Highland Uranium Mill Site

License Amendment Application
Rockville, MD
March 22, 2011

ExxonMobil

Environmental Services

Introduction: Proposed Action

- ExxonMobil has Prepared a License Amendment Application Proposing:

  – Revision of Existing Alternate Concentration Limits (ACL) for the Highland Site for final site closure and license termination

    - New Proposed Points of Compliance (POC)
    - New Proposed Points of Exposure (POE)

  – Re-Definition of the Proposed Long-Term Surveillance and Monitoring (LTSM) Boundary

    - Inclusion of Highland Pit Lake in LTSM Boundary

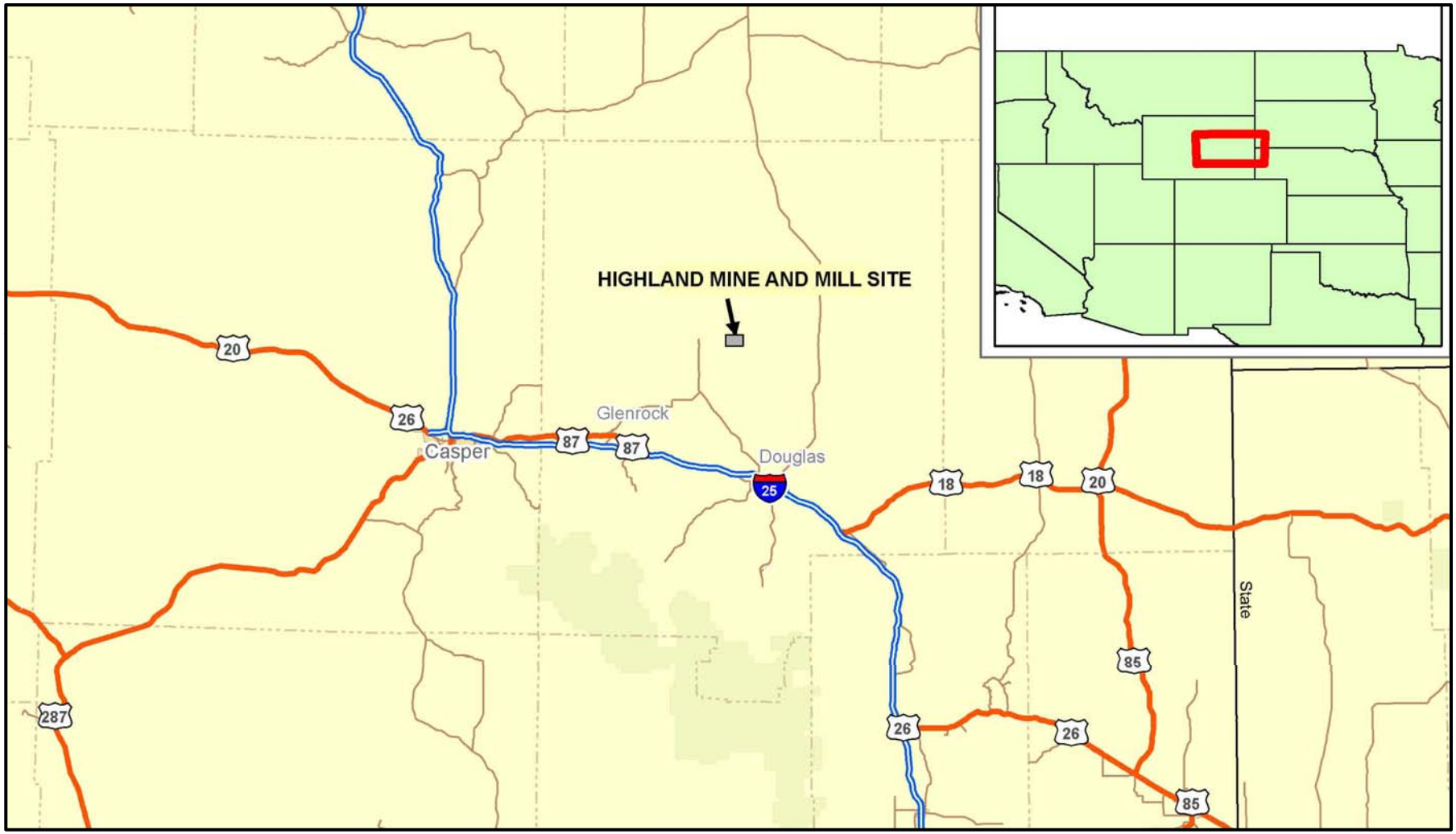
Introduction: Proposed Action

- ExxonMobil's License Amendment Application Includes:
  - – License Application Memorandum:
    - Statutory and Regulatory Background
    - Regulatory Pathway to NRC Approval
  - – Detailed Technical and Environmental Reports:
    - Groundwater Quality Analysis for Southeast (SE) Drainage ACL Justification
    - Analyses of 11e.(2) Constituents in Pit Lake and SE Drainage
    - COC Transport Assessment
    - Corrective Action Assessment
    - LTSM Approach
    - Ecological Risk Assessment
    - Proposed Engineered Barriers to Prevent Access to Pit Lake (e.g., Fences, Rock Barriers) During LTSM

Today's Presentation

- Site History
- Statutory and Regulatory Background
- Technical Presentation
  - Site Specific Data and Analyses
  - 11e.(2) seepage from tailings
    - Pit Lake
    - SE Drainage
  - Supporting Hydrologic Data
  - Site Chloride and Sulfate Mass Balance
  - Site Transport of Uranium
    - Uranium Speciation
    - Uranium Isotope Activity Ratio

Project Location: Converse County, Wyoming



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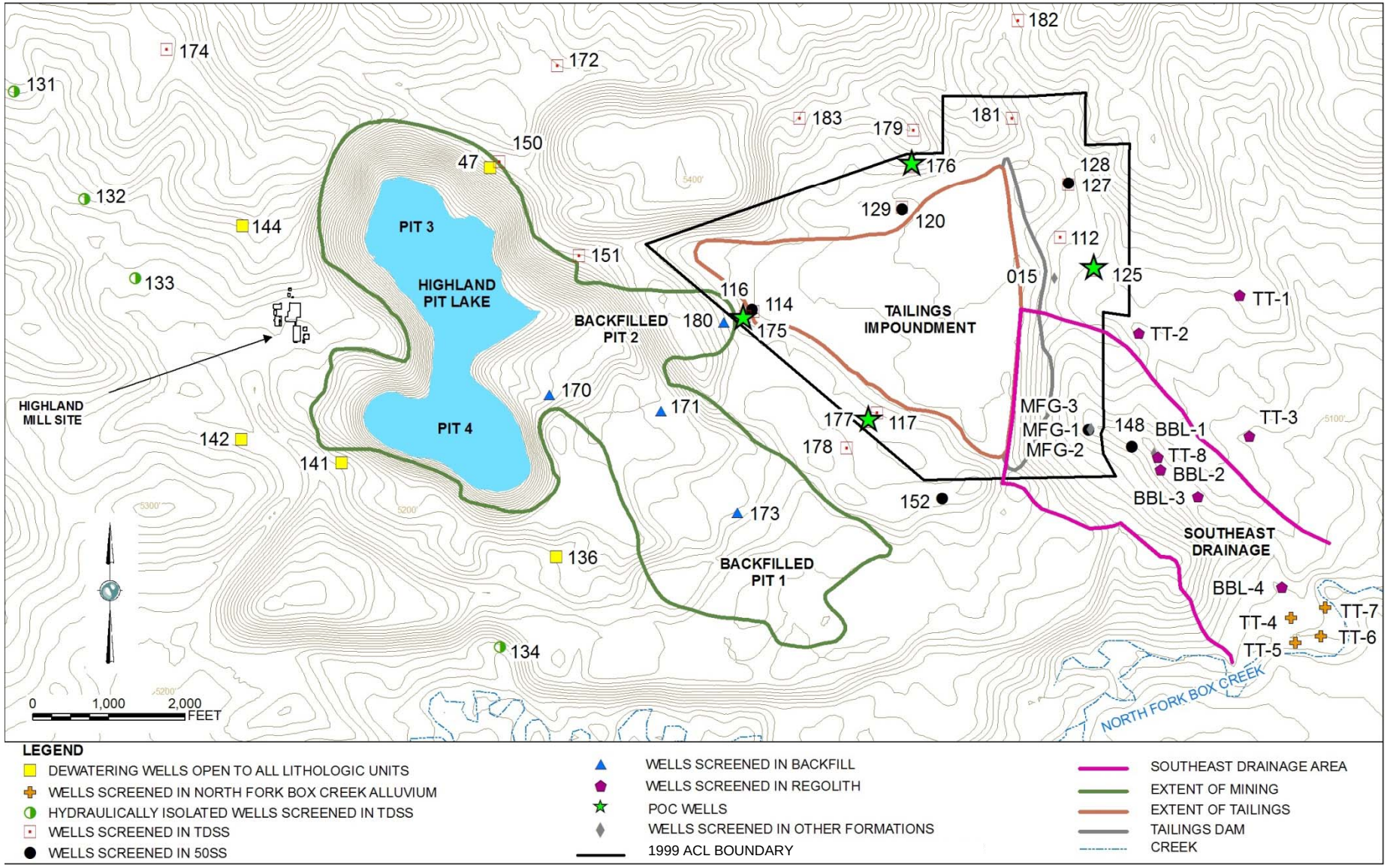
Site Features and Topography



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Site History

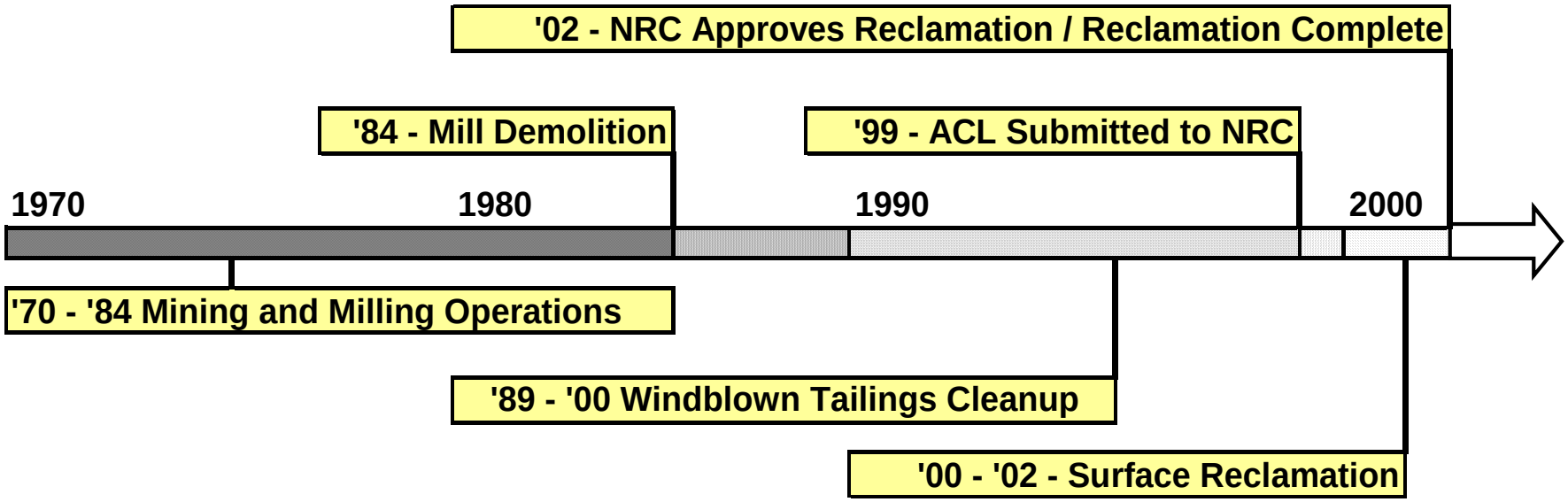
- Mining
  - Mining (mostly surface) 1970 through 1984
  - 2190 acres disturbed by mining
- Milling from 1972 through 1984
  - 11.3 million tons of ore
  - 200 acre Tailings Impoundment

Site History (cont'd)

- Reclamation
  - Two phases completed in 1989 and 2000
    - 200 acres of Tailings Impoundment covered
    - 3.5' compacted clay + 6" of top soil
    - Revegetated
    - Approved by NRC in 2002

Site Reclamation

- Mill demolition
- Windblown tailings cleanup
- Surface reclamation
- NRC Approved ACLs (1999)



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Statutory and Regulatory Background

- Section 83 of the Atomic Energy Act of 1954 (AEA), as Amended by the Uranium Mill Tailings and Radiation Control Act (UMTRCA), requires transfer of all:
  - AEA Section 11e.(2) Byproduct Material to DOE or the resident State for LTSM
  - Property necessary for disposal and long-term containment of 11e.(2) Byproduct Material
- Acceptable transfer procedures include:
  - Title to the 11e.(2) containing property transferred to DOE
  - Durable institutional controls on relevant property (e.g. covenants)

Agency & Licensee Responsibilities

- Under UMTRCA, Congress Mandates a *Unique* Regulatory Regime for 11e.(2) Byproduct Material:
  - Environmental Protection Agency (EPA):
    - Creates Standards for Control of Radiological and Non-Radiological Hazards including:
      - Groundwater protection standards
  - Nuclear Regulatory Commission (NRC):
    - Creates Regulatory Program for 11e.(2) Byproduct Material that conforms to the requirements of EPA standards
    - Establishes Criteria for Transfer of 11e.(2) Byproduct Material to Long-Term Custodian (10 CFR Part 40, Appendix A)
    - Evaluate and approve alternatives to requirements of Part 40, Appendix A proposed by the licensee
    - All radiological and non-radiological components of 11e.(2) Byproduct material are under the commission's exclusive, preemptive AEA jurisdiction

Agency & Licensee Responsibilities (cont'd)

- Department of Energy (DOE):
  - Serve as Primary Long-Term Custodian for 11e.(2) Byproduct Material
  - Act as General Licensee of NRC in Perpetuity for Long-Term Control of 11e.(2) Byproduct Material Sites (Both Title I and II Sites)

- 11e.(2) Byproduct Material Licensees (Title II Uranium Mills):
  - Complete Reclamation of Site in Accordance with Appendix A Criteria
  - Licensees Can Propose Alternatives to Any Requirement in 10 CFR Part 40, Appendix A (Uranium Recovery)
  - Obtain License Termination from the NRC
  - Transfer Title to 11e.(2) Byproduct Material and Associated Lands to DOE (or the Resident State) *at No Cost to the Government*

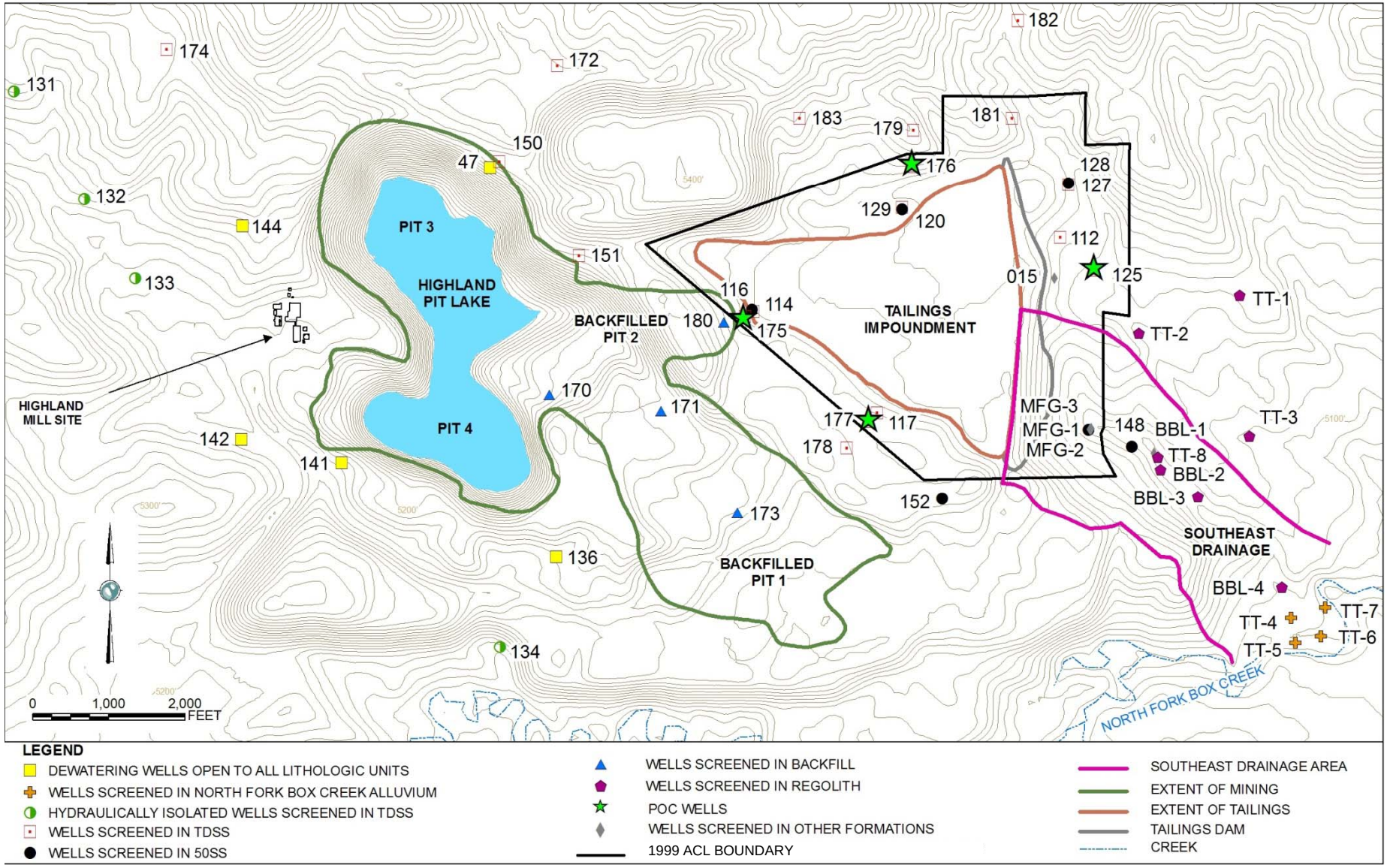
Technical Overview

- 11e.(2) Byproduct Seepage into SE Drainage and Pit Lake
  - Supporting Hydrologic Data
  - Site Chloride and Sulfate Mass Balance
  - Site Transport of Uranium
    - Speciation
    - Isotope Activity Ratio

Reassessment of Groundwater Contamination

- Southeast Drainage
  - Well 148 Dry
  - Additional wells installed in 2004
  - Water quality in new wells indicates seepage of 11e.(2) Byproduct material from Tailings Impoundment
- Pit Lake
  - Regulatory Change (Concurrent Jurisdiction)
  - Updated hydrogeologic model of Pit Lake (fill curve)
  - Prompted revision of geochemical evolution of Pit Lake
  - Sulfate, Chloride, Selenium, Uranium

Site Features and Topography



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Supporting Data for 11e.(2) Byproduct Seepage

- Hydrology: Seepage studies - water seeping from tailings
- Site Chloride and Sulfate (Cl & SO_4) Mass Balance
- Site Transport of Uranium
  - Speciation & mobility
  - Isotope Activity Ratio (AR)

Supporting Data for 11e.(2) Byproduct Seepage

- **Hydrology: Seepage studies - water seeping from tailings**
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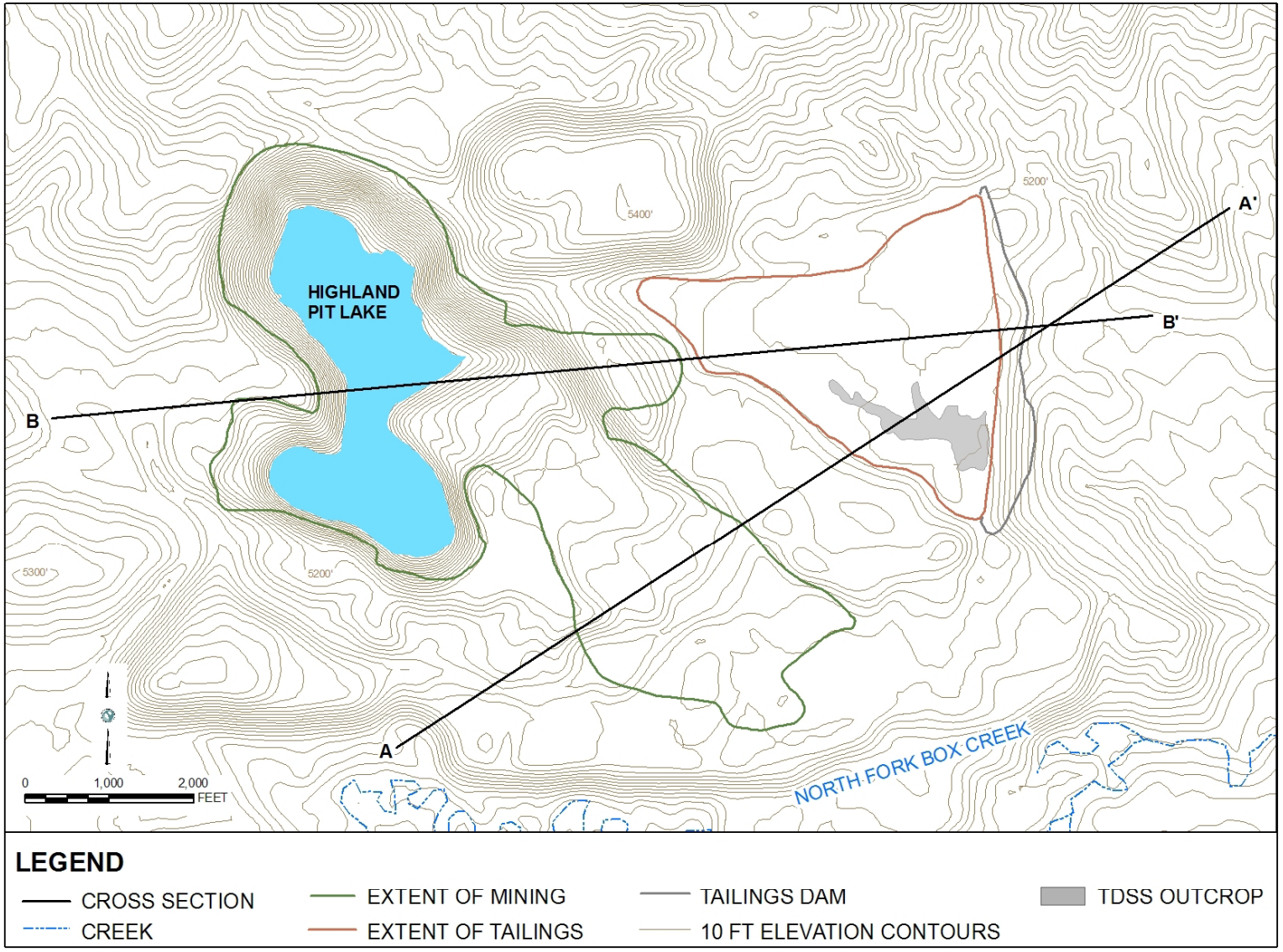
Groundwater Overview

- 25 years of available data
- Primary geologic units include Tailings Dam Sandstone (TDSS), Ore Body Sandstones (OBSS), and shallow flow in the Southeast Drainage (SE Drainage)
- TDSS and deeper OBSS separated by Tailings Dam Shale (TDSH)
- OBSS is comprised of individual sandstone layers separated by intervening shales

Geological Cross Sections



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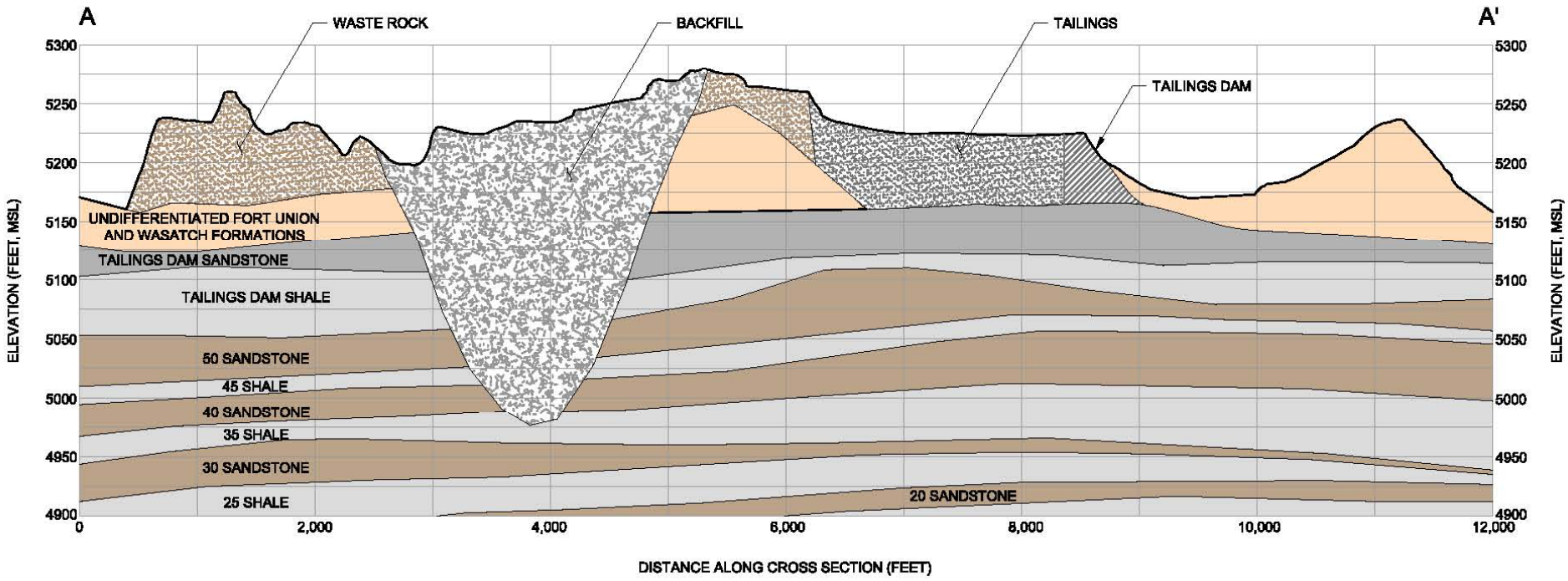
Geo-Hydrologic Cross Section (Current)



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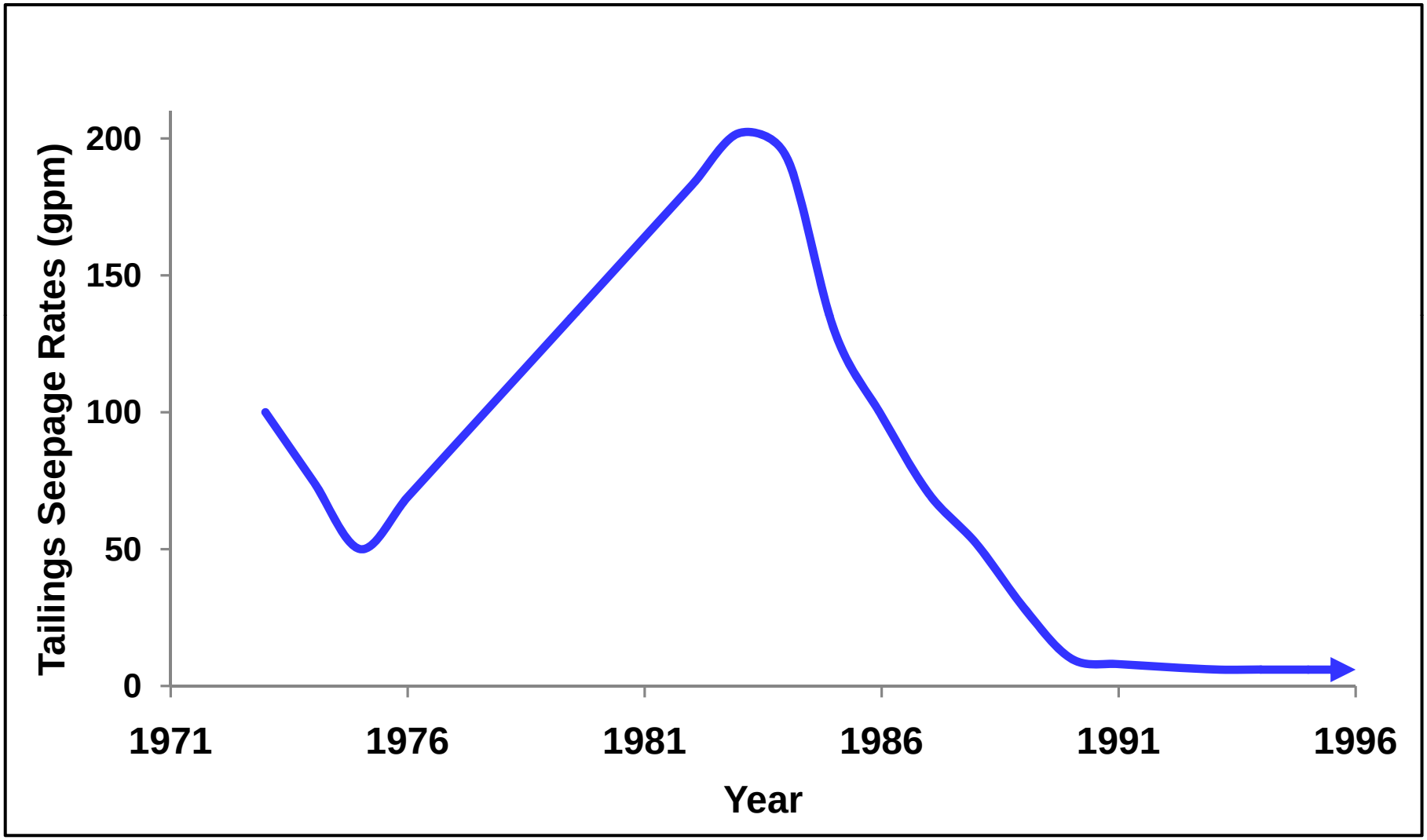
Groundwater Overview

- Groundwater conditions have changed significantly over time
  - Pre-mining groundwater conditions (before 1970) – descriptions from early documents, limited data
  - Active mining (1970 – 1984) – significant changes to local groundwater flow and chemical migration from dewatering and tailing seepage as described in mine-era assessments
  - Post-closure (1984 – current) – changes to groundwater conditions due to closure activities as characterized by data from numerous monitoring wells

Groundwater Overview

- Significant migration of tailings seepage to open and backfilled pits occurred during active mining
  - 1978 – *Identification of Future Water Problem (Dames & Moore)* – Seepage from tailings area to open pits estimated at ~ 100 gpm
  - 1982 – *Highland Uranium Tailings Impoundment Seepage Study (EPRCO)* – Defined primary transport pathways between tailings impoundment and pits
  - 1988 – *Highland Reclamation License Amendment Response (Exxon, WWL)* – "likely that most of the seepage from the tailings basin [impoundment] flowed toward the pit during active operations." Seepage to pits estimated at ~ 44 to 100 gpm

Estimated Tailings Seepage Rates



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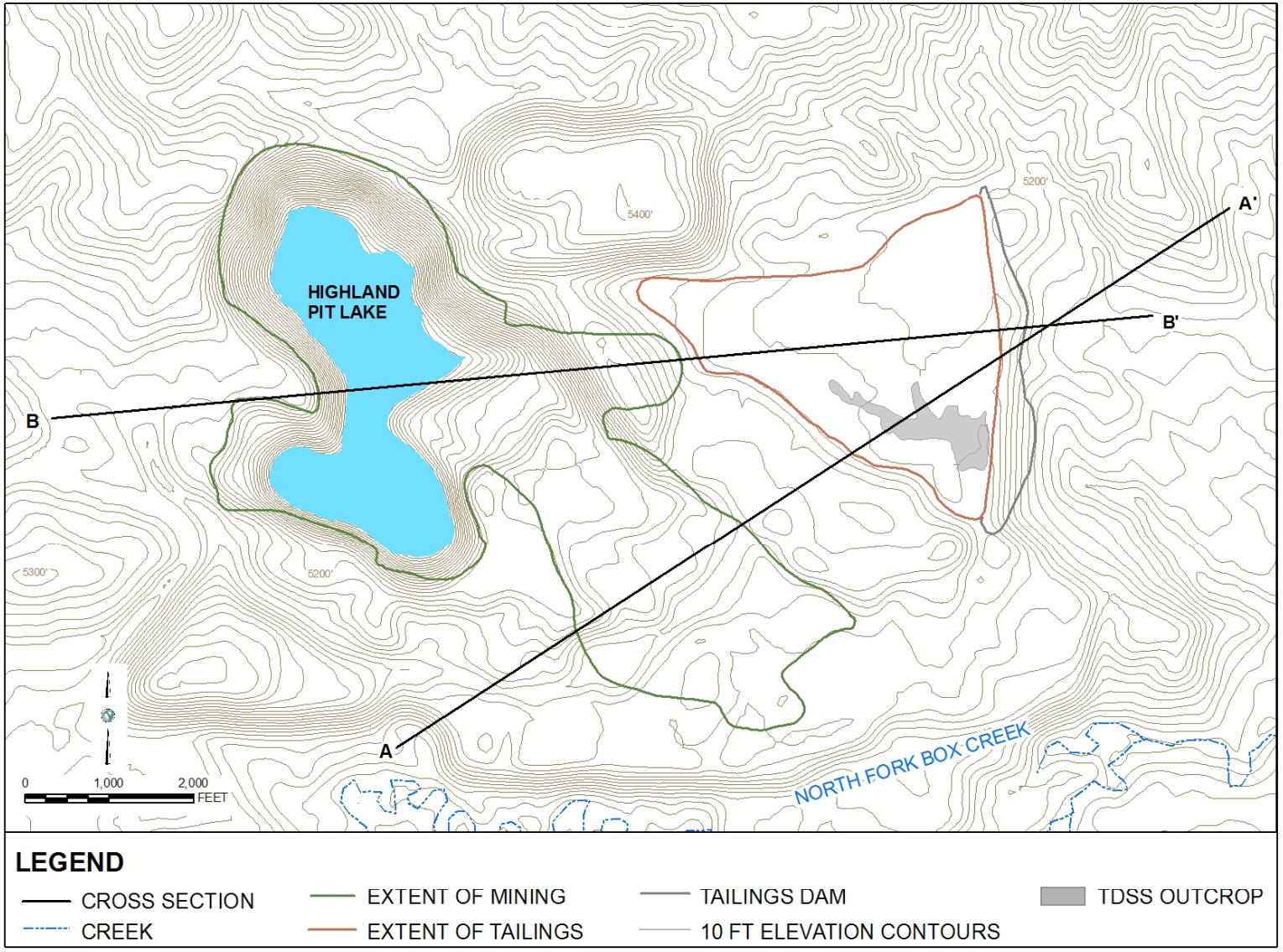
Cross Sections for Primary Transport Pathways



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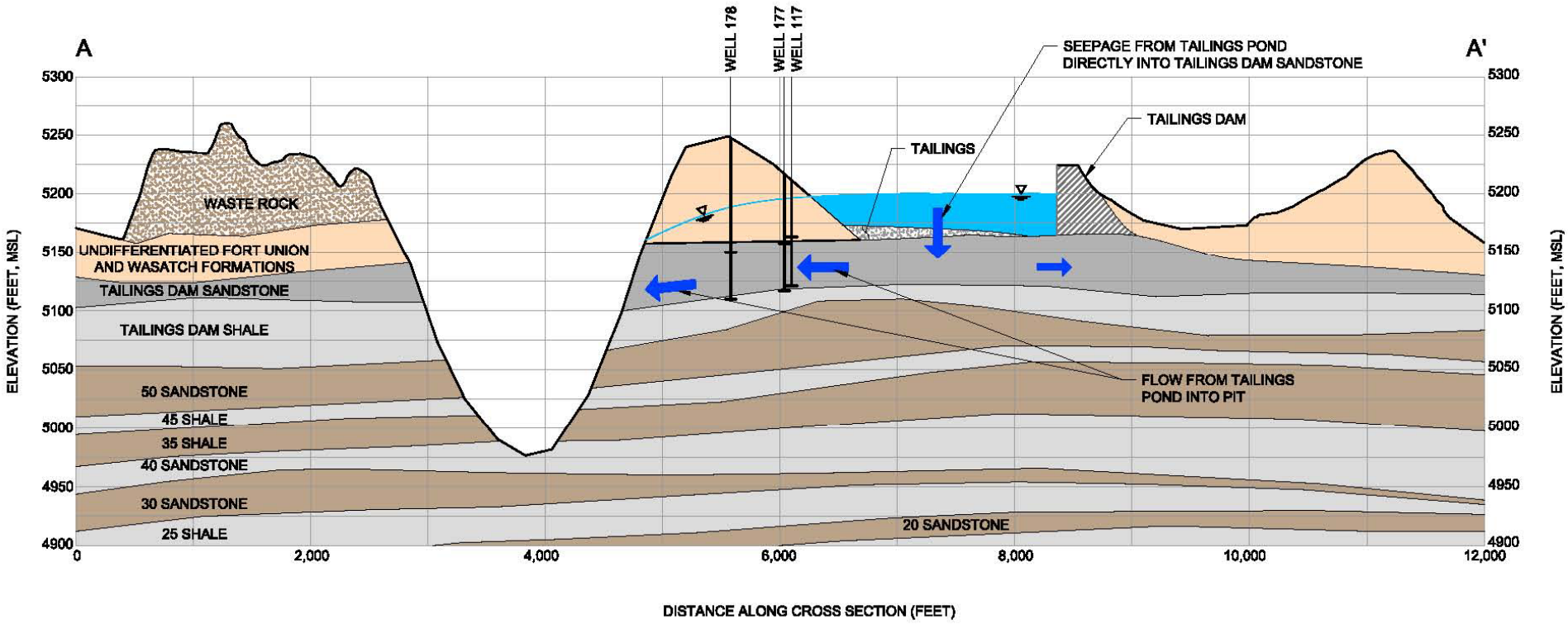
Flow and Transport During Active Mining



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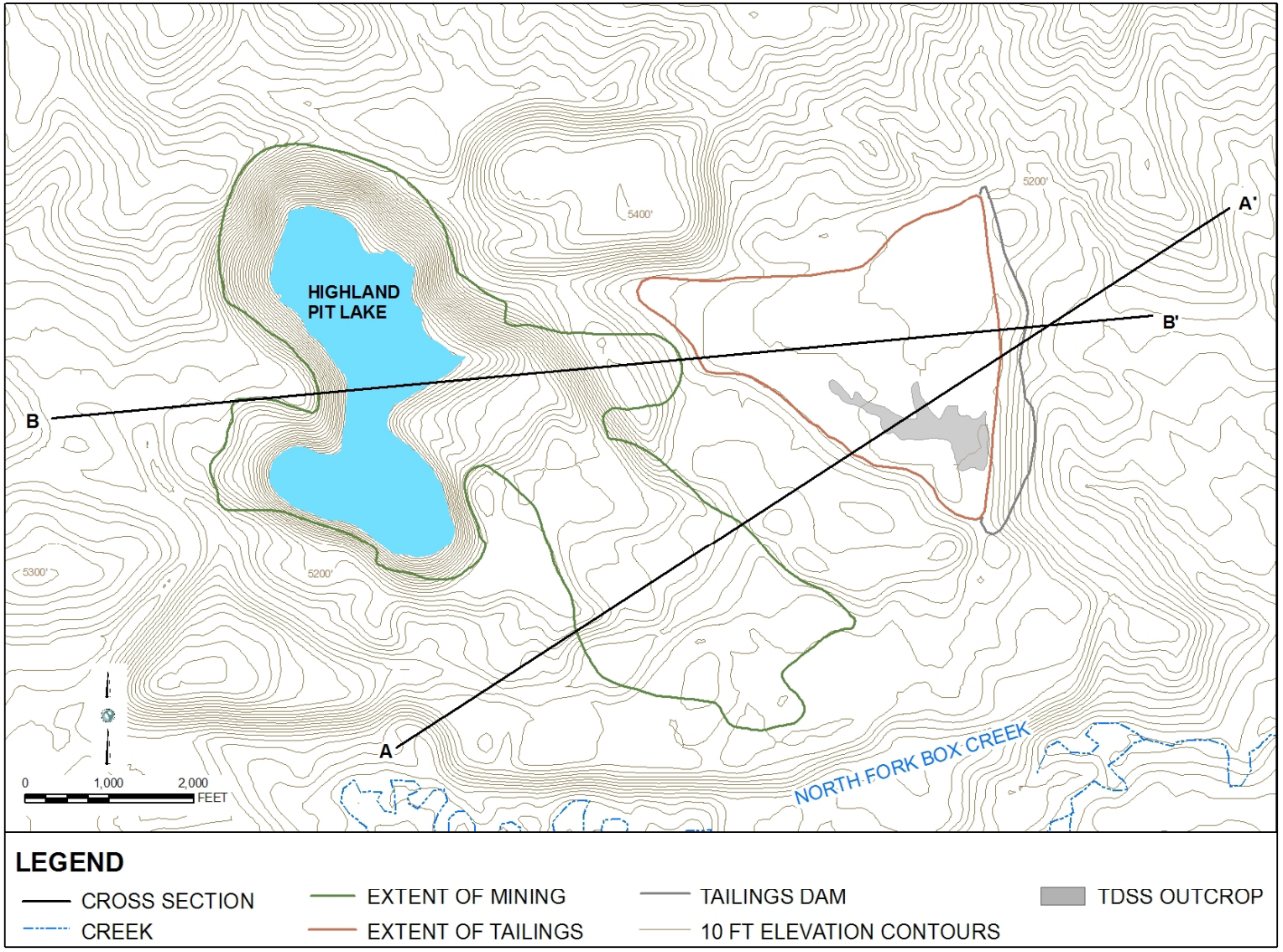

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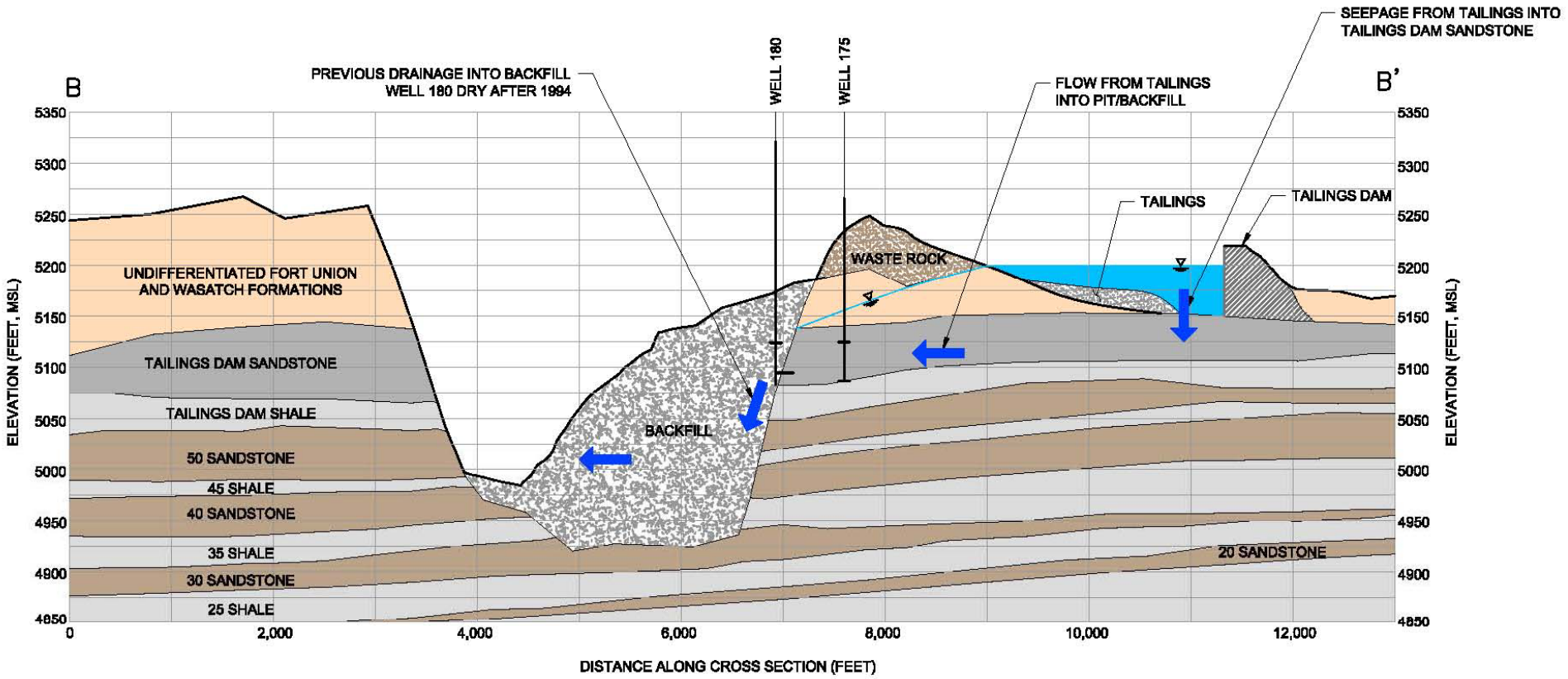
View of B to B’ During Active Mining

Flow and Transport During Active Mining



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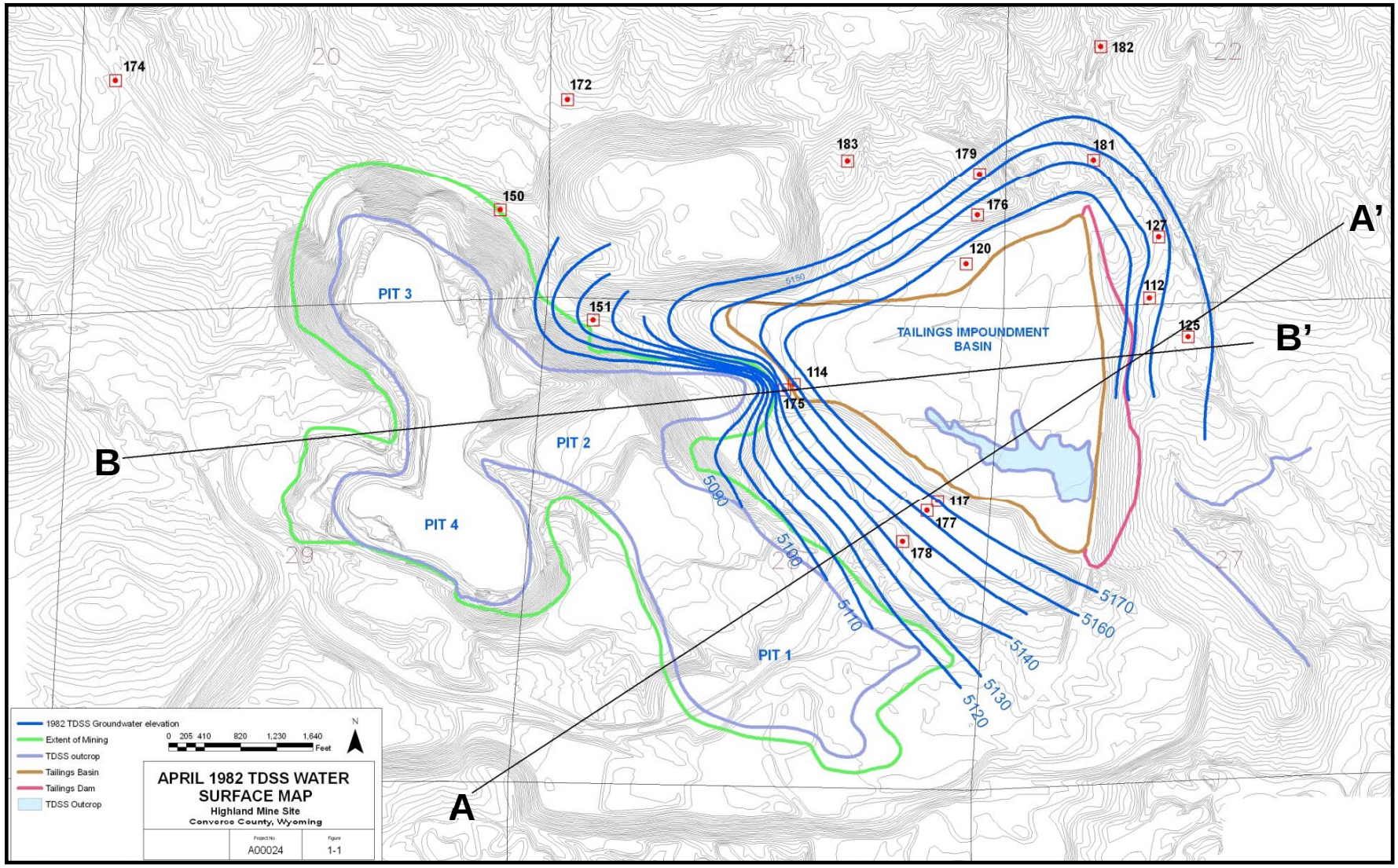
TDSS Potentiometric Map - 1982



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11e.(2) Seepage to Pit Lake

- TDSS received direct recharge from tailing pond
  - Preferential flow and transport occurred along (perpendicular to) dip filling previously unsaturated material
- Seepage between 1972 and 1984 estimated to average approximately 120 gpm (Dames and Moore, EPRCO, WWL)
- Up to 660 million gallons containing 11e.(2) flowed into backfill and pits during milling

11e.(2) Seepage to Pit Lake (cont'd)

- Groundwater travel-time estimates along quickest flow paths range from 1 to 2 years

- Total seepage to pit could be up to 1 billion gallons over the last 30 years

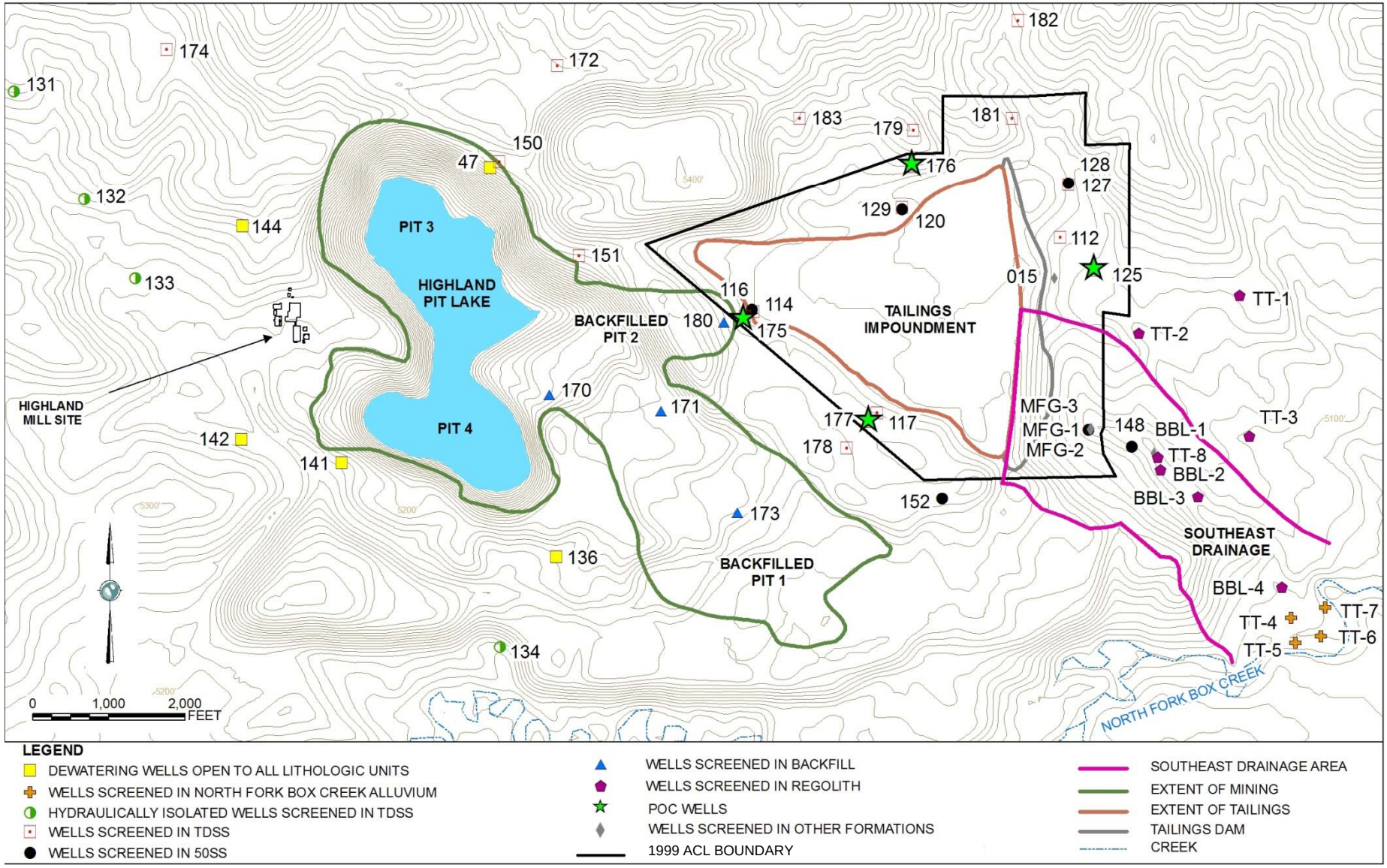
  – 660 million gallons during milling

  – Up to 400 million gallons afterward

11e.(2) Seepage to the SE Drainage

- Groundwater flow limited to shallow weathered zone underneath and adjacent to the channel
- During milling, active seepage from the Tailings Impoundment flowed within the drainage
- *De minimis* (0.13 gpm) seepage is now occurring and expected to continue
- Proposed LTSM Boundary will ensure adequate protection of public health, safety, and the environment

Site Features and Topography



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Long-Term Hydrologic Conditions

- Pit Lake will remain a hydrologic sink

- Seepage in Southeastern Drainage at steady state

Supporting Data for 11e.(2) Byproduct Seepage

- Hydrology: Seepage studies - water seeping from tailings
- **Site Chloride and Sulfate (Cl & SO_4) Mass Balance**
- Site Transport of Uranium
  - Speciation & mobility
  - Isotope Activity Ratio (AR)

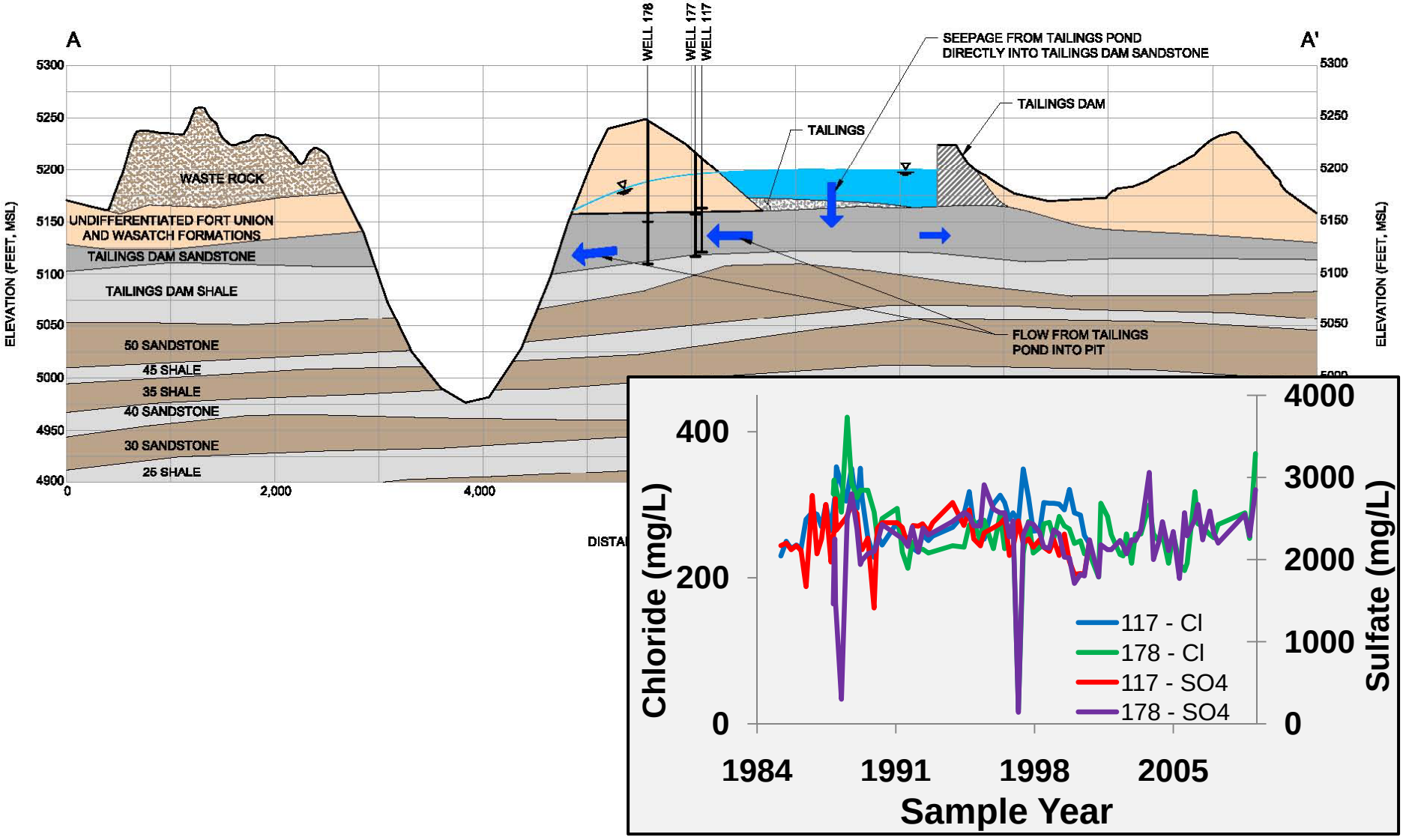
Chloride and Sulfate Mass Balance

Constituent	Average Ground Water Concentration[1] (mg/L)	Average Pit Lake Concentration[1] (mg/L)	Concentration in Tailings Solution[2] (mg/L)	Model Predicted Pit Lake Concentration[1] (mg/L)
Chloride	9.8	24	218	23
Sulfate	186	335	7,600	333

[1]1987 values

[2]From EPRCO 1982

Chloride and Sulfate Transport to Pits



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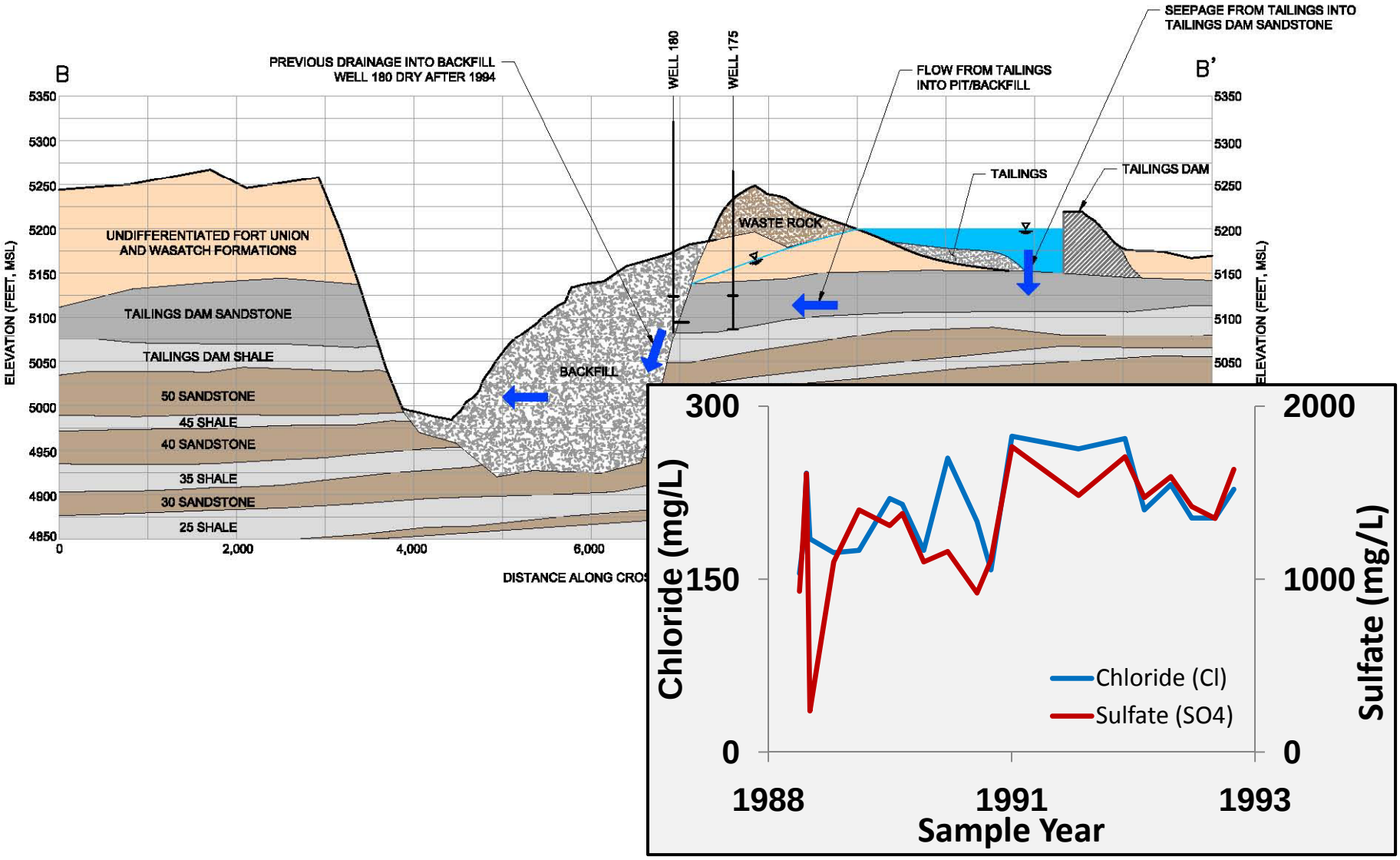

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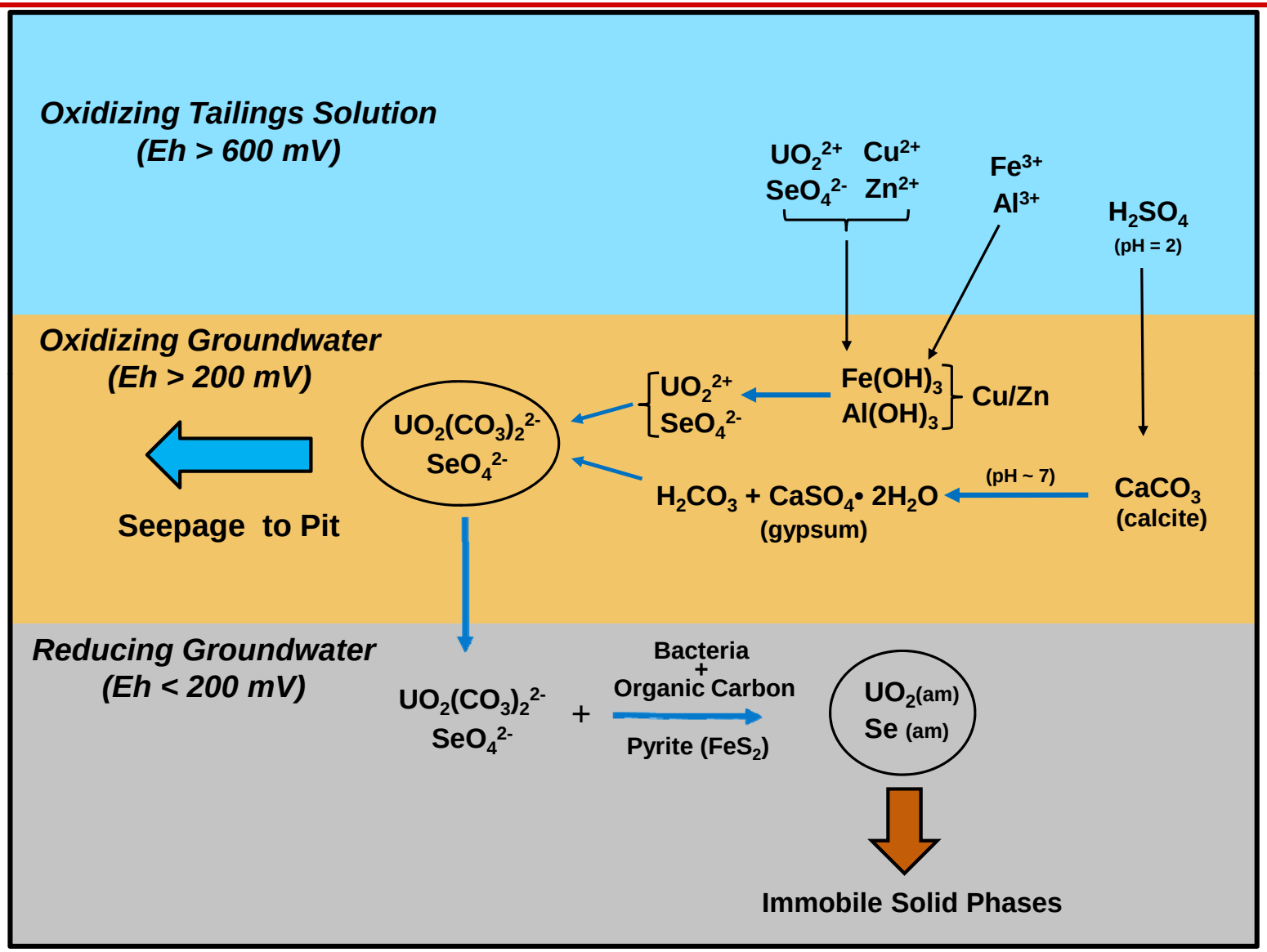
Conceptual Geochemical Model



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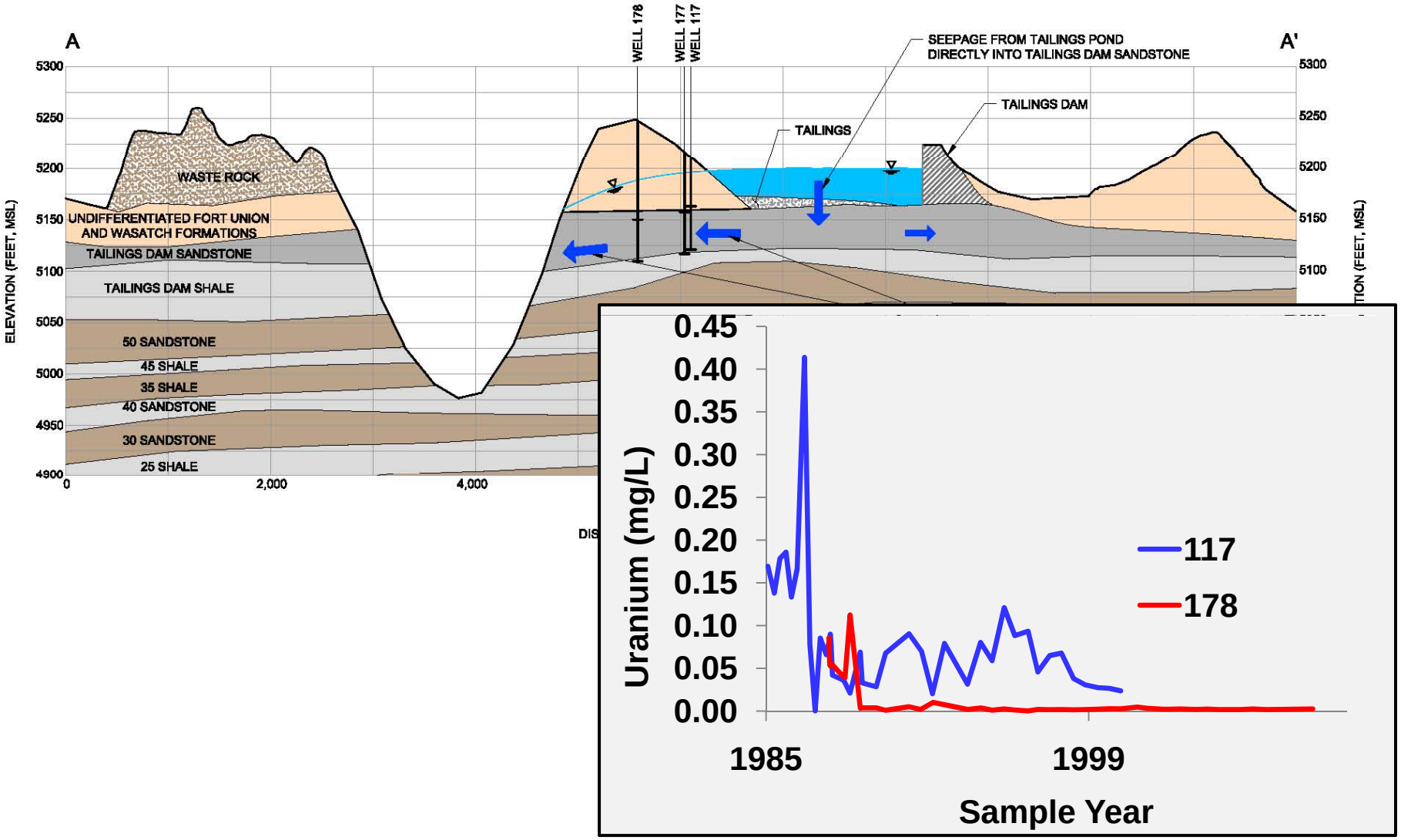
Highland Uranium Speciation

Location ID	pH	U (µg/L)	Percent Distribution of Species (PHREEQC Model)			
			$UO_2(CO_3)_3^{-4}$	$UO_2(CO_3)_2^{-2}$	$UO_2CO_3^0$	Total
112	7.1	20	53	47	< 1	100
114	6.0	0.70	6	74	20	100
120	6.7	0.60	57	43	<1	100
178	6.8	2.3	49	50	<1	99.0
Pit Lake	8.3	3,100	92.3	7.6	<1	99.9

Geochemistry at Highland Mill Site

- Speciation calculated with United States Geologic Survey (USGS) geochemical model (PHREEQC)
- Uranium-Carbonate complexes predominate
- Oxidizing conditions existed along primary flow paths
- Therefore – Uranium mobile
- Geochemical analysis predicts seepage from the Tailings Impoundment has contributed the following to the Pit Lake:
  - 53% of the chloride
  - 30% of the sulfate
  - 24% of the uranium
  - 11% of the selenium

Uranium Transport to Pits



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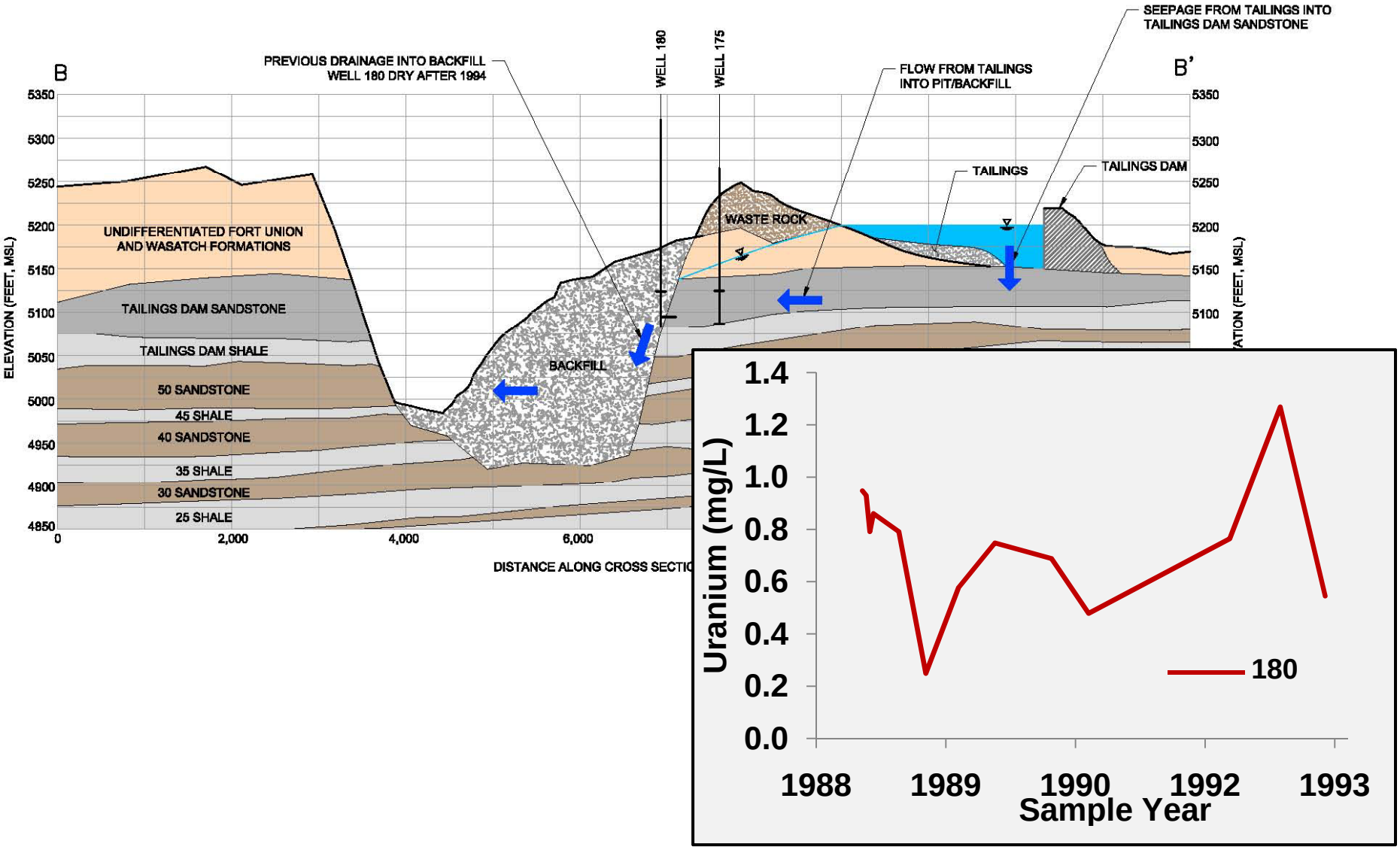

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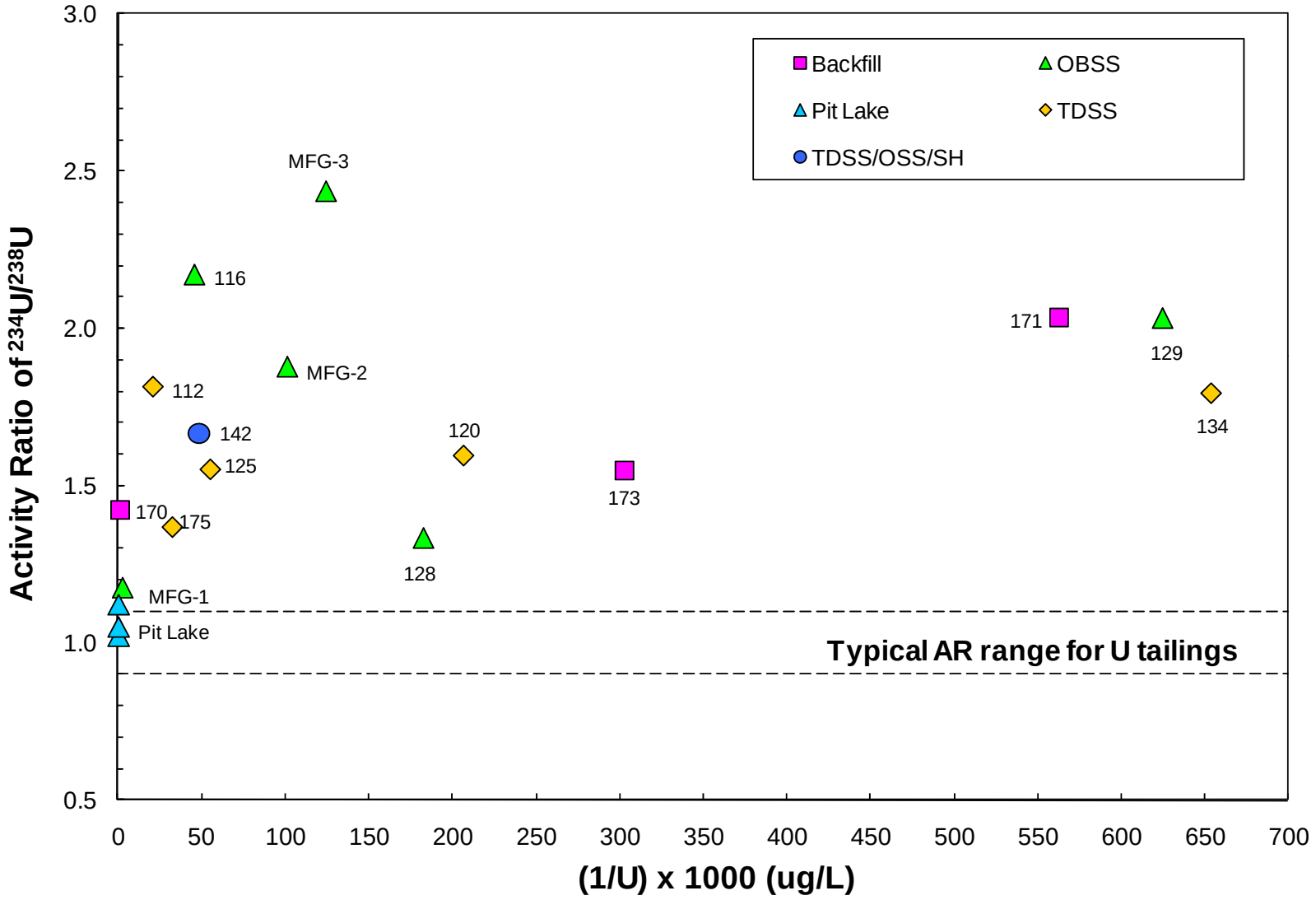
- **Site Transport of Uranium**
  - Speciation & mobility
  - **Isotope Activity Ratio (AR)**

Uranium Isotope Geochemistry

- The $^{234}U/^{238}U$ alpha activity ratios can help to differentiate sources
- Tailings solutions expected to have an AR of approximately 1
- Groundwater expected to have AR values greater than 1
- Highland site background groundwater AR values range from 1.36 to 5.73

Highland Site Isotopic Signature



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Findings are consistent with transport of 11e.(2) Byproduct materials present at uranium mill sites and DOE facilities

Amendment to Existing ACLs

- Contains:
  - Facility description
  - Extent of Groundwater Contamination
  - Hazard Assessment (source and contamination characterization, transport assessment, exposure assessment)
  - Corrective Action Assessment (feasibility, costs, benefits, ALARA)
    - SE Drainage Alternatives
    - Pit Lake Alternatives
  - Long-Term Custodial Care and Monitoring
  - Supporting Data and Ecological Risk Assessment

- Report and Technical Data Third-Party Peer Reviewed by an Expert Panel

Conclusion: Today's Presentation

- Statutory and Regulatory Background
- UMTRCA & 11e.(2) Byproduct Material – Agency and Licensee Responsibilities
- Concurrent Jurisdiction
- Technical Presentation
  - Site Specific Data and Analyses
  - 11e.(2) seepage from tailings
  - Supporting Hydrologic Data
  - Site Chloride and Sulfate Mass Balance
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