Progress in Remediating ARD-Contaminated Groundwater at Bingham Canyon Mine, Utah, USA

Kennecott Utah Copper
Presentation Outline

• Nature of Problem
• Regulatory Framework
• Containment and Remediation
• Water Treatment
• Cleanup Timeframe
• Questions
Acknowledgements
Nature of Problem
Kennecott Utah Copper (KUC) Bingham Canyon Mine
Regulatory Framework
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

- 1986 — EPA begins Preliminary Site Investigation
- 1994 — EPA proposes site for National Priority List (NPL)
- 1995 — Memo of Understanding between EPA, State of Utah, and Kennecott Utah Copper (KUC)
- 1998 — RI/FS completed (Site Investigation)
- 2000 — ROD issued (Approval of Cleanup Plan)
- 2002 — RDRA completed (Design and Implementation)
- 2008 — Consent Decree issued (Legal Agreement)
- 2008 — NPL proposal withdrawn
Natural Resource Damage (NRD)

- 1986 — State of Utah files NRD claim for groundwater impacted by ARD
- 1992 — Initial NRD settlement rejected after Jordan Valley Water Conservancy District (JVWCD) intervenes
- 1995 — NRD settlement approved; KUC provides funding to “restore, replace, or acquire equivalent”
- 2004 — State of Utah approves a joint KUC/JVWCD groundwater treatment project
- 2006 — KUC commissions Reverse Osmosis (RO) water treatment plant for Zone A
- 2012 — JVWCD anticipated to open KUC funded RO water treatment plant for Zone B
Remedies Summary

- **EPA through CERCLA:**
  - Maintain source controls and provide plume containment through pumping
  - Remediate aquifer through pumping and monitored natural attenuation (MNA)
  - Treat extracted groundwater and dispose of treatment residuals

- **State of Utah through NRD:**
  - Construct and operate a RO water treatment plant for Zone A
  - Fund construction of RO water treatment plant for Zone B to be owned and operated by JVWCD
  - Each plant to produce 3,500 acre-feet/year for 40 years
Containment and Remediation
<table>
<thead>
<tr>
<th></th>
<th>ECG1146</th>
<th>BSG1201</th>
<th>BSG2784</th>
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<tbody>
<tr>
<td>Installed</td>
<td>1995</td>
<td>2003</td>
<td>2008</td>
</tr>
<tr>
<td>Material</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Diameter</td>
<td>18-inch</td>
<td>18-inch</td>
<td>18-inch</td>
</tr>
<tr>
<td>Total Depth</td>
<td>760 ft bgs</td>
<td>752 ft bgs</td>
<td>870 ft bgs</td>
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<tr>
<td>Screen Intervals</td>
<td>500-700 ft bgs</td>
<td>500-740 ft bgs</td>
<td>490-600 ft bgs</td>
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<td></td>
<td></td>
<td></td>
<td>700-850 ft bgs</td>
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<tr>
<td>Static Water Level</td>
<td>390 ft bgs</td>
<td>460 ft bgs</td>
<td>420 ft bgs</td>
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<tr>
<td>Pumping System</td>
<td>200 HP SS Submersible</td>
<td>200 HP SS Submersible</td>
<td>200 HP SS Submersible</td>
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<tr>
<td>Average Pumping Rate</td>
<td>670 gpm</td>
<td>620 gpm</td>
<td>620 gpm</td>
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<tr>
<td>Production 5 Year Rolling Average</td>
<td>2,100 to 2,600 acre-feet/year</td>
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# Sulfate Extraction Wells

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<tr>
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<th>BFG1200</th>
<th>B2G1193</th>
<th>LTG1147</th>
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<tbody>
<tr>
<td>Installed</td>
<td>2001</td>
<td>1998</td>
<td>1995</td>
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<tr>
<td>Material</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
<td>Carbon/Stainless</td>
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<tr>
<td>Diameter</td>
<td>18-inch</td>
<td>18-inch</td>
<td>16-inch</td>
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<tr>
<td>Total Depth</td>
<td>820 ft bgs</td>
<td>1,070 ft bgs</td>
<td>605 ft bgs</td>
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<tr>
<td>Screen Intervals</td>
<td>420-800 ft bgs</td>
<td>450-1060 ft bgs</td>
<td>400-590 ft bgs</td>
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<tr>
<td>Static Water Level</td>
<td>420 ft bgs</td>
<td>450 ft bgs</td>
<td>420 ft bgs</td>
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<tr>
<td>Pumping System</td>
<td>350 HP SS Submersible</td>
<td>350 HP SS Submersible</td>
<td>200 HP SS Submersible</td>
</tr>
<tr>
<td></td>
<td>350 HP Booster</td>
<td>350 HP Booster</td>
<td>250 HP Booster</td>
</tr>
<tr>
<td>Average Pumping Rate</td>
<td>1,400 gpm</td>
<td>1,500 gpm</td>
<td>400 gpm</td>
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<tr>
<td>Production 5 Year</td>
<td></td>
<td>3,500 to 3,800 acre-feet/year</td>
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<tr>
<td>Rolling Average</td>
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</tbody>
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Rio Tinto

Water Treatment
Pump and Treat Strategy

- SULFATE EXTRACTION WELLS (~3,300 gpm)
- RO WATER TREATMENT PLANT
- DRINKING WATER (3,500 acre-feet/year) -> JVWCD
  - CONCENTRATE -> RECYCLE / DISCHARGE

- ACIDIC EXTRACTION WELLS (~2,000 gpm)
- TAILINGS LINE
  - AQUEOUS -> RECYCLE / DISCHARGE
  - SOLIDS -> IMPOUNDMENT

- HIGH-DENSITY SLUDGE LIME TREATMENT PLANT
  - AQUEOUS -> DISCHARGE
  - SOLIDS -> REPOSITORY

POST MINE CLOSURE PLAN
Reverse Osmosis Treatment Plant

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Two X 2-stage skids</th>
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<tbody>
<tr>
<td>Membranes</td>
<td>Hydranautics ESPA2</td>
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<tr>
<td></td>
<td>(Spiral Wound Polyamide)</td>
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<tr>
<td>Pressure Vessels</td>
<td>Protec and CodeLine</td>
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<tr>
<td>Feed Rate</td>
<td>3,000 gpm to Membranes</td>
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<tr>
<td>Recovery Rate</td>
<td>71 to 74%</td>
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<tr>
<td>Remineralization</td>
<td>200 gpm</td>
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<tr>
<td>Production Rate</td>
<td>2,400 gpm</td>
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<tr>
<td>Production Goal</td>
<td>3,500 acre-feet/year</td>
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Tailings Line Management Criteria

- Compliance point is the North Splitter Box (located north of the Copperton Concentrator)

- Neutralization potential (NP) in a given month should be either; greater than or equal to the Copperton Concentrator tailings NP, OR at least 5 t CaCO₃ eq/kt
  - Evaluated as a six-month rolling average

- Aqueous alkalinity should be greater than or equal to 10 mg CaCO₃ eq/L at least 90% of the time
  - Evaluated as a six-month rolling average

- Aqueous pH should be greater than or equal to 6.7 at least 90% of the time
  - Evaluated per calendar year
Cleanup Timeframe
Column Leaching Tests and Geochemical Modeling Summaries

- Performed in 1990’s as part of the RIFS process to:
  - Evaluate remedial options and assist with designing remedial pumping network

- Column Leaching Tests:
  - Approximately 40 pore volumes, equivalent to approximately 800 years

- Geochemical Modeling:
  - Five different models were developed to evaluate lime demand, with a total of 9 different simulations
  - Extrapolation column data, extrapolation of data from complete recovery wells, expanded 1D geochemical model, empirical rinse curve model, and an extended 1D advection-dispersion model with mass extraction
Calculated Lime Demand

Year

Rinse curve model
Extrapolated well data model
Advection-dispersion-extraction model
Geochemical model (clean)
Geochemical model (transition)
Upper 95% confidence limit of all models

Lime demand (t/ML)


0 1 2 3 4 5
Questions