

Finite Element Water Balance Modeling in a Coal Refuse Pile Cap and Cover Reclamation¹

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Abstract: A novel combination of reclamation techniques, geomorphic landforming and paper mill residuals used as a soil amendment, has the potential to be applied to abandoned mine land reclamation in Appalachia and the United States. The geomorphic approach attempts to approximate the long-term, steady state landform condition, leading to reduced erosional adjustment compared to standard engineered fill designs. Use of paper mill residuals utilizes waste products near their source as part of a manufactured soil. This study evaluated this approach by analyzing regraded coal mine refuse slopes for safety and erosion sustainability. A cap and cover system was designed for the Royal Scot refuse pile near Rupert, WV³ and was applied to geomorphic slopes. The cap and cover system was composed of two layers: a 60 cm compacted low permeability layer (hydraulic barrier) composed of refuse, and a 30 cm vegetative growth layer composed of refuse (80%) and paper mill residuals (20%). Three-dimensional finite element modeling was performed to assess ground surface terrain profiles, considering weather and material strength impacted by a 100-year storm event. The focus of the analysis was the effectiveness of the hydraulic barrier layer and the final slope stability of the system. To assess the effectiveness of the design, two models were performed: with the cap and cover system on the surface and with the refuse as a surface. Results from the modeling indicate that the steepest slopes (2H:1V) of the cap and cover reclamation remain stable with a factor of safety of 2.3. Implementation of the cap and cover reduced 42% of infiltration volume into the refuse, with most of the precipitation retained on the growth layer. The model shows the water volume within the pile returning to the initial volume after 56 days due to evapotranspiration and seepage.³

Additional Key Words: Coal Refuse, Mine Waste Reclamation, Finite Element Modeling.

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3. Work reported here was conducted near 38°00'55.3"N 80°36'16.5"W.