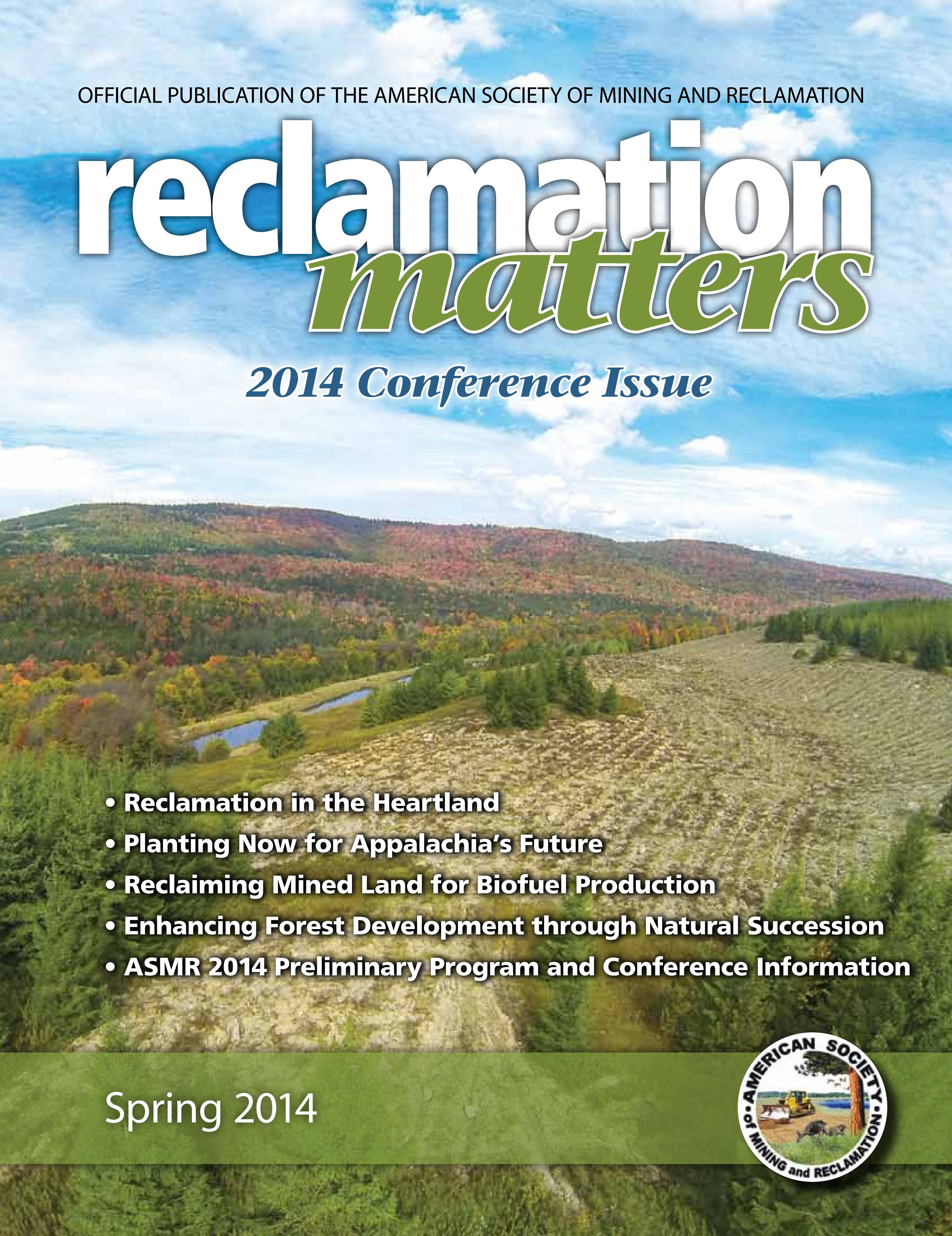
OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation matters

2014 Conference Issue



- Reclamation in the Heartland
- Planting Now for Appalachia's Future
- Reclaiming Mined Land for Biofuel Production
- Enhancing Forest Development through Natural Succession
- ASMR 2014 Preliminary Program and Conference Information

Spring 2014

AMERICAN SOCIETY of MINING and RECLAMATION

Should this land be mined for coal?

It already was.

NorthAmerican
COAL
CORPORATION

reclamation matters
is published by:
DEL Communications Inc.
Suite 300, 6 Roslyn Road
Winnipeg, Manitoba
Canada R3L 0G5

PRESIDENT
David Langstaff

PUBLISHER
Jason Stefanik

MANAGING EDITOR
Lyndon McLean
lyndon@delcommunications.com

SALES MANAGER
Dayna Oulion
dayna@delcommunications.com

SALES REPRESENTATIVES
Cheryl Ezinicki
Ross James
Colin James Trakalo

PRODUCTION SERVICES
S.G. Bennett Marketing Services
www.sgbennett.com

ART DIRECTOR
Kathy Cable

LAYOUT & DESIGN
Joel Gunter

ADVERTISING ART
Caitlyn Haier
Dana Jensen

Publications Mail Agreement #40934510
Return undeliverable Canadian addresses to:
DEL Communications Inc.
Suite 300, 6 Roslyn Road
Winnipeg, Manitoba R3L 0G5
Email: david@delcommunications.com

DEL Communications Inc.

PRINTED IN USA | 03/2014

contents

Index to Advertisers

NASLR and ASMR: A Match Made in Reclamation

By Bob Nairn, ASMR President

Editor's Note: This message was published in the National Association of State Land Reclamationist's (NASLR) newsletter, Winter issue 2013. Bob Nairn felt this message should be provided to ASMR members.

As the current president of the American Society of Mining and Reclamation (ASMR), it was my sincere pleasure to attend and present at the recent NASLR National Meeting in Hot Springs, Arkansas. Our two societies share both interest in and passion for land and water reclamation, and I hope we can develop successful collaborative relationships. The stated purpose of ASMR is "to encourage and assist any agency, institution, organization, or individual in efforts to reestablish, enhance, or protect our natural resources disturbed by mining or other human activities, or by disturbance through natural events." One of the objectives of ASMR is "to support other reclamation societies and organizations," and I encourage all NASLR members to visit www.asmr.us to learn more.

Membership in ASMR is open to any person with an interest in the reclamation of lands and waters. Annual dues are reasonable: $10 for students, $50 for regular members and $100 for sustaining members (emphasizing the organizational affiliation) or corporate members. There is also a one-time $500 life membership available. All ASMR members are automatic members of the International Affiliation of Land Reclamationists (IALR), which includes ASMR, along with our British, Canadian, Australian and Chinese colleagues. In 2012, ASMR had over 400 members representing 37 US states and 12 countries. ASMR currently maintains seven Technical Divisions: Ecology, Forestry and Wildlife, Geotechnical Engineering, Land Use Planning and Design, Soils and Overburden, Tailings and Water Management. These divisions reflect the diverse interests and expertise of the membership.

The annual ASMR National Conference, typically held in June and alternating between the eastern and western US, is the society's "big event." The conference includes workshops, plenary presentations, concurrent oral technical sessions, poster sessions, exhibitors, receptions, an awards banquet, a social event, and field tours. Our next meeting is in Oklahoma City, OK from June 14-21, 2014. **ASMR would be pleased to include a "NASLR Session" at our next meeting, with NASLR choosing speakers and moderating the session. Perhaps a joint meeting could be organized in 2015 or 2016, including closer collaboration and sharing organizational responsibilities**.

The awards banquet is the highlight of the annual conference, where both professional (William T. Plass Award, Reclamationist of the Year, Barnhisel Reclamation Researcher of the Year and Pioneers in Reclamation Award) and student (BS, MS and PhD Memorial Scholarships, Best Student Presentation and Poster, Student Research Grant and Student Travel Grant) award winners are honored.

ASMR published National Conference Proceedings volumes from 1984 to 2012, which serve as invaluable resources for cutting-edge reclamation research, technologies and case studies. The *Journal of ASMR*, first published in 2012, is our new peer-reviewed, online scientific journal. *Reclamation Matters*, published twice a year since 2004, is the official society publication and provides news, features, announcements and case studies. **ASMR would be pleased to offer Reclamation Matters to all NASLR members free of charge**. Current ASMR initiatives include a survey of member needs, promotion of student and early career professional participation, an improved and expanded electronic presence and strategic expansion of the membership base.

Having attended the last NASLR national meeting, I can say with great confidence that ASMR and NASLR members share professional interests. NASLR members' expertise across industries (including coal, sand and gravel, limestone, etc.) fits well with ASMR's focus of serving as a resource across the entire reclamation profession. Furthermore, as the ultimate driver of the reclamation profession, the regulatory focus of NASLR's members notably compliments ASMR's member areas of technical expertise, and could form a new Technical Division. I hope that NASLR's members will consider the benefits that ASMR offers, and that we explore ways to collaborate as professional societies and as individuals. Please do not hesitate to contact me (nairn@ou.edu) or any other ASMR members as we explore these possibilities, and thank you for your consideration. ■

You Can Make A Difference!

By Jeff Skousen

One of the first assignments I give to the 90 students in my environmental science class is to describe how they deal with challenging environmental issues. My intent is for them to consider their excuses for not doing something. Here is the assignment:

When we first encounter an environmental problem, our first response is to blame someone. The blame often goes to greedy company CEOs who only want money for themselves and their stockholders (the bottom line), selfish and ignorant politicians who are only interested in getting re-elected and receiving financial contributions, or misguided people who have a narrow perspective and only care about their agenda. We tell ourselves that these are the villains and we are the victims.

After blaming someone or something, we often fall into mental traps that can lead to denial or indifference, and we do nothing. Here are several of these mental traps.

1. *Gloom-and-doom pessimism (it's hopeless, we're all going die anyway);*
2. *Technological optimism (discoveries and technology will eventually fix the problem, so do nothing);*
3. *Confusion freeze (the problem is too complex, we don't know enough yet to do anything);*
4. *I'm only one person (any little thing I do will not matter or it will go unnoticed);*
5. *It's not 'my' problem (it's the villain's or government's problem and they should go to jail);*
6. *I'm so poor (if I had money I would do better).*
7. *I'm lazy (I admit it, I'm a slob).*

Explain which of these mental traps you use to justify your actions or inactions in helping to solve or reduce environmental problems.

Give two examples of environmental problems and how someone might justify their indifference or denial to both of these problems by using one of these mental traps.

I have given this assignment for 15 years and the excuse used by students far more than any other is #4 "I'm Only One Person." When I ask why, most of them feel their efforts to conserve electricity or to reduce water use or to use less gasoline will make no difference. They say most people do not care or will not be inconvenienced, so it is easy for them to do less than they could.

As you can imagine, I try to emphasize that each person's effort is critical and, if all the students in this class do their part, large changes can happen. From small cumulative efforts, great things can occur. Furthermore, if they teach their roommates, families, and future children, the efforts will be multiplied.

I use a quote taken from a piece of graffiti from the Berlin Wall:

"Many small people, who in many small places do many small things, can alter the face of the world."

On the final exam, the last question worth five points is:

My mysterious please to you. Decipher by using the next letter in the alphabet (z = a, a = b, b = c, etc.).

Xnt bzm lzjd z cheedqdmbd! Rlzkk Bgzmfdr oqdbdcd Fqdzs Nmdr! ■

How to Choose an Analytical Laboratory

By Chris Johnston

Reclamation is a part of what we think about on a daily basis and it is our job to understand what is needed to achieve successful reclamation. In a very general sense, we must first have an understanding of what the land use and environment was like prior to disturbance so that those conditions can be reproduced as closely as possible when it comes time to reclaim the land. Second, we need to understand what resources are currently present and how to handle those resources so they can be preserved and used to their fullest during the reclamation process. And of course, we need to perform the work within an appropriate time frame and within permit requirements.

An important consideration when determining what is to be conserved for future use is the collection of samples. Typically, samples are collected before any disturbance and sent to an environmental laboratory for analysis. Each sample is analyzed for a number of chemical and physical parameters. The parameters selected and their results help determine if that material should be set aside for future reclamation or if is unsuitable for reclamation purposes. Sounds pretty easy, but what determines if the data you are getting are data you can trust? That is where the laboratory you are working with comes into play. Here are a few tips you can use to help ensure you are working with the best data possible.

Laboratory capabilities and services can vary dramatically. A few things to keep in mind when selecting a laboratory include whether or not a lab is certified or accredited for the analysis you will be needing, the time they need to analyze a sample and report the data back to you (turnaround time), the cost to complete the analysis, level of customer service, and any additional services besides analytical that might help facilitate the project. Some of these are required to get the job done right and some are more service related, but they should all be considered when choosing a quality laboratory.

Like many other professional entities, there are certification and accreditation opportunities for laboratories. In many situations laboratories are required to be certified or accredited to perform the work. In addition, if there is going to be a need for subcontracting to be done, all supporting labs need to be certified or accredited, as well. For many companies this is the best indicator of a laboratories capability to do a good job. It means that the data you are getting are accurate, complete, comparable and defensible. Keep in mind however, that if a specific analytical method is required, you need to make sure the laboratory is certified or accredited to perform that method and not an alternate.

In addition to, or as part of, a laboratory's accreditation or certification program, laboratories may also have to perform proficiency tests. These tests provide a blind check and allow a laboratory to monitor its quality of data by assessing its ability to produce precise and accurate results. Additional involvement in these programs when voluntary should be viewed as a laboratory's desire to provide the best data possible to its clients. Results of these proficiency tests should be made available to prospective clients upon request.

Any lab you consider should also meet or exceed any quality control requirements for each method and analysis they provide. When requested, the lab should be willing and able to report any quality control results associated with the batch in which your samples were run including duplicate samples, blanks, blank spikes, and standards. These should be provided at no extra cost to the client. A more comprehensive quality control package can also be provided that can include all calibration information and standards, raw instrument data, bench sheets and sample and solution preparation information. This type of package is typically provided at some additional cost to your client. Keep in mind when first discussing the needs to make sure the laboratory can meet all the data quality objectives as set forth in the sampling and analysis plan.

It is very important to make sure the lab can meet the holding times required for analysis. Holding times are defined by method and in place to assure the samples will be analyzed in an appropriate amount of time. Holding times can vary depending on the method used for analysis and if the sample has been preserved or not. Results from analysis that have been completed after the holding time is exceeded are typically not accepted for regulatory requirements and new samples will have to be collected. It is a good idea to check with the lab prior to sampling to make sure current lab capacity will allow for analysis within holding times, especially during busy times of the year such as spring and fall.

Another “time” to be mindful of when working with laboratories is their standard turnaround time. This is the amount of time it takes the laboratory to login, process (if necessary), analyze, QA/QC, and report the results. Typical turnaround times for water range from seven to 10 days and soil approximately 15 days. Your turnaround time can be shortened by requesting a “rush” or “urgent” turnaround. Make sure to get the pricing from the laboratory for shorter turnaround times as they are typically 1.5X to 2X the standard turnaround time price. Turnaround times are one way a laboratory can distinguish itself from other laboratories.

Now that we know the laboratory can provide the services and how long it is going to take to get the results, how much is the service going to cost. Like any other industry, pricing caninimum of two to three quotes to have vary greatly so it is important to get a ma good understanding of the range that is being offered. Price is not always the driving factor when choosing a laboratory, but in many cases it is the first thing noticed. Price should be one of the deciding factors in selecting a laboratory but not the only deciding factor.

Other ways a laboratory can distinguish itself from other laboratories are by its level of customer service and whether the laboratory offers any additional services that could help facilitate the project. Every lab preaches customer service but is that portrayed in their everyday communications and work habits? Do they respond in a timely manner when you have questions or concerns regarding samples, or when you are questioning their data analyses? When it comes to choosing a quality laboratory, you can tell a lot by the way they react to emergency situations and time frames or when their data analyses are being questioned. Also ask the lab about any other services they may offer. In some cases, the lab can help in ways you would not normally expect. For example, does the laboratory provide field sampling services, set up of monitoring stations and networks, electronic data submission, work with regulatory agencies on your behalf? You may be surprised.

Ultimately, there are a number of factors that go into selecting the right laboratory. Take the time up front to do your due diligence and ask the questions that need to be asked. Any laboratory worth its weight understands your position and should do everything they can to help you meet your mark. ■

Reclamation in the Heartland: The Tar Creek Superfund Site and the Tri-State Mining District

By Bob Nairn, ASMR 2014 Conference Chair

Photo 1

Although we often think of mining in the mountains of Appalachia and the Rockies, the Great Plains offers what was once considered "the greatest zinc field in the world" - the Tri-State Mining District (TSMD) of Oklahoma, Kansas and Missouri.

Significant quantities of lead and zinc were produced from the TSMD from the 1890s through the 1960s (Photo 1). Peak production occurred in the early 1920s, when the mines accounted for over 55 percent of total U.S. zinc production. By the late 1950s, depressed global markets resulted in the suspension of most mining operations. By the early 1970s when mining ceased, almost four million tons of lead concentrates and 23 million tons of zinc concentrates had been produced. Like many abandoned hard-rock mining areas, the TSMD presents consider-


Photo 2

able environmental challenges, including contaminated surface and ground waters (Photo 2), waste piles called “chat” (Photo 3), fines impoundments (Photo 4) and collapse features (Photo 5). Straddling the boundaries of the three states and two U.S. Environmental Protection Agency (EPA) regions (Regions 6 and 7), the mining district offers substantial jurisdictional complexities, especially considering the presence of significant Native American lands in Oklahoma. Today, the district includes four EPA CERCLA or Superfund sites, including Tar Creek in Oklahoma.

The Tar Creek Superfund Site includes the former Picher Field, and the Tar, Lytle, Beaver, and Elm Creek watersheds. The site of extensive underground room and pillar mining for nearly a century, the area is now characterized by large waste or “chat” piles, extensive un-vegetated fines impoundments, metals-contaminated artesian mine water discharges and streams, and collapse features. The Tar Creek site was placed on the National Priorities List in 1983, and five operable units have been established to facilitate clean up.

As part of the 31st National Meeting

Photo 3

of ASMR in Oklahoma City, a post-conference "can't-miss" field tour to the Tar Creek Superfund Site and Tri-State Mining District will be held Thursday June 19 to Friday June 20.

This two-day event will also include visits to other important sites. The Grand River Dam Authority's (GRDA) Grand River Energy Center (formerly the Coal Fired Complex), features both coal-fired generation and, by 2017, a new combined cycle gas unit that is designed to be the most efficient in the United States. Pensacola Dam, the longest multiple arch dam in the world, was built in 1940 to provide hydroelectric power and forms the 46,500 acre Grand Lake O' the Cherokees, the ultimate repository for Tar Creek and TSMD waters and sediments. On the shores of Grand Lake, sits the GRDA Ecosystems and Education Center, which includes a state-of-the-art water quality laboratory available to university researchers.

At Tar Creek and the TSMD, visitors will be immersed in the 2,500-acre mine-scarred landscape, sitting above approximately 76,000 acre-feet of contaminated mine pool waters. Field tour attendees will climb a chat pile (yes, you can climb an Oklahoma mountain and look out across the plains), and visit un-reclaimed and reclaimed tailings areas and a large waste repository. Chat-injection sites (where fine wastes are slurried and injected into the underground workings) will also be included. In addition, the Quapaw Tribe of Oklahoma will lead a visit to the Catholic 40, the first tribally-led Superfund cleanup in the entire nation. The first and only full-scale passive treatment system (PTS) in the TSMD, the Mayer Ranch PTS will be toured (Photo 6). This system was designed to treat 250 gallons per minute of mine water contaminated with iron, zinc, lead, cadmium and arsenic.

A visit to the Tar Creek and TSMD region is simply unforgettable; it is a "must see" opportunity. Residents from the area are proud to say that they and their forebears mined the lead and zinc that won the World Wars – and they did. The resulting environmental challenges are a case study in reclamation science and should be of great interest to all ASMR members.

Additional Field Tour Opportunities

In addition to the two-day field tour to the TSMD, two additional one-day field tours will be offered on Thursday June 19, in conjunction with the ASMR national meeting. A tour of an active limestone quarry and related reclamation operations will be held. The site is located in the Arbuckle Mountains of south central Oklahoma and in the Arbuckle-Simpson aquifer, a much-studied and important ground

Photo 4

Photo 5

water source. Another field trip will be offered to abandoned coal mine reclamation areas. Eastern Oklahoma's rich history of coal mining provides ample opportunities to visit highwall reclamation, subsidence abatement, mine fire mitigation and mine water passive treatment sites. Please plan to take advantage of one of these exciting field tour opportunities at ASMR in OKC! ■

Photo 6

2014 Conference

American Society of Mining and Reclamation
31st National Meeting

June 14 – 20, 2014 | Renaissance Oklahoma City Convention Center Hotel | Oklahoma City, OK

"Exploring New Frontiers in Reclamation"

Preliminary Program and Conference Information

Oklahoma is a land of unique geography, ecology, history and people. Stretching from the Ozark Highlands and Ouachita Mountains in the east, through the Cross Timbers and prairies of the Great Plains, to the tablelands, mesas and caprock canyons of the west, Oklahoma is home to 12 U.S. Environmental Protection Agency Level III ecoregions - making it one of the most ecologically diverse of all the states. Oklahoma history is also varied, from its rich Native American past and frontier "Land Run" settlement to today's vibrant energy and agriculture-driven economy. Oklahoma offers breathtaking scenery, Americana charm and hospitable people. Oklahoma was one of the last frontier states and was opened to European settlement only in the 1890s. The state is home to 39 Native American tribes (38 that are federally recognized) and Oklahoma culture is rich in this Native American legacy. In the center of the state is Oklahoma City, a dynamic, modern urban center that will offer a capital experience for ASMR's 31st National Meeting. The conference theme *"Exploring New Frontiers in Reclamation"*, reflects both Oklahoma's unique history of settlement and its relative youth as the 46th state (entering the Union in 1907), as well as ASMR's ongoing membership expansion into the full suite of reclamation practitioners.

All conference activities will take place at the Cox Convention Center, conveniently connected via Skywalk to the Renaissance Oklahoma City Convention Center Hotel. Pre-conference activities include a Technical Workshop on Saturday-Sunday June 14-15. A Welcome Reception the evening of Sunday June 15 will include appetizers and refreshments in the Great Hall, allowing time to visit with exhibitors and see old and new colleagues. The Plenary Session will begin our technical program on Monday, followed by the ASMR Awards Luncheon on this first full day of the conference. Monday evening features the Early Careers Professionals' Social Event at a nearby location, while Tuesday evening includes the Poster Session and Mixer. Wednesday evening offers the ASMR Evening Social Event at the Oklahoma History Center featuring dinner, entertainment and opportunities to tour the exhibits. Each day, catered breakfasts, lunches and morning and afternoon breaks will be provided in the Great Hall at the Cox Convention Center. Thursday and Friday feature three great field tour opportunities. Ample time will be provided for fellowship and technical exchanges. See you in OKC in June!

ASMR 2014 Program Committee

Bob Nairn: Conference Chair

Robert C. Knox: Technical Program

Molly Smith, David Cates, Geoff Canty: Program and Field Tours

Cindy Murphy: Program and Social Events

Julie LaBar: Early Career Professionals' Social Event

Robert Darmody: Sponsors and Exhibitor Registration

Oklahoma Center for Continuing Education: Registration

Meeting Financial Sponsors (to date)

Platinum

Opportunities still exist! See attached information.

Gold

Office of Surface Mining Reclamation and Enforcement

Center for Restoration of Ecosystems and Watersheds, University of Oklahoma

Silver

Opportunities still exist! See attached information.

Bronze

Oklahoma Energy Resources Board

Blackbird Environmental LLC

Oklahoma Department of Environmental Quality

Transportation to Oklahoma City

Air: Oklahoma City is serviced by **Will Rogers World Airport** (OKC) which is located just six miles from downtown Oklahoma City. (405-680-3200; http://www.flyokc.com).

Transportation from the airport: The conference hotel provides complimentary shuttle service to and from the airport for hotel guests (Black Tie Valet through the Renaissance Oklahoma City Hotel, 405-228-8000 or 405-228-2014). The shuttle runs every hour-on-the-hour starting at 4 AM until 12 PM. Please call the valet to schedule transportation at other times. It is strongly recommended that guests call for shuttle service when they land. Expect a 15 to 20 minute wait time for the shuttle to arrive to the airport. Pick up will be on the ground level outside of baggage claim.

Other transportation options are available for a fee and include Airport Express (405-681-3311), Metro Express (405-681-3311), car rental or taxi service (available at the airport) and mass transit (Oklahoma City Metro Transit, 405-235-7433; http://www.gometro.org).

Highway: Interstates 35, 44, and 40 serve Oklahoma City. (Oklahoma is also home to the longest stretch of historic US Route 66 and the historic route goes directly through the heart of Oklahoma City).

Rail: *The Heartland Flyer* provides service between Oklahoma City and Fort Worth, TX (**Amtrak** 1-800-872-7245; http://www.amtrak.com). The train station is located near the conference venue at 100 South E.K. Gaylord Boulevard.

Bus: The **Greyhound** (1-800-231-2222; http://www.greyhound.com) station is located at 427 W Sheridan (405-235-6425; open 24 hours a day).

Conference location

The conference location is the Cox Convention Center, adjacent to the Renaissance Oklahoma City Convention Center Hotel and the revitalized Bricktown entertainment district. (Cox Convention Center, 1 Myriad Gardens, Oklahoma City, OK 73102; http://www.coxconventioncenter.com/)

Conference lodging

Block rates have been established at the Renaissance Oklahoma City Convention Center Hotel (10 North Broadway Avenue; Oklahoma City, Oklahoma 73102; 405-228-8000). ASMR block rates are for single/double occupancy accommodations at $139 plus tax. A limited number of rooms are included at the prevailing government per diem rate (requires valid government ID at check-in). Group rates will be honored two days before group arrival and two days after group departure based on rate and space availability. For reservations: call **1-888-236-2427** or **1-800-468-3571** or visit online at: **www.marriott.com/okcbr**. The group name is "American Society of Mining and Reclamation" and the group code "**ASMASMA**". Any additional information will be posted on the ASMR web page (www.asmr.us) as it becomes available.

Reservations must be made at least 30 days prior to arrival and require the group name and valid credit card. For check-in/out times, room amenities, and further information, go to the Marriott website.

Parking in Oklahoma City

Parking in downtown Oklahoma City is at a premium and conference attendees are encouraged to plan accordingly. Hotel Valet Parking at the Renaissance is $25.00 (plus tax) per day with "come and go" privileges. A half day rate of $15 (plus tax) is available for group members who are not staying at the hotel. Hotel Self-Parking at the Santa Fe Garage (2 Santa Fe Plaza) is $10.00 per day. Hotel guests can purchase parking through the Renaissance Hotel. The garage has a convenient skywalk connection to the hotel. Other nearby parking includes Century Center (100 W. Main; $10/day for a 24 hour period); Sheridan/Walker (501 W. Sheridan; $10/day for a 24 hour period); Courtyard (2 West Reno; $10/day for a 24 hour period) and Cox Convention Center (1 Myriad Gardens; $8/day with day ending at 6:30 PM). **Please note that none of the parking garages have "come and go" privileges**. There are also many other parking garages and surface lots in the downtown area that are open to the public. Street parking meters are also available and rates are enforced from 8 AM until 6 PM, Monday through Saturday. For more information, and other parking options, go to http://parkingokc.com/parking/ or http://okc.about.com/od/mapsandtransportation/a/downtownokcparking.htm.

About Downtown Oklahoma City and Bricktown

The meeting location is near the "Bricktown" entertainment district of Oklahoma City, a well-known area just east of downtown. The former warehouse district includes over 50 dining and drinking establishments. The Bricktown entertainment district also includes *Redhawks Field at Bricktown* (home of the AAA OKC Redhawks who are scheduled to be at home on Saturday, Sunday and Monday June 14, 15 and 16), the *Bricktown Canal* (with water taxi service), and many other attractions. The *Oklahoma City National Memorial* (former site of the Alfred P. Murrah Federal Building), *Myriad Botanical Gardens* and *Crystal Bridge Tropical Conservatory, Oklahoma City Museum of Art, Chesapeake Energy Arena* and *Oklahoma City Civic Center* are all within walking distance. More information on Oklahoma, Oklahoma City and Bricktown can be found at the following web links: Oklahoma Tourism (http://www.travelok.com/), Oklahoma City Tourism (http://www.travelok.com/Oklahoma_City), Oklahoma City Convention and Visitors Bureau (http://www.visitokc.com/) and Bricktown Entertainment District (http://welcometobricktown.com/ and http://bricktownokc.com/).

Continuing Education Units

Through the Oklahoma Center for Continuing Education, full conference registrants will be eligible for two Continuing Education Units (CEUs). More information on obtaining CEU certificates will be available at conference registration.

Conference Workshop

Dates: Saturday June 14 (9:00 AM to 5:00 PM) and Sunday June 15 (9:00 AM to 4:00 PM)
Location: Convention Center Room 17 and nearby field sites
Lead Instructor: Russell Dutnell, PE
Number of attendees: Minimum - 6 Maximum - 18
Cost: $150
Description: FGM 101 (Introduction to Fluvial Geomorphology) - Have you seen the acronym FGM and wondered what it was, only to discover that it stands for Fluvial Geomorphology and still wonder what it is? Well, simply put, FGM is the study of the form and process of streams and rivers as they flow over the land. This two-day short course will provide the basic concepts of FGM and how they may be applied to restore streams to conditions better suited to handle flood flows and transport sediment while maintaining the biological integrity of our planet's waterways. The course will include classroom instruction, outside demonstrations and a field trip. The short course will be taught by Russell Dutnell, a Professional Engineer who has been applying FGM in stream and river restoration projects for over 15 years. He is currently the owner and sole proprietor of Riverman Engineering, PLC located in Norman, Oklahoma specializing in FGM, stream assessment and stream restoration.

Post-Conference Field Tours

Field Tour #1: Coal, Hydroelectric Power and the Tri-State Lead-Zinc Mining District
Dates: Thursday June 19 and Friday June 20, with overnight accommodations in Miami, OK
Number of attendees: Maximum - 57
Cost: $150 (includes transportation, lunches and overnight accommodations; dinner Thursday night is **not** included)
Description: This exciting overnight field tour will feature stops at the Grand River Dam Authority's Grand River Energy Center (formerly the Coal Fired Complex), Pensacola Dam, and Ecosystems and Education Center on day one. The Energy Center features both coal-fired generation and, by 2017, a new combined cycle gas unit that is designed to be the most efficient in the United States. Attendees will also visit the historic Tri-State Lead-Zinc Mining District. The Tri-State District's approximately 4,000 mines produced 23 million tons of zinc concentrates and four million tons of lead concentrates over a century of operation. Straddling the boundaries of three states (Oklahoma, Kansas and Missouri) and two U.S. Environmental Protection Agency regions (Regions 6 and 7), the jurisdictional complexities of the mining

district are often cumbersome and convoluted, especially considering the presence of significant Native American land holdings in Oklahoma. The district includes four U.S. EPA Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund) sites. Attendees will view unreclaimed areas, a waste repository, waste injection sites, a full-scale passive treatment system and the site of the first tribally-led Superfund cleanup

Field Tour #2: Limestone Mining and Reclamation
Dates: Thursday June 19
Number of attendees: Maximum - 57
Cost: $50 (includes transportation and lunch)
Description: Limestone is one of the most widely available mineral resources in Oklahoma and accounts for about 60% of non-fuel mineral tonnage, with almost 500 million tons mined in the last 25 years. Three major production areas exist: the Tulsa-Rogers-Mayes Counties region north of the Arkansas River, the Wichita Mountains area of Comanche and Kiowa Counties and the Arbuckle Mountains region of Murray and Pontotoc Counties. This field tour will visit an active quarry operated for more than 40 years by a major producer in the Arbuckle Mountains.

Field Tour #3: Abandoned Mine Reclamation in Eastern Oklahoma
Dates: Thursday June 19
Number of attendees: Maximum - 57
Cost: $50 (includes transportation and lunch)
Description: Oklahoma coal was first mined commercially in 1873, with greater than 200 million tons produced to present day. The history of Oklahoma coal mining is inextricably linked with the state's Native American legacy as Indian Territory and the opening of the American West by the railroads. Eastern Oklahoma is home to active surface and underground operations as well as many abandoned and inactive mines. Reclamation of some of these sites is complicated by past disposal of oil field waste materials. Reclamation practices include passive treatment systems, alkaline injection technology sites, collapse/subsidence abatement areas and land reclamation areas.

Welcome Reception

Sunday June 15, 6:00 PM to 8:00 PM

The Welcome Reception will be held in the Great Hall at the Cox Convention Center on Sunday evening June 15, from 6:00 PM to 8:00 PM for all conference attendees. Light appetizers and refreshments will be available. Visit with old and make new acquaintances and learn about the latest in research and technical development.

Plenary Session

Monday June 16, 8:30 AM to 12:00 PM

The Monday morning Plenary Session in the Cox Convention Center Great Hall will include welcome remarks and a Native American opening ceremony. Plenary presentations have been confirmed from the Oklahoma Secretary of Energy and Environment, Oklahoma Geological Survey and the University of Oklahoma Vice-President for Weather and Climate.

ASMR Awards Luncheon

Monday June 16, 12:00 PM to 2:00 PM

The ASMR Awards Luncheon is the highlight of the annual meeting, where both professional (William T. Plass Award, Reclamationist of the Year, Barnhisel Reclamation Researcher of the Year and Pioneers in Reclamation Award) and student (BS, MS and PhD Memorial Scholarships, Student Research Grant and Student Travel Grant) award winners are honored. This year, we are holding the awards luncheon earlier in the week than usual so that our awardees are well-recognized. The cost is included in conference registration. Additional tickets ($30 each) may be purchased for family members and others.

Early Career Professionals' Social

Monday June 16, 6:00 PM to 10:00 PM

The Early Career Professionals will host their 5th Annual social event on Monday, June 16 from 6:00 to 10:00 PM. The purpose of the Early Career Professionals' social event is to provide individuals who are just starting their journey in mining and reclamation with a relaxed setting where they can interact with those who have amassed a wealth of knowledge over their careers. It is a great networking opportunity in a fun and friendly atmosphere and will include representatives from industry, consulting, academia, and regulatory agencies. So if you are a little wet behind the ears or wise beyond your years, this event is for you. The event is casual and includes hor d'oeuvres and refreshments. Tickets are $25 each and can be conveniently purchased during online conference registration or at the conference venue when you arrive.

Poster Session and Mixer

Tuesday June 17, 5:00 PM to 7:00 PM

The Poster Session will be held in the Cox Convention Center Great Hall on Tuesday evening June 17, along with a Social Mixer including refreshments. Posters will be displayed on an air wall and pins will be provided. It is asked that poster dimensions be no more than 3' tall x 3' wide.

Evening Social Event

Wednesday June 18, 6:00 PM to 10:00 PM

An evening social for attendees and accompanying persons is scheduled for Wednesday, June 18 at the Oklahoma History Center (http://www.okhistory.org/historycenter/). Buses will provide transportation to and from the Oklahoma History Center, located adjacent to the State Capitol building. The evening begins at 6:00 PM with self-guided tours of the Center's five main galleries of Smithsonian-quality exhibits, followed by a buffet dinner (with a dramatic view of the Capitol) and musical entertainment provided by The Hosty Duo (you'll understand why these witty, original performers have such a large local following). The cost for the evening event is $50 each (in addition to conference registration). Tickets can be conveniently purchased during online conference registration. Please be sure to join us at this unique setting to explore Oklahoma's rich and diverse heritage and enjoy a wonderful evening of history, fun and fellowship!

"The mission of the Oklahoma Historical Society is to collect, preserve, and share the history and culture of the state of Oklahoma and its people. Located on 18 acres across from the Capitol building, the Oklahoma History Center is beautifully designed to provide visitors a self-guided exploration of Oklahoma - past to present. With four permanent galleries, a special events hall, and outdoor exhibits, guests will experience Oklahoma's spirit, triumphs and tragedies... from oil and space exploration to the land run of 1889. The Oklahoma History Center is your opportunity to experience Oklahoma's inspiring and adventurous past."

Silent Auction

Please bring items to contribute to ASMR's Silent Auction! Items will be displayed prominently near the Cox Convention Center Great Hall and the concurrent Technical Session rooms. The Silent Auction raises funds for the ASMR Student Travel Fund to assist our talented students in attending future meetings. Bidding will begin on Monday morning and continue through Wednesday at 11:00 AM, after which winners will be announced at lunch. Several excellent donations have already been made. Add yours to help our students!

Poster Session – Great Hall
The Use of Sewage Sludge and Crocodile Manure For Treating Acidic Metalliferous Mine Drainage by J. Robinson (student)
GIS Analysis of Changes in Volume and Mass of Chat Piles in the Picher Mining District, Ottawa County, Okla., 2005–10 by J. Smith
Biogenic Hydrogen Sulfide Production for Metal Recovery Dissolved in Acid Mine Drainage by S. Ji, I. Nam, G. Yim, Y.W. Cheong, C. Oh and J.S. Ahn
Effects of Mushroom Compost With Limestone Granules on Metal Removal in Vertical Flow Column by Y. Cheong, G. Yim, S. Ji, O. Chamteut, S.E. Young and H. Ji-Hae
Soil Test and Bermuda Grass Forage Yield Responses to Animal Waste and FGD Gypsum Amendments by J.J. Read, A. Adeli, D.J. Lang, K.K. Crouse, N.R. McGrew and J.D. Friedlander
Dual Microcapillary Barriers in Conjunction With Water Harvesting Can Increase Reclamation Success in the Wamsutter Natural Gas Production Area by S. Cude, J. Norton, T. Kelleners and M. Ankeny (student)
Vegetative Trends on Reclaimed Gas Well Pad Locations in the Pinedale Anticline Gas Field, SW Wyoming by R.S. Carr, III and A. Davison
Preliminary Greenhouse Investigation of Selenium Removal from Soil by Phytoremediation by R.G. Paudel, P.D. Stahl and C.F. Strom (student)
Current State of Frac Sand Mine Reclamation Techniques in Wisconsin by Y.B. Johnson, S.M. Alvarez and A.L. Delyea-Petska (student)
Long-Term Effect of Herbaceous Species Cover on the Development of Soil Properties on Reclaimed Mine Site by R. Anderson, E. Bair, J. Gillespie, M. Livas, E. Salkind, A.O. Abaye and C.E. Zipper (student)
Open Limestone Channel Treatment Dynamics: A Case Study Treating Low-pH Coal Mine Drainage in PA by A. Conrad, K. Palmer, A. Rose and W. Strosnider (student)
Comparison of Long-term Recovery Between Managed and Unmanaged Reclaimed Mine Lands by T. Macy and N. Kruse (student)
Passive Co-Treatment of Polymetallic Acid Mine Drainage at Cerro Rico de Potosí, Bolivia by R. Peer, J. LaBar, B. Winfrey, R. Nairn, F.L. Lopez and W. Strosnider (student)
Hydrology and Geochemistry of the Palzo Surface Mine, Williamson County, Illinois – 2003-2013 by P.T. Behum, R. Kiser and B. Johnsrud (student)
Characterization and Heavy Metals Status in Pre-mined Soils in North-East Botswana by O. Dikinya (student)
Assessment of Benthic Macroinvertebrate Community Impairment from Residual Aluminum Contamination in the Confluence of Middleton Run, Ohio, USA and the Impacts of Ingested Aluminum of Crayfish Growth by W. Hellyer, N. Kruse and K. Johnson (student)
The Recovery of an AMD-Impacted Stream Treated by Steel Slag Leach Beds: A Case Study in the East Branch of Raccoon, Creek, Ohio by C. Hawkins, N. Kruse, A. Mackey, J. Bowman (student)
Steel Slag Leach Bed Longevity Analysis by S. Landers, S. Maj, A. Mackey and N. Kruse
Influence of Water Chemistry and Sediment Transport on Biological Recovery Downstream of Lime Dosers by H. Bedu-Mensah and N. Kruse (student)
Prairie Restoration on Former Mine Landscapes may Serve as Hybrid or Novel Ecosystems by S. Byrd and R. Glover
Late Summer Native Establishment by J. Paternoster
Bats Associated with Inactive Mine Features in Southeastern Arizona by A.M.D. Barclay
Dissolution Variability in Open Limestone Channel Substrate: Simple Lab Trials by R. Zoubareva, L. Mignogna, D. Mack, D. Civis, J. Skipper, N. Lassak, A. Conrad, J. Bandstra, A. Rose and W. Strosnider (student)
Effects of Hydromulch Products on Rapid Vegetative Establishment on Mississippi Roadsides by B. Stewart, T.J. Bradfore, G. Munshaw and W. Philley
Utilization of River Sediments as Topsoil to Reclaim Brownfields and Other Sites by R.G. Darmody
Application of Remote Sensing for Modeling Mine Fire and Vegetation: A Case Study of Jharia Coalfields, India by P. Kumar, R.K. Chopra and B.C. Dey
Impacts of Aeration on Hydraulic Characteristics of Passive Treatment Systems by J. Arango, K. Strevett and R. Nairn (student)

Accompanying Person/ Significant Other Activities

The Oklahoma City area has an amazing variety of activities and attractions. Whether searching for unique attractions or family-friendly activities, Oklahoma City is the right place. Experience Oklahoma's warm hospitality with its deep western heritage, and enjoy a destination steeped in culture and adventure. Explore the variety that the city's many districts offer, including arts and entertainment, shopping, history, heritage and so much more. The possibilities for fun in Oklahoma City are endless.
Places to visit near the conference venue include: Bricktown, The Bricktown Canal, The Oklahoma City National Memorial and Museum, Myriad Botanical Gardens and Crystal Bridge , Oklahoma City Museum of Art, The Red Earth Museum, Jogging Trails (YMCA/Bricktown) and many others.

Other Places in Oklahoma City include: Harn Homestead and 1889rs Museum, Oklahoma City Zoo and Gardens, Gaylord-Pickens Oklahoma Heritage Museum, Science Museum Oklahoma, 45th Infantry Division Museum, Museum of Osteology, Frontier City Amusement Park, White Water Bay Water Park, Remington Park (horseracing and casino), National Cowboy and Western Heritage Museum, National Softball Hall of Fame and Museum, Oklahoma State Firefighter's Museum and others.
Destinations near Oklahoma City include: The University of Oklahoma (OU) in Norman, including the Sam Noble Oklahoma Museum of Natural History and Fred Jones Jr. Museum of Art, Jacobson House Native Art Center, located near the OU campus in Norman and tribal casinos administered by various Native American tribes.

Other Oklahoma attractions (may require an extended visit) include: Chickasaw Cultural Center, (80 miles south), Wichita Mountains National Wildlife Refuge (90 miles southwest), Indian City USA Cultural Center (60 miles west), Great Salt Plains State Park (the only place in the world where visitors may dig for hourglass selenite crystals, 120 miles northwest) and the Nature Conservancy Tallgrass Prairie Preserve (the largest protected remnant of tallgrass prairie left on earth, 140 miles northeast).

Wild Women of Reclamation

The Wild Women of Reclamation (WWR) group was started at last year's Laramie meeting to provide mentorship and professional support for women in the society and the reclamation profession. WWR will convene Monday morning June 16 at 6:30 AM for a breakfast meeting and discussion in one of the concurrent Technical Session rooms (look for signs outside the rooms). Several women will provide brief presentations on their careers to date. Discussions on the opportunities and challenges in the reclamation industry will follow.

Haulin' ASMR

Haulin' ASMR is an informal runner's club that gets together for some exercise before ASMR activities begin. Anyone interested in running may meet in the Renaissance Hotel lobby at 6:30 AM, Sunday through Thursday. Several safe and local routes exist. Maps will be included in the conference registration materials.

ASMR 2014 Win Free Stuff Contest

Do you like to win free stuff? Then play to win at ASMR '14 in OKC! The rules are simple:
1. Get a free ASMR '14 OKC koozie.
2. Use your koozie to keep your favorite beverage ice cold.
3. Take a digital photo of you and your koozie at the most unusual or exotic mining and reclamation place possible.
4. Send that photo to ASMR President Bob Nairn at nairn@ou.edu before June 1, 2014.
5. Win free stuff at ASMR '14 OKC!

Please send an email (nairn@ou.edu) if you were not in Laramie and need a koozie!

Exhibitor and Sponsor Information

The 31st National 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 and water reclamation industry. **Register now to bring your company exhibit and/or sponsor an event in Oklahoma City in June 2014!**

All exhibitors will be listed on the ASMR website by name and logo with a link to the company's website or short listing of contact information. The website listing will remain on the ASMR website until the 2015 annual meeting.

EXHIBITOR SPACE DETAILS

- Exhibitor space will be co-located with all breaks, breakfasts, lunches, poster session, receptions, etc. in the Cox Convention Center Great Hall (Rooms C, D, and E, representing over 17,000 ft^2 of contiguous space).
- Each 10' x 10' booth features a 3' x 6' table with chair, waste basket, backdrop, and standard electrical service. Should you require additional features (e.g., additional electrical service), please contact rdarmody@illinois.edu or nairn@ou.edu.
- The Great Hall has been arranged to facilitate traffic throughout the entire exhibit area by strategic placement of refreshment areas and concurrent technical session rooms, registration, and silent auction.
- The Convention Center will be open daily during the conference with locked security at night.
- A floor plan map outlining the location of conference activities and exhibitor booths is shown on the following pages.

- Please select three booth locations in order of preference. Reservations will be made upon receipt of funds on a first-come, first-serve basis.
- Please note that the booth floor plan is subject to change dependent upon the number of exhibitors. An updated floor plan will be posted on the ASMR web page as exhibit spaces are sold.
- The final registration materials for attendees will include a packet identifying all exhibitors, their addresses, and the services and/or products provided. Please include a short narrative of your business for this packet. We anticipate one to two additional mailings, as well as website exposure, and these will include **confirmed** exhibitors and sponsors. To maximize your company's exposure, early registration is essential!
- Exhibitor setup can begin Sunday June 15 at 9:00 AM and must be completed by 5:00 PM. Breakdown can begin Wednesday June 18 at 5:00 PM and must be completed by 12:00 PM on Thursday June 19.

Your company can also be a **sponsor** of any or all of the following activities. A **Welcome Reception** on the evening of Sunday June 15 will include appetizers and refreshments. The **Career Professionals' Social Event** will be held on Monday evening June 16. An early evening **Poster Session and Mixer** where soft drinks and libations will be available for purchase is planned for Tuesday June 17. An off-site **Evening Social Event**, including an evening of dinner and entertainment, is scheduled for Wednesday June 18. The **ASMR Awards Luncheon Banquet** will be held Monday June 16, and additional **catered lunches will be provided Tuesday through Thursday. Breakfasts** and **refreshment breaks** (coffee in the mornings and soft drinks in the afternoons) will be offered as well. With the exception of the Early Career and Society Social Events, **all of these activities will take place in the Convention Center Great Hall where the exhibitors' booths will be located**. Maps of the meeting space are attached and may also be found on the ASMR webpage (www.asmr.us). Each of these events represents a sponsorship opportunity as well as full meeting sponsorships at the Platinum, Gold, Silver, and Bronze levels (please see following information for sponsors for more details).

Please fill out the attached Exhibitor and/or Sponsor Registration Form and **return with payment prior to April 15, 2014 to:**

American Society of Mining and Reclamation (ASMR)
c/o Robert G. Darmody, ASMR Executive Secretary
1305 Weathervane Dr.
Champaign IL 61821
Cell: 217-493-7847
Office: 217-333-9489
Fax: 217-244-3219
e-mail: rdarmody@illinois.edu

Sponsorship Opportunities

American Society of Mining and Reclamation (ASMR) 31st National Meeting
June 14 – 20, 2014
Renaissance Oklahoma City Convention Center Hotel
Oklahoma City, OK

The annual meeting of the American Society of Mining and Reclamation will be the forum for learning about the latest in research and technical development, keeping up with the latest in mining and reclamation news, and meeting old and making new colleagues. Professional reclamationists in industrial, consulting, academic, and non-profit sectors from Oklahoma, the United States and the world will join to share ideas and information to the benefit of our shared profession. Professionals working in Oklahoma are especially encouraged to participate.

Sponsorship Opportunites Available!

Platinum Level - $10,000
Gold Level - $5,000
Silver Level - $3,000
Bronze Level - $1,000

Break and Meal Sponsors
Early Career Event Sponsors
Program Advertising

See next page for sponsorship details!

Sponsorship Details

Platinum Level Sponsors: $10,000

- One free exhibitor booth and four free registrations
- Special recognition at Awards Luncheon
- Display of logo and name on separate frame in continuing loop presentation of sponsors between sessions, during breaks, etc.
- Logo on conference giveaways and program
- Link to sponsor website on ASMR website for one month before the 2014 Oklahoma City, OK meeting through one month before the 2015 Lexington, KY meeting
- Recognition ribbons on conference participant name tags

Gold Level Sponsors: $5,000

- One free exhibitor booth and three free registrations
- Special recognition at Awards Luncheon
- Display of logo and name with one other company in continuing loop presentation of sponsors between sessions, during breaks, etc.
- Logo and name in program
- Link to sponsor website on ASMR website for one month before the 2014 Oklahoma City, OK meeting through one month before the 2015 Lexington, KY meeting
- Recognition ribbons on conference participant name tags

Silver Level Sponsors: $3,000

- Exhibitor booth at reduced rate (if exhibiting) and two free registrations
- Special recognition at Awards Luncheon
- Display of logo and name in continuing loop presentation with two other companies of sponsors between sessions, during breaks, etc.
- Logo and name in program
- Link to sponsor website on ASMR website for one month before the 2014 Oklahoma City, OK meeting through one month before the 2015 Lexington, KY meeting
- Recognition ribbons on conference participant name tags

Bronze Level Sponsors: $1,000

- Exhibitor booth at reduced rate (if exhibiting) and one free registration
- Special recognition at Awards Luncheon
- Display of logo and name in continuing loop presentation with three of other companies of sponsors between sessions, during breaks, etc.
- Logo and name in program
- Link to sponsor website on ASMR website for one month before the 2014 Oklahoma City, OK meeting through one month before the 2015 Lexington, KY meeting
- Recognition ribbons on conference participant name tags

Break and Meal Sponsors: $300 - $1000

- Sponsor's name appears on a board next to food and beverage buffet area, as well as in the program
- Announcements will be made by moderators prior to breaks and meals that mention sponsor of upcoming break
- Special recognition at Awards Luncheon and Business Meeting
- Break and meal sponsorships: Breakfast $500, Lunch $750, AM Break $300, PM Break $350

Early Career Social Event: $150- $500

- Special event for young professionals
- Sponsor's name appears on a board next to food and beverage buffet area, as well as in the program
- Announcement of sponsor will be made by prior to event
- Special recognition at Awards Luncheon and Business Meeting

Program Advertising (camera-ready artwork)

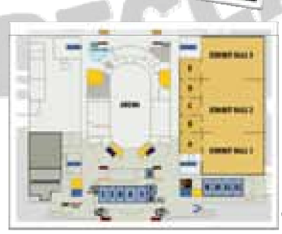
- Business Card Size (4" x 2") - $250
- ½ Page Advertisement (4" x 4") - $500
- Full Page Advertisement (4"x 8") -$1,000

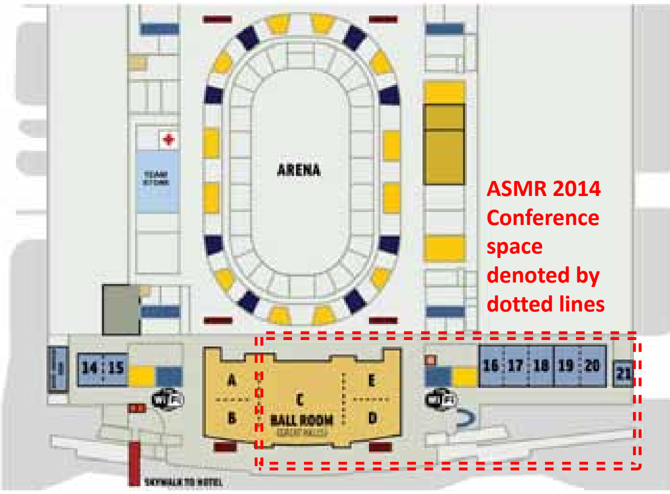
Exhibitor/Sponsorship /Advertising Questions:

Robert W. Nairn, Ph.D.
Conference Chair, (405) 325-5913,
nairn@ou.edu

Robert Darmody, Ph.D.
ASMR Executive Secretary, (217)-333-9498,
rdarmody@illinois.edu

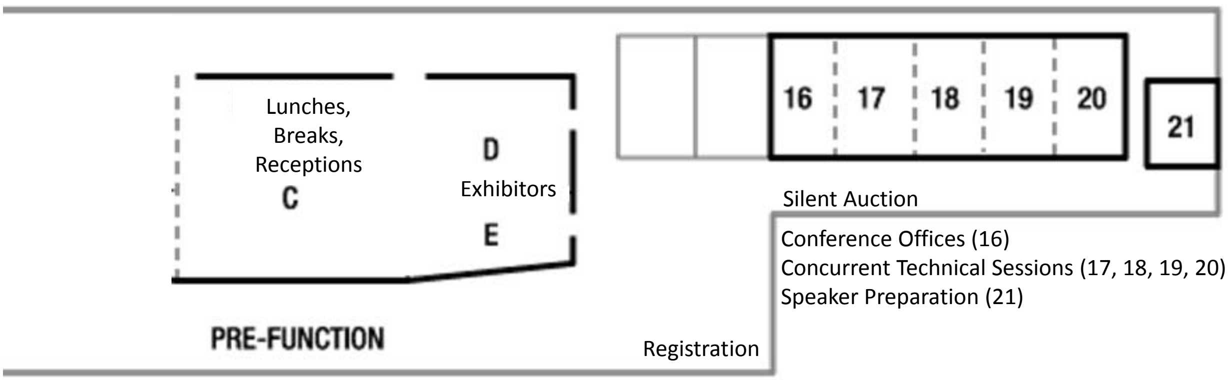
Spaces are Limited Reserve Now!

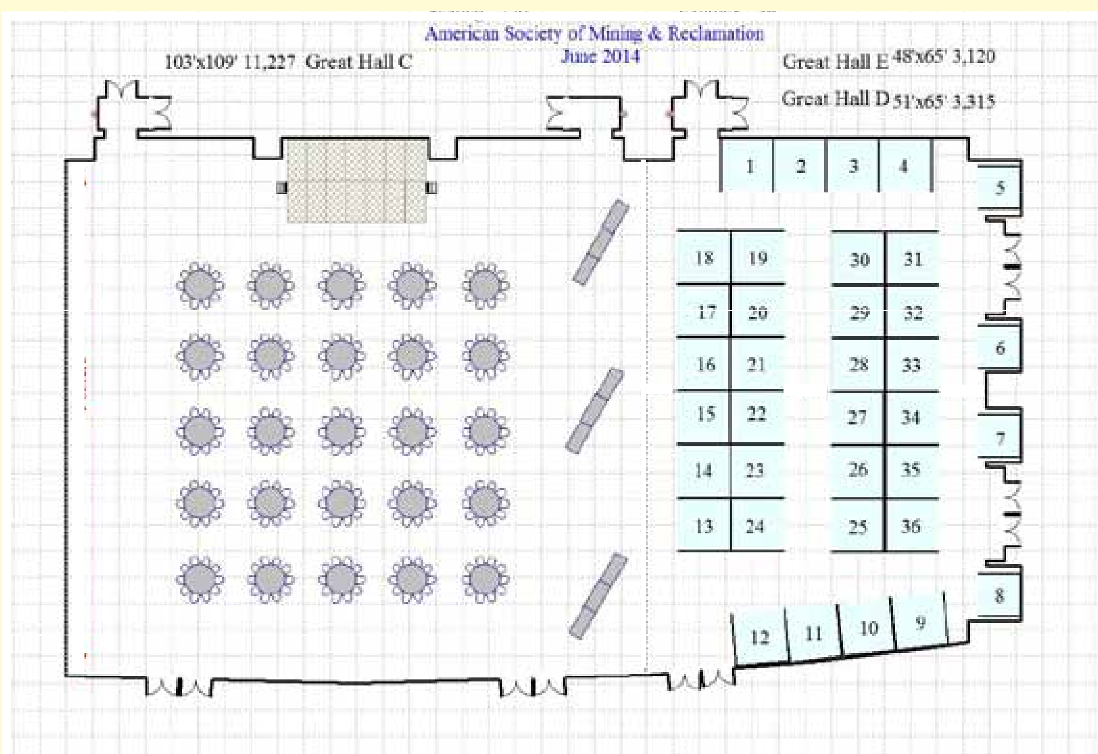




All ASMR events will take place in the west end of the Second Floor of the Cox Convention Center, connected via Skywalk directly to the Renaissance Hotel.

See next page for Exhibitor Booth layout.





ASMR 2014 EXHIBITOR REGISTRATION FORM

Company Name: ____

Registrant(s)/Contact Name(s): ____

Address: ____

City/Province: ____

State: __________ Zip: _______________ Country: ________________

Phone: ____________________ Fax: _________________________

E-Mail: ____

Web page address: ____

<u>Booth Preferences</u> (#1 – #36 on attached map,
visit ASMR web page (<u>www.asmr.us</u>) to view available locations. First Come, First Served)

1st Choice	**2nd Choice**	**3rd Choice**

<u>Exhibitor Selections and Costs</u>

<u>Non-Sponsor Booth</u> **$1,000** ________ (Includes 2 non-refundable registrations)

<u>Sponsor Booth</u> **$ 750** ________ (Must also register as Meeting Sponsor)

<u>See attached document for Sponsorship details</u>; Platinum and Gold Sponsors receive one free booth; Silver and Bronze sponsors receive one booth at discounted price of $750

(Pay by check or credit card. Please add 6% for processing fee if using a credit card).

Visa or MasterCard #________ ________ ________ ________ Expiration Date _______

Name on card ____

TOTAL: $____________

***NOTE: For additional information and/or to discuss company logo, please contact:**
Robert G. Darmody, ASMR Executive Secretary, at 217-493-7847 or <u>rdarmody@illinois.edu</u>

Checks should be made payable to ASMR by **April 15, 2014**. Mail or e-mail to:

American Society of Mining and Reclamation (ASMR)
c/o Robert Darmody
1305 Weathervane Dr.
Champaign IL 61821
Cell: 217-493-7847
Office: 217-333-9489
Fax: 217-244-3219
E-mail: <u>rdarmody@illinois.edu</u>

ASMR 2014 Sponsor Registration Form

Company Name: ____

Registrant(s)/Contact Name(s): ____

Address: ____

City/Province: ____

State: __________ Zip: _______________ Country: ________________

Phone: ____________________ Fax: _________________________

E-Mail: ____

Web page address: ____

Sponsor Selections and Costs (see attached document for Sponsorship details)

Meeting Sponsors

Platinum Level	**$10,000** and up	________	(exhibitor booth included)
Gold Level	**$5,000-$9,999**	________	(exhibitor booth included)
Silver Level	**$3,000-$4,999**	________	(exhibitor booth at reduced rate)
Bronze Level	**$1,000-$2,999**	________	(exhibitor booth at reduced rate)

Meal and Refreshment Break Sponsors

Breakfast	**$500**	________
Lunch	**$750**	________
Evening	**$1,000**	________
Morning Break	**$300**	________
Afternoon Break	**$350**	________

SUBTOTAL: $________

(Pay by check or credit card. Please add 6% for processing fee if using a credit card)

Visa or MasterCard #________ ________ ________ ________ Expiration Date _______

Name on card ____

TOTAL: $____________

NOTE: For additional information, or provide Early Career Social Event Sponsorship, please contact:
Robert Darmody, ASMR Executive Secretary, at 217-493-7847 or rdarmody@illinois.edu.

Checks should be made payable to ASMR by **April 15, 2014**. Mail or e-mail to:

American Society of Mining and Reclamation (ASMR)
c/o Robert Darmody
1305 Weathervane Dr.
Champaign IL 61821
Cell: 217-493-7847
Office: 217-333-9489
Fax: 217-244-3219
E-mail: rdarmody@illinois.edu

Preliminary Technical Program (DRAFT and SUBJECT TO CHANGE)

Saturday June 14 - Sunday June 15, 2014

Workshop: FGM 101: Introduction to Fluvial Geomorphology

Sunday June 15, 2014

1:00-6:00	Registration - Pre-Function Area
6:00-8:00	Welcome Reception - Great Hall

Monday June 16, 2014

06:30-09:00	**Buffet Breakfast - Great Hall**
07:00-12:00	Registration - Pre-Function Area
08:30-12:00	**Plenary Session - Great Hall**
08:30-08:45	Welcome - Robert Nairn, Conference Chair
08:45-09:15	Native American Welcome
09:15-10:00	Opening Remarks - Secretary Michael Teague Oklahoma Secretary of Energy and Environment
10:00-10:30	**Break - Great Hall**
10:30-11:15	Recent Earthquakes in Oklahoma: Significance and Perspective- Austin Holland, Research Seismologist, Oklahoma Geological Survey
11:15-12:00	Weather, Water and Climate at the University of Oklahoma - Berrien Moore University of Oklahoma Vice President for Weather and Climate Programs
12:00-2:00	**ASMR Awards Luncheon - Great Hall**

	Room 17 **Special Session: 20th Anniversary of USBM Passive Treatment IC 9389**	**Room 18** **Innovative and Emerging Reclamation Technologies**	**Room 19** **Forestry and Wildlife**	**Room 20** **Soils and Overburden**
2:00-2:30	Effective Passive Treatment of Coal Mine Drainage by R.S. Hedin, T. Weaver, N. Wolfe and G. Watzlaf	Common Sense Solutions for Management of Global Warming by K.C. Vories and J. Vories	Bats Associated with Inactive Mine Features in Southeastern Arizona by A.M. D. Barclay	TDS Related Leaching Potentials of Coal Spoil and Refuse From Tennessee and Virginia by Z.W. Orndorff, W.L. Daniels, C.E. Zipper and M.J. Eick
2:30-3:00	Implementation of Passive Treatment for Irreversibly Damaged Waters by R. Nairn	New Progresses of Land Reclamation in China by W. Xiao, Z. Hu and Y. Fu	Impact of Mine Drainage on the Genetic Diversity of Brook Trout by F.J. Brenner, G.T. Herald, L.M. McGarvey, L.Q. Rittenhouse and S.M. Rummel	Gray Sandstone as a Topsoil Substitute on Surface Coal Mines in Appalachia by L. Wilson-Kokes and J. Skousen (student)

3:00-3:30	Creating Anaerobic Environments to Control Acid Generation in Pyritic Material by R.L. Kleinmann	Geomorphic Reclamation of the Rosebud Pit, Wyoming by T. Hulet, M. Donner and G. Boulter	Pine Plantations On Reclaimed Minelands: Growth Rates Versus Unmined Lands by J. Priest, J. Stovall, D. Coble, B. Oswald and H. Williams (student)	Long-Term Effect of Herbaceous Species Cover on the Development of Soil Properties on Reclaimed Mine Sites by R. Anderson, E. Baer, J. Gillespie, M. Livas, E. Salkind, A.O. Abaye and C.E. Zipper (student)
3:30-4:00	**Break - Great Hall**			
	Room 17 Special Session: 20th Anniversary of USBM Passive Treatment IC 9389	**Room 18 Innovative and Emerging Reclamation Technologies**	**Room 19 Forestry and Wildlife**	**Room 20 Soils and Overburden**
4:00-4:30	Land Application of Biochemical Reactor Effluent: An Innovative Method for Mitigating Acid Rock Drainage by J.J. Gusek	The Lionkol Project, Practical Application of Geomorphic Mine Land Reclamation Methods by H.H. Hutson and B. Thoman	Tree and Ground Cover Establishment Over Seven Years as Affected by Seeding and Fertilization Rates by J. Franklin and D. Buckley	Prime Farmland Crop Yields From Four Soil Reconstruction Treatments Following Mineral Sands Mining: A 9 Year Summary by Z.W. Orndorff, W.L. Daniels, M.S. Reiter and A.F. Wick
4:30-5:00	Panel Discussion: 20 Years of Passive Treatment	Late Summer Native Establishment by J. Paternoster	Case Study: Shullsburg (WI) Lead/Zinc Mine Reclamation by T. Hunt	Agricultural Impacts of Longwall Mine Subsidence: The Experience in Illinois, USA and Queensland, Australia by R.G. Darmody, R. Bauer, D. Barkley, S. Clarke and D. Hamilton
5:00-5:30		The American Society of Mining and Reclamation: The First 40 Years by R.G. Darmody and J. Skousen	Meadow Creek Restoration/ Stibnite Mine Idaho by L. Ballek	Phytoremediation on Lead and AMD Soils by L. Sakiah, M. Makgae and S. Tlowana (student)
6:00-10:00	**Early Career Professionals' Social - Early TapWerks Ale House, Bricktown**			

Tuesday June 17, 2014

06:30-09:00	**Buffet Breakfast - Great Hall**			
	Room 17 Passive Treatment Systems: Biochemical Reactors	**Room 18 Special Session: Sediment Management**	**Room 19 Forestry and Wildlife**	**Room 20 Soils and Overburden**
08:30-09:00	Biochemical Reactors for Treating Mining Influenced Water by P. Eger, C. Baysinger, D. Cates and S. Hill	Mobility of Arsenic in Sediments of Coalbed Natural Gas (CBNG) Disposal Pond Playas in the Powder River Basin, Wyoming by K.C. McNicholas and K.J. Reddy (student)	Influence of Spoil Type on Discharged Water Quality and Hydrologic Function of Experimental Reforestation Plots in Pike County, Kentucky by K. Sena, C. Barton, C. Agouridis, P. Angel and R. Warner (student)	Application of FPXRF Technology and Field Expedient Sample Preparation Techniques by M. Stinnett, R. Thomas and J. Yfante
09:00-09:30	Bench Scale Biochemical Reactor Treatment of Uranium, Radium and Selenium by R. Schipper, E. Blumenstein, T. Rutkowski and B. Nielsen	Remediation of Tar Creek Sediments and Adjacent Mine Waste Areas: Design Considerations by B. Burnett	Vegetation and Soil Development in Planted Pine and Naturally Regenerated Hardwood Stands 48 Years After Mining by J. Franklin and J. Frouz	Soil Metal Concentrations in Proposed Wetland Development Areas near the Tri-State Lead-Zinc Mining District by. R. Nairn and D. Townsend

09:30-10:00	Column Study Treatability Testing for in Situ Remediation of Mining-Influenced Water by N.T. Smith, N. Anton, D. Reisman, A. Frandsen, R. Olsen, M. Sieczkowski and D. Smith	Sediment Metal Concentrations in Selected Coves of Grand Lake O' the Cherokees by S. Zawrotny, J. Arango, L. Diede, A. McLeod, M. Salisbury, G. Rutelonis, R. Knox and R. Nairn	*Forest and Wildlife Technical Division Meeting*	Evaluation of Land Reclamation Suitability in Juye Coal Mining Area by J. Li, X. Zhao, W. Li, Y. Wang and J. Liu
10:00-10:30	**Break - Great Hall**			
	Room 17 Passive Treatment Systems: Biochemical Reactors	**Room 18 Special Session: Sediment Management**	**Room 19 Stream Ecology**	**Room 20 Soils and Overburden**
10:30-11:00	Analysis of Microbial Communities in Vertical Flow Bioreactors at the Tar Creek Superfund Site by K. E. Duncan, R. Nairn, K. Strevett and J.K. Choi	Investigations of Bioavailability, Toxicity and Accumulation of Trace Metals From Shallow Sediments in Grand Lake Following Simulated Disturbance Events by S. Morrison, S. Nikolai, D. Townsend and J. Belden (student)	Assessment of Benthic Macroinvertebrate Community Impairment from Residual Aluminum Contamination in the Confluence of Middleton Run, Ohio, USA and the Impacts of Ingested Aluminum on Crayfish Growth by W. Hellyer, N. Kruse and K. Johnson (student)	Towards Closure of the Fire Road AMD Mine in New Brunswick, Canada by K. Phinney, M. Coleman, K. Butler and S. Pelkey
11:00-11:30	The Use of Waste Mussel Shells to Treat Acid Mine Drainage in Upward-Flow Sulfate-Reducing Bioreactors by B. Uster, A.D. O'Sullivan, J. Pope, D. Trumm and M. Milke (student)	Dredging Management in Grand Lake O' The Cherokees, Oklahoma: Developing Permitting Strategies Using Shoreline Classifications, Substrate Characteristics, and Contaminant Concentrations by S. Nikolai and D. Townsend	The Recovery of an AMD-Impacted Stream Treated by Steel Slag Leach Beds: A Case Study in the East Branch of Raccoon, Creek, Ohio by C. Hawkins, N. Kruse, A. Mackey and J. Bowman (student)	The History of Lead and Zinc Smelting in Oklahoma by R. Kottke
11:30-12:00	The Use of Sewage Sludge and Crocodile Manure For Treating Acidic Metalliferous Mine Drainage by J. Robinson (student)	Utilization of River Sediments as Topsoil to Reclaim Brownfields and Other Sites by R. Darmody and J. Marlin	Fishes of a Contaminated Stream After Operation of a Passive Treatment System by N. Shepherd, W. Matthews, R. Nairn, J. Barkstedt, and N. Franssen (student)	*Soils and Overburden Technical Division Meeting*
12:00-1:30	**Lunch - Great Hall**			
	Room 17 Passive Treatment Systems: Aerobic Systems	**Room 18 Special Session: Sediment Management**	**Room 19 Ecology**	**Room 20 Tailings**
1:30-2:00	Impacts of Aeration on Hydraulic Characteristics of Passive Treatment Systems by J. Arango, K. Strevett and R. Nairn (student)	Pedogenesis and Local Water Quality Effects of Upland Placement of Saline Dredge Spoils in Virginia by W.L. Daniels, N.W. Haus, G.R. Whittecar and C.H. Carter III	Biodiversity Assessment of an Ecologically Engineered Treatment System for Metals-Contaminated Mine Drainage by B. Furneaux and R. Nairn (student)	Cleanup of Historic Smelter Sites in Oklahoma by S. Downard
2:00-2:30	Storm Event-Driven Metal Transport Dynamics Between the Initial Oxidation Cells of a Passive Treatment System by L.R. Oxenford and R. Nairn (student)	Panel Discussion: Sediment Management	Development of Ecosystem Structure and Function on Reforested Mined Lands by B. Avera, B. Strahm, J. Burger and C. Zipper (student)	Tar Creek: Early History and Legacy of Mining in the Tri-State Mining District by A. Hughes
2:30-3:00	Performance of the Swank Open Limestone Channel, Cambria County, PA by W. Strosnider, A. Conrad and A. Rose		Comparison of Long-term Recovery Between Managed and Unmanaged Reclaimed Mine Lands by T. Macy and N. Kruse (student)	Characterization of Mine Tailings (Chat) at the Tar Creek Superfund Site or "What is Chat? Let's Talk About It" by D. Cates and D. Datin

3:00-3:30	**Break - Great Hall**			
	Room 17 Passive Treatment Systems: Aerobic Systems	**Room 18 Aggregate Mining and Slope Stabilization**	**Room 19 Ecology**	**Room 20 Tailings**
3:30-4:00	An Evaluation of Passive Treatment Systems Treating Oxic Acidic Mine Drainage by A.W. Rose	Dolese Bros. Co., Davis Quarry, Mining, Water Management and Stream Enhancement by M. Helm and T. Dupuis	Influence of Water Chemistry and Sediment Transport on Biological Recovery Downstream of Lime Dosers by H. Bedu-Mensah and N. Kruse (student)	Tar Creek: Superfund Remedy for Mine and Mill Wastes on Operable Unit 4 Remediation by D. Datin
4:00-4:30	Solving Mine Drainage Problems at the Soudan Mine; The Final? Answer by P. Eger, P. Jones, D. Green and B. Forder	Environmental Considerations of Proppant Frac Sand Mining and Processing by K. Ware	Litter Decomposition Rates in Mine Water Wetlands and Ponds by J. Brumley and R. Nairn (student)	Geochemical Modeling to Assess Impact of Chat Fine Injections on Aquifer Quality at the Tar Creek Superfund Site, Oklahoma by B. Schroth, R. Thomas and S. Irving
4:30-5:00	*Water Management Technical Division Meeting*	Stabilization of the Pensacola Dam West Abutment by S.R. Jacoby, C. Landrum and S. Walker	Warm-Season Grass Production on Two Mine Soils Amended with Spent Mushroom Compost by J.S. Banfill and R.C. Stehouwer (student)	*Tailings Technical Division Meeting*

5:00-7:30	**Poster Session and Mixer- Great Hall**

Wednesday June 18, 2014

06:30-09:00	**Buffet Breakfast - Great Hall**		
	Room 17 Passive Treatment Systems: Other Technologies	**Room 18 Tailings: Innovative Approaches**	**Room 19 Ecology**
08:30-09:00	Steel Slag Leach Bed Longevity Analysis by S. Landers, S. Maj, A. Mackey and N. Kruse	Potential Recovery of Aluminum, Titanium, Lead, and Zinc From Fine Tailings in the Abandoned Picher Mining District of Oklahoma by W.J. Andrews, R.W. Nairn and C.J.G. Moreno	Reflecting 50 years of Reclamation: My Career 1963-2013 by B.A. Buchanan
09:00-09:30	Sequestration of Heavy Metals on Manganese Oxide Coatings in Passive Treatment Systems by J.J. Gusek, L. Josselyn and D. Millsap	Tribal-Led Remedial Action at the Tar Creek Superfund Site - Catholic 40 by C. Kreman and T. Kent	Reclamation in Southeastern Wyoming: Beauty is in the Eye of the Beholder by B. Schladweiler and C. Adams
09:30-10:00	Getting the Lead Out (and Other Trace Metals) - Solving Mine Water Problems With Peat-Based Sorption Media by P. Eger, P. Jones, D. Green and B. Forder	*Land Use Planning Technical Division Meeting*	Reclamation Success Variables on Highway Construction Projects in Colorado by A.J. DeJoia, A. Hirsch, B. Roeder and M. Banovich
10:00-10:30	**Break - Great Hall**		
	Room 17 Challenges in Passive Treatment	**Room 18 Oil and Gas Reclamation and Remediation**	**Room 19 Ecology**

10:30-11:00	Rehabilitation of Pennsylvania Passive Treatment Systems by R.M. Mahony, B J. Page, C.F. Denholm, T.P. Danehy, C.A. Neely, S.L. Busler and M.H. Dunn	Bridging the Gaps Between Policy, Practice, and Science by M. Curran and P. Stahl (student)	Establishment and Growth of Switchgrass and Other Biomass Crops on Surface Mines by J. Skousen, C. Brown and D. McMichael
11:00-11:30	Passive Co-Treatment of Polymetallic Acid Mine Drainage at Cerro Rico de Potosi, Bolivia R. Peer, J. LaBar, B. Winfrey, R. Nairn, F.L. Lopez and W. Strosnider (student)	Effects of Soil Disturbance and Packed-Box Amendment Study on Two Sodium-Affected Natural Gas Well Pads in Wamsutter, WY by S. Day, J.B. Norton and C.F. Strom (student)	A Comparison of Shrub Cover Methods by C.D. Bonham
11:30-12:00	Jennings Passive Treatment System Rehabilitation by M.H. Dunn, T.P. Danehy, C.A. Neely, R.M. Mahony, S.L. Busler, B.J. Page and C.F. Denholm	Patterns of Tree and Plant Community Development Across Different Soil Types on a Reclaimed Oil Sands Mine Site by B. Pinno, A. Lewis and R. Errington	The Five Fundamentals of Successful Mined Land Rehabilitation by M.S. Theisen and L.G. Girard
12:00-1:30	**Lunch - Great Hall**		
	Room 17 **Water Management**	**Room 18** **Oil and Gas Reclamation and Remediation**	**Room 19** **New Technological Approaches**
1:30-2:00	Challenges in Passive Treatment Design: The Future at Tar Creek by D. Cates and R. Nairn	An Update and Overview of the Oklahoma Energy Resources Board by S. Sowers	Solar-Powered Irrigation System - Jewett Lignite Mine, Jewett, TX by D. Ezell and J. Young
2:00-2:30	Active Alkaline Addition Schemes for Removal of Diverse Contaminants From ARD by T. Wildeman, K. Vatterrodt, L. Figueroa and C. Bucknam	Reclamation in the Pinedale Anticline Gas Field, SW Wyoming: A Ten-Year Perspective by A. Davison and R.S. Carr III	Upper He Creek Water Balance Evaluation by T.W. Schmidt and K.L. Milmine
2:30-3:00	Monitoring Experimental Valley Fills Designed for Reduction of Total Dissolved Solids in Discharged Waters by D. Evans and C. Zipper	Assessment and Remediation of Salt Contamination at Oil and Gas Well Drilling Sites by J.B. Fisher	Application of Remote Sensing for Modeling Mine Fires and Vegetation in Jharia Coalfields, India by P. Kumar, R. Chopra and A. Horel
3:00-3:30	**Break - Great Hall**		
	Room 17 **Water Management**	**Room 18** **Oil and Gas Reclamation and Remediation**	**Room 19** **Ecology**
3:30-4:00	Hydrology and Geochemistry of the Palzo Surface Mine, Williamson County, Illinois 2003-2013 by P.T. Behum, R. Kiser and B. Johnsrud (student)	Regional Variance in Site Selection for Land Disturbing Activities in Oklahoma by C. Porter	*Ecology Technical Division Meeting*
4:00-4:30	Water Quality Impacts from Mining at the Tar Creek Superfund Site by D. Cates	Beneficial Use of Coal Bed Natural Gas Produced Water Through Managed Irrigation in the Powder River Basin of Wyoming by C. Driessen, K. House and K. Harvey	*Geotechnical Engineering Technical Division Meeting*

4:30-5:00	Selected Metals in Sediments and Streams in the Oklahoma Part of the Tri-State Mining District, 2000-2006 by W.J. Andrews, M.F. Becker, S.L. Mashburn and S.J. Smith	Streamlining Reclamation Monitoring in the Sagebrush Steppe by C. Strom
5:30-10:00	**Evening Social Event - Oklahoma History Center, Buses leave Hotel at 5:30 and 6:00**	

Thursday June 19 and/or Friday June 20, 2014

Field Tour #1: Coal, Hydroelectric Power and the Tri-State Lead-Zinc Mining District **(overnight, continues through Friday June 20)**

Field Tour #2: Limestone Mining and Reclamation

Field Tour #3: Abandoned Mine Reclamation in Eastern Oklahoma

Conference Registration

As part of a new initiative to help ASMR become more electronically-oriented, conference pre-registration will be conducted online this year for the first time. **A dedicated, secure web page has been developed by the Oklahoma Center for Continuing Education that will allow attendees to register for full or one-day conference attendance, workshops, field tours, the Early Career Professionals' Social, and the Evening Social Event, as well as for Accompanying Persons attendance and extra Awards Luncheon tickets. The site is linked at the ASMR web page, www.asmr.us**. Please check the site and register! The direct link for conference registration is https://registration.occe.ou.edu/reg/reg_p1_form.aspx?oc=10&ct=PART&eventid=6747.

Please note that Exhibitor and Sponsor registrations will not be on the web page but will be handled by Executive Secretary Bob Darmody (rdarmody@illinois.edu; please see previous information). On-site registration will also be conducted at the conference venue for walk-in registrants. We look forward to seeing you in Oklahoma City in June!

In order to facilitate transportation, lodging, meal functions, and meeting room needs for the conference, and to **avoid late fees**, the Program Committee strongly encourages pre-registration for the conference.

Costs for all conference activities are listed below.

General and Technical Sessions

Full ASMR member Pre-registration: Sunday June 15-Thursday June 19 (Until June 1, 2014; includes ASMR Awards Luncheon ticket)	**$275/person**
Full ASMR member Late-registration: Sunday June 15-Thursday June 19 (after June 1, 2014; includes ASMR Awards Luncheon ticket)	**$325/person**
Full Non-ASMR member Pre-registration: Sunday June 15-Thursday June 19 (Until June 1, 2014; includes ASMR Awards Luncheon ticket)	**$325/person**
Full Non-ASMR member Late-registration: Sunday June 15-Thursday June 19 (after June 1, 2014; includes ASMR Awards Luncheon ticket)	**$375/person**
Accompanying person	**$100/person**
One day registration (Monday, Tuesday or Wednesday)	**$125/person**
Student registration (until June 1, 2014; includes ASMR Awards Luncheon ticket)	**$125/person**
Late student registration (after June 1, 2014; includes ASMR Awards Luncheon ticket)	**$175/person**

Workshops

Introduction to Fluvial Geomorphology (Saturday June 14, 9AM-5PM; Sunday June 15, 9AM - 4PM)	**$150/person**

Field Tours

Coal, Hydroelectric Power and the Tri-State Lead-Zinc Mining District (Thursday June 19 and Friday June 20; includes transportation, lunches and overnight accommodations; dinner Thursday night is **not** included; maximum 57)	**$150/person**
Limestone Mining and Reclamation (Thursday June 19; includes transportation and lunch; maximum 57)	**$50/person**
Abandoned Coal Mine Reclamation (Thursday June 19; includes transportation and lunch; maximum 57)	**$50/person**

Other Functions

Early Career Professionals' Event	**$25/person**
ASMR Awards Luncheon (included in full registration; cost is for additional ticket)	**$30/person**
Evening Social Event (includes entrance fee, meal and entertainment)	**$50/person**

Reclamation of Mined Land with Switchgrass, Miscanthus, and Arundo for Biofuel Production[1]

Jeff Skousen, Professor of Soil Science and Land Reclamation Specialist, West Virginia University, WV 26506; Travis Keene, Mycogen Seeds, Mt. Joy, PA; Mike Marra, U.S. Army Environ. Command, Fort Sam Houston, TX; Brady Gutta, Project Manager, West Virginia Water Research Institute, Morgantown, WV 26506.

Introduction

West Virginia has thousands of hectares of marginally productive, reclaimed coal mined lands. While these lands were successfully reclaimed to the standards of the day, the existing cover of cool-season grasses and legumes does not realize the productive potential of this area for biomass production. These reclaimed mine lands present an opportunity for sustainable energy production. In 2008, West Virginia leaders encouraged the coal industry to develop reclaimed lands to provide feedstock for alternative transportation fuels that would lessen our dependence on foreign oil. Moreover, the Obama administration has also made known its commitment to the development of alternate energy sources and associated "green jobs" that include expansion of the use of biomass. While fossil fuels will continue to serve the majority of West Virginia's and the Nation's energy needs, biomass will help in a carbon-constrained environment by producing energy from sunlight and atmospheric CO_2 while sequestering additional CO_2 in below-ground organic matter thereby improving soil quality. Mined lands offer a unique opportunity since <10% of the total land area in West Virginia is used for agricultural purposes (pasture and cropland). The use of reclaimed mined lands provides the land base that could promote an energy-based economy with the use of agricultural products.

Clipping one plant of the private variety of Miscanthus at Alton, WV, in 2012, after the third growing season.

The growth of the corn-based ethanol industry has placed added pressure on conventional crop lands and rising agricultural commodity prices will create an opportunity for states like West Virginia who have large areas of reclaimed land (Diffenbaugh et al., 2012). Compared to traditional food crops, plants used for biomass are low-value, require several years to establish, and therefore they are unlikely to compete economically with corn and soybeans on conventional agriculture lands (Walsh et al., 2003). More likely, plants grown for biomass production will be established on marginal agricultural land where production is limited by poor soil properties, drought, cold, short growing seasons, and long distance to markets. Biomass production for most bioenergy crops is favored by a long, warm and wet growing season. Biomass crops can be grown in areas such as West Virginia where large areas of reclaimed lands and marginal lands exist, where a suitable climate is present for biomass growth, and where the crops can be transported to a large portion of the USA energy market.

Growth of Kanlow switchgrass after the third growing season at Alton, WV.

Switchgrass

Switchgrass is a highly-productive, native, perennial warm-season grass that has been promoted for biomass-producing potential (Parrish and Fike, 2005). It was one of the primary components of the American Tall-grass Prairie prior to cultivation. Foliage of mature plants is between 1 to 3 m in height and production on agricultural land can be between 8 to 15 Mg ha^{-1} depending on soil quality and water availability. A number of trials have demonstrated that switchgrass can be successfully grown for biomass (Lemus et al., 2002; Mulkey et al., 2008; Mulkey et al., 2006; Parrish et al., 2008; Schmer et al., 2006; Tober et al., 2007). Yields vary widely depending on edaphic conditions and the location of trials. Schmer et al. (2008) recorded yields ranging from 10 to 20 Mg ha^{-1} per year across ten farms in the upper Great Plains states. Switchgrass establishment is slow, generally requiring three years to reach full stand establishment. When it senesces in autumn, most of the nutrients and salts are returned to the soil for next year's growth. It also has a dense root system that can grow to a depth of 2 m or more.

Switchgrass should be ideally suited for reclamation because of its hardiness and inherent tolerance to a number of these limiting soil factors on mined sites. Switchgrass has been used in reclamation studies on roadsides (Skousen and Venable, 2008), surface mines (Skeel and Gibson, 1996; Marra and Skousen, 2013; Dere et al., 2011), sand and gravel mines (Gaffney and Dickerson, 1987), lignite overburden (Skousen and Call, 1987), and lead and zinc mines (Levy et al., 1999). In 2008, switchgrass trials were established for bioenergy production in West Virginia (Marra et al., 2013). They found that switchgrass on reclaimed land with topsoil produced yields of nearly 7,000 kg ha^{-1}, but yields were three times lower (2,000 kg ha^{-1}) on reclaimed lands with no topsoil. Switchgrass can be a successful reclamation species, but only a few studies are available on the ability of switchgrass to produce adequate amounts of biomass for bioenergy production on mined lands.

Plot layout for the yield trials at Alton, WV with two varieties of switchgrass, two varieties of Miscanthus, and giant cane.

Miscanthus

Miscanthus is a genus of 15 species of perennial grasses native to Asia and Africa (Hecht, 2011). Certain species have been used in Japan for thousands of years primarily for forage and thatching. Specimens were first collected in the 19th century as ornamental plants and are still planted today because of their aesthetic value. Following the oil crisis of the 1970s, the search for bioenergy crops began (Heaton et al., 2012) and Miscanthus was identified for its high energy yield per hectare and relative low energy input cost compared to other bioenergy crops (Hastings et al., 2008). The type most commonly grown for biomass is *Miscanthus x giganteus*, which is a sterile hybrid between *M. sinensis* and *M. sacchariflorus* (Heaton et al., 2012). Large stems emerge from rhizomes annually reaching a maximum height of 3 to 4 m and stands persist and remain productive for 15 to 20 years (Hopwood, 2010). The canes themselves sprout from underground rhizomes, which are perennial and tough, and survive in all but the coldest areas of Europe. Miscanthus is best suited for areas with at least 70 cm of rainfall per year, but yields will improve with more rainfall up to 170 cm per year. Like switchgrass, the cane senesces in autumn, with most of the nutrients and salts being returned from the canes to the rhizomes below ground for next year's growth. The standing cane's dry matter content will increase over winter, reaching 60 to 90% by the time it is ready to be harvested in February to April. The main feature distinguishing Miscanthus from other biomass crops is its high lignocellulose content. However, Miscanthus has traits that make it better suited for thermochemical conversion processes than biological fermentation (Heaton et al., 2012). Miscanthus yield trials were undertaken at 16 locations throughout 10 European countries resulting in yields ranging from 10 to 40 Mg ha^{-1} (Heaton et al., 2008). Yields in the USA (Illinois) have reached over 40 Mg ha^{-1}. Miscanthus has the potential to yield more annual biomass than any other major biomass crop except Saccharum and Arundo species. In small trials at three separate sites in Illinois, Miscanthus yielded 10 to 16 Mg ha^{-1}, which was two to four times more biomass than switchgrass (Heaton et al., 2008).

Giant Cane

Giant cane (*Arundo donax* L.) is a tall, perennial cane that grows in damp soils of either fresh or moderately saline water. It is native to eastern and southern Asia, but it has been widely planted and naturalized in temperate, subtropical and tropical regions of both hemispheres (Angelini et al., 2009). It forms dense stands on disturbed sites, sand dunes, wetlands and riparian habitats. It can grow from 6 to 10 m in height with hollow stems. Giant cane needs to be established by vegetative propagation (rhizomes) due to a lack of viable seed production. It is capable of growing on a wide range of soils and can provide very high biomass yields with low environmental impact and low inputs from fertilizer, tillage and pesticides. Heating value is similar to other biomass crops at 3.3 to 3.8 MJ kg^{-1} (7,000 to 8,000 BTU lb^{-1}). Dry matter yields varied from 13 to 40 Mg ha^{-1} in central Italy (Angelini et al., 2005). Comparable studies have not been published in the United States on *Arundo* yields because it is viewed as an invasive plant, but similar yields of 20 to 25 Mg ha^{-1} dry matter (DM) are anticipated with stands of giant cane in the USA.

The objective of this project was to determine DM yields of switchgrass, Miscanthus and giant cane on a reclaimed surface mine in central West Virginia.

Materials and Methods

Field plots were established at the Alton site, a previously surface mined area of approximately 160 ha located in Upshur

Table 1. Ranges and average of selected chemical properties of mine soils at the Alton site where switchgrass, Miscanthus and giant cane were established.

Soil Samples	pH	P	K	Ca	Mg	Base Sat
		mg kg^{-1}	———	cmol^{+} kg^{-1}	———	%
Range	**6.7-8.0**	**9-35**	**0.1-0.2**	**0.9-5.6**	**0.7-1.9**	**95-100**
Average	**7.4**	**26**	**0.2**	**4.5**	**1.3**	**100**

Sparse growth of giant cane at Alton, WV, after the third growing season.

County, West Virginia (38°49`0074"N 80°11`4283"W). The site was mined for the Kittanning coal seams with truck-shovel equipment spreads. The site was reclaimed in 1985 with less than 15 cm of soil being replaced over the mixed overburden, and standard reclamation practices were employed. Grass and legume species planted were tall fescue (*Festuca arundinacea* L.), orchardgrass (*Dactylis glomerata* L.), birdsfoot trefoil (*Lotus corniculatus* L.) and clovers (*Trifolium* spp.), and the soils were fertilized and limed according to regulations. The site supported a 100% ground cover of herbaceous plants during the ensuing 25 years. Of the total land area, about 30 ha were suitable for biomass production. The test area of about 10 ha was sprayed with glyphosate herbicide (Roundup) at recommended rates the previous fall and again in the spring before planting.

The experimental design was an incompletely randomized design. Two varieties of switchgrass, two varieties of Miscanthus, and one variety of giant cane were randomly assigned and established in 0.4-ha plots, and replicated five times (except for giant cane with only three) for a total of 23 plots. On June 22, 2010, Kanlow and BoMaster switchgrass varieties were drilled into the killed sod by the use of an agricultural sod-seeding drill at the rate of 11 kg ha^{-1} pure live seed (PLS). The switchgrass seed was purchased from Ernst Conservation Seeds (Meadville, PA). Two sterile varieties (public and private clonal varieties) of *Miscanthus x giganteus* were obtained from Mendel Bioenergy Seeds (Hayward, CA) and planted as sprigs at a rate of 15,000 plugs per ha (0.9-m spacing). Giant cane rhizomes were obtained from White Technologies, LLC (Clinton, IN) and planted at a rate of 4,500 rhizomes per ha (1.5-m spacing). Both sprigs and rhizomes were planted at a depth of 5 to 7 cm in the mine soil. Plot configuration is shown in Figure 1.

Clippings of switchgrass and miscanthus were taken in October 2011 and 2012 to determine yield two and three growing seasons after establishment at a cutting height of 8 cm in six randomly-placed 0.25-m^2 quadrats in each plot. Giant cane biomass was clipped similarly but only in 2012. Biomass was dried and weighed to determine DM yield and converted to kg ha^{-1}. Rainfall was 155 cm in 2011 and 130 cm in 2012 at the nearest weather station to the site. Precipitation during 2011 and 2012 was within 10% of the average precipitation of 140 cm per year.

Soil samples were taken in 2010 to a depth of 10 cm at 20-m intervals along a transect that passed through the middle of the 10-ha area. Soil samples were dried and rocks were removed through dry sieving. The fine material (<2 mm) was dried

Tremendous growth of the private variety of Miscanthus at Alton, WV, after the third growing season.

and used for analyses. Soil pH was determined on a 1:1 mixture with deionized distilled water with a pH meter (Mettler Toledo SevenEasy pH Meter). Soils were extracted with a Mehlich 1 solution (0.05 M HCl and 0.025 M H_2SO_4). The resulting solution was analyzed with an emission spectrophotometer (Perkin Elmer Optima 2100 DV) for P, K, Ca, Mg, Al, Ba, Fe, and Mn (Wolf and Beegle, 1995).

Results

Soil sampling and analysis showed the mine soils at this site to have neutral pH of 6.7 to alkaline pH of 8.0 (Table 1). These mine soils also showed good fertility with medium to high levels of phosphorus, potassium, calcium and magnesium. Soil testing revealed that herbaceous crops

Table 2. Average dry matter yields (with standard deviations) of switchgrass, miscanthus and giant cane at Alton, WV in October 2011 and 2012.

Plant Species	2011	2012
	———— kg ha-1	------------------------------
Switchgrass		
Kanlow	4,040 (2,643)	4,887 (1,138)
BoMaster	2,752 (1,381)	3,981 (3,136)
Miscanthus		
Public	2,248 (2,006)	4,905 (3,002)
Private	6,553 (5,847)	15,467 (10,447)
Arundo	NA	515 (180)

like switchgrass and Miscanthus should not be hindered by soil fertility at this site.

Switchgrass and Miscanthus stands were well established after the second growing season and increased to a consistent stand in the third growing season (Pictures 1-3). Kanlow switchgrass produced from 20 to 40% more yield than BoMaster during 2011 and 2012. Dry matter yields for Kanlow varied from 4,000 to 4,900 kg ha^{-1}, while BoMaster produced 2,750 to 4,000 kg ha^{-1} (Table 2). Both varieties demonstrated during the second and third years after planting that they are suited to this area in West Virginia for good growth and productivity.

While yields were not quite at the 5,000 kg ha^{-1} target level for economic feasibility established by the West Virginia Department of Environmental Protection, the target yield will likely be achieved in succeeding years. Weeds were found in appreciable quantities in the stands during the first and second years after planting, but they declined in 2012 as the switchgrass shaded and out-competed the weeds. Switchgrass stands do not develop fully until after the third growing season (Marra et al., 2013). Therefore with less competition from weeds and greater stand density and growth, target yields are anticipated to be reached. These 25-yr-old soils have had organic matter additions from previous vegetation growth, and nutrient cycles have re-established in these soils which has helped to improve soil fertility for these low-maintenance grasses.

Miscanthus yields for the public variety were between 2,200 and 4,900 kg ha^{-1} and more than doubled the third year (Table 2). A similar trend was observed with the private variety, showing more than a doubling of yield between the second and third growing seasons, but it had triple the biomass of the public variety in 2012. The tremendous yield of the private variety after the third growing season was similar to Miscanthus growth on good agricultural soils (Heaton et al., 2008), which indicates this variety has great promise to produce high yields on marginal lands like these reclaimed surface mined lands. It will be interesting to see if yields increase further during the fourth growing season in 2013.

Giant cane showed much lower yield at only 515 kg ha^{-1} in 2012 (Table 2). Giant cane did not establish nearly as well as the other two species although height growth was good (Picture 4). Weed competition inhibited the growth of giant cane and the number of stems was reduced as a result of competition. It is also possible that these mine soils are too compact or too clayey for good growth of giant cane since it prefers loose sandy soils. Clippings in 2013 and beyond will confirm whether this species can grow and compete on these reclaimed mine soils.

Conclusions

After the third year, switchgrass and Miscanthus showed good growth potential on reclaimed lands. These crops with more time and increasing stand establishment may achieve target yields established by the WV Department of Environmental Protection for economic feasibility. Yields of switchgrass after the third year were nearly 5,000 kg ha^{-1} for Kanlow switchgrass, and the goal of 5,000 kg ha^{-1} seems to be attainable in succeeding years. Miscanthus biomass production was three to four times greater than switchgrass, attaining an average of more than 15,000 kg ha^{-1} with the private variety during the third year, while yields were three times lower with the public variety. Giant cane yield was very low due to poor stand establishment and weed competition. Yields of these three species will be monitored to determine whether sustained yields can be reached with little or no inputs in these mine soils. ■

Acknowledgments

The authors thank Mr. Richard Herd and Dr. Paul Ziemkiewicz, Water Research Institute at West Virginia University, for initiating this project. Thanks also are extended to Mr. Ken Ellison, West Virginia Department of Environmental Protection, for providing funding for this project. We appreciate the help of Mr. Mike Reese and Mr. Bill Snyder for planting seeds/rhizomes and maintenance of the site. We also thank Carol Brown, Trevor Cummings, and Marcus McCartney for field assistance.

References

Angelini, L.G., L. Cecarini, and E. Bonari. 2005. Biomass yield and energy balance of giant reed (*Arundo donax* L.) cropped in central Italy as related to different management practices. European J. Agron. 22: 375-389.

Angelini, L.G., L. Ceccarini, N.N. Di Nasso, and E. Bonari. 2009. Comparison of *Arundo donax* L. and *Miscanthus x giganteus* in a long-term field experiment in central Italy: analysis of productive characteristics and energy balance. Biomass Bioenergy 33: 635-643.

Dere, A.L., R.C. Stehouwer, and K.E. McDonald. 2011. Nutrient leaching and switchgrass growth in mine soil columns amended with poultry manure. Soil Sci. 176: 84-90.

Diffenbaugh, N.S., T.W. Hertel, M. Scherer, and M. Verma. 2012. Response of corn markets to climate volatility under alternative energy futures. Nature Climate Change 2: 514-518.

Hastings, A., J. Clifton-Brown, M. Wattenbach, P. Stampfl, P. Smith, and P.C. Mitchell. 2008. Potential of Miscanthus grasses to provide energy and hence reduce greenhouse gas emissions. Agron. Sustainable Dev. 28: 465-472.

Heaton, E. A., N. Boersma, J.D. Caveny, T.V. Voigt, and F.G. Dohleman. 2012. Miscanthus (*Miscanthus x giganteus*) for Biofuel Production. Retrieved December 17, 2012, from: http://www.extension.org/pages/26625/miscanthus-miscanthus-x-giganteus-for-biofuel-production

Heaton, E. A., F.G. Dohleman, and S.P. Long. 2008. Meeting US biofuel goals with less land: the potential of Miscanthus. Global Change Biology 14: 2000-2014.

Hecht, I. 2011. The Plant Encyclopedia: The Global Guide to Cultivated Plants. Retrieved December 17, 2012, from http://theplantencyclopedia.org

Hopwood, L. 2010. NNFCC Crop Factsheet: Miscanthus. Retrieved December 17, 2012, from NNFCC The Bioeconomy Consultants: http://www.nnfcc.co.uk/publications/nnfcc-crop-factsheet-miscanthus

Lemus, R., E.C. Brummer, K.J. Moore, N.E. Molstad, C.L. Burras and M.F. Barker. 2002. Biomass yield and quality of 20 switchgrass populations in southern Iowa, USA. Biomass Bioenergy 23: 433-442.

Levy, D.B., E.F. Redente, and G.D. Uphoff. 1999. Evaluating the phytotoxicity of Pb-Zn tailings to big bluestem (*Andropogon gerardii* Vitman) and switchgrass (*Panicum virgatum* L.). Soil Sci. 164: 363-375.

Marra, M., T. Keene, J. Skousen, and T. Griggs. 2013. Switchgrass yield on reclaimed surface mines for bioenergy production. J. Environ. Qual. 42:696-703.

Mulkey, V.R., V.N. Owens, and D.K. Lee. 2008. Management of warm-season grass mixtures for biomass production in South Dakota USA. Bioresour. Technol. 99: 609-617.

Mulkey, V.R., V.N. Owens, and D.K. Lee. 2006. Management of switchgrass-dominated conservation reserve program lands for biomass production in South Dakota. Crop Sci. 46: 712-720.

Parrish, D.J., and J.H. Fike. 2005. The biology and agronomy of switchgrass for biofuels. Critical Rev. Plant Sci. 24: 423-459.

Parrish, D.J., J.H. Fike, D.I. Bransby, and R. Samson. 2008. Establishing and managing switchgrass as an energy crop. Forage Grazing Lands Doi: 10.1094/FG-2008-0220-01-RV. Retrieved December 12, 2012. http://www.plantmanagementnetwork.org/pub/fg/review/2008/energy/

Schmer, M.R., K.P. Vogel, R.B. Mitchell, and R.K. Perrin. 2008. Net energy of cellulosic ethanol from switchgrass. Proc. Natl. Acad. Sci. U.S.A. 105: 464-469.

Schmer, M.R., K.P. Vogel, R.B. Mitchell, L.E. Moser, K.M. Eskridge and R.K. Perrin. 2006. Establishment stand thresholds for switchgrass grown as a bioenergy crop. Crop Sci. 46: 157-161.

Skeel, V.A., and D.J. Gibson. 1996. Physiological performance of *Andropogon gerardii, Panicum virgatum,* and *Sorghastrum nutans* on reclaimed mine spoil. Restor. Ecol. 4: 355-367.

Skousen, J.G., and C.L. Venable. 2008. Establishing native plants on newly-constructed and older-reclaimed sites along West Virginia highways. Land Degrad. Dev. 19: 388-396.

Skousen, J.G., and C.A. Call. 1987. Grass and forb species for revegetation of mixed soil-lignite overburden in east central Texas. J. Soil Water Conserv. 42: 438-442.

Tober, D., W. Duckwitz, N. Jensen, and M. Knudson. 2007. Switchgrass biomass trials in North Dakota, South Dakota, and Minnesota. USDA-NRCS, Bismark, ND.

Walsh, M.E., D.G. De La Torre Ugarte, H. Shapouri, and S.P. Slinsky. 2003. Bioenergy crop production in the United States. Env. Res. Econ. 24: 313-333.

Wolf, A., and D. Beegle. 1995. Recommended soil tests for macronutrients: Phosphorus, Potassium, Calcium and Magnesium. p. 30-38. *In* Sims, J.T. and A.M. Wolf (eds.), Recommended Soil Testing Procedures for the Northeastern United States. Northeastern Regional Pub. No. 493 (2nd Ed.). Agricultural Experiment Station Univ. of Delaware, Newark, DE.

Green Forests Work: Planting Now for the Future of Appalachia

Nathan Hall, Michael French, Rebecca Dyer, Chris Barton, Patrick Angel, and Scott Eggerud

The beautiful and valuable eastern deciduous forest in Appalachia. This ecosystem is the target and goal of reforestation efforts by Green Forests Work.

History and Background

The Appalachian Regional Reforestation Initiative (ARRI) was formed in 2004 to promote the planting of high-value hardwood trees on surface mines, increase the survival rates and growth rates of those trees, and to expedite the establishment of forest habitat through natural succession. The ARRI Core Team was created to facilitate and coordinate the coal industry, landowners, university researchers, watershed, environmental, and conservation groups, and State and Federal government agencies that have an interest in creating productive forestland on reclaimed coal mines. The ARRI Science Team was established to ensure that the methods ARRI promotes are based on proven science and research, and to guarantee the continued scientific research into forestry reclamation. See the following website for more information about the reforestation initiative in Appalachia: http://arri.osmre.gov/

Focused efforts by ARRI have had a significant impact on the way surface mines are being reclaimed by the coal industry in Appalachia. Since 2004, approximately 85 million trees have been planted and approximately 50,586 ha (125,000 ac) restored to forests on mined land. ARRI is 'forward looking,' diligently working to educate and train the active mining industry and regulatory personnel about the FRA in order to promote forest reclamation from this point forward.

ARRI began to also 'look backward' at the estimated 300,000 hectares (741,000 acres) of non-forested, unused post-bond release "legacy" mined lands that could be available for reforestation in the eastern US. The reforestation guidelines for unused mined land developed by ARRI scientists as described in Forest Reclamation Advisory #11 (Burger et al., 2013) were applied to several legacy sites in 2009. This was accomplished through volunteer planting events that relied on donated equipment time from cooperative coal companies and donated tree seedlings from private and public tree nurseries. The success of these efforts led ARRI to explore the logistics of continued tree plantings on legacy mined lands, with the conclusion that it would be necessary to start a separate non-profit that could solicit funding for projects and operational costs from external grants and donations.

Creation of Green Forests Work

The Green Forests Work (GFW) for Appalachia program was created to establish high-quality forested land on coal surface mines that were reclaimed after passage of the Surface Mining Control and Reclamation Act of 1977 (i.e., post-SMCRA) and that had used practices that were not conducive to effective reforestation (Photo 2). The GFW program is intended to reforest post-SMCRA mine sites as a means of achieving societal benefits that include:

1) restoring the landscape's capacity to produce forest products for future use in manufacturing and energy production,
2) restoring an "environmental infrastructure" – ecosystem processes and services provided by native forests – to coal mined Appalachian landscapes, and
3) building a human-resource capacity and infrastructure via private and non-profit sectors to restore forests on for-

A typical post-reclamation surface mined site. Deep ripping and tree planting would greatly expedite natural succession to a forest.

A bulldozer sinks a four-foot ripping shank into reclaimed mine soil in Pike County, KY.

Volunteers listen carefully to tree planting instructions and prepare the appropriate mix of seedlings.

mer mine sites that will generate jobs and economic activity, even decades after the program's completion.

A seed grant from the Appalachian Regional Commission was received in 2011 to help develop the program. The grant was utilized to undertake the following tasks: 1) develop a business plan for GFW and organize development of 501(c)3 non-profit organization status, 2) hire personnel to administrate the program and to solicit and secure additional funds for site preparation, planting, monitoring and maintenance activities, 3) provide on-the-ground support for identifying and preparing reforestation locations, 4) provide oversight of the program's implementation, and 5) work with TACF state chapters to ensure local breeding orchards are operating to their maximum potential to facilitate the future availability of blight-resistant seed stock in a timely fashion.

GFW takes ARRI's work on legacy mined lands to a larger scale, while remaining a close partner throughout dozens of annual planting events as well as off-season planning and preparation. From 2009 to the present, GFW and ARRI partnered with state and federal agencies, watershed groups, coal operators, conservation groups, environmental organizations, faith-based groups, and numerous universities, colleges, and high schools to coordinate 136 tree planting projects/events throughout Appalachia. These events involved 453 partner organizations, over 7,500 volunteers, and have resulted in the planting of over one million trees on about 1,600 acres of previously reclaimed mine sites where reforestation was not attempted, or where the results were undesirable.

The methods employed during GFW plantings follow those outlined in Forest Reclamation Advisory #11 (Burger et al., 2013). The principal components of this approach are as follows:

1) Mitigate compaction by "deep ripping" the ground with a 3 to 5 foot long ripping shank pulled by a large bulldozer or excavator. Ideally the ground will be cross ripped on 8 foot centers, creating a "tic-tac-toe" pattern of decompaction (Photo 3).
2) Control exotic vegetation through targeted herbicide use. A post-planting spot spray utilizing tree shields has been shown to be the most effective single application approach, though a pre-planting broadcast burn-down may be required for sites heavily infested with aggressive vegetation.
3) Properly plant native, mostly hardwood tree species. Professional tree planters are preferred, but carefully trained volunteers overseen by foresters have been used.
4.) Perform follow-up analysis and management as necessary.

GFW/ARRI foresters return to each site after planting to measure survival, productivity, natural regeneration, and to see what can be learned from the plantings that will enable greater success on future projects. Succession can be arrested or substantially slowed due to mine soil compaction and aggressive herbaceous competition. Experience has shown that ripping a site not only facilitates forest establishment, but also prepares a seedbed for natural succession. Ultimately, reforestation success on these sites is a function of the trees' ability to grow freely above the competing vegetation, avoiding hazards including animal browse and rodent damage, and tolerating adverse mine soil conditions that could not be ameliorated.

Still smiling after a day of physical labor, volunteers from several colleges finish planting five acres in Pike County, KY.

A healthy two-year-old Red Spruce seedling on deep ripped ground.

Freshly ripped mined lands ready for tree planting in Randolph County, WV.

This post-reclamation reforestation effort also provides educational outreach for public, industry, and regulatory authorities. The many benefits of reforestation are demonstrated at volunteer tree planting events as participants are empowered to take part in an effort to improve the environment. Ripping and tree planting partnerships with several mining companies have led them to embrace the FRA on their active mining operations. In addition, many state and federal regulators involved have expressed positive attitudes for the forestry post-mining land use.

After several years of piecing together tree planting projects with donated trees, in-kind services, volunteer tree planters, and very limited funding, the GFW/ARRI tree planting events are now evolving into large scale projects funded by grants, cost share programs, utility companies seeking carbon credits, corporate donations, and threatened species restoration efforts (such as for the Golden Winged Warbler). Most of this funding is used for site preparation and to purchase seedlings. In many situations volunteer tree planters are necessary not only to ensure an educational and public outreach component, but to effectively plant large areas with limited funding.

The following projects highlight the ongoing and growing scope of work for GFW and ARRI:

Combs/Hatcher American Chestnut CIG Planting, Pike County, KY

The American Chestnut Foundation (TACF) is a close partner in GFW and ARRI's efforts to restore native trees to mined lands. Working since 1983 to breed seedlings that are naturally resistant to the fungal blight which nearly extinguished this once dominant Appalachian giant, TACF has developed an intensive research and development program which has culminated in the production of Restoration Chestnuts 1.0. Restoration Chestnuts 1.0 are a population of backcrossed chestnuts, containing approximately 15/16 American chestnut genetic material for form and functionality, and 1/16 Chinese chestnut genetic material for blight resistance. A Conservation Innovation Grant from the USDA-Natural Resources Conservation Service has partially funded several mixed hardwood/Restoration Chestnut plantings on reclaimed mines across Appalachia, and this site in Pike County is an excellent example. Remaining funding for this site was provided by TACF, GFW, and a private donor.

The Conservation Innovation Grant plantings are approximately 30 acres and consist of a 1-acre progeny test and a mixed hardwood/Restoration Chestnut planting across the remaining acreage. The progeny test consists of many Restoration Chestnut 1.0 families and some pure American and pure Chinese chestnuts. This will allow TACF to demonstrate how well the Restoration Chestnuts 1.0 behave when compared to pure American chestnuts, and how well they respond to the chestnut blight when compared to Chinese chestnuts. The surrounding mixed hardwood/Restoration Chestnut 1.0 reforestation area will demonstrate how TACF's backcross chestnuts compete in a mixed hardwood setting.

This site has been deep ripped and a five-acre planting event was conducted in November 2013. A broad array of partners engaged in that event, including Berea College, Bridgewater College, Univer-

State	2009	2010	2011	2012	2013	Total
Alabama					3,850	3,850
Kentucky	13,890	88,029	138,250	44,355	44,140	328,664
Maryland		26,520	3,500	2,400	1,500	3,920
Ohio	3,500	8,228	1,400	136,675	2,190	151,993
Pennsylvania	2,000	4,080	147,006	40,219	84,243	277,548
Tennessee			1,000	600	5,820	7,420
Virginia	6,325	5,440	2,100	3,950	32,717	50,532
West Virginia	9,440	12,988	59,260		81,722	163,410
Total Trees	35,155	145,285	352,516	228,199	256,182	**1,017,337**

Breakdown of the number of trees planted by state 2009-2013.

sity of Kentucky, Robinson Scholars, and an AmeriCorps team. The remaining 25 acres will be planted by a series of college and university groups, both local and distant in origin, as well as faith-based volunteers, conservation groups, and local high schools. When completed, the planting will serve as both a demonstration area to enable a better understanding of how the Restoration Chestnuts will perform in the wild, as well as a launching pad for the return of the chestnut across its natural range. Chestnut locations are established using GPS and scientists with TACF, GFW, and the ARRI Science Team will continue to monitor these plantings in partnership with local citizen scientists that will "adopt" the site.

Aerial view of one prepared section of Lambert Run Red Spruce Restoration Project.

Lambert Run Red Spruce Restoration Project, Randolph County, WV

In partnership with the Monongahela National Forest, WV Division of Natural Resources, USDA-NRCS Plant Materials Center, and the Central Appalachian Red Spruce Initiative, GFW and ARRI have initiated a project through funding from American Rivers to implement 120 acres of Red Spruce reforestation and wetland restoration in the Cheat Mountain region of Randolph County, WV.

This follows on the heels of a successful 2011 collaboration that effectively restored the native Red Spruce to about 90 acres of land in the nearby Barton Bench area. The earlier efforts largely utilized volunteers, natural resource professionals, and a team of AmeriCorps service workers; survival and growth results from those plantings are extremely encouraging. Both sites are located within high-altitude sections of the Monongahela National Forest and represent lands that were surface mined in the late 1970s, then subsequently acquired by the National Forest Service after grassland reclamation and non-native pine planting was completed by the coal company.

The Red Spruce ecosystem is unique to certain high-altitude parts of Appalachia, and the Cheat Mountain portion of the Monongahela National Forest is home to 145 state rare plant species as well as several animal species that are listed as threatened or endangered. These include the West Virginia Northern Flying Squirrel, Cheat Mountain Salamander, and Southern Water Shrew. The reforestation efforts here will primarily be carried out by professional tree planters, but a significant volunteer and educational component will occur as well.

Conclusion

Forests are a renewable resource. Successful reestablishment of the hardwood forests that once dominated these lands will provide a sustainable, multi-use resource that will create economic opportunities while enhancing the local and global environment. Potential jobs could include a wide variety of positions such as nursery workers, equipment operators, tree planters, forest managers, and wildlife biologists as well as jobs related to managing sites for renewable energy and climate change mitigation.

By recreating forests where no forests currently exist, the economic opportunities provided by this program will not only provide for the Appalachian people today but will put those lands on a trajectory that will ensure that a forest is available for use by future Appalachian citizens. The Appalachian forest is one of the most beautiful in the world, is one of the region's most valuable assets, and has played an integral part in the rich cultural heritage of the mountain people. As support for the program grows, GFW can proceed in developing a skilled green workforce to restore, protect, and manage this natural resource that is so vital to the region's current and future prosperity. You can be a part of this effort by contacting GFW with any information related to interested landowners of reclaimed mined lands and potential project partners. For more information, please visit www.greenforestswork.org. ■

J.A. Burger, C.E. Zipper , P.N. Angel, N. Hall, J.G. Skousen, C.D. Barton, S. Eggerud. 2013. Establishing native trees on legacy surface mines. U.S. Office of Surface Mining. Forest Reclamation Advisory Number 11. 10 p. http://arri.osmre.gov/fra.htm.

Mine Reclamation Practices To Enhance Forest Development Through Natural Succession

J. Groninger, J. Skousen, P. Angel, C. Barton, J. Burger, C. Zipper

(Editor's Note: This article was originally published as Forest Reclamation Advisory No. 5 by the Appalachian Regional Reforestation Initiative, US Office of Surface Mining.)

Photo 1: Succession and invasion of native species over 47 years formed a forest on this mine site in eastern Tennessee. This site was mined and reforested with various pine species and black locust in 1959 on un-compacted spoil with no planted ground cover. Succession has occurred over the years and the pine forest has been replaced with vegetation similar to the nearby native forest: yellow-poplar dominant in the overstory, red maple, sassafrass and northern red oak in the mid-story, and blueberries, ground pine, Virginia creeper and ferns in the understory (photo by Vic Davis)

Succession is a term used to describe natural changes in plant community composition over time. In the forested Appalachian region, disturbances from storms, fire, logging, or mining can disrupt or destroy established forests. Natural processes that lead to restoration of the forest vegetation after such a disturbance usually begin quickly and result in development of another forest. On former mine sites, the quality of that forest and the speed with which it develops depend upon the conditions created by the mining and reclamation process (see Photo 1).

Conventional surface mine reclamation as practiced from the late 1970's to the present commonly featured smooth grading of topsoil or topsoil substitute material followed by establishment of grasses and legumes that grow rapidly to form a thick groundcover. These compacted mine soils and competitive grasses hinder tree establishment and growth and delay the process of succession to forest cover.

In contrast, reclamation practices known as the Forestry Reclamation Approach (FRA) are intended to encourage succession in a manner that helps the mine operator satisfy regulatory requirements cost effectively and achieve prompt bond release (See Box 1).

This advisory describes the ways in which reclamation methods can encourage rapid succession and accelerate development of high quality postmining forests.

Box 1: Can the Forestry Reclamation Approach Achieve the Rapid Succession of Natural Forests?

After harvest in natural forests, most regenerating hardwood trees grow as sprouts from well-established root systems. This type of regrowth cannot occur on reclaimed mines because those rooting systems have been removed. Unless native forest soils are used in reclamation, mine sites lack the seed and bud banks (live seeds on or in the forest floor and buds that can produce sprouts) of native forests so the vegetation immediately following reclamation is unlikely to be as diverse.

Photo 2: On this eight-year-old mine site in Perry County, Kentucky the following species of trees were planted: white oak, white ash, eastern white pine, northern red oak, black walnut, and yellow poplar. The high-quality growth medium on this site (loose-dumped, uncompacted mine spoils) allowed planted seedlings to achieve greater survival and faster growth while allowing more invasion by non-planted forest species, compared to an adjacent mine site that was graded using conventional practices (Angel 2006) (Photo by Mike Hiscar).

In some cases, mine sites that have been reclaimed using FRA (see Burger 2005) will undergo succession more rapidly than natural forest sites after timber harvest. The canopy of trees established on an ungraded eastern Kentucky mine site (see Photo 2) experienced closure about seven years after an initial planting at 6 x 6 foot spacing. The dense planting of early- and later- successional tree species kept competing weeds at a minimum, which allowed rapid invasion by 27 forest tree species that were growing nearby. In addition, the number of naturally invading forest species (trees and other vegetation types) was 10 times greater on loose-dumped spoils than on those spoils that were graded using conventional reclamation practices (see Figure 1).

As the FRA is used on more reclaimed mines, researchers will have the opportunity to improve this technique and further increase the value of reclaimed lands for future generations.

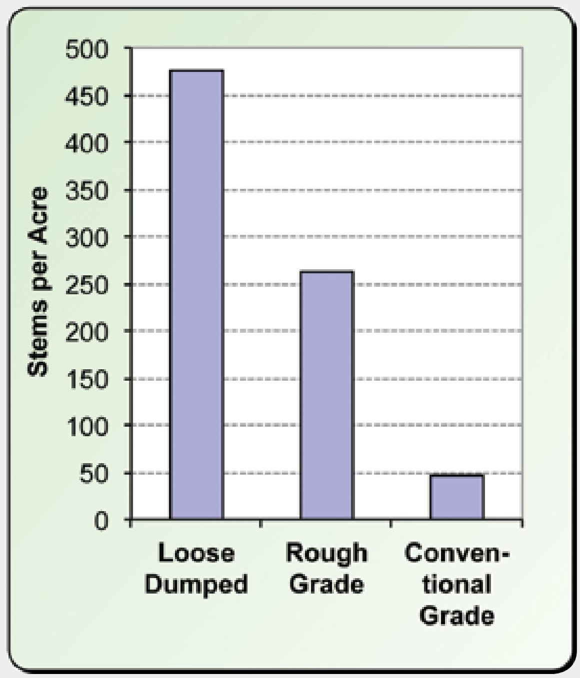


Figure 1: Naturally seeded forested species in uncompacted, rough graded and conventionally reclaimed spoils after eight years on a surface mine in Perry Co. KY. The uncompacted sandstone spoils were conducive for natural succession to occur as noted by a higher number of invading stems per acre and greater site occupancy than observed on the conventional (compacted) spoil. (Cook, 2007)

Succession: From bare ground to forest

When land is disturbed in a manner that removes all vegetation, including seeds and plant material capable of re-sprouting, and nothing is done to revegetate, succession occurs slowly. At first, "pioneer" plant species including grasses, other herbs such as goldenrods and ragweed, vines, and shrubs such as raspberry and blackberry invade and dominate the site. Depending on soil and site conditions, this plant community type may continue to dominate for many years, or it may be replaced within several years by other kinds of plant communities, including forest trees.

When soil and vegetation conditions are favorable for trees, fast-growing short-lived (early-successional) trees like black locust, sassafras, Virginia pine, and hawthorn overgrow the shrubs. In time, these early-successional trees make the site more habitable for slower-growing but longer-lived (later-successional) trees like oaks, hickories, cherry, sugar maple, and ash. As succession proceeds, the open spaces between trees continue to decrease. When the tree tops (or canopy) of the emerging forest grow together so that very little light reaches the ground, a phase of succession called canopy closure occurs, often 15 to 20 years after the initial disturbance. After canopy closure, lower-growing vegetation beneath the forest canopy (called the understory) declines as a response to decreased sunlight until another disturbance opens up the forest.

How long does it take for a forest to mature?

When succession occurs under good conditions, some fast-growing timber trees may grow to a size that can be harvested as soon as 30 to 40 years following disturbance, while slower-growing hardwoods may require 50-60 years or longer (see photo 3).

Other sites may still be in the grass-herb-shrub stage with only scattered trees for several decades after a disturbance because soil conditions are not suitable or the understory vegetation is too competitive for tree recruitment. This is called "arrested succession," which is a failure of later-successional species to invade and eventually dominate a site (see Box 2). Arrested succession also occurs in areas where high deer or rodent populations consume or destroy tree seedlings.

What factors affect succession on a mine site?

Rooting medium quality: If soil replacement results in a rooting medium that is shallow or has been compacted, the site will be prone to drought and plant nutrition problems. Mine soil pH that is too high (pH>7) or too low (pH<5) and mine soils that have high levels of soluble salts can also cause plant nutrition problems. Seeds of unplanted forest species that are carried to the mine site by wind or wildlife will not germinate and grow if the soil surface is compacted or has chemical properties that are not well suited to their needs. Those grass and shrub species that are able to establish and grow on such soils will dominate on such sites, and forest succession will progress slowly. In contrast, a deep and loose growth medium that contains plant nutrients encourages invasion and canopy development by species from the native forest. These soil properties promote a diversity of trees and other vegetation and are productive for timber and wildlife.

Photo 3. These 55-year-old black walnut trees were planted and grew on spoil banks in Pike County, Indiana (Photo by R. Rathfon).

Box 2: "Arrested Succession"

Photo 4. Black locust and grass vegetation were planted on this Garrett County, Maryland, coal surface mine in 1990. As a result, the development of natural forest community through natural succession has been delayed, a condition knows as "arrested succession." (Photo by Mike Hiscar, 2006).

A condition known as "arrested succession" – a failure of later-successional species to colonize a site – can occur after reclamation if principles of natural succession are ignored (see Photo 4).

For decades, a common reclamation practice consisted of seeding fast-growing grasses such as tall fescue and sericea lespedeza to rapidly revegetate mine sites. Often, black locust seed was added to the ground cover seeding mix. This practice produced thick vegetation that easily satisfied bond release requirements of those times. But within 10 years after planting, most black locust trees become infested by a tiny insect known as the locust borer which causes them to lose vigor, and they break down to a shrub-like form. Because the black locust trees' sparse canopy and nitrogen-fixing capability allows the groundcover grasses to persist, the thick herbaceous cover under the black locust remains intact, preventing the invasion of other trees and forest vegetation. Because other native tree species are not present to replace the black locust, tall fescue and companion species such as sericea lespedeza can dominate such sites for decades.

Groundcover vegetation:

Where tall, aggressive grasses are established on the site through reclamation, or where herbs, shrubs, and vines become established in dense thickets, new tree establishment is hindered and young trees become stunted. Because a sparser groundcover allows sunlight to reach the soil surface, planted seedlings can grow and seeds from the surrounding area carried in by wind and wildlife can become established more easily. Tall, thick groundcovers also remove water and nutrients from the soil rapidly, leaving fewer of these essential resources for the slower-growing trees. These groundcovers also attract deer, which can consume the tree seedlings, and they provide cover for small rodents which can gnaw on planted seedlings.

A mixture of tree species:

Natural forests in the Appalachians consist of a mixture of tree species. Some become dominant soon after disturbance and play an important role in establishing the full range of forest plant species. In time, these typically short-lived species die, decline, or are harvested as the longer-lived tree species take over. A mature, closed forest canopy then results. Mine operators can shorten the time it takes nature to produce a valuable forest by preparing the site with loose, good quality mine soils that encourage establishment of volunteer early-successional species, and by planting a mixture of early- and later-successional tree species.

- Early-successional trees are fast growing species such as pines, sweet birch, sourwood, red maple, and bigtooth aspen that provide habitat for birds and other seed-moving animals and help suppress grasses, allowing native forest plant species to become established. Early successional species such as dogwoods and redbud produce fruit and may further contribute to forest development by attracting seed-carrying birds and other wildlife.
- Later-successional tree species are those which typically dominate a site later in the natural succession process. These include many of the commercially valuable hardwoods – such as the oaks, hickories, walnut, and cherry – that are characteristic of mature Appalachian and Midwestern forests. Many of these species have relatively large and heavy seeds that are not moved quickly over long distances by natural forces. Planting later-successional species on a mine site can help these species become established more rapidly than occurs through unassisted natural succession.

Box 3: Making post-reclamation vegetation more diverse

Natural Appalachian forests contain hundreds of plant species. Replacing all of these species through re-planting and seeding is virtually impossible. Natural colonization and replacing topsoils are two mechanisms that can increase plant diversity of reclaimed sites.

Reclaimed mine sites are naturally colonized by native vegetation

In Virginia, researchers studied vegetation change on mine sites over time (Holl 2001, 2002). In 1992, and then again in 1999, they documented the species present on mine sites of three different age classes – reclaimed in 1967-1972, 1972-1977, and 1980-1987 using techniques typical for those times – and in the adjacent natural forests. Succession was clearly evident because many more species were present on reclaimed sites than had been originally planted, and many of the unplanted species also occurred in the adjacent forests.

However, natural succession occurs slowly when conventional reclamation practices are applied. On the 1972-77 sites which had been reclaimed with aggressive groundcovers, grass-like herbaceous vegetation was still dominant 15 to 20 years after the initial reclamation. By 1999, the herbaceous cover was finally beginning to yield to those woody species with small seeds that can be carried by wind and birds, including red maple and sweet birch. While most native forest species were present, some understory species such as trillium, wintergreen, and serviceberry were not found on any of the reclaimed mines, even by 1999 despite the fact that most of these small contour mine sites were located within a few hundred yards from undisturbed forest.

Accelerating succession by spreading forest soils

In some areas, soils salvaged from the pre-mining forest floor can be recycled to produce a plant-growth medium after mining. In these cases, seeds or roots contained in the soil can sprout, establishing species not typically spread by wind or wildlife or where potential seed sources are far away (Wade 1994). For example, at a mine site in Kentucky that was reclaimed using topsoils reclaimed from the adjacent natural forest, 63 species from the natural forest donor site were found on the reclaimed mine site within one year after the soils were spread (Hall 2007). Some important points must be considered when implementing this treatment:

- Native forest soil aids succession most effectively when moved directly from the mining area to the reclamation area. Soil storage prior to re-spreading causes seeds and roots to lose viability, with longer storage periods causing greater losses.
- Fast growing agricultural grasses and legumes are incompatible with most native forest vegetation. As a result, spreading native topsoil is most effective as a reforestation practice when other groundcovers, especially agricultural grasses and legumes, are not seeded,
- Moved topsoil must be free of invasive plant species such as multiflora rose, oriental bittersweet and Japanese honeysuckle for this treatment to provide a long-term benefit to forest development. Careful inspection of the source site prior to mining and keeping soil moving machinery clean are precautions needed to prevent spread of these species through topsoil replacement. Spreading soils from areas with undesirable species during reclamation can lead to establishment of those species on the mine site, causing arrested succession.

To maximize forest value where reclamation has produced soil, groundcover vegetation, and other conditions favorable to reforestation (FRA conditions), planted trees should be compatible for growth in mixed stands. High value later-successional species capable of living for at least several decades should be favored for planting. On such productive sites, early-successional trees and shrubs should only be planted in significant numbers if they will help improve the growth and value, and further aid the colonization of longer-lived and more valuable trees.

Other soil and site factors will also influence the speed of natural succession on mine sites. For example, use of excavated soils that contain living seeds and roots from the native forest in reclamation areas can accelerate natural succession. Mined areas that are close to unmined native forest will be colonized by native forest species more rapidly than sites further from unmined forests (see Box 3).

What reclamation practices aid establishment of forest by accelerating natural succession?

Reforestation researchers have developed the Forestry Reclamation Approach (FRA) that, when implemented properly, can accelerate natural succession on reclaimed mine sites, aiding formation of healthy, diverse hardwood forests (see Burger and others 2005). The FRA can be summarized in five steps:

1. Create a suitable rooting medium for good tree growth that is no less than four feet deep and comprised of topsoil, weathered sandstone, and/or the best available material.
2. Loosely grade the topsoil or topsoil substitute established in step one to create a non-compacted growth medium.
3. Use ground covers that are compatible with growing trees.
4. Plant two types of trees – early-successional species for wildlife and soil stability, and commercially valuable crop trees.
5. Use proper tree planting techniques.

The FRA accelerates natural succession by creating conditions similar to those where native forests thrive.

Conclusion

Landowners and mine operators are increasingly choosing forest as the postmining land use. Compared to conventional reclamation practices, reclamation using the Forestry Reclamation Approach (FRA) allows more planted seedlings to survive and more species from the surrounding forest to invade the reclaimed mine site. Agencies in the ARRI States allow both planted trees that survive and invading trees that are compatible with the postmining land use to be counted toward the tree-stocking standard for reclamation success. Reclamation practices that encourage natural succession can help mine operators meet regulatory requirements and achieve prompt bond release while restoring native forests. ■

References

P. Angel, D. Graves, C. Barton, R. Warner, P. Conrad, R. Sweigard, C. Agouridis. 2006. Surface mine reforestation research: Evaluation of tree response to low compaction reclamation techniques. P. 45-58, in: Proceedings, American Society of Mining and Reclamation.

J. Burger, D. Graves, P. Angel, V. Davis, C. Zipper. 2005. The Forestry Reclamation Approach. U.S. Office of Surface Mining. Forest Reclamation Advisory No. 2.

B. Cook. 2007. Unpublished data (MS Thesis, University of Kentucky, in preparation).

S. Hall. 2007. Topsoil Seed Bank of an Oak-Hickory Forest in Eastern Kentucky as a Restoration Tool on Surface Mines. MS Thesis, University of Kentucky, Lexington, KY. pp 92.

K. Holl, C. Zipper, J. Burger. 2001. Recovery of Native Plant Communities after Mining. Virginia Cooperative Extension Publication 460-140.

K. Holl. 2002. Long-term vegetation recovery on reclaimed coal-surface mines in the eastern USA. Journal of Applied Ecology 39:960-970.

G. Wade. 1994. Grass competition and establishment of native species from forest soil seed banks. Landscape and Urban Planning 17:135-149.

Acknowledgements

Faculty and researchers from the following universities and organizations contributed to this Forest Reclamation Advisory: Ohio University, Ohio State University, Pennsylvania State University, Purdue University, Southern Illinois University, University of Kentucky, University of Maryland, University of Tennessee, Virginia Polytechnic Institute and State University, West Virginia University, and United States Forest Service.

John Groninger. Southern Illinois University, Carbondale. groninge@siu.edu

Jeff Skousen, West Virginia University, Morgantown. jskousen@wvu.edu

Patrick Angel, Office of Surface Mining Reclamation and Enforcement, U.S.D.I., London Kentucky. pangel@osmre.gov

Christopher Barton, University of Kentucky, Lexington. barton@uky.edu

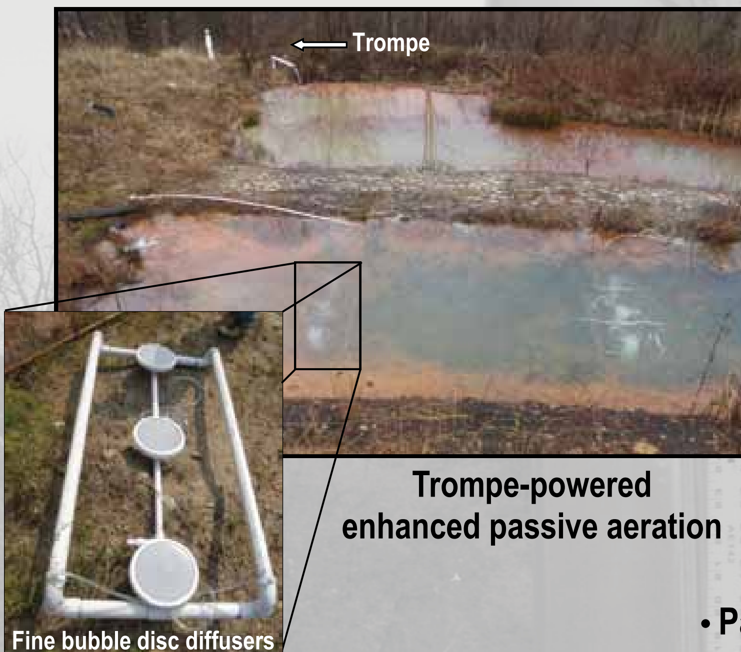
James Burger (jaburger@vt.edu) and Carl Zipper (czip@vt.edu), Virginia Tech, Blacksburg.


HARDWOOD SEEDLINGS FOR REFORESTATION
from SuperTree Seedlings®

With over 80 hardwood species for wetlands mitigation, mine reclamation and wildlife food and habitat, SuperTree Seedlings® is the leading seedling producer providing the highest quality reforestation stock.

mine drainage treatment & utilization

BioMost, Inc.
434 Spring Street Ext., Mars, PA 16046
Phone 724-776-0161 bmi@biomost.com
www.biomost.com



Trompe-powered enhanced passive aeration

PROVIDING ENVIRONMENTAL CONSULTING AND CONSTRUCTION SERVICES TO THE ENERGY INDUSTRY FOR 15 YEARS

MixWell retrofit for pebble quicklime systems

Increase pebble quicklime efficiency up to 40%

A-Mixer passive lime mixing for quick or hydrated lime

MixWell & A-Mixer use no electricity or moving parts

- Passive Treatment System Design
- Active Treatment System Design
- Passive Chemical Mixing Systems
- Enhanced Passive Aeration
- System Value Engineering & Evaluation
- Construction & Contracting Services
- Watershed Assessments
- Post-Mining Trust Funds
- Resource Recovery
- Wetland Planting & Upland Revegetation
- Streambank Stabilization
- Environmental Permitting
- Wetland Delineation & Mitigation Plans
- Operation & Maintenance Services
- Patented Technology
- Micro-Hydroelectric Design/Build

BioMost, Inc.

mining & reclamation services