SURFACE MINING - USING MIXED OVERBURDEN TO CREATE PRIME FARMLAND[1]

by

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Abstract. Mining companies are required by regulation to replace prime farmland by sequential soil horizon during the reclamation phase of mining. However, by the use of selective handling techniques, prime farmland soils can be produced using mixed overburden. Overburden characterization is performed using gridded geophysical logs and cores to determine the best material available to use during reclamation. A postmine soil mapping project indicated the Grayrock, Grayvar, and Bigbrown soil series at two mine sites in east Texas could meet the criteria for prime farmland soils. At the Monticello Winfield Mine, the Grayrock and Grayvar soils on 1 to 5 percent slopes were declared as prime farmland by the U. S. Soil Conservation Service in 1991. The Bigbrown soil series on 1 to 5 percent slopes was declared a prime farmland soil by the SCS in 1993 at the Big Brown Mine. Postmine prime farmland soils at Monticello Winfield Mine compose 65.9 percent of the mined area, compared to 38.8 percent prime farmland soils within the permit area prior to mining. Prime farmland soils at the Big Brown Mine made up 4.7 percent of the area before mining but 58.6 percent of the postmine soils. Use of selected overburden material, especially in areas where native soils have low to moderate productivity, is considered a viable alternative based on this and other studies.

Additional Key Words: stratigraphic units, postmine soil mapping, overburden evaluation.

Introduction

Mining companies are required by regulation to replace prime farmland soils by sequential horizons (A and B or C horizons) if the soils have historic cropland use. Regulatory authorities in most states may approve substitute materials in the top four feet of reclaimed soil if this material will produce a soil having as good, or greater, productive capacity as the native prime farmland soils. Productivity of the replaced prime farmland soil must also be proven.

The development of the prime farmland soils concept occurred in the 1970s because of the covering of the nation's best farmlands by concrete as urban areas spread across former cropland. A brief discussion of the criteria for prime farmland soils follows.

Criteria for Prime Farmland Classification

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops and is also available for these uses (the land could be used as cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water). It has the soil quality, occurs in an area which has an adequate growing season, and available water capacity needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. The best farmlands typically are those derived from loessial materials or the grasslands of the Great Plains.

The Natural Resources Conservation Service's State Conservationist in each state has developed criteria for prime farmland soils specific to that state's climate and soils. There are requirements for soil moisture, temperature, pH, drainage and water table, salinity, flooding, slope and erosion, permeability, rock fragments and calcium carbonate equivalent. This paper will deal with the criteria associated with Texas soils.

Soil Moisture. Texas is divided into moisture zones, but, basically, available water capacity must be equal to or greater than 4 inches in the top 40 inches of soil, or the land has a developed irrigation water supply that is dependable and meets minimum water quality standards for irrigation water.

Temperature. The soil temperature at a depth of 20 inches is greater than 32 degrees F. All soils in Texas meet this criterion.

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Hydrogen Ion Concentration (pH). The soil has a pH between 4.5 and 8.4 in all horizons within a depth of 40 inches or in the root zone if the root zone is less than 40 inches deep.

Drainage and Water Table. The soil drainage class is either somewhat poorly drained, moderately well drained, or well drained, or the soils lack a high water table that adversely affects production of crops commonly grown in the area or has an installed drainage system which prevents a high water table or poor drainage from adversely affecting the production of crops commonly grown in the area.

Salinity. The soil can be managed so that electric conductivity is less than 4 mmhos/cm in all horizons, and the soil lacks a natric horizon.

Flooding. The soil surface is flooded less than once in two years or for less than two days during the growing season of crops commonly grown in the area.

Slope and Erosion. The soil is not presently gullied, eroded or severely eroded. The soil has a slope of less than or equal to 5 percent.

Permeability. The soil has a permeability rate of at least 0.06 inches per hour in the most restrictive horizon in the upper 20 inches.

Rock Fragments. Less than 35 percent by volume of gravel; less than 10 percent by volume of cobbles; no stones greater than 10 inches in diameter, or too few stones to interfere with tillage.

Calcium Carbonate Equivalent. The soil has a weighted average calcium carbonate equivalent, in the fraction less than 2 cm in diameter, of less than 40 percent in the root zone.

Problems with Existing Regulations

As stated earlier, regulations require the sequential removal and replacement of soil horizons, and soil productivity shall be returned to equivalent levels of yield as nonmined land of the same soil type in the surrounding area under equivalent management.

This sounds very good in theory. However, it is considerably more difficult to accomplish in the field. The method frequently used to replace native soil horizons sequentially is by the use of scrapers or end dumps. Either method may result in soil compaction. Soils replaced using scrapers would often make better streets or parking lots than cropland due to the amount of compaction which was induced during the placement phase by loaded scrapers going over them.

Methods

The method which Texas Utilities Mining Company (TUMCO) employs for reclamation is the use of selected mixed overburden materials in mining. This approach was based, at least in part, on a study (Angel, 1973) which found that east Texas overburden materials are favorable for vegetation. Selection of overburden for placement in the top four feet of reclamation is guided by the geologic studies required to obtain the permit for mining. Stratigraphic units are mapped and correlated throughout the mine area by use of gridded geophysical core data and electrical logs. Stratigraphic units are defined as strata within the overburden which exhibit distinctive textural composition, a reasonably consistent and predictable stratigraphic relationship with mineable lignite seams in the permit area, a recognizable geophysical log signature, and a mappable thickness and geographic extent (DeMent, et. al., 1992). Weighted averages of the major parameters (pH, ABA, texture, and trace elements) are obtained for each stratigraphic unit. These averages are then compared to the values in the native soils and the criteria set out by the state's regulatory agency to determine the best material for use in reclamation. The overburden is selectively handled by draglines or cross-pit spreaders during the mining, with unsuitable materials placed low in the spoil. The suitable strata are placed so that they are the only materials occurring in the leveled postmine topography from which minesoils could develop.

Texas Utilities, in cooperation with the Natural Resources Conservation Service (formerly Soil Conservation Service), developed a postmine soil mapping and classification program. Postmine soil mapping provides a valid procedure for comparing premine and postmine soil quality. The results of this program suggested that minesoils developed from mixed overburden could potentially meet all the criteria for prime farmland soils. Several years of field trials and data collection went into the effort. The NRCS, in 1991, declared the first mixed overburden prime farmland minesoil at the Monticello Winfield Mine in northeast Texas.

Results

Postmine Soils

The native soils of east Texas are mostly either deep sands (>40 inches of sand or very fine sand) or have a claypan at shallow depths (<20 inches). Both tend to be very droughty soils, either because of the high sand content throughout or because of the abrupt textural break at shallow depths causing a boundary across which water, air, and roots have difficulty passing. Most native soils in east Texas have low pH and low acid-base account (ABA) values (Smith and Sobek, 1978). Postmine soils where selective overburden handling is practiced tend to have higher mean values for these parameters and more consistent textures throughout the minesoil profile (Table 1).

The mining operation, in which selected geologic materials are used in the top four feet of reclaimed soil, breaks up the claypan where it exists and removes the deep sand layer where it occurs. The minesoils produced exhibit a much more uniform texture throughout than most of the native soils in east Texas. The surface of most of the reclaimed soils is more clayey, which allows for higher water-holding capacity and higher cation exchange capacity. The lower layers of these reclaimed soils are usually less clayey than the native soils, allowing freer movement of roots, water, and air.

Table 1. Mean values for premine and postmine soils

	Native Soils	Post-mine Soils	Native Soils	Post-mine Soils
	0-12"		12-48"	
Big Brown				
pH	5.6	6.5	5.4	6.4
ABA	0.5	3.2	-0.3	2.7
Sand	69	35	44	34
Clay	17	27	41	28
Monticello Winfield				
pH	4.9	6.9	4.9	7.0
ABA	-0.5	5.9	-2.7	5.3
Sand	72	31	54	30
Clay	12	28	30	28

At the Monticello Winfield Mine, the Grayrock soil series (fine-silty, mixed, nonacid, Typic Udorthents) on 1 to 5 percent slopes and the Grayvar soil series (fine-loamy, mixed, nonacid, thermic, Typic Udorthents) on 1 to 5 percent slopes were declared as prime farmland soils by the Natural Resources Conservation Service in 1991. The Grayvar series is a proposed series but meets the prime farmland criteria. The Bigbrown soil series (fine-silty, mixed, nonacid, Typic Ustorthents) on 1 to 5percent slopes was declared a prime farmland soil by the NRCS in 1993. Table 2 presents a comparison of areal extent of prime farmland soils between premine and postmine areas.

Table 2. Percentage of prime farmland soils.

	% of premine area	% of postmine area
Big Brown	4.7	58.6
Monticello Winfield	38.8	65.9

<u>Productivity</u>

Estimated yield comparisons for major forage crops such as Coastal bermuda grass (<u>Cynodon</u> <u>dactylon</u> (L.) Pers.) and winter wheat (<u>Triticum</u> <u>aestivum</u> L.) are provided in Table 3 for the Grayrock soil series. Native soil yield estimates were made by the Natural Resources Conservation Service (USDA-SCS, 1989) for a low level of management and are based mainly on the experience and records of farmers, conservationists and extension agents from the area. These can vary in any given year depending on weather, management practices and the presence or absence of disease and insects. Yields for Coastal bermuda grass for Grayrock series come from production averages over a number of years in compliance with regulatory requirements (TUMCO, 1996).

Estimated wheat yields were summarized in 1989 following three years of study on a 10-acre plot of Grayrock silty clay loam, 1 to 5 percent slopes. Management on the study area conformed to normal farming practices within the area. Due to variances in weather and damage from migratory geese, annual yields ranged from 29 to 59 bushels per acre. The estimated wheat yield shown in Table 3 is an average of the three-year study.

In addition to the above information, a 5-acre plot of alfalfa (<u>Medicago</u> <u>sativa</u> L.) planted in 1989 continued to produce a healthy crop through the 1996 growing season, producing four hay cuttings. This is in an area of the state where native soils are not adapted to alfalfa production.

Table 3. Premine/postmine yield comparisons - Monticello Winfield Mine.*

	YIELDS	
SOIL	C. BERMUDA	WHEAT
	(tons/ac)	(bu/ac)
Bernaldo	3.1	-
Freestone	3.1	35
Nahatche	2.9	-
Wolfpen	2.6	-
Woodtell	2.8	35
Grayrock**	3.4	39

* A dash means not commonly grown. See text for source of estimates.
** Minesoil; remainder are native soils.

Table 4 provides the estimated yield information for the Bigbrown soil series for Coastal bermuda grass (TUMCO, 1997) and wheat. The wheat yield is based on one year's data on Bigbrown.

Table 4. Premine/postmine yield comparisons - Big Brown Mine.*

SOIL	C. BERMUDA	WHEAT
	(ton/ac)	(bu/ac)
Crockett	2.0	35
Edge	1.9	28
Gasil	2.2	28
Gredge	2.0	-
Nahatche-Hatliff	2.1	-
Padina	1.8	-
Silawa	1.9	-
Silstid	1.9	-
Bigbrown**	3.0	52

* A dash means not commonly grown. See text for source of estimates.
** Minesoil; remainder are native soils.

These studies have not received statistically valid testing but support the conclusions of the NRCS that the yield potential is equal to or greater than that of native soils of the area.

Conclusions

The general consensus among many people in the general public today, as in the past, is that surface mining is an aberration and should be brought to an abrupt halt. Although it is true that mining may have caused environmental damage before mining regulations were promulgated in the mid-1970s, the reclamation work done by current mining techniques is proving beneficial to wildlife and soils in many instances. It is also furnishing a valuable soil resource for current and future users of the land. Many people in east Texas have sought for years for a method to break up the claypans so prevalent in that part of the state. Surface mining has provided that method, and has even given an increase in the percentage of the landscape occupied by soils meeting the criteria for prime farmland soils. Flexibility to use techniques such as this should be encouraged as much as possible in applicable situations. Where overburden materials are as consistent and desirable as those in this study, the results can be very beneficial.

Literature Cited

Angel, P. N. 1973. A Soil Analysis of the Strip Mine Spoil Bank at Fairfield, Texas. M.S. Thesis, Stephen F. Austin Univ. Nacogdoches, TX. 75 pp.

DeMent, J. A., S. Cooney and J. Denman. 1992. Development of a Prime Farmland Minesoil in Selectively Cast Overburden in Northeast Texas. Proceedings of the 1992 National Symposium on Prime Farmland Reclamation. (St. Louis, MO, August 10-14, 1992).

Smith, R. M. and A. A. Sobek. 1978. Physical and Chemical Properties of Overburdens, Spoils, Wastes, and Lands. American Society of Agronomy, Madison, WI. New Soils. In: Reclamation of Drastically Disturbed

TUMCO. 1996. Monticello Mine, 1,961 Acre Bond Release Application. Submitted Oct. 31, 1996.

TUMCO. 1997. Big Brown, 2,022 Acre Bond Release Application. Draft.

USDA-SCS. 1989. Forage Production Standards for Post Mine Soils. In: Monticello Permit No. 30B Surface Mining Application, Section 145 Appendix D. Submitted 5-31-96.