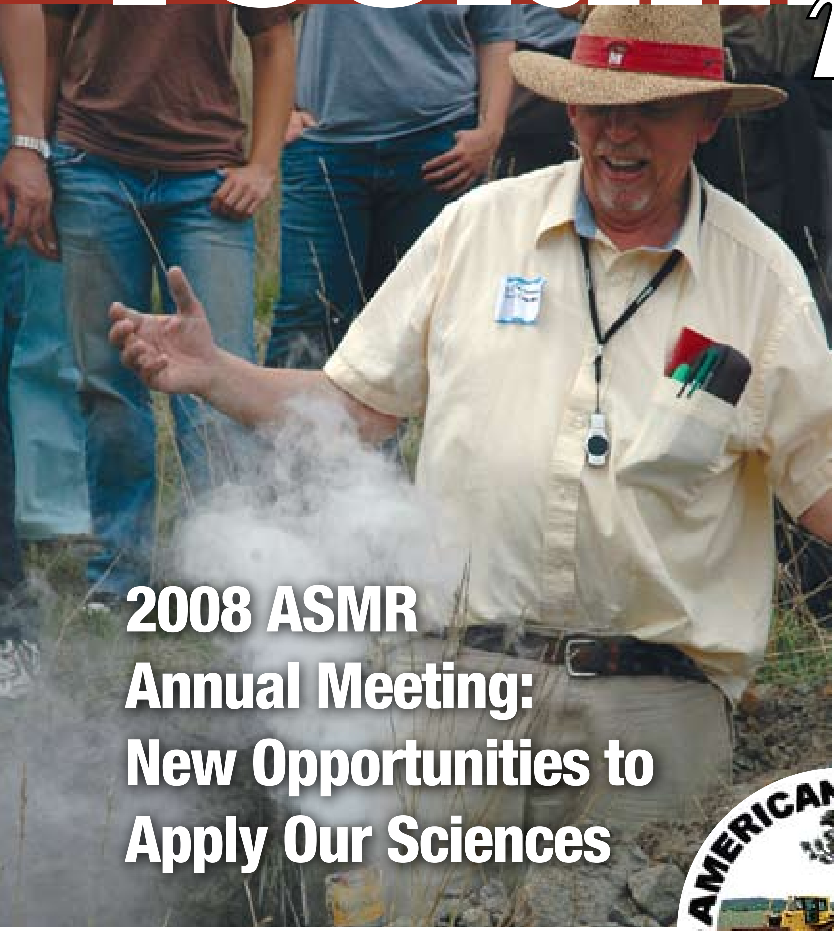
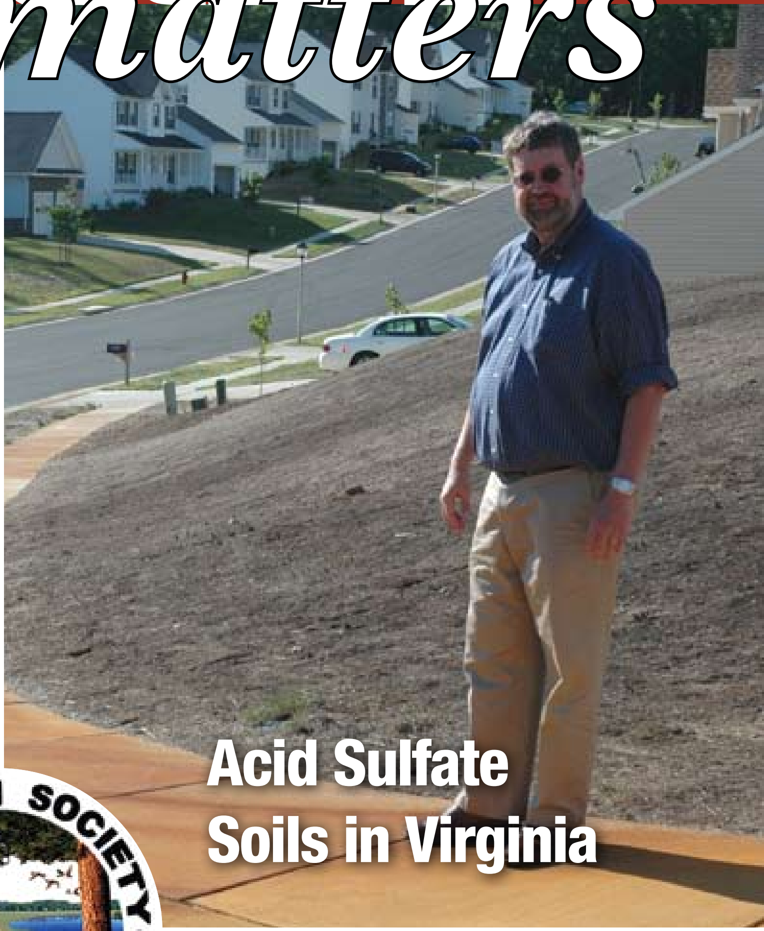
THE OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

Issue 1 2008

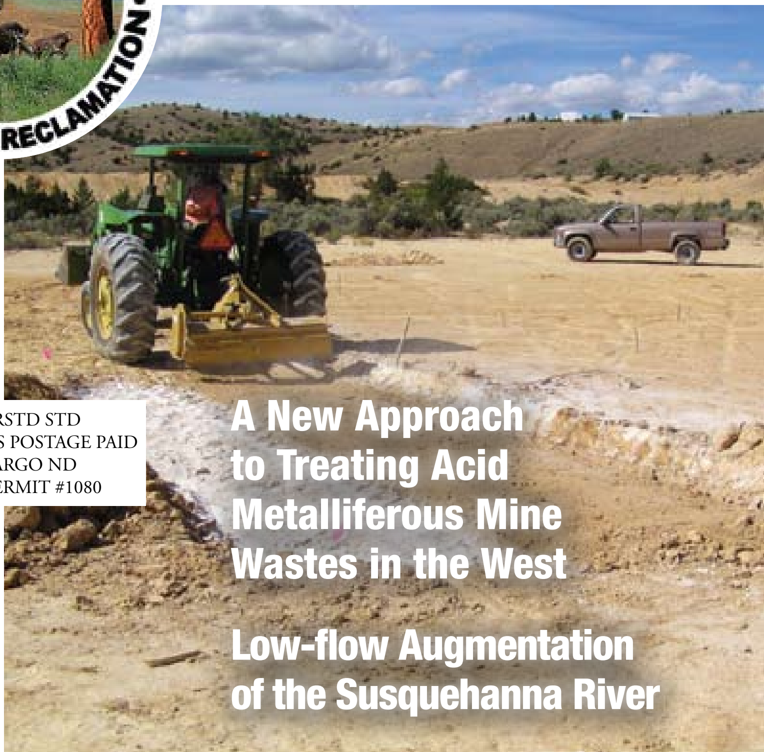
reclamation *matters*



2008 ASMR Annual Meeting: New Opportunities to Apply Our Sciences



Acid Sulfate Soils in Virginia



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A New Approach to Treating Acid Metalliferous Mine Wastes in the West

Low-flow Augmentation of the Susquehanna River

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contents

Issue 1 2008
Volume 3
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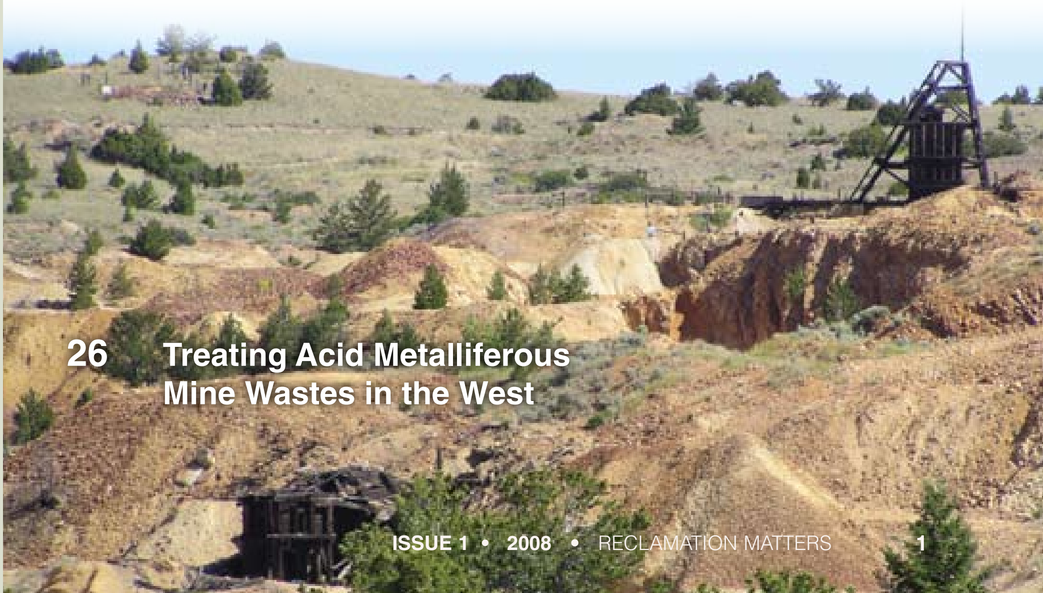

BY PAUL EGER

You've Come a Long Way Baby ...

Last time it was Dylan lyrics, now it's cigarette commercials! What do you expect from a child of the '60s who grew up with concepts like "the medium is the message"?

As we approach our 25th annual meeting in Richmond, it seems appropriate to focus on how far we've come, not just as a society, but also in terms of our understanding and practice of reclamation. We have grown from a handful of people who first met in West Virginia in the early 1980s who focused predominantly on coal, to an organization of 450 people worldwide that discusses all types and aspects of mining and reclamation. We have learned a lot about what causes environmental problems and we have developed approaches to prevent many of the impacts associated with historic mining. Impressive strides have been made in reclaiming prime farmland, returning mine sites to original contours and reclaiming infertile mine tailings. And we have made great progress in treating mine drainage problems with low maintenance systems – including wetlands, a variety of sulfate reducing systems, and anoxic limestone drains. Watershed groups are mobilizing and attacking local problems, and mining companies now discuss the "triple bottom line" which reflects environmental and social concerns in addition to traditional economic considerations.

Despite our progress, there are still more challenges. Many historic mine sites still need remediation, and new mining methods and proposals often pose difficult reclamation challenges. New regulatory approaches and flexibility may also be required as we look at innovative ways to reclaim sites and try to combine re-mining historic mine sites with reclamation. We've come a long way in our first 25 years and I look forward to all that we will accomplish in our next 25. See you in Richmond! ■

BY DR. RICHARD I. BARNHISEL

25 Years of Service to Our Members

The American Society of Mining and Reclamation (ASMR) held elections which were completed in mid-January. The incoming president-elect is Dennis Neuman and the two members to the National Executive Council (NEC), our governing board, are Eddie Bearden and David Lang. Dennis is currently a NEC board member and is the program chair for the meetings to be held in Billings, Mont., in 2009. He is a part of the Reclamation Research Group, LLC in Bozeman. Eddie works for Luminant Mining Company, LLC, formally known as TXU Mining Company. David is an associate professor of agronomy at Mississippi State University. These persons will assume their respective positions at mid-conference in Richmond, Va. The current officers include: Past-President, Robert Darmody; President, Paul Eger; President-Elect, Vern R. Pfannenstiel; and the current NEC board members are Dennis Neuman, Kimery Vories, Claire Dunne, and Anne Wagner. Dennis and Kimery will be leaving the NEC board as representatives, as will Bob Darmody as past-president.

By the time this issue of the magazine reaches you, the "official" membership renewal period of January and February will have ended. However, we welcome anyone not having renewed their dues to send them to me. We also hope many of the nearly 2,500 persons receiving *Reclamation Matters* who are not members will consider joining ASMR. Our dues are relative inexpensive – just $50 for regular members, $100 for corporate and sustaining members, and $10 for students. You would be helping not only our society to grow, but also helping to provide benefits to those interested in reclamation of our lands, regardless of the way they might have been disturbed. Forms to either join or renew your membership may be found on the ASMR Web page. The simplest way to find this site is to search on Google, or some other search engine, for ASMR or the American Society of Mining and Reclamation.

The main goal of the society is to share procedures and technologies for successful reclamation through meetings and the proceedings of our annual meetings. We hope to encourage professionals, as well as students, to study and develop new methods in reclamation and to serve as an avenue to publish these findings. We offer scholarships to students and hope to encourage them to enter the reclamation profession.

The postings on the "Assistantships and Job Opportunities" section of our Web site continue to be very popular. If you have an available position, send me the announcement and I will place it on the Web page. There is no cost for this listing. The advantage of being an ASMR member is that I send out a blind alert when a position has been listed.

If you haven't made plans to join us at Richmond in June, do it now. There are many interesting papers being prepared for these meetings. As I write this section for *Reclamation Matters,* these papers are being reviewed to be placed on a CD to be distributed at the meetings. This year we will be celebrating our 25th year, and these meetings will be held jointly with the International Affiliation of Land Reclamationists (IALR), which will be their 10th meeting. See you in Richmond! ■

BY JEFF SKOUSEN

Lend a Hand!

About a month ago, I received a copy of my alma mater's alumni magazine and saw that two of my favorite professors in range science were retiring. One of these professors had a particularly strong impact on my undergraduate experience so I wrote to congratulate him on his retirement. Among other things, I said, "… for our assignment in your wildlife management class, I chose to observe pheasants and document their habitat and behavior. At the end of the semester, the report was written and you gave me an A. You wrote a note on my report saying the data were very interesting and encouraged me to prepare an article to submit to a journal. I took your comment seriously. I prepared a manuscript and, with a lot of help from my advisor and the journal editor, the article was eventually accepted and my first journal article was published in 1982…"

As I reflected on Jerran Flinders' encouragement, I realized that many other individuals at various stages in my life had significant effects on me. Jim Davis, who gave me my first job in reclamation with the Utah Wildlife Resources, taught me the importance of good experimental design and correct data gathering techniques, and he convinced me that I could do graduate work. Chris Call and James Coker helped me as I continued my graduate training at Texas A&M and as I worked at Texas Utilities. John Sencindiver gets my everlasting gratitude for his constant encouragement, much-needed advice, and unwavering support when I arrived at West Virginia University. Much of what I know started with John's mentorship of a young and very inexperienced faculty member.

I suspect each of you have had similar mentors in your life in a variety of settings. Some were coaches of sports teams who gave you an optimistic "can do" attitude, some were religious leaders that helped you gain perspective on life's meanings, some may have been family members or good friends who came to your aid during personal trials, and some showed you the way when you needed it most. Some of our deepest friendships and enduring relationships were forged by someone extending comfort, guidance and service at pivotal periods.

Recognizing these dramatic and life-changing influences that people have had in our lives, all of us should seek to do the same for others. The challenge is to recognize those who are in need and to lend a hand even when we do not feel we can spare the time. Each of us has expertise and knowledge that others need or want. By mentoring others, we can in a small way repay all those who have done the same for us.

As I get older, I find myself wondering about my legacy and the contributions I have made to society. The good work I have tried to do will not survive me by very long unless I pass it on. But remember, mentoring is a two-way process; a cross-pollination takes place between mentors and apprentices, especially when we both listen carefully to questions and share ideas.

So I encourage you to share your knowledge and experience with others, especially the younger people, because your influence or your action might make the difference! ■

BY ZENAH W. ORNDORFF, W. LEE DANIELS, DELVIN S. FANNING
VIRGINIA TECH AND THE UNIVERSITY OF MARYLAND

Active Acid Sulfate Soils

in the Upper Coastal Plain of Virginia:

Two Reclamation Case Studies

Figure 1. Dr. Delvin S. Fanning demonstrates the violent oxidation reaction of sulfidic Tertiary sediments (sulfidic materials by Soil Taxonomy) with 30% hydrogen peroxide for participants of an acid sulfate soils tour for the World Congress of Soil Science, July 8, 2006.

In the eastern United States, the primary area of concern over acid rock drainage has been upon the Appalachian coal basin and associated pyritic overburden and coal waste materials (Sobek et al. 2000; Daniels and Stewart 2000). However, sulfidic deposits that give rise to active acid sulfate soils upon exposure to aerobic conditions are found in various geologic and geomorphic settings across the state of Virginia (Orndorff and Daniels 2004). In many of these settings, construction of highways, as well as commercial and residential sites, has resulted in localized acid rock drainage (ARD) problems. Increased development, along with wetland excavation and the ever-deeper nature of road cuts, has resulted in several new problem exposures, particularly of sulfide-bearing Tertiary sediments in the Upper Coastal Plain. Exposure of these sediments results in localized ARD that threatens water quality, in addition to the active acid sulfate soils that present problems for fill stability, integrity of building materials, and vegetation management.

Exposure of acid generating geologic materials during construction is a relatively new problem in Virginia. Although problematic roadcuts have been identified across the state for over 30 years, ARD problems associated with disturbance of Tertiary marine sediments for commercial and residential construction have become recognized mainly in the past decade. Consequently, most people involved in land development in this region are unaware of the problems associated with sulfide oxidation until they are encountered firsthand. Few developers have experience with acid sulfate soils and thus reclamation efforts have fallen to soil scientists with experience with such soils at Virginia Tech and the University of Maryland.

When notified of a possible acid sulfate site, current standard protocol by Virginia Tech is to conduct a field investigation, procure soil and drainage samples, complete laboratory analyses, and develop a reclamation prescription based on sample characteristics and site specific conditions. The prescriptions are largely based on values for peroxide potential acidity (PPA) – a procedure used to predict liming requirements based on the total acidity produced after complete oxidation of a sample by hydrogen peroxide (Barnhisel and

Harrison 1976). Fertilization needs also are addressed, and incorporation of organic amendments or topsoil covers is typically recommended, but not always essential for reclamation success. Emphasis is placed on the importance of thoroughly incorporating the lime to at least 15 cm, and on seeding only during established planting dates in the fall or spring. Two examples where this process has been completed include Stafford Regional Airport (SRAP) in Stafford, Va., and the Great Oaks subdivision in Fredericksburg, Va., as described subsequently in this report.

Stafford County Regional Airport (SRAP)

Construction of SRAP in the late 1990s exposed over 150 hectares of lower Tertiary age Coastal Plain sediments, most of which qualified as *sulfidic materials* (which acidify to pH 4 or less upon exposure to oxidizing conditions – some at SRAP acidified to less than 2 pH) as defined by *Soil Taxonomy* (Soil Survey Staff 2006). The airport runway was constructed through a deeply dissected landscape and long spur ridges were excavated to depths > 25 meters, exposing significant volumes of gray to dark gray (Munsell chromas of 1 or less) sulfidic sediments which show the presence of pyrite (FeS_2) by giving a violent heat and fume generating reaction with 30 percent hydrogen peroxide as demonstrated in Figure 1. This material was placed into intervening valley fills to support the runway, and excess was placed into several large, steeply sloping excess spoil fills along a first-order stream draining the eastern section of the site. The sulfidic nature of these materials was unfortunately not recognized until after final grading was completed, so the acid-forming *sulfidic materials* were not isolated away from drainage and, in fact, were essentially scattered randomly and thoroughly throughout the site. There is also anecdotal (personal communication) evidence that the contractors involved thought the dark colored materials were high in organic matter and, therefore, intentionally tried to spread them across the final revegetation surface.

An initial site visit in December 2001 revealed classic symptoms of active acid sulfate soils and acid sulfate weathering. The slopes were barren of vegetation and white salt efflorescences were prominent, as well as sulfurous odor that likely came from sulfur dioxide (not hydrogen sulfide that emanates from tidal marsh environments). A detailed discussion of the active acid sulfate soils at SRAP can be found in Fanning et al. (2004). Concrete lined drainage ditches and culverts throughout the airport were iron-stained from acid drainage, and the cement compounds were noticeably etched and degraded. Galvanized steel pipes in stormwater basins below the site were severely corroded, releasing large volumes of sulfidic sediments into the receiving floodplain.

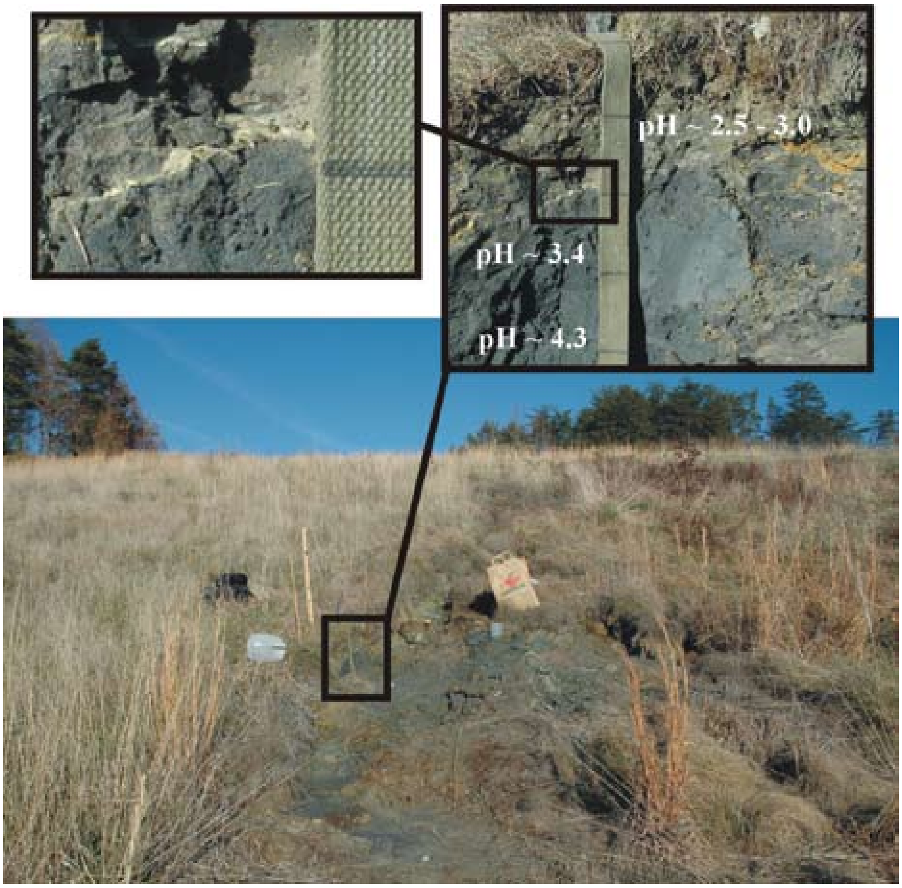

Figure 2. Photos of gullies from year 2005 on a reclaimed scalped land surface (engineering cut) with 25% slope at SRAP. The gullies have exposed dark gray sulfidic sediments. The details of a soil profile along the gully (10 cm increments on the tape) are shown to the upper right. Jarosite (a pale yellow mineral that formed on faces of the newly-formed soil structure after the new land surface was made in 2001) is shown within the profile in a close-up to the upper left.

In December 2001, surface soils across the site were mapped into 40 units and sampled. Soil pH ranged from 1.8 to 5.3 with an average of 3.0. Peroxide potential acidities ranged from 0 to 42 Mg calcium carbonate equivalence (CCE) per 1000 Mg material, with an average of 9.6. This is equivalent to approximately 22 Mg CCE per hectare (incorporation depth of 15 cm). We recommended that the site be variably limed to each sampling cell's requisite CCE requirement, fertilized appropriately, treated with an organic soil amendment, and seeded to acid- and salt-tolerant grasses and legumes, based upon our experience with sulfidic coal waste revegetation (Daniels et al. 2000). The airport opted to use lime-stabilized biosolids (sewage sludge) which are essentially an "all-in-one" treatment and, more importantly, were free of cost. In comparison, purchasing and applying agricultural lime, fertilizer and compost was estimated to cost over $2 million. The biosolids were supplied by the Blue Plains water treatment facility in Washington D.C., and several smaller regional treatment plants.

The recommendations described above were completed during the spring of 2002. Due to late seeding (past mid-April) and an exceptionally hot and dry summer, the site required overseeding in September, but by late October 2002 the airport was fully revegetated (> 90 percent living cover). Surface soil samples collected one, two and 3.5 years following reclamation, indicated average post-amendment pH across the site was > 6.0. To date, the vegetative cover has been maintained successfully without further amendment, however, highly acidic outcrop and seep areas on steep cut and fill slopes continue to demand intensive spot-liming and mulch treatments over time (Figure 2).

Throughout the reclamation period, water quality was monitored from several locations in and around the airport. Due to the naturally acidic nature of the soils within this watershed, background surface water (i.e., two streams draining into the airport) had pH values in the 4 to 5 range, and dissolved Fe concentrations less than 5 mg/L. In comparison, water discharging from the airport in early 2002 was highly acidified (pH < 3.5) and high in dissolved metals and S. Water quality responded quickly to the application of biosolids with pH increasing and dissolved metals decreasing. Since the reclamation work was completed through to the last sampling date in March 2006, water discharging from the airport typically has had pH values > 5 and metals and S concentrations have remained relatively low.

The only water quality data of concern, post-biosolids treatment, is the fact that the May through October 2002 samplings revealed significant levels of ammonium-N discharging from the airport. Current USEPA (1999) water quality criteria for ammonia indicate that all of our observations were significantly less than acute toxicity criteria (e.g., 36 mg/L at pH 7.0) but were approaching or significantly above the chronic effects level of approximately 4.0 mg/L. We believe the long-term impact from N losses was minimal compared to the potential environmental cost of taking no action.

Great Oaks Subdivision

Construction of the Great Oaks subdivision in Fredericksburg, Va., began in 2001. Problems arose in 2003 when major land disturbance exposed sulfide-bearing Tertiary marine sediments. Unaware of acid sulfate soil issues, the developer proceeded as usual with final grading, which resulted in variable dispersion of *sulfidic materials* throughout the newly constructed soils. Residents began moving into the development in early 2004. Researchers at Virginia Tech became aware of the site in August 2005 after being contacted by a concerned resident who could not establish a lawn (Figure 3). During the initial site visit, visual signs of acid sulfate weathering were only moderately evident. Surface soils consisted dominantly of "bright" oxidized colors (browns, yellows and reds) typically not associated with sulfidic soils. Reduced gray sediments indicative of *sulfidic materials* were observed, but seemed minimal. Some lawns were patchy, and iron staining on sidewalks was present, but not extensive. By the following summer these indicators were much more readily apparent with approximately 30 lots affected by acid sulfate weathering with the presence of active acid sulfate soils (Figure 4).

Although this site initially appeared only moderately impacted, the presence of sulfide-bearing sediments was enough to affect soil properties, plant growth and water quality. Peroxide potential acidity values for grab samples of surface soils were as high as 85 Mg CCE/ha, however, one solid dark gray clod found on the surface of one yard yielded a value of over 2,240 Mg CCE/ha. Although we believe this sample was an exception, it helps explain

Figure 3. Reclamation at Great Oaks subdivision in Fredericksburg, Va. A lawn covered with dead turf in the summer of 2005 (upper left) was treated that fall with applications of heavy lime (upper right), phosphorus and compost to achieve a successful cover (bottom) by the spring of 2006.

Figure 4. Dead turf and iron-stained concrete sidewalks and street gutters on a lot in the Great Oaks subdivision in May 2006 (top), and preliminary revegetation success a year later after reclamation measures were completed by the developer (bottom).

why some PPA values may be higher than expected given overall oxidized appearance of the soil and the seemingly low quantities of reduced gray sediments. Based on composite samples, a reclamation prescription was developed which included heavy liming (56 Mg/ha), phosphorus fertilization (336 kg/ha), and if possible an organic amendment such as compost – all to be incorporated to a depth of 15 cm. Due to the location in a residential neighborhood, application of biosolids (sewage sludge) was not an option. The reclamation work on one lot (Figure 3) was completed in fall 2005, and a grass cover was established by the following spring. As of our last field visit (October 2007), the grass continued to persist with few patchy areas.

Since spring 2006, the developer has applied a less intensive reclamation protocol to many of the acid sulfate affected properties at Great Oaks. Preliminary success of these measures in May 2007 is shown in Figure 4, but most of these lawns suffered an almost complete dieback of vegetation over the summer of 2007. Residents should still be concerned about possible acid sulfate corrosion of concrete and metal pipes on their properties and possible continued detrimental acid sulfate effects upon the quality of surface and ground waters within and leaving Great Oaks. Local water quality impacts (yellow boy, etc.) to a draining stream are clearly apparent in the field. On a positive note, the developer reportedly applied a protective asphalt base coating on all home foundations at the time of construction, and it is hoped this will prove acid-resistance over the long term.

Active measures taken by homeowners allowed Great Oaks to become the subdivision that made a difference. A resident whose property was affected by acid sulfate soils was elected to the Fredericksburg city council in 2006. He helped pass a city ordinance to reduce exposure of sulfidic materials from new construction. The new Acid Sulfate Soils Testing Policy specifies that soils must be tested for pH and potential acidity to the maximum depth of excavation to ensure that acidity levels are appropriate to support vegetation and to minimize damage to water quality and building materials. This is the first such ordinance in the mid-Atlantic region, and it will hopefully set a standard for other localities. The policy, which was effective as of March 2007, is available at www.cses.vt.edu/revegetation/remediation.html

Unfortunately, developers and engineers continue to expose *sulfidic materials* during earth-moving activities, unaware of or ignoring the pernicious chemical and mineralogical nature of these soils and sediments. Virginia Tech has been involved in an intensive outreach/extension effort to inform the development and engineering communities of the dangers of disturbing sulfidic materials, but the vast majority have not been trained and do not recognize these materials in the field. Similar acid forming materials underlie much of the mid-Atlantic Middle and Upper Coastal Plain at depths ranging from -5 meters to -15 meters and pose a distinct threat whenever deep excavations are executed. Hopefully, ordinances such as the one developed by Fredericksburg, will bring enhanced awareness of the need to prevent the exposure of sulfide-bearing soil materials that lurk at some depth within the soil-geologic column in many parts of the world. ■

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25th Annual Meeting
American Society of Mining & Reclamation
AND
10th Meeting
International Affiliation of Land Reclamationist

Richmond ✦ June 14 - 19, 2008

Advance Program & Registration Information

Acid sulfate soil impacts to soil and water quality in Stafford VA

Mineral sands (Ti + Zr) mine on former prime farmland in Dinwiddie VA.

"New Opportunities to Apply Our Science"

Major Sponsors (To Date)

Iluka Resources Inc.
Marshal Miller & Associates
USDI Office of Surface Mining
Virginia Dept. of Mines, Minerals & Energy
Virginia Tech Dept. of Crop and Soil Environmental Sciences
Weanack Land LLP

2008 Program Overview

Day	Time	Event (Program Page 15 for Details)
Saturday, June 14	8:00 a.m. to 5:00 p.m.	**Pre-Meeting Field Trip** *Mineral sands mining, dredge spoil utilization,* *wetland creation, sand & gravel mining.*
Saturday, June 14 to **Wed.,** June 18	12:00 p.m. Saturday to 4:30 p.m. Wednesday	**Registration Open** in Lower Lobby of Marriott Hotel During Meeting Hours
Sunday, June 15	8:00 a.m. to 5:00 p.m. 9:30 a.m. to 3:00 p.m. 5:30 p.m. to 7:30 p.m.	**3 Short Courses** **Civil War Battlefields Tour #1** **Opening Reception**
Monday, June 16	9:00 a.m. to 11:15 a.m. 11:30 a.m. to 12:00 p.m. 12:00 p.m. to 2:00 p.m. 2:00 p.m. to 5:30 p.m. 5:30 p.m. to 7:30 p.m.	**Welcome and Plenary Session** **ASMR General Business Meeting** **ASMR Awards Luncheon – 25th Anniversary** **Technical Sessions and Tech. Div. Meetings** **Exhibitor's Reception/Exhibit Hall**
Tuesday, June 17	8:15 a.m. to 5:30 p.m. 5:30 p.m. to 10:00 p.m.	**Technical Sessions and Tech. Div. Meetings** **Society Social Dinner at Shirley Plantation**
Wednesday, June 18	8:15 a.m. to 4:25 p.m. 5:30 p.m. to 8:30 p.m.	**Technical Sessions and Tech. Div. Meetings** **IALR Reception & Social**
Thursday, June 19	8:00 a.m. to 6:00 p.m.	**Post Meeting Field Trips** *1- Mineral Sands Mining and Reclamation* *2- Historic gold/metal mining and rehabilitation* *3- Acid sulfate soil impacts and remediation*
Monday, June 16 to **Wed.,** June 18	8:30 a.m. to 5:00 p.m. Each Day	**Non-Technical Tours** *Colonial Williamsburg, Richmond Gardens & Museums, Busch Gardens*
Friday, June 20	9:30 a.m. to 3:00 p.m.	**Civil War Battlefields Tour #2**

Travel, Lodging, and Sightseeing Information

Located in historic Richmond, the Lewis Ginter Botanical Garden offers year-round beauty with more than 40 acres of spectacular gardens and the mid-Atlantic's only classically styled Conservatory open to the public. PHOTO BY JOEL SOWERS

Transportation:

Richmond is served by eight major airlines via the newly-reconstructed Richmond International Airport (RIC) and by Amtrak rail service from the Washington, D.C. area. The airport is seven miles from downtown Richmond; complete airport information, flight listings, and shuttle/taxi listings are posted at: http://www.flyrichmond.com/

Meeting Venue and Lodging:

The Richmond Marriott will host all meeting functions, technical sessions, and exhibits. The Marriott is located in downtown Richmond, just blocks away from the Virginia Capitol and Civil War museums, and has been completely refurbished over the past two years. We encourage all attendees to stay at the Marriott hotel due to ASMR's contractual arrangements with this fine facility! Several restaurants and pubs are nearby, and we will provide shuttle service in the evenings to more distant restaurant and entertainment locales.

A block of rooms has been arranged for ASMR at the Richmond Marriott (downtown) under the name *American Society of Mining & Reclamation*. The ASMR room rate is $129 per night plus tax. Additional persons will be charged $10 per night per room. The current standard/corporate rate at this hotel is $269 per night. Hotel information and maps are available at the Website listed below. **The cut-off date for preferred rate reservations is Wednesday, May 14, 2008.**

Reservations may be made by calling 1-800-228-9290 or online at www.marriott.com/ricdt. The group code for online registration via the Marriott Web site is "**marmara**". A limited block of government rate rooms is also available at the Federal per diem rate (currently $115 per night plus tax) for individuals with valid ID at check-in. For online government rates, use "**amramra**" as your group code.

Sightseeing and Family Travel Opportunties in and Around Richmond:

Due to the timing and location of this year's ASMR/IALR meetings, we hope that you will consider the following sightseeing and vacation opportunities in and around Richmond:

Major Attractions Within One Hour of Richmond:

Busch Gardens, Colonial Williamsburg, Jamestown Settlement, Kings Dominion, Shirley Plantation, Yorktown Victory Center, and 10+ Civil War battlefields.

Major Attractions Within Two Hours of Richmond:

Washington D.C., Quantico Marine Museum, Smithsonian Aviation Museum/Dulles, Norfolk & Naval Base, Virginia Beach, and many more Civil War battlefields!

Richmond Highlights:

Downtown Richmond has undergone a major rebuilding and revitalization program over the past several years, and provides an impressive array of restaurants, museums, historical attractions, and entertainment options (http://visit.richmond.com/). Of particular note are the Virginia Museum of Fine Arts, Lewis Ginter Botanical Gardens, Confederate White House & Museum of the Confederacy, Tredegar Iron Works/Civil War Center, James River Canal Walk, and numerous Civil War battlefields nearby.

Sponsorship Opportunities

The following organizations have committed to be major sponsors of ASMR/IALR 2008:

Iluka Resources Inc.
Marshall Miller & Associates
USDI Office of Surface Mining
Virginia Dept. of Mines, Minerals & Energy
Virginia Tech Dept. of Crop and Soil Environmental Sciences
Weanack Land LLP

Information on sponsorship opportunities is available at the Web link below. All sponsors will be prominently featured in the on-site program and recognized at meeting events. Sponsorship is very important to ASMR as a mechanism to keep registration to a minimum and to encourage student participation. Details on sponsorship opportunities are available at the URL listed below!

ASMR Annual Exhibit and Tradeshow

The ASMR Exhibit and Trade Show is an important part of every meeting and serves as an important focal point for both technical and social interaction. Coffee and refreshment breaks and receptions will be held in this area along with poster presentations. Setup time is scheduled from 12 noon to 5:30 p.m. on Sunday, June 15, 2008 with breakdown following the afternoon break between 3:00 p.m. and 6:00 p.m. on Wednesday, June 18, 2008. Exhibit & Trade Show registration and logistical information are available at the Web link below. Standard exhibitor registration is $1,000 and includes two full registrations.

IALR and International Delegate Recognition

This meeting will serve as the 10th meeting of the International Affiliation of Land Reclamationists (http://ces.ca.uky.edu/asmr/IALR.htm). IALR presentations will be highlighted in the program and a special IALR social function will be held (location TBA) on Wednesday evening June 18. International delegates needing assistance with travel arrangements should contact the IALR Coordinator for assistance: W. Lee Daniels (wdaniels@vt.edu).

Program Updates and Information:

http://www.cses.vt.edu/revegetation/ASMR_2008.html

National Executive Committee (NEC) Meetings

The ASMR NEC will meet from 9:00 a.m. to 5:30 p.m. on Sunday, June 15, and again from 8:30 a.m. to 12 noon on Thursday, June 19. Location TBA at registration.

Workshops/Short Courses, Sunday, June 15

All workshops run from 8:00 a.m. to 5:00 p.m.; CEUs will be granted by Va Tech

Workshop #1:

Passive Treatment of Mine Drainage.
Robert S. Hedin, Ph.D. and George R. Watzlaf; Hedin Environmental, Pittsburgh.

The reauthorization of Title IV of the Surface Mining Control and Reclamation Act (SMCRA) will dramatically increase funds available for the treatment of mine water. It has been projected that about $4 billion will be made available for mine reclamation over the next 10 years, with 30 percent (up from 10 percent) of this “set aside” for water treatment. In many states, this will translate into a tenfold increase in funding for the treatment of mine water. Because of this drastic increase in funding, there is a critical need for scientifically sound and practical information in order to successfully design and build passive treatment systems. This course will cover the basics of the biogeochemistry of the formation, mitigation and treatment of acid mine drainage. Passive treatment of mine drainage will be taught from an applied science perspective and include very useful information: the essential water quality/quantity characterization, selection of the proper passive treatment system, correctly sizing the system, successful construction techniques, required maintenance after construction, as well as all of the cost associated with these tasks. Practical rules of thumb and information on useful field tests and procedures that will help to ensure the success of passive systems will be provided based on years of experience and empirical data.

Cost: *$150 per person including lunch*
Min/Max participants: 15/45

Workshop #2:

Estimating Erosion Rates on Mine Lands: An Introduction To The Revised Universal Soil Loss Equation (RUSLE, Version 2) ***Terry Toy, Ph.D., University of Denver (retired)***

Successful mine reclamation requires erosion control. The Revised Universal Soil Loss Equation (v.2) is the best, practical tool for estimating erosion rates on mine lands. These erosion-rate estimates, then, provide a solid foundation for erosion-control and reclamation planning. Increasingly, regulatory authorities are requiring, or strongly encouraging, erosion-rate estimates as part of new, revised, or renewed reclamation plans. In this workshop, you will learn the basics of RUSLE 2 use through discussions coupled with "hands-on" exercises. You will learn how environmental conditions influence erosion rates and how RUSLE 2 captures the main effects of these conditions to estimate erosion rates. You will learn how to manipulate RUSLE 2 in order to evaluate the effectiveness of various erosion-control alternatives. You will learn that RUSLE 2 also can provide sediment discharge estimates that can be a part of sediment-control planning. Participants will receive a workbook of RUSLE 2 exercises, a CD containing the RUSLE 2 program, and a user's guide for RUSLE 2 applications on severely disturbed lands as a part of the registration fee. Participants are expected to bring a laptop computer to the workshop into which the RUSLE 2 program can be loaded (arrange authorization to add a program, if necessary).

Cost: *$175 per person including lunch*
Min/Max participants: 5/20

Workshop #3:

Recognition and Remediation of Acid Sulfate Soil Conditions. ***Zenah Orndorff, Ph.D. (Va Tech), Del Fanning (U of MD) and W. Lee Daniels (Va Tech)***

Acid sulfate soils are increasingly encountered at construction and road-building sites in the mid-Atlantic region as sulfide bearing sediments and rocks are disturbed and oxidize to produce highly acidic seepage waters that stain and damage concrete (see program cover) and other building materials. When these materials are exposed at the surface they produce extremely acidic soils (< pH 3.5) that are impossible to revegetate via conventional method. Exposure of acid sulfate materials also produces acidic sediments and runoff that damage local water quality. This intensive one-day short-course will focus on field recognition, prediction, and remediation of the adverse effects of acid sulfate soil weathering processes. The relationship of acid sulfate occurrence to regional geologic conditions and land disturbance practices will be reviewed in detail. Several case studies will be reviewed in detail including the Stafford Airport and Great Oaks subdivision sites that will be featured in post-meeting Field Trip #3.

Cost: *$125 per person including lunch*
Min/Max participants: 5/50

Plenary Session

Monday, June 16,
9:00 to 11:30 a.m.

A range of speakers from various mining/environmental, non-mining remediation, and regulatory sectors will address the meeting theme, ***New Opportunities to Apply Our Science,*** from local, national, and international perspectives. Our speakers will include:

Dr. Mike Karmis, Director, Virginia Center for Coal & Energy Research

Mr. John Craynon, USDI Office of Surface Mining, Washington, D.C.

Mr. Ed Chu, USEPA National Center for Environmental Economics

Mr. Neil Humphries, Director URS Corp, U.K. & Ireland

Mr. Conrad Spangler, VDMME

Technical Sessions

Monday to Wednesday, June16 to 18

Go to http://www.cses.vt.edu/revegetation/ASMR_2008.html for an updated listing of all Technical Session oral presentations (85+) and posters. The overview schedule of Technical Sessions follows on page 15 and a detailed list of all papers as of January 2008 begins on Page 19.

Photo by Daniel Farrell

Shirley Plantation

ASMR Dinner

Shirley Plantation, Tuesday, June 17

Buses will depart the Marriott between 4:30 and 6:30 to transport you 20 miles down scenic Route 5 along the James River to Shirley Plantation (http://www.shirleyplantation.com). Shirley is Virginia's first plantation (1613) and features the Great House and eight other historic original outbuildings. Those arriving on the earlier buses will be able to tour adjacent research areas (see pre-meeting field trip description) and leisurely explore Shirley Plantation's extensive grounds and outbuildings or take a guided tour of the Great House. A BBQ dinner will be served at 7:00 p.m. followed by a bluegrass band. Beer, wine and soft drinks will be provided throughout the evening. Early buses will return to Richmond departing at 8:30 p.m. with later buses departing by 10:00 p.m. The cost for this event is $40 per person.

ASMR June 2008 Technical Session Schedule Overview – 85+ Technical Presentations!

Monday June 16 a.m.	9:00-11:15	**Plenary Session**		
		Room 1	Room 2	Room 3
Monday June 16 p.m.	2:00-3:15	1 - Revegetation and Wildlife #1	2 - Soil Reconstruction #1	3 - Mine Water Treatment #1
Break				
	3:40-4:30	4 - Revegetation and Wildlife #2	5 - Soil Reconstruction #2	6 - Mine Water Treatment #2
	4:30-5:30	TD* - Ecology	TD - Soils and Overburden	TD - Geotechnical Engineering
Tuesday June 17 a.m.	8:15-9:55	7 - Coal Mine Reforestation in Appalachia #1	8 - Beneficial Reuse of Waste Materials #1	9 - Biochemical Reactors for the Treatment of Mining Influenced Waters #1
Break				
	10:20-noon	10 - Coal Mine Reforestation in Appalachia #2	11 - Beneficial Reuse of Waste Materials #2	12 - Biochemical Reactors for the Treatment of Mining Influenced Waters #2
Tuesday June 17 p.m.	1:30-2:45	13 - Soil and Overburden Reclamation and Management	14 - Reclamation Planning - Land Use #1	15 - Mine Water Treatment #1
Break				
	3:10-4:25	16 - Reclamation Reforestation	17 - Reclamation Planning - Land Use #2	18 - Mine Water Treatment #2
	4:25-5:30	TD - Forestry and Wildlife	TD - Land Use Planning and Design	TD - Water Management
Wednesday June 18 a.m.	8:15-9:55	19 - International Tailings Reclamation	20 - Reclamation Planning – Remediation #1	21 - OSM/VISTAs: Partners in Remediation
Break				
	10:20-noon	TD - International Tailings Reclamation	22 - Reclamation Planning – Remediation #2	23 - Stream Water Quality #1
Wednesday June 18 p.m.	1:30-2:45		24 - Reclamation Planning - Regulatory Issues #1	25 - Stream Water Quality #2
		Break		
	3:10-4:25	*Technical Division Meetings	26 - Reclamation Planning - Regulatory Issues #2	27 - Stream Water Quality #3

A detailed list of all papers as of January 2008 begins on Page 19.

Field Trips and Non-Technical Tours

Pre-Meeting Tour
Saturday, June 14
8:00 a.m. to 6:00 p.m.

Mineral sands mining, dredge spoil utilization, wetland creation, sand & gravel mining and reclamation
Leader: W. Lee Daniels, Virginia Tech

This field trip will depart the Richmond Marriott at 8:00 a.m. and travel by vans to the Iluka Mineral Sands mining complex in Dinwiddie County to tour active mining operations, prime farmland reclamation research, and the Virginia Tech/Carraway-Winn cooperative research farm. The tour will then proceed to Vulcan's Puddledock sand and gravel mine near Petersburg for an overview of active mining and reclamation procedures and challenges. The trip will conclude with a visit to Weanack LLP in Charles City County to focus on beneficial conversion of dredge materials to agricultural uses and research on creation of tidal freshwater wetlands. Related details on these sites and associated Virginia Tech research and outreach programs can be found at http://www.cses.vt.edu/revegetation/

Cost: $50 per person; includes transportation and lunch.
Min/Max participants: 10/60

Post-Meeting Tours
Thursday, June 19
8:00 a.m. to 6:00 p.m.

Cost for all trips: $50 per person; includes transportation and lunch

Tour #1 – Mineral Sands Mining and Prime Farmland Reclamation
Leaders: W. Lee Daniels (Va Tech) and Chuck Stilson & Clint Zimmerman (Iluka Resources)

Mineral sands mining for ilmenite, rutile, and zircon will disturb over 5,000 acres of prime agricultural farmland in Virginia and North Carolina (USA) over the next 20 years. Mining of the Virginia deposit (Old Hickory) was initiated in 1997 and approximately 1,500 acres have been disturbed to date with approximately 500 acres reclaimed to support a mix of agricultural post-mining land uses. This tour will travel to the Iluka Mineral Sands mining complex in Dinwiddie County to tour active mining operations, prime farmland reclamation research and the Virginia Tech/Carraway-Winn cooperative research farm. Mine tour stops will include active mining pits, tailings/slimes backfill and management, topsoil handling, and final grading and reclamation. Reclamation research stops will include pre-mining soils and local geomorphic relationships, soil reconstruction experiments, forage management experiments, and biosolids utilization research on the Carraway-Winn Reclamation Research Farm. Sturdy boots are required for this trip and you should expect to get muddy. Min/Max participants: 10/90
Info: http://www.cses.vt.edu/revegetation/mine-%20mineral_sands.html

Tour #2 – Historic Gold and Metal Mining and Rehabilitation
Leaders: Allen Bishop and Bob Sobeck, VDMME Div. of Mineral Mining

Mining began at the massive sulfide deposits of the Gold-Pyrite belt in Mineral, Va., in 1834 with exploration continuing into the 1970s. With 20 metal mines in this area of Louisa and Spotsylvania Counties, this tour will visit several mines along Contrary Creek that have not been reclaimed and the Valzinco Mine where reclamation has recently been completed. Reclaimed under Virginia's Orphaned Land Program, the Valzinco Mine reclamation has seen average annual pH values of 2.6 – 3.9 rise to above 5 and dissolved metal concentrations fall 75 percent to 99 percent. The tour will include discussion of the history of the mining in this area, the environmental and safety problems, which continue to exist many years after mining has ceased, and the various techniques to reclaim the sites. Sturdy shoes recommended. Min/Max participants: 10/60

Tour #3 – Acid sulfate Soil Impacts and Remediation
Leaders: Zenah Orndorff (Va Tech) and Del Fanning (U of MD)

Acid sulfate soils are increasingly encountered at construction and road-building sites in the mid-Atlantic region as sulfide bearing sediments and rocks are disturbed and oxidize to produce highly acidic soils and local water quality impacts. This field trip will visit a range of acid sulfate soil impacted sites near Fredericksburg including Stafford Regional Airport, Great Oaks Subdivision, and Massaponax. Recognition of acid sulfate soil conditions, associated morphologies, and damage to concrete/soil/water will be reviewed at Stafford Airport along with a tour of areas remediated via use of lime stabilized biosolids. The tour will return via Luck Stone's Caroline sand and gravel mine where active mining/reclamation will be reviewed along with a discussion of remediation of on-site acid-sulfate sediments that were used for pond embankments. Sturdy shoes recommended. Min/Max participants: 10/60
Info: http://www.cses.vt.edu/revegetation/remediation.html

Non-Technical Tours

Sunday, June 15 – Civil War Battlefields Tour #1

Tour vans will depart the Marriott at 9:30 a.m. and travel to Petersburg to meet your dynamic tour guide, Mr. John Marler (http://www.appomattoxtours.com/). The tour will start with an overview of the city and the siege. Next, you will take a walk round Battery #5 for a review of the initial Federal assault, and visit the site of the charge of the 1st Maine Heavy Artillery (largest loss of troops in any action during the war…started out with 900+...10 minutes later 632 were dead and wounded). The tour will continue to Lee's last offensive at Fort Stedman and then onto the Battle of the Crater plus other smaller sites. This tour will finish up with a delicious lunch at the Brickhouse Run Pub in restored Petersburg and then your vans will return you to hotel by 3:00 p.m.

Cost: $50 person including transportation and lunch. Min/Max participants: 20/60

Monday, June 16 – Colonial Williamsburg and Shopping Van will depart the Marriott at 8:30 a.m. and transport you to Colonial Williamsburg and area shopping. Return to hotel at 5:00 p.m.. **Cost:** $20 per person for transport and assistance by a "local". Admission fees not included.
Min/Max participants: 6/24
Info: http://www.colonialWilliamsburg.com/

Tuesday, June 17 – Lewis Ginter Botanical Gardens, Virginia Museum of Fine Arts, and other Richmond cultural sites. Van will depart the Marriott at 8:30 a.m. and return at 4:30 p.m. **Cost:** $20 per person for transport and local assistance. Admission fees not included. Min/Max participants: 6/24
Info: http://www.lewisginter.org/; http://www.vmfa.state.va.us/

Wednesday, June 18 – Busch Gardens
Van will depart the Marriott at 8:30 a.m. and transport you to Busch Gardens in Williamsburg. **Cost:** $20 per person for transport and assistance by a "local." Return to hotel at 5:30 p.m. Admission fees are not included. Min/Max participants: 6/24
Info: http://www.buschgardens.com/BGW/default.aspx

Friday, June 20 – Civil War Battlefields Tour #2

Tour vans will depart the Marriott at 9:30 a.m. and travel to Petersburg to meet your dynamic tour guide, Mr. John Marler (http://www.appomattoxtours.com/). This tour will start with the Battle of Weldon RR followed by a visit to Poplar Grove National Cemetery. Next you will visit Fort Fisher, (largest fort in the Union lines), and the "Fishook" (where the kickoff for the final charge of Petersburg began). Then it's onto Five Forks battlefield where Custer and other famous solider fought. The tour will conclude at Ft. Gregg, (the Alamo of the Confederacy). Compared with the first Civil War tour offered on June 15, this tour visit more remote locales and involve more walking. Your vans will return you to hotel by 3:00 p.m.

Cost: $50 person including transportation and lunch. Min/Max participants: 20/60

ASMR/IALR 2008 Meeting Committee and Contact Information

Program Chair: ***W. Lee Daniels***, 540-231-7175, wdaniels@vt.edu
Crop & Soil Env. Sciences, Virginia Tech

Proceedings: ***R.I. Barnhisel****, 859-351-9032, asmr5@insightbb.com
ASMR Executive Secretary

On Site Registration and Exhibits: ***Sue Brown,*** 540-231-5741, suebrown@vt.edu
Crop & Soil Env. Sciences, Virginia Tech

Local Arrangements: ***Chee Saunders,*** 804-798-6525, chee.saunders@mma1.com
Marshall Miller & Assoc., Ashland, Va.

Field Trips: ***Allen Bishop***, 434-951-6310, Allen.Bishop@dmme.virginia.gov
Va. Dept. Mines, Minerals & Energy, Charlottesville, Va.

Technical Sessions: ***Carl Zipper,*** 540-231-9782, czip@vt.edu
Crop & Soil Env. Sciences, Virginia Tech

*R.I. Barnhisel is also the ASMR contact for all inquiries related to manuscript submission and review, meeting pre-registration, and membership applications.

Registration Form

2008 ASMR/IALR Meetings, June 14-19, Richmond, Va.

Conference Registration

		No.	Cost
Early Registration*	$350	____	____
Late Registration* (Postmarked/received after May 2, 2008)	$400	____	____
Student Registration* (With valid ID or ASMR student member)	$175	____	____
One-Day Registration (circle M, T and/or W)	$200	____	____
Spouse/Guest Lunch Tickets (M or T, cost per day)	$ 30	____	____
Spouse/Guest Registration* (with one paid regular registration)	$175	____	____
ASMR Social Dinner @ Shirley Plantation	$ 40	____	____

**Includes access to all sessions and exhibits, 2 receptions with food/ drinks, 3 continental breakfasts, all day coffee/snack breaks, awards luncheon, Tuesday buffet lunch, and Proceedings CD.*

Workshops/Short Courses**

Workshop #1: Passive Treatment of Mine Drainage	$150	____	____
Workshop #2: Estimating Erosion Rates on Mine Lands	$175	____	____
Workshop #3: Recognition/Remediation Acid Sulfate Soils	$125	____	____

Technical Tours** (Transport and lunch included)

Pre-meeting tour on Saturday, June 14	$ 50	____	____
Post meeting tours on Thursday, June 19 (Circle tour: #1 #2 or #3)	$ 50	____	____

Non-Technical Tours** (Transport included for all)

Civil War Battlefields, #1 – 6/15 & #2 – 6/20, w lunch (Circle choices)	$ 50	____	____
Williamsburg 6/16; Richmond 6/17; Busch G. 6/18 – (Circle choices)	$ 20	____	____

***Contingent upon minimum participation. Fees will be refunded for low enrollment activities.*

Total registration costs for conference, workshops and tours:	**Total**	______
Credit card processing fee:	$5	______
No refunds after June 2. Prior to June 2 we will deduct $50 for cancellations.	**Grand Total Due:**	______

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Registration contacts (R.I. Barnhisel): Ph. 859-351-9032; Fax 859-335-6529; asmr5@insightbb.com

ASMR 2008 Technical Sessions

Preliminary Detailed Schedule

Notes: *Title and author information given here is taken directly from abstracts as submitted and may change with final manuscript submission. Acceptance into final program for oral presentation is contingent upon final manuscript submission and approval. Concerns regarding these listings and manuscript status should be directed to R.I. Barnhisel – asmr5@insightbb.com*

Papers with first author in bold font are international contributions.

Oral presentations will be 20 minutes with 5 minutes for Q&A

Session 1: Revegetation and Wildlife #1 – Monday, June 16, 2:00 – 3:15 p.m.

Assessment of Abandoned Quarries in Lebanon, East Mediterranean for Revegetation and Water Harvesting. **T.M. Darwish**, R. Stehouwer, D. Miller, J. Sloan, I. Jomaa, A. Shaban, C. Khater, and M. Hamzé; National Council for Scientific Research-Remote Sensing Center, P.O. Box: 11-8281, Mansourieh, Lebanon

Reclamation and Revegetation in the Copper Basin: London Mill Area. K. L. Faulk, C.L. Stokes, and F. Miller; Barge, Waggoner, Sumner & Cannon, Inc. Nashville TN

Root and Shoot in Metallicolous and Non Metallicolous Ecotypes of Thlaspi Caerulescens Growing in Mine Soils of Mibladen and Zaida (North West of Morocco). **Safae Berrah El Kheir,** Nadia Saidi, and Abdelhak Bouabdli; Environment Georesources Laboratory, Geology Department, IBN Tofail University, Kenitra, Morocco

Session 2: Soil Reconstruction #1 – Monday, June 16, 2:00 – 3:15 p.m.

Subsoils As Topsoil Substitutes for Surface Coal Mine Reclamation In Mississippi: Alluvial Floodplains. David J. Lang and George Hawkey; Dept. of Plant and Soil Sci., Miss. State University

Effects of Stockpiling and Topsoil Replacement on Soil Carbon Pools. A.F. Wick, P.D. Stahl, L.J. Ingram, and L. Vicklund; University of Wyoming, Dept. of Renewable Resources, Laramie, Wyo.

Research on Land Reclamation Using the Deep Digging and Shallow Padding Method. **Zheng Liquan**, Hu Zhenqi, Zhao Yanling, and Yue Mei; Institute of Land Reclamation and Ecological Reconstruction of China University of Mining & Technology, Beijing, China

Session 3: Mine Water Treatment #1 – Monday, June 16, 2:00 – 3:15 p.m.

Microcosm Evaluation of Crab-Shell Chitin for the Remediation of Mine Impacted Water from Three Sites within Central Pennsylvania and Comparison with Other Leading Substrates. M.A. Robinson-Lora and R.A. Brennan; Department of Civil and Environmental Engineering, The Pennsylvania State University, University Park, Pa.

Evaluation of Three Different Purities of Crab-Shell for the Remediation of Mine Impacted Water: Uncoupling the Contributions of Chitin, Protein, and Calcium Carbonate. K.M. Korte, C.E. Newcombe, and R.A. Brennan; Department of Civil and Environmental Engineering, The Pennsylvania State University, University Park, Pa.

The Use of Peat Pellets to Remove Trace Metals from Mine Drainage. Paul Eger, Eric Paulson, and Doug Green; Minnesota Dept of Natural Resources, Division of Lands and Minerals, Box 45 500 Lafayette Road, St. Paul, Minn.

Session 4: Revegetation and Wildlife #2 – Monday, June 16, 3:40 – 5:00 p.m.

Differential Uptake of Transition Elements by Mesquite Obtained from Plants Grown in Impacted and Clean Sites. Nazmul Haque, Jose R. Peralta-Videa, and Jorge L. Gardea-Torresdey; The University of Texas at El Paso, El Paso, TX

Coal Mining and the Endangered Indiana Bat. Kimery C. Vories; Mid-Continent Region, U.S. DOI Office of Surface Mining, 501 Belle St., Alton, Ill.

Ecology Technical Division Meeting

Session 5: Soil Reconstruction #2 – Monday, June 16, 3:40 – 5:00 p.m.

Impact of Soil Reconstruction Method on Nitrate Accumulation in Forages Grown for Livestock Feed. Chris D. Teutsch and W. Lee Daniels; Dept. of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Impact of Soil Reconstruction Method on Yield, Nutritive Value and Botanical Composition of a Mixed Cool-Season Grass-Legume Stand. Chris D. Teutsch and W. Lee Daniels; Dept. of Crop and Soil Environmental Sciences, Virginia Poly. Institute and State University, Blacksburg, Va.

Utilizing Dredged Sediment for Brownfield Reclamation. Robert Darmody; University of Illinois.

Soils and Overburden Technical Division Meeting

Session 6: Mine Water Treatment #2 – Monday, June 16, 3:40 – 5:00 p.m.

Removal Mechanisms for Constructed Wetlands Receiving Lead Mine Water. Mark Fitch, Joel Burken, and Chang Ye; Civil, Architectural and Environmental Engineering, University of Missouri-Rolla, Rolla, Mo.

Designing a Biochemical Reactor for Selenium and Thallium Removal, from Bench Scale Testing Through Pilot Construction. E.P. Blumenstein, J. Volberding, and J.J. Gusek; Golder Associates, Inc., 44 Union Blvd #300, Lakewood, Colo.

Case Studies - Bench Scale Biochemical Reactor Results from Two Sites at the Elizabeth Mine, Vermont. David Reisman; Engineering Technical Support Center, LRPCD, NRMRL, ORD, U.S. EPA, Cincinnati, OH

Geotechnical Engineering Technical Division Meeting

Session 7: Coal Mine Reforestation in Appalachia #1 – Tuesday, June 17, 8:15 – 9:55 a.m.

Tree Growth, Natural Regeneration, and Hydrologic Characteristics of Three Loose-Graded Surface Mine Spoil Types in Kentucky. Patrick N. Angel, Christopher D. Barton, Richard C. Warner, Carmen Agouridis, Tim Taylor, and Sarah L. Hall; Soil Science, University of Kentucky (UK), Lexington, Ky.

Evaluating Spoil A.m.endment Use on Reforestation Productivity in the Eastern and Western Kentucky Coalfields. Christopher D. Barton, Rick J. Sweigard, and Donald Marx; Department of Forestry, U.K.

Early Tree and Ground Cover Establishment as Affected by Seeding and Fertilization Rates in Tennessee. D. S. Buckley and J. A. Franklin; Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tenn.

Native Hardwood Reforestation after Five Years for Phase III Bond Release. J. A. Burger, D. Mitchem, C. E. Zipper, and R. Willia.m.s; Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Session 8: Beneficial Reuse of Waste Materials #1 – Tuesday, June 17, 8:15 – 9:55 a.m.

Soil Nitrogen Replenishment Resulting from Long-Term Application of Biosolids for Reclamation of Strip-Mined Land. G. Tian, T.C. Granato, A.E. Cox, R. I. Pietz, and C.R. Carlson, Jr.; MWRD-Chicago, Lue-Hing R&D Complex, 6001 W. Pershing Road, Cicero, Ill.

Nutrient Fluxes from Abandoned Mine Soils Reclaimed with Poultry Manure and Paper Mill Sludge. Ashlee Dere, Richard Stehouwer, and Kirsten McDonald; Penn State Univ., Univ.Park, Pa.

Transformation of Phosphorus and Nitrogen in Deep Row Biosolids Incorporation Technology in Coastal Plain Mining Sites in Virginia. Kirill Kostyanovsky, Katrina Lasley, Beshr Sukkariyah, Gregory Evanylo, and Chao Shang; Dept. of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Alkaline Addition Problems at the Skytop/Interstate-99 Site, Central Pennsylvania. Arthur W. Rose and Hubert L. Barnes; Geochemistry, Pennsylvania State University, University Park, Pa.

Session 9: Biochemical Reactors for the Treatment of Mining Influenced Waters #1 Tuesday, June 17, 8:15 – 9:55 a.m.

Bench-Scale Studies Comparing Chitin and Organic Substrate on the National Tunnel Waters in Blackhawk, Colorado: Unusual Manganese Removal. C. Venot, R.A. Brennan, L. Figueroa, T.R. Wildeman, D. Reisman, and M. Sieczkowski.

Final Results of Two-Year Sulfate Reducing Bioreactor Pilot Test at the Golinsky Mine, California. James Gusek, Thomas Rutkowski, Eric Blumenstein, and Brad Shipley; Golder Associates, Inc., 44 Union Blvd #300, Lakewood, Colo.

Performance of Mesocosm Sulfate-Reducing Bioreactors for Treating Acid Mine Drainage in New Zealand. **Craig A. McCauley**, Aisling D. O'Sullivan, Paul A. Weber, and Dave A. Trumm; Department of Civil and Natural Resources Engineering, University of Canterbury (UC), Christchurch, New Zealand

The Construction and Instrumentation of the Standard Mine Pilot Treatment System. David Reisman, Thomas Rutkowski, Pat Smart, and James Gusek; Engineering Technical Support Center, LRPCD, NRMRL, ORD, U.S. EPA, Cincinnati, OH

Session 10: Coal Mine Reforestation in Appalachia #2 – Tuesday, June 17, 10:20 – noon

Survival and Growth of Commercial Hardwoods in Brown vs Gray Sandstone on a Mountaintop Mine in Southern West Virginia. Paul Emerson and Jeff Skousen; 1112 Agricultural Sciences, Division of Plant and Soil Sciences, West Virginia University, Morgantown, W.Va.

Fourth-Year Tree Response to Three Levels of Silvicultural Input on Mined Lands. C. Fields-Johnson, T.R. Fox, J.A. Burger, and C. E. Zipper; Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Direct-Seeding Versus Containerized Transplantation of American Chestnuts on Loose Mine Spoils in the Cumberland Plateau. Michael E. French, Christopher D. Barton, and Donald Graves; Department of Forestry, University of Kentucky.

Phytopthora Occurence at a Surface Mine Reforestation Site. Kathryn M. Adank, Christopher D. Barton, and Patricia B. de Sá; Department of Earth and Environmental Sciences, University of Kentucky (UK), Lexington, Ky.

Session 11: Beneficial Reuse of Waste Materials #2 – Tuesday, June 17, 10:20 – noon

Evaluation of Leachate Chemistry from Coal Refuse Blended and Layered with Fly Ash. Hunt, Joe, Matt Eick, W. Lee Daniels, and Mike Beck. Dept. of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Use of Fly Ash to Control Acidic and Heavy Metal Pollution from Coal Waste. **Hu Zhenqi**, Zhang, Mingliang, Ma Baoguo, Wand Ping, and Kang Jingtao. Institute of Land Reclamation and Ecological Restoration, China University of Mining and Technology, Beijing, China.

Plant Growth Effects of CCP Amendment to Mine Spoils and Associated Leaching Potentials. Michel A. Beck, W. Lee Daniels, and Matt Eick; Dept. of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Remediation of Acid Sulfate Soils with Lime-Stabilized Biosolids, Lime and Yardwaste Compost. Z.W. Orndorff and W.L. Daniels; Dept. of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Session 12: Biochemical Reactors for the Treatment of Mining Influenced Waters #2 Tuesday, June 17, 10:20 – noon

Effect of Substrate on Performance of Field Scale Biochemical Reactors Treating Mine-Influenced Water. David J. Reisman, Linda Figueroa, Amy Pruden, Maria Virginia Prieto, Luciana Pereyra, Sage Hiibe, and Michael Holmes; Engineering Technical Support Center, LRPCD, NRMRL, ORD, U.S. EPA, Cincinnati, OH

Chemical and Microbiological Long-Term Monitoring of Two 1,500-Gallon, Sulfate-Reducing Tanks for the Passive Treatment of Acid Mine Drainage. Ana Ruiz, Linda Figueroa, Marek Zaluski, and Diana Bless; Environmental Science and Engineering, Colorado School of Mines, Golden, Colo.

Evaluation of Solid and Liquid Phase Organic Substrates Used Sulfate-Reducing Bioreactors for the Treatment of Mining Impacted Water. Christophe Venot, Linda Figueroa, James J.Gusek, Thomas Wildeman, Mike Holmes, and David Reisman.

Session 13: Soil and Overburden Reclamation and Management

Tuesday, June 17, 1:30 – 2:45 p.m.

Reclamation of Acid forming Mine Spoils in Paracatu, Minas Gerais State, Brazil. **Luiz Eduardo Dias** and Igor Rodrigues de Assis; Soil Department, Federal University of Viçosa, Viçosa-MG. Brazil.

Standard Weathering Procedure for Coal Overburden, Inter-Laboratory Study of Leachate Composition. Eric F. Perry, B. Keith, C. Brady, Roger J. Hornberger, and Joan Cuddeback; Office of Surface Mining, 3 Parkway Center, Pittsburgh, Pa.

Effect of Na-Bentonite and Mycorrhizae on Remediation of Cadmium Conta.m.inated Soil. **Xiuhong Yang,** Zhenqi Hu*, Xiumin Yang, Shilu Tang, Ning Li; Institute of Land Reclamation and Ecological Restoration, China University of Mining and Technology, Beijing, China.

Session 14: Reclamation Planning – Land Use #1 – Tuesday, June 17, 1:30 – 2:45 p.m.

Cimarron Ponds Post-Mining Housing Develop.m.ent: 28 Years of Visual Quality Change. E.J. Lee and J.B. Burley; Landscape Architecture Program, School of Planning, Design, and Construction, Michigan State University, 101 UP&LA Building, E. Lansing, Mich.

Creative Landforming for Mine Reclamation Integrating GIS Analysis, Visualization and Computer Based Landform Design Tools. Charles Yuill; Natural Resource Analysis Center, West Virginia University, 2008 Agricultural Sciences Building, Morgantown, W.Va.

The Application of RS and GIS to the Environmental Monitoring of Typical Chinese Coal Mining Area in Loess Plateau-A Case Study in Shenfu Coal Mine Site. **Yanling Zhao,** and Shilu Tang, China University of Mining and Technology, Beijing.

Session 15: Mine Water Treatment #1 – Tuesday, June 17, 1:30 – 2:45 p.m.

Passive Treatment of Acid Mine Drainage – The Enos Reclamation Project, Indiana:

Preliminary Results. Paul T. Behum, Dan R. Hause, Mark A. Stacy, and Tracy D. Branam; OSM, Mid-Continent Regional Office.

An Innovative Source Treatment Technology for Acid Mine/Rock Drainage. Song Jin, Jeffrey Morris, Paul Fallgren, and Ronald Gossard; Western Research Inst., 365 North 9th St., Laramie, Wyo.

Watershed-Scale Environmental Monitoring to Prioritize Mine Drainage Passive Treatment Implementation. R.W. Nairn, K.A. Strevett, J. LaBar, A. Sutter, J. Clifton, W. Strosnider, J. Brumley, and D. Lutes; Center for Restoration of Ecosystems and Watersheds, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, Okla.

Session 16: Reclamation Reforestation – Tuesday, June 17, 3:10 – 5:00 p.m.

Successful Oak-Bottomland Restoration in the Missouri River Floodplain. Stephen Harris; RP.M. Ecosystems LLC, 2150 Dryden Road, P.O. Box #6, Dryden, N.Y.

Revegetation on Tin-Mined Land Using Various Local Tree Species in Bangka Island, Indonesia. **Nurtjahya Eddy**, Setiadl Dede, Guhardja Edi, Muhadiono, and Setiadi Yadi; Program Studi Biologi, Universitas Bangka Belitung, Indonesia.

Scots Pine Ecosystem Biogene Budgeting in Reclaimed Mine Soil on External Slopes of a Lignite Mine in Central Poland. **Marcin Pietrzykowski**; Department of Forest Ecology, Forest Faculty, Agricultural University of Cracow, Al. 29 Listopada 46, Pl. 31 – 425 Cracow, Poland.

Forestry and Wildlife Technical Division Meeting

Session 17: Reclamation Planning – Land Use #2 – Tuesday, June 17, 3:10 – 5:00 p.m.

Cow-Calf Production on Reclaimed Surface Mined Pastures in Appalachia. Chris D. Teutsch, Mike Collins, and David C. Ditsch; Dept. of Crop and Soil Environmental Sciences, Virginia Tech, Blacksburg, Va.

Farmland Restoration and Pollution Prevention in the Overlapped Areas of Crop and Mineral Production. **Fu Meichen**, Hu Zhenqi, Liu Shuang, Zhang Jianjun, and Zhang Lanlan; School of Land Sciences and Technology, China University of Geosciences, Beijing, China

Where Next for Knowledge Needed for Sustainable Reclamation and Regeneration in the UK? **R.N. Humphries,** URS Corporation, Derby, U.K.

Post-Mine Land Use and Sustainability Optimization using the Geofluv™ Approach. Brian Parker, Marshall Miller & Assoc., Richmond, Va.

Land Use Planning and Design Technical Division Meeting

Session 18: Mine Water Treatment #2 – Tuesday, June 17, 3:10 – 5:30 p.m.

Generation of > 500 mg/L Alkalinity in a Vertical Anoxic Limestone Drain. J.A. LaBar, R.W. Nairn, and G.A. Canty; Center for Restoration of Ecosystems and Watersheds, School of Civil Engineering and Environmental Science, University of Oklahoma, 202 West Boyd St., Norman, Okla.

Get the Iron out of Your System. K. Spangler, L. Figueroa, and B. Honeyman; Division of Environmental Science and Engineering, Colorado School of Mines, Golden, Colo.

Sustainable Passive Treatment of Mine Drainage: Demonstration of Manganese Resource Recovery. Clifford Denholm, Timothy Danehy, Shaun Busler, Robert Dolence, and Margaret Dunn; BioMost, Inc., 3016 Unionville Rd., Cranberry Twp., Pa.

Self-Sustainable Mine Drainage Treatment. Robert S Hedin, Hedin Environmental, Pittsburgh, Pa.

Water Management Technical Division Meeting

Session 19: International Tailings Reclamation – Wednesday, June 18, 8:15 – 9:55 a.m.

The Influence of Soil Reconstruction Techniques on Mineral Sands Mine Soils in Virginia. K. Meredith, W.L. Daniels, Z. Orndorff, M. Alley, and C. Teutsch; Dept. of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Advances in Reclamation at Iluka's Mineral Sand Mines in Virginia. Clint Zimmerman, Chuck Stilson, P.E., W. Lee Daniels; Iluka Res. Inc., Stony Creek, VA, and Virginia Tech.

Testing and Analyses of Chat and Asphalt-Containing Chat. Souhail R. Al-Abed, David J. Reisma, Gautha.m. Jegadeesa, Niranjan Deshpande, and Bruce Morrison; Waste Management Branch, LRPCD, NRMRL, Office of Research and Develop.m.ent, U.S. EPA, Cincinnati, OH

A Two-Phase Process on the Revegetation of Acidic Bauxite Tailing Ponds in the Amazon Region, Brazil. **L.E. Dias**, A.A. Franco, E.F.C. Ca.m.pello, S.M. Faria, A.F. Castilho, and J.C. Henriques; DPS/Universidade Federal de Viçosa, Viçosa-MG, Brasil

International Tailings & Reclamation Technical Division Meeting (After break)

Session 20: Reclamation Planning & Remediation #1 – Wedneday, June 18, 8:15 – 9:55 a.m.

Assessment and Closure of the Glengarry Adit, New World Mining District, Cooke City, Montana. M. B. Marks, A. R. Kirk, and M. Cormier; Geologist, USDA Forest Service, Gallatin Natl. Forest, Bozeman, Mont.

Development and Application of Pre-Remedial Design Tool for the Clark Fork River Superfund Site. D. Neuman, P. Hansen, D. Smith, K. Knutson, and S. Brown; Reclamation Research Group, Bozeman, Mont.

Remedial and Reclamation Cost Estimating for Large Mine Sites. Gunnar R. Emilsson and Charles Freshman; CDM, 50 West 14th Street, Helena, Mont.

Physical and Chemical Assessment of the Maude Monroe Mine Site: A Group Field Project for Engineering Students. V. S. Franciscus, J. F. Ranville, T. R. Wildeman, and S. Frail; Division of Environmental Science and Engineering, Colorado School of Mines, Golden, Colo.

Session 21: OSM/VISTAs: Partners in Remediation – Wedneday, June 18, 8:15 – 9:55 a.m.

Acid Mine Drainage Remediation in a Small Watershed. Jaclyn D. Long; OSM/VISTA, Savage River Watershed Association

Friends of Deckers Creek - the Clean Creek Program. James Nutaitis

Where Did All the Water Go? Randall Drake Asberry, OSM/VISTA: Friends of the Cheat

Administering a Brownfields Assessment Grant. Greg Taylor; OSM/VISTA, Upper Guyandotte Watershed Association

Session 22: Reclamation Planning – Remediation #2 – Wednesday, June 18, 10:20 – noon

A Hydrologically Networked Watershed Model for Evaluating and Treatment Scenarios. Michael Strager, Vishesh Maskey, Brady Gutta, Richard Herd, Jenifer Fulton, Todd Petty, James Stiles, Julie Svetlik, and Paul Ziemkiewicz; West Va. Water Res. Institute, West Va. Univ., Morgantown, W.Va.

Optimizing Management of PAH Contaminated Sediment from the Appomattox River Federal Navigation Channel. G. Tracey, G. Berman, S. Insalaco, S. Powell, R. Pruhs, R., Reali; W.L. Daniels; C. Carter; SAIC, 221 Third St., Newport, R.I.

Simplified Water Quality Modeling and Strategic Watershed and Restoration. James M. Stiles; Limestone Engineering, PO Box 715, Reedsville, W.Va.

Acrylic Polymers as Used in the Mining Industry. Lola M. Green and John Vermillion; Environmental Products & Applications, Inc., 73-710 Fred Waring Dr., Suite 220, Palm Desert, Calif.

Session 23: Stream Water Quality #1 – Wednesday, June 18, 10:20 – noon

Strategic Restoration of West Virginia Watersheds Impaired by Historic Acid Mine Drainage. J. Todd Petty, Brady Gutta, Richard Herd, Jennifer Fulton, James Stiles, Michael Strager, Julie Svetlick, and Paul Ziemkiewicz; West Va. Water Res. Inst., West Va. Univ., Morgantown, W.Va.

Changes in Flow and Acidity over Various Time Spans in Five Underground Mines in West Virginia. Ben Mack and Jeff Skousen; Division of Plant and Soil Sciences, West Virginia University, Morgantown, W.Va.

Quantity and Quality of Streamwater Draining Mined Areas of the Upper Schuylkill River Basin, Schuylkill County, Pennsylvania, 2005-2007. Charles A. Cravotta III and John M. Nantz; U.S. Geological Survey, Pennsylvania Water Science Center, New Cumberland, Pa.

Preliminary Results: Release of Metals from Acid-Mine Drainage Contaminated Streambed Sediments under Anoxic Conditions. Barbara A. Butler and David Reisman; Land Remediation and Pollution Control Division of the National Risk Management Research Laboratory of the U.S. EPA, Cincinnati, OH

Session 24: Reclamation Planning - Regulatory Issues #1 – Wednesday, June 18, 1:30 – 2:45 p.m.

Second-Generation SMCRA. W. Clark Ashby, Clay A. Kolar, and Jack Nawrot; Plant Biology, Southern Illinois University, Carbondale, Ill.

Enforcement versus Compliance Assistance. Stephen M. Testa and James S. Pompy; California State Mining and Geology Board, 801 K Street, Suite 2015, Sacramento, Calif.

Using Environmental Permits for Boosting the Environmental Performance of Large-Scale Lignite Surface Mining Activities in Greece. ***Z.*** **Agioutantis** and F. Pavloudakis; Dept. of Mineral Resources Engineering Technical University of Crete, Greece

Session 25: Stream Water Quality #2 – Wednesday, June 18, 1:30 – 2:45 p.m.

Hydrologic and Aquatic Impacts from a Landslide in the Tennessee Coal Fields. Robert G. Liddle and Steve Bakaletz; U.S.D.I. Office of Surface Mining, 710 Locust St., Knoxville, Tenn.

Water Quality Prior to and after Reclamation at the Abandoned Valzinco Zn-Pb Mine Site, Spotsylvania County, Virginia. Robert R. Seal, II, Jane M. Hammarstrom, Allen Bishop, Nadine M. Piatak, Denise M. Levitan, Edward Epp, and Robert Sobeck; US Geological Survey, 954 National Center, Reston, Va.

A Legacy of Nearly 500 Years of Mining in Potosí, Bolivia: Receiving Stream Water Quality. W.H. Strosnider, R.W. Nairn and F. Llanos; Center for Restoration of Ecosystems and Watersheds, School of Civil Engineering and Environmental Science, University of Oklahoma, 202 West Boyd St. Norman, Okla.

Session 26: Reclamation Planning – Regulatory Issues #2 – Wednesday, June 18, 3:10 – 4:25 p.m.

Mining Project Approvals in Western Australia. **B. Clark** and K. Lindbeck; Keith Lindbeck & Associates, P.O. Box 144, Bull Creek, Western Australia, 6149, Australia

ITRC – Improving Regulatory Acceptance for New Approaches to Mine Waste Issues. Paul Eger, Cherri Baysinger, and Steve R. Hill; Minnesota Dept. of Natural Resources, Division of Lands and Minerals, Box 45 500 Lafayette Road, St. Paul, Minn.

Session 27: Stream Water Quality #3 – Wednesday, June 18, 3:10 – 4:25 p.m.

Changes in Metal and Sulfate Concentrations over Time in Fourteen Upper Freeport and Four Pittsburgh Underground Mines in West Virginia. Ben Mack and Jeff Skousen; Division of Plant and Soil Sciences, West Virginia University, Morgantown, W.Va.

Approaches to Complying with Water Quality Standards for Selenium. Jarvis Harper and Jim Malcolm, FTN Associates, Ltd. Little Rock, Ariz.

Acid Mine Reclamation in Spotsylvania County, Virginia, USA: Using Water Chemistry and Vegetation Re-establishment as a Measure of Success. Robert G. Sobeck, Jr., James Perry, Allen Bishop, and Edward Epp. Metcalf & Eddy|AECOM, Washington, D.C., Va. Inst. Marine Science, and Va. Div. Mineral Mining.

Poster Presentations

Revegetation of Gold Mine Tailings in Nopiming Provincial Park, Manitoba. **S. Renault**, J. Markham, L. Davis, and M. Martin; Dept. of Biological Sciences, University of Manitoba, Winnipeg, R3T 2N2, Man., Canada

Prime Farmland Soil Reconstruction: the Past, Present, and Future. H. Raymond Sinclair Jr. and Robert R. Dobos; USDA-Natural Resources Conservation Service, Federal Building, Lincoln, Neb.

Research Initiatives for Developing Passive-Treatment Technologies for Ameliorating Acid Mine Drainage in New Zealand. **Craig A. McCauley**, Aisling D. O'Sullivan, Paul A. Weber, Dave A. Trumm, Andrew K. Brough, and Mark W. Milke; Department of Civil and Natural Resources Engineering, University of Canterbury (UC), Christchurch, New Zealand

Chitin as a Fractional A.m.endment to Spent Mushroom Compost to Enhance the Efficiency and Effectiveness of Biological Acid Mine Drainage Treatment. C.E. Newcombe and R. A. Brennan; Department of Civil & Environmental Engineering, The Pennsylvania State University, University Park, Pa.

Characterization of Bacterial Communities Associated with Low-pH Fe(II) Oxidation in Coal Mine Drainage. John M. Senko, Mary Ann Bruns and William D. Burgo, Department of Civil and Environmental Engineering and Dept. Crop and Soil Sciences, The Pennsylvania State University.

Characterization of Mn(II)-Oxidizing Bacterial and Fungal Communities in Coal Mine Drainage Treatment Systems. Hui Tan, Cara M. Santelli, Colleen M. Hansel, John M. Senko and William D. Burgos. Department of Civil and Environmental Engineering, The Pennsylvania State University; and School of Engineering and Applied Science, Harvard University

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Treating Acid Metalliferous Mine Wastes in the West – A New Approach

Introduction

There are tens of thousands of abandoned hard rock mines in the American West, many of which are releasing contaminants, threatening human health and the environment, and violating environmental laws. Size of sites range from the very large to the very small; a typical abandoned mine site is shown in Figure 1. The Bureau of Land Management (BLM) lists over 9,400 mostly historic AML sites in their inventory. AML sites differ from closure of active mine sites in that no onsite presence is maintained. Consequently, facilities such as impoundments and dams have failed and often no pre-closure planning work was completed.

Figure 1. Typical abandoned mine in western Montana.

Environmental Impacts

Environmental impacts at AML sites are highly variable, but many are characterized by high concentrations of toxic metals, cyanide and acidity in mining wastes that are released into surface water, groundwater, and soils. Funding priority has been given to sites with tailings and rock dumps situated in stream channels and to sites that present significant human or ecological risk. Usually these sites are located on public lands used for recreation, grazing, wildlife and water resources. Often these sites are remote and have poor road access and no electric power, and may have restrictions to reclamation or further disturbance because of designation of cultural resources, wilderness, or National Conservation Areas.

At a typical AML site, tailings from historic mining reside in old, breached impoundments. Sometimes tolerant plant colonists have established on tailings interspersed with bare tailings, but frequently the tailings are devoid of vegetation. Barren tailings release metals into the air as dust, into surface water by erosion and leaching, and into groundwater by leaching. Bare tailings are not only toxic to plants, but represent a loss of habitat, and are toxic to fish and wildlife, as well. Such sites may not comply with federal and state environmental laws regulating air, water and soil pollution and may be subject to enforcement.

Current cleanup methods usually involve removing and transporting contaminated materials to a disposal facility, or isolating the mine wastes in repositories and capping them with clean fill. Both technologies are very expensive. Clean up costs range from $10,000 to $8 million per site or more. It is important, therefore, that lower cost clean up alternatives be found for AML sites or their contaminants may end up polluting the environment for hundreds of years. The BLM recognized the need for research and demonstration to develop more cost-effective appropriate technologies to reclaim BLM AML sites. Phytostabilization is one such technology that shows promise (Neuman and Ford 2006; USEPA, 2007).

Phytostabilization – A New Approach

With benefit of soil amendments, plants can reduce surface water erosion of metals-containing tailings and acidity and improve water quality. Air and groundwater releases are reduced similarly. This is termed "phytostabilization" and is a low-cost technology used to remediate AML sites. In 2003, the BLM funded a research project to investigate the use of western range plants to stabilize mining waste and to provide technology transfer and guidance to the field for phytostabilization of mining waste for western ecoregions. An AML mine site in western Montana, Keating Tailings (Figure 2) was selected and the research was con-

Figure 2. Low pH, elevated metal levels in mine tailings at Keating impoundment.

ducted by a team of scientists from the Reclamation Research Unit at Montana State University.

Project Goals

The objective of conducting phytostabilization studies was to provide BLM managers and decisions makers with site-specific information and data relating to the implementation, costs, and effectiveness of this technology so that it may be applied to other mine tailing sites administered by BLM. The project goals were as follows:

- Construct replicated experimental plots using soil amendments designed to ameliorate the plant inhibiting chemical characteristics of the tailings.
- Seed the experimental plots with appropriate native plants that can thrive in the newly created root zone.
- Monitor vegetation response variables (specifically establishment, seedling density, and cover).
- Determine tailings pH, EC, and soluble metal levels before and after treatment.

Keating Tailings Site

Acid metalliferous wastes resulting from historic gold and copper mining operations at the Keatings Mine site in Montana contain phytotoxic levels of several metals and are generally devoid of vegetation. With an estimated volume of 100,000 m^3, these tailings represent unacceptable risk to the environment and human health. The tailings are acidic, with pH levels less than 4, and contain elevated concentrations of metals, including copper (500 mg/kg), arsenic (300 mg/kg), and zinc (1000 mg/kg).

Replicated experimental plots were implemented in 2003 using soil amendments, lime and organic matter, designed to reduce the plant inhibiting chemical characteristics of the tailings (Figure 3). The plots were seeded with a mix of indigenous native plant species. Vegetation performance of plants grown in the amended or phytostabilized tailings was compared to results for plants seeded into tailings that were not amended, and performance of plants seeded in an adjacent off-site, but non-impacted area.

Results of Treatment

Additions of $Ca(OH)_2$ and $CaCO_3$ and organic matter allowed seeded native vegetation to establish on previously barren acid metalliferous tailings. Soluble concentrations of metals in the treated root zone were reduced one to three orders of magnitude compared to untreated tailings. Four years of monitoring data include vegetation emergence and establishment, density, aboveground biomass, and canopy cover by species (Figure 4). Canopy cover of perennial grasses growing on the treated tailings was statistically greater than grasses on the untreated tailings and equivalent to grasses growing on the off-site native soils. Colonization by forbs, shrubs, and trees into the treated plots was noted in 2007. These included plains cottonwood (*Populus deltoides*) aspen (*Populus tremuloides*), rubber rabbitbrush (*Chrysothamnus nauseosus*) and big sagebrush (*Artemisia tridentata*). Vegetation in treated plots was dominated by robust slender wheatgrass (*Elymus trachycaulus)* as shown in Figure 5. Concentrations of metals in vegetation were evaluated in terms of plant sufficiency/excess, and in terms of maximum allowable dietary levels for cattle. Elemental levels in perennial grasses were generally below the maximum tolerable concentrations suggested by the National Research Council (NRC 2005) for grazing cattle and horses. The project data can be viewed online from Neuman and Ford (2006).

Conclusions

Treatment of acid metalliferous hard rock mine waste and tailings followed by revegetation using native plant species is an alternative technology to traditional excavation of waste materials and storage

Figure 3. Incorporating lime and organic matter into experimental plots in 2003.

Figure 4. Measuring vegetation cover on experimental plots in 2006.

in repositories. This is a cost-effective, low energy technology that can be applied at remote abandoned mine sites, as well as at large sites where traditional clean up strategies can be economically impractical.

Phytostabilization is being employed or planned at large Superfund sites including the Clark Fork River and Anaconda Smelter sites in Montana, and the Upper Arkansas River site in Colorado. In a recent publication, the Environmental Protection Agency describes the use of soil amendments for remediation, revitalization and reuse (EPA 2007). ■

Literature Cited:

NRC. 2005. Mineral Tolerance of Animals, 2nd Revised Edition. Committee of Minerals and Toxic Substances. National Research Council of the National Academies. The National Academies Press, Washington, D.C. 496pp.

Neuman, D. and K.L. Ford. 2006. Phytostabilization as a remedial alternative at mining sites. Technical Note 420. BLM/ST/ST-06/003+3720. Bureau of Land Management, Denver, CO. 48 pp. Online at: www.blm.gov/nstc/library/techno2.htm

USEPA. 2007. The use of soil amendments for remediation, revitalization, and reuse. EPA 542-R-07-013, Solid and Emergency Response (5203P), U.S. Environmental Protection Agency, National Service Center for Environmental Publications, Cincinnati, OH. Online at: www.clu-in.org/publ.cfm

Figure 5. Robust Slender wheatgrass *(Elymus trachycaulus)* with excellent above- and below-ground biomass in 2006.

APPALACHIAN REGIONAL REFORESTATION INITIATIVE

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Conference agenda and registration information will be available at www.arri.osmre.gov

For more information, contact Jeff Skousen, West Virginia University, jskousen@wvu.edu

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Low-flow Augmentation of the Susquehanna River

by Pumping and Treating Mine Pools

Introduction

In recent years, consumptive use of water by industries, agriculture and other users has become a potential problem for the lower Susquehanna River. For example, the flow during summer of 2005 was only about 20 percent of the average long-term flow, and far less than the flow in other seasons (Susquehanna River Basin Commission 2005). The Susquehanna River Basin Commission (SRBC 2007) determined that about 15.7 million gallons/day (MGD) was consumed by agricultural users. The SRBC's regulatory consumptive use program requires regulated users to compensate for their use during times of low flow. Seasonal pumping from mine pools is a means of compensating for consumptive use.

Another major problem in the Susquehanna basin is abandoned mine drainage (AMD) (Figure 1). The most deleterious levels of acid and metals enter from abandoned underground mines in the bituminous district in the western part of the watershed (Figure 2), though large volumes of less acid water also are discharged in the anthracite district in eastern Pennsylvania.

Controlled pumping from a mine pool combined with treatment of the water is a method of solving both the low-flow deficiency and the acid drainage problem. If the pumping rate is increased in summer, the low-flow problem can be ameliorated. User charges by the SRBC have the potential to pay for treatment.

This type of scenario is part of an ongoing program of the Pennsylvania Department of Environmental Protection (PA DEP) to utilize mine pools for beneficial purposes that will pay for treatment. Other projects of this type include treatment of the discharge from the abandoned Shannopin Mine in Greene County

Figure 1. The Stonebridge-Argyle discharge near Gallitzin, PA

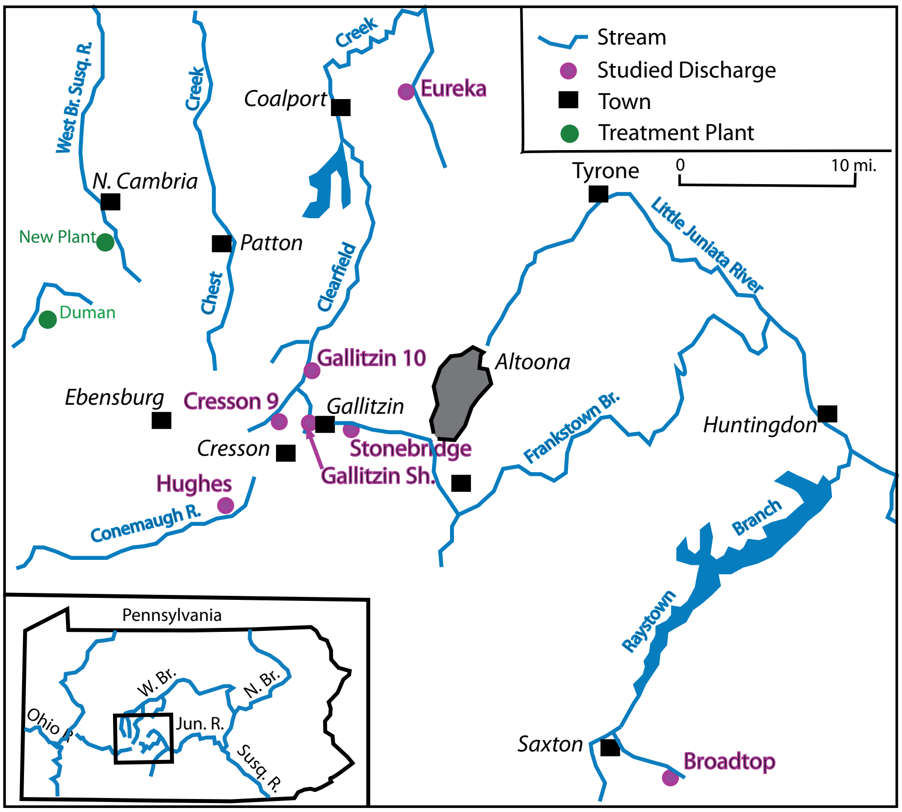

Figure 2. Map showing location of the studied mine pools (after Figure 1 of GAI Consultants, 2007).

to allow mining of reserves down dip, and to provide water for a power plant project just over the state line in West Virginia (Laurita 2006). PA DEP is also in negotiations for the treatment of three additional mine pools to facilitate mining or provide power plant water. In these proposed scenarios, the Commonwealth would provide financial assistance toward capital costs, either through grants or loans, and the companies involved would set up a trust to fund perpetual treatment. While none of these are located in the Susquehanna River basin, they all involve partnerships with private companies that are expected to result in the perpetual treatment of large-volume abandoned mine discharges.

The PA DEP will build a new AMD treatment plant in the headwaters of the West Branch Susquehanna River. Construction is expected to begin in 2008. Previously, this AMD was being pumped from the abandoned Lancashire #15 underground mine and treated at the Duman plant in Cambria County (Figure 2). This plant, which discharged into Blacklick Creek in Ohio River Watershed, was built by the mining company responsible for the mine in 1970. After completion of mining in 1968, a major mine pool blowout occurred in the headwaters of the West Branch (the mined area straddles the divide between the Ohio and Susquehanna basins). Subsequently, the mining company built the Duman plant and treated the discharge until it went bankrupt. At that time, plant operations became the responsibility of the Clean Streams Foundation, using funding from remaining company assets supplemented with state mine drainage abatement funds. The plant, however, is old and inefficient and is in need of significant upgrading, so a new plant is being built on the Susquehanna side of the divide. The PA General Assembly has appropriated funds to the SRBC for a trust fund that will partially fund the new plant's operations in return for low-flow water that will compensate for agricultural consumptive use. The new treatment plant will discharge about 10 MGD into the West Branch. This water will be considered new to the West Branch and will contribute to making up the added 15.7 MGD desired at low flow.

To make up the remaining 5.7 MGD, a study of 10 additional mine pools was commissioned by the PA DEP, Bureau of Abandoned Mine Reclamation (BAMR). The study was conducted by GAI Consultants Inc., and subcontractor U.S. Environmental Research Services Inc. (GAI Consultants 2007). After three months of sampling and investigation, the 10 candidate mine pools were reduced to five pools. At the headwaters of Clearfield Creek, the Cresson 9, Gallitzin 10 and Gallitzin Shaft mine pool cluster was studied (Figure 3). Just east of these, the Argyle-Stonebridge mine drains into the Juniata River but can be pumped into the Cresson 9 mine. The Hughes mine drains from a borehole into the Conemaugh River (Ohio River Watershed), but the mine pool extends into the Clearfield Creek Watershed near Cresson and could be combined with the Cresson pools. The Eureka 29 shaft near Beccaria drains a large set of mines into Muddy Run, a tributary of Clearfield Creek. In the Broadtop coal field about 20 miles to the east of Altoona, the very extensive Rockhill mine drains from the Dudley discharge into tributaries of the Juniata River.

Extensive studies of the five pools were conducted for a period of nine months. The studies included compilation of mine maps and historical data on production and seam thickness, acquisition of historical and new data on flow and water chemistry of the discharges, and evaluation of potential problems with existing wells and subsidence, impact on receiving streams, and costs of treatment. Based on these studies, the Cresson-Gallitzin-Stonebridge pools and the Broadtop pool have been chosen as the best candidates for further development to produce the needed 5.7 MGD of new water. The other sites, however, may be of interest if additional consumptive use is desired.

Volume and Area of Mine and Mine Pool

The amount of additional flow that can be derived from a mine pool depends on the volume of the mine pool and its recharge rate. A large pool can provide significant additional flow without being pumped dry. A large inflow rate, however, is also essential to refill the pool during the non-pumped period.

The volumes of the mine pools were estimated from mine areas on maps of the mines, plus recorded thickness and recovery of the coal seam, and the level of pool fill as indicated by the elevation of discharge from the mine. The area of unsaturated workings, where groundwater is being captured, was also estimated from the mine maps.

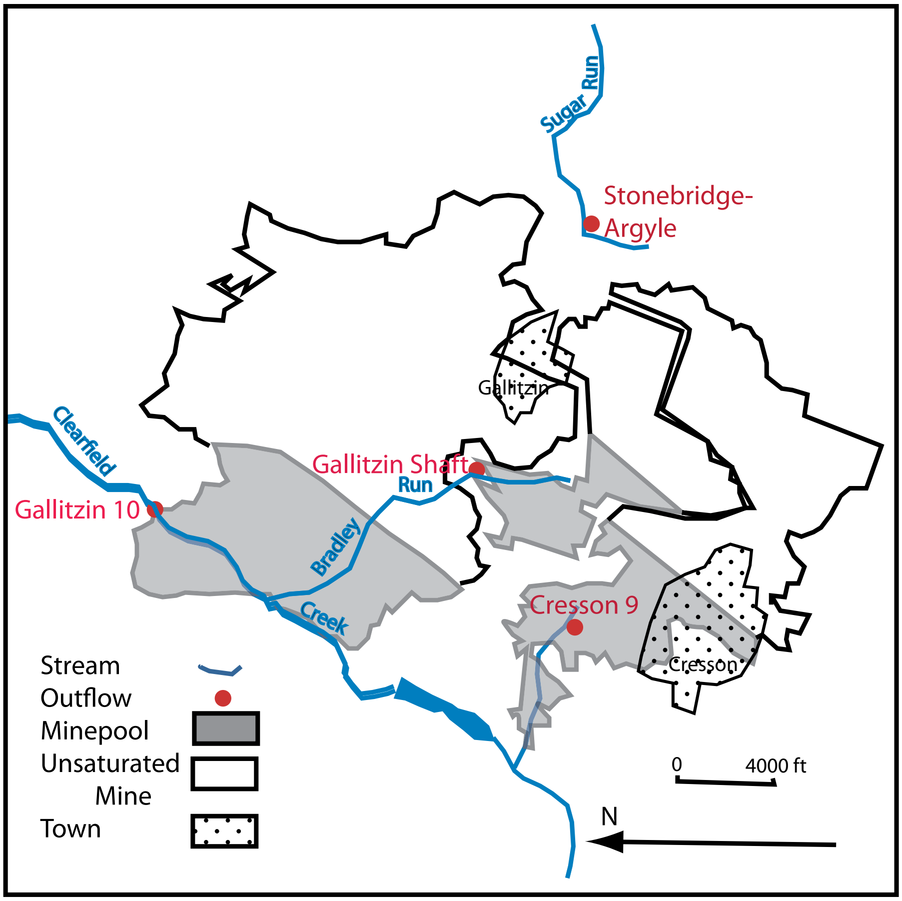

Figure 3. Map showing the Cresson 9, Gallitzin 10, Gallitzin Shaft and Stonebridge Argyle mine pools, discharge points, and streams (after Figure 2 of GAI Consultants, 2007).

Flow, Sustainable Yield and Net New Water

The proposed scenario is to augment normal flow by pumping (and treating) the flow for a four-month (120-day) period. The mine pool would then be allowed to recover during the remaining eight months of the year. If the pool recharged to overflow level, the overflow would be treated.

Several methods were utilized to estimate the flow. Historical data from mine permits and other studies were available for most of the discharges. The current flow was measured by installation of weirs on all discharges, with manual bimonthly measurement from April through December 2006, and by continuous ultrasonic flow meters during the latter part of the project (Figure 4).

For the investigated mine pools (except Hughes) only part of the pumped water is new water during the low-flow period. New water to the Susquehanna is the flow exceeding the normal flow during the low-flow period, so it was necessary to estimate the normal low flow of each discharge. The normal low flow was taken to be the Q7-10 from each discharge. The Q7-10 is the lowest seven-day flow over a 10-year period. This quantity was estimated by finding correlations between the observed flow of the discharges and the flow of downstream USGS stream gauges for the period of available data. The Q7-10 of the USGS gauges was determined from daily data for the stream gauge over a 20-year period. The Q7-10 for the discharge in question was then estimated from the correlation to the gauged stream flow.

The sustainable yield was defined as the maximum possible daily average withdrawal from the mine pool during a 120-day pumping period. The sustainable yield must not empty the mine pool, and it must allow recharge back to the initial volume at the start of the pumping period. The sustainable yield was determined by iteration over an annual cycle at varying pumping rates until a balance was achieved between outflow and inflow during the year, under the condition that the mine pool never fell below an assigned pump elevation.

Net new water was taken as the pumping rate during the four-month low-flow period minus the Q7-10 flow.

Chemistry of Mine Pool and Pumped Water

The amount and cost of treatment depends on the chemistry of the water discharging from the pool. The base level is the chemistry of the current discharge. To determine this, the discharging water was sampled bimonthly by PADEP personnel and analyzed for pH, conductance, acidity, alkalinity, Fe, Mn, Al, SO_4, Ca and Mg. Past records of water chemistry were also compiled from mine permits and other records.

Pumping and draw down of the mine pool is expected to modify the chemistry. For these mine pools, which have been stable for many years, it is assumed that stored acidity in the form of precipitates on the walls will not affect the chemistry during drawdown. Draw down of the pool, however, will expose additional pyrite to air, resulting in an increased generation of acidity and metals. This effect was estimated from the increased area exposed by draw down.

Examination of the chemical data showed that much of the acid originally generated by pyrite oxidation had been neutralized. Assuming all SO_4 was derived from pyrite oxidation, the calculated concentration of acidity based on SO_4 content was much greater than the observed acidity. Of the calculated acidity, 50 percent to 80 percent of the acidity generated by pyrite oxidation had been neutralized in the current discharge. Neutralization evidently occurred by reaction with carbonate minerals and other minerals in rock encountered by infiltrating groundwater and during residence in the unsaturated and saturated parts of the mine. Draw down would decrease the amount of neutralization in the decreased mine pool, but would increase neutralization in the enlarged unsaturated zone. The extent of neutralization in the unsaturated zone was estimated from free-draining mines in the region, and the extent of neutralization per unit area in the saturated mine pool was estimated by difference.

Modeling of the changes in acidity shows a slight to moderate increase in acidity because of drawdown. The increase is largest in pools that have high acidity and those that are drawn down to unsaturate the largest proportion of the pool volume.

Figure 4. The Hughes borehole outflow showing weir and water level recorder.

Characteristics of Selected Pools

Figure 3 shows the geometry of the Cresson 9, Gallitzin 10 and Gallitzin Shaft pools, and the location of the Stonebridge discharge, with total mine areas of 2100, 4051, 1692 and 2137 acres, respectively. The volumes of the mine pools are 384, 1132, 247 and 471 million gallons, respectively. Calculations show that the net new water during a four-month pumping period is 1.5, 3.29, 2.44 and 1.4 MGD, respectively.

A combination of the Cresson 9, Gallitzin Shaft and Stonebridge, treated in a single plant, can provide 5.34 MGD of new water at low flow. Water from the Gallitzin 10 is not included in this net new water because of potential costs associated with household water supply as discussed below. The influent mixture from the Cresson 9-Gallitzin Shaft would have an acidity of 76 mg/L with 15 mg/L Fe. The output from the combination approximates the 5.7 MGD needed for agricultural consumptive use. The treatment plant is assumed to operate at this rate during the low-flow period, and to be operated at a lower rate to avoid untreated outflow from the discharges during the remainder of the year. The calculated operating cost is $0.67/1,000 gallons.

Homes overlying the Cresson-Gallitzin-Stonebridge pools are served by public water so that no problems are anticipated from existing wells. The overburden thickness is large enough that no problems are anticipated from subsidence on drawdown of the mine pools. In contrast, some household wells in the area of the Gallitzin 10 pool might be affected by draw down so an extension of a public water supply would be required for use of this pool.

Treatment of the Cresson 9 and Gallitzin Shaft discharges would remove the major sources of acidity and metals in 4.2 miles of Clearfield Creek. Fishing should recover in the stream and in the Cresson Lakes, which are just downstream of the Cresson 9 discharge. In addition, pumping of the Stonebridge-Argyle pool into the Cresson 9 pool would eliminate the dominant source of acidity to Sugar Run, the receiving stream of this mine system. Sugar Run should greatly improve in quality, though some much smaller sources would remain.

The Broadtop area provides more water at lower cost. A mined area of 4,533 acres drains into the Dudley discharge, which flows at about 3,200 gallons/minute. The water is less acid than the Cresson area (40 mg/L acidity, 3.3 mg/L Al). New water during the low-flow period would be 7.6 MGD, considerably in excess of the needed 5.7 MGD. The estimated operating cost of treatment is $0.47/1,000 gallons. A downside of this mine pool is the necessity to treat a very large amount of water during normal flow, because the mine pool is recharged rapidly. This may be less of an issue in the future as the BAMR is designing and completing surface reclamation projects that will reduce surface water inflows to the mine complex. Although calculations indicate that subsidence might occur in some areas, there are no homes in the critical areas.

The Dudley discharge from the Broadtop mines is currently the major source of acidity and metals to Shoup Run. The treatment plant is planned to discharge into Six Mile Run, so about five miles of Shoup Run should recover, with beneficial results further downstream.

Conclusions

Several of the mine pools studied have the potential to augment the low-flow of the Susquehanna River. The development of the pumping and treatment facilities would have the dual benefit of augmenting the flow and of removing major sources of acid and metals to receiving streams. Many miles of streams would recover from their current degraded condition. Further investigations of the projects are underway.

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Final	6.8	-34	2	10	2	1258

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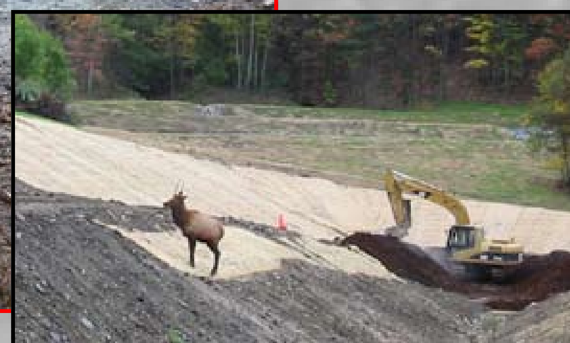

"I want to thank everyone who helped us meet the demanding schedule I set…We met every date and that would not have been possible without the dedication of the (team)…"
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