The rising cost of closure – it’s the water and a lot more

Terry Braun, PE
CIM 2015 Conference (Montreal)
May 13, 2015
What is happening…

- Expectations for mine closure costing are increasingly global
- There’s now a place for everything and everything needs a place
- Perpetuity has a number
- Economic trade-offs between direct cost and long-term cost obligations
Expectations

Closure Planning as Part of Mine Design
Pre-Closure Plan
Financial Assurance
Closure Plan Review and Updates
Financial Assurance Review and Updates
Detailed Plan and Cost Estimate
Closure Engineering for Permitting and Construction
Construction Monitoring
Post Closure Monitoring and Maintenance Plan

Detailed Site Investigation, Design and Planning
CONSTRUCTION
Concurrent Reclamation
OPERATIONS
Interim Period Prior to Start of Closure
Active Closure
Post-Closure Revegetation
Post-Closure Water Quality Monitoring
Suspension or Termination
Temporary Closure
Expectations – Zooming In

- Closure Planning as Part of Mine Design
- Pre-Closure Plan
  - Financial Assurance
- Closure Plan Review and Updates
  - Financial Assurance Review and Updates
- Detailed Plan and Cost Estimate
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Detailed Site Investigation, Design and Planning

CONSTRUCTION

CONCURRENT RECLAMATION

OPERATIONS

Interim Period Prior to Start of Closure

Active Closure

Post-Closure Revegetation

Post-Closure Water Quality Monitoring

Suspension or Termination

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Expectations – Zooming In

- Closure Plan Review and Updates
- Detailed Plan and Cost Estimate
- Closure Engineering for Permitting and Construction
- Construction Monitoring
- Post Closure Monitoring and Maintenance Plan

OPERATIONS

- Concurrent Reclamation
- Interim Period Prior to Start of Closure
- Active Closure

Temporary Closure

- Post-Closure Revegetation
- Post-Closure Water Quality Monitoring
No Concurrent – Interim – Active – 10y PC

Concurrent Reclamation

Interim Period Prior to Start of Closure

Active Closure

Post-Closure Revegetation

Post-Closure Water Quality Monitoring

OPERATIONS
Post-Closure Revegetation
Post-Closure Water Quality Monitoring

Concurrent Reclamation
Interim Period Prior to Start of Closure
Active Closure

Concurrent – Interim – Active – 10y PC

OPERATIONS
Mine Water Management – Active – 10y+ PC

Concurrent Reclamation

Interim Period Prior to Start of Closure

Active Closure

Post-Closure Revegetation

Post-Closure Water Quality Monitoring

OPERATIONS
Evolution of perpetuity in terms of post-closure mine water management

5 years and we’ll check

to

30 years is a reasonable assumption

to

100 years and counting
<table>
<thead>
<tr>
<th>Property, Location, Owner</th>
<th>Start of Operation</th>
<th>Current Production</th>
<th>Commodity and Mining Method</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greens Creek, Alaska, Hecla Mining Company</td>
<td>1987</td>
<td>2,000 ore tonnes per day</td>
<td>Silver, Gold, Zinc and Lead Underground, mill operations, dry stack tailings</td>
<td>Estimated end of mine life in 2028</td>
</tr>
<tr>
<td>Red Dog Mine, Alaska, Teck Cominco Alaska and NANA Regional Corporation</td>
<td>1989</td>
<td>10,000 ore tonnes/day</td>
<td>Zinc and Lead Open Pit, mill operations</td>
<td>Estimated end of mine life in 2039</td>
</tr>
<tr>
<td>Chino Mine, New Mexico, Freeport McMoran Copper and Gold, Inc.</td>
<td>1910</td>
<td>36,000 ore tonnes per day 150 million pound copper production via SX/EW</td>
<td>Copper Open Pit, mill and leach operations, conventional tailings</td>
<td>Estimated end of mine life in 2036 Completed 640 acres of reclamation in 2013</td>
</tr>
<tr>
<td>Property, Location, Owner</td>
<td>Start of Operation</td>
<td>Current Production</td>
<td>Commodity and Mining Method</td>
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<td>--------------------------</td>
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</tr>
<tr>
<td>Continental Mine, New Mexico, Freeport McMoRan Copper and Gold, Inc.</td>
<td>1968</td>
<td>6,500 ore tons per day</td>
<td>Copper Open Pit and Underground, conventional tailings</td>
<td>Restart in 2016, estimated end of mine life in <strong>2025</strong></td>
</tr>
<tr>
<td>Questa Mine, New Mexico, Chevron Mining Inc.</td>
<td>1919 to 2014 (UG) 1964 – 1983 (Open Pit)</td>
<td>14,000 ore tons per day</td>
<td>Molybdenum Underground Block Cave, mill flotation, conventional tailings</td>
<td>Chevron announced closure in <strong>June 2014</strong></td>
</tr>
<tr>
<td>Tyrone Mine, New Mexico, Freeport McMoRan Copper and Gold, Inc.</td>
<td>1916 to 1921 (UG) 1967 to 1992 (open pit mill) 1984 to present (SX/EW)</td>
<td>100 million pound copper production via SX/EW</td>
<td>Copper Open Pit, leach operations</td>
<td>Estimated end of mine life in <strong>2020</strong> Completed 4,600 acres of reclamation between 2003 and 2013</td>
</tr>
</tbody>
</table>
## Associated Financial Assurance Est.

<table>
<thead>
<tr>
<th>Property, Location</th>
<th>Current Life of Mine (Years)&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Surety Cost Estimate (USD) Undiscounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Knox, Alaska&lt;sup&gt;2&lt;/sup&gt;</td>
<td>5</td>
<td>99,231,393 2013</td>
</tr>
<tr>
<td>Greens Creek, Alaska&lt;sup&gt;3&lt;/sup&gt;</td>
<td>13</td>
<td>68,918,907 2014</td>
</tr>
<tr>
<td>Red Dog Mine, Alaska&lt;sup&gt;4&lt;/sup&gt;</td>
<td>24</td>
<td>305,150,000 2010</td>
</tr>
<tr>
<td>Chino Mine, New Mexico&lt;sup&gt;5&lt;/sup&gt;</td>
<td>21</td>
<td>493,450,000 2007</td>
</tr>
<tr>
<td>Continental Mine, New Mexico&lt;sup&gt;6&lt;/sup&gt;</td>
<td>9</td>
<td>25,588,000 2014</td>
</tr>
<tr>
<td>Questa Mine, New Mexico&lt;sup&gt;7&lt;/sup&gt;</td>
<td>0</td>
<td>1,109,602,975 2013</td>
</tr>
<tr>
<td>Tyrone Mine, New Mexico&lt;sup&gt;8&lt;/sup&gt;</td>
<td>5</td>
<td>480,504,000 2008</td>
</tr>
</tbody>
</table>

1. As of January 1, 2015
### NPV Assumptions

<table>
<thead>
<tr>
<th>Property, Location, Owner</th>
<th>Discount Rate</th>
<th>Long term inflation rate</th>
<th>Post-Closure Operations and Maintenance Period</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Knox, Alaska, Fairbanks Gold Mining, Inc., Kinross</td>
<td>7.8%</td>
<td>3.5%</td>
<td>18 years (8 years WQ standards achieved, additional 10 years monitoring)</td>
<td>Kinross 2013</td>
</tr>
<tr>
<td>Questa Mine, New Mexico, Chevron Mining Inc.</td>
<td>6.81%(^1)</td>
<td>2.62%(^2)</td>
<td>128 years (28 years reclamation and water treatment, 100 years water treatment and monitoring)</td>
<td>Chevron 2013</td>
</tr>
</tbody>
</table>


\(^2\) US Department of Labor – Consumer Price Index – All Urban – West Consumers, Average from 1991 to 2012
New Mexico Financial Assurance

• Reported annually by the Mining and Minerals Division of the Energy, Minerals and Natural Resources Department

• Questa (Chevron)
• Tyrone, Chino and Continental (FCX)
• Copper, Open Pit, leach operations
• ~ 100 year operating history
• Approximately 8,500 acres of disturbance
• Completed 4,600 acres of reclamation between 2003 and 2013
• $149MM Direct Cost
Operating Costs - Tyrone

5MM USD per Year
Year 6 through 10

2.6MM USD per Year
Year 80 to 100
## Unit costs for water treatment

<table>
<thead>
<tr>
<th>Property, Location</th>
<th>Average Treatment Rate (gpm)</th>
<th>Treatment Method(s)</th>
<th>Average Cost per kgal</th>
<th>Duration (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Dog Mine, Alaska</td>
<td>2,900</td>
<td>Lime Neutralization with High Density Sludge</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Chino Mine, New Mexico</td>
<td>1,000</td>
<td>Lime Neutralization with High Density Sludge</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Questa Mine, New Mexico</td>
<td>1,300</td>
<td>Lime Neutralization with High Density Sludge</td>
<td>7.5</td>
<td>100</td>
</tr>
<tr>
<td>Tyrone Mine, New Mexico</td>
<td>500</td>
<td>Evaporation</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>475 to 275</td>
<td>Lime Neutralization with High Density Sludge coupled with membrane filtration</td>
<td>20</td>
<td>95</td>
</tr>
</tbody>
</table>
Financial assurance instruments over time

- Tyrone Mine
- Reported by MMD
ARO trends for FCX
• “All inclusive” closure cost estimates are a global phenomena
• Perpetuity >= 100 years
• Source control (active closure) and management of migration (post-closure) economic trade-offs are increasing in scale
• Financial assurance industry is adapting
• ARO accounting can be the fastest changing liability on the balance sheet
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