

**NOMINATION  
2004 ABANDONED MINED LAND RECLAMATION AWARD**

**COLORADO DEPARTMENT OF NATURAL RESOURCES  
COLORADO DIVISION OF MINERALS AND GEOLOGY  
COLORADO INACTIVE MINE RECLAMATION PROGRAM**

Huntsman and Bear Creek Coal Refuse Reclamation Project  
Western Pitkin County, near Redstone, Colorado

Cover Photo: Citizen tour of Coal Basin mine area.



**NOMINATION  
2004 ABANDONED MINED LAND RECLAMATION AWARD**

**COLORADO DEPARTMENT OF NATURAL RESOURCES  
COLORADO DIVISION OF MINERALS AND GEOLOGY  
COLORADO INACTIVE MINE RECLAMATION PROGRAM**

Project Name: Huntsman and Bear Creek Coal Refuse Reclamation Project;  
Western Pitkin County, near Redstone, Colorado

Nominating  
Organization: Steve Renner and Loretta Pineda  
Colorado Division of Minerals and Geology,  
Colorado Inactive Mine Reclamation Program  
1313 Sherman Street, Room 215, Denver, Colorado 80203  
(303) 866-3819

Nomination Submitted March 19, 2004

**Project Statistics**

	<b>Huntsman Portion</b>	<b>Bear Creek Portion</b>
Start Date	August 10, 1998	July 27, 1999
Completion Date	November 13, 1998	October 14, 1999
Construction Days	70	57
Project Cost	\$ 211,320	\$ 207,885
Construction Contractor	Ray Ward Trucking; Dolores, Colorado	Dirt-N-Iron Construction; Loma, Colorado
Project Design	Colorado Inactive Mines Program	Colorado Inactive Mines Program
Acreage Reclaimed	6	8

## Introduction

The Colorado Division of Minerals and Geology, Colorado Inactive Mine Reclamation Program, is proud to submit its reclamation efforts of an unstable coal refuse pile as a nomination for an Abandoned Mine Land Reclamation Award in 2004.

The reclamation work being nominated consists of two complimentary projects conducted at a refuse pile located in the high altitude country of western Colorado at an elevation of 8,100 feet. These two projects, the Huntsman and Bear Creek Projects, were conducted adjacent to each other on the same refuse pile. Due to the funding limitations and the vast number of projects accomplished annually by Colorado, the coal refuse pile was stabilized over the course of two construction seasons as two distinct projects. The cumulative results of the combined projects created a stable and useful landform that enhances slope stability while protecting adjacent water resources from the adverse impacts of coal refuse placement.

The coal refuse piles were part of the historic Coal Basin area mines. Operated by John Cleveland Osgood of the Colorado Fuel and Iron Company (CF&I), the Coal Basin Mines were known for their high-grade coking coal and the beehive coking ovens near Redstone. Redstone, known, as the "Ruby of the Rockies" was the model coal mining town and is now on the National Register of Historic Places. Mining in the Coal Basin area spanned from the early 1900's through the 1990's. In the early 1990's the permitted underground coal mining complex at Coal Basin terminated operations, and subsequently filed for bankruptcy protection. The Colorado Inactive Mine Program using revoked bond monies reclaimed the Coal Basin Mine, which is the highest elevation coal mine in North America.

These two projects, the Huntsman and Bear Creek Projects, were completed on abandoned or pre-Title V portions of a large coal refuse disposal facility. The combined Huntsman and Bear Creek projects are exemplary for several reasons:

- **Hazards Abated:** The Huntsman and Bear Creek Projects were initiated to address issues that threatened public health and safety and environmental resources at the site. Reclamation work at the site eliminated unstable eroding slopes, which posed a potential flood hazard to Coal Creek, a significant regional tributary to the Crystal River.
- ? **Slope Stability:** Reclamation operations relieved slope stresses that threatened to initiate a deep seated slope failure. Excavation and coal refuse removal at the Huntsman area was required to create the desired slope angle. The excavated material had to be transported from the area due to the proximity of Coal Creek to the toe of the refuse. This material was transported to a portion of the mine site being reclaimed by the Colorado Inactive Mines Program using the forfeited reclamation bond. This material was used to compliment the reclamation work at that area, while solving the problem of excess material disposal at the Huntsman area.
- ? **High Altitude Considerations:** Because of the large amount of annual snowfall that can occur in the mountains of western Colorado, the annual rate of erosion is great. Experience gained during reclamation of nearby large refuse disposal facilities suggested that traditional methods of interrupting long slope lengths were counter productive, leading to accelerated erosion of the reclaimed ground surface during

snowmelt. Alternative methods of disrupting the slopes were developed and implemented to accommodate the volume of snowmelt water experienced here. These methods include the use of dozer created shelves and track excavator created pockets.

- ? **Weed Control:** An invasion of noxious weeds threatened the successful establishment of desirable species at the Huntsman area. The weed invasion was thwarted by the implementation of an Integrated Pest Management (IPM) system. The IPM relied on a large-scale biologic control program, followed by periodic spot herbicide application. Goats were used to obtain initial control, and to significantly reduce the weed seed supply. Herbicide was applied in subsequent years via backpack-mounted sprayers. Applicators were trained to spot-spray only listed noxious weeds, while not impacting desirable species.
  
- ? **Wildlife Enhancement:** Shrub and tree “islands” were planted at the Bear Creek area to enhance wildlife habitat, and to mimic the natural vegetation pattern on adjacent, undisturbed lands. Seedling trees were randomly planted on the Huntsman area.
  
- ? **Sediment/Erosion Control:** Both project areas are covered by a Stormwater Discharge Permit. Sediment control measures, such as silt fence and barrier berms were employed throughout the construction sequence. Following construction, vegetative sediment barriers at the toe of the slopes, ground surface manipulation on the slopes and vegetative cover are used to minimize sediment generation, and delivery to adjacent water resources.
  
- ? **Public Land Management:** The project areas are located on public lands managed by the U. S. Forest Service. The area is used for recreation, cattle grazing and wildlife habitat. The Division worked closely with the Forest Service and a local cattle grazing association when developing an appropriate seed mixture for the projects. Agreements were reached with both organizations to manage access during both the construction process, and during the vegetation establishment period. Eventually, the Forest Service allowed development of a horse-pack trail that now bisects the Huntsman area.
  
- ? **Educational Opportunities:** The reclamation experience at the Huntsman and Bear Creek Projects has been used as an opportunity to educate the public about the reclamation process. Public meetings in the community were conducted prior to construction to explain the reclamation concept and to solicit comments. Tours of the site were conducted during and following reclamation construction to provide a first hand look at job progress and the end results for interested citizens. Subsequent to project completion, the areas have been used in an outdoor education program conducted jointly by the Inactive Mines Program and the Forest Service for area high school science students.

## **Project Area Overview**

The Huntsman and Bear Creek Abandoned Mine Land Reclamation Project area is located within Coal Basin, a high mountain drainage basin located in western Pitkin County, a mountainous and rugged portion of the state. The project area is situated at an elevation of about 8,100 feet. The mountain basin where the coal refuse disposal facility is located is narrow and steep, with nearly vertical cliffs and high velocity streams being very common. Annual precipitation is approximately twenty-eight inches, and annual average snowfall is approximately 170 inches, roughly equivalent to that received at many ski resorts in western Colorado. Due in large part to the highly erosive soils and relatively steep slopes found in this area, the annual rate of erosion is great. Coal Creek, the major drainage in the area, is confluent with the Crystal River approximately four miles downstream from the project area. Vegetation at this elevation is predominantly an aspen / spruce / fir transition, with grasses and shrubs dominating open areas. The area has historically been used principally for open range grazing and by hunters in the Fall. More recently, an increase in day users, generally hikers and mountain bikers, have been accessing the area.

The Huntsman and Bear Creek Abandoned Mine Land Reclamation Projects were conducted on a portion of a larger coal refuse disposal facility. The majority of the facility operated under a mining and reclamation permit issued by the Colorado Title V regulatory program. However, the lower margins of the facility were operated prior to implementation of the Surface Mining Control and Reclamation Act, and were exempt from the reclamation obligations imposed on the remainder of the facility.

## **Huntsman Project Overview**

The purpose of the Huntsman Project was to alleviate potential refuse pile instability. Prior to the project this portion of the larger refuse pile was severely over-steepened and had little, if any plant growth medium on it. Portions of the slope approached vertical, while other areas were closer to 1H:1V. As a result, vegetative cover was negligible, and surface erosion of the refuse material was significant. More importantly, however, the lower portion of the area presented evidence of potential mass instability. Surficial bulging, drainage from the base of the pile and mid-slope tension fractures had been observed. These features indicated that a deep-seated failure of the refuse facility could occur. This portion of the larger refuse facility is located immediately adjacent to Coal Creek, a significant tributary to the Crystal River. Coal Creek is incised, in a narrow valley. Failure of the refuse facility could cause temporary blockage of Coal Creek. A breach of the temporary blockage could lead to downstream flooding and large-scale erosion. To alleviate these concerns, stabilization of the Huntsman area slopes was required.

Stabilization of the Huntsman slopes required removal of the steep upper portion of the area. Due to the proximity of the refuse toe to Coal Creek, the slope length could not be extended toward the creek. Therefore, the upper portion of the project area had to be excavated to achieve the project goals of unloading surcharge, and creating a moderated slope. A limiting factor at the upper portion of the project area was a boundary between the pre-Title V portion of the facility, and the portion of the facility permitted under the Title V program.

The design slopes for the project were 2H:1V. Although a gentler slope angle would have been desirable, the proximity of the creek to the toe of the slope, and the boundary of the permitted area at the upper margin of the area limited the area available for cut and fill

operations. Approximately 60,000 cubic yards of refuse were excavated from the upper margins of the project area. Of this volume, 15,000 cubic yards of material were placed at one portion of the toe of the slope to act as a buttress. This material was placed in thin horizontal lifts, and compacted in place. The remaining 45,000 cubic yards of excavated refuse was hauled off-site approximately one-quarter mile to another area being reclaimed by the Inactive Mine Program. The material was used to create a gentle slope at the base of a vertical cut. In this way, excavation and selective placement of the refuse accomplished multiple goals; stabilization of the Huntsman project area by removal of mass from the top of an unstable slope, and creation of a safe, stable landform at a vertical highwall-like cut slope.

During excavation operations, the exposed refuse was compacted by the heavy equipment. In order to promote soil adhesion, a light dozer was used to rip the face of the facility perpendicular to the fall of the slope. A topsoil substitute material was placed over the roughened face of the facility to an average depth of eight inches.

Erosion at high altitude, relatively steep slope reclamation projects in high snow pack areas is a significant reclamation issue. At other nearby refuse piles reclaimed with bond revocation monies, traditional methods of interrupting long slopes were employed. However, methods such as cross-slope berms or terraces tended to fail, due in large part to the differential melting of snow pack on north facing slopes. Therefore, an innovative method of interrupting the slope was attempted.

The method used to interrupt the slope was to create hundreds of small dozer terraces on the newly created Huntsman slope. The terraces were created by positioning the dozer at the base of the slope, and backing the dozer upslope approximately one-dozer length. The operator would then lower the dozer blade, and push downhill until approximately six to eight inches of soil had accumulated in front of the blade. This action resulted in the creation of a gently sloping terrace approximately eight inches tall, twelve feet wide (parallel with contour) and four feet long (perpendicular to fall of the slope). Following construction of a terrace, the dozer would back up the hill two lengths, drop the blade and push forward one length to create an up-slope terrace. This process was repeated across the entire face of the project area.

Two years following project completion, the area suffered an invasion of various species of thistle, a listed noxious weed in Colorado. In order to control the weed invasion, an integrated pest management program was developed for the site. In partnership with the U.S. Forest Service and Pitkin County, the Division received a grant from the Colorado Department of Agriculture to control the weed invasion. Biologic controls were used the first year to greatly reduce the weed seed population. 500 goats were allowed to graze the property. The goats, if moved in an appropriate rotation, preferentially consume the thistle flowers, thus eliminating the seed source. In following years, spot spraying of remnant weeds served to essentially eradicate the problem. The area was reseeded in conjunction with the grazing program, and now supports a diverse vegetative community.

### **Bear Creek Project Overview**

The purpose of this project was to enhance the stability of the area located east of the Huntsman project area. Slope stabilization was accomplished by reconstructing the slope of the facility through excavation and placement of refuse. Approximately 90,000 cubic yards of coal refuse was excavated from the upper half of the refuse disposal facility, and pushed down hill to create the design slope of 2.1 H:1V to 2.5 H:1V. The material was

placed over a system of French drains designed to carry entrained water and ground water away from the base of the fill. The refuse was compacted in shallow lifts that were gently inclined toward the face of the fill to encourage moisture drainage, should rainfall become entrained in the material during construction. Each lift was compacted prior to placing the overlying lift. The regarded surface was loosened and covered as described for the Huntsman Project except that the earthen material was clearly lacking in organic matter. Approximately two tons per acre certified weed free straw mulch was applied over the top of the dirt layer.

The slope interruption method used at the Huntsman was not contemplated at Bear Creek, because the slope length was much greater here. Therefore the potential of runoff achieving erosive velocities was much greater. Because of the greater slope length, a more disruptive soil surface had to be developed.

Contemporaneous with application of the straw mulch to the soiled slope surface, a light track excavator was positioned at the top of the slope. The excavator would extend its arm uphill of the tracks in a 180 degree radius, and punch the bucket into the ground surface approximately twelve inches. The operator would then curl the bucket toward the excavator, mixing a small amount of coal refuse, the dirt and the straw mulch together, while creating a pocket twelve inches deep by the width of the bucket, by about eighteen inches in length. Pockets were created immediately adjacent to one another in a random pattern across the entire face of the facility. The close spacing, but limited size, of these pockets provided three important qualities; the straw mulch was thoroughly mixed with the dirt to incorporate the organic matter into the growth medium, a small amount of dirt from one pocket would fall into the downslope pocket, thus covering exposed coal refuse with a small amount of growth medium, and surface water flow paths and velocities were drastically reduced, thus resulting in a greatly diminished erosion potential across the entire facility. Additional benefits to this technique included the creation of thousands of microclimates to enhance revegetation potential, and a more natural look to the reclaimed facility than what would have resulted from construction of berms or terraces.

Locally obtained willow cuttings were placed at the toe of the western (wetter) half of the fill slope, while containerized shrubs were planted at the toe of the eastern half of the fill slope. Trees were planted in clumps at the top, near the mid-slope area and at the toe of the slope in an effort to mimic local growth patterns.

## **Conclusion**

The pre-Title V portions of the refuse disposal facility represented a relatively small percentage of the entire refuse disposal facility. However, the adverse impacts from this small area were significant. Both the Colorado Division of Minerals and Geology and the Office of Surface Mining identified the pre-Title V portions of the refuse disposal facility as an imminent hazard to Coal Creek. The issues identified and abated included the potential threat to Coal Creek if a deep-seated slope failure within the refuse were to occur, and the observable large-scale surficial erosion that was observed. The erosion was a result of the over-steep slopes and a lack of significant vegetative cover that existed on the un-reclaimed area. Without completing this project, these factors would result in continuous sediment delivery to Coal Creek. The reclamation completed at these two project areas accomplished these objectives, as well as the long-term objectives of returning the Coal Basin area for other beneficial uses, including grazing, wildlife habitat and the conservation of public lands.

Steep slopes, refuse creep and refuse erosion at Huntsman prior to construction



Stabilized and revegetated Huntsman Project Area, year following biologic weed control project at the site





Goats grazing revegetated area to reduce weed infestation. Note dozer benches still in place, third year following construction.



View toward west parallel with contour at Bear Creek showing slope instability, steepness and refuse failures prior to construction.