Testing for potential acidity is recommended on fresh, unweathered minesoils that are suspected of becoming extremely acid as they weather. This test also is recommended on some partially weathered minesoils that are already extremely acid and show indications of continuing to be acid for many years.

Phosphorus

Testing soils for plant-available phosphorus (P) usually is recommended because P often is deficient or unavailable to plants. Several methods are available for determining plant-available P in soils; but not all methods give meaningful results in spoils or minesoils, nor is any one method necessarily best for testing all types of minesoils. For example, an extracting method known as the Bray #1 has given meaningful results on many of the minesoils derived from rocks of Pennsylvanian Age, but several other standard agricultural tests did not give meaningful results. Thus, results of soil tests for P should be accepted only if the soil-testing facility can show that the tests are meaningful for the minesoil materials being tested. To be meaningful, the results of the tests should indicate accurately (correlate with) the response of plants to that nutrient when added to the soil being tested.

Potassium

Most standard soil tests for potassium (K) give values that are reasonably meaningful when used on minesoils. However, fertilizer experiments on minesoils generally have shown little or no increase in plant yield due to application of potassium fertilizer. Thus, soil testing for K may be of little benefit except for areas designated for production of agricultural crops.

Other Tests

Normally, additional soil tests are not needed for determining the plantability and treatment of reconstructed soils and minesoils. Exceptions may be where unusual toxicity problems are encountered, such as with boron, selenium, or other minor elements. Tests for soil nitrogen have value mainly for replaced topsoil to be used for cropland purposes. In minesoils, their value is limited because much of the nitrogen present is not biologically available. Also, nitrogen usually is deficient in minesoils and nitrogen fertilization is recommended as a standard practice.

Other soil tests can be made, but because the geology, chemistry, and physics of minesoils are so complex and varied, these tests may have value only where meaningful interpretations of them have been developed for the particular soils being revegetated.

HANDLING OF PLANT-GROWTH MEDIA

The goal of soil reconstruction is to create a soil that is as deep and as favorable to root growth as is necessary to achieve the productivity standard established in the PAP. Proper handling of soil and geologic strata is extremely important to the successful revegetation of reconstructed soils on surface-mined land. Errors made in soil handling such as excessive compaction may be nearly impossible to correct.

The special handling requirements for soils on prime farmlands are presented in a separate section of this handbook entitled Special Considerations.

Removal

It is important that the topsoil be removed from the land in a separate layer and replaced on the backfill area, or if not used immediately, segregated in a separate stockpile from other spoil. Stockpiles should be protected from erosion and from being contaminated by acid or toxic material, and the topsoil should be maintained in a usable condition for sustaining vegetation when restored during reclamation. Where topsoil is of insufficient quantity or of poor quality for sustaining vegetation, or where other strata can be shown to be more suitable for vegetation requirements, such other strata that are best able to support vegetation can be used and should be removed, segregated, and preserved in a like manner as the topsoil.

To meet the success standards required by the approved State regulatory program, the operator may need to reconstruct soils with rooting depths as deep as the normal soils of the permit area. To achieve this the operator may need to remove and stockpile separately all soil horizons to have suitable rooting-depth material available for soil reconstruction.

Methods

There are several kinds of equipment available to remove the topsoil and other soil layers. These include scrapers, dozers, draglines, excavating wheels, front-end loaders, and road graders. The machine selected should provide the least damage to soil structures and pore space and still allow effective segregation of soil layers during the soil removal process.

Timing

Topsoil and other soil horizons or geologic strata should be removed after the vegetative cover that would interfere with its salvage is cleared from the area. The soil should be removed before any drilling, blasting, mining, or other surface disturbance.

Removal of soils when they are dry or when the moisture content is less than 75 percent of optimum (Standard Proctor Test) will help preserve soil structure, reduce compaction, and reduce loss of pore space. The optimum moisture content for plant growth is close to ⅓ bar ten-

sion (field capacity) in many soils. Moving soil while it is this wet will cause problems throughout the soil handling, reconstruction, and revegetation processes. Soil moved while wet will compact easily and may be slow to dry. Removing topsoil when the entire soil layer was frozen caused minimal compaction and maintained favorable soil structure and pore space.

Storage and Protection

It is essential that the topsoil, or substitute materials where used, be protected against wind and water erosion, and remain free from contamination by acid or toxic materials.

Storage

A soil survey provides information helpful in selecting sites for stockpiles. Important site considerations are the surface relief, slope length, steepness, aspect, surface and internal drainage conditions, flood hazard, and susceptibility to slippage. Sufficient area should be prepared for each stockpile and hillside sites with springs or seeps should be avoided. Precipitation and runoff should drain away from the stockpile and depressions that entrap water on the stockpile avoided. The approved State regulatory program may contain standards on the steepness and length of each side slope of the stockpiles.

Contaminants

Possible contamination sources include acid-mine drainage, flooding, parking and maintenance of equipment, and dust from haul roads.

Wind and Water Erosion

Stockpiled topsoils and other soil materials may be susceptible to water and wind erosion. Stockpiles that will not be used for reconstruction within 30 days may need to be seeded and mulched. Quick-growing annual or perennial plants can be seeded or planted as soon as weather and seedbed conditions permit after the stockpile is established. In the Western Coal Region, irrigation may be needed to establish cover on stockpiles.

Berms, diversions, or other structures may need to be constructed to retard soil erosion from the stockpile area.

Mulches and Soil Stabilizers

Cereal straw or hay are mulches commonly used to help stabilize soil stockpiles. Other materials being used as mulches include preparations of wood cellulose fiber, wood excelsior, bark, whole-tree chips, and synthetic products. The tacking of straw and hay mulch can be done with various soil-stabilizer products and cellulosic "hydromulches."

Replacement

The replaced minesoil material should be graded to approximate the original soil contour, and to have positive drainage so that any settlement that takes place will not create ponding situations on the reconstructed soils. Treatment such as ripping or scarification may be required to reduce potential slippage of the redistributed materials and to promote root penetration.

Methods

Selection of equipment for replacement and reconstruction of minesoils should be based on the need to provide the least amount of compaction possible. Hauling material to the site in dump trucks (base level dumping) and spreading with small low-ground-pressure dozers generally is acceptable. Soil materials may be returned to the site in parallel windrows with scrapers or trucks and the material then spread between the windrows with road graders or low-ground-pressure dozers. All operations should be designed to minimize traffic on the soil materials. The use of rippers or scarifiers may be required on traffic areas to help alleviate compaction.

Topsoil should be returned to the reconstructed site and placed at a thickness specified in the PAP. Ripping the graded material before replacing the topsoil may help reduce the abruptness of the interface between the two materials and possibly improve root penetration into the lower material. The quality of the root-growth medium also can be improved by adding and incorporating lime where the material has pH values less than 5.5.

All reconstructed soils are subject to wind and water erosion. The extent of this hazard depends on the season of the year, slope length and gradient, soil erodibility of the topsoil material, and the length of time between completed soil reconstruction and the establishment of permanent vegetative cover.

Several erosion control methods can be used to stabilize the soil surface until permanent vegetative cover has been achieved. These include the use of mulches and soil stabilizers, diversions, siltation structures, and windbreaks such as snow fence and temporary vegetative cover. A provision for surface drainage may be needed to handle runoff from the reconstructed soil areas in a manner that minimizes the risk of channel cutting or surface ponding. Fiber netting or other devices may be needed to hold soil and mulch in places where the flow of water is concentrated.

Compaction

Soil replacement activities should be conducted when soils are dry or when moisture content is less than 75 percent of optimum (Standard Proctor Test) to help minimize compaction of the rooting zone. The ultimate goal of soil replacement and reconstruction is to create soil horizons that have moist bulk-density values equivalent to those in a similar layer in the undisturbed soils. In some cases where the natural soils contain layers high in moist bulk-density restrictive to plant growth, it may be possible to create reconstructed soils that have lower bulk-density

values. The reconstructed soils could provide a better root-growth medium in this situation.

Moist bulk-density values of soils determined at the permit area before surface mining provide the best benchmark of bulk-density values to use as goals in the reconstruction process. A rule of thumb that could be applied in soil reconstruction is to limit the increase in moist bulk density to 0.2 grams per cubic centimeter over that which existed at a comparable depth before mining.

The moist bulk-density values of the reconstructed soil should allow root extension similar to that in an equivalent layer in the undisturbed soil. This standard is needed to help assure that revegetation can meet the success standard requirement in the PAP.

Compaction during soil reconstruction destroys pore space. This reduces the movement of air and water within the soil and impedes root growth. Errors made in soil handling that result in excessive compaction may be nearly impossible to correct. The best solution to this potential problem is to avoid excessive compaction.

The following guide shows bulk densities that are limiting to plant yields in soils with different particle-size family (textural) classes.

Family class	*Yield-limiting Moist Bulk Density (g/cm^3)*
Sandy	1.80
Coarse-loamy	1.70
Fine-loamy, coarse-silty, fine silty	1.65
Clayey, 35-45% Clay*	1.55
Clayey, 56-75% Clay*	1.30

*For clay contents between 45 and 56 percent, determine density limits by interpolation.

Source: Kansas Standard and Specifications for Land Reconstruction, Currently Mined Land, October, 1984.

Timing

Ideally, soil replacement should be timed to coincide with periods of the year when chances are best for successfully revegetating the reconstructed soils. On some mining operations and in some regions, soil replacement may occur on a nearly continuous basis throughout the freeze-free portions of the year. On these permit areas, there may be special problems in controlling erosion, reducing compaction, and establishing vegetation. In some regions, optimum conditions for replacement are severely limited by weather patterns.

Contemporaneous

Some coal-mining operations move soil materials directly from the area being mined to regraded spoil areas for soil reconstruction. By using this procedure, the operators avoid the costs of stockpiling the topsoil material and other soil layers. During the favorable times of the year, the soil material can be moved without excessive compaction and replaced to form reconstructed soils with rooting zones very similar to those of the unmined soils. But this procedure creates problems in revegetating the reconstructed soils during excessively dry or wet conditions or during cold periods when seedings or plantings will not be successful. Additional protection from wind and water erosion may be required during these unfavorable periods. The use of mulches, soil stabilizers, and temporary vegetative cover may be necessary to protect the soil surface until a favorable period exists for establishing the permanent vegetative cover.

Seasonal

Ideally, soil replacement would be done just before seasons of the year when there is the best chance for new seedings or plantings to become established. In most regions of the country, these ideal planting seasons occur in spring and fall. In some regions, the best season to replace topsoil is mid to late summer when drier soil conditions usually can be anticipated just before the late summer and early fall seeding period. In some regions, spring is the best time to plant but the winter period preceding it is the least suitable time to move and replace soil.

Bond Release Phases

The permittee may file a request for bond release as he or she nears completion of the reclamation work. The permittee is required to publish in a local newspaper (for 4 weeks) his or her intent to seek bond release, and to write to adjoining property owners, local government bodies, planning agencies, water and sewer treatment authorities, or water companies in the locality of the intent to seek bond release. The State regulatory authority will conduct an investigation and find in writing that the operator has satisfactorily accomplished reclamation before any portion of the bond is released.

Phase one

The State regulatory authority may release 60 percent of the bond when the operator completes backfilling, regrading, and drainage control of the bonded area in accordance with the approved PAP.

No part of the bond may be released so long as the lands to which the release is applicable are contributing suspended solids to streamflow or runoff outside of the permit area in excess of requirements set by PL 95-87 section 515 (b)(10).

Phase two

An additional percentage of the bond may be released after vegetation has been established on the regraded mined lands in accordance with the approved PAP.

A portion of the bond is retained by the State regulatory authority to cover possible use of a third party to reestablish vegetation. This portion is retained for the full period of operator responsibility (which may be 10 years or more in western mining regions). This period of time may be needed to meet the success standard required by the law and the approved PAP.