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August 7, 2006

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Winston-Salem
Regional Office

NC Department of Environment and Natural Resources
Division of Waste Management
585 Waughtown Street
Winston-Salem, NC 27107

Attention: Mr. Tim Jewett
Permitting Engineer, Solid Waste Section

Subject: Marshall Steam Station - FGD Landfill
Solid Waste Facility Permit No. 18-09
Use of Bottom Ash for Operational Cover

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 8/18/2006 BY TMJ
PERMIT # 18-09
RCO FILE COPY

Dear Mr. Jewett:

For the FGD landfill being constructed at the Marshall Steam Station, Duke Energy had planned to utilize soils stockpiled as part of the landfill excavation as the operational cover placed over the liner system. However, based on particle size studies, no suitable soils are available that would not cause significant clogging with the liner system's 8 oz. non-woven geotextile. As a result, Duke Energy is proposing to use bottom ash generated at the Marshall Station in lieu of soil. As discussed below, bottom ash meets both the physical requirements (particle size) and chemical requirements (based on leaching studies) to be a suitable substitute for the soil layer.

The physical properties of bottom ash and the potential application as operational cover were evaluated by Chas. E. Sells. The landfill design called for an 8oz. non-woven geotextile, with an Apparent Opening Size (AOS) equal to a #100 sieve (0.15mm). Samples of bottom ash were obtained from the Marshall Station and the grain size distributions were determined for three types of bottom ash material (Bottom Ash – Block Aggregate, Bottom Ash – Raw, Bottom Ash – Fines). An evaluation of each bottom ash against the non-woven geotextile was then performed by using the flow-chart found on Figure 2.4a in Designing With Geosynthetics, 5th Edition, Koerner. This method determines the size of the O_{95} (equivalent to the AOS) for the geotextile, based on characteristics of the grain size and other properties of the material to be placed against the geotextile. Based on this evaluation, placement of all three types of bottom ash was found to be acceptable against a geotextile with an AOS of 0.15mm. A copy of the referenced figure has been provided as Attachment 1.

The leaching attributes of bottom ash were then evaluated against the leachate concentrations identified in the Compliance Demonstration Report and Addendum submitted for this project. A table has been provided in Attachment 2 which demonstrates the leachate concentration of bottom ash are significantly less than the gypsum and filter cake planned for this landfill.

Therefore, based on the physical and chemical characterizations of bottom ash, Duke Energy is requesting DENR approval to use bottom ash as a substitute for soil for the operational cover at the Marshall FGD landfill. If you require any additional documentation or have any additional questions or concerns, please feel free to contact me at (704) 382-7161

Sincerely,

Patrick J. McCabe

Patrick J. McCabe, PE
Manager - Environmental Field Support

Attachments

cc: Ed Mussler, DENR
Brian Wootton, DENR

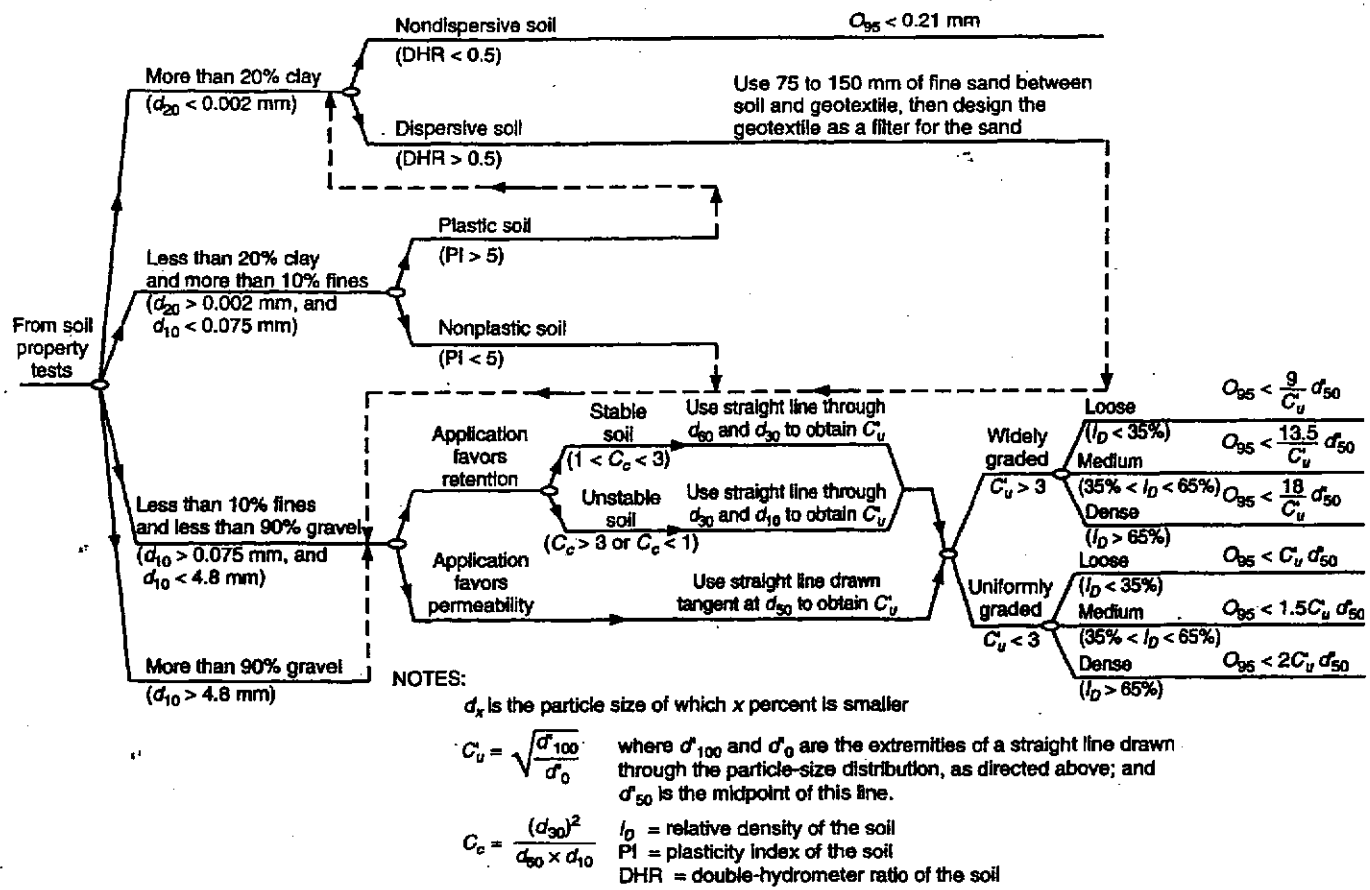
bc/w attachments: A. Kitzmiller – MSS
D. Burrell - MSS
C. Hallman - Charlotte

bc/wo attachments: R. Baker - Charlotte

File Number: 403.070.03 Marshall Steam Station (NC)
UPS:

ATTACHMENT 1

Figure 2.4a in Designing With Geosynthetics, 5th Edition, Koerner



NOTES:

d_x is the particle size of which x percent is smaller

$C'_u = \sqrt{\frac{d'_{100}}{d'_0}}$ where d'_{100} and d'_0 are the extremities of a straight line drawn through the particle-size distribution, as directed above; and d'_{50} is the midpoint of this line.

$C_c = \frac{(d_{30})^2}{d_{60} \times d_{10}}$ I_D = relative density of the soil
PI = plasticity index of the soil
DHR = double-hydrometer ratio of the soil

Figure 2.4a Soil retention criteria for geotextile filter design using *steady-state flow* conditions. (After Luettich et al. [6])

ATTACHMENT 2

Comparison of Leaching Characteristics

MSS Bottom Ash Leachate Comparison

Analyte	Units	NCAC 2L Groundwater Standards	Maximum Value from Initial Leaches	CO Plant Leach #1	CO Plant Leach Dup #1	HC Plant Leach #1	MSS Bottom Ash SPLP[1]		
							2003	2004	2005
pH	std units	6.5 to 8.5	7.35	7.35	7.31	7.14	5.33 to 5.76	4.29 to 5.01	3.87 to 4.5
Arsenic	mg/L	0.010	<0.010	<0.010	<0.010	<0.010	< 0.004	< 0.004	<0.010
Barium	mg/L	2.0	0.0507	0.0411	0.0429	0.0507	0.029	0.039	0.175
Boron	mg/L	0.32	0.162	0.149	0.162	0.13	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	0.005	<0.0020	<0.0020	<0.00020	<0.0020	<0.001	<0.001	<0.0025
Calcium	mg/L	n/a	614	597	614	612	1.199	0.623	0.667
Chloride	mg/L	250.0	5.33	5.33	4.98	3.67	< 1.0	< 1.0	<1.0
Chromium	mg/L	0.05	<0.0060	<0.0060	<0.0060	<0.0060	<0.001	<0.002	<0.040
Copper	mg/L	1.0	0.0035	0.0031	0.0035	<0.0030	<0.002	<0.004	<0.005
Fluoride	mg/L	2.0	**4.45**	**4.45**	**4.02**	**3.05**	<0. 001	<0.001	<0.001
Iron	mg/L	0.3	0.051	<0.020	0.051	0.026	0.069	0.147	0.05
Lead	mg/L	0.015	<0.0050	<0.0050	<0.0050	<0.0050	<0.002	<0.004	<0.010
Magnesium	mg/L	n/a	1.73	1.6	1.73	1.23	0.132	0.114	0.093
Manganese	mg/L	0.05	0.0292	0.0286	0.0292	0.0187	0.00266	0.00338	0.0021
Mercury	mg/L	0.0011	<0.00020	<0.00020	<0.00020	<0.00020	<0.001	<0.001	<0.0004
Nickel	mg/L	0.1	<0.010	<0.010	<0.010	<0.010	0.00276	<0.004	<0.010
Potassium	mg/L	n/a	0	<1.0	<1.0	<1.0	0.45	<0.25	<0.25
Selenium	mg/L	0.05	<0.010	<0.010	<0.010	<0.010	< 0.004	< 0.004	<0.010
Silver	mg/L	0.018	<0.0050	<0.0050	<0.0050	<0.0050	<0.001	<0.001	<0.005
Sodium	mg/L	n/a	2.83	0.93	0.94	2.83	n/a	n/a	n/a
Sulfate, SO_4	mg/L	250.0	**1510**	**1,490**	**1,500**	**1,510**	1.99	1.03	2.13
TDS	mg/L	n/a	2200	2,160	2,180	2,200	n/a	n/a	n/a
Zinc	mg/L	2.1	0.0157	0.012	0.0133	0.0157	0.0035	0.0052	<0.005

1. Reported data is the maximum SPLP concentration reported for annual Marshall bottom ash samples which includes samples of bottom block sand, bottom oversize and bottom fines.