Highland Uranium Mill Site

Final Site Closure Proposal
Casper, Wyoming
August 3, 2010

ExxonMobil

Environmental Services

Introduction: Proposed Action

- ExxonMobil Environmental Services is in The Process of Preparing a License Amendment Application Proposing:
  - Re-Definition of the Proposed Long-Term Surveillance and Monitoring (LTSM) Boundary
  - 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)
  - *Inclusion of 11e.(2) Byproduct Material from Reclaimed Tailings Impoundments within Highland Pit Lake in LTSM Boundary*

Introduction: Proposed Action

- ExxonMobil's License Amendment Application Will Include:
  - Detailed Technical and Environmental Reports:
    - Data on Groundwater Quality/Contamination and Constituent-Specific Analysis for ACL Justification
    - Studies and Analyses on Pit Lake and 11e.(2) Constituents Therein
    - Transport Assessments
    - Corrective Action Assessments
    - LTSM Approach
    - Ecological Risk Assessment
    - Proposed Barriers to Human and Wildlife Access to Pit Lake (e.g., Fences, Rock Barriers)
  - License Application Memorandum:
    - Statutory and Regulatory Background
    - Regulatory Pathway to Approval

Introduction: Today's Presentation

- Statutory and Regulatory Background
- UMTRCA & 11e.(2) Byproduct Material – Agency and Licensee Responsibilities
- Concurrent Jurisdiction
- Technical Presentation
  - Site Specific Information
  - 11e.(2) seepage from tailings
  - Supporting Hydrologic Data
  - Site Chloride and Sulfate Mass Balance
  - Site Transport of Uranium
    - Uranium Speciation
    - Uranium Isotope Activity Ratio
- Site Visit

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 and the Property Used For Its Safe Disposal and Containment to DOE or the Resident State for LTSM.

- Title to the Property Must Be Transferred

Statutory and Regulatory Background

- Under UMTRCA, Congress Created the NRC as the Following:
  - An Independent Regulatory Agency:
    - Not Directly Subject to Aspects of Statutes Such as the National Environmental Policy Act (NEPA) That Impact Its Subject Jurisdiction
  - A "Reactive" Federal Regulatory Agency:
    - Licensee Has Primary Responsibility for AEA Materials: Licensee Proposes Potential Actions and NRC:
      - Approves in Full;
      - Approves With Conditions; or
      - Denies
  - NRC Does Not Have the Authority to Require Any Potential Option; But, Under 10 CFR Part 40, (Uranium Recovery) *Licensees Can Propose Alternatives to Any Requirement in Part 40, Appendix A*

UMTRCA & 11e.(2) Byproduct Material

Agency & Licensee Responsibilities

- Under UMTRCA, Congress Mandates a *Unique* Regulatory Regime for 11e.(2) Byproduct Material:
  - Environmental Protection Agency (EPA):
    - Create *Generally Applicable Standards* for Control of Radiological and *Non-Radiological* Hazards
    - *Non-Radiological* Hazards Subject to Equivalent Protection as That Provided by Resource Conservation and Recovery Act (RCRA)
    - Title I "Inactive Sites" and Title II "Active Sites" Regulatory Programs
  - Nuclear Regulatory Commission (NRC):
    - Create Regulatory Program for Control of 11e.(2) Byproduct Material and *Conform* Requirements to EPA *Generally Applicable Standards*
    - Establish Criteria for Transfer of 11e.(2) Byproduct Material to Long-Term Custodian (10 CFR Part 40, Appendix A)

UMTRCA & 11e.(2) Byproduct Material

Agency & Licensee Responsibilities

- 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
  - 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*

Concurrent Jurisdiction Over Non-Radiological Hazards of 11e.(2) Byproduct Material

- NRC Legal Staff Initially Concludes that NRC *and Non*-Agreement States Have Concurrent Jurisdiction Over the *Non*-Radiological Constituents in 11e.(2) Byproduct Material

- National Mining Association Challenges the Interpretation Arguing:
  - Federal Preemption Under the AEA/UMTRCA
  - Conflicts with Agreement State Program
  - Could Inhibit or Prevent Timely Final License Termination

Concurrent Jurisdiction Over Non-Radiological Hazards of 11e.(2) Byproduct Material

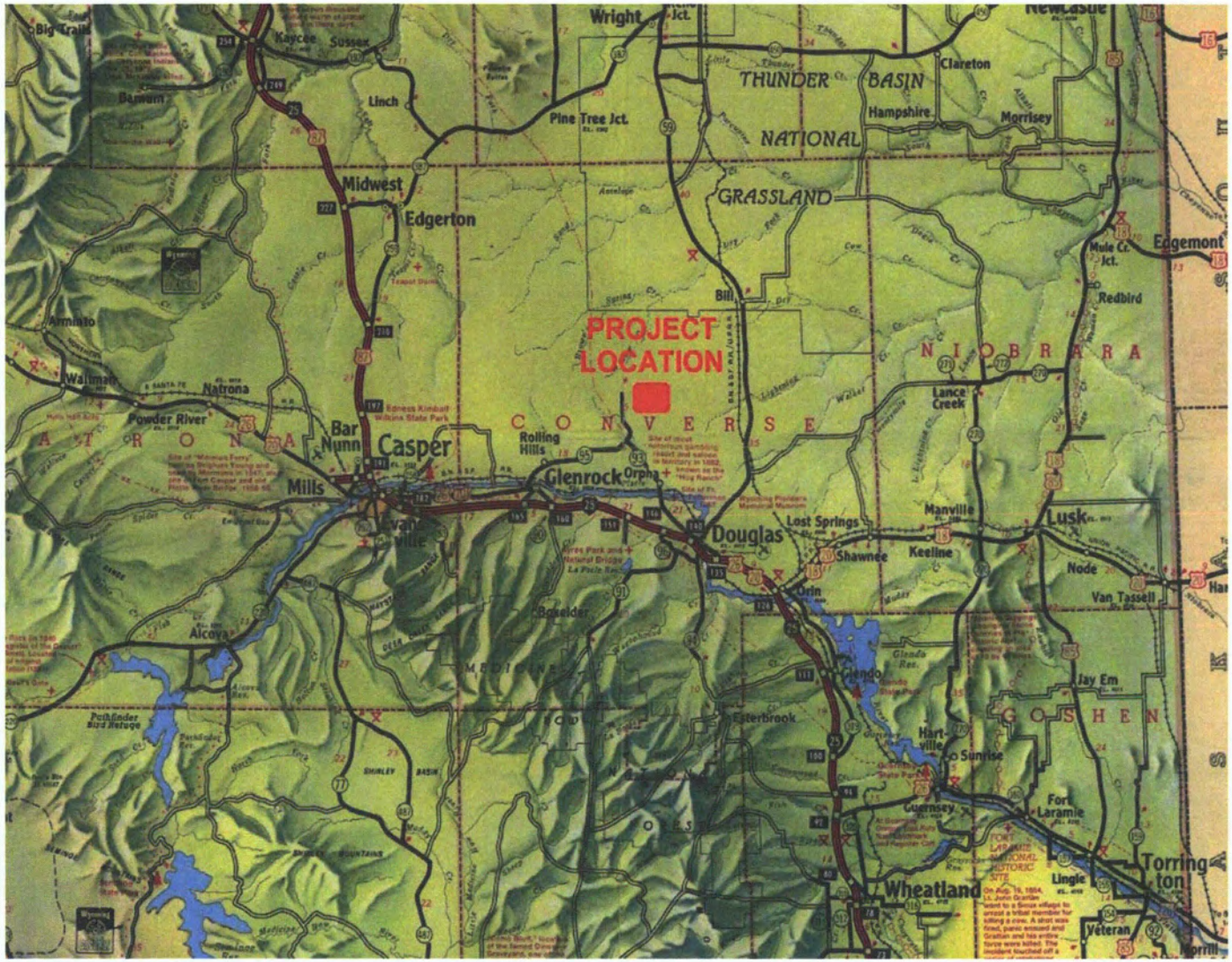
- Commission Concludes in CVR-SECY-99-027 (1999):
  - Radiological and *Non*-Radiological Constituents on "Same Footing" and "Inextricably Linked"
  - UMTRCA Calls for a "Comprehensive Remedial Program" for 11e.(2) Byproduct Material (Preemption)
  - *Non*-Agreement States are Preempted From Regulating *Non*-Radiological Constituents in 11e.(2) Byproduct Material
  - *FINAL CONCLUSION: ALL RADIOLOGICAL AND NON-RADIOLOGICAL COMPONENTS OF 11E.(2) BYPRODUCT MATERIAL ARE UNDER THE COMMISSION'S EXCLUSIVE, PREEMPTIVE AEA JURISDICTION*

Technical Overview

- Highland Mill Site - Location, Description, General Information

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

Project Location



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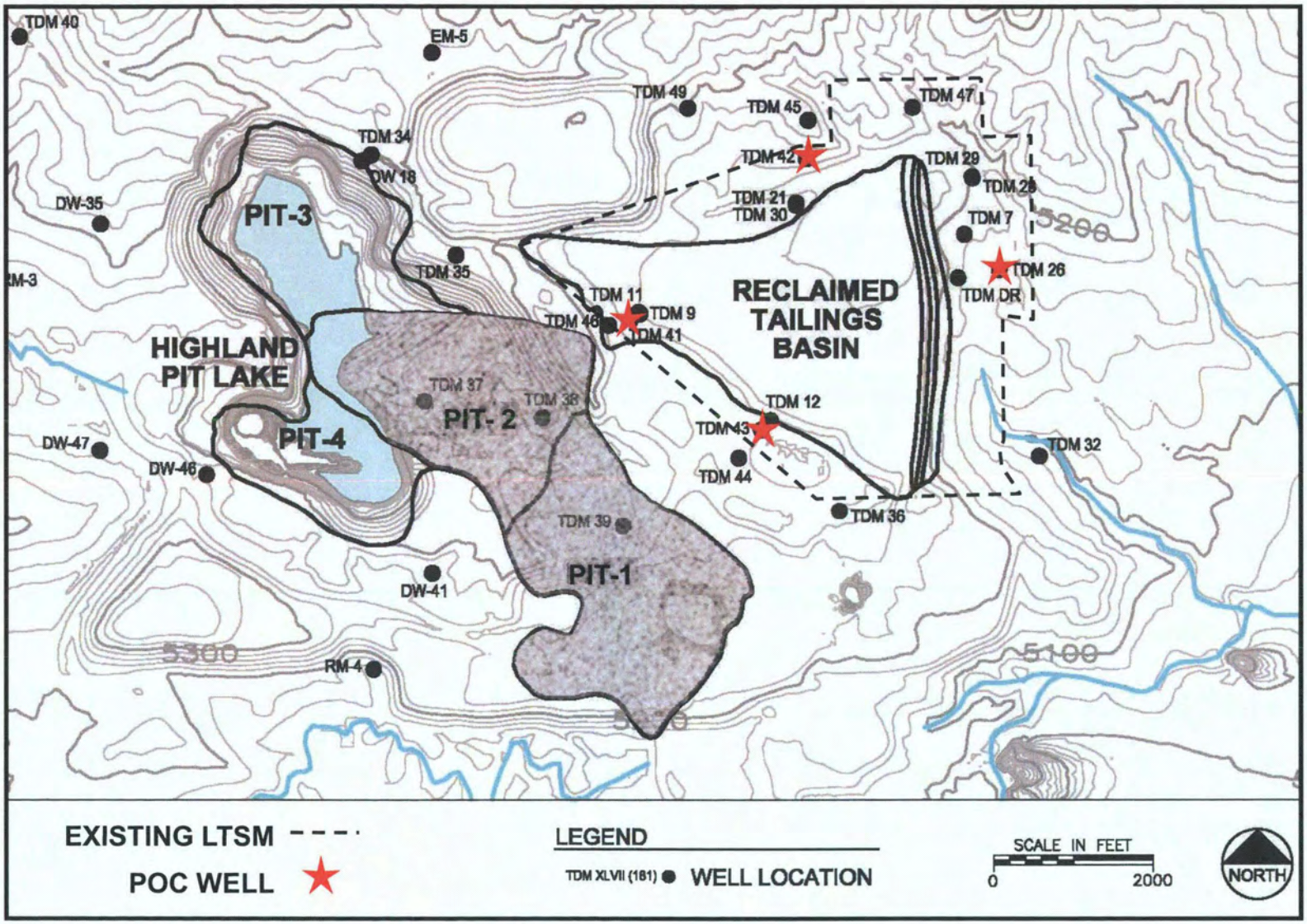
Site Features and Topography



ExxonMobil 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

ExxonMobil Site History (cont'd)

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

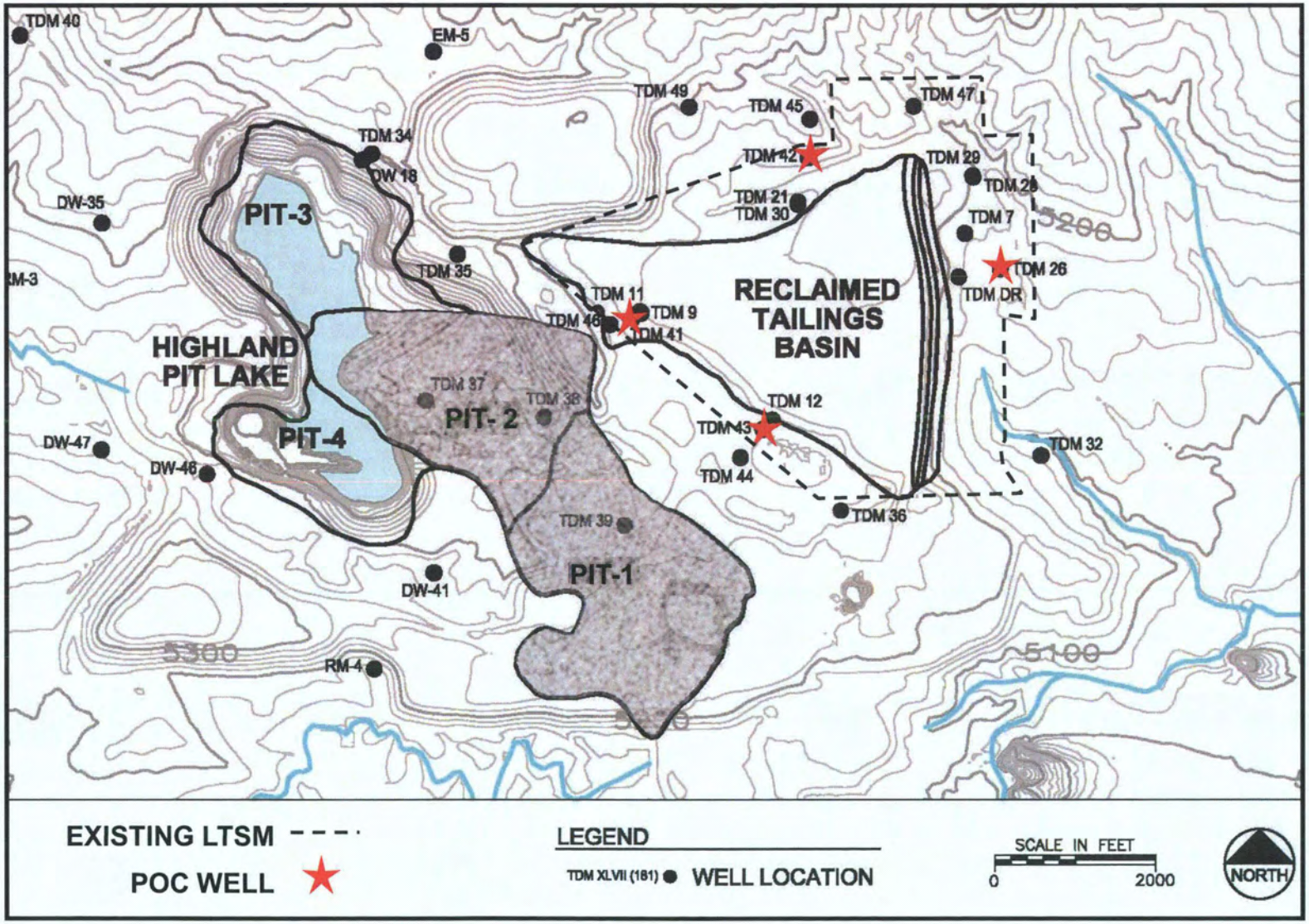
ExxonMobil Site Reclamation

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

Reassessment of Groundwater Contamination

- Southeast Drainage
  - Well 148 Dry
- Pit Lake
  - Sulfate, Chloride, Uranium
  - Regulatory Change (Concurrent Jurisdiction)

Site Features and Topography



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
  - U speciation & mobility
  - Uranium Isotope Activity Ratio (AR)

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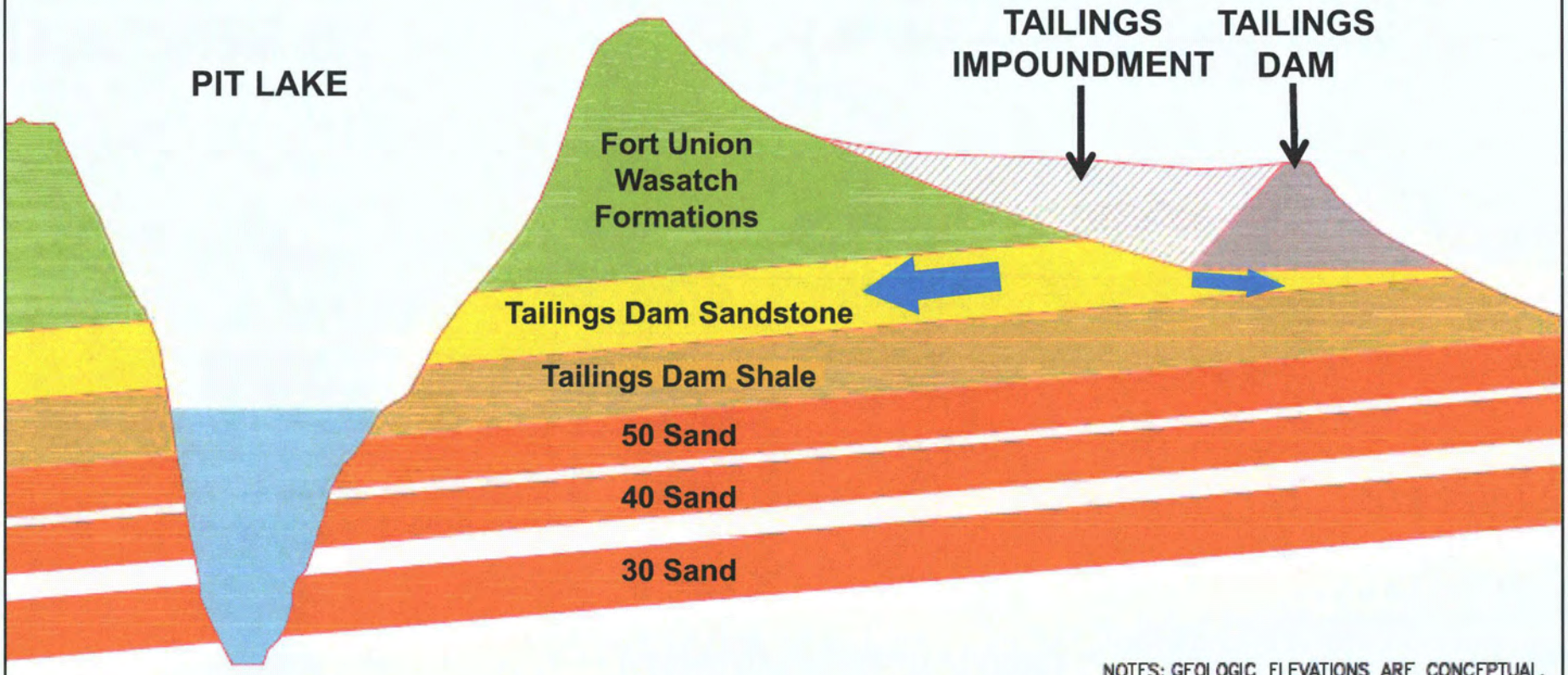
Groundwater Overview

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

Generalized Hydrologic Cross Section



NOTES: GEOLOGIC ELEVATIONS ARE CONCEPTUAL.
STRATA THICKNESS ARE APPROXIMATE.

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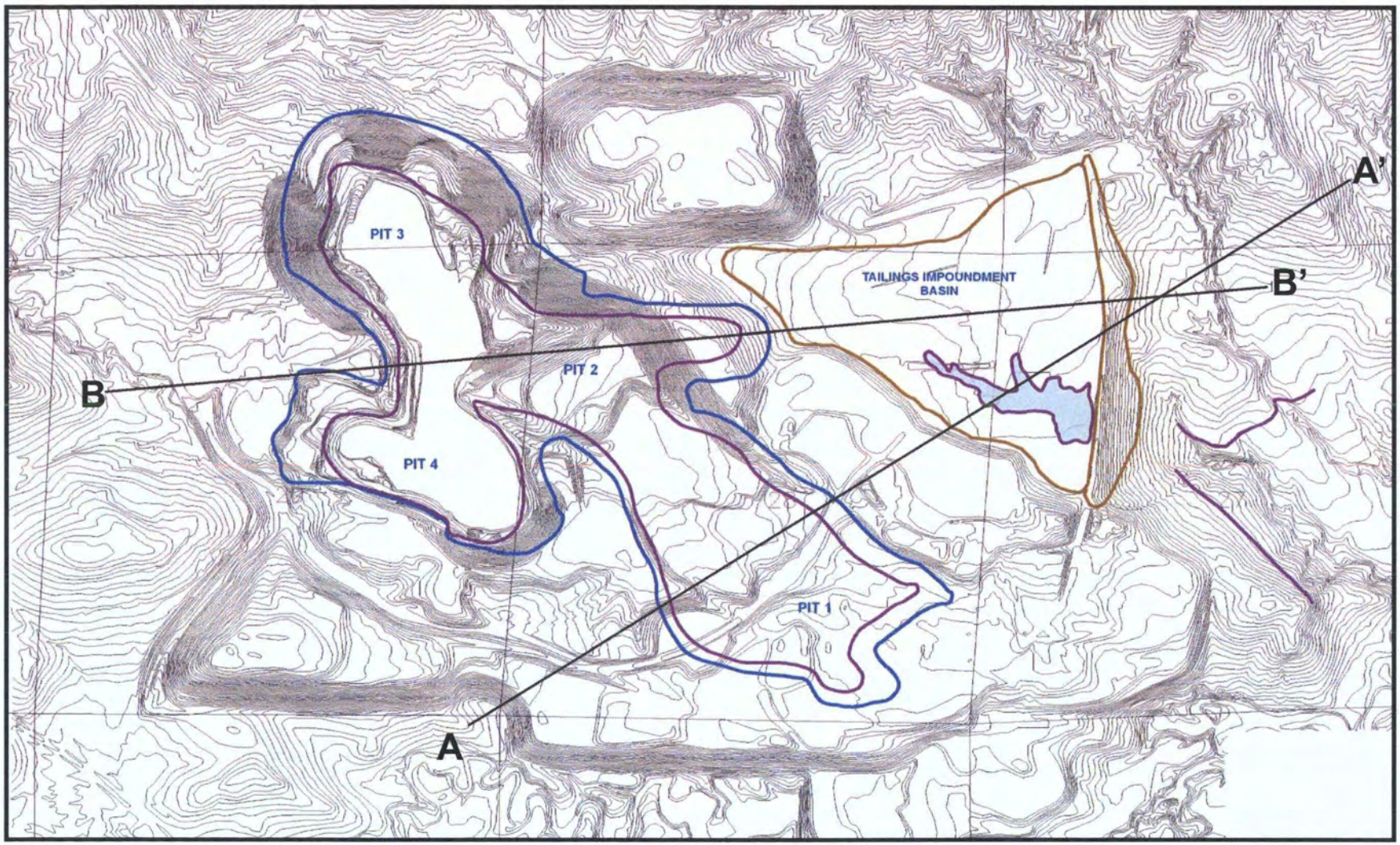
Groundwater Overview

- 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 tailing 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 flowed toward the pit during active operations." Seepage to pits estimated at ~ 44 to 100 gpm

Primary Transport Pathways and Cross Sections



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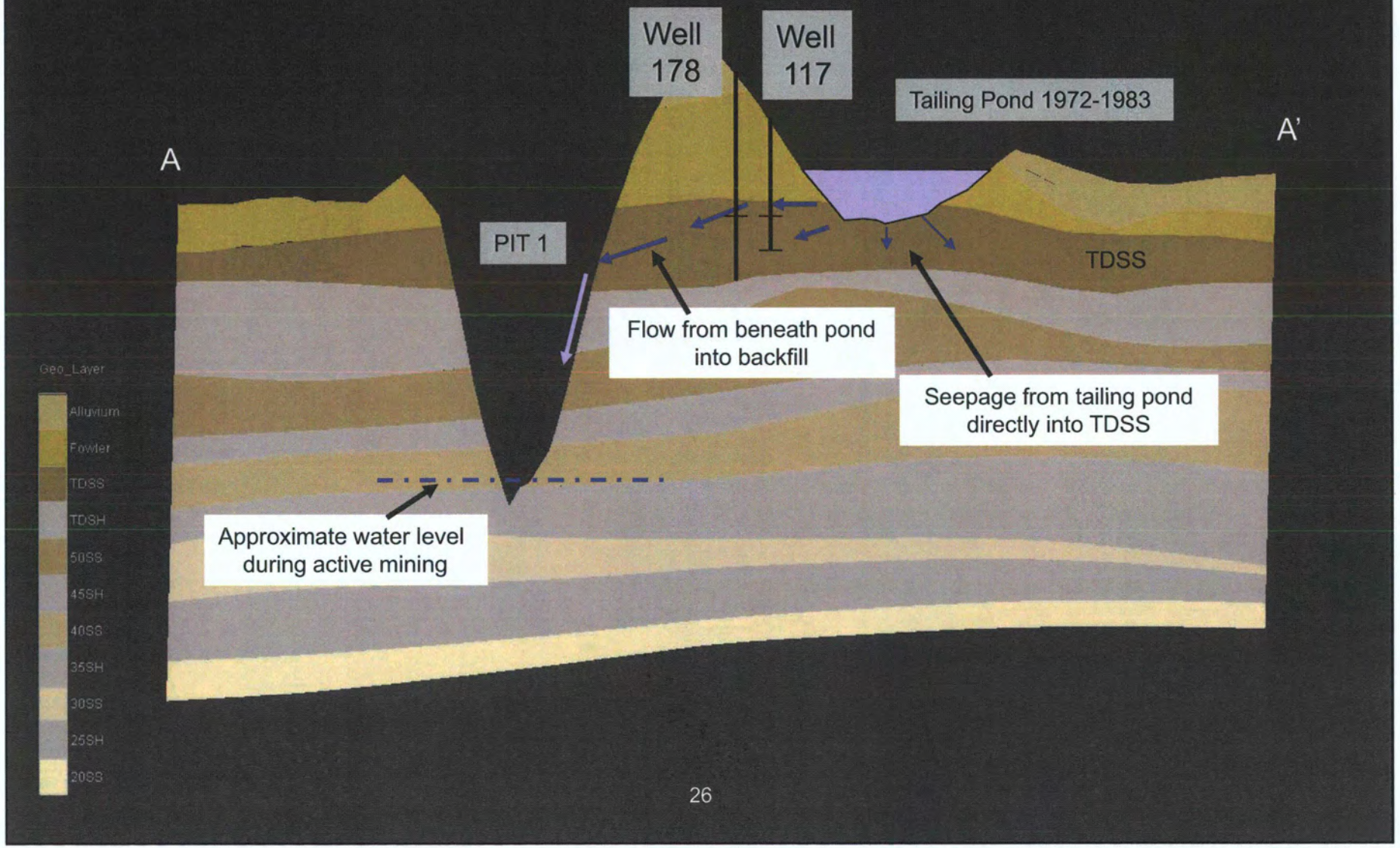
Flow and Transport During Active Mining

Cross Section A to A'



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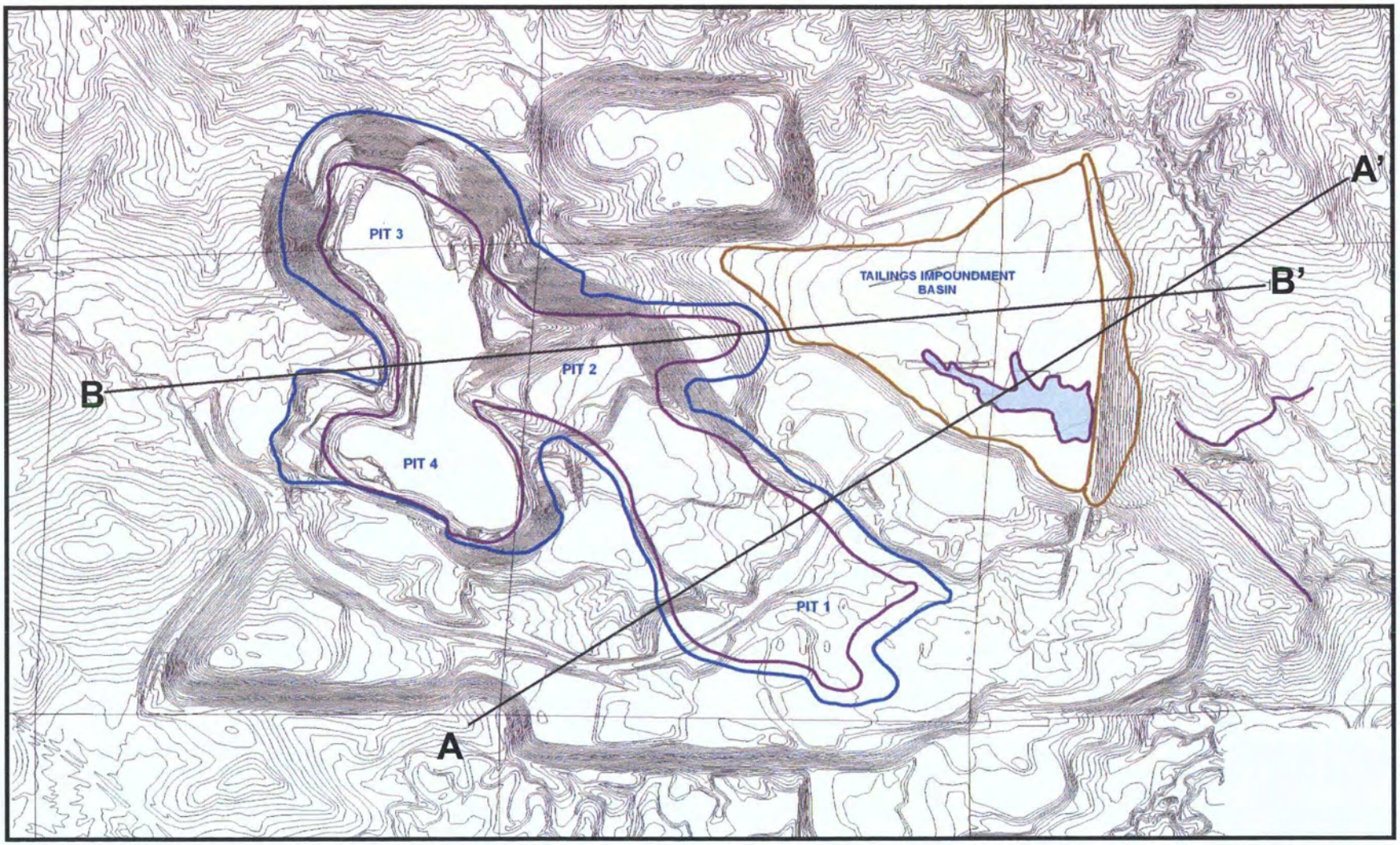

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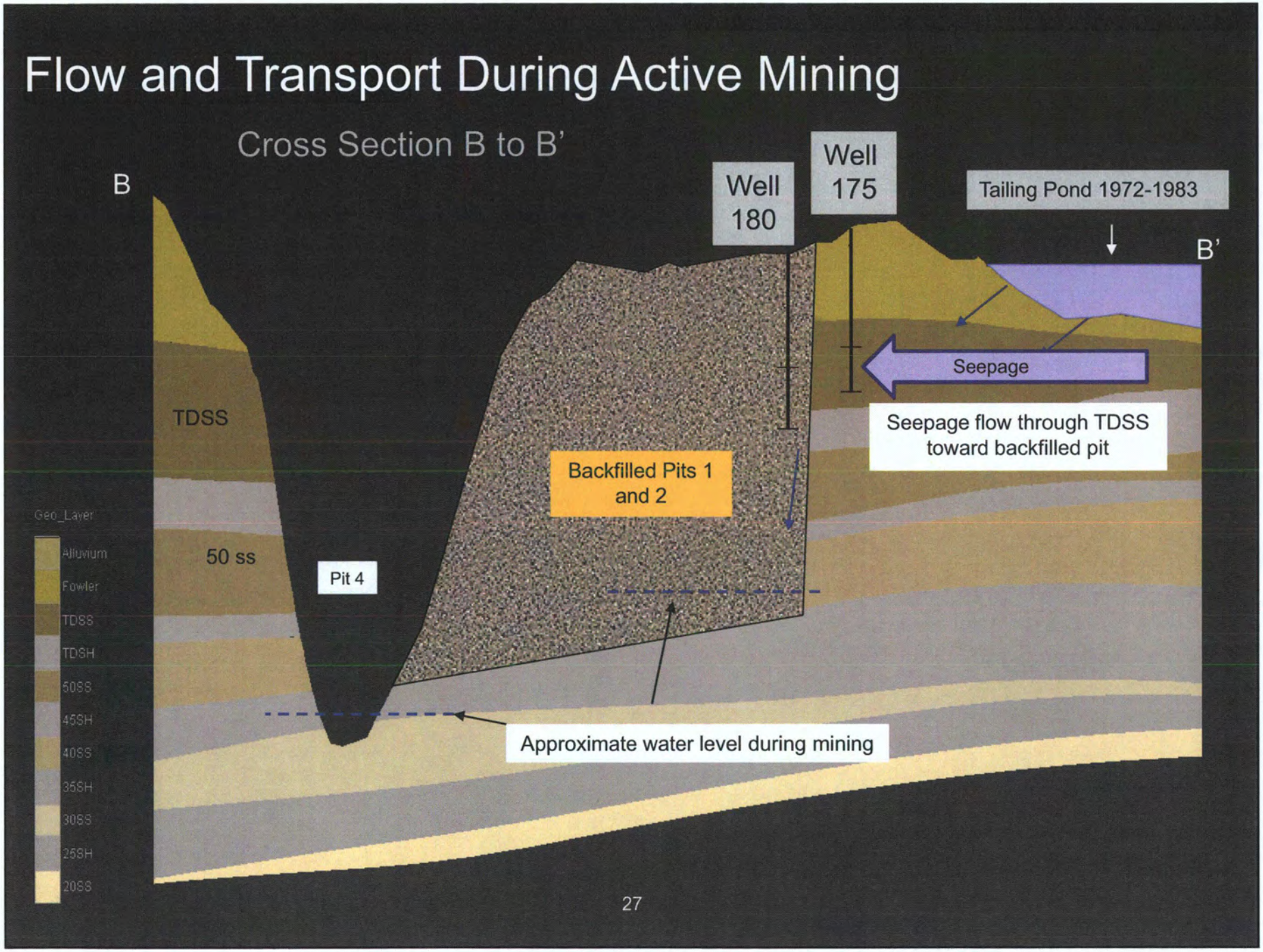
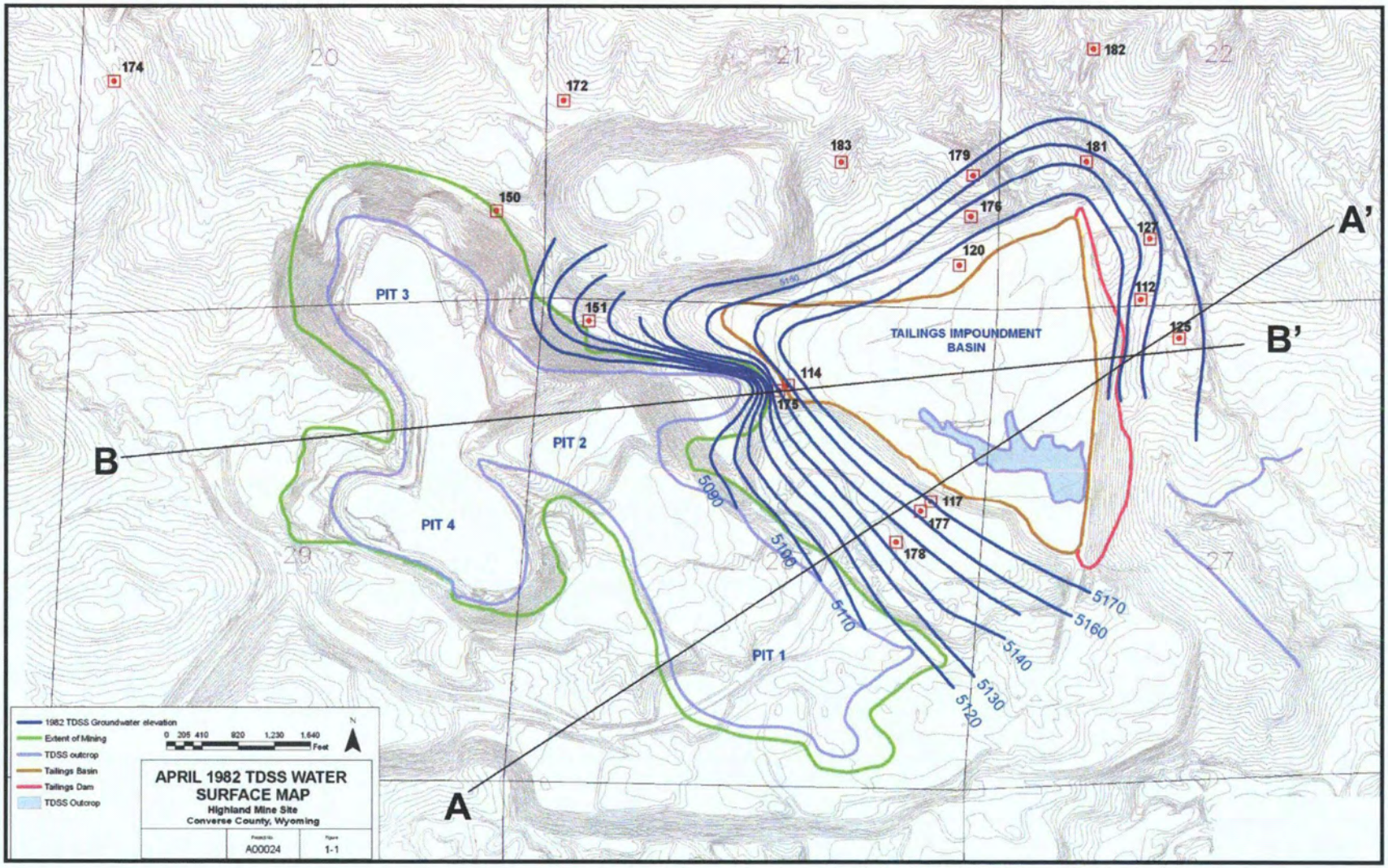


TDSS Potentiometric Map - 1982



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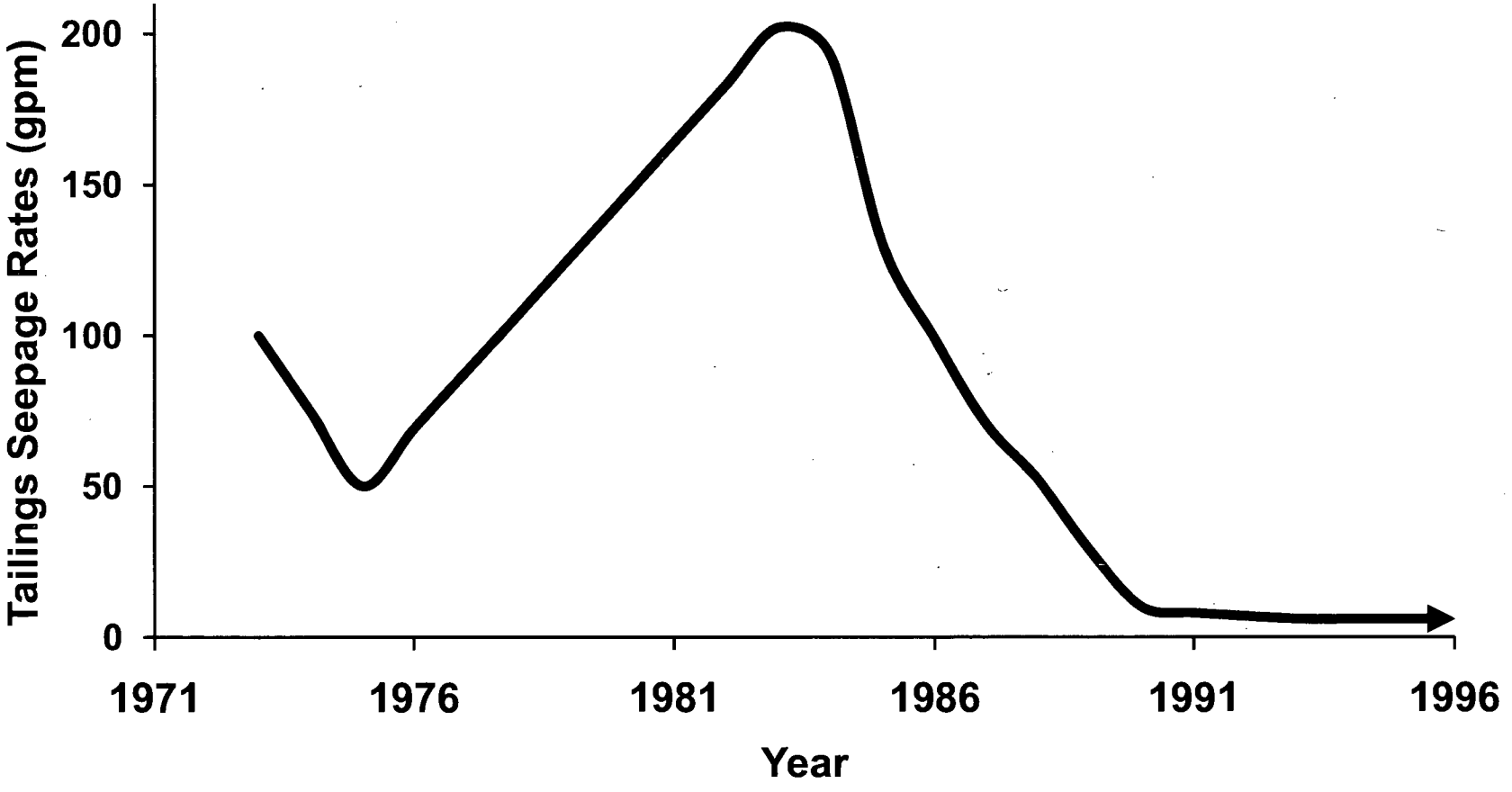
Estimated Tailings Seepage Rates



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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 tailing impoundment flowed within the drainage
- Seepage is occurring and expected to continue in perpetuity

Long-Term Hydrologic Conditions

- Pit Lake will remain a hydrologic sink
  - Long-term predicted pit lake elevation at approximately 5060 ft.
- 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
  - U speciation & mobility
  - Uranium Isotope Activity Ratio (AR)

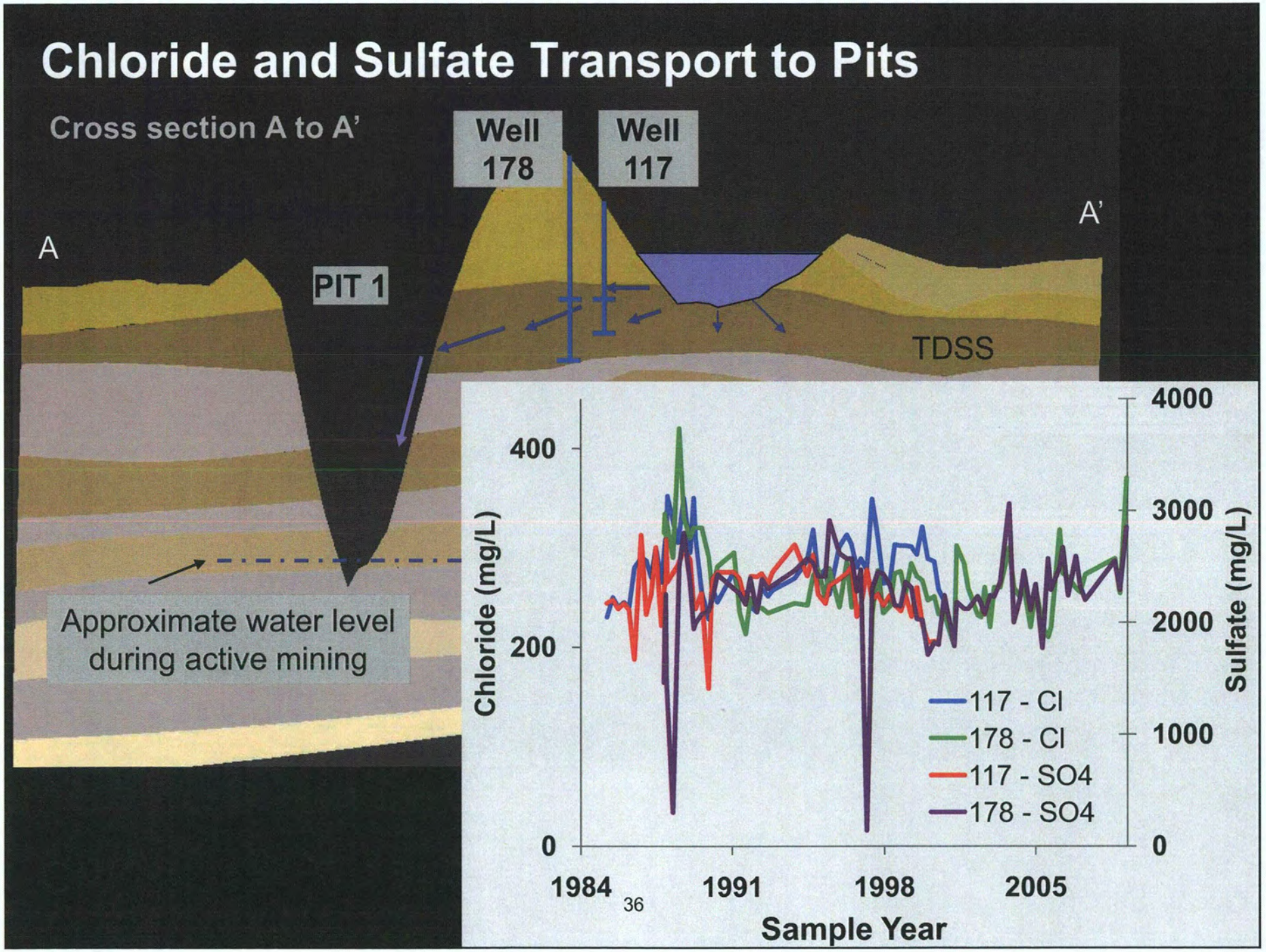
Chloride and Sulfate Mass Balance

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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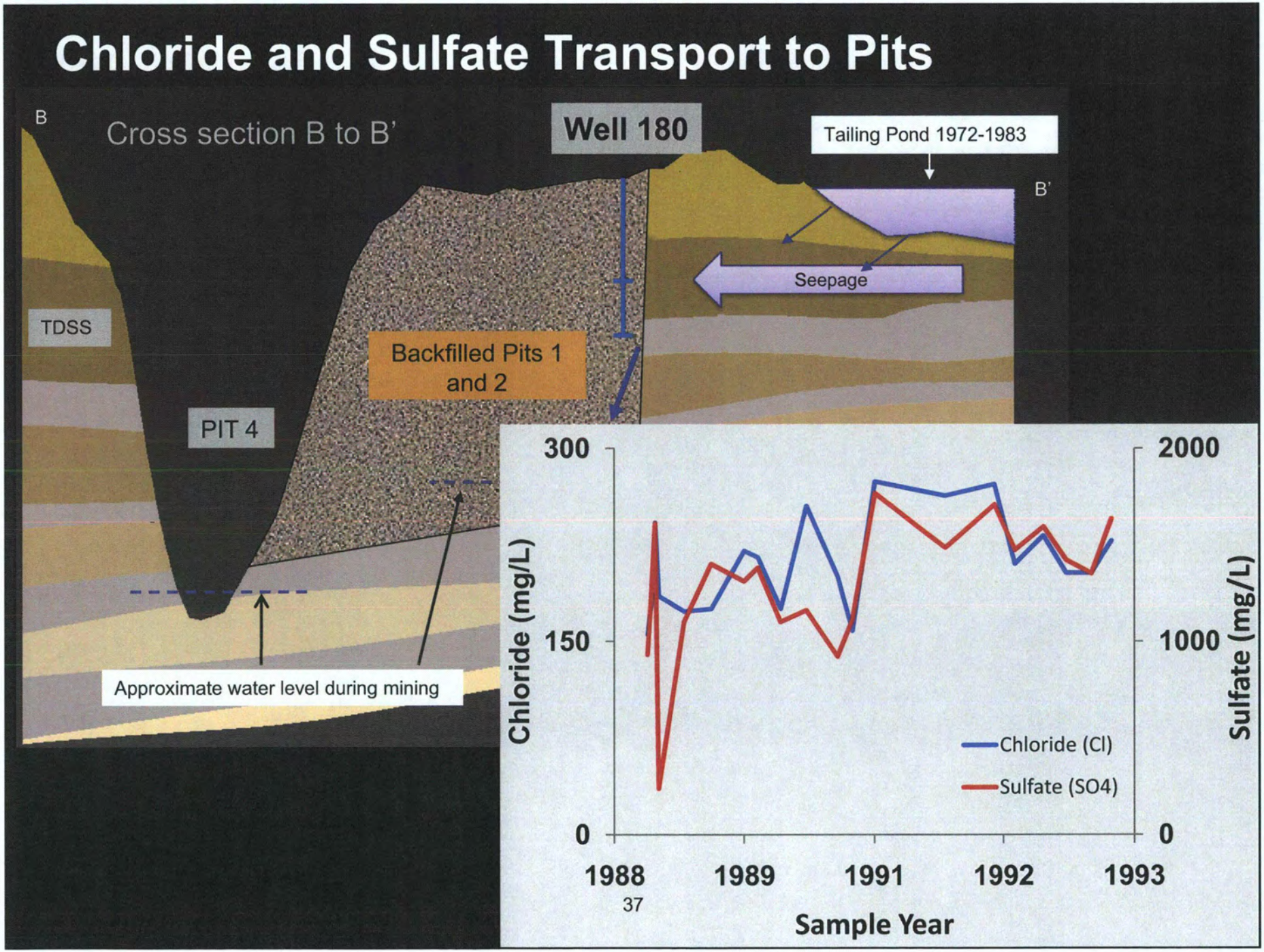

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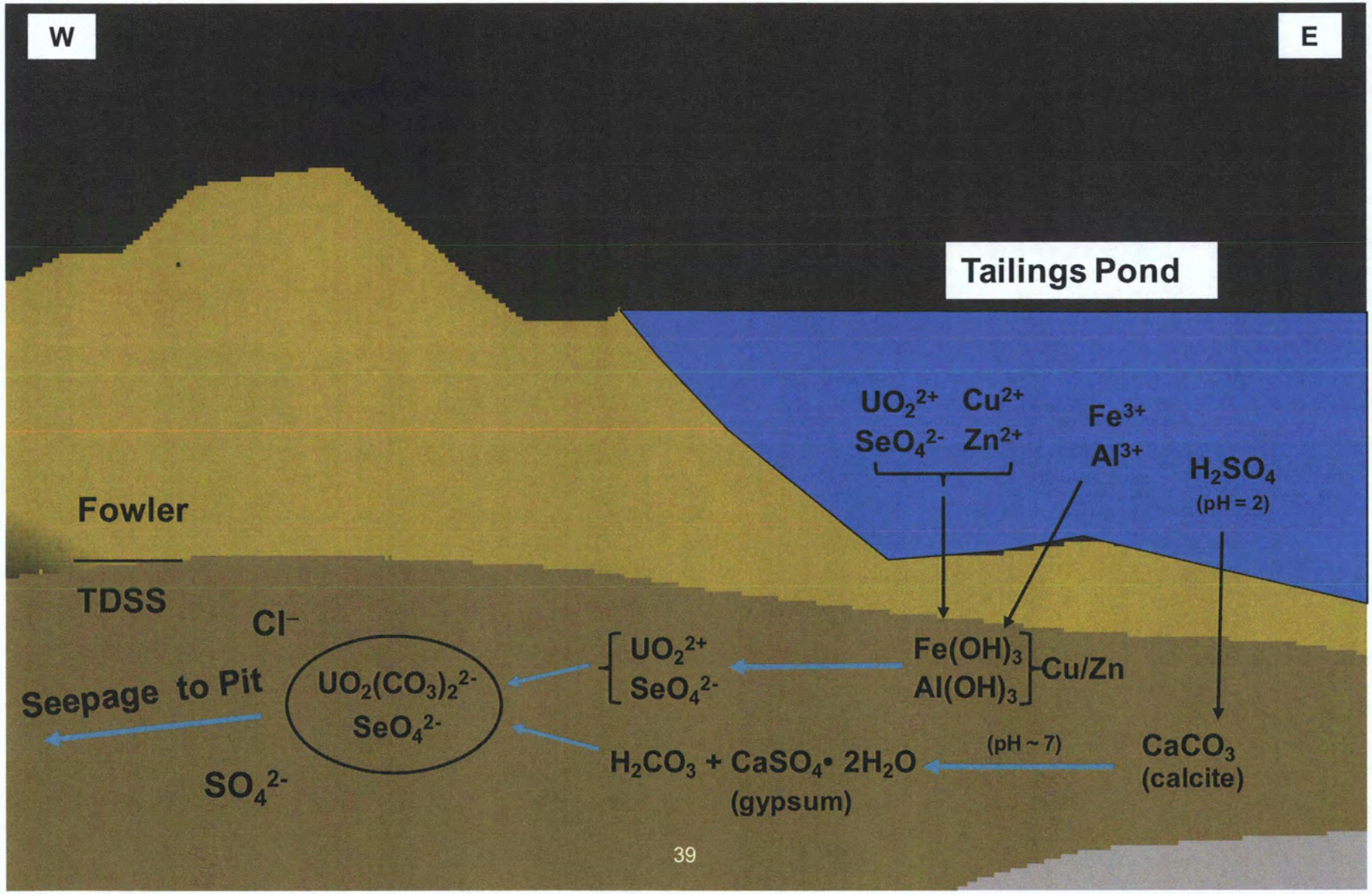
Conceptual Geochemical Model



U-Carbonate Complexes are Highly Mobile

Accepted Throughout Scientific Literature:

"The carbonate complexes are extremely important because they greatly increase the solubility of uranium minerals, facilitate U(VI) oxidation, and also limit the extent of uranium adsorption in oxidized waters, thus increasing uranium mobility"

Donald Langmuir, Ph.D., Colorado School of Mines

(Aqueous Environmental Geochemistry, 1997)

Colon et al. (2001). Historical case analysis of uranium plume attenuation. Soil and Sediment Contamination. and US Nuclear Regulatory Commission (2001). Historical Case Analysis of Uranium Plume Attenuation. US NRC Document NUREG/CR-6705

Curtis et al. (2009). Comparing approaches for simulating the reactive transport of U(VI) in groundwater. Mine Water Environment

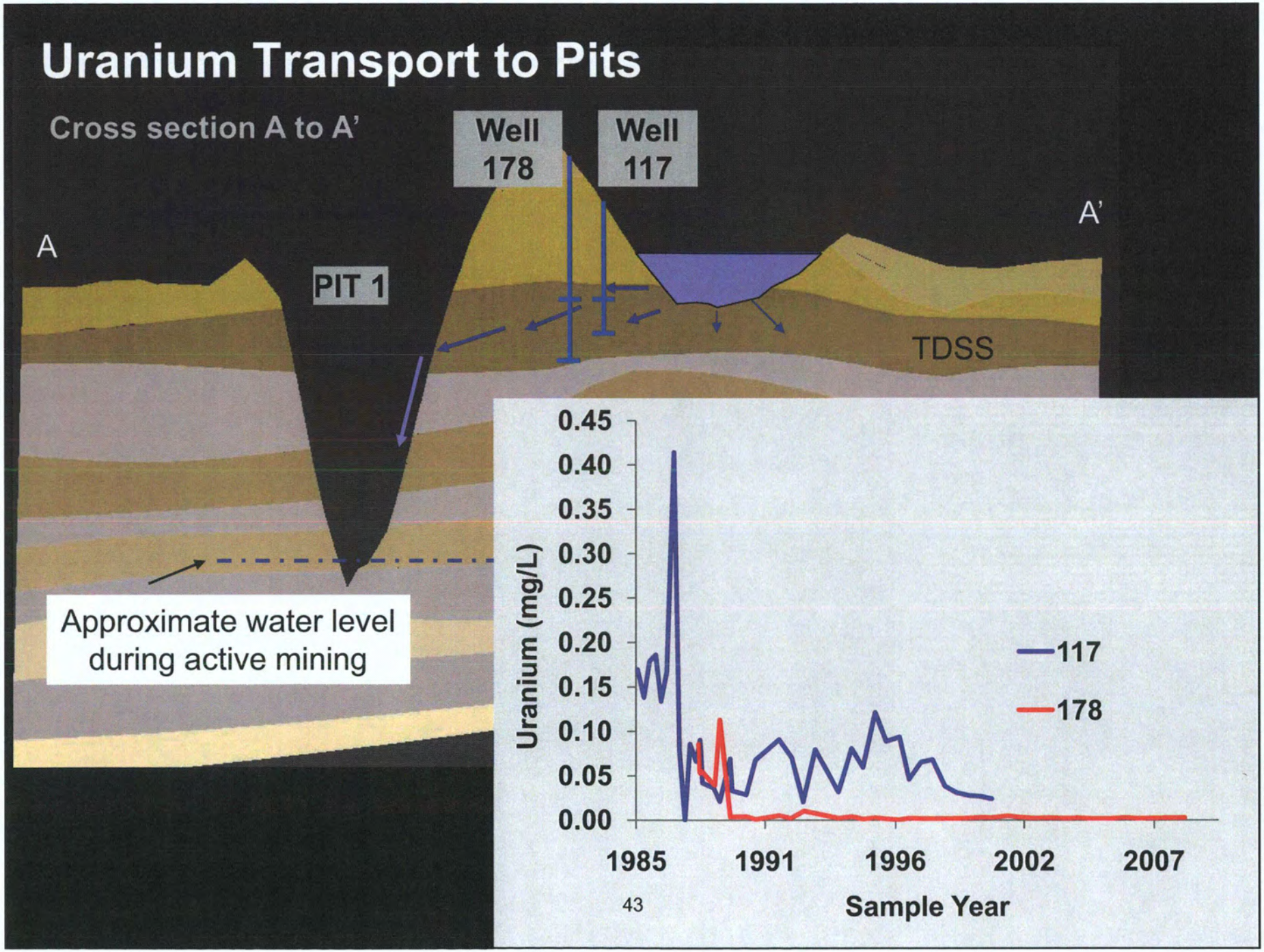
Highland Uranium Speciation

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

Uranium 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 highly mobile

Uranium Transport to Pits



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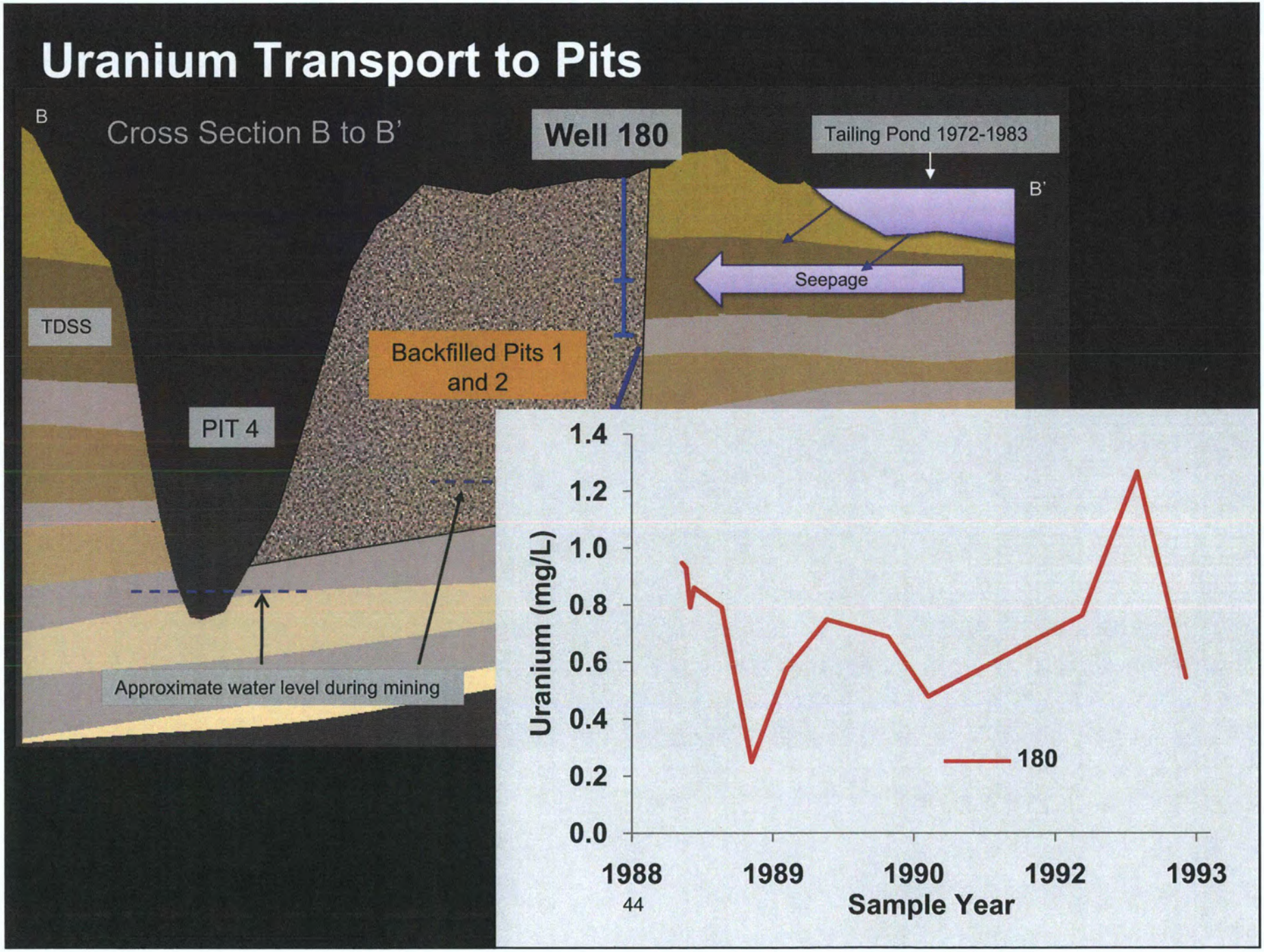

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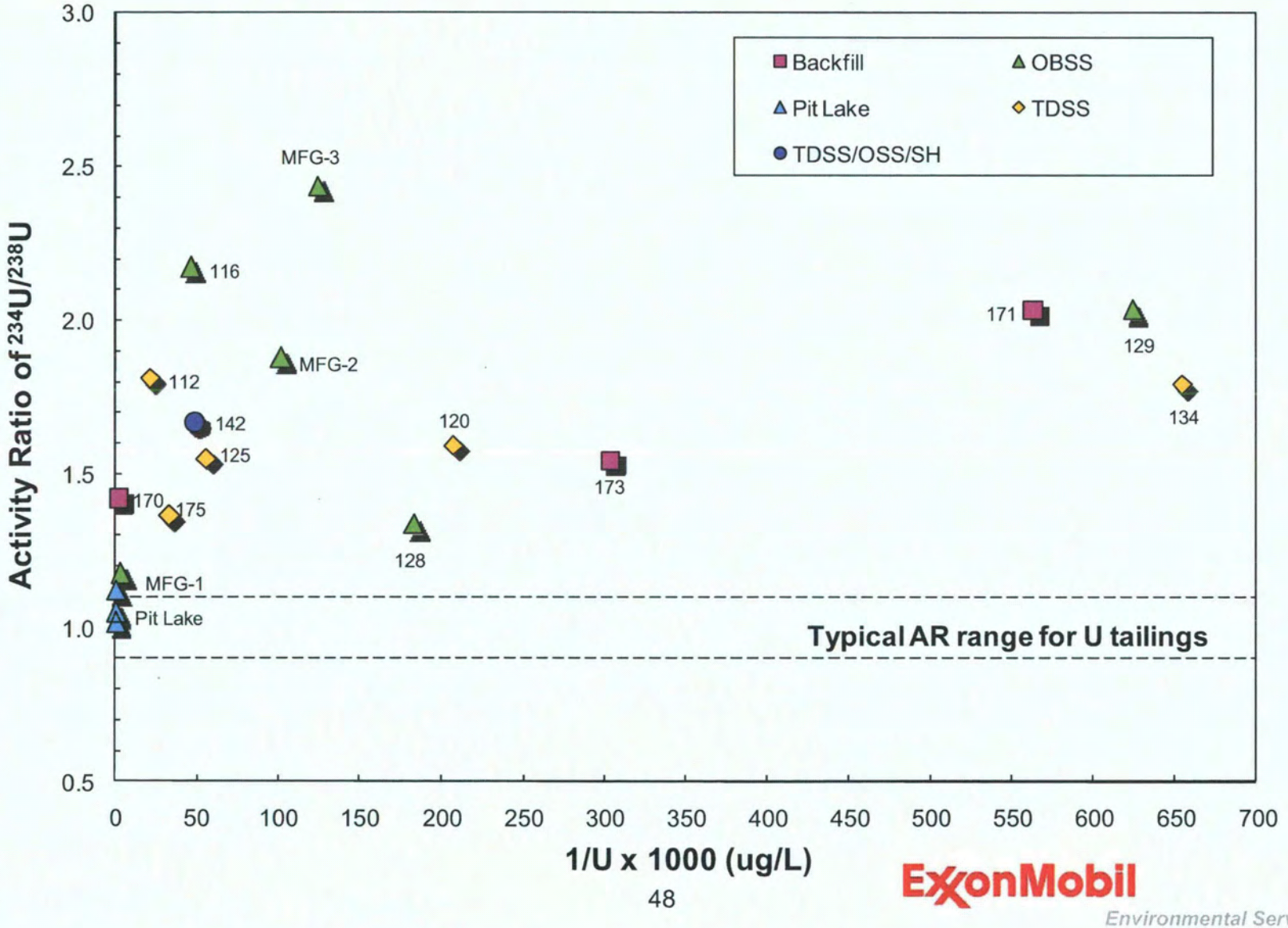
- **Site Transport of Uranium**
  - U speciation & mobility
  - **Uranium Isotope Activity Ratio (AR)**

Uranium Isotope Geochemistry

- The activity ratios of $^{234}U/^{238}U$ can help to differentiate sources
- Tailings solutions expected to have an AR of approximately 1
- Ground water 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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11e.(2) transport consistent with uranium mill sites in the US

Amendment to Existing ACL

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

Conclusion: Today's Presentation

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