ONE MILLION YARDS OF TOPSOIL SALVAGE WITH DOZERS, TRUCKS, AND SHOVELS[1]

Peter Kim Carroll[2]

Abstract.--In 1986 the Black Thunder Mine successfuly salvaged 1.3 million bank cubic yards (bcy's) of both deep and shallow phase topsoil. Nearly one million bcy's were salvaged with dozers, trucks, and shovels. Topsoil was stockpiled or direct-hauled to recontoured surfaces. At peak production, up to 40,000 bcy's of soil was moved per day. Topsoil compaction appears to be the most critical factor associated with truck haulage.

INTRODUCTION

The Black Thunder Mine (BTM) is located in southern Campbell County, Wyoming. It is the largest producing surface coal mine in North America, shipping 21 - 23 million tons of coal per year. Yet the mine utilizes basic, single-seam, truck/shovel mining and reclamation techniques. While BTM is directly involved with a number of diverse reclamation projects, most are typical of those found throughout the industry, particularly in the Powder River Basin.

The salvage of several hundred thousand bank cubic yards (bcy's) of shallow phase topsoil using dozers, trucks, and shovels however, is unique. While trucks, shovels, and loaders have been used at BTM and elsewhere to salvage deep phase soil, it is uncommon to see that equipment salvaging significant volumes of shallow soil (some less than six inches in depth). The justification, procedures, benefits, and problems encountered with that process are discussed below.

JUSTIFICATION

All mining procedures including topsoil handling must be scrutinized for optimum efficiency, particularly in today's market. Our 1986 truck/shovel topsoil salvage procedure was the result of such a process. It was designed specifically to remove approximately 750,000 bcy's of topsoil before winter weather restricted salvage operations.

BTM typically prestrips approximately 75 to 100 acres by November to allow uninterrupted pit advancement through the winter. Our scraper fleet was generally unavailable for topsoil salvage in 1986 due to an increased number of special projects. However, truck and shovel utilization was down because of lower overburden stripping ratios: caused by pit advancement into the drainage of Little Thunder Creek, an area of lower coal cover. Yet the option to use "surplus" dozers, trucks, and shovels for topsoil salvage created internal skepticism. In the past, dozer salvage had not worked; experience indicated that it was impractical to salvage topsoil without intermixing some overburden. This was of particular concern since approximately 75 percent of the proposed salvage area contained soils less than eighteen inches in depth.

Prior to 1986, scrapers and/or contract services were used to salvage topsoil. BTM had initiated salvage of deep phase soil using both loaders and electric shovels in April of 1986. The salvage of some 300,000 bcy's of deep phase topsoil using shovels and loaders led us to believe that salvage of shallow entisols might be possible if dozers were used to concentrate the soil for more efficient loading.

In June the decision was made to evaluate, through field application, the proposed dozer salvage option. That option proved viable. During 1986, BTM salvaged a total of 1.3 million bcy's of topsoil. 980,000 bcy's were handled using dozer, shovel, and truck salvage procedures.

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[2]Peter Kim Carroll, Sr. Environmental Coordinator, Thunder Basin Coal Company, Wright Wyo.

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SALVAGE PROCEDURES

Primary and secondary equipment utilized in the process included:

- BE 295B Electric Shovel (27 bcy dirt bucket)
- P&H 2800 Electric Shovel (38 bcy dirt bucket)
- Caterpillar D-10 Dozer (19.7ft. U blade)
- Caterpillar D-9 Dozer (16.4ft. U blade)
- Caterpillar 16-G Blade
- Caterpillar 992 Loader (13 cy bucket)
- Various 170 Ton Haul Trucks (2-8 were used, depending on haul distances)

To maximize shovel utilization, a D-10 dozer capable of dozing 2,000 bcy's of material per hour was assigned to doze topsoil into large windrows for subsequent salvage by one of the shovels. Care was taken to maximize dozer efficiency. To do that salvage areas were sampled to determine average topsoil depths. Salvage windrows were then constructed on areas containing native topsoil, where depths of three feet or more were found. Such placement reduced the amount of rehandle necessary. Windrows were often constructed along one side of a drainage where topsoil depths were greater, but such that water runoff would not be impounded.

The dozer worked consecutive, parallel panels when possible. The length of dozer push was limited to 200 feet; however, in shallow entisols we found this distance to be prohibitive. Too much intermixing of overburden and topsoil was occuring; therefore, in shallow soils the length of push was limited to 100 feet. Due to extended corner bits on the D-10, additional care was required to minimize the amount of overburden being mixed with topsoil.

To reduce the likelihood of intermixing topsoil and overburden, dozer salvage was stopped several inches short of the topsoil contact. The operator periodically ripped through the topsoil to identify that contact zone. D-9 dozers were also used periodically to assist in salvage as needed.

To increase operator awareness, BTM implemented comprehensive topsoil training for several operators from each of our four rotating shifts. Selected operators were generally proficient at operating all equipment. We found the detailed topsoil training to be extremely beneficial. Trained operators were able to help less experienced personnel control and monitor the salvage process. The environmental department provided quality control, calling for additional salvage and cleanup as necessary.

As localized dozing progressed, a 16-G blade was used to complete cleanup. The smaller blade windrows were subsequently combined with the larger windrows for salvage. As cleanup proceeded, the shovel was positioned to begin loading. Limited access usually restricted shovel operation to single-sided loading. Normally only one shovel at a time was being used for salvage, however during peak operation two were operated simultaneously. The Caterpillar 992 loader was used to salvage topsoil from isolated areas and for final cleanup behind the shovel.

BTM normally uses topsoil "islands" to monitor topsoil salvage using scrapers. However, this practice was discontinued for safety reasons. We found that operator visibility from the trucks and shovels was too limited to safely work around the islands.

KEY BENEFITS

In addition to being able to move large volumes of material with truck haulage we also had the ability to economically move that topsoil over long distances. Since we were actively reclaiming our "north pit", some three miles from the salvage area we chose to direct-haul approximately 60,000 bcy's of topsoil to facilitate completion of permanent reclamation. In addition to moving topsoil economically with the trucks, we felt that additional benefits could be realized from the increased vegetation diversity expected from direct haul back.[3,4]

To facilitate contemporaneous reclamation, 480,000 bcy's of topsoil were also directly applied to recontoured surfaces in the "south pit" area located two miles from the salvage area. The expensive alternative to direct-haulback would have been to rehandle previously stockpiled topsoil.

By using trained operators and special salvage procedures we were also able to doze and load topsoil at night, increasing overall production. To reduce the potential of cutting into overburden, night dozing was limited to deep phase soils. Cleanup was restricted to daylight hours.

A less tangible benefit was also realized with our ability to better allocate manpower and equipment resources in light of reduced overburden stripping ratios.

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[3]King, L.A. 1980. Effects of topsoiling and other reclamation practices on nonseeded species establishment on surface mined land at Colstrip, Montana. Masters Thesis. Montana State Univ., Bozeman, Mt. 128 p.

[4]Walsh, James P. 1985. Soil and overburden management in western surface coal mine reclamation - findings of a study conducted for the Congress of the United States. Proceedings from the second annual meeting of the American Society for Surface Mining and Reclamation. Denver, Co.

PRACTICAL CONCERNS

The compaction resulting from truck traffic was a concern. Both the D-9 track dozer and 16-G blade were used to alleviate compaction by ripping replaced soils. Ripping depths were limited to 24 inches to reduce the intermixing of overburden and topsoil. To further reduce compaction, replaced topsoil was left fallow through the summer. Winter wheat was planted in the fall to help reduce erosion. The majority of soils being salvaged were sandy loams. The sandy texture of that soil should increase infiltration rates of both air and water, further reducing compaction. Revegetation results should provide valuable insight as to the effectivness of those efforts.

The likelihood of intermixing shallow soils and overburden in "rough" terrain is very real. In areas of shallow topsoil, salvage was completed almost exclusively with the 16-G blade. Special care was required to insure that oversize equipment did not overdig or gouge into the overburden during salvage and loading operations. Final cleanup of all areas required the use of approximately 30 percent more support equipment than does scraper salvage.

While BTM does not currently salvage the "A" topsoil horizon separately, the salvage procedure as utilized could preclude such handling.

As discussed earlier, topsoil identification training was required before acceptable dozer salvage occured. However, not all operators required equal training if they coordinated salvage activities with the more experienced operators.

To utilize direct-haulback using this procedure a large area of recontoured surface must be available. The Wyoming Department of Environmental Quality currently requests that all areas scheduled for permanent reclamation be approved for retopsoiling. The process may take as long as four weeks to survey final elevations, analyze overburden samples, and to submit and receive final approval to resoil any given area. To maintain replacement continuity, we found that a minimum of 15-30 acres should be approved and ready for retopsoiling at any given time.

PRODUCTIVITY AND EFFICIENCY

At peak production, up to 40,000 bcy's of topsoil were being salvaged per day using two shovels. However, salvage was discontinuous in any given month. A maximum of 180,000 bcy's of topsoil were moved per month in September and November. A total of 987,000 bcy's of topsoil were salvaged during 1986 using shovels, loaders, and trucks.

Production records indicate that shovel efficiency decreased approximately 65 percent as compared to similiar operations in overburden. Lower efficiencies resulted from several factors, including:

1) Increased cable and shovel moves

2) Lower working faces

3) Uneven terrain

4) One-sided shovel loading

5) Undertrucked shovels

To evaluate representative costs, the increased requirement for "cleanup" support equipment should be considered. Increased wear and tear on the shovels, dozers, and trucks must also be calculated.

Tangible savings were realized from effective long-haul opportunities. While difficult to determine, the advantages of direct-haulback are real. For BTM the ability to quickly move large volumes of topsoil also proved to be invaluable.

SUMMARY

Dozers, electric shovels, and 170 ton end dump trucks have been used successfuly to salvage and replace topsoil at rates of up to 40,000 bcy's per day. Peak salvage efficiencies are achieved in deep phase soils; however, shallow entisols have been effectively salvaged.

Compaction appears to be a critical factor associated with topsoil replacement using trucks. Revegetation results should indicate if ripping and fallowing prove effective in reducing that compaction.