MINELAND RECLAMATION AT LTV STEEL MINING COMPANY

LEARNING FROM THE PAST PREPARING FOR THE FUTURE[1]

by
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Abstract: LTV Steel Mining Company's Mineland Reclamation Program, part of a broader corporate philosophy of multiple resource management, began over forty years ago on Minnesota's Mesabi Iron Range. From research studies which tested plant species, fertilizer needs, planting methods and mulching techniques, the program has been expanded to stabilize large acreages of overburden and tailing materials generated by this major iron ore producer. Control of wind and water erosion with chemicals and vegetation is the primary objective of reclamation, but long-range goals to restore disturbed land productivity are also being met. Since October, 1980, the program has operated within the guidelines of the Minnesota Mineland Reclamation Law. Specific design, operating and cost data are presented regarding reclamation work on pitwall areas, surface and rock stockpiles, tailing basin beach areas and tailing dam backslopes.

Additional Key Words: Site preparation, planting seasons, glacial till, in-pit stockpiling, imprinting, lignin sulfonate, "I" beam sloping equipment, cultipacker, klodbuster, wildlife benefits.

Introduction

LTV Steel Mining Company (formerly Erie Mining Company) is located about 70 miles north of Duluth on the eastern end of the Mesabi Iron Range in Northeastern Minnesota. The company is owned by LTV Steel and managed by Cliffs Mining Company. Capable of producing 9.0 Million tons per year (MTY) of high quality iron ore pellets, LTV Steel Mining Company is scheduled to move 45.7 Million tons (MT) of all material in 1992 to produce 7.7 MT of product at its beneficiation facilities at Hoyt Lakes. Mining is active in the Biwabik Iron Formation, where the hard taconite rock is drilled, blasted, hauled to loading pockets and transported by trains to the plantsite.

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Here it is crushed, milled and the magnetic iron separated from the gangue. The concentrate reports to the agglomerator where it is mixed with bentonite clay (a binding agent), pelletized and indurated at over 2350°F in vertical shaft furnaces. Finished pellets are stockpiled on-site to cool in preparation for rail car loading and transport 75 miles east on our private railroad to dock facilities at Taconite Harbor on Lake Superior. Here the pellets are loaded into 1,000 foot ore carriers and shipped down the Great Lakes System to the steel mills.

The process of iron ore mining and beneficiation at LTV Steel Mining Company generates three broad classes of solid waste materials: overburden (glacial till and waste rock) from the mining operation (20.5 MTY); tailing resulting from the milling process (17.5 MTY) and a small amount of ash from our coal fired power generating plant at Taconite Harbor. Only the two major solid waste products, overburden and tailings will be discussed in this paper.

History of Reclamation

In order to support a large iron ore processing facility, it was necessary to acquire thousands of acres of land surrounding our operations. Effective use of these properties to meet company goals and public needs was accomplished by establishing a program of multiple resource management. This type of management considers all compatible resources, including minerals, timber, wildlife, water and where safe, recreation. Reclamation of mine generated solid waste materials is an essential part of multiple resource management and has been given a high priority by our company for many years. The goal of our Mineland Reclamation Program has always been to establish self-sustaining communities of grasses, legumes and trees which will effectively control erosion, improve aesthetic quality and give the land future utility for timber, wildlife and other uses.

Although our little corner of the world has been the butt of many cold weather jokes and has a well deserved reputation as the "icebox of the lower forty-eight", climatic conditions are conducive to vegetation establishment. We average an 111 day growing season. The July mean temperature in Northeastern Minnesota is 67°F and annual precipitation averages 28 inches water equivalent, with 14 inches of that falling as rain during the growing season.

In 1948, Dr. C. O. Rost, a University of Minnesota soil scientist, was contracted to commence field testing various grasses, legumes and woody species on taconite tailings. His final report, submitted to the company in 1954, confirmed that plant establishment was feasible given supplementary nutrient additions.

Extensive in-house plant material and nutrient testing on all solid waste products followed during the 1960's and early 1970's. Under the able leadership of Sam Dickinson, Company Forestry Supervisor who retired in 1978, research knowledge was refined and applied to large scale reclamation plantings. By the late 1970's, we had tested hundreds of plant species and reclaimed thousands of acres of stockpiles, pitwall and tailing basin areas. In 1977, the company received the National Environmental Industry Award for excellence in land reclamation. All this research and extensive land rehabilitation was accomplished **voluntarily** prior to legislation which created the State of

Minnesota's Mineland Reclamation Law in October, 1980.

Since the effective date of that law, all reclamation activities are governed by rules and regulations set by the Minnesota Department of Natural Resources.

Mine Area Reclamation

Reclamation in the mining areas requires handling two distinctly different types of overburden: glacial till and waste rock. Both materials must be removed in some areas to expose the minable ore body. Till, or surface, is removed directly from the bank, while rock must be drilled and blasted before moving. The thickness of both surface and waste rock varies greatly (0-50+ feet), depending on location. Three main types of mine-created landforms are reclaimed by LTV Steel Mining Company: surface pitwalls, surface stockpiles and rock stockpiles. Surface banks where the mine has reached ultimate limits and completed stockpiles are scheduled for reclamation at the earliest possible date to take advantage of equipment still present in the area. Whereas glacial till provides a somewhat satisfactory medium for plant growth, waste rock does not (Table 1) and must be sheathed with surface material before reclamation can begin.

Pitwall Design Standards

Prior to 1980, surface pitwalls were shaped with crawler tractors to between 2:1 and 3:1 slopes, depending on the space available and the discretion of individual machine operators. Length of slope and bench widths varied with the surface layer thickness. Imprinting with track pad grousers parallel to slope contours is normally done to promote good microclimatic conditions for seed germination.

TABLE # 1. GENERAL PHYSICAL & CHEMICAL SOIL PROPERTIES OF OVERBURDEN MATERIAL EASTERN MESABI IRON RANGE

Soil Properties	Surface	Waste Rock
Texture	Silty Sand Glacial Till	-
Compaction	Compacts Mod. Well	Compacts Poorly
Drainage	Well Drained	V. Well Drained
Organic Matter	Low	None
Rock Content	Large Rocks Present	100% Broken Rock
pH	6.0 - 8.0	-
Avail. Nitrogen	15 Lbs./Acre	None
Phos. (P_2O_5)	100 Lbs./Acre	None
Potassium (K_2O)	150 Lbs./Acre	None
Toxicity to Plant Matls.	None	None
Color	Light Brown	Gray to Black
Reflectivity	Medium	Low

Since implementation of the mineland reclamation law, more specific standards are followed (Figure 1). A minimum twenty (20) foot bench is maintained between the toe of the surface slope and the crest of the rock portion of the pitwall. Lift heights are kept below 60 feet and the sloped area between benches is shaped with large crawler tractors to no steeper than 2-1/2:1. Benches are contoured into the surface material to control runoff and are wide enough to pool water until infiltration can occur.

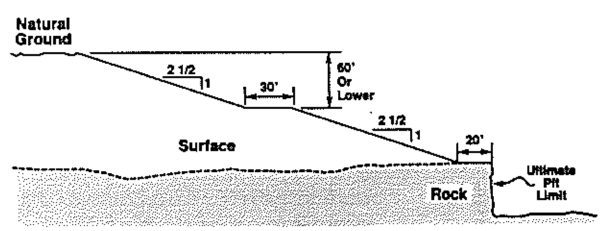

Figure 1. Pitwall Design Standards

Stockpile Design Standards

Stockpiles are generally sited away from the minable ore body so future operations are not encumbered. These stockpile zones are generally defined by intrusions of giants range granite north of the iron formation and an approximate ultimate pit edge all material ratio of 10:1 on the south side of the formation. In recent years, in-pit stockpiling has become a cost effective alternative as sections of mining areas become exhausted.

<u>Surface stockpiles</u>. Past practice on surface stockpile design was to simply maintain enough bench access for seeding equipment. Benches were generally left 15 to 20 feet wide, slopes at the angle of repose (approximately 1-1/2:1), and tops rough contoured by dozers to assure seeding equipment access. Lift heights between benches had no restrictions.

Under the Minnesota Mineland Reclamation Law, lifts on surface stockpiles can be no higher than forty (40) feet, benches no narrower than thirty (30) feet, and slopes between benches shaped no steeper than 2-1/2:1. Benches must also be sloped towards the interior of the stockpile to control runoff (Figure 2).

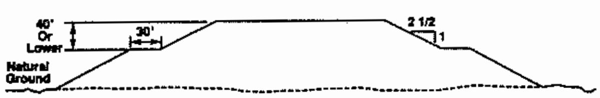

Figure 2. Surface Stockpile Design Standards

<u>Rock Stockpiles</u>. Rock overburden is normally broken into two categories: non-economic material with 10% magnetic iron content or above is classified as lean taconite, while material containing less than 10% mag iron is considered waste rock. The two types of rock are stockpiled separately. During the 1970's the company's design standards for rock and lean ore stockpiles included narrow benches and lift heights between benches of 30 - 50 feet. On stockpiles close to highways or other public facilities, surface sheathing was often done as the first step in establishing a vegetative screen to improve aesthetics. Depth of till material varied from six inches to three or four feet. In many cases, enough surface was available from stripping operations for dozers to rough grade the flat areas and push ample till over the crests to cover the angle of repose slopes.

Post 1980 design standards include bench widths no narrower than thirty (30) feet (designed to control runoff) and slopes between benches no steeper than the angle of repose. Two (2) feet of surface material must be placed on all benches and tops of rock and lean ore stockpiles to facilitate vegetation establishment. Lift heights between benches are normally kept at thirty (30) feet or lower, but may be placed at forty (40) feet if the slopes between benches are sheathed and vegetated (Figure 3a and 3b). Research is currently underway on our property to reduce the sheathing depth requirement to six (6) inches.

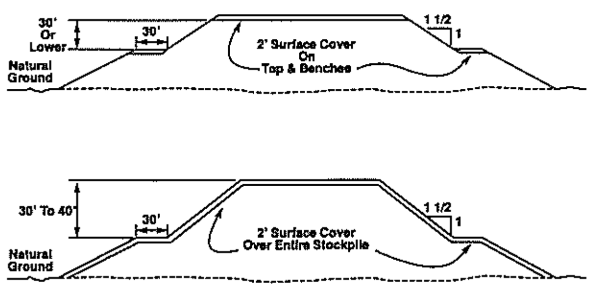

Figure 3A & 3B. Rock Stockpile Design Standards. 0'-30' Lift Heights; 30'-40' Lift Heights

__Vegetation Establishment Procedure__

The common denominator for vegetation establishment on pitwall slopes, surface and rock stockpiles is the planting medium - glacial till material. Many years of testing plant materials and nutrient amendments have led to the use of standard fertilizer application and perennial seed mix rates on most mine reclamation projects. In 1991, we used fifty-seven lbs./acre available NPK fertilizer and our standard mineland reclamation seed mix consisting of:

SPECIES	RATE (LBS/ACRE) BULK	PLS
Red Fescue (__Festuca rubra__)	10	7.8
Smooth Brome (__Bromus inermis__)	10	7.6
Timothy (__Phleum pratense__)	5	4.2
Oats (__Avena sativa__)	15	13.4
Sweetclover (__Melilotus alba__)	5	4.2
Birdsfoot Trefoil (__Lotus corniculatus__)	15	12.5
White Dutch Clover (__Trifolium repens__)	5	4.2
Total	65	53.9

All Legumes are pre-inoculated with nitrogen bacterium supplemented with twice the recommended rate of inoculum when applied by hydroseeder. Other seed species (including a wildflower mix) are often tried to test their adaptability to site specific situations.

The actual operation is done by company employees using in-house equipment. A Finn Bantam 8 Hydroseeder is pulled by either a dual rear wheel flatbed truck or a D-6 crawler. The tractor is preferred in most areas due to its versatility in rocky, steep or muddy terrain. All four tires on the hydroseeder have been foam-filled to eliminate downtime from flat tires. If a water source is not readily available near the project, a 6,000 gallon tank trailer is placed on-site to supply the hydroseeder.

Seed and fertilizer are applied together in one or two acre loads, with one fifty (50) lb. bale of wood fibre mulch added (to suppress foaming) per 800 gallon tankfull of water. Seeded areas are not normally mulched and maintenance is done as required until the site stabilizes and the vegetative community is self-sustaining.

Some of the more successful tree species which have been planted or volunteered on large scale reclamation sites include: Red Pine (__Pinus resinosa__), Jack Pine (__Pinus banksiana__), Hybrid Poplar (__Populus X__), Trembling Aspen (__Populus tremuloides__) and Paper Birch (__Betula papyrifera__). We are currently testing black locust (__Robinia pseudoacacia__) in 4' x 4' spacing for potential use as a "living fence" to restrict access to pit highwall areas.

In accordance with the Mineland Reclamation Law, all vegetation must meet three (3) year density standards of 90% ground cover (5 year for south and west aspect slopes). After ten (10) years, the site must be supporting a vegetative community with characteristics similar to those in an approved reference area. If this situation exists as per DNR inspection, the mine owner may apply for release from further reclamation liability.

Cost Summary.

Table 2 summarizes costs associated with the reclamation of mining landforms. Material movement is not considered, since it is a mining cost which would be incurred even if reclamation work were not done.

TABLE # 2. RECLAMATION COSTS* - MINING AREAS

Operation	Cost/Unit	Rate	Cost/Acre
Site Preparation:			
Labor & Equipment[1]	$53.62/Hr.	0.175 Acre/Hr.	$307
Seeding:			
Labor & Equipment[2]	$100/Hr.	1 Acre/Hr.	100
Seed[3]	$1.06/Lb.	65 Lbs./Acre	69
Fertilizer[4]	$228/Ton (11.4¢/Lb.)	300 Lbs./Acre	34
Total Cost - Site Preparation & Seeding			$510/Acre

*1991 Costs/Prices
1. D-9L Tractor & Operator
2. D-6 Tractor & Operator Pulling Bantam "8" Hydroseeder & Operator
3. LTV Steel Mining Company Standard Reclamation Mix
4. 19-19-19 NPK Analysis Fertilizer

Tailing Reclamation

At near full production, LTV Steel Mining Company generates 48,000 tons of tailings daily and has deposited approximately 500 million tons into our four-celled basin area since the plant began operation in 1958. Tailings are the siliceous waste product of our conventional rod and ball mill grinding circuit, including fine screening, flotation and magnetic separation. After the extractable iron is removed from the ground crude ore, tailing is pumped as a 40% solid (by weight) to the 3,100 acre tailing basin. It is spigoted at predetermined locations around the periphery and allowed to flow towards the basin interior. Naturally, the larger particles settle out first, with the finer material being deposited near the beach areas. A sequence of spigoting and pushing the coarser tailing up with dozers to form five (5) foot lifts along the basin edge is continued until a vertical twenty (20) foot dam lift has been completed. A thirty (30) foot bench is then reserved and a new lift started, causing the basin to rise in terrace-like steps. This is referred to as the upstream method of dam construction (Figure 4).

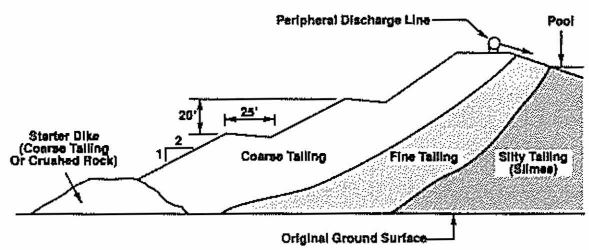

Figure 4. Typical Upstream Method of Tailing Dam Construction

The material used for dam construction is taken from tailing deposition areas where up to 75% of the tailings are larger than 65 mesh (Figure 5).

On the other hand near the beaches, where most of the silty tailings (slimes) come to rest, as much as 93% will pass through a 200 mesh screen (Figure 6).

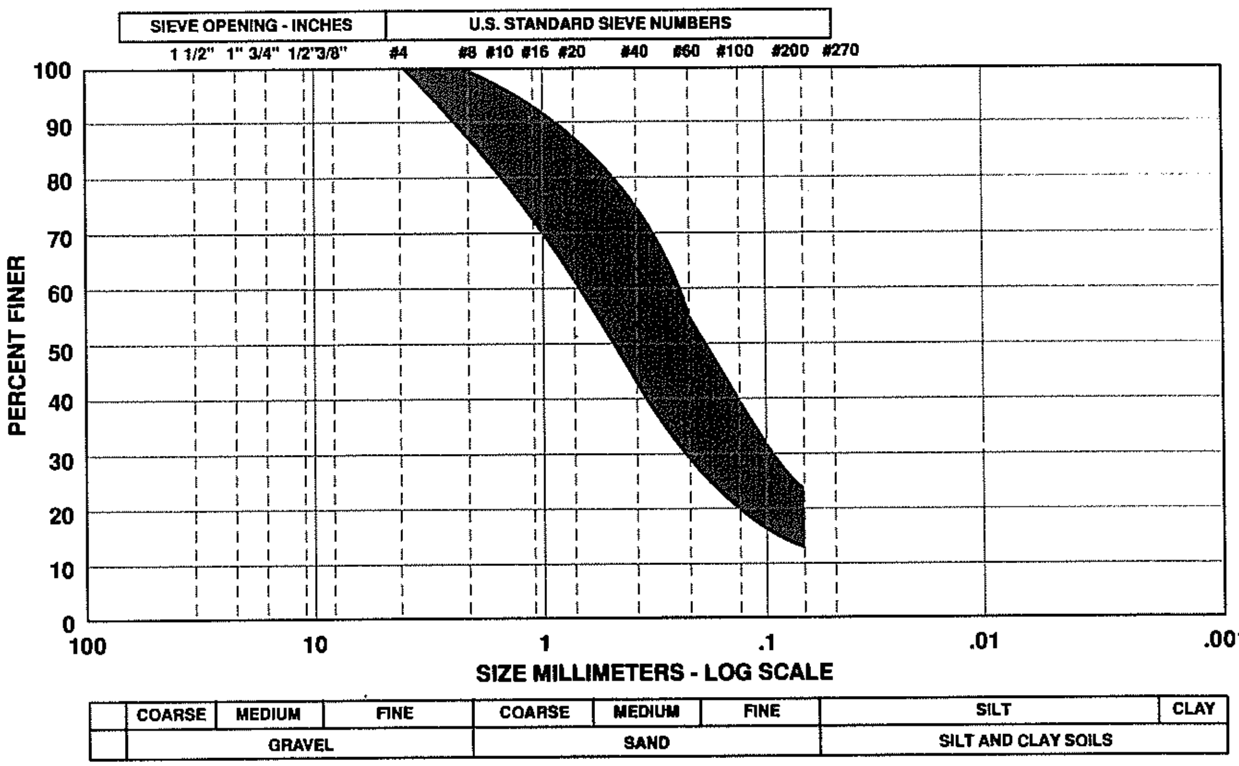

Figure 5. LTV Steel Mining Company Coarser Tailing Grain Size Distribution

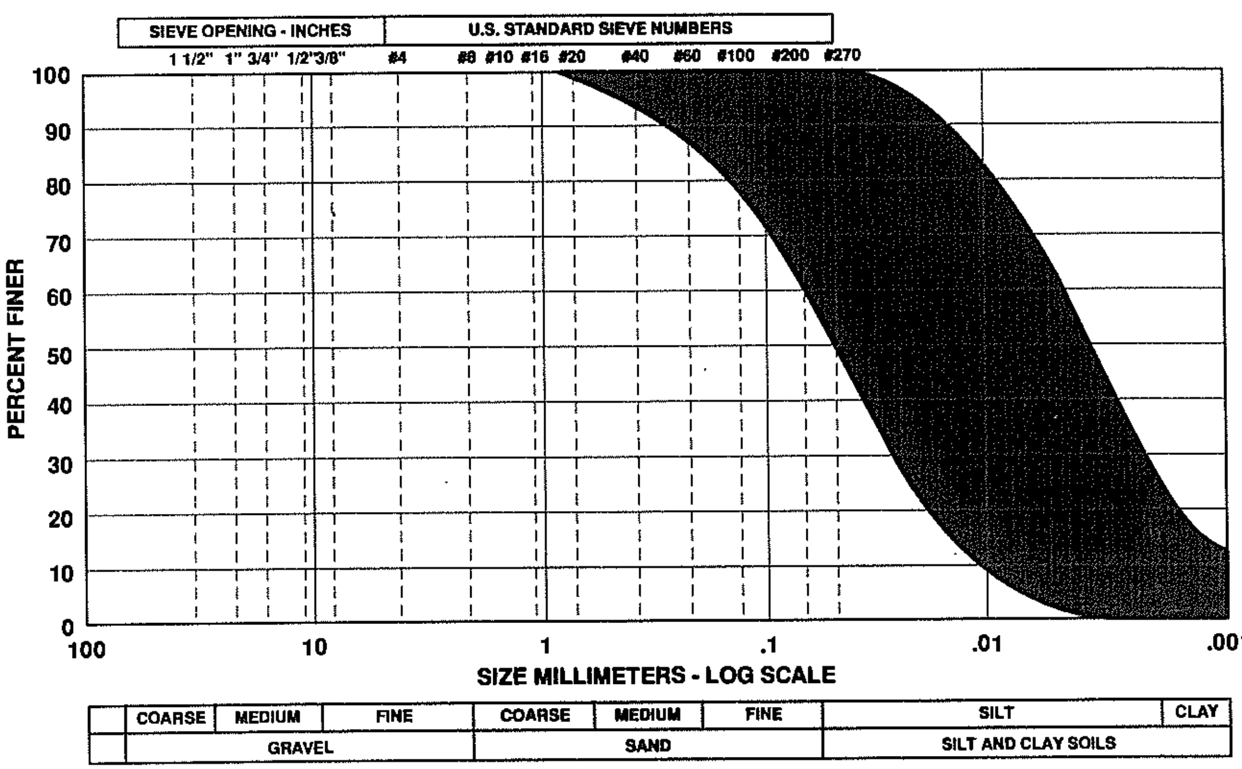

Figure 6. LTV Steel Mining Company Silty Tailing (Slimes) Grain Size Distribution

Evaluation of the general physical and chemical properties of tailing (Table 3) has revealed that this sterile rock flour contains nothing toxic to plant growth and pH adjustments are not necessary. Surprisingly, tailing contains ample available quantities of potassium, one of the major nutrients required by vegetation. Problems which do need to be addressed, however, include the material's extreme nitrogen and phosphorus infertility, droughty surface conditions on the well drained dam backslopes and high temperatures on south and west aspect slopes.

TABLE # 3. GENERAL PHYSICAL & CHEMICAL SOIL PROPERTIES OF LTVSMC TAILINGS

Soil Properties	Coarse Tailings	Fine tailings
Texture	Medium Sand	Silt
Compaction	Compacts Mod. Well	Compacts Well
Drainage	Well Drained	Poorly Drained
Organic Matter	None	None
Rock Content	None	None
pH	7.4 - 8.4	7.4 - 8.4
Avail. Nitrogen	None	None
Phos. (P_2O_5)	None	None
Potassium (K_2O)	200+Lbs./Acre	200+Lbs/Acre
Toxicity to Vegetation	None	None
Color	Gray	Gray
Reflectivity	Low	Low

We have already mentioned that initial research to stabilize taconite tailing started in 1948. During the late 60's and early 70's, efforts concentrated on tests to determine fertilizer rates, planting methods, species adaptation and moisture/temperature control techniques which could be used to develop a reclamation operating plan for our commercial plant's large tailing basin. That leap, from research to standard operating procedures, was made in the middle 1970's and is reflected in our present day program.

It is not the intent of this paper to discuss the complete development of our company's tailing reclamation program - Sam Dickinson has made some very comprehensive presentations on the subject. Rather, we would like to review current reclamation operations on our basin 20 plus years after large scale plantings began. To do this, we will break the tailing areas down into two sections: temporary stabilization in the active interior of the basin and permanent stabilization on the backslopes of the dams. It must be said here that the 1980 Mineland Reclamation Law did not change our design criteria on the tailing basin. Vegetation, however, must meet the same density and composition standards that were previously outlined in the mine area portion of this paper.

Interior Stabilization

Stabilization on the poorly drained, relatively flat basin interior is strictly a temporary treatment, with temporary being defined as anywhere from two weeks to 10 years. The goal of our program here is to effectively and cheaply control fugitive dust while providing food and cover for wildlife wherever practical. Water levels in the basin are held as high as possible, keeping most of the fine tailings under water and not susceptible to wind erosion. Very minor site preparation is required due to the flat nature of the basin's interior.

Short-Term Chemical Treatment. In exposed deposition areas that will be dormant less than one growing season, planting vegetation is not feasible. Here we use a 1:6 lignin sulfonate/water mix to control dust until the area is reactivated. The cheap and readily available pulp and paper mill by-product is applied by company crews to the fine tailing area using a flex-trac trailer equipped with a tank, pumping system, and 30' wide spray boom. Approximately 1 acre can be stabilized with the 1,300 gallon payload of mixed chemical. High flotation equipment must be used to pull the heavy trailer because the fine tailing sub-surface can be very soft. Since lignin sulfonates are water soluble and leach quickly when subjected to heavy rains, multiple applications for short-term dust control are possible. Nelson, Yardley and Lacabanne (1977) found that lignin sulfonate was still effective on taconite tailings after 2½ months under static conditions. Through many years of testing various chemicals, we have found that lignin sulfonates are the most cost/effective choice in our situation for short term stabilization.

Vegetative Treatment. Vegetative stabilization is the preferred treatment on interior areas which will be inactive for one or more growing seasons. Certainly it is more aesthetically pleasing than chemical treatment, and although initial costs may be slightly higher, longevity and wildlife benefits more than balance out the difference. In contrast with reclamation work done in the mining areas, vegetation establishment on the tailing basin is done by contract to our specifications, with the successful bidder providing all equipment, seed, fertilizer and mulch necessary to complete the job.

Most planting on the interior, or beach areas, is done between May 15th and June 10th to take advantage of good spring moisture conditions. In the past few years, however, we have seeded and fertilized frozen "slime" areas in late March with successful results. 300 lbs/acre 11-55-0 fertilizer and a seed mix consisting of 40 bulk lbs/acre Japanese Millet and 5 bulk lbs/acre Redtop were broadcast over areas which are inaccessible after they thaw. Vegetation densities have been adequate to control dust for two years if the areas are not disturbed by additional deposition.

Reclamation equipment can usually work within fifty (50) feet of the water's edge on freshly deposited silty tailing. First, sections of the basin interior are evaluated for dust lift-off potential and future scheduled deposition. In areas which will be undisturbed for one or two growing seasons, fertilizer is mechanically spread at the rate of 80 lbs/acre available nitrogen and phosphorus. Discing with conventional farm equipment follows to work the nutrients into the tailing four to six inches. Experience has shown that phosphorus tends to bind up with the fine tailing fraction, and must be worked in to obtain good root development (Dickinson, 1975). Broadcast seeding with either Barley (Hordeum vulgare) 100 bulk lbs/acre, Sunflowers (Helianthus spp) 100 bulk lbs/acre or millet (Setaria spp) 30 bulk lbs/acre is followed by cultipacking to firm the loose tailing. No mulching is normally required on interior plantings because the water table is close to the surface. Even though these crops die after one year's growth, enough dry plant material remains to effectively control dust for 2 years. Using the same fertilizer rates and planting techniques, one hundred (100) bulk lbs/acre of Spring Seeded Rye (Secale cereale) or Buckwheat (Fagopyrum esculentum) are planted in areas requiring two to three years stabilization. In addition to providing excellent food for wildlife, both species display greater longevity than other inexpensive grains due to seed setting and reseeding habits. Additional nutrient supplements beyond those used for one or two year plantings are not required.

Areas which will be dormant for more than three years require longer lived species. Two perennial grass/legume mixes which have been successful on LTV Steel Mining Company's basin interior are:

SPECIES	RATE (LBS/ACRE) BULK	PLS
Oats (Avena sativa)	25	22.3
Redtop (Grostis alba)	8	5.8
Red Fescue (Festuca rubra)	10	7.8
Alfalfa (Medicago sativa)*	6	5.3
Birdsfoot Trefoil (Lotus corniculatus)*	6	5.0
Total	55	46.2
Buckwheat (Fagopyrum esculentum)	50	41.0
Red fescue (Festuca rubra)	10	7.8
Sweetclover (Melilotus alba)*	5	4.2
Total	65	53.0

*Pre-Inoculated

Refertilization to supplement the initial base application of 80 lbs/acre available N and P is normally not required, but has been done on occasion to improve vigor and density. Other treatments which have been tried with success in recent years to improve stand quality include use of "green manure" cultivation and controlled burning.

Backslope Stabilization

Stabilization of the well drained tailing dam backslopes is a permanent treatment well adapted to reclamation which emphasizes the use of vegetation. Here our primary goal is complete dam stability through good engineering design and operating procedures. A self-sustaining community of perennial grasses and legumes is a vital part of the system - effectively controlling erosion which could threaten the dam's integrity. Another objective is to give the area future utility for non-mining uses such as wildlife habitat.

Site Preparation. After a twenty (20) foot lift of tailing has been completed, the backslopes are shaped to 2:1 and an 18 inch berm established on the outside edge of the bench immediately below the newly shaped slope. This design effectively ponds runoff water until it disappears through evaporation and infiltration. Sloping used to be done with crawler tractors, but a new method has been developed by the tailing basin section of our Ore Dressing Department. It involves dragging a large, 40 foot "I" beam along the bank until the desired slope is achieved. The beam is anchored top and bottom by large rubber-tired dozers. Savings in time and equipment/operator costs are striking - a 1000 foot long slope which would have taken 1 week to do with a crawler tractor now is done and ready for seeding in 2 hours.

Seeding Operation. Backslope seeding is being done successfully in the spring, early fall or as a dormant planting in October. In our efforts to establish a self sustaining plant community on the basin slopes, the first step is to boost the nutrient levels in the coarse tailing material. Fifty-five (55) lbs/acre available nitrogen and 320 lbs/acre available phosphorus are sprayed on the prepared slopes with a hydroseeder. The fertilizer is then worked into the tailing four (4) to six (6) inches using a klodbuster. Next, a proven perennial grass/legume mixture is spread by hydroseeder and the seed covered by dragging a light chain along the slope. The klodbuster was recently tested for its seed covering capabilities but we found that a high percentage of the seed was buried too deep for effective germination.

Two seed mixes currently being used at LTV Steel Mining Company for effective backslope tailing reclamation are:

SPECIES	RATE (LBS/ACRE) BULK	PLS
Canada Bluegrass (Poa compressa)	10	6.8
Redtop (Agrostis alba)	5	3.6
Cicer Milkvetch (Astragalus cicer)*	20	16.1
Birdsfoot Trefoil (Lotus corniculatus)*	20	16.7
Perennial Ryegrass (Lolium perenne)	10	8.3
Total	65	51.5
Smooth Brome (Bromus inermis)	10	7.6
Red Fescue (Festuca rubra)	10	7.8
Perennial Ryegrass (Lolium perenne)	10	8.3
Alfalfa (Medicago sativa)*	20	17.8
Birdsfoot Trefoil (Lotus corniculatus)*	20	16.7
Total	70	58.2

*Pre-Inoculated and Supplemented

The heavy seed rates, especially the loading of legumes, were developed for two reasons: one, this is a practice that has shown excellent long-term results in Ontario, Canada, and is doing a good job for us; and two, most seedings in recent years have been dormant and rates are high to allow for seed depredation. As in other perennial mixes we use, legumes are pre-inoculated and supplemented with nitrogen bacterium in the hydroseeder tank.

Normal practice on the tailing basin is to mulch all permanent plantings to control moisture and surface temperature during germination and early growth stages. Up until 1990, our standard mulch consisted of two (2) tons of straw or hay blown onto the seedbed with 250 gallons of asphalt per acre. Although we have always had a few problems with wind roll-up, none have ever compared with the 15 acre mulch failure (out of 32 acres) which we experienced two years ago. We are currently researching different mulches and tacking agents which will hopefully neutralize the compound problem of high basin heights and heavy wind conditions. To date, a combination of straw or hay tacked with newsprint hydromulch shows the most promise.

Cost Summary

Table 4 summarizes the current costs associated with stabilization and reclamation of taconite tailings.

TABLE # 4. STABILIZATION AND RECLAMATION COSTS - TACONITE TAILINGS

Stabilization Type	Effectiveness	Maintenance	Approx. Cost[1] Dollars/Acre
Chemical-Lignin Sulfonate	Good	Moderate	119
Vegetative Temporary-Grains	Excellent	Minimal	140
Temporary-Perennial Seed Mix	Excellent	Minimal	170
Permanent[2]	Excellent	Minimal	1,046

1. 1991 Cost Figures
2. Includes Mulching and Site Preparation

Summary

Over forty years ago, visionaries laid the foundation of an idea that would one day turn thousands of acres of mining waste on the Mesabi Iron Range back into productive land. Many problems had to be overcome during the infant stages of our land reclamation program, and the challenge continues today. We are very grateful to organizations like the Soil Conservation Service, the Bureau of Mines, the University of Minnesota and others who gave and continue to give freely of their knowledge, ideas and encouragement in the name of Natural Resource Conservation.

Part of a land use philosophy called Multiple Resource Management, LTV Steel Mining Company's Reclamation Programs are meeting both short-term operational objectives and long-term land stewardship goals. Self-sustaining, perennial seed mixes and trees have been used to stabilize stockpiles, mine pitwall, tailing beaches, tailing basin backslopes and many other smaller but no less important areas. In the process, we are producing food and creating permanent habitat for many different species of animals and birds, including deer, bear, moose, fox, wolves, many rodents, geese, cormorants, ducks, grouse, blue heron and raptors of many varieties.

LTV Steel Mining Company is an organization that produces high quality iron ore pellets which ultimately become fine steel products for families, business, agriculture, transportation and national defense. We are also a company with a proven commitment to maintain the high quality of the environment in which we live and work.

LTV Steel Mining Company - a company learning from the past, and preparing for the future.

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