork panels are handled using an underhung monorail hoist and custom lifting beam assembly. The lifting beam is capable of latching or releasing the stoplogs when they are positioned in the slot by using a counterbalance mechanism, enabling the lifting beam to latch or release the stoplog deep into the slot without direct manual intervention.

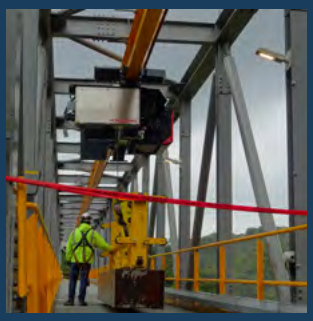
# SOCIAL AND/OR ECONOMIC BENEFITS

The use of pumps to control inflow water in a TMF is very common in the mining industry; however, for Cobre Panama, a pump-based system is only used for normal mill operations. The spillway tower provides a gravity-based solution which reduces the energy consumption and long-term maintenance costs otherwise needed for TMF pond control using a pump-based system.

# ENVIRONMENTAL BENEFITS

Innovative features were incorporated into the design to address environmental concerns. Custom-molded rubber seals were added to the stoplogs. Tremie concrete will be placed in lifts between the stoplogs and formwork panels to provide multiple robust barriers to prevent the migration of tailings fines to the watercourse downstream and ensure water quality compliance. The wheeled gate, which is designed to close by gravity under full flow conditions, provides a means to terminate the flow through the tunnel in an emergency. The gate, hoist and some bridge components were designed for re-use in the Phase 2 structure, reducing the overall footprint and enhancing a sustainable design solution.


Spillway tower intake



# MEETING CLIENTS NEEDS

FQML first engaged KCB to conduct a concept study and evaluation of the temporary river diversions for starter dam construction and the permanent facilities for the TMF. KCB's scope progressed from conceptual design and value-engineering-based assessment, to detailed design of the Phase 1 spillway intake tower and tunnel, including preparation of construction drawings and specifications.

The design of the spillway tower reflects KCB's multi-disciplinary expertise in various industry sectors. The design was completed in Civil 3-D, Revit and SolidWorks to integrate the complex civil, structural, and mechanical components. The spillway tower and tunnel arrangements were developed collaboratively with FQML to arrive at a practical and innovative design. This achieved the project objective of developing a spillway tower with an intake and tunnel to enable a controlled, gravity-based, discharge of the catchment inflow water and reduce the need for pumping infrastructure and long-term maintenance requirements. Construction of the Phase 1 spillway tower was complete in the summer of 2019 with operation commencing in the fall of 2019.

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