ERP GRANT APPLICATION

Section 1: Summary Information

1. Project title:	Corona and Twin Peaks Mine Drainage Treatment Project
2. Applicant name:	Tuleyome, Inc.
3. Contact person:	Bob Schneider
4. Address:	607 North Street
5. City, State, Zip:	Woodland, CA 95695
6. Telephone #:	(O) 530-350-2599; (C) 530-304-6215
7. Fax #:	530-350-2729
8. Email address:	bschneider@tuleyome.org
9. Agency Type:	Federal Agency State Agency Local Agency Nonprofit Organization University (CSU/UC) Native American Indian Tribe
10. Certified nonprofit organization:	Yes No [*in process of obtaining certification*]
11. New grantee:	Yes No
12. Amount requested:	$1,422,469
13. Total project cost:	$1,525,469
14. Topic Area(s):	Mine Remediation
15. ERP Project type:	Primary: Full-scale Implementation Secondary: Research
16. Ecosystem Element:	Contaminants (inorganic)
17. Water Quality Constituent:	Mercury, trace metals (nickel, iron, manganese), other (low pH)
18. At-Risk species benefited:	James Creek: Rainbow trout Detert Reservoir: Rincon Ridge ceanothus, Cobb Mountain lupine, Cobb Mountain lupine, Colusa layia, Napa bluecurls, narrow-anthered California brodiaea, Cobb Mountain lupine, Townsend's big-eared bat, Cobb Mountain lupine, foothill yellow-legged frog, Rincon Ridge ceanothus, Sonoma ceanothus, Sonoma beardtongue, foothill yellow-legged frog, foothill yellow-legged frog, Mt. Saint Helena morning-glory
19. Project objectives:	1. Characterize and clean up toxic mine site 2. Facilitate transfer of ownership of critical open space 3. Demonstrate effective governance structure for toxic mine site clean up 4. Investigate and resolve liability issues 5. Demonstrate innovative technologies
20. Time frame:	3 years

Section 2: Location Information

1. Township, Range, Section: and the 7.5 USGS Quad map name.	Township/Range/Sections covering the area: - T10N-R06W-28 - T10N-R06W-27 - T10N-R06W-32 - T10N-R06W-34 - T10N-R06W-33 - T09N-R06W-4 Quad map “Detert Reservoir”
2. Latitude, Longitude (in decimal degrees, Geographic, NAD83):	38.670833, 122.536226
3. Location description:	Upper and Lower Corona Mine and Twin Peaks Mine; upper James Creek Watershed, tributary to Pope Creek, tributary to Lake Berryessa
4. County:	Napa
5. Directions:	Travel North on CA-12 from Napa Valley; turn right on CA-29 N/Lincoln Ave and proceed 10 miles; turn right on Livermore Rd and proceed 5 miles; turn right onto Oat Hill Rd N and proceed 2 miles
6. Ecological Management Region:	1 – Upland River - Floodplain
7. Ecological Management Zone(s):	None
8. Ecological Management Unit(s):	None
9. Watershed Plan(s):	None
10. Project area:	440 acres on two parcels containing three mine-disturbed areas and associated drainage waters
11. Land use statement:	• **Current**: Scarred landscape with mercury mine adits in private ownership • **Future**: Publicly accessible open space in public ownership
12. Project area ownership:	% Private 100 % State__0_____ % Federal____0____
13. Project area with landowners support of proposal:	100%

Section 3: Landowners, Access and Permits

1. Landowners Granting Access for Project

A provisional access agreement from landowner John Livermore is in **Appendix A**.

2. Owner Interest

The Twin Peaks and Corona Mines are located on and immediately adjacent to an abandoned Oat Hill Mine Road easement held by Napa County. The easement abandonment, which occurred about thirty years ago, includes the provision that the County may reestablish the easement at any time for public purposes. The southern eight miles of the Oat Hill Mine Road easement, which was also abandoned in the past, was reestablished in 2007 as a non-motorized hiking, mountain biking and horseback-riding trail. The northern five miles of the Oat Hill Mine Road easement were not opened to public use at that time due to concerns about public health and safety related to the Twin Peaks and Corona Mines. Opening the northern five miles of the Oat Hill Mine Road to public use is one of the priority projects identified in the District's Master Plan adopted in 2009.

The owner of the parcels (John Livermore) on which the two mines are located agreed, when he took title to the property approximately a decade ago, to donate the parcels to the Land Trust of Napa County upon or prior to his death. However, the Trust is extremely concerned about liability issues and has made it clear they are not in a position to accept the properties. The current owner of the parcels is in his mid-90s, and anxious to resolve the issues related to the properties while he is still alive.

3. Permits

Government permits known to be needed to complete the project are:

- NPDES Construction General Permit from the State Water Resources Control Board for construction activities
- Napa County grading permit
- Streambed Alteration Agreement from the California Department of Fish and Game
- Clean Water Act Section 401 water quality certification from the California Regional Water Quality Control Board
- Clean Water Act Section 404 permit with the US Corps of Engineers

The project also requires evaluation for compliance with the California Environmental Quality Act (CEQA). The project plans to complete an Initial Study and prepare a Mitigated Negative Declaration.

The needed permits and CEQA evaluation have not been secured and will be addressed as part of this effort.

4. Lead CEQA agency

Napa County, which will eventually take ownership of/jurisdiction over the land, should be the lead CEQA agency. The Napa County Regional Park and Open Space District will be the lead CEQA agency.

5. Required mitigation: Yes No

Section 4: Project Objectives Outline

1. List task information

This project directly addresses Ecosystem Restoration Program Goal 6 (Water and Sediment Quality), Objective 1 to "Improve and/or maintain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta estuary and watershed; and eliminate, to the extent possible, toxic impacts to aquatic organisms, wildlife, and people."

2. Additional objectives

This project will clean up a mine site on private property, serving as a model for successfully cleaning up abandoned mines for public benefit. The current owner, John Livermore, would donate the property to the Napa County Regional Park and Open Space District (and the District would accept it) if site and discharge contamination risks were resolved. The property is an important component in the Napa County Open Space and Trails Plans, connecting two pieces of the Palisades public lands and providing opportunity for a trail connecting to Lake County.

3. Source(s) of above information

The Corona and Twin Peaks mines are inactive historical mercury mines from the East Mayacmas Mercury District (Yates and Hilpert, 1946). Recent investigations by the US Geological Survey have documented that these mines release iron, sulfate, nickel, and mercury to the James Creek watershed (USGS, 2007). Use of semi-passive biogeochemical technology to address mine drainage is documented to significantly improve quality of receiving waters, and reduce or eliminate toxicity effects in receiving waters (USEPA, 2006). Much of this earlier work has focused on addressing the impacts of coalmine drainage, and drainage from hard rock copper and precious metals mines. This project proposes to document the effectiveness of semi-passive biogeochemical treatment technology to remediate the impacts of discharge from remote inactive historical mercury mine sites.

James Creek is listed as impaired for mercury and nickel (State Water Resources Control Board, 2010). This project will address those contaminants, improving downstream water quality in a tributary to Putah Creek, a tributary to the Delta.

Section 5: Conflict of Interest

Primary Contact for Proposal: Bob Schneider, Tuleyome

Primary Investigator: Bob Schneider, Tuleyome

Co-Primary Investigator: None

Supporting Staff: Sara Husby, Executive Officer; Charlotte Orr, Executive Assistant, Andrew Fulks, President and licensed landscape architect; Chad Robert, PhD wetland scientist

Subcontractors who will perform tasks listed in the proposal include:

- Stephen McCord, Larry Walker Associates
- Greg Reller, Burleson Consulting
- Tim Tsukamoto, TKT Consulting
- Peter Green, University of California Davis
- Darell Slotton, University of California Davis

- Craig Thomsen, University of California Davis
- Vic Claassen, University of California Davis
- Michael Lozeau, Lozeau Drury LLP

Names and organizations of all individuals not listed in the proposal who helped with proposal development are tabulated here:

Last Name	First Name	Organization	Role
Bryant	Leif	County of Napa Flood Control District	Supported project concept with local contacts; benefits open space interests in Napa County
Smith	Justin	Livermore Ranch	Supported project proponents with site-specific information; land manager benefits with funds to undertake site improvements
John	Woodbury	Napa County Regional Park and Open Space District	Reviewed proposal; potential recipient of land if sufficiently remediated

Section 6: Project Tasks and Results Outline

1. Detailed Project Description

The proposed project will treat toxic mine adit drainage discharging in the Bay-Delta watershed. This project will address the ERP goal to "Improve and/or maintain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta estuary and watershed; and eliminate, to the extent possible, toxic impacts to aquatic organisms, wildlife, and people."

The project area, highlighted in **Appendix B Figures B-1 and B-2**, is in the James Creek subwatershed, tributary to Pope Creek, a major tributary to Lake Berryessa. Discharges from Lake Berryessa pass through Putah Creek to the Yolo Bypass in the northern Delta. Approximately 40 more abandoned mines exist in this region (known as the East Mayacmas Mining District; approximately half of the East Mayacmas and Clear Lake Mining Districts and all of the Knoxville Mining District lie within the Putah Creek Watershed), cumulatively representing the third largest mercury producing region in the nation (the top two are also found in the Coast Range) when production was most active between 1850 and 1961 (USBM, 1965). Cache Creek is estimated to contribute almost half of the mercury load to the Delta from the Sacramento River watershed. Prioritizing these mines and demonstrating effective clean up methods are critical to addressing this toxic health hazard.

This project will focus on mitigating continuous toxic discharges from the Upper and Lower Corona Mine and Twin Peaks Mine. Photos of each mine's adit, existing temporary infiltration trenches for Upper Corona and Twin Peaks Mines, and the proposed treatment area for Lower Corona Mine drainage are all provided in **Appendix C Figures C-1 through C-3**. The hypothesis to be tested by this project is that long-term, semi-passive treatment of toxic discharges is feasible and will benefit the downstream ecosystem.

Continuous discharges of drainage water from the three adits are slightly acidic with high concentrations of iron and nickel, and some mercury in the suspended solids. Drainages from

the Twin Peaks and the Upper Corona adits have been improved to the point where they no longer discharge into the creek. However, the current improvements are not ideal—difficult to maintain and clogging with iron precipitate. This project will develop and implement a reliable, long-term, maintainable solution for both dissolved nickel and for solids.

The Lower Corona Mine's discharge has not been addressed to date. To work on the site, the project will first need a supply trail. Then, the existing channel will be re-routed along the edge of the steep, narrow channel to provide working space. The site improvements will make space for a semi-passive treatment system. The treatment system will divert the discharge away from the creek, then it will mitigate the discharge in a fashion similar to the demonstrated (for greater than 5 years) successful efforts at the other two mines, for which flow and chemical composition are similar.

The California Porter-Cologne Act is the basis for state water quality regulations. There are adequate provisions for "Good Samaritan" rules that shield individuals and organizations that work to improve water quality. The Clean Water Act provides for federal regulation of water quality. The US Environmental Protection Agency (USEPA) administrates this landmark law. The USEPA can issue an Action Memo that provides performance guidelines and measureable benchmarks for compliance to those undertaking water quality cleanup projects. However, the Act also has provisions for third-party lawsuits to enforce the Act. While important to the long-term effectiveness of the CWA these third-party lawsuits can also restrict efforts on the part of individuals, organizations, landowners and agencies to participate in water quality and mine clean up projects on a voluntary proactive basis.

John Livermore, the current private landowner, would like to donate the two parcels containing the three mine sites to the Napa Land Trust, Napa County Regional Park and Open Space District, or some group who would preserve the land. Unfortunately, Napa County will not take the land at this time because of the potential liability for cleanup of the three mine sites.

2. Background and Conceptual Models

Half of all toxic mercury pollution that enters the Sacramento River system comes from the Putah and Cache Creek River systems in the Northern Inner Coast Range. Mercury was mined from this region for use in gold mining in the Sierra Nevada. The Knoxville and the Abbott-Turkey Run mines are among the most well known but there are over 80 abandoned mercury mines in the Putah and Cache Creek watersheds, some of which were among the largest producers in the state.

This mining legacy contributes to the state's listing as impaired of James Creek (nickel and mercury), Lake Berryessa (mercury), and lower Putah Creek (mercury and boron). James Creek has been identified as prime trout habitat. A fish consumption advisory is posted for Lake Berryessa and for lower Putah Creek because of fish mercury contamination. Lower Putah Creek is a Wild Trout stream and drains into the Yolo Bypass, a nationally recognized fish rearing, wildlife habitat, farming, and flood control area with some of the highest mercury concentrations in the Bay-Delta.

This project will address several key issues associated with mine cleanup projects, including:

- Physical hazards – Restricting access to the adits and infiltration trenches by people and wildlife
- Chemical hazards – Treating mine drainage and site seepage/runoff to attain water quality standards

- Legal liability – Protecting "Good Samaritans" who implement projects or manage lands for the good of society
- Multiple goals (public health & safety, wildlife habitat, cultural resources, etc.) – Seeking multiple benefits while addressing competing interests
- Limited funds – Minimizing remediation costs to encouraging similar efforts elsewhere.

3. Approach and Scope of Work

This project is designed to:

- Characterize the mine-impacted sites through mapping and characterize adit discharges through sampling and laboratory analysis
- Design and implement innovative technologies for toxic mine drainage seepage and semi-passive treatment
- Develop and demonstrate an effective approach for toxic site cleanup involving private land owners, non-profit organizations, regulators, and interested stakeholders and "Good Samaritan" participants
- Investigate and resolve liability issues to facilitate transfer of land comprising a critical open space and wildlife linkage from private to public ownership

This project will be implemented under the following six major tasks:

- Coordinate Stakeholders
- Establish Baseline Conditions and Monitor Effectiveness
- Research, Address, and Summarize Liability Issues
- Construct Landscape Controls
- Construct Semi-passive Mine Drainage Treatment Systems
- Report Results

Task 1. Coordinate Stakeholders

The project team will coordinate with stakeholders through a listserv providing approximately monthly status updates, quarterly open meetings, and informal individual communications regarding specific issues. The stakeholder group may provide input to project planning, monitoring, designing treatment system, and reporting.

The current private landowner (John Livermore) and the future public landowner (Napa County Regional Park and Open Space District) are critical stakeholders and the primary beneficiaries of this project. Federal (USEPA, BLM, US Fish & Wildlife Service, USBR) and state regulators (State Water Resources Control Board, Central Valley Regional Water Quality Control Board, Department of Toxic Substances Control, Department of Fish & Game), water managers (Solano Irrigation District), and local stakeholders (Upper Putah Creek Stewardship Committee) are stakeholders insofar as the project aims to treat contaminated water to improve downstream water quality and associated habitat.

More broadly, this project will be of interest to four larger stakeholder groups:

- Integrated Regional Water Management, Westside Group—This group includes representatives from the five counties constituting the Putah and Cache Creek watersheds (Colusa, Yolo, Lake, Napa, and Solano). The Group's IRWM Plan includes

a water quality component, which specifically identifies the mining legacy in the Coast Range.

- Delta Tributaries Mercury Council—The Sacramento River Watershed Program facilitates this stakeholder group to bring together scientists, regulators, landowners, resources managers and users, to collaboratively develop and implement a strategic plan for the management of mercury in the Delta and its tributaries and monitor its effectiveness.
- California Abandoned Mine Lands Forum—The Department of Conservation convenes the Forum to provide a venue for discussion and coordination on water quality, safety and environmental hazard issues that agencies and other groups face with their abandoned mine land remediation projects in California.
- Environmental and social justice organizations—Several organizations will be interested in the project's water quality and public health issues.

Task 2. Establish Baseline Conditions and Monitor Effectiveness

The project will collect quantitative and qualitative data before implementation. This information will be used to compare current/baseline conditions to treated/remediated conditions, and to ensure that the project is implemented according to plan and mitigates for environmental effects.

Characterize Drainage Water Quality

The project will conduct a treatability study in Year 1 prior to full-scale design to properly scale each treatment system's hydraulic residence time and treatment load. Some preliminary measurements have been conducted in developing this proposal, but this project will systematically measure the flow rate and concentrations of metals of concerns, major ions, and other water quality conditions in the drainage waters from each adit to inform the physical scale of the treatment systems to be designed and constructed.

Proper scaling of the treatment system components requires knowledge of the concentration of major ions (cations and anions such as sulfate, carbonate, chloride, and nitrate/nitrite) and metals and metalloids that may be present in the drainage water. Together, the flow and concentration measurements allow estimation of the mass of material expected to be removed by treatment. In-laboratory column-scale experiments will be used to evaluate the necessary site-specific design parameters.

Site Characterization

Site characterization is necessary to (1) ensure that the mined materials present on the landscape comply with applicable regulations to protect human health and the environment, (2) identify opportunities for diversion of surface water away from the sites, and (3) design the treatment systems. Site characterization activities will include creating a map of the Corona and Twin Peaks Mines that accurately depicts the locations of adits, remaining mine-related infrastructure and mined materials such as waste rock and calcined tailings, and existing infiltration trenches. Samples of the waste rock and tailings will also be collected to evaluate their metal contents, metal mobility, and mineralogy. This information will also inform treatment system design by documenting the locations of mined materials that should not be disturbed during the remediation system construction or operation and by allowing evaluation of the attenuation capacity of site soils.

Effectiveness Monitoring

The project will monitor influent, effluent and receiving water quality to characterize the effectiveness of the treatment system at reducing the concentrations and loads of pollutants in mine drainage. Monitored parameters will include, at a minimum:

- Flow rates
- Conventional measures (turbidity, dissolved oxygen, pH, alkalinity, temperature, major ions, electrical conductivity, sulfate, total organic carbon)
- Total settleable solids and total suspended solids concentrations
- Total mercury and methylmercury, and trace metals (including nickel, iron, copper, aluminum, and others) concentrations

The project will monitor approximately 20 times spanning the operation of the treatment system.

Monitor Aquatic Biosentinels

Slotton and Ayers of UC Davis assessed mercury levels in biosentinel aquatic organisms in the project area in 1998 (Slotton and Ayers, 1999). This project will use the same research team to perform a similar analysis specifically in the project area, as well as in downstream receiving waters (1) before cleanup/treatment for baseline data and (2) afterwards to assess effectiveness.

Certain aquatic organisms can be used as effective “bioindicators” of mercury exposure for human and wildlife fish consumers. The Slotton lab at UC Davis has developed and refined this approach over the past 20 years. This project will collect appropriate biosentinel small fish and aquatic insects at creek locations upstream and downstream of both the Corona Mine and the Twin Peaks Mine. Small fish biosentinels will be prepared and analyzed individually, whole body, and analyzed for total mercury (which is equivalent to methyl mercury in fish samples). Aquatic insect samples will be prepared as multi-individual composites of whole individuals (n ≥8 each), ideally collected in 3-4 unique replicates at each sampling site. These samples will be analyzed for total mercury and methylmercury, as the methylmercury percentage in invertebrates is often variable.

This work will include the field collection of the samples, their preservation, processing, and analysis for mercury, and presentation of the resulting data. Field sampling, sample preparation, and analysis will follow techniques refined by the Slotton laboratory at UC Davis since 1985 and in conformance with the Quality Assurance Project Plan developed for studies conducted for the California Bay-Delta Authority, also known as CALFED.

Task 3. Research, Address, and Summarize Liability Issues

This project will document work to obtain Good Samaritan protections and a USEPA Action Memo. In addition, efforts to work with the broader stakeholder interests (Task 1) will minimize future liability exposure.

Comply with Applicable Laws

A mine site cleanup action must support and be consistent with attainment of legal requirements over the long term. Chemical-specific, location-specific, and action-specific laws apply to a mine site cleanup action.

For using state funds, the project will need CEQA documentation. The Napa County Regional Park and Open Space District will be the lead CEQA agency, working with the project team (including Tuleyome staff) to evaluate the environmental setting and implement appropriate

mitigation measures. The project will most likely complete an Initial Study and prepare a Mitigated Negative Declaration.

A new federal Good Samaritan Administrative Order provides some legal protection, although it is not well tested yet. In particular, it is unlikely to provide protection from third-party lawsuits under the Clean Water Act. Working with the Order's provisions, the project will prepare a simple project plan, for which USEPA will write an Action Memo.

Evaluate Open Space / Public Use Criteria and Legal Liability

The Napa County Regional Park and Open Space District is very interested in eventual ownership of the subject parcels because this would facilitate completion of the Oat Hill Mine Trail as a public recreational and historical mining interpretation facility. However, the District faces the same liability challenges as the land trust. Unless the property can be cleaned up in the next few years while the current owner is alive, and a mechanism created to fund and implement long-term maintenance and monitoring, the northern section of the Oat Hill Mine Trail will most likely not be completed, the mine adits and tailings will continue to cause water quality violations, and the properties will get caught up in a morass of estate and other legal wrangling.

For these reasons, the District is excited about this grant proposal. If it is granted, the District will work with Tuleyome to enter into a partnership agreement to implement the grant. As the potential future property owner of the two mines, the District's role would be to assure that cleanup, monitoring, maintenance and liability issues are adequately addressed to enable the District to take on ownership responsibilities.

Address Archeological Interests

The Corona and Twin Peaks mines contain remnants of mine-related infrastructure that represent the regional historic mining heritage. While these site features should be preserved, they may also provide an attractive nuisance to recreational visitors. This project will add signage and fence off structures and bar mine shafts to inhibit access, as appropriate.

To ensure that residual mercury that may be present does not cause harm to the public, this project will measure mercury vapors in the breathing zone in the vicinity of remnant infrastructure. Such measurements will be completed under varying site conditions (after early season rain, during warm weather, etc.), and will focus on determining if mercury is present in air in the breathing zone (knee to head level) near site features such as remaining furnaces, condensers, and adits.

Task 4. Construct Landscape Controls

Mining debris covers lands downhill of the adits. The following nine subtasks will be performed to construct appropriate landscape controls at the mine sites to address these sources of toxins:

- Identify sites, erosion / leaching risks and botanical inventory
- Sample and characterize substrate
- Review literature, update and focus evaluation objectives for desired management outcomes
- Parameterize models for substrate hydrology of ambient site conditions and treatment scenarios.
- Characterize plant-available nutrients and chemical conditions.
- Conduct bench- or pilot-scale field trials to evaluate potential substrate hydrology and nutrient treatments

- Modify and specify selected treatment options for field construction demonstration plots (full scale, limited distribution)
- Specify, monitor, and inspect full-scale treatments in field
- Monitor plant growth and site erosion resistance response

The project will include the following revegetation activities in conjunction with soils evaluation and improvements:

- Conduct vegetation surveys during spring and summer to locate plant materials that have revegetation potential, including species from wetland, stream edges, grassland, chaparral, and woodland communities. In addition, on-site native plants that are growing on disturbed areas will be identified for potential use. (Making use of the wide range of local, site-adapted, native plants that are typically available in areas—but are often overlooked as revegetation candidates—will help in developing a sustainable revegetation program and one that eventually mimics undisturbed sites nearby.
- Develop suitable plant materials for field plantings through propagule collection, storage, pre-treatment, germination, and container-plant development (Depending on site conditions, we would expect to use combinations of direct seed, cuttings, and container plants, using herbaceous and woody species, including native perennial grasses, forbs, shrubs, and trees).
- Establish pilot experimental plantings and demonstration plots with the goal of identifying and establishing plants that are self-sustaining and do not need irrigation after they are established. Additionally, due to anticipated herbivore issues from deer, rabbit, or small mammal grazing and browsing—a major deterrent in many revegetation projects—plantings will also be monitored for tolerance (or resistance) to herbivores.
- Assist with developing planting designs at individual sites, taking into account site goals, slope and soil variability, moisture conditions, structure and function of plant materials, plant densities, herbivore issues, and the likelihood for phased plantings.
- Expand experimental plantings to larger project area with the goal of producing self-sustaining plantings, high plant cover, increased soil stabilization, habitat improvement, and revegetated areas that mimic adjacent undisturbed sites.

Finally, minor ditches and culverts will be constructed to control rainfall runoff around the treatment systems (Task 5).

Task 5. Construct Semi-passive Mine Drainage Treatment Systems

Each of the three adits discharges a steady stream of toxins. Construction of the designed semi-passive mine drainage treatment systems will include site preparation and drainage treatment system construction.

Prepare Site

Oat Hill Road and spurs provide relatively good access for equipment to the Upper Corona Mine and Twin Peaks Mine. This project will provide minor grading to ensure safe passage for vehicles and equipment. The project will construct a supply trail and clear land from Oat Hill Road down to the Lower Corona Mine, a distance of approximately 1,000 feet. On the downstream side of Lower Corona Mine, an area of approximately 0.25 acre adjacent to the stream will be regraded to provide a level surface for the semi-passive mine drainage treatment system.

Construct Drainage Treatment Systems

The project will construct three discharge treatment systems:

- Iron precipitate management in Upper Corona Mine and Twin Peaks Mine adits
- Nickel infiltration of Upper Corona Mine and Twin Peaks Mine discharges
- Semi-Passive treatment system to provide bio-chemical and physical control of iron, mercury, nickel, and sulfate in mine drainage at the lower Corona adit

An example conceptual design for one type of semi-passive mine drainage treatment is shown in **Appendix C Figure C-4**. Example photos of system components at other locations are provided in **Appendix C Figure C-5**. The actual system may vary from this design depending on site and discharge characterization results, and column testing results. Potential technologies being considered include the multi-stage biological system shown below, an elemental iron 'doped' sand bed, microbial mats, and liquid substrate bioreactor.

System design will occur in three stages: (1) a lab testing concept memorandum that provides a basis for selection of column contents, sizing, and monitoring; (2) a design basis memorandum that documents site characterization and column test results, recommends the specific semi-passive treatment technology and evaluates design parameters; and (3) the design which will guide system construction. These activities will be completed in the first year to 15 months of the project.

System construction will begin after design completion with mobilization and site preparation. System construction is anticipated to be completed within 30 workdays of project initiation. Disturbed areas will be stabilized and protected from erosion by installation of appropriate best management practices. System construction is anticipated to occur early within the second year of the project.

Task 6. Report Results

The final report will clearly describe the design and construction of the landscape controls (Task 4) and treatment systems (Task 5), and maintenance protocols. Permitting documents (Task 3) will be prepared and provided in complete form. Legal liability issues will be summarized, including how they were successfully resolved (Task 1 and 3). Effectiveness of the treatment systems' collective ability to improve downstream water quality will be quantified (Task 2).

4. Deliverables

Project deliverables include the following:

- Three semi-passive adit drainage treatment systems (designed and constructed)
- Contouring for erosion and drainage control (design and site work)
- Minutes from stakeholder meetings
- Environmental documentation
- Treatment system operation, maintenance, and monitoring plans
- Final report detailing project activities, monitoring data, and resolution of liability issues

5. Feasibility

Our approach to completing of the project tasks described above within the three-year project schedule is described below. Tuleyome is the lead applicant, responsible for payments, reporting, and accounting. The Project Lead will make key decisions on project direction.

Stakeholder coordination by Mr. Schneider has been ongoing and will continue throughout the project duration. The Project Manager will provide day-to-day communication, guidance and leadership to team members.

The appropriate team members will complete each of the project components in parallel. Permitting, baseline characterization, and coordination of stakeholders would begin immediately after project kickoff. Design of the treatment system is contingent on characterization results and permit conditions; and construction is contingent on completion of the design, weather, and permit conditions. Project reporting would include annual progress summaries and a final report of project results. Expected progress in parallel is shown on **Appendix C Figure C-6**.

The most significant potential impediments to project success are a prolonged permit process, and inability to resolve liability issues. Another possible impediment is the impact of weather during construction. These factors are described below.

Permitting: Permitting agencies (Napa County, State of California, and federal agencies) are all aware of the potential benefits of the project, and project team members are familiar with permit processes and implementation. Based on timeframes needed to permit similar (and even more complex) projects the project team believes that acquisition of the necessary permits within one year to eighteen months of project initiation is feasible. Initiation of construction will depend on completion of the design, and obtaining permits.

Weather: The sites are accessed on dirt roads and located on steep slopes. Thus, high intensity short duration storm events could create significant difficulties in accessing the sites, and/or safely performing on-site activities during the proposed monitoring, construction, and operating activities. The overall impacts of weather on the proposed project are anticipated to be a nuisance rather than creating significant delays. In the event of a significant rain event during construction, the anticipated delay is expected to consist of days or a week based on the historical impacts of weather on site access. Construction activity is possible throughout the year at the sites with expectation of minor short-term weather related delays. Weather-related impacts can be partially addressed through scheduling construction to occur in the late spring to minimize the likelihood for either weather related construction delays, or work restrictions due to wildfire hazard. The anticipated duration of construction is about 10 days for earthwork, and up to 30 days for treatment system installation.

Photos from a recent mine site cleanup at the nearby Abbott – Turkey Run Mine are shown in **Appendix C Figure C-7**. Those site improvements were designed and implemented in one year. Similar site work at the Corona Mine is expected to be feasible within one year given the similar terrain and ground cover. System monitoring and testing will be implemented in the third year, over a full water year.

Toxic Clean-Up Liability – "You touch it, you own it"

A critical impediment to toxic mine clean up is concern of on going fiscal liability through either the Federal Clean Water Act or California Water Code. Efforts to shield participating parties from potential liability are difficult. The California Water Code was amended in 1998 to shield Good Samaritan cleanups conducted under regulatory agency oversight. The Federal Clean Water Act (CWA) provides for initiation of lawsuits against property owners and/or operators of property that discharge toxic substances at concentrations exceeding numerical criteria to waters of the United States. To date, many public agencies and private landowners have experienced such lawsuits and incurred substantial liability. The possibility of such legal action currently prevents private parties from taking actions that are expected to reduce the quantity of toxic substances discharged to waters of the United States from abandoned mines, but that may

not reach numerical criteria in post-activity discharges. This project will examine this issue in detail and attempt to identify a model for minimizing such liability.

Perhaps, best known are Trout Unlimited's efforts to clean up abandoned mine drainage on Kerber Creek in Colorado. After much negotiation Trout Unlimited and the Environmental Protection Agency reached an agreement that will shield TU from potential liability as it works to clean up mine tailings along 17 miles of Kerber Creek by following an EPA-approved work plan. This was an easier case in that there was no flow to water bodies.

While the state provides for "Good Samaritan" work, the federal Clean Water Act allows third party lawsuits. While appropriate in many cases this can also impede legitimate cleanup efforts. Provisions of Brownfield cleanup laws may be applicable and need further investigation.

6. Relevance to the CALFED ERP

This project is specifically relevant to ERP priority 3(b) "construct facilities to control drainage from abandoned mines that adversely affect water quality in the Bay-Delta."

Projects of this type have not been attempted by non-profits for fear of liability risk. Tuleyome is taking that risk to provide leadership with the goal of learning by doing and then replicating appropriate actions elsewhere. Many impairment listings in the Delta proper and in its tributaries' watersheds are caused by the California mining legacy. This project takes the challenge—and opportunity—presented by the state to address that critical pollutant source.

7. Expected quantitative results (project summary)

Three ongoing sources of mine drainage to Putah Creek, Lake Berryessa and the Sacramento-San Joaquin Delta will be treated on site. The property on which the mines occur covers 440 acres. The total acreage disturbed will be less than one acre.

Current (pre-treatment) and future (post-treatment) annual average loads (flow rate and concentrations) of toxic metals (mercury, nickel, and iron) from mine drainage will be significantly reduced (1) from the property to James Creek and (2) to the Bay-Delta.

8. Other products and results

Two other key products will result from this project:

- Liability issues summary and means of resolution for converting legacy mining contaminated private lands to uncontaminated open space public lands.
- Summary of design and operation considerations for replicating the adit drainage treatment technology regionally. Documented success at the Corona and Twin Peaks Mines would encourage the implementation of similar projects at the more the 80 additional mercury mine sites in the Putah Creek drainage as well as several hundred mercury mines throughout the Coast Ranges.

9. Qualifications

The project organizational chart will be as shown in **Appendix C Figure C-8**.

BOB SCHNEIDER is the Senior Policy Director for Tuleyome. He has a B.S in geology from UC Davis. He is the Senior Policy Director for Tuleyome, a 501(c)(3) regional conservation organization based in Woodland, CA. Bob spent 20 years as a builder and developer managing multi-million dollar projects including the 5th Street Plaza redevelopment project in downtown Davis. He served 8 years on the Central Valley Regional Water Quality Control Board of which

he was chair for 6 years. During his tenure on the Board Bob directed the implementation of the Irrigated Lands Program and oversaw the development of the Clear Lake and Cache Creek, Harley Gulch and Sulphur Creek Total Maximum Daily Load Plans. Most recently Bob participated in the Delta Methyl Mercury TMDL stakeholder group. He has excellent contacts at the Water Board and in the environmental and social justice communities.

STEPHEN MCCORD, Ph.D., P.E., is a Senior Engineer at Larry Walker Associates and a registered Professional Engineer in the State of California. Dr. McCord was chosen for this project because he has over 15 years of experience in the environmental engineering field with projects throughout California and several other US states, as well as in Australia, Canada, Haiti and sub-Saharan Africa. At Larry Walker Associates, Dr. McCord has managed stormwater monitoring projects in the Sacramento area and water quality field studies in rivers, deltas and bays throughout the state. Technical analyses have included evaluating runoff treatment effectiveness; developing a conceptual and mass balance model of mercury for the Sacramento River Watershed; and preparing program annual reports. Policy and regulatory projects have included analyzing and negotiating NPDES permit conditions for wastewater and stormwater utilities; leading stakeholders in the development of water quality trading policy; preparing and commenting on pollutant control programs, water quality criteria, and state and federal policy documents; and developing urban stormwater management plans. Dr. McCord also facilitates stakeholder groups in the Sacramento River Watershed and Bay-Delta for coordinating regional monitoring and for addressing mercury issues.

GREGORY J. RELLER, P.G., QSD, is a Senior Geologist at Burleson Consulting, Inc, and California Professional Geologist with more than 24 years experience, and a qualified stormwater pollution prevention plan developer (QSD). Mr. Reller has worked at hundreds of abandoned mercury, lode gold, placer gold, copper, and tungsten mines in California providing services including stormwater management, hydrogeology, aqueous chemistry, mine waste characterization, stormwater and groundwater monitoring, revegetation, and erosion control. He has managed cleanups—including demolition of mine infrastructure, removal of tailings, soil washing and on site encapsulization of mine wastes, earthwork, and stabilization—of the Deer Trail Mercury Mine, White Cap Mill, and Boston Mine in California. Mr. Reller's work at the Boston Mine received the 2006 US Department of the Interior Environmental Achievement Award. Mr. Reller also assessed mercury loading from the Sulphur Bank Mercury Mine to Clear Lake and is assisting in the clean up of the Leviathan Mine south of Lake Tahoe. Mr. Reller planned and implemented effective water management controls to reduce erosion and the generation of acid at inactive mine sites; provided permitting and mine drainage treatment services to active mines; designed a pilot passive mine drainage treatment system for an active gold mine in California; supported negotiations of national pollutant discharge elimination system permit conditions for active and abandoned gold mines; conducted field evaluation of abandoned mines; and prepared stormwater pollution prevention plans for abandoned mines.

PETER G. GREEN, Ph.D., is an Associate Research Engineer in the Department of Civil and Environmental Engineering at the University of California, Davis, with over 20 years of trace chemical analytical experience including 18 years with ICP-MS. Among his diverse past projects are several involving heavy metals, acid mine drainage mitigation including mercury methylation associated with the Sulphur Bank Mercury Mine in Clear Lake, CA. A publication on the latter was reviewed as "one of the most significant advances in Hg biogeochemistry in recent years". Other publications concerned the mitigation of Cu and Zn from the Penn Mine in Calaveras County, CA. Besides his own research, Dr. Green is the Assistant Director of the UCDavis Interdisciplinary Center for Plasma Mass Spectrometry, a state-of-the-art NSF-funded user/service facility for trace metal analysis.

CHAD ROBERTS, Ph.D., is a professional wetland scientist and ecologist at Roberts Environmental and Conservation Planning LLC with more than 30 years experience in identifying and documenting environmental consequences from proposed land use activities, including identifying or specifying effective mitigation measures for impacts to streams and wetlands. He has directed CEQA compliance efforts on a variety of project types affecting aquatic resources and water quality, including wastewater treatment facilities and land uses requiring stormwater permits.

ANDREW FULKS, President of Tuleyome, is a Licensed Landscape Architect with over 20 years experience in ecosystem restoration and mitigation. He has experience with erosion control, riparian and woodland restoration, grassland restoration, vernal pool mitigation, as well as community and volunteer restoration. Andrew works for the University of California, Davis, as the Manager of the Putah Creek Riparian Reserve, a 650-acre teaching, research, and habitat mitigation area located on the UC Davis Campus. He is currently serving as President of Tuleyome, a multi-county environmental non-profit, sits on the board of directors of the California Native Grasslands Association, and is the incoming 2012 President of the Society for Ecological Restoration California Chapter.

VIC CLAASSEN, PH.D., completed graduate work at the University of California, Davis in 1992 and has held a research soil scientist position in the Department of Land, Air and Water Resources since that time. He manages the Soil and Revegetation Lab, which specializes in rapid site evaluation of drastically disturbed sites (all topsoil and biological activity removed) and development of constructable treatments to regenerate soil function. Principle among these functions is correction of soil hydrology to avoid overland flow during target storm events and for retention of sufficient moisture for summer growth of perennial plant species. These regenerated site characteristics, along with correction of nutrient and chemical conditions, are intended to set the degraded site on a trajectory to sustainable revegetation and erosion resistance with reduced maintenance inputs. Projects have been undertaken on mines (Spenceville, Leviathan, Sulphur Bank, Gambonini for Department of Conservation), national parks (Rocky Mountain Bear Lake Road, Yosemite El Portal realignment, Lassen visitor center), land management agencies (serpentine revegetation and watershed enhancement for Bureau of Land Management at San Benito Mountain and along Colusa 20, Bear Creek Ranch; road edge revegetation and mitigation of hydromodification impacts for Caltrans at multiple locations around the state), a municipality (revegetation of freeway excavation slopes for San Jose), and public interest groups (Blue Ridge Berryessa Natural Area Conservation Partnership at the Knoxville Mine site, Society for Ecological Restoration-California, California Native Grass Association). Technical interests involve field measurement and modeling of soil rooting zone hydrology and regeneration of stable organic matter pools for soil aggregation, erosion resistance and nutrient release. A preliminary reconnaissance trip to the Oat Hill / Corona sites was done in Fall, 2008 with Craig Thomsen and Justin Smith. The preliminary conclusions and approaches made then still appear to hold, but our hydrologic and soil organics evaluation methods have advanced since that time, resulting from lab developments on similar types of projects.

CRAIG THOMSEN, M.S., is a Rangeland Ecologist, with the Dept. of Plant Sciences, UC Davis (20 years), a revegetation specialist and a State Certified Rangeland Manager. For over a decade he has worked in the Upper Cache (Bear Creek) watershed to address soil erosion, mercury (Sulphur Creek mining district and Bear Creek mercury deposition zones), poorly functioning riparian communities, and invasive plants. Through grants and in-kind support, he has brought in over $1,500,000 to support land stewardship projects in the watershed. A major component of this work has been to apply his expertise in native plant revegetation for disturbed lands. For the past five years, he has been the Bear Creek watershed coordinator (Bay-Delta,

DOC-funded), where he has worked with a wide range of private, non-profit, state, and federal stakeholders to address land stewardship issues. In collaboration with Dr. Jim Weigand, State Ecologist for BLM, Mr. Thomsen co-authored (2010) the Bear Creek Watershed Assessment (DWR funded), a two-year effort that evaluated social, environmental, and economic conditions within the watershed, and outlined programs for watershed improvements. He is currently conducting a multi-year riparian and upland enhancement project on BLM land (Wildlife Conservation Board-funded) with the goals of restoring degraded riparian corridors, reducing upland soil erosion, improving water quality, enhancing hydrologic function, and protecting biological diversity. He is working with a team of specialists, using science-based, innovative approaches to achieve project goals and insure their long-term sustainability.

DARELL SLOTTON, PH.D., is a Research Ecologist at UC Davis who has specialized in the development and refining of techniques utilizing biosentinel organisms for the monitoring of methylmercury exposure most relevant to human and wildlife risk. He has directed applied research projects addressing heavy metal contamination and bioaccumulation issues in California for over 20 years. He runs a mercury analytical and research laboratory at UC Davis. In the 1990s, Dr. Slotton worked throughout the gold mining region of the Sierra Nevada, using benthic invertebrates and fish as sentinels of bioavailable mercury exposure. Slotton has led dozens of mercury studies throughout Coast Range watersheds. A multi-year project addressed mercury bioaccumulation in the Truckee River and Pyramid Lake, Nevada. International projects include mercury bioaccumulation and source assessment studies in the Lake Titicaca watershed of Peru and the Ayeyarwaddy River system of Myanmar. Between 1998 and 2008, Slotton directed several large regional projects, primarily developing and refining mercury biosentinel techniques for the state in the Sacramento-San Joaquin Delta, Cache Creek, Yuba River, and across the Bay-Delta watershed. Recently, his team has been conducting the newly expanded Regional Monitoring Program (RMP) small fish mercury program throughout San Francisco Bay for the San Francisco Estuary Institute (SFEI), together with projects in both the North and South Bay for other agencies. He and his team conducted intensive, characterizing biosentinel work specifically in the James Creek watershed in the late 1990s.

TIMOTHY TSUKAMOTO, PH.D., is a Principal Chemist for TKT Consulting, LLC, with more than 23 years experience in the mining industry. Dr. Tsukamoto is a former Research Professor at the University of Nevada, Reno. He was the primary scientist in the development of UNR's "Passivation Technology" for the prevention of acid mine drainage. Dr. Tsukamoto has designed both active and passive systems for treatment of mine drainage in 9 states and 2 countries where he was also the scientific lead for optimization and operations consulting. He has worked on several abandoned mine sites in California including Colorado Hill, Zaca Mine, and the Brush Creek Mine. Dr. Tsukamoto was the lead developing scientist of semi-passive bioreactors for treatment of acid mine drainage and he designed the first circulating bioreactor at the Leviathan Mine. Dr Tsukamoto has published over 40 technical papers and presentations and is recognized as an international expert in mine water treatment and prevention of mine drainage.

MICHAEL R. LOZEAU is a partner with Lozeau Drury LLP and has been practicing environmental law in the San Francisco Bay area for the last 18 years. Mike has extensive experience representing public interest clients on matters involving the federal Clean Water Act and state clean water laws, including California's Porter-Cologne Water Quality Control Act. He is equally at home before both federal and state courts as well as California's regional water quality control boards and the State Water Resources Control Board. Mike also has handled cases involving numerous other statutes, including the federal Endangered Species Act, the California Endangered Species Act, CEQA, NEPA and the California Coastal Act. From 1999 through the end of 2004, Mike was a staff attorney with the Earthjustice Environmental Law

Clinic at Stanford and a Lecturer at Stanford Law School. In 2003, the San Francisco Chronicle named Mike one of the Top 25 lawyers in the San Francisco Bay area. From 1994 to 1999, Mike served as the Executive Director of Waterkeepers Northern California and served as the San Francisco Baykeeper. Prior to that position, he maintained a solo practice in San Francisco, focusing on citizen enforcement cases and served as San Francisco Baykeeper's legal counsel beginning in 1991. Mike graduated with Honors from Rutgers Law School-Newark in 1989 and has a B.A. in Zoology from the University of New Hampshire. Mike was a founding Board member of the Waterkeeper Alliance from 1997-2001 and served as the Alliance's Vice-President. Currently, Mike serves on the Board of Directors of the Golden Gate Audubon Society and the Executive Committee of the Environmental Law Section of the Bar Association of San Francisco.

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Section 7: Project Budget

1. Detailed Project Budget

			Totals	Cost Share
PERSONAL SERVICES				
Staff Level	**# Hours**	**Hourly Rate**		
Senior	1200	$110	$132,000	$44,000
Admin. Asst.	360	$60	$21,600	
		Subtotal=	$153,600	
		Staff Benefits @ 25%=	$38,400	
		TOTAL PERSONAL SERVICES=	$192,000	$44,000
OPERATING EXPENSES				
Subcontractors				
Environmental Review and Permitting			$140,000	$4,000
Address Archeological Interests			$9,500	$1,000
Site Mapping			$24,700	
Drainage Sampling and Analysis			$24,000	
Site Characterization			$10,070	$2,000
Column testing (8 months)			$49,400	
Treatment System Designs			$64,000	
Construction - Supply Trail			$33,250	$4,000
Construction - Treatment Pad			$15,580	
Construction - Stream Restoration			$14,250	
Construction - Erosion Controls			$9,880	$4,000
Construction - Lower Corona Treatment System			$34,200	$6,000
Construction - Twin Peaks and Upper Corona Treatment Systems			$4,750	$4,000
Operations - Startup			$49,970	$8,000
Operations - System Optimization			$48,830	$8,000
Operations - OMM Planning			$13,395	$2,000
Operations - OMM			$47,880	$16,000
Materials				
Twin Peaks Improvements			$37,100	
Upper Corona Improvements			$43,700	
Lower Corona Adit Improvements			$15,250	
Lower Corona Adit Approach			$15,000	
Lower Corona Treatment System			$89,400	
System Optimization			$10,000	
OMM			$25,000	
Stakeholder Coordination			$28,800	
Legal Liability Review			$50,000	
Final Report Preparation			$40,000	
Printing and Duplicating			$200	
General Expense			$3,000	
Travel and Per Diem			$2,700	
		TOTAL OPERATING EXPENSES=	$953,805	$59,000
EQUIPMENT				
Stream Restoration			$15,000	
Erosion Controls			$20,000	
Lower Corona Treatment System			$100,000	
Twin Peaks and Upper Corona Trench Improvements			$10,000	
System Optimization			$20,000	
OMM			$20,000	
		TOTAL EQUIPMENT COSTS=	$185,000	$0
		SUBTOTAL=	$1,330,805	
ADMINISTRATIVE OVERHEAD @ 8% (Less Equipment)			$91,664	
		GRAND TOTAL=	**$1,422,469**	**$103,000**

2. Budget justification

Costs are itemized in the budget to the extent practicable.

3. Administrative overhead

8% administrative overhead is applied.

Appendix A. Provisional Landowner Access Agreement

Tuleyome, Inc.
607 North Street
Woodland, CA 95695
Access/Entry Agreement
Corona and Twin Peaks Mine Drainage Treatment Project in Upper Putah Creek Watershed

I. PURPOSE
The following agreement details the requirements of both the landowner and Tuleyome, Incregarding the ***Corona and Twin Peaks Mine Drainage Treatment Project in Upper Putah Creek Watershed.*** Said property is located ***in the Upper James Creek watershed,***tributary to ***tributary to Pope Creek, tributary to Lake Berryessa***

I, ***John Livermore)***, hereinafter called "Landowner", am aware that a habitat restoration project grant application has been submitted to the CALFED Ecosystem Restoration Program (ERP) for funding. The project has been explained to me by the ***Tuleyome, Inc.*** I support the goals of the project. If the project is selected for funding, the Landowner will enter into a ten year landowner agreement that will be project specific.

II. ACCESS PERMISSION
Landowner hereby grants ***Tuleyome and team members***, Department of Fish and Game (DFG), NOAA's National Marine Fisheries Service (NOAA Fisheries Service), and U.S. Fish and Wildlife Service (USFWS) representatives permission to enter onto real property owned by the Landowner to perform pre-project evaluation. Access shall be limited to those portions of Landowner's real property where actual restoration work is proposed to be performed and those additional portions of real property that must be traversed to gain access to the work site. The applicant will contact the Landowner at least 72 hours prior to any visit. At no time will DFG, NOAA Fisheries Service, or USFWS representatives access the property without the applicant, unless expressively given permission by the Landowner.

III. DURATION OF NOTICE
The term of this agreement shall commence upon signing of this Agreement and terminate on ***(end date)***.

IV. LIABILITIES
Reasonable precautions will be exercised by ***Tuleyome and team members*** to avoid damage to persons and property. ***Tuleyome*** agrees to indemnify and hold harmless the Landowner and agrees to pay for reasonable damages proximately caused by reason of the uses authorized by this agreement, except those caused by the gross negligence or intentional conduct of the Landowner.

John S. Livermore — Mar 1, 2011
Landowner Signature — Date

Landowner Address:
Landowner Phone Number:

Bob Sl — February 28, 2011
Applicant Signature — Date
Bob Schneider
Senior Policy Director
Tuleyome, Inc.

Appendix B. Site Maps

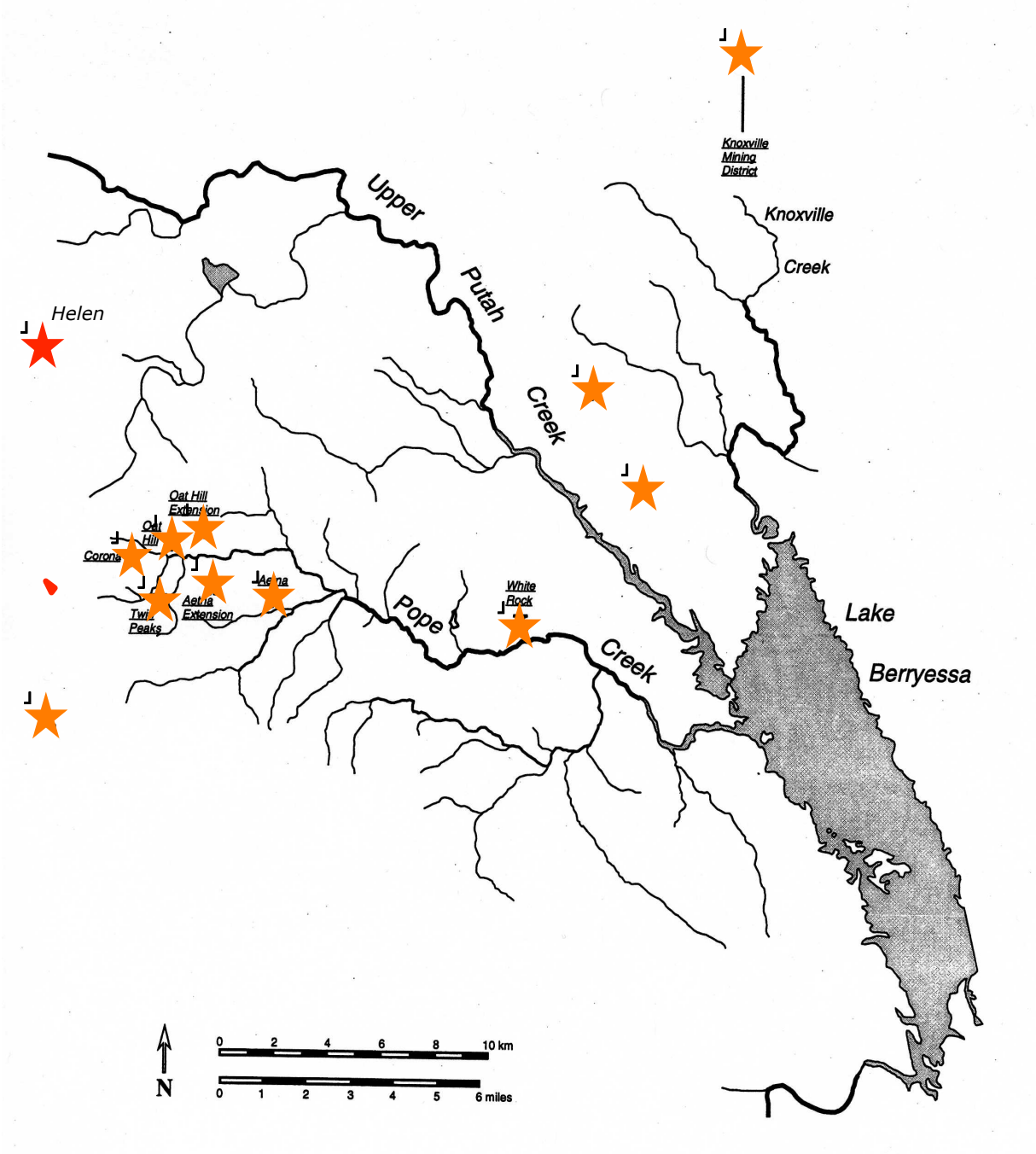


Figure B-1. Putah Creek Watershed above Lake Berryessa. Major mercury mining sites are indicated with stars. The project area is the Corona Mine, among the mines encircled in red.

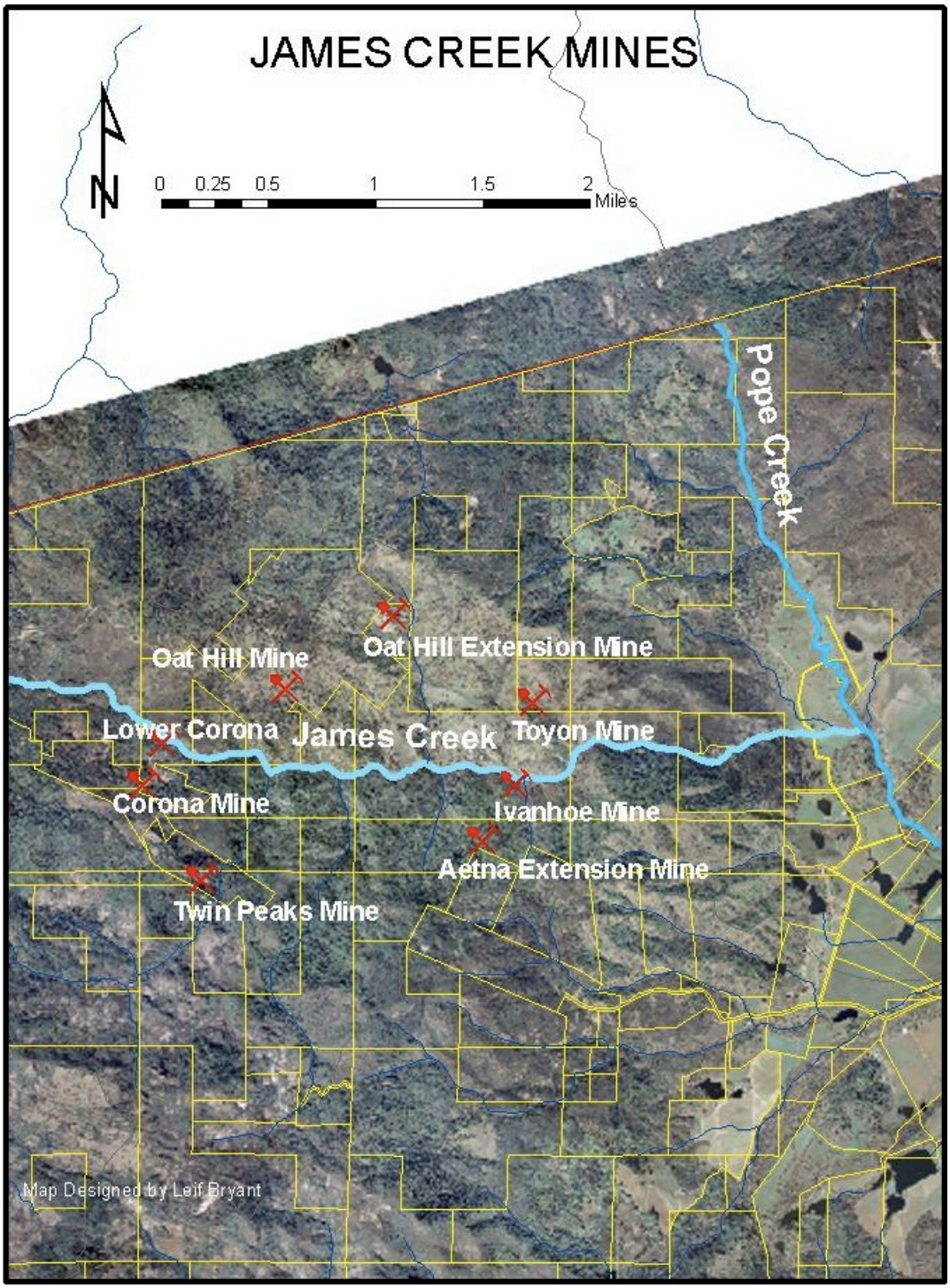


Figure B-2. James Creek mines, major waterways, and land ownership parcels

Appendix C. Photos and Schematics

a)  b) 

Figure C-1. Photos of Twin Peaks Mine, a) existing adit and b) infiltration trench

a)  b) 

c)  d) 

Figure C-2. Photos of Upper Corona Mine, a) delapidated mining equipment, b) revegetated hillslope covering mine tailings, c) existing adit, d) infiltration trench.

a)  b) 

Figure C-3. Photos of Lower Corona Mine, a) existing adit and adjacent tributary, and b) proposed spreading ground area downstream.

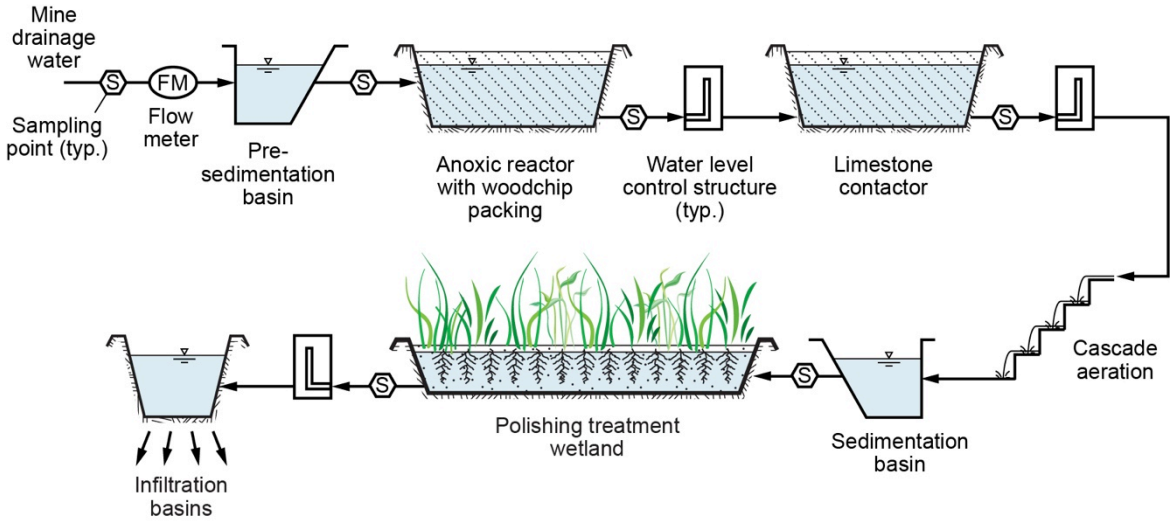
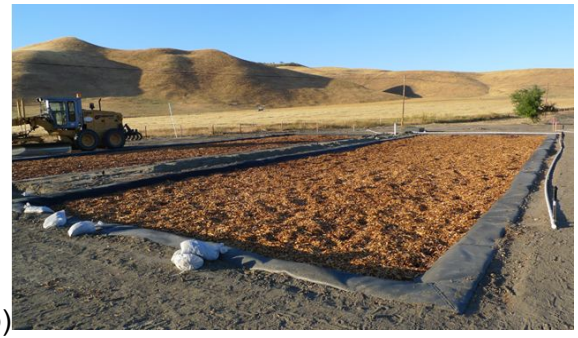


Figure C-4. Conceptual design of passive treatment pilot system for mine drainage water

a)

b)



c)

d)

Figure C-5. Views of treatment components proposed for passive treatment of mine drainage water: (a) sedimentation basin with water level control and access ramp for removal of precipitate, (b) anoxic woochip reactor, (c) limestone contactor, Cavanagh et al., 2010, and (d) cascade aeration, Cavanagh et al., 2010.

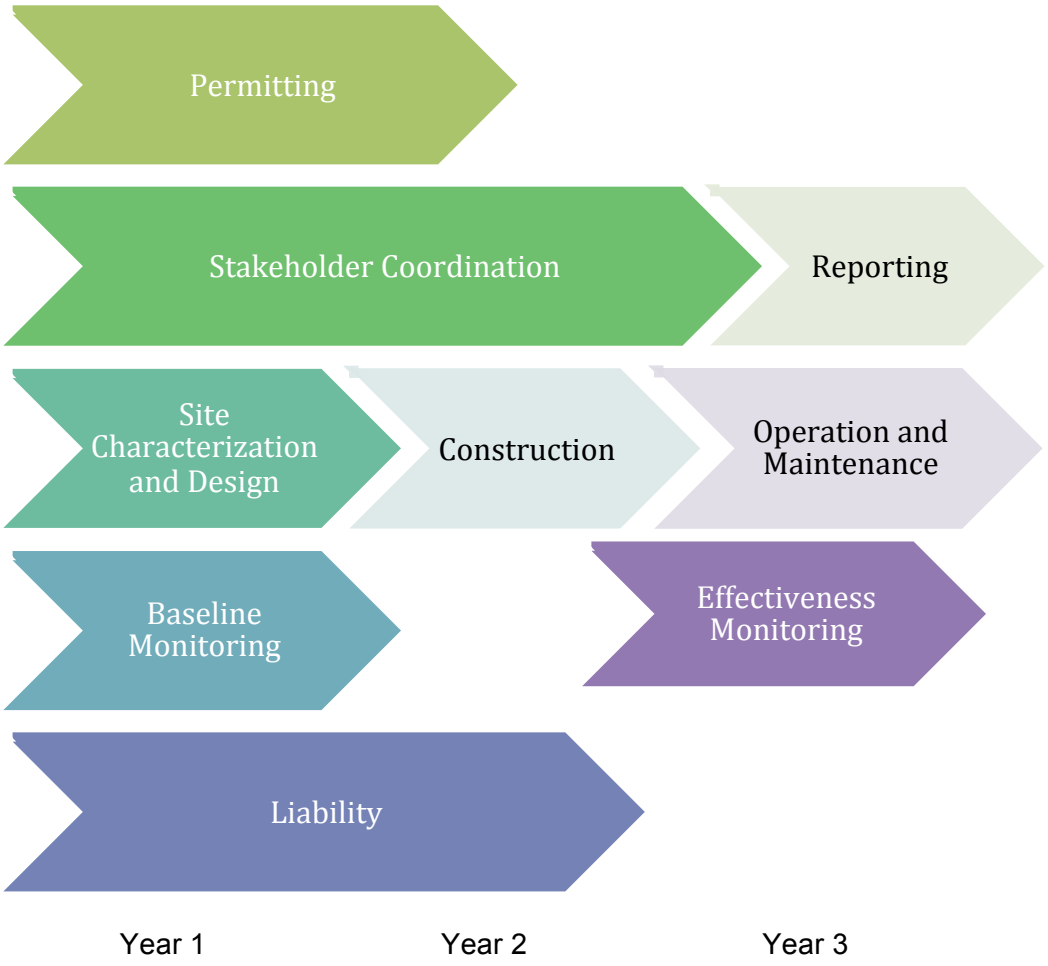


Figure C-6. Schedule by major tasks.

a) 

b) 

Figure C-7. Example photos of a recent clean up project of the Abbott - Turkey Run Mine off Highway 20, 2007.

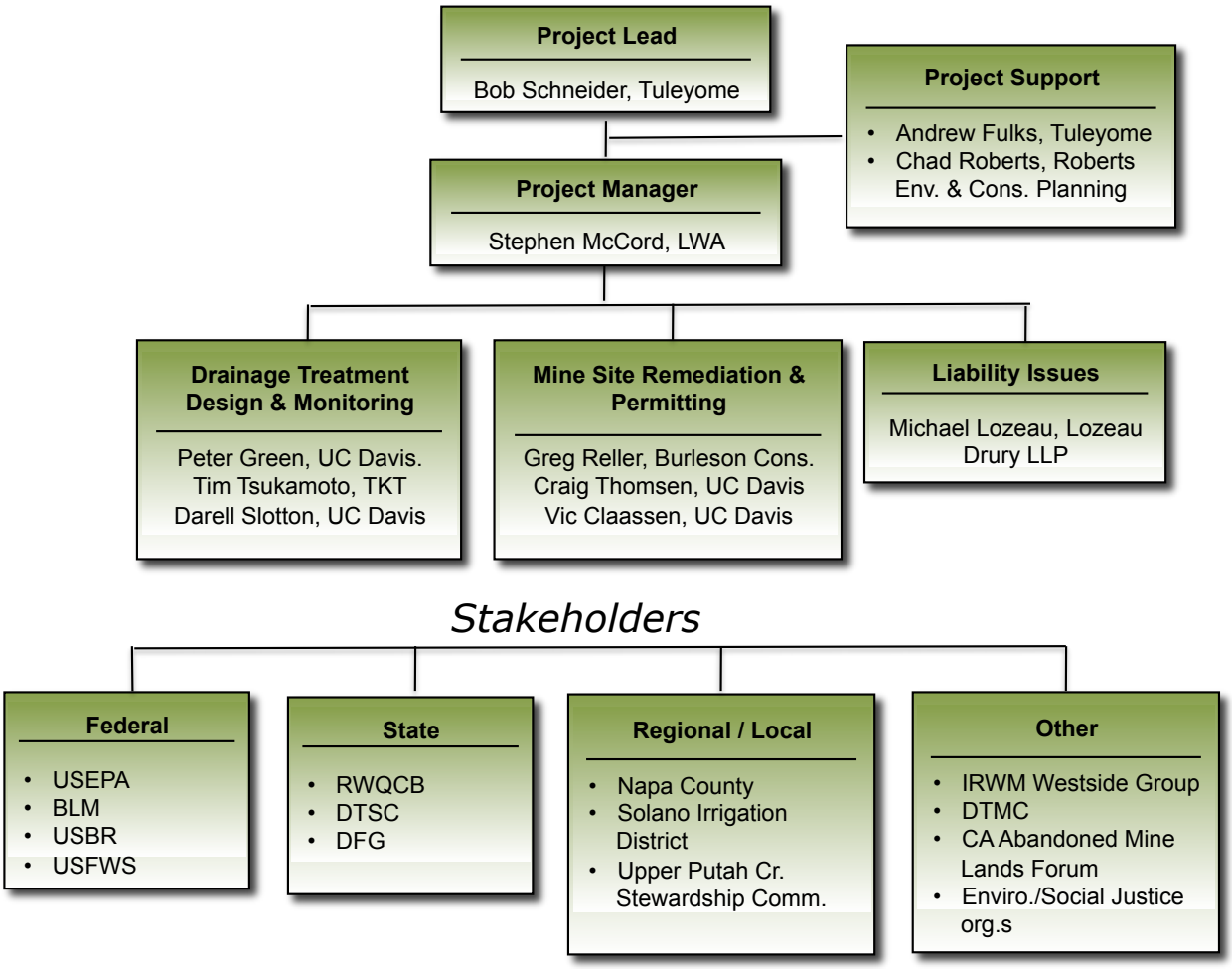


Figure C-8. Project organizational chart.