RECLAMATION OF ABANDONED IRON MINES IN MINNESOTA[1]

by

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ABSTRACT - Since mining began in 1882, millions of tons of earth have been displaced on Minnesota's three Iron Ranges: the Cuyuna, Mesabi, and Vermilion. The mining process left gigantic pits, tailings basins, and stockpiles. Some of these pits are several miles long and hundreds of feet deep. Tailings basins cover from 40 acres to over 13,000 acres and the overburden and lean ore removed to reach the merchantable ore was stockpiled, creating large hills, some of which are hundreds of feet high covering hundreds of acres.

In 1978, state legislation created the Mineland Reclamation Division of the Iron Range Resources and Rehabilitation Board (IRRRB) and we were mandated to reclaim abandoned minelands. Funding for the Mineland Reclamation Division is provided by a portion of the Taconite Area Environmental Protection (TAEP) Fund whose funds are derived from the taconite production tax. The taconite production tax is paid by the mining companies on each ton of taconite produced in lieu of a property tax.

The IRRRB Mineland Reclamation Division receives TAEP funds to reclaim, reforest, or restore abandoned minelands. Our work consists of eliminating dangerous areas, establishing vegetation, repairing and preventing erosion and dust problems, and creating another use for these lands, i.e. recreation, wildlife habitat, and/or reforestation.

Introduction

The mining procedures and volume of material in mining iron ore makes it physically impossible to return the land

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to its original state. Therefore, reclamation efforts are directed towards six problem areas: eliminating unsafe areas, maintaining water quality, minimizing erosion, minimizing air pollution, ensuring the reestablishment of vegetation, and returning lands to acceptable aesthetics. These goals are realized through efforts in reshaping, stabilization and revegetation.

Reshaping the abandoned pits is a common reclamation activity because it reduces the dangers of steep banks and makes the land usable. Reshaping the pit involves changing the shapes of the walls and planting vegetation to control erosion.

Revegetation also plays a crucial role in mineland reclamation. It produces an aesthetically pleasing appearance, controls erosion, prevents dust pollution and provides barriers to unsafe areas.

Stabilization is accomplished through effective reshaping and revegetation techniques.

Some of the uses of reclaimed lands include projects that are related to: tourism and recreation or wildlife and timber production. Tourism projects have included campgrounds and site-seeing destinations. Recreation projects have included sliding hills, trails, beaches and boat accesses. Wildlife production is enhanced through various planting activities which improve the natural habitat on tailings basins and stockpiles. Red pine, jack pine and white spruce constitute the majority of trees planted on abandoned minelands for timber production. There have, however, been forty-four different species of trees and shrubs planted since 1978.

Reclamation Procedures

Reclamation projects on abandoned minelands in Minnesota are carried out by the State of Minnesota Department of Iron Range Resources and Rehabilitation Board (IRRRB), Mineland Reclamation Division as directed by state legislation starting in 1978. Most of the projects are on publicly owned land, i.e. State, County, City or Township.

The first step in the reclamation process is to work with the respective officials to incorporate their needs and ideas into the project design. For recreation development projects, the IRRRB Mineland Reclamation Division requires that, prior to construction, the local government unit assume responsibility for maintenance of the project upon completion. Most design work is done in-house, but larger and more complicated design is contracted out. With very few exceptions all project construction is done through the State contract procurement and purchasing procedures.

The first step in the construction phase is the reshaping of the mine, stockpile or other mining facility. Most of this work is done with large dozers or scrapers. In reshaping, our first concern is establishing a

safe land form that will allow vegetation to quickly stabilize the new slope and prevent erosion. The surface overburden and pit walls are composed of glacial till. When designing a project we generally like to provide a finished grade of 2 1/2 horizontal to 1 vertical and slope distances of 100 feet or less. In silty, more erodible soils the grades should be less and in gravelly soils, steeper slopes can be acceptable. Adequate control of water is very important to the success of the project. Final grading is done on the contour to limit erosion during the establishment of vegetation.

The next step is establishing a vegetative cover that will stabilize the surface, be self-sustaining and add value to the land. Since the glacial till is low in nitrogen and has little or no organic matter, the use of clovers and other legumes is essential to success. These plants have the ability to fix nitrogen from the air and thereby provide a continuous source of nitrogen to the plant community. Sod forming grasses are also important as is a quick germinating nurse crop to protect the slower germinating plants. A typical seed mixture is shown in Table 1.

If the site is low and tends to be wet, red top and alsike clover would be substituted for the other grasses and legumes. All legume seed should be inoculated with nitrogen fixing bacteria prior to being planted on freshly disturbed mine wastes. On slopes, we feel it is important to use herbaceous plants for quick stabilization. On flatter areas, shrubs and trees are used in the initial cover. Due to the rocky nature of the soils and roughness of the terrain, broadcast or hydro-seeding is used rather than a drill seeder.

These soils have low fertility, therefore, we fertilize areas to be planted to hasten site stabilization. When hydro-seeding, the fertilizer is to be applied with the seed. Fertilizer formulation and amounts applied are tailored to the site. Fertilizing a slope may encourage weed growth, but we feel that is of greater importance to hasten site stabilization through the use of fertilizer.

Table 1. - A typical northern Minnesota seed mixture.

	% Of Mix
Nurse Crop-Perennial rye grass (Lolium perenne)	10%
Permanent Grasses-Smooth brome (Bromus inermis)	}
-Red fescue or (Festuca rubra)	} 60%
-Red top (Phragmites communis)	}
Legumes-Birdsfoot trefoil (Lotus corniculatus)	}
-Red clover or (Trifolium pratense)	} 30%
-Alsike clover (Trifolium hybridum)	}
	100%

With very few exceptions, all seeded areas are mulched to aid seed germination and to minimize soil erosion. We rarely apply seed, fertilizer, and mulch all at one time using a hydro-mulcher. When this is done, less seed is placed in contact with the soil since a portion of the seed is tied up in the mulch blanket and tends to rapidly dry out. For this reason, we specify that seed and mulch must be applied in two operations. When using a hydro-mulcher we normally specify that 1,400 to 1,500 pounds per acre of mulch be applied. Hay or straw is used as mulch on most of our projects and it is blown on at the rate of two tons per acre and anchored with a special slotted disc. We have also used a tackifier and plastic netting to hold hay or straw on a slope.

There are now quite a number of specialized products on the market to deal with water erosion and aid germination. One of these products is the wood fiber blanket. Wood fibers, from sound green timber, measuring 8" or more in length, are properly cured to achieve adequately curled and barbed fibers. These fibers are then placed between net mesh having a mesh size greater than one square inch but less than 1 1/2" x 3". U-shaped stapes 6" or longer anchor the blanket in place. Wood fiber blankets are intended for use as a temporary covering on seeded areas to prevent erosion during establishment of the herbaceous cover.

Two types of wood fiber blanket are used in projects: Regular - for use on slopes and areas where water velocity is minimal and spread out; High Velocity - for use on areas where water flow is moderate and concentrated.

There are also a number of three dimensional plastic nets on the market, designed to minimize erosion in places where moderate to heavy water velocities are expected. These are designed to form a dense mat, capable of preventing erosion, when grass roots tie down the mesh. The three dimensional plastic nets are used over areas that have been seeded.

In some cases large amounts of water must be carried down a slope without causing excessive erosion. One way of accomplishing this is to design a riprap waterway to carry the water. In many instances mine rock is readily available for this use. Under these conditions a waterway is excavated from the slope large enough to carry the expected water flow. It is then covered with a geotextile filter, designed to prevent the riprap from being undercut by flowing water. The geotextile filter is then covered with a 6" layer of sand and the rock riprap is placed on top of this sand cushion. The rock should be sized to have enough large rock to hold the riprap in place and smaller rock to fill voids. Concrete flumes and pipe slope drains can also be used for this purpose.

Revegetation

Revegetation efforts involve not only seeding and

fertilizing areas, but also include the operation of a growth chamber which provides trees and shrubs for our mineland reclamation projects. In November, 1988, work began on designing a state-of-the-art growth chamber facility that would house two growth chambers, a headhouse, a lab, Mineland Reclamation Division offices, multi-purpose classroom and storage areas. Our new facility, completed in April, 1991, provides opportunities to expand education outreach programs in our classroom, produce over 300,000 containerized seedlings per year needed to meet our reclamation needs and also provide unique plant materials for the IRONWORLD USA grounds.

Reforestation of abandoned mining lands has been a priority of the program since its inception in 1978. Between 1978 and 1991, 2,000,000 trees were planted on abandoned mining lands. The majority of these trees were containerized and bareroot seedlings, but in highly visible sites or where screening was necessary 3' to 4' transplant trees were planted. The agency also has two tree spades which transplant 6' to 10' trees.

Tourism and Recreation Development

Several types of projects are included under the tourism and recreation development program. Three campground recreation areas, two historical parks, three observation overlooks, three swimming beaches, a marksmanship center, three winter sliding hills, and an abandoned mine site fish stocking program were all developed under mineland reclamation leadership and funding. These projects have stimulated the local tourism industry.

Mine Pit Access Construction

Twenty-five accesses to water filled abandoned mine pits have been constructed to date. Having created some highly desirable landscapes adjacent to mines, the next logical step was to provide safe, public access to these flooded mines and stock fish. Small mines have carry-in canoe accesses and the larger mines have drive-in accesses. These mines were stocked with rainbow, lake, splake and brown trout, along with some walleye and crappie. The IRRRB initiated the stocking program in 1984. At present time the State of Minnesota DNR has an annual stocking program for the abandoned water filled mine pits.

The drive-in accesses are constructed using 12 foot concrete planks. The planked sections of the access are 40 feet long, with about one-half in the water and an equal amount above the water. These planks are bolted together and underlain with crushed rock and geotextile filter. In some locations portable toilets, water, picnic and campground facilities are provided. These projects provide a safe place for everyone to fish near their community as well as provide an additional, unique fishing experience for visitors to our area.

Mine Pit Wall Reclamation

Twelve major pit wall reshaping projects have been completed by the Mineland Reclamation Division. the largest pit wall reshaping was at the St. James Pit, near Aurora, Minnesota, which was completed in 1982. The St. James Mine in Aurora was closed in 1966. The high quality water accumulation in the pit was the municipal water supply. Through the years, however, the south mine bank encroached on the city. After heavy rains and spring runoff, the water became discolored and turbulent due to the red clay pit walls. The city asked the IRRRB to reshape 4,000 feet of pit bank closest to town. Because of the magnitude and complexity of the project, an engineering firm was selected to design and supervise the project. That portion of the bank to be reshaped was overlain with red clay. About 45,000 cubic yards of clay was removed from the steep, highly eroded pit wall and was used to cover rock stockpiles overlooking the city. These stockpiles were then revegetated. It was found that by removing the clay, the remaining 60,000 cubic yards of rock and gravel overburden could be pushed into the mine without endangering the water supply. The bank was regraded to a 2 1/2 to 1 slope with a 25 foot bench about five feet above the water line. The portion of the bank immediately below the bench was covered with mine rock riprap. The disturbed area was then revegetated. This project transformed an eroded mine into a beautiful body of water. The St. James Pit Reclamation Project was awarded the "Seven Wonders of Engineering" by the Minnesota Society of Professional Engineers in 1983.

Waste Rock Stockpile Reclamation

Sixteen major stockpile reclamation projects have been completed under the program. The Leonidas Overburden Stockpile is a good example of how a stockpile is reclaimed.

A large overburden stockpile is located immediately adjacent to the cities of West Eveleth and Leonidas. Being covered with rock, little vegetation grew on it and it was dusty and unsightly. To rectify this condition, portions of this stockpile adjacent to these cities was reshaped and covered with surface overburden. About 180,000 cubic yards of rock was moved in the reshaping. The design called for short slopes with benches constructed between them. Many erosion control products were used on this project. After the slope and benches were veneered with 2 feet of surface, it was revegetated. This project has reduced a dust problem and greatly improved the appearance of the area.

Conclusion

In Minnesota, we are fortunate to have ample rainfall and no apparent toxicity that prevents the reclamation of lands disturbed by iron mining.

Abandoned mine pits normally become flooded

providing good habitat for trout. Through the cooperation of local government and industry, the IRRRB has been able to convert many abandoned minelands into safer, more productive lands. We know the public uses these areas whether they have been reclaimed or not and, by providing safe access to a variety of sites, the public will prefer to use the reclaimed, safer areas. With proper design and construction; maintenance cost is minimal, while the enjoyment of those using these lands is great.

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