Humbug Creek Watershed Assessment
Pre-Tour Presentation
Reclaiming the Sierra Conference 2012
Malakoff Diggins State Historical Park

• Malakoff Mining Pit and town of North Bloomfield –intimately connected
• National Register of Historic Places (No. 852)
• Public Resources Code (5019.59) mandates the DPR to preserve and protect
Overview

• History
• Current Conditions
• Assessment Goals
• Field trip landmarks
North Bloomfield Mining Company

- Formed in 1866
- Malakoff Diggings operated from 1866-1900
- Largest and best financed mines in the West
- Claims covering ~1,600 acres with gravel 250-600ft deep
- Estimated capacity of gold in 1870 ~$69 Million
- Sawyer Decision 1884, Caminetti Act 1893
- Debris dams to contain HMD-Englebright
Drain Tunnels

• 1851-Hiller Tunnel 450ft long (over capacity by 1872)
• 1875-North Bloomfield Tunnel 7,874 ft
  – Eight shafts ~200ft deep, 4.5 x 9ft wide
  – 1,900 ft of sluice
  – 6,000ft no sluice use bare rock of tunnel
• 4,000ft of undercurrents to South Yuba
Historic use of Mercury

- Quicksilver was added to the sluices to catch the gold
- 15 flasks, 1,147.5 lbs were added to sluices and undercurrents each run (Mineralogist Report in 1882)
- Mercury was also scattered over the bank to be washed and allowed to work down
- 30% of mercury lost, equal to 30lb of mercury per meter of tunnel lost each year during 1853-1884 (Bowie, 1905)
- **9,778 kilograms** of elemental mercury were lost to the environment at Malakoff Diggins (Moyle, 1993)
35-40 Million gallons of water were used each day—provided by the Yuba Canal Company.

~40 M yrd$^3$ of rock was mined (Jarman 1927).

~29 M yrd$^3$ was discharged as tailings to SYR.

Pit is 7,000 ft long, 3,000 ft wide and 600 ft deep.
Operation Summary

1. Gold bearing gravel was washed from the cliffs
2. Slurry was directed through a series of flumes on the pit floor
3. Slurry fell 440ft down the pit shaft (Shaft 8)
4. Washed through 7,874 ft tunnel
   - 1,900 ft of sluice, where 75lbs flasks of mercury were added
   - 6,000 ft of bare rock
5. Discharged into 4,000 ft of undercurrents
6. Washed into the Humbug Creek and South Yuba River
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Unstable Landscape

- One mile long pit (7000ft), half mile wide (3000 ft)
- Surrounded by cliffs 200-750 ft high
- Aquiferous gravels, Quaternary colluvium and Holocene deposits
- Diggins erosion and deposition processes
  - ~50,000 yrd$^3$/yr average erosion
  - ~30,000 yrd$^3$/yr deposition of sand and gravel
Air Shafts and Tunnel Openings

- Shaft 1 Pond
- Shaft 2 Hole
- Shaft 3 Red
- Shaft 5 Green
- NB Tunnel opening
- Shaft 8 in Pit
Suspended Sediment Concentration vs Discharge

Hiller Tunnel
Water Quality Measurements
1979 NCRCD and 1986 DWR

Suspended Sediment Yield vs Discharge

Turbidity vs Discharge
Potential Sources of Mercury rich sediments

1) hydraulic pit floor
2) tunnel and associated shafts
3) Humbug and Diggins Creek channels
4) Gravel and sediment terraces above waterways
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Watershed Assessment

• A tool to **help identify available data or information gaps**
  
  ▪ The scientific interpretation of watershed information and data, leading **to conclusions about watershed condition**
  
  • An objective problem-solving tool that **identifies the potential causes of problems**
  
  • Analysis and findings that can be used to **develop appropriate actions**
  
  • A component of a watershed management package that **leads to planning, implementation, evaluation, and additional monitoring**
What will the watershed assessment be used for?

- Informing a watershed management plan
- Regulatory concerns
- Restoration or enhancement planning
- Monitoring program development
- Remediation action development and design
Issue Based Questions

What can be done to improve the water quality of Humbug Creek Watershed?
- Turbidity
- Mercury
- Other Metals

What is the sediment yield for Diggins and Humbug Creek?

Where is the mercury coming from?

What restorative actions would improve water quality?

How can the physical hazards be addressed?
Working Hypotheses

• Malakoff Diggins, Hiller, Lake City, and North Bloomfield Tunnels, and other mines within the Humbug Creek watershed are releasing sediment and metals in quantities that are impacting the ecosystem.

• Water quality impairments could be reduced through adjustments to physical and chemical conditions at source areas.

• Alteration or reduction of sediment transport mechanisms could significantly reduce sediment and mercury contamination both within mining-related sites and at downstream locations.
Sampling Plan Components

- Streamage; Hydrology, Turbidity
- Storm event sample collection
  - Grab samples for mercury, TSS, other metals
- Air Shaft and Tunnel Water Chemistry
- Mercury Source ID-Macroinvertebrates
- Pit Erosion and Deposition
- Soil Development-quality
- Mercury Remediation
Water Quality Sampling Locations
Event Driven Sampling Plan for Mercury and TSS

Brooks Rand Laboratories: EPA Methods 1630

- 1-3 grab samples for each storm
- 3-5 storms
- THg (unfiltered and filtered)
- TSS
- Other metals

TSS, Turbidity and Hg Relationship
Poster by Harihar Napar
Chico State Graduate Student
Sampling Dates

November 2011-present

Stage (ft)

Grab Samples
Metal Sampling in Air Shafts and Tunnels

BSK Laboratories: EPA Methods 200.7 and 200.8

- Water Chemistry of shafts and tunnels
  - Sampled with a bailer
- Bacterial processes
- Transport tracing

David DeMaree
Chico State Graduate Student
Mercury Source ID

- Macro-invertabrate sampling
  - Summer 2012

Susan Miller
Chico State Graduate Student
Biota Sampling Locations

- Diggins Creek Watershed
- Malakoff Diggins
- Hiller Tunnel
- Lower Humbug Creek Watershed
- North Bloomfield Tunnel
- Lake City Tunnel
- Gold Separation Flume

Gage Location
Pit Erosion and Deposition Processes

Keith Landrum
Chico State Graduate Student
Soil Development

Kathy Berry-Garrett
Chico State Graduate Student
Mercury Remediation
Phyto translocation

Rebecca Bushway
Chico State Graduate Student
Assessment Purpose Statement

To determine the watershed processes that contribute to the degraded state of the watershed, specifically with respect to, water quality.

The primary purpose of determining the processes contributing to water quality degradation is to design solutions that mitigate these impacts and improve ecosystem health.
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Thank you!
Working Group
Chico State
Graduate Students