Improvement and Reform Act of 1996 requires the NRCS to make available for public review and comment proposed revisions to conservation practice standards used to carry out the highly erodible land and wetland provisions of the law. For the next 60 days, the NRCS will receive comments relative to the proposed changes. Following that period a determination will be made by the NRCS regarding disposition of those comments and a final determination of change will be made.

Pearlie S. Reed,

Chief, Natural Resources Conservation Service, Washington D.C.

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DEPARTMENT OF AGRICULTURE

Natural Resources Conservation Service

Mining Specifications for Prime Farmland

AGENCY: Natural Resources Conservation Service, USDA.

ACTION: Notice of proposed specifications with request for comments.

SUMMARY: The Natural Resources Conservation Service (NRCS) of the Department of Agriculture (USDA) is issuing proposed specifications for soil handling in relation to mining activities on prime farmland, as provided for in the Surface Mining Control and Reclamation Act of 1977 (SMCRA). SMCRA requires the Secretary of Agriculture to establish specifications for the removal, storage, replacement, and reconstruction of prime farmland soils. The Soil Conservation Service, now called the Natural Resources Conservation Service, first proposed these specifications on February 19, 1988 (53 FR 4989). NRCS has made revisions to the proposed specifications and now seeks additional public comment prior to issuance of final specifications.

DATES: Comments must be received by November 27, 1998.

ADDRESSES: Mail written comments to Gary Nordstrom, Director, Conservation Operations Division, Natural Resources Conservation Service, P.O. Box 2890, Washington, D.C. 20013. Submit electronic comments to gary.nordstrom@usda.gov

FOR FURTHER INFORMATION CONTACT: Gary Nordstrom, Director, Conservation Operations Division, Natural Resources Conservation Service, 202–720–1845.

SUPPLEMENTARY INFORMATION:

General Background on Proposed Specifications

Section 515(b)(7) of the Surface Mining Control and Reclamation Act of 1977 (SMCRA), Public Law 95–87, 30 U.S.C., 1265(b)(7), authorizes the Secretary of Agriculture to establish specifications for soil removal, storage, replacement, and reconstruction for all prime farmlands, as identified in Section 507(b)(16) of the Act, 30 U.S.C. 1257(b)(16), to be mined and reclaimed. This authority is delegated to NRCS in 7 CFR 2.61(a)(22).

NRCS determined that national specifications for soil handling must allow for consideration of the wide diversity of soils, geology, climate, mining equipment, and crops in coal mining areas across the nation. These differences are recognized in the permanent program regulations published by the Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, specifically in 30 CFR 823.4(a), which states that ''NRCS within each State shall establish specifications for prime farmland soil removal, storage, replacement, and reconstruction.''

Accordingly, NRCS developed the specifications set forth in this proposed notice to ensure that local and site-specific factors are considered. Within the individual States, each NRCS State Conservationist will maintain and make available a local version of these specifications that incorporates the general criteria set forth in these specifications and any modifications made for the respective State. To the fullest extent possible, the basic specifications and the applicable modifications for individual States reflect the latest scientific information and experience regarding reclamation techniques.

During the development of the proposed specifications, NRCS national office provided certain general guidelines to assist the NRCS State staffs in developing specifications at the local level. These guidelines were set out in the advance notice of the proposed rule published on August 26, 1985 (50 FR 34490). The first version of these proposed specifications was published on February 19, 1988 (53 FR 4989). The specifications in this notice reflect comments received as a result of the 1988 publication and includes technical revisions based on research results and improvements in technology which have occurred since the 1988 publication.

Although NRCS had originally intended to publish these specifications as a codified regulation under 7 CFR part 652, it has been determined that the guidance included within this notice is advisory in nature, not regulatory. Therefore, these specifications will not appear in the Code of Federal Regulations as a rule.

Discussion of the Proposed Specifications

The Soil Removal section provides guidance on the identification of prime farmland soils where a published survey is not available and outlines how a soil scientist should proceed with identifying and sampling the soils to be removed for later replacement and reconstruction. This section identifies needed documentation of field conditions, including rooting zones; surface relief; pre-mining drainage conditions (including subsurface); flood frequency; physical, chemical, and morphological soil properties of the soils to be removed; and the equipment and procedures to be used in soil removal. The soil removal specifications address the handling of the various soil horizons encountered on prime farmland and the procedures to be followed if substitute materials are to be used. NRCS recognizes that compaction of prime farmland soils during removal and reconstruction is a significant factor in prime farmland reclamation and, therefore, the specifications include guidance to avoid compaction problems.

In the Soil Stockpiling section, NRCS recognizes that stockpiling of soil horizons, while not the preferred procedure for reclamation, is often necessary because of weather conditions, limitations or availability of equipment, or the reclamation method utilized. These specifications provide guidance to ensure that if stockpiling is utilized, the soil resources will be protected until reconstruction begins. This section provides criteria for stockpile site selection, protection against contamination and loss, and temporary distribution if long-term stockpiling is required.

In the Soil Reconstruction section, NRCS incorporates the principle of SMCRA that the reclamation of prime farmland requires the re-establishment of the pre-mining productivity of the disturbed soils. The soil reconstruction specifications provide a framework which, if followed and the required conditions are achieved, should maximize the probability that the reconstructed soil will achieve the required productivity.

Many factors contribute to the pre-mining productivity of prime farmland, including the chemical and physical characteristics of the soil horizons, the soil depth, the soil slope, and the

drainage conditions. Research has shown that when the post-mining soil characteristics are similar to the pre-mining characteristics, pre-mining productivity can be achieved.

These specifications provide for documentation of the characteristics of original soil, as required by sections 507 and 508 of SMCRA, 30 U.S.C 1257 and 1258, and provide that the reconstructed soils should achieve, as best as possible, these characteristics. These specifications provide guidance on how to utilize pre-mining information in the development of a reconstruction plan for successful reclamation. This guidance includes provisions regarding rooting depths, chemical and physical characteristics of the soil horizons, and site conditions. These specifications also include erosion control measures to ensure that the reconstructed soils remain in place after reclamation.

NRCS has attached appendices A and B for information and compliance assistance purposes. These appendices do not establish an obligation not otherwise imposed by rules and regulations, nor do they detract from obligations imposed by other rules and regulations. Appendix A contains information describing the procedures for determining the rooting zone of the pre-mined prime farmland soil. Appendix B contains information describing the procedure and quantitative specifications which can be used to evaluate the rooting zone of the reconstructed soil in relation to the pre-mined soil.

Implementation Issues

It is important that the implementation and administration of the specifications be understood by everyone with an interest in the successful reclamation of surface mined prime farmlands. Once these specifications are finalized, NRCS will place these specifications in each NRCS State Office. NRCS will send copies to each State Regulatory Authority (RA) and each OSM office so that the specifications can be used in carrying out their responsibilities for prime farmland reclamation.

The applicant for a mining permit on prime farmland will prepare a reclamation plan, as required by sections 507 and 508 of SMCRA, 30 U.S.C. 1257 and 1258, based upon the particular prime farmland soils proposed to be mined, the equipment to be used, and the physical characteristics of the site. Because these conditions vary considerably among sites, the mining and reclamation plans will also vary. The RA must rely on its technical staff to assure the proposed reclamation plan will likely yield the required results. The RA technical staff will utilize the NRCS specifications in making their recommendations for approving, disapproving, or revising the proposed reclamation plan. In addition to the plan review by the RA technical staff, the RA will consult with the NRCS State Conservationist on the plan prior to a final decision. The NRCS State Conservationist will review and comment on the proposed reclamation plan and, if the plan does not reflect NRCS specifications, the NRCS State Conservationist will suggest appropriate plan revisions to the RA.

The RA will make a final decision on the reclamation plan based, in part, on its review of NRCS specifications and consideration of comments received from the NRCS State Conservationist. The decision will be specific to the particular permit under review.

If a NRCS State Conservationist determines that a revision in the State reconstruction specifications is desirable, then NRCS, in consultation and cooperation with the RA, will utilize a public outreach process to obtain comments on the proposed revision. Under no circumstances will the State reconstruction specifications be less effective than the National specifications. After a public comment process, including publication in the **Federal Register** and internal review by the NRCS and RA, the NRCS State Conservationist will incorporate the changes into the specifications and distribute them to the NRCS local offices within the State and to the RA. The RA will make the revised specifications available to mine operators and other interested parties.

Questions and Answers

NRCS lists below questions related to implementation of NRCS specifications which have arisen during their development along with answers to those questions.

Question 1: Are the RA's required to incorporate the NRCS specifications into their approved state program through the formal amendment process?

Answer: The RA will use the specifications in making their determinations on prime farmland reclamation plans, but they are not required to be a part of the approved state program.

Question 2: What if the RA decides not to incorporate the State Conservationist's recommendations into a reclamation plan?

Answer: The RA is required, under section 510(d)(1) of SMCRA, 30 U.S.C.1260(d)(1), to consult with the State Conservationist and to consider any suggested revisions. It is not mandatory that NRCS recommendations be adopted on the permit application and reclamation plan. Under the OSM regulations, 30 CFR 823.15, success of prime farmland reclamation is based on crop production. NRCS specifications are provided to aid the permittee and RA in reviewing and approving reclamation plans and in achieving productivity standards. The specifications are not performance standards. Section 515(b)(7), 30 U.S.C. 1265(b)(7), sets forth the general performance standards for mining and reclamation activities on prime farmland. Under the OSM regulation, the ultimate standard which must be met is the production standard. The specifications were not developed to restrict prime farmland reclamation, but rather to provide a basis upon which a prime farmland reclamation plan can be developed. A reclamation plan that differs from the specification can be approved if, in consultation with NRCS, the RA determines that a plan takes into consideration the particular soil conditions, equipment, and mining reclamation methods applicable to a site and will yield the desired results.

Question 3: The proposed specifications would require permit applicants to submit information which may not be required under the current RA regulations or in the current permit application form. What will be required of the RA's to address this issue?

Answer: The proposed specifications allow for a variety of options in the area of needed information. This approach is consistent with the variable site conditions, mining and reclamation equipment, and procedures inherent in mining. Individual State RA's will determine their informational needs using the NRCS specifications. Some RA's, at their discretion, may wish to change permit information requirements.

Question 4: How will the adoption of the NRCS Soil Reconstruction Specifications change the manner in which prime farmland plans are currently being approved?

Answer: Adoption of these specifications will formalize the knowledge and expertise that NRCS has brought to prime farmland reclamation for over 20 years. State and Federal RA's and mine operators have always relied upon the NRCS for technical advice relating to prime farmland reconstruction. State RA's have been required to consult with NRCS on every acre of non-exempted prime farmland which has been mined since enactment of SMCRA. Many State RA's with a large amount of prime farmland being mined,

such as Illinois, have included NRCS in their mine plan review prior to the enactment of SMCRA. Because of this long relationship and prior history of consultation, most of what will happen after the adoption of these specifications will not be new. Formalization of the specifications will provide a written framework developed during many years of experience and research, from which RA's and permittee can operate. The specifications will be available to all who have an interest in prime farmland restoration.

Applicability.

The specifications apply to the removal, stockpiling, replacement, and reconstruction of soil materials during surface coal mining and reclamation operations on prime farmland, as defined and regulated by the Surface Mining Control and Reclamation Act of 1977 (SMCRA), 30 U.S.C. 1201 *et seq.*

These specifications are to be used in conjunction with the permanent program performance standards of the Office of Surface Mining Regulation and Enforcement, Department of the Interior, which are set forth in 30 CFR 785.17, 816.22, and part 823. These specifications apply to prime farmlands as defined by the Secretary of Agriculture in 7 CFR part 657 and historically used for cropland.

Definitions

The following definitions apply to all documents issued in accordance with these specifications, unless specified otherwise:

Prime farmland means that land which is defined by the Secretary of Agriculture in 7 CFR part 657 and which has been historically used for cropland.

Reclamation Plan means the part of a permit application that details the actions a mine operator will take to restore the area to be mined to an approved post-mining land use.

Rooting zone means the part of the soil that can be penetrated by plant roots. The rooting zone of a soil can be obtained from a published NRCS soil survey or determined in the field by a soil scientist in accordance with procedures.

Soil characteristics mean properties of the soil which can be described or measured by field or laboratory observations, such as color, temperature, water content, structure, pH, and exchangeable cations.

Soil morphology means: a. The physical constitution of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile, and by the texture, structure, consistence, and porosity of each horizon; or

b. The visible characteristics of the soil or any of its parts.

State regulatory authority means the agency in each State which has the primary responsibility at the state level for administering the initial or permanent state regulatory program.

Soil scientist means a technical specialist with the academic credentials or work experience which enables the specialist to use established procedures to collect the required information about soils.

Soil survey means field and other investigations which result in a map showing the geographic distribution of different kinds of soils and an accompanying report that describes, classifies, and interprets such soils for use, and which meets the standards of the National Cooperative Soil Survey and the procedures of the USDA as incorporated by reference in 30 CFR 785.17(c)(1).

Soil removal

Specifications for Designating Prime Farmland Soils for Removal

a. A soil scientist should locate and mark, on the ground and on the plan map, the boundaries of prime farmland soils that will be removed during mining. Prime farmland soils on the proposed mining site will be identified from a published NRCS soil survey. If a soil survey is not available or does not provide the physical, chemical, and morphological soil properties described in 30 CFR 785.17(c)(ii), a soil scientist should sample and document those properties for the identified prime farmland soils using the following procedures:

i. Soil laboratory analysis for testing any sample will use the procedures described in Soil Survey Investigations Report No. 42.

ii. Identify the rooting zone of the undisturbed prime farmland soils in the reclamation plan.

iii. Identify the original topography of prime farmland soils to be mined in the reclamation plan.

iv. Identify the pre-mining surface and internal drainage conditions, flooding frequency, and surface or subsurface drainage systems of the prime farmland in the reclamation plan.

v. Identify the equipment that will be used for soil removal in the reclamation plan.

Specifications for Soil Removal.

a. Soil removal should be accomplished with adherence to the following principles;

i. Minimize pre-mining compaction and destruction of the soil structure by using equipment that will have the least impact on the natural soil.

ii. Route soil removal equipment and adjust removal depth with each cycle of that equipment to minimize the compaction and destruction of soil structure in the natural soil.

iii. Remove the topsoil layer (A, AP, AE, AB, E horizons and, where appropriate, dark noncalcareous Bw and Bt horizons) and, if there is not a currently or recently mined area to replace the topsoil, place it in a designated stockpile. If the natural topsoil layer is less than 6-inches thick, remove the top 6 inches of soil and treat it as topsoil. The topsoil of prime farmlands may be mixed only if the resulting topsoil will have greater potential productivity, as determined using the characteristics set forth in Appendix B, than the prime farmland topsoil alone. In no case will prime farmland topsoil be mixed with topsoil containing rocks larger than 2mm.

iv. Remove the B horizon and/or C horizon, or an RA approved substitute rooting media and, if there is not a currently or a recently mined area to concurrently place the rooting media, place it in a designated stockpile.

v. Soil removal should occur only in water state classes that are slightly dry or dryer, as defined in the Soil Survey Manual, United States Department of Agriculture, Handbook No. 18, October 1993.

b. Substitution of selected overburden materials for any portion of a prime farmland soil is subject to the regulations in 30 CFR 785.17, 816.22, and part 823. Substitution of any material for naturally occurring prime farmland soils should be approved by the RA, in consultation with the NRCS, only when the substitute material will have a clearly demonstrated productivity potential equivalent to or higher than the reconstructed original soil material. This will be based on characteristics outlined in Appendix B.

Soil Stockpiling

Specifications For Stockpiling

Stockpiling is permitted only if the soil removal and reconstruction operations cannot be carried out concurrently.

a. Stockpiled materials should:

i. Be placed on a stable site within the permit area;

ii. Be protected from contaminants and unnecessary compaction that would interfere with revegetation;

iii. Be protected from wind and water erosion through prompt establishment

and maintenance of an effective, quick growing vegetative cover or through other measures approved by the regulatory authority; and

(iv) Not be moved until required for redistribution.

b. Where long-term surface disturbances will result from facilities, such as support facilities and preparation plants, and where stockpiling of soils would be detrimental to the quality or quantity of those soils, the RA may approve the temporary distribution of the removed soil materials to an approved site within the permit area to enhance the current use of that site until needed for later reclamation, provided that diminish the capability of host site and the soil material will be retained in a condition more suitable for redistribution than if stockpiled.

c. Sites subject to flooding or slippage are to be avoided for stockpiling of soil. The soil survey map for the proposed stockpiling site, as well as a field investigation, should be used to determine if a proposed soil stockpile location will be subject to flooding or slippage.

d. Ponding of water should be avoided on all stockpiles.

e. All woody vegetation and any other materials on the stockpile site that may degrade the quality of stored material or interfere with placement or removal of stockpiled soils should be removed.

f. The topsoil should be stockpiled separately from the subsoil or approved substitute material.

g. If possible, topsoil and subsoil stockpiles should not be located on prime farmland soils. If prime farmland must be used as a stockpile site, actions should be taken to avoid and mitigate any adverse effects such as compaction.

Soil Replacement and Reconstruction

Specifications for soil replacement and reconstruction are as follows:

a. The minimum depth of soil and substitute soil material to be reconstructed should be 48 inches; or (1) a lesser depth equal to the depth of a sub-surface horizon in the natural soil that inhibits or prevents root penetration; or (2) a greater depth if determined by the RA, in consultation with the NRCS, to be necessary to restore the original soil productive capacity.

b. The rooting zone of the pre-mining soils will be used as a basis for determining the replacement soil depth. Appendix A provides guidance for establishing the pre-mining rooting zone depth. The depth and quality of the rooting zone of the reconstructed prime farmland soils should be equal to or greater than the pre-mined soil rooting zone. The depth and quality of the replaced subsoil should be verified, using characteristics in Appendix B, before replacement of the topsoil.

c. Topsoil, or the approved substitute material, must be returned to the mined area to a thickness not less than that of the pre-mined topsoil or to a minimum of 6 inches if the topsoil before mining was less than 6 inches thick.

d. The reconstructed soil should have a hydraulic conductivity, texture, porosity, consistency, penetration resistance, and other physical properties which approximates the pre-mined soil or are more favorable for plant growth as outlined in Appendix B.

e. The reaction (pH) and other chemical properties of the major horizon of the reconstructed soil must be within the ranges of the pre-mined soil or be more favorable for plant growth. (Appendix B provides additional guidance on desirable physical and chemical properties for the reconstructed soils).

f. Final grading of the reconstructed soil should provide for adequate surface drainage and for slope gradients within the range of the pre-mined prime farmland mapping units. In semi-arid and arid regions, surface drainage patterns and slope gradients must be reestablished to ensure that reconstructed prime farmland soils receive approximately the same amount of surface water run-on from adjacent areas as they did in their pre-mined condition.

g. Soon after topsoil replacement, the soil should be tilled at sufficient depth to encourage root and water penetration into the subsoil to reduce runoff and erosion.

h. Erosion control measures contained in the approved reclamation plan should be implemented immediately after replacement of the topsoil. These erosion control measures should meet, at a minimum, the specifications found in Section IV of the local NRCS Field Office Technical Guide for seeding, mulching, and other appropriate erosion control methods.

All field observation and testing should be performed by a soil scientist or persons under the direction of a soil scientist.

Appendices

Appendix A: Criteria for Determining Pre-Mining Rooting Zone

Soil horizons are considered as preventing root penetration if their physical or chemical properties or water holding capacity cause them to prevent penetration by roots of plants common to the area. Soil features, e.g. tillage pan, formed during mechanical disturbance are not to be considered as root inhibiting for purposes of determining pre-mining rooting zone.

Most prime farmland soils have a favorable rooting depth of at least 48 inches and, for such soils, proper soil reconstruction to this depth will help in the restoration of productivity. However, there may be some prime farmland soils for which reconstruction to a greater depth is needed. Where bedrock or approved root inhibiting horizons are at a depth of less than 48 inches, reconstruction is thus required to a lesser depth. Fragipans or other root inhibiting layers, in order to qualify for exclusion from reconstruction, must contribute little or nothing to the productive capacity of the soil. This contribution must be less than 0.06 inches per inch of available water capacity to qualify for such exclusion.

The rooting zone of the prime farmland soils before mining will be determined and documented in the reclamation plan. The rooting zone can be obtained from published soil surveys or field determination.

If a soil survey or field determination (observation of rooting depth in an excavation) is not used to determine the rooting zone, the following guidelines will be used to determine depth (below 20 inches) to a root inhibiting soil layer for each of the following factors.

Sodium Adsorption Ratio (SAR): This is a measure of the amount of sodium (Na^+) relative to calcium (Ca^+) and magnesium (Mg^+) in the water extract from saturated soil paste. SAR is calculated from the following equation:

$$SAR = Na^+ / \sqrt{\left(Ca^{++} + Mg^{++}\right)/2}$$

Soils having the SAR values listed below will have increased dispersion of organic matter and clay particles, reduced permeability and aeration, and a degradation of soil structure.

SAR Values

A value of greater than 30 is a root inhibiting soil layer

Electrical Conductivity: This is a measure of the concentration of water soluble salts in a soil (from an extract of saturated soil paste) and is used to indicate saline soils. High concentrations of neutral salts interfere with the absorption of water by plants because the osmotic pressure in the soil solution is higher than that in the plant cells. Salts in a soil layer can interfere with the exchange capacity of nutrient ions, thereby resulting in nutritional deficiencies in plants. Soils having the following value will be root inhibiting:

A value of greater than 8 mmho/cm.

Aluminum Saturation: Excess aluminum restricts plant root penetration and proliferation in acid subsoils by decreasing water uptake in plants. Aluminum toxicities damage roots to the extent that they cannot absorb adequate water. High concentrations of aluminum are linked to adverse interaction with other elements, e.g., iron and calcium. The relationship of aluminum and calcium is the most important factor affecting calcium uptake by plants. Aluminum toxicity is linked to phosphorus deficiency, and conversely, aluminum tolerance is related to the efficient use of phosphorus. A value of equal to or more than 55 percent aluminum saturation for cotton, peanuts, soybeans, and other similar crops and equal to or more than 60 percent aluminum saturation for corn, wheat, sorghum, and other similar crops is a root inhibiting soil layer using the following equation—

$$\frac{\text{Potassium chloride (KCl) extractable aluminum}}{\text{NH4OAc Extractable bases} + \text{KCl extractable aluminum}} \times 100$$

Root Inhibiting Structures: Separations between structural units that allow roots to enter have an average spacing of more than 4 inches on the horizontal dimension before being considered root inhibiting structure. Any of the following soil conditions will be considered a root inhibiting soil layer:

Strong subangular blocky larger than 4 inches or, moderate subangular blocky larger than 4 inches or,

Strong angular blocky larger than 4 inches or, moderate angular blocky larger than 4 inches or,

Prismatic larger than 4 inches or, columnar larger than 4 inches.

Separations between structural units that allow roots to enter will have an average spacing of more than 4 inches on the horizontal dimensions before being considered a root inhibiting structure. The consistency is always firm or firmer. The kind and size of structure and consistency are always evaluated under moderately moist or very moist conditions.

Moist Bulk Density: Bulk density is an indicator of the soil's ability for root development, both vertically and horizontally. A soil having moist bulk density equal to or more than values shown in table 1 is considered having a soil root inhibiting layer:

TABLE 1.—ROOT-LIMITING BULK DENSITIES FOR EACH FAMILY TEXTURE CLASS

Family texture class	Rooting-limiting bulk density g/cm3
Sandy	1.85
Coarse loamy	1.80
Fine loamy	1.78
Coarse silty	1.79
Fine silty	1.65
Clayey:	
35–45% clay	1.58
>45% clay	1.47

Soil Strength: Soil strength measurements with the deep-profile penetrometer appear to be a viable parameter for assessing rooting depth to root inhibiting soil layer when chemical and plant nutritional variables are not crop yield-limiting factors. A review of the literature for field measurements of soil strength over a period of about 15 years has concluded that more field measurements are needed before useful limits of soil strength can be established.

Appendix B: Desirable Characteristics for Physical and Chemical Properties of Reconstructed Soils

The reconstructed soils should have the following characteristics. These characteristics will help ensure the success of meeting the performance standards. Terms used in this Appendix are explained in Appendix A.

All rooting media must meet the following chemical and physical properties to have the minimal favorable environment for root growth:

Sodium Adsorption Ratio

$$SAR = Na^{+} / \sqrt{\left(Ca^{++} + Mg^{++}\right)/2}$$

SAR: A value of less than 4.

Electrical Conductivity:

A value of less than 4 mmho/cm.

Aluminum Saturation: Aluminum saturation value of less than 20 percent for cotton, peanuts, soybeans, and other similar crops and less than 35 percent aluminum saturation for corn, wheat sorghum, and other similar crops using the following equation—

$$\frac{\text{Potassium chloride (KCl) extractable aluminum}}{\text{NH4OAc Extractable bases} + \text{KCl extractable aluminum}} \times 100$$

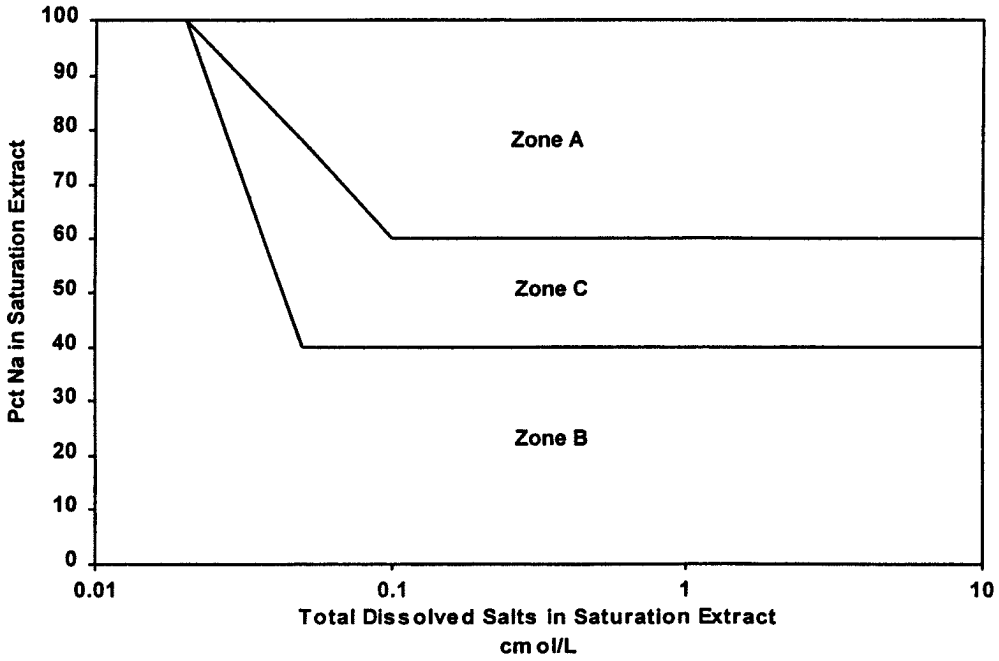
Root Permissive Structure: The reconstructed soil must have a root permissive structure after the soil material has been subject to the passage of at least 1.5 pore volumes of water in excess of the retention at 15 bar bringing all parts through the depth of consideration at least one time to very moist or wet. The pore volume is obtained by multiplying the depth zones by the water holding capacity volume fractions to follow: stratified by family particle-size class excluding the effect of those larger than two mm:

Family particle size [a]	Volume fraction
Sandy	0.10
Coarse-loamy	0.18
Fine-loamy	0.20
Coarse-silty	0.25
Fine-Silty	0.23
Clayey	0.15

[a] Family particle size classes defined in Soil Taxonomy Agriculture Handbook 436.

Alternative volume fractions may be substituted if documented. The volume of water for the family particle-size class is multiplied by the thickness of the zone and the amounts of zones are added through to 48 inches. Under rain fed conditions, the water addition is taken as the aggregate of successive monthly positive differences between precipitation and the evapotranspiration as computed by an acceptable method. Figure 1 is a method for determination of soluble salts and percent sodium from extract for identifying dispersive soils. Irrigation *should be considered* when precipitation is insufficient to subject the reclaimed soil to the passage of at least one pore volume of water while all parts of the soil are very moist or wet. The water added must not change the soil solution chemistry from indicative of dispersion (zone A in figure 1) to non-dispersive (zone B).

Figure 1. The field of percent sodium and total dissolved solids, both for the saturation extract, divided into a non-dispersive part (zone A), a dispersive part (zone B), and a transitional part (zone C). From Flanagan, C.P. and G.G.S. Holmgren. 1977. Field methods for determination of soluble salts and percent sodium from extract for identifying dispersive soils. Am. Soc. Test Mat. STP 623. Reference Address: American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohcken, PA 19428–2959



Moist Bulk density is an indicator of the soil's ability for root development, both vertically and horizontally. Table 2 has values for bulk densities for use during reclamation of mined soils by family soil texture classes for nonlimiting to rooting, critical to rooting, and root-limiting. As a general rule, reclaimed soils do not have continuity of pores or interpedal voids: therefore, values in table 2 are important consideration during the reconstruction and reclamation of mined soils.

TABLE 2.—NONLIMITING, CRITICAL, AND ROOT-LIMITING BULK DENSITIES FOR EACH FAMILY TEXTURE CLASS

Family texture class	Nonlimiting bulk density	Critical bulk density g/cm^3	Rooting-limiting bulk density
Sandy	1.60	1.69	1.85
Coarse loamy	1.50	1.63	1.80
Fine loamy	1.46	1.67	1.78
Coarse silty	1.43	1.67	1.79
Fine silty	1.34	1.54	1.65
Clayey:			
35–45% clay	1.40	1.49	1.58
>45% clay	1.30	1.39	1.47

Caution—Because of the diversity of soil texture, rock fragments, climate, mining equipment, and other variables during reclamation, moist bulk density values are only a guide. In spite of overall high bulk density, there are cases where good root deployment and targeted crop yields have been achieved, mainly because the pattern of pore spaces was favorable. On the other hand, there are cases in which the overall bulk density is not high and good root deployment was expected, but a very thin highly compacted layer that could not be detected in a standard test method prohibited the entry of plant roots.

Soil Strength: Soil strength is highly correlated to crop yields on reclaimed and reconstructed mined soils. The response is curvilinear with crop yield decreasing as soil strength increases. There appears to be a lower and upper thresholds to the effect of soil strength on crop yield.

The mechanical impedence is at a minimum at or near 10 PSI. Therefore, the rooting volume does not change dramatically below the level of 100 PSI. Soil strength with 150 PSI range begins to impact rooting, and in the range of 280 PSI is root-limiting. Even though a reconstructed mined soil has nonlimiting soil strength for rooting, a significant difference in crop yield may occur compared to the soils on the permit area prior to mining. It must be understood that the quality of subsoil material, which is replaced during reconstruction and reclamation as well as reclamation practices, will become a dominate influence to any further increase in yield for soils having nonlimiting soil strength. The PSI values are determined by inserting into the soil profile a 3/4 inch rod with a 300 right circular cone point welded to the end of the rod.

Signed at Washington, D.C. on October 15, 1998.

Pearlie S. Reed,

Chief, Natural Resources Conservation Service.

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DEPARTMENT OF COMMERCE

Membership of the Departmental Performance Review Board

AGENCY: Department of Commerce.