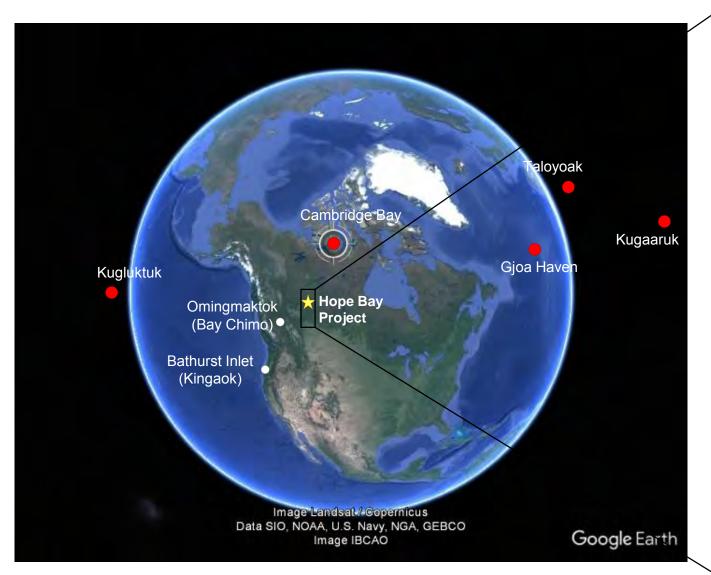
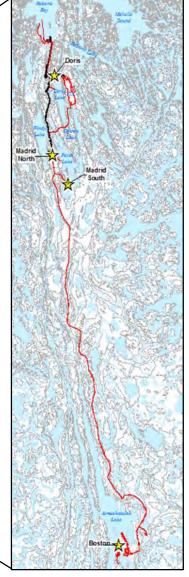


Nunavut Water Board Technical Meeting May, 2018

Project Location







Approved Doris Project (No.003 and 2AM-DOH1323)





Existing Permits and Licences - Doris



Project Certificate

- Issued 2006, Amended 2016
 - Allows Construction, Development, Production, Closure
 - Environmental compliance and protections
 - 2000 tonnes per day
 - Discharge Effluent to Roberts Bay

Type A Water Licence 2AM-DOH1323

- Issued 2007, Amended 2016, Applies from 2013 to 2023
 - Water Use
 - Doris Lake 480,000 m³ per year Mining and Processing
 - Windy Lake 22,000 m3 per year Domestic
 - Reclaim Water no limit Processing
 - 2.5 million tonnes to Tailings Area
 - Reclamation Security \$31 Million

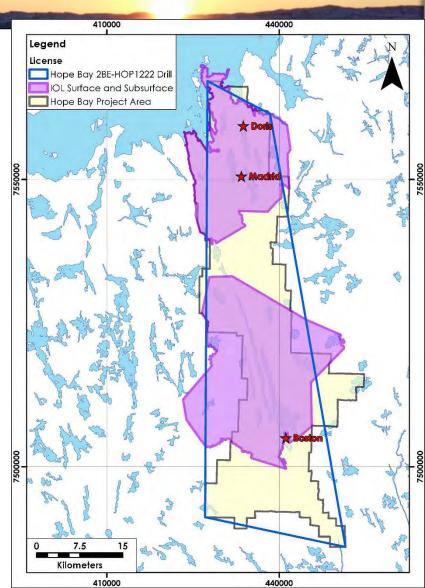
All operations comply with all Federal and Territorial laws and regulations

- Effluent to comply with Metal Mining Effluent Regulation

Type BE Water Licence - Exploration



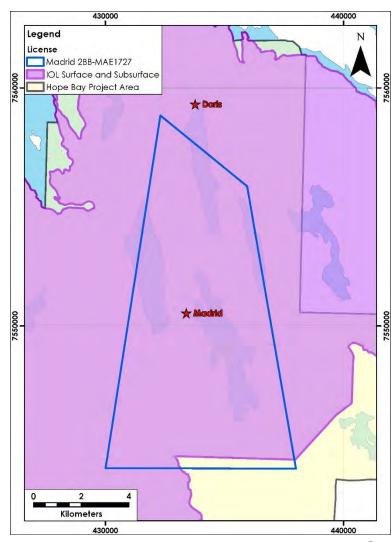
- Type B Water Licence 2BE-HOP1222
- Issued 2012, Expires 2022 (renewable)
- Entire Hope Bay Property
- Permitted Activities
 - Surface Exploration and Drilling
 - Water Use 343 m3 per day.
 - Domestic water use at Doris Camp
 - Construct new camp (180 persons)



Madrid Type BB Water Licence



- Type B Water Licence 2BB-MAE1727
- Madrid North and South
- Issued 2017 Expires 2027 (renewable)
- Permitted Activities
 - Surface and underground exploration
 - Extract 50,000 tonnes bulk sample from each of Madrid North and South
 - Construct surface facilities and roads
 - Haul ore to Doris Plant
 - Water Use
 - 108,000 m3 per annum, 295 m3 per day
 - <u>Reclamation Security Bonds</u> (60 days before activity - proposed)
 - Madrid North \$4 million
 - Madrid South \$3.1 million
 - Roads \$17 thousand

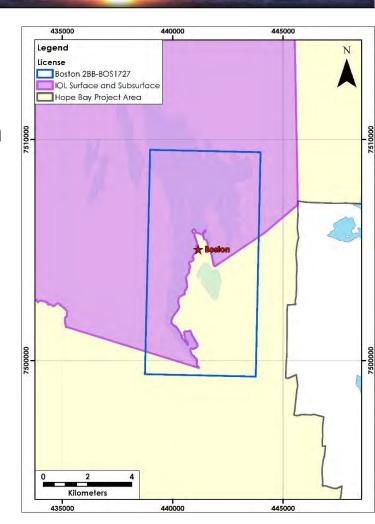


Boston Type BB Water Licence



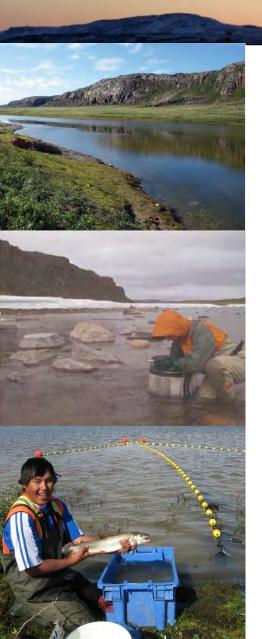
- Type B Water Licence 2BB-BOS1217
- Renewed 2017, Expires 2027 (renewable)
- Permitted Activities
 - Surface and underground exploration
 - Extract bulk sample
 - Construct surface facilities, roads and camp
 - Water Use 100 m3 per day
 - Winter road access from Doris
 - Scope includes:

"...camping, prospecting, drilling, bulk sampling, operation of a bulk sampling and crushing and sorting plant, underground development, the operation of a fuel storage facility, a landfarm facility, and sampling for environmental baseline data collection."



Monitoring and Reporting





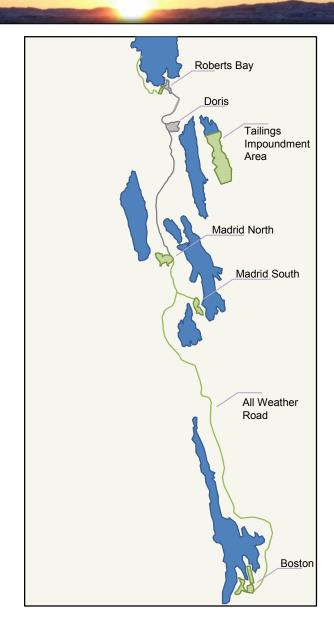
- Aquatic Effects Monitoring Plan
- Environmental Effects Monitoring Program
- Surveillance Network Program
 - Type A Water Licence –monthly
 - o Type B Water Licence(s)- monthly
- NWB Annual Reports
 - Type A and Type B Water Licence
 - Due March 31

Madrid-Boston Project Highlights



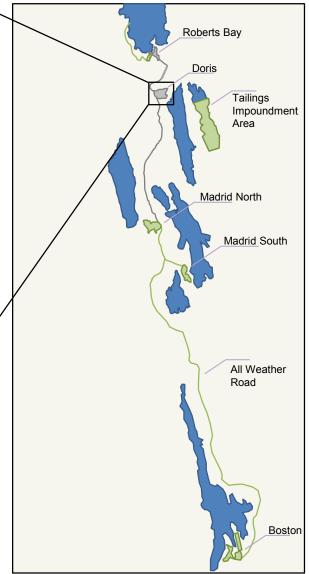
Madrid and Boston Highlights	
Mining	 Underground mining and crown pillar recovery with waste rock stored above ground temporarily and then put back into the underground mines.
Processing	 Approximately 6,000 tonnes of ore processed per day
Gold Production	 Gold production at Doris and Boston. Concentrates produced at Madrid North
Transportation	 Sealift arrives at Roberts Bay and utilize cargo dock and jetty Gold bars flown out to market from Doris and Boston Road connecting Madrid and Boston to Doris and Roberts Bay
Employment	 Fly in-fly out operation from Edmonton and Kitikmeot 870 workers during peak operations (for approximately 14 years)
Economic Benefit	 Royalties, mineral taxes and other payments of approximately \$500 million over the life of the Hope Bay Project for Canada, Nunavut, KIA and NTI (excluding Doris)



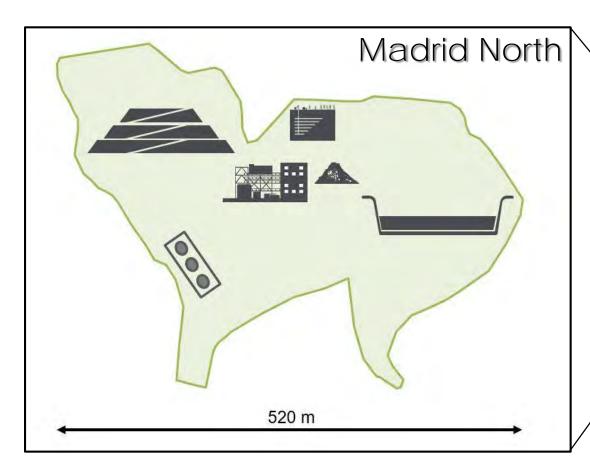


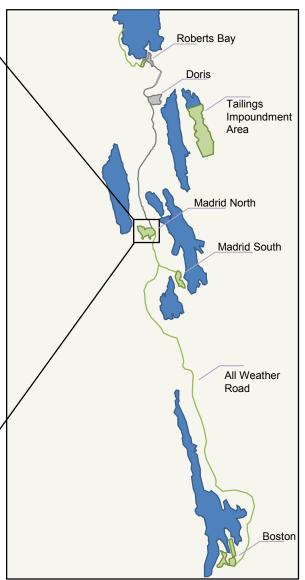




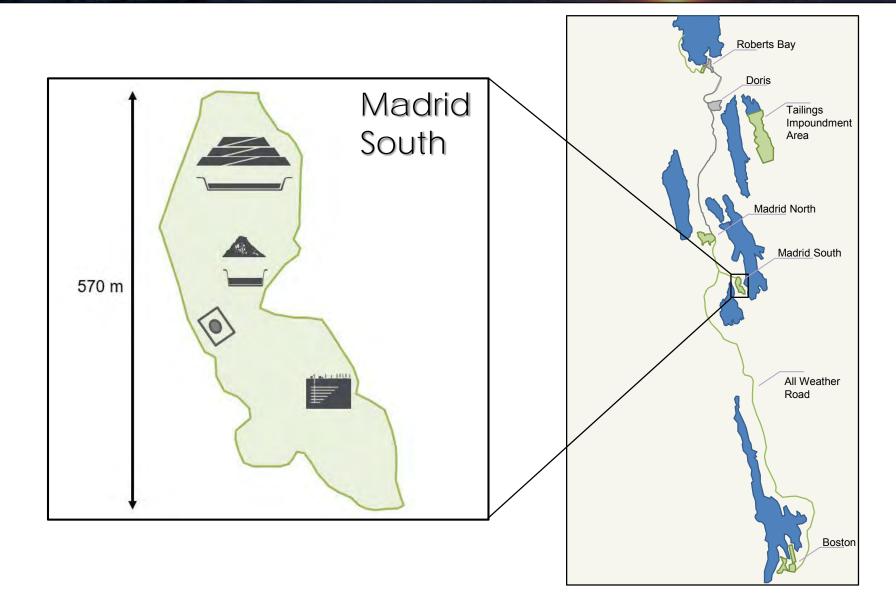






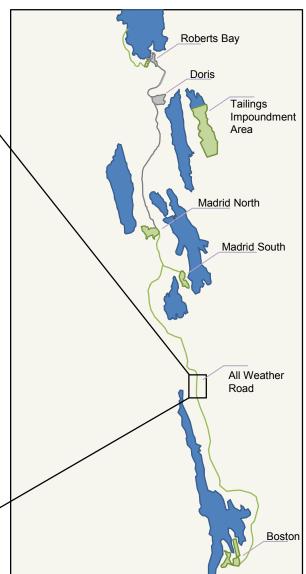




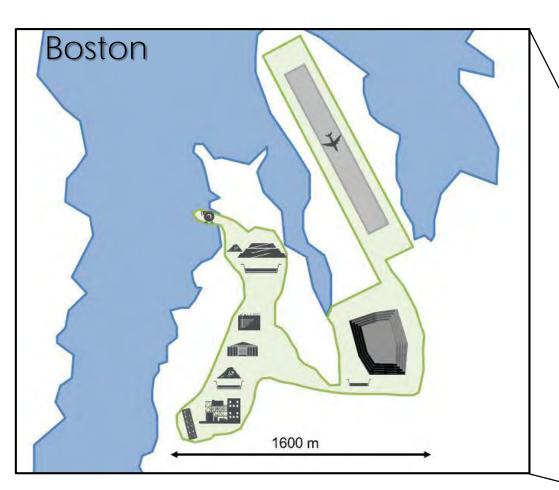


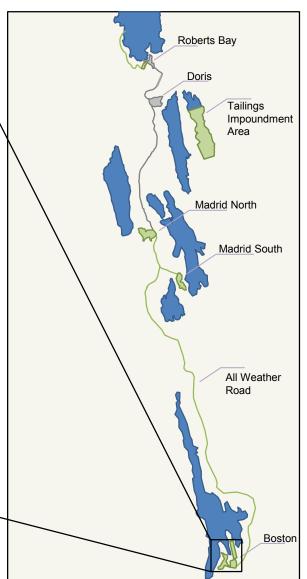




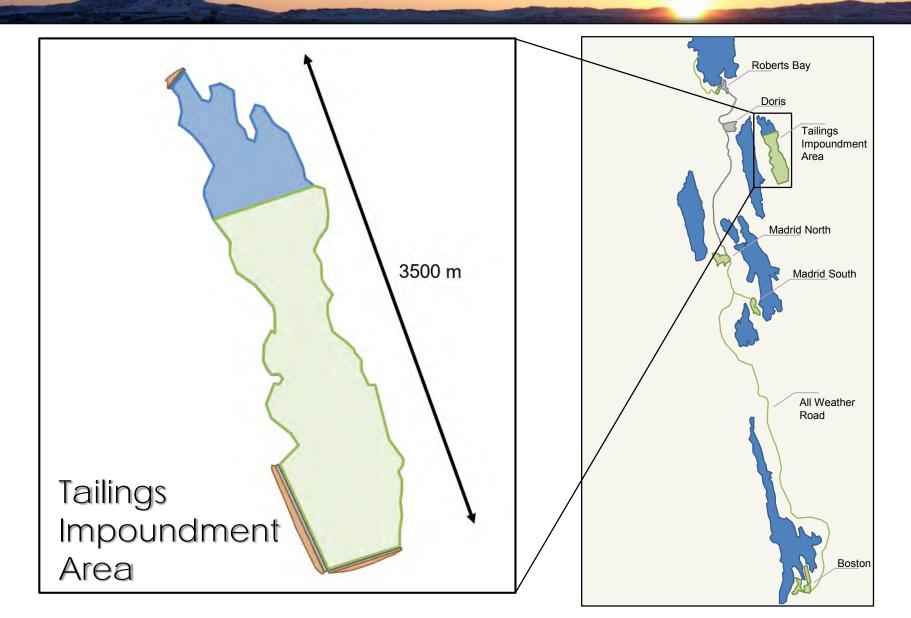
















Proposed Amendment No. 2 Type A



- Scope includes Doris, Madrid Sites and All Weather Road
 - Expand 2AM-DOH1323 Amendment No. 1 by incorporating into this Licence the scope of all facilities and activities authorized under the Type B Licence 2BB-MAE1727
 - Camp Capacity 400 persons
 - Expand TIA capacity to 18 million tonnes
 - Water Allowance:
 - Domestic from Windy Lake: 43,800 m3/year
 - Industrial from Doris Lake: 1,930,000 m3/day
 - Concentrator at Madrid
 - AWR to Boston
 - Allows commercial mining

Proposed Boston Type A



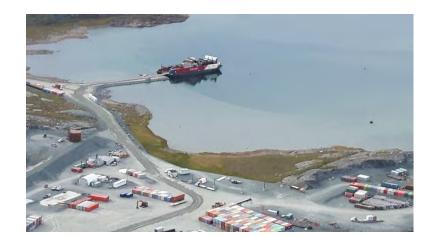
Project Certificate and Boston Type A Water Licence

- Scope:
- Construct and operate Boston Site
- Camp Capacity 300 persons
- Tailings Management Area capacity of 5.1 million tonnes
 - Water Allowance:
 - Domestic from Aimaokatalok Lake 33,000m3/year
 - Industrial from Aimaokatlok Lake 450,000m3/year
- 2400 t/d process plant
- Allows water use, waste management and construction of all surface infrastructure
- Allows commercial mining

Closure and Reclamation



- Doris-Madrid Interim Closure and Reclamation Plan was updated
- Boston Conceptual Closure and Reclamation Plan was developed
- Overall objectives of closure planning at Hope Bay:
 - Physical Stability
 - Chemical Stability
 - Future use and aesthetics
- Planning provides basis to estimate financial security



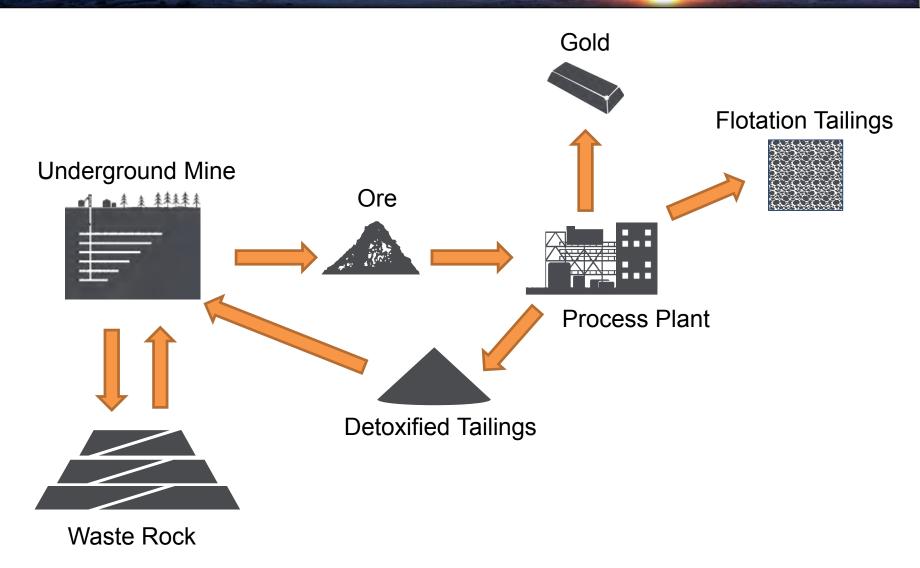




Tailings and Waste Rock Mangement

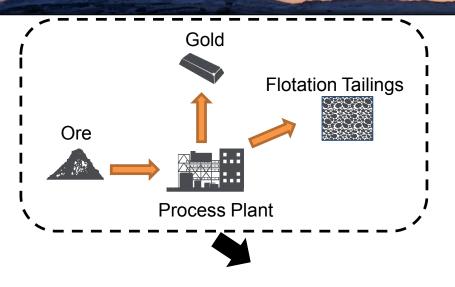
Tailings and Waste Rock

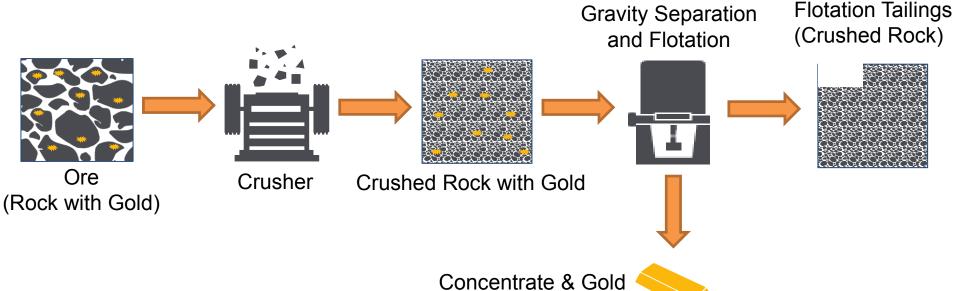




Flotation Tailings

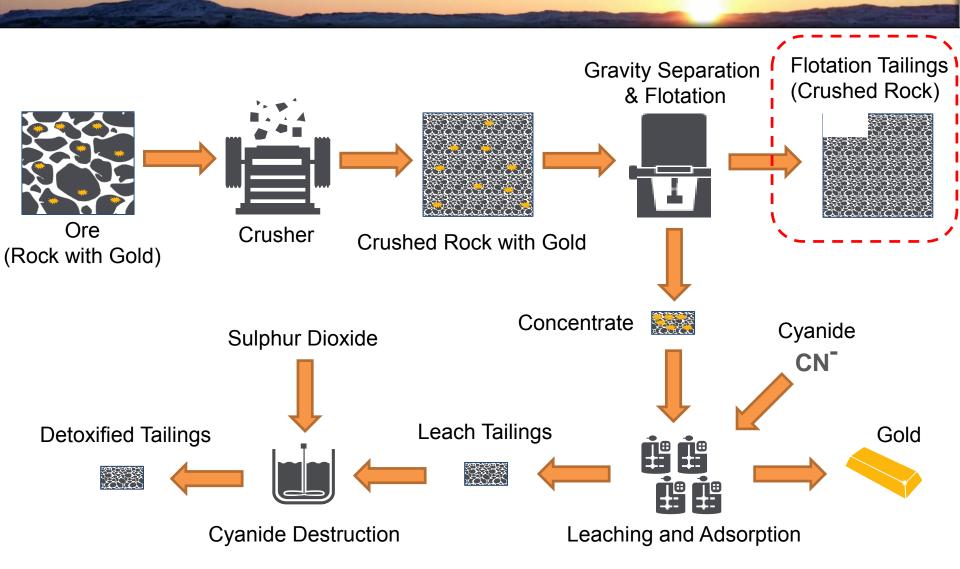






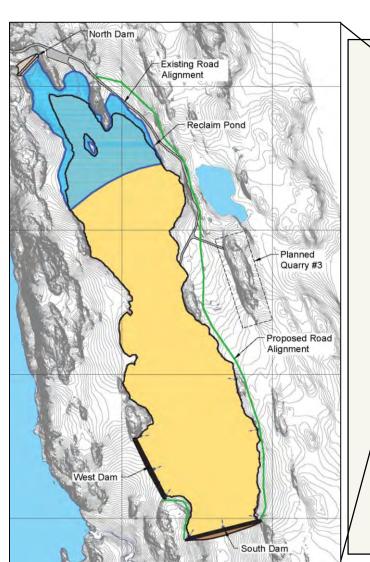
Detoxified Leach Tailings

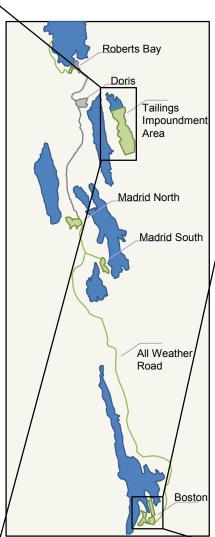




Overview of Tailings Management

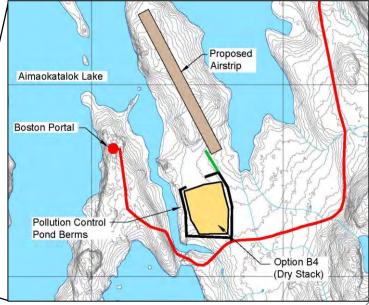






- Doris Conventional Tailings Impoundment Area
- Boston Dry Stack
 Tailings Management

 Area

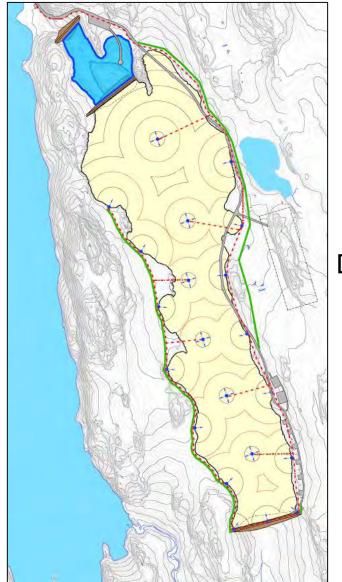


Alternative Analysis - Doris



Siting Options

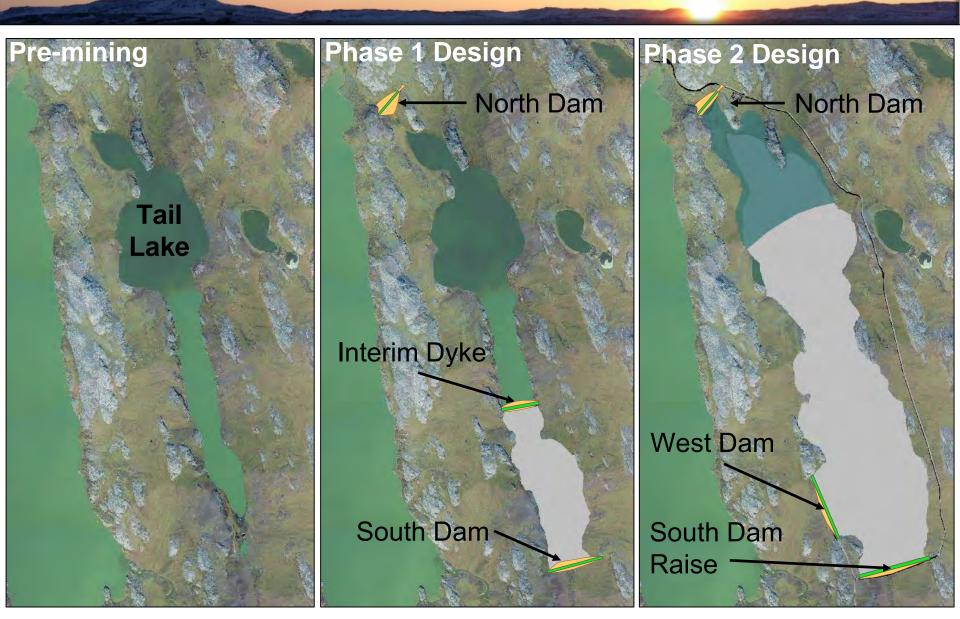




Deposition Options

Tailings Impoundment Area - Doris





Tailings Impoundment Area - Doris



- Slurry tailings
- Low solids content
- Pumped
- Similar to:
- Meadowbank
- Nanisivik

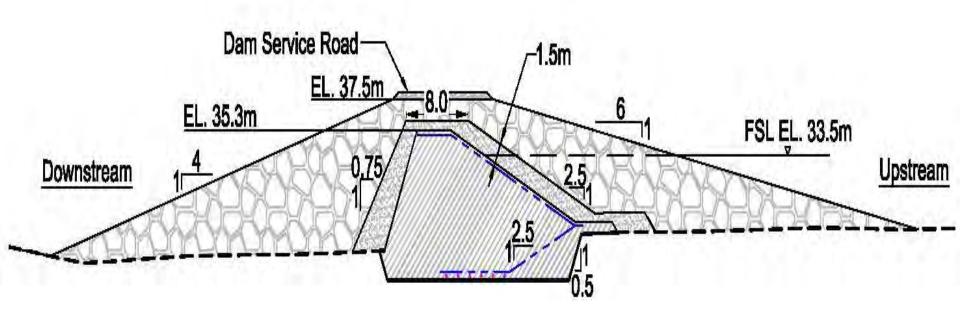






North Dam: Frozen Core Dam





- Seepage Analysis
- Stability Analysis
- Creep Analysis
- Thermal Analysis

- Settlement Analysis
- Frost Heave Assessment
- Freeboard Hydraulic Assessment

North Dam





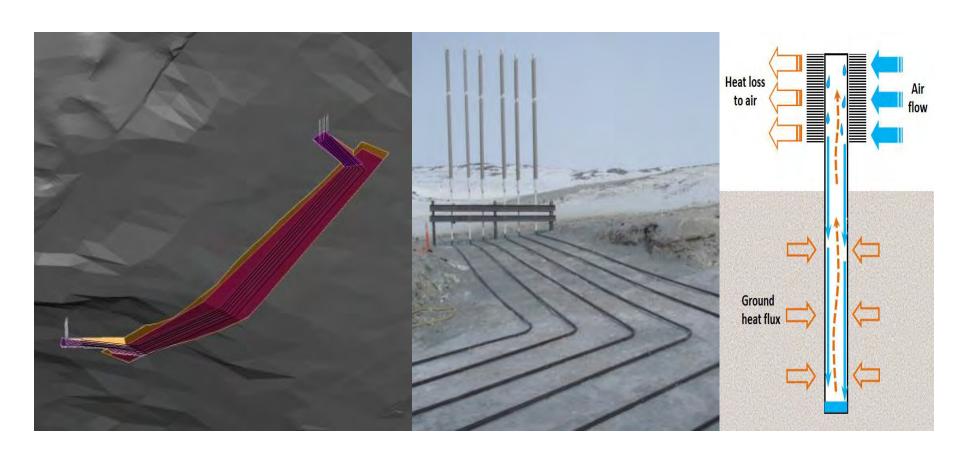
Key Trench Excavation





Thermosyphon Installation





Frozen Core Construction





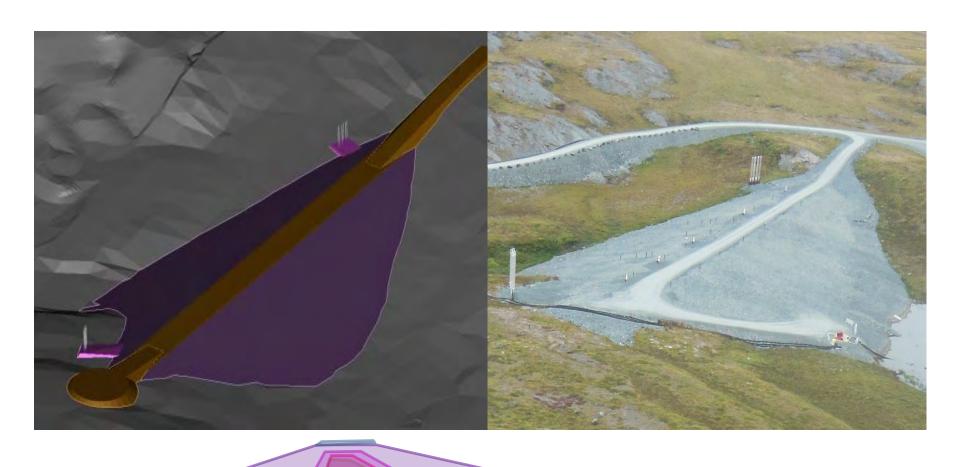
Liner (GCL) Installation





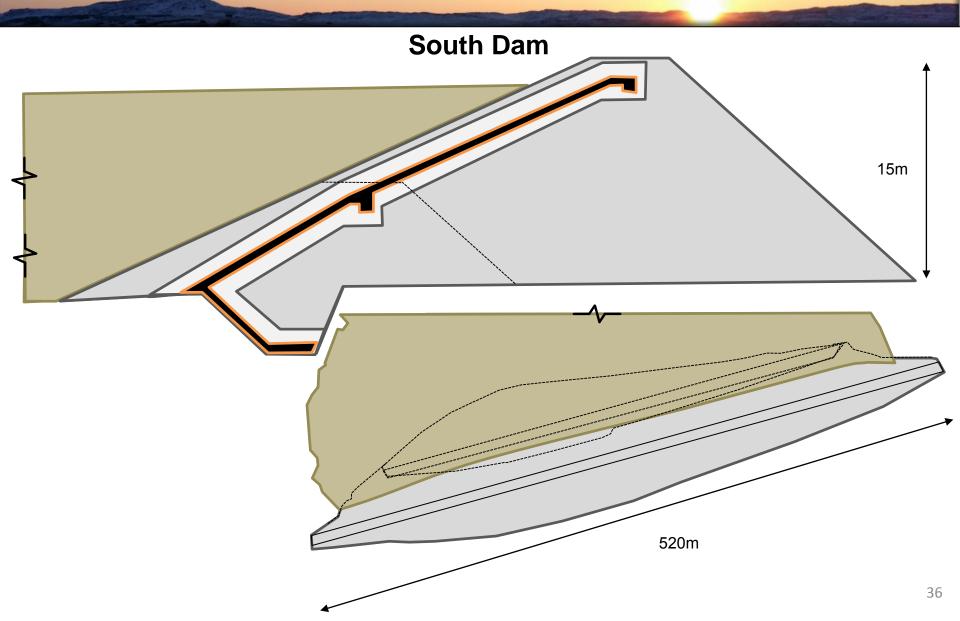
Transition & Shell Construction





Tailings Impoundment Area - Doris





South Dam

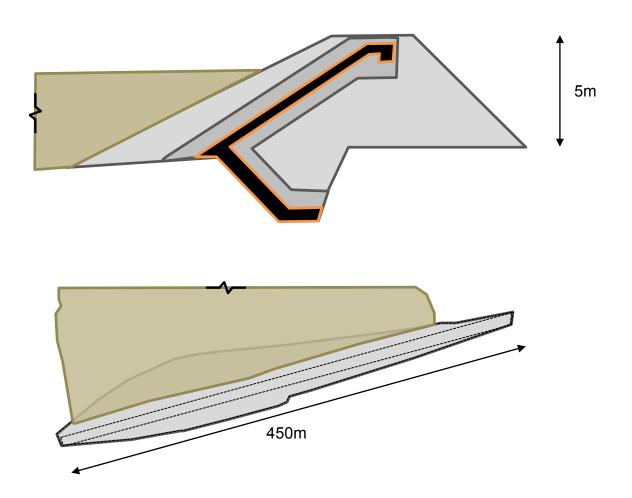




Tailings Impoundment Area - Doris

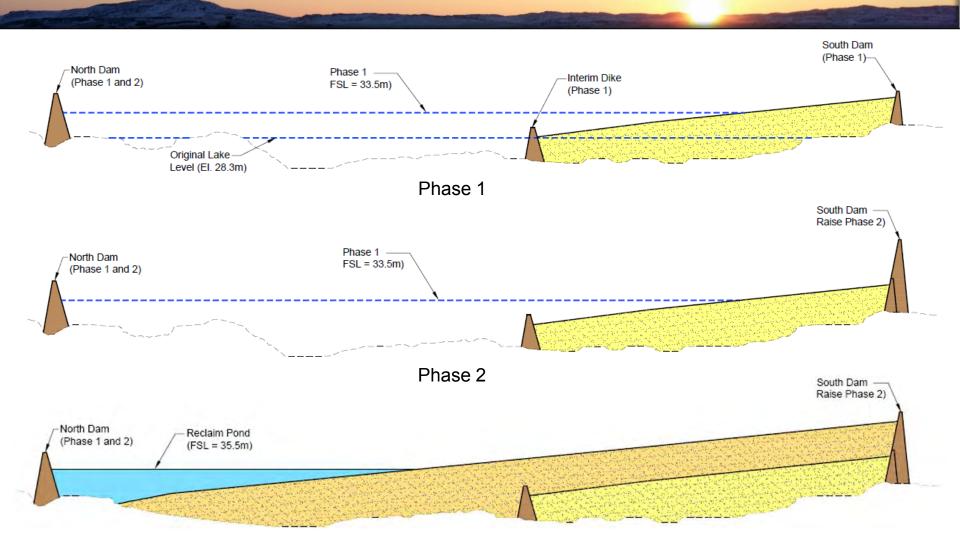


West Dam



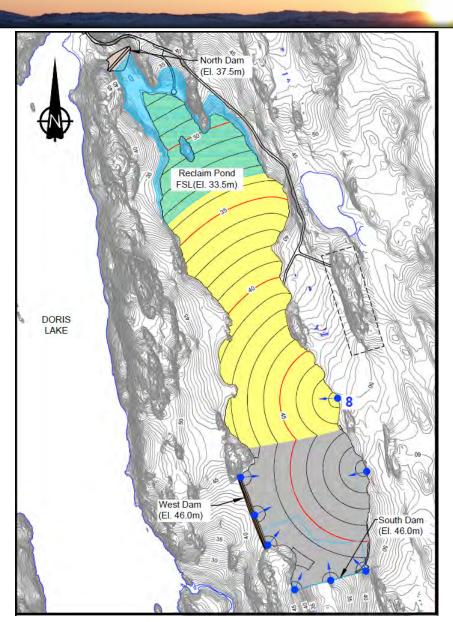
Tailings Impoundment Area - Doris





Tailings Impoundment Area – Doris Operations





Tailings Impoundment Area - Doris



tonnes per day

No change

No change

No change

No change

41

Summary of proposed changes

Component	Phase 1	Pnase 2							
Tailings Volume (tonnes)	2.5 million	Additional 15.5 million							
Tailings Production Rate	Maximum nominal 2,000	Maximum nominal 3,600							

tonnes per day

Only flotation tailings

Subaerial

Seasonal discharge to

Roberts Bay

Breach North Dam; 0.3 m

thick dry cover over tailings

Tailings Make-up

Closure Strategy

Deposition Method

TIA Discharge Strategy

Tailings Impoundment Area - Doris

Component

Tailings Geochemistry

North Dam



Phase 2

No change

liner

No change

42

Summary of proposed changes

Phase 1

Frozen core dam

	1102en core dam	No change
North Dam Spillway	Includes spillway	No change
South Dam	Frozen foundation with liner	Dam raised by 8 m
Interim Dike	New containment structure	Not required
West Dam	Did not exist	Frozen foundation with

Non acid generating;

Neutral metal leaching

Tailings Impoundment Area - Closure MAC



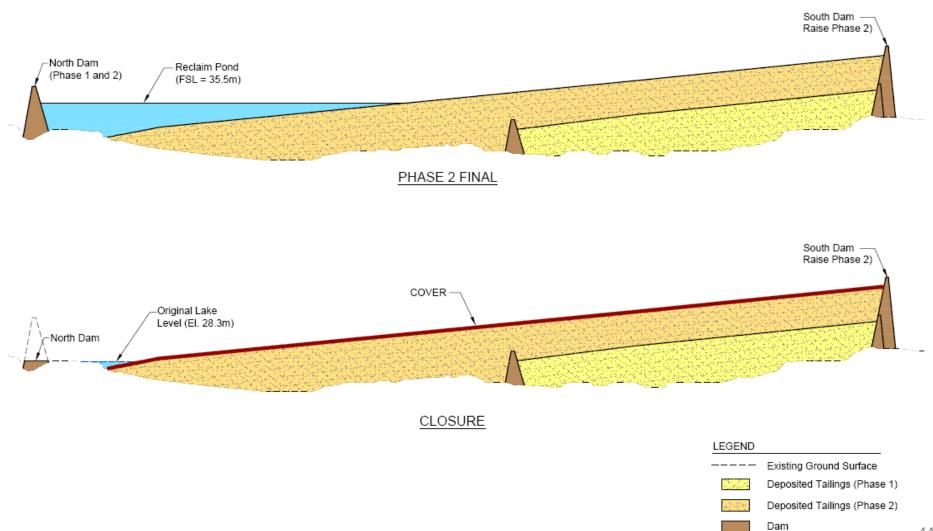






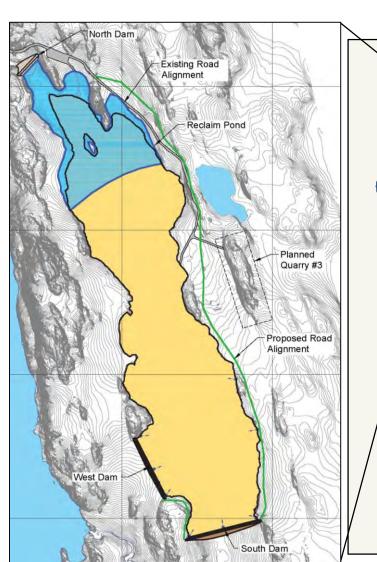
Tailings Impoundment Area - Closure





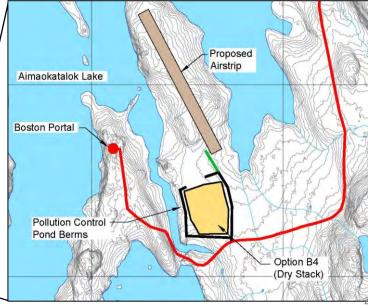
Summary of Tailings Management





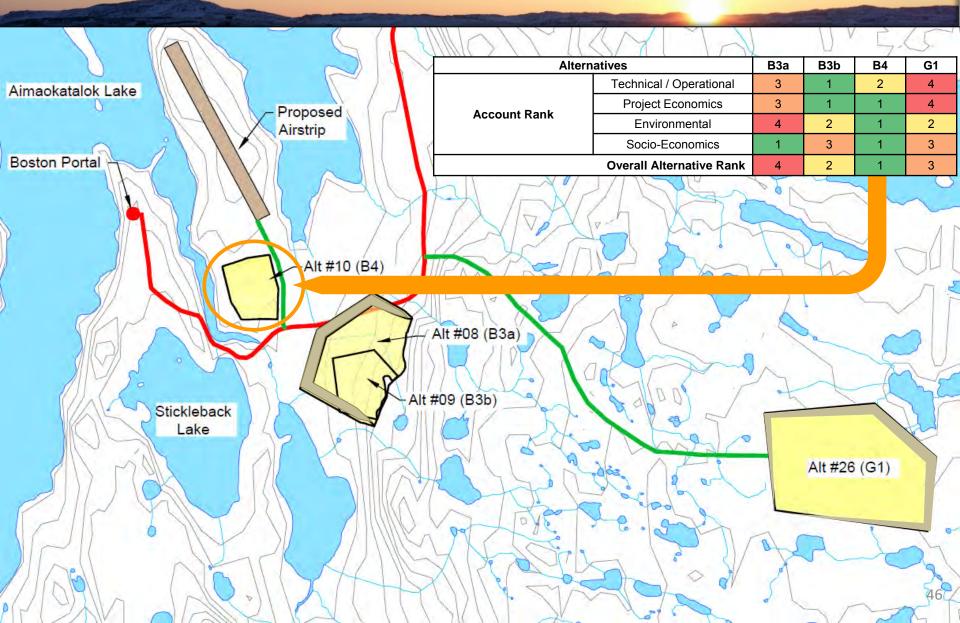
- Roberts Bay Doris Tailings Impoundment Madrid North Madrid South All Weather Road **Boston**
- Doris Conventional Tailings Impoundment Area
- Boston Dry Stack
 Tailings Management

 Area



Alternative Analysis - Boston



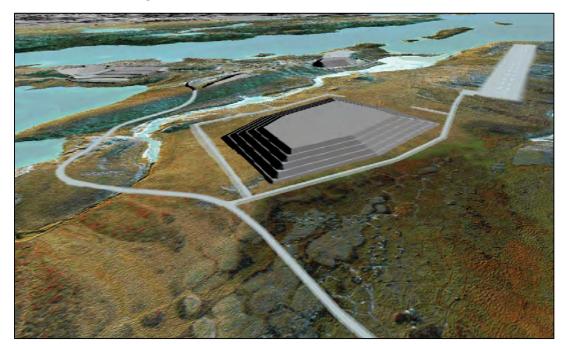








- Filtered tailings
- Trucks, Dozers, Compactors
- Stackable and compactable
- Similar to:
 - Raglan
 - Fort Knox
 - Pogo

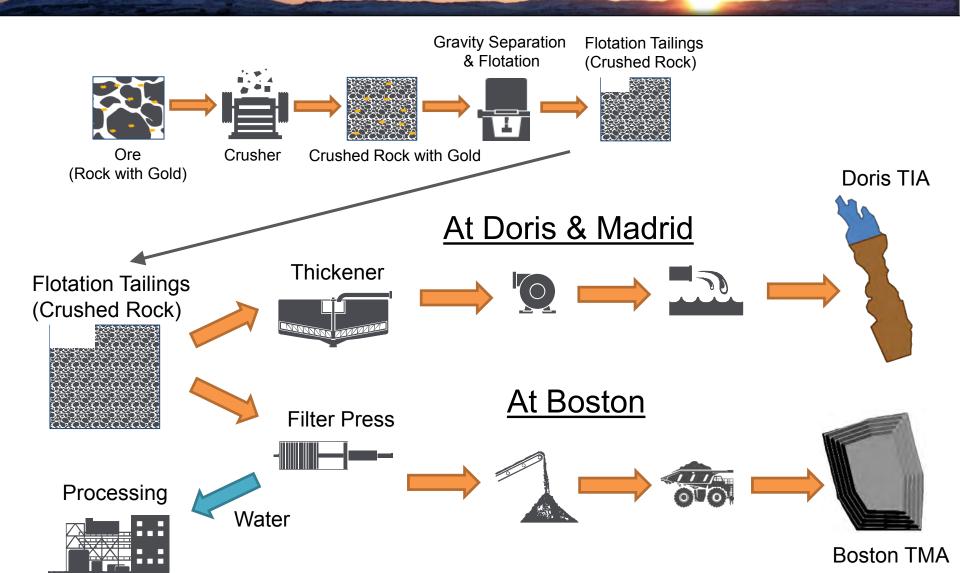




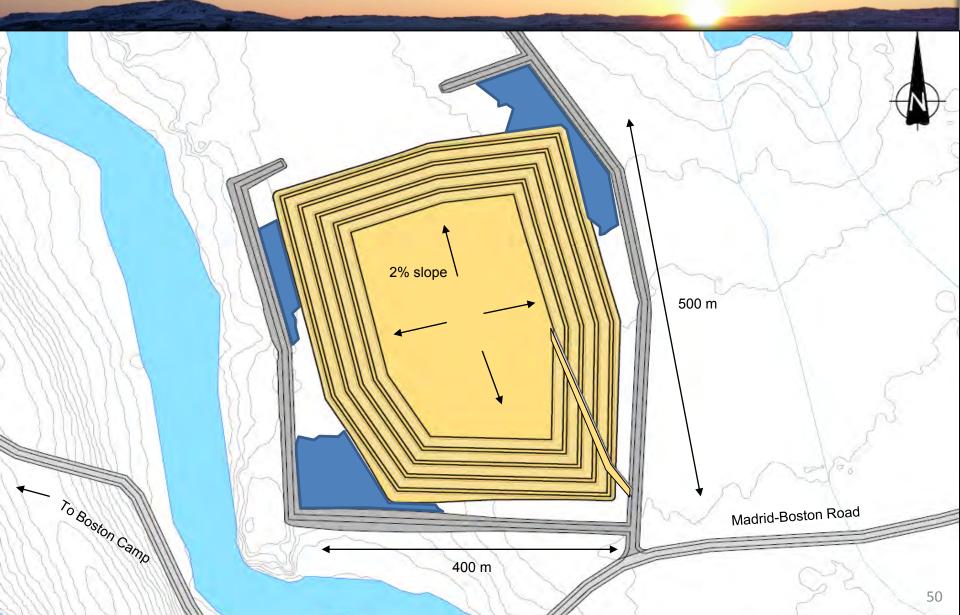


Tailings





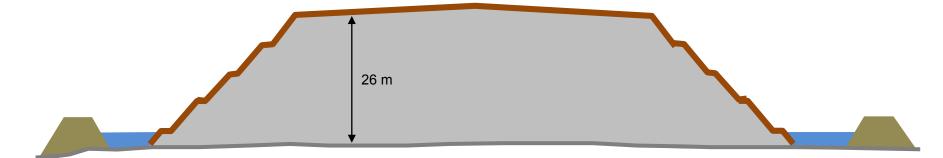






- Stability Analyses
- Geomembrane Leakage Assessment

- Thermal Analyses
- Deformation and Settlement Analysis



- Water collection
- Erosion Protection
- Dust Management

- Compaction and grading
- Lined Protective Cover
- Stable landform



Component	Criteria							
Dam Hazard Classification	Significant							
Design Life								

- **Active deposition period**
- **Assumed Post-closure monitoring period**
- Long-term design basis
- **Tailings Production Rate**
- **Tailing Moisture Content**
- **Tailings Dry Density**
- **Tailings Storage Requirement**
- By mass
- By volume
- **Tailings Deposition Method**

- - 8 years 10 years

 - Up to year 2100
- 2,400 tonnes per day
- 20.5% (by weight)
- 1.8 t/m^3
- 5.1 Mt
- 2.8 Mm³
- Load, haul, dump, place, and compact filtered tailings

Dust Management











Tailings Management Area - Boston Closure Quarry Rock Bedding Geotextile Liner

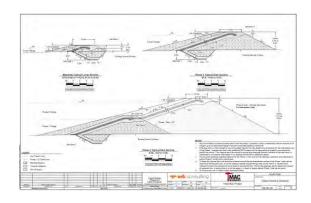
Tailings Facility Designs



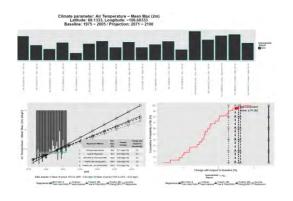
Additional geotechnical investigation and detailed design prior to construction







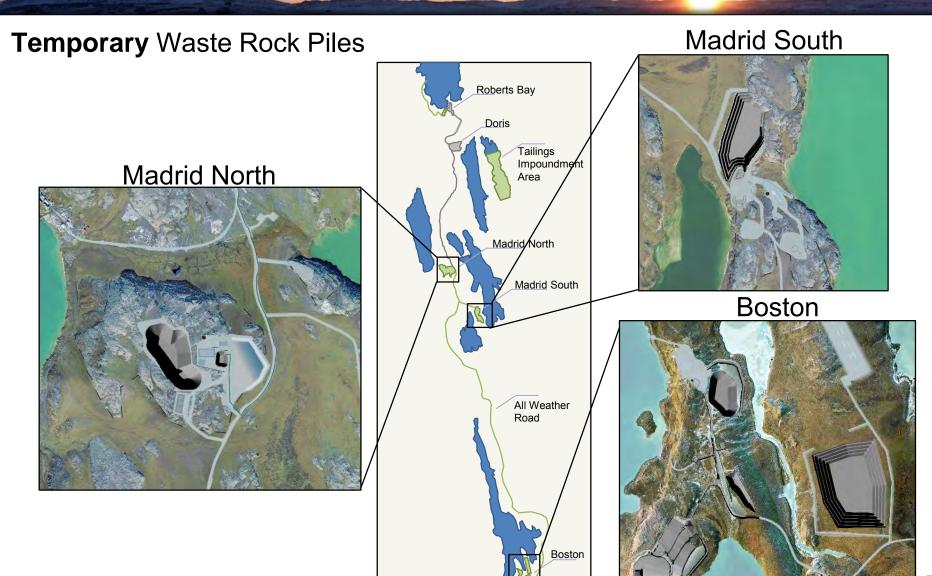
Consider Climate Change







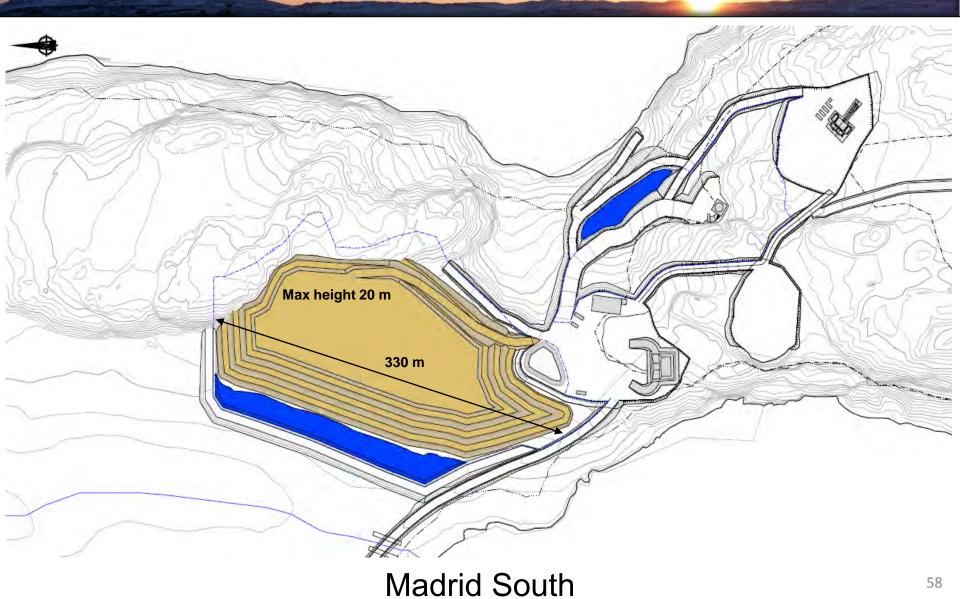




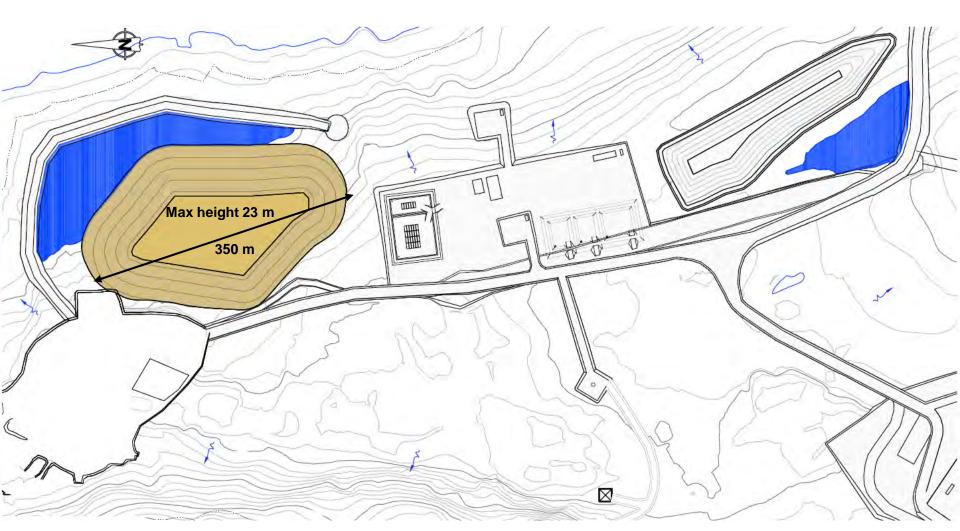






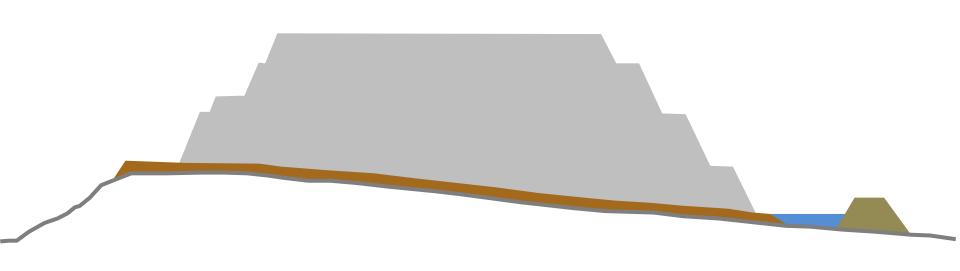






Boston





Stability Analyses



Area	Action	Phase 1 Project						Phase 1 and Phase 2 Project Overlap					Phase 2 Project										Post-closure Period			
	Action	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
	Stockpiled																									
Doris	Used																									
	Closure																									
	Stockpiled							Ĭ																		
Madrid North	Used																									
	Closure																									
	Stockpiled																									
Madrid South	Used																									
	Closure																									
Boston	Stockpiled																									
	Used																									
	Closure																									

Tailings and Waste Rock Management



- State of practice tailings management
 - Doris Tailings Impoundment Area
 - Boston Tailings Management Area
- No waste rock left on surface post closure

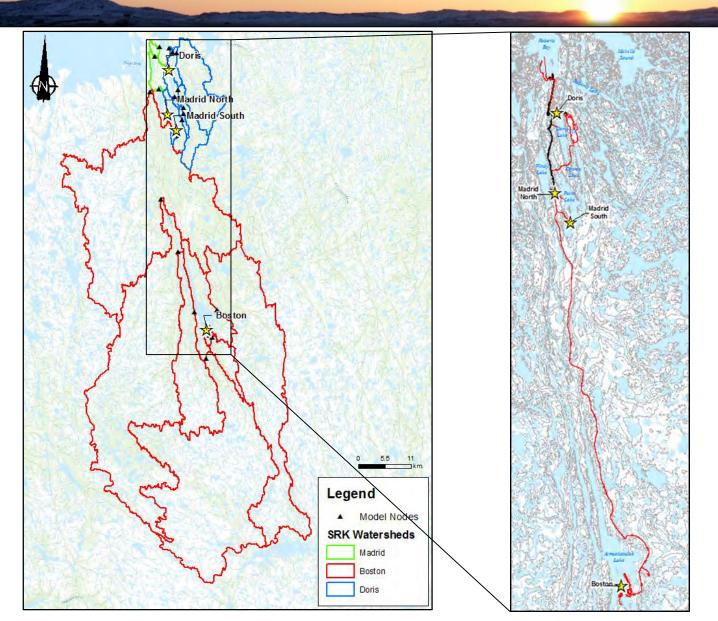




Water Management

Hydrological Setting





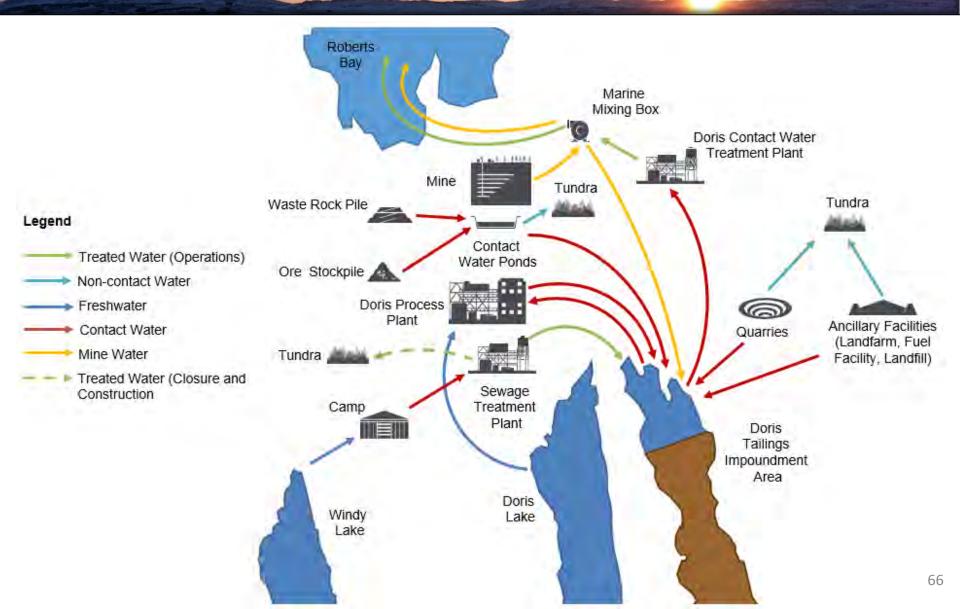
Doris Water Management





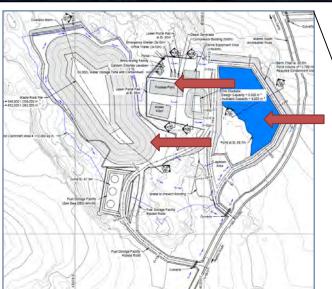
Doris Water Management



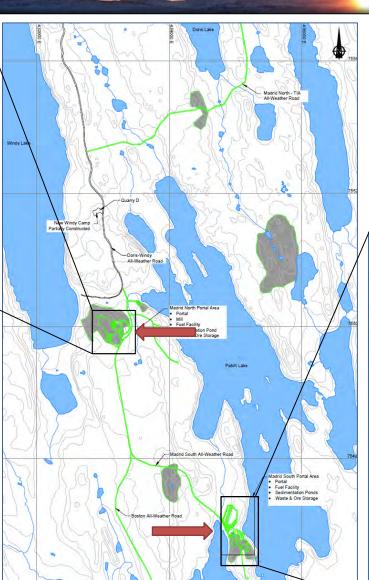


Madrid Site Layout

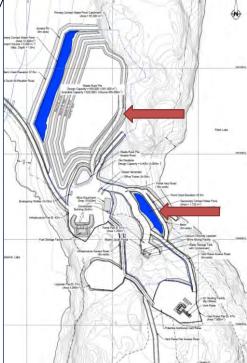




Madrid North

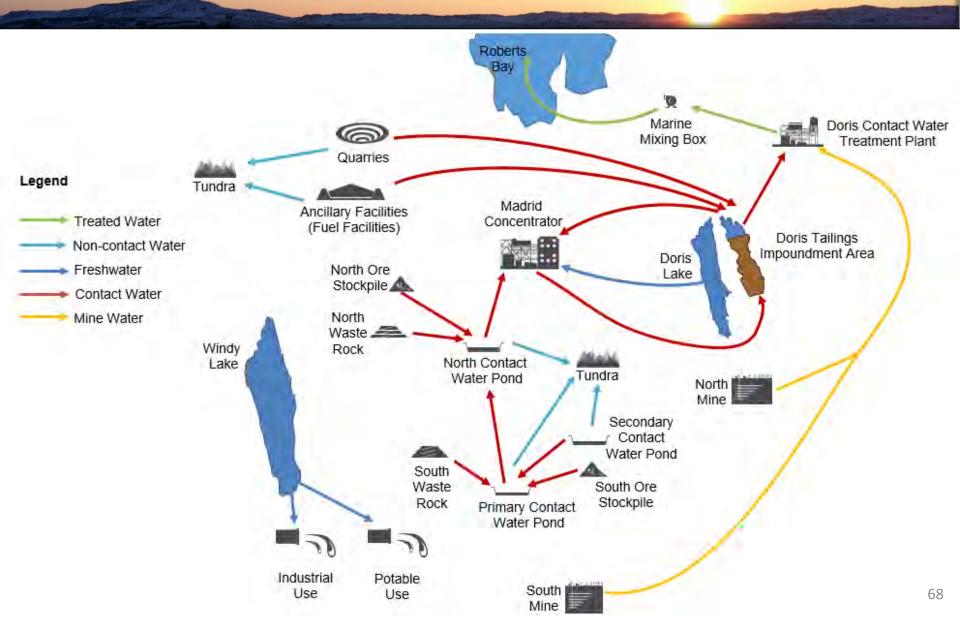


Madrid South



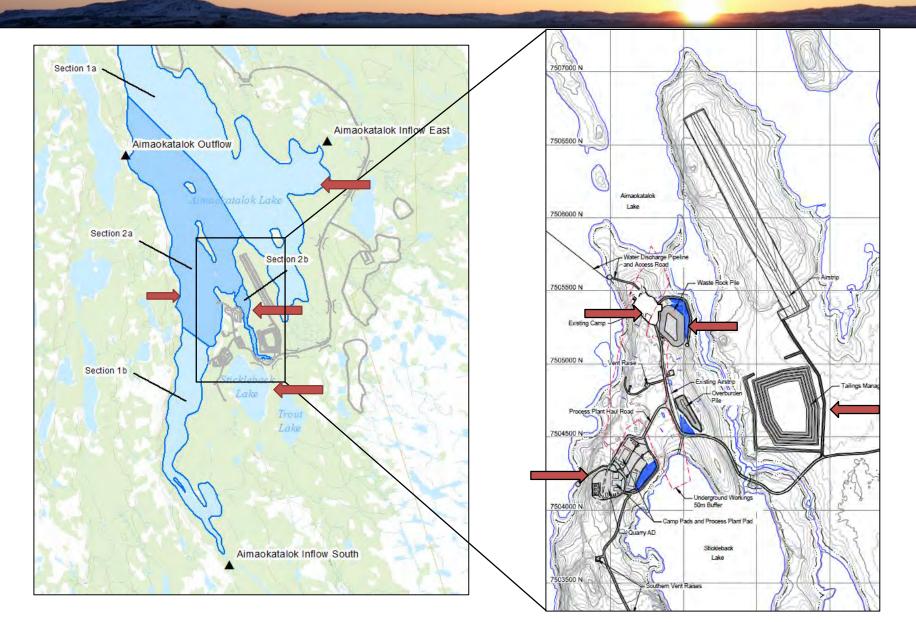
Madrid Water Management





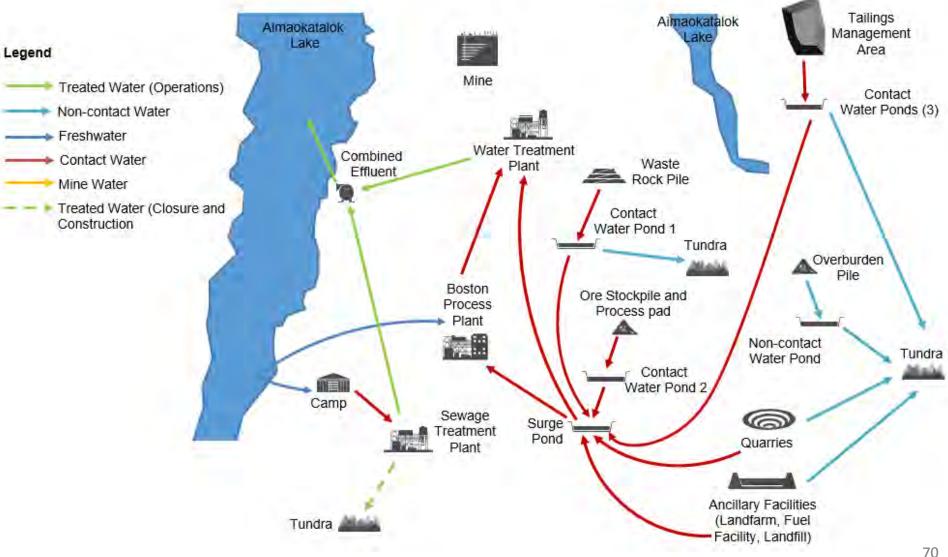
Boston Site Layout and Aimaokatalok Lake





Boston Water Management



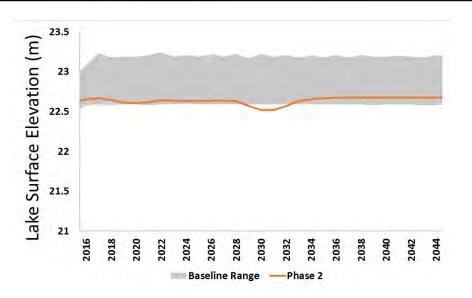


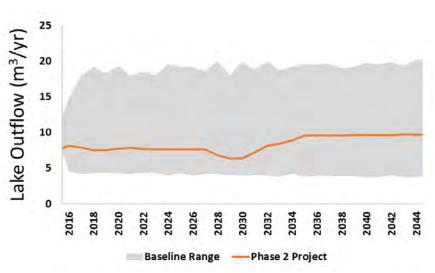


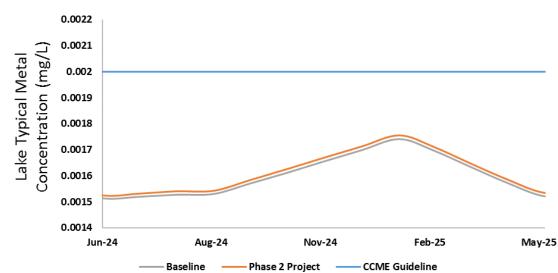
Modelling Approach and Methods

Purpose of Modelling





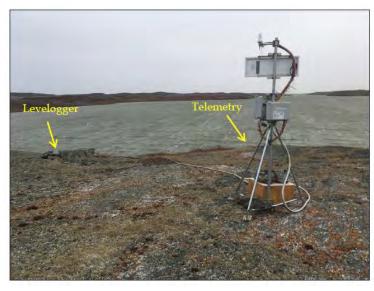




Water Balance Approach – Same as for Doris Amendment



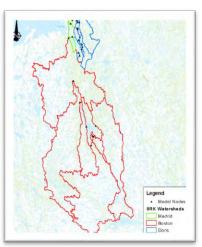






Model Inputs - Quantity





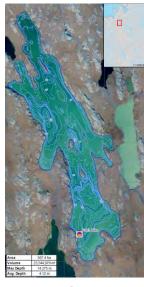
Catchments



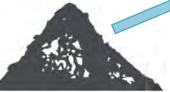
Site Footprint



Hydrology
(Precipitation,
Evaporation,
Climate Change, and
Runoff Coefficients)



Water Storage and Bathymetry

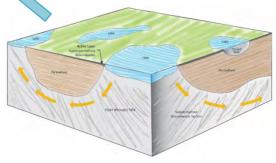


Mining and Milling Quantities



Model

Water Consumption

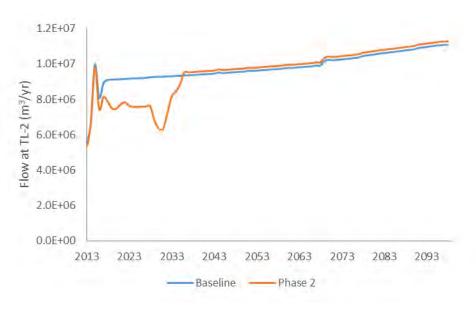


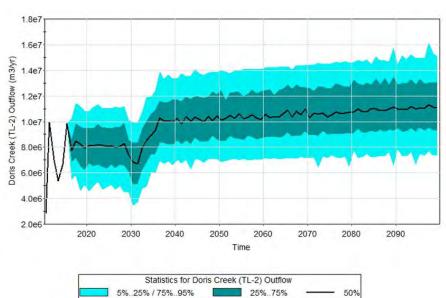
Groundwater Inflows

Model Inputs - Climate Change



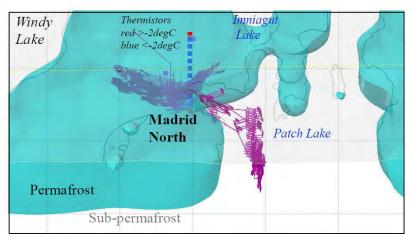


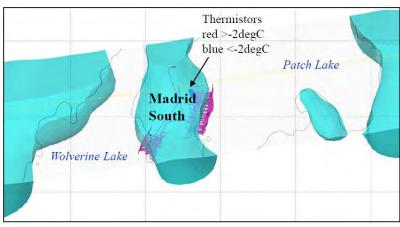


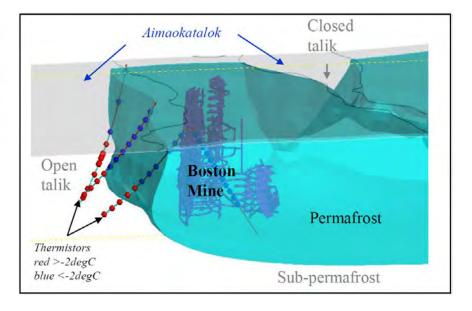


Model Inputs - Groundwater



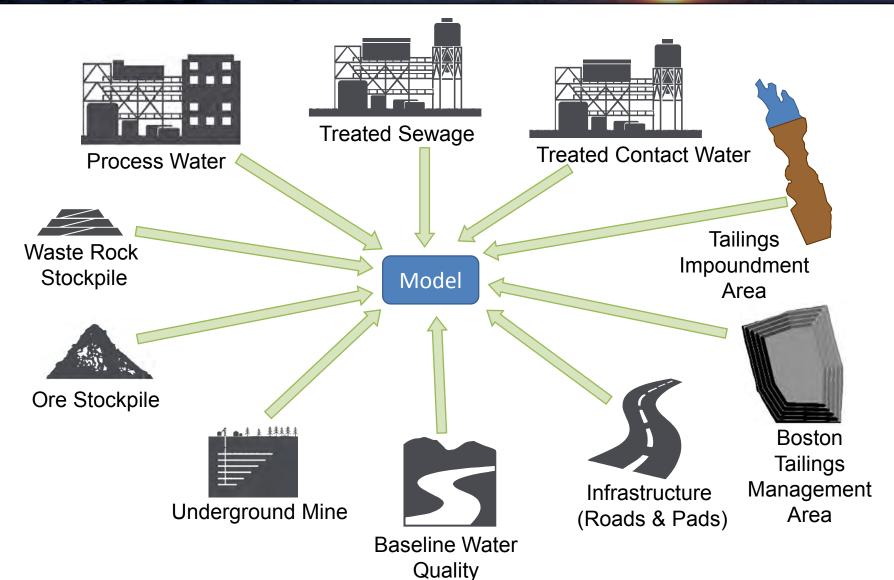






Model Inputs - Quality



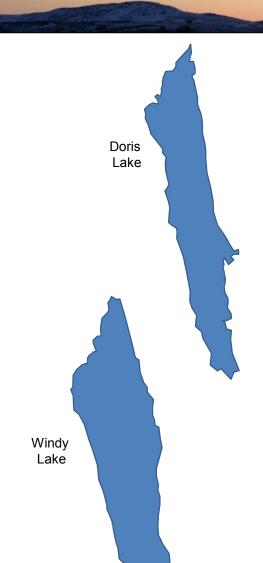




Model Results

Doris/Madrid Water Use

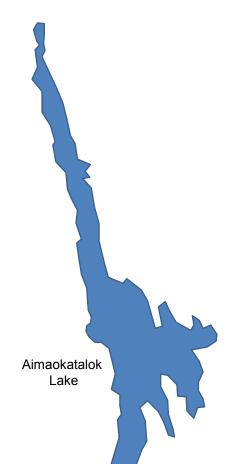




Water Demand	Lake Withdrawal (m³/day)		
	Doris	Windy	
Doris Process Plant	880	-	
Madrid Concentrator	110	-	
Doris Camp Potable	-	120	
Doris/Madrid General Use	1,470	-	
Total Phase 2	2,460	120	
Increase from Phase 1	1,340	57	

Boston Water Use

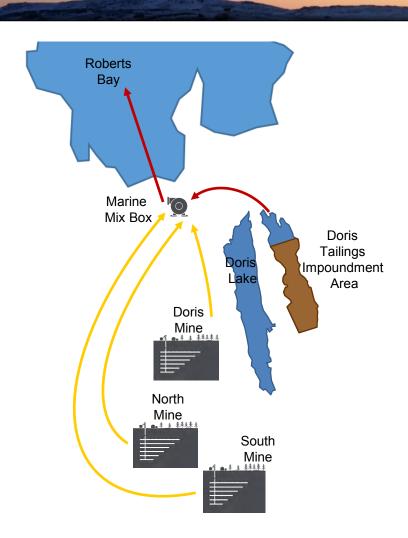




Water Demand	Aimaokatalok Lake Withdrawal (m³/day)		
Boston Process Plant	550		
Boston Camp Potable	90		
Boston General Use	1,000		
Total Phase 2	1,600		

Marine Discharge





Maximum Discharge Rate to Roberts Bay (m³/day)				
Phase	Summer	Winter	Closure	
1	7,000	3,000	4,000	
2	9,750	3,000	6,750	

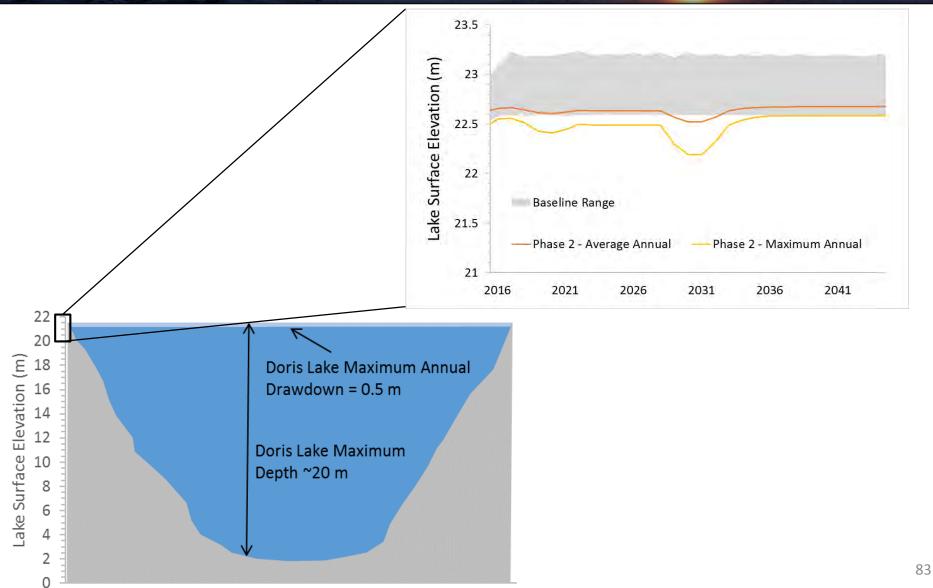
Model Results - Lake Results



Watershed	Lake	Drawdown (cm)		Annual Lake Outflow Reduction Relative to Baseline		
		Average	Maximum	Average	Maximum	
Doris	Wolverine	1	5	26%	56%	
	Imniagut	94	180	-	-	
	Patch	2	7	11%	24%	
	Doris	7	40	18%	32%	
Madrid	Windy	<1	1	1%	1%	
Boston	Stickleback	<1	1	8%	12%	
	Aimaokatalok	<1	1	0%	0%	

Model Results: Doris Lake Short Term Drawdown

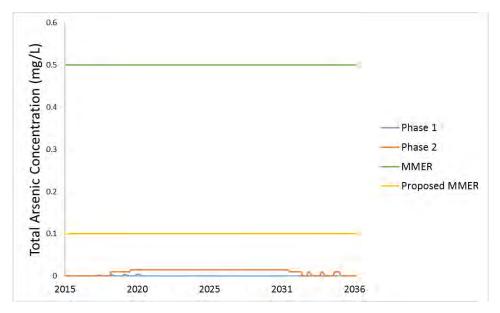




Effluent Quality

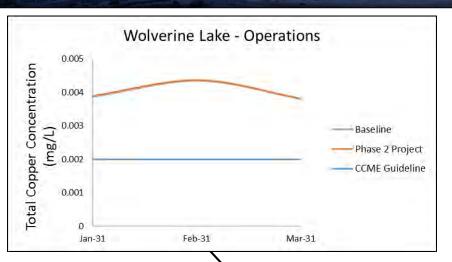


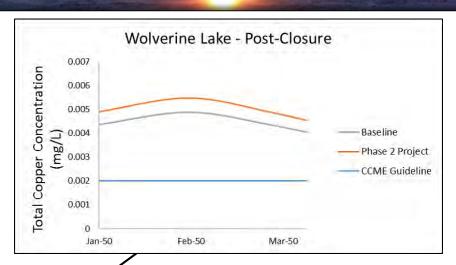
		Marine Mixing Box				Boston	
Parameter MMER		Operations		Closure		Operations	
		Average	Peak	Average	Peak	Average	Peak
TSS	15	15	15	12	15	8.5	14
Arsenic	0.5	0.014	0.015	0.0081	0.01	0.0041	0.013
Copper	0.3	0.0093	0.031	0.0052	0.0085	0.00061	0.0019
Cyanide	1	0.024	0.23	0.0011	0.0092	0.069	0.25
Lead	0.2	0.00042	0.00092	0.00027	0.00064	0.00054	0.0018
Nickel	0.5	0.077	0.2	0.0056	0.013	0.0026	0.0085
Zinc	0.5	0.051	0.16	0.0093	0.022	0.0058	0.019

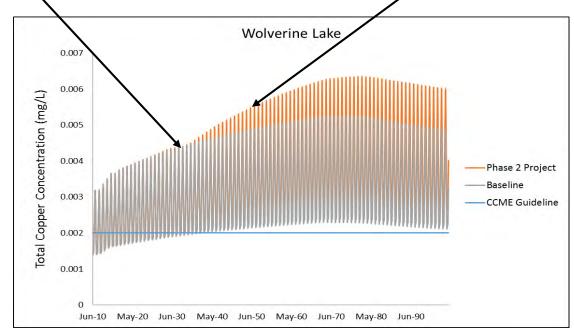


Wolverine Lake – Minimal Incremental Change







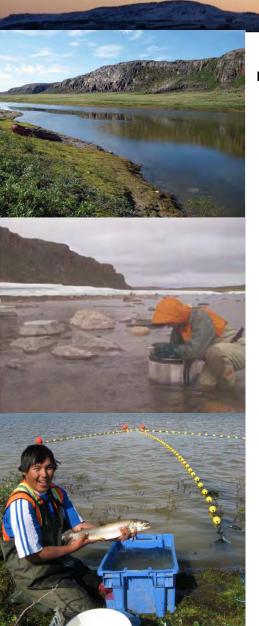




Freshwater Environment

Freshwater Environment





- Valued Ecosystem Components:
 - Surface Hydrology
 - Surface Water Quality
 - Sediment Quality
 - Fish
 - Fish Community
 - Arctic Char
 - Arctic Grayling
 - Lake Trout
 - Arctic Cisco
 - Broad Whitefish
 - Fish Habitat

Assessment Approach



Early Stages of Assessment

- 1. Start with Traditional Knowledge
- 2. Identify Study Areas based on potential Project interactions
- 3. Collect baseline data from within designated Study Areas

Impact Assessment Approach

- 4. Identify Project Interactions with Freshwater Environment
- 5. Identify Mitigations to reduce Project Impacts
- 6. Model Project Interactions on water quantity and quality
- 7. Assess potential Residual Effects of Project on Freshwater Environment
- 8. Develop monitoring approach based on outcome of EIS review

Inuit Engagement



Historical and Current Inuit Comments and Concerns:



- shallower lakes and lower water flows
 - frozen to streambed in winter
- mine exploration and development
- contaminant exposure through fish consumption
- potential habitat loss and approach to fisheries offsetting
- no identified drinking water sources in Project area, but water use exists

Freshwater Environment - Study Area



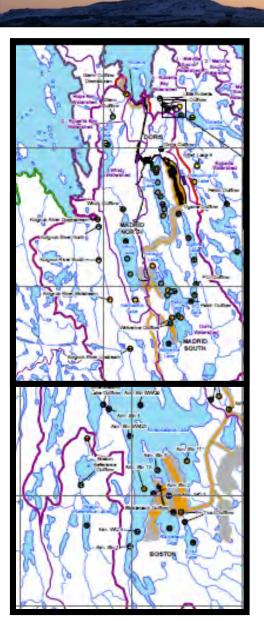


Local Study Area – Extending one watershed or sub watershed boundary from Project infrastructure

Regional Study Area – Extending one watershed or sub watershed boundary from LSA

Existing Environment





- Freshwater data has been collected in Hope Bay Belt since 1993
 - Project lakes and streams
 - Reference lakes and streams
- Freshwater lake and stream data includes:
 - Hydrology (streams) and lake levels
 - Water quality (winter and summer)
 - Sediment quality (summer)
 - Primary producers
 - Secondary producers
 - Fish and fish habitat, including tissue metals

Hydrology Assessment





- Potential impacts assessed:
 - Changes to surface hydrology
 - o Water withdrawal from lakes
 - Construction and use of underground mines
 - Modification of natural drainages



Water and Sediment Quality Assessment





- Potential impacts assessed:
 - Changes to freshwater water or sediment quality
 - Site preparation, construction and decommissioning
 - o Site and mine contact water
 - o Explosives
 - o Treated discharge
 - Dust Deposition

Fish Assessment





- Potential impacts assessed:
 - Fish habitat loss or alteration
 - Fish mortality or changes to population abundance
 - Project infrastructure and development
 - o Water withdrawal and use
 - Changes in water and sediment quality



Freshwater - Mitigation and Management

- Mitigation by Project Design
 - o Use existing infrastructure
 - Only 1 Metal Mining Effluent Regulations discharge to freshwater throughout entire Belt
- Regulatory Requirements
 - Type A Water License
 - Fisheries Act Metal Mining Effluent Regulations, Offsetting
- Management Practices
 - DFO guidance (work windows, explosives use, harm avoidance)
 - Reuse and recycle water
- Adaptive Management
 - Monitoring

Freshwater – Monitoring and Management



- Aquatic Effects Monitoring Plan
 - o Belt-wide plan including Doris, Madrid, and Boston
- Environmental Effects Monitoring Program
 - Aimaokatalok Lake
- Surveillance Network Program
 - o Type A Water Licence
- Fisheries Offsetting Monitoring Program
- Management Plans

Technical Comments – Freshwater Receiving Environment



- KIA: 7 comments
- ECCC: 4 comments
- DFO: 4 comments
- INAC: 4 comments

Technical Comments and Responses - Water



- Aquatic Effects Monitoring Program
 - o Belt-wide AEMP
 - Total and free cyanide will be analyzed
 - Lake levels in Doris, Patch, Windy, Ogama, PO, and Imniagut lakes will be monitored to inform Fisheries Authorizations
 - MMER/EEM studies have been harmonized within AEMP
 - o Aquatic Response Framework has been developed
- Environmental Effects Monitoring Program
 - Statistical approach has been clarified
 - Sampling stations have been moved closer to outfall
- Site Specific Water Quality Objectives
 - TMAC will monitor lake water quality and SSWQOs will be considered under the Aquatic Response Framework of the AEMP if necessary.

Technical Comments and Responses – Freshwater Fish



Fisheries Offsetting

- Lake level/stream flow monitoring to refine fish habitat losses (m²) predicted during FEIS
- TMAC will work with DFO, the KIA, and Inuit Environmental Advisory
 Committee to identify candidate offsetting options with a preference
 for developing a community-based offsetting program near
 Cambridge Bay
- TMAC will develop an Offsetting Plan commensurate with anticipated losses

Construction of in-water infrastructure

- Provide final designs to DFO
- Work with DFO, the KIA, and the Inuit Environmental Advisory
 Committee to develop a construction plan that includes mitigation, monitoring, and reporting requirements.

Conclusions of Freshwater Assessments



No significant Project or Cumulative impacts



Thank You, Questions



