Uranium Tailings Management at AREVA Resources Canada

Part 2: the Kiggavik Project in Nunavut

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Location

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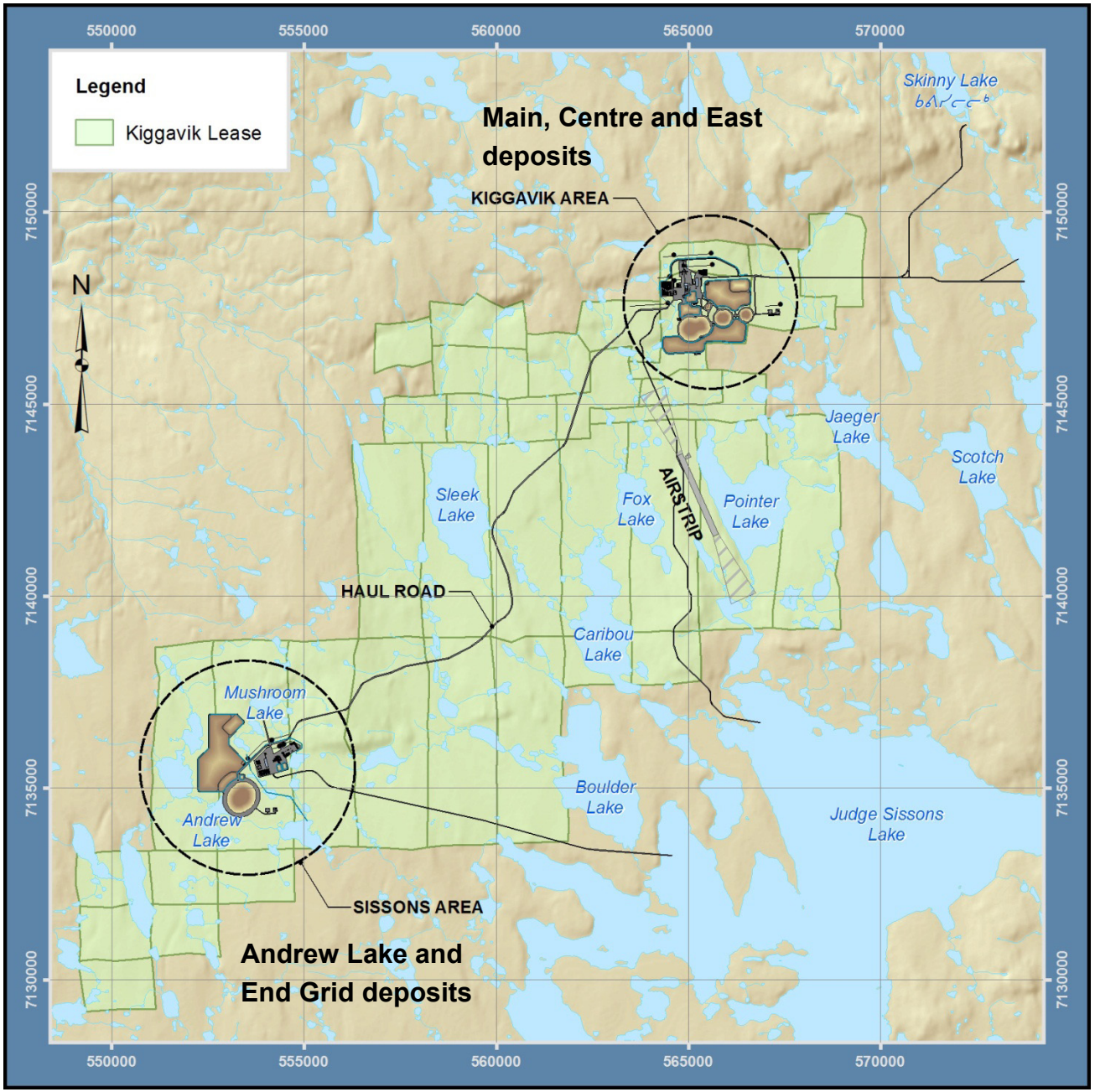
Kiggavik Project



Resources

51,000 tU (133 Mlbs)

0.46% U

4 open pits

1 underground mine

Project Proposal

Nov. 2008

Draft EIS

Dec. 2011

Construction

2017

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Tailings Management - Design Principles

- To avoid interaction between tailings and natural water bodies
- To maximize the use of mine workings for long-term management of tailings
- To ensure the long-term protection of Kiggavik's terrestrial, aquatic and human environment
- Potential for future deposits to be considered
- Stability, integrity and geochemical performance should not rely on maintaining present temperatures and permafrost conditions

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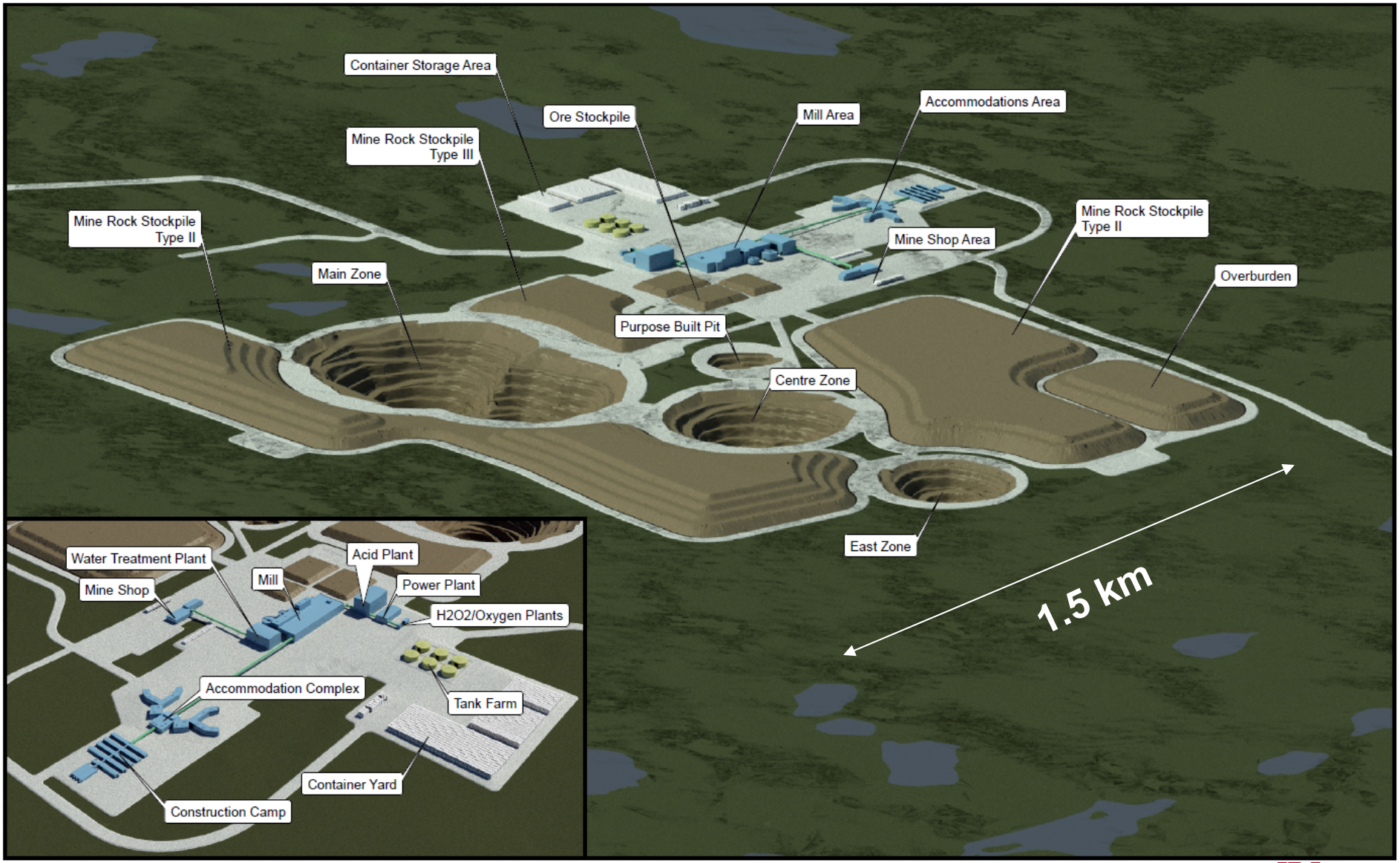
Project Overview – Kiggavik Site



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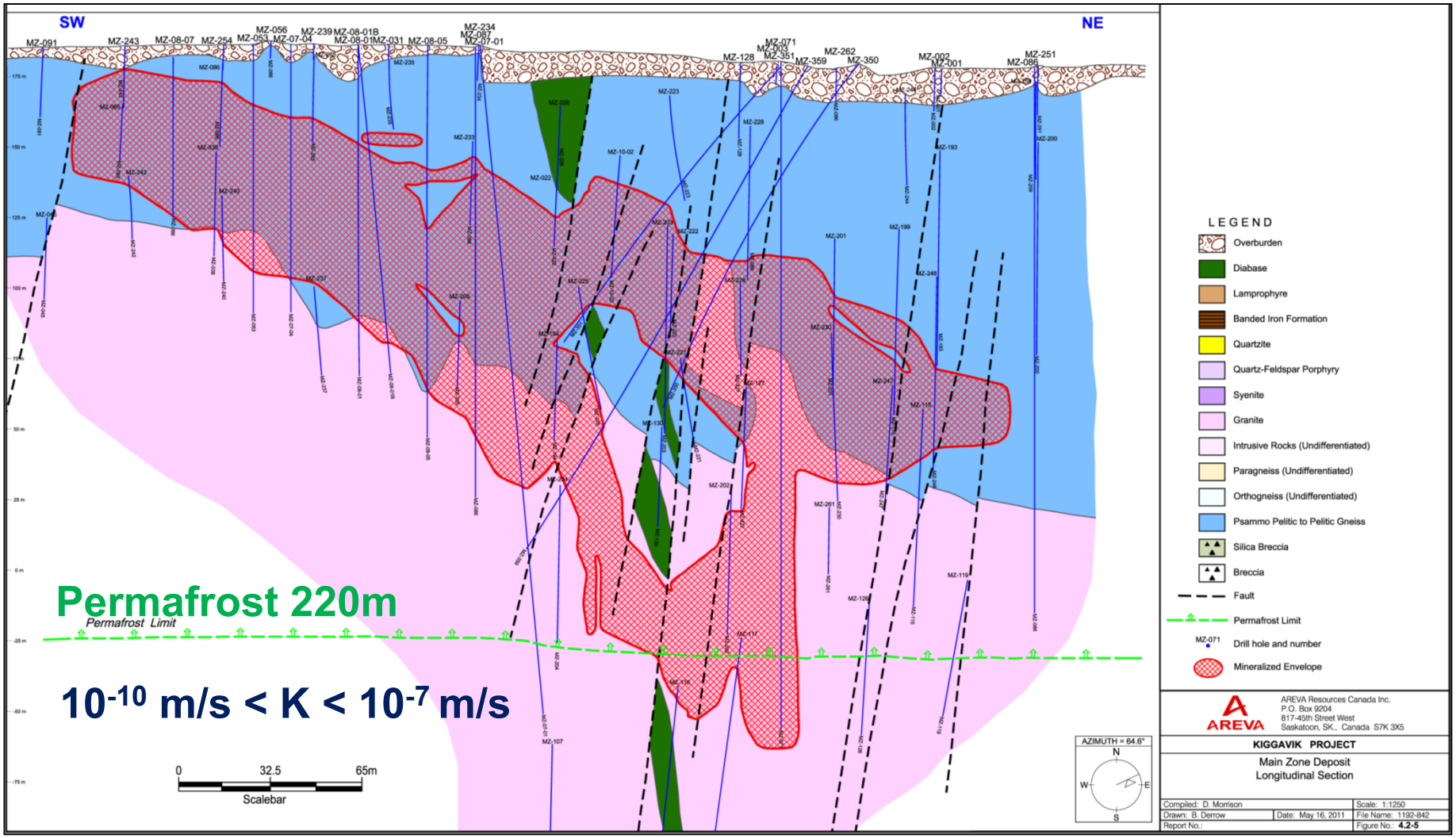
Main Zone Geology



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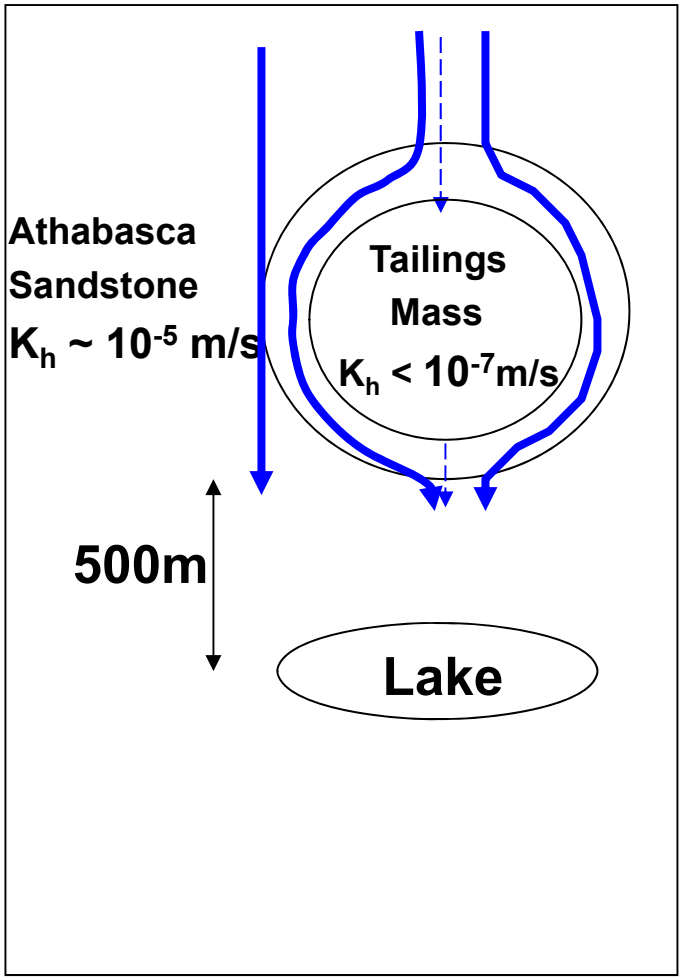
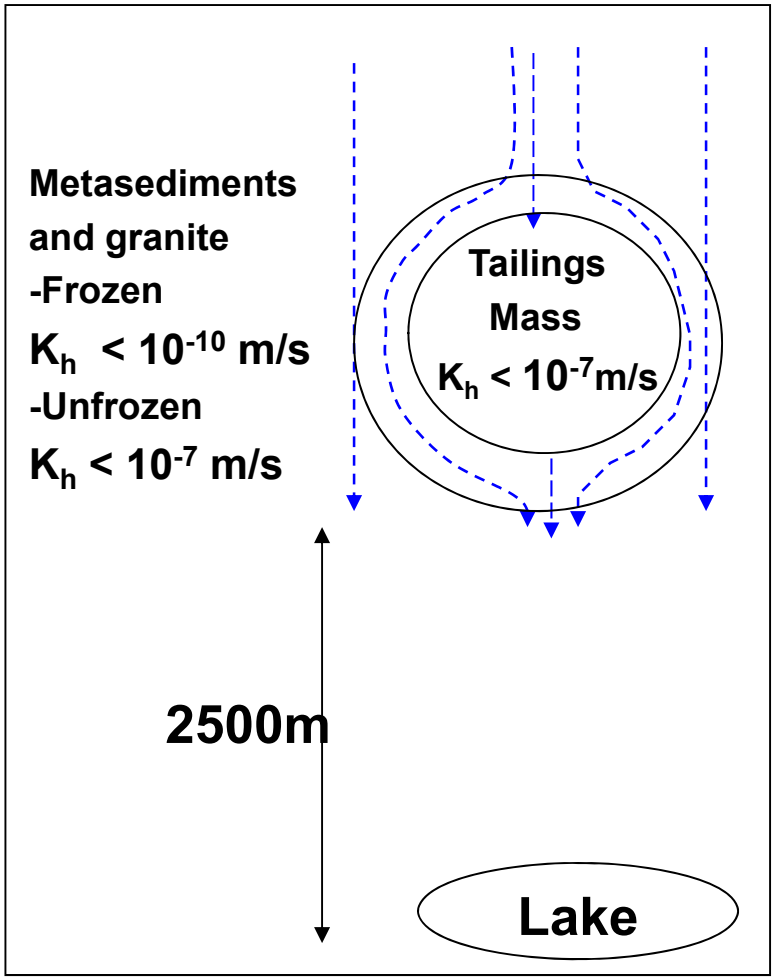
Kiggavik vs JEB



Jeb TMF – McClean Lake



Kiggavik Project

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Typical Ore Assay Average

Analyte	Kiggavik Project Deposits					Athabasca basin
	Main Zone	Centre Zone	East Zone	Andrew Lake	End Grid	
U (ppm)	4,570	5,683	744	4,625	2390.6	35,000
As (ppm)	2.2	20.4	3.0	7.1	19.4	58,000
Co (ppm)	16.8	16.4	8.5	7.1	15.8	3,400
Cu (ppm)	38.1	63.5	6.1	13.7	115.9	1,700
Mo (ppm)	113.5	9.6	1.9	19.7	19.5	1,020
Ni (ppm)	47.3	69.7	18.9	73.4	80.5	38,000
Pb (ppm)	199.8	226.8	47.5	184.5	114.5	4,000
Se (ppm)	3.0	0.2	1.5	1.2	12.7	24
V (ppm)	484.4	410.0	233.1	526.5	230.8	780

Sulphur Content from < 0.1% to 1%S

Fe_2O_3 %(w/w) 2.6 to 7%

Clean ore

Reasonably easy to leach, Recovery > 96%

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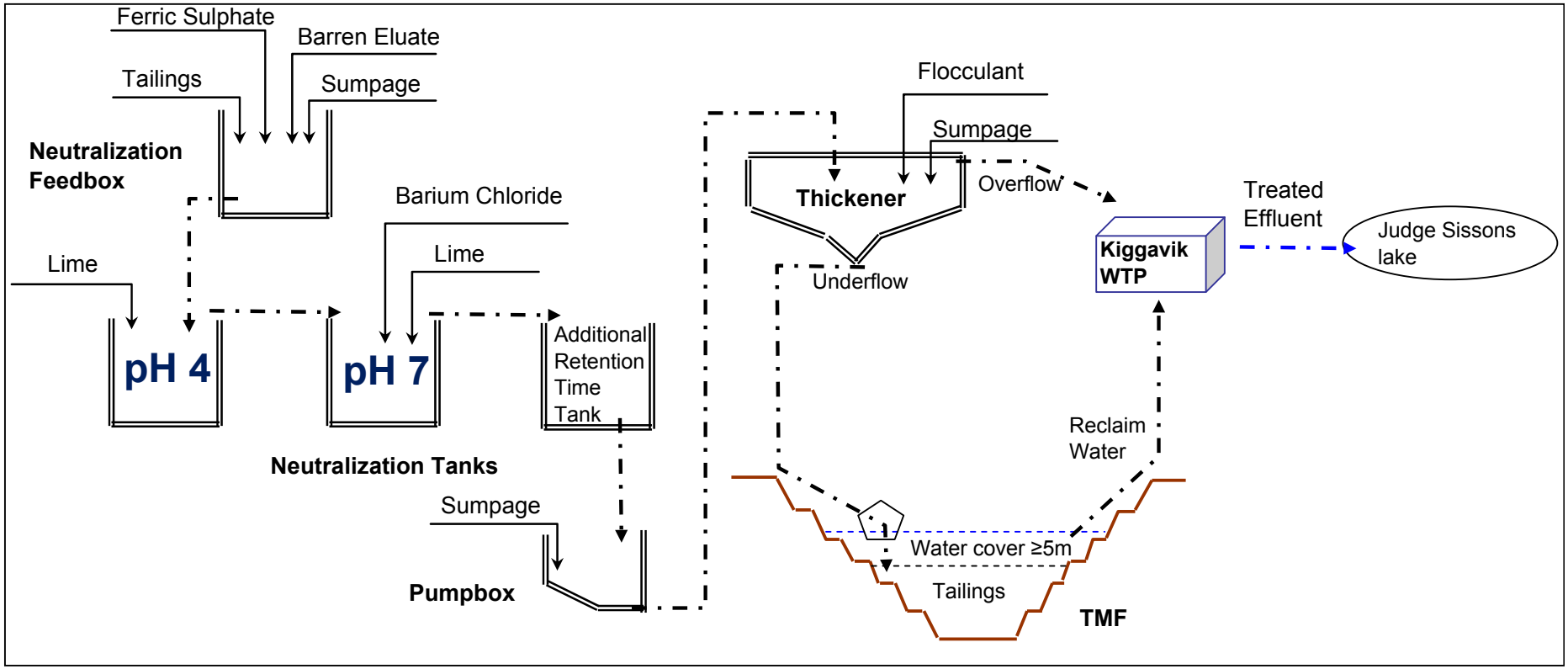
Tailings Management System Schematic Diagram

Mill circuits

Crushing – Grinding – Leaching – Resin In Pulp – Elution – Gypsum Precipitation – Uranium precipitation

Tailings Neutralization



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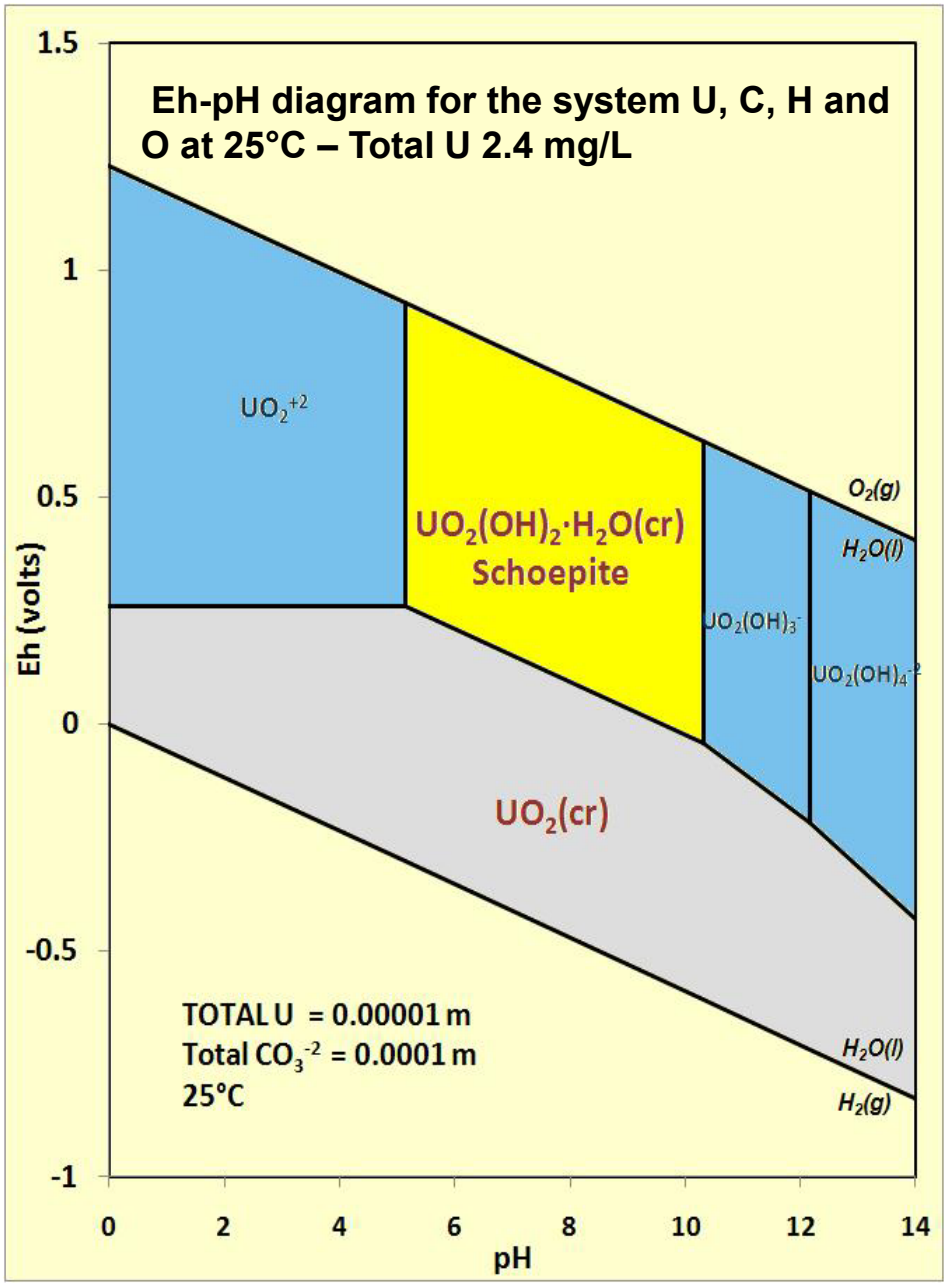
Uranium



Schoepite is the most likely U(VI) bearing phase that will form

Uraninite U(IV) stable form under reducing conditions

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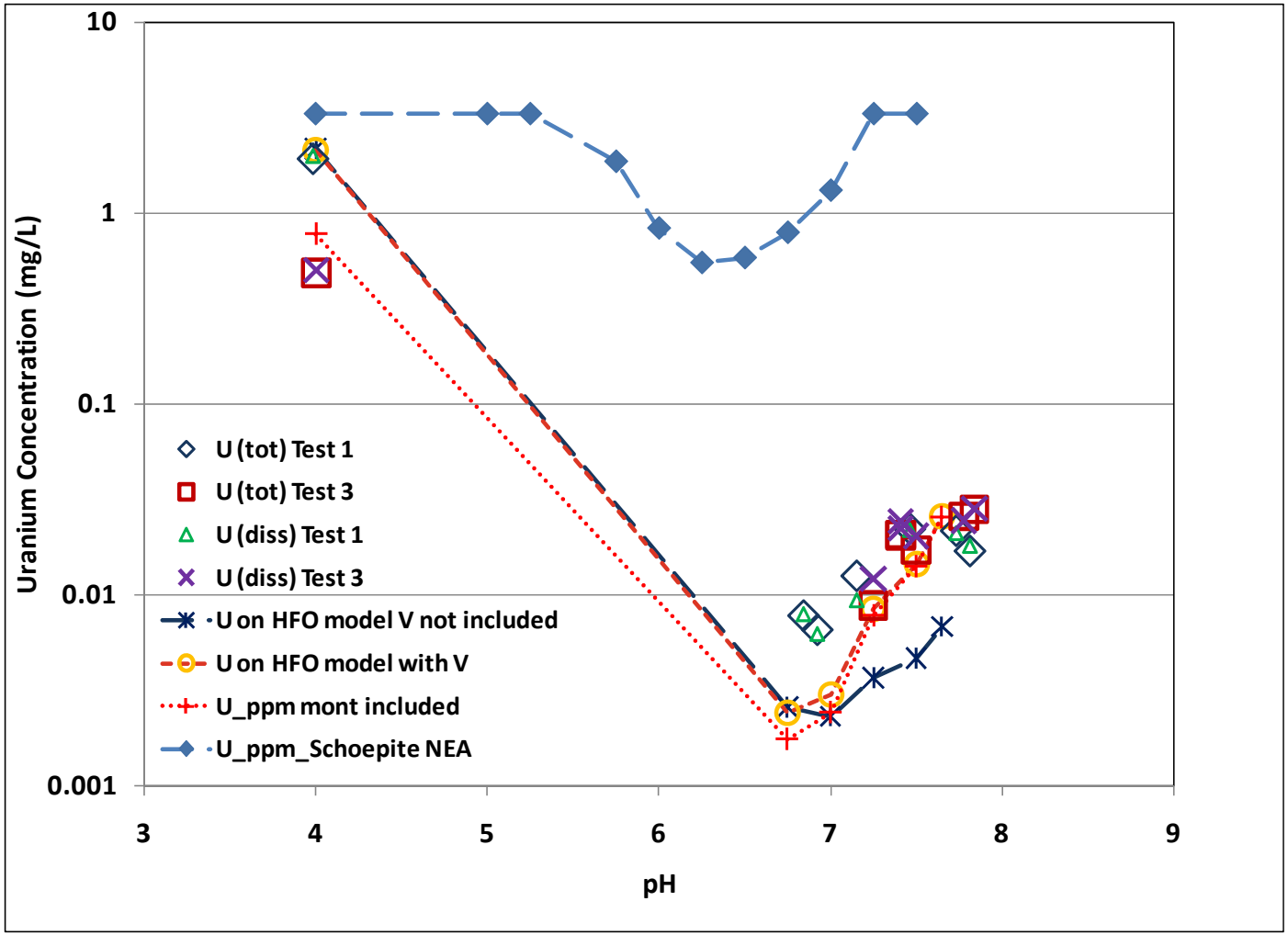
Measured vs Calculated Uranium Concentrations



Importance of surface complexation reactions

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Initial vs Neutralized Tailings

Parameter	Initial Solution	Neutralized Tailings	Ratio
As	1	0.0176	57
Cd	0.0317	0.003	11
Co	5.79	0.0556	104
Cr	63.2	0.34	186
Cu	443	0.4	1,108
Mo	0.159	0.141	1
Ni	33.3	0.31	107
Se	0.1	0.05	2
U	5.94	0.109	54
Zn	79.5	3	27
Ra-226 (Bq/L)	80	10	8

Units in mg/L unless specified

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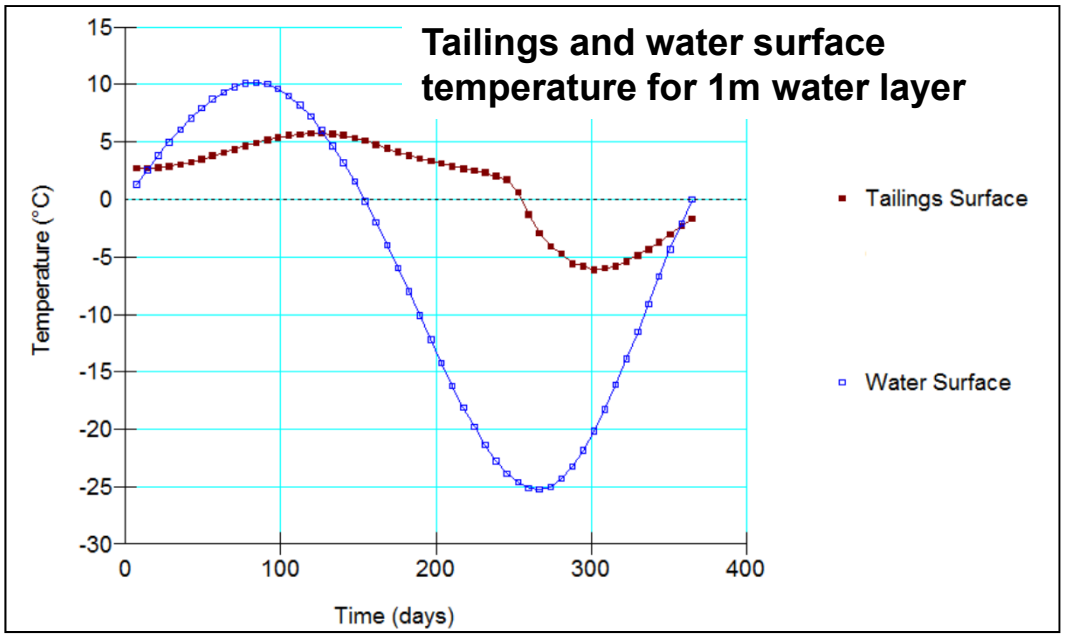
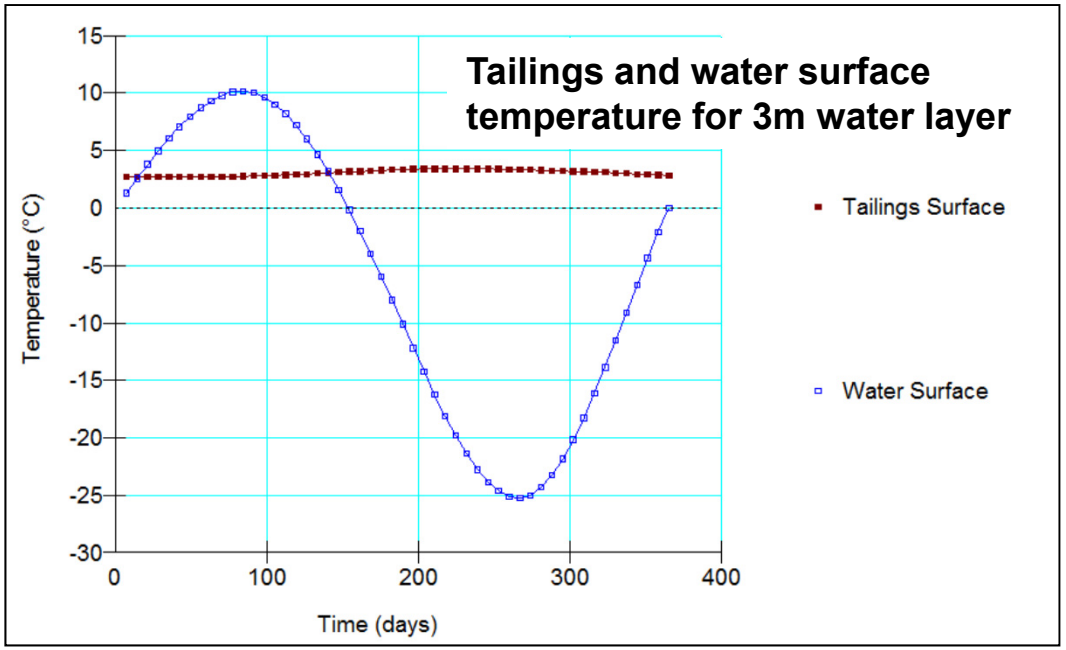
Prevention of Ice Lens Formation





Tailings deposition under a minimum 3 m of free water will prevent freezing of the tailings

Design based on a 5m water cover during deposition and early consolidation

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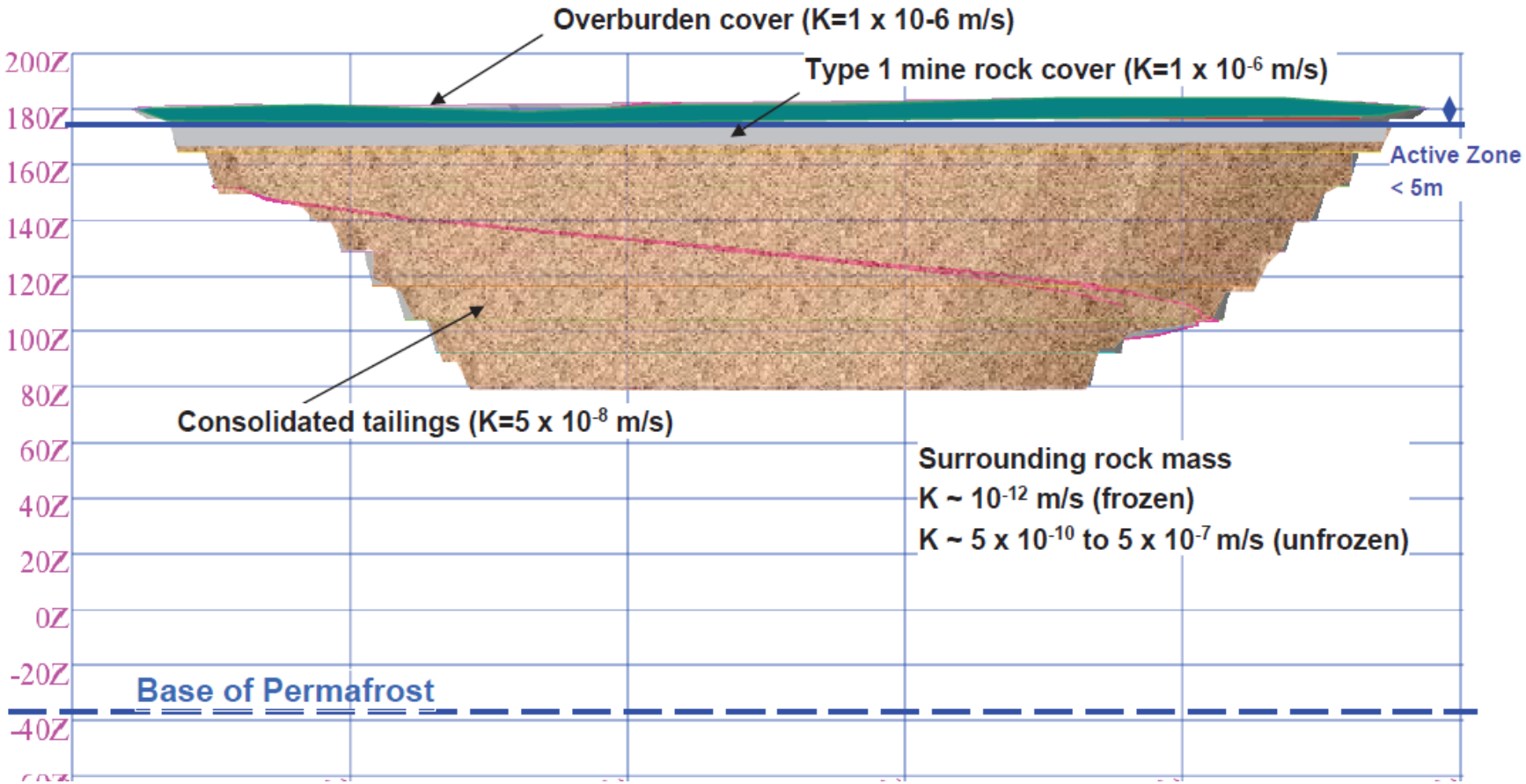
Decommissioning – Centre Zone



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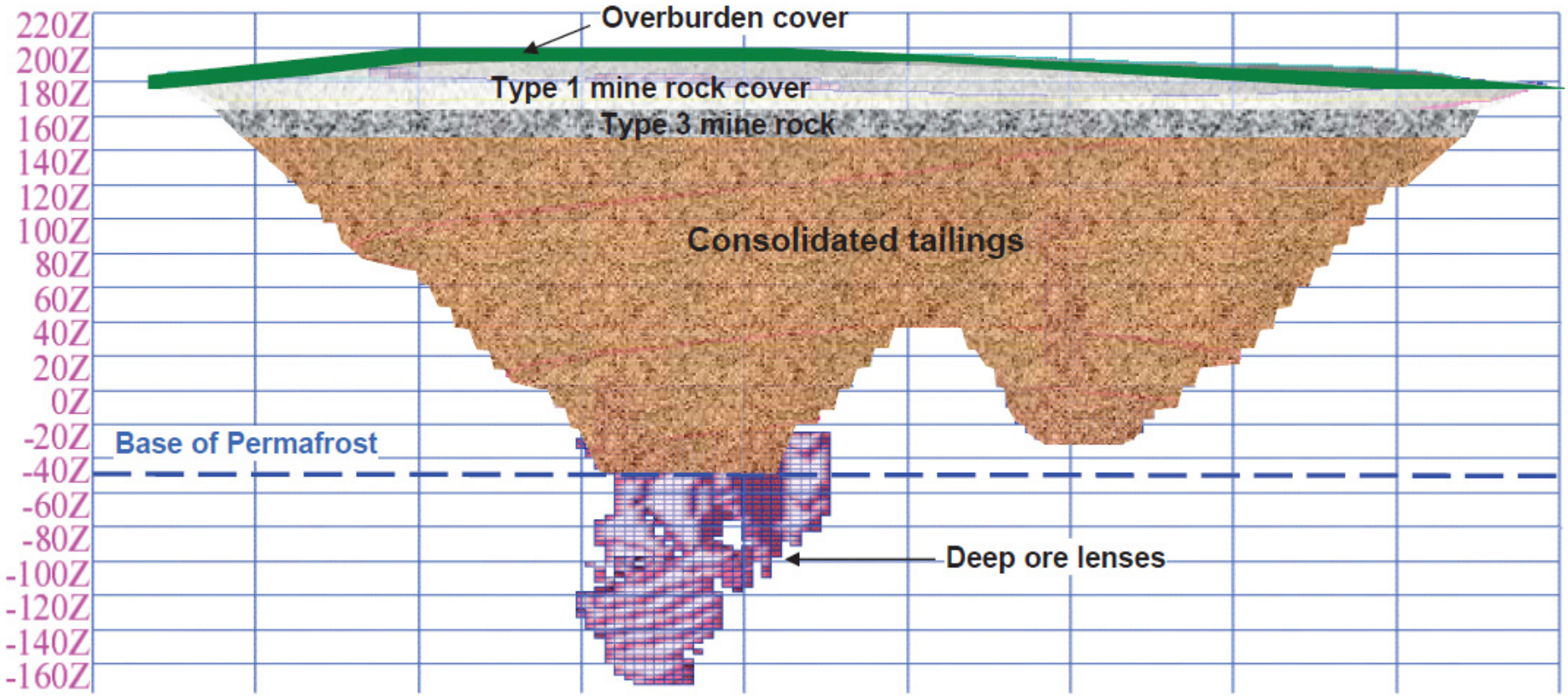
Decommissioning – Main Zone



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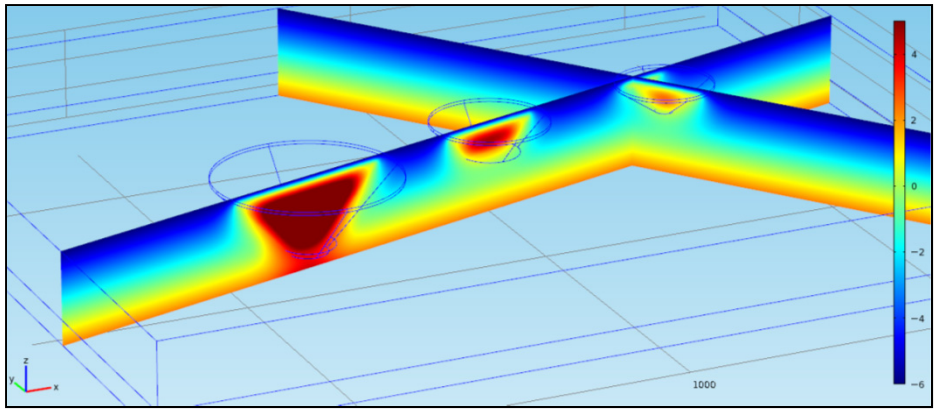
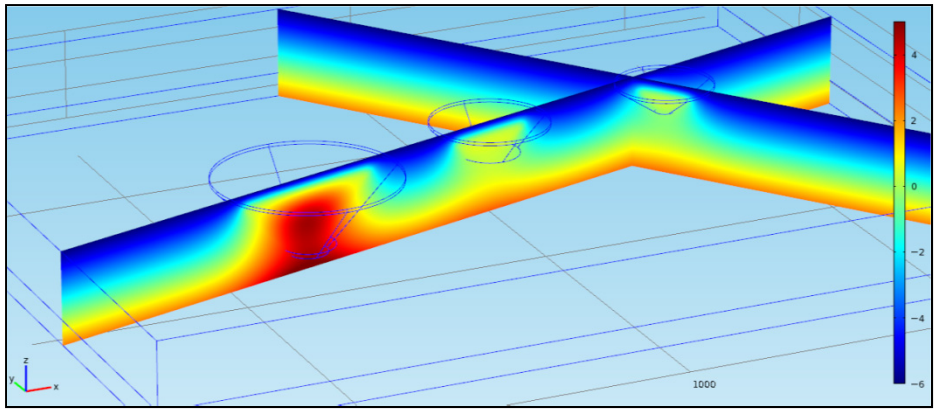
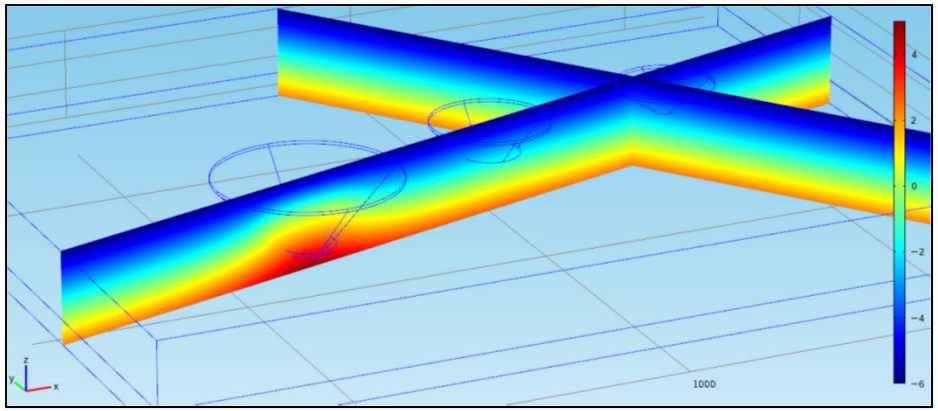
Thermal profile in pits – no warming



20 years after closure



200 years after closure



2000 years after closure

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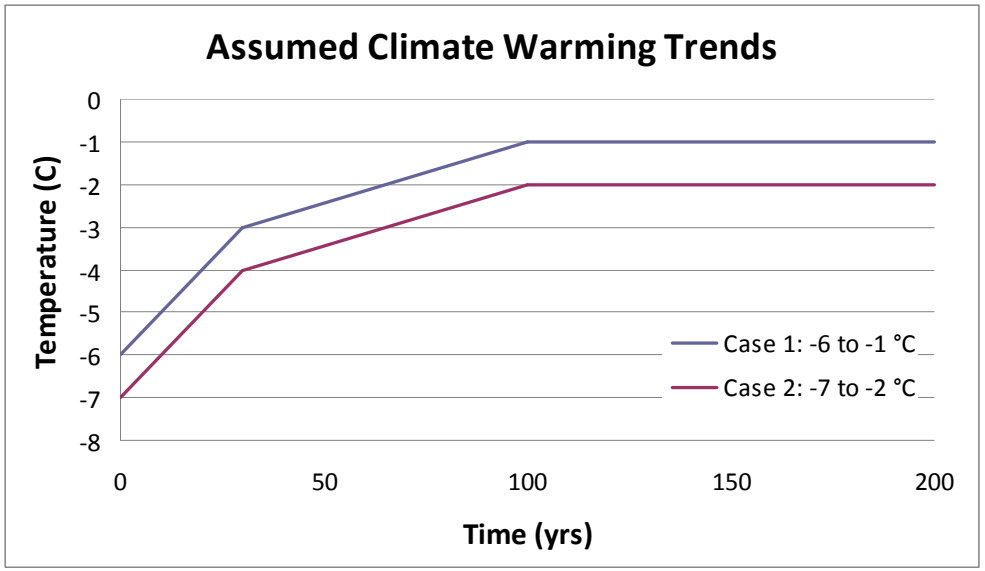
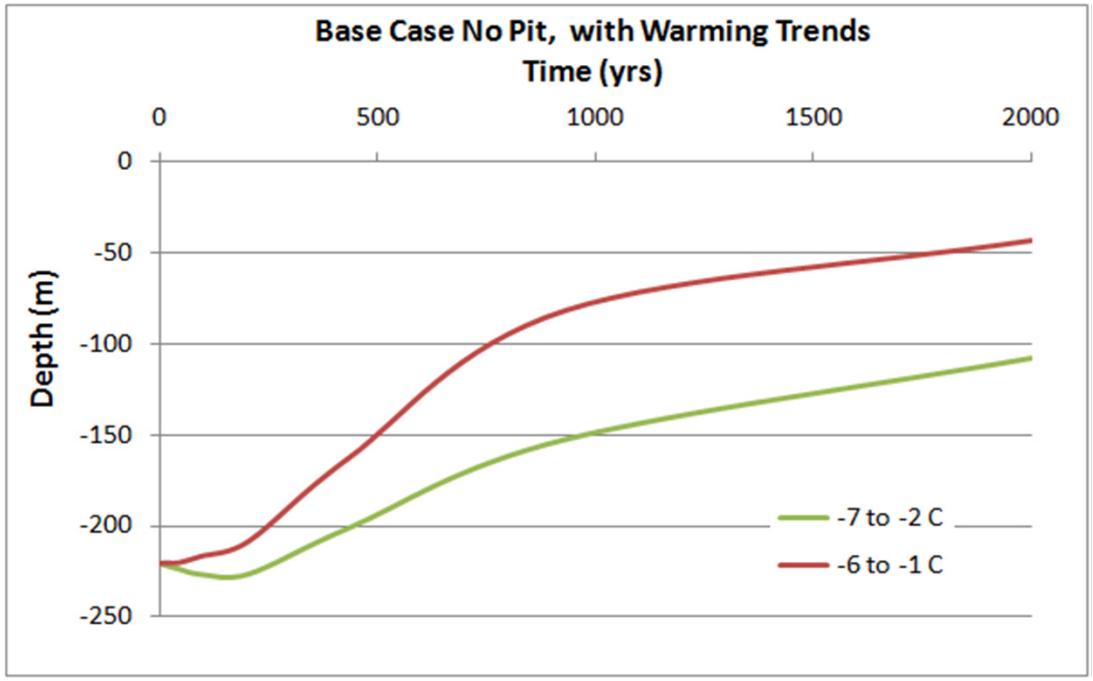
Permafrost vs Climate Warming





Complete melting of permafrost was conservatively assumed to assess long term performance

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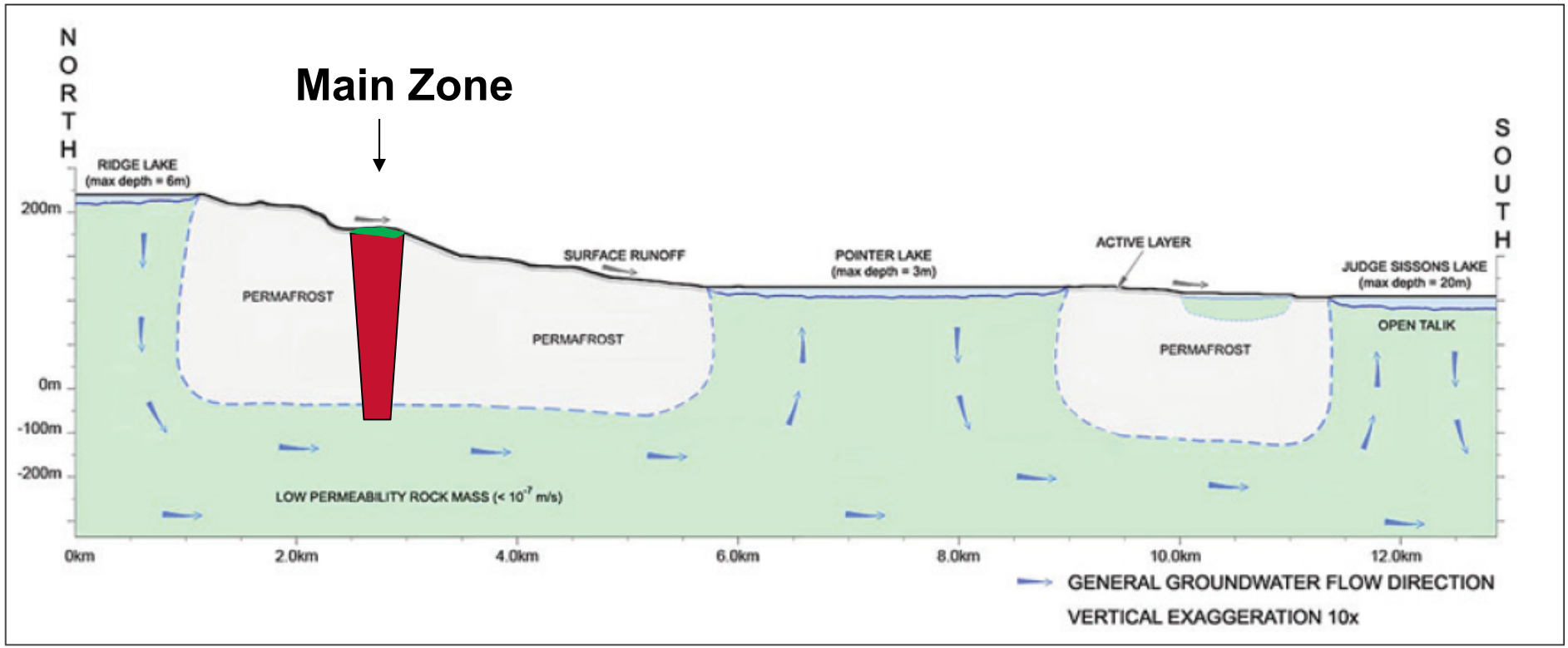
Conceptual Model of Groundwater Flow



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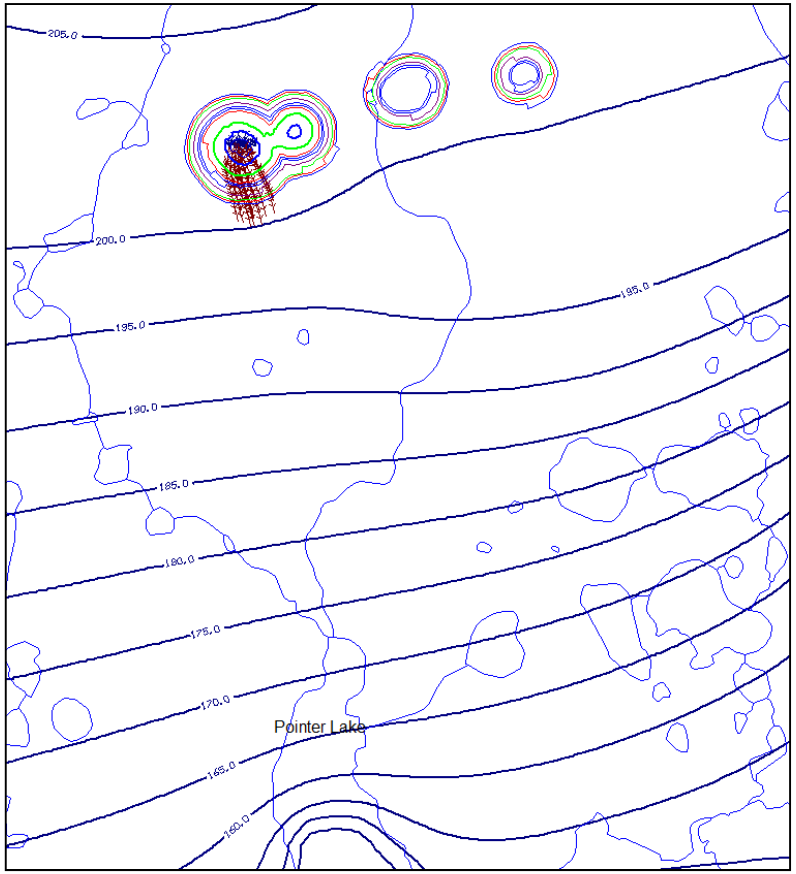
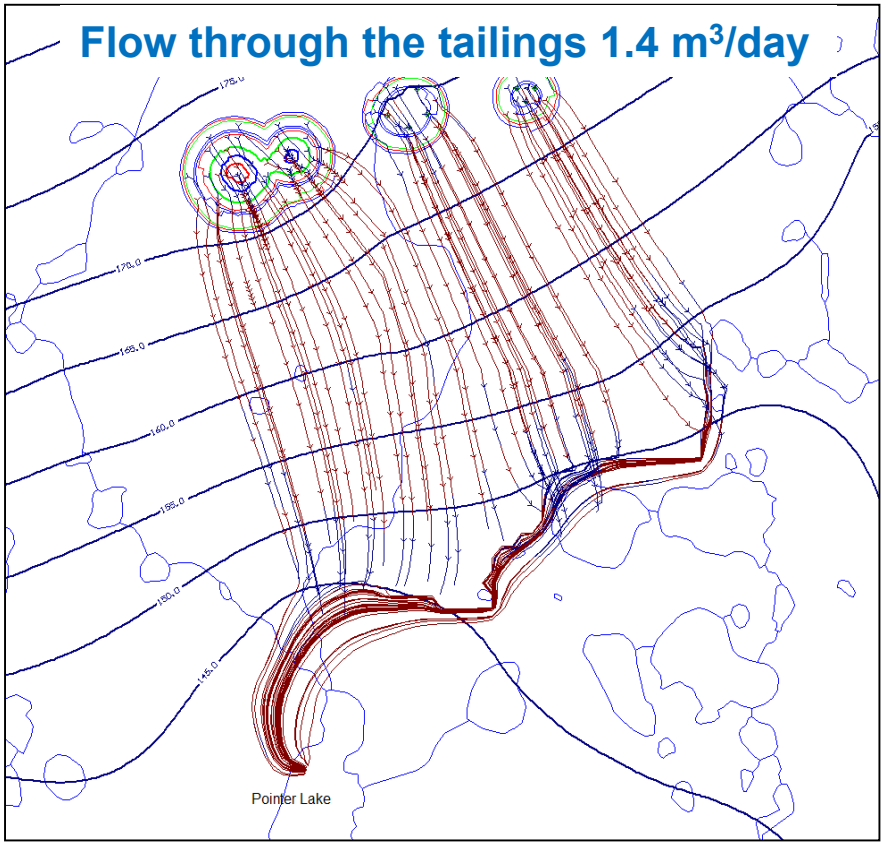
Pathlines Analysis



Current permafrost conditions (pathlines at 10,000 years)



No-permafrost scenario (pathlines at 1,000 years)

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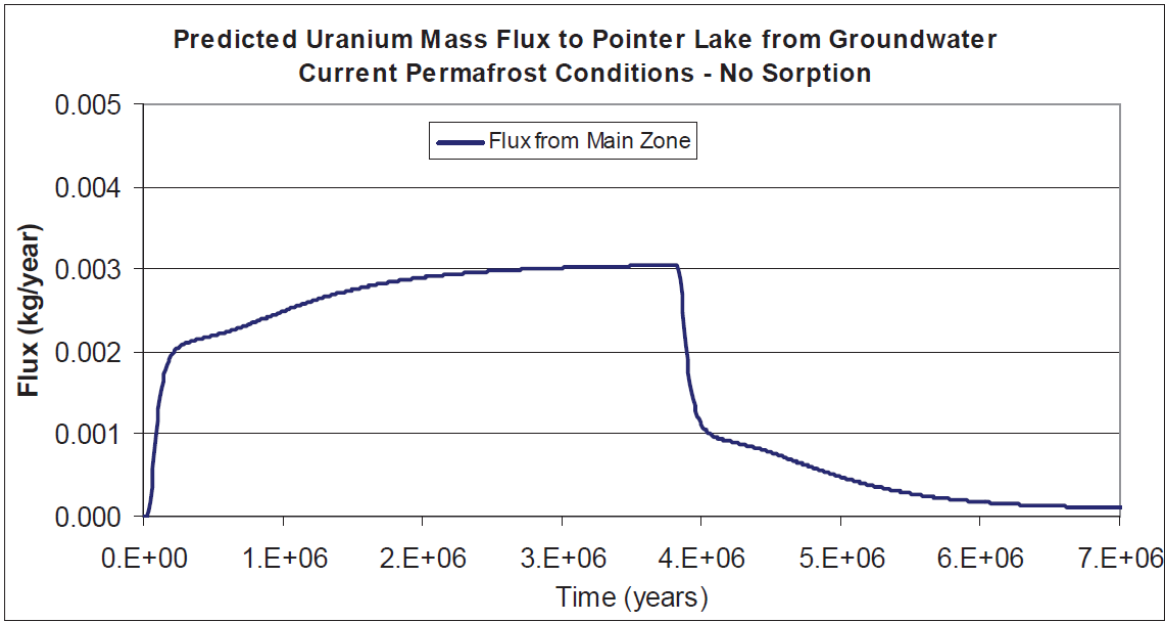
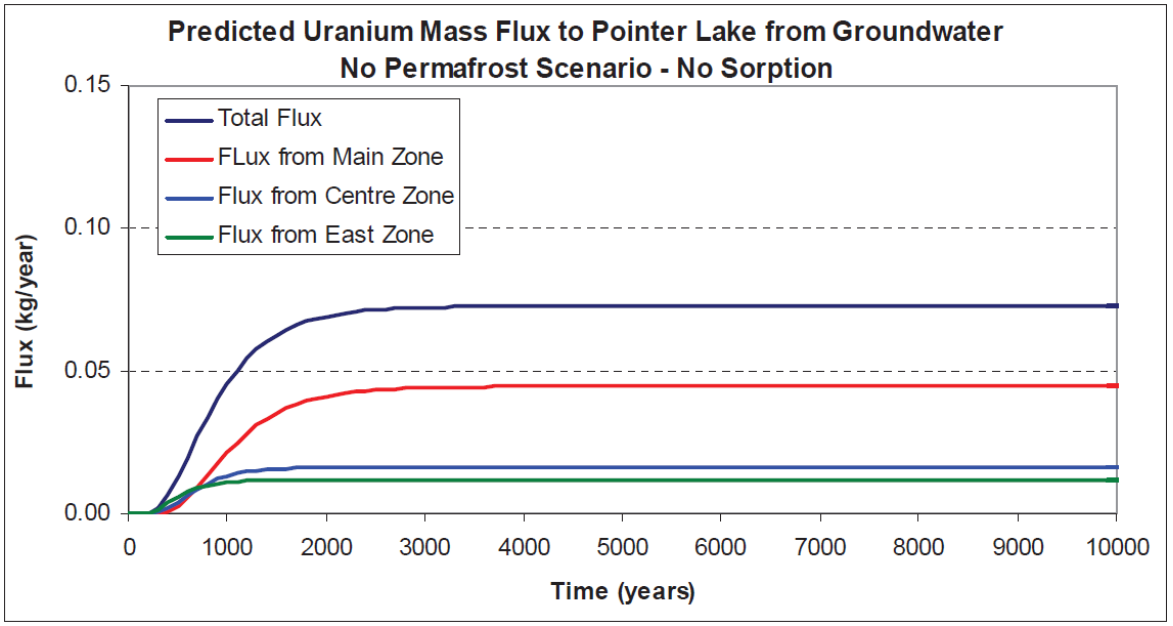
Mass Transport





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Long-term concentrations in Pointer Lake

			Predicted Incremental	
	Reference Values		Surface Water Concentrations	
Parameter	Baseline	Guideline	Current Permafrost	No-Permafrost
As	21	5	4.0E-06	6.9E-04
Cd	< 0.1	0.017	1.0E-05	1.7E-03
Co	<0.1		2.0E-06	3.5E-04
Cr	<0.5	1 to 8.9	7.1E-05	1.2E-02
Cu	0.8	2	8.1E-05	1.4E-02
Mo	<0.1	73	4.0E-05	6.9E-03
Ni	0.4	25 to 150	8.1E-05	1.4E-02
Se	<0.1	1	1.0E-05	1.7E-03
U	<0.1	15	2.8E-05	4.8E-03
Zn	5.8	30	6.1E-04	1.0E-01
Ra-226 (Bq/L)	<0.005	0.5	1.9E-06	3.2E-04

Units in ug/L unless specified

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Conclusion

- Laboratory tests and geochemical models confirmed the performance of the proposed tailings treatment system for the Kiggavik mill, with estimated long term pore water concentrations for U and most metals lower than 1 mg/L
- Groundwater flow and solute transport models confirmed the performance of the tailings containment system and the limited interaction between tailings and natural surface water bodies under current permafrost and 'no-permafrost' conditions

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