Colomac Remediation Project
Major Civil Works

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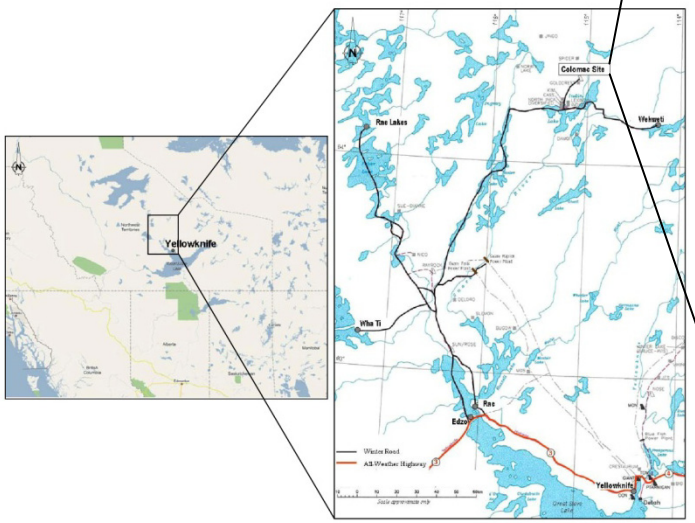
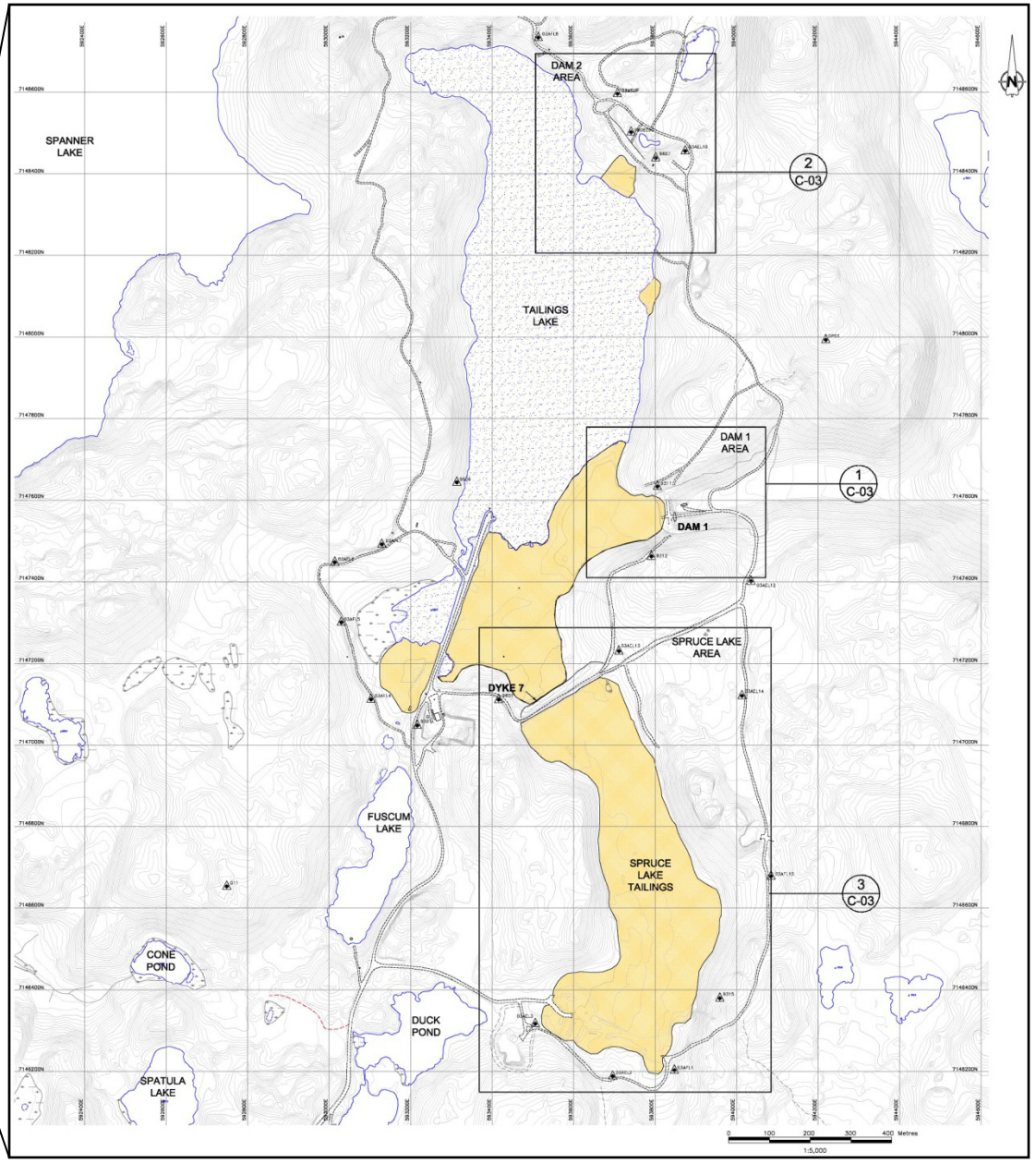
- Colomac is located about 220 kilometres northwest of Yellowknife and operated intermittently as a gold mine from 1989 to 1997.
- It reverted back to the Crown in 1999 when the mine's owner at the time, Royal Oak Mines Inc., went into receivership prior to the implementation of any significant closure or remediation activities.
- Indian and Northern Affairs have responsibility for the site.





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Spruce Lake Tailings surface

The objectives of the tailings covers are to prevent contact between the tailings and wildlife, and to minimize the generation of dust, while presenting neither an attraction to caribou, nor an impediment to their movement.

Water management was by a drainage ditch excavated long the eastern shoreline which connects to Dyke 7 Spillway

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Tailings surface was hummocky in some areas and irregular in others mainly due to the thawing of ice lenses and subsequent water erosion. This made placement of cover and travel by heavy equipment difficult

Surface re-grading was performed using a snow cat

Wide working areas prevented repeated traffic over local areas causing liquefaction of the tailings

Uniform cover thickness was achieved using tripods constructed at the design height

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Geotextile and cover placement in Tailings Lake

Design cover thickness was maintained by using a metal post attached to a base plate placed on the tailings surface

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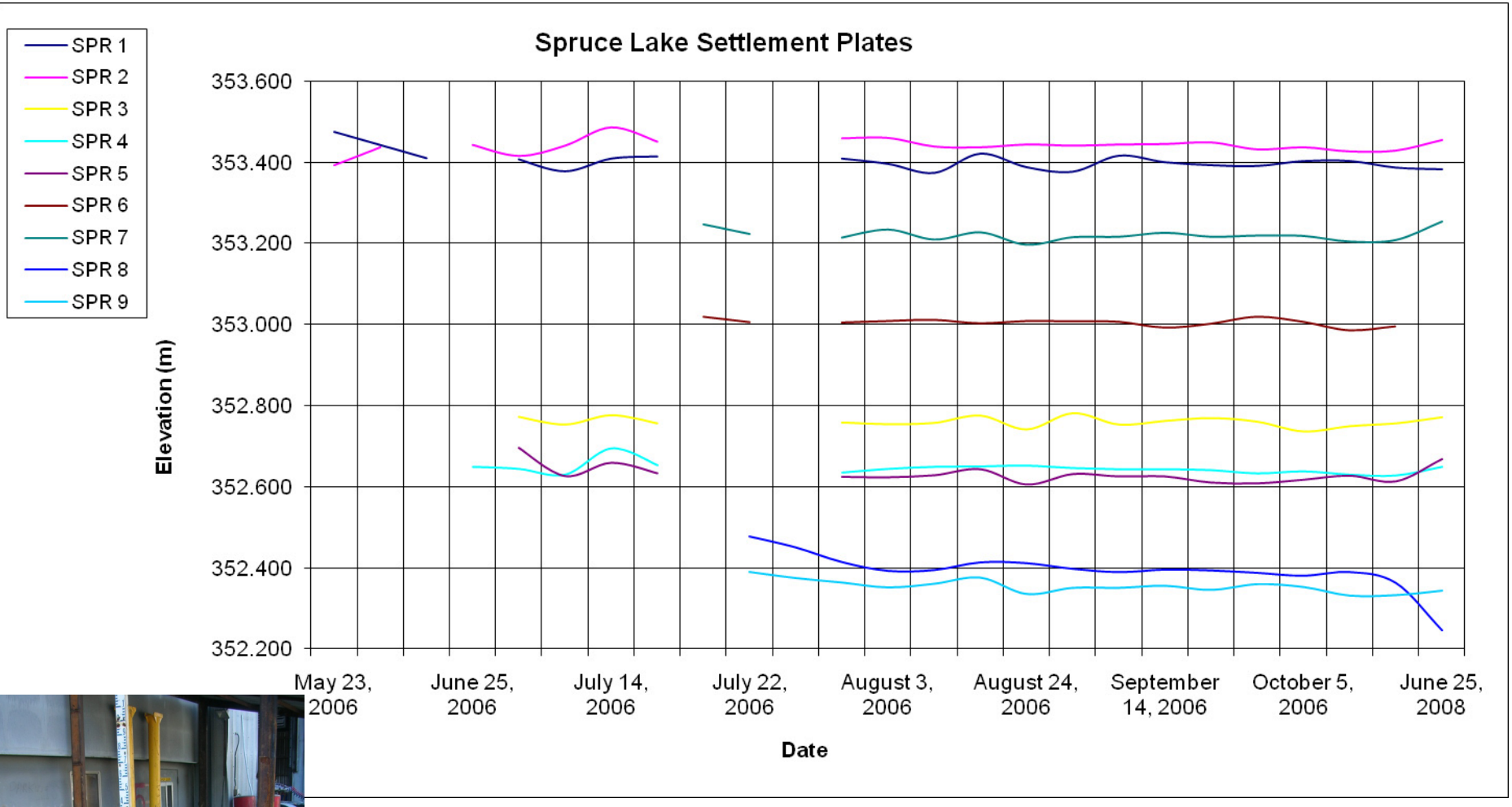
Final covered tailings surfaces



Settlement pins were installed in the Spruce Lake Tailings cover to monitor settlement during construction.

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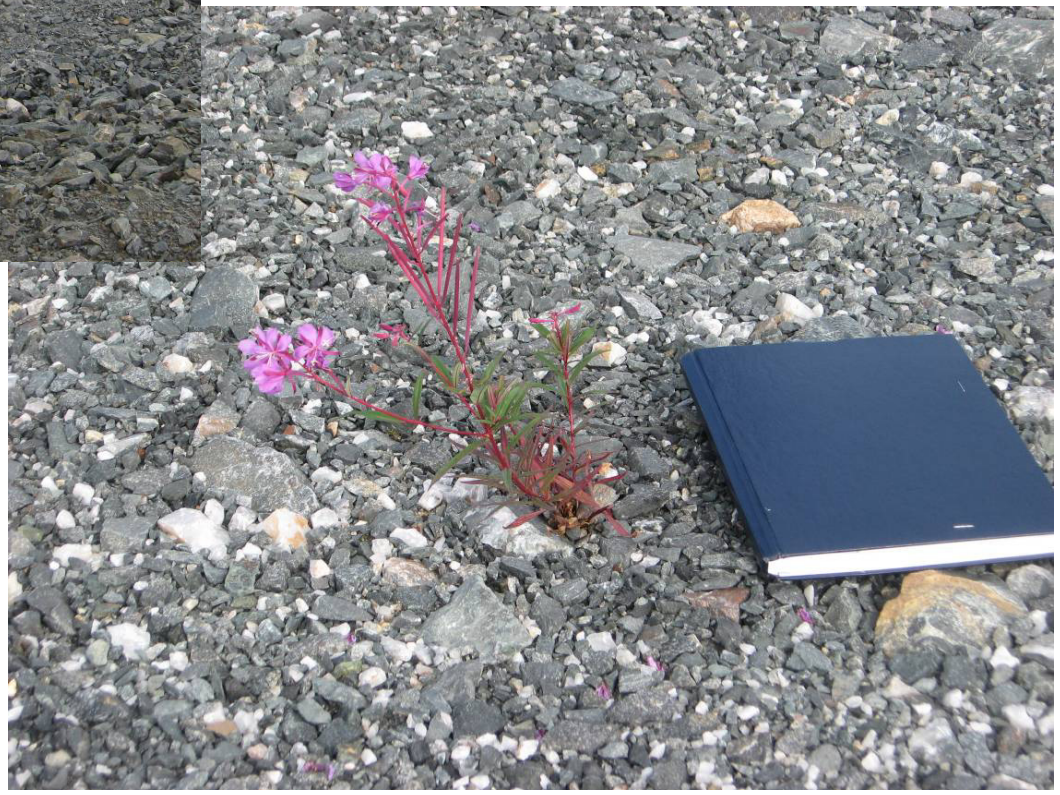
Tailings cover 2 years later



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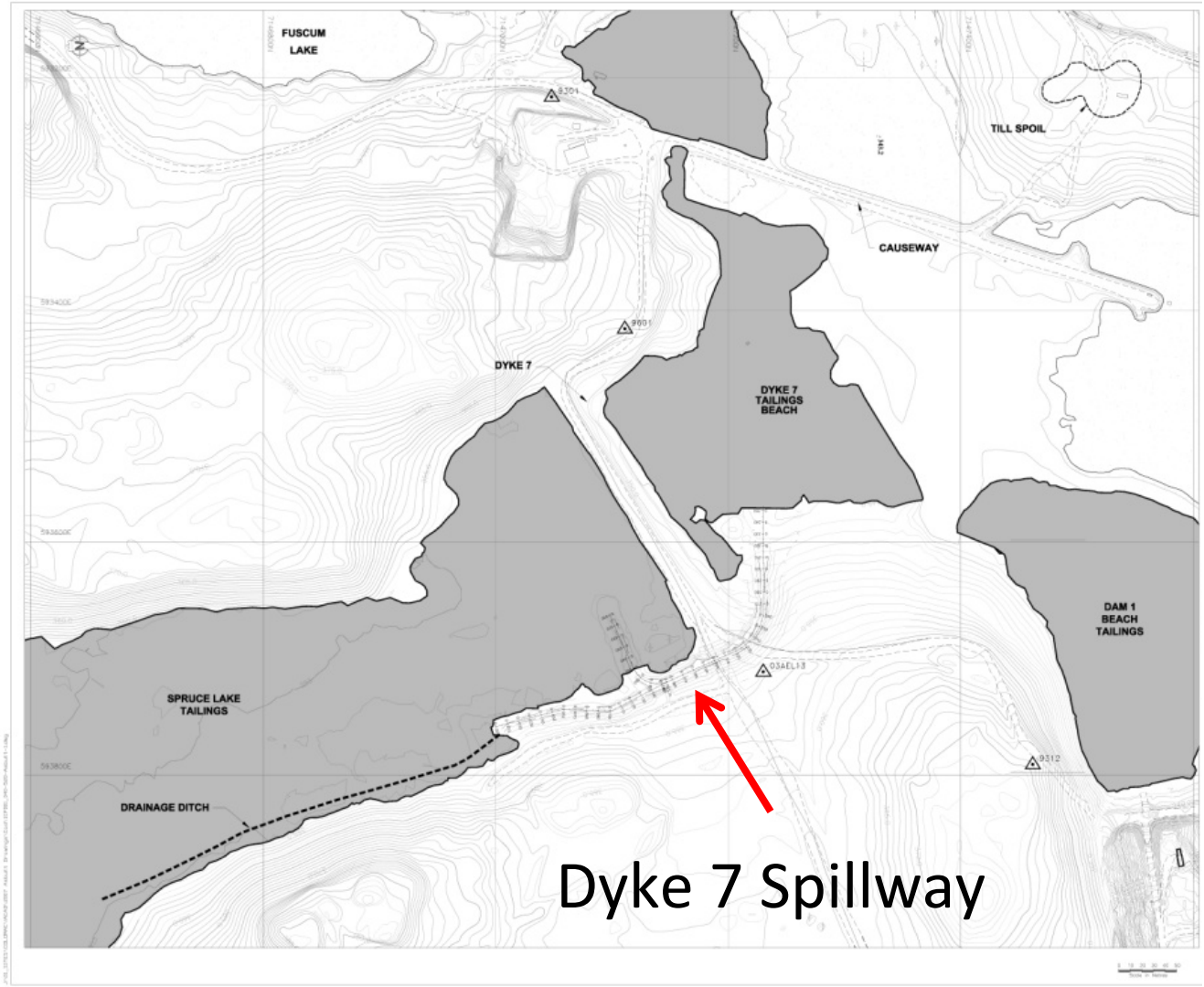

The objective of the Dyke 7 spillway is to provide for the passage of water from the Spruce Lake tailings surface to Tailings Lake, and thereby to stop the historical piping of water and tailings through Dyke 7 itself, which could compromise the overall geotechnical stability of Dyke 7.

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Start of Dyke 7 Spillway excavation with excavation and blasting of bedrock

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The Drainage Ditch and a Swale were tied into Spillway to manage surface water

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Spillway downstream of Dyke 7

Stilling basin at the downstream end of the Spillway

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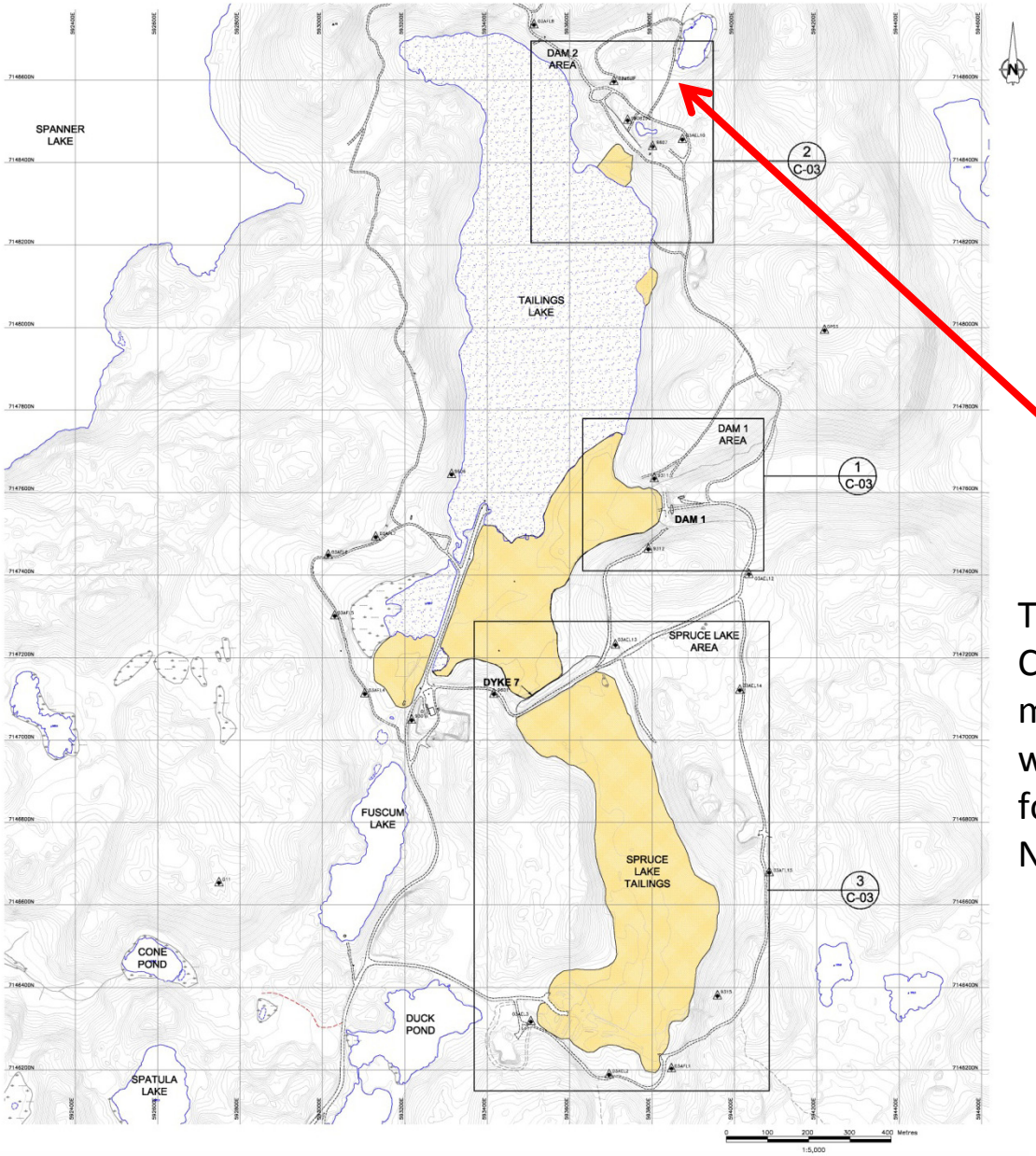

Dam 2
Discharge Channel

The objective of the Dam 2 Discharge Channel is to provide for the passive movement of water from Tailings Lake, which collects all of the drainage from the former TCA, to North Pond. Discharge from North Pond flows to “L” Shaped Lake.

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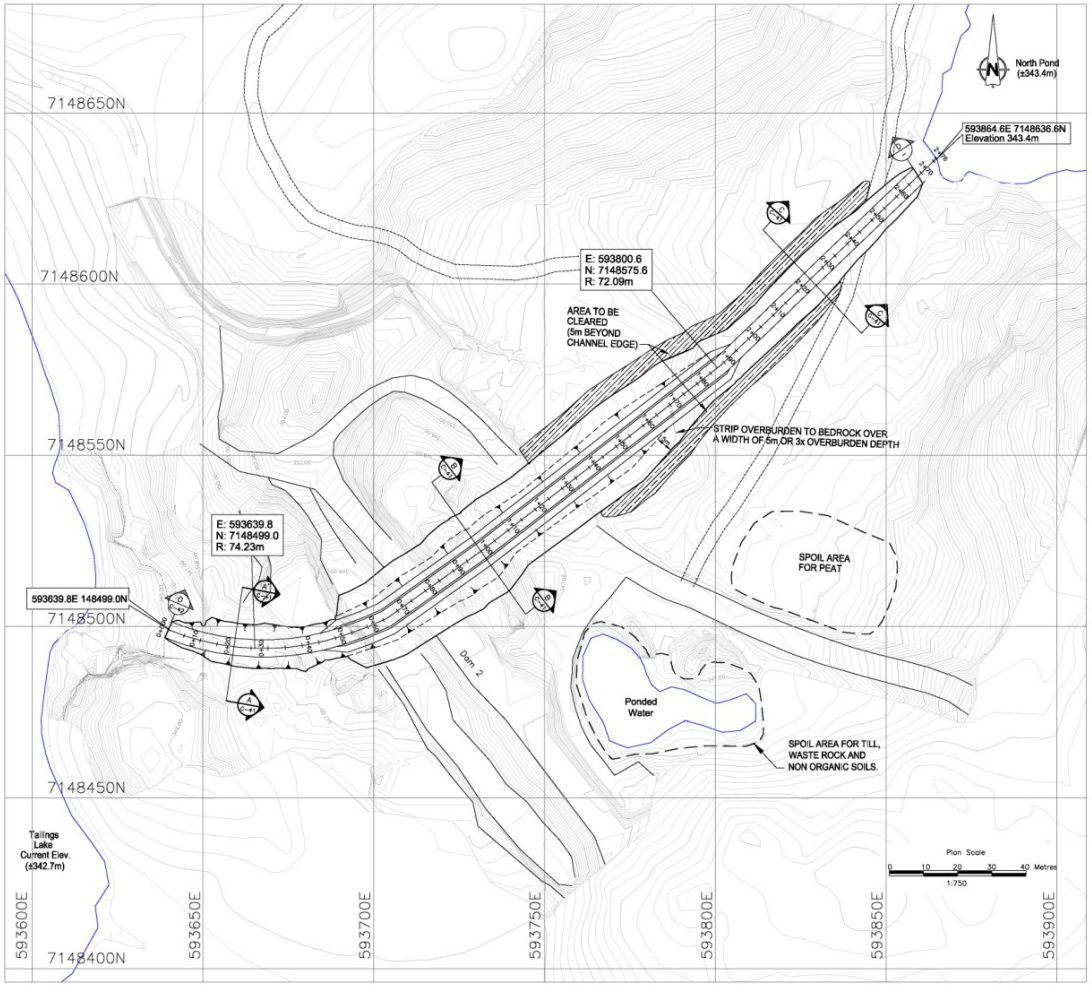

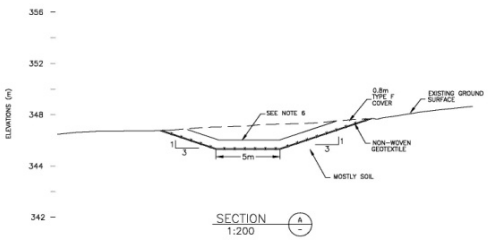

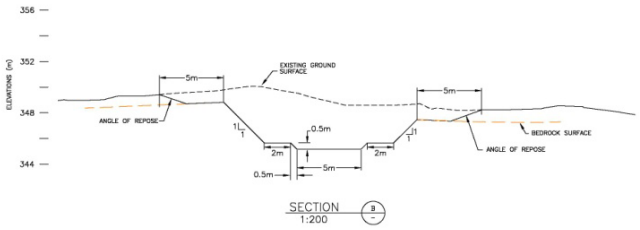

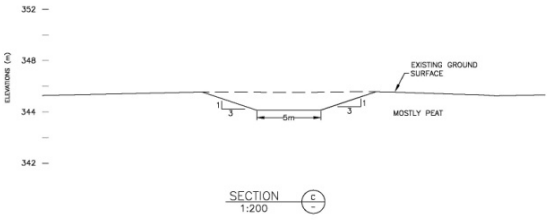

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Excavation of peat and blasting of bedrock along the downstream reach of the Discharge Channel

Excavation of till along the upstream reach of the Discharge Channel

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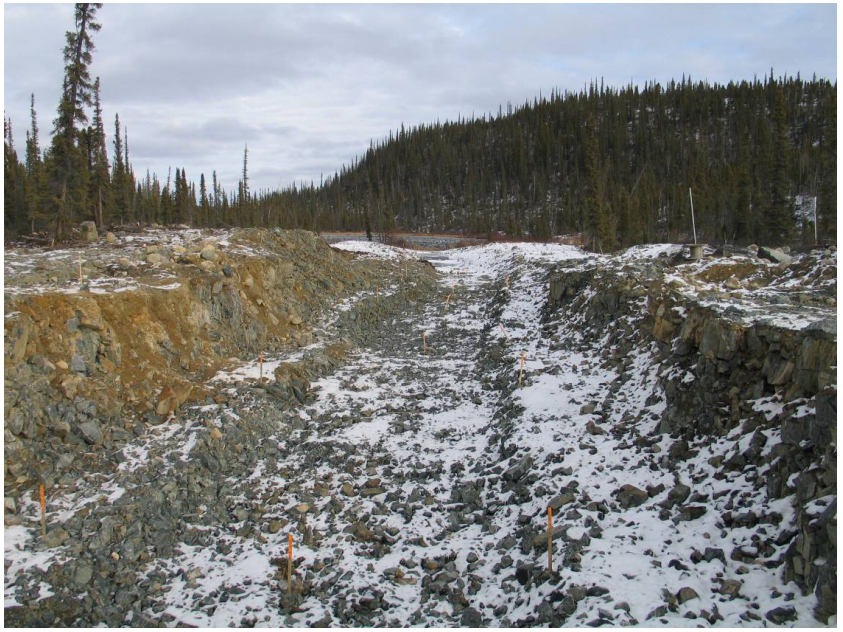
Completed Dam 2 Discharge Channel

Location of invert



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Dam 2 Discharge Channel 2 years later

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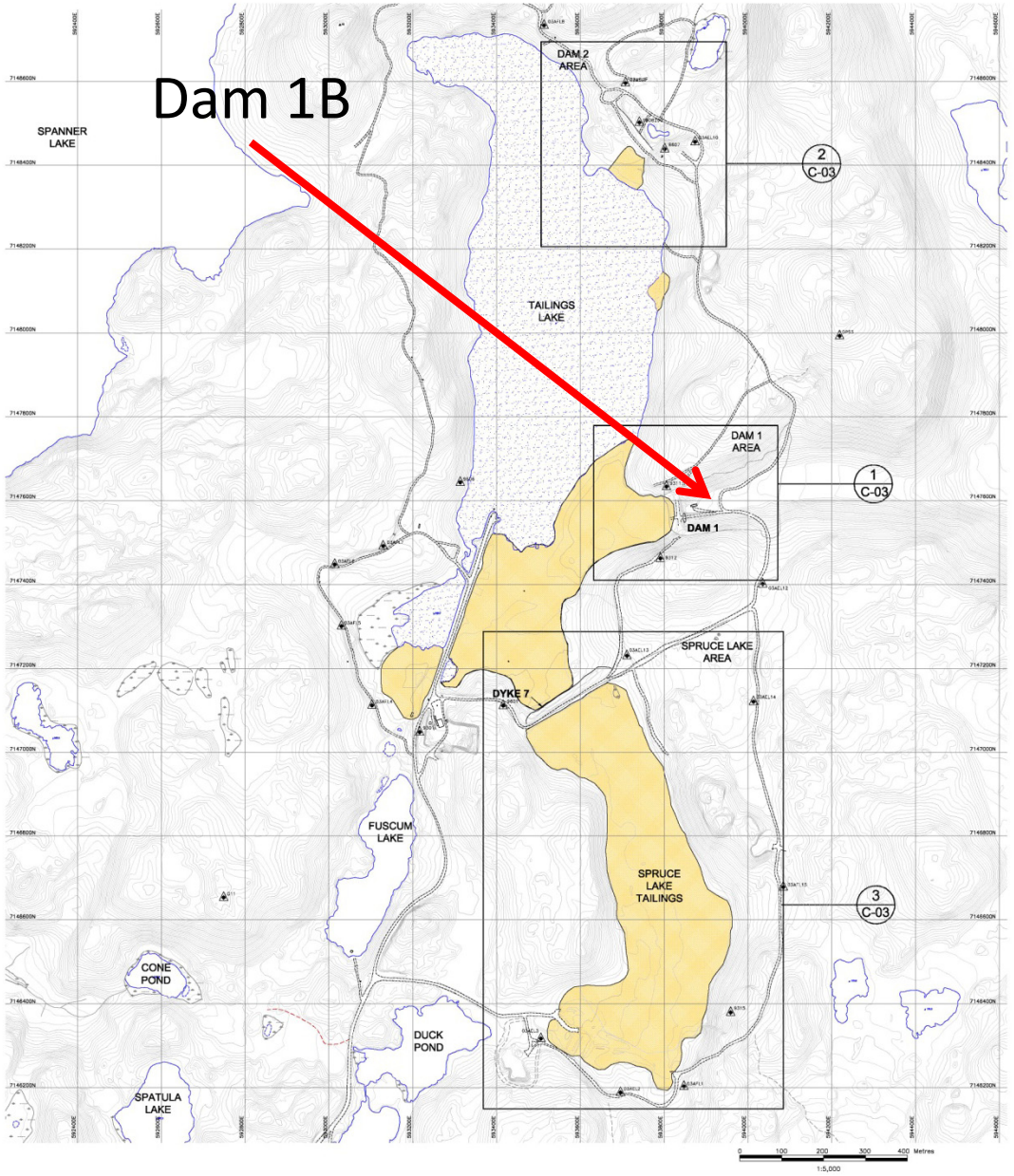
- The objective of Dam 1B is to replace the pump-back system, at the toe of Dam 1A that required year-round operation. Dam 1B is superior as it functions passively over the long-term.
- The design objectives are:
  - Seepage control: Dam 1B is constructed in an area of frozen soil and, as long as the soil remains frozen, seepage will be essentially negligible. This implies a requirement for long-term thermal stability.
  - Thermal stability: To ensure complete sealing of the liner to the foundation, the key trench and permafrost foundation must remain frozen indefinitely.
  - Long-term stability: Stability criteria is provided by the Canadian Dam Association and is based on consequences of failure. Failure of Dam 1B would release contaminated water, but not tailings. The environmental impact would be localized and of short duration. The uncontrolled release of contaminated water would discourage local people from using the area for subsistence hunting and fishing. The loss of traditional subsistence territory would be considered moderate damages. That reasoning leads to Dam 1B being classified as a "low" consequence dam.



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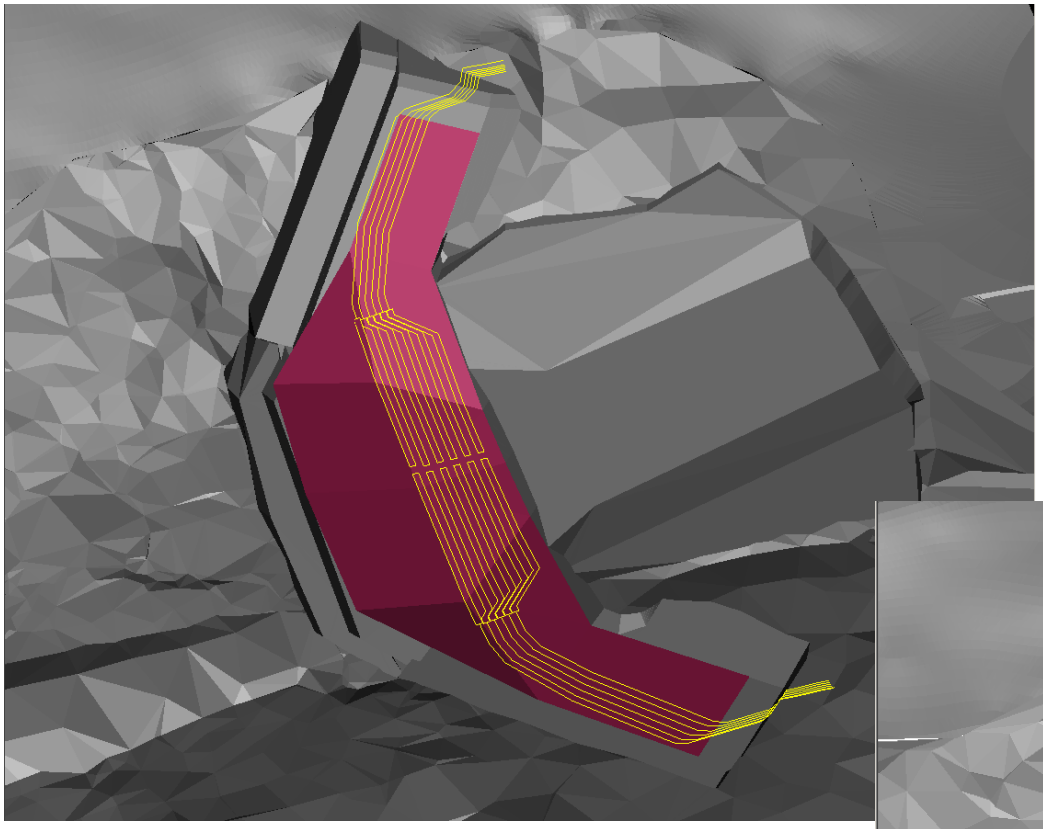
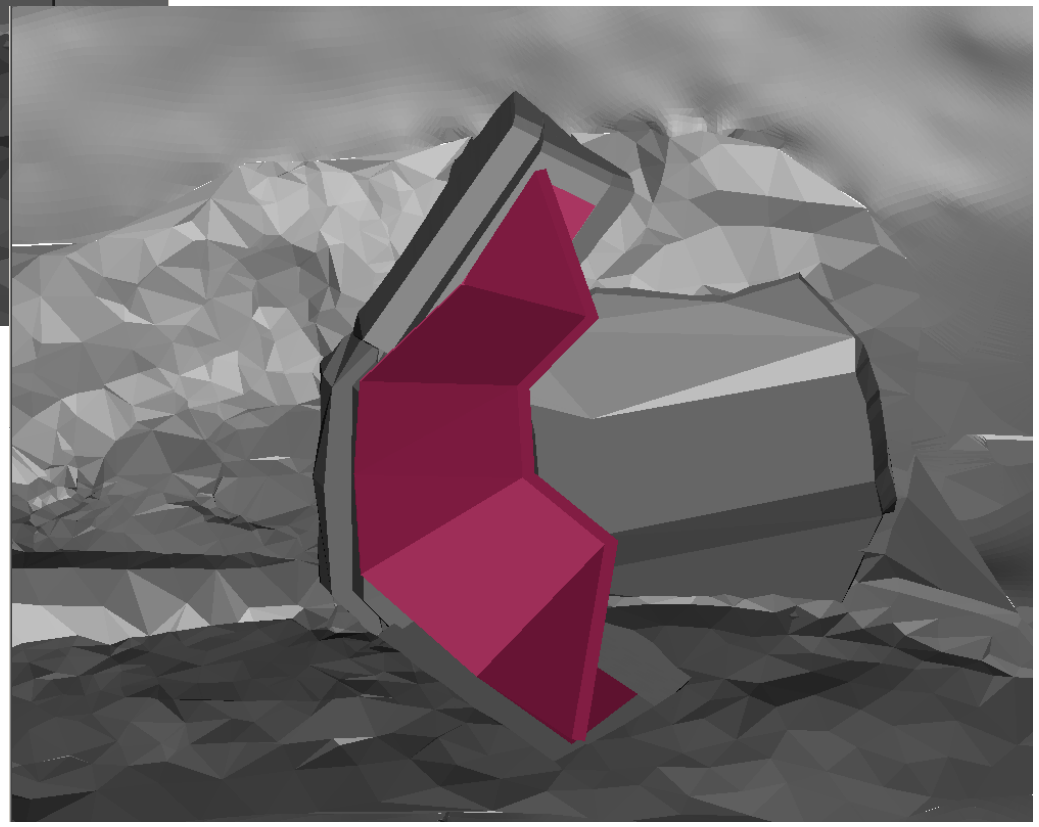
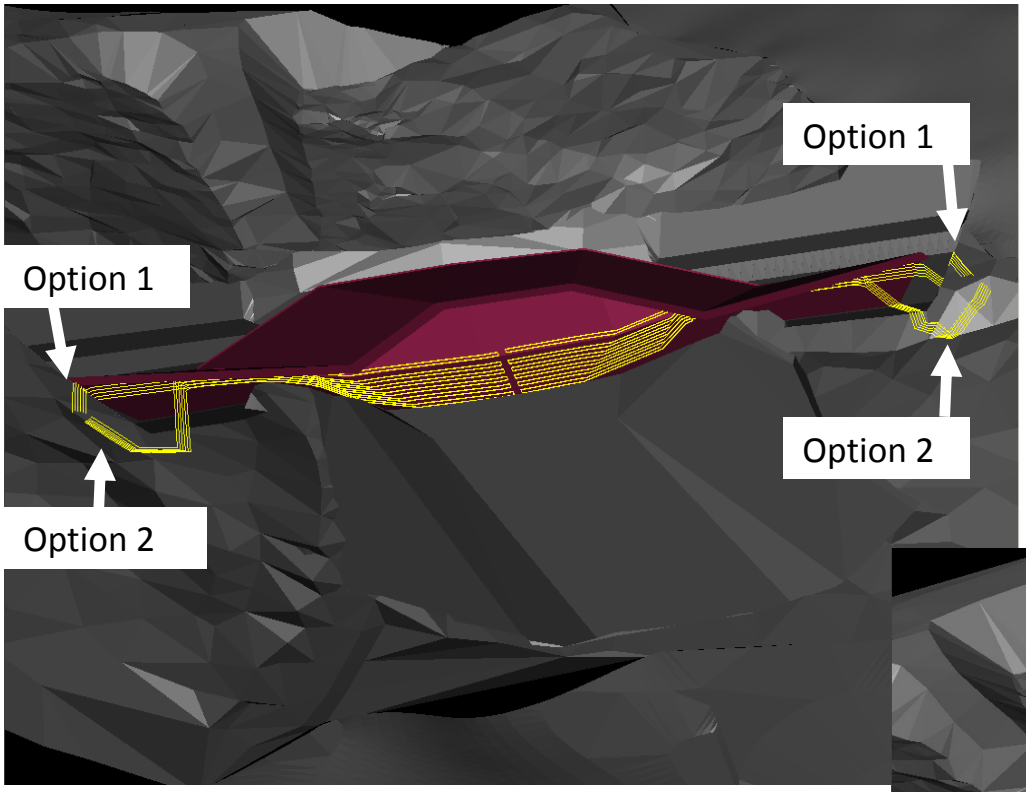
Valley downstream of Dam 1



- Three dimensional view of the excavated key trench and peat excavation.
- Bottom of the liner placed in the key trench.
- Thermosyphon's along the bottom of the key trench placed on top of the bottom liner.



Top of the liner placed in the key trench.



- Lower and Upper Liners and Thermosyphon's in place..
- Two options were considered for radiator location. Option 1 was selected.

Construction of Dam 1B completed

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- Relief of the bedrock surface in the abutments was greater than expected.
- The rock surface was cleaned by hand prior to placing a leveling course of granular material

Placing the leveling course of granular material

A zone of tailings mixed with bentonite was used to create a low permeability zone between the liner system and the bedrock surface

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Liner installation was labour intensive and required physical dexterity on the part of the installer.

- The thermosyphons were constructed in the base of the key trench.
- It is important that the thermosyphons and evaporator pipes always maintain a positive gradient

- From the top of the abutment the evaporator pipes were connected to the base of the radiators
- The radiators were lifted into place under the watchful eye of the contractor and welded into place

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The thermosyphon system is charged with helium and a Helitest Helium Detector is used to detect leaks along the length with additional attention paid to all welds

- The Helium is evacuated from the system and each thermosyphon loop is charged with liquid CO_2.
- The amount of CO_2 used to charge each loop is determined by weight.

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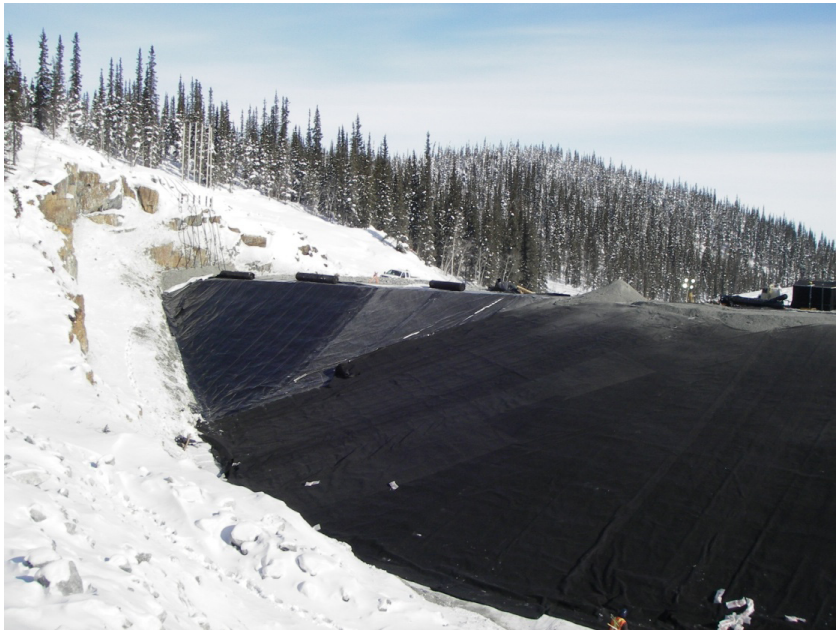

The liner system installed on the upstream face of Dam 1B

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Completion of the infill between Dam 1 and Dam 1B

Completion of the downstream face of Dam 1B

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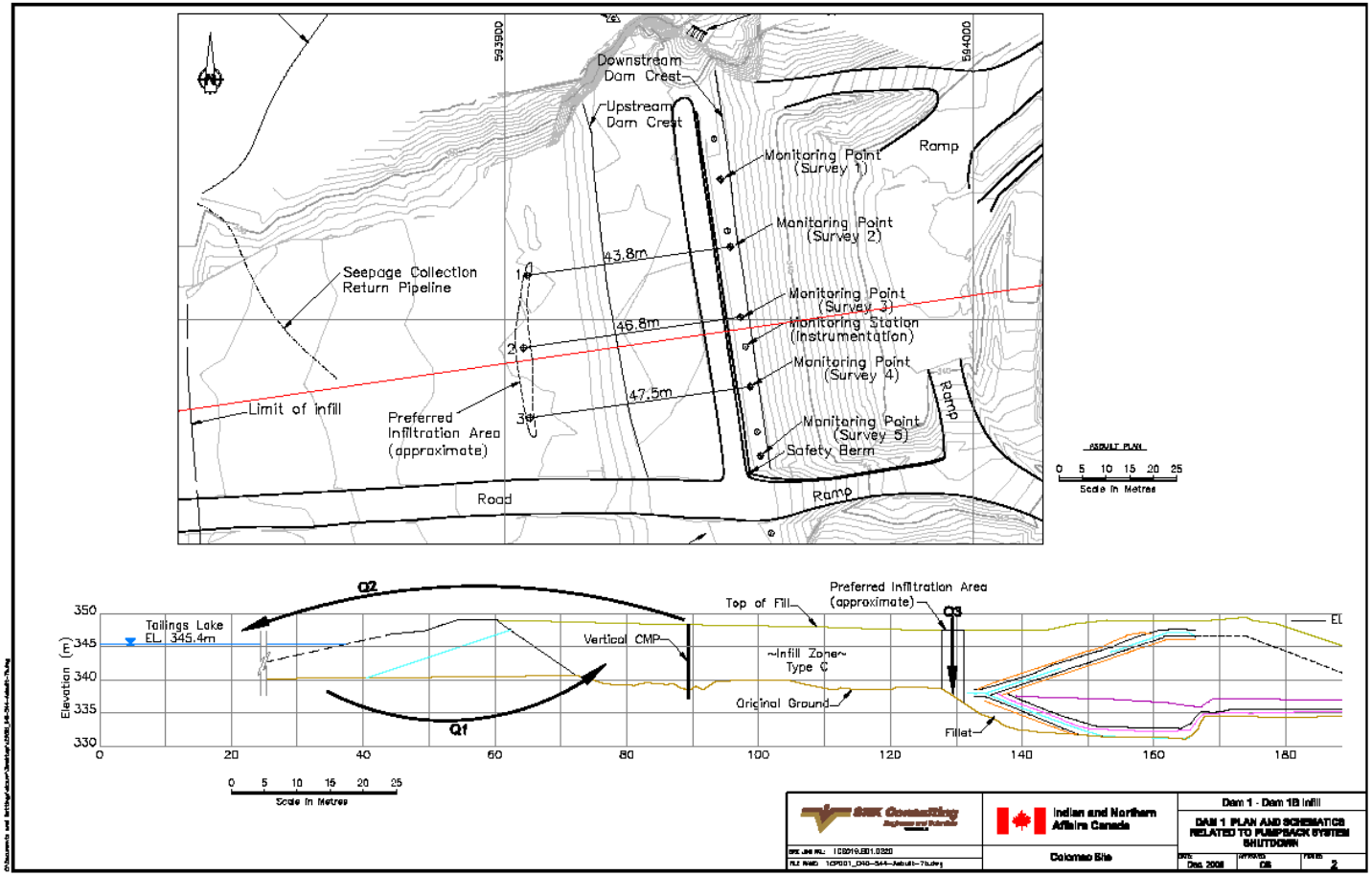
Construction of Dam 1B completed only the radiators remain visible



Shut Down Program

- Starting in mid December 2008, water was pumped from Tailings Lake to a point about 45 m upstream of the crest of Dam 1B. Once the volume of water pumped back to Tailings Lake from the sump starts to increase significantly, turn off the lake pump because the water level in the rock-fill will now be at approximately the same level as the inlet level at the sump.
- Raise the level of the sump pump by 0.5 m and continue to pump from the sump to Tailings Lake over the Christmas period. This will maintain the water level in the infill, and provide an opportunity for the pore water within the abutments to freeze in place.
- In early January 2009, repeat the sequence of pumping water from Tailings Lake to the infill at a location close to Dam 1B, and once the pump-back volumes from the sump start to spike, turn off the lake pump and raise the sump pump by 0.5m. With the water level at a new level, continue to continue to pump from the sump to Tailings Lake.
- Repeat the last step at 0.5 m increments on a weekly basis so that the pore water in the infill is made up of surface water from Tailings Lake. This ended in early March 2009.

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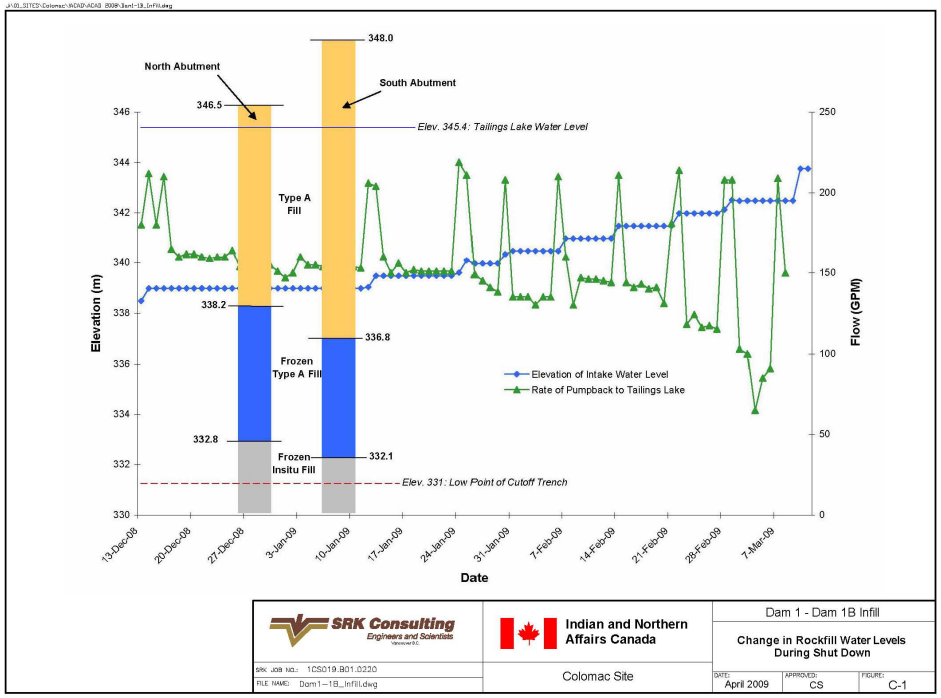
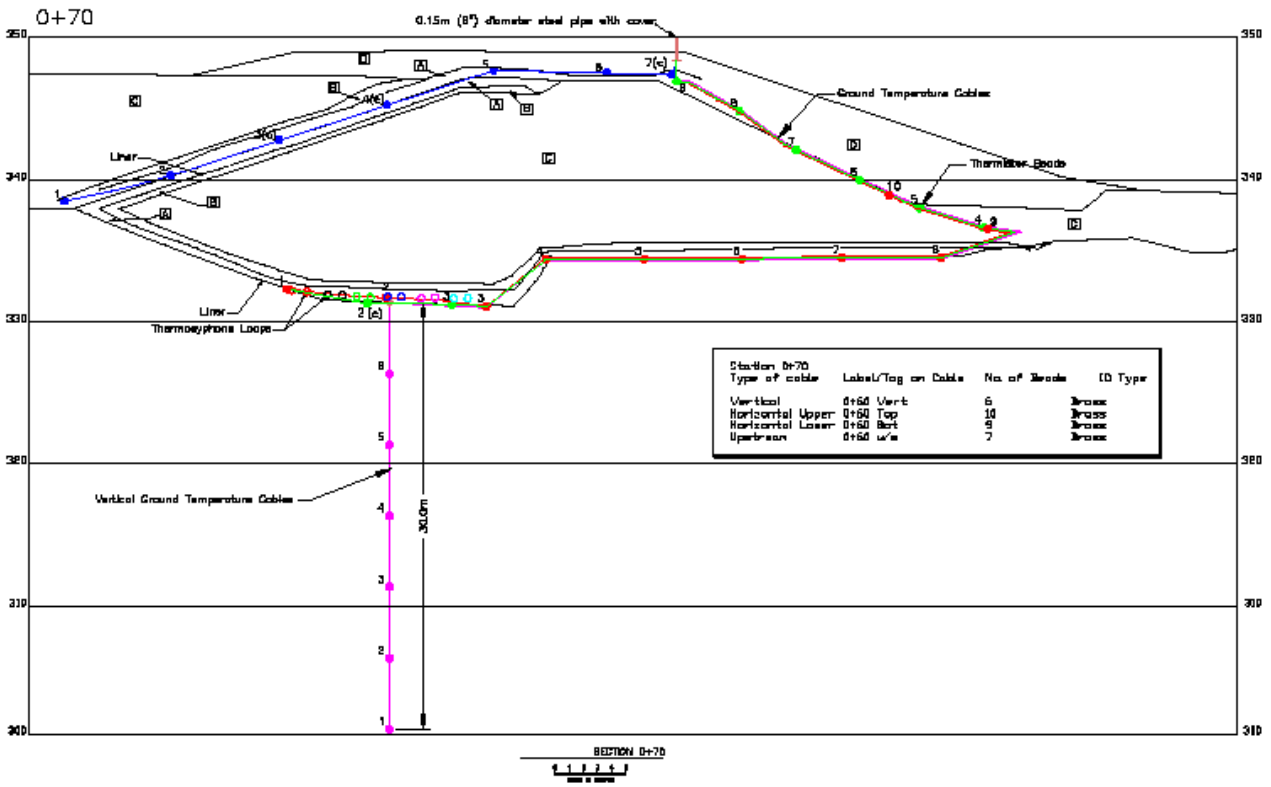


Observations

- The rate at which water was pumped from Tailings Lake to the discharge point on the surface of the infill is understood to have been typically about 160 USgpm, and at no time did the water reporting to the surface of the infill freeze sufficiently fast that the deposition point had to be moved.
- The initial phase of pumping started about mid-day on 12 December and was terminated at about 11pm on 13 December, when a 30% increase (to 210 USgpm) in the pump-back rate to Tailings Lake was detected. During this period, the water level within the rock-fill near Dam 1B is understood to have increased from about El. 331.0 m to about 338.6 m.
- The water level within the rock-fill was maintained at about E. 338.6 for about 29 days, following which the water level was raised by about 3.5 m, to El. 342.1, at a rate of 0.5 m per week using the above procedures.
- The final 1.2 m raise in the water level, to El. 343.4, took about 2 days. At this water level, the approximate difference in head between Tailings Lake and the water level in the infill was 2.0 m, but the flow reporting to the sump had slowed “to a trickle.”
- Over the course of the shut down program, due to a gradual reduction in the head differential between Tailings Lake and the water level in the rock-fill, the rate at which seepage was pumped from the sump to Tailings Lake gradually decreased from about 180 USgpm to less than 100 USgpm during the latter stages of the program, to zero when the pumps were pulled from the sump on 9 March.
- Over the course of the program, no signs of seepage, such as wet zones in the snow immediately downstream of the toe of Dam 1B, were observed.

Observations Cont.



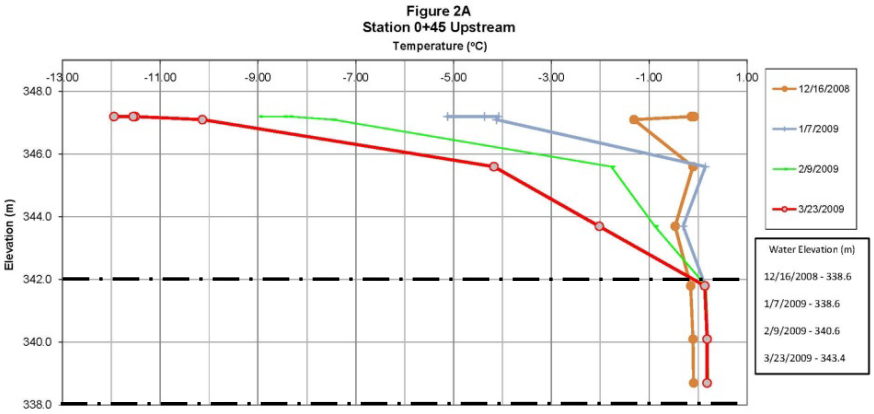
ASBUILT

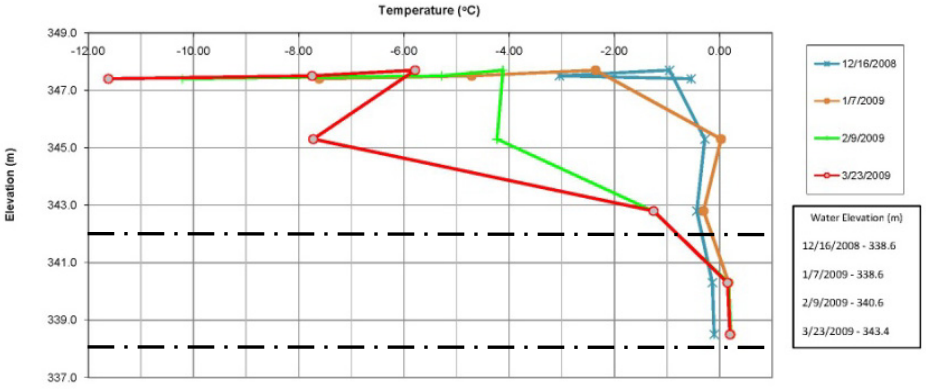
COLOMAC SITE
REMEDIATION PROJECT

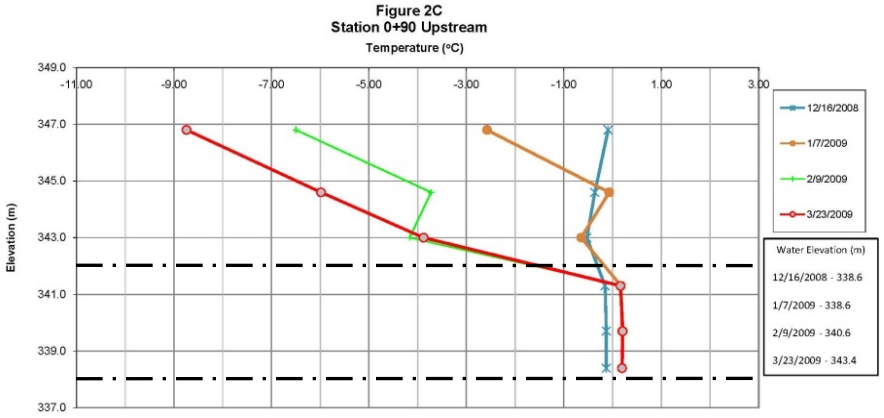
COLOMAC, NT

SECTION 0+70

Thermistor Strings Located on the Upstream face of Dam 1B







- The data from 16 December is approximately 0.2° C colder than it should be compared to data from the subsequent three data sets (see uniform temperature offset between approximately El. 338 and 342), and reflects the use of a different readout unit on 16 December.
- There is no detectable change in temperatures in the portion of the liner above the chevron (approximate El. 338 m), which is somewhat surprising as one would have expected a modest increase in temperature due water entering the voids in the fill upstream of the liner (see temperatures between approximately El. 338 and 342).

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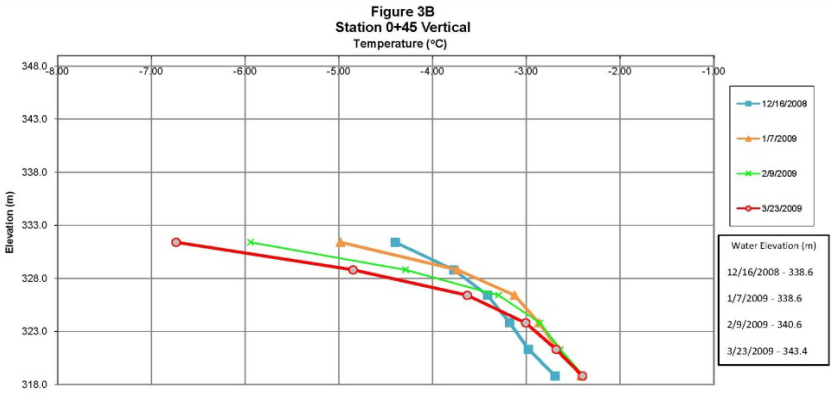
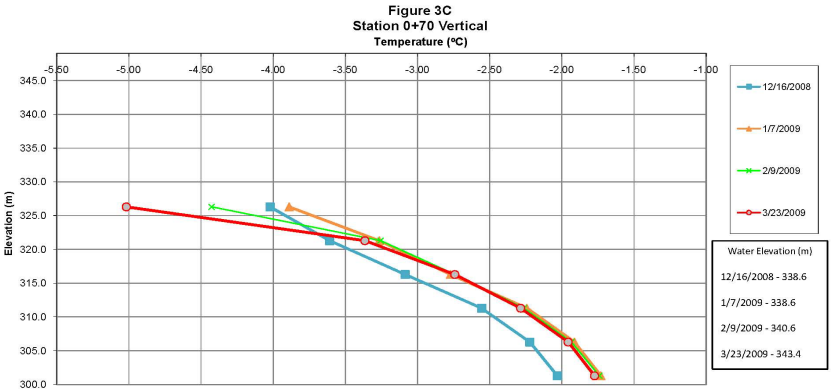
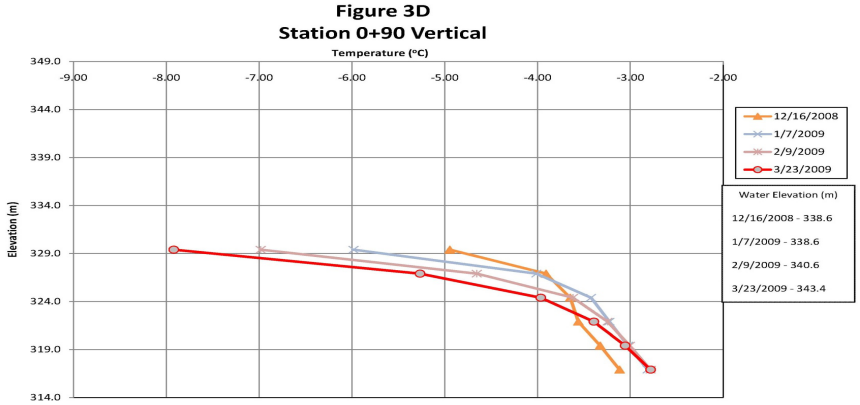
Vertical Thermistor Strings Located Vertically under the Key Trench







- As expected, the program has had no effect on the trend, observed previously, of falling temperatures within the foundation soils below the cutoff trench during winter.

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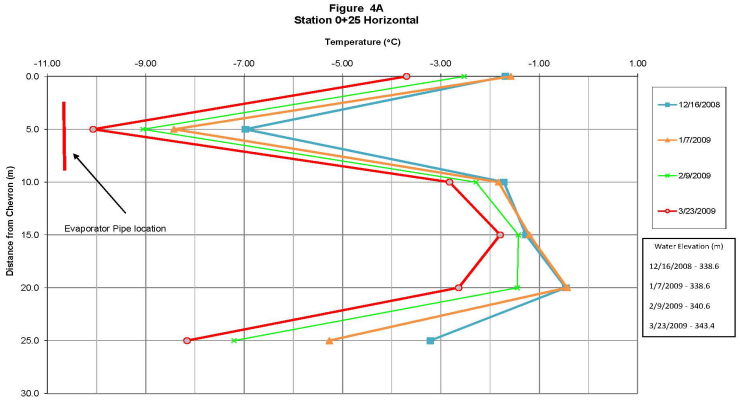
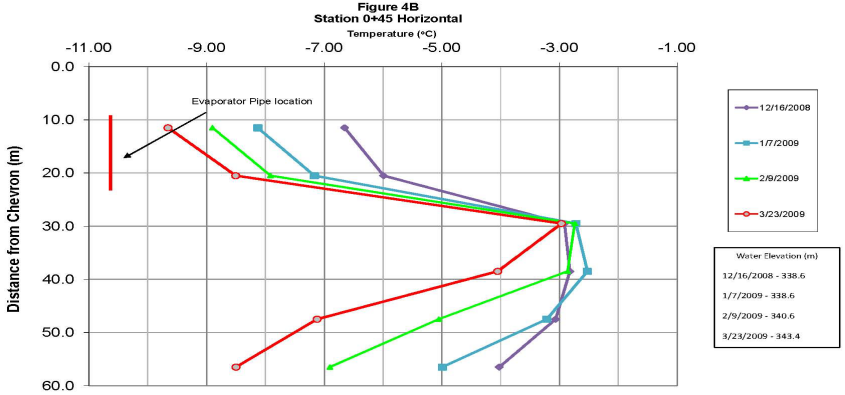
Horizontal Thermistor Strings Located Along the Base of Dam 1B





- The thermosyphons are having a significant effect on temperatures within Dam 1B, as evidenced by a temperature differential of about 5 to 6° C in December and 7 to 10° C in March.

Conclusion

- The thermistor data indicates that the shutdown program has not affected the thermal regime within Dam 1B. As for the abutments, there is no data from which one can draw conclusions.

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