

**OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERAL RESOURCES MANAGEMENT**

****PROCEDURE DIRECTIVE****

PERMITTING 2016-02

SUBJECT: Coal Waste Cover Reduction

EFFECTIVE: August 22, 2016

PURPOSE: To aid the mining industry in establishing acceptable practices when a variance is granted to reduce the thickness of material used to cover coal mine waste (refuse).

Introduction / Purpose

The purpose of this procedure directive is to aid the mining industry in establishing acceptable practices when reducing the thickness of material used to cover coal mine waste. The procedure is based on first-hand observations of past practices conducted in the State of Ohio and review of published research conducted by both government agencies and academic sources.

This procedure directive is to act as a template for acceptable methods of reclamation on coal waste disposal sites. All performance standards required by state and federal laws must be met. Failure to achieve all performance standards could result in long term water treatment and delayed bond releases.

History

Ohio's mining law and rules, Ohio Revised Code Chapter 1513. and Ohio Administrative Code 1501:13-9-04, 1501:13-9-13, and 1501:13-9-14, require all toxic material such as coal waste to be buried with four feet of non-toxic, non-combustible material. The law and rules allow for a variance from the 4 feet of cover if it can be demonstrated that the refuse disposal is stable and will not diminish the hydrologic balance, and re-vegetation will be diverse and permanent. Covering refuse piles with 4 feet of non-toxic material can create permitting challenges for borrow areas. This directive is organized to describe data collection, neutralization of refuse, cap design, plant selections and maintenance.

Required Documents

Construction of refuse disposal areas requires additional attention to detail and documentation, to ensure that all critical steps of construction are completed correctly and recorded to help address unforeseeable issues in the future. To provide proper documentation and clarity for the permittee and inspector, the [Refuse Pre-Construction Specification](#) form and [Coal Refuse Certification of Completed Work](#) form must be submitted to the Division. The use of these forms is required on the construction of refuse piles including ones without variances.

The [Refuse Pre-Construction Specification](#) form is required to document the details of construction activities, contemporaneous reclamation with proposed reclamation areas, sampling of refuse and soil lab analyses, neutralization required prior to capping, cap construction details, and any other specification needed to ensure the refuse disposal area is being constructed as designed.

The [Coal Refuse Certification of Completed Work](#) form is required to document what has actually occurred on site. This form will capture any key construction activities. Provide as-built designs if necessary. Document type and amount of neutralization material added, lift thickness of sealant material used and lift thickness of resoiling material used. This form is required to be certified by the professional engineer who is overseeing all construction activities.

Data Collection

For newly constructed or existing refuse disposal areas, it will be necessary to gather data on the refuse and the material used to construct the cap. Submittal of the following, as part of an Application for a Coal Mining and Reclamation Permit, is required to ensure that the applicant has a plan to complete reclamation of the site.

- Seasonal Reclamation Plan – once the in place refuse is to final grade and prior to capping, provide a seasonal reclamation plan to the Division, providing how reclamation will occur, how much area will be reclaimed and results from a sampling of the area to be reclaimed. Submit plans for the work to be completed during the season on the [Refuse Pre-Construction Specification](#) form. An acceptable Seasonal Reclamation Plan must have re-soiling sampling requirements that are similar to those in the sampling plan described on page 2 of [PD Technical 94-1, Alternative Resoiling Material](#). Every ten (10) acres to be reclaimed requires one lab sample composed of one subsample for each acre. This sampling should be completed on only the area that will be reclaimed that season. If the proposed area is not reclaimed during the applicable season, it must be resampled as a part of the next season reclamation plan. Submit required sampling results on the [Drilling Report – Surface](#). Refuse must be

sampled for pH, percent of total sulfur or pyritic sulfur, neutralization potential, potential acidity and calcium carbonate deficiency.

- Neutralization Material - Provide details on the type of material to be used for neutralization. Provide acid base accounting analytical results and any other critical information for the type of material being used.
- Sealant Material - Provide details on the sealant material to be used (see [Coal Waste Plan](#)).
- Re-soiling Material - Provide details on source (permitted location or other), quality by standard agriculture soil test (pH, Buffer pH, Phosphorus, Potassium, Calcium, Magnesium and Cation Exchange Capacity) and quantity available.

It is understood that refuse piles evolve to fit the needs of a permittee over time and plans sometime change. If the information isn't available at the time the refuse disposal area is being permitted, it will need to be submitted for review as an Application to Revise a Permit (ARP), or to the inspector.

Neutralization of Refuse

All refuse disposal sites will require the permittee to add enough neutralizing material to neutralize a minimum of the top two feet of refuse by calculating the tonnage of refuse located in the top two feet of the area to be reclaimed.

- The neutralization material added should be incorporated by lightly disking or using other methods on the area to be reclaimed to help prevent excessive run off of neutralization material.
- The refuse material will need to be neutralized to a calcium carbonate deficiency of zero (0).
- Neutralization parameters will need to be reported on the [Refuse Pre-Construction Specification](#) form.
- Neutralization of the upper two feet of refuse is separate from liming requirements for vegetation establishment.
- Calculations for neutralization shall be completed on the [Coal Refuse Neutralization sheet](#) (see following example).

Table A: Acid Base Accounting – Coal Refuse Characterization										
Analyses based on: (Indicate total sulfur or pyritic sulfur)										
thickness, feet	area, acres	volume, acre-feet	refuse unit weight, tons/acre-foot	refuse gross unit weight, tons	potential acidity, tons CaCO ₃ /1000 tons of material	neutralization potential, tons CaCO ₃ /1000 tons of material	calcium carbonate deficiency, tons CaCO ₃ /1000 tons of material	gross potential acidity, tons CaCO ₃	gross neutralization potential, tons CaCO ₃	gross calcium carbonate deficiency, tons CaCO ₃
2	20	40	2500	100000	15	5	10	1500	500	1000

Table B: Acid Base Accounting – Coal Refuse Neutralization				
Analyses based on: (Indicate total sulfur or pyritic sulfur)				
gross calcium carbonate deficiency, tons CaCO ₃ (from Table A)	calcium carbonate deficiency, tons CaCO ₃ per acre	neutralizing material	neutralizing material, percent CaCO ₃ equivalent	<u>Actual amount of neutralizing material needed, tons per acre</u>
1000	50	aglime	80%	62.5

Cap Design

To reduce the capping requirement to a level that is less than four (4) feet, efforts must be made to slow or prevent the movement of air and water through the cover material and into the coal waste. Acidification of the capping material occurs through the movement of water either by seeps of poor quality water, or through the capillary movement of water that relocates nutrients, metals and salts which change the soil chemistry.

To prevent water movement to and from the refuse and provide adequate rooting material, the Division requires a cover that meets the following specifications:

- Is a minimum two feet thick.
- Sealant material: Minimum 12 inches of non-toxic, non-combustible material is compacted to a Standard Proctor (ASTM D698) number, specific to the material used, which will achieve a desired permeability of 1×10^{-7} cm/sec determined by soil mechanics analysis (ASTM D5084). Deviation from permeability of 1×10^{-7} cm/sec may be approved at the discretion of the Division. Capping material that is borrowed from an onsite location needs to be suitable for its intended use. Suitable material should have a minimum plasticity index of 12 as tested by

Atterberg Limit tests (ASTM D4318). Evaluate the material for Grain Size Distribution (ASTM D422) and Permeability (ASTM D5084). The material shall not contain sod, brush, roots, frozen soil or other perishable materials. Rock particles larger than 3 inches shall be removed prior to compaction. Using the Unified Soil Classification System, sealant material must be described as clay, for example CL, CL-ML or SC. The material used should be able to be compacted to achieve a permeability of 1×10^{-7} cm/sec. Provide one Standard Proctor test (ASTM D698) or Modified Proctor test (ASTM D1557) per 2000 cubic yards or for each lift.

- Re-soiling material: Minimum 12 inches of the best available material on site or within the proposed borrow area for establishing diverse and permanent vegetation.
- Positive drainage must be achieved in all locations.
- Placement of cap needs to be completed in a controlled manner to achieve uniform thickness per the approved design.
- Compaction is required on all areas that have a slope of less than 25% and is recommended on all areas where possible. (See the table below for a comparison of infiltration rates when various materials and slopes are applied.)

**Infiltration Rate (IR)
Inches/Hour**

Soil Texture, Type	Percent of Slope				
	0-4%	5-8%	8-12%	12-16%	Over 16%
Coarse Sand	1.25	1.00	.75	.50	.31
Medium Sand	1.06	.85	.64	.42	.27
Fine Sand	.94	.75	.56	.38	.24
Loamy Sand	.88	.70	.53	.35	.22
Sandy Loam	.75	.60	.45	.30	.19
Fine Sandy Loam	.63	.50	.38	.25	.16
V. Fine Sandy Loam	.59	.47	.35	.24	.15
Loam	.54	.43	.33	.22	.14
Silt Loam	.50	.40	.30	.20	.13
Silt	.44	.35	.26	.18	.11
Sandy Clay	.31	.25	.19	.12	.08
Clay Loam	.25	.20	.15	.10	.06
Silty Clay	.19	.15	.11	.08	.05
Clay	.13	.10	.08	.05	.03

- Alternative capping materials may be proposed that supplant portions of the requirements discussed in these guidelines. Alternative capping plans could include the use of material such as, but not limited to, synthetic liners or coal combustion by-products. Adding alkaline material to the refuse in excess of the requirements in these guidelines could warrant an alternative capping plan. The Division should be contacted as early in the planning process as possible if alternative capping materials or plans are being considered. For geo-synthetic liners or geo-synthetic clays, additional testing parameters will be assigned during permit review and approval.

Summary of HELP Model Simulation on Various Cover Systems

Simulation ID	HELP File Name	Cover Thickness (ft)	Cover Components	Average Annual Percolation through cover (gallons per acre per year)	Percent of Ave Annual Precipitation percolating through cover (%)	Coal Waste Material to be Covered
A	4ftcrs	4	48" uncompactd SC, 3E-05	160,820	16.4	Coarse Coal Refuse (SC,1.2E-04)
B	2ftcrs	2	24" uncompactd SC, 3E-05	161,420	16.5	Coarse Coal Refuse (SC,1.2E-04)
C	2ftcars	2	18" uncompactd SC, 3E-05 6" compactd CL, 1E-07	74,280	7.6	Coarse Coal Refuse (SC,1.2E-04)
D	3clcrs	2	12" uncompactd SC, 3E-05 12" compactd CL, 1E-07	34,100	3.5	Coarse Coal Refuse (SC,1.2E-04)
E	4ulcrs	4	48" compactd SC, 2.7E-06	114,890	11.7	Coarse Coal Refuse (SC,1.2E-04)
F	4clcrs	4	24" uncompactd SC, 3E-05 24" compactd CL, 1E-07	53,260	5.4	Coarse Coal Refuse (SC,1.2E-04)
G	4ftsl	4	48" uncompactd SC, 3E-05	160,820	16.4	Fine Coal Slurry (CL,6E-07)
H	2clsl	2	12" uncompactd SC, 3E-05 12" compactd CL, 1E-07	34,100	3.5	Fine Coal Slurry (CL,6E-07)

Notes:

- Model's "A", "E" and "G" are intended to characterize the four foot cover required by coal regulation. They presume that a soil material with permeability of at least 3×10^{-5} cm/sec is achieved.
- Each Simulation was modeled for five years. Therefore, the average values are for the five year period.
- USCS Soil Classification : SC= Clayey Sand; CL= CLAY

The above table was produced by an industry and government accepted computer model call Hydrologic Evaluation of Landfill Performance (HELP)

Runoff coefficients were computed for a good stand of grass, two percent slope and a slope length of five hundred feet.

Final grading of a coal refuse pile must ensure positive drainage on all constructed aspects of the coal waste disposal area. Water accumulating on the surface has the ability to cause instabilities, promote acidification of the resoiling material and harm vegetation. All bench grades should be surveyed to ensure correct slopes over long distances are maintained to prevent pooling water and erosion. To account for settling of refuse over time, especially on slurry disposal areas, the top of refuse shall be graded to a minimum slope of two percent.

Plant Selection

Below is a table of suitable plant species for refuse piles. The goal of a refuse planting is to provide a stable permanent vegetative cover that consists of a minimum of two grasses and two legumes. Plant characteristics should be considered to ensure survivability in the environment created on a reclaimed refuse pile.

Refuse Reclamation Plants				
Name	Seeding rate (lbs. per acre)	Rooting depth (minimum inches)	Drought tolerance	pH Range
Orchard Grass	10-12	12	Medium	5-7.5
Tall Fescue	10-20	12	Moderate	5.5-7.0
Perennial rye	8-12	10	Low	5-8
Birdsfoot Trefoil	5-8	14	Medium	5-8
White (Ladino) Clover	4-6	12	Low	5.2-8.0
Red Clover	6-10	12	Low	5.5-7.6
Alsike clover	6-8	12	Low	5.6-7.5

Maintenance

The Division cannot, under law, mandate maintenance after bond release. However, due to the nature of some refuse piles exceeding the standard five year reclamation time frame, it is necessary to discuss maintenance to ensure that vegetation and other aspects of the reclaimed refuse pile are meeting performance standards at the time of bond release.

Maintenance amendments such as fertilizer and agricultural lime are recommended to be applied periodically to ensure that soil nutrient levels are optimal for continued vegetation growth. Soil samples should be taken every three to five years, with lime and fertilizer applied as prescribed by a soil test. Efforts should be made to ensure that application of nutrients is done at a time when the cap is stable and not excessively wet so that equipment will not cause damage or tire rutting of the reclaimed surface.

References

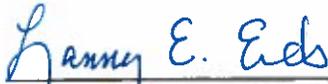
Aspects of the following reference material, in addition to field observation of reclaimed coal mine waste (refuse) sites, were used to provide support for the development of this directive.

1. W. Lee Daniels, Barry Stewart, and C.E. Zipper, [Powell River Project Reclamation Guidelines for Surface-Mined Land](#), Virginia Cooperative Extension, Publication 460-131.
2. Mike Sponsler, ODNR-DMRM Memo [Acid and Toxic Materials](#), providing D.B. Warbutron, J.R. Nawrot & W.B. Klimstra, Coarse Refuse: Alkaline Enhancement and Reduced Soil Cover, An Effective Reclamation Alternative, Cooperative Wildlife Research Laboratory, Southern Illinois University.
3. W. Lee Daniels, [Effect of Cover Soil Thickness on Revegetation of Acidic Appalachian Refuse](#), 2005 National Meeting of the American Society of Mining and Reclamation, Breckenridge, CO, June 19-23, 2005, Published by ASMR, 3134 Montavesta Rd., Lexington, KY.
4. Truax-Traer Coal Company, Pinckneyville, IL, A Division of Consolidation Coal Company, [Control of Mine Drainage from Coal Mine Mineral Wastes, Phase I Hydrology and Related Experiments](#), Produced for the Environmental Protection Agency Project No.14010DDH, August 1971. *
5. Z.V. Kosowski, [Control of Mine Drainage from Coal Mine Mineral Wastes, Phase II Pollution Abatement and Monitoring](#), Prepared for Office of Research and Monitoring, U.S. Environmental Protection Agency, Washington, DC, Project No.14010 DDH, May 1973. *

** Note: These documents (Reference #4 and #5) have been downloaded exactly as they appear from U.S. EPA's website. Some pages appear to be missing and/or page numbers skipped; however this is due solely to blank pages within the original document that were not scanned.*

6. J.R. Nawrot, G. Smout, & D. Brenningmeyer, [Soil Cover and Alkaline Amendment Alternatives for Coal Slurry Impoundments](#), Publication Source unknown.
7. Jack Nawrot and Gene Smout, [The New Kathleen Mine - Soil Covered Refuse Demonstration: 20 Years Later](#), Publication Source unknown.
8. Sara Pantini, H. James Law, Iason Verginelli, Francesco Lombardi, [Predicting and Comparing Infiltration Rates Through Various Landfill Cap Systems Using Water-Balance Models—A Case Study](#), Publication Source unknown.
9. Dr. Leslie Smith, Dr. Dina L. Lopez, Dr. Roger Beckie, Dr. Kevin Morin, Dr. Richard Dawson and Dr. William Price, [Hydrogeology of Waste Rock Dumps](#), Final Report to Department of Natural Resources Canada, July 1995.

10. Kristen Hanselman and Gerard M. Courtin, [Effect of Different Cover, Cover/Tailing Mixes and Capillary Breaks On Water Dynamics Within Tailings and Paper Waste Cover Materials](#), Publication Source unknown.



Lanny E. Erdos, Chief
ODNR - Division of Mineral Resources Management