NATIONAL ASSOCIATION OF ABANDONED MINED LANDS

Nomination Category: Remediation of Contamination Impacting the Environment or Human Health

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Project Name: Casino Mine Reclamation Project

Project Location: Clear Creek County, Colorado

Project Start Date: May 2019

Project Completion Date: October 2021

Colorado Division of Reclamation, Mining and Safety Project Managers: Julie Annear and Deb Zack

Project Partners: Freeport MacMoran, Total Eclipse Mining Company, Candace Lukow, Clear Creek County

General Contractor: Nezhoni Construction, McCollum's Excavating

Project Cost: $395,000

Funded By: Freeport McMoRan, Colorado State Severance Tax

Date Submitted: June 12th, 2023

Casino Mine Reclamation Project-Clear Creek County, Colorado

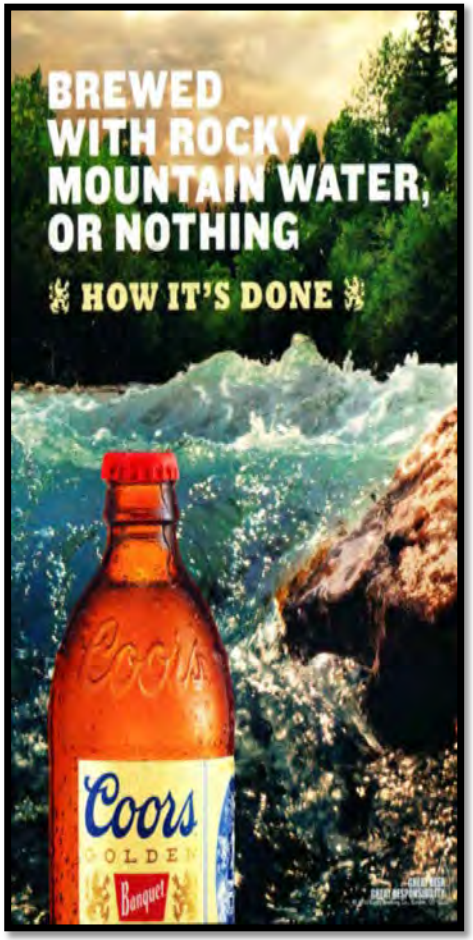


Photo #1-Famous Coors Logo

BACKGROUND

The Casino Mine Project is located in Virginia Canyon approximately two miles above the town of Idaho Springs, Colorado. Mining began in Virginia Canyon in 1860 following the discovery of placer gold in Clear Creek. The larger mines operated until World War II, when a presidential order required cessation of all mines not mining strategic metals. Clear Creek, running through Virginia Canyon, attracts numerous hikers, bikers and kayakers and is the main source of drinking water for 350,000 residents from six municipalities in the Denver metro area. Many industries also rely on Clear Creek, most famously Coors Brewing Company. The Casino mine is located adjacent to a tributary to Clear Creek. The mine site occupies approximately one acre.

Virginia Canyon is one of the largest sources of heavy metals to Clear Creek. Heavy metals in the flow from Virginia Canyon originate from leaching of eroded mine waste in the stream channel, direct leaching of mine waste piles, and leaching of un-mined sources. The stream segment in which the Casino mine is located is listed on the Clean Water Act Section 303 (d) list for manganese, arsenic, lead, cadmium, zinc and nickel. The segment does not meet Aquatic Cold Water Class 1 use standards or Water Supply standards.

Virginia Canyon is included in the Clear Creek/Central City Superfund site. EPA placed the site on the Superfund program's National Priorities List (NPL) in September 1983. Since this time EPA, the Colorado Department of Public Health and the Environment and the Division of Reclamation, Mining and Safety have conducted remediation work on numerous waste piles and draining tunnels in the watershed..

An extensive study of over two hundred mine sites in the watershed indicated that the Casino mine was one of the highest priority sites in the watershed for reclamation due to the concentration of heavy metals, particularly manganese, in the waste pile. The waste pile associated with Casino mine is located adjacent to Seaton Gulch, a tributary to Clear Creek. Prior to reclamation, metal-laden, acidic sediment was continually eroded by Seaton gulch thus transporting heavy metals and sulfates into Clear Creek. Also, fugitive dust was emanating from the site potentially impacting nearby residents as well as the many bicyclists that ride up and down Virginia Canyon. Mountain biking and the tourists dollars that it attracts is an important source of capital for the nearby town of Idaho Springs.

Photo # 2- Casino Mine Pre- Reclamation- Deep Erosion Gullies in Casino Waste Pile with High Concentrations of manganese, cadmium, copper and zinc


Private Residences In Proximity to Casino Mine Site
Legend
Casino Shaft Mine
Private Residence
Private Residence
Private Residence
279
Casino Shaft Mine
Private Residence
279
Private Residence
Ivo Bathers Road
N

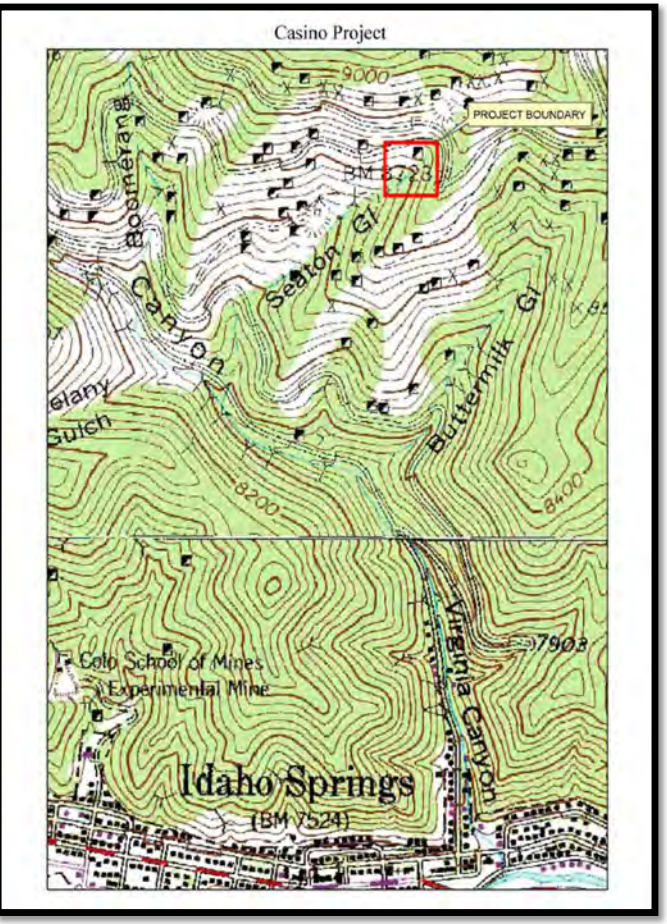


Figure #1-Map of Casino Mine Site and Virginia Canyon Mine Sites

OVERVIEW OF PROJECT GOALS AND ACCOMPLISHMENTS

The project goal was to reduce the amount of metal-laden sediment eroding from the Casino waste pile and eliminate the potential for fugitive dust. This included installing a concrete wall to provide a physical barrier between the waste pile and the adjacent gulch. Also, the wall allowed for the reduction of the gradient of the side slopes of the waste pile by providing additional storage for mine waste, facilitating the establishment of vegetative cover. The final grade of the waste pile conforms to the pre-mining natural topography and the seed mix was designed to replicate the native grasses and forbs in the surrounding landscape. The majority of the project work took place in the spring and summer of 2020. There were numerous challenges related to working during COVID as well as coordinating landowner consent from landowners with disparate interests, and Clear Creek County. Most profound was the lack of access to the site due to the very steep natural topography.

The project was eventually completed and has been very successful in reducing erosion of contaminated material from the waste pile.

The work was made possible by generous contributions from Freeport McMoRan and State of Colorado severance tax funds. Because of Freeport's generosity, the Casino mine, one of the worst contributors' of manganese in the stream segment, is now stable and revegetated. Clear Creek County was also instrumental in providing support in traffic control and waiving permits for excavation and construction.

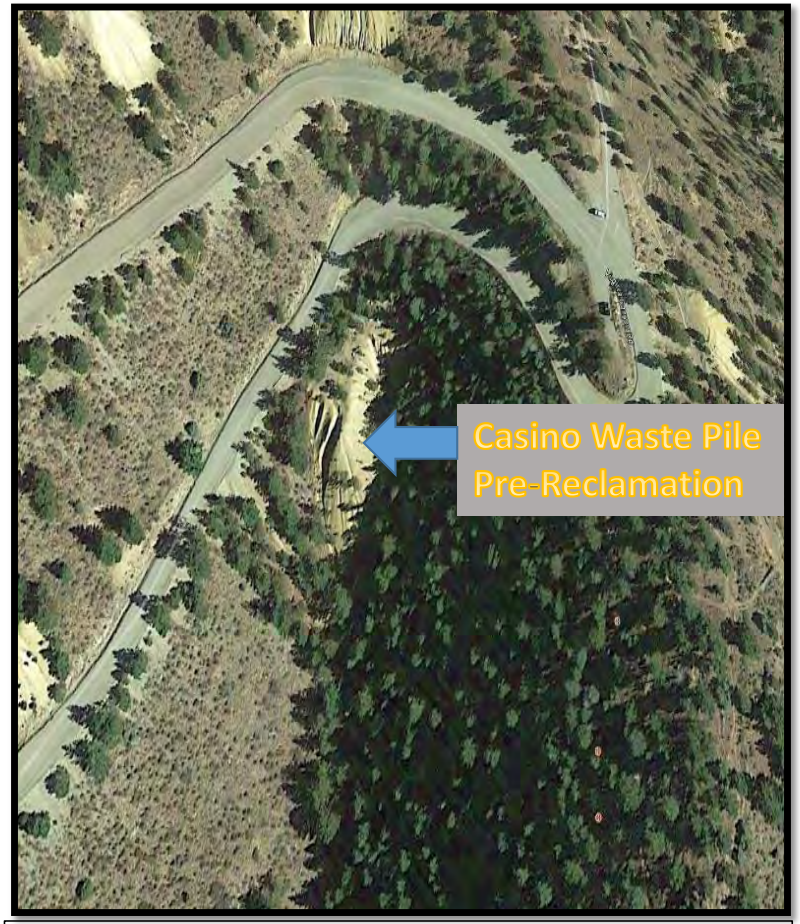


Figure #2- Casino Mine Pre-Reclamation\Access by Steep Unpaved Mountain Road. Steep incised gullies.

ABANDONED MINE PROBLEM

The Casino mine waste pile is located directly adjacent to Seaton Gulch, a tributary to Clear Creek. Prior to reclamation, a culvert located on Virginia Canyon road directed drainage onto the waste pile and actively eroded the mine waste into Seaton Gulch. Deep gullies were cut in the face of the pile and sediment eroded from the pile into the adjacent drainage during storm events and spring runoff. Also, fugitive dust containing heavy metals emanated from the area. Several residences are in relatively close proximity to the site and many tourists travel Virginia Canyon Road. Virginia Canyon is a very popular mountain biking destination and fugitive dust may greatly impacts riders. Recent assessments of the area indicate that some of the mine waste piles in Virginia Canyon may pose an unacceptable human health risk to local residents living in the area due to heavy metals.

Virginia Canyon contains over two hundred waste piles associated with abandoned mines. In 2001 the Division of Reclamation, Mining and Safety published a Reclamation Feasibility Report for Virginia Canyon. Water quality, mine waste and sediment data were used in conjunction with site observations to prioritize mining sites for reclamation. Leachate analysis of the waste rock at the Casino indicate that the site had the highest soluble manganese concentrations of all the sites tested. Virginia Canyon and it's tributaries are high gradient and shallow resulting in the bed sediments containing high concentrations of sorbed metals. The sorbed metals are susceptible to release, depending on the water chemistry.
The report indicated that the Casino waste rock has elevated concentrations of copper and zinc and concentrations of manganese in the waste rock were 100 times the Regional Screening Level (RSL) Residential standards. Zinc concentrations were 25 times the RSL Residential standards. Sulfate salts and secondary sulfates were present at the toe of the pile, indicating that some leaching of heavy metals from this pile occurs.

Casino Mine Waste Pile Leachate Analysis Results

pH	As	Cd	Cu	Fe	Mn	Pb	Zn
s.u	ppb	ppb	ppb	ppb	ppb	ppb	ppb
2.82 (RSL) * Residential (R) Industrial (I)	350 -	6300 Exceeds R	6300 Exceeds R & I	6200 Exceeds R	180,000 Exceeds R & I (100 x residential)	53 -	53,000 Exceeds R & I (25 x residential)

*RSL-Regional Screening Level

CONSTRUCTION AND REVEGETATION

The goal of the project was to prevent erosion and leaching of heavy metals from the Casino waste pile. In order to achieve this goal it was necessary to provide a physical barrier between the flow in Seaton Gulch and the waste pile. A secondary goal was to reduce the gradient of the side slopes of the waste pile in order to facilitate revegetation and reduce dust emanating from the pile.

The project work was divided into two phases:

Phase I- Construction-Began in the fall of 2019. Because of the difficult site conditions and severe weather events, the project extended into 2020. COVID began in the spring of 2020 and there were numerous delays related to material and labor shortages. Initially, the contractor had great difficulty finding skilled operators or laborers. Also, it was difficult to obtain materials such as concrete and pipe. The project also presented numerous logistical challenges including working with unstable material and coordinating with multiple landowners. All of these factors presented numerous project management challenges while at the same time trying to stay within budget. The work consisted of the following:

- Installation of erosion control measures to protect adjacent tributary to Clear Creek.
- Construction of over 90 feet of concrete wall
- Regrading and consolidating over 18,000 cubic yards of mine waste
- Establishing a run on control channel to redirect flow in the gulch around the waste pile
- Armoring portions of the stream channel with large riprap

Phase II- Revegetation and Slope Stabilization-Was delayed because of funding issues and eventually took place in the fall of 2021.
The work consisted of the following:

- Amending the mine waste with lime and compost
- Installation of erosion control blanket and straw wattles
- Revegetation with a native seed mix
- Application of wood straw mulch

CONSTRUCTION OF CONCRETE WALL

Prior to beginning construction, sediment control fence was installed on the perimeter of the site. Following installation of sediment control, the next phase of the project involved constructing a concrete wall along a portion of the waste pile bordering Seaton Gulch. Access to the site was very difficult as the face of the waste pile was almost vertical. Consequently, it was necessary to create a new access road across the waste pile in order to form and construct the wall. However, the road could not accommodate a dump truck or dozer and access was limited to an excavator and skid steer.

The waste pile was excavated to expose bedrock along the channel to anchor the wall. Bedrock was located much deeper than planned and the location of the wall footer had to be modified resulting in increased excavation of material.

Two significant storm events destroyed the formwork for the wall footer also causing delays and cost increases. Eventually, rebar dowels were drilled into bedrock and the footer and wall forms were set. **(See drawing).**

The original design included extending the wall along the entire interface of the waste pile and gulch. During construction, a landowner rescinded consent for the extension of the wall across his property. After much contention riprap was placed instead.

Because the wall had to be relocated, it was necessary to increase the wall height in order to accommodate this change. Due to the increased height, three concrete counterforts were anchored into bedrock on the side of the channel to stabilize the wall. Four inch diameter perforated HDPE pipe was wrapped in Mirifi filter fabric, bedded in gravel and installed along the entire perimeter of the wall in order to relieve hydrostatic pressure between the wall and the waste pile.

Because of the poor access to the site, a concrete pump was used to transport the concrete to the lower portion of the site. The wall was over 100 feet below the road and a specialized pump was used to transport and place the concrete.

The wall was poured in two phases. First, the footer for the wall was formed in a step configuration. This was necessary to accommodate the steep gradient of the channel. After the footer had cured, the wall was formed and poured. A total of one hundred thirteen cubic yards of 4500 psi concrete was used to construct the wall and footer. The wall is ninety feet long and eighteen inches wide. The height of the wall ranges from seven feet to twelve feet. The wall provides a physical barrier between the gulch and the mine waste. It also provides extra storage for mine waste.

Photo # 3- Preparing Channel for Wall and Riprap. Over 3,000 cubic yards of material had to be excavated in order to expose bedrock. Rebar was drilled into bedrock in order to anchor the wall

CONCRETE WALL SPECIFICATIONS

Ninety feet of concrete wall, ranging in height from 7 to 12 feet, was installed to provide a barrier between the mine waste and the channel. The wall was keyed into bedrock and provided a separation between the mine waste and flow in Seaton Gulch. The wall also provided extra storage for mine waste and allowed for a reduction in the gradient of the side slopes of the waste pile facilitating revegetation and providing slope stability.

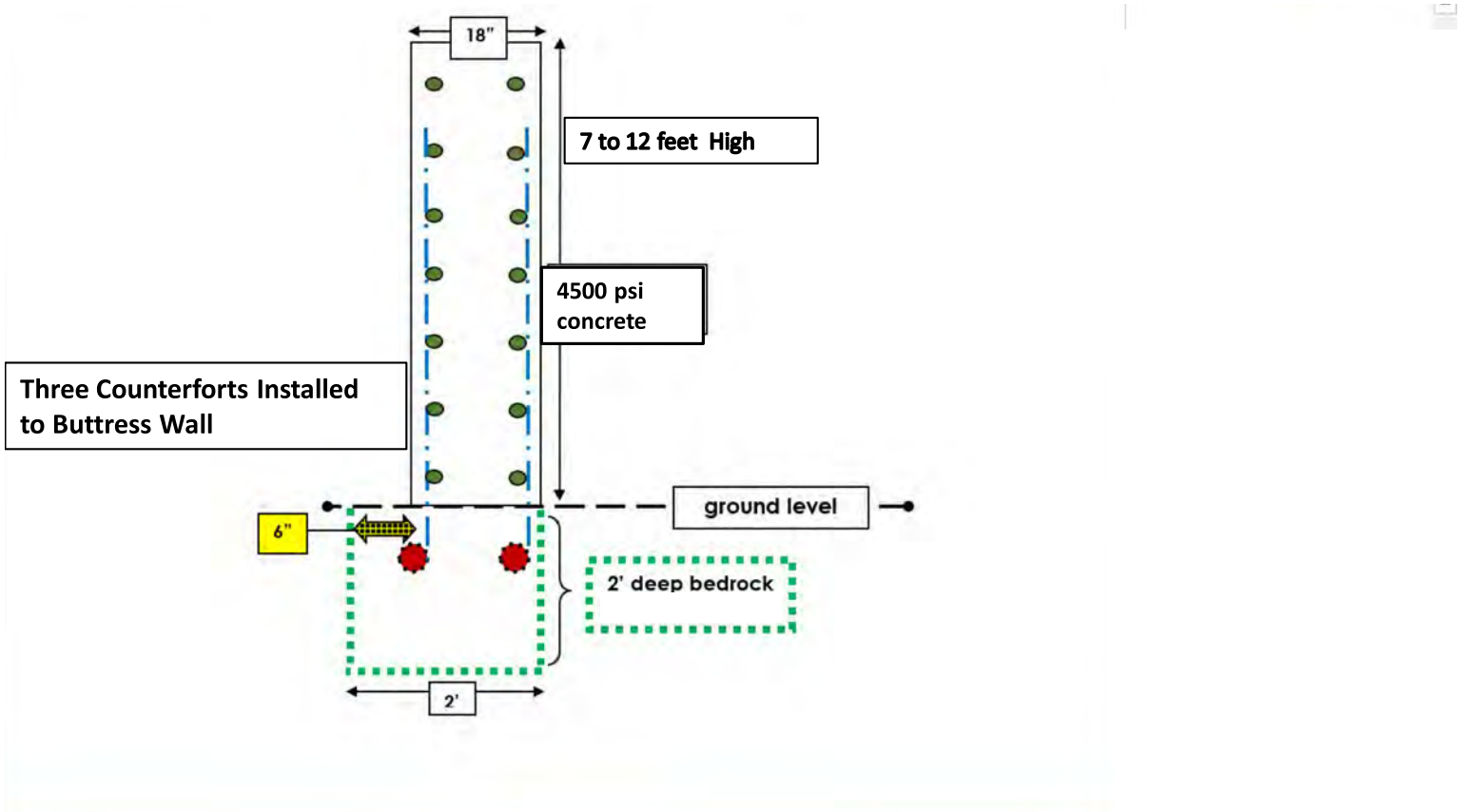


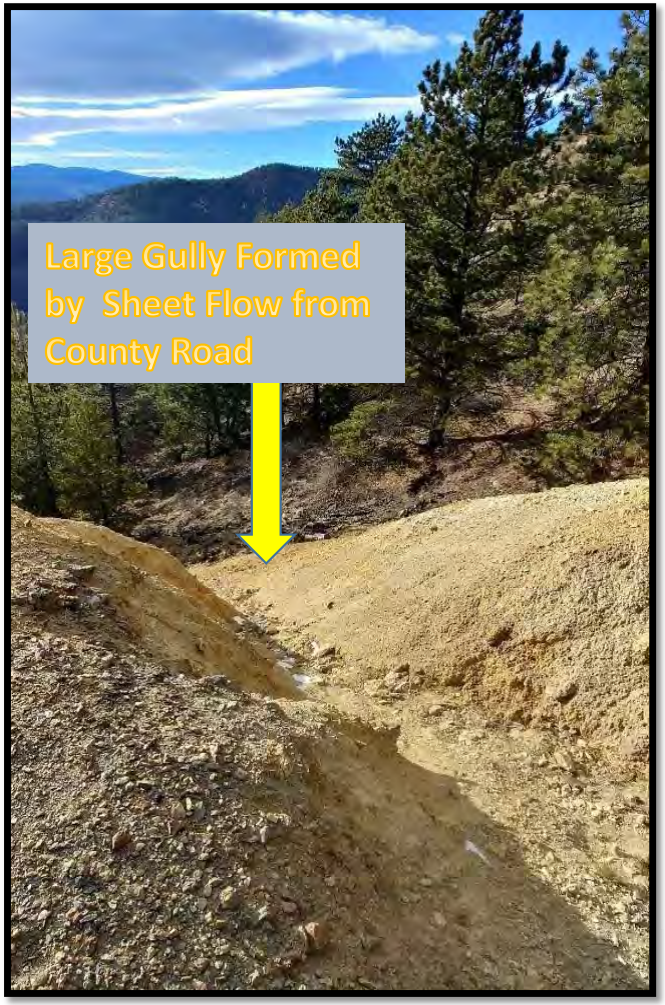
Photo # 4- Pouring Footer-Rebar Dowels Installed

Photo # 5- Forming Wall

Photo # 6- Counterforts on Concrete Wall

Photo # 7-Upper Concrete Wall Anchored in Bedrock

Photo # 8 - Concrete Wall Backfilled with Mine Waste and Revegetated- Over 18,000 Cubic Yards of Material Consolidated Behind Wall



Photos # 9 and 10
(Left) Large Erosion Gully on Face of Pile.

(Above) Concrete Wall Provided Extra Storage for Mine Waste as Well as Physical Barrier Between Mine Waste Pile and Drainage.

Photo # 11- Reclaimed and Revegetated Mine Waste

CONSOLIDATION OF MINE WASTE

Following completion and curing of the wall, mine waste was re-contoured and placed behind the wall. Prior to reclamation, the side slopes of the waste pile were almost vertical and contained deep gullies. The project work involved moving over eighteen thousand cubic yards of mine waste from the upper portion of the pile and consolidating it behind the concrete wall. The final grade of the majority of the waste pile is 2H:1V. In areas where the grade is steeper, large riprap was placed horizontally across the slope to reduce sheet flow and erosion. The grade conforms to the natural, pre-mining, topography of the area. **Because of the poor access and steep slopes, it was not feasible to use trucks or bulldozers to move the material. All material, over 18,000 cubic yards, was moved with the excavator and skid steer. The topography of the site could not accommodate a dump truck or dozer.**

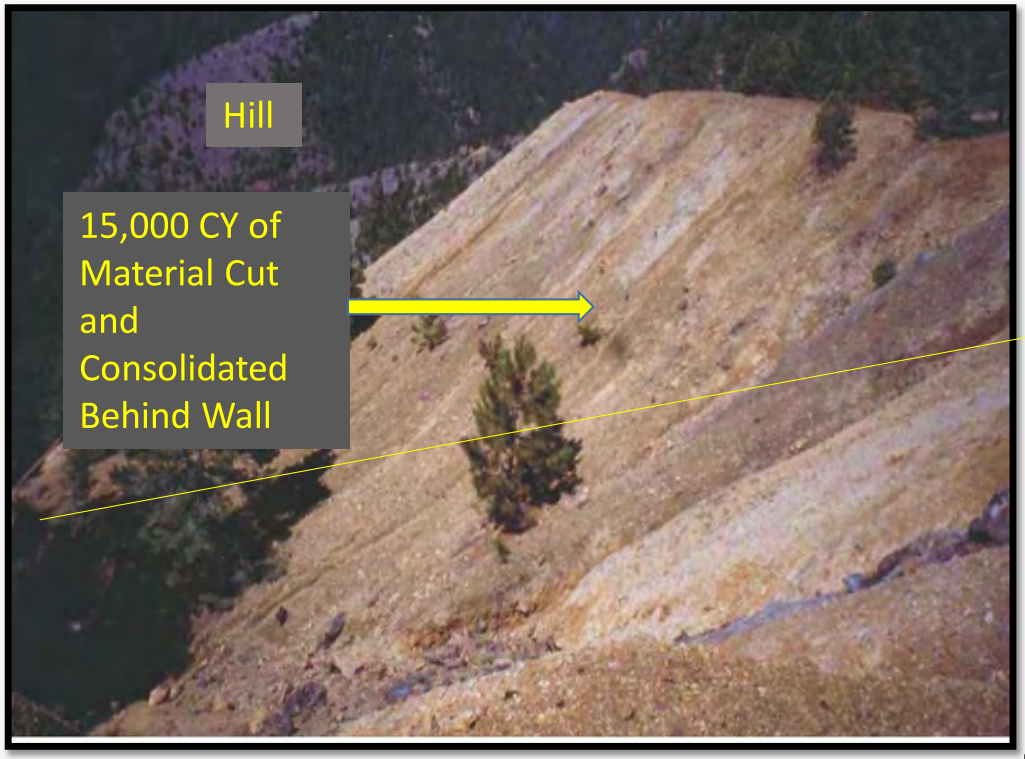


Photo # 12- Casino Waste Pile Pre-Reclamation

Photo # 13- Casino Waste Pile Post-Reclamation. The site was returned to the natural, pre-mining topography.

Photos # 14 and 15 -Transporting Material Downhill and Grading Waste Pile with Excavator. Grade was too steep for trucks and dozers. It took over 5 months to achieve the final grade using only a skid steer and excavator to transport and consolidate material.

Photos # 16 & 17-(Left) Nearing Final Grade of Top Portion of Site (Right) Top Portion of Site-Post Reclamation

Photo #18 (Left), Final Grade of Waste Pile-. Over 18,,000 cubic yards of material was cut from the top of the waste pile, transported downhill and re-contoured using an excavator and skid steer. It took over 5 months of construction to achieve the final grade.
Photo # 19 (Right)- 1.5 Year Post-Reclamation.

INSTALLATION OF RIPRAP

Riprap was installed in portions of the channel above and below the wall. Approximately, two hundred linear feet of channel was lined with four foot diameter riprap. Also, boulders were placed on the slopes of the waste pile after the final grade was achieved to reduce erosion and provide microclimates for forbs and trees. A run-on diversion ditch was constructed to capture sheet flow from Virginia Canyon road. **Over two hundred twenty tons of riprap was installed on-site. Because of the difficult access, all riprap had to be transported and placed using an excavator. During the course of construction, the delivery truck driver carelessly dumped 4 foot diameter boulders down the slope on which the excavator was working. The project manager took cover behind the wall.**

(Left) Photo # 20 Delivery Truck Prior to Dumping Boulders Down the Slope towards Project Manager and Operator

(Upper Right) Photo # 21, Placing Riprap to Armor Ditch for Erosion Control

(Lower Right) Photo # 22-Armored Ditch 1.5 Years Post-Reclamation

Photos # 23 & 24-Armored Lower Channel Pre and Post-Reclamation

Photos # 25 & 26 -Upper Portion of Wall and Riprap in Channel. Landowner consent could not be obtained to continue the wall up the channel. Consequently, the mine waste had to be excavated from the channel and then armored with riprap. Over 220 tons of riprap were installed at the project site.

CASINO MINE REVEGETATION

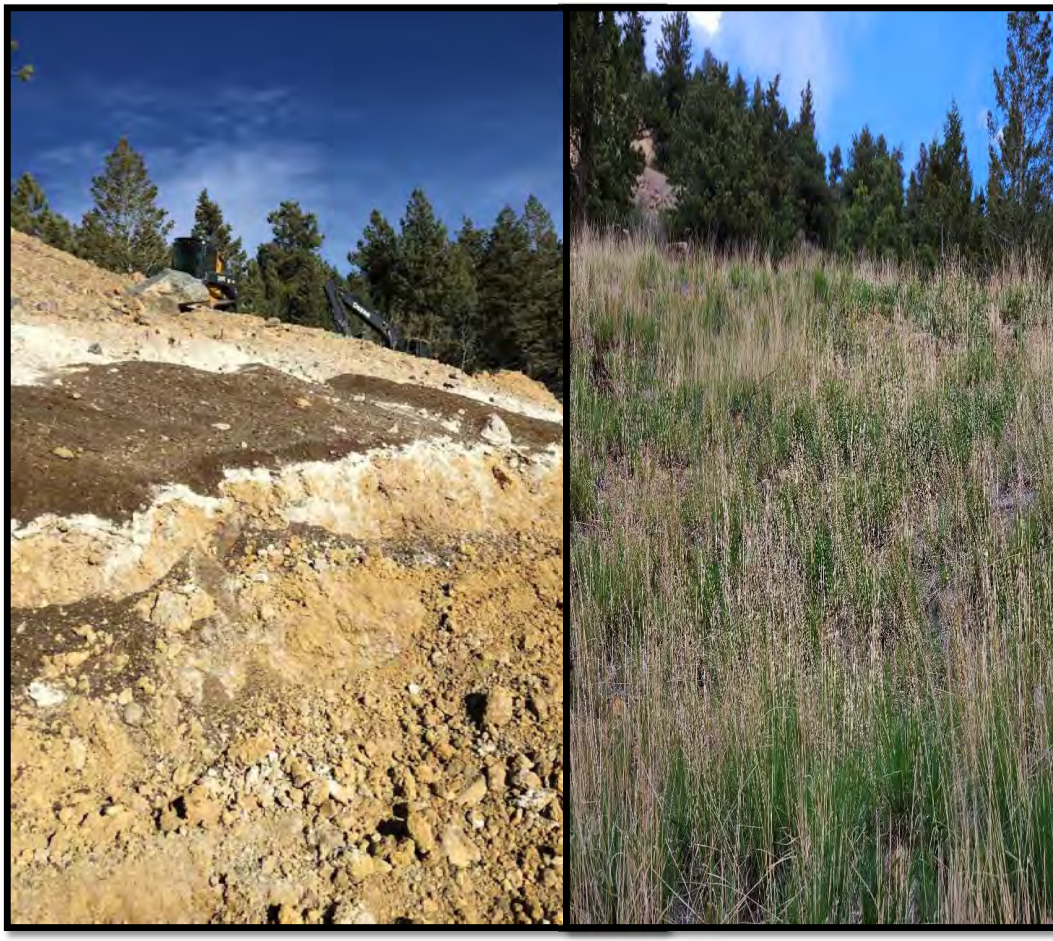
The final phase of the project was revegetation of the waste pile. The PH of the mine waste is 2.82 and contained no organic material. Prior to reclamation, the mine waste pile was almost completely devoid of vegetation. Importing topsoil to cap the waste pile was cost prohibitive. Consequently, an innovative technique to create growth medium was borrowed from Climax mine, owned by Freeport MacMoRan. The mine shared valuable information on this technique and this exchange of information saved thousands of dollars as compared to using a top dressing of imported growth medium.

The technique involved amending the mine waste with compost and lime. The mine waste was amended with pulverized limestone to raise the PH and compost was added to provide nutrients and organic material. The "recipe" had to be tailored to the Casino mine site as the mine waste had a very low PH. However, the technique was successful and **saved over $80,000.**

Following the application and incorporation of amendments, the entire area was seeded with a native seed mix and wood straw mulch was applied. Biodegradable straw wattles and soil retention mat were installed to stabilize the slope and aid in establishing vegetation.

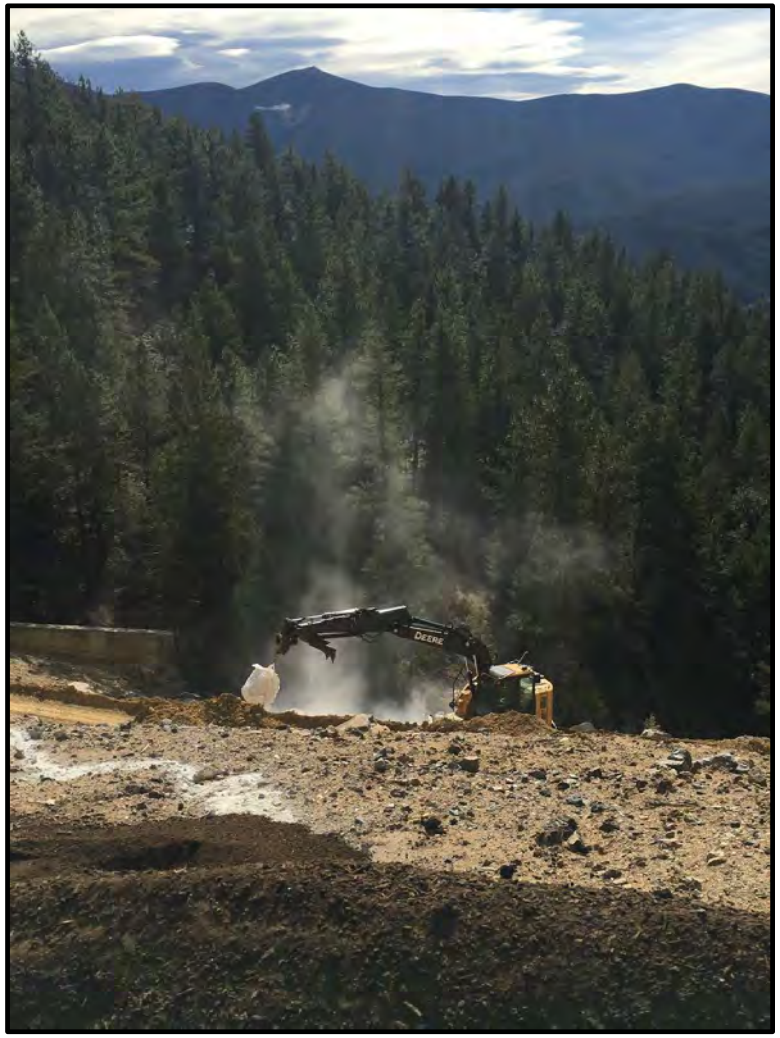
APPLICATION AND INCORPORATION OF PULVERIZED LIME AND COMPOST

One hundred fifty cubic yards of compost was hauled to the site from the local sanitation department providing cost savings. Seventy five tons of pulverized limestone was brought to the site in Supersacs and transported onto the waste pile by excavator. The two amendments were uniformly combined with the mine waste into the upper twelve inches of the soil profile. **Because of the poor access, machine access is not possible and hand mixing of the compost and lime was necessary on approximately one half of the project area. This was a labor intensive and time consuming process.**



Photos # 27 & 28-Compost and Lime Applied to Mine Waste & Slope Post-Reclamation

Photos # 29 , # 30 and # 31 - Transporting Crushed Limestone In Supersacs and Spreading Lime with Excavator



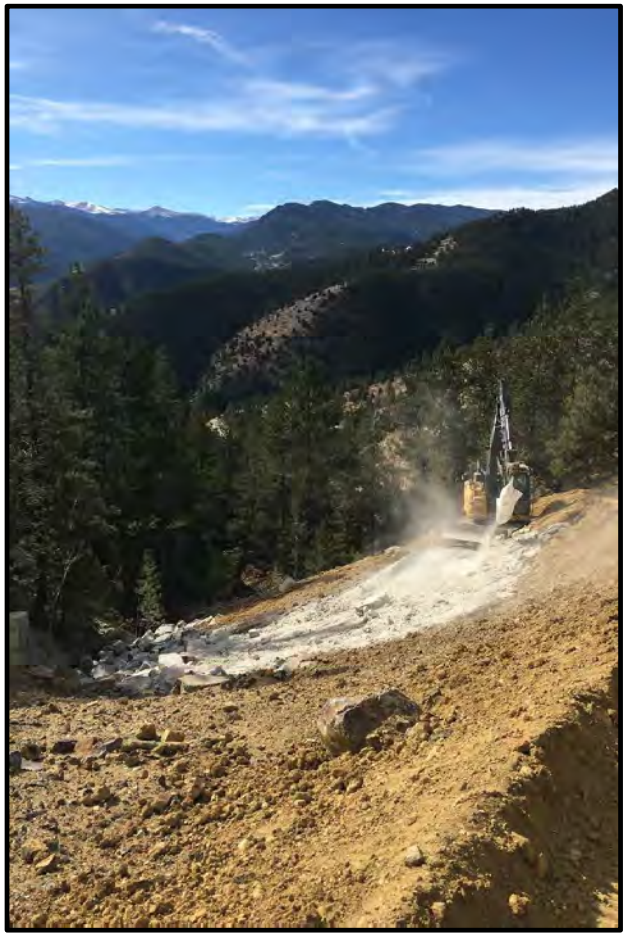


Photo # 32 - Slope 1.5 Years Post-Reclamation

Photos # 33 & 34-Incorporating Lime and Compost with Skid Steer and Hand Labor & Slope 1.5 Years Post Reclamation

INSTALL EROSION CONTROL MEASURES CONSISTING OF SOIL RETENTION BLANKET AND STRAW WATTLES

Due to the steep natural topography of the site, the final grade of portions of the waste pile was steeper than 2H:1V. In order to reduce erosion and aid in establishing vegetation, soil retention blanket was installed over a portion of the waste pile. The areas were seeded with a native seed mix prior to installing the blanket. In addition, over 200 linear feet of biodegradable straw wattles were installed on portions of the waste pile to reduce erosion potential.

SEEDING AND INSTALLATION OF MULCH

Following incorporation of the soil amendments, the waste pile was seeded with a native seed mix. Seed was incorporated by hand. The seeded area was then covered with a wood straw mulch which was also applied by hand. Over three tons of wood straw mulch was applied and incorporated without the aid of mechanized equipment

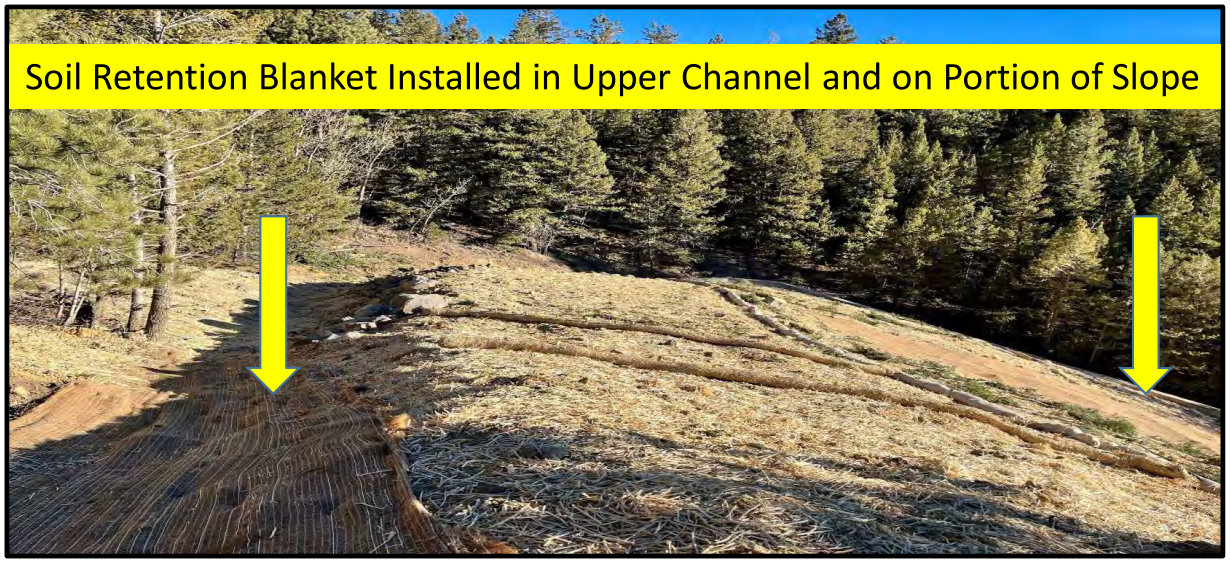
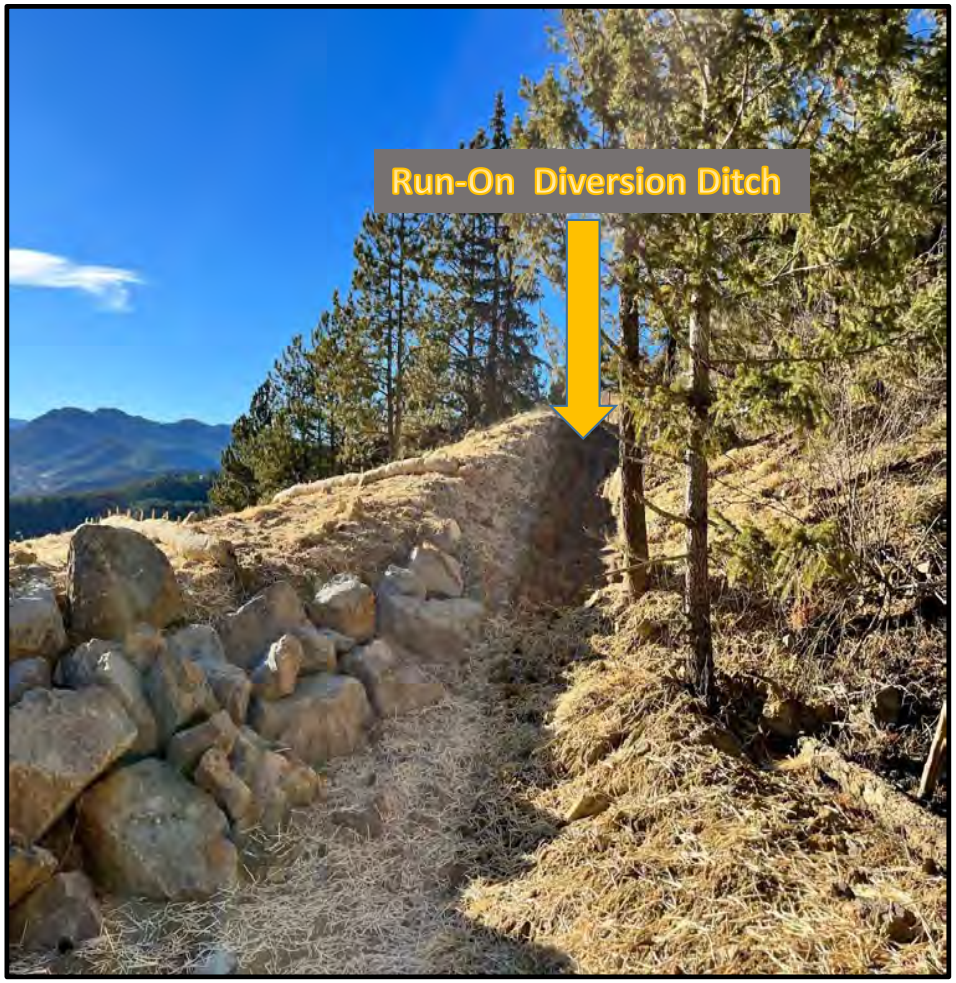
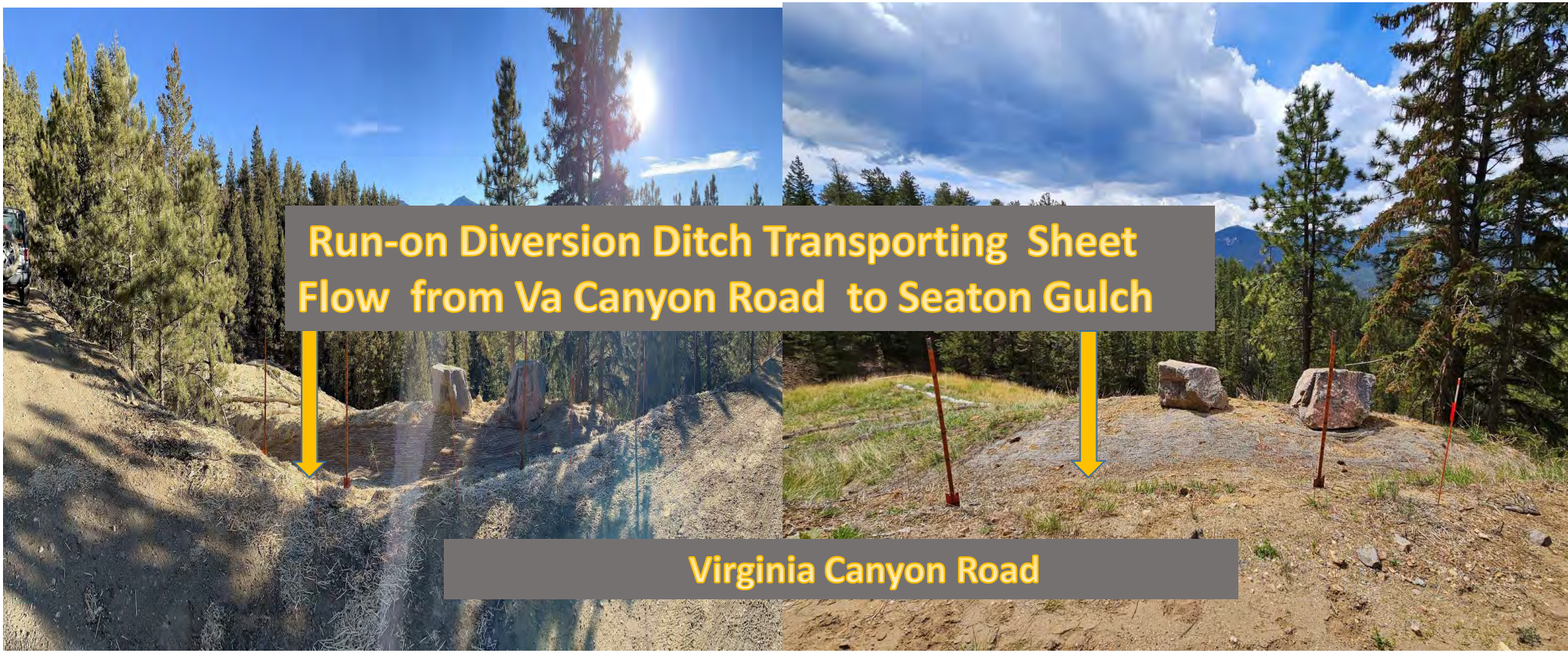


Photo # 35 , (Top) Wood Straw Mulch Bales Prior to Installation.

Photo # 36 , (Bottom) Reclaimed Slope with Soil Retention Blanket, Wood Straw Mulch and Biodegradable Straw Wattles

Photos # 37 & 38 -Upper Channel and Run-On Ditch to Divert Sheet Flow from Virginia Canyon Road Around Waste Pile into Lined Channel





Photos # 39 & 40- Run on Diversion Ditch Pre and Post-Reclamation

Photos # 41 & 42 - Waste Pile with Erosion Control Mat, Straw Wattles and Wood Mulch and One Year Post-Reclamation

Photos # 43 & 44, Pre and Post Reclamation Flow of Seaton Gulch Same View

SUMMARY

Clear Creek is a drinking water source for more than 350,000 people living in the Denver area, and is a favored place for kayaking, rafting, fishing, wildlife watching and gold panning. The human health and aquatic life impacts from the Casino mine site involved potential exposure to heavy metals such as copper, manganese and cadmium through erosion of contaminated sediment into downstream water supplies as well as fugitive dust. Because of the high concentration of heavy metals in the Clear Creek Watershed related to anthropogenic sources, primarily mining, the EPA Region 8 created a Superfund site which includes the Casino mine.

Thanks to the generosity of Freeport McMoRan, there has been a significant reduction in the contribution of heavy metals leaching and eroding from the Casino waste pile and, since the site was reclaimed, fugitive dust is no longer emanating from the site. The waste pile is now stable and post reclamation monitoring showed no erosion. There is evidence that deer, elk and moose are foraging on the grasses at the site and wild turkeys were also observed indicating that the positive improvements to the watershed are long term and sustainable.

The project greatly benefitted from county involvement, industry support and a commitment on the part of private and governmental entities to address the problems in the watershed in a cost effective and timely manner. Numerous technical challenges related to site conditions, landowner consent, as well as working during the pandemic, were overcome to complete the project. The use of innovative technology also resulted in significant cost savings and the site may serve as a prototype for reclaiming other mine waste piles in the EPA Superfund designation. Despite the challenges, the project was completed on budget and has inspired others to take on the challenge of reclaiming legacy mines in the Clear Creek watershed. Eventually, it is hoped that reclamation will improve aquatic life habitat and restore the pristine mountain environment in the entirety of the Clear Creek Watershed. The tourism dollars that recreation attracts are the life blood of the economy in Clear Creek County and tourists demand a clean and healthly environment. The Casino project addressed the environmental impacts of one of the mine sites in the watershed for years to come for a modest amount of funds thanks to the cooperation of industry, government and the local community.

FREEPORT-MCMORAN COPPER & GOLD

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

SEAL OF CLEAR CREEK COUNTY COLORADO 1861

Casino Mine Pre-Reclamation. Deeply incised Gullies and No Vegetative Cover (2019)-Image From Google Earth

Casino Mine One Year Post-Reclamation-Gullies Removed. Site Stable & Revegetated (2022)-Image from Clear Creek County Website

Photos # 45 & 46 , Prior to Reclamation and Reclaimed Slope of Waste Pile