



Overview: Mine Site

Groundwater Data Collection

(February 2-4, 2005 EPA Technical Meeting)



Outline

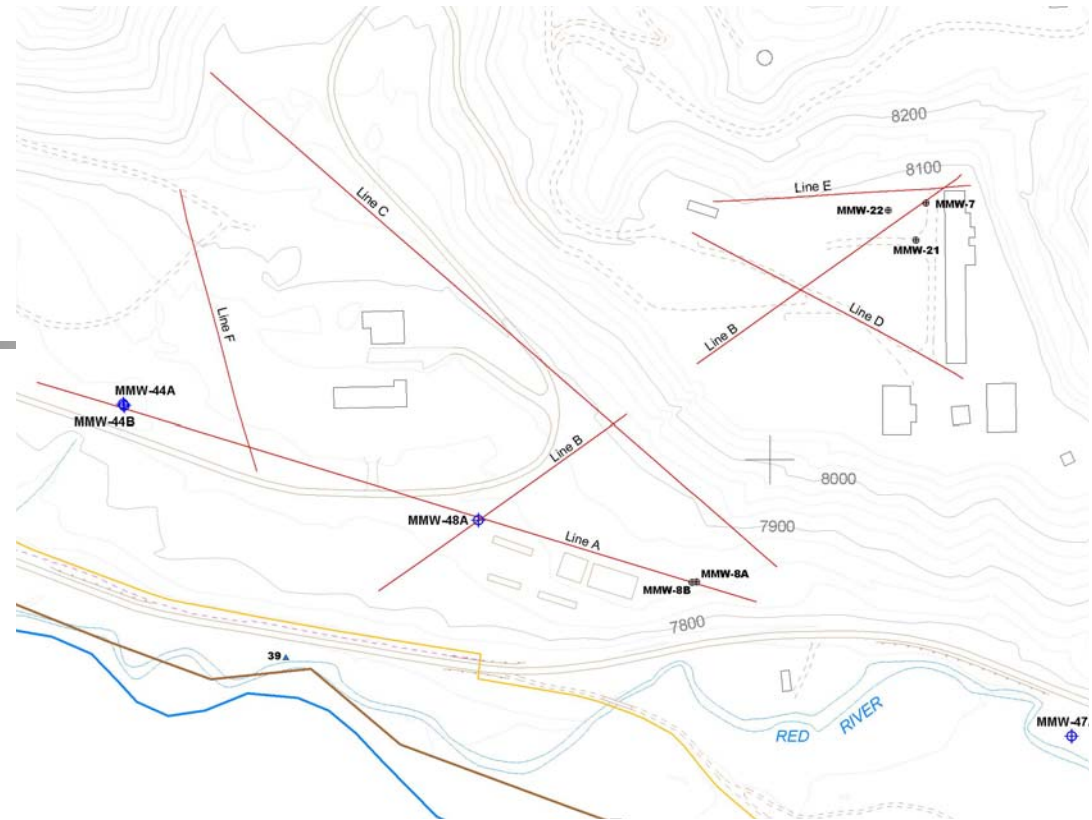
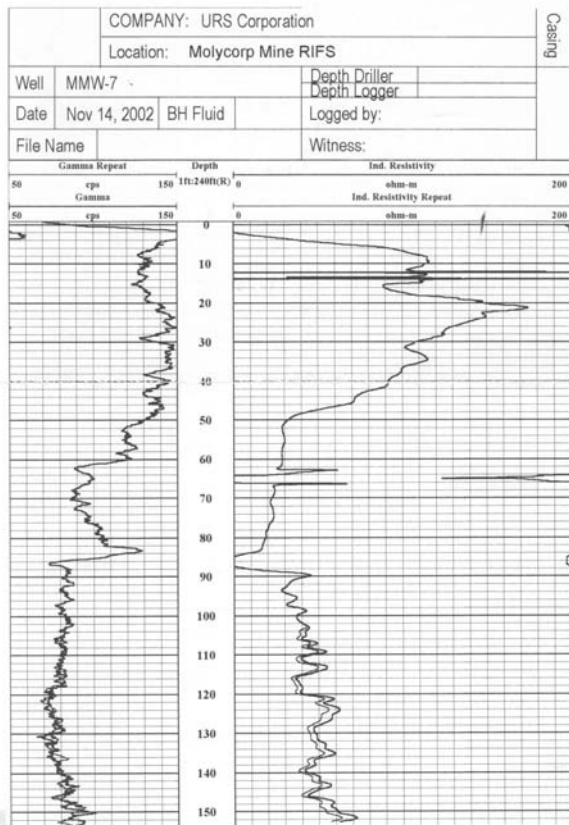
- Summary of data collection
 - Well installations, geophysics, etc.
 - DQOs
 - Off- and on-mine site reference groundwater
 - Mine site groundwater
 - Red River drinking water
- Data review for specific mine areas (e.g, Capulin Canyon, underground workings, Spring 13)
- New information for Front Rock Piles

Drilling and Well Installation



- Planned wells/borings:
 - 8 monitoring wells
 - 1 boring planned for a well but was not installed
- Additional wells:
 - 2 monitoring wells

Geophysics



- 7 seismic refraction and seismic refraction tomography lines at lower Goathill Gulch
- Borehole geophysics in one well MMW-7

Hydraulic Testing of Monitoring Wells

- Objective: estimate hydraulic conductivity of colluvial/debris flow material (March 2004)
- 4 wells were slug tested multiple times
- 1 well was pump/recovery tested
- Not originally in Work Plan



Colloidal Borescope Testing

- Requested by EPA
- Performed in 3 wells in March 2004





Groundwater DQOs

- Concentrations > RBSLs?
- Concentrations > State Groundwater Standards and MCLs?
- Adequately determined the nature and extent of concentrations > RBSLs?

Groundwater Sampling



- Fall 2002 though Spring 2004
- Quarterly sampling of all wells and springs
- Monthly sampling of new monitoring wells

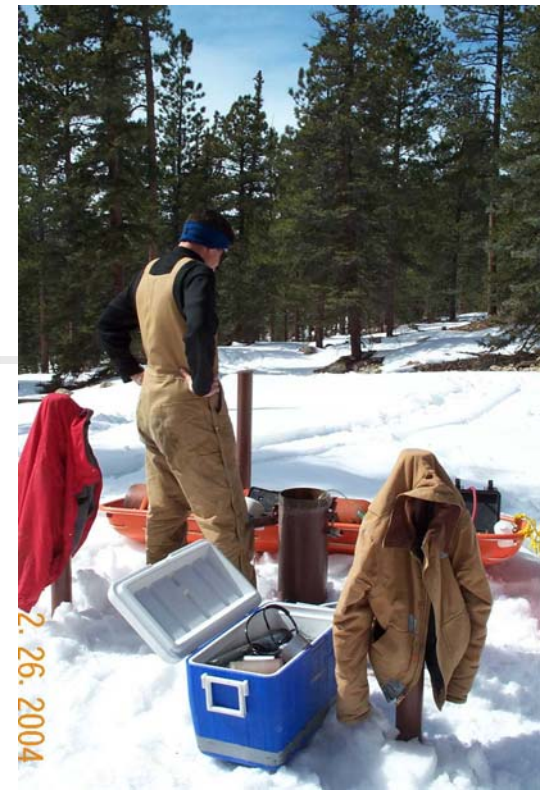


Off-Mine Reference Groundwater

- **Alluvium** (Straight Cr., LaBobita, Elephant Rock GG wells)
 - 14 samples analyzed for metals and inorganics; 1 for stable isotopes
- **Colluvium** (Straight, Hottentot and Hansen Cr.)
 - 31 samples analyzed for metals and inorganics; 1 sample analyzed for stable, sulfur and lead isotopes and age dating

Off-Mine Reference Groundwater

- Bedrock (Straight Cr.)
 - 16 samples analyzed for metals and inorganics; 1 for stable isotopes and age dating
- Alluvial Springs (Waldo and Chambers)
 - 9 samples analyzed for metals and inorganics; 1 sample analyzed for stable isotopes

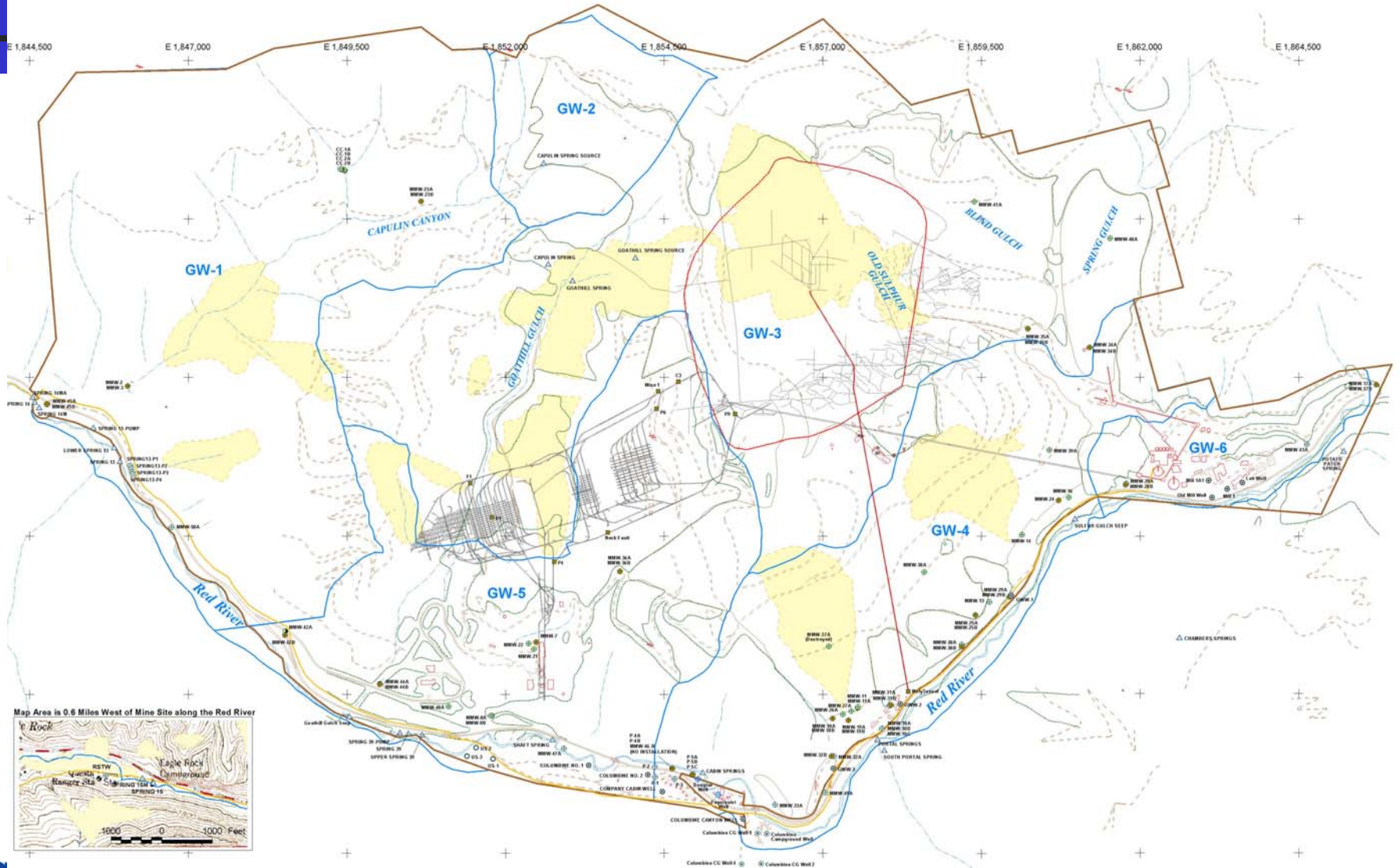


On-Mine Reference Groundwater



- **Alluvium** (MMW-17A)
 - 15 samples analyzed for metals and inorganics; 1 sample analyzed for stable isotopes and explosives
- **Colluvium** (Capulin Canyon CC-1A and -2A)
 - 21 samples analyzed for metals and inorganics; 1 sample analyzed for stable, sulfur and lead isotopes
- **Bedrock** (Capulin Canyon CC-1B and 2B; MMW-17B)
 - 41 samples analyzed for metals and inorganics; 1 sample analyzed for stable isotopes and age dating

Mine Site Groundwater Exposure Areas



GW-1 Capulin Canyon



- 2 alluvial wells
- 2 colluvial wells
- 3 bedrock wells
- 6 alluvial seeps
- 112 total samples collected and analyzed for metals and inorganics
- 1 explosive sample was collected
- 1 age date; 7 stable, 4 lead and 4 sulfur isotopes; and 1 lanthanide samples were additionally collected

GW-2

Capulin Rock Pile

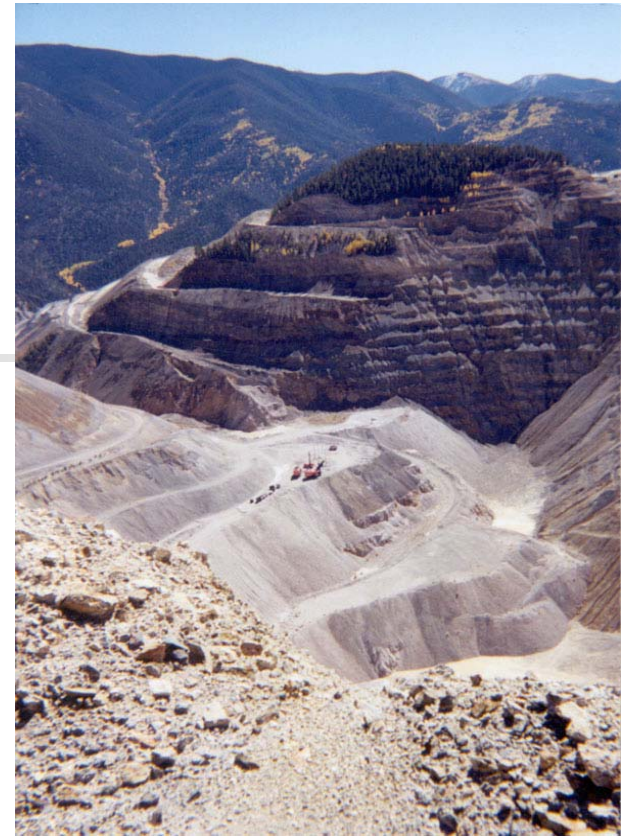
- 1 colluvial seep (Capulin Spring Source)
- 2 total samples collected and analyzed for metals and inorganics
- 1 sample additionally analyzed for stable isotopes



GW-3

Central Mine

- 3 colluvial wells; 2 are dry
- 2 bedrock wells
- 3 underground locations
- 2 colluvial seeps
- 37 total samples collected and analyzed for metals and inorganics
- 10 explosives, SVOCs, and VOCs samples were collected
- 5 stable isotopes samples were additionally collected



GW-4

South Mine Rock Piles

- 22 alluvial wells
- 6 colluvial wells
- 11 bedrock wells
- 1 underground location
- 3 alluvial seeps
- 317 total samples collected and analyzed for metals and inorganics
- 115 explosives; and 2 SVOCs and VOCs samples were collected
- 8 age date; 25 stable, 4 lead and 4 sulfur isotopes; and 9 lanthanides samples were additionally collected



GW-5

Lower Goathill



- 9 alluvial wells
- 5 colluvial wells
- 5 bedrock wells
- 5 underground locations
- 2 alluvial seeps
- 1 colluvial seep
- 206 total samples collected and analyzed for metals and inorganics
- 62 explosives; 66 SVOCs and VOCs; and 5 TPH samples were collected
- 4 age date; 19 stable, 3 lead and 3 sulfur isotopes; and 3 lanthanides samples were additionally collected

GW-6 Mill Area



- 3 alluvial wells
- 1 bedrock well
- 38 total samples collected and analyzed for metals and inorganics
- 2 explosives; and 16 SVOCs and VOCs were collected
- 2 age date; and 4 stable isotopes samples were additionally collected and tested



GSI



- Piezometers at Zwergle, RR-5BB, 11B2, 11B3, 13A, 13B, and 15 were additionally sampled as part of GSI studies (October 2003, April and September 2004)
- 72 samples were collected and analyzed for dissolved metals and inorganics



Town of Red River Drinking Water

- The Town operates 4 wells ½ mile up Pioneer Creek
- Wells are completed in alluvium along the creek
- The only water treatment consists of chlorination
- 3 total samples were collected from Red River Condos Nos. 1 and 2, and Red River Lodge
- Samples were analyzed for metals and inorganics

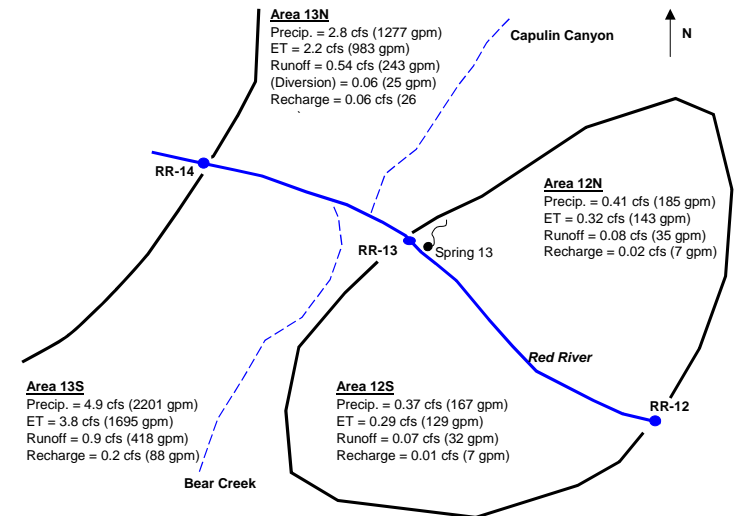


Data Review for Specific Mine Site Areas

Capulin Canyon



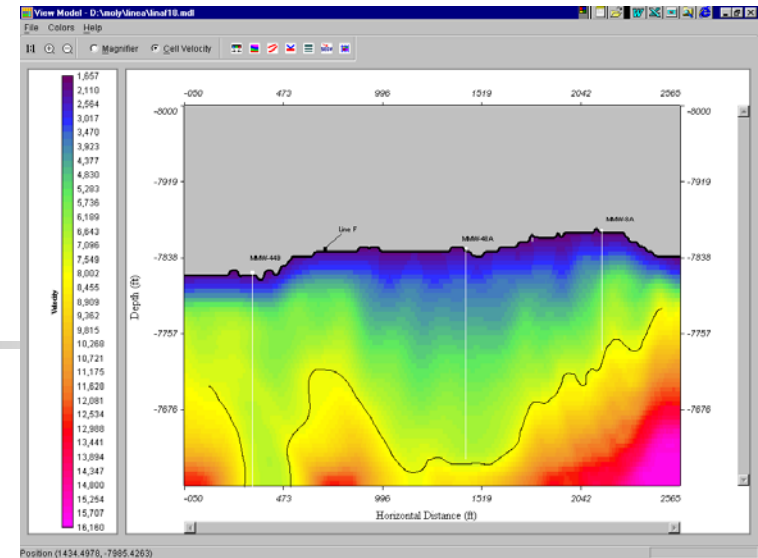
- 2 colluvial and 2 bedrock wells
- Hydraulic testing in all 4 wells
- Estimate of groundwater recharge from preliminary water balance
- Colluvial underflow at canyon mouth
- Groundwater chemistry and water levels



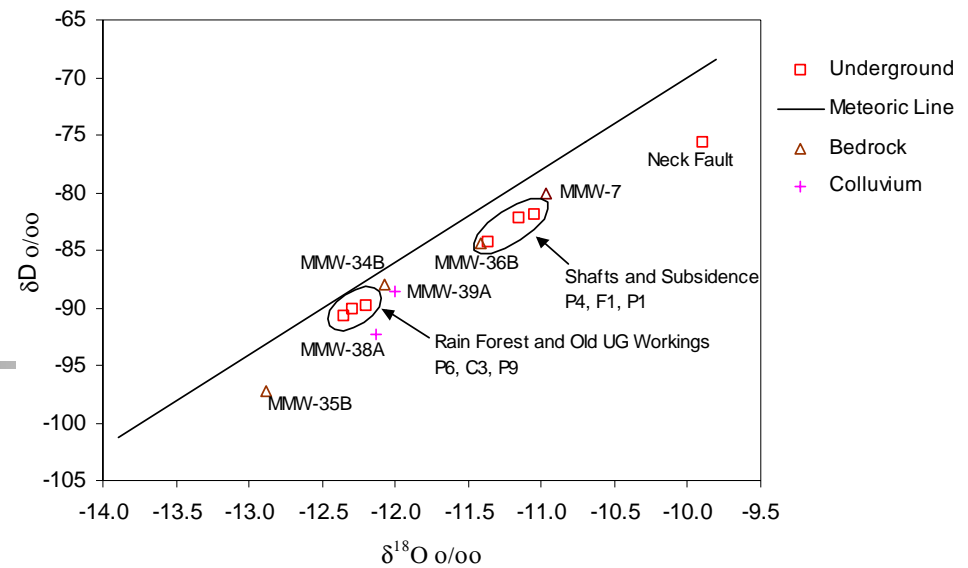
Preliminary - For Discussion Purposes Only

Lower Goathill/ Sugar Shack West

- 7 geophysics lines
- Contour of top of bedrock surface
- 7 colluvial and 5 bedrock wells
- Hydraulic testing in 2 wells
- Borescope in MMW-7 and MMW-36B
- Stable, lead, sulfur isotopes; lanthanides and age dating
- Debris fan underflow estimates
- Groundwater chemistry and water levels

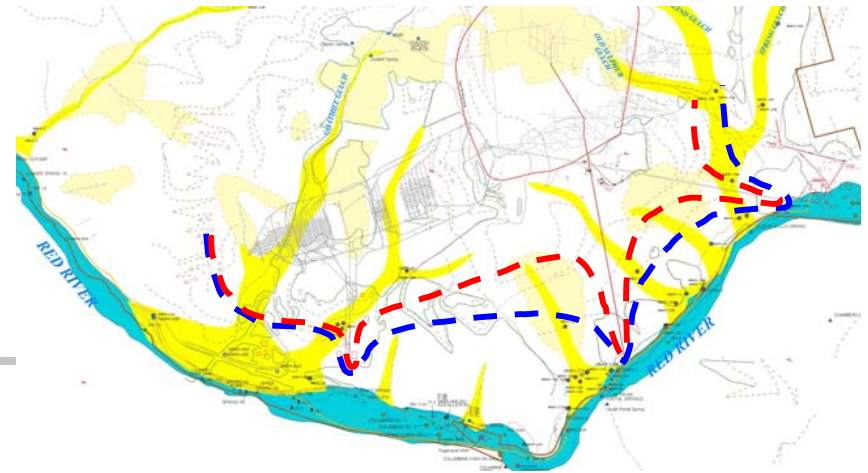


Underground Workings



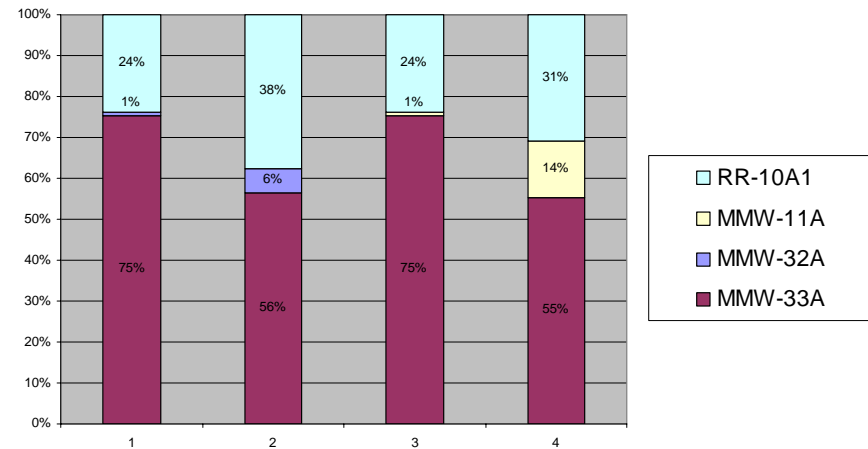
- Historical and current inflow rates
- Water and load balance
- Groundwater chemistry
- Stable isotopes linking surrounding bedrock groundwater to underground water

Dewatering Influences



- Borescope for 3 wells showing flow directions toward underground or shafts/tunnels
- Stable isotopes linking surrounding bedrock groundwater to underground water
- Water levels showing steady declines
- Estimate of dewatering influences and capture zone

Cabin Springs

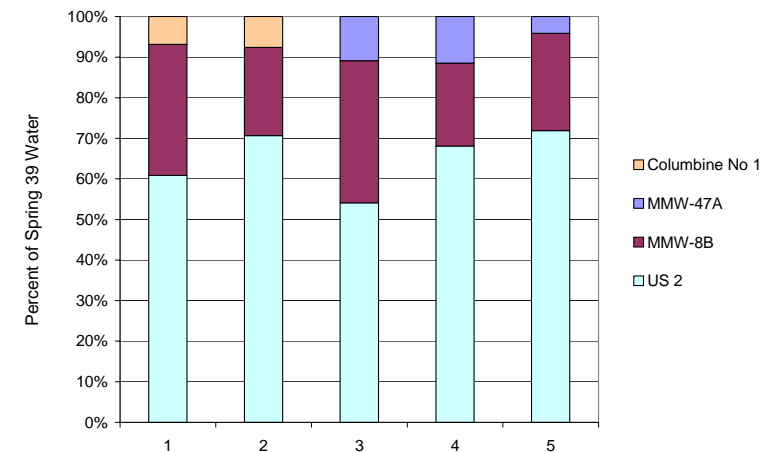


- Historical chemistry and flow
- 1996 pumping test of Columbine No. 2 and pumping effects on spring flow
- Surrounding alluvial and bedrock groundwater chemistry
- Correlations between high water table and times of spring flow
- Geochemical modeling of upgradient waters

Spring 39



- Historical chemistry and flow
- Geochemical modeling of surrounding waters
- Groundwater flux measurements from:
 - 2001 and 2002 USGS tracer tests
 - 2002 to 2004 RI flow measurements
 - 2004 Radon 222 study



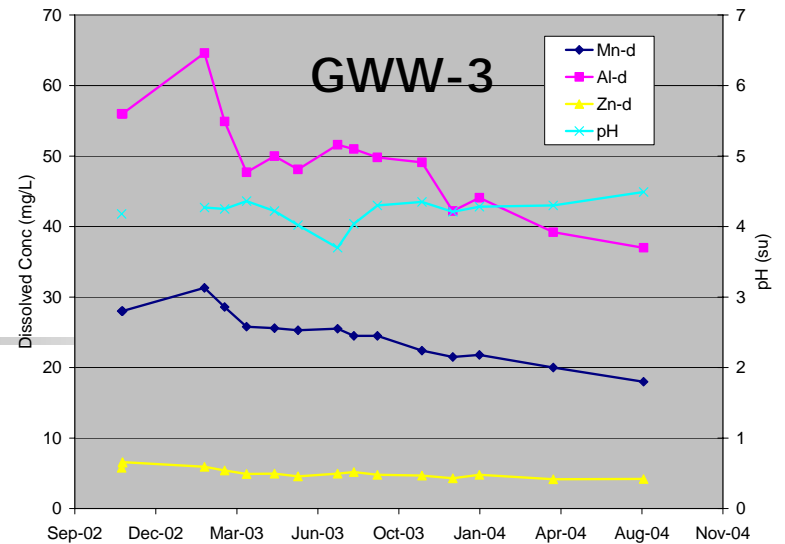
Spring 13



- Historical chemistry and flow
- Estimate of groundwater recharge in the area from preliminary water balance
- Stable isotopes and age dating
- Geochemical modeling of surrounding waters
- Groundwater flux from USGS tracer tests; RI flow measurements; Radon 222 study
- Identified areas of natural mineralization
- Identified areas of fill material after 1979 flood



Best Management Practices



- Chemical and flow information for:
 - Groundwater Collection System:
 - GWW-1, -2 and GWW-3
 - Spring Collection Systems:
 - Spring 39 Pump and Spring 13 Pump

Data Collection Summary



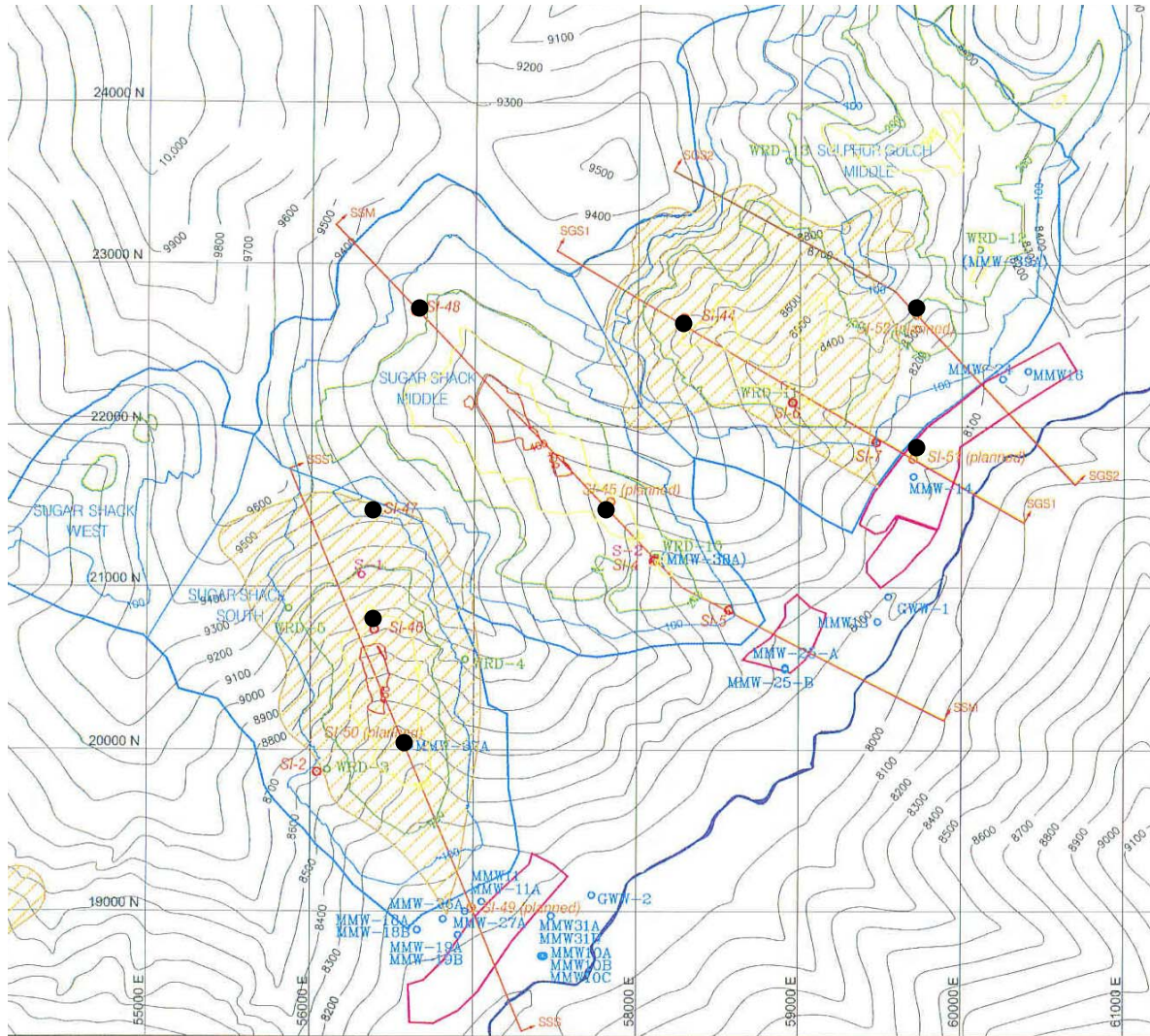
- ~ 950 groundwater/seep samples were collected
- ~ 180 samples from GSI piezometers and additional wells were collected in addition to what was planned
- ~ 50 additional samples were collected and analyzed for one or more of the following: stable, lead or sulfur isotopes; age dating; or lanthanides
- The collective groundwater and seep data have been used to assess the nature and extent of contamination
- Collection efforts have satisfied groundwater DQOs

New Information for Front Rock Piles

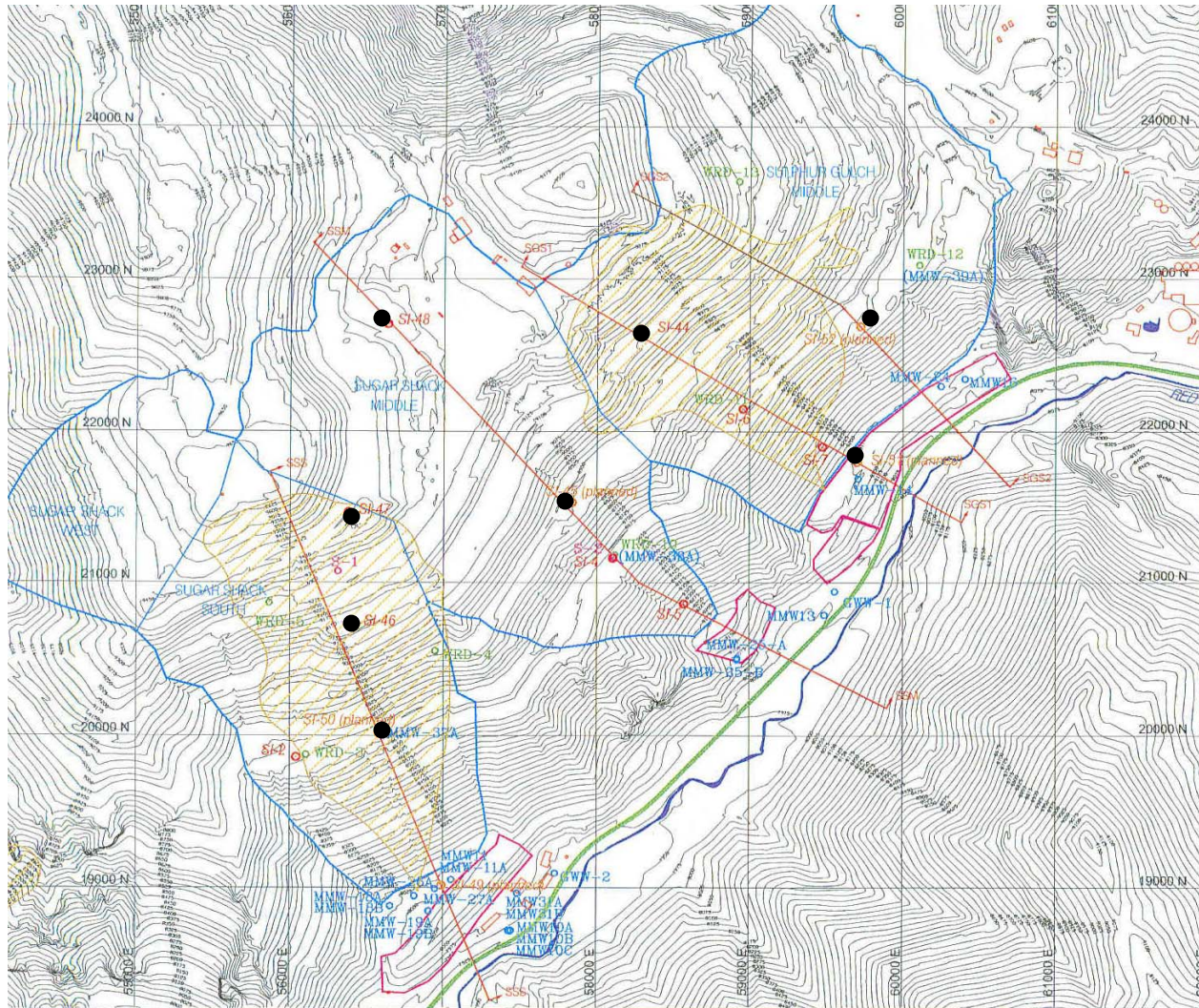


- Source: September 28, 2004 update on geotechnical analysis of front rock piles
 - Installed 8 Slope Inclinometers
 - Installed vibrating wire piezometers in rock pile, colluvium and bedrock at each location (Piezometers are saturated for a min of 24 hours)
 - Becker drilling rig used
 - Annulus in bedrock is grouted, colluvium and mine rock filled with pea gravel; surface is not sealed and surface water can infiltrate

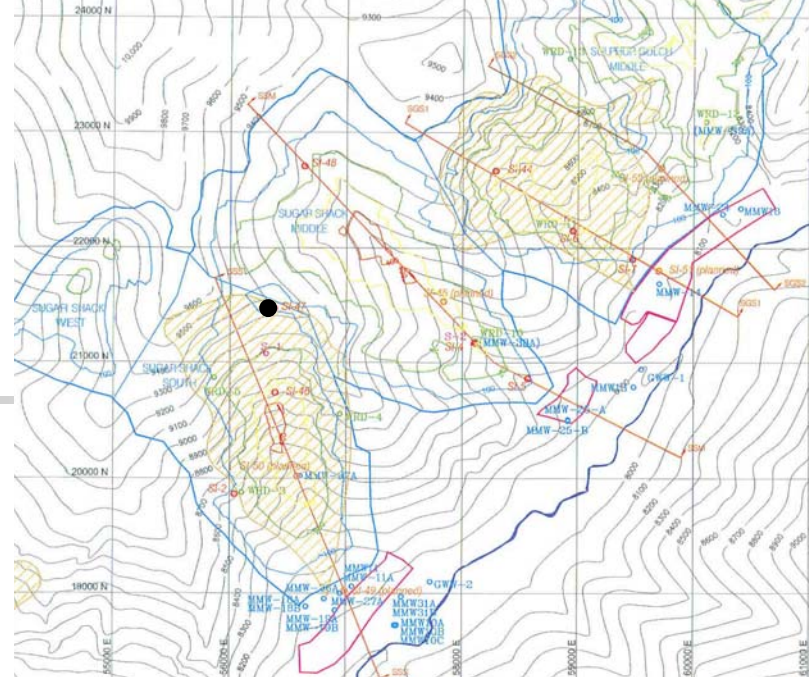
Front Rock Piles with New SI Locations (Pre-Mine Topo)



Front Rock Piles with New SI Locations (Current Topo)

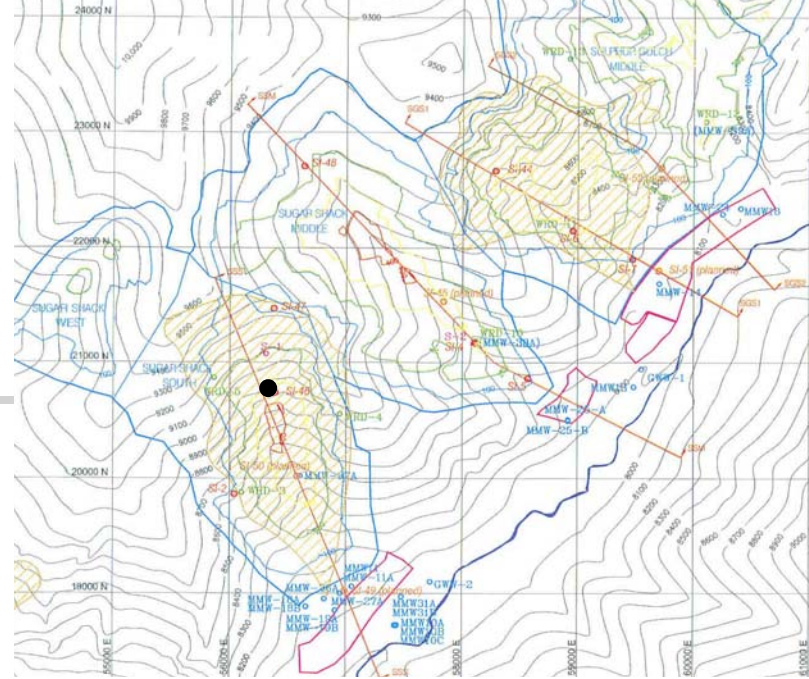


Sugar Shack South Rock Pile



- SI-47 (9,425' 4th bench) VW Piezo depths:
 - In mine rock at 101'
 - In colluvium at 140'
 - In bedrock at 262'
- Little to no colluvium encountered
- Depth to top of bedrock ~ 140'
- All piezometers are dry

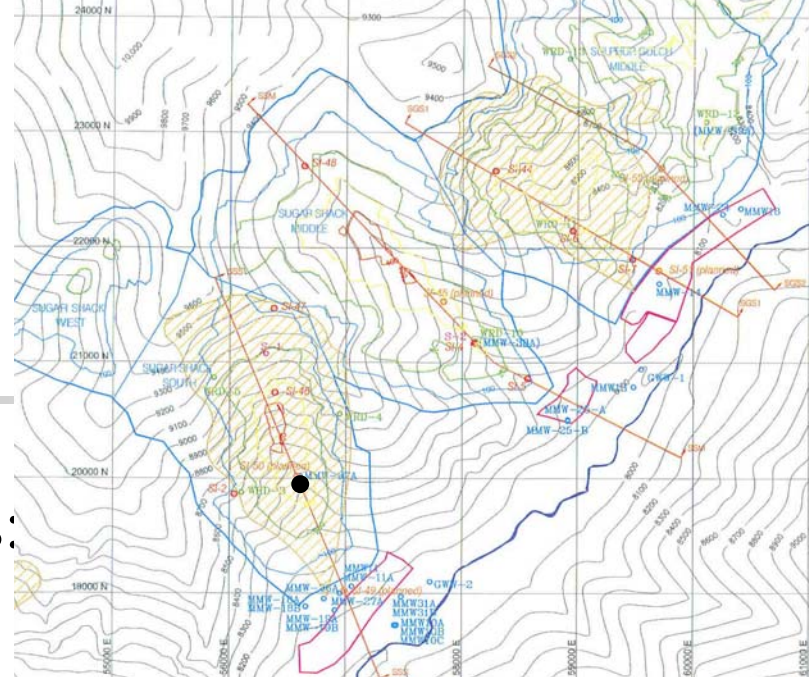
Sugar Shack South Rock Pile



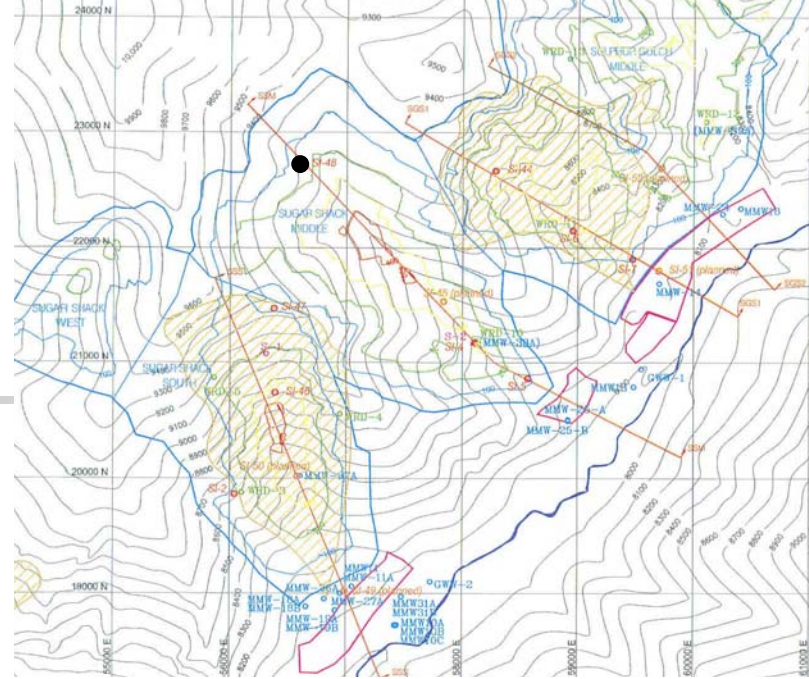
- SI-46 (9,150' 3rd bench) VW Piezo depths:
 - In mine rock at 371'
 - In colluvium at 382'
 - In bedrock at 435'
- Colluvium/mine rock contact at 380'
- Top of bedrock at 383'
- 3' of colluvium
- Piezometers in mine rock and colluvium are dry
- Phreatic surface is in bedrock ~ 8' below top of bedrock

Sugar Shack South Rock Pile

- SI-50 (8,713' 1st bench) Piezo depths:
 - In mine rock at 298'
 - In colluvium at 391'
 - In bedrock at 452'
- Colluvium/mine rock contact a 304'
- Piezometer in mine rock is dry
- Top of bedrock at 400' (96' of colluvium)
- Perched groundwater in colluvium 78' below base of mine rock (~20' of saturated colluvium)
- Phreatic surface is ~7 ft below top of sound bedrock
- Borehole collects runoff

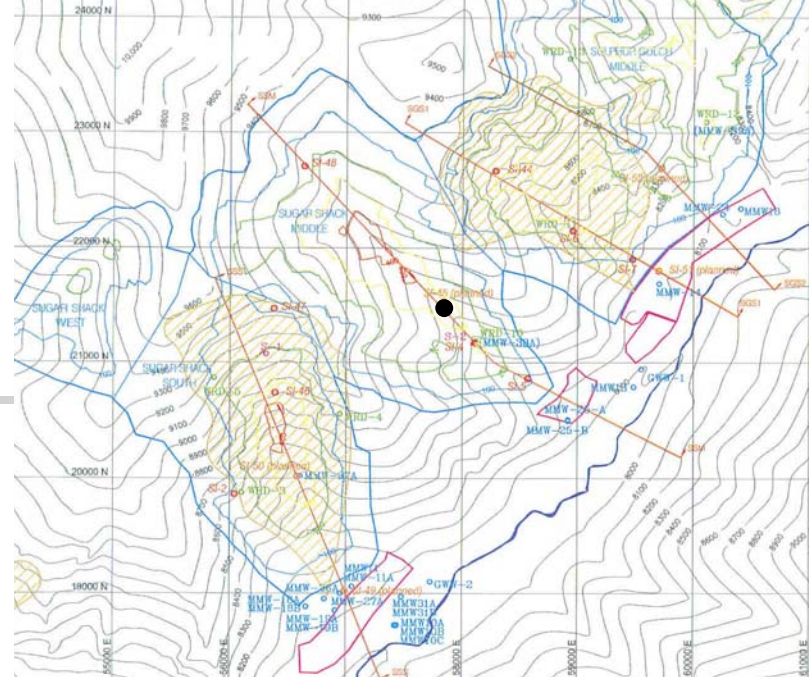


Middle Rock Pile



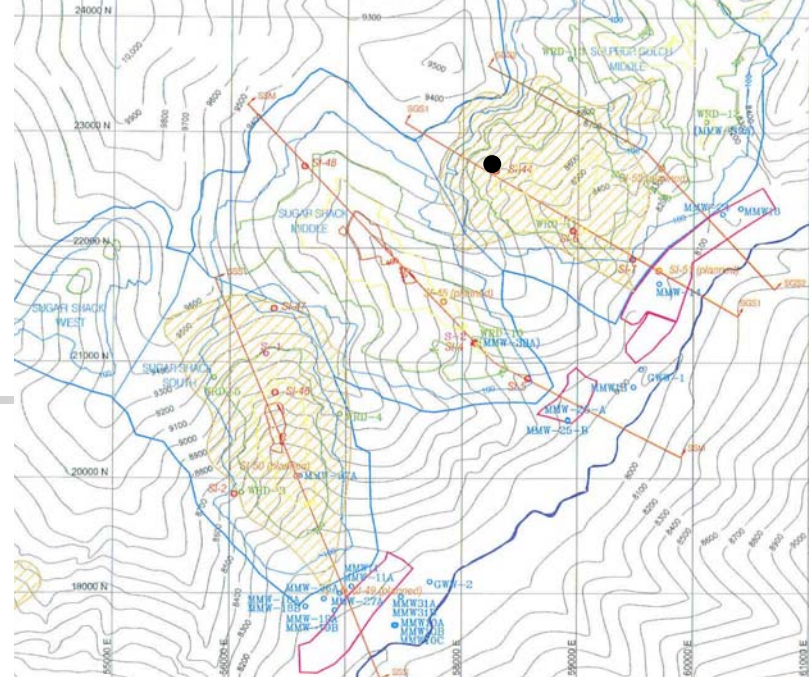
- SI-48 (9,333' top of pile near truck shop) VW Piezo depths:
 - In mine rock at 160'
 - In colluvium at 201'
 - In bedrock at 269'
- Colluvium/mine rock contact at 185'
- Weathered bedrock at 201', solid at 226'
- 16' of colluvium
- All piezometers are dry

Middle Rock Pile



- SI-45 (8,906' 2nd bench) VW Piezo depths:
 - In mine rock at 285'
 - In colluvium at 342'
 - In bedrock at 386'
- Colluvium/mine rock contact at 314'
- Top of bedrock at 345'
- Colluvium is 31' thick
- Water in colluvium ~ 20' above top of bedrock
- Piezometer data unavailable, newly completed

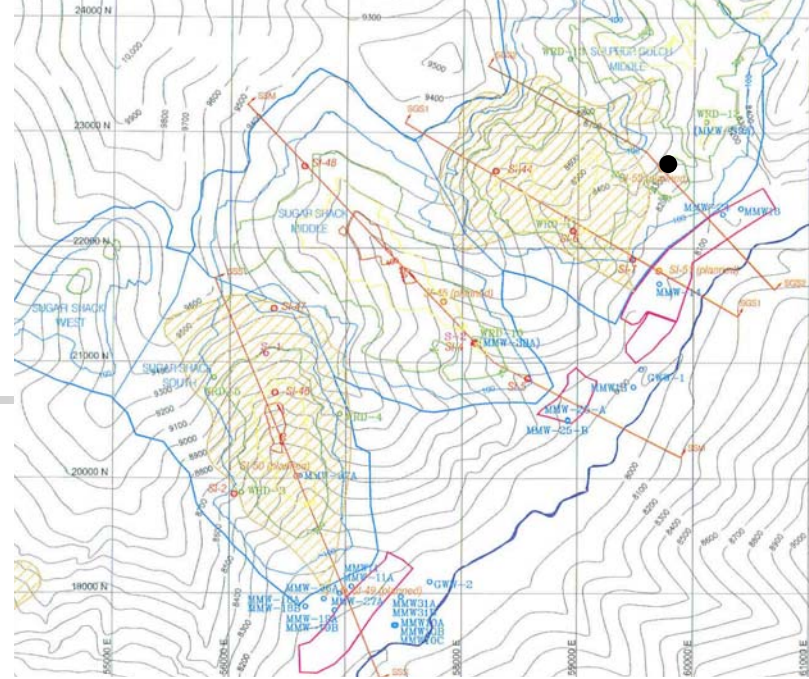
Sulphur Gulch Rock Pile



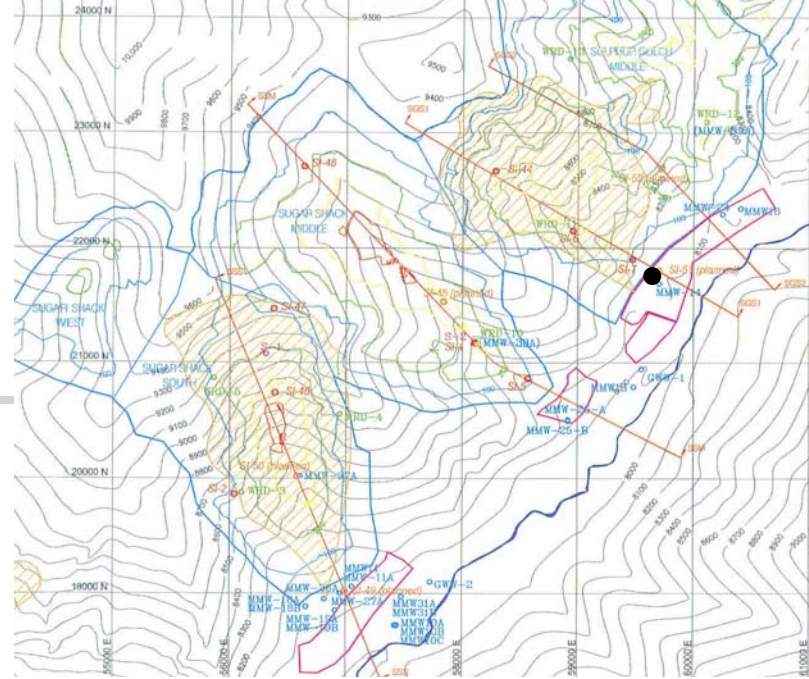
- SI-44 (9,050' 3rd bench) VW Piezo depths:
 - In mine rock at 183'
 - In colluvium at 246'
 - In bedrock at 277'
- Colluvium/mine rock contact at 245'
- Weathered bedrock at 247', sound at 250'
- ~ 2' of colluvium
- No apparent groundwater during drilling
- Piezometer data unavailable

Sulphur Gulch Rock Pile

- SI-52 (8,563 1st bench) Piezo depths:
 - In mine rock at 171'
 - In colluvium at 191'
 - In bedrock at 231'
- Colluvium/mine rock contact at 184'
- Top of bedrock at 197' (13' of colluvium)
- No apparent groundwater during drilling
- Phreatic surface is 34' or more below the top of bedrock
- Piezometer data unavailable
- Borehole collects runoff



Sulphur Gulch Rock Pile



- SI-51 (8,180' toe of rock pile) VW Piezo depths:
 - In mine rock at 72'
 - In colluvium at 152'
 - In bedrock at 179'
- Colluvium/mine rock contact at 112'
- Top of bedrock at 153'
- Wet zone noted at 50 to 80 ft during drilling, then slight moisture to dry conditions into bedrock
- Piezometer data unavailable



How Does the New Information Add to Our Current Understanding?

- **Mine Rock:**
 - Unsaturated except for about 6' at MMW-38A in Middle Rock Pile
- **Colluvium:**
 - Thins upslope
 - Additional saturation found at:
 - Sugar Shack South at SI-50 (1st bench 8,713')
 - Middle Rock Pile at SI-45 (2nd bench 8,906')
 - Unsaturated below all rock piles by 3rd bench (9,050')
 - Groundwater may be perched (e.g., SI-50)



How Does the New Information Add to Our Current Understanding?

- Bedrock phreatic surface
 - Deepens upslope
 - Can be greater than 120' below the top of bedrock (e.g., SI-47 Sugar Shack South)
 - Is at least 34' below the top of bedrock surface at SI-52 (1st bench), suggesting that the decline dewateres the overlying bedrock as previously proposed