

# PRESENTATION ABSTRACTS



Reclaiming the Sierra:  
Green \$olutions to Abandoned Mines

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Miners Foundry  
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# INSTALLATION AND OPERATION OF A PASSIVE TREATMENT SYSTEM TO TREAT MINING INFLUENCED WATER FROM THE MAGENTA DRAIN PORTAL AT EMPIRE MINE STATE HISTORIC PARK, GRASS VALLEY, CA

James Gusek, Lee Josselyn, William Agster, Steve Lofholm, and Daniel Millsap

**Abstract.** Empire Mine State Historic Park (EMSHP) near Grass Valley, CA contains historic mine workings that flooded with ground water since the Empire Mine closed in 1957. Mining influenced water (MIW) perennially flows from portions of the underground workings via the Magenta Drain portal located near the northwest corner of the Park and into an unnamed channel. The MIW water has a neutral pH (no acid mine drainage), but contains elevated concentrations of iron, arsenic, manganese, and various other trace metals. Design treatment flows vary significantly from 20 gallons per minute to a maximum 100 year storm event level of 1,200 gallons per minute.

Several active treatment alternatives were evaluated including traditional lime dosing and green sand; passive treatment technologies, including biochemical reactors were also considered. However, bench scale test results indicated that simple settling of suspended iron oxy-hydroxide (with co-precipitated arsenic) and passive aerobic precipitation of manganese oxide could meet regulatory mandated effluent limits. Passive treatment methods are economical, with lower initial capital costs, lower long term operations and maintenance costs and smaller carbon footprint than active treatment methods. Keeping with California's Dept. of Parks and Recreation (DPR) Mission Statement, "to preserve the State's extraordinary biological diversity and protecting its most valued natural and cultural resources," the technology is green and sustainable which is critical since the passive treatment system (PTS) will, in principle, operate into perpetuity.

The PTS was designed considering the climate, flow regime, and space considerations of the site. MIW is diverted from the Magenta Drain portal to a pump vault where it is conveyed through an above-ground insulated pipe into a settling pond and then through two different types of aerobic wetlands where settling, precipitation and natural biochemical processes occur, and the treated water is returned by gravity to the Magenta channel just downstream of the diversion point. The pond and wetlands are lined with geosynthetic membrane liner. The PTS is designed so that the majority of the iron precipitate and co-precipitated arsenic will settle into the settling pond. Wetland 1 contains approximately 12 inches of soil planted with willows and rushes, providing oxygenation to further remove additional dissolved iron from the MIW. Wetland 2 contains limestone that supports algae that will remove manganese. PTSs typically take from two to three years to mature and reach their maximum metals removal capability.

DPR and their consultant worked collaboratively with the Central Valley Regional Water Quality Control Board to prepare a Report of Waste Discharge and are in the process of obtaining revised Waste Discharge Requirements for operation and monitoring of the treatment system performance.

The PTS has been operating since November 2011 with excellent results. Even though the system is not fully mature, a majority of the effluent limits were met within the first four months of operation and will continue to improve overall as the system matures.

The PTS requires minimal operation and maintenance compared to an active treatment system and uses natural processes to remove metals from MIW. In addition, the PTS does not require a fixed plant that would utilize hazardous/toxic chemicals to recover metals in the MIW.

**Additional Key Words:** passive treatment system, arsenic, iron, manganese, trace metals

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For presentation at the Reclaiming the Sierra: *Green Solutions for Abandoned Mines Conference*, Nevada City, CA. May 3, 2012

James Gusek and Lee Josselyn are engineers, Bill Agster is the construction manager, and Steve Lofholm is a hydrogeologist with Golder Associates Inc. Daniel Millsap is the EMSHP Project Manager for the California Department of Parks and Recreation.

## Assessment of Mercury and Mine Waste Deposits at Stocking Flat in the Deer Creek Watershed, Nevada County, California

C.N. Alpers<sup>1</sup>, J.A. Fleck<sup>2</sup>, E. Beaulieu<sup>3</sup>, R.L. Hothem<sup>4</sup>, J.T. May<sup>5</sup>, M. Marvin-DiPasquale<sup>6</sup>, A.E. Blum<sup>7</sup>, and P.G. Graves<sup>8</sup>

<sup>1</sup> U.S. Geological Survey, California Water Science Center, 6000 J St., Placer Hall, Sacramento, CA 95819; [cnalpers@usgs.gov](mailto:cnalpers@usgs.gov); 916-278-3134

<sup>2</sup> U.S. Geological Survey, Sacramento, CA 95819, [jafleck@usgs.gov](mailto:jafleck@usgs.gov)

<sup>3</sup> U.S. Geological Survey, Sacramento, CA 95819, [ebeauli@usgs.gov](mailto:ebeauli@usgs.gov)

<sup>4</sup> U.S. Geological Survey, Dixon, CA 95620, [roger\\_hothem@usgs.gov](mailto:roger_hothem@usgs.gov)

<sup>5</sup> U.S. Geological Survey, Sacramento, CA 95819, [jasonmay@usgs.gov](mailto:jasonmay@usgs.gov)

<sup>6</sup> U.S. Geological Survey, Menlo Park, CA 94025, [mmarvin@usgs.gov](mailto:mmarvin@usgs.gov)

<sup>7</sup> U.S. Geological Survey, Boulder, CO 80303, [aebalum@usgs.gov](mailto:aebalum@usgs.gov)

<sup>8</sup> Bureau of Land Management, Sacramento, CA 95814, [p15grave@blm.gov](mailto:p15grave@blm.gov)

Stocking Flat, located on Deer Creek about 3 km downstream (west) of Nevada City, is a site that includes a rapidly eroding cut-bank containing sediment made up of a mixture of hardrock mine waste, placer mine waste, and other sediment from the watershed. During the latter half of the 19th century and the first part of the 20th century, it was common practice throughout the western U.S. to use mercury (Hg) to enhance gold recovery at hardrock gold mines (stamp mills) and at hydraulic mines (sluices), and to deposit Hg-contaminated mine wastes in local creeks and rivers. The U.S. Geological Survey (USGS) sampled sediment from the cut-bank (left bank) and from the adjacent floodplain (right bank) and measured erosion by using tripod-based LiDAR (Light Detection And Ranging).

Preliminary results indicate that more than 163 cubic meters of sediment eroded from the cut-bank between December 2010 and May 2011. This sediment contained at least 12 grams of Hg, a minimum estimate that does not account for discrete beads of liquid Hg or gold-mercury amalgam (AuHg). Mineralogy and geochemistry of three discrete size fractions of sediment (less than 0.063 mm, 0.063 to 0.25 mm, and 0.25 to 1.0 mm) were compared to end-member mine waste from other parts of the watershed to estimate the proportions of hardrock and placer mine wastes in the eroding cut-bank.

In addition, the USGS sampled water, sediment, fish, and predatory invertebrates (larval dragonflies, crane flies, damselflies, mayflies, stoneflies, and dobsonflies; and adult water striders) during 2010-11 to assess temporal and spatial variability of Hg and methylmercury concentrations at several locations in Deer Creek, both upstream and downstream of Stocking Flat. Results from these investigations will be used by the BLM to determine whether removal or stabilization of Hg-contaminated sediment may be needed.

**Penn Mine Ecosystem Restoration Project**  
**Effective Soil Remediation and Revegetation Techniques**  
**on Pyritic Mineral Deposits at an Abandoned Copper and Zinc Mine**

Max J. Busnardo (presenter) and Patrick Reynolds (co-author)  
H. T. Harvey & Associates

The East Bay Municipal Utility District implemented water quality and habitat restoration actions to restore ecosystem services at Penn Mine. Penn Mine is a 30-acre abandoned copper and zinc mine located on pyritic mineral deposits in the Sierra Nevada foothills adjacent to Camanche Reservoir within the Mokelumne River watershed, California. Prior to restoration, Penn Mine was a substantial source of acidic, copper and zinc laden run-off to the reservoir. Acidic mine waste covered the entire site including two creeks. Site conditions precluded vegetation establishment and acid rock drainage resulted in downstream fish kills. Approximately 360,000 cubic yards of waste rock and alluvium were excavated and moved to an on-site landfill. Soil treatments, creek channel reconstruction and site revegetation were implemented following waste removal. Soil treatments included application of dicalcium silicate, installation of cover soil, and incorporation of composted-organic matter into the cover soil. The cover soil was hydroseeded and planted with California native grassland, riparian and oak woodland species. The soil paste pH, prior to soil treatment, was below the known pH tolerance limits of the target native tree species. Post-restoration monitoring led to the following conclusions: 1) soil remediation measures increased the subgrade soil paste pH; 2) cover soil exhibited improved fertility and aggregate formation; 3) post-restoration soil conditions supported rapid establishment of target native vegetation; 4) red willow, sandbar willow and Fremont cottonwood survived and grew rapidly where floodplain soil paste pH was extremely low (2.5 to 3.5), and; 5) net annual mass export of copper and zinc to Camanche Reservoir decreased by 99 % and 90 %, respectively.

## **Proposed San Juan Ridge Mine**

**Tim Callaway and Clay Guzi**

Shasta Gold Corp

San Juan Mining Corp.'s CEO, Tim A Callaway, will discuss the company's proposal to re-open the San Juan Ridge Gold Mine, located on San Juan Ridge in Nevada County. The San Juan Gold Deposit is a cemented placer (gravel) deposit, a remnant of a 60 million year old extinct riverbed that sits on the San Juan Ridge. The San Juan Ridge Gold Mine was operated as an underground mine by a former owner from 1993 to 1997, and closed with declining gold prices in late 1997. When the prior operation was granted a Conditional Use Permit by Nevada County, there was years of baseline environmental studies completed and more than one Environmental Impact Report prepared. The prior project's impacts on the community surrounding the mine will be discussed in detail by Mr. Callaway.

San Juan Mining Corp. is located in Nevada City, and was formed for the express purpose of mining the San Juan Deposit. The company is proposing to re-open the underground mine and conduct operations there for approximately 10 years. San Juan Mining Corp. has proposed to pay for a new Environmental Impact Report, which will be prepared by Consultants selected and retained by Nevada County. Issues important to the community as well as to San Juan Mining Corp., such as groundwater, traffic, wildlife, streams, air quality, noise impacts, etc. will be studied in great detail with mitigations measures developed to eliminate or reduce project impacts. The company believes they can effectively prevent the prior project impacts, but acknowledges there is essentially no project without some form of impact. San Juan Mining Corp. hopes to work with leaders in the San Juan Ridge community, and in Nevada County, to create effective mitigation measures for the impacts identified during the environmental review process.

## **Toolkit Training Program for Health Care Providers**

**Tony DeRiggi, MD**

The Toolkit is a combination of easy-to-use reference guides for health providers and user friendly health education materials on preventing exposures to toxic chemicals and other substances that affect infant and child health.

The Toolkit materials are a compilation of current knowledge on the effects of toxic chemicals on child development, and have been endorsed by the American Academy of Pediatrics.

The Pediatric Environmental Health Toolkit Training uses various case examples to highlight the relationship between environmental exposures and children's health, and clinical use of the Toolkit.

Upon completion the learner will be able to:

- Identify routes of exposure to common toxic chemicals and substances including mercury, lead, arsenic, solvents, pesticides, and persistent organic compounds such as PCBs;
- Recognize links between these toxic chemicals and health effects;
- Provide anticipatory guidance keyed to well-child visits;
- Enhance patient communications on environmental health issues;
- Discuss the unique vulnerabilities of children, the “built” and “food” environments, and other important issues;
- Use the Pediatric Toolkit in the busy practice setting.

## Engineered Pumpable pHoam™: A New Innovative Method for Mitigating Acid Rock Drainage

James Gusek<sup>1</sup>, Brian Masloff<sup>3</sup>, and John Fodor<sup>3</sup>

Presented by Paul Eger<sup>2</sup>

### Abstract

If one can embrace the medical analogue, much of the mining industry currently suffers from a massive bacterial infection. When pyrite-bearing or sulfide-bearing rock formations, tailings, or mine wastes are infected by *Acidithiobacillus ferro-oxidans*, the likelihood of forming acid rock drainage (ARD) is almost guaranteed. The “pharmacy” of antibiotics available is extensive, ranging from solid alkaline amendments like limestone to liquid “medicines” such as sodium lauryl sulfate, sodium thiocyanate, waste milk, and bipolar lipids. Unfortunately, the “geo-medical” teams of geochemists, microbiologists, engineers, and mine managers lack the tools to surgically apply these active ingredients where they are needed most with a minimum of waste. Distribution of fine grained limestone on the surface of an acidic mine waste dump is analogous to applying a bandage soaked in antacid to treat an upset stomach. The implementation of up-to-date best management practices has not healed the patient; an equivalent combination of hypodermic needle, cyber knife, and arthroscopic probe is clearly needed.

Using an engineered, flow-able or pumpable foam or pHoam™ as the medicinally analogous “dextrose delivery solution” for solid and/or liquid “geo-antibiotics”, the authors have combined off-the-shelf technologies that have been previously applied in solving geotechnical problems in the mining industry. A patent for the innovative process is pending. This paper discusses method concepts and the advantages it could provide over conventional best management practices.

Preliminary laboratory test results suggest that the delivery of solid and liquid materials into porous, unsaturated rock can provide a variety of ARD-suppressing coatings.

The timing of ARD-suppressing materials’ application to ARD-prone wastes in the mining and processing cycle may govern whether these materials behave as a post-infection medicine or as a vaccine that prevents infection altogether. Field demonstration sites are being sought.

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<sup>1</sup>Golder Associates Inc., Lakewood, CO, USA, [James\\_Gusek@golder.com](mailto:James_Gusek@golder.com)

<sup>2</sup>Golder Associates Inc., Minneapolis, MN, USA, [Paul\\_Eger@golder.com](mailto:Paul_Eger@golder.com)

<sup>3</sup>Cellular Concrete Solutions LLC, Golden, CO, USA, [bmasloff@cellular-concrete.com](mailto:bmasloff@cellular-concrete.com); [jfodor@cellular-concrete.com](mailto:jfodor@cellular-concrete.com)

## REMEDIAL TECHNOLOGIES FOR MINE WASTES - AN ITRC WEB BASED GUIDANCE

Instructor: Paul Eger (Senior Engineer, Golder Associates Inc.; 1751 West Country Road B, Suite 105, Roseville, Minnesota 55113; 651-697-9737; Paul\_Eger@golder.com)

Overview: The ITRC is a state-led, national coalition helping regulatory agencies, site owners, and technology developers and vendors achieve better environmental protection through the use of innovative technologies. ITRC establishes teams to address major environmental problems facing the states.

Abstract. Mining practices and the lack of mine land reclamation have led to sites with significant environmental and human health issues. Historical and current practices have led to operating sites with mine waste issues that must be addressed when operations cease. Typical remedial solutions are often lengthy and expensive, and are unacceptable to the mining community, the regulatory community and to the public. Some mined sites contain enough residual mineralization that remaining and subsequent reclamation may be economically feasible. Some current operations may even have the infrastructure in place to co-manage the cleanup of legacy waste while in operation. However, current regulations often provide barriers to these approaches. Innovative approaches and technologies need to be developed and implemented at current and former mining projects that solve our environmental issues and remove existing regulatory barriers. The ITRC Mine Waste team has developed a Web-based guidance ITRC MW-1, 2010 (available) at <http://www.itrcweb.org/miningwaste-guidance/> that helps project managers select technologies to deal with mine waste. The guidance contains decision trees, technology overviews, case studies, and regulatory challenges.

The decision trees guide users to a set of treatment technologies that may be applicable to their site. Each technology overview includes information on applicability, advantages, limitations, performance, stakeholder concerns, regulatory considerations, and lessons learned. Case studies support the technology overviews. Together the guidance helps project managers decide how well a technology may fit their remedial/reclamation goals.

**Update on California Suction Dredge Mining Regulation, Legislation, Litigation**  
**Abstract and Presentation by Steve Evans, Friends of the River**

Suction dredging is a form of placer gold mining. A 2-8 inch diameter nozzle and hose attached to a centrifugal pump, driven by an engine, suctions gold-bearing gravel and sediment from the stream or river-bottom. The gold is captured in a sluice and the remaining sediment and gravel is discharged back into the river.

Suction dredging mining was common in the gold-bearing streams of the Sierra Nevada, Klamath Mountains, and San Gabriel Mountains of California. The California Department of Fish and Game (CDFG) issued an average of 3,200 permits annually under the old 1994 regulations. In 2006, a state court ordered CDFG to develop new mining regulations and in 2009 it enjoined CDFG from issuing any permits pending new regulations. This moratorium was reinforced by the California Legislature in 2009.

CDFG issued draft suction dredge mining regulations in early 2011. CDFG's environmental analysis found that suction dredging causes several unmitigated significant impacts, including water pollution from the discharge of mercury and other heavy metals, disturbance of riparian habitat and riparian-dependent bird species, cumulative effects on wildlife and habitat, substantial adverse change to historical and archeological resources, and violation of local noise ordinances. Mining critics also believe the proposed regulations fail to adequately address adverse impacts on wild trout and threatened and endangered fish and allow mining in State and National Parks, Wild & Scenic Rivers, Indian Reservations, and other areas where mining is typically prohibited.

In 2011, the California Legislature adopted budget language that required CDFG to adopt regulations that mitigate all significant impacts and propose a fee structure that covers state costs. CDFG issued revised regulations in early 2012, but the regulations fail to comply with state law. Conservationists, anglers, and Native Americans, as well as miners, are again challenging the regulations in state court.

## **Revegetation for Slope Stabilization and Erosion Control in California Mine Reclamation**

**GARDNER, Leah, Dept. of Conservation, Office of Mine Reclamation**

*801 K Street, MS 09-06, Sacramento, CA, 95814. Leah.Gardner@conservation.ca.gov*

Revegetation offers the best long-term, sustainable solution to stabilizing slopes and preventing erosion and sedimentation on lands disturbed by surface mining. The self-perpetuating revegetated cover intercepts raindrops and reduces the velocity of surface runoff while the plant roots help bind the soil together providing tensile strength to slopes and decreasing the incidence of erosion, slumping, and slope failure.

Established native plants blend the site with the natural surroundings and provide ecosystem services, such as supporting microbial and chemical processes and biotic interactions. Examples of revegetation successes on mined lands throughout California will be used to explain the techniques of successful revegetation in a variety of ecosystems. Requirements for revegetation under SMARA (California's Surface Mining and Reclamation Act) will also be discussed.

## Reclaiming Hydraulic Gold Mine Sluice Tunnels

### Rick Humphreys

Authors:  
HUMPHREYS, Richard D.  
State Water Resources Control Board  
1001 I Street  
Sacramento, CA 95814  
[Rhumphreys@waterboards.ca.gov](mailto:Rhumphreys@waterboards.ca.gov)

WEAVER, Rick  
United States Forest Service, Tahoe National Forest  
631 Coyote St.  
Nevada City, CA 95959  
[rweaver@fs.fed.us](mailto:rweaver@fs.fed.us)

SHIPLEY, Brad  
United States Forest Service, Tahoe National Forest  
631 Coyote St.

Nevada City, CA 95959  
[bshipley@fs.fed.us](mailto:bshipley@fs.fed.us)

LAWLER, David  
Bureau of Land Management  
2800 Cottage Way, Suite W-1834  
Sacramento, CA 95825-1886  
[dlawler@ca.blm.gov](mailto:dlawler@ca.blm.gov)

WEDEN, Chris  
United States Environmental Protection Agency,  
Region 9  
75 Hawthorne Street  
San Francisco, CA, 94105  
E-mail not available at this time

Sluice tunnels were used at hydraulic mines between about 1860 and 1890 convey hydraulic mine debris and water from mine pits to nearby rivers or streams and recover gold. These tunnels, driven through rock, ranged in length from hundreds to thousands of feet and thus, were major engineering feats of their day. Literally hundreds were built. Wooden sluices installed in these tunnels were charged with mercury to enhance gold recovery. During mining, much mercury was lost with hydraulic mine debris, and through sluice floorboards. The tunnels were a major conveyance for mercury enriched-hydraulic mine debris from the mines to the major Sierra Nevada and Sacramento River watersheds. Even though hydraulic mining was shut down by the 1884 Sawyer decision, regional legacy mercury pollution manifests itself today as elevated mercury in biota, and has led to fish consumption advisories at numerous waterbodies.

Additionally, since the late 1990's, these tunnels have been "rediscovered" and recognized as environmental hazards because they often contain substantial amounts of mercury lost through sluice floorboards. Amateur gold prospectors tear up the sluices and recover gold impregnated mercury from the sluice foundation. Over the last 7 years, CERCLA Response Actions by the United States Forest Service, Bureau of Land Management, and the United States Environmental Protection Agency were directed at three tunnels. The objective of these actions was to prevent mercury in them from being removed. Although the tunnels were similar, treatment methods employed varied greatly. The presentation will provide an overview of the similarities and differences of the three projects.

## Sustainable Remediation and Green Resource Extraction Practices of Acid Mine Drainage Sites

James A. Jacobs and Stephen M. Testa

Acid mine drainage (AMD) is created from the oxidation of pyrite and other iron sulfide minerals exposed to water and oxygen in the atmosphere in the presence iron and sulfur oxidizing bacteria. The resulting biochemical reactions create sulfuric acid and low pH waters, which in turn, solubilize other associated metals such as aluminum, manganese, iron and heavy metals contained in the surrounding rocks and sediments.

The Sierra Range in California contain countless acid mine drainage challenges at orphan metal mine sites where the miners have long ago extracted the gold and valuable minerals and left the waste rock and mine pits open to the atmosphere where acid mine drainage processes start. The acid drainage process precipitates the orange-yellow iron hydroxide staining that is common in creeks and rivers in mining areas. Once started, the acid drainage process is virtually impossible to stop and remediate. Over the past decade, advances in understanding biochemical processes associated with acid mine drainage has allowed for a more sustainable approach to remediation and resource recovery. In addition to recycling water from former mine pits, acid mine drainage can be used as a source of resources. In several cases in West Virginia, Maryland and Pennsylvania, treated mine waters are being used to grow rainbow trout as aquaculture benefits from the dewatering of excess shallow groundwater from coal mines in areas where mine drainage problems are common. Recovery of metal resources can be enhanced by optimizing the microbial environment which favors bioleaching and precipitation using various biomining techniques. Wetlands construction is a way to provide valuable wildlife habitat and passive ecosystem services while passively treating acid mine drainage. Acid mine drainage case studies associated with water reclamation, aquaculture, biomining and wildlife habitat creation will be discussed in the context of sustainable remediation and green resource extraction practices.

James A. Jacobs, P.G., C.H.G., is president of Environmental Bio-Systems in Mill Valley, California (geojimj@gmail.com). Stephen M. Testa, P.G., C.E.G. is the Executive Officer at the California State Mining and Geology Board (stesta@goldrush.com). They are co-editors with Jay Lehr on a book titled *Acid Mine Drainage, Rock Drainage and Sulfate Soils: Prediction and Remediation* to be published by John Wiley & Sons in the near future.

## **Addressing Administrative Challenges to Abandoned Mine Site Cleanup**

**Stephen McCord (McCord Environmental), Greg Reller (Burleson Consulting)**

About 50,000 abandoned mines across the State of California pose a combination of physical, toxic, and water quality threats to humans and the environment. While many of these abandoned mines' features (such as rock piles, openings, pits, and denuded areas) are significant, uncontrolled sources of toxins and sediment to California water bodies, there remains a distinct lack of clarity in both federal and California regulatory programs to address them. Currently, four California and Federal regulatory programs address abandoned mine sites that are contaminating surface waters: California Public Safety and Health Code, California Water Code, Federal Clean Water Act, and Federal Comprehensive Environmental Response, Compensation, and Liability Act. While the engineering solutions to control much of the metal and sediment contamination of California's waterways attributed to abandoned mines are reasonably straightforward, compliance with the wide array of regulatory requirements often paralyzes interested parties who would like to take action. This talk will summarize the current regulatory programs, first noting the paralyzing requirements but then also sharing success stories and suggested improvements.

**Alternative methods for the evaluation of arsenic bioavailability:  
Reclaiming mine-scarred lands while protecting human health**

**Valerie Mitchell, Ph.D. and Perry Myers**

Mitchell, V.L.<sup>1</sup>, Basta, N.T.<sup>2</sup>, Casteel, S.W.<sup>3</sup>, Myers, P.<sup>2</sup>

<sup>1</sup> California Department of Toxic Substances Control, 8800 Cal Center Drive, Sacramento, CA 95826

<sup>2</sup> School of Environment and Natural Resources, The Ohio State University, Columbus, OH 43210

<sup>3</sup> Dept. of Veterinary Pathobiology, University of Missouri, Columbia, MO 65211

Abandoned Mine Lands in California are a major threat to human health and the environment and a challenge for Brownfields revitalization. Arsenic is the key chemical of concern at the majority of former gold mines in the California Mother Lode. Many of these former mining areas are now high growth areas within California's expanding population. Under current practices many sites are cleaned up to background due to arsenic's high cancer potency. However, it is known that frequently only a fraction of the arsenic in soil is bioavailable thus resulting in overly conservative cleanups. Alternative site-specific cleanup goals may be established upon completing expensive and time-consuming *in vivo* studies that estimate the relative bioavailability (RBA) of arsenic in a given soil. DTSC was awarded a Training, Research and Technical Assistance Grant from USEPA to identify and develop less expensive methods capable of predicting bioavailability of arsenic in soils from former mine sites. Utilization of these methods will potentially allow for more cost effective site evaluations and subsequent cleanups while continuing to be protective of human health and the environment. DTSC has partnered with Ohio State University, United States Geological Survey, Chapman University, and the University of Missouri to complete a study to accomplish this goal. A total of 25 soil samples were collected from the Empire Mine State Historic Park (EMSHP) region to assist in the development of these methods. Soils were homogenized and screened down to less than 250 um fractions and distributed to the investigative team for various analyses. The total arsenic content of these soil samples ranged from 15 to 12,095 mg/kg. Six of these 25 samples were identified as being of particular interest based on various criteria including total As content (302-12,041 mg/kg), predicted *in vitro* bioaccessibility (IVBA) (1.5-9.3%), and mineralogical content. These 6 soils were then analyzed using the *in vivo* method. RBA's ranged from 3.8 to 19.6%. IVBA as measured in a gastrointestinal model correlated with the RBA results but consistently under predicted the *in vivo* results. A five-step sequential chemical extraction technique was also utilized to estimate RBA. The arsenic liberated in the first 3 fractions combined ( $\Sigma$ F1-F3) consistently over estimated RBA while the first 2 fractions ( $\Sigma$ F1-F2) under predicted RBA. An intermediary step (F2.5) aimed at improving the accuracy of prediction of RBA is currently being developed. Six additional samples have been selected for *in vivo* analysis to be completed in the summer of 2012. The 12 total site samples, as well as catalogued samples from previous studies, will be used to refine the sequential chemical extraction technique and evaluate the efficacy of the method on soils from various mineralogical regimes. Results to date, progress on refining the *in vitro* analysis and what is planned for the next 12 months will be discussed during the session.

## **Fish and Dust: Two Studies on Exposure to Mining Toxins in the Gold Country**

**Carrie Monohan, Ph.D., Science Director, The Sierra Fund Nevada City, CA 95959**

Two pilot studies were conducted to assess the exposure potential to mining toxins that remain as a result of the Gold Rush, The Gold Country Angler Survey and The Gold Country Recreational Trails and Abandoned Mines Assessment.

### *Gold Country Angler Survey*

Methyl mercury exposure and health hazard awareness of people fishing at mercury-contaminated water ways was determined based on responses to a standard interview. A total of 151 interviews were completed in 2009 and 2010 (Rollins Lake (33), Upper Scotts Flat (23), Camp Far West (21), Lake Englebright (17), Nimbus Dam (16), Lake Wildwood (15)). Over 90% of respondents reported eating fish that were caught by themselves or by someone they know. Approximately half (47%) the anglers interviewed planned to eat the fish they caught that day, and the majority of those (73%) planned to feed the fish to their families. Anglers often feed the fish they catch to children under the age of 18 (50%), women of child bearing age (54%) and, to a lesser extent, pregnant women in their household (6%). Mercury exposure calculations indicate that 9% of anglers interviewed consumed more mercury than state guidelines recommend. The maximum mercury exposure level from sport fish consumption calculated from the survey responses was 90 µg MeHg/day, more than four times the recommended safe level of 21µg MeHg/day.

### *Gold Country Recreational Trails and Abandoned Mines Assessment*

Recreational trail layers were overlaid with known abandoned mine sites databases using GIS. Surface soil samples were taken from sites where trails went through or near (within 30 ft) abandoned mine sites. This pilot study identified contaminants of concern (COC) at popular recreation areas around Downieville, Nevada City, and Foresthill, CA. In the Downieville area, Saddleback Road had elevated levels of lead (max. 1,570 mg/kg), the Columbo Mine area had elevated levels of arsenic (max. 442 mg/kg), and Slug Canyon on the North Yuba Trail Extension also had elevated levels of arsenic (max. 439 mg/kg). In the Nevada City area, Banner Mountain Trail and mine waste above Little Deer Creek had elevated levels of arsenic (max. 4,050 mg/kg). In the Foresthill off-highway vehicle (OHV) designated recreation area, lead was at elevated levels in the Marall Chrome Mine (max. 4,790 mg/kg). In addition asbestos was detected at the Marall Chrome Mine pit and on the Loop 4 Trail (max. 40% chrysotile).

### *Summary*

These results indicate that people are consuming locally-caught sport fish from mercury-contaminated water ways in amounts that exceed safe levels and that people may be exposed to elevated levels of heavy metals on dusty trails at popular recreation areas. Additional surveys and a comprehensive dust exposure study are recommended in addition to immediate posting of contaminated sites.

## **Mercury Health: Information on Mercury in the Environment and in the Human Body**

**Sherri Norris, Executive Director, California Indian Environmental Alliance**

California Indian Environmental Alliance (CIEA) is pleased to partner with The Sierra Fund to offer our “Mercury Health: Information on Mercury in the Environment and in the Human Body” at Reclaiming the Sierra 2012. California Indian Environmental Alliance (CIEA) staff has given mercury in the human body presentations and trainings since 2003.

This training provides a background on how mercury gets into waterbodies and, subsequently as methylmercury, into the fish that we eat. Participants will learn how to identify at risk patients, how to advise patients to reduce mercury in their bodies, and receive an overview of the wide variety of symptoms of mercury exposure.

Participants will receive a set of CIEA’s peer-reviewed educational materials, developed to address the educational needs of high risk communities and pregnant women, developing fetuses, and children, who are most affected by mercury in the human body. These include CIEA’s “Eating Fish Safely” brochures, “Mercury Health Toolkit,” and available local fish advisory information.

This training is eligible for a maximum of 1.0 AMA PRA Category 1 Credits™ through CIEA’s partnership with the Center for Occupational and Environmental Health, accredited by the Institute for Medical Quality/California Medical Association.

**Physicians:** The COEH Continuing Education Program is accredited by the Institute for Medical Quality/California Medical Association (IMQ/CMA) to provide continuing medical education for physicians. The COEH Continuing Education Program takes responsibility for the content, quality and scientific integrity of this CME activity.

The COEH Continuing Education Program designates *Mercury Health* for a maximum of 1 *AMA PRA Category 1 Credits™*. Physicians should only claim credit commensurate with the extent of their participation in the activity. This credit may also be applied to the CMA Certification in Continuing Medical Education.

**Nurses:** COEH Continuing Education Program is a provider approved by the California Board of Registered Nursing, Provider # 12983. Nurses may report 1.2 contact hours for this course.

## **Leona Quarry Reclamation: Soil Treatments, Native Plant Revegetation and Five Years of Long-term Monitoring of a Formerly Severely Degraded Site**

Pat Reynolds, Associate Restoration Ecologist (H. T. Harvey & Associates)-Presenter  
Max Busnardo, Senior Associate Restoration Ecologist (H. T. Harvey & Associates)-Co-author

Leona Quarry in Oakland, California, operated from 1900 through the 1980's. Quarry activities created highly disturbed, steep and unstable slopes dominated by bare soils and invasive plant species. The approximately 40-acre quarried slope spans approximately 700 vertical feet and is a highly visible scar in the Oakland hills. An interdisciplinary team of civil and geotechnical engineers, restoration ecologists and landscape architects worked collaboratively to design the reclamation. The design goals included slope stabilization, soil preparation to facilitate native plant establishment, and revegetation in an effort to restore native plant-dominated coastal sage scrub, chaparral, and oak woodland.

Following a 3-year pilot revegetation program, H. T. Harvey & Associates prepared revegetation plans for the main quarry that incorporated lessons learned from the pilot program. The soil amendment approach was designed to create soil conditions similar to nearby undisturbed reference sites.. Different soil treatment approaches were required for cuts and fills. Due to stability concerns, soil amendments could not be directly incorporated into the cut slopes and were applied to the soil surface via hydroseed equipment. Individual planting holes within cut slopes were backfilled with on-site amended topsoil. Soil amendments were directly incorporated throughout the fill slopes. The revegetation methods included hydroseeding of native shrubs and herbaceous vegetation over the entire site and container plant installation over approximately 40% of the site.

Five years of vegetation monitoring has shown high plant survival, high and increasing cover of native tree and shrub species and increasing average tree heights. Fill slopes had more vegetative cover than cut slopes. Similarly, seed recruitment created more vegetative cover than container plantings. Several biotic factors negatively affected plant establishment, particularly non-native plant invasion and deer browse. Good vegetation maintenance coupled with close coordination with monitoring results and maintenance activities, played a key role in facilitating native habitat establishment.

## Reclamation of Spenceville Copper Mine

### Stephen Reynolds

Stephen Reynolds, Senior Engineering Geologist  
California Geological Survey  
801 K Street, Suite 1324  
Sacramento, CA 95814  
916-322-6968  
Stephen.Reynolds@conservation.ca.gov

The abandoned Spenceville copper mine is located in western Nevada County California, within California Department of Fish and Game's (DFG) Spenceville Wildlife Area. The mine reclamation was a unique and successful blending of multiple government and private-sector entities collaborating to eliminate a significant environmental and safety hazard while enhancing recreational opportunities on public lands. DFG chose to pursue performance standards for the reclamation contract. This approach required DFG provide real-time on-site expertise for project management. In addition, it required contractors be capable of real-time adaptations to changing conditions. DFG chose a team of small firms and experts from government agencies.

The 10-acre site encompassed 60,000 cubic yards of mine waste, and a one-half acre water-filled mine pit. The mine pit contained 71/2 million gallons of pH 2.5 acid mine drainage. Surface water runoff from the waste piles and ground-water seepage through the pit resulted in an on-going discharge of AMD to tributaries of Bear River. AMD contained high concentrations of copper, zinc, iron, and aluminum, toxic to aquatic life, contributed to general watershed degradation.

The reclamation included the innovative use of sugar-beet processing waste to treat mine waste. Treated mine waste was used to backfill the mine pit. A multi-stage system was used for treatment of the mine-pit AMD. Treated AMD was used to irrigate wildlife fodder. Geomorphic-based protocol was used to define final site contours. The project also included construction of 800 feet of new stream channel based upon geomorphic design. Five years of quarterly post-reclamation water quality monitoring. The project received regulatory certification in 2008.

## **The Mining Law of 1872: the Mark of a 140-Year-Old Law on the California Landscape**

**Elyssa Rosen, Pew Campaign for Responsible Mining**

In 1969, the late and legendary U.S. Interior Secretary Stewart Udall, when he left the cabinet, wrote, "After eight years in this office, I have come to the conclusion that the most important piece of unfinished business on the nation's resource agenda is the complete replacement of the Mining Law of 1872." More than four decades later, this 19th-century relic stubbornly remains on the books, at a high cost to America's environment and its taxpayers. In our modern era, the industry that mines gold, uranium and other hardrock minerals on America's public lands still operates under a law largely unchanged since it was signed by President Ulysses S. Grant to encourage development of the frontier. Today global industries do not compensate taxpayers for what the Congressional Budget Office estimates is \$ 2.4 billion worth of precious metals taken each year from public lands in the West, and leave the high cost of cleanup. This talk will trace the history of efforts to reform the Mining Law of 1872, compare it to policies that regulate other mineral development, and describe how this antiquated law impacts the California landscape.

## **Semi-Passive Bioreactors for Treatment of Acid Mine Drainage**

**Timothy Tsukamoto, PhD.**

TKT Consulting, LLC  
2050 Driscoll Dr Reno, NV 89509  
tkttim@gmail.com

The use of sulfate-reducing bioreactors to treat acid mine drainage has advantages over active treatment technologies due to the passive to semi-passive nature of the treatment. These semi-passive sulfate-reducing bioreactors utilized sulfate-reducing bacteria which consume ethanol to reduce sulfate to sulfide and precipitate metals as metal-sulfides. Because alcohols do not freeze under normal site conditions, this carbon and energy source can be gravity fed or pumped to supply the bacteria continuously throughout the year. A rock matrix with large pore spaces is utilized in conjunction with a flushing mechanism to reduce the chance of plugging and short circuiting within the bioreactor. In addition, the majority of the metals are removed outside of the bioreactor. Treated water, laden with sulfide is mixed with untreated water in a settling pond where the metals are removed. Water, essentially free of metals, is then passed through the bioreactor where sulfate-reduction and sulfide generation occurs. This system is less active than conventional lime treatment and can operate for longer periods of time without replacement of the matrix when compared to traditional passive bioreactors. This system was developed at the Leviathan Mine, Alpine County California, located in a remote site approximately 7000 ft elevation on the eastern slope of the Sierra Nevada Mountains. The largest and newest semi-passive bioreactor is located at the Nacimiento Mine in New Mexico.

## **Marrall Chrome Mine Preliminary Assessment/Site Inspection (PA/SI), Tahoe National Forest**

**Weaver, R.S.**

U.S. Forest Service, 631 Coyote Street, Nevada City, CA 95959

The Forest Service, an agency within the U.S. Department of Agriculture, is currently investigating the release of hazardous substances at the Marrall Chrome Mine on located on Tahoe National Forest lands in Placer County, California.

The Marall Chrome Mine is a former open pit chromium mine that consists of an open excavation and a tailings pile. The entire pit is excavated in ultramafic rock and serpentine outcroppings are visible throughout the pit. The area surrounding the mine pit also contains serpentine rock outcrops. Naturally-occurring asbestos (NOA) in the form of chrysotile has been detected in samples in mine pit and surrounding area. The site is currently in an active OHV recreation area with trails used for ATVs and dirt bikes. The mine pit is also used for target shooting.

This site was identified in the report "Gold Country Recreational Trails and Abandoned Mines Assessment" released by The Sierra Fund on June 22, 2010. In the report, The Sierra Fund raised potential public health concerns regarding the Site as a result of the presence of elevated concentrations of chromium, lead and chrysotile asbestos in the soils and mine pit and surrounding area.

In response to these findings, the Forest Service contracted with Tetra Tech EMI, Inc. to conduct a preliminary assessment/site inspection (PA/SI) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for the Marall Chrome Mine. The purpose of which was to define the nature and extent of any contamination that may be present, the potential exposure threat to human health and the environment, and whether a response action under CERCLA is warranted.

Tetra Tech collected soil, tailings, sediment, and surface water samples to identify potential release areas, evaluate whether a release of hazardous substances has occurred, assess potential risk to human and ecological receptors, and assess potential threats to water quality. All samples were analyzed for total metals, and select samples were analyzed for asbestos and dissolved metals through waste extraction testing. The following areas were identified by the Forest Service for assessment:

- Roads and Trails
- Mine Pit and Tailings
- Mine Pit Drainage Channel and Pagge Creek

Potential risks to human health and ecological receptors were evaluated by comparing concentrations of metals in solid matrix samples to federally accept screening criteria that is used to evaluate metals at Abandoned Mine lands.

## **Transport of mercury past a recreational dam on Deer Creek in Nevada County, California**

**Justin Wood, Sierra Streams Institute**

Deer Creek is impacted by a century and a half of gold mining, development, water management, and agriculture. A study of the means and extent of downstream transport of mercury past Lake Wildwood dam, a recreational dam on Deer Creek, was completed in 2012, the result of a long collaboration with the Lake Wildwood Association. The study investigated the hypothesis that mercury is being transported past the dam trapped in a sediment/organic matter complex, during storms and the periodic reservoir release. The project consisted of collection and analysis of water samples during winter storms in 2008-2011 and during the periodic release conducted in 2008 and 2011. These data were combined with flow data collected downstream of Lake Wildwood to calculate the amount of mercury leaving the reservoir and the watershed during high flow events. A significant element of the project was collaboration with Lake Wildwood to make modifications to the management of the release so that the health of the downstream creek, which hosts spawning salmon, is protected. During the October 2008 release, total transport of mercury was 9g of mercury directly below the reservoir and 13.5g of mercury 3.35 miles downstream of the reservoir, a mile from the Yuba River confluence. Peak flows showed an average of 0.03g/hr of mercury transport, with a maximum of 0.23g/hr. Composition of transported material bound to the mercury was 40-70% sediment, with the remainder presumed to be organic matter, including algae. Management practices during the 2011 release were modified from the 2008 release strategy, most notably the duration of the release which was reduced from 17 days to 8 days. Hydrological and water quality data analysis is in progress to determine which practices are most beneficial to salmon and to downstream watersheds, and to guide future releases.

## Framework for Responsible Mining: an Alaskan perspective

Kendra Zamzow, PhD<sup>1</sup>

Mineral extraction impacts the environments, economies, and social fabrics. “Responsible Mining” has different meaning to different groups, and a Framework to address Responsible Mining needs to be flexible yet stand on basic principles. These principles – including participatory decision making and transparency -- should be recognized and adopted by mining companies and regulatory agencies. Alaska has a legacy of mining and is at the forefront of some of the largest proposed mines in the United States. Alaskan mining often occurs on traditional indigenous lands, much of it only transferred to the State of Alaska within the last 40 years. Communities and tribes should consider what Responsible Mining could mean to them when engaging on specific projects. Examples of specific mining projects in Alaska will be provided, with a discussion of a policy document developed in response to proposals within the Bristol Bay watershed.

Dr. Zamzow has lived and worked in Alaska since 1986, and for the last four years has represented tribal and community interests in reviewing the potential environmental impacts of large mines. The talk will draw from two documents: A Framework for Responsible Mining (Miranda, M, D Chambers, and C Coumans, 2005, Center for Science in Public Participation) and Standards and Practices for Environmentally Responsible Mining in the Nushagak River Watershed (2011, Nushagak-Mulchatna Watershed Council).

## Mercury Old and New on the Kuskokwim

Kendra Zamzow, PhD<sup>1</sup>

**Abstract:** The Kuskokwim River is one of the largest and longest in Alaska, and subsistence fishermen heavily rely on it. It also lies within a natural mercury belt. The region was one of the largest producers of mercury until the mid-1900s. Today, a legacy mine is being addressed adjacent to the proposed development of Alaska’s largest gold mine. The Donlin gold mine would be the first in Alaska to thermally process ore, releasing by-product mercury. This talk discusses how the legacy and proposed mine are different, how Donlin proposes to prevent new mercury contamination, perspectives of the people in the area, and what Alaskan regulators will need to address.

<sup>1</sup> *Center for Science in Public Participation, Chickaloon, AK*