Demonstrating a Market-Based Approach to the Reclamation of Mined Lands in West Virginia

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ABSTRACT

This is the first quarter progress report of Phase II of a three phase project to develop and evaluate the efficacy of developing multiple environmental market trading credits on a partially reclaimed strip mined site near Valley Point, Preston County, WV. Baseline water quality, hydrology and soil carbon data were collected and regulatory approvals were obtained in Phase I work, which has been summarized in a report to DOE. Phase II project objectives are twofold: First a portion of the soil of a 12 hectare site will be amended with class F fly ash and five species of commercial hardwood tree seedlings will be planted in test plots. Seedling viability and growth will be measured and the mass of sequestered carbon will be quantified. Second, we will design and construct a passive acid mine drainage treatment system and quantify resulting load reductions. The work completed this quarter focused on executing a site access agreement with the landowner and collecting additional baseline water quality data on which to base the design of the acid mine drainage (AMD) treatment system.

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INTRODUCTION

The objective of this project is to demonstrate and evaluate the efficacy of developing multiple environmental market credits on mined lands as an economic incentive to encourage landowners and/or third parties to invest in more and enhanced mined land reclamation. There is increasing recognition by public and private sectors that market-based or incentive-based programs can supplement traditional prescriptive regulatory programs to accomplish greater pollutant reductions at less cost. The sulfur dioxide (SO_2) and nitrous oxide (NO_X) cap and trade programs under the Clean Air Act are successful examples of such programs. Environmental commodity trading markets such as carbon sequestration, conservation banking, wetland banking and water quality credit trading are emerging at the international, national and state levels as market-based mechanisms to address climate change, protect threatened and endangered species, prevent wetland loss and encourage watershed restoration more quickly and at less cost. In contrast to traditional command-and-control regulatory approaches, federal agencies are shifting to incentive-based structures where landowners are rewarded for activities that support vital ecosystem services such as clean air and water, and healthy and diverse habitat.

This project is the outcome of a 2000 Memorandum of Understanding between the Department of Interior, Office of Surface Mining (OSM) and the Department of Energy (DOE) that supports the development and use of multiple environmental credit markets to encourage private investment in abandoned mine lands (AML) restoration. Many believe a market-based approach has the potential to promote innovative AML restoration, new technology and more ecologically holistic restoration at significantly less public cost.

While a federal or state regulatory agency determines the rules of the market/market structure, the supply and demand forces determine the price. Credits can be used or sold in order to comply with mitigation requirements of federal statutes such as the Clean Air Act, Clean Water Act and Endangered Species Act or with state/watershed level water quality trading programs.

Concern over the increasing level of atmospheric carbon dioxide (CO_2) and its effect on climate has resulted in the development of carbon sequestration commodity markets both in the United States and abroad. At least 160 nations have already signed on to the global warming treaty called the Kyoto Protocol while others are taking different approaches to minimize greenhouse gases thought to cause the phenomenon. The Kyoto Protocol has resulted in a European Union mandatory greenhouse gas reduction program, which has spurred a dynamic CO_2 cap and trade program with carbon credits selling for over $25.00/ton. Although the market in the United States remains voluntary, seven Northeast states have formed the so-called Regional Greenhouse Gas Initiative that will implement a cap-and-trade program to lower CO_2 emissions. In the meantime, many proactive corporations in anticipation of a federal greenhouse gas regulatory control program, are investing in carbon sequestration projects to reduce their potential financial exposure when and if a carbon cap and trade program is promulgated. Several electric utilities, for example, helped design the Chicago Climate Exchange while a handful of power companies are participating in the U.S. Environmental Protection Agency's (EPA) Climate Leaders Program.

Conservation banking, with about 75 endangered species banks, is growing allowing private landowners to sell species credits in exchange for developing or protecting key species' habitats. Habitats that support rare plant and animal species are selling for up to $125,000/acre. In contrast, wetland mitigation banking is relatively well developed with over 300 banks selling credits for anywhere from $5,000 to $ 250,000 per acre depending on the local or watershed market demand.

With respect to water quality trading, the EPA released a policy in January 2003 that encourages states to develop trading programs that are intended to help restore impaired waters at less cost. A number of state and watershed-based water quality trading programs are operating across the country with many more under development and consideration. Although most of the existing trading programs have thus far been limited to nutrients and sediment there is a clear need for development and implementation of programs to address other pollutants especially those associated with acid mine drainage (AMD). A framework for such an AMD trading program has been developed in the Cheat River watershed by a diverse group of stakeholders and awaits support from West Virginia Department of Environmental Protection (WVDEP) for implementation.

In Appalachia, the vast majority of land that is surface mined is forested. Laws originally passed in Ohio, Pennsylvania, and West Virginia, during the 1940's and 1950's, were designed to reclaim these disturbed forested lands by backfilling and replanting trees and shrubs. During ensuing decades and by 1977, laws and regulations governing surface mine reclamation in the eastern U.S. evolved into seeding grasses and legumes rather than establishing trees. The rationale for this change was that grasses and legumes quickly stabilized the soil reducing erosion, provided a quick economic return to land owners through haying or grazing of livestock, and was aesthetically pleasing. The outcome of these recent laws generally hindered tree planting because they permitted partial release of reclamation bonds as soon as the ground cover requirement was met. Under this framework reforestation was an added reclamation expense.

In response to some of the post-mining land use concerns of large scale surface mining, the West Virginia legislature in 2000 required re-establishment of commercial forest trees on surface coal mines, and especially on those sites where mountaintop removal mining has occurred. The reforestation policies specify replacement of the upper four feet of soil on the surface and also require minimal compaction during placement of this material. Testing currently is underway to identify optimal soil reconstruction standards for mine reforestation in West Virginia.

Where acid generating geological formations were mined, reclaimed mines after 10 to 20 years often revert to low-productivity savannas with the understory dominated by acid tolerant native grasses and forbs and an overstory consisting of Black Locust (*Robinia pseudo-acacia* L.). Many of these sites generate acid mine drainage. Conversion of such lands to productive forest while improving the quality of acid mine drainage-impaired waters is environmentally and economically desirable to the general public. Unfortunately, financial incentives for individual landowners to invest in upgrading their lands are insufficient based on traditional timber markets alone, and there are no financial incentives to encourage landowners to invest in water quality or habitat improvements. It is estimated that restoration of the land through direct public financing would cost the government billions of dollars. Alternatively, market-based incentives for AML reclamation have the potential to result in greater net ecosystem improvements more quickly and at less private (e.g. landowner) and public cost. Potential sources of market incentives for landowner-funded restoration include the development of carbon credits, water quality credits, wetland mitigation credits, and species conservation credits.

This project is designed to demonstrate a market-based reclamation approach through working with multiple partners. The project is funded by the National Energy Technology Laboratory of the U.S. Department of Energy (DOE) through a grant to the Electric Power Research Institute (EPRI). EPRI is responsible for program management, coordination and reporting. The National Mine Land Reclamation Center (NMLRC) of West Virginia University is a co-funder in the project, providing $32,720 in cost-share. As a subcontractor to EPRI, NMLRC is responsible for technical oversight as well as construction planning and implementation. GreenVest, another subcontractor to EPRI is responsible for developing the landowner access agreement and valuing any resulting water quality and carbon trading credits. Another partner in this project is Allegheny Energy who has agreed to provide the fly ash for the soil amendment in return for any resulting carbon sequestration and water quality trading credits. Additional partners, serving in an advisory capacity to the project, are Mr. David Bassage of the West Virginia Department of Environmental Protection's (WVDEP) Office of Innovation; Mr. Keith Pitzer, Executive Director of the Friends of the Cheat, a local watershed organization; and Mr. Bob Runowski of the U.S. Environmental Protection Agency (EPA) Region 3, Watershed Protection Division.

This project will provide insight into whether development of carbon sequestration and water quality trading credits on mined lands will provide an economic incentive for landowners and third parties to reclaim more lands to better quality at a faster rate. The project emphasis will be on developing water quality and carbon trading credits and creating wildlife habitat by planting trees and warm season grasses. Water quality improvements will be developed through a water quality enhancement mitigation project using a passive acid mine drainage (AMD) treatment system technology, and potential carbon credits will be developed through carbon sequestration in planted hardwood trees.

This is a three phased project: Phase I objectives were to identify an appropriate project site and determine baseline soil carbon, surface hydrology and water quality data and secure regulatory approvals. The Phase I report summarizing this work has been submitted to the DOE Project Manager. In phase II of the project, fly ash is to be applied to the soil as an amendment to provide neutralizing alkalinity and the site is to be planted with 5 species of commercial hardwood tree seedlings. In addition, a passive AMD treatment system will be installed to achieve reductions in acidity, metals and improvement in pH. The effects of the reforestation in sequestering carbon and the AMD treatment system in reducing pollutant loadings will be measured in Phase III of the project. Costs associated with each of these improvements will be measured to determine the minimum value at which carbon and water quality credits would have to be traded to make the marginal environmental benefits worth the necessary additional investment.

EXECUTIVE SUMMARY

This is the first quarter report of Phase II of a project funded by the DOE to develop and evaluate the efficacy of developing multiple environmental trading credits on partially reclaimed mined land. The project is the outcome of a 2000 memorandum of understanding between DOE and OSM to encourage environmental trading market credit development on mined lands in order to obtain more and better reclamation at less cost. Environmental credit trading markets such as carbon sequestration, water quality trading and wetland and species conservation banking are emerging as a supplement to traditional command and control regulatory programs as a means to obtain more effective and less costly environmental restoration and protection.

A 12-hectare privately owned project site located on a partially reclaimed strip mine near Valley Point, Preston County, WV was chosen by the project team for this demonstration and evaluation. Phase I of the project focused on collecting baseline soil carbon, hydrology and chemistry data and baseline water quality data from AMD emanating from the project site. Regulatory approvals were also obtained. The focus of this phase of the project was to obtain the landowner access agreement and to collect additional baseline AMD water quality data on which to design the passive treatment system.

Executing the agreement with the landowner has proven to be difficult. The project team had verbally agreed with the landowner to construct the passive treatment system on an AMD seep (seep #72) at the entrance to the project site that discharges to an unnamed tributary of Sovern Run. NMLRC has water quality and flow data for this seep dating to the early 1990s and a number of baseline water quality samples were collected during Phase I. However, the landowner subsequently notified the project team in November 2003 of his desire to move the location of the passive treatment system to the back side of his property to address an AMD seep and an AMD contaminated pond that are tributary to Conner Run. Additionally, he desired to have the reforestation site moved several hundred meters to the Southeast. The agreement was modified accordingly and presented but he objected to the duration of the conservation easement proposed for the reforestation site. Another modification of the agreement has been made and presented. The original project schedule called for completion of the access agreement in October 2003, initiation and completion of AMD project construction in July 2004 and October 30, 2004 respectively. Ash application on the reforestation site was to be completed by October 30, 2004 and tree planting was to be completed by April 30, 2005. Project progress is contingent on execution of the site access agreement. It has still not been executed, and as a result the project is significantly behind schedule.

As a consequence of moving the location of the passive treatment system, baseline AMD quality data had to be collected from the Conner Run drainage. Due to heavy snowpack and difficult access, only one sample was collected during the reporting quarter: March, 2004. The results are presented herein.

EXPERIMENTAL

Reforestation and Enhancement of CO_2 Sequestration:

> The objective of this project is to establish a commercially valuable forest on acidic mine soil in North Central West Virginia and quantify, verify and value the resulting carbon sequestration credits. Fly ash from the Allegheny Energy Albright Power Station in Albright, WV will be used as soil amendments to the mine spoil. This is a Class f fly ash with a neutralization potential (NP) between 2-20 tons/1000 tons $CaCO_3$ equivalents. Ash will be applied (rates will be determined based on NP value of selected ash and soil NP at the selected site) to the surface of a poorly reclaimed surface mine in West Virginia. The selected site is located on an abandoned Freeport surface mine in Eastern Preston County, near Valley Point, WV.

The tree planting plots have an acidic, compacted, clayey soil. It has been determined that fly ash addition will add needed lime while improving soil structure. The 12-hectare site will be divided randomly into six, two-hectare plots. Half of those plots will receive ash amendment and the other half will not. All plots will be tilled and/or ripped regardless of ash amendment. Only one level of ash amendment will be used and it will be based on the lime requirement of the soil.

Albright Power Station fly ash has a lime content of about 1.5% or 15T/1000T. Table 1 shows the calculation used to determine the amount of fly ash needed for soil neutralization. Ash will be supplied and trucked to the site by Allegheny Energy and will be tilled or ripped into the top 30 cm of the soil surface.

Table 1 Calculation Used to Determine Fly Ash Necessary for Soil Amendment

	analytical results: Mg of NP / Ha .1524 m = Mg / 907.4Mg	Mg NP deficit in 12 Ha of soil	ash needed to neutralize 12 Ha of soil
Clark Farm Soil	-1.24	-14.88	8,320 Mg
Albright Units 1 and 3 ash average	4.29		

Following ash application tree seedlings of five hardwood tree species [black cherry (*Prunus serotina* Ehrh.), white ash (*Fraxinus americana* L.), red oak (*Quercus borealis*), white oak (*Quercus alba*), and chestnut oak (*Quercus prinus*)] will be transplanted to the site. Spacing for each seedling will be 2 x 2 meters. Single species rows within each 2-hectare plot will be randomized. Planting in rows will facilitate planting and later assessment. Based on the 2 x 2 meter spacing stocking density would be approximately 3,062 trees/hectare, or 36,750 trees for a 12-hectare site. The experimental design will be a completely randomized in three replications with two soil treatments: fly ash amendment and no fly ash amendment and five tree species treatments. Thus, an analysis of variance will be conducted, which will test individual tree species performance on the fly ash and non-fly ash treated plots. Grasses and legume growth will be controlled either by tilling or by spraying to eliminate interference with tree growth, particularly on the non-fly ash treated plots.

Reclamation of AMD-Impaired Surface Waters:

Results from the preliminary field investigation and water quality assessment will be used to design a passive AMD treatment system for the acidic discharge(s). The system will be designed based on the unique attributes of the selected AMD site. Treatment methods will be selected based on water chemistry, flow, treatment needs and physical setting.

Pre-Post-treatment water quality will be determined through the following work subtasks:

- Field pH will be determined at each stream sampling station using a Corning 312 Portable pH meter;
- Stream channel width and depth will be measured at each sampling station using surveyor tape and other appropriate distance measuring devices; and
- Flow will be determined at each sampling station, using either a Marsh McBirney flow meter or another reliable flow measuring technique.

Water samples from each sampling station are filtered through a 0.45 um filter and collected into 2 new, plastic, 250 ml sampling bottles. The non-acidified sample will be analyzed for pH, acidity, alkalinity, sulfate and conductivity. The acidified sample will be used for elemental analysis (Fe, Mn, Al, Ca and Mg) using ICP technology.

The following EPA (1) and Standard Methods (2) were used for the analysis of water quality samples.

Parameter	Method	Detection Limit (mg/L)
Flow	Marsh-McBirney Flow Meter	
pH:	EPA 150.1, Electrometric	0.1
Field pH:	Oakton pH pen	+/- 0.2
Acidity	EPA 305.1, Titrametric	1.0
Acid Load (Tons/yr)	Flow (gals/min.) x Acidity Conc. x .0022	
Mineral Acidity	SM 2310, Titrametric	1.0
Estimated Acidity	Based on [H, Fe, Al, Mn]	
Alkalinity	EPA 310.1, Titrametric	1.0
Iron	EPA 200.7, ICP	0.05
Manganese	EPA 160.2, Gravimetric	0.01
Conductivity	EPA 120.1, Specific Conductivity	1.0 umho
Sulfate	EPA 300.0	1.0
Aluminum	EPA 200.7, ICP	0.05
Calcium	EPA 200.7, ICP	0.01
Magnesium	EPA 200.7, ICP	0.01

EXPERIMENTAL WORK TASKS

Reforestation and Enhancement of CO_2 Sequestration:

Task 1- Soil preparation:

The site will be divided randomly into six, two-hectare plots. Half of those plots will receive ash amendment and the other half will not. All plots will be tilled and/or ripped regardless of ash amendment. Only one level of ash amendment will be used and it will be based on the lime requirement of the soil (Table 1).

Task 2-Tree seedlings planting:

Following ash application tree seedlings of five hardwood tree species [black cherry (*Prunus serotina* Ehrh.), white ash (*Fraxinus americana* L.), red oak (*Quercus borealis*), white oak (*Quercus alba*), and chestnut oak (*Quercus prinus*)] will be transplanted to the site. Spacing for each seedling will be 2 X 2 meter. Single species rows within each two-hectare plot will be randomized. Planting in rows will facilitate planting and later assessment. Based on the 2 X 2 meter spacing stocking density would be approximately, 3,062 trees/hectare or 36,750 trees for the 12-hectare site. The experimental design will be a completely randomized design in three replications with two soil treatments: ash amendment and no ash amendment and five tree species treatments. Thus, an analysis of variance will be conducted, which will test individual tree species performance on the two soil treatments. Grasses and legume growth will be controlled either by tilling or by spraying to eliminate interference with tree growth, particularly on the non-ash treated plots.

Disking and seedling planting will be conducted by subcontractors.

Task 3-Performance of hardwood seedlings:

Tree survival and growth will be measured by National Mine Land Reclamation Center staff approximately six months following planting. Performance of hardwood seedlings will be measured by percent survival, seedling height and diameter.

Task 4-Compilation of final report:

A final report will be compiled using the results of the seedling data analysis.

Reclamation of AMD-Impaired Surface Waters:

Task 1-AMD treatment system designs:

Results from the preliminary field investigation and water quality assessment conducted during Phase I was to be used to design a passive AMD treatment system for the acidic discharge(s). As discussed below, however, the landowner desired that the system be constructed on the Conner Run drainage seep instead of the Sovern Run seep. This necessitated additional baseline water quality data monitoring of the Conner Run seep. The system will be designed based on the unique attributes of the Conner Run AMD site. Possible treatment systems include open limestone channels (OLCs), limestone leach beds, steel slag leach beds, limestone ponds, anaerobic wetlands, anoxic limestone drains (ALDs), successive alkaline producing systems (SAPS) and settling basins. NMLRC will develop the initial treatment system design and an engineering firm will develop the engineering specifications of the treatment structure.

Task 2-Construction of AMD treatment system:

Following design and approval of a suitable AMD treatment system, construction of the system will be conducted by an approved contractor.

Task 3-Post-construction water quality monitoring:

Monthly monitoring of the treatment system will be conducted following construction. Samples will be taken upstream and downstream of treatment structures and analyzed for pH, alkalinity, acidity, sulfate, conductivity, Ca, Mg, Fe, Al, and Mn. If steel slag systems are installed trace metals, such as Ag, As, B, Ba, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl, V and Zn, will also be analyzed.

Task 4-Data analysis and interpretation:

Analysis of water quality data will be conducted by NMLRC staff to determine the efficiency of the treatment system. Percent acidity, acid load and metal reductions will be calculated based on pre-treatment and post-treatment water quality.

Task 5-Compilation of final report:

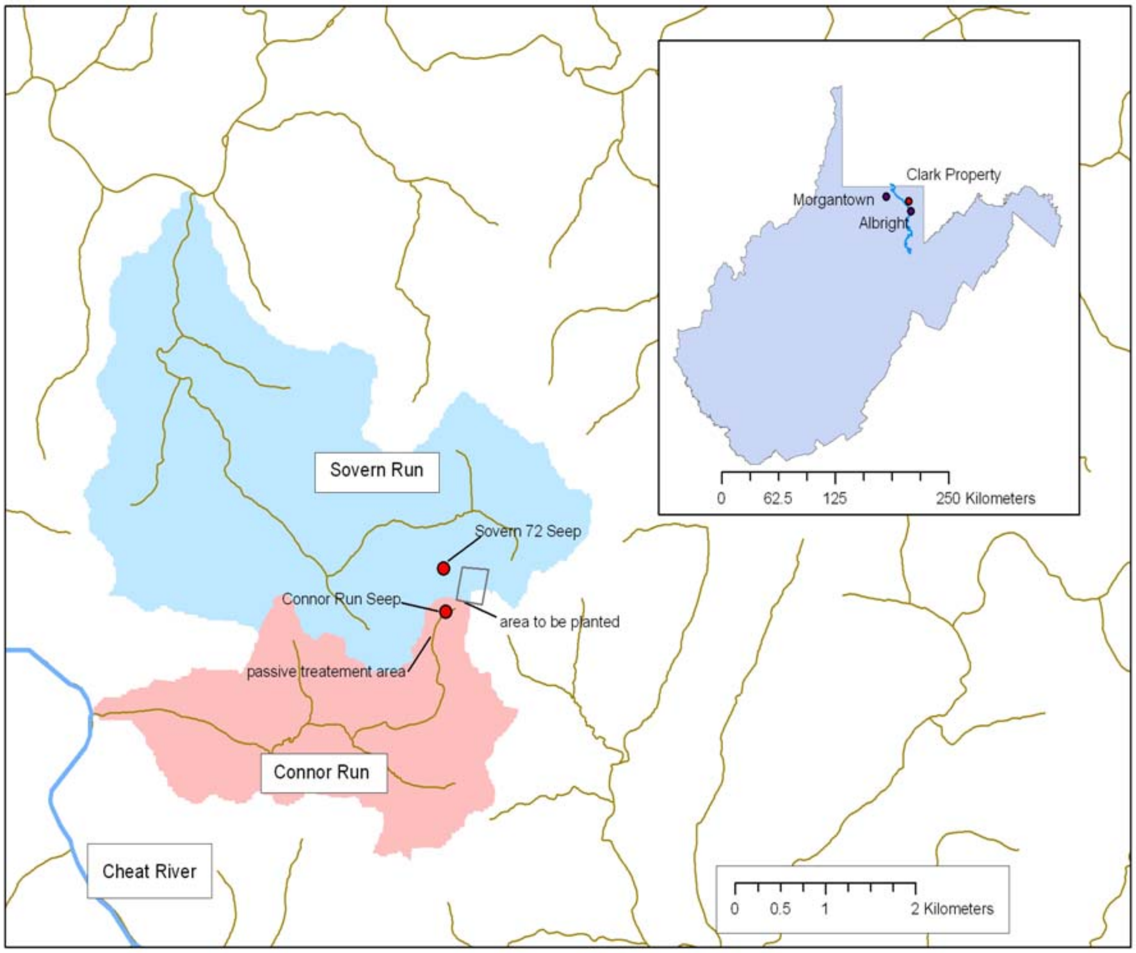
System design specifications and treatment efficiency will be discussed in a future quarterly and final report.

RESULTS AND DISCUSSION

Project Site Location and Access Agreement

The 12-hectare site selected for this project is located on an abandoned Freeport Seam surface mine in Eastern Preston County, near Valley Point, WV that was mined in the early 1970s. It is part of an approximate 48-hectare parcel owned by Mr. and Mrs. Jeff Clark. It is located approximately 17.7 kilometers from Allegheny Energy's Albright Power Station and contains two AMD seeps; one that drains to Sovern Run and the other that drains to Conner Run (Figure 1). Conner Run is a 5.5-kilometer long direct tributary of the Cheat River.

Figure 1 Project Location Map Depicting Sovern Run and Conner Run AMD Discharges, Proposed Passive Treatment System and Reforestation Sites



The site was chosen because it met site selection criteria developed by the project team, as outlined below:

- A mine surface area of approximately 10-15 hectares;
- Located within 25 kilometers of the Allegheny Energy Supply's Albright Power Station to facilitate fly ash transport;
- An on-site acidic discharge that currently is degrading water quality of receiving streams and impeding development of an aquatic habitat; and
- A gently sloping site, with no high wall.

In the late 1990's, the West Virginia Department of Environmental Protection's Abandoned Mine Lands Program partially reclaimed this site. The reclamation consisted of re-grading a highwall, installing piping to convey the mine drainage out of collapsed portals, and constructing an open limestone channel to collect the mine water and convey it off of the property to an unnamed tributary of Sovern Run.

The topography of the reforestation site consists of gently rolling terrain with relatively young and small woody vegetation. There are assorted small conifers as well as some Black Locust on some portions of the property (Figure 2). Also, there is a dense stand of pine trees located in the southwestern portion of the property. This stand of trees also covers two of three sides of a valley that faces southwest. An AMD seep emanates from the toe of the valley and drains to the unnamed tributary of Conner Run (Figure 3).

Figure 2 Photo of Reforestation Site Prior to Clearing and Grubbing

Figure 3 Photo of AMD Conner Run Seep Emanating from the Base of Surface Mine Spoil

During Phase I the landowner had verbally agreed to provide site access for carbon soil and water quality sampling at an AMD discharge located on an unnamed tributary to Sovern Run. Water quality monitoring data for this site was presented in the Phase I final report. However, during negotiations on the access agreement, the landowner expressed his desire to move the location of the proposed passive AMD treatment system to the backside of his property to address an AMD seep tributary to Conner Run (Figures 1 and 3). The rationale for this request is that he did not own the majority of the downstream property traversed by the unnamed tributary to Sovern Run on which an open limestone channel installation was planned and strongly indicated that the landowner (his father) would not grant property access. He was also interested in the possibility of the project addressing an approximately one-hectare (former sedimentation) pond contaminated with AMD that discharged into Connor Run and the Cheat River (Figure 4). At the same time the landowner expressed his desire to shift the 12-hectare reforestation site approximately 200 meters to the Southeast side of his property. As a result, the landowner access agreement was revised and renegotiated with the landowner.

Figure 4 AMD Contaminated Pond in Conner Run Drainage

On February 4, 2004 a revised agreement was sent to Mr. Clark covering the corrected acreage and incorporating his comments from the second agreement. This was the third agreement sent to Mr. Clark. After several months of meetings and calls with Mr. Clark, he refused to sign the agreement expressing concerns over conditions that would have established a conservation easement, which would grant the perpetual right of ingress to and egress from the easement to monitor the development of the carbon credits in the planted trees, a principal objective of the project.

Faced with the loss of access to the property, a discussion was held with our DOE project officer and it was agreed that the primary objective was to document the costs and results of the reforestation and water improvement project rather than to document the long-term development of the carbon credits. A new access agreement was drafted by GreenVest, which only required five years of access for R&D purposes. This agreement was sent to Mr. Clark during March. As of the date of this report, Mr. Clark had not signed the agreement.

Baseline Water Quality Monitoring on Conner Run

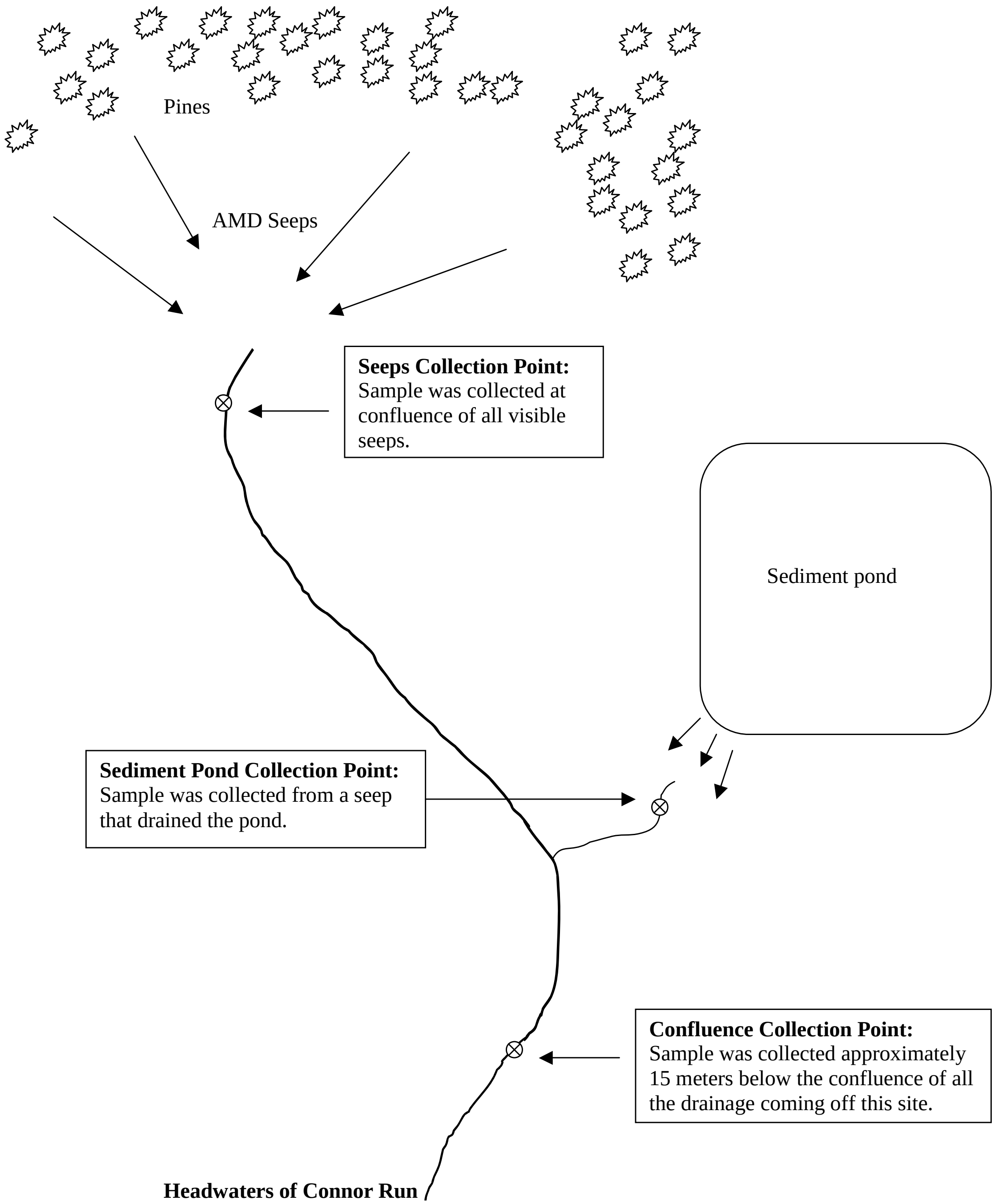
As a result of the landowners desire to move the proposed AMD Treatment system baseline water quality monitoring sampling was initiated on the Conner Run seep in March 2004. Water quality sampling results from two AMD locations (pond and seep) and a confluence location on the Conner Run AMD are shown in Table 2. Please see Figure 1 below for locations.

Table 2 Water Quality Analysis Results: Conner Run Drainage

January, February, March				
Sampling Station	Units	Pond	Seep	Confluence
date		3/23/2004	3/23/2004	3/23/2004
Flow	L/Min		11.35	13.76
Flow	gpm		2.64	3.2
Field pH			NM	NM
pH		4.1	3.5	3.7
acidity	mg/l	114	171	102
est. acidity	mg/l	104.02	211.11	118.86
alkalinity	mg/l	0	0	0
acid-alk	mg/l	114	171	102
Mg	mg/L	17.3	30.1	18.4
Ca	mg/L	19.2	33.8	24.9
Fe	mg/L	0.23	28.6	11.5
Al	mg/L	17.2	11.3	10
Mn	mg/L	3.81	9.56	5.68
SO4	mg/L	224	363	221
Cond.	µs/cm	251	757	481
Loadings				
Acid Load	kg/yr		901.20	651.59
Fe Load	kg/yr		150.73	73.46
Al Load	kg/yr		59.55	63.88
Mn Load	kg/yr		50.38	36.28

These data, which will support, in part, the design of the passive treatment system, indicate AMD quality typical of the Freeport coal seam: moderate acidity, zero alkalinity and high aluminum and manganese concentrations.

Figure 5 Sample Locations for the Conner Run Site



CONCLUSIONS

The Clark Farm, located just outside of Valley Point, in Preston County, West Virginia, is ideally suited to the objectives of this project. The mine soils are acidic in nature and therefore meet the requirement for alkaline amendment. The baseline carbon balance has been completed and will be compared to the final carbon balance at the end of the project to ascertain the amount of carbon sequestered from the atmosphere through reforestation. Only one pre-construction water quality analysis for this site has been collected due to inclement weather and the landowner's desire to move the proposed passive AMD treatment system to an AMD seep from the backside of his property that is tributary to Conner Run. Landowner uncertainty with respect to the location of the passive treatment system and the reforestation site as well as his desire to minimize the duration of the conservation easement has delayed execution of the access agreement. We continue to work with the landowner to resolve his concerns. Additional baseline AMD quality samples are needed and will be collected from the Conner Run drainage.

REFERENCES

1. EPA – United States Environmental Protection Agency, "Method for the Chemical Analysis of Water and Waste," EPA 600/4-79-020.

2. Standard Methods for the Examination of Water and Wastewater, 18th Edition.