Chuitna Coal Project
PacRim Coal, LP

Overview of Water Balance and Mine Water Control Plan

Presented to:
Cooperating Agencies

April 17, 2009
Meeting Objectives

• Review Site Baseline Hydrology, Hydrogeology and Water Quality

• Review Mine Site Water Balance and Approach

• Review Conceptual Mine Water Control Plan

• Receive Agency Input on Water Management Concepts
CHARACTERISTIC FLOW AND TEMPERATURE REGIMES IN CHUITNA AND TRIBUTARIES
Daily Flow Variation at Station 180 – 2003 Creek

Mean Daily Discharge (cfs)

Month/Day

Minimum Flow  Mean Flow  Maximum Flow
Daily Flow Variation at Station 180 – 2003 Creek

Mean Daily Flow (cfs)

Month/Day

Mean Flow

Average Deviation
SURFACE WATER TEMPERATURE
Annual Variation in Stream Temperature

Oct-91 | Jan-92 | Apr-92 | Jul-92
------ | ------ | ------ | ------
C120   | C195   |

Legend:
- C120
- C195
Diurnal Variation in Daily Temperature
Daily Temperature Variation vs Mean at Station 180 on 2003 Creek

Error bars represent the average daily deviation from the monthly mean temperature.
SURFACE WATER QUALITY
General Surface Water Quality

• Approximately 25 years of sampling data

• Water Quality in Chuitna and Tributaries reflects the geology of the area

• Bicarbonate Water Type
  ➔ Low Hardness
  ➔ Low Dissolved Solids (salts)
  ➔ Neutral pH
Surface Water Quality Characteristics

- Water Quality in All Tributaries and Chuitna is Similar

- Relatively High Levels of Dissolved Iron and Manganese

- Total Aluminum and Total Zinc become elevated with Suspended Sediments
  - Dissolved Metals Remain Low
<table>
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<tr>
<th>Date</th>
<th>TSS mg/L</th>
<th>Hardness mg/L</th>
<th>Al - T µg/L</th>
<th>Cu - T µg/L</th>
<th>Cu - D µg/L</th>
<th>Fe - T µg/L</th>
<th>Fe - D µg/L</th>
<th>Mn - T µg/L</th>
<th>Mn - D µg/L</th>
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Groundwater System
Ground Water

- Approximately 1/3 Annual Precipitation Infiltrates to Groundwater
  - Provides Base Flow
  - Remains Predominantly in the Uppermost Groundwater System – Glacial Drift and Alluvium
Groundwater Flow Direction from Glacial Drift
Groundwater Conceptual Site Model
Groundwater Quality
Groundwater Quality Characteristics (Continued)

• Similar to Surface Water Quality when TSS of the sample is low.

• Several sample results with very high TSS (1,000 mg/L+)

• High TSS = High total metals
  → Low metals when TSS is low

• Likely result of well construction/sampling issues
  → Well Construction and Development
  → Iron Precipitation on well casing
## Groundwater Quality

<table>
<thead>
<tr>
<th></th>
<th>TSS (mg/L)</th>
<th>Al (total) (µg/L)</th>
<th>Cu (total) (µg/L)</th>
<th>Fe (total) (µg/L)</th>
<th>Mn (total) (µg/L)</th>
<th>Zn (total) (µg/L)</th>
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</table>

[a] TSS ranges compared to geometric mean of detected metals values, except as noted.
[b] Based on one sample with detected TSS greater than 5 mg/L.
[c] All samples for SubRed1 showed non-detect values for TSS (<5 mg/L).
Groundwater Pumping:

- Pumping primarily from Glacial Drift and Sub-Red 1 Sand
- Pump rates required for mining based on groundwater model (Arcadis)
- Goal is to offset baseflow reductions in adjoining streams with augmented flow from wells as best possible (reductions are minimal)
Goal: Determine Need for and Size of Impoundments to store and treat mine water
*Analysis based on wet years will control (maximize) impoundment sizing

Components:
- Rainfall & Snowmelt
- Evaporation
- Surface Runoff
- Infiltration ==> Baseflow & Groundwater Recharge
- GW Pumping
Overall Approach

• Determine Natural Condition Water Balance
• Estimate Changes Due to Disturbance
• Integrate natural and disturbed conditions with GW pumping and mine plan
• Predict monthly water management needs through Year 8 of mining
Sources of Water from Mining Area

- Precipitation and Runoff
  - Rainfall (Stormwater)
  - Snowmelt

- Groundwater Pumping
  - Dewatering of Glacial Drift
  - Reduce Hydrostatic Head in Red 1 Sand Formation

- There is no processing of the coal needed for this project. It will be excavated, crushed and shipped to the port.
Water Balance: Natural Condition

Based on:

Streamflow from C180 record. Uses long flow record (24 calendar years at C180, 19-22 occurrences of each month)

Evaporation from 1982 through 2008 average, Matanuska Station

Infiltration to Deep GW Recharge assumed to be 5% of total precipitation

This approach avoids uncertain rainfall & snow measurements
Water Balance: Natural Condition Components

Water Balance Components, C180 Watershed

- Estimated Precip
- Adjusted Evap
- Streamflow
Water Balance: Disturbed Areas

Used Natural Conditions Water Balance Run-off Coefficients as a starting point

Recomputed for disturbed land by eliminating 80% of evaporation losses
## Water Balance: Runoff Coefficient Table

### Runoff Coefficient Derivation

<table>
<thead>
<tr>
<th>Month</th>
<th>Flow at C180 (cfs)</th>
<th>Adjusted Evap. (in)</th>
<th>Losses to Groundwater (in)</th>
<th>Estimated Precip. (in)</th>
<th>Runoff Coefficient</th>
<th>Runoff Depth</th>
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<td>Disturbed</td>
<td>Natural</td>
<td>Disturbed</td>
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<td>Jan</td>
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<td>36.38</td>
<td>15.58</td>
<td>2.73</td>
<td>54.69</td>
<td>0.67</td>
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Water Balance: Integration with Mine Plan

• Compute monthly water yield from disturbed and undisturbed areas reporting to each structure based on effective precipitation and runoff coefficients

• Add groundwater pumping volumes

• Storage Requirements Based On:
  • Total Water Handled
  • Season of the Year
  • Instream Flow Capacities
  • NPDES Permit Requirements and Limits
Mining Operation
Typical Coal Mining Sequence

- **Backfilling**
- **Active Mining**
- **Pre-Mining**

- **Topsoil Replaced/Revegetation**
- **Regrade**
- **Backfilling**
- **Active Pit**
- **Prestripping/Topsoil removal**

**Direction of Mining**

- **Over and Inter Burden**
- **Coal Seams**
- **Spoils**

**Two Bull Ridge Usibelli Coal Mine Healy Alaska**

Distance ~1 mile
How Water Is Managed – **Major** Control Methods

- **Clean Water Diversion**
  - Keeps Water from Undisturbed areas away from mining

- **Groundwater Wells**
  - Pumped to dewater before mining

- **Settling/Storm Water Ponds**
  - Prevents erosion and sediments from leaving mining area

- **Infiltration Basins**
  - Used to Return Groundwater to support Stream Baseflow and Groundwater Recharge

- **On site Storage**
  - Surface Storage Pond
Mine Plan
General Water Control Plan
Year 1 of Mining
General Water Control Plan
Year 7 of Mining
Settling Pond Conceptual Design
How Water Is Managed – **Local** Control Methods

- Silt Fences
- Hay Bales
- Check Dams
- Grading Controls
- Vegetation
- Sediment Traps or Depressions

**All These Methods Will Be Used to Control Flow Velocity and Erosion Throughout the Mine Site**
Agency Input

- Water Control and Permitting Designed to Maintain Surface Water Flows and Quality

- What Key Items Does the Water Plan Need To Address?
  - Flow
  - Temperature?
  - Others?
Next Steps

• Final Development and Review of Water Balance
• Initial Design and Locations for Site Water Control
• Submit Final Draft Conceptual Water Management Plan to Agencies for Review
• Begin Developing Detailed Plan
• Review Workshop with Agencies on Draft Detailed Plan
• Revise and Submit Final Detail Water Management Plan