Restoring Ecological Function to Reforested Mined Lands:
Connecting Soils with Forest Productivity and Ecosystem Services

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Project Summary

This project contributes to the legacy of reforestation research at the Powell River Project and provides benefit to the larger Appalachian Coal Region. Dr. Brian Strahm has recently (2009) joined the faculty of the Department of Forest Resources and Environmental Conservation at Virginia Tech following the retirement of Dr. Jim Burger who has led the reforestation research program at the Powell River Project since 1980. Drs. Strahm and Burger have worked very successfully with Dr. Carl Zipper over the last three years to facilitate this transition in order to maintain the strong tradition of reforestation research in reclaimed mined lands centered at the Powell River Project. This level of cooperation is expected to continue into the future as reforestation research moves from an era focused on seedling establishment into one focusing on forest stand development, productivity, and the ability of reforested landscapes to provide valuable ecosystem services, all of which provide benefits to the landowners, mining companies and local communities. Specifically, this project has augmented the core focus of the Forestry Reclamation Approach (FRA) to "fast forward" vegetative succession and return high value hardwoods to the post-mining landscape by providing information to simultaneously "fast-forward" the restoration of the ecological services, function and productivity of the pre-mining forested landscape. Thus, this project utilizes the long-term Controlled Overburden Placement Experiment (COPE) to evaluate the effects of topsoil substitutes and organic amendments on the carbon (C), nitrogen (N), and phosphorus (P) cycles that combine to regulate forest productivity, C sequestration and the buffering of nutrient losses to nearby aquatic ecosystems. Additionally, the project capitalizes on the unique opportunity to work closely with Dr. Lee Daniels to better understand the differences that reclamation through reforestation and herbaceous vegetative cover have on these important biogeochemical cycles. The culmination of this work will help guide reclamation and reforestation efforts on mined lands and directly address the growing social and regulatory pressures facing the coal mining industry regarding the return of ecosystems services and productivity to the post-mining landscape. We have made great strides in this effort to-date and will detail our progress, findings, and plans below.

Scope of Work

Introduction:

During the first few decades following the implementation of the Surface Mining Control and Reclamation Act (SMCRA) of 1977, reforestation efforts in reclaimed mined lands generally resulted in high seedling mortality and low levels of forest productivity. Decades of work centered at the Powell River Project and led by Dr. Jim Burger have identified a five-step process known as the Forestry Reclamation Approach (FRA) to overcome many of the issues preventing successful seedling establishment, and accelerate the return of a forest community that would otherwise take centuries to achieve through natural successional pathways. The FRA has been identified as a desirable method to support forested land uses on reclaimed mined land by the Appalachian Regional Reforestation Initiative (ARRI), the US Office of Surface Mining and many state mining agencies, including the Virginia Department of Mines, Minerals and Energy. Thus, reforestation is an increasingly feasible and appealing option for reclaiming post-mining landscapes throughout the Appalachian region.

The benefits of successful post-mining reforestation include potential financial returns to the landowner in the form of forest products and the provision of valuable ecosystem services [e.g. carbon (C) sequestration, watershed protection] throughout the period of stand development. In fact, the two are so strongly linked that ecosystem services are often provided in direct proportion to forest productivity. Ultimately, however, both of these reforestation benefits are constrained by site quality, and specifically by soil properties and processes.

In the same way the FRA strives to “fast forward” vegetative succession and return high value hardwoods to the post-mining landscape, there is a need to rapidly reestablish the ecosystem services and functions associated with the native pre-mining forested landscape. This is ecologically important in sustaining forests after seedling establishment, but is also critical in addressing the increasing social and regulatory pressures regarding environmental quality following mining operations. Thus, this research project initiates a new line of reforestation research that builds on the concepts and successes of the FRA and represents a critical step toward understanding how the management and manipulation of forest soils can restore ecosystem services, functions and productivity on post-mining reforested landscapes.

The Controlled Overburden Placement Experiment (COPE) at the Powell River Project, co-funded in 1982 by the US Office of Surface Mining and the Powell River Project, is the longest intact and continuously monitored experimental manipulation of topsoil substitutes and organic amendments in the world. Thus, the COPE provides an incredibly unique opportunity to leverage this previous investment and long-term research history to answer fundamental questions regarding reforestation research. Namely, to understand how these different topsoil substitutes [five different mixes of sandstone and siltstone (SS:SiS)] and organic matter amendments (topsoil return, sawdust addition and four incremental loading rates of biosolids) drive forest productivity and provide beneficial ecosystem services under forest cover. All treatments in the COPE are split between herbaceous (dominantly tall fescue) and forest (red oak following pine) vegetation. This provides another advantage by allowing for close collaboration with Dr.

Lee Daniels and comparisons with his work on soil weathering that have primarily focused on the herbaceous side of the plots. Such comparisons will provide additional information regarding the differential response of important C and nutrient [nitrogen (N) and phosphorus (P)] cycles, the ultimate drivers of productivity, nutrient retention, and C accumulation/sequestration, to different vegetative reclamation techniques (e.g. reforestation vs. hayland/pasture).

Objectives:

1. Determine the effects of topsoil substitutes and organic amendments on the long-term (~30 year) accumulation of soil nutrient (N and P) and organic C stocks on reforested mined lands.
2. Assess the potential for different topsoil substitutes and organic amendments under forest vegetation to affect the sequestration of C into passive (~1,000 yr residence time) soil pools.
3. Compare the differences in the above measurements across sites with different vegetation histories (e.g. forest vs. herbaceous).
4. Relate observed soil properties to historic observations of forest productivity (e.g. total biomass production).

Methods and Procedures:

We have completed the second of a two-year study to meet the above objectives. The study focused on the suite of comparisons available at the COPE across topsoil substitutes, organic amendments, and vegetative histories. The COPE, initiated in 1982, consists of two distinct experimental units. The topsoil substitute portion of the COPE consists of four replications of five overburden mixes. These mixes include pure sandstone (SS), pure siltstone (SiS), and mixes of 2:1 SS:SiS, 1:1 SS:SiS, and 1:2 SS:SiS arranged in a randomized complete block design. The organic amendment portion of the COPE was constructed using the 2:1 SS:SiS overburden mix with four replicates each of seven treatments: control (CON), topsoil (TS), sawdust (SD), and biosolids at four different application rates: 22.4 Mg ha^{-1} (22B), 56 Mg ha^{-1} (56B), 112 Mg ha^{-1} (112B), 224 Mg ha^{-1} (224B), arranged in a randomized complete block design. All COPE plots measure 7 x 3.5 m and are split by different vegetative covers (forest vs. herbaceous). Aboveground vegetative responses (biomass and nutrient contents) have been characterized periodically throughout the history of the COPE.

Following Dr. Daniels' recent work on the herbaceous plots, we have sampled from multiple soil pits under historic forest cover in each plot. Present sampling efforts have attempted to account for varied historical methods and allow for the greatest number of comparisons with ancillary studies. To do so, soil was sampled at depths of 0-5 cm, 5-10 cm, and 10-25 cm (Figure 1), and will be analyzed independently and combined mathematically following analysis for comparison with other observations.

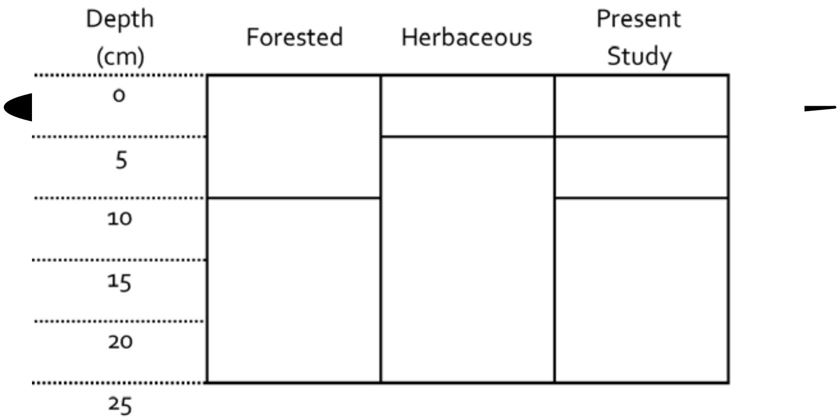
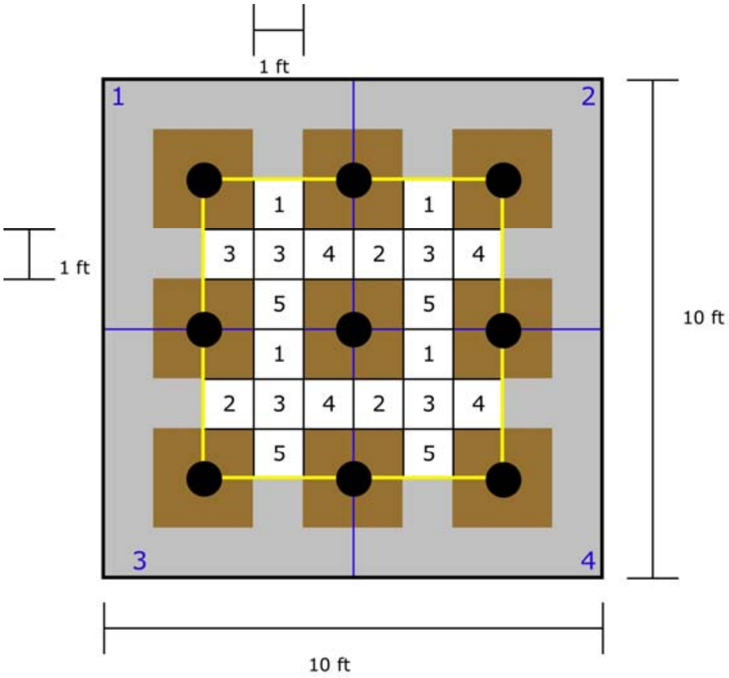


Figure 1. Correlation of current sampling depths with past sampling depths.

Two samples were taken at each forested plot. Plots were divided into 30 x 30 cm quadrats. Tree mats were installed around the northern red oaks with dimensions of approximately 60 x 60 cm to suppress vegetative competition immediate to the planted seedlings. Following harvest of the oaks in 2009, it was observed that the mats both preserved the pine litter and excluded the oak litter. For these reasons, quadrats acceptable for sampling will only occur in the corridors. Additionally, only those quadrats completely within the area of influence of the trees will be candidates for sampling. Figure 2 depicts the areas that contain available quadrats, which are signified as black and white numbered plots.



🟫 area of tree mats

▨ outside area of tree influence

Figure 2. Sample quadrats for random soil sample collection on forested side of COPE plots.

Random number generation was used to select sampling sites. Each plot was divided into four quadrants. Two quadrants were randomly selected. From those two quadrants, one quadrat was selected. This method was utilized to maximize spatial variability of samples. Further exclusion criteria were required to avoid areas that did not yield representative samples. These criteria included, but were not limited to, if the quadrat contained a pine stump, had a large cobble-sized or greater stone on the surface, was visibly disturbed (e.g. used for past sampling), or was adjacent to another quadrat chosen for sampling. Any stones or roots that were too large to take in the sample or could not be extricated were measured for volume and the volume recorded.

Key Findings: Topsoil Substitutes

Soil organic matter (SOM), organic C (C_O), and total N (N_T) concentrations were found to be significantly different between rock mix treatments for both the 5 to 10-cm and 10 to 25-cm depths; however, no significant differences were found between treatments from 0 to 5 cm (Table 1; Figs. 3 & 4). C_O values decreased with depth (Fig. 3). Upon conversion from concentration to content (Mg ha^{-1}), C_O and N_T were not significant at any depth and no obvious trends across treatments apparent. The C_O-to-N_T ratio (C_O:N_T) was also not significantly different at any depth and ranged from approximately 14:1 (1:1 SS to SiS 10-25 cm) to 19:1 (2:1 SS to SiS 0-5 cm) (Table 1). The C_O sequestration rate (Mg ha^{-1} yr^{-1}) was calculated (C_O Mg ha^{-1}/29 yr) for each treatment, and values ranged from 0.49 to 0.55 Mg ha^{-1} yr^{-1} (Table 2). However, neither significant differences nor trends were observed between treatments.

The goals of this study were to examine the state of 29-year-old, reclaimed mine soils, particularly with regards to nutrient retention and cycling, C sequestration, and the comparison of these functions to those of unmined soils. The continuing goal is to provide data for the comparison of C-sequestration potential of forested soils against herbaceous soils after 29 years; to provide additional information on topsoil substitute development; and to promote the establishment of temperate hardwood forest as the post-mining land use for reclaimed coal mines in the Appalachian region. The differences observed in chemical and physical properties of the rock mix treatments 29 years after reclamation offer further support selecting topsoil substitutes during mine planning that are suitable for the desired end land use. Topsoil substitute characteristics continuously evolve, however, and their selection should be made with short-term and long-term end land use goals in mind. Additionally, the continued research of mine soil development provides important data to coal mine operators and policy makers in order to make educated, economic, and environmentally conscious changes to reclamation practices.

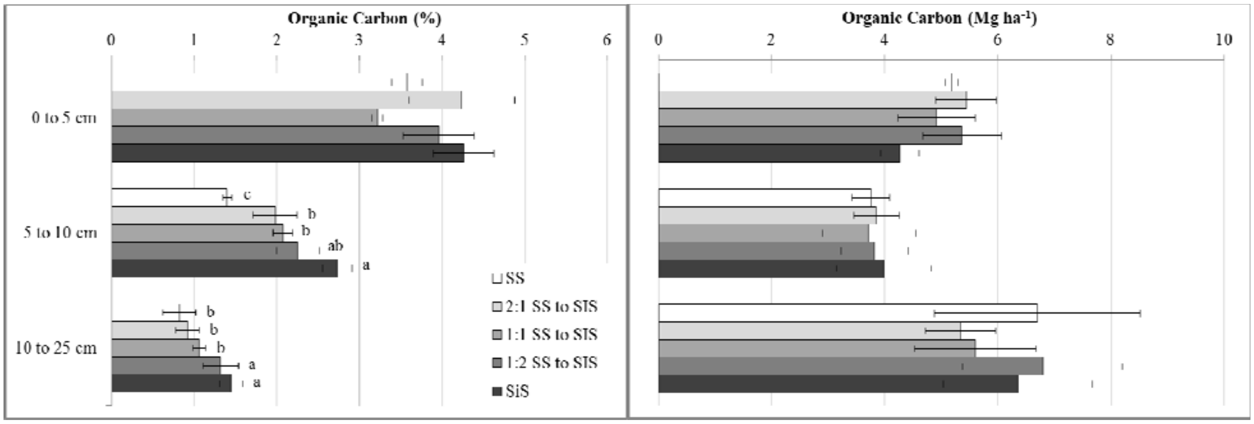


Figure 3. Concentration (%) and content (Mg ha^{-1}) of organic carbon in each treatment by depth. Standard errors bars of the treatment mean for each depth are displayed, where n=4. Letter groups indicate significantly different treatments within each depth (p>0.10).

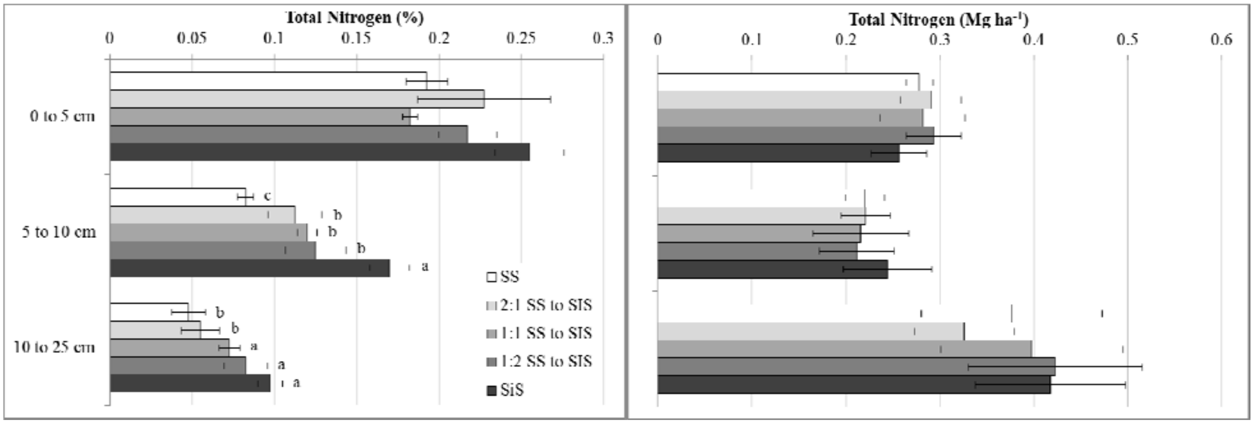


Figure 4. Concentration (%) and content (Mg ha^{-1}) of total nitrogen in each treatment by depth. Standard errors bars of the treatment mean for each depth are displayed, where n=4. Letter groups indicate significantly different treatments within each depth (p>0.10).

Table 1. Concentrations of organic matter (%) and phosphorus (mg kg-1), organic carbon to nitrogen ratios, and pH of rock mix samples. Significant differences between treatments for each depth indicated by letter groupings (p <0.10). Standard error expressed for n=4.

	SS			2:1 SS to SiS			1:1 SS to SiS			1:2 SS to SiS			SiS		
Depth	**Mean**	**Std Error**		**Mean**	**Std Error**		**Mean**	**Std Error**		**Mean**	**Std Error**		**Mean**	**Std Error**	
Walkely-Black SOM (%)															
0 to 5 cm	6.15	± 0.31		7.29	± 1.10		5.53	± 0.12		6.81	± 0.74		7.33	± 0.63	
5 to 10 cm	2.41	± 0.09	(c)	3.41	± 0.46	(b)	3.56	± 0.21	(b)	3.87	± 0.45	(ab)	4.70	± 0.31	(a)
10 to 25 cm	1.41	± 0.34	(b)	1.58	± 0.24	(b)	1.83	± 0.13	(ab)	2.28	± 0.36	(a)	2.49	± 0.23	(a)
C_O:N_T															
0 to 5 cm	18.71	± 0.57		18.80	± 0.58		17.62	± 0.52		18.16	± 1.18		16.85	± 0.86	
5 to 10 cm	17.07	± 0.40		17.50	± 0.28		17.38	± 0.32		18.33	± 1.09		16.14	± 0.28	
10 to 25 cm	18.31	± 2.40		16.92	± 1.12		14.48	± 0.77		16.19	± 0.51		15.08	± 0.55	
P (mg/kg)															
0 to 5 cm	22.50	± 0.96	(b)	22.50	± 1.04	(b)	43.00	± 5.12	(a)	36.75	± 2.50	(a)	40.25	± 4.39	(a)
5 to 10 cm	21.25	± 1.65	(b)	27.00	± 2.12	(b)	49.75	± 6.56	(a)	45.75	± 3.22	(a)	50.00	± 7.49	(a)
10 to 25 cm	22.25	± 6.01	(c)	31.25	± 2.63	(c)	67.00	± 5.60	(ab)	58.50	± 2.53	(b)	72.50	± 8.21	(a)
pH															
0 to 5 cm	4.92	± 0.04	(c)	5.55	± 0.12	(b)	6.08	± 0.19	(a)	6.16	± 0.12	(a)	6.45	± 0.23	(a)
5 to 10 cm	4.82	± 0.10	(c)	5.57	± 0.25	(b)	6.16	± 0.27	(ab)	6.33	± 0.25	(a)	6.46	± 0.33	(a)
10 to 25 cm	5.23	± 0.12	(c)	6.08	± 0.17	(b)	6.72	± 0.25	(a)	7.05	± 0.26	(a)	7.03	± 0.32	(a)

Table 2. Contents (Mg ha^{-1}) of organic matter, carbon, and primary and secondary nutrients, and carbon sequestration rates (Mg ha^{-1} yr^{-1}) of Rock Mix samples. Significant differences between treatments for each depth indicated by letter groupings (p<0.10). Standard error expressed for n=4.

Treatment		**Walkley-Black SOM**	**C_O**	**N_T**	**P_M**	**K**	**Ca**	**Mg**	**Fe**	**Zn**	**Mn**	**Cu**	**B**	**C_O Sequestration Rate**
							Content (Mg ha^{-1})							**(Mg ha^{-1} yr^{-1})**
SS	Mean	26.91	15.64	0.88	2.71	6.28	52.33	15.39	8.60	0.287	7.26	0.2182	0.0128	0.54
	Std Error	3.46	2.01	0.12	0.61	0.51	7.18	1.39	1.17	0.045	0.64	0.0228	0.0008	0.07
					(b)		(c)		(a)		(a)			
2:1 SS to SiS	Mean	25.17	14.63	0.84	2.68	4.25	63.26	19.14	5.33	0.269	4.35	0.2053	0.0116	0.50
	Std Error	2.21	1.29	0.10	0.27	0.23	7.51	2.43	0.35	0.030	0.52	0.0150	0.0015	0.04
					(b)		(bc)		(b)		(b)			
1:1 SS to SiS	Mean	24.48	14.23	0.90	5.09	4.41	82.90	21.71	5.15	0.284	5.63	0.2634	0.0143	0.49
	Std Error	2.42	1.41	0.11	0.89	1.06	10.34	2.58	1.07	0.036	0.71	0.0540	0.0018	0.05
					(a)		(ab)		(b)		(b)			
1:2 SS to SiS	Mean	27.48	15.98	0.93	4.18	4.13	91.57	23.71	4.36	0.283	5.17	0.2401	0.0153	0.55
	Std Error	3.70	2.15	0.15	0.07	0.27	7.41	1.71	0.23	0.009	0.45	0.0126	0.0014	0.07
					(a)		(a)		(bc)		(b)			
SiS	Mean	25.11	14.60	0.92	4.26	3.97	88.55	22.45	3.58	0.238	4.86	0.2129	0.0142	0.50
	Std Error	3.14	1.82	0.10	0.95	0.88	14.98	4.18	0.85	0.039	0.74	0.0439	0.0020	0.06
					(a)		(a)		(c)		(b)			

Key Findings: Organic Amendments

The effects of the organic amendment treatments are still exerting significant influence over the SOM, C_O and N_T concentrations (%) at all depths. (Figs. 5 & 6; Table 3.). The TS treatment consistently has the lowest concentrations, followed by the CON treatment, for all three parameters at all three depths. In the 0 to 5-cm depth, the SD SOM and C_O concentrations (C_O 6.78 ± 0.65%) are significantly greater than all the other treatments, and the TS (C_O 2.40 ± 0.32%) treatments are significantly lower than the SD and biosolids treatments (Fig. 5; Table 3). From 5 to 10 cm, the SOM and C_O concentrations of the CON (C_O 1.95 ± 0.16%) are not significantly different from the TS or 22B and 56B treatments. The SD and 224B treatments have significantly higher SOM and C_O than all other treatments, with exception of the 112B treatment. In the 10 to 25-cm depth, the concentrations of SOM and C_O in the CON (C_O 1.06 ± 0.13%) are higher than the TS treatment, and lower than that of the SD and biosolid treatments. The only treatment that is significantly different from the CON is the 224B (C_O 1.56 ± 0.17%) treatment. For all depths, the SD and biosolid treatments have greater N_T concentrations than the CON (Fig. 6). In the 0 to 5-cm depth, 224B and 112B are significantly higher than SD, and SD is significantly higher than the CON (0.225 ± 0020%). The TS (0.088 ± 0.005%) treatment is significantly lower than the SD and biosolids N_T concentrations. The N_T concentrations from 5 to 10 cm are significantly greater in the 112B (0.200 ± 0.022%) and 224B (0.233 ± 0.012%) treatments and significantly lower in the TS (0.088 ± 0.005%) treatment than all other treatments. The N_T concentration in the SD (0.165 ± 0.017%) treatment is significantly higher than the CON (0.123 ± 0.012%). In the 10 to 25-cm depth, only the 224B (0.115 ± 0.010%) treatment is significantly different from the CON (0.073 ± 0.009%). The TS (0.058 ± 0.003%) treatment continues to contain the least N_T by percentage, and is also significantly lower than all biosolids treatments. In all depths, the biosolid N_T concentrations generally increase with increasing application rate.

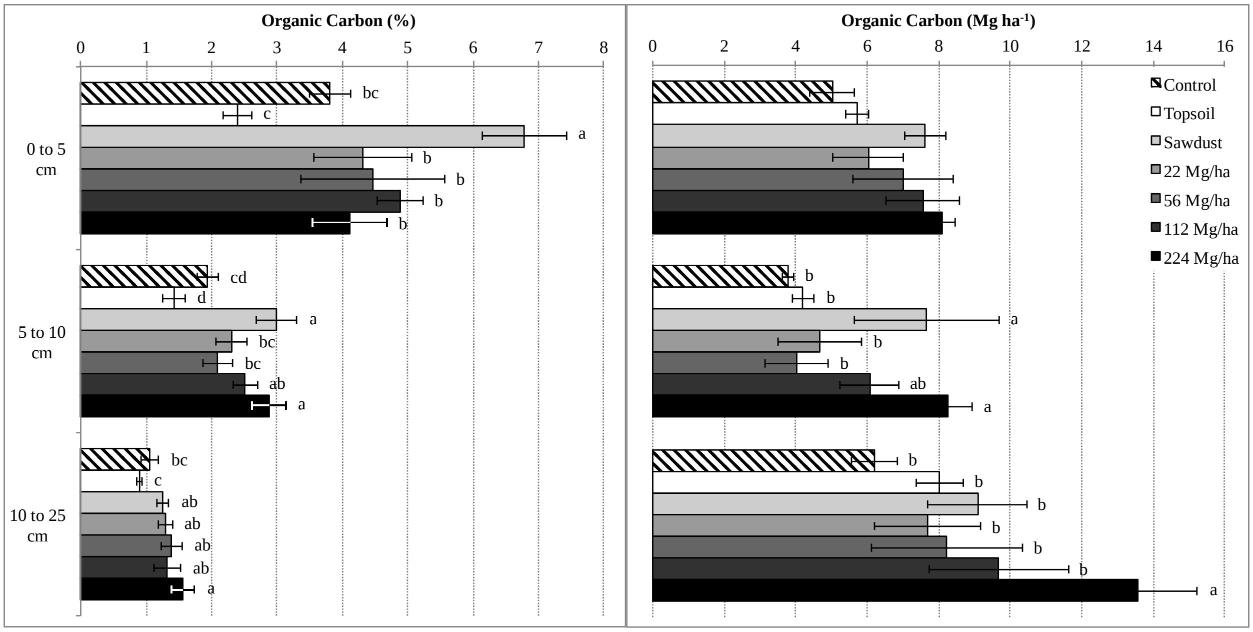


Figure 5. **Concentration (%) and content (Mg ha^{-1}) of organic carbon for Surface Treatment treatments by depth. Significant differences ($p < 0.10$) between treatments for each depth denoted by different letters. Error bars for n = 4.**

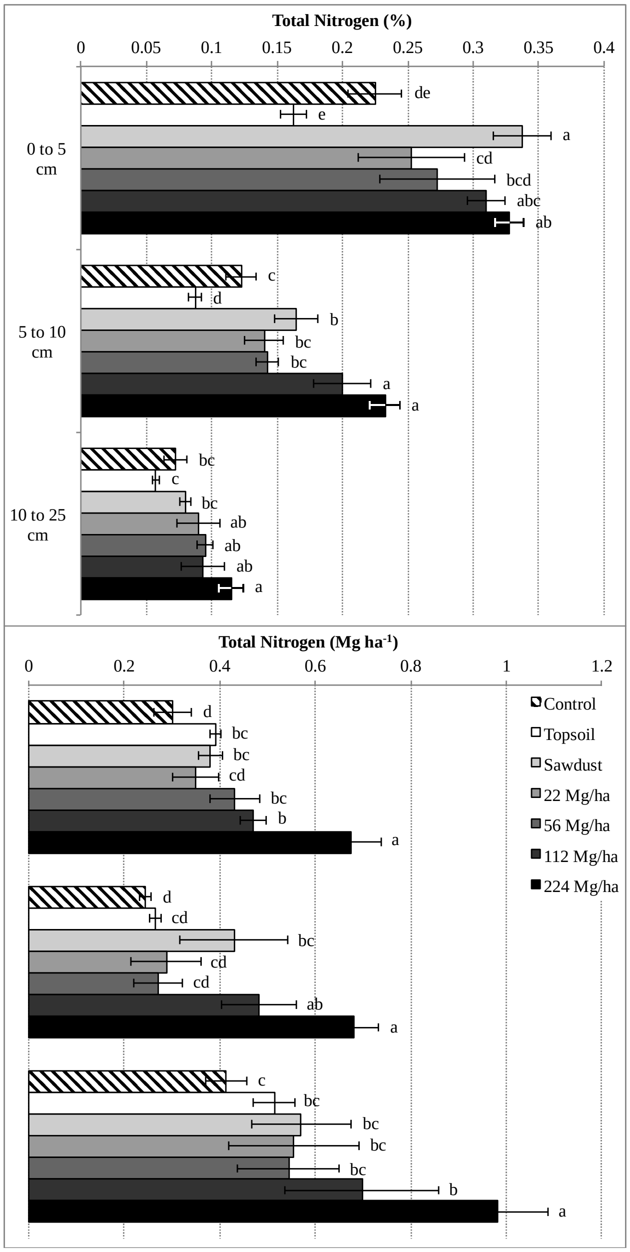


Figure 6. Concentration (%) and content (Mg ha^{-1}) of total nitrogen for Surface Treatment treatments by depth. Significant differences ($p < 0.10$) between treatments for each depth denoted by different letters. Error bars for n = 4.

Table 3. Concentrations of organic matter (%), organic carbon to total nitrogen ration, pH, and Mehlich 1 acid extractable phosphorus, potassium, calcium, and magnesium (mg/kg) of Surface Treatment samples. Significant differences between treatments for each depth indicated by letter groupings (*p* <0.10). Standard error expressed for n=4.

	Control		Topsoil		Sawdust		22.4 Mg/ha Biosoilds		56 Mg/ha Biosolids		112 Mg/ha Biosolids		224 Mg/ha Biosolids	
Depth	**Mean**	**Std Error**	**Mean**	**Std Error**	**Mean**	**Std Error**	**Mean**	**Std Error**	**Mean**	**Std Error**	**Mean**	**Std Error**	**Mean**	**Std Error**
Walkley-Black SOM (%)														
0 to 5 cm	6.56	± 0.55 (bc)	4.12	± 0.38 (c)	11.67	± 1.11 (a)	7.43	± 1.28 (b)	7.68	± 1.90 (b)	8.40	± 0.61 (b)	7.07	± 0.98 (b)
5 to 10 cm	3.35	± 0.28 (cd)	2.46	± 0.29 (d)	5.15	± 0.54 (a)	3.96	± 0.41 (bc)	3.60	± 0.40 (bc)	4.32	± 0.33 (ab)	4.94	± 0.46 (a)
10 to 25 cm	1.83	± 0.23 (bc)	1.54	± 0.08 (c)	2.16	± 0.16 (ab)	2.23	± 0.19 (ab)	2.40	± 0.27 (ab)	2.28	± 0.35 (ab)	2.69	± 0.29 (a)
C_O:N_T														
0 to 5 cm	17	± 1.12 (b)	15	± 0.64 (bc)	20	± 0.74 (a)	17	± 0.84 (b)	16	± 1.18 (b)	16	± 1.29 (b)	12	± 1.37 (c)
5 to 10 cm	16	± 0.25 (b)	16	± 1.31 (b)	18	± 0.26 (a)	16	± 0.27 (ab)	15	± 0.85 (bc)	13	± 0.80 (cd)	12	± 0.85 (d)
10 to 25 cm	15	± 0.41	16	± 0.93	16	± 0.75	15	± 1.95	15	± 0.93	15	± 1.35	14	± 0.58
P (mg kg^{-1})														
0 to 5 cm	27.00	± 2.27 (c)	17.75	± 0.95 (d)	19.75	± 5.12 (d)	31.00	± 4.48 (c)	44.25	± 4.48 (b)	102.25	± 20.91 (a)	132.00	± 20.23 (a)
5 to 10 cm	33.50	± 1.55 (c)	18.00	± 0.91 (d)	23.00	± 2.20 (d)	40.25	± 8.72 (c)	59.75	± 8.72 (b)	134.00	± 19.94 (a)	162.75	± 25.46 (a)
10 to 25 cm	46.50	± 4.63 (cde)	33.25	± 2.63 (e)	41.75	± 3.57 (de)	48.75	± 7.41 (cd)	64.50	± 7.41 (c)	107.75	± 22.90 (b)	168.25	± 26.27 (a)
pH														
0 to 5 cm	5.97	± 0.18	5.90	± 0.12	5.51	± 0.13	5.62	± 0.15	5.53	± 0.22	5.68	± 0.11	5.98	± 0.09
5 to 10 cm	5.91	± 0.13 (a)	5.73	± 0.10 (ab)	5.38	± 0.05 (c)	5.57	± 0.12 (bc)	5.63	± 0.05 (b)	5.65	± 0.04 (b)	5.75	± 0.04 (ab)
10 to 25 cm	6.43	± 0.12	5.98	± 0.09	5.98	± 0.08	6.05	± 0.17	6.16	± 0.30	6.04	± 0.16	6.21	± 0.12
K (mg kg^{-1})														
0 to 5 cm	54.25	± 3.47	65.25	± 9.04	65.00	± 4.80	62.00	± 3.70	65.00	± 5.03	77.50	± 6.89	67.00	± 8.07
5 to 10 cm	37.25	± 1.25	35.25	± 0.95	38.75	± 1.44	39.00	± 1.73	38.25	± 0.25	39.50	± 1.66	33.50	± 3.57
10 to 25 cm	37.75	± 0.75 (bc)	36.25	± 1.03 (bcd)	38.50	± 0.96 (ab)	35.75	± 1.03 (cd)	40.25	± 0.48 (a)	36.00	± 0.58 (cd)	34.75	± 1.70 (d)
Ca (mg kg^{-1})														
0 to 5 cm	1149.0	± 90.9	989.3	± 27.6	1223.8	± 138.4	1188.8	± 77.1	1123.8	± 52.9	1368.8	± 85.6	1427.0	± 200.1
5 to 10 cm	806.5	± 64.4 (b)	658.0	± 33.1 (c)	760.5	± 68.0 (bc)	829.5	± 61.6 (b)	857.5	± 47.0 (b)	1077.3	± 81.8 (a)	1285.0	± 100.3 (a)
10 to 25 cm	615.0	± 36.6 (cd)	544.0	± 20.2 (d)	592.3	± 28.7 (d)	663.5	± 68.0 (bcd)	730.8	± 33.4 (bc)	771.8	± 81.3 (b)	1024.3	± 79.1 (a)
Mg (mg kg^{-1})														
0 to 5 cm	231.00	± 15.66 (a)	176.75	± 10.40 (bcd)	224.25	± 8.40 (a)	205.25	± 13.64 (ab)	185.50	± 6.81 (bc)	168.00	± 10.68 (cd)	146.00	± 25.65 (d)
5 to 10 cm	213.75	± 9.83 (a)	170.50	± 4.73 (cd)	198.50	± 5.24 (ab)	186.75	± 10.73 (bc)	175.75	± 5.94 (cd)	159.25	± 11.17 (de)	150.75	± 1.65 (e)
10 to 25 cm	200.25	± 9.75	179.50	± 5.04	197.00	± 8.03	191.75	± 12.55	193.50	± 13.46	167.00	± 15.09	182.75	± 8.50

Deliverables:

To date, this work has been presented at five professional conferences, one of which was an invited talk at an international conference. The references for the presentations are given below:

Craig, N.G., B.D. Strahm, J.A. Burger, *W.L. Nash, and W.L. Daniels. Long-term Carbon and Nutrient Development in Coal Mine Topsoil Substitutes in Southwest Virginia. American Society of Mining and Reclamation Annual Meeting, Tupelo, MS. June 10-14, 2012.

Craig, N.G., B.D. Strahm, J.A. Burger, W.L. Nash, and W.L. Daniels. Long-Term Soil Carbon and Nitrogen Accrual in Coal Mine Topsoil Substitutes Under Contrasting Vegetation in Southwest Virginia. Soil Science Society of America International Annual Meeting, San Antonio, TX. October 16-19, 2011.

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These project funds have primarily been used to support the graduate study of Ms. Nina G. Craig. Nina just successfully defended her Master's thesis on this work and is presently employed in the mining industry in Alberta, Cana. During her tenure here, Nina represented herself and this project well. Below is a list of her accomplishments:

2012	Memorial Scholarship Recipient ($1,140 in prizes), American Society of Mining and Reclamation
2012	Second-place M.S.-level Oral Presentation ($100), American Society of Mining and Reclamation Annual Meeting
2012	Best Poster Runner-Up, Department of Forest Resources and Environmental Conservation Graduate Student Symposium
2011	President's Award Recipient ($300 prize), Canadian Society of Soil Science
2011	Best Poster, Division S-7 Graduate Student Poster Session, Soil Science Society of America International Annual Meeting
2011	Best Poster ($300 prize), American Society of Mining and Reclamation Annual Meeting
2011	Best Poster, Department of Forest Resources and Environmental Conservation Graduate Student Symposium

We are currently in the process of converting the body of Nina's thesis into at least two peer reviewed manuscripts detailing the results from this work and exploring the opportunity to author a Virginia Cooperative Extension bulletin to aid in the transfer of this information to land owners, land managers, and reclamation specialists.