TOPSOIL

Section Editor: Laurel Vicklund

Handbook of Western Reclamation Techniques

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SECTION 4: TOPSOIL

A. INTRODUCTION

Section editor: Laurel E. Vicklund

Topsoil is the most valuable and voluminous environmental resource to be managed in mining and other projects where earthmoving is required. Vegetation establishment and general reclamation success are enhanced by proper salvage and replacement of topsoil.

Microorganisms, seeds, and roots are stored in the upper inches of this skin. The sooner salvaged topsoil can be replaced, the better chance these living features of the soil have to contribute to reclamation success.

Salvage, stockpiling, and replacement activities require large equipment and a dedicated amount of time. Planning and coordination are necessary to ensure that areas are properly salvaged ahead of land disturbing activities, and that timely topsoil replacement and seeding take place as soon as practicable after the land has been reshaped and regraded.

Topsoil salvage and replacement procedures are featured in this section. The methods described for topsoil removal include practices for managing salvage depth to ensure adequate recovery. Non-traditional methods for enhancing native vegetation establishment are presented in the subsection entitled, "Preserving Seedbed Viability Through Direct Haul of Frozen Topsoil."

There is no single best method of handling topsoil salvage and replacement activities. Application of a combination of the techniques presented in this section will aid in adequate topsoil salvage and replacement.

B. SALVAGE

1. Topsoil Identification and Salvage Control

Section editor: Laurel E. Vicklund *Subsection author: Frank K. Ferris*

Applicability

Topsoil salvage is required by law for mining, and is highly recommended for other forms of surface-altering land disturbances to assure productivity of reclaimed lands. Topsoil identification, stripping control, and experienced equipment operators will assure a high quality topsoil resource for reclamation.

Special Considerations

Topsoil varies in depth atop overburden or subsoil, which are less productive than topsoil for plant growth. Thus, stripping overburden along with topsoil may significantly reduce plant productivity and should be avoided. Accurate identification of topsoil in the field will lead to adequate segregation of topsoil from underlying materials.

Techniques

a. Topsoil Identification

Topsoil identification for equipment operators is most understandable and useful when it is related to location, depth, color, structure, texture, salt depositions, and site ripping. An operator need not have specialized knowledge of topsoil to become expert at stripping.

(1) Location

Deep topsoil is usually located in draws and valley floors; ridge tops generally have very shallow topsoil. Shallow ridge topsoil usually covers subsoil or unweathered overburden that may not be favorable for reclamation.

(2) Color

Brownish earth-tone colors consistent with near surface color indicate topsoil. When bright colored earth tones or distinct color change occurs, it usually means topsoil has ended. Soil moisture darkens the soil so recent rainfall saturation should not be mistaken for an actual change of color.

(3) Structure

Structure is the best indication of topsoil to the trained eye, and well-developed topsoil that lies below the immediate surface can be identified by its blocky hexagonal shape. Deeper-lying overburden has an irregular, blocky look; as does poorly developed near-surface material. Well-developed topsoil has a regular shape due to the presence of organic clays. Tilling destroys soil structure, however, so even well-developed topsoil that has been tilled will not show this structure.

(4) Texture

Because of their limited capacity to support plant growth, soils composed mostly of sand or mostly of clay are best not mixed with other topsoil and should typically be excluded from stripping. Heavy clay soils have limited water infiltration capacity while very sandy soils have poor water retention capacity and are often very low in nutrients.

(5) Salt Deposition

Faint to very white deposits on the surface or within the profile typically indicate the accumulation of salt, usually carbonates and sulfates. Rainfall and surface runoff carry these salts in solution to a certain point and then evapotranspiration causes them to precipitate, which results in salt accumulation over time. In contrast to the whitish appearance of carbonates and sulfates, dark blackish patches on the soil surface where vegetation does not grow usually indicate the accumulation of sodium salts. These areas should be avoided where possible.

In low-lying areas and in drainages, soil with visible salt deposits may be too saline or alkaline for optimum plant growth. Visible salts are a good indication that stripping should cease some feet distant from the accumulation zone. In upland areas, topsoil showing some salt accumulation may be entirely satisfactory. A soil scientist or other skilled professional can make the call when a situation is uncertain.

(6) Roots

Roots can be indicators of topsoil. A dense mass of roots indicates the surface sod. However isolated roots, especially shrub roots, can penetrate well beyond topsoil. Therefore, roots alone should always be used with caution in determining topsoil depths.

b. Topsoil Salvage Control

Topsoil salvage control is best accomplished when several of the following tools are employed for overall control: pedestals, ripping, backhoe pits, site supervision, topsoil classes, augers, and skilled equipment operators.

(1) Pedestals

Pedestals are the most critical references for quality control (see Figure B-1 and 2). They illustrate topsoil horizons and reference the original surface. For example, pedestals eliminate the possibility of draw bottoms being viewed as stripped when in fact no topsoil was stripped (see Figure B-3).

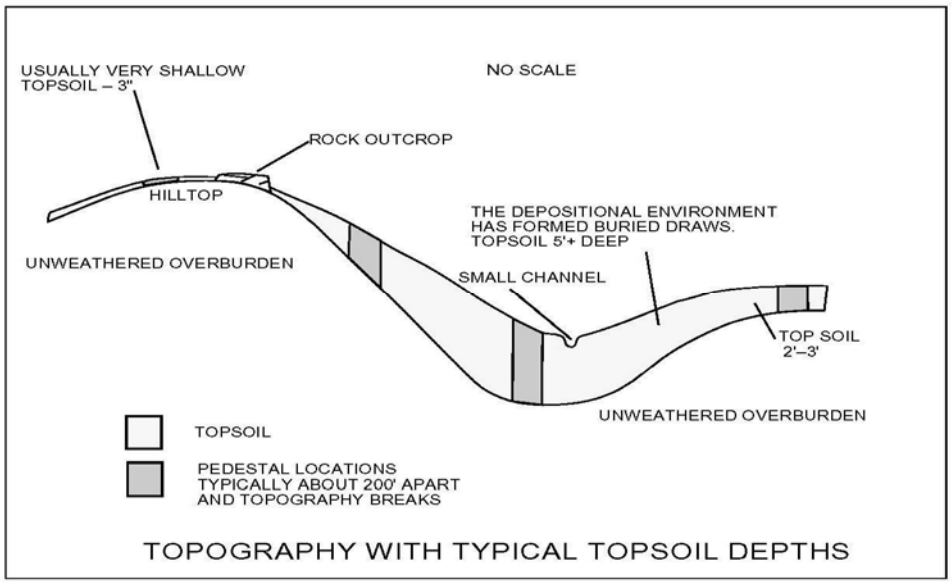

Figure B-1

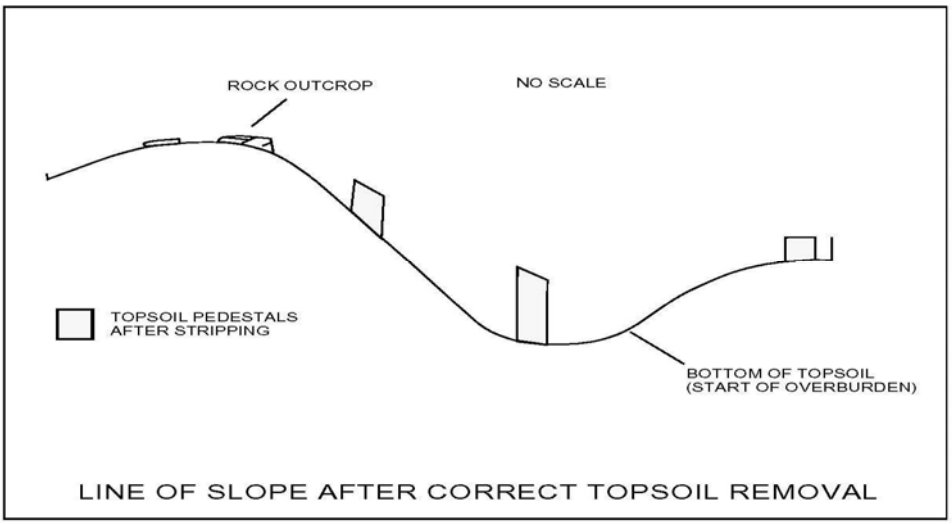

Figure B-2

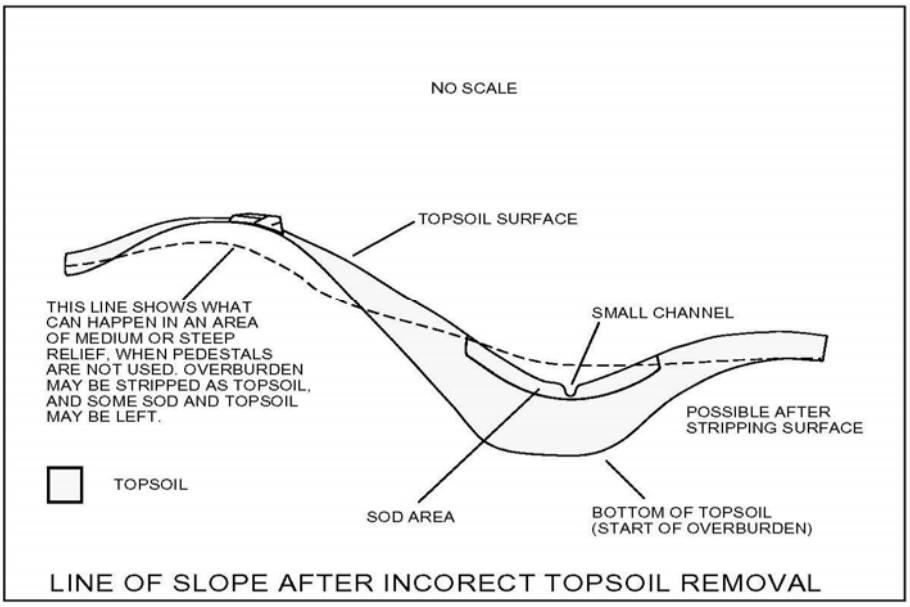

Figure B-3

(2) Ripping

Ripping the area as it is being stripped is the best way to identify topsoil, or the completion of topsoil salvage. Ripped topsoil shows structure while ripped overburden shows a color change from topsoil and a lack of structure.

(3) Backhoe Pits

This is an excellent method of staking topsoil depth. Backhoe pits work very well, because one can enter the sloped pit and observe and dig at the topsoil horizons to determine the color, texture, structure, and moisture limits as well as salt deposition.

(4) Site Supervision

Checking the salvage operations often during the day is important for quality control. Quality control is maintained by halting stripping operations at the bottom of the topsoil, inspecting, and then removing any topsoil remaining in areas the operator may have stopped stripping too soon. During inspections, identify additional cuts or clearly indicate when salvage in an area is complete. When a dependable, quality equipment operator is stripping deep topsoil, multiple visits per day may not be needed.

(5) Instruction

Topsoil identification classes for equipment operators help assure quality topsoil salvage operations. This document can be used as a class study guide.

(6) Quality Contractor

If topsoil handling is contracted, an experienced, reputable contractor is important for a good salvage operation. The foreman and key operators need previous experience, or training to be effective.

(7) Augers

These can be used by a highly trained individual to stake topsoil depths, but should not be used as a primary tool for identifying stripping depths. The auger cuttings are difficult to interpret, as the act of cutting blends soil horizons, masking individual soil features.

2. Topsoil Stripping

Section editor: Laurel E. Vicklund *Subsection author: Frank K. Ferris*

Applicability

General good practice and in some cases regulations, require that all topsoil be removed from areas to be affected within a work area or permit area, and be immediately replaced for reclamation or temporarily stockpiled in the most advantageous manner.

Special Considerations

As with all land disturbing activities, dust emissions resulting from topsoil activities need to be kept to a minimum. Inadequate dust control could result in work stoppage. Access and haul roads associated with topsoil activities should be maintained in safe operating condition. Stripping equipment should be properly maintained and safely operated by qualified operators.

Techniques

a. Topsoil Salvage Control

(1) General

Undisturbed topsoil should be off limits to all equipment and vehicles except when being stripped. This will keep disturbances to a minimum and eliminate topsoil contamination.

The area requiring topsoil removal should be staked or otherwise identified. Prior to starting operations each day, a v-ditch approximately 12" deep and draining back to the stripped area when possible should be cut around the area to be worked. Topsoil should be hauled only on previously stripped areas between the active removal area and the stockpile or replacement area. Whenever possible, all disturbed areas should drain directly to sediment control structures. For optimum quality control, topsoil removal and replacement should occur in daylight.

A clear boundary delineating the native and stripped areas should be established and maintained at all times. The stripped edge should be sloped back to 2H:1V, and a 2H:1V toe-ditch should be bladed into the sub-soil along the final topsoil edge. This ditch provides sediment control for the area and reduces disturbance to the remaining topsoil areas.

(2) Stripping Methods

Topsoil stripping should be completed in one area before moving to another. Stripping should typically progress from areas of thin soils to areas of deeper soils in order to reduce potential contamination. This may result in a down slope progression, which is generally preferred by the dirt contractor for ease of loading. Down-slope loading can lead to difficulties with sediment control, so proper planning needs to be employed to ensure adequate protection is provided.

(3) Pedestals

Topsoil depths, which are generally surveyed at 200-foot intervals prior to initiation of stripping, are indicated on stakes. Pedestals of topsoil are left around these stakes to allow verification of the stripping depths. These pedestals and survey control points are left in place until the project supervisor approves removal. Upon clearance for removal, the pedestals are salvaged as topsoil.

(4) Completion

Upon completion, all topsoil removal areas should be bladed to collect any additional topsoil not salvaged initially by the scrapers or other loading equipment. This topsoil can then be loaded-out and stockpiled or spread. After the final topsoil has been removed, the stripped area can be smooth-bladed for ease in the ensuing operations or left rough to reduce runoff.

(5) Sediment Control

Sediment control needs to be addressed daily. At the end of each work day, all disturbed areas must be contained and controlled. The optimum procedure for sediment control is to strip from the bottom of drainages upward. This helps to prevent contamination of topsoil by disturbed runoff. Up-slope stripping for sediment control can conflict with down-slope stripping for contamination prevention. Thus, it may be necessary to strip drainage corridors to establish proper drainage prior to additional topsoil removal.

b. Contractor Considerations

(1) Environmental Regulations

All levels of contractor supervisory personnel need to be aware of, and required to abide by, all state and federal environmental regulations that govern surface coal mining or other land surface disturbing activities. It is the responsibility of the contractor to train each contractor employee with regard to these requirements.

(2) Security

Access and security policies are site specific, and need to be addressed site-by-site. At surface mining locations, it may be advisable to require the contractor to have a supervisor with State Mine Certification on site during all contractor working hours. The supervisor should have the authority and responsibility to exercise the terms of the contract on behalf of the contractor.

c. Quantities

(1) Daily Work Report

The project supervisor should inspect the working area prior to the beginning of each shift. A daily work report, showing all load counts and hours worked for each piece of equipment, should be completed and signed by the project supervisor.

(2) Payment Calculations

Typically, payment for topsoil removal is based on a per-cubic-yard unit rate of material handled. The unit rate should include payment for all other incidental work, such as haul road construction and upkeep, drainage control, ditch and berm construction, and other ancillary activities needed to complete the job. Mobilization and demobilization costs may be additional to the unit rate(s).

Topsoil quantities and removal areas can also be calculated using aerial photography or standard field survey methods. These methods should be used to confirm the quantities estimated by load count. Retainage of 10% to 20% is usually held until load count volumes are confirmed.

3. Topsoil Stockpiling

Section editor: Laurel E. Vicklund *Subsection author: Marilee G. O'Rourke*

Applicability

Topsoil stripped from an area prior to disturbance can be preserved for later use in a topsoil stockpile. As is always good practice and as may be required by regulation, topsoil that is not to be promptly redistributed should be stockpiled in a manner that minimizes wind and water erosion and unnecessary compaction.

Special Considerations

Procedures should be followed that will prevent the loss of topsoil from the stockpile through erosion. The establishment of a quick-growing cover of vegetation on the topsoil stockpiles is

advantageous for this purpose, and may be required by regulation. A more permanent form of vegetation cover may be necessary for long-term stockpiles. Proper construction of stockpile slopes as well as a ditch/berm around the stockpile will also aid in erosion control and topsoil conservation and provide for safe equipment operation.

Techniques

The limits of topsoil stockpiles should be surveyed and field-staked prior to placement of topsoil. Roads to and from stockpiles need to be stripped of topsoil prior to use, unless the duration of their use is short enough to warrant mere blading of the upper several inches Stockpiles should be identified by topsoil stockpile sign before stockpiling is begun; in many instances this is a regulatory requirement.

Construction of a perimeter ditch/berm should precede any activities associated with material placement in the stockpile. The topsoil stockpile should be completely enclosed with this ditch/berm, which should be at least 1.5 feet high, or higher as needed for sediment control and topsoil conservation. If a sediment control structure is required, the ditch/berm will need to be constructed to ensure drainage to the structure.

V-ditches are cost-effective but are usually not sufficient for long-term sediment control and topsoil protection. Flat-bottomed ditches have better capacity and are easier to maintain. If v-ditches are employed, the depth from the bottom of the “v” to the top of the berm should be at least 1.5 feet. On native topsoil, the v-ditch must not penetrate the full depth of the topsoil, which would result in the mixing of topsoil and overburden or subsoil materials. V-ditches should only be used on flat terrain where flowing water in the ditch will not reach erosive velocities.

Berms, while more costly to build, are more durable and can be revegetated. A berm can be constructed with topsoil destined for the stockpile, and then cross-sectioned along with the pile for volume determinations. Significant precipitation events can cause water to build up and ultimately breach a berm, causing severe erosion and loss of the topsoil resource. Proper berm design may include construction of a spillway to eliminate this concern.

Ideally, topsoil stockpile slopes should not exceed 5H:1V, to allow for seeding necessary to prevent erosion. However, slopes as steep as 2.5H:1V can be safely negotiated by four-wheel drive, dual-tired farm machinery and by tracked equipment. When stockpiling is completed, the stockpile may be scarified parallel to the contour to minimize wind and water erosion. Large rocks uncovered during final grading activities should be removed to facilitate revegetation.

4. Topsoil Stripping Equipment

Section editor: Laurel E. Vicklund *Subsection author: Frank K. Ferris*

Applicability

There are three general equipment fleet types used to remove and/or move topsoil. These are scrapers; loaders, trucks, and dozers; and shovels/backhoes and trucks. Each fleet has unique characteristics. Using a fleet of equipment in the wrong application will usually lead to poor quality topsoil recovery, higher costs, and potential compliance problems.

Special Considerations:

Other than removal of topsoil from the upper portion of stockpiles, topsoil should not be stripped at night. Color changes, which are critical in differentiating between topsoil and overburden, are not readily evident after dark.

The stripping of frozen topsoil must be carefully evaluated. Under high moisture conditions and deep frost, shallow topsoil can be cemented to the overburden and it is extremely difficult to strip only the topsoil. Evaluate the site conditions and, if necessary, bypass until later.

Techniques

a. Scrapers

Scrapers are the best stripping method for quality control. Scraper cuts should be no more than 50 percent of the topsoil depth for topsoil six inches or deeper. Trying to single-pass load topsoil that is two feet or less in depth can result in mixing with significant amounts of overburden.

As a general rule, topsoil stripping should proceed from higher to lower topographical areas; generally this is also from shallow to deeper topsoil. In this way the scrapers are always being pushed downhill for their best productivity, and they finish loading in an unstripped area. After the hill slope is stripped to the draws and the width of the topsoil remaining in the draw is not sufficient to obtain a full scraper pan, the direction of topsoil stripping in the draw should be changed to parallel the flow line of the draw.

When completing an area, the topsoil being dragged out of the cut and onto stripped ground will be significant. Loose topsoil inadvertently dragged onto previously stripped areas is difficult to salvage and likely to be lost or contaminated. By reversing scraper traffic periodically, this loss can be minimized.

b. Loaders, Trucks, and Dozers

A bulldozer is not designed to cut six inches of compacted topsoil and a loader operator generally cannot see the digging face. Because of these operational constraints, it is much more difficult to accurately strip topsoil with dozers than with scrapers. However, loaders, trucks, and dozers work well in two feet and thicker topsoils that are on a flat-to-gently rolling topography, especially if the subsoil is suitable as a topsoil substitute. In this case, if topsoil with some suitable subsoil is dozed into piles or rows, and the loader cuts into the undisturbed suitable subsoil under the topsoil while loading, the topsoil quality will not be measurably impacted.

In irregular topography with shallow topsoil on unweathered overburden, the loader and dozer fleet will significantly cut and load overburden and degrade the topsoil resource.

c. Shovels/Backhoes and Trucks

Shovels and trucks are very cost effective in moving large topsoil stockpiles where the shovel is able to stay near its design productivity. If the shovel and truck operation is trying to take all the topsoil stockpile, the economics of the operation will be decreased by 50 percent for the volume that is represented by the stockpile edges and floor. A shovel will spill topsoil, leave stockpile edges and leave topsoil under its tracks if the site is not flat or level. Additional support equipment is needed to push bypassed topsoil into

the shovel face. In some cases it is more efficient to complete stripping with scrapers and not use extra support equipment to keep the pile edges and floor pushed in to the loading pile.

A large backhoe loading trucks can be a effective method of salvaging topsoil, especially in deeper soils. The backhoe sits on ground ahead of its cut and pulls the topsoil toward the face of the salvage operation. The backhoe generally has a limited cut depth and the operator can always see the cut.

d. General Notes

Using specific equipment from one equipment fleet to compensate for the weak area of another fleet usually works very well. For example, scrapers could be used to strip the shallow topsoil and place it on the deep topsoil in flat areas for the loader, truck, and bulldozer operation.

C. TOPSOIL REPLACEMENT

1. Replacement Depths

Section editor: Laurel E. Vicklund *Subsection author: Frank K. Ferris*

Applicability

Uniform topsoil depth replacement is often required on reclaimed topography at surface coal mining operations. That notwithstanding, wind and water erosion will ultimately make topsoil depths uneven. In some areas, different topsoil depths will add to species diversity, but extensive erosion may produce very low productivity and an area that is hard to stabilize. Erosion and deposition move topsoil to low-lying areas and where soil-forming processes typically develop topsoil more rapidly than in upland areas. Varying topsoil depth in accordance with topography will help offset these processes, and make more effective use of the topsoil resource.

Special Considerations

In reclamation, sufficient topsoil depth is needed to provide vegetative cover consistent with the surrounding vegetation. The depth of replaced topsoil varies according to how much the area is exposed to erosion. Erosion forces greater than normal for surrounding undisturbed areas can reduce the depth of replaced topsoil to below the minimum needed for suitable vegetation density. The techniques suggested here can help to counteract the effects of excessive erosion, but in some cases approval from the appropriate regulatory agency may be required for their application.

Techniques

Erosion potential is a function of slope steepness, soil texture, and concentration of wind and water movement. By placing deeper topsoil in highly erosional areas and less in depositional areas, the site will be more productive during and after reclamation is complete (Figure C-1-1). The effects of excessive erosion in upland areas, which can lead to areas of low vegetation productivity, can be counteracted by placing deeper topsoil in highly erosional areas.

Additional topsoil should be placed at erosional points, such as heads of draws, shoulderslopes, backslopes, and footslopes where erosion could result in excessive topsoil loss. Less topsoil should be placed in depositional areas, toes of slopes and ridges, and low gradient channels.

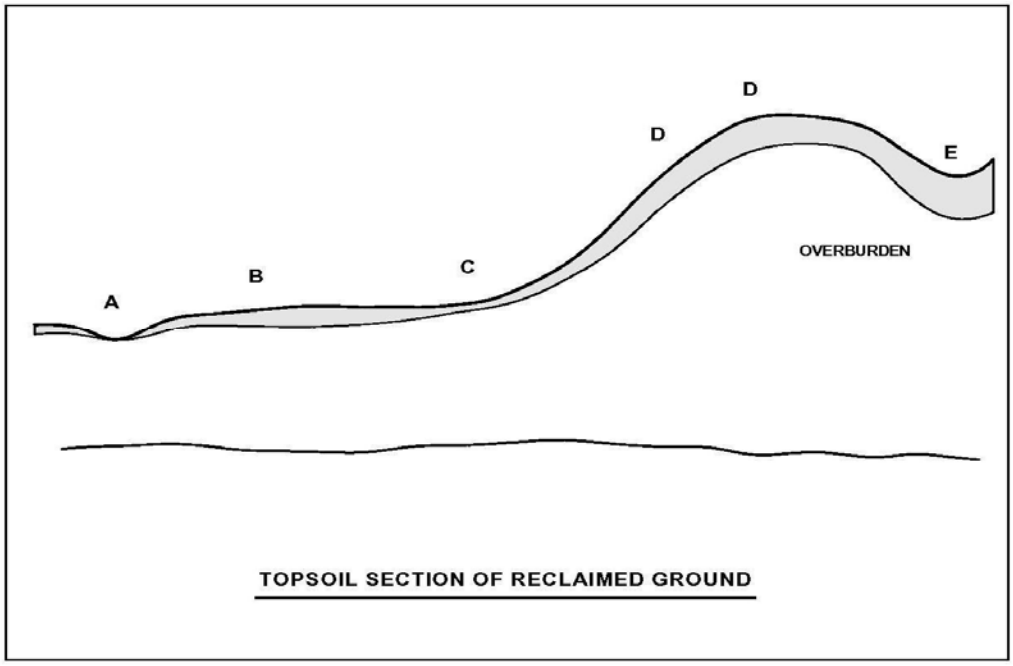

Figure C-1-1

2. Topsoil Replacement

Section editor: Laurel E. Vicklund *Subsection author: Marilee G. O'Rourke*

Applicability

The replacement of topsoil after mining or other activities marks the beginning of reclamation. Careful planning and supervision by the environmental professional, as well as the skill of the equipment operators, will ensure this foundation is properly laid.

Special Considerations

Dust emissions resulting from topsoil replacement activities need to be kept to a minimum. Inadequate dust control could result in work stoppage. Access and haul roads associated with topsoil activities should be maintained in safe operating condition. Equipment should also be maintained in a safe operating condition and should be safely operated.

Techniques

a. General

Prior to topsoil replacement, confirmation of approved final grade and any required sampling of the subsoil should be obtained. The replacement area should then be delineated and scarified parallel to the contour at an approximate depth of one foot on 18-inch intervals.

Special features such as rock piles for wildlife habitat are typically constructed within the redistribution areas prior to topsoil placement, in order to avoid unnecessary compaction and disturbance of the topsoil after replacement. Topsoil is then tapered into the edges of such features during replacement. Rocks unearthed during scarification are either pushed together to form small piles or added to existing rock piles.

AREA (following figure)	DESCRIPTION OF TOPOGRAPHY	SUGGESTED TOPSOIL PLACEMENT RANGE	COMMENTS (see cross section for additional detail)
A	Major channel bottom	Zero	Major channels are usually wet, depositional, have a shallow gradient, and support extensive vegetation.
B	Grain/hay field	85 to 100 percent	Depth may vary according to postmining land use requirements. Deep rooting crops may require deeper soil.
C	Toe of slope	35 to 60 percent	Toe of slope areas need to have a maximum slope of 7H:IV and should be about 300 feet wide. This thinned area may be from 100 to 600 feet wide, depending on the length of transition from slope to field and the size of the slope above the area.
D	Hill slopes and tops	150 percent	Through wind and water erosion, topsoil will be moved from this area, therefore the 150 percent of average topsoil depth. On a more complex hill topography, there could be multiple areas of erosion and deposition.
E	Steep gradient draws	200 percent minimum	Draws and drainage channels coming off of hilly areas usually have a steeper gradient than would be ideal. This steeper gradient will likely cause some erosion in the channel. To be sure the topsoil in the channel is not completely eroded away, additional topsoil is suggested to ensure vegetative establishment. In areas where erosion has broken through the topsoil, it is more difficult to establish adequate vegetation.

Sediment control needs to be addressed daily as discussed above for topsoil removal. At the end of each work day all replacement areas should be contained and controlled.

(1) Equipment Traffic

Equipment operation on topsoil areas should be limited to the extent necessary to remove topsoil from the undisturbed area or stockpile and redistributed it on regraded areas. Equipment traffic routes should not be allowed on topsoiled areas, although roadways may be constructed through topsoil areas by leaving roadways untopsoiled until replacement has been completed elsewhere in the area.

Roadways should have sufficient width to accommodate the expected traffic and maintenance activities. Berms should be constructed near the edges of the roadways to delineate the edge of the active area and protect the topsoil resource. Ideally, topsoil redistribution should only be done during daylight hours.

(2) Replacement Depths

Replacement depths should be determined and marked in the field prior to the initiation of replacement. These depths may be uniform or non-uniform depending on the reclamation objectives. Topsoil thickness can be increased in localized areas to produce micro-contours. Redistributed topsoil should be blended with previously reclaimed areas or native edges where applicable. Guidance stakes on a maximum of 100-foot centers provide verification of the topsoil redistribution depths while maintaining existing contours. In areas of rough topography, stakes should be placed more frequently to indicate topographic break points and other surface elevation changes.

(3) Final Touches

Following topsoil redistribution, the area should be bladed and inspected to ensure that drainage will be adequate and that localized ponding will not occur. The area should then be scarified to a depth of approximately one foot at 18-inch intervals. To minimize erosion problems, scarification should be performed parallel to the contour. The topsoil redistribution edges should be bladed to form 2H:1V slopes in order to protect the resource from erosion while maintaining a clear demarcation of the limit of activity.

A perimeter ditch/berm, constructed of overburden material, ought to be built around the outer edge of the area for sediment control and topsoil conservation. Edges of redistribution areas should be straight and smooth.

(4) Remaining Stockpile

Partially used stockpiles should be recontoured with slopes no steeper than 5H:1V or consistent with existing slopes. The exposed area of the stockpile should be scarified parallel to the contour to minimize erosion. As discussed earlier, a ditch/berm approximately 1.5 feet or higher as needed for sediment control and topsoil conservation, should be reestablished around the remaining stockpile.

b. Contractor Considerations

(1) Environmental Regulations

All levels of contractor supervisory personnel need to be aware of, and required to abide by, all state and federal environmental regulations applicable to the type of operations in which they are working. It is the responsibility of the contractor to train each contractor employee with regard to these requirements.

(2) Security

Access and security policies are site specific and need to be addressed site-by-sites. At surface mining locations it may be advisable to require the contractor to have a supervisor with State Mine Certification on site during all contractor working hours. The supervisor should have the authority and responsibility to exercise the terms of the contract on behalf of the contractor.

(3) Daily Work Report

The project supervisor should inspect the working area prior to the beginning of each shift. A daily work report, showing all load counts and hours worked for each piece of equipment, should be completed and signed by the project supervisor.

(4) Payment Calculations

Typically, payment for topsoil redistribution is based on a per-cubic-yard unit rate of material handled. The unit rate should include payment for all other incidental work, such as haul road construction and upkeep, drainage control, regraded area scarification, topsoil scarification, ditch and berm construction, and other ancillary activities needed to complete the job. Mobilization and demobilization costs are usually additional to the unit rate(s). Topsoil quantities and redistribution areas can also be calculated using aerial photography or standard field survey methods. An average depth of topsoil replaced for a specific area is also calculated.

3. Elevation Control

Section editor: Laurel E. Vicklund *Subsection author: Frank K. Ferris*

Applicability

Depth control is needed to attain the desired topsoil replacement depth for optimum reclamation success.

Special Considerations:

Control of topsoil replacement depth is difficult, because the reference point is continually being covered with topsoil.

Techniques

a. Staking

Staking with four-foot lath seems to be the best method of controlling topsoil replacement depth. Important points for staking are spacing, location, marking, and proofing.

(1) Spacing

Spacing needs to be frequent enough to prevent shallow areas in between the stakes. The rows should be spaced three to four scraper widths apart. Rows can be approximately 35 to 40 feet apart, with stakes at 40 to 80 foot intervals (Figure C-3-1). The interval will be determined by the level of experience of the equipment operator.

(2) Location

Location of stakes should be in a basic grid pattern, with extra stakes at topography breaks. These stakes at topography breaks are the most important.

(3) Marking

Stake marking can be done by painting the portion of the stake to be covered, painting the portion to be left uncovered, or simply marking the final fill line. Any of these methods seem to work well as long as both sides of the stake are marked. About a two-inch overfill is usually needed to account for compaction and settling.

(4) Proofing

Depth proofing is a good quality control check, and an absolute necessity when payment is based on fill depth. Backhoe pits provide the best verification because they clearly illustrate the topsoil/subsoil interface.

4. Preserving Seedbed Viability Through Direct Haul of Frozen Topsoil

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Applicability

In the summer of 1987, reclamation personnel at the Wyodak Mine near Gillette, Wyoming, observed that a small parcel of regraded spoil that had received "live" frozen topsoil during a stripping operation the previous winter was producing noticeable stands of native grasses and shrubs. "Live" topsoil is material that is hauled directly from the stripping area to the replacement area. It was also noted that the density of undesirable plant species of an opportunistic nature was lower when compared to adjacent areas conventionally seeded.

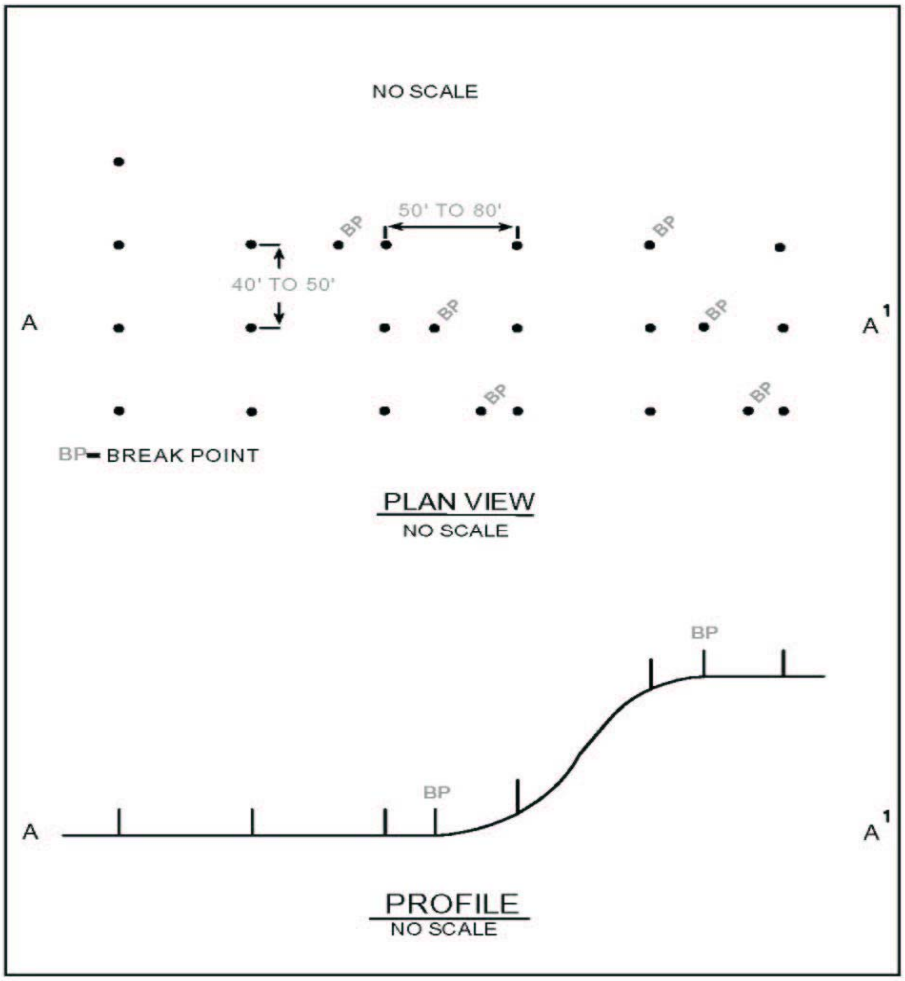

Figure C-3-1

While a formal study was never conducted, it is visibly evident even today that the parcel of land has better diversity and density of native species than do adjacent reclaimed areas. It is also thought, though never so far calculated nor weighed against operational difficulties that hauling "live" frozen topsoil may reduce the cost of final revegetation.

Special Considerations:

While the practice of hauling frozen topsoil might not be considered desirable by operations personnel, on to believe that several long-term benefits could be achieved using this method. Ideally, the direct haul of frozen topsoil would:

1. Propagate heartier stands of native grasses and shrubs.
2. Reduce plant stress by moving them while they are in a dormant state.
3. Reduce the amount of interseeding needed in some reclamation operations.
4. Speed the succession of native species on reclaimed lands.
5. Lower seed costs.

While making a standard practice of moving topsoil in the dead of winter usually is not thought to be an ideal reclamation practice, these results indicate occasional use of the practice might have

benefits in special situations. A mosaic of mature native grasses, distributed among areas seeded by conventional means, would provide a seed source for adjoining lands, and mature shrubs would tend to spread to areas outside of the mosaic.

Techniques

During the winter of 1986/1987, an area of approximately 16 acres in and near the floodplain of the restored Donkey Creek channel received "live" frozen topsoil during a direct haul stripping operation. A dozer/scraper fleet was used for this operation. Replacement depth was approximately 1.88 feet. Efforts were made to selectively handle the top six inches of frozen topsoil, and "cap" topsoil previously laid. It was hoped that this "seed bank" approach might encourage quicker reestablishment of native species and cover. (Wyodak Mine Annual Report, 1987)

Spring and fall plantings were not conducted in the area during 1987, but were delayed until the following year. In spite of this, substantial stands of intermediate, western and bluebunch wheatgrass appeared during the spring and summer of 1987, along with two predominant shrub species, rubber rabbitbrush and silver sagebrush. It is also theorized that native plant species in this area benefited from the infiltration of additional moisture during the spring runoff, as the area was not bladed following topsoil placement.

Operational difficulties were encountered as could be expected with any wintertime stripping operation involving scrapers. Rough conditions, common in the cut and fill areas, reduced cycle times. "Live" topsoil was many times placed beneath "B" and "C" horizon material in the reclaimed area due to logistical difficulties. Although it turned out to have a positive effect as was previously mentioned, final grading could not be done effectively because the massive blocks of frozen topsoil were nearly impossible to fine blade.

Another fear was that seeds of undesirable weed species would be caught in the void spaces left in the ungraded topsoil, germinate, and compete with native plant species. The opposite has in fact proven true, as the area was nearly free of kochia weed during the first growing season and has not experienced the encroachment of undesirable weed species.

D. REFERENCES

Wyodak Mine. November 30, 1987. Annual Report, submitted to the Wyoming Department of Environmental Quality - Land Quality Division. p. 10.