NFRC Realignment Project

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At one time, the Faro Mine was one of the world's largest open-pit lead and zinc mine that supplied 15% of global output.

Faro Mine

Located in the Yukon on a 2500 hectare site 350 kilometers northeast of Whitehorse

Open pit mine produced lead and zinc, operated from 1969 until 1998

In 1998 the last operator, Anvil Range Mining Corp, went into receivership

Deloitte and Touche was the court appointed Interim Receiver until 2009

Faro Mine Setting

- Mean Annual Air Temperature = -2°C
- Mean January Air Temperature = -15°C
- Mean July Air Temperature = +12°C
- Mean Sub-Freezing Air Temperatures from October through April
- Mean Annual Total Precipitation = 443 mm
- Discontinuous permafrost exists at site
- Daylight hours range from 6 hours in December/January to 19 hours in June

Faro Project Closure Objectives

Protect human health and safety

Protect and, to the extent practicable, restore the environment including land, air, water, fish and wildlife

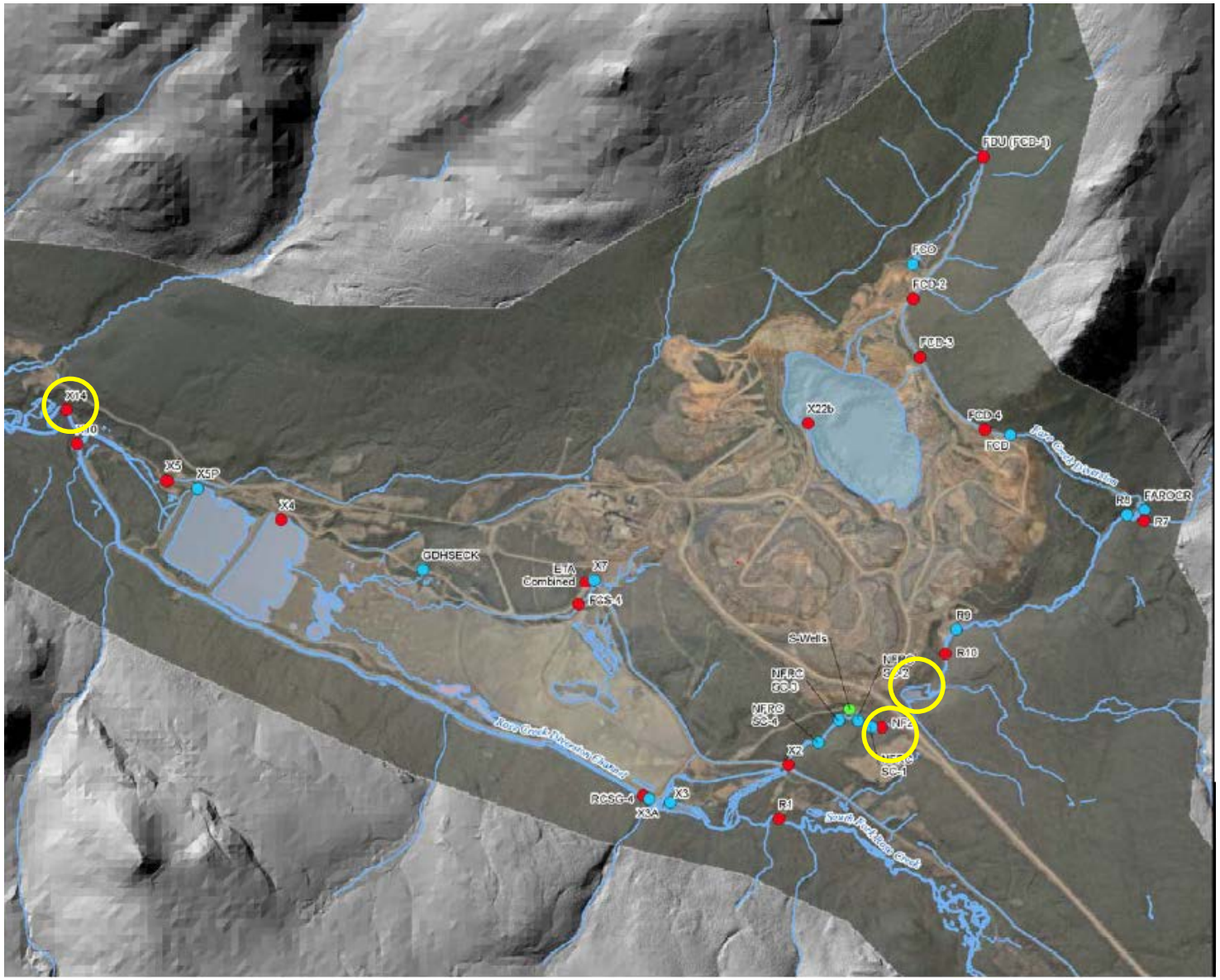
Return the mine site to an acceptable state of use that reflects pre-mining land use where practicable

Maximize local and Yukon socio-economic benefits

Manage long-term site risk in a cost-effective manner

Faro Mine Area Flow Monitoring Stations

- Routine monitoring in October 2013 showed elevated levels of zinc at the X14 water quality monitoring site.
- The following week, investigative monitoring continued.
- Elevated zinc levels were discovered at NF1 (the Rock Drain Head Pond) and NF2, immediately downstream of the North Fork Rock Drain.



North Fork Rose Creek Seepage

In March 2014, approximately $ 1M spent to drill seven wells in an unsuccessful attempt to delineate and potentially intercept the source of the seep.

In Fall 2014, INAC and the Government of Yukon received a Letter of Direction from Environment Canada's Inspector to immediately take measures to stop the deposit of the deleterious substance into Rose Creek.

In Winter 2014/15, a seepage interception system was installed downstream of the rock drain. This approach was intended to remove a portion of the contaminated water at the rock drain outlet before it traveled downstream in the North Fork Rose Creek (NFRC).

NFRC Realignment Project – CH2M (Feb 2015 – Aug 2016)

In February 2015, CH2M Hill Canada Ltd. (CH2M) initiated design of the NFRC Realignment Project. CH2M subcontracted BGC to provide permafrost engineering and cold regions construction input.

Summer 2015 site investigation: boreholes, test pits, surface and downhole geophysics, laboratory testing.

In August 2016, CH2M submitted conceptual design basis report.

In September 2016, BGC took over as lead designer for the NFRC Realignment Project.

NFRC Realignment Project (BGC 2016 – present)

- Summer 2016 site investigations: boreholes, test pits, downhole geophysics, laboratory testing.
- July 2017: BGC submitted conceptual design report for the non-contact water (NCW) diversion.
- Summer 2017 site investigations: boreholes, test pits, laboratory testing.
- April 2018: BGC submitted detailed design report for the NCW diversion and conceptual design report for the contact water collection system.
- Fall 2018: planned initial construction for the NFRC Realignment Project.

NFRC Realignment Project Design Approach

1. A non-contact water (NCW) diversion channel intended to convey non-contact water from upstream and separate this water from the waste rock dump (WRD)-impacted seeps
2. A contact water (CW) collection and conveyance system, intended to collect WRD-impacted seepage flowing into the NFRC and transport for temporary storage and later treatment.
3. Alteration of the NFRC required a Fisheries Act Authorization (FAA), including fish habitat compensation measures.
4. Project proceeded under Urgent Works auspices; no other regulatory review required.
5. Design objective is for water quality at monitoring station X2, located at the North Fork Rose Creek Mine Access Road crossing, to meet water quality criteria.

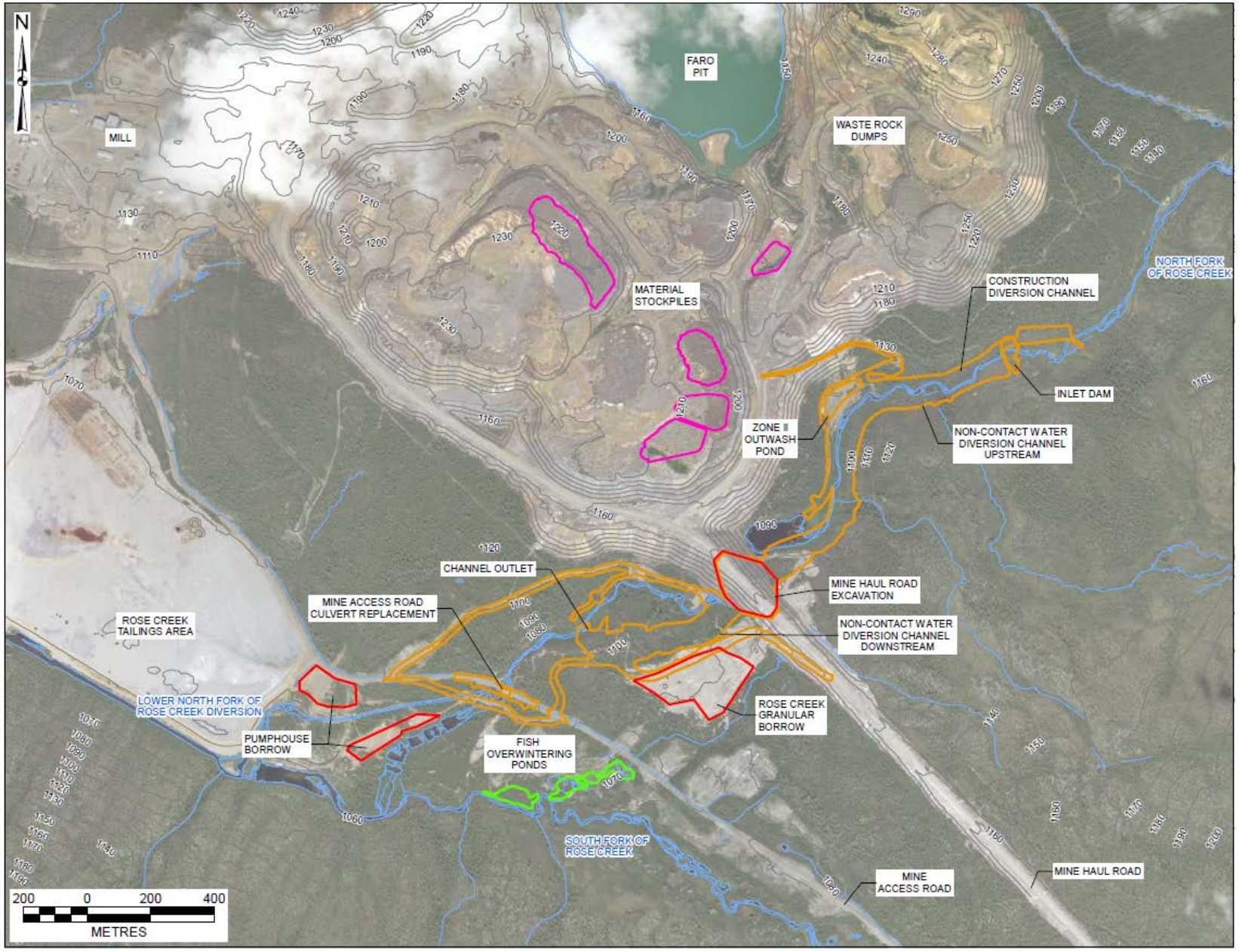
NFRC Realignment Project Plan View

Construction Challenges:

- Diversion channel constructed within existing impacted NFRC valley while protecting the downstream aquatic environment
- Subarctic climate
- Sporadic discontinuous permafrost

Construction Components:

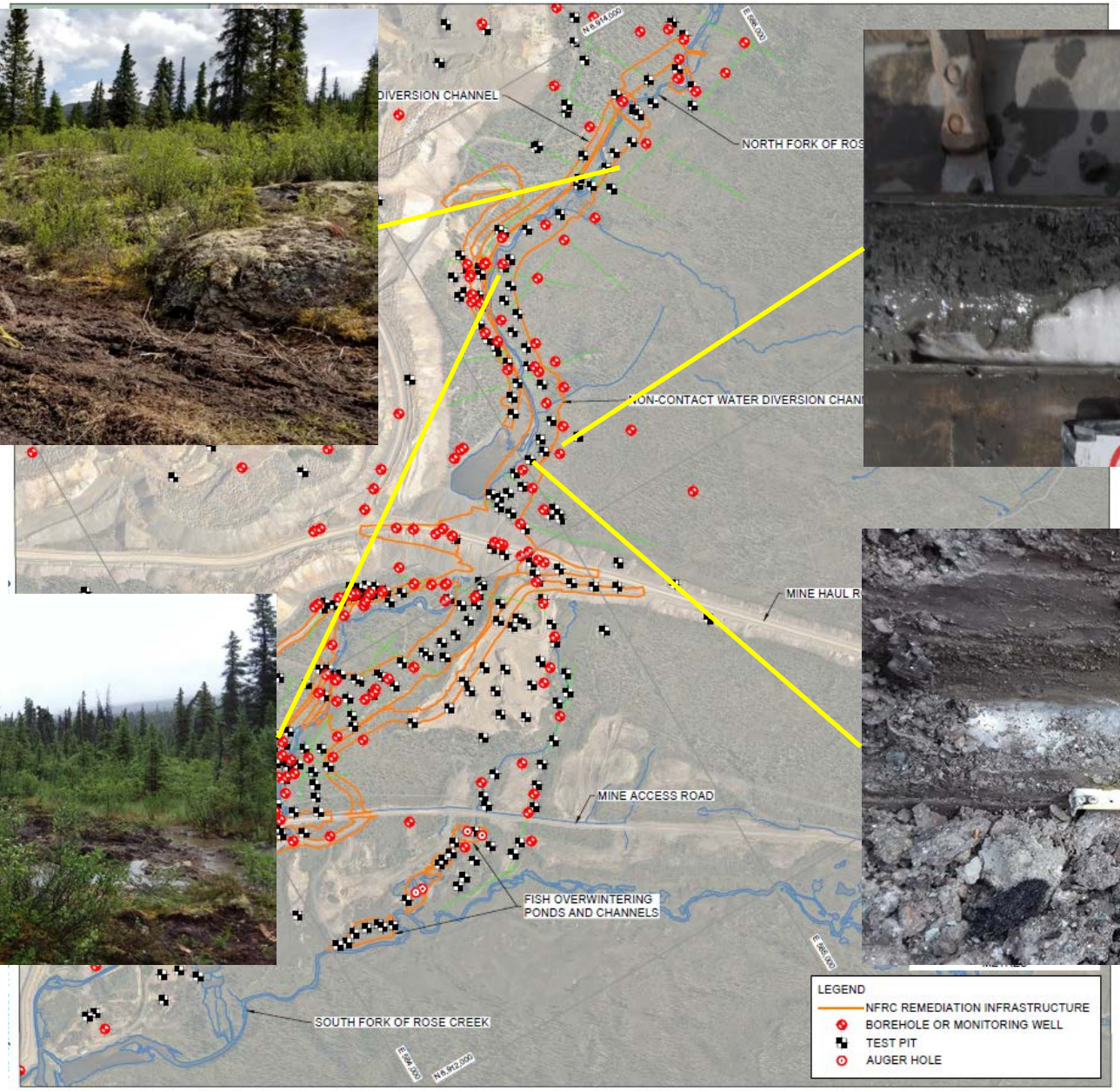
- Construction Access Roads
- Borrow Areas
- Material Stockpiles
- Construction Diversion Channel
- NCW Diversion Channel & Inlet/Outlet
- Mine Haul Road Excavation
- Mine Access Road Culvert Replacement
- Fish Overwintering Ponds

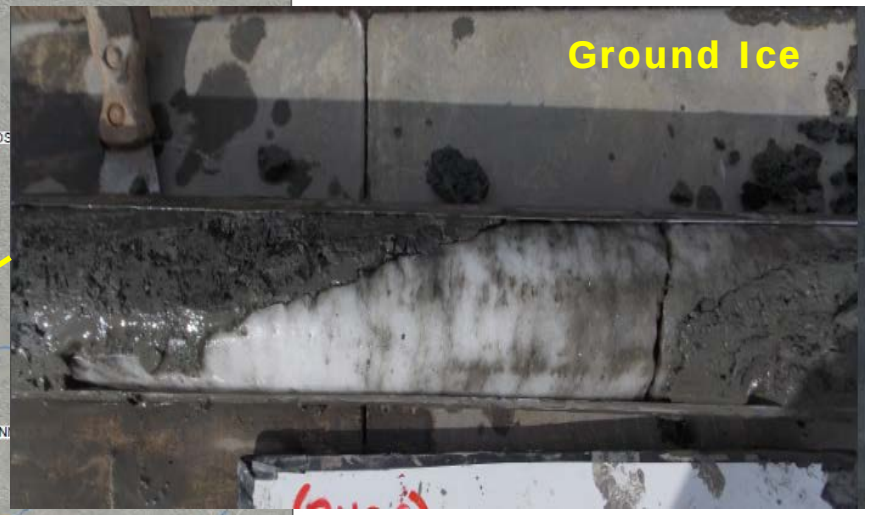


NFRC Aerial View, Looking West

- NFRC Valley Floodplain
  - Varied overburden materials:
    - fluvial/glaciofluvial
    - till
    - colluvium
  - Sporadic discontinuous permafrost
    - ground temperature >-1°C
    - permafrost thickness from 2 to 25 m

NFRC Site Conditions



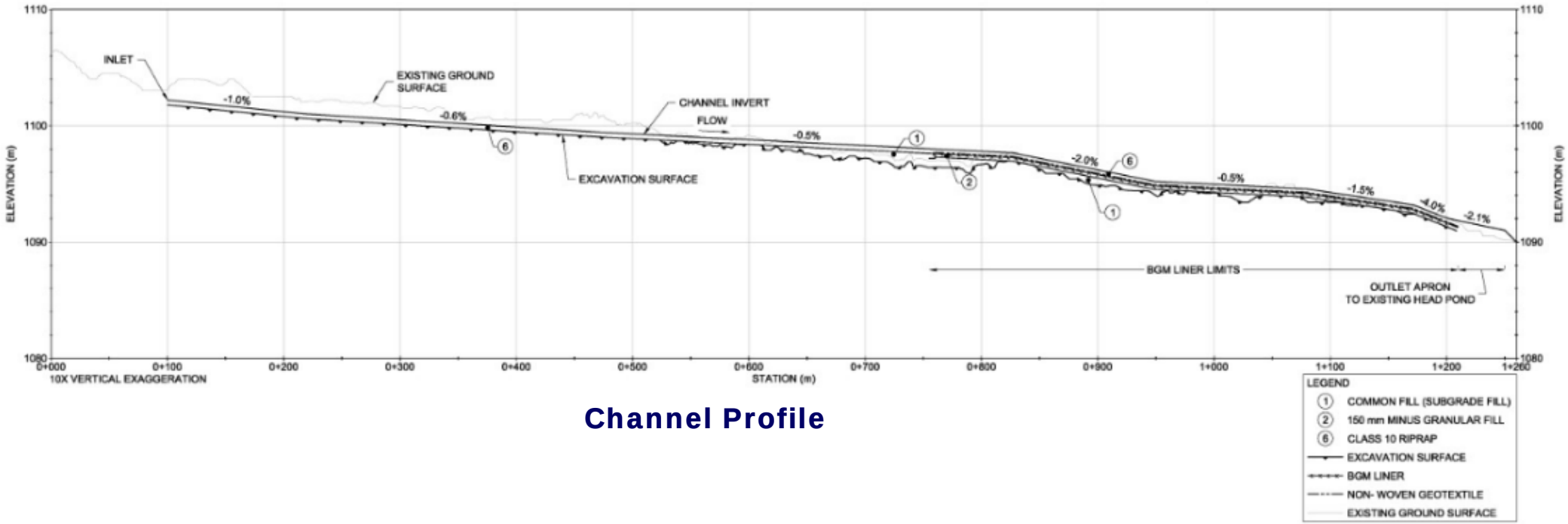


NFRC Subsurface Conditions

- Topsoil, peat and organics
- Overburden
  - Fluvial
  - Glaciofluvial
  - Till
  - Colluvium
    - Sand, gravel, cobbles, boulders, and fines of varying proportions, moisture content, and ice content

Construction Diversion Channel

- 1.1 km long channel constructed upstream of the haul road to allow construction of NCW Diversion Channel away from existing active stream
- ~ lower 450 m length of channel is lined with geomembrane liner to protect against potential contamination

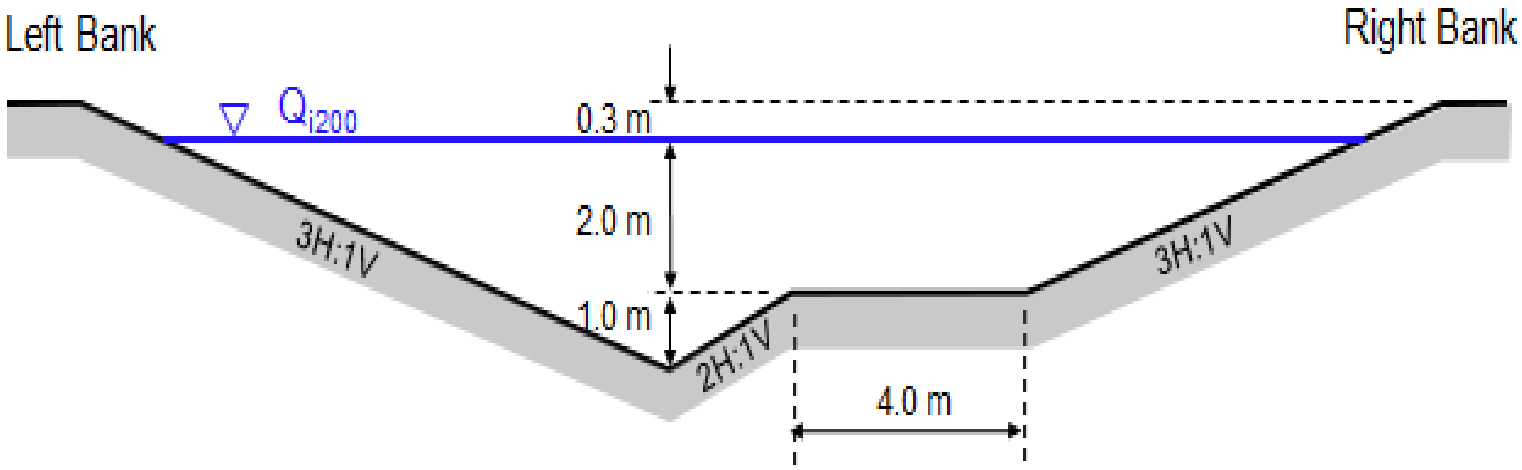


Channel Profile

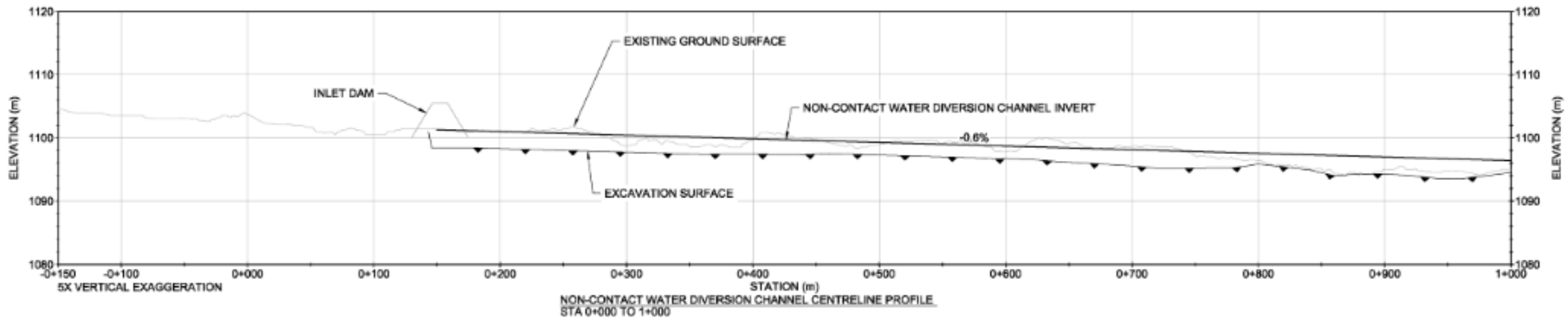
NCW Diversion Channel Description

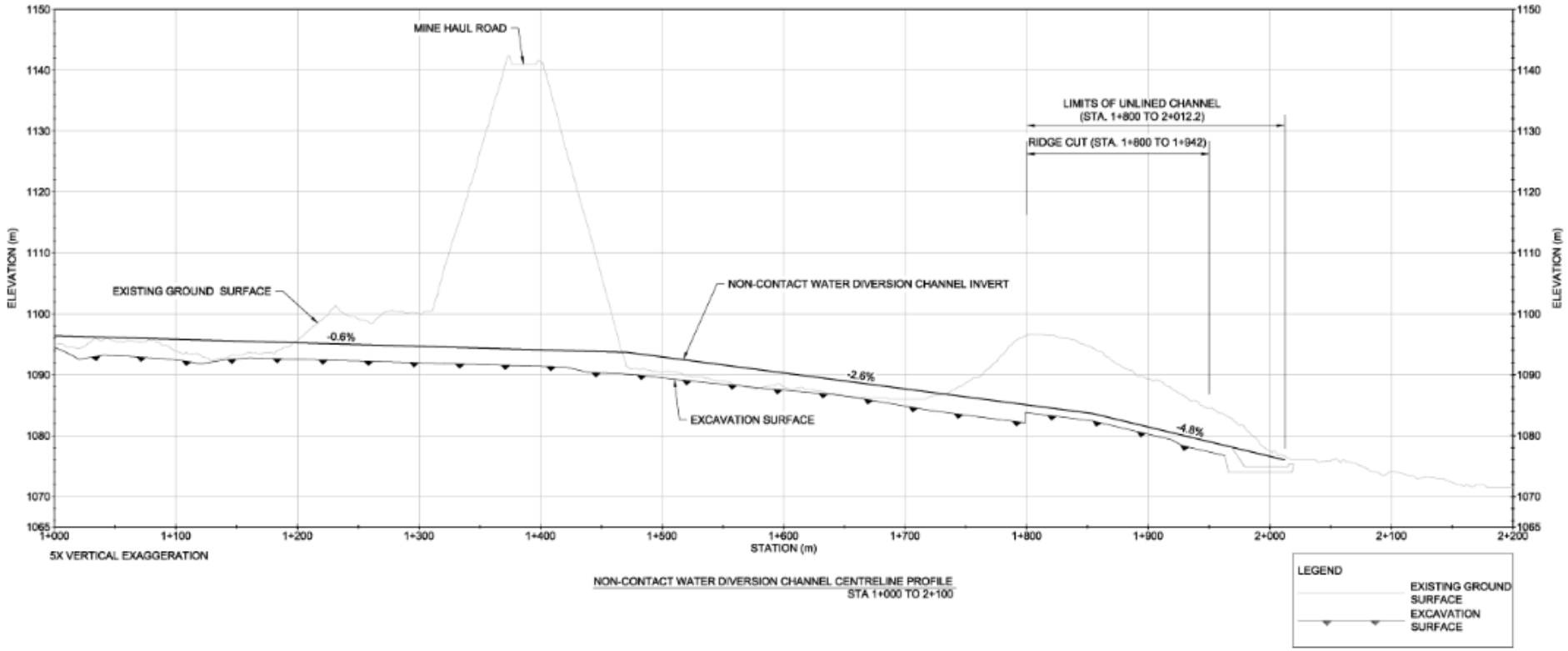
- 1.85 km engineered channel
- Channel is designed for:
  - 200-year flood event (78 m^3/s), plus 0.3 m freeboard
  - Fish passage
  - Protection against aufeis formation


Faro Creek Diversion aufeis

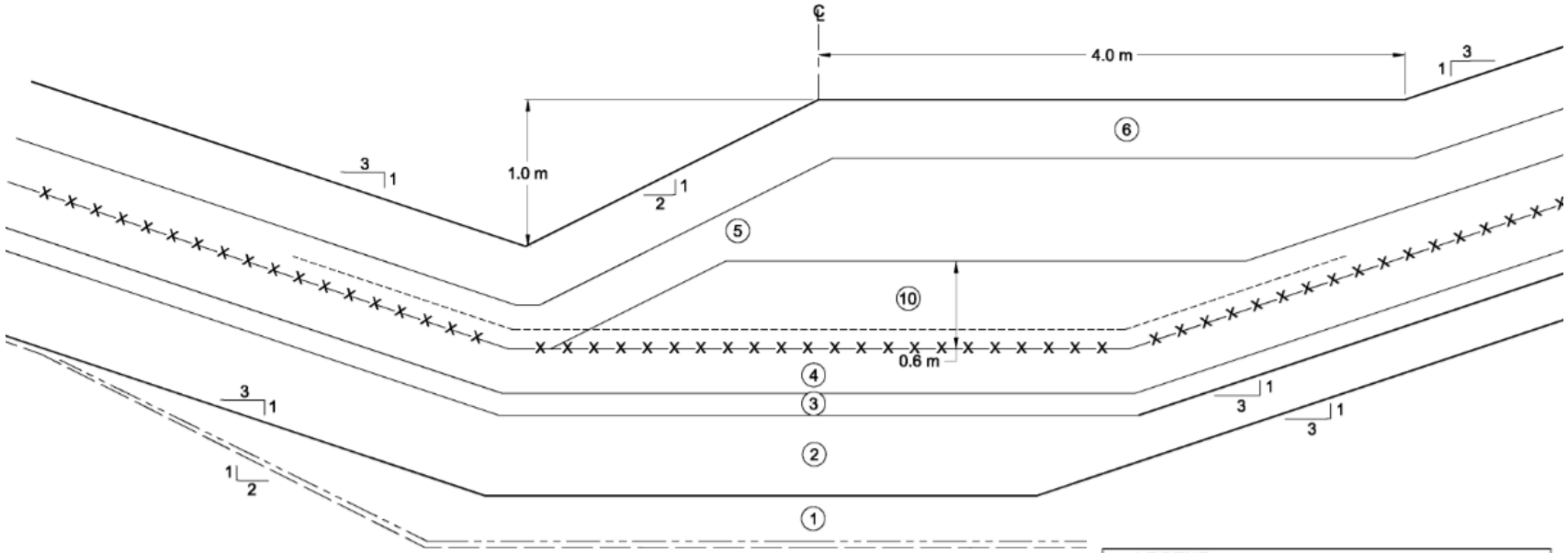


NCW Diversion Channel Profile





NCW Diversion Typical Channel Section (Upstream of Haul Road)

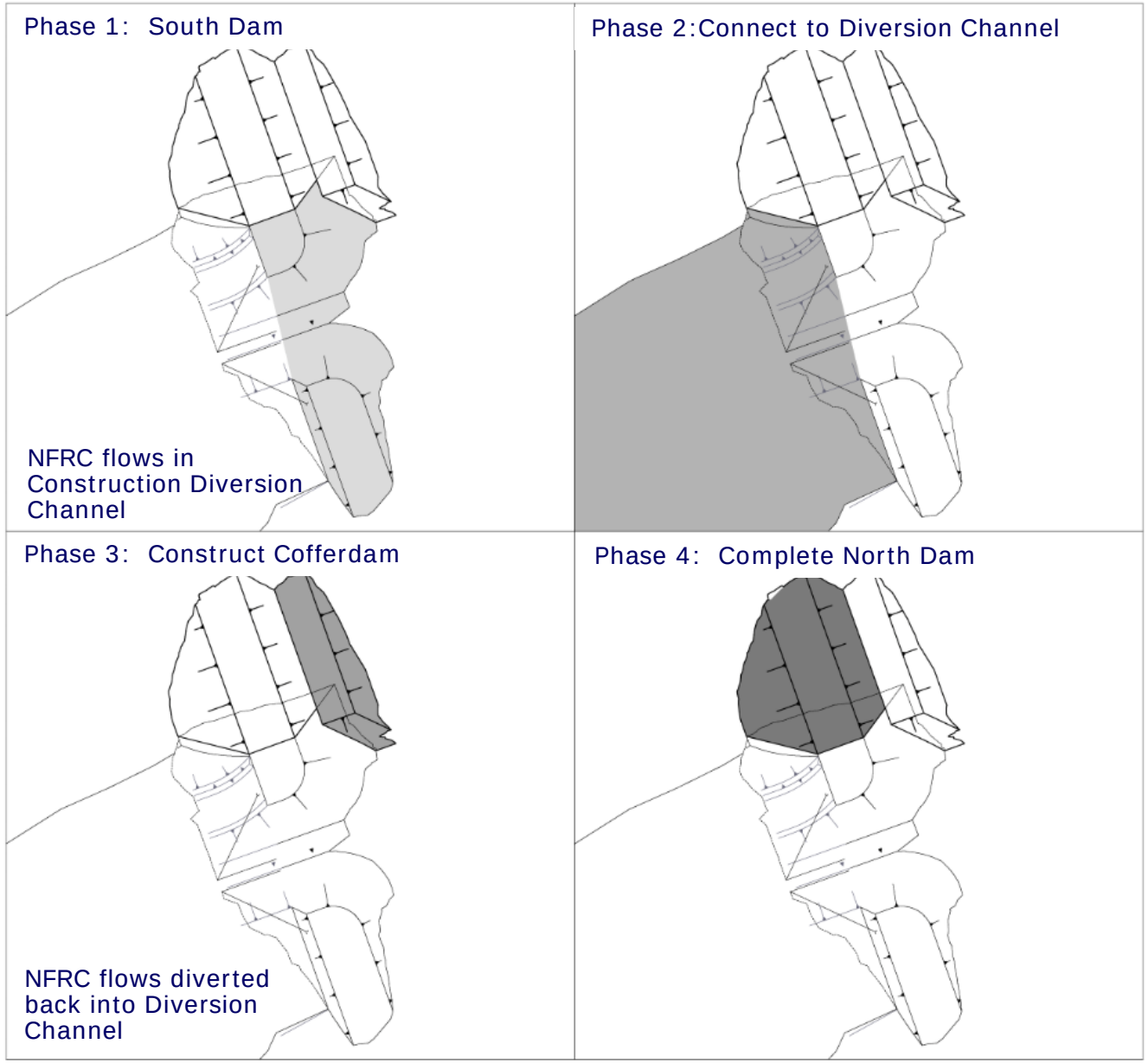


LEGEND

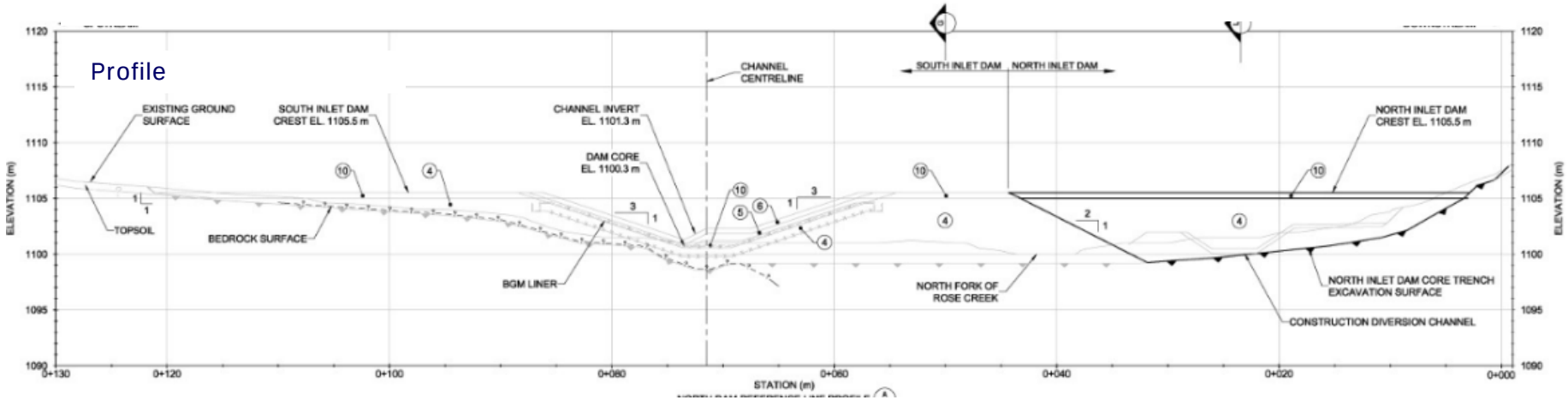
1	COMMON FILL
2	150 mm MINUS GRANULAR FILL
3	FILTER SAND
4	LOW-PERMEABILITY FILL
5	RIPRAP BEDDING
6	CLASS 10 RIPRAP
7	CLASS 100 RIPRAP
10	75 MM MINUS GRANULAR FILL
℄	CENTRELINE
	EXCAVATION SURFACE
	EXISTING GROUND SURFACE
x x x x	BGM LINER
	NON-WOVEN GEOTEXTILE
	WOVEN GEOTEXTILE

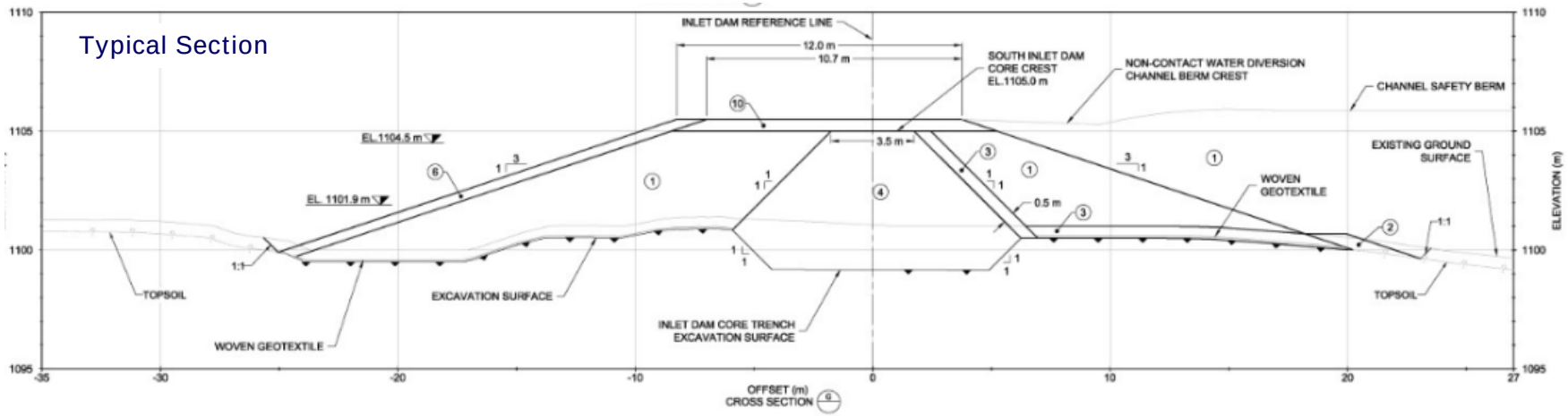
- Incorporates pilot channel
- Composite-lined channel to minimize channel leakage
- Channel lining materials for erosion protection, geomembrane liner protection, drainage

NCW Diversion Channel Inlet Dam



NCW Diversion Channel Inlet Dam
Longitudinal Profile and Cross Section

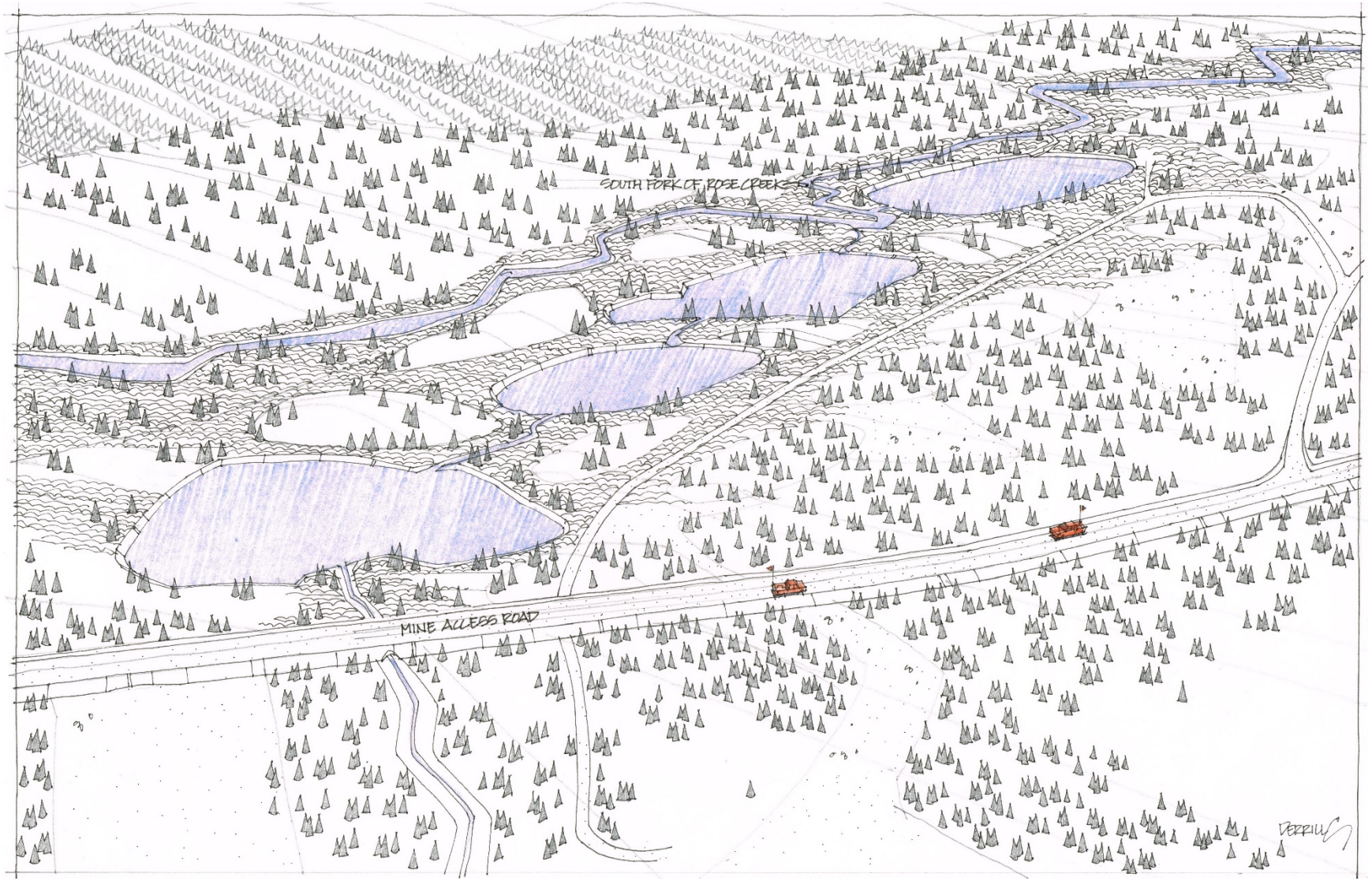




Excavated Materials – Mine Haul Road Fills

- Glaciofluvial sands and gravels
- Waste Rock Fills (mostly non-potentially acid generating, Non-PAG, but with some visible sulphides)
- Potential for re-use as construction fills

Fish Overwintering Ponds



Construction Considerations

Construction in active stream

- *Requires construction diversion channel to divert NFRC flows away from work area*
- *Requires fish salvage and installation of fish barriers for duration of construction*

Construction water management

- *Sediment and metals-impacted construction water*

Construction in permafrost

- *Partial sub-excavation of unsuitable soils, including permafrost, to minimize post-construction thaw settlement*
- *Foundation preparation during winter months to minimize warming of permafrost foundation due to exposure to warm ambient temperatures and solar radiant heating*
- *Channel fills use mainly granular fills that can be placed and compacted during sub-freezing conditions.*

Recent Fish Salvage Work

Summary

- The objective of the NFRC Realignment Project is for water quality at monitoring station X2 to meet water quality criteria.
- This will be achieved by constructing a 1.85 km long diversion channel
  - To separate the non-contact water from upstream from the waste rock dump-impacted seepage into the NFRC
  - To work in conjunction with a contact water collection and conveyance system.
- Construction challenges:
  - Constructing an non-contact diversion channel within an already impacted area while protecting the downstream aquatic environment.
  - Construction is in a northern environment with subarctic climate and sporadic discontinuous permafrost.
- Construction is planned to be initiated in Fall 2018. Year-round construction is planned.

Thank You – Questions?

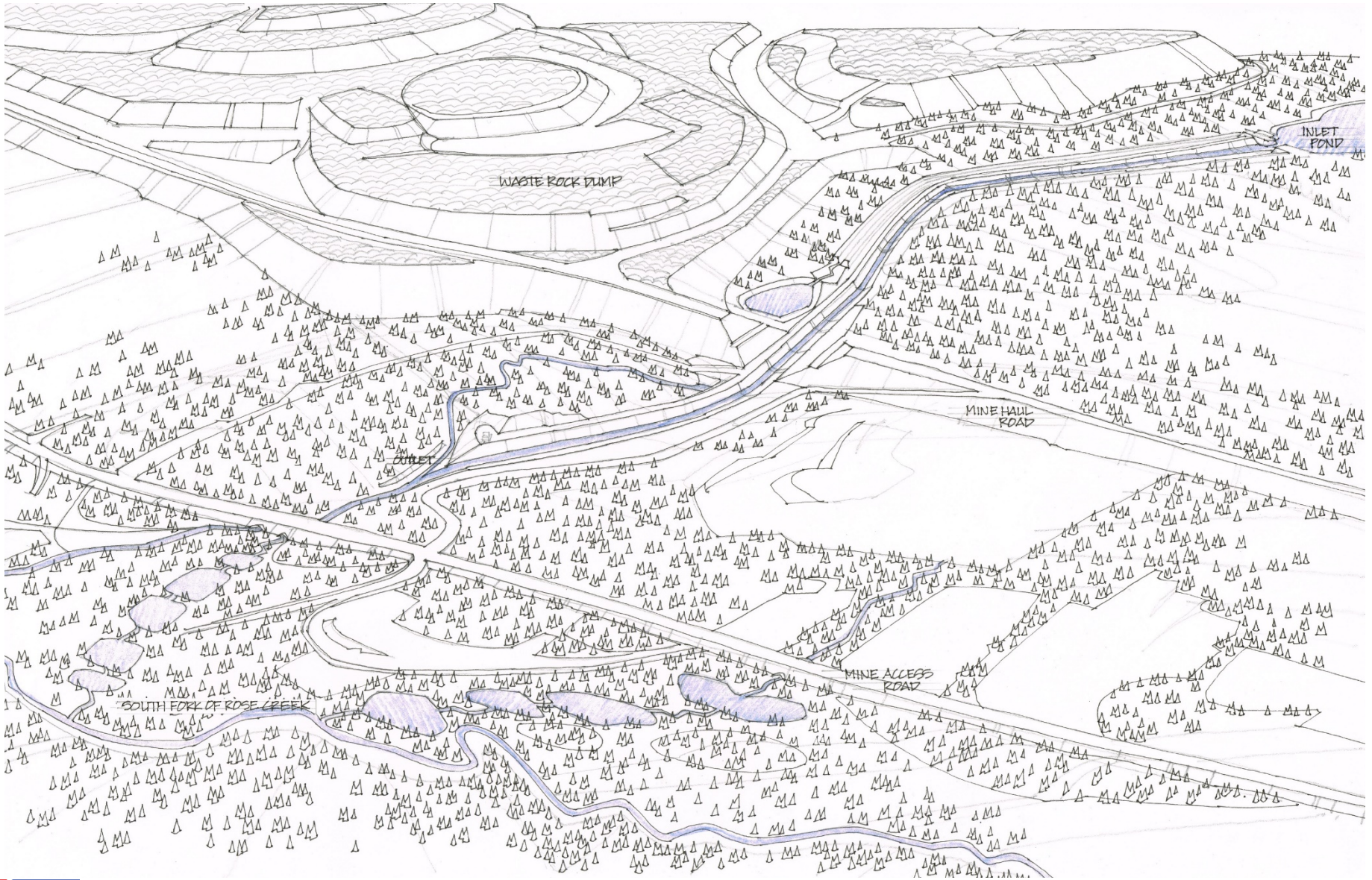


Illustration courtesy Derrill Shuttleworth