Lion Creek/Minnesota Mine
Erosion and Sediment Control Project

A Cooperative Project between
Arapaho & Roosevelt National Forests Abandoned Mine Lands Program
Trout Unlimited Mine Restoration Project
Clear Creek Watershed Foundation

Final Report

by

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Clear Creek Watershed Foundation
August 31, 2012
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Erosion and Sediment Control Project

Project Purpose and Description
The primary objective of this project was to facilitate proper drainage by stabilizing run-off gullies, thereby reducing erosion and sediment from the Minnesota Mine into Lion Creek. The need for the project stems from a USFS/EPA Cooperative Agreement in the mid-90s to conduct reclamation under a "non-time-critical removal (response) action" in the vicinity of the Minnesota Mine and Mill, including the inter-mingled and adjoining Forest Land, located about 1.5 miles north of the Town of Empire in Clear Creek County, Colorado.

The project work was essentially a maintenance project on the drainage system that was constructed during the original USFS/EPA site remediation. EPA, CDPHE and the USFS conducted a remedial action at the Minnesota Mine in 1997 in order to clean up the eroding tailings pile and to improve water quality in Lion Creek. Tailings piles were capped, revegetated and stormwater controls were established to reduce erosion and contaminated run-off. The runoff channel installed below the reclaimed Minnesota Tailings pile concentrated stormwater runoff and caused fairly severe erosion, creating a gully with up to 20' highwalls near the confluence with Lion Creek. The gully was approximately 250' long, dropping approximately 44 vertical feet to Lion Creek. The project did not involve any work in Lion Creek, but it is intended to improve water quality in Lion Creek and the West Fork of Clear Creek. The project consisted of erosion controls in the gully and a final boulder rundown structure for the runoff before it enters Lion Creek.

A secondary objective of the project was to remove black plastic netting that was used as an erosion control fabric to support revegetation of the disturbed area during the first remediation effort. This plastic netting was neither photodegradable nor biodegradable, and it was not well anchored into the soil. The Forest Service was concerned about the poor revegetative success in the areas where the netting was applied, as well as the hazard it posed to indigenous mammals. The focus of the netting removal was to only remove sections of netting not secured with existing vegetation, i.e., remove netting where revegetation had not succeeded. This was achieved by limiting the total amount of disturbance across the reclaimed site while removing the maximum amount of netting. The removal and site re-stabilization efforts were extended as far as possible within the available budget. Areas where netting was removed were then prepared for revegetation. Soil amendments were applied, including biosol and humate. A native seed mixture appropriate for the site conditions was planted. Biodegradable excelsior (coconut fiber) erosion control blankets were used to replace the plastic netting.

Project Area
The Lion Creek/Minnesota Mine Erosion and Sediment Control Project area is located approximately 1.5 miles north of the intersection of Main Street and Highway 40 in Empire, Colorado. The site is located on Lion Creek, a tributary to the West Fork of Clear Creek at an elevation of 9600 feet.
The project area is 1/2 mile past a locked gate controlled by USFS and the owners of the mining claims in the vicinity of the Minnesota mining area. The road to access the gully was used but not disturbed in any manner. The only private land affected by the project is the Morritz claim, just west of the first hairpin turn on the access road. Consent for entry to perform the project workplan was obtained from Mrs. Norma Heon, owner of the Morritz claim.

**Project Partners and Coordination**

This project would not have been possible without the funding, technical expertise and the tree trunks used for log revetments to stabilize the gully, all of which were provided by the Forest Service. Ms. Trez Skillern, Hydrologist USDA Forest Service, Abandoned Mines Program served as the Forest Service’s project manager and was integrally involved in the project from its inception to completion.

The project was enhanced significantly through the involvement and contributions from Trout Unlimited (TU). Ms. Elizabeth Russell, TU’s Mine Restoration Project Manager, secured additional funding for the project as shown in Table 1. The generous contribution from TU allowed the gully stabilization effort to be fully realized and enabled the additional wildlife protection and habitat improvement measures through the removal of the black plastic netting across the project site, as well as the subsequent revegetation measures.

The Clear Creek Watershed Foundation (CCWF) provided project development and on-the-ground project management services, along with in-kind support for the project. David Holm served as CCWF’s project manager. Frontier Environmental Services, Inc. (FESI) provided all construction services (Brent Scarbrough, Construction Manager) and project supervision (Clay Combrink, Superintendent). Albert Frei & Sons provided a very generous, deeply discounted donation of rock materials (333 tons), without which the project could not have been constructed.

This project was closely coordinated with the Arapaho & Roosevelt National Forests through its project manager (Ms. Skillern). A summary of this project was presented to the Upper Clear Creek Watershed Association during its regular monthly meeting in June 2012. The project workplan was provided to appropriate Clear Creek County Departments on July 12. A site meeting involving County officials was held on August 15, 2012. The county provided field notes and comments and a response from CCWF was provided on August 31, 2012.

**Project Implementation**

This project involved reshaping the gully channel to remove the highwalls and placing 17 drop structures from the top of the gully down to the rundown structure into Lion Creek. The log revetments serve several purposes. They provide a cellular structural form for each of the 17 step-basins while allowing water to pass easily through and over each drop. During the first years following installation they provide each drop basin with independent structural integrity. They also reflect the extensive use of cribbing for structural stabilization during the mining era, although the embedded angular boulders and riprap used to buttress and line the channel will provide the long-term fully integrated geomorphic stability for the drainage-way. The drop structures provide a more natural looking and functioning step-pool profile in the channel than a total rock-lined channel design. The salvaged trees for mine remediation provide an ecological service realized from tree removal for trail construction and forest health maintenance.
A total of 17 drop-structures were constructed where there was previously a 20% grade in the channel. Prior to remediation, water flowing in the gully achieved supercritical flow conditions during runoff events, which is why the erosion was so severe. The channel is dry in all other conditions. The drop structures consist of log revetments constructed by stacking and pinning three 12' long tree trunks across the channel. The ends of the log structures were keyed into the side slopes and also held in place by 24" VH Boulders. Angular riprap (9' and 12'') and filter fabric were also used to anchor the revetments and protect the channel. The reconstructed channel is approximately 8' wide where the log revetments are exposed although the riprap continues upslope along the channel such that the riprap lined portion of the channel is actually 12' wide across the top. The gully only receives drainage from the ~4.5 acre reclaimed area of the Minnesota Mine and an adjacent area (~6.5 acres) that is well forested.

**Project Tasks**

**Task 1 - Project Mobilization and Demobilization**
This objective included any required utility locates, professional liability insurance (prorated to project) and transport of equipment to and from the site.

**Task 2 - Purchase and Transport of Rock Materials to the Job Site**
Rock materials consisting of 9 inch, 1ft. and 2 ft.-sized boulders were purchased (with a generous discount from the local Albert Frei & Sons quarry) and a private sub-contractor hauled and stockpiled the rock near the head-cut of the Gully on the Morritz Mine Claim. Transport costs applied to both purchased and donated rock materials. A total of 333 tons of rock were delivered to the site and used for the stabilization effort.

**Task 3 - Load and Transport Tree Trunk Logs to the Job Site**
Tree logs for the log revetment drop structures were obtained by the contractor and transported to the project site and stockpiled at the top of the large gully, where they were pinned together prior to installation. Tree trunks were salvaged from a USFS site near Bakerville. Trunks were hand-loaded onto a trailer and hauled to the site by FESI personnel.

**Task 4 - Remove Hazardous Highwalls and Rough-grade Drainage-way**
The project site had highly eroded vertical cut-banks that approached 20 feet in height at some points. These hazardous banks were knocked down and the entire drainage-way was regraded prior to channel construction.

**Task 5 - Reconstruct Drainage Channel using Log Revetments and Riprap**
The newly constructed channel includes 17 log drops, which consist of three tree trunk logs pinned together using #8 rebar. The coupled trees were pinned to the slope using rebar and keyed into the slopes on the edges. The finished log drops are approximately 8 feet wide across the channel. The channel consists of 9” riprap placed approximately 18” thick on top of a geotextile filter fabric to prevent fines migration. The channel is nominally 12 feet wide and 250 linear feet long. The outfall into Lion Creek was constructed using 12” riprap as shown below.

**Task 6 - Prepare Channel for Revegetation and Install Erosion Control Blanket**

The margins of the channel were amended with compost, and seeded and fertilized with an upland seed mix approved by the USFS and suitable for this elevation. In addition, humate and biosol soil conditioner were utilized to fortify the soil. Biosol was applied at a rate of 1500 pounds per acre. A biodegradable straw coconut blanket was placed immediately adjacent to the channel on both sides for a width of 8 feet. This erosion control blanket was used to support the revegetation of the reshaped channel side slopes. This maintenance effort is expected to serve its intended purpose over a 50-year period.

**Task 7 - Remove Previously-installed Non-photodegradable Erosion Control Netting**

Black plastic netting was installed during the 1997 Minnesota Mine reclamation effort in various locations. Priority area for removal was been identified by USFS. The highest priority area was nearly ½ acre on the west side of the Minnesota Mine reclamation area. This removal site slopes steeply down to the left descending bank of Lion Creek. Lower priority areas included the borrow site along the access road and other places where the plastic material had been uprooted by the wind. The areal scope of this project was determined by the remaining budget following the gully drainage reconstruction.

**Task 8 - Prepare Area for Revegetation and Install Biodegradable Erosion Control Blanket**

The netting removal area was amended with humate and biosol utilized to fortify the soil, then seeded and fertilized with an upland seed mix approved by the USFS and suitable for this elevation. Biosol and humate were applied at a rate of 1500 pounds per acre. A biodegradable erosion control blanket was placed in netting removal areas.

**Project Budget**
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<tr>
<th>Funding Source</th>
<th>Amount ($)</th>
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<tr>
<td>USFS Grant 07-CS11021007-026 Abandoned Mine Program</td>
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<tr>
<td>Trout Unlimited Donation</td>
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<tr>
<td>In-kind Donation of Rock Materials (Albert Frei &amp; Sons)</td>
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<tr>
<td>In-Kind Donation of Professional Time and Resources</td>
<td>1,000</td>
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<tr>
<td><strong>Total Budget</strong></td>
<td><strong>66,441</strong></td>
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**Project Cost**

<table>
<thead>
<tr>
<th>Project Activity</th>
<th>Cost ($)</th>
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<tr>
<td>Task 1- Project Mobilization and Demobilization</td>
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<tr>
<td>Task 2- Purchase and Transport of Rock Materials to the Job Site</td>
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<tr>
<td>Task 3- Load and Transport Tree Trunk Logs to the Job Site</td>
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<td>Task 4- Remove Hazardous Highwalls and Rough-grade Drainage</td>
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<td>Task 5- Reconstruct Drainage Channel Using Log Revetments &amp; Riprap</td>
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<td>Task 6- Prepare Channel for Revegetation and Install Erosion Control Blanket</td>
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<td>Task 7- Remove Previously-installed Non-photodegradable Erosion Control Netting</td>
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<td>Task 8*- Prepare Netting Removal Area for Revegetation and Install Biodegradable Erosion Control Blanket Where Required.</td>
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<td>Task 9- Project Management, Administration and Reporting (USFS +CCWF)</td>
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<td>Albert Frei &amp; Sons In-kind Donation of Rock Materials</td>
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<td>CCWF In-kind Donation of Time and Resources</td>
<td>1,500</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>66,441</strong></td>
</tr>
</tbody>
</table>

*Note- This task was extended to utilize the entire remaining budget for the project.

**Conclusion**

The Lion Creek/Minnesota Mine Erosion and Sediment Control Project was primarily aimed at establishing conditions for proper drainage from the Minnesota Mine into Lion Creek by stabilizing a severely eroded gully near the outlet of the mine runoff channel. The project involved the construction of 17 step pool basins using angular riprap boulders ranging in size from 9" to 2 feet as the smallest dimension. A geotextile filter fabric was installed beneath the riprap channel lining. Tree trunks were used as log revetments for the step pool basins and to serve as drop structures. The logs add aesthetic and ecological value to the riprap channel. Over the long-term, the angular riprap boulders will become completely interlocked providing the foundation of a geomorphologically stable drainage system. The watershed drained by this outlet system is approximately 10 acres of which 6.5 acres are forested and 4.5 acres are reclaimed (revegetated) mined land.

Above the now-stabilized gully, as part of the 1997 EPA/USFS remedial action, the drainage channel and portions of the reclaimed tailings pile were stabilized using a black plastic netting material. The netting presented a real hazard to wildlife using the area and its black color.
intensified the solar radiation and heat gain reaching the soils on this site, which has a full-sun southern exposure. This had limited the success of the revegetation component of the original remedial action.

The project area where black plastic netting was removed is approximately 1.3 acres. Only sections of netting not secured with existing vegetation were removed. This was achieved by limiting the total amount of disturbance across the reclaimed site while achieving the maximum possible removal of netting. The removal and site re-stabilization efforts were extended as far as possible within the available budget. Soil amendments and a native seed mix were applied and biodegradable erosion control blankets were installed in most areas where the plastic netting was removed.

The entire project was constructed within the nine day period starting on August 13, 2012 and ending on August 22, 2012.