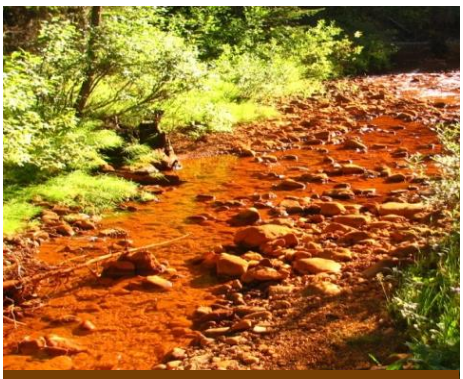
Project Name: McLaren Tailings Abandoned Mine Site Reclamation Project, Cooke City, Montana.

Summary

DEQ and Pioneer partnered to successfully remediate the McLaren Abandoned Mine Site, turning a previously unusable area back to its historical landscape while cleaning up a contaminated Soda Butte Creek. It has preserved an important fishery and the natural resources of Yellowstone, while protecting human health and the environment. Given the 80-year legacy of contamination, DEQ is surprised by the excellent water quality throughout the project area following the removal of the wastes. This result is attributable to Pioneer's project design engineering incorporating aggressive capture and treatment of contaminated media.

Project

In 1933, the McLaren Gold Mines Company discovered the McLaren deposit on Henderson Mountain. In 1934, they constructed a mill and a tailings impoundment. The McLaren Mill produced a gold and copper concentrate. During operations, Soda Butte Creek's channel was filled with tailings and overflow from the tailings impoundment flowed downstream into Yellowstone National Park. Park Rangers documented a regular pattern of leaks and breaks in the dam surrounding the tailings impoundment. The mill operated until 1953. However, closure did not end the downstream environmental impacts. By the late 1960s, Soda Butte Creek was considered the most polluted stream entering Yellowstone National Park. Investigations showed that ferrous iron precipitates and heavy silt loads from the tailings were adversely affecting the fish producing capacity of Soda Butte Creek within the Park. In 1969, Bear Creek Mining, the site owner, and a Kennecott Corporation subsidiary, rehabilitated the site by covering the eroding tailings with soil, demolished the buildings, and excavated a new channel for Soda Butte Creek along the north side of the tailings impoundment. The problem, however, persisted.



Soda Butte Creek 2008

Subject to an Emergency Response Action by the U.S. Environmental Protection Agency (EPA) in 1988, Kennecott completed corrective actions from September 4, 1988, until September 24, 1990. In March 1991, the Bureau of Reclamation evaluated the effectiveness of the stability actions and concluded the tailings dam was only "marginally stable." Directed by the EPA, Kennecott completed additional construction activities until August 22, 1991. On August 10, 1993, Pioneer Technical Services, Inc. (Pioneer) completed a site investigation (PA# 34-004) for the Abandoned Mine Reclamation Bureau (AMRB) as part of an inventory project. Pioneer collected samples of waste rock, tailings, groundwater, surface water, sediment, and background soils.

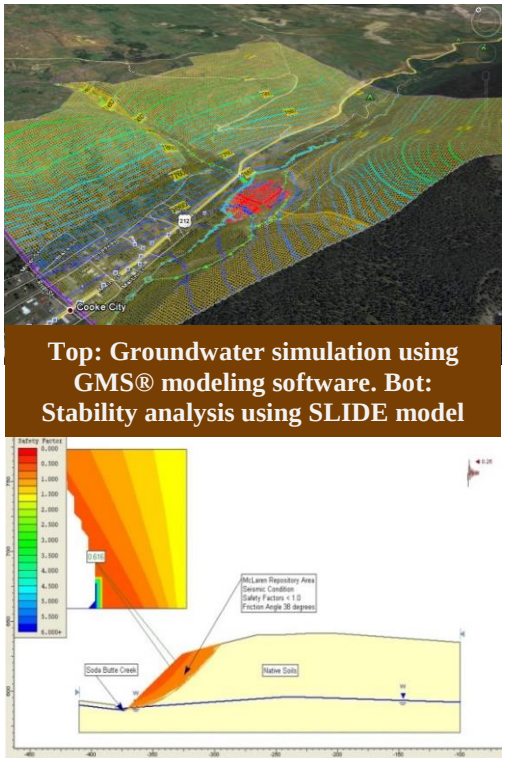
In 2000, DEQ/MWCB contracted Pioneer to conduct another limited site investigation. Pioneer collected surface water, sediment, and tailings samples and installed/sampled multiple boreholes and test pits in potential tailings, waste rock, and borrow areas. Pioneer used the results to develop an Expanded Engineering Evaluation/Cost Analysis (EEE/CA) and identify the design objectives for the McLaren Tailings Site. The objectives centered on preventing releases of

contaminated tailings and waste rock into the affected creeks and the release of contaminated water from tailings and waste rock materials that would cause exceedances in surface water and groundwater quality standards. Another objective was to isolate contaminated tailings and waste rock materials to prevent unacceptable risks to human health and/or aquatic life and other environmental receptors.

Based on the preferred alternative outlined in the EEE/CA and the need for an on-site repository area, the DEQ purchased five acres of US Forest Service property located west of the site. In 2007, DEQ initiated additional site investigations. In fall of 2008, DEQ retained Pioneer to conduct the following additional site investigations at the site and the repository property:

- Existing cover soil: installed 35 borings and 64 test pits across the site.
- Source area: installed 45 test pits to depths below the tailings/mine waste areas.
- Groundwater: collected groundwater samples, installed 1 pumping well and 11 piezometers, and conducted a 24-hour aquifer test.
- Surface water: collected surface water samples in Soda Butte Creek.
- Geotechnical: characterized existing cover soils and subsurface soils for stability analysis. Completed bench scaling testing including analyzing stabilized tailings using the Synthetic Precipitation Leach Procedure (SPLP).
- Stream channel: characterized reference reaches within the Soda Butte Creek/Miller Creek channels above/below the site for stream designs (identified channel widths/cross sections/vegetation).

Based on the investigations results, Pioneer developed a final reclamation report for DEQ and the project stakeholders (National Park Service, US Forest Services, DEQ, Beartooth Coalition, and the Park County). Pioneer coordinated closely with these parties to incorporate ideas and requirements into the site design objectives. Based on the additional site investigation results, groundwater/surface water modeling, soil stability analysis, and sediment transport modeling results, Pioneer developed a remedial design that proposed to stabilize/remove 250,000 cubic yards of mine tailings, mine wastes, and impacted soils; construct an on-site repository, a site-wide dewatering system and water treatment system, 4,000 linear feet of storm water conveyance channels and infiltration systems; reconstruct 2,000 linear feet of Soda Butte Creek and Miller Creek; and revegetation of 25 acres.



Top: Groundwater simulation using GMS® modeling software. Bot: Stability analysis using SLIDE model

DEQ awarded the contract for the McLaren Tailings Abandoned Mine Site Reclamation Project in April 2010 and construction began in June 2010. The list below summarizes the remedial activities implemented under the project:

- Construct site access/haul roads to deliver equipment and lime/organic amendment materials.
- Construct complex dewatering system that included 17 pumping wells.
- Construct a 40x60 foot insulated steel building for the water treatment system and all components for the sediment detention pond.
- Construct a 36-mil HDPE-lined 100x650-foot long/10-foot deep sediment discharge pond.
- Install 40x70 and 15x70 foot U80 rated bridges.
- Install, operate, and maintain a temporary construction dewatering system.
- Install/remove 1,500 linear feet of wildlife exclusion fencing around the sediment pond.
- Operate, maintain, and monitor water treatment system for 23 consecutive months.
- Handle soil and materials: excavate, load, haul, and stockpile 83,000 yards of cover soil; excavate, load, haul, place, and compact 235,000 bank cubic yards of material; install 26,000 bank cubic yards of soil on repository cap; stabilize 248,000 bank cubic yards of tailings, mine wastes, and impacted soils; excavate 83,000 bank cubic yards of soil from repository and construct two earthen dams; provide, install, and remove 43,500 square yards of interim liner placed during winter; provide/amend 4,800 dry tons of organic amendment; construct 2,000 linear feet of storm water control channels; install 23,500 square yards of geochusion, 60-mil textured HDPE, and geocomposite.
- Backfill the disturbed footprint with 45,000 cubic yards of amended cover soils.
- Remove/dispose of water treatment system and dewatering control building from the site.
- Reconstruct 1,317 linear feet of Soda Butte Creek and 467 linear feet of Miller Creek.
- Clear/grub 12 acres; fertilize, seed and mulch 27 acres; and install 1,000 trees/shrubs.

Pioneer's Roll

Pioneer played an extensive role in this project that stretches over the past two decades. Pioneer first became involved with the McLaren tailings site in 1993 when the Montana DEQ began looking at the site. Pioneer conducted site investigations, analyzed and interpreted the data, and prepared the remedial design to meet DEQ's remediation objectives. During construction, Pioneer provided Construction Administration. Now that construction is complete, Pioneer is preparing the Construction Completion Report, a detailed and critical requirement to gain DEQ's and the Office of Surface Mining's approval of the completed project.

Other Consultants

As part of Pioneer's remedial design included constructing a site-wide dewatering system and water treatment system, MSE-Technology Applications of Butte, Montana, assisted with the specifics for the system. This included electrical, emergency generator, and auto switching system design; instrumentation controls; and radio communications designs required for the dewatering system, water treatment system, and dewatering control building.

Pioneer's contribution to the project

Original or Innovative Application of New or Existing Techniques

This project incorporated two original/innovative techniques that were crucial to the project's success and the reduction in schedule and costs. ***The first of these techniques was the method of dewatering the tailings for removal***. The results of a 24-hour pumping test and groundwater

modeling task indicated that the shallow groundwater within the tailings could be effectively dewatered by pumping the majority of the water from the site perimeter and from the underlying alluvial aquifer. Groundwater pumped from the alluvium underneath the tailings resulted in draining water from the saturated tailings into the underlying dewatered alluvium. Underneath the tailings is a highly conductive and thick alluvial zone surrounded by less conductive and thinner alluvium. The highly conductive zone was the original Soda Butte Creek channel and was targeted with larger pumping wells with higher production rates. The surrounding thinner and less conductive alluvium was dewatered with clusters of smaller wells with lower production rates. The 14 dewatering wells installed around the perimeter were operated year round to maintain the cone of depression within the tailings impoundment. This minimized recharge to the tailings during spring runoff and maintained the flow water through the lined sediment detention pond. Flow through the sediment detention pond was necessary to keep the liner from floating during spring recharge and the pond from freezing solid during the winter months. The water from the perimeter wells was clean and did not require treatment during winter operations. This unique method of dewatering was very successful at the site and allowed the contractor to excavate and stabilize dryer than expected tailings with reduced quantities of quicklime.

The second unique technique applied involved quicklime to stabilize the tailings. Based on the bench scale testing conducted during the geotechnical investigations, Pioneer determined it would be necessary to add 3 to 5 percent quicklime by weight to the tailings to obtain the optimum moisture content for compaction in the on-site repository. To meter the correct quantity of quicklime into the tailings and incorporate at depth and *in-situ*, the remedial design stabilized the tailings using a system developed by ALLU Finland Ltd. Involved in several equipment engineering projects for mass stabilization, ALLU cooperated with the largest construction companies and research institutions to develop reliable and effective equipment for processing soft, non-bearing soils. Using the ALLU allowed the contractor to stabilize the tailings in 10-foot depth intervals to maximum tailing thicknesses of 40 feet. To expedite the tailings placement in the repository DEQ allowed the contractor to add additional lime in the repository with a spreader and disk. ***Using the quicklime resulted in a stable repository and reduced the leachability of metals from the tailings. Without this, the tailings would not have fit within the space available for the repository.***

Future Value

The McLaren project successfully solved an obvious, decades-old environmental problem immediately adjacent to one of America's most iconic properties, Yellowstone National Park. There were many impassioned stakeholders in the project, including federal agencies, state and local governments in Montana and Wyoming, non-governmental organizations, and members of the public. The design team successfully navigated a myriad of technical, environmental, and socio-economic issues to determine the best alternative. The team used engineering analysis to evaluate and incorporate ideas from many stakeholders, which contributed to consensus building between the stakeholders. As a result, the project was not only a technical success, but improved the public's perception of the profession.

Social, Economic, and Sustainable Design Considerations

From 1934 to 1953 the McLaren Mill processed gold and copper and mining operations dumped tailings into Soda Butte Creek (a creek immediately upgradient of the Lamar River in Yellowstone National Park). By 1960 Soda Butte Creek was recognized as one of the most

contaminated streams entering Yellowstone. This McLaren Reclamation Project was successful in restoring Soda Butte Creek. As a highly visible stream right along the high road at the northeast entrance to Yellowstone, the obvious impairment had an emotional, social, and economic impact on the local residents and park visitors. The design had to restore the aquatic habitat and protect the water resources of Yellowstone. Socially, it also had to address the fact that, because of its highly visible nature and proximity to the park, the work itself had to be executed in a manner acceptable to the residents, park visitors, and the many stakeholders. Economically, during the work, the project provided local job opportunities to the community of Cooke City and surrounding areas and provided increased revenue to the local economy. The restoration of aquatic habitat right within Cooke City will likely lead to more fisherman days in the immediate area and draw more Park tourists to the city. The success of the project will ultimately benefit Cooke City's primary economic driver, which is tourism.

Complexity

The McLaren Tailings Abandoned Mine Site Reclamation Project was extremely complex and had many design and construction challenges. These challenges included *limited space, short construction seasons, shallow groundwater, limited repository capacity, remoteness of site, and limited site access for materials transportation*. The project required a complex site dewatering system, a system to treat the water to state water quality standards prior to discharge to Soda Butte Creek, stabilization of very wet tailings materials, and an on-site repository. In addition, as an extra complex element, all activities occurred within a quarter mile of the community of Cooke City and roughly 4 miles from the perimeter of Yellowstone. The work was under constant public view. Given the complexity of the project, Pioneer worked with all the stakeholders in the early phases of the project to develop a flexible remedial design to meet the remediation objectives, and accounted for and ultimately mitigated the future impacts from the site to the downgradient Soda Butte Creek and Lamar River in Yellowstone. The completed project provides an ecosystem to enhance the fishery in the downgradient reaches of Soda Butte Creek and winter/summer recreational opportunities for the community not available since 1935.

Successful Project

The total project construction budget was $26.1 million, with final construction costs of approximately $23.7 million. The cost saving and reduced schedule are due to the effectiveness of the site dewatering system and water treatment system and the DEQ's decision not to transport a portion of stabilized tailing for gold recovery. Reduced transportation and the contractor's ability to work with dryer than expected tailings reduced the construction schedule from 5 years to 4 years and reduced construction administration costs. The owner needs were satisfied and exceeded. Pioneer's budget, as the design engineer and lead construction administration firm, was $2.3 million. Pioneer's actual total fees were $2.1 million.

Total budgeted cost: $ 26.1 million
Pioneer's budgeted cost: $2.3 million
Scheduled completion: October 1, 2015

Total actual cost: $23.7 million
Pioneer's actual cost: $2.1 million
Actual: October 8, 2014