Memorandum 99-3

TO: All Operators and Interested Parties

FROM: Michael Sponsler, Director
Indiana Division of Reclamation

DATE: July 15, 1999

SUBJECT: Mined Land Technical Reforestation Guidance & Recommendations

Introduction

Data from permits issued during the permanent program in Indiana show coal mine operators have been replacing more combined forest and fish and wildlife habitat after mining than that which existed prior to mining (see pie chart). Despite the fact that substantial quantities of woody plant species have been planted, the Division believes growth and productivity of trees planted on reclaimed land can be improved to increase the value of forests and wood products. Scientific literature and a review of reforestation recommendations published by other coal mining states shows that proper reclamation is critical for producing productive forests. It is hoped application of these ideas will assist the coal mining industry in enhancing and encouraging successful reforestation efforts in the state of Indiana, so as to increase both the quantity and quality of reforestation on Indiana surface mines. Specifically, these recommendations can assist coal mine operators so that your bond release efforts will occur rapidly and successfully. These ideas will also serve to improve the productivity of trees planted on Indiana reclaimed surface mined lands for the benefit of the land owner and future generations.

Rationale

Reclamation techniques and husbandry practices which are conducive to productive forest lands and wildlife areas are essential when successful achievement of the postmining land use demands good tree/shrub survivability and growth.

Current reclamation practices present three prevalent problems which inhibit proper reforestation (KY DSMRE RAM #124,1997; Virginia DMME, 1996).

1) Excessive compaction of the rooting medium (soil or approved soil

substitute/supplement).

2) Inappropriate rooting medium (spoil material).

3) Excessive competition from the herbaceous ground cover species established to control erosion.

Research, both independent and generated by mining and reclamation professionals responsible for meeting current standards, indicates that the following conditions are necessary to ensure proper tree growth and survival on mined lands.

1) The replaced rooting zone soil on areas which will support a land use of forest or wildlife habitat must be composed of soil materials with a high water holding capacity, because trees have a high demand for water. Therefore, most tree species require a thick uncompacted rooting zone of 4-6 feet of soil material with texture that holds high amounts of available water (KY RAM #124,1997). Upland deciduous trees require greater than 0.10 inch of available water per inch of soil to be well suited for use as wildlife habitat (NSSH,1996). Available water holding capacity (AWC) is reduced for coarse fragments (rock fragments) in a direct relationship with percent by volume of coarse fragments, i.e. 15 percent coarse fragments reduces AWC by 15 percent. A minimum of 5 percent coarse fragments is needed before a reduction is calculated. (NSSH,1986). As a rule of thumb, the techniques employed to assure maximum crop production on prime farmland reclamation sites also apply to maximum tree productivity for trees planted on reclaimed Midwestern surface mines, because both vegetation types have a high water demand.

2) To attain best survival and productivity which will lead to quick bond release, it is recommended during the mining and reclamation process, acid or toxic material be covered with four to six feet of acceptable rooting medium that will support trees, unless a best available material is approved for use. All highly alkaline materials with excessive soluble salt levels should also be buried in a similar fashion.

3) It is recommended that herbaceous and woody species are selected which (a) provide long term erosion control, (b) are compatible with one another, and (c) are suited to site specific conditions. Less aggressive ground covers will facilitate tree seedling survival. Selection of herbaceous and woody species shall be in accordance with the revegetation requirements of 310 IAC 12.

Forestry Reclamation Practices

These reclamation practices are recommended when establishing a postmining land use which requires the planting and survival of woody species (trees and shrubs).

1) **Selection of a growth medium**

In addition to the available topsoil, at least four feet of the best available rooting medium within the permit area should be placed on the surface to accommodate the needs of deeply rooted

trees. Rooting media with low to moderate levels of soluble salts (less than 8 mmho/cm), an equilibrium pH of 5.0 to 7.0, low pyritic sulfur content and a texture conducive to proper drainage are preferred. Research in Virginia recommends that alkaline shale materials be avoided in the growth medium for trees (Burger and Torbert,1992). However, for those few sites where the best available material may vary from the above recommendation, an equilibrium pH as low as 4.5 and as high as 7.5 can be successful, so long as species tolerant of those conditions are selected and utilized.

2) **Soil Replacement Techniques**

Minimizing soil compaction during application of the rooting medium and the final grading operation is extremely important. Once material with appropriate texture is selected, care must to taken to minimize heavy equipment traffic on the soil materials during and after replacement of the rooting zone. Research indicates that the best available known technology for preventing compaction is to replace the soils with end dump trucks that do not drive upon the soil, followed by a final grading with low ground pressure bulldozers (Dunker et. al.,1998)(Burger and Torbert,1992)(Torbert et. al.,1994). The operator is still responsible for assuring that AOC and backfill stability are achieved.

3) **Tree compatible ground cover**

Reforestation requires a carefully planned balance between ground cover and tree requirements for light, water and space. Ground cover is recommended to include grasses and legume species that are slow growing, are tolerant of a pH of 4.5 to 7.5, and can be established in mine soils. Tree compatible ground covers are relatively sparse during the first year and become increasingly lush by the second and third years. This allows tree seedlings to emerge above the ground cover and ensures their survival. Kentucky-31 fescue, Sericea lespedeza, all vetches, clovers (except Ladino), alfalfa and other aggressive or invasive species should be avoided. For best results, a herbaceous seed mixture for an area which is to be planted to trees and shrubs should have a balance of permanent grasses, legumes, temporary plants and small grains/ground cover species. Successful forest revegetation is based on tree survival and rapid growth, not the height and density of the ground cover. A balanced seed mixture will allow for short-term and long-term erosion control and not inhibit tree growth or survival. Some suitable examples of good woodland ground cover species seed mixtures follow:

Upland Mixture	Wet Mixture	Acid Tolerant Mixture
Orchardgrass	Virginia Wildrye	Redtop
Perennial Ryegrass	Redtop	Timothy
Red Creeping Fescue	Korean Lespedeza	Perennial Ryegrass
Redtop	Deertongue	Weeping Lovegrass (annual)
Ladino Clover		Birdsfoot Trefoil
Korean Lespedeza		Partridge Pea (annual)
Partridge Pea		Deertongue
Birdsfoot Trefoil		

Wherever possible, the operator should consider the use of native species.

4) **Fertilizer requirements**

Fertilizer requirements should be based on a current soil test. Make sure to inform the soil

test laboratory that it will be making a recommendation for an area to be planted to trees. The fertilizer recommendation should have an adequate rate of phosphorus and potassium and a low rate of nitrogen. The lower rate of nitrogen reduces the height of the ground cover but not its density. By the third year, the inoculated legumes should be providing an adequate supply of nitrogen.

5) **Tree species selection**

Tree species, shrub species and nurse tree/shrub selections should be based on the approved postmining land use and site specific characteristics. If available, mychorrizae inoculated seedlings can be helpful to enhance success. Considerable thought and planning should go into the species selection process. Consultation with a state or private forester is recommended. Wherever possible, the operator should consider the use of native species. The species established must be capable of satisfying the requirements of a particular postmining land use whether it is forest land or fish and wildlife. The requirements are listed in 310 IAC 12-5-64.1.

6) **Tree planting**

Trees can be properly established by utilizing mechanical planters, hand planting or a combination of these methods, depending upon the species established. An experienced, reputable tree planter should be used. Some examples of recommended woodland planting mixtures follow:

Upland Mixture	Acid Tolerant Mixture
Red Oak	Sweetgum
White Oak	Shingle Oak
White Ash	Red Oak
Black Cherry	Pitch Loblolly Pine
Sweetgum	White Ash
Shagbark Hickory	Green Ash
Pecan	Arnot Bristly Locust
Black Walnut	Sycamore
Black Locust	River Birch
Tuliptree (does well in association with Black Locust)	Silver Maple

Wetland Mixture	Wildlife Upland Forest Mixture
Bald Cypress	Persimmon
Overcup Oak	Red Oak
Pin Oak	White Oak
Buttonbush	Shagbark Hickory
Ninebark	Kentucky Coffeetree
Green Ash	Pawpaw
Swamp White Oak	Crabapple
Cherrybark Oak	Black Cherry
River Birch	Silver Maple
Blackgum	Hazelnut
Shumard Oak	Scarlet Oak

If you have any questions or comments about this memorandum, or need further information concerning the ongoing reforestation initiative, please contact me at the Jasonville field office, at (812) 665-2207.

Trees Available from the Indiana Division of Forestry

Bald Cypress
Black Cherry
Blackgum
Black Locust ❖
Black Oak
Black Walnut
Bur Oak
Cherrybark Oak
Chinkapin Oak
Eastern Red Cedar
European Black Alder
Green Ash
Osage Orange
Overcup Oak
Pecan
Persimmon
Pin Oak
Pitch Loblolly Pine▲
Red Oak
Red Pine▲
River Birch
Sawtooth Oak
Scarlet Oak
Shagbark Hickory
Shellbark Hickory
Shingle Oak
Shumard Oak
Silver Maple
Swamp White Oak
Swamp Chestnut Oak
Sweetgum
Sycamore
Tuliptree
Virginia Pine▲
White Ash
White Oak
White Pine▲

Shrubs Available from the Indiana Division of Forestry

Arnot Bristly Locust
Bicolor Lespedeza
Black Chokeberry
Buttonbush
Flowering Crabapple
Flowering Dogwood
Ninebark
Northern Bayberry
Pawpaw
Redbud
Silky Dogwood
Washington Hawthorn

❖ Black locust is a good early successional "nurse tree" species, but should be limited to 25% of the mixture to prevent over-dominance which discourages growth of climax tree species.

▲ Pines are not generally native to southwestern Indiana and should be limited to applications such as windbreaks and shelterbelts.

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Pope, P.E. 1993. Some soil fungi are beneficial to tree seedling growth. Purdue University Cooperative Extension Publication. FNR-104. 12pp.

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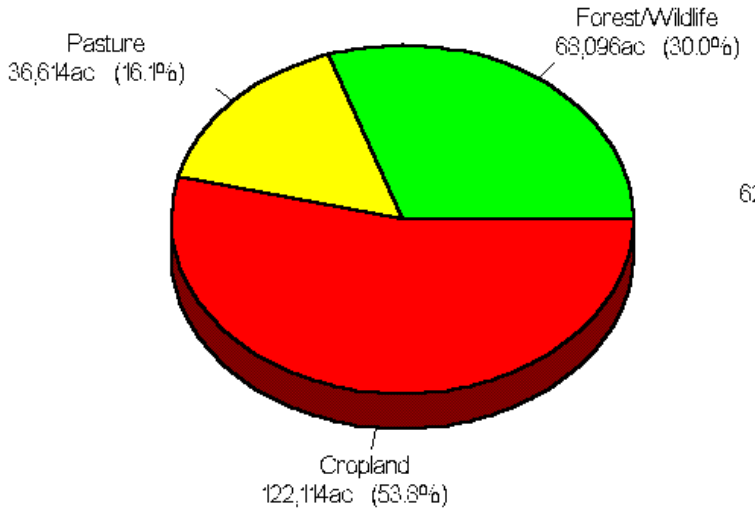
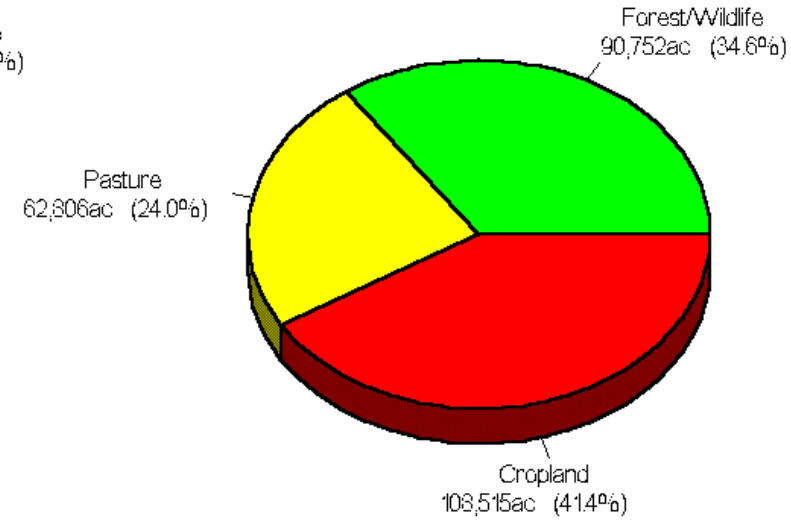
Land Uses

1982-1998





PreMining

PostMining