Current geochemical understanding and implications for long-term care of the closed Pine Point, NWT tailings impoundment area

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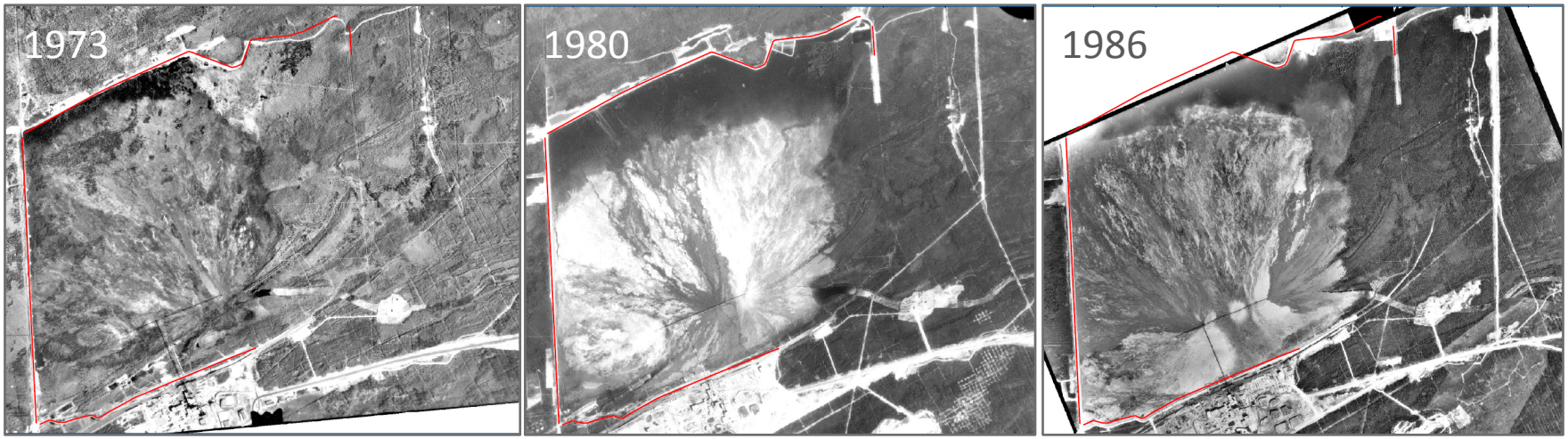
Teck BARR

agenda

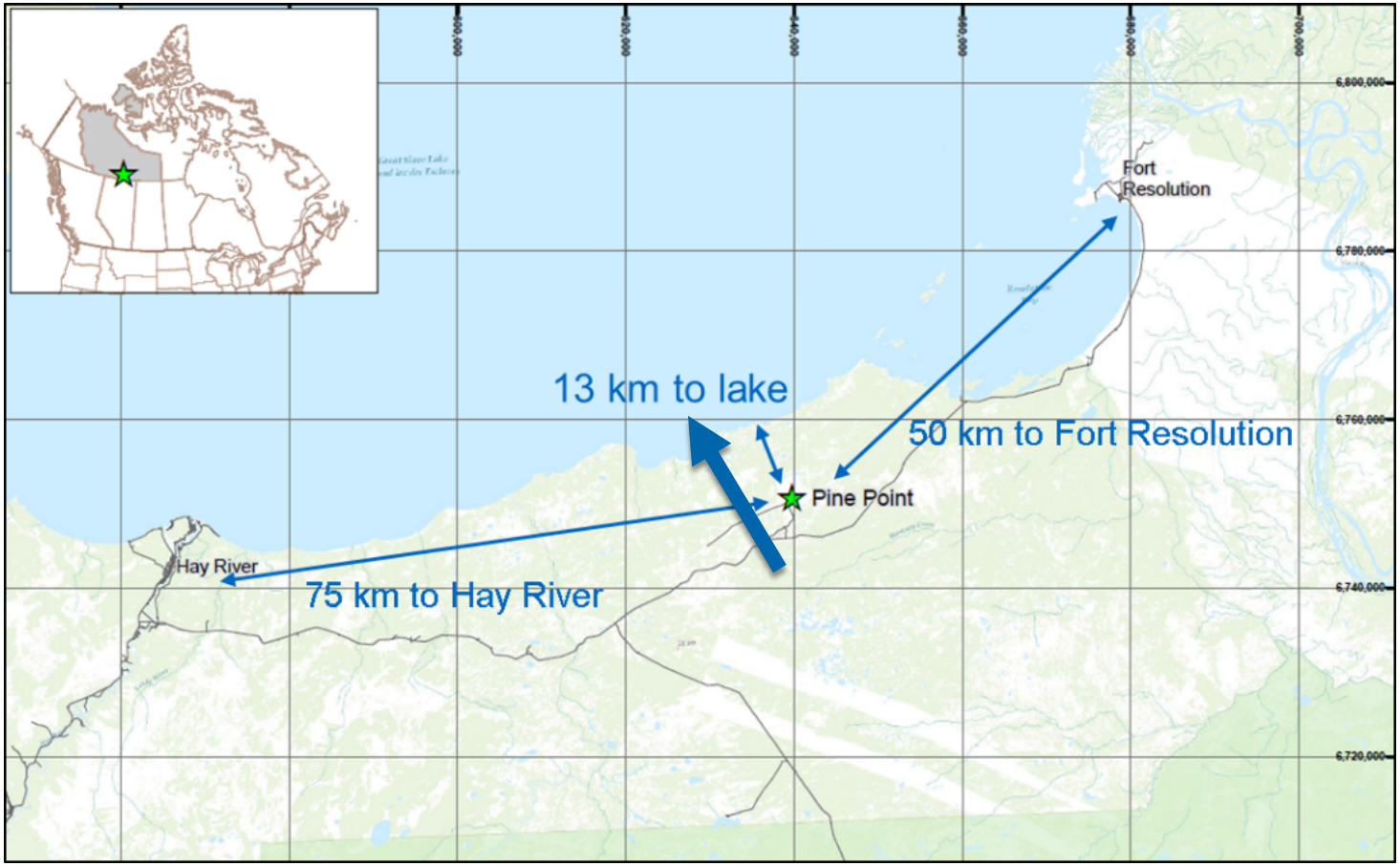
background	closure work	geochemical program	what's next
• location • geologic setting • mining history • current site conditions	• MVLWB principles • closure objectives • research activities	• conceptual site model • water quality • tailings characterization • water balance	• filling in the data/time gaps • developing closure options

BARR

background

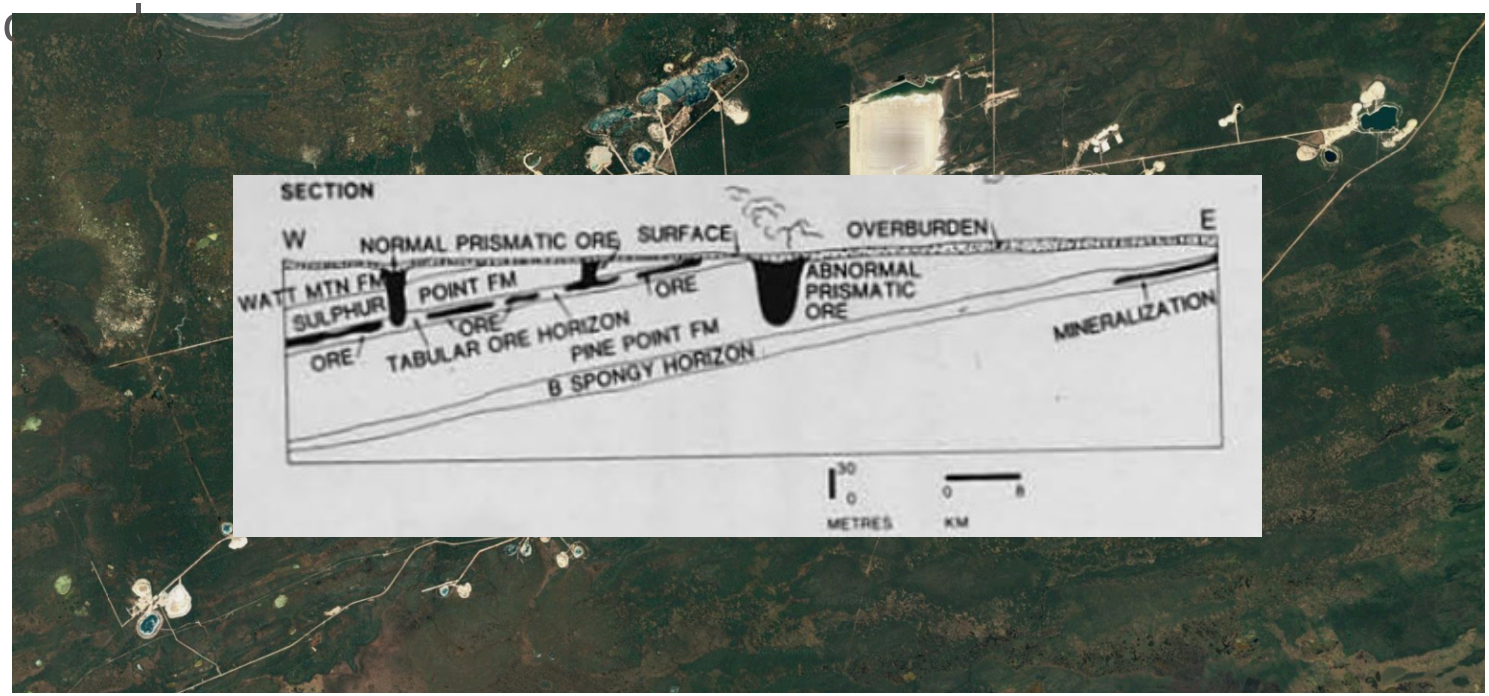


location


Fort
Resolution
13 km to lake
50 km to Fort Resolution
Pine Point
Hay River
75 km to Hay River
6,800,000
6,780,000
6,760,000
6,740,000
6,720,000

geological setting

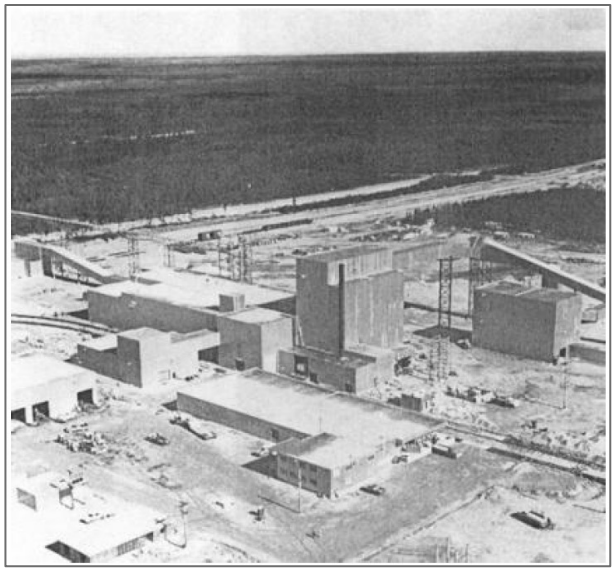
- surficial material at TIA is peat, lacustrine silts and clays, and glacial till
- bedrock is ~15m below TIA
- Mississippi Valley-type Pb-Zn deposit (galena and sphalerite)
- hosted in karst features of the middle Devonian carbonate barrier



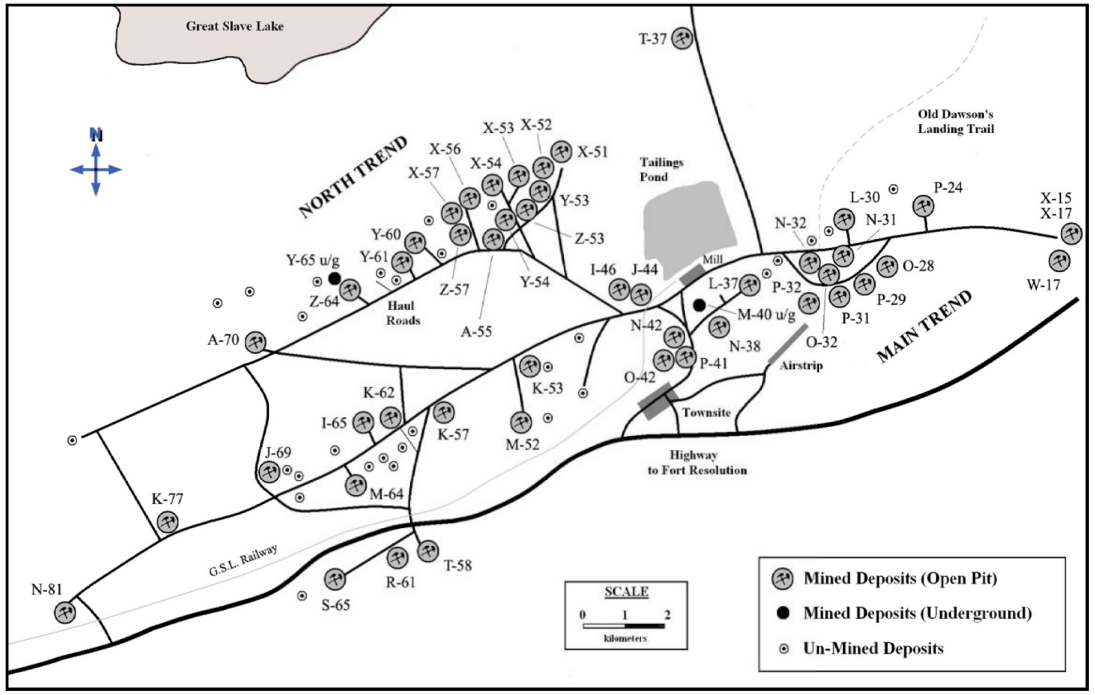
Google Earth, 2019; Rhodes et al., 1984

mining history

- open pit mine operated for 24 yrs (1964-1988)
- Produced 70 million tonnes of Pb-Zn ore (2.9% Pb and 6.8% Zn)
- closed-circuit ball and rod milling and flotation used to process ore/ tailings
- 54 million tonnes of tailings



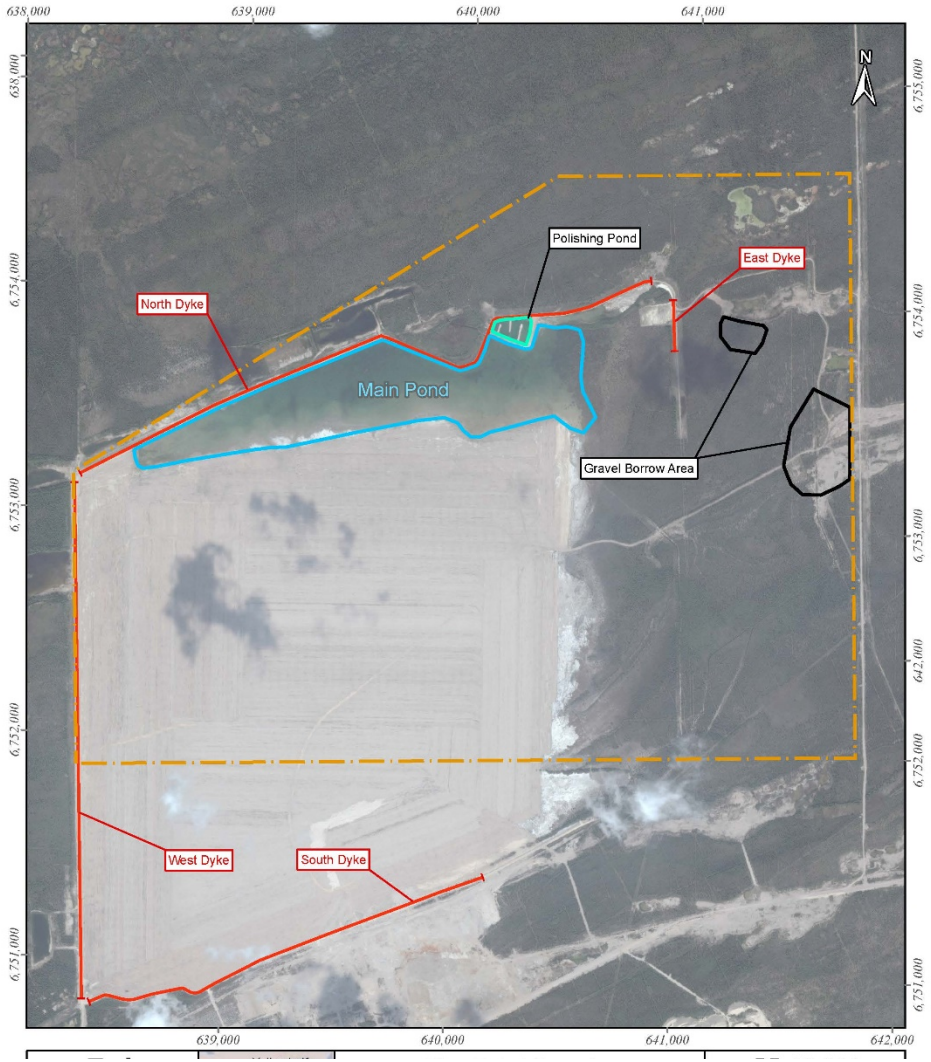
mill building (1965)



Mined and unmined deposits

Silke, 2009

current site conditions



- facility is in closure-active care phase of mine life
- tailings deposit
  - 570 hectares
  - Up to 15m thick
  - dolomite and calcite
  - 150 mm sand and gravel cover
- main and polishing ponds
  - captures runoff
  - zinc in main pond (~1.5 mg/L) exceeds Water Licence limit of 0.5 mg/L
  - lime added to polishing pond to maintain limit compliance (currently discharging ~0.2 mg/L)

closure work

MVLWB principles for closure

PHYSICAL STABILITY

CHEMICAL STABILITY

NO LONG-TERM ACTIVE CARE REQUIREMENTS

FUTURE USE

closure objectives

To maintain or enhance:

- dust level acceptability
- embankment structure stability
- blending with local topography & vegetation
- acceptable effluent discharge impacts on downstream ecosystems
- diminished threat of contamination from tailings
- reduced risk of ARD/ML
- preventing catastrophic and/or chronic release of tailings

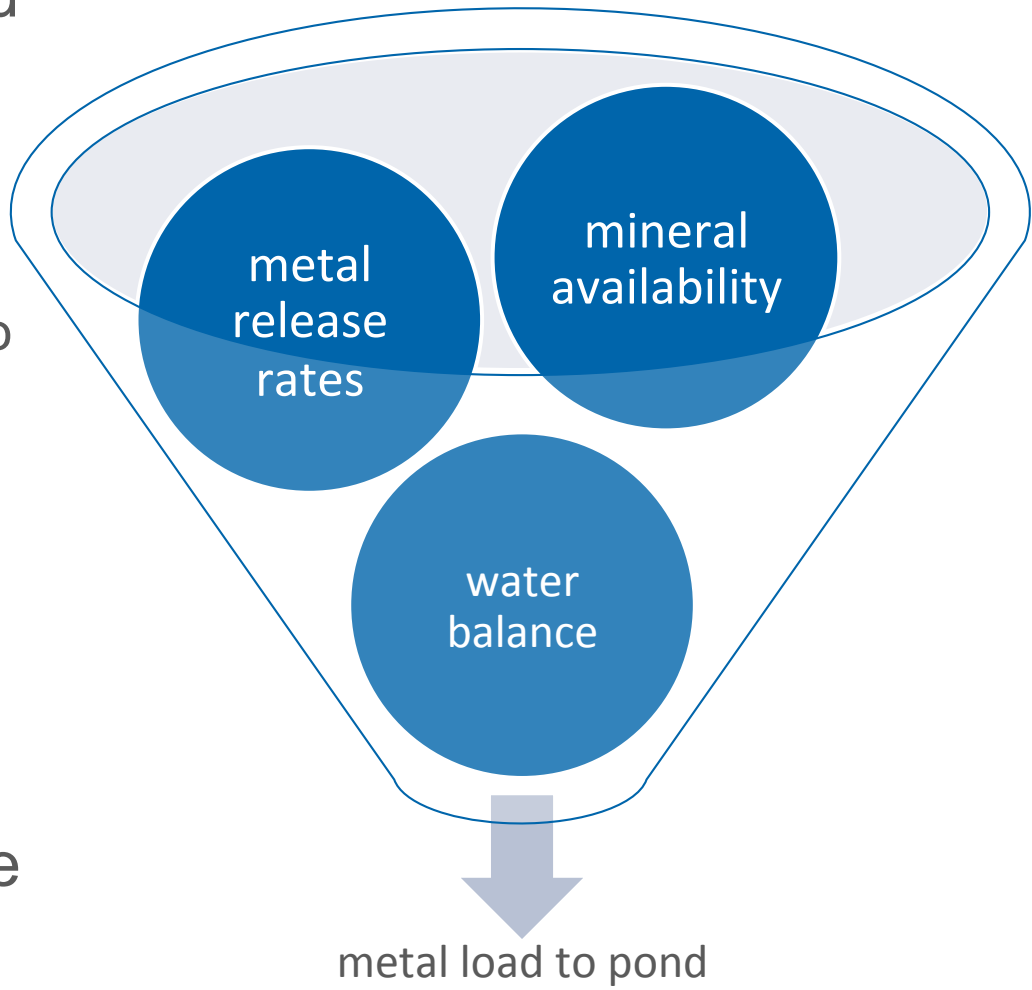
reclamation research activities

- groundwater and surface water monitoring
- on-site meteorological station
- infiltration testing
- water balance (GoldSIM)
- geochemical evaluation
- risk assessment (biological assessment)
- climate change assessment

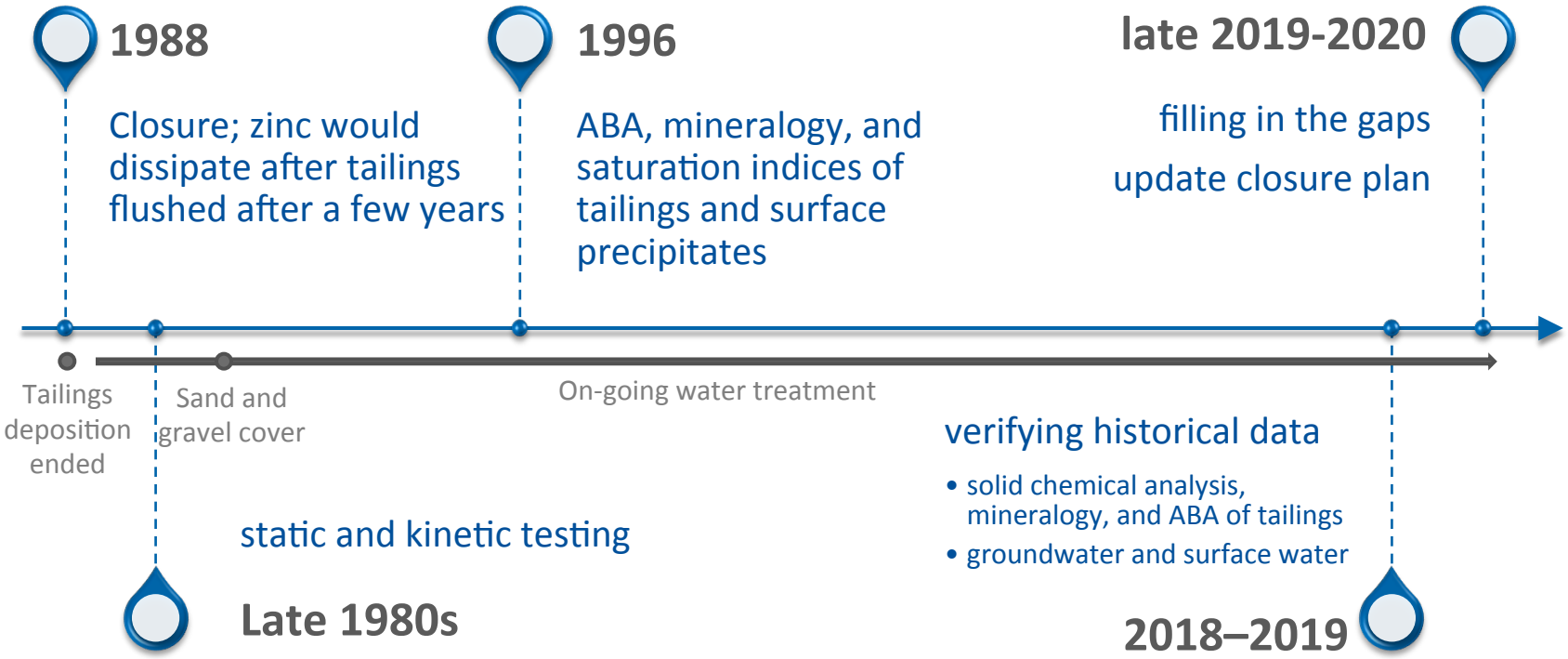
geochemical program

geochemical program objectives

- determine metal (Zn) load to pond
  - rate of metal leaching
  - how parameter concentrations and flow into the TIA main pond fluctuate with location and time
  - how metal concentrations vary in response to closure options
- couple geochemistry results with water balance



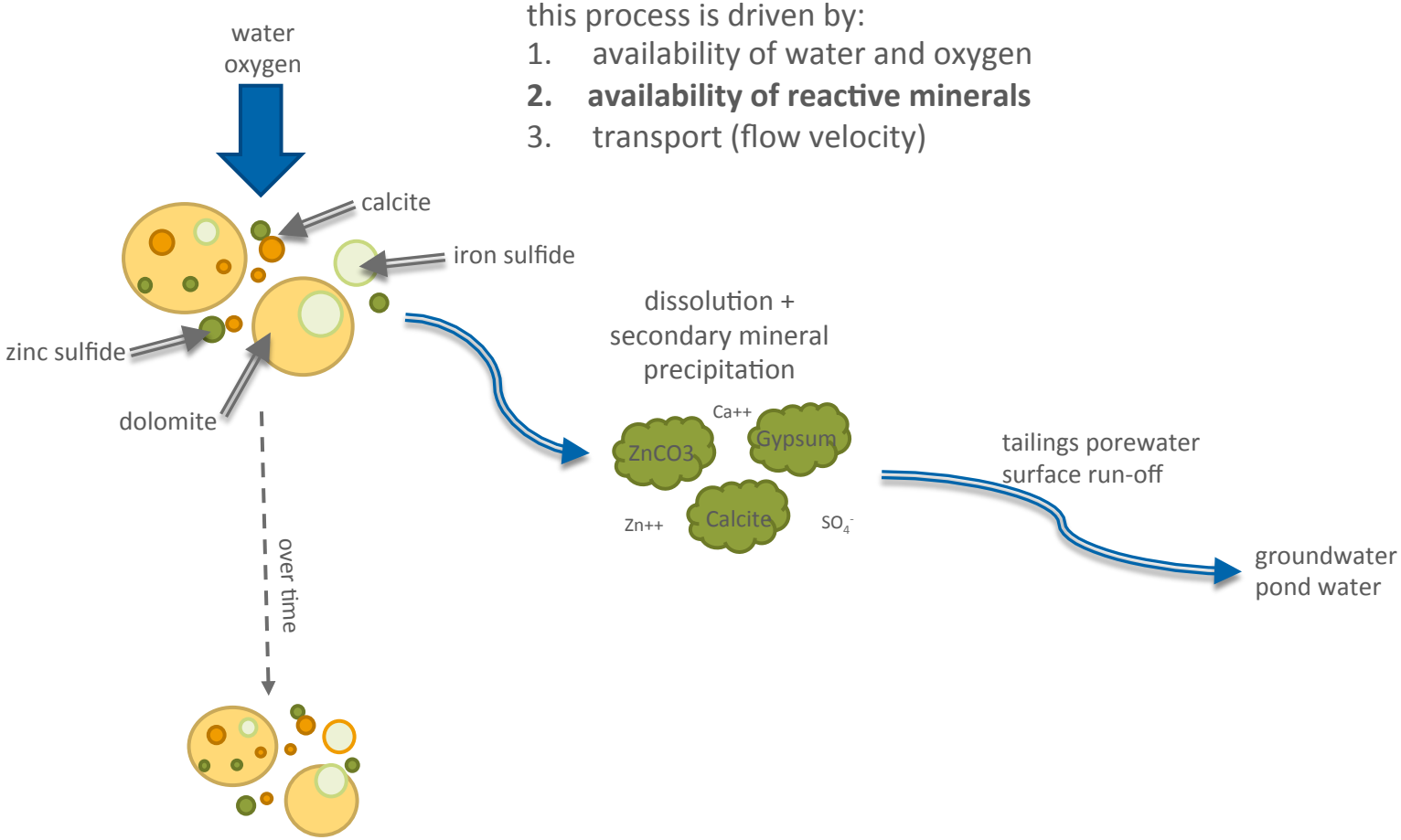
geochemistry timeline



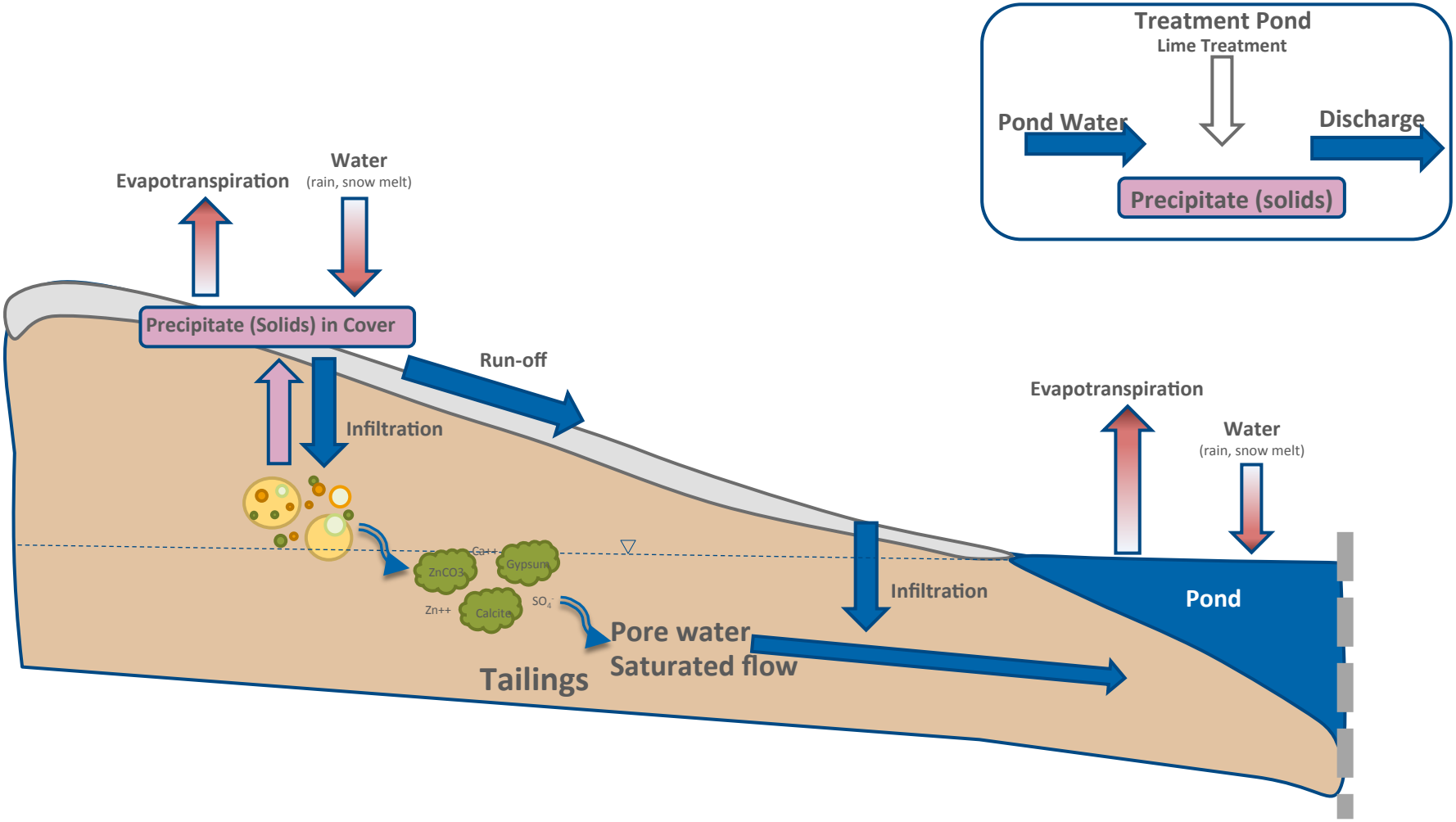
zinc mobility

this process is driven by:

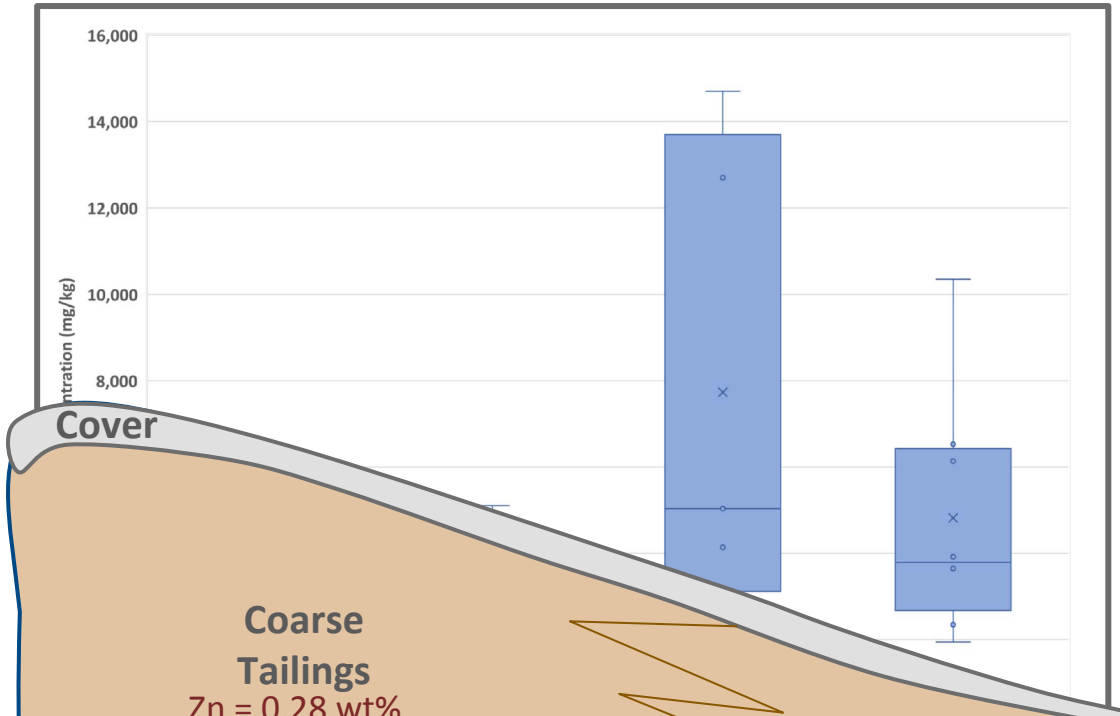
1. availability of water and oxygen
2. **availability of reactive minerals**
3. transport (flow velocity)

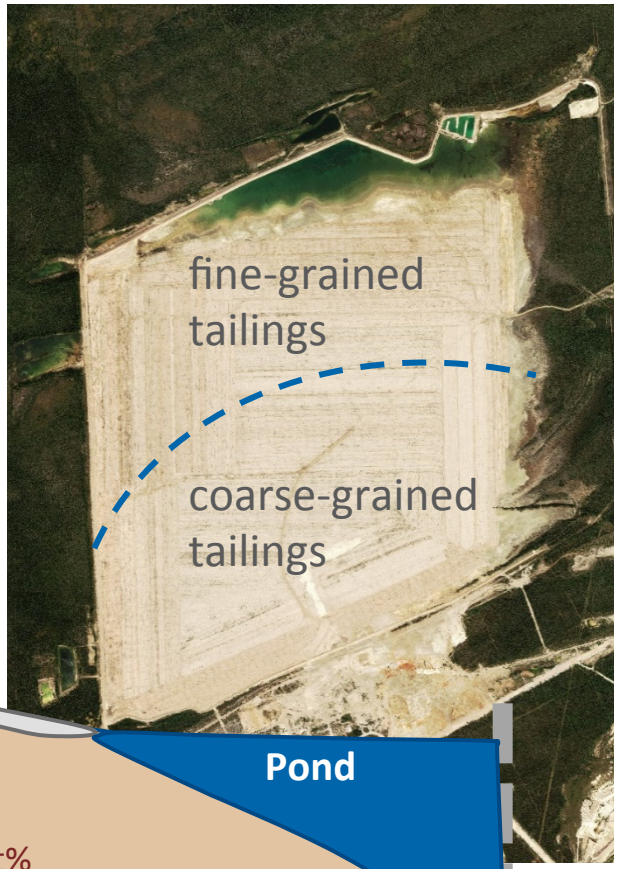


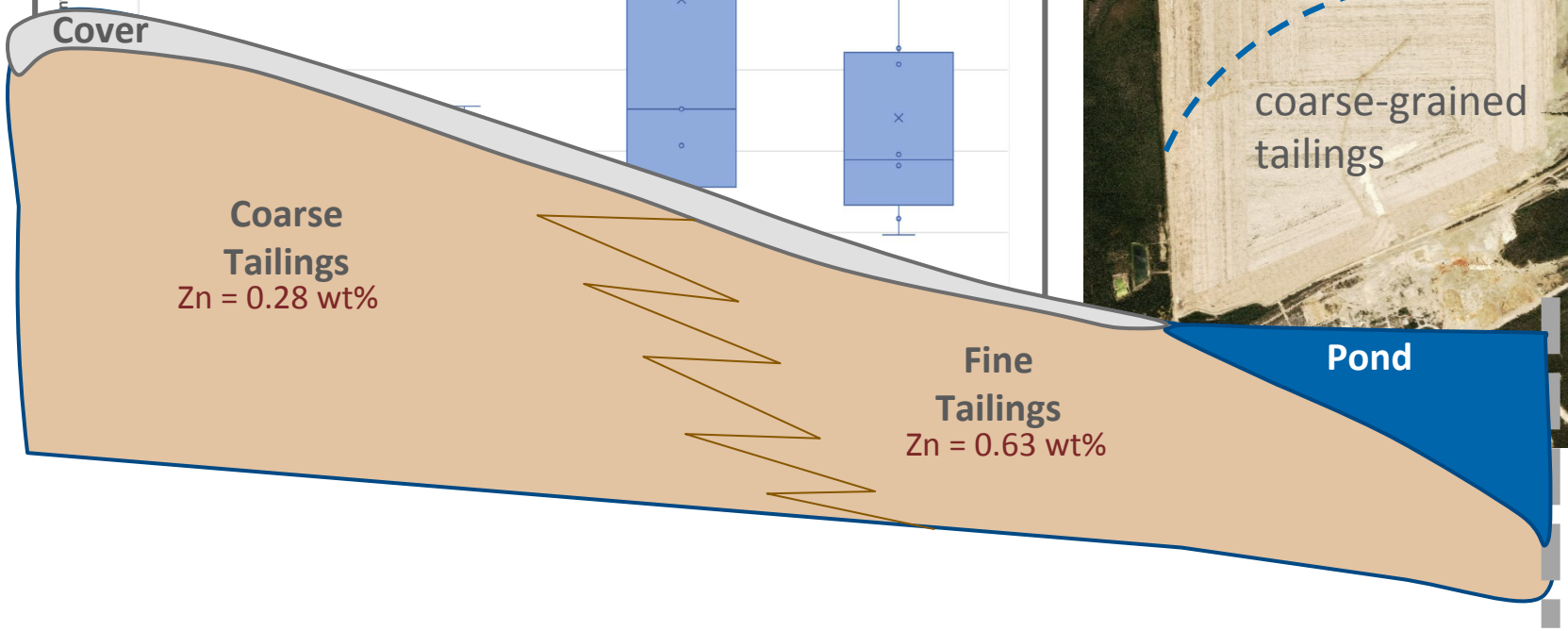
conceptual site model



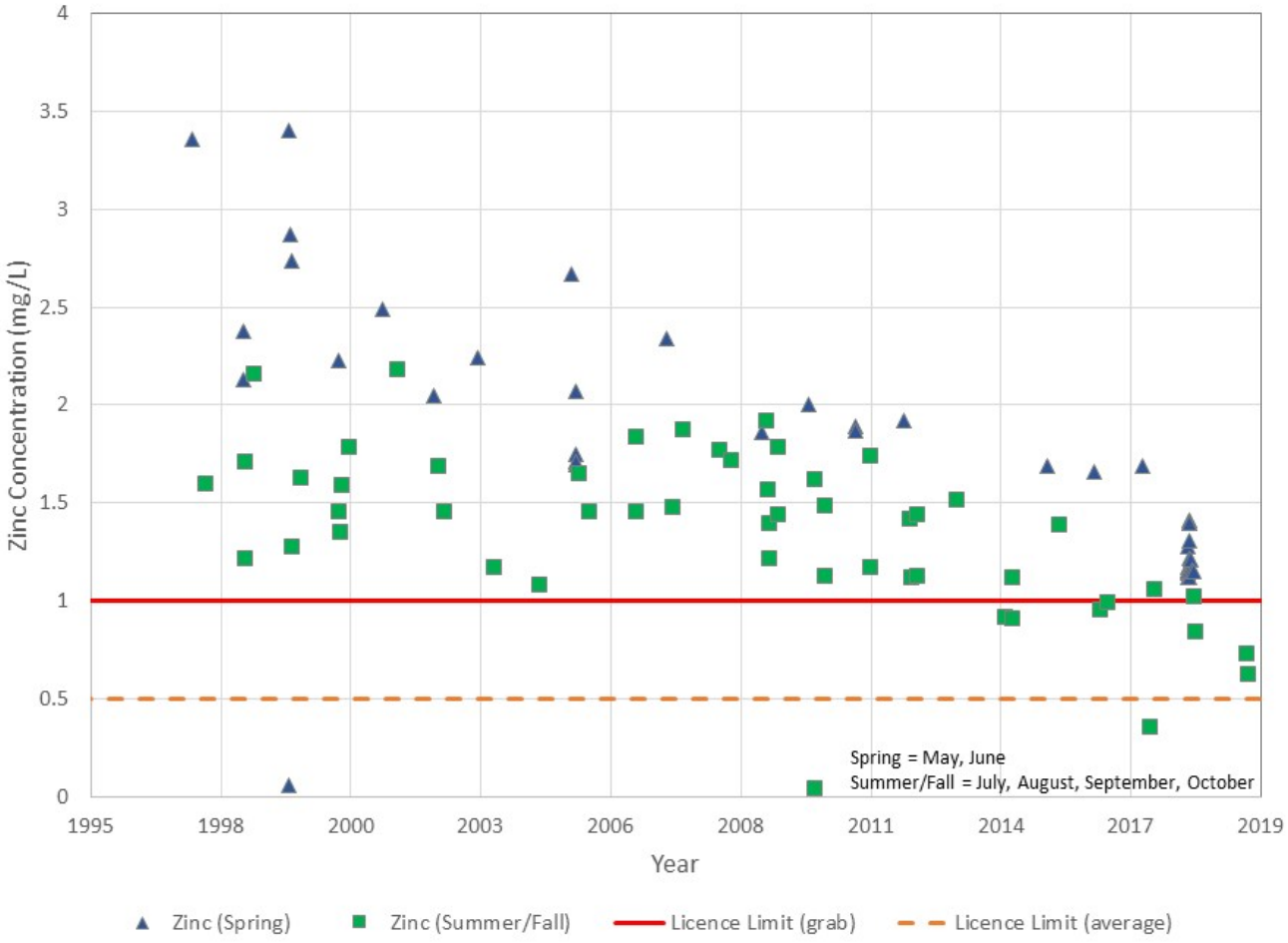
tailings characterization: grain size and zinc content





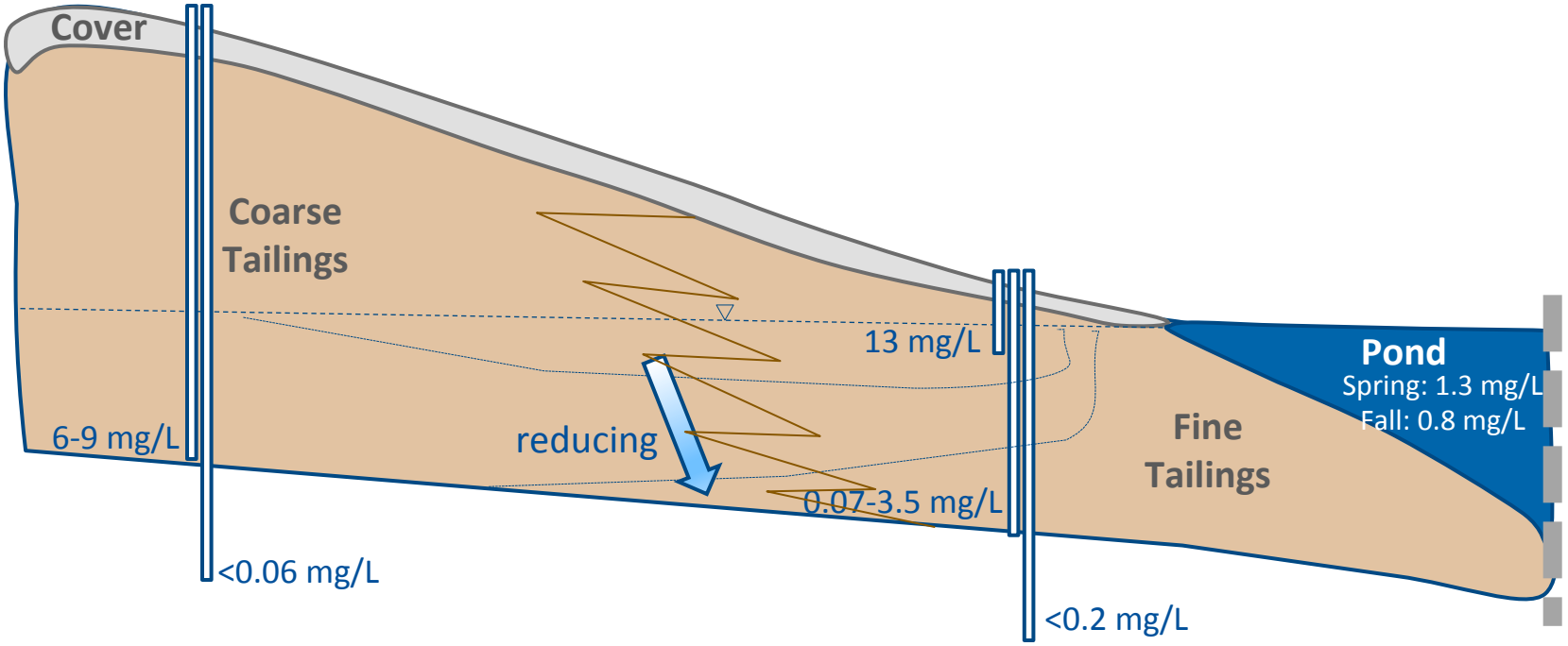


main pond water quality



groundwater quality

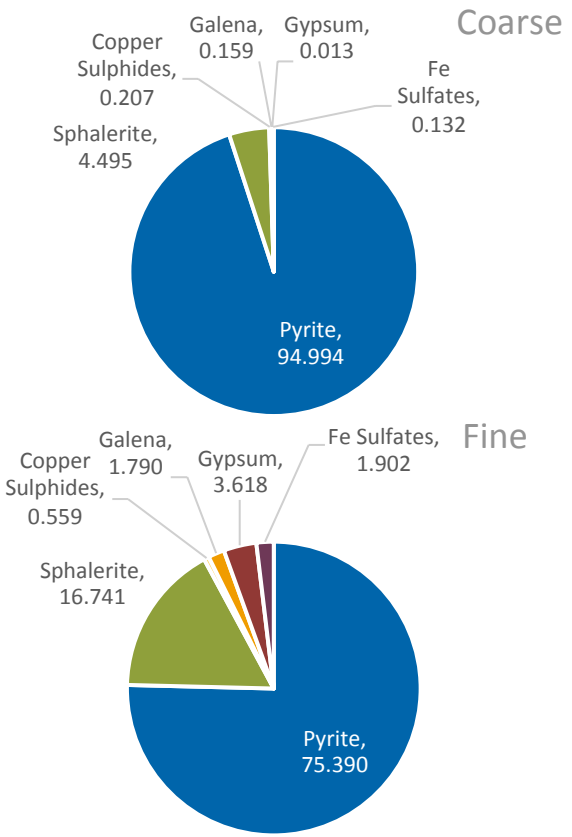
- zinc in the tailings ranged from 0.07 – 13 mg/L (2018-2019)
- reducing conditions in tailings porewater
- Zn-carbonates at saturation when porewater Zn is >5 mg/L



tailings characterization: mineralogy

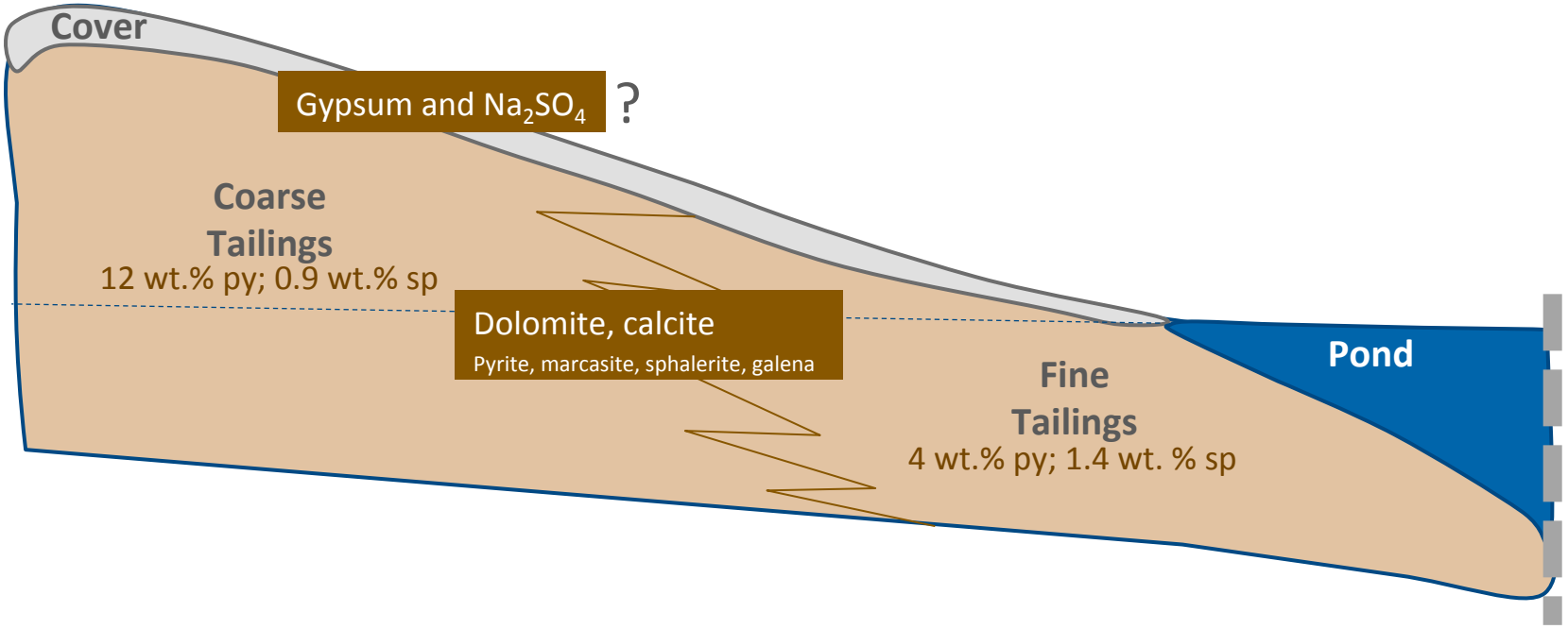
- dolomite primary mineral with lesser calcite
  - trace: pyrite, marcasite, sphalerite, galena, muscovite, quartz, gypsum

Sample Location	Coarse tailings at water table (%)	Fine tailings Unsaturated (%)
Dolomite	**79.21**	**72.13**
Calcite	**5.08**	**8.57**
Siderite	0.04	0.13
Ankerite	**0.69**	**2.81**
Pyrite	**11.98**	**3.97**
Sphalerite	**0.91**	**1.40**
Copper Sulphides	0.04	0.04
Galena	**0.08**	**0.40**
Gypsum	0.00	0.54
Fe Sulfates	0.05	0.31
Iron Oxides	0.02	0.40
Ilmenite/Pseudobrookite	0.02	0.01
Corundum	0.00	0.66
Amphibole/Pyroxene	0.03	0.31
Muscovite	0.13	1.25
Chlorite	0.61	0.38
Feldspar	0.37	3.41
Quartz	0.59	2.70



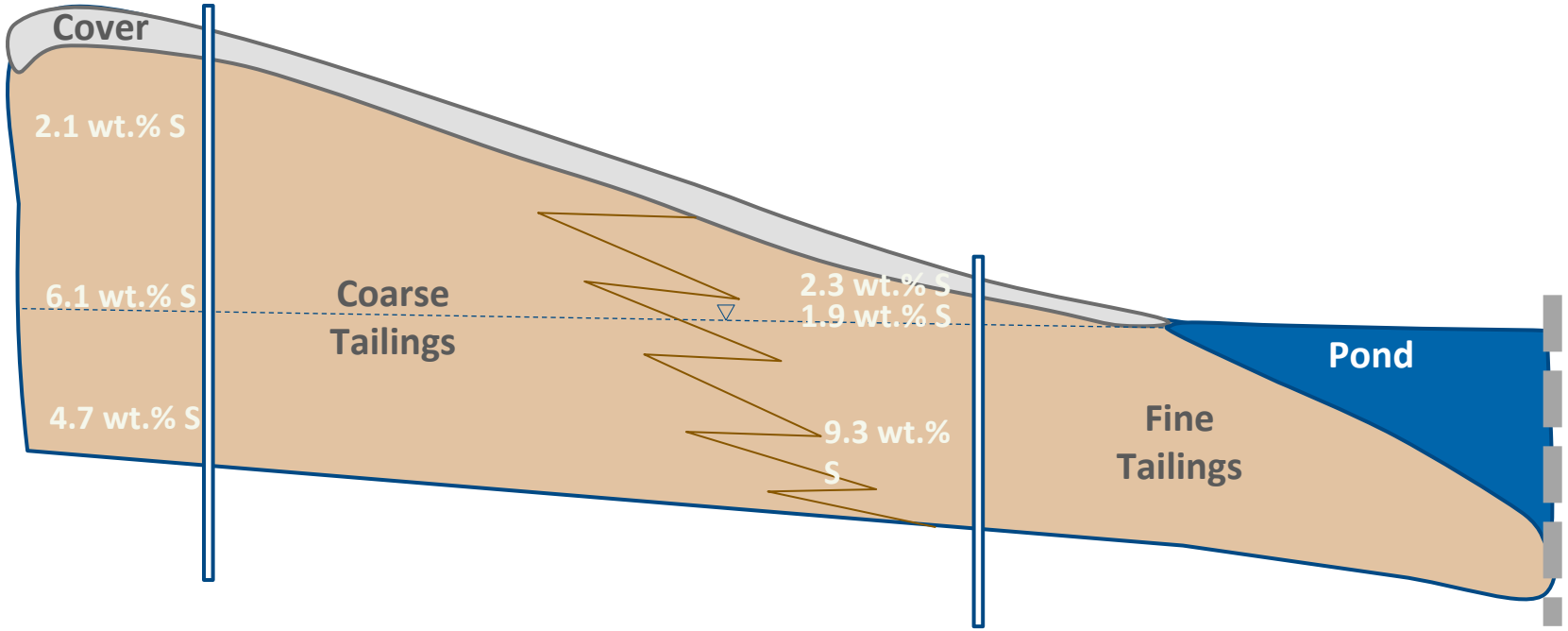
tailings characterization: mineralogy

- Mixture of polycrystalline aggregates, intergrowths, and liberated minerals
- iron oxyhydroxide rims absent on iron sulphides in all samples
- narrow alteration rims (1 µm) observed on galena and sphalerite in near surface coarse grained tailings



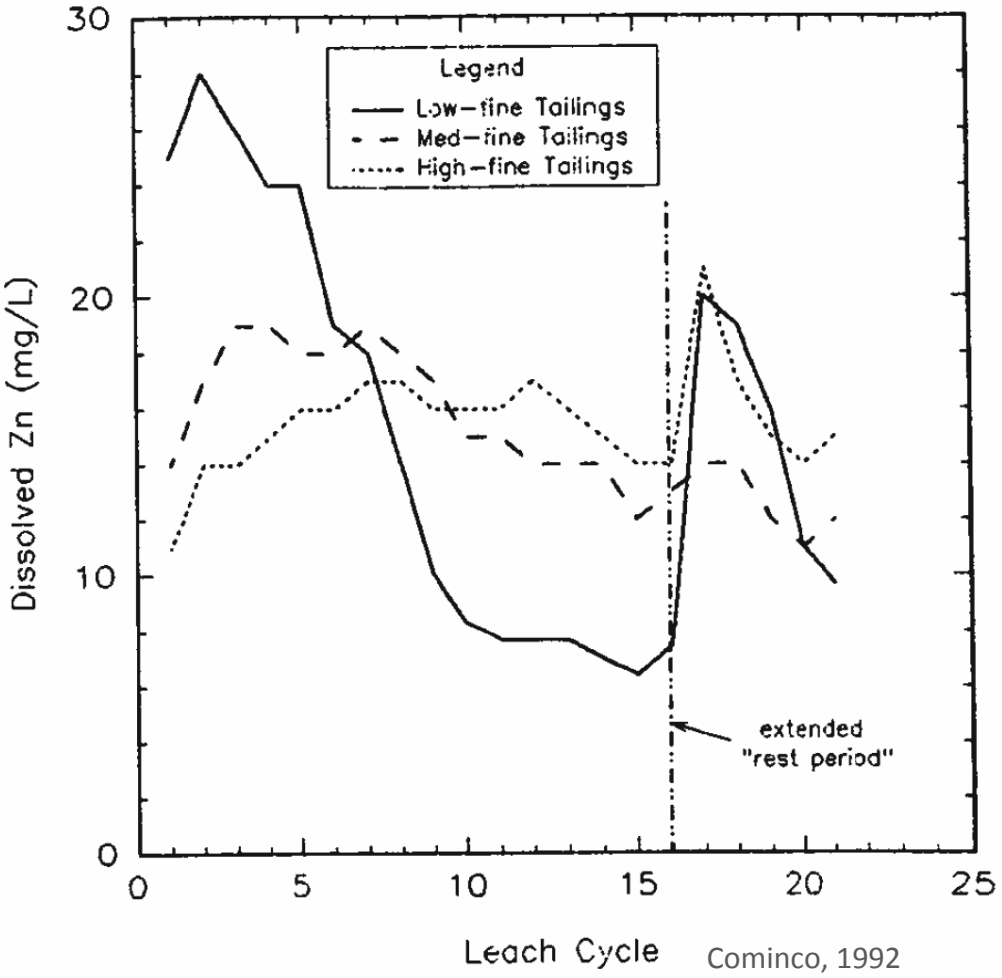
tailings characterization: ABA

- higher sulfur content in saturated, fine grained samples
- similar sulfur content in unsaturated tailings
- all samples are net-neutralizing



tailings characterization: kinetics

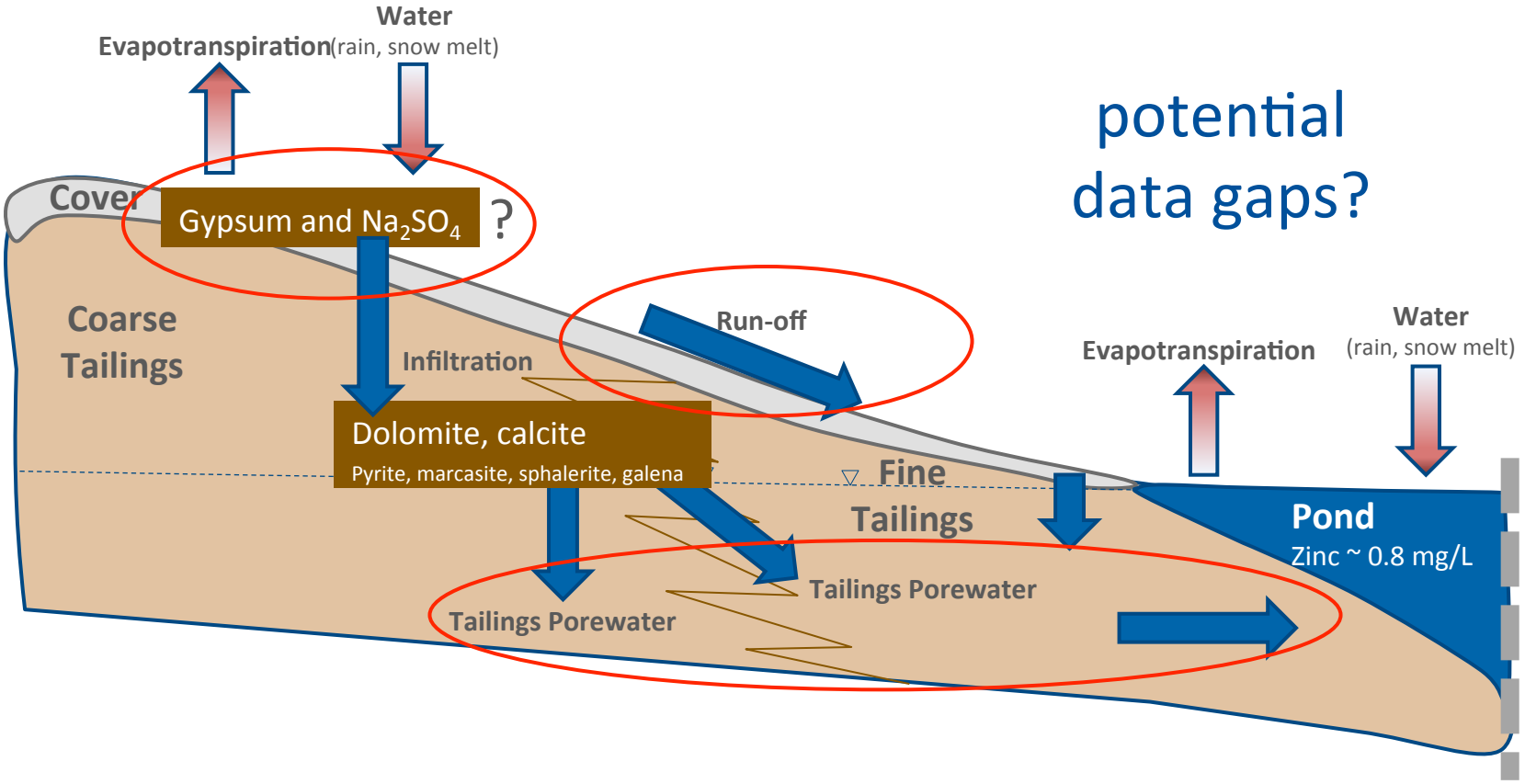
- column testing on low-, medium-, and high-fines tailings
  - Zn leachate ranged from 6.4-28 mg/L
  - cumulative zinc removal: 62-64 µg/g of tailings
  - Assumed 18% infiltration, resulting in 4.5 to 7.5 tonnes of zinc/yr



Cominco, 1992

conceptual site model + preliminary water balance

- net evaporative
- pond inflow dominated by runoff
- porewater contributes lower volumes of (likely) higher conc water



what's next: filling in the gaps

filling in the (time/data) gaps

- build upon historical dataset
  - evaluate cover material
  - update kinetic testing data: shake flask extraction and trickle leach columns
  - revisit mineral relationships (QEMscan)
- refine water balance and couple with geochemical data to better define metal load to pond
- determine and evaluate effect of closure strategy

acknowledgements

- Teck
- Golder
- Bureau Veritas Laboratories

thank you!

references

- Cominco, 1992. *Pine Point Tailings – Metal Leaching Potential and Discharge Water Quality*. Research Report No. 92PR05.
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