

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation *matters*



29th Annual Meeting – SUSTAINABLE RECLAMATION

Physical, Chemical and Biotic Aspects of Radium Transport and Fixation in Soil

Selecting Materials for Soil Construction When Establishing Forests

Reclamation of Marcellus Shale Drilling Sites in West Virginia

Appalachian Regional Reforestation Initiative

Indiana Soils – Prime Farmland Team



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reclamation matters

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Safety and Reclamation

Eddie Bearden, President of ASMR

Although I dislike wearing hard hats as much as the next person, I wish I had been wearing one last night – in my attic, of all places! I was up there looking for something and rose up suddenly into one of the cross braces. To say the least, it was harder than my hard head!

That started me thinking about safety, both at home and at work. When I actually worked on a mine as a reclamation specialist, one of my coworkers frequently said, "When you're out in reclamation, the only thing that can fall on you is the sky, and a hard hat won't help if that happens!" But there were occasions that a hard hat came in handy even in reclamation; like when we were bouncing across the pasture and hit a hole or I was working on something and stood up and banged my head.

Now that I work in consulting, I don't get to a mine as often as I'd like, but does that exempt me from safety needs? No. I still take my annual refresher so I'm ready to go to a mine any time. And I still have to drive safely, whether from home to the office and back or to a mine. We all have folks who count on

us, so we should practice safety if only for their sakes. God gave us a brain to use, and working safely is one way He wants us to use it.

I watched an episode of Gold Rush in which a mine was shut down by MSHA for lack of safety training. Was the inspector being unreasonable, even though the mine had "operated for 23 years with no accidents"? No – partially, he was doing his job and partially he was helping care for the miners. Most of us probably rail about MSHA occasionally, but the inspectors I have met do their job more out of concern for others than to be punitive.

Another place to practice safety this summer is in getting to the ASMR Annual Meeting in Tupelo, MS. Whether you plan to fly or drive, you still want to arrive safely both in Tupelo and back home. And by the way, do you remember what "ROM" stands for to ASMR members? We were each challenged at the last meeting to Recruit One Member. How are you doing on your part of that?

Here's hoping I see you in Tupelo in June – safely! ■

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Index to advertisers listed on page 38.

Revisiting Our Goals

Abbey Wick



The Early Career group has progressed nicely since our formation a couple of years ago. We have hosted two very successful social events that have provided opportunities for members to get acquainted with each other and have allowed us to raise funds to support future activities. We have also organized a field tour that was well attended and fully supported by our fund raising efforts. As we continue to move forward with the Early Career group, I think it's important to re-visit our initial goals to not only measure our progress, but to also identify our short-comings. This should help us better focus our efforts in 2012.

Goal 1: provide insight into how being part of ASMR can help early career members develop their careers.

This goal is somewhat difficult to measure, especially in the short-term. I can only refer to my personal experiences on this one to give an idea of what ASMR can do for those starting their careers. I have been intimately involved with ASMR since the Breckenridge meetings in 2005; serving on planning committees, the NEC and now chair of the Early Career group. My involvement has built relationships and resulted in numerous job leads from other ASMR members. I also find myself referring to my efforts in ASMR when applying for jobs – employers really appreciate involvement with national societies. Though it is still somewhat premature to fully evaluate the Early Career group success or weakness when it comes to this goal, I think we'll see more NEC nominees and planning committee members coming from the Early Career pool of members. Then those members can help guide the society and then reflect upon how being part of ASMR has advanced their careers.

Goal 2: create networking opportunities by having a social event at the meetings to form relationships among young professionals

I think we've done really well with our efforts when it comes to this goal. I've received feedback from Early Career members on how the social events have helped build camaraderie among members and improved networking opportunities at the meetings. The value in the "setting" these events create during the ASMR meetings is priceless. The planning committees for future meetings embrace the scheduling of our events, which have become an integral part of our national meetings. Through these events, members are recognizing that there are ways they can contribute to the society.

Goal 3: host professional development workshops and field tours at conferences

This is still a work in progress – we tested the waters by hosting a field tour in Bismarck. It was a success, so we will continue on with these efforts for future meetings. There has been some discussion of a field tour for the upcoming meeting in Tupelo. Any suggestions for workshops and field tours are welcome (afwick@vt.edu).

Goal 4: recruit and retain new members by building up student chapters at universities and getting new members involved in the workings of the society

There is a society-wide campaign right now called "recruit one member." As Early Career members we can contribute to this campaign by reaching out to our colleagues and getting them to join. Has everyone done their part so we can double our membership by Tupelo? We have also seen the establishment of one student chapter at the University of Wyoming (Restoration Outreach and Research – ROaR) due to the efforts of some very ambitious people. They have been actively participating in restoration projects on the Laramie River, state lands and also at a superfund site (you can follow their activities on Facebook). Though I have been in contact with this group, I have to admit that we could do more to support these groups and to help other student chapters become established. As Early Career members, we can be the interface between the students and the NEC to get the best possible programs and support levels in place. Again, any suggestions on how we can better achieve this goal are welcome.

As a group, I'd say we're doing pretty well. But...there is always room for improvement. Once we're satisfied with our progress of our four initial goals, it will be time to add some new goals to keep us moving forward. It's our ability to reflect on how we can better serve ASMR that will keep our group successful. Again, additional involvement from members is welcome and appreciated.

I should mention that Chris Johnston has lined up an excellent social event for Tupelo on the rooftop of the Park Heights Restaurant. Please make sure you join us! You can check out the venue at <http://parkheightsrestaurant.com/> ■

29th Annual Meeting of the American Society of Mining and Reclamation **SUSTAINABLE RECLAMATION**

**Hilton Garden Inn and Bancorp South Arena
Tupelo, Mississippi
June 8 – 15, 2012**

ADVANCED PROGRAM & REGISTRATION INFORMATION

Tupelo, Mississippi is located in northeast Mississippi in the heart of Dixie. Come experience southern hospitality at its best with a warm Mississippi Welcome. The 29th Annual Meeting of the American Society of Mining and Reclamation, with a theme of "Sustainable Reclamation," will provide an exceptional opportunity for you to share with mining and reclamation professionals from all over the USA, Canada, and Overseas. It will truly be an international gathering with nearly 100 scientific presentations. Register now to be a part of the largest reclamation meeting to be held in Tupelo, Mississippi in June 2012!

A Welcome Reception the evening of Sunday, June 10 will include appetizers and a no-host bar. The Early Career Professionals will host an evening of appetizers at the Park Heights Restaurant Rooftop on Monday evening, June 11th. A "Taste of

Mississippi" evening with Entertainment by "Elvis" at the Tupelo Automobile Museum is scheduled for Tuesday, June 12th. The ASMR Awards Banquet will be held Wednesday evening June 13th, with catered lunches Monday through Wednesday in the Hilton Conference Center. All breakfasts and refreshment breaks (coffee in the mornings and soft drinks in the afternoons) will be held in the lobby of the BancorpSouth Arena during the technical sessions (See Exhibitor and Arena Maps on the www.asmr.us webpage under Upcoming Meetings). An early evening reception at the poster session in the Hilton Conference Center where soft drinks and libations will be available to purchase between 5:00 and 6:30 PM is also planned on Wednesday, June 13. Each of these provides an opportunity for fellowship with colleagues with similar mining and reclamation interests.

SMR PROGRAM COMMITTEE

Dr. David Lang, Chair and Local Host

Dr. Barry Stewart, Co-Chair

Dr. Richard Barnhisel, Editor & Registration

Mr. Kimery Vories, OSM Symposia

OSM Planning Team: Kimery Vories, Henry Austin, David Kovaluk, Jennifer Nicholson, Sherry Wilson, Lois Uranowski, and Duane Matt

Tupelo Local Arrangements: Courtney Holcomb, Shari Long, Kara Penny, Linda Eliff

Spouses Activities: Maureen Lang and Robyn Nawrot

Mine Tours: N. Rebecca McGrew, Brad Brasfield, Sherry Wilson, Jennifer Nicholson

Program Typing: Ms. Tina Barnett, Dept. of Plant and Soil Sciences

Printing of Program: David Kovaluk, Office of Surface Mining

FINANCIAL SPONSORS (pending)

North American Coal

Office of Surface Mining

Peabody Energy

Tupelo Visitors and Convention Bureau

Mississippi State University: Office of Research and Development

Taft Coal Sales (Lunch on Tour)

Thompson Machinery (Lunch on Tour)

TRANSPORTATION TO TUPELO, MISSISSIPPI

Airline: Tupelo is served by two incoming flights daily (Monday-Friday) from Memphis, TN on Delta/Pinnacle airlines. There is one incoming flight into Tupelo from Memphis on Saturday and Sunday as of November, 2011 so make your airline reservations early. Delta Airlines/KLM will be the Official Airline of the 29th ASMR Annual Meeting in Tupelo, MS. Reservations and ticketing are available via www.deltacom. When booking online, select Meeting Event Code and enter the meeting code NM8Z2 in the box provided on the Search Flight page. You'll receive a 2-5% savings on discounted, restricted fares and up to 5-10% on full, unrestricted fares. Bookings need to be made via the Delta website or there will be an additional \$25 fee for telephone reservations. Tupelo is 90 miles from the Memphis airport that is serviced by several incoming flights daily and has several rental car companies. Tupelo is 125 miles from the Birmingham, Alabama airport which also has several incoming flights daily and rental cars. It is served by I-22/US 78 that runs from Memphis to Birmingham and by US 45 North to South from Jackson, TN. Both are four lane highways. The Natchez Trace is a beautiful two lane road from Nashville, TN, but it has speed limits of 40-50 MPH that are strictly enforced by the National Park Service. The hotels do not provide shuttle service so you will need to call for a Taxi: A-1 CABS: 1-662-840-4300; TUPELO CAB CO: 1-662-842-1133 or AAA Taxi 1-662-871-8998.

HOTELS IN TUPELO, MISSISSIPPI

The conference Hotel will be the Hilton Garden Inn (adjacent to the BancorpSouth Arena and Conference Center) at 363 East Main Street. A block of rooms at \$99 for either a King or two Queens is being held until May 1st so make your reservations early.

Use the link at the Hilton http://hiltongardeninn.hilton.com/en/gi/groups/personalized/T/TUPTUGI-ASMR-20120607/index.jhtml?WT.mc_id=POG or call 1-662-718-5500 with American Society of Mining and Reclamation (ASMR) as the group code.

Our second conference Hotel is the Courtyard by Marriot at \$89 for a King or 2 Queens (with a different Group Code: ASMG). You must call the hotel 1-662-841-9960. It is located at 1320 North Gloster Street 2.4 miles from the BancorpSouth Arena and Conference Center. Limited shuttle service will be available provided by the Tupelo Visitor's Bureau, so you may need to rely on taxi service. This would be a good location if you bring your own vehicle as there is plenty of free parking at the BancorpSouth Arena Conference Center. The Courtyard by Marriot will honor the Federal per Diem rate of \$77 with a Federal government ID at check in.



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PRE-CONFERENCE TOURS**Saturday – June 9, 2012**

1. Red Hills Lignite Mine, hosted by North American Coal. Travel down the Natchez Trace to Chester, MS with stops at the Bynum Indian Mounds and Jeff Busby Park which sits just north of the lignite mine. Mississippi has 400,000 acres of surface-minable lignite land with two active lignite mines operated by North American Coal. The Red Hills Mine near Chester/Ackerman Mississippi started operations in 1998 with nearly 6000 acres within their permit area. They disturb and reclaim 100 to 200 acres annually to mostly loblolly pines, mixed hardwood plantings, or open pasture and produce 2.8 – 3.2 million tons of lignite annually. Lignite is sold to an adjacent power plant operated by Suez Energy. The tour will include discussion of geomorphic stream restoration using woody material for stabilization and research plots currently being conducted by USDA. Lunch will be provided by Thompson Machinery, a division of Caterpillar Mining. Bring your hard hat, safety glasses, and steel toed boots for this tour. Cost: \$30, Minimum 30
2. Brices Cross Roads near Baldwyn, MS. Experience a Civil War Re-Enactment of the June 10th, 1864 battle that was one of the last victories won by the Confederacy. "The Confederate victory at Brices Cross Roads was a significant victory for Major General Nathan Bedford Forrest, but its long term effect on the war proved costly for the Confederates. Brices Cross Roads is an excellent example of winning the battle, but losing the war." We'll stop at the Last Stand Civil War Museum for lunch and visit Indian Mounds and the Natchez Trace Visitor's Center on the way back to Tupelo. Cost: \$50, Minimum 30

Sunday – June 10, 2012

3. Tennessee-Tombigbee Waterway – Constructed by the U.S. Army Corps of Engineers to connect the Tennessee River directly to the Gulf of Mexico, it provides an alternative route for barge traffic on the Mississippi River, particularly during times of flooding. It opened in 1985 after being conceived of since the 1770's. The tour will travel along the Natchez Trace and includes stops at Pharr Indian Mounds, Jamie L. Whitten Lock and Dam, Bay Springs Lake Visitor's Center, and lunch at the "Divide Cut". We'll return across scenic countryside east of the Waterway and stop at the Jamie L. Whitten Historical Park near Fulton, MS. Cost: \$50, Minimum 30.

POST-CONFERENCE TOUR**Thursday – June 14, 2012**

4. Taft Coal Sales near Jasper, Alabama. This is a central Alabama surface bituminous coal producer with steam, industrial and metallurgical coal reserves operated by Walter Minerals, a division of Walter Energy. It was acquired in 2008 and is being reclaimed with plantings of hardwoods. Bring your hard hat, safety glasses and steel toed boots for this tour. Lunch will be provided by Walter Energy. Cost: \$30, Minimum 30.

SPOUSAL & OTHER TOURS**To be arranged daily****Spouse Activities – Led by Maureen Lang & Robyn Nawrot**

We have lots of exciting places to visit and things to do in the Tupelo Area. We plan to visit and tour a number of Mississippi's famous antebellum homes. We have many antique and interesting gift shops to explore. There are consignment shops to visit and, on Saturday, June 9th, there is a monthly flea market held in one of the massive furniture marts or go on one of the professional tours. Let's not forget a visit to Elvis Presley's birthplace and museum just down the road from the hotel. Food is also an experience here, ranging from lunch at a teahouse, with beautiful antique linens for sale to down home Southern food of Fried Chicken, Catfish, and Barbeque served with delicacies such as corn salad, turnip greens, and fried green tomatoes. One day we'll visit our shopping area Barnes Crossing with a good-sized mall and lots of supplemental stores it nearby. Tupelo has an interesting "Old Downtown Area" within walking distance with interesting shops, including the Hardware store where Elvis bought his first guitar. All in all, Tupelo and her nearby areas have lots for the spouses to do and see as others are involved with meetings. As we say here: "Y'all come, too!" Lunches and other admission fees will be at your own expense.

OTHER TOURS & ACTIVITIES**Private John Allen Fish Hatchery**

<http://www.fws.gov/pvtjohnallen/>

This is a National Fish Hatchery which is administered by the U.S. Fish & Wildlife. Fish raised on Federal hatcheries are stocked in public waters to support Federal fishery responsibilities mandated by law. These include fish for restoration where, for example, habitat degradation has altered a stream's natural reproductive capability; to recover threatened or endangered populations; to preclude listing of certain species under the Endangered Species Act; to restore inter-jurisdictional fish populations, or to support depleted recreational fish populations in Federal and state waters. Tour led by Jack Nawrot, just 2 miles from the conference hotel, no charge.

Elvis Presley Birthplace & Museum

<http://www.elvispresleybirthplace.com/>

Just 1 mile from the conference hotel, visit the little home where the King of Rock and Roll was born. Also onsite is a replica of the church where Elvis started his singing of gospel music that led to his career, and a museum highlighting his early life. Transportation provided by the Tupelo Convention and Visitor's Center. Admission: \$10

SILENT AUCTION

Be sure to remember to bring items that we use for our silent auction to bolster our Student Travel Grant fund. Bidding will begin on Monday and run through Wednesday afternoon. Bring items to the ASMR Exhibit Booth #27-28.

ASMR GOLF TOURNAMENT

To be arranged by Dr. Barry Stewart

Indicate your interest by circling either Sunday or Thursday on the registration form. Fees to be paid at the course. Golf clubs will be available to rent or bring your own. Green fees and a cart will be \$34 at the Big Oaks Golf Course. <http://www.bigoaks-golfcourse.com/index.html>

WORKSHOP

Sunday – June 10, 2012

The Updated Revised Universal Soil Loss Equation (RUSLE 2) for Mine Sites

Dr. Terry Toy

Successful mine-land reclamation requires erosion control. In addition, erosion control remains the best method of sediment control. The Revised Universal Soil loss Equation, version 2 (RUSLE 2) is the best, practical, method of soil-loss estimation for reclamation and erosion control planning. Now, RUSLE 2 has been updated and adapted to better suit mine-site conditions. In this introductory course, you will receive a free copy of the RUSLE 2 program and learn how to tailor RUSLE 2 to your site conditions. Your instructor will demonstrate numerous common erosion-control scenarios that will allow you to compare the probable erosion rates under various reclamation strategies. You are welcome to follow along on your laptop computer. Participants will come to appreciate the ease and versatility of the RUSLE 2 program. During the workshop, you will also learn how environmental conditions affect erosion processes and rates. In recent years, various agencies have encouraged the use of RUSLE 2 for reclamation and erosion-control planning. RUSLE 2 puts the mine staff and the regulator on the same page in terms of erosion control planning. Sunday all day, June 10, 2012; 8:30 am-5 pm (Box lunch provided) Cost: \$100 per person includes software and materials (Bring your own laptop) Minimum: 10 participants

EXHIBITOR & SPONSOR INFORMATION

June 8-15, 2012

Bancorpsouth Arena (Tupelo, MS)

The 29th Annual Meeting of the American Society of Mining and Reclamation will provide an exceptional opportunity for your company or organization to interface with mining reclamation professionals and those who influence decisions about the purchase of products and services for the land reclamation industry. Register now to be a sponsor and/or to bring your company exhibit to Tupelo in June 2012!

Exhibitors will be listed on the ASMR website by name/logo which includes either a link to the company's website or short listing of contact information. The website listing will stay on the main ASMR website until the 2013 annual meeting. Your company can also be a sponsor of any or all of these activities (please see separate information for sponsors for more details). Traditional booths for display feature a 10 x 10' fully-draped booth, with up to two 6' skirted-tables and two chairs. Arrangements should be made separately should you require additional features such as electrical service; please contact us and we will try to accommodate as best we can. The Bancorp South Arena Lobby has been arranged to facilitate traffic throughout the entire exhibit area by strategic placement of refreshment areas and concurrent technical session rooms. Setup time can be early Saturday June 9th (by 5:00 pm on Sunday, June 10, 2012) with breakdown after 3:30 pm break on Wednesday, June 13, 2012. All materials must be removed as the Arena will begin removing the pipe and draping on Thursday. The Bancorp South Arena will be open daily during the conference with locked security at night. A floor plan outlining the location of sold booths within the Bancorp South Arena is listed on the web page <http://www.asmr.us/Meetings/2012/Exhibit%20Hall%20Map%20-%20Sold%20Booths.pdf>. Please select three locations by preference of those remaining. Reservations will be made upon receipt of funds (\$1,000 per booth) on a first-come, first-serve basis. Please note that the booth floor plan is subject to change dependent upon number of exhibitors.

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The final registration materials for attendees will include a packet identifying all exhibitors, their addresses, and the services and/or products provided, website exposure, and these will include confirmed exhibitors and sponsors. To maximize your company's exposure, early registration is essential!

Please fill out the Sponsor/Exhibitor Registration Form (available on the asmr web page www.asmr.us) and return with payment to by March 1, 2012:

Sponsors at the \$5,000 Gold Level will enjoy:

- One free exhibitor booth
- Two free registrations.
- Meal tickets including the social event.
- Special recognition at the Business Meeting.
- Your logo will be given top billing on give-aways and the inside of the program cover.
- A link to your company website will be attached to the ASMR website for one month before the 2012 Tupelo

meeting and will continue to run until one month before the 2013 meeting.

Sponsors at the \$3,000 Silver Level will enjoy:

- Exhibitor booth (if exhibiting) (Booth cost is \$750, normally \$1000.)
- One free registration.
- Meal tickets for all lunches (excluding social dinner)
- Special recognition at the Business Meeting.
- A link to your company website will be attached to the ASMR website for one month before the 2012 Tupelo meeting until the end of the year.

Sponsors at the \$1,000 Bronze Level will enjoy:

- Exhibitor booth (if exhibiting) (Booth cost is \$750, normally \$1000.)
- Special recognition at the Business Meeting

- A link to your company website attached to the ASMR website for one month before the 2012 Tupelo meeting and for two additional months after the meeting

Sponsors for breaks and meals will enjoy:

- Your company's name will appear on a board located next to food and beverage area
- Announcements will be made by moderators prior to breaks and meals that mention the sponsor of the upcoming break.
- Meal Sponsorship: Breakfast: \$500 | Lunch: \$750
Evening Meal: \$1,000 | AM Break: \$300 | PM Break: \$350
Young Professionals Evening: \$500

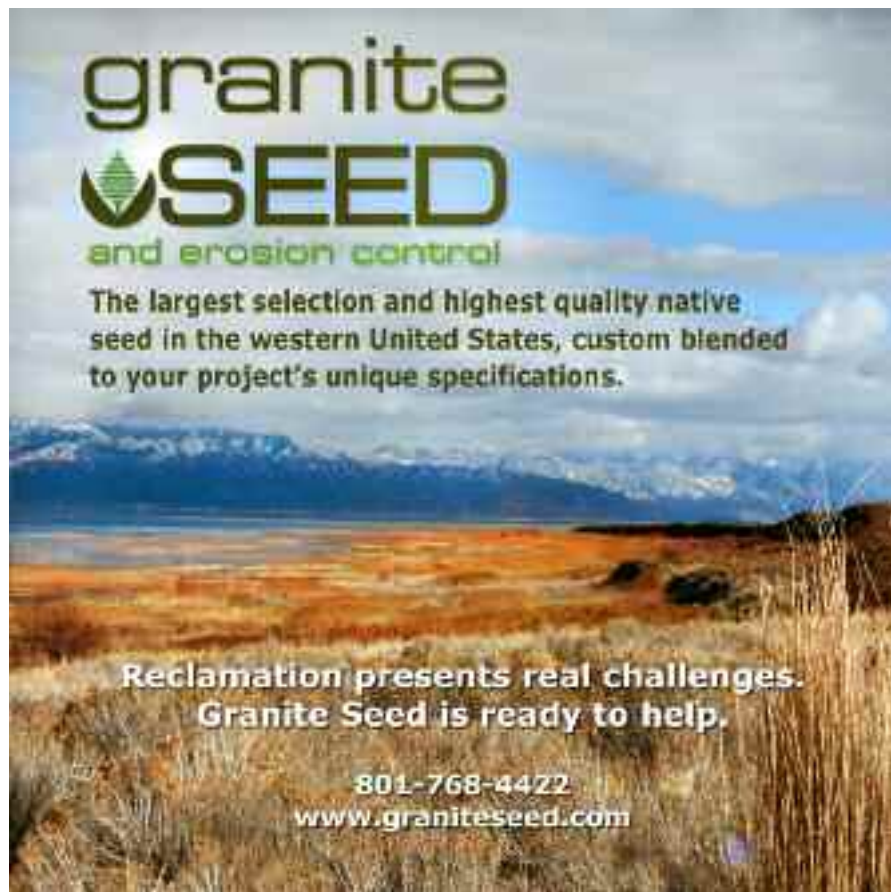
Exhibitor/Sponsorship questions, contact:

Dick Barnhisel
3134 Montavesta Road
Lexington, KY 40502
Tel: (859) 351-9032

Email: asmr5@insightbb.com

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— PRELIMINARY AGENDA —

SATURDAY, JUNE 9, 2012

Breakfast (on your own)

Pre-Conference Tours

North American Coal's Red Hills Lignite Mine

8:00am – 4:00pm (lunch included)

Brice's Crossing Civil War Battlefield & Natchez Trace

8:00am – 4:00pm (lunch included)

Exhibitor Setup – *BancorpSouth Arena*

SUNDAY, JUNE 10, 2012

Breakfast and Lunch (on your own)

9:00 am – 5:00 pm

National Executive Committee

ASMR Golf Tournament – *Big Oaks Golf Course (or on TH-6/14)*

Tour along the Natchez Trace, the Tennessee-Tombigbee Waterway and
Jamie L. Whitten Historical Park

8:00am – 4:00pm – (lunch included at "Divide Cut")

8:30a m – 5:00 pm

Workshop – *Dr. Terry Toy*

Erosion Prediction with RUSLE2 – (lunch included)

Exhibitor Setup by 5:00 pm – *BancorpSouth Arena*

3:00 pm – 6:00 pm

Registration – *BancorpSouth Arena*
(Turn in your PowerPoint files)

6:00 pm – 8:00 pm

Welcome Reception – *BancorpSouth Arena*

MONDAY, JUNE 11, 2012

6:30 am – 10:00 am

Breakfast – *BancorpSouth Arena Lobby*

7:00 am – 8:00 am

Registration – *BancorpSouth Arena*
(Turn in your PowerPoint files)

Opening Plenary Session – "Sustainable Reclamation" – *BancorpSouth Arena*

8:00 am – 8:30 am

North American Coal

8:30 am – 9:00 am

The Geology of Mississippi: A Reference for the State's Geology and Mineral Resources
David T. Dockery III, Chief of Surface Geology Division, Mississippi Office of Geology

9:00 am – 9:30 am

Mine Regulation and Reclamation in Mississippi
Michael B.E. Bograd, Stan Thieling and David T. Dockery III, Mississippi Office of Geology

9:30 am – 10:00 am

The OSM Stream Protection Rule
Bill Winters, Office of Surface Mining, U.S. Department of Interior

10:00 am – 10:30 am

Break

10:30 am – 11:15 am

The Emerging Requirement for an Evidence Based Certainty for the
Delivery of Restoration Schemes In Mineral Applications in the United Kingdom
Neil Humphries, Visiting Professor at National Soils Research Institute,
University of Cranfield and Vice President, URS United Kingdom

11:15 am – 12:00 pm	Ecosystem Restoration: A Critical Component of Sustainable Mining and Reclamation James Burger, Professor Emeritus, Department of Forestry and Environmental Conservation, Virginia Tech University
12:00 pm – 1:30 pm	Lunch – Hilton Garden Inn Ballroom/Conference Center <i>Mississippi Welcome</i> Dr. Greg Bohach, Vice President for Agriculture, Forestry and Veterinary Medicine, Mississippi State University Invited Guest Speaker – (12:30 – 1:00) Office of the Governor CONCURRENT SESSIONS – BancorpSouth Arena
1:30 pm – 2:00 pm	OSM STREAM SESSION Water Tailings Session Ecology – P. Ehret WATER TAILING SESSION Comparison of Hydrologic Characteristics From Two Differently Reclaimed Tailings Ponds; Graves Mountain Site, Lincolnton, GA – G. Geidel ECOLOGY Assessing the effect of cattle grazing alone and with goats on botanical composition of pastures established on reclaimed coal mined lands. – O. Abaye, M. Webb and C. Zipper
2:00 pm – 2:30 pm	OSM STREAM SESSION Stream Restoration at Midwest Surface Coal Mines, Keys To Success.– R Williams WATER TAILING SESSION Potential of Impounded Fine Coal Refuse Slurry Breakthroughs into Underground Mines. – P.R Michael, D. L. Lane, M.W. Richmond, D.E. Stump and M.J. Superfesky ECOLOGY Switchgrass potential on reclaimed surface mines for biofuel production in West Virginia – M. Marra and J. Skousen
2:30 pm – 3:00 pm	OSM STREAM SESSION Lessons Learned from a Thousand Streams. – W. Kinney WATER TAILING SESSION Preliminary Assessment of Floodplain Soil Metal Concentrations: Neosho River, Oklahoma – L.J. Mignogna*, W.A Runyon, R.W. Nairn and W.H.J. Strosnider ECOLOGY Kern River Natural Gas Pipeline Expansion – D.R Chenoweth
3:00 pm – 3:30 pm	Break – <i>Exhibit Hall</i> CONCURRENT SESSIONS – BancorpSouth Arena
3:30 pm – 4:00 pm	OSM STREAM SESSION The Good, the Bad, the Ugly – USCOE – R Retherford WATER TAILING SESSION Three-year Pilot Case Study of Selenium Treatment via a Biochemical Reactor – T. Rutkowski* and R Schipper ECOLOGY Achieving Reclamation Success Globally – Peabody Energy's Experience in Mongolia – V.R Pfannenstiel
4:00 pm – 4:30 pm	OSM STREAM SESSION Hydrology and Sediment Transport Characterization and Management – T. Staub WATER TAILING SESSION Eleven Years Evaluation of a Reclaimed Tailing from Bauxite Washing in Result of Fertilization Levels – LE. Dias, S.M. de Faria, I.R Assis, LAO.P. Guimaraes and G.C. Rocha ECOLOGY Lessons learned for harvesting seed from semi-natural grasslands for biodiversity mitigation and enhancement schemes in South Wales, UK – R.N. Humphries

- 4:30 pm – 5:00 pm OSM STREAM SESSION
CONSOL Burning Star 4 – A Case Study – **B. O’Leary**
- 6:00 pm – 10:00 pm EARLY CAREER PROFESSIONALS EVENT
Park Heights Restaurant – (Rooftop)

TUESDAY, JUNE 12, 2012

- 6:30 am – 10:00 am **Breakfast** – *BancorpSouth Arena Lobby*
- 7:00 am – 8:00 am **Registration** – *BancorpSouth Arena*
(Turn in your PowerPoint files)
- CONCURRENT SESSIONS** – *BancorpSouth Arena*
- 8:30 am – 9:00 am OSM SYMPOSIUM: AMD MITIGATION CASE STUDIES IN THE ILLINOIS COAL BASIN
AMD Remediation at the Superior C.C. #4 Mine in Illinois – **L. Lewis and P. Behum**
- 9:00 am – 9:30 am OSM SYMPOSIUM: AMD MITIGATION CASE STUDIES IN THE ILLINOIS COAL BASIN
Theoretical versus observed hydrochemical performance of sulfur reducing bioreactors;
lessons learned from intensive monitoring of several systems in south-central Indiana
– **Branam, T.D., Reeder, M.D. and G.A. Olyphant**
- SOIL ORGANISMS
Soil biota development in post mining sites on climatic gradient from east to mid-west of USA
– **Frouz, J., Pizl, V., Tajovsky, K., Stary, J., Hanel, L., Novakova, A., Lukesova, A., Kristufek, V., Devetter, M. and Cajthaml, T.**
- WATER STREAMS
Genetic Diversity of Brook Trout Populations in Several Subwatersheds of the
West Branch Susquehanna River Watershed.
– **S. M. Rummel* and F.J. Brenner**
- 9:30 am – 10:00 am OSM SYMPOSIUM: AMD MITIGATION CASE STUDIES IN THE ILLINOIS COAL BASIN
Remediation of Acid Mine Drainage using Sulfate-reducing Bioreactors –
Case Example: the Tab-Simco Passive Treatment System.
– **Behum, P., L. Lewis, R. Kiser and L. Lefticaru**
- SOIL ORGANISMS
Microbial Quality of Reclaimed Mine Soils Following Time and Treatment Based Influences
– **Brooks, J.P., A. Adeli, J.J. Read, D.J. Lang, M.R. McLaughlin and J. Willers**
- WATER STREAMS
Passive Treatment System (PTS) To Revive Water Quality for the Rio Juckucha Area Near Potosi, Bolivia
– **K.J. Palmer, F.L. Lopez, A. Ruben, P. Neptune, R. Monje, R.W. Nairn and W.H. Strosnider**
- 10:00 am – 10:30 am **Break** – *Exhibit Hall*
- CONCURRENT SESSIONS** – *BancorpSouth Arena*
- 10:30 am – 11:00 am OSM SYMPOSIUM: AMD MITIGATION CASE STUDIES IN THE ILLINOIS COAL BASIN
Impacts of Abandoned Mine Land Reclamation on Water Quality within the
South Fork Patoka River Watershed. – **Stacy, M.**
- SOIL ORGANISMS
Soil Algae and Cyanobacteria of Post-Coal Mining Areas. – **A. Lukesova and J. Frouz**
- WATER STREAMS
Leaf litter breakdown in reconstructed Appalachian coal-mine streams:
Relationships to environmental variables. – **R.J. Krenz*, S.H. Schoenholtz & C.E. Zipper**
- 11:00 am – 11:30 am OSM SYMPOSIUM: AMD MITIGATION CASE STUDIES IN THE ILLINOIS COAL BASIN
Hydrogeologic modeling of three sulfur reducing bioreactors; implications for system design and
long-term performance. – **Waddle, R.C. and G.A. Olyphant**
- SOIL ORGANISMS
Microscopic Fungi in Reclaimed Soils in the Rolling Hills Wind Plant, Glenrock, WY.
– **Alena Novakova, Jan Frouz and Vit Hubka**

11:00 am – 11:30am	WATER STREAMS Conductivity Sensor Performance – T.P. Maupin, C.T. Agouridis, C.D. Barton and R.C. Warner
11:30 am – 12:00pm	OSM SYMPOSIUM: AMD MITIGATION CASE STUDIES IN THE ILLINOIS COAL BASIN Geochemical evaluation of a prematurely exhausted sulfur reducing bioreactor; Lacy South Site, south-central Indiana – Burch, P.L., Branam, T.D., and G.A. Olyphant SOIL ORGANISMS The impacts of surface mining restoration efforts on soil dwelling nematode communities in the Appalachian region. – Haley Smith WATER STREAMS Use of MODFLOW Drain Package for Simulating Interbasin Transfer in Abandoned Coal Mines. – M.D. Kozar * and KJ. McCoy
12:00 pm – 1:30 pm	Lunch – <i>Hilton Garden Inn Ballroom/Conference Center</i> CONCURRENT SESSIONS – <i>BancorpSouth Arena</i>
1:30 pm – 2:00 pm	WATER AMD The Beginning: Passive Treatment of A Highly Acidic Mine Drainage Discharge. – C.A. Neely*, C. Denholm, S. Busler, T. Danehy, B. Page and M. Dunn SOILS EVALUATION Corn Yield and Physical Properties Measured on Soil Reconstructed by the University of Kentucky Soil Regenerator. – L.G. Wells and S. Bodapati FORESTRY Chestnut Survival and Growth After Four Years on Surface Mines in West Virginia – J. Skousen
2:00 pm– 2:30 pm	WATER AMD Permitting and Construction of a micro-hydroelectric Power Facility utilizing treated mine drainage. – B.J. Page*, T.P. Danehy and Cody "Buck" Neely S.L. Busler, C.F. Denholm and M.H. Dunn SOILS EVALUATION Screening Criteria for Beneficial Utilization of Dredge Sediments in Virginia, USA – W. Lee Daniels, Abbey Wick, Charles Carter III and Charles Saunders FORESTRY The influence of Soil Variables and Seeding Genotype on Ectomycorrhizal Root Colonization on American Chestnut on Abandoned Mine Lands. – J.M. Bauman, C.M. Byrne and S. Hiremath
2:30 pm – 3:00 pm	WATER AMD Expanding the Scope of Passive Treatment of Acid Mine Drainage with Municipal Wastewater. – W.H.J. Strosnider, B.K. Winfrey and R.W. Nairn SOILS EVALUATION Feasible Strategies for 226Reclaiming Re-Contaminated Soils from ISR U Mine Spills. – L. Cox and P. Stahl FORESTRY Survey for the Presence of Phytophthora Cinnamomi on Reclaimed Mined Lands in Ohio Chosen for Restoration of the American Chestnut. – S. Hiremath, K. Lehtoma and J.M. Bauman
3:00 pm – 3:30 pm	Break – <i>Exhibit Hall</i> CONCURRENT SESSIONS – <i>BancorpSouth Arena</i>
3:30 pm – 4:00 pm	WATER AMD Engineered Pumpable pHoam™: A New Innovative Method for Mitigating ARD. – James Gusek*, P.E., Brian Masloff and John Fodor SOILS EVALUATION A System to Evaluate Prime Farmland Reclamation Success Based on Spatial Soil Properties. – RE. Dunker, D.G. Bullock, G.A. Bollero and KL. Armstrong FORESTRY Groundcover Influences Hardwood Reforestation Success on Reclaimed Appalachian Mined Lands. – B.D. Strahm, JA. Burger, C.E. Zipper, R.S. Allen and Z.D. Addington

4:00 pm – 4:30 pm	WATER AMD Treatment of Acid Mine Drainage through Constructed Wetlands in Indian Coal Mine – A Case Study. – AK Debnath* and V.K Pandey SOILS EVALUATION Application of Econometric Techniques for Ensuring Slope Stability in an Open Pit Mine: A Case Study. – Pradeep Kumar and Agota Horel FORESTRY Ground Cover Species Effects on Oak Seedlings Grown in Minesoil. – J. Franklin, D. Buckley, E. Aubuchon and A. Klobucar
4:30 pm – 5:00 pm	TECHNICAL SESSION BUSINESS MEETINGS
4:30 pm – 5:00 pm	WATER AND TAILINGS MANAGEMENT SOILS AND OVERBURDEN LAND USE, ECOLOGY AND FORESTRY
5:30 pm – 10:00 pm	Taste of Mississippi Event with an Elvis Tribute Artist <i>Tupelo Auto Museum</i> (Pork & Catfish – BBQ)

WEDNESDAY, JUNE 13, 2012

6:30 am – 10:00 pm	Breakfast – <i>BancorpSouth Arena</i>
7:00 am – 8:00am	Registration – <i>BancorpSouth Arena</i> (Turn in your PowerPoint files) CONCURRENT SESSIONS – <i>BancorpSouth Arena</i>
8:30 am – 9:00 am	WATER PASSIVE TREATMENT The Development of a Demonstration Passive Treatment System for Removing Sulfate at a Site on Vancouver Island, British Columbia – E.P. Blumenstein* and JJ. Gusek LAND USE PLANNING Lessons-Learned Applying Geomorphically Stable Landform Design Concepts to Reclamation of Abandoned Mines. – M.R Donner*, P.E. and B.A.D. Hill, P.E. SOIL & VEGETATION CHANGES OVER TIME Age Chronosequence Effects on the Quality Characteristics of Reclaimed Coal Mine soils under Forest and Pasture Based System as influenced by Landscape in Mississippi. – Adeli, A, D.J. Lang, J.P. Brooks, M.R. McLaughlin, JJ. Read and J. Willers
9:00 am – 9:30 am	WATER PASSIVE TREATMENT Re-Aerating Off the Grid: Improving Passive Treatment Success with Solar and Wind Energies. – R.W. Nairn*, KA. Strevett and B.M. Callies LAND USE PLANNING Reclamation Implications of Overlapping Industries in Southern Campbell County, Wyoming. – Brenda K. Schladweiler* SOIL & VEGETATION CHANGES OVER TIME Long-term Effects of Rock Type and Weathering on Southwest Virginia Mine Soils. – Whitney L. Nash* and W. Lee Daniels
9:30 am – 10:00 am	WATER PASSIVE TREATMENT Passive Treatment of Mining Influenced Wastewater with Biochemical Reactor Treatment at the Standard Mine Superfund Site, Crested Butte, CO. – N. Gallagher, E. Blumenstein, T. Rutowski, J. DeAngelis, D. Reisman and C. Proggess LAND USE PLANNING In Situ Coal Gasification: An Emerging Technology. – Kristin M. Brown*

9:30 am – 10:00 am	SOIL & VEGETATION CHANGES OVER TIME In Situ Characterization of Coal Combustion Byproducts Fifteen Years After Emplacement in an Abandoned Mine Land Site. – LC. Martin, T.D. Branam, S. Naylor and G.A. Olyphant
10:00 am – 10:30am	Break – Exhibit Hall CONCURRENT SESSIONS – BancorpSouth Arena
10:30 am – 11:00 am	WATER PASSIVE TREATMENT Design and Construction Challenges for Limestone-Based Passive Treatment Systems in the Rural Andes, Potosi, Bolivia – W.H. Strosnider*, J. Alvarez, F.S. Llanos Lopez, C. Breazile, S. Crook, P. Monje, T. Cooper and R.W. Nairn LAND USE PLANNING Developing Quarry Capture Prevention Techniques on the Buttahatchie River. – B.J. Maurer* and J.J. Ramirez-Avila SOIL & VEGETATION CHANGES OVER TIME Vegetative Community Development on Reclaimed Coal Mine Land in East Texas. – C.L. Michaels*, B.P. Oswald, H.M. Williams and K.W. Farrish
11:00 am – 11:30 am	WATER PASSIVE TREATMENT Event-driven metal transport dynamics in the Initial Oxidation Cells of a Passive Treatment System. – LR. Oxenford and R.W. Nairn LAND USE PLANNING Hydrologic Characterization of Multiple Seam Underground and Surface Mining in Northern Appalachia – J.W. Hawkins* and J.J. Smoyer SOIL & VEGETATION CHANGES OVER TIME Use of Animal Waste and Flue Gas Desulfurized Gypsum to Improve Forage Production on Reclaimed Mine Soil in Mississippi. – J.J. Read, AAdeli and D.J. Lang
11:30 am – 12:00 pm	WATER PASSIVE TREATMENT Toward Sustainability in Passive Treatment: Using Stakeholder Partnerships to Ensure Sound Science. – R.W. Nairn*, KA. Strevett, D.E. Townsend, J. Luedecke, J. Long and M. Grigsby LAND USE PLANNING Optimization of Concurrent Mining and Reclamation Plan for Single Coal-Seam – A Case Study in Northern Anhui, China – Zhenqi Hu* and Wu Xiao SOIL & VEGETATION CHANGES OVER TIME Young Forest Composition and Growth on a Reclaimed Appalachia Coal Surface Mine after Nine Years. – C.E. Zipper*, JA. Burger, D.M. Evans and P. Donovan
12:00 pm – 1:30pm	Lunch – Hilton Garden Inn Ballroom/Conference Center CONCURRENT SESSIONS – BancorpSouth Arena
1:30 pm – 2:00 pm	RECLAMATION POLICY The Appalachian Research Initiative for Environmental Science (ARIES). – J.R. Craynon*, P.F. Ziemkiewicz, W.L. Daniels, R.C. Warner and M.E. Karmis SOIL CARBON Long-term Carbon and Nutrient Accrual in Coal Mine Topsoil Substitutes in Southwest Virginia – N.G. Craig*, B.D. Strahm, JA. Burger, W.L. Nash and W.L. Daniels DISSOLVED SOLID TRANSPORT Linking Temporal Patterns of Dissolved Solids to Mining Land uses in Central Appalachian Coal field Streams. – Anthony J. Timpano, Stephen H. Schoenholtz, Carl E. Zipper and David J. Soucek

- 2:00 pm – 2:30 pm **RECLAMATION POLICY**
 Life Cycle Assessment Analysis of Various Active and Passive Acid Mine Drainage Treatment Options for the Stockton Coal Mine, New Zealand.
 – T.J. Hengen*, M.K. Squillace, J.J. Stone, A.D. O’Sullivan and F.A. Crombie
- SOIL CARBON**
 Understanding Soil Carbon and Open Pit Mining in the United Kingdom’s Developing Soils Policy Context.
 – R. Neil Humphries
- DISSOLVED SOLID TRANSPORT**
 Influence of Roadside Establishment Practices on Sediment and Nutrient Loss.
 – K.R. Briscoe, G. Munshaw, J.J. Varco and B.R. Stewart
- 2:30 pm – 3:00 pm **RECLAMATION POLICY**
 Introduction to Land Reclamation Policies and Regulations in China
 – Zhenqi Hu
- SOIL CARBON**
 Carbon Accumulation and Stabilization Following Mineral Sands Mining in Eastern Virginia
 – A.F. Wick, W.L. Daniels, Z.W. Orndorff and M.M. Alley
- DISSOLVED SOLID TRANSPORT**
 Nutrient and Sulfide Export from a Mine Drainage Passive Treatment System
 – S.A. Yopez* and R.W. Nairn
- 3:00 pm – 3:30 pm **Break**
- 3:30 pm – 5:00 pm **ASMR Poster Session – Hilton Garden Inn Ballroom/Conference Center**
- Arsenic Adsorption in Soils With Different Mineralogical Compositions**
 – I.R. Assis, L.E. Dias, R.B.A. Fernandes, S.C. Silva and J.W.V. Mello
- Substrate Physical Quality in Overburden Slopes Dumps of Iron Mining Activities in Carajas, Brazil**
 – G.C. Rocha, I.R. de Assis, L.E. Dias and S.M. de Faria
- The Pailaviri Tailings Deposit, Potosi, Bolivia: Ideal Geochemistry for Extreme Acid mine Drainage Evolution**
 – A.A. Neptune, F.S. Llanos Lopez, R.R. Callapa, K.J. Palmer, R.W. Nairn, J.Z. Bandstra & W.H. Strosnider
- Carbon Isotopes As A Basis For Evaluating Alkalinity Generation Over Time With A Sulfate-Reducing Bioreactor in South-Central Indiana**
 – Steven W. Emehiser, Peter E. Sauer, Tracy D. Branam and Greg A. Olyphant
- Long-Term Effects of Herbaceous Species and Trees On Reclaimed Mine Soil Properties**
 – Kelly McMillen, Elliott Carver, Melanie Letalik, Ozzie Abaye, Carl Zipper & Amy Gail Fannon-Osborne
- Influence of Weed Mats and Tree Shelters on Survival and Growth of American Chestnut on Post-Bond Release Surface Mines in Eastern Kentucky**
 – Hannah Z. Angel, Christopher D. Barton and Patrick N. Angel
- Effects of Enhanced Efficiency Industrial By-Products on Leaching Losses of Broiler Litter Derived Nutrients Applied to the Mine Soils as Reclamation Technique in Mississippi**
 – Jing Sheng, A. Adeli, J. Brooks, M.R. McLaughlin, J.J. Read and D.J. Lang
- Soil Microbial Community in Post Mining Sites in Sahara Mine, IL Reclaimed by SMECTRA and Pre-SMECTRA Technologies**
 – Jan Frouz, Vaclav Kristufek and Tomas Cajthaml
- Evaluation of Species for Rapid Establishment on Mississippi Roadsides**
 – Timothy Bradford, Jr., G.C. Munshaw, B.R. Stewart and H.W. Philley
- Evaluating Strategies for Controlling Autumn Olive (*Elaeagnus Umbellata*) on Reclaimed Surface Mine Land at The Wilds in Southeastern Ohio**
 – Shana Byrd, Nicole Cavender, Nina Sengupta and Jenise Bauman
- Soil Rotifers on Coal Post Mining Dumps: Development on Chronosequences**
 – M. Devetter and J. Frouz

- 3:30 pm – 5:00 pm **Soil Microfungal Communities in Three Various Post-Mining Areas (Wyoming, Tennessee and Indiana)**
– Alena Novakova, Vit Hubka and Jan Frouz
- Passive Treatment System (PTS) To Revive Water Quality for the Rio Juckucha Area near Potosi, Bolivia**
– Kelsea J. Palmer, F. Llanos Lopez, Ruben, Ashley Neptune, P. Monje, Robert W. Nairn & William H. Strosnider
- Preliminary Assessment of Floodplain Soil Metal Concentrations: Neosho River, Oklahoma**
– L.J. Mignogna, W.A. Runyon, R.W. Nairn and W.H.J. Strosnider
- 6:00 pm – 10:00 pm **ASMR Awards Banquet – Hilton Garden Inn Ballroom**

THURSDAY, JUNE 14, 2012

- Breakfast and Lunch (on your own)**
- Exhibitor Take Down (by Noon)**
- 8:30 am to Noon **National Executive Committee Meeting**
- ASMR Golf Tournament – Big Oaks Golf Course**
(or on M-6/11)
- 8:00 am – 4:00 pm **Taft Coal Sales**
- Post-Conference Mine Tour – Jasper, Alabama**
(lunch included)
- Other Potential Tours**
(Spousal and Others)
- Monday – Thursday**
- Antebellum Homes in Aberdeen and Columbus Private John Allen Fish Hatchery (M, Tu, W)**
- Elvis Presley Birthplace and Museum (M, Tu, W)**
- Downtown Tupelo and The Mall at Barnes Crossing**
- Dinner (on your own)**

FRIDAY, JUNE 15, 2012

- 8:00 am **Meeting Adjourns**

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Physical, Chemical and Biotic Aspects of Radium Transport and Fixation in Soil

LISA COX AND PETER STAHL

WYOMING RECLAMATION AND RESTORATION CENTER, UNIVERSITY OF WYOMING, LARAMIE, WY

Acknowledgements: This project was funded by WY U mine operators via Wyoming Mine Association (WMA) and University of Wyoming School of Energy Resources (SER.) Sample sites were provided by Uranium One, with special thanks to Donna Wichers, Bill Kearney and Clint Oliver.

Introduction

Soil is composed of both biotic (living) and abiotic (non-living) components, and is broadly categorized as organic or mineral, with mineral soils making up the majority of soil on earth. The objective was to evaluate the effects of soil properties on the mobility and fixation of ^{226}Ra in soils and to determine the presence of ^{226}Ra in soils from ISR Uranium (U) mine sites in Wyoming. This information can be used to assess methods for removing or remediating soils with elevated levels of ^{226}Ra found at ISR U mine surface spill sites. While Wyoming U mines are predominantly found in semi-arid basins, as shown below, it is expected that a general understanding of factors influencing mobility and fixation of ^{226}Ra in soils would be applicable in other areas.



View of header house at Satellite 3-1, Willow Creek ISR U mine site, with typical prairie grass in foreground.

Pete Stahl collects background soil samples at Willow Creek Satellite 3-1.



Chemical and Physical Aspects of Radium Transport and Fixation in Soil

The primary chemical soil characteristics influencing ^{226}Ra transport or immobilization in soils are cation exchange capacity (CEC), pH, and Ca and CO_3 content. CEC, a physical surface property, is directly related to the amount of clay and organic matter in a soil (Sylvia et al. 2005).

Both exchangeable and acid soluble ^{226}Ra decreased with an increase in pH and CEC in the event of a spill in soil (Rachkova et al. 2010). Nathwani and Phillips (1979) attributed higher retention rate of ^{226}Ra in soils to the greater number of exchange sites associated with higher CEC. Amini et al. (2005) found a significant relationship among CEC, SOM and clay content in soils, and used these three factors to create a model for predicting CEC in aridisols in Iran.

As with many metals, pH is known to influence ^{226}Ra mobilization in the soil profile. Available ^{226}Ra decreases in soil solution with increased pH (Vandenhove et al. 2009, Rachkova et al. 2010) as shown in Figure 1. Complexation of chelating ligands with various metal ions is dependent upon specific pH conditions, and chelation is one method of immobilizing metals, including ^{226}Ra , in soils (Shah et al. 2007).

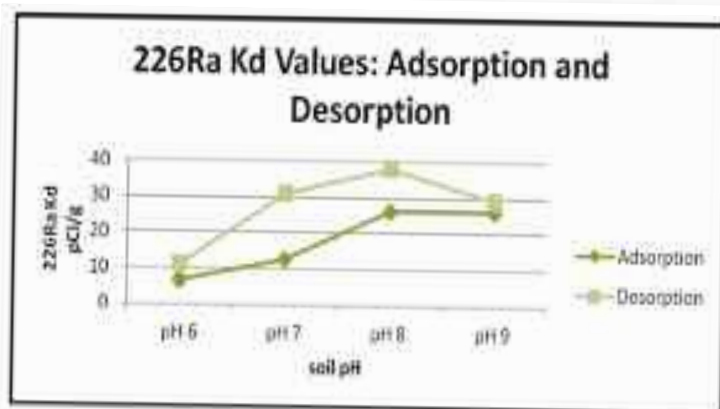


Figure 1. ^{226}Ra adsorption and desorption Kd values as found in site-specific sandy sediments in groundwater above the Gorleben salt dome in Germany (Meier 1994). Adsorption and desorption both occurring at higher pH suggest the influence of other factors, such as competing cations.

Soil pH, while known to influence ^{226}Ra mobility in the profile, is controlled by multiple physical, chemical and biological interactions taking place in soils. Reclamationists working with radioactive soils must consider each situation on a case by case basis.

Sample Site #	Texture	pH
31L2	Silty clay	8.02
31L6	Silty clay	8.18
31L2BG	Clay loam	7.43
31L6BG	Silty clay loam	7.51
31U2	Sandy loam	6.59
31U6	Sandy clay loam	8.02
31U2BG	Silty clay loam	7.46
31U6BG	Clay	7.81
342	Sandy loam	7.73
346	Silty loam	7.55
342BG	Silty loam	7.30
346BG	Loam	7.23

Table 1. Soil pH of samples taken on two ISR U mine sites at Willow Creek Satellite 3, September 2011. 31L samples were from a drainage near a well head at Satellite 3-1; 31U samples were near a header house above drainage; 34 samples were near a header house at Satellite 3-4.

Soil pH is alkaline in Wyoming where U is mined. Stahl et al. (2002) found soils sampled at three U mined sites ranged from 6.4 to 8.0, and additional samples taken at another site (Christiansen Ranch satellite 3) in September, 2011, ranged from 6.59 to 8.18 (Table 1).

Rachkova et al. (2010) found adsorption, being pH-dependent, can be influenced by competing cations. As shown in Figure 2, eight of 10 soils sampled at the Willow Creek Satellite 3-1 site in Wyoming showed increasing exchangeable Ca measurements corresponding with increased ^{226}Ra content, suggesting a possible relationship between the two Be-

cause Ca is similar chemically to Ra, this could be a concern in Wyoming's drier soils, where Ca is less likely to leach out of the profile and may build up in soil in the form of CaCO_3 , or may simply remain abundant in the soil profile. Chao et al. (1998) listed carbonates as a primary mechanism for retaining heavy metals in soil. Radium is known to form aqueous complexes with both sulfate and carbonate ions, which affects transport in soils (Zhang et al. 2002).

Biological Aspects of Radium Soil Mobility

While soil microbial processes are a primary aspect of soil ecology, microbial transformation of ^{226}Ra is not possible in soil because ^{226}Ra exists only in the +2 oxidation state. This is not the case with other radionuclides. For example, U can be reduced from its soluble hexavalent state, U(VI), to its insoluble tetravalent state, U(IV), with microbial metabolic assistance, therefore immobilizing the element for sequestration, either for remediation or recovery purposes (Lovley et al. 1991).

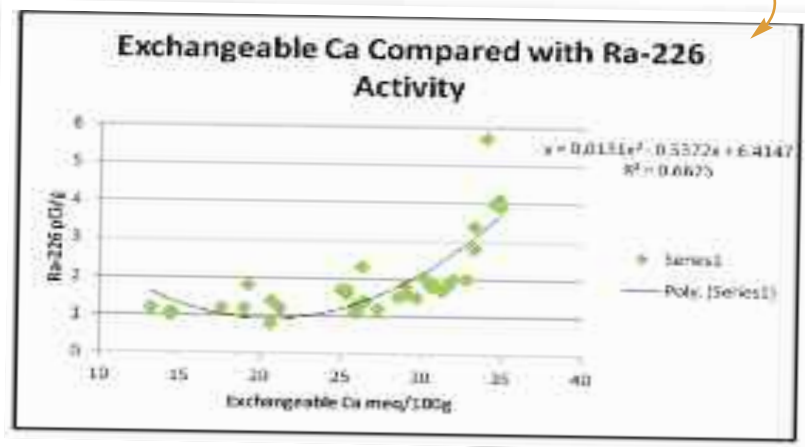
It has been shown that $(\text{Ba,Ra})\text{SO}_4$ coprecipitation is an important process controlling ^{226}Ra solubility in natural waters, and has been used in contaminated sediments as well (Misra 2001, Grondin 2012). Under certain reducing conditions, sulfate-reducing bacteria may produce rapid dissolution of $(\text{Ba,Ra})\text{SO}_4$, thus ^{226}Ra may actually be remobilized in contaminated sediment under particular anaerobic, sulfate-reducing circumstances (Misra 2001).

A 1997 study by Bunzl cited microorganisms and mycorrhizal fungi, specifically, along with organic substance concentration, as important factors in mobility of radionuclides in soils (Strebl et al. 2007). Arbuscular mycorrhizal fungi (AMF) symbiotic associations with plant roots are known to enhance plant growth by extending the ability of plants to access water and nutrients from the soil while benefitting from plant-produced C transfer to the fungi (Sylvia et al. 2005). This association extends to disturbed sites, where these fungi play a critical role in the uptake, accumulation and retention of heavy metals (Karimi et al. 2011).

Bacterial effects on ^{226}Ra in soils may not exist directly. However, these microorganisms can have an indirect effect on the element by affecting the successful associations of AMF with plants that might act as heavy metal accumulators, for example. In the case of ^{226}Ra , if phytosequestration, or plant uptake and retention of the metal, were a method to be considered for remediating ^{226}Ra -contaminated soils, not only the plants involved in taking up the radium, but associated organisms interacting in the soil would be determinants in the degree of success this method would have.

Organic matter and the humic substances found within OM, play roles in the immobilization and retention of ^{226}Ra in soils as well. Nathwani and Phillips (1979) found OM adsorbed more than

Figure 2. Comparison of exchangeable Ca and ^{226}Ra from samples taken at Willow Creek Satellites 3-1 and 3-4.



10 times the ^{226}Ra adsorbed by clays in their studies. Chao et al. (1998) listed humic substances in OM as a primary mechanism for retaining heavy metals in soils. Walton et al. (1994) explained that humic substances complex with these metals.

The basin soils of Wyoming where U mining is located are aridic in moisture regime, as seen in Picture 3, intergrading toward an ustic moisture regime, which has higher annual precipitation and greater vegetation biomass than other more arid environments. Still, the growing season is short on these lands which are predominantly covered with Wyoming big sagebrush shrub habitat or mixed prairie grassland (Driese et al. 1997). Stahl et al. (2002) found OM content on the Highland Ranch and Irigary sites to range from 1.71% to 2.48%.

While OM may be a lower percentage of the soil composition than in other regions, its role remains important, both above and below ground. It is a substrate for microorganisms and macro fauna such as earthworms. Litter protects the soil from excess heat and from raindrop impact. Flora and fauna contribute to OM formation and nutrient cycling. And organic matter and humus could be critical in the immobilization of heavy metals, including ^{226}Ra , thus contributing greatly to remediation efforts of contaminated soils.

Conclusion

Soil ecological processes affect many of the soil properties that are associated with ^{226}Ra transport or immobilization in the soil. While it can appear as though one of various processes or soil properties could be attributed to the state of ^{226}Ra in a soil, these interact in ways so complex that often it is difficult to establish to what degree a single soil characteristic or ecological process is responsible for immobilization or transport of that element in the soil column. Research has established that soil texture class, CEC, pH, Ca and carbonate (CO_3) content, and OM or humus content are all important influences in ^{226}Ra transport in soils. However,

Wyoming basin landscape typical of U mining, with Pumpkin Butte, where Uranium One has ISR U mines, in background.



these are interrelated. Soils from Wyoming basin U mine sites tend toward finer textures, as seen in Pictures 4 and 5.

A finer soil texture generally corresponds with a higher CEC, as does an abundance of OM in soil. Soils high in OM tend toward a lower pH. Ca in drier soils may build up and eventually form CaCO_3 . Micro and macro flora and fauna have roles to play in the weathering of soils to finer particle size and clay structure, OM and humus development, and Ca and other cation and nutrient availability and cycling in soils. Thus, ^{226}Ra transport or immobilization in soils is af-

ected by a multitude of abiotic and biotic soil factors that make up soil ecology.

Willow Creek U mine Satellites 3-1 and 3-4 had not been mined in the past 8 years; however, the three areas sampled had seen multiple small spills during mining operations in the past. Thus, they were chosen for the potential of ^{226}Ra levels above background of $1.5 \pm 0.3 \text{ pCi/g}$ to $3.7 \pm 0.3 \text{ pCi/g}$, established as baseline in 1986-1987. The soil samples collected in September and November of 2011 were finer textured, including predominantly silty clays, silty clay loams and clays. Soil pH ranged from 6.59 to

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Clayey soil from Willow Creek Satellite 3-1 drainage, and clay soil from same site in lab.



8.18, from neutral to alkaline. ^{226}Ra was not found in any sample to exceed the 5.0 pCi/g above background regulatory threshold in the top 6 in. Activity ranged from 0.8 +/- 0.4 pCi/g to 5.7 +/- 0.6 pCi/g. Samples collected at 3-foot intervals along a 30-foot transect within the drainage at Satellite 3-1 near a well head that had seen several spills, ^{226}Ra activity did not vary or decrease significantly with distance from the spill site. Exchangeable Ca and ^{226}Ra activity were seen to increase

in relation to each other for most samples.

The combination of these results suggests the influence of multiple factors, including time, on ^{226}Ra mobility and fixation in Wyoming soils on ISR U mine sites. Further, results illustrate the importance of thorough soil characterization on site-specific cases in making decisions about remediation or removal of soils with elevated levels of ^{226}Ra from spills.

Knowledge of the factors that contribute to mobility and fixation of ^{226}Ra can help operators and reclamationists make decisions regarding remediation or removal of soil containing levels of ^{226}Ra that exceed regulatory standards. This knowledge is applicable to a multitude of settings, from cleaning up surface spills resulting from ISR U mining, to reclamation of abandoned mine lands and mill facilities.

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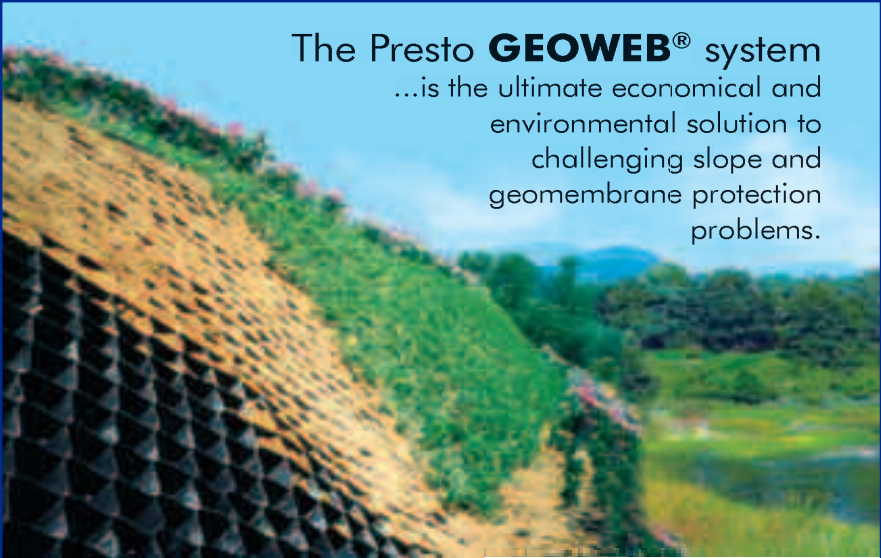
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References

- Amirani, M., K C Abbaspour, H. Khademi, N. Fathianpour, M. Afyuni, and R Schulin. 2005. Neural network models to predict cation exchange capacity in arid regions of Iran. *European Journal of Soil Science*. 56: 551-559.
- Chao, J.-C., A Hong, RW. Okey, and RW. Peters. 1998. Selection of chelating agents for remediation of radionuclide-contaminated soil: Proceedings of the 1998 Conference on Hazardous Waste Research (Snowbird, UT, May 19-21).
- Driese, Kenneth L, William A Reinert, Evelyn H. Merrill, and Kenneth G. Gerow. 1997. A digital land cover map of Wyoming, USA: a tool for vegetation analysis. *Journal of Vegetation Science*. 8: 133-146.
- Karimi, Akbar, Habib Khodaverdilo, Mozghan Sepehri, and Mirhassan Rasouli Sadaghiani. 2011. Arbuscular mycorrhizal fungi and heavy metal contaminated soils. *African Journal of Microbiology Research* 5(13): 1571-1576.
- Lovley, Derek R, Elizabeth J. P. Phillips, Yuri A Gorby, and Edward R Landa. 1991. Microbial reduction of uranium. *Nature*. 350:413-416.
- Meier, H., Zimmerhackl, E., Zeitler, G. and Menge, P. 1994. Parameter studies of radionuclide sorption in site-specific sediment/groundwater systems. *Radiochimica Acta* 66/67: 277-284.
- Misra, M., RK Mehta, and P. Lan. December, 2001. Remediation of Ra from Contaminated Soils. Reno, NV: University of Nevada- Reno for US-EPA Cooperative Agreement No. CR-826147
- Nathwani, Jatin S. and Clolin R Phillips. 1979. Adsorption of ²²⁶Ra in soils. *Chemosphere*. 5: 285-291.
- Rachkova, N.G., I.I. Shuktomova, and A.I. Taskaev. The state of natural radionuclides of U, Ra, and thorium in soils. 2010. *Eurasian Soil Science*. 43(6): 651-658.
- Shah, Bhavna A, Ajay V. Shah, and Riddhish R Bhatt. 2007. Studies of chelation ion-exchange properties of copolymer resin derived from salicylic acid and its analytical applications. *Iranian Polymer Journal*. 16(3): 173-184.
- Stahl, Peter D., Barry L. Perryman, Shankar Sharmasarkar, and Larry C. Munn. March, 2002. Topsoil stockpiling versus exposure to traffic: A case study on In Situ U well-fields. *Restoration Ecology*. 10(1): 129-137.

- Strebl, Friederike, Sabine Ehlken, Martin H. Gerzabek and Gerald Kirchner. 2007. Behaviour of radionuclides in soil/crop systems following contamination. In: George Shaw (Ed.), *Radioactivity in the Terrestrial Environment* (19-42). Oxford, UK: Elsevier.
- Vandenhove, V., C. Gil-Garcia, A Rigol and M. Vidal. 2009. New best estimates for radionuclide solid-liquid distribution coefficients in soils. Part 2. Naturally occurring radionuclides. *Journal of Environmental Radioactivity*. 100: 697-70.

- Walton, B.T., E.A. Guthrie, and A.M. Hoyleman. 1994. Toxicant degradation in the rhizosphere. In: Anderson, T.A. and J.R. Coats (Eds.), *Bioremediation Through Rhizosphere Technology*. 11-26. Chicago: American Chemical Society Symposium Series 563.
- Zhang, Peng-chu, James L. Krumhansl, and Patrick V. Brady. 2002. Introduction to properties, sources and characteristics of soil radionuclides. In: Peng-Chu Zhang and Patrick V. Brady (Eds.) *Geochemistry of Soil Radionuclides*. Madison, WI: Soil Science Society of America ■



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INDIANA SOILS – Prime Farmland Team Winner of the 2010 Department of the Interior Partners in Conservation Award

BY LARRY EMMONS AND KEN ROGERS



Team members and OSM Director Joseph Pizarchik at Partners in Conservation Award Presentation 2010.

The Indiana Soils – Prime Farmland Team was the winner of the 2010 Department of the Interior Partners in Conservation Award. The Indiana Soils – Prime Farmland Team is a unique advisory group initially formed in 1996 with representatives of the DOI-OSM, USDA-NRCS, and Indiana Department of Natural Resources (IDNR). The Team was developed to address mined farmland reclamation. The Team now includes other state agencies, academia, industry, and farmers that joined the Team to contribute their expertise to develop innovative and practical farming methods used on restored farmland.

Team Purpose Statement: To develop and provide recommendations that ensure the protection, restoration, and management of soil resources affected by coal mining in Indiana

Team Goal: To promote coordination among the various government agencies, and other entities, concerned with the maintenance of prime farmland and cropland capable land resources.

It was decided early on that better farmland reclamation practices might be achieved by collaborating with diverse experts in the agricultural and mine reclamation fields. With the creation of the Indiana Soils – Prime Farmland Team and resulting partnership, the ability to leverage the practical experience of coal mining companies and the scientific expertise of the state universities greatly enhanced the Team's knowledge and experience regarding reclamation and use of restored agricultural lands.

One of the Team's accomplishments was development of the 20 page "Farm Management Practices for Reclaimed Cropland" handbook. This guide provides farm producers with the latest and best practices to increase the profitability of agricultural production on lands that were disturbed by surface mining activities. The Team also sponsors biennial Prime Farmland Field Days. These are tours of active coal mining and reclamation operations. Local farmers and land owners are invited to attend and view

demonstrations of the best practices for restoring prime farmland and cropland soils and the best practices for the management of restored crop-producing soils.

For the Indiana coal field, up to 50 percent of the acreage permitted (2007) has been prime farmland. This land is temporarily taken out of production during the period of time it takes to mine and reclaim it. After reclamation, the reconstructed soils will have characteristics that are different from the pre-mining soil conditions and will require different management techniques than they did before mining. Examples of the change in soil characteristics are the increased tendency to erode because the structure of the soil is changed and increased compaction due to soil handling by large earth moving equipment. Specific management techniques are required to provide sustainability of these drastically disturbed prime farmlands by preventing erosion of this limited natural resource and sustaining the water resources of the area by preventing pollution and managing runoff of rainfall. Proper management of the natural resource of prime farmlands in Indiana provide crop production that impacts global commerce while protecting surface water from additional pollution impacts to the Ohio and Lower Mississippi River Basins and the Gulf of Mexico.

In June 2011 the Prime Farmland Team and Peabody Energy sponsored a Prime

Tour of active mining area at Somerville Mine.



Soil pit in restored prime farmland area.



It was decided early on that better farmland reclamation practices might be achieved by collaborating with diverse experts in the agricultural and mine reclamation fields.

Farmland Field Day tour at Somerville mine in Gibson County Indiana. The tour let the public view the mining operations and active prime farmland reclamation and the restoration of productivity by specific land management practices. At this event the 20-page handbook outlining methods to properly manage reclaimed crop producing lands (prime farmland) was also made available to participants.

The partnership that is the Indiana Soils – Prime Farmland Team is very special and may be unique in its composition. The regulatory agencies are partnered with the regulated coal mining industry and agricultural experts from the USDA and academia. The independent nature of this

partnership allows this group of people with their highly diverse views and opinions to collaboratively recommend methods of reclamation and management that improve sustainable crop production of restored prime farmland.

The ability of the Team to communicate the latest technological advances and tools for management of agricultural lands impacted by mining to the users of those lands – the family farmers of Indiana and surrounding states – is its primary goal. The Indiana Farm Bureau and Purdue University Extension Service Team members use their network of newspaper and radio contacts to advertise the 2009 handbook. The Team spon-

sored biennial Field Days, which is another method to communicate the best practices for the management of reclaimed farmland. The handbook is also available on OSM and NRCS websites.

The Indiana Soils – Prime Farmland Team is a long-term, self-directed, and unfunded partnership. The Team's efforts have resulted in the availability of the latest farming practices and conservation techniques being made easily available to the farmers utilizing reclaimed croplands. The Team efforts have also educated farmers and land owners to the methods utilized to restore cropland productivity during the reclamation process. ■

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Reclamation of Marcellus Shale Drilling Sites in West Virginia

JEFF SKOUSEN AND PAUL ZIEMKIEWICZ
WEST VIRGINIA UNIVERSITY

Introduction

The rapidly developing boom in natural gas drilling into the Marcellus Shale in the Appalachian Region is the biggest economic and environmental event in the 21st Century. An estimated 100 to 500 trillion cubic feet of natural gas is trapped in the tiny pores of the Marcellus Shale which underlies large areas in New York, Pennsylvania, Ohio and West Virginia (Figure 1). The U.S. uses about 20 trillion cubic feet of natural gas each year.

ground formations to allow trapped natural gas to flow into cracks where the gas can be collected. The Marcellus Shale natural gas deposits are located at depths of 3,000 feet in Ohio dipping to more than 9,000 feet in depth eastward near the Virginia border, and the average depth of Marcellus Shale wells in West Virginia is 5,300 feet (Figure 2). The Marcellus Shale layer varies from between 50 to 100 feet in thickness so it is important to locate and map the formation for accurate drilling.



Figure 1. The distribution of Marcellus Shale in the Appalachian Region of the U.S.

Hydraulic fracturing (or hydrofracking) is the process of injecting fluids under high pressure into shale layers, thereby creating small fractures and allowing the natural gas to be released and extracted. Hydraulic fracturing has been used by the oil and gas industry since the 1940s. Combined with more recently developed horizontal drilling techniques, it has made the region's shale deposits economical for gas production.

Hydraulic fracturing creates fissures, or fractures, in under-

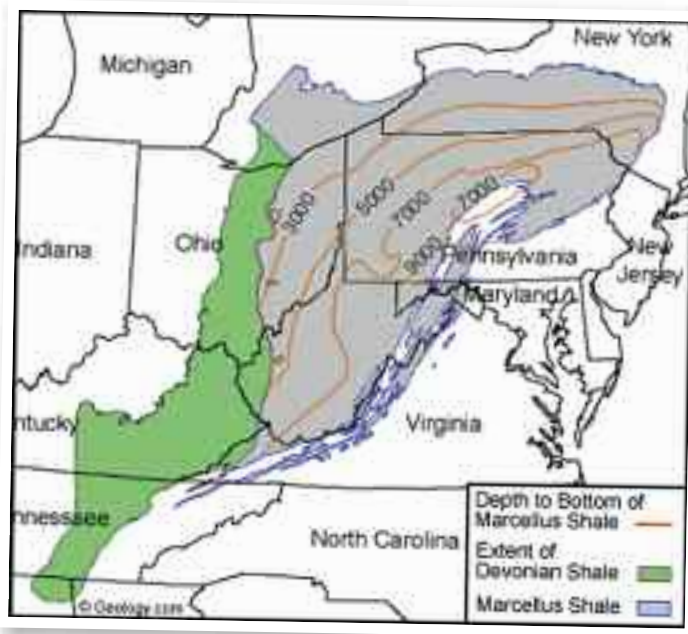


Figure 2. Depths from the surface to the Marcellus Shale formation in the Appalachian Region of the U.S.

In the drilling process, bore holes of 6 to 8 inches in diameter are vertically drilled down into the earth's crust to the approximate 5,000-foot depth of the Marcellus Shale layer. About 500 feet above the shale layer, the bore hole is slanted or curved so that the bore hole gradually becomes horizontal when it reaches the shale formation (Figures 3 and 4). Drilling continues for up to 3,000 feet horizontally through the shale. Steel casing is linked together and passed down through the bore hole. After the casing is in place, the sections in the Marcellus formation are perforated. Once the bore hole has been drilled and cased, water, sand and a mixture of chemicals are pumped down the well at

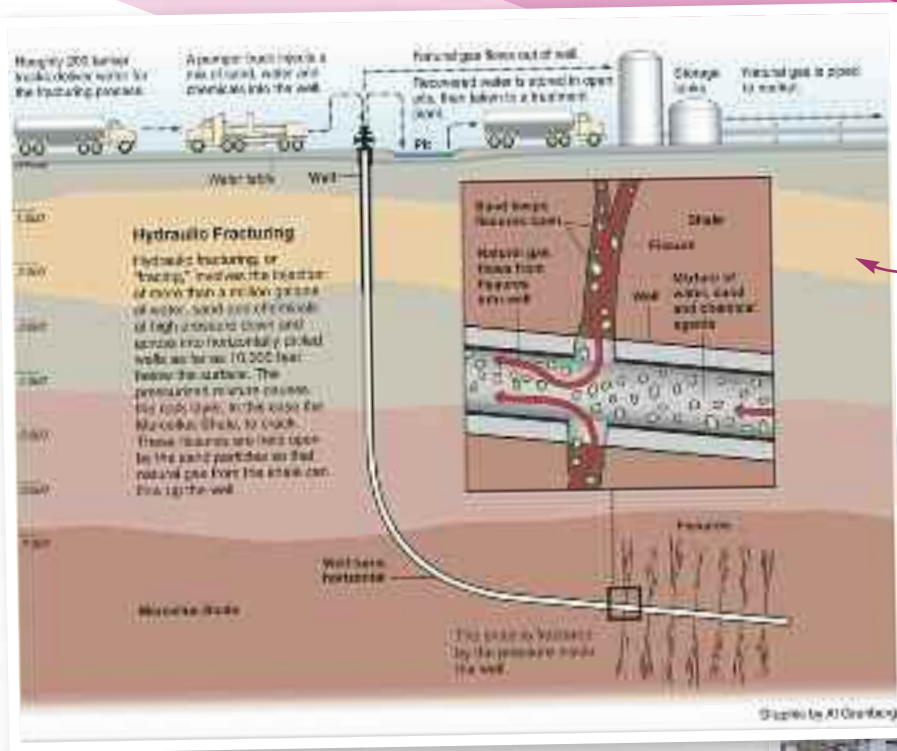


Figure 3. A simplified diagram of the horizontal drilling and hydrofracking procedure to capture natural gas contained in the Marcellus Shale (image courtesy of Brad Cole, Geology.com).

Figure 4. A Marcellus drill rig which is used to bore a vertical and horizontal well



high pressure to exit at the casing perforations and create fissures in the shale. The sand fills the fissures so that when the pressure is released the fissures remain open to permit the flow of gas to the well. Since the gas is under pressure in the shale, the gas pushes the water back out of the well and the water and gas are separated at the surface. The gas is then collected for transport. After the initial release of gas and flow back water to the surface, the well can supply natural gas with much lower levels of flow back water. Most of the flow back water comes to the surface about three weeks after the initial fracking. Low volumes of water are then “produced” along with gas during the production stage.

Landowners should become familiar with laws governing permitting requirements, pad site development, disposal of drill cuttings, water usage and wastewater disposal, gas withdrawal, road construction and maintenance, company access and royalties for natural gas withdrawn from wells near or on their property. Laws and regulations governing Marcellus Shale permitting, drilling, and reclamation are being formed in these states.

Environmental Concerns

LAND

To drill a new Marcellus Shale natural gas well, the operator must obtain a well permit from the West Virginia Department of Environmental Protection and post a bond. The bond amount is \$5,000. The company must provide maps showing the location of the well and proximity to other features like coal seams, houses and other structures, surface water such as streams and rivers, and water supplies including ground water wells. Gas well drilling involves constructing roads, clearing and leveling land, and installing drilling pads, ponds and pipelines (Figure 5). Drilling pads may range in size from two to ten acres and erosion control strategies must be in place to control erosion and sedimentation on the site. Site plans require gas companies to use preventative

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measures such as Best Management Practices to restore the site, including re-applying topsoil, and vegetation must be established within nine months of well completion by planting grass, trees or crops (Figures 6 and 7). The practices should minimize discharge of water from the drilling pad to surface waters and preserve the quality of streams and protect ground water supplies.



Figure 5. Marcellus Shale drilling site with water-holding structures and support facilities during drilling operations.

Figure 6. After the drilling operation and the majority of flow-back water has occurred (six to 12 months after drilling), a well head and barrels are left on site for further gas and water collection. The site can be reclaimed by removing the ponds and ditches, and regrading the pad site to a similar contour before disturbance. A reclamation seed mix which matches the landowner's desires can be used.



Figure 7. Reclaimed Marcellus Shale drill site showing access road, well head and condensate tank.

Land Reclamation Considerations

Like any major disturbance where topsoil is removed and the excavation cuts into geologic materials, planning is a critical element of the process. The first step should be to install erosion control structures like ditches and ponds that will collect any runoff carrying sediment from the disturbed site. The sediment can settle in ponds before the runoff water is discharged into nearby streams or waterways. If a pond is to be used to hold drill cuttings or other flow back water, these ponds should be lined and not allowed to receive runoff water from the site. The water and contents of these drill cutting or brine holding ponds should be removed by tanker trucks and taken to a water treatment facility, and not released into receiving streams. Also, the soil on out slopes of ponds should be limed, fertilized, seeded with herbaceous species, and mulched to control erosion.

Once water control has been installed, then the forest or pasture where the drilling site is planned can be disturbed. The trees can be harvested by a local timber operator. The absolute most important element to ensure proper reclamation is saving and re-applying the soil. The soil is comprised of all soil layers down to broken or weathered bedrock, including the O, A, E, B, and C horizons. We recommend that at least 2 feet of soil be salvaged, and up to 4 feet if available, and placed in a stockpile. The soil stockpile should be seeded with a vegetation cover if the stockpile will remain there for more than 6 months. If the soil to be salvaged is less than 2 feet deep, we recommend that 2 feet of soil and soil-like rocky material be saved and stockpiled for redistribution during reclamation.

Once horizontal drilling and hydrofracking are completed and much of the drilling equipment is removed, then the pond and the area around the fracking operation can be reclaimed. The ponds, both holding ponds and sediment control ponds, can be emptied and pushed in, as well as the pad site. The land contours previously there before disturbance can largely be restored with the soil and geologic materials on site. Pushing topsoil back onto the contoured areas at thicknesses similar to what was removed will largely allow the site to be revegetated with similar

plants that were originally present. Soil tests can be done to determine recommended rates of lime and fertilizer to apply during revegetation. Normally in this area, 3 to 5 tons/acre of lime will be applied and 500 pounds/acre of 10-10-10 fertilizer may be spread. An herbaceous seed mixture suitable to the landowner's desires for pasture/hay or other land use should be seeded, followed by the application of 1.5 tons/ac of hay or straw mulch. A seed mix for a grass legume pasture could be Annual Rye – 30 lbs/ac, Tall Fescue – 15 lbs/ac, Orchardgrass – 10/lbs/ac, White Clover – 10 lbs/ac, and Birdsfoot Trefoil – 5 lbs/ac.

Pipelines to carry natural gas from a well head to larger pipelines are also needed and pipeline disturbances also require reclamation (Figure 8). The same reclamation techniques stated above can be used to reclaim these pipeline corridors. Again, soil salvage and re-spreading is the key to good reclamation (Figure 9).



Figure 8. Pipelines are necessary for Marcellus Shale wells, and land disturbed for these pipeline corridors must be reclaimed.

Figure 9. Reclaimed gas pipeline corridor.



WATER

Drilling and fracking a vertical Marcellus Shale gas well requires about 100,000 gallons of water. On the other hand, a typical horizontal well takes between 2 and 6 million gallons of water. These water requirements, while large, are only one-time events and temporary. The water to conduct these activities can come from a variety of sources including nearby streams, rivers, and lakes. The water is often transported to the drilling sites in tanker trucks and stored on site in tanks or impoundments. The drilling company must identify where they plan to obtain and store the water during drilling operations. During drilling, water and drill cuttings are often deposited into small ponds (Figure 10). Since the drill cuttings typically contain brine and grease, plastic liners are required to keep water from infiltrating through the bottom to protect streams and groundwater. In addition, the landowner should request testing to ensure that toxic compounds or radioactivity, if present, are handled properly. The drill cuttings settle out in the ponds and the fluids can be reused in the drilling operation. When the ponds are removed during reclamation, the water and solids in these ponds should be removed by tanker trucks and disposed of at water treatment facilities.



Figure 10. A holding pond lined with a plastic material to store drill cuttings and water at a Marcellus well site.

What is injected into the ground during hydraulic fracturing? Ninety nine percent of frack fluid is water. The other one percent is composed of sand and small amounts of other additives such as acids, gels, surfactants and corrosion inhibitors. The drilling operator must identify where the returned frack water (flow back water) will be stored, treated and disposed.

Returned frack water must be recycled and reused, or collected and treated at a licensed wastewater treatment facility. The fracking water initially contains little salt (unless it is recycled from another site) but the return water removes salts in the Marcellus formation and returns to the surface as brine water. About 10 to

40% of the injected water returns to the surface. The remainder stays in the formation. While it is unlikely that recycling returned frack water will eliminate all of the waste disposal problem, it has many benefits. Recycling the water to frack other Marcellus Shale wells reduces the amount of truck traffic needed to haul waste water away from the drill site and it reduces demands on fresh water supplies and the trucking needed to bring that water to the site.

Once the drilling is completed and the initial large volumes of injected frack water return to the surface, gas production begins and much lower volumes of very saline "produced water" are collected and periodically hauled away. Produced water can be disposed of by underground injection into permitted wells or it might be taken to a licensed treatment facility (Figure 11). The quality of the water may dictate the treatment and disposal options.



Figure 11.
An underground
injection well into
which frack waters
can be disposed.

What is in returned frack water? Returned frack water (RFW) contains both inorganic compounds like salts and metals as well as organic compounds like natural gas liquids and oils. Table 1 shows a typical range of inorganic concentrations in RFW. The wide range in salt content often reflects the stage in well development when the sample was taken. At the early stages after fracking (RFW 4 and 5), most of the RFW is the injected water and as that volume decreases, more salty water dominates, resulting in a decrease in flow but an increase in saltness (RFW 1 and 2) (Figure 12). ■

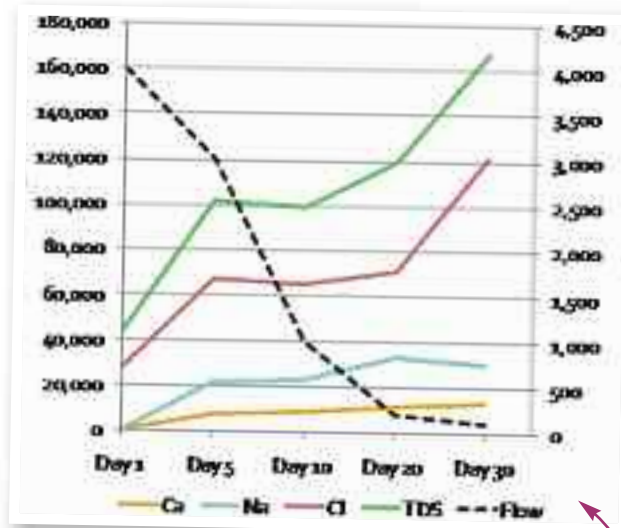


Figure 12. After completion of fracking, flow back of water to the surface is initially high but decreases rapidly. At the same time, salt concentrations increase.

	RFW 1	RFW 2	RFW 3	RFW 4	RFW 5
Total Dissolved Solids (TDS)	189,000	104,000	38.7	12.61	8.8
Total Suspended Solids (TSS)	519	570	99	220	44
Chlorine	107,000	65,000	17,100	7,172	6,575
Sodium (Na)	48,100	33.7	8,560	2,863	3,550
Calcium (Ca)	22,200	12,800	1,640	1,749	319
Magnesium (Mg)	2,000	1,470	193	122	31
Strontium (Sr)	2,970	1,440	301	nd	nd
Potassium (K)	668	444	243	57	nd
Sulfate (SO ₄)	49	414	28	71	99
Barium (Ba)	1,300	176	175	nd	27
Iron (Fe)	48	30	37	27	37
pH	6	6	7	6	8
Oil & Grease	3	nd	5	49	5

Table 1. Chemical analysis of five returned frack waters (RFW). All values other than pH are in mg/L. TDS is total dissolved solids, a measure of the salt content. TSS is suspended solids and O&G is oil and grease.

Appalachian Regional Reforestation Initiative

2012 Conference | May 22-23, 2012 | Big Stone Gap, Virginia

ARRI 2012: The Virginia Department of Mines, Minerals and Energy is pleased to host the 2012 ARRI conference with a theme *ARRI 2012: Branching Out*. DMME and the OSM Big Stone Gap area office will showcase reforestation efforts that implement the forestry reclamation approach on abandoned mine lands, legacy sites, and other innovative applications of the Forestry Reclamation Approach.

Where: The 2012 Conference will be held at Mountain Empire Community College (MECC) in Big Stone Gap, Virginia. The college is directly off U. S. Route 23 and is adjacent to the DMME office. The physical address of the college is 3441 Mountain Empire Road, Big Stone Gap, VA 24219. Upon entering the college campus, bear to the left and drive up the hill to parking lots adjacent to the Goodloe Center. A campus map is at <http://www.mecc.edu/map.htm>

Events: There will be a field tour on May 22 departing the MECC campus at 9:00. Transportation will be provided for up to 100 participants. Lunch will be on your own, with busses/vans allowing choices of Italian, Mexican, Chinese, and traditional American. After a tour of FRA work at Virginia Tech's Powell River Project, tour participants can plan to return to MECC by 5:30. On Wednesday May 23, the Goodloe Center at MECC will be the site for reforestation presentations beginning at 9:00. Lunch (all you can eat barbeque) will be provided. The conference should finish at 5:00. If there is interest, there will be an early morning bird trip to see and hear neotropical migrants, including cerulean warblers, and an early visit to an old growth stand of eastern hemlocks, threatened by the hemlock adelgids.

Lodging: A block of room is reserved for conference participants at Comfort Inn in Big Stone Gap. This hotel is a two-minute drive from the MECC campus. Comfort Inn has a government rate of \$77 plus tax. The block is reserved for the period May 21 through May 23, and the block of rooms will be held through May 1. Please reference the number 224445 when making a conference reservation. Comfort Inn's number is (276) 523-5911. Other nearby lodging options include:

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- Inn at Norton | Norton (12 minutes)
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Presentations: The conference agenda includes reforestation presentations on Wednesday, May 23. Suggested topics include abandoned mine land reclamation, riparian/wetland establishment, wildlife, American chestnut restoration, GPS applications, and forest economics. Traditional forestry reclamation approach topics are also welcome. Presenters are asked to prepare a 20 minute PowerPoint, and leave 5 minutes to answer questions. Interested presenters should submit an abstract to:

Richard Davis at
Richard.Davis@dmme.virginia.gov or
Tim Brehm at
tbrehm@osmre.gov by May 7, 2012.

Exhibitors: Businesses interested are welcome at the ARRI conference. Exhibitors can set up between 7:30 and 8:30 on May

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22, and after 5:30 on May 22. Exhibitors are asked to remove their exhibits by 6:00 on May 23. The exhibitor fee is \$100, which includes registration for two individuals.

Registration: To encourage participation, registration fees are at a minimum level to cover conference expenses. The registration fee of \$30 includes field tour

transportation, a 2012 ARRI cap, and the Wednesday all you can eat lunch. Registration for students is \$15. Registration information will be on the ARRI website by February 15, 2012.

Getting there: Mountain Empire Community College is located on U.S. Highway 23 South in Wise County, in the southwestern tip of Virginia between Ken-

tucky and Tennessee. MECC's address is 3441 Mountain Empire Road, Big Stone Gap, VA 24219. Highway 23 is the main north-south highway in southwest Virginia and connects to the north with Interstate 64 and Route 119 in Kentucky, and Interstate 26 and Interstate 81 to the south in Tennessee.

COMING FROM THE NORTH

MECC is located on the right just past the second Big Stone Gap, Virginia exit (there are only two Big Stone Gap exits), on southbound US Highway 23.

COMING FROM THE SOUTH

MECC is located roughly 12.5 miles north of Duffield, Virginia, situated on the left as you drive north on US Highway 23.

Big Stone Gap: While in Big Stone Gap, please take the opportunity to visit nearby places of interest. The Southwest Virginia Museum <http://www.swvamuseum.org/> has fascinating exhibits on the early history and development of the coal industry. The Harry Meador Museum <http://www.bigstonegap.org/attract/coal.htm> focuses on the mining history of the area. Big Stone Gap has a greenbelt trail that can be accessed at several points in town. High Knob, at 4223 feet above sea level, is the highest point in far southwest Virginia and is a short drive from Norton. During the late 1930s, the Civilian Conservation Corps constructed the nearby High Knob Recreation Area.

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Forest Reclamation Advisory

Forest Reclamation Advisory No. 8 | January 2011

Selecting Materials for Soil Construction When Establishing Forest on Appalachian Mine Sites

Jeff Skousen, Carl Zipper, Patrick Angel, Jim Burger, and Christopher Barton

Introduction

The Forestry Reclamation Approach (FRA) is a five-step method for reclaiming coal-mined land to forest (FRA Advisory #2, Burger et al., 2005). The FRA is based on knowledge and experience of forest soil scientists and reclamation practitioners over the past 50 years. Forest Reclamation Advisories have been written on several FRA steps. They can be obtained at <http://arri.osmre.gov/FRA/FRAshmt>.

The first step of the FRA is: "create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone and/or the best available material."

The selection and placement of a suitable rooting medium is critical for good survival and growth of trees in surface mine reclamation. Constructing mine soils using materials that are suitable for reforestation enhances and accelerates the development of a diverse forest ecosystem. This Forest Reclamation Advisory provides guidance on how to execute step 1 of the FRA. The guidance is intended for use by coal surface mining operators that are seeking to re-establish native forest as a post-surface mining land use in the Appalachian Region of the USA.

Background

Weathering is the process of changing rocks into soil-like materials. The eastern USA's Appalachian Mountains are among the world's most ancient landscapes. Soils on these landscapes were developed over long time periods from the parent rock material in response to climate, organisms (plants and animals), and landscape position (Jenny, 1941). These soils are unique and provide the foundation for the plant and animal ecosystems that have developed. Throughout the Appalachians, diverse plant communities have evolved on these weathered rock and soil materials (Figure 1).

During surface mining, unweathered rocks from deep within the earth are often brought to the land surface where they are exposed to air and water. When placed on the surface as growth media, these rocks react with air and water, and break down, both physically and chemically, releasing soluble salts and changing

mineral forms (Sencindiver and Ammons, 2000). Plants will establish and grow in these pre-soil materials, producing organic matter which aids development of the soil and makes it more favorable to colonization by microorganisms and more plants (Johnson and Skousen, 1995). These processes are well known, occur naturally, and can be accelerated by reclamation processes such as fertilization and seeding. However, when starting with unweathered rock materials, long time periods are required before a soil similar to the native soil develops which can then support a plant community similar to that which existed before mining (Figures 2 and 3).



Figure 1. The Mixed Mesophytic Forest of the Appalachian Mountains of the eastern USA is an diverse assemblage of over 40 tree species arrayed across the landscape based on native soil properties and other environmental factors.

While unweathered gray rock materials brought to the surface during mining will eventually weather into soils, forest development can be accelerated by using salvaged soil and/or weathered brown rock materials when reconstructing the land surface. Trees and other plants that are native to Appalachian landscapes have evolved to grow in the region's soils and near-surface weathered



Figure 2. The native soils of the region have developed over a long time based on the climate (rainfall and temperature), landscape position, plants and animals, and the parent material from which it was formed. These soils have suitable properties and contain seed banks that are critical to the re-establishment of diverse forest ecosystems on mined lands. As such, these soil materials should be saved and re-spread on the reclaimed surface.

Figure 3. In the background is the native plant community which has developed on native soils in the Appalachian Region. In the foreground, the native soil has been stripped off of the surface to make way for holes to be drilled to blast the overburden to reach the coal. The overburden consists of the weathered brown sandstone (about 20 ft) underlain by unweathered gray sandstone and siltstone.



Figure 4. Weathered brown sandstone in West Virginia originally dumped in piles and leveled with one pass has weathered after two years into a mine soil that supports good tree growth and has good colonization of native plants. Mine soil pH is 6.0.



Figure 5. Unweathered gray sandstone in West Virginia originally dumped in piles and graded with one pass shows some weathering into smaller particles after two years, but has shown generally poor tree growth and poor colonization by native plants compared to weathered brown sandstone soil materials. The pH of these mine soils is >8.



rocks. Such materials are superior to broken unweathered gray rocks in their ability to supply nutrients, air, and water to plants (Figures 4-7). Although the broken unweathered gray rocks are able to develop these capabilities with time, use of salvaged soils and weathered rocks for mine soil construction can accelerate forest growth and development. It is preferable to plant native hardwood trees into the soil in which they were adapted to grow (Hall, 2007; Smith, 1983; Torbert and Burger, 2000).

Guidelines

1. Salvage and re-spread topsoil, if it is available, of good quality and can be obtained without compromising machine operator safety.

The term "topsoil," as we are using it here, refers to soil materials that can be removed with a dozer and is generally composed of fine-textured material in the O, A, E, B, and C horizons (or to a depth of broken bedrock). Topsoil also includes organic matter,

coarse woody debris, such as stumps and roots remaining from harvested trees prior to mining operations, and rocks found within the soil profile. The best topsoil materials are those with the most organic materials, i.e., those which occur closest to the surface.

Topsoil from forested areas contains materials that aid plant community development on reclaimed mine landscapes and will enhance ecosystem services. Two properties of topsoil make it especially valuable for re-spreading during reclamation. First, viable seeds and propagules contained in the soil (called a seed bank) enable the re-establishment of native forest plant species that are not planted (Hall, 2007). Second, organic matter and humus in the native topsoil provide nutrient pools for elements like nitrogen and phosphorus which are essential for plant



Figure 6. Tree growth and herbaceous plant cover is good in weathered brown sandstone as shown at the same site in Figure 4 planted with native hardwoods after six years of growth.

Figure 7. Tree growth and herbaceous cover on unweathered gray sandstone is relatively poor at the same site as Figure 5 planted with native hardwoods after six years of growth. The trees are surviving but their growth is retarded. Minesoil pH remains above 7.5 after six years.



growth. Organic matter also enhances the re-establishment of soil animals and microorganisms, which are important for nutrient cycling and are helpful in creating channels for air and water movement in the soil, and can promote favorable landscape hydrologic properties.

Topsoil should be considered a "living resource" and re-spread immediately when possible to maintain living soil animals, microorganisms, and roots and seeds. When topsoil is obtained from forested areas prior to mining, the salvage operation should take stumps, roots, and woody debris left on the site and then transport them to the reclaimed area and re-spread with the topsoil.

Even if salvageable topsoil is not available in quantities sufficient to produce a soil of adequate depth over the entire reclamation area, replacement of fresh topsoil over portions of the reclamation area and/or mixing salvaged topsoil with other overburden materials are critical to the re-establishment of a native forest plant community and will promote essential ecosystem components on the reclaimed land (Holl et al., 2001).

Salvaged topsoil, especially if lacking rocks and organic debris, will often be prone to erosion initially than the rocky spoils used in some reclamation practices today. Thus, when a tree-compatible herbaceous ground cover (slow-growing) is used, some erosion of the topsoil may occur during the first year or two, as the seeded and volunteer vegetation is becoming established (FRA Advisory #6, Burger et al. 2009). If invasive species are prominently growing in the area where topsoil is being obtained, re-spreading "contaminated" topsoil on the reclaimed area will result in the re-establishment and spread of these invasive species. When invasive tree species such as Tree of Heaven (*Ailanthus altissima*), Autumn Olive (*Elaeagnus umbellata*), and Paulownia (*Paulownia tomentosa*) are growing in an area, contaminated topsoil should be separated to avoid proliferation of these invasive species on the newly reclaimed area.

When both salvaged native soils and other materials are being used for mine soil construction, "mixing" can be accomplished after both materials have been transported to the reclamation area through light-grading operations (FRA Advisory #3, Sweigart et al. 2007). It is essential that such spreading and grading be done in

a fashion to avoid compaction. It is not necessary to get an even distribution or mix of topsoil materials. Additional equipment operation to mix these materials should be avoided to reduce the potential for compacting the surface layers.



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Figure 8. Weathered brown sandstone can be found immediately below the soil and it will often extend to about 30 feet from the surface. Under the brown sandstone material will be found the unweathered gray sandstone. The brown sandstone has been found to be a better material to place on the surface for forestry post-mining land uses.



2. Where available and of suitable quality, weathered spoil materials, and most especially sandstones, should be salvaged and re-spread.

Weathered brown sandstone materials can be easily recognized on most mine sites due to their color (Figure 8). They are usually found to a depth of 20 to 30 feet from the surface. However, some brown sandstones may not be suitable for use as a growth medium because of the presence of weathered sulfate minerals or partially-weathered pyritic materials, which will cause water quality problems (Isabell and Skousen, 2001). Weathered brown sandstone will generally have a pH from 4.5 to 6.0. If the pH is below 4.0, it probably contains acid-producing minerals and should not be used.

Some weathered sandstone materials are low in essential plant nutrients and mixing these materials with weathered siltstone or shale materials will improve soil fertility (Casselmann et al., 2006). Mixing with some unweathered materials can also provide better soil fertility and laboratory tests can predict available nutrient concentrations in these various materials.

3. When topsoil and weathered brown sandstone are not available to provide 4 feet or more of growth media on the surface, unweathered overburden materials with favorable properties can be used to supplement the amount of material needed.

Unweathered materials can be sandstones, siltstones, and shales. Just as color can distinguish the weathering status of brown sandstone, white and gray colors of overburden layers indicate where unweathered materials are located. Favorable properties of unweathered materials are that they contain no pyritic minerals and are composed of rocks that break down to form soil-like materials easily when exposed to air and water. The resulting soil materials should weather to generate soil pH in the 5 to 7 range within a few years.

If only unweathered materials are available for growth media, a mixture of primarily sandstone with small amounts of shale and siltstone (all with favorable properties) can be used (Conrad

et al., 2002), but generally these materials will not support the rapid growth and development of trees, nor the re-establishment of a diverse ecosystem (Burger et al., 2007). The use of a mixture of topsoil and weathered brown sandstone is preferred above the use of unweathered materials exclusively. A mixture of topsoil, weathered brown sandstone, and unweathered materials can be substituted as the best available material and can be used for forest mine soils.

4. Avoid surface placement of materials that are unsuitable as growth media for native forest trees.

Materials with unfavorable properties are those that:

- 1) contain pyritic minerals because such materials will have a tendency to generate acids and excess salts, thereby elevating the total dissolved solids (TDS) concentrations in runoff water creating soils and water with pH below 4.0;
- 2) will not break down rapidly into smaller particles, such as materials typically used for durable rock;
- 3) have high pH (>8) and high electrical conductivity (EC);
- 4) are classified as carbonaceous rocks such as "black shales;"
- 5) maintain soil pH >7.5 for several years after placement and contain high amounts of limestone or calcareous materials (Daniels and Amos, 1984; Haering et al., 1993; Sencindiver and Ammons, 2000).

Summary and Conclusions

Step 1 of the FRA is intended to "create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone and/or the best available material." The native topsoil in this region is thin and can be lost during site preparation for mining. Pre-mining site preparation techniques should minimize the loss of this material provided that machine operator safety is not compromised. This topsoil contains organic matter, forest floor seed, coarse woody debris, root fragments, and other root propagules, which can

greatly enhance natural colonization of native forest plants onto the site. These plants will add diversity to the plant community and aid in forest ecosystem development. Weathered brown sandstone is that broken rock material below the soil down to a depth of 20 to 30 feet. The use of topsoil and weathered brown sandstone is generally preferred above the exclusive use of unweathered materials from deeper in the overburden column.

Selection of appropriate growth media is site specific. While topsoil and weathered brown sandstone materials are preferred growth media for trees on reclaimed lands, other materials either weathered or unweathered containing favorable properties can be used. Unsuitable materials are those containing pyritic minerals, have high pH due to high carbonate (limestone) contents, produce high EC upon weathering and leaching, and are black shales.

When native forest re-establishment is the post-mining land use designation and reclamation goal, the above guidelines can aid the mine operator's choice of "best available" growth media to apply to the surface.

References

- Burger JA, V.M. Davis, J. Franklin, C. Zipper, J.G. Skousen, C.D. Barton, P.N. Angel. 2009. Tree compatible groundcovers for reforestation and erosion control. Appalachian Regional Reforestation Initiative, US Office of Surface Mining. Forest Reclamation Advisory Number 6. Available online at <http://arri.osmre.gov>
- Burger, J., D. Graves, P. Angel, V. Davis, and C. Zipper. 2005. The forestry reclamation approach. Appalachian Regional Reforestation Initiative, U.S. Office of Surface Mining. Forest Reclamation Advisory Number 2. Available online at <http://arri.osmre.gov>
- Burger, J.A., D. Mitchem, and W.L. Daniels. 2007. Red oak seedling response to different topsoil substitutes after five years. In: Proc., 2007 American Society of Mining and Reclamation Meet. Gillette, WY. 2-7 June 2007. R.I. Barnhisel (ed.) ASMR, Lexington, KY.
- Casselman, C.N., T.R. Fox, J.A. Burger, A.T. Jones, and J.M. Galbraith. 2006. Effects of silvicultural treatments on survival and growth of trees planted on reclaimed mine lands in the Appalachians. *For. Ecol. Manag.* 223: 403-414.
- Conrad, P.W. 2002. An evaluation of the impact of spoil handling methods on the physical properties of a replaced growing medium and on tree survival. Ph.D. Diss. Univ. of Kentucky, Lexington. 262 p.
- Daniels, W.L., and D.F. Amos. 1984. Generating productive topsoil substitutes from hard rock overburden in southern Appalachians. *Environ. Geochem. Health* 7: 8-15.
- Haering, K.C., W.L. Daniels, and J.A. Roberts. 1993. Changes in mine soil properties resulting from overburden weathering. *J. Environ. Qual.* 22: 194-200.
- Hall, S. 2007. Topsoil seed bank of an Oak-Hickory forest in eastern Kentucky as a restoration tool on surface mines. M.S. Thesis, University of Kentucky, Lexington, KY. 92 pp.
- Holl, K., C. Zipper, and J. Burger. 2001. Recovery of native plant communities after mining. Virginia Cooperative Extension Publication 460-140. <http://pubs.ext.vt.edu/460/460-140/460-140.html>
- Isabell, M., and J. Skousen. 2001. Overburden analysis and special handling at Fola Coal Company. *Green Lands* 31(4): 46-53. <http://anr.ext.wvu.edu/r/download/43793>
- Jenny, H. 1941. *Factors of Soil Formation*. McGraw-Hill Book Company, Inc., New York.
- Johnson, C., and J. Skousen. 1995. Minesoil properties of 15 abandoned mine land sites in West Virginia. *J. Environ. Qual.* 24: 635-643.
- Sencindiver, J.C., and J.T. Ammons. 2000. Minesoil genesis and classification. p. 595-613. In R. Barnhisel et al. (ed.) *Reclamation of drastically disturbed lands*. 2nd ed. Agron. Monogr. 41, ASA, CSSA, and SSSA, Madison, WI.
- Smith, H.C. 1983. Growth of Appalachian hardwoods kept free to grow from 2 to 12 years after clearcutting. USDA Forest Service, Northeastern Forest Experiment Station, Res. Paper NE-528. Parsons, WV.
- Sweigard, R., J. Burger, C. Zipper, J. Skousen, C. Barton, and P. Angel. 2007. Low compaction grading to enhance reforestation success on coal surface mines. Appalachian Regional Reforestation Initiative, U.S. Office of Surface Mining. Forest Reclamation Advisory Number 3. Available at <http://arri.osmre.gov/>
- Torbert, J.L., and J.A. Burger. 2000. Forest land reclamation. p. 371-398. In R.I. Barnhisel et al. (ed.) *Reclamation of drastically disturbed lands*. 2nd ed. Agron. Monogr. 41. ASA, CSSA, and SSSA, Madison, WI. ■

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