Chesapeake Bay Stewardship Fund

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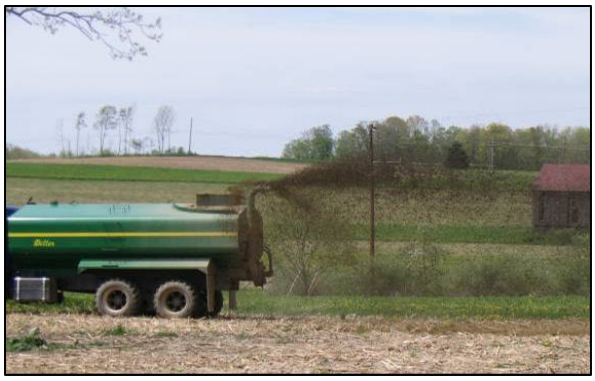
Chesapeake Bay Program
A Watershed Partnership

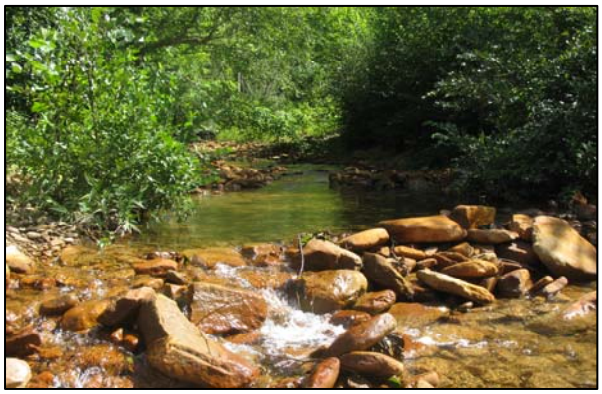
Controlling P in Animal Waste Management Systems with Mine Drainage Residuals

Organization: Trout Unlimited
Project Partners: Iron Oxide Recovery, Inc; Oklahoma State University
Grant Award: $254,034
Matching Funds: $255,654

Project Description. This project will field-demonstrate the ability and cost-effectiveness of using mine drainage residuals (MDRs) to decrease water extractable phosphorus (P^{we}) in manure management systems located in the West Branch Susquehanna River watershed. Successful implementation of this science will augment efforts to reduce the non-point phosphorous loadings received in the Chesapeake Bay while enhancing efforts to remediate abandoned mine drainage in the West Branch Susquehanna River basin, which contains more than 1,200 stream miles polluted with abandoned mine drainage.



Innovative cost-effective practices for substantially decreasing phosphorus in manure management systems are needed, as these systems are a significant source of non-point pollution to the Chesapeake Bay. Solids produced in the treatment of mine drainage have a high capacity for phosphorus-sorption and have significantly decreased P^{we} when added experimentally to animal manures. By utilizing this phosphorous-soprtion capability, this project promotes the concept of resource recovery by determining the economic benefits of mine drainage treatment wastes, which is key to the continued and successful reclamation of abandoned mine drainage in the West Branch Susquehanna River basin, as well throughout the Bay watershed.



Goals and Outcomes.

Short-term

1. Demonstrate an innovative method for decreasing P^{we} in manure management
2. Establish a novel use for residual solids produced by mine drainage treatment
3. Demonstrate the feasibility of a linkage between mine drainage treatment and nutrient pollution in the Chesapeake Bay

Long-term

1. Contribute to meeting the goals of the Chesapeake Bay Program
2. Contribute to improved quality of coldwater fisheries throughout the Chesapeake Bay watershed

Status. This past year, the project was developed to full-scale at a dairy farm in Clearfield County. MDR was blended with dairy manure immediately before manure field-application. Two test plots and a control plot received two different MDR amended manures and were then planted with corn. No phosphorus deficiencies were observed in either the test or control plots.

The MDR addition impacts on phosphate levels were then evaluated in the manure management system. A dosing curve was developed that indicated that a 12 gram/gallon amendment of the MDRs lessened the approximate 300mg/L of P^{we} by 50%. Investigations were continued to evaluate the possible environmental consequences of extensive adoption of MDR for P^{we} control. Concerns about toxic metal contents of MDR were investigated by reviewing detailed chemical analyses of numerous MDRs from additional sources in Pennsylvania. The investigation focused on the application limits of the metals detailed in EPA's Section 503 Biosolids Rule. The review established that most MDRs had metal concentrations well below EPA's 503 limits and would subsequently not cause metal loading problems. However, the review also established that excessive metal concentrations were present in a fraction of MDRs analyzed and that the most common contaminant was arsenic (As). The presence of As was not unexpected because iron-rich MDRs are known to be particularly effective sorbants of this metal, but the review reinforced the need to screen MDRs before their use in agricultural applications.

The effectiveness of MDR for P^{we} control in poultry manure was assessed by blending MDR with poultry laying house manure and partially weathered poultry manure. The results from these tests were inconclusive. The laying house manure produced results similar to P^{we} control in dairy manure, but P^{we} control in the partially weathered poultry manure was ineffective. These results suggest that poultry manure may be too dry and too heterogeneous for P^{we} control with MDR. In addition, the need for P^{we} control in swine manure was evaluated at a swine operation in Clinton County. The manure at this operation contained very low solids content and it was determined that its phosphorus concentrations were too low to be of environmental concern.

Challenges and Lessons Learned. Moving forward, the challenges will include the formal approval by the PA State Conservation Commission and the USDA-NRCS of the use of MDRs as a best management practice for reduction of P^{we} in dairy manure management. Another challenge may include finding a source of funding that would provide for a cost-share incentive to encourage dairy farmers and/or manure handlers to adopt and implement this new and innovative best management practice.

Readiness for Scale Up. This project is ready for "scale up," pending support through new funding. Future plans include the development of an MDR availability list through the evaluation of MDR sources throughout the Chesapeake Bay for suitability as a best management practice to reduce P^{we} in dairy manure management. It will be necessary to obtain formal approval from the USDA-NRCS and other appropriate bay state authorities for the use of MDRs as a best management practice. Next steps also include pursuing and obtaining a source of funding that would provide for a cost-share incentive to encourage dairy farmers and/or manure handlers to adopt and implement this new and innovative best management practice.

For more information, contact:

Amy G. Wolfe
Trout Unlimited
Eastern Abandoned Mine Program
Email: awolfe@tu.org
Phone: (570) 748-4901

Dr. Robert Hedin
Iron Oxide Recovery, Inc.
Email: bhedin@hedinenv.com
Phone: (412) 571-2204

	A	B	C	D	E	F	G	H	I	J	K
1	**Pennsylvania P Index Version 2** (October 2009, Penn State, Dept. Crop & Soil Sciences & USDA-ARS, Pasture Systems & Watershed Mgmt. Research Unit)										
2											
3	**FARM IDENTIFICATION**		**PART A: SCREENING TOOL**			**CMU/Field ID**	**baseline**	**increase buffer**	**decrease manure**	**restrict spreading**	**MDR addition**
4			Is the CMU in a Special Protection watershed?			If the answer is Yes to any of these questions, Part B must be used.	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
5			Is there a significant farm management change as defined by Act 38? (see belo				**No**	**No**	**No**	**No**	**No**
6			Is the Soil Test Mehlich 3 P greater than 200 ppm P? (enter soil test value in pp				210	210	210	210	210
7			Is the Contributing Distance from this CMU to receiving water less than 150 ft.?				**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
8			The following Act 38 criteria determine when there is a significant farm management change:				Part B	Part B	Part B	Part B	Part B
9			1. net increase of greater than 10% in AEUs per acre								
10			2. a change in crop management that results in a farmwide reduction of greater than 20% in nitrogen necessary for realistic expected crop yields								
11			3. alternative organic sources will replace all or some of the nutrient sources listed in the plan								
12			4. additional lands are brought into the operation (purchased or rented)								
13	**PART B: SOURCE FACTORS**					**CMU/Field ID**	**baseline**	**increase buffer**	**decrease manure**	**restrict spreading**	**MDR addition**
14	SOIL TEST	Mehlich 3 Soil Test P (ppm P)					210	210	210	210	210
15						**Soil Test Rating = 0.20* Mehlich 3 Soil Test P (ppm P)**	42	42	42	42	42
16	FERTILIZER P RATE	Fertilizer P (lb P_2O_5/acre)					20	20	20	20	20
17		P Applied from multiple fertilizer applications, if any (From Multiple Applications Calculator)					0	0	0	0	0
18	FERTILIZER APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April - October	0.8 Incorporated >1 week or not incorporated following application in Nov. - March	1.0 Surface applied to frozen or snow covered soil	0.2	0.2	0.2	0.2	0.2
19						**Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method**	4	4	4	4	4
20	MANURE P RATE	Manure P (lb P_2O_5/acre)					90	90	45	90	90
21		P Applied from multiple manure applications, if any (From Multiple Applications Calculator)					0	0	0	0	0
22	MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April - October	0.8 Incorporated >1 week or not incorporated following application in Nov. - March	1.0 Surface applied to frozen or snow covered soil	0.8	0.8	0.8	0.6	0.8
23	P SOURCE COEFFICIENT	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet Table 1					0.65	0.65	0.65	0.65	0.3
24						**Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient**	47	47	23	35	22
25						**Source Factor Sum**	93	93	69	81	68
26	**PART B: TRANSPORT FACTORS**					**CMU/Field ID**	**baseline**	**increase buffer**	**decrease manure**	**restrict spreading**	**MDR addition**
27	EROSION	Soil Loss (ton/acre/yr)					3	3	3	3	3
28	RUNOFF POTENTIAL	0 *Drainage Class is* Excessively	2 *Drainage Class is* Somewhat Excessively	4 *Drainage Class is* Well/Moderately Well	6 *Drainage Class is* Somewhat Poorly	8 *Drainage Class is* Poorly/Very Poorly	4	4	4	4	4
29	SUBSURFACE DRAINAGE	0 None or No direct outlet to receiving water		1 Random Drainage - Outlets directly to receiving water		2 * Patterned drainage - Outlets directly to receiving water	0	0	0	0	0
30	CONTRIBUTING DISTANCE	0 > 500 ft.	2 350 to 500 ft.	4 200 to 349 ft.	6 100 to 199 ft. OR < 100 ft. with 35 ft. buffer	9 ‡ < 100 ft.	6	4	6	6	6
31						**Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance**	13	11	13	13	13
32	MODIFIED CONNECTIVITY	0.85 50 ft. Riparian Buffer APPLIES TO DIST < 100 FT		1.0 Grassed Waterway or None		1.1 Direct Connection APPLIES TO DIST > 100 FT	1.0	1.0	1.0	1.0	1.0
33	* OR rapidly permeable soil near a stream					**Transport Sum x Modified Connectivity / 24**	0.54	0.46	0.54	0.54	0.54
34	‡ "9" factor does not apply to fields with a 35 ft. buffer receiving manure.					**P Index Value = 2 x Source x Transport**	**100**	**86**	**75**	**87**	**73**
35	**MANAGEMENT GUIDANCE**					**Optional Calculators**					
36	P Index Rating: Values	Nutrient Application Guidance				**User Inputs** 1. Manure Units (gal/A or T/A)	gal/A	gal/A	gal/A	gal/A	gal/A
37	Low: 59 or less	Nitrogen based management				2. N plan manure rate (units above)	10000	10000	5000	10000	10000
38	Medium: 60 to 79	Nitrogen based management				3. Manure P analysis (units above lb P_2O_5)	9	9	9	9	9
39	High: 80 to 99	Phosphorus limited to crop removal				P Applied at N Rate listed above in (2) (lb P_2O_5/A)	90	90	45	90	90
40	Very High: 100 or greater	No Phosphorus applied									
41						**User Input** 4. Planned crop - P removal (lb P_2O_5/A)	50	50	50	50	50
42						Actual total P applied based on values in PI above	110	110	65	110	110
43											
44						**User Input** 5. Actual Planned Rate (units above)					
45						P Applied at Planned Rate (lb P_2O_5/A) **Enter in MANURE P RATE above**	0	0	0	0	0
46											
47						Calculated Maximum Manure Rate (units above) (‡)	5801	8519	5000	7735	10000
48						P Applied at Calculated Maximum Rate (lb P_2O_5/A) (‡)	52	77	45	70	90
49						‡ Missing data = Rate calculator requires all Manure Rating data be entered into the P Index.					

Chemical composition of MDRs and EPA's 503 metal limits for land applied biosolids

Element	Units	503 Limit	Brandy	Farmington "Farm"
Fe	%	None	13.1	50.0
Ca	%	None	19.6	0.1
Si	%	None	2.3	3.6
Al	%	None	2.0	0.4
S	%	None	1.4	0.8
As	ppm	75	17	12
Cd	ppm	85	0.8	1.8
Cr	ppm	3,000	14	16
Cu	ppm	43,000	22	<1
Mo	ppm	75	<5	<5
Ni	ppm	420	373	50
Pb	ppm	840	<5	14
Se	ppm	100	<3	<3
Zn	ppm	7,500	434	40
Hg	ppm	57	na	na