



## **RESUME**

### ***MARK A. REINSEL***

#### **HIGHEST DEGREE:**

Ph.D. Chemical Engineering, Montana State University, 1995

#### **PROFESSIONAL EXPERIENCE:**

2010 – Present President, Apex Engineering, PLLC, Missoula, MT  
2002 – 2010 President, Apex Engineering, PLLC, Helena, MT  
2004 – 2008 Adjunct Professor, Department of Environmental Engineering, Montana Tech, Butte, MT  
2001 – 2004 Adjunct Professor, Department of Chemical Engineering, Montana State University, Bozeman, MT  
1999 – 2002 Project Engineer, Hydrometrics, Inc., Helena, MT  
1995 – 1999 Senior Chemical Engineer, Hydrometrics, Inc., Helena, MT  
1991 – 1995 Graduate Research Assistant, Center for Biofilm Engineering, Montana State University  
1989 – 1991 Senior Process Engineer, 3M Company, Hutchinson, MN  
1984 – 1987 Product Engineer, 3M Company, Hutchinson, MN

#### **AREAS OF EXPERTISE:**

- Analysis of treatment alternatives for industrial wastewater, groundwater, drinking water and stormwater
- Process design and budgetary cost estimates
- Bench and pilot testing
- Innovative technology investigation and development
- Field installation and start-up
- Process analysis and trouble-shooting
- Hazardous waste treatment
- Technical writing

#### **PATENTS:**

Anoxic Biotreatment Cell – U.S. Patent #5,908,555

#### **PROFESSIONAL LICENSES AND MEMBERSHIPS:**

Registered Professional Engineer – Montana and Nevada  
Lifetime Member – American Institute of Chemical Engineers (AIChE)

#### **TECHNICAL TRAINING:**

Advanced Waste Water Treatment  
Biological Nutrient Removal  
Reverse Osmosis

## **MICROBIAL PROCESS ENGINEERING PROJECTS:**

*Keeyask Project, BBE Hydro Constructors, Gillam, Manitoba.* Project manager for developing and implementing a process to treat 100 million gallons of quarry water containing elevated levels of nitrate, nitrite and ammonia at a large-scale hydropower project. The selected treatment process requires addition of microbial inoculum (from an existing on-site wastewater treatment plant), a carbon source (ethanol), biofilm attachment surfaces (modules from Floating Island International) and circulation (submersible and air-lift pumps).

*Microbial Sulfate Reduction, Veris Gold, Elko, Nevada.* Reviewed previous test work and made recommendations for enhancing *in situ* bioreactor performance at this active gold mine. Approximately 5-10 gpm flowing from a mine rock disposal area (RDA) is treated for sulfate and total dissolved solids reduction. The project team has designed and is constructing passive bioreactors to treat seepage from three RDAs at the site.

*Microbial Sulfate Reduction, Clearwater Layline, Virginia, Minnesota.* Serving as technical consultant to set up and evaluate sulfate-reducing bioreactors to treat mine water to meet stringent State of Minnesota standards.

*Acid Rock Drainage Treatment, Kinross Gold, Arco, Idaho.* Performed successful column testing with passive bioreactors and limestone to reduce sulfate, TDS, aluminum and iron concentrations.

*Floating Islands, Floating Island International, Shepherd, Montana.* Serving as technical consultant to explore and expand application of the patented floating island (FI) technology for water quality improvement, wildlife habitat and other uses. Tasks have included designing, optimizing and analyzing bench and pilot tests, investigating and designing new applications for the FI technology, writing proposals and technical support for various FI projects. Additional duties include data compilation and synthesis, case study development, and interaction with FI licensees and potential customers.

*Biological Nitrate and Perchlorate Removal, Alpha Explosives, Lincoln, California.* As process engineer, have assisted in site remediation of contaminated groundwater since 2000 and designed, implemented and analyzed data from four *in situ* pilot bioremediation tests. Full-scale remediation at the site began in 2006, with Phase 2 of remediation and monitoring currently underway.

*East Boulder Mine, Stillwater Mining Company, Big Timber, Montana.* Assisting with *in situ* bioremediation field tests to address high nitrate levels in a groundwater plume downgradient from the mine. Developed and explored ideas for improving the performance of this mine water treatment system, which biologically removes nitrate and ammonia.

*Asarco El Paso Site, CDM, El Paso, Texas.* Performed column testing to determine biological treatment efficiencies for nitrate and selenium in groundwater from a former

smelter site. Also determined design criteria for a full-scale groundwater system using biological treatment.

*Montanore Mine, Montanore Minerals Corp., Libby, Montana.* The project required researching and evaluating treatment alternatives (biological and chemical) for removing nitrate and ammonia from mine water at this new facility. The design flow rate is 200 gpm. Preliminary design was done by Apex Engineering and Morrison-Maierle, with final design and construction currently on hold.

*Nitrogen Removal, Coeur Alaska, Juneau, Alaska.* The project involved researching and evaluating treatment alternatives (biological and chemical) for removing nitrate and ammonia from mine water at this new mine, with a design flow rate of 1000 gpm. Final design and construction is currently on hold.

*Biological Nitrate and Sulfate Removal, Kinross Gold, Republic, Washington.* Served as process engineer to design and construct three biological treatment systems for nitrate and sulfate removal to meet state antidegradation standards. Flow rates range from 6 to 50 gpm, with nitrate-nitrogen concentrations of 6 to 30 mg/L and sulfate concentrations of 100 to 900 mg/L. Project duties included column testing, preparation of engineering reports and O&M manuals for state review, meeting with state scientists and engineers, conceptual design and cost estimation, final design and construction oversight, teaming with other consultants on the project, and start-up and operations support. The selected technology combines engineered reactors and *in situ* biological treatment.

*In Situ Nitrogen Removal in Groundwater, Stillwater Mining Company, Nye, Montana.* Project manager to evaluate methods for enhancing nitrogen removal during and after biotreatment at the Stillwater Mine. Pilot test data showed that *in situ* nitrification (ammonia removal) can be achieved, followed by *in situ* denitrification (nitrate removal) if additional carbon is supplied. Nitrogen concentrations in groundwater were reduced to below background levels.

*Biological Nitrate Removal (Pilot Test), Minera Yanacocha, Cajamarca, Peru.* Project manager for design and implementation of an Anoxic Biotreatment Cell (ABC) for nitrate removal from excess mine water. This pilot system was designed to reduce the nitrate-nitrogen concentration from approximately 30 mg/L to less than 10 mg/L while treating up to 50 m<sup>3</sup>/hr (220 gpm) of water. Design goals were achieved in the year-long pilot test and a final report was issued. The Minera Yanacocha site, whose majority partner is Newmont Mining Corporation, is one of the largest gold mines in the world.

*Biological Nitrate Removal (Plant Design), Stillwater Mining Company, Nye, Montana.* Project manager for design and implementation of an ABC bioreactor for nitrate removal from mine adit discharge water. Researched available technologies, designed reactor system (including microbial, chemical, mechanical and electrical aspects), and oversaw construction. Initial bioreactor exceeded design criteria by operating at flows up to 160 gpm and up to 95 percent removal of nitrate. Based on this success, Stillwater Mining constructed ABC systems capable of treating a total of 2400 gpm at two sites.

*Biological Nitrate Removal (Bench Testing), ASARCO Incorporated, Noxon, Montana.* Designed and operated bench-scale columns to determine rates for denitrification (biological nitrate removal) and nitrification (biological ammonia removal) at low temperatures. Designed pilot-scale denitrification system for Asarco Troy Unit and investigated full-scale biotreatment options for Asarco Rock Creek. Provided oral presentations and written responses to comments on the Rock Creek draft Environmental Impact Statement and draft MPDES permit.

*Biological Nitrate Removal (Plant Design), Wharf Resources, Lead, South Dakota.* Project manager for design and implementation of an ABC bioreactor for nitrate removal from a gold mine neutralization solution, including bench-scale tests and full-scale design (microbial, piping and structural aspects). This bioreactor was designed to treat a higher flow (200 to 400 gpm) and a higher nitrate concentration (110 mg/L as N) than at Stillwater.

*Passive Bioreactor Pilot Test, ASARCO Incorporated, Patagonia, Arizona.* Project engineer for a passive bioreactor pilot test to evaluate metals removal from acid rock drainage at a closed mine site. Within 45 days after reactor start-up, removal rates for total metals were 99 percent for both iron and zinc, and 78 percent for manganese. Sulfate removal was approximately 90 percent, to an effluent concentration of 250 mg/L. Treatment also increased the water pH by approximately 1 unit, to pH 6.7.

*Biological Treatment of Heap Leach Water, Barrick Goldstrike, Elko, Nevada.* Project manager for Anoxic Biotreatment Cell column testing to evaluate removal of sulfate, nitrate, acidity and metals from heap leach water. Significant decreases were measured in sulfate and total dissolved solids concentrations, and groundwater standards were met for all other parameters.

*Biological Selenium Removal (Pilot Test), Kinross DeLamar, Jordan Valley, Oregon.* As project manager, designed and inoculated a pilot-scale ABC bioreactor to remove nitrate, selenium and sulfate from this closed silver mine.

*Biological Nitrate Removal, Coastal Chem, Battle Mountain, Nevada.* Project manager for ABC column testing and evaluation of treatment alternatives for removal of high nitrate concentrations from groundwater. Nitrate concentrations were reduced from 300 mg/L to less than 10 mg/L in a residence time of 6 hours.

*Passive Biotreatment System, Canyon Resources Corp., Hilger, Montana.* Designed a pilot-scale (10-gpm) passive biotreatment system for thallium removal from surface water at a reclaimed gold mine.

*Microbial Oil Souring Research and Development, Montana State University, Bozeman, Montana.* Researched fundamentals of sulfate-reducing bacterial activity in oil reservoirs, a \$7 billion/yr. problem worldwide, in an initiative sponsored by five oil companies. Operated batch, continuous-stirred and packed bed biological reactor

experiments, including set-up, laboratory analysis, data analysis and modeling. Invented several biological and chemical methods for inhibiting the undesirable microbial growth of sulfate-reducing bacteria.

*Sulfate-Reducing Bacteria Project, MSE, Inc., Butte, Montana.* Analyzed data, performed lab analysis and assisted in field sampling for this project in the DOE-funded Mine Waste Technology Pilot Program. Provided recommendations from bench- and pilot-scale experiments for implementation into the full-scale passive biotreatment system designed to remove metals and neutralize pH from mine effluent.

**CHEMICAL PROCESS ENGINEERING PROJECTS:**

*Sulfate Removal, ATI (Canada) Corp., Calgary, Alberta.* Ran bench tests with the Cost-Effective Sulfate Removal (CESR) process to remove sulfate from mining-impacted water. This process may be used prior to the ATI process for selenium removal. Independent lab verification and on-site pilot testing will be the next steps in the project.

*Easton Pacific Mine, RAM Resources, Virginia City, Nevada.* Teaming with KirK ENR to provide a treatment system for antimony and uranium, with a design flow rate of 10 gpm. Several types of adsorptive and ion exchange media have been evaluated in bench tests to date.

*Audit Protocols, Integrity Solutions, Missoula, Montana.* Answered pre-audit questions for a confidential client operating oil and gas transmission and distribution pipelines on the North Slope of Alaska.

*Sulfate Removal, Kawneer Company Canada, Lethbridge, Alberta.* Reviewed the current water treatment process, ran chemical treatment bench tests on-site and provided further recommendations.

*Renewable Energy Process Audit, Full Circle Biofuels, Bozeman, Montana.* Performed an engineering review at the Full Circle Biofuels biodiesel plant. The process audit and engineering review report are necessary for the facility to be eligible for renewable energy credits.

*Jerritt Canyon Mine, Veris Gold, Elko, Nevada.* Completed pilot testing and full-scale design for a mine water treatment plant to remove arsenic and antimony. The selected technology is a combination of coagulation/filtration and adsorptive media, with Phase 1 scheduled to treat up to 1200 gpm and Phase 3 up to 6000 gpm.

*Renewable Energy Process Audit, Montana-Dakota Utilities, Billings, Montana.* Performed an engineering review at the Billings Regional Landfill Biogas Project for Control Union (U.S.A.), Inc. The process audit and engineering review report are necessary for the facility to maintain compliance with EPA regulations, and to be eligible for renewable energy credits.

*Cormidom Sulfate Removal Project, Dominican Republic.* Performed two rounds of bench tests to remove sulfate from mine water using the CESR process. This process could potentially replace an ultrafiltration/reverse osmosis process treating the mine wastewater. We reduced the sulfate concentration from about 2800 mg/L to 670 mg/L, which met the process goals. The next step is a potential pilot test.

*Closed Asarco Smelter, East Helena, MT.* Bench tests were performed to evaluate possible process changes and optimization for the High Density Sludge (HDS) water treatment plant. Various reagents and dosages were evaluated. It was concluded that a process engineer should monitor future HDS operations for process and influent quality changes. An evaporator may replace the HDS plant as treatment volumes decline.

*King-king Mine, St. Augustine Gold Company, Philippines.* Teamed with Golder Associates on developing mine water treatment alternatives and costs for this proposed open-pit gold mine. Prefeasibility work was completed in 2012, with the higher-level feasibility study scheduled for late 2015. Four to five separate water treatment plants, each utilizing different processes, are envisioned.

*Fort Knox Mine, Kinross Gold, Fairbanks, Alaska.* Worked for Morrison-Maierle, Inc. to develop pump and piping systems for Carbon-in-Column (CIC) system #2 for expanded heap leach operations at the mine, and for expanding CIC #1. Technical memos, process and instrumentation diagrams, and material take-offs were also developed.

*Central Treatment Plant Operations, U.S. Army Corps of Engineers, Kellogg, Idaho.* Have served as process engineer at the Bunker Hill Central Treatment Plant since 1999, leading efforts in plant optimization, effluent quality improvement and cost reduction. This 2000-gpm lime treatment plant removes metals from acid rock drainage at a large Superfund site prior to discharge to a trout stream. Following modifications to plant operations (at no capital cost), annual operating costs were reduced by \$125,000. Served as design team leader for approximately \$3 million in plant upgrades in 2003-2005.

*Kensington Mine, Coeur Alaska, Juneau, Alaska.* This project involved optimizing operations at the mine water treatment plant, which has a capacity of 1500 gpm. Tasks included visiting the site, developing operating guidelines, writing an Operations and Maintenance Manual, designing a nitrogen removal system, designing upgrades for increased capacity, and investigating and testing alternatives for manganese and sulfate removal.

*Central City/Clear Creek Water Treatment Plant, Colorado Department of Health and Environment, Central City, Colorado.* Served as technical expert to Golder Associates in evaluating and designing a high density sludge (HDS) lime treatment plant for acid rock drainage at this Superfund site. Historic mining and milling activities have resulted in contamination with cadmium, copper, manganese and zinc, all of which exceed water quality standards, significantly impact aquatic life and pose a threat to human health.

*Golden Sunlight Mine, Barrick Gold, Whitehall, Montana.* Worked with Hydrometrics as a water treatment expert to design and estimate costs for an acid rock drainage treatment plant, which will be constructed after closure of this active gold mine.

*Polyoxin Production, Northwest Agricultural Products, Pasco, Washington.* Served as process engineering consultant to develop a cost-effective method of producing a high-value product, Polyoxin D, for agricultural use.

*Missouri River Water Treatment Plant, City of Helena, Montana.* Teamed with Hydrometrics, Inc. to reduce waste volumes at this drinking water plant. Tasks included compiling flow and water quality data, bench testing, investigating treatment technologies and interacting with vendors.

*Arsenic Removal, City of Jackson, Montana.* Teamed with Morrison-Maierle, Inc. to investigate and implement water quality improvements at this rural drinking water plant, in the form of a Preliminary Engineering Report (PER). Grant funding is currently being sought for final design and construction.

*Kendall Mine, Canyon Resources Corp., Hilger, Montana.* Teaming with Hydrometrics to evaluate and implement a final water treatment solution at this closed gold mine. Thallium is the primary contaminant of concern. A final treatment system using clinoptilolite, an inexpensive natural zeolite, and multimedia filtration was designed.

*Mount Emmons Solids Removal, Frank Environmental Services, Crested Butte, Colorado.* Project manager for two process improvements at this mine water treatment plant: 1) evaluation and implementation of a process to replace the dated dissolved air flotation technology for solids removal, and 2) evaluation and implementation of a process to replace two antiquated belt presses for final solids removal. Tasks have included site visits, vendor interaction, and bench and pilot testing, along with investigating general cost reduction.

*Mount Emmons Water Management Plan, U.S. Energy Corporation, Crested Butte, Colorado.* Developed an ongoing water management plan for the client and regulators. The project objectives were to: 1) provide a baseline report to the client regarding water management needs during ongoing underground activities; 2) identify parameters that may require water treatment; and 3) compile information that can be presented to and discussed with regulators.

*Hazardous Waste Consultant, Aspen Publishers.* Wrote technical and legal articles concerning hazardous waste for this bimonthly journal.

*Selenium Removal Options, ConocoPhillips Refinery, Billings, Montana.* Teamed with Hydrometrics to evaluate future discharge and treatment options at this oil refinery. Tasks included process review, collection of water quality data and review of appropriate treatment technologies.

*BP Produced Water Treatment, Veolia Water Systems, Wamsutter, Wyoming.* Served as technical reviewer for an innovative pilot treatment system developed by Veolia Water Systems, which will discharge high-quality effluent from shale gas produced water at a British Petroleum (BP) site in Wyoming.

*Tailings Treatment Facility, Coeur Alaska, Juneau, Alaska.* This project involved optimizing operations at the TTF mine water treatment plant at the Kensington Mine, which has a capacity of 1500 gpm. Worked with Crown Solutions (design team) and Coeur Alaska (owner). Tasks included visiting the site, developing operating guidelines, and writing an Operations and Maintenance Manual.

*Seep Water Treatment Project, Kensington Mine, Coeur Alaska, Juneau, Alaska.* This project involved selecting and implementing an effective, low-cost system for removing metals from an acid rock drainage seep at a remote site. We selected the Rotating Cylinder Treatment System (RCTS) from Ionic Water Technologies as the principal component of the treatment system. The 60-gpm plant was designed in early 2009, installed on-site in July and began meeting water quality standards in August.

*Sulfate and TDS Removal, Queenstake Resources, Elko, Nevada.* Performed two rounds of successful bench tests of an innovative chemical treatment process for sulfate and TDS removal from mining-impacted surface water, reducing TDS from over 10,000 mg/L to less than 1,000 mg/L.

*Lucky Friday Mine, Hecla Mining Company, Mullan, Idaho.* Assisted in troubleshooting and optimizing operations at a new mine water treatment system comprising clarification and multimedia filtration.

*Buckhorn Mountain Project, Kinross Gold, Republic, Washington.* Served as process engineer at a 100-gpm mine water treatment system at this new gold mine. Project tasks included process analysis, bench testing, process design, cost estimation, construction technical support, and system start-up and optimization. Treatment parameters include nitrate, ammonia, arsenic and metals, and technologies considered include ion exchange and biological treatment. The ion exchange plant started operations in late 2007, with upgrades implemented in 2008 for enhanced removal of all contaminants.

*Idaho Cobalt Project, Formation Capital Corp., Salmon, Idaho.* Served as process engineer to develop a water treatment process for this mine, which was recently permitted. Tasks included literature searches, bench testing, pilot testing and process flowsheets. The proposed design includes hydroxide precipitation, ion exchange and biological treatment, with sulfide precipitation and membrane processes also considered.

*IMA Mine, Gentor Resources, Whitehall, Montana.* Served as process engineer to develop a water treatment process for this mine, which is in the permitting stages. Tasks included literature searches, process flowsheets, cost estimates and recommending bench testing.



*Whirlwind Mine, Energy Fuels Corp., Nucla, Colorado.* Researched and evaluated methods for removing selenium from mine water at this uranium mine.

*Energy Queen Mine, Energy Fuels Corp., Nucla, Colorado.* Developed treatment alternatives for removing radium and other contaminants at this proposed uranium mine.

*Idaho Cobalt Project, Formation Chemicals, Inc., Kellogg, Idaho.* Served as process engineer to recommend a treatment plant design in Phase I of this project. Designed and conducted five series of bench-scale tests and one pilot test, and wrote a final report. Sodium hydrosulfide (NaHS) addition was selected to meet low metals concentrations prior to discharge.

*Aspen Air, Billings, Montana.* Served as technical consultant in developing options for managing cooling water blowdown at a proposed facility in Lockwood, Montana. We presented several alternatives for minimizing, eliminating and treating the blowdown, and recommended alternatives to provide the most cost-effective long-term approach.

*Arsenic Removal, Gore Hill Water District, Great Falls, Montana.* Served as process engineer to investigate alternatives and implement treatment for arsenic removal at a small utility, teaming with Great West Engineering. Provided preliminary engineering design and cost estimates for central treatment and ideas for water blending.

*Dixon Agency Water Supply, Salish & Kootenai Housing Authority, Dixon, Montana.* Served as process engineer to investigate and implement treatment alternatives for arsenic removal for a small tribal utility, teaming with Morrison-Maierle, Inc. Provided preliminary engineering design and cost estimates for both central treatment and point-of-use devices.

*Groundwater Treatment, BMP Investments, Inc., Roundup, Montana.* Investigated technologies for groundwater treatment and use at this large coal mine, teaming with Hydrometrics.

*Copper Removal, City of Boulder, Boulder, Montana.* Served as process engineer to evaluate and implement a solution for high copper concentrations in the drinking water distribution system, teaming with Morrison-Maierle. Pilot testing was then performed.

*Montanore Mine, Mines Management, Inc., Libby, Montana.* Provided technical review and design assistance for a water treatment system at this new copper/silver mine. Pilot testing and equipment procurement were completed and a 500-gpm filtration/ultrafiltration plant was started up.

*Antimony Removal, Glacier International Airport, Kalispell, Montana.* Investigated and evaluated methods for removing antimony from car wash water, to allow discharge to groundwater. Following bench testing, a chemical treatment system was selected and pilot-tested.

*Mine Water Treatment, Kinross DeLamar, Jordan Valley, Oregon.* Investigated alternatives and provided cost estimates for treatment of seeps and tailings water at this closed silver mine.

*Canadys Power Station, South Carolina Electric & Gas Company, Columbia, South Carolina.* Served as technical consultant for selection of a water treatment system to remove arsenic from a process waste stream of 5 mgd (3500 gpm). Both proven and innovative technologies were evaluated to minimize capital and operating costs, while reliably treating approximately 200 ppb of arsenic to a discharge limit of 5 ppb. Tasks included review of water quality data, bench testing results, pilot test work plans, data and reports, and existing treatment systems.

*Reverse Osmosis Treatment Plant Design, ASARCO Incorporated, Noxon, Montana.* As project engineer, designed and prepared budgetary cost estimates for a 650-gpm two-stage reverse osmosis system to treat adit and tailings water from this proposed 10,000 ton/day copper and silver mine. Investigated disposal options for waste brine from the reverse osmosis process and investigated ion exchange technology. Also designed a combined reverse osmosis/biological water treatment system.

*Wood Gulch Mine, Homestake Mining Company, Elko, Nevada.* Investigated technologies for passive removal of arsenic at this closed mine and wrote a report with recommendations. Researched technologies, documented field applications and obtained preliminary cost estimates.

*Analysis of Water Reuse and Treatment Options, PPL Montana, Colstrip, Montana.* Project manager to investigate methods for reducing process water inventory at this coal-fired power generation facility. Investigation included bench-scale testing, modeling and cost analysis of numerous water use and treatment options. Summarized findings in a report for the client, which was presented to regulatory authorities.

*Treatment Plant Cost Analysis, Montana Resources, Butte, Montana.* Reviewed proposed treatment methods and costs for a 2000-gpm stream that required treatment. Several concessions were obtained from regulating authorities, which allowed the client to reduce anticipated operating costs. This 2000-gpm HDS lime treatment plant was built in 2002.

*Closed Smelter Superfund Site, ASARCO Incorporated, Tacoma, Washington.* Investigated technologies for treating surface water to meet the remediation goals for arsenic and metals proposed by EPA for this closed smelter site. Developed six treatment options, with their achievable quality levels and associated costs, for Technical Impracticability Report. Performed bench-scale and pilot-scale settling tests to meet remediation goals using polymer addition and filtration, and incorporated findings into Preliminary and Intermediate Design documents.

*Hazardous Waste Engineering, Montana State University, Bozeman, Montana.* Taught MPEM 5130 several times as part of the curriculum for a Master's of Project Engineering and Management. This on-line degree is offered by Montana Tech.

*Stormwater Treatment Preliminary Design Report, Land and Water Consulting, Kalispell, Montana.* Process engineer for preliminary design report on stormwater treatment options and costs for the proposed Glacier Mall project, which was proposed to be the largest mall in the state.

*Arsenic Removal, Great West Engineering, Carter, Montana.* Investigated and analyzed treatment alternatives (for arsenic, manganese and radon) for a small utility, and provided preliminary engineering design and cost estimates for both a central treatment system and point-of-use devices. Teamed with Great West Engineering.

*High Efficiency Reverse Osmosis Pilot Test for Metal Finishing Wastewater, Honeywell Federal Manufacturing & Technologies, Kansas City, Missouri.* As project manager, evaluated patented High Efficiency Reverse Osmosis (HERO™) process in conjunction with the U.S. Environmental Protection Agency's Environmental Technology Verification for Metal Finishing (ETV-MF) Program. The objective of the ETV-MF Program is to identify promising and innovative pollution prevention treatment technologies through EPA-supported performance verifications, and to provide objective performance data to providers, purchasers and permittees of environmental technologies. Effluent water quality from the pilot test was very good, several reports were written and the HERO™ technology was added to the list of ETV-approved technologies.

*Textile Wastewater Treatment, America Textile, La Paz, Bolivia.* Project manager for treatment system to remove organic dyes, salts and suspended solids from textile wastewater. Evaluated HERO™ process in small-scale pilot tests, where high-quality permeate was produced at a recovery rate of 97 percent.

*Sulfate Removal Evaluation, Mine Waste Technology Program, Butte, Montana.* Served as project manager of bench-scale treatability tests for sulfate removal from the Berkeley Pit, a large Superfund site in Butte. The Cost Effective Sulfate Removal (CESR) process, which chemically precipitates sulfate after addition of a proprietary powder, reduced sulfate concentrations in this project from 8700 mg/L to as low as 5 mg/L. This project was funded by the U.S. EPA under the Mine Waste Technology Program at Montana Tech.

*Pulp and Paper Wastewater Treatment, Industrias Centauro, Durango, Mexico.* Project manager for water treatment system to remove dissolved solids from industrial wastewater. Water reuse is economical in this arid region and a supply of high-quality boiler feed water is required for a planned cogeneration facility. In a bench test of the HERO™ process, high-quality permeate was produced at a recovery rate of 97 percent.

*Metallurgical Wastewater Treatment, Molymet, Santiago, Chile.* Project manager to develop a treatment system for a metallurgical plant waste stream. Successfully removed

sulfate and other contaminants to required levels, and developed process flow diagrams and budgetary capital and operating costs. Also recommended investigating simpler and lower-cost alternatives such as evaporation, whose testing was subsequently authorized by the client. Coordinated vendor testing and water analysis, and summarized projected water quality and budgetary costs in a final report.

*Thallium Removal Pilot Test, ASARCO Incorporated, East Helena, Montana.* Project manager for a pilot test using natural zeolites to remove thallium from wastewater. We designed, constructed and operated a 10-gpm pilot system for three months to evaluate whether more stringent discharge limits for thallium could be met using this technology. Thallium removal was generally successful but it was determined that this adsorption technology would not consistently meet the proposed limits, due to large fluctuations in the influent water quality.

*Sulfur-Modified Iron for Arsenic Removal, Peter F. Santina, Concord, California.* Process development work was performed using this patented technology for arsenic removal from drinking water and industrial waters. Two reports were written summarizing the results, comparing the results and costs to alternative technologies, and recommending future work. This recommended work, using bench-scale tests to explore different conditions and new applications, laid the foundation for a \$150,000 federally funded pilot test.

*Smelter Wastewater Treatment Plant Optimization, ASARCO Incorporated, East Helena, Montana.* This project involved developing and implementing methods for improving performance of the Asarco East Helena HDS™ water treatment plant. Bench-scale treatability tests were performed in the laboratory to examine the effects of numerous proposed process changes on HDS™ plant performance (arsenic and metals removal), and several of these changes were implemented. This 100-gpm plant had been built in the early 1990s.

*Evaluation of Thallium Removal Options, Canyon Resources Corp., Hilger, Montana.* Project engineer for water treatment phase of this project, aimed primarily at removal of thallium from process water and surface water at this reclaimed open-pit gold mine. Investigated chemical and thermodynamic models, and developed methods in bench-scale experiments to remove thallium and other metals to the very low levels required by human health standards. Designed a 100-gpm water treatment system for process water using reverse osmosis and zeolite adsorption, and assisted in start-up and process optimization.

*Pretreatment Standards Compliance Agreement, American Chemet, East Helena, Montana.* As project manager, investigated regulations and developed plan to meet EPA pretreatment standards for discharge to the City of East Helena's Publicly Owned Treatment Works (POTW). This project involved close coordination with the client, EPA, local officials and other consultants. Developed a compliance plan to meet the applicable pretreatment standards, and coordinated water quality monitoring and analysis for one year after a solution was implemented.

*Sulfate Removal for Battery Manufacturer, Commonwealth Technology, Inc., Lexington, Kentucky.* Project manager for evaluating sulfate removal technologies from wastewater at a battery manufacturing plant. Evaluated Hydrometrics' CESR process in bench tests. Wrote report recommending: 1) reducing sodium concentrations to improve CESR process efficiency, or 2) evaluating patented HERO™ process.

*Phosphorus Plant Water Treatment, FMC Corporation, Pocatello, Idaho.* Examined treatment methods and discharge alternatives for process water streams at the largest elemental phosphorus plant in the U.S. Parameters of concern were metals, cyanide and elemental phosphorus. Investigated treatment technologies and timelines for implementation, and regulatory constraints for meeting anticipated water quality limits, both for NPDES and “zero-discharge” options.

*Arsenic Removal Evaluation, Wharf Resources, Lead, South Dakota.* Developed methods in bench-scale and pilot-scale testing for removal of arsenic to low levels (below 0.05 mg/L) from several process waters. Applied Sulfur-Modified Iron technology to site waters and performed process development work.

*Treatment Plant Preliminary Design, Golden Sunlight Mines, Inc., Whitehall, Montana.* Investigated treatment alternatives, and prepared process flow diagrams and cost estimates, for a water treatment plant at this open-pit gold mine.

*Iron Mountain Laboratory/Treatability Test Services, CH2M Hill, Redding, California.* Coordinated analysis of sediment and water samples from a large Superfund site, and developed test methods for determining the optimal treatment technique for removing these hazardous materials.

*Arsenic Removal, ASARCO Incorporated, Tacoma, Washington.* Performed bench-scale treatability tests in the laboratory and on-site for arsenic removal from groundwater emanating from this closed landfill containing wood wastes and smelter slag. Investigated *in situ* treatment methods.

*Process Engineering Services for Plant Optimization, Encycle/Texas, Corpus Christi, Texas.* Teamed with process engineering, sales, and marketing personnel on cost reduction projects at this solid and liquid waste recycling facility.

*Treatment Plant Optimization, ASARCO Incorporated, Columbus, Ohio.* Performed treatability study with recommendations for improving effluent quality from the water treatment plant at this closed zinc oxide plant.

*Treatment Plant Optimization, Zortman Mining, Inc., Zortman, Montana.* Provided expertise for the treatment of metals and arsenic in acidic drainage from this gold mining operation, which is now closed. This 1000-gpm lime treatment plant, designed by Hydrometrics at a remote site, is still operating and provides extended trouble-free operation.

*Process Engineering Services for Cost Reduction, 3M Company, Hutchinson, Minnesota.* Implemented programs aimed at unit cost reduction, improved customer service, quality improvement and equipment reliability in VHS magnetic tape coating area. Also responsible for evaluation and correction of daily quality and production problems.

*Product Engineering Services for Quality Improvement, 3M Company, Hutchinson, Minnesota.* Complete product oversight responsibilities for VHS magnetic tape, including quality improvement, customer service, unit cost reduction, troubleshooting and new product information.

**PEER-REVIEWED PUBLICATIONS:**

Reinsel, M.A., J.T. Sears, P.S. Stewart and M.J. McInerney, 1997. Control of Microbial Souring by Nitrate, Nitrite or Glutaraldehyde Injection in a Sandstone Column. *Journal of Industrial Microbiology*, 17:128-136.

Chen, C.-I. and M.A. Reinsel, 1996. Characterization of Microbial Souring in Berea-Sand Porous Medium With a North Sea Oil Field Inoculum. *Biofouling*. 9(3):175-186.

Chen, C.-I., M.A. Reinsel and R.F. Mueller, 1994. Kinetic Investigation of Microbial Souring in Porous Media Using Microbial Consortia From Oil Reservoirs. *Biotechnol. Bioeng.* 44:263-269.

Reinsel, M.A., J.J. Borkowski and J.T. Sears, 1994. Partition Coefficients for Acetic, Propionic, and Butyric Acids in a Crude Oil/Water System. *Journal of Chemical & Engineering Data*, Vol. 39, No. 3, 513-516.