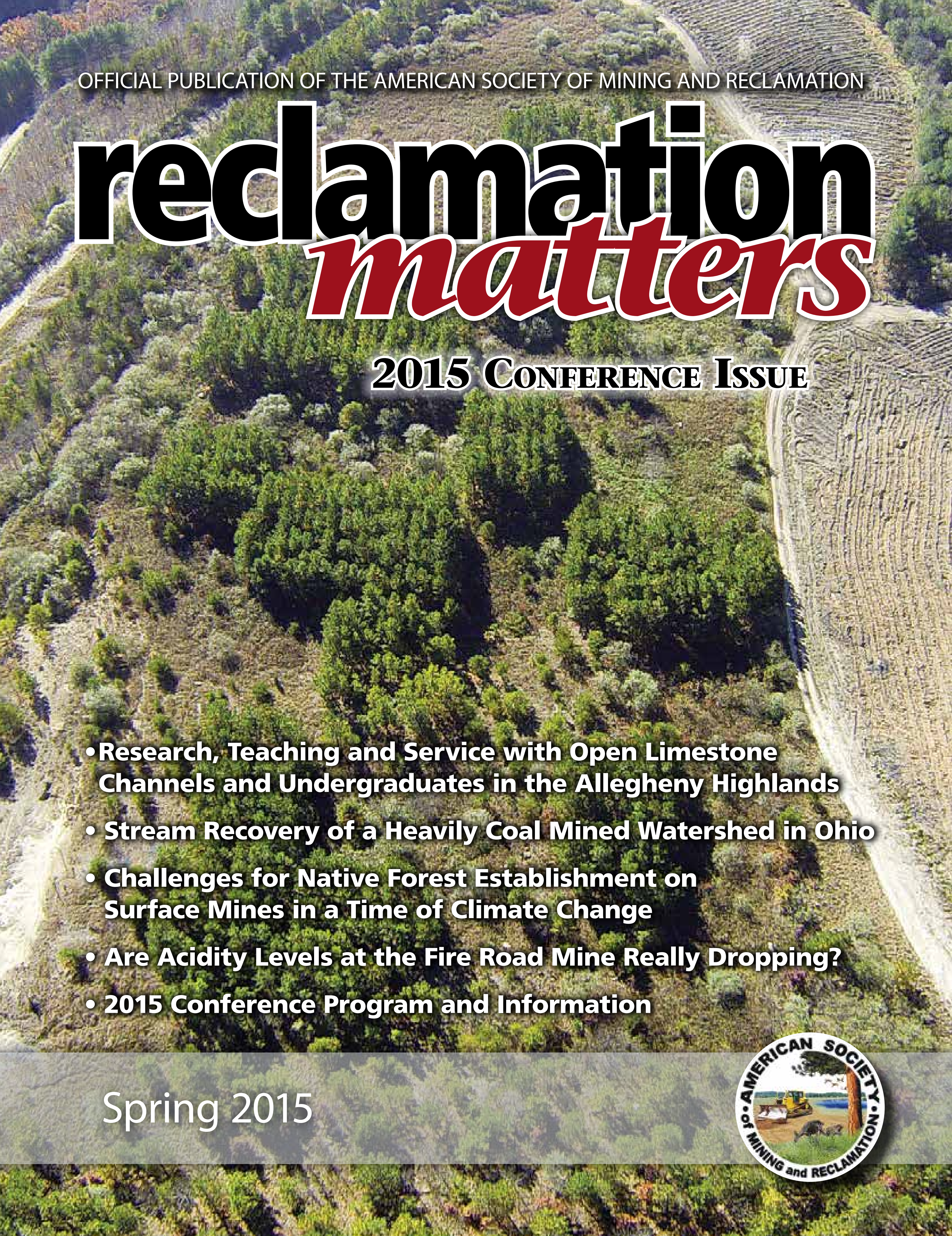

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation matters

2015 Conference Issue

- Research, Teaching and Service with Open Limestone Channels and Undergraduates in the Allegheny Highlands
- Stream Recovery of a Heavily Coal Mined Watershed in Ohio
- Challenges for Native Forest Establishment on Surface Mines in a Time of Climate Change
- Are Acidity Levels at the Fire Road Mine Really Dropping?
- 2015 Conference Program and Information

Spring 2015

AMERICAN SOCIETY of MINING and RECLAMATION

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NorthAmerican Coal Corporation

reclamation matters

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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
Dana Jensen
Sheri Kidd

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

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Come to the ASMR Meeting in Lexington

By Joe Friedlander, ASMR President

If you're looking for the latest information about land reclamation, you'll find it at the 32nd Annual Meeting of the American Society of Mining and Reclamation June 7-11 in Lexington, Kentucky. With more than a hundred papers proposed to be given, this looks to be one of the best meetings yet. And Lexington, Kentucky in June is a great place and ideal time to learn about mid-America's coal country and enjoy the Bluegrass Region. This year ASMR is teaming with the 9th annual meeting of the Appalachian Regional Reforestation Initiative, making this an even more diverse event.

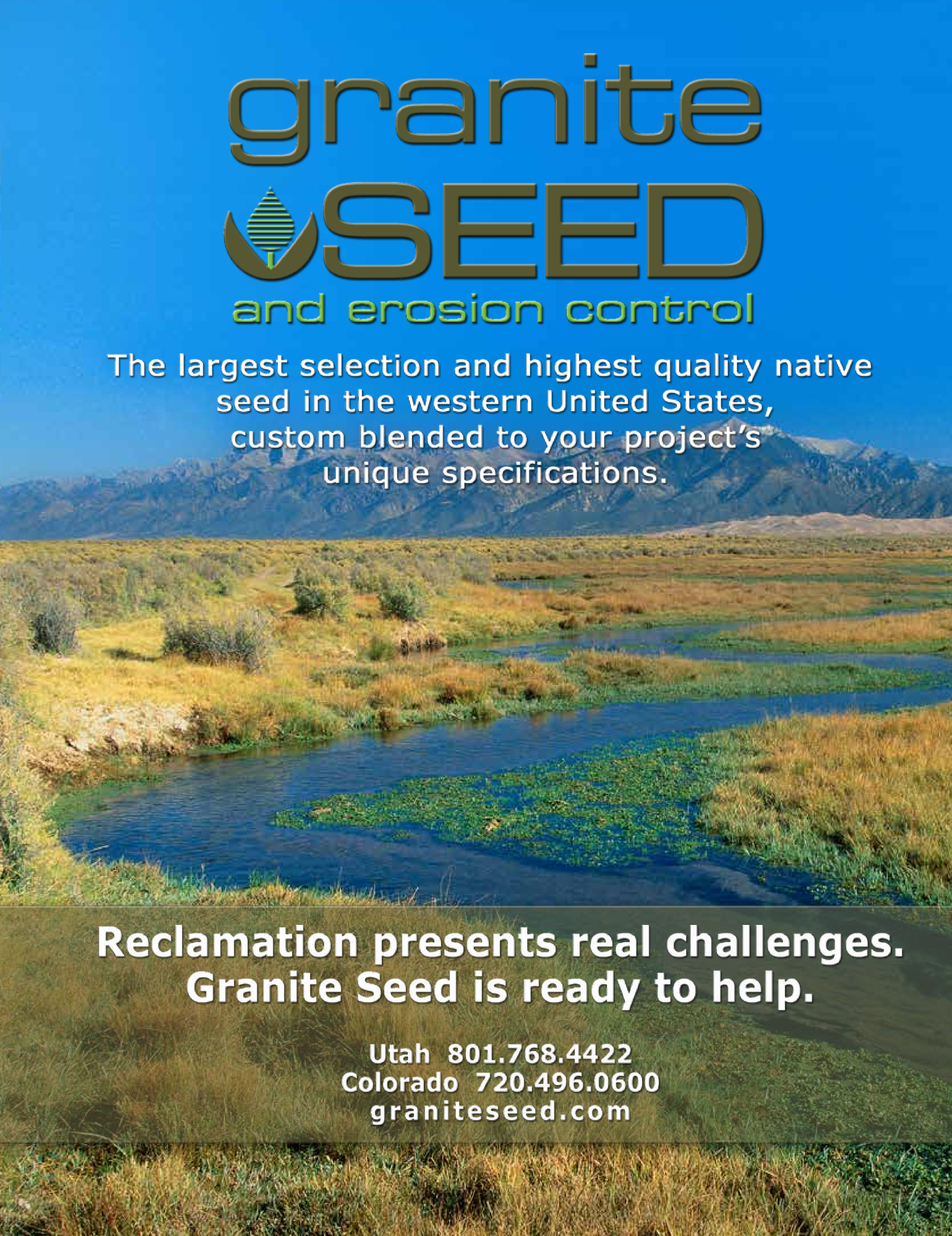
For more than 30 years ASMR has been recognized as holding what can arguably be described as the world's best annual conference to share information about disturbed land reclamation. Held in a different location every year, these meetings bring together world-wide recognized leaders from industry, academia, and government to present their latest research findings as well as case studies documenting both the achievements and shortfalls of new and different reclamation techniques.

In addition to papers, this year's program features workshops on geodatabase collection, and forestry reclamation on active and legacy mine sites. Optional field tours of reclamation research sites, as well as tours of historical sites and a distillery, will be capped with an evening social at the Kentucky State Horse Park.

At the awards luncheon, ASMR will recognize high-achieving students with scholarship awards. Other prestigious awards will be presented by ASMR, recognizing the best of the best for their contributions in advancing the art and science of land reclamation.

We know these aren't easy days for the mining industry. Depressed markets and excessively expansive new federal environmental regulations have forced many mines to close or idle back significantly. And the Central Appalachian coal fields in southern West Virginia and eastern Kentucky have felt the brunt of these impacts more than any other part of the country. But this makes the work of ASMR even more important – efficient and economical land reclamation provides for low-cost mining. This helps keep mines open in a fiercely competitive world-wide market. The Lexington meeting may prove to be even more valuable than others simply because it fulfills a demand for new ideas to help mining companies survive and thrive through these difficult times.

Hope to see you there! ■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Five Guides to Leadership

By Jeff Skousen

Last year, I attended a presentation given to a group of potential student leaders by our university president. Using some of the things he presented, I developed my own five leadership principles.

1. Have a thick skin. Do not take offense.

Everyone thinks they can run the company or organization better than you. Take their criticisms and suggestions without offense and try to see any truth in their statements. Try to learn from their remarks even if sarcastic and mean-spirited.

2. Take your job seriously, but do not take yourself seriously.

Sometimes people in leadership positions think they are very special, infallible, and the center of the universe. None of these are true, so get over yourself.

3. Be cheerful. Laugh a lot.

No one likes a grumpy, complaining, or dictatorial leader. See the humor in others and in yourself.

4. Listen. Then make decisions.

Surround yourself with thinkers and movers, not "yes" people. Get good advice and recommendations from a variety of sources. Make the best decisions you can with all the facts you can gather. Look to the future as to how this decision will impact others and do things for the right reasons. Once you have enough information and have considered alternatives, decide on the best course and act. All the facts may not be available, so leaders must sometimes do the best they can and move forward with confidence and conviction. Some leaders ponder and dilly-dally over decisions for too long. Listen, decide, and act.

5. Admit mistakes readily, apologize, correct, then move on.

Leaders often make mistakes, but the problem with some leaders is that they cannot bring themselves to admit it publicly and to make amends. Leaders must acknowledge errors and learn from mistakes.

I think these principles will help parents, consultants, employees, presidents of big and small companies, and entrepreneurs be better leaders and people who others will want to follow. ■

Take Advantage of the ASMR Experience

By Cally Driessen

ASMR takes pride in its new members and recognizes them as the future of the organization. We offer scholarships, travel grants, and very low membership fees for students. Not to mention a venue to present research and network with professionals from all aspects of the reclamation world. With such incentives, we can't help but scratch our heads when we hear student chapters are dissolving and only a few students apply for scholarships each year. In 2014, there were a total of five applicants for the three scholarships.

It's not all doom and gloom, however. We've had very successful Early Career events at several meetings, with a large turnout from local students as well as early and late career members. Students also remain important contributors to the annual meetings as presenters and audience members. The question remains: are we doing enough to retain young members and help develop their careers in the reclamation industry? This is the goal of the Early Career group, and it should be the goal of every member. I think, in addition to the Recruit One Member campaign, we also consider retaining our student members as they advance in their careers.

As I look back on my experiences with ASMR, I can't help to think of the people and institutions that motivated me to retain my membership. I was fortunate to attend universities with active ASMR members and hire on with a company that sponsored many ASMR events. I had access to the incentives thanks to the members of those institutions. So pass along the scholarship and travel grant memos to students in your area, even if it's the second or third time you've sent them. Remember the deadline for scholarships (http://www.asmr.us/Forms/Forms.htm) is March 31st!

If you have ideas on how to improve the ASMR experience for students and Early Career professionals, please contact me (cahudlow@gmail.com) or other members of the NEC. Dick Barnhisel has organized what I am sure will be another successful Early Career social for the 2015 Lexington meetings. To have a successful Early Career social, we need participation from students, early career professionals, and more senior professionals. We have a tradition of pairing less experienced members with more experienced mentors to meet new people and start conversation.

Hope to see you in Lexington! ■

The Three Bobs

Reflections on Two Decades of Passive Treatment

By Robert Hedin, Robert Nairn, Robert Kleinmann, William Strosnider

Introduction

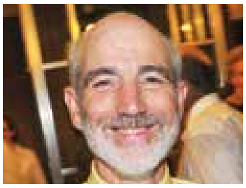
The 2014 ASMR National Conference in Oklahoma City presented a unique opportunity for reflection on the short history of the passive treatment of acid mine drainage since the Bureau of Mines Information Circular (IC) 9389. This publication led to a dramatic increase in the application of passive treatment, while forming a foundation for much of the subsequent research to develop and refine new treatment approaches. IC 9389 was produced by Robert (Bob) Hedin, Robert (Bob) Nairn, and Robert (Bob) Kleinmann in 1994. The 2014 ASMR conference held a special session for these passive treatment pioneers to reflect upon the development of IC 9389 and the two decades of passive treatment applications since.

Bob I

Bob Hedin reported on the long-term effectiveness of passive treatment systems in Pennsylvania. The presentation was organized along the lines of the technology selection decision tree presented in IC 9389. The decision tree, in various modified forms, has been one of the most enduring components of the publication. Hedin presented treatment data for four treatment systems. One was an aerobic pond/wetland system that has effectively treated a large Fe-contaminated discharge for eight yrs. The second system was an anoxic limestone drain that has produced alkaline water for 18 yrs. The third system was an oxic limestone bed system that utilizes newer flushing concepts and has been able to treat low pH water contaminated with Al and Mn for four years. The fourth system was the largest passive treatment system in Pennsylvania that treats low pH water containing Al, ferric iron, and Mn. The system has produced an alkaline effluent with low metals for 10 years. The key point made by Bob the First was, with good design and construction, passive treatment can reliably produce high quality effluents for years.

Bob II

Bob Nairn focused on the importance of IC 9389 as the foundation of passive treatment research for the past two decades. Although initially focused on abandoned coal mine waters in northern Appalachia, the use of passive treatment technologies has expanded to multiple continents, addressing waters of varied chemical compositions from many different types of mining operations. The research performed at the U.S. Bureau of Mines was critical to the success of these projects. As an example, his presentation examined the first and only full-scale passive treatment system in the Tri-State Lead-Zinc Mining District (TSMD) of Oklahoma, Kansas, and Missouri. In 1984, the first Record of Decision at the Tar Creek Superfund Site, part of the TSMD, stated that impacts to surface waters were due to irreversible man-made damages from mining. Completed in 2008, the parallel treatment train, 10-process-unit, Mayer Ranch passive treatment system decreases iron, zinc, lead, cadmium and arsenic concentrations to concentrations acceptable for receiving stream water quality and aquatic life. The success of passive treatment may bring about a reassessment of 30-year-old administrative decisions.



Bob III

Bob Kleinmann chronologically sandwiched the remarks of Bob I and Bob II by first providing a brief history of the beginnings of passive treatment of mine water, a decade before the publication of IC 9389, and then provided his projection of where the next decade will take us. Bob the Third first talked about how the first attempts at passive treatment simulated a sphagnum moss bog that had been shown to improve water quality from an abandoned mine site. This approach worked with relatively mild mine water but failed miserably with poor quality water. The moss was too good at removing metals from the water – so good that there was an "advancing wall of death" as the moss that first contacted the water removed the metals until it died and petrified, after which the next segment of the bog underwent the same fate. Better success was had with *Typha* (cattails) wetland vegetation, which removed little of the metals themselves but created a good environment for the iron-oxidizing bacteria to function. The cattails helped filter the iron floc from the water mostly by slowing down the water flow. It was in one of these early cattail systems that anaerobic sulfate reduction was first observed to be occurring in water that had entered the spent mushroom compost substrate. This observation led to the construction of what were originally referred to as anaerobic wetlands, but are now referred to as bioreactors.

Bob III went on to discuss how the latter technology might evolve during the next decade. In his view, the anaerobic environment can be initiated up-gradient in the toe of the tailings or waste rock, reducing the space required for passive treatment. Furthermore, the further up-gradient in the source material that you create the anaerobic environment, the less pyrite oxidation will occur, converting passive water treatment technology to at-source control. There are certain key requirements: oxygen entry and mobility into the pyritic material must be minimized and technologies to add or inject inexpensive organic waste into the pyritic material must be developed. He also suggested some caveats. First, if the pyritic material contains secondary minerals that have formed, such as iron and manganese hydroxides, then manganese and arsenic, if present, could be remobilized as the environment becomes anaerobic. Second, metal sulfides will precipitate, as they do in bioreactors, which means that the site must be closed and reclaimed in such a way that oxygen entry and circulation is prevented. He hopes to initiate tests of this concept during the next year or two.

The special session was concluded with an extended question and answer period in which the trio reflected upon the future of passive treatment, along with another respected pioneer in passive treatment, James (Jim) Gusek. The panel agreed that there is still much room for innovation in passive treatment technologies, especially with respect to the treatment of new contaminants of interest, reduction of nuisance constituents, in-situ reduction of acid mine drainage generation, lower maintenance systems, metal reclamation, and sustainable reactive materials. ■

National Association of State Land Reclamationists Update

Michael Smith is current President of NASLR, a District Mining Manager for Pennsylvania DEP, and a professional geologist.

By Michael W. Smith, NASLR President

Way back in 1972, when the concept of mine reclamation was starting to gain traction nationwide, a group of state mine reclamation professionals conceptualized a national mine reclamation organization. The following year, the National Association of State Land Reclamationists (NASLR) was born at its first annual conference in Atlanta, GA. Since that time, state reclamation agencies have hosted the annual conference in a variety of locations throughout the nation. NASLR also established coal and non-coal mined land reclamation awards, a "Reclamationist of the Year" award, an educational scholarship for students in a mine reclamation field, a reclamation outreach award and a quarterly newsletter. Over 25 states and provinces are or have been members of NASLR.

With the recession of 2008, state reclamation agency budgets were hit hard. Travel opportunities to attend national meetings disappeared almost overnight and willing-and-able hosts for the meeting became difficult to find. By 2013, NASLR's continued existence was beginning to look tenuous at best. Last year, NASLR leadership began to look at potential partners, first among them being ASMR. Bob Nairn, then ASMR President, even wrote an article in *Reclamation Matters* suggesting that NASLR would be a good match and recommended it partner with ASMR – a gesture which was greatly appreciated by NASLR.

Obviously, there is a lot of overlap between NASLR and other reclamation-oriented organizations: ASMR, NAAMLP, and IMCC to name a few, but NASLR serves a unique niche focusing on the reclamation of active coal and active non-coal mining operations. NASLR members are state reclamation agencies and state reclamation professionals. Industry, consultants, vendors, and other friends of mine reclamation are welcomed as associate members.

At last year's annual meeting in Newburg, NY, NASLR decided to make a concerted effort to expand its presence and reach out to former members, states, and individuals, as well as to states that hadn't been members before. To this end, you will likely see us at this year's ASMR conference in Lexington, KY, and perhaps visiting selected state reclamation agencies. Please stop by and say hello and talk some reclamation with us. We would like to encourage you to join NASLR.

"Wave Field", one of several famous pieces of landscape art at the Storm King Art Centre, NY, created during the reclamation of a sand and gravel operation and visited during a recent NASLR field trip.

Now a little bit about our annual meeting and field trip. Every year, a member state hosts the annual meeting. This year's meeting is scheduled for September 14-16 in Wise, Virginia, at the Historic Inn at Wise, nestled in the Appalachian Mountains of Southwest Virginia. Wise is just a stone's throw from Big Stone Gap (site of *Big Stone Gap*, the movie, hitting theatres soon) and very close to Bristol, VA/TN, home to the annual Rhythm and Roots Reunion music festival each September. Wise stands to be

Reconstructed Stream Channel in IL. (2010)

Final Cut Lake at an IL Coal Mine. (2010)

an excellent location for this conference considering the many locations to view exemplary reclamation accomplished in nearby mining areas, combined with the charming appeal and breathtaking scenery of this small town.

The annual meetings consist of technical sessions, a field trip to nearby mining and reclamation sites (sometimes with a few other sites of general interest mixed in for good measure), a short business meeting, and a banquet where awards and scholarships are presented. Registration cost is very reasonable, often with the help of reclamation-minded sponsors, and, in my opinion, the conference is one of the best values to be found anywhere. Technical presentations are always practical and relevant to the reclamation professional, and to state regulators. Likewise, the field trips are excellent vehicles to show off reclamation accomplishments, and innovative reclamation techniques at different mining operation throughout the country. In past field trips, we've looked at stream reconstruction and post-mining lakes in Illinois, sand and gravel operations converted to landscape art exhibits in New York, fluorescent mineral mines in North Carolina, AMD prevention and treatment in Pennsylvania, and searched for diamonds in Arkansas, just to name a few.

NASLR's traditional membership has been from the eastern and central U.S., with a few western states and Canadian provinces. This year, with the recent addition of Alaska as a member state, we plan to have a greater presence in the west as well as reconnecting with member states that dropped out in the aftermath of the great recession.

Information about NASLR, the 2015 Annual Conference and Field Trip in Wise, VA, and nomination forms for reclamation awards and scholarships can be found at www.naslr.org.

NASLR members also receive a quarterly newsletter with news and general articles of interest to reclamation professionals and state regulators. Current and previous newsletters are available on the NASLR website. Annual memberships in NASLR are $200 for states, $10 for individuals and associates, and $100 for corporate sponsors. However, if you attend the annual conference, no dues are required for individuals or associates.

I hope I have generated some renewed interest in NASLR and what it has to offer the reclamation community.

For more information, please visit our website or email me at michaesmit@pa.gov. ■

2013 Mined Land Reclamation Award Winner. (P & N Coal)

Innovative Tree Planting at a NY Quarry. (2014)

2015 Conference

32nd Annual Meeting Of The American Society Of Mining & Reclamation

9th Annual Meeting of the Appalachian Regional Reforestation Initiative

June 7-11, 2015 | Clarion Hotel | Lexington, Kentucky (USA)

"Reclamation Opportunities for a Sustainable Future"

Program and Registration Information

The Clarion Hotel (https://www.youtube.com/watch?v=i3KDCJoHeng for a three-minute video) in Lexington, KY is the site for this year's conference. Sunday's optional activities include a workshop, a tour, and a golf outing in addition to the Exhibitors' Welcome Social. There are no sessions planned for Tuesday to allow for additional tours as well as a workshop or a golf outing and concluding with the off-site Social at the Kentucky Horse Park.

The **Exhibitors' Welcome Social** will be Sunday evening, which includes appetizers and a no-host bar. This will provide an opportunity to visit with the Exhibitors as well as with other participants. The **Plenary Session** will begin on Monday morning followed by the **Awards Luncheon** at noon. Technical sessions will start in the afternoon and continue on Wednesday and Thursday. Monday evening the **Early Career Professionals' Social** will take place at an off-site location. The Exhibitor Hall and Convention Area Maps may be found on the ASMR web site http://www.asmr.us/Meetings/UpcomingMeetings.htm) as well as other opportunities which may be of interest in planning your vacation in KY. An expanded version of the preliminary program giving additional information related to the hotel; workshop descriptions; the forestry, historic sites, and distillery tours; the Tuesday evening social; and other events, etc. may be found there as well.

The Conference Program Committee consists of Dr. Richard Barnhisel, Co-Chair; Chris Barton, Co-Chair and Field Trips Coordinator; Paul Rothman, ARRI Co-Chair; Lela and Karen Barnhisel, on-site registration; Dr. Robert Darmody, Pre-registration and ASMR Executive Secretary; and Patrick Angel, Mike Bower, Steve Felch, and Kenton Sena.

The Convention Center at the Clarion Hotel is served by the airport at Lexington (LEX); Cincinnati International Airport (CVG), about 70 miles north; and Louisville International Airport (SDF) about 75 miles to the west. There is an abundance of free parking at the hotel. The Group Name: American Society of Mining & Reclamation with the group code: **ASMR2015** with a room rate of $99 (standard room), other types of rooms are also available. You need to make your Clarion Hotel as well as Conference Reservations by **May 1, 2015** as rooms will be released after that date and the registration rates increase on that date. To reserve your room directly: phone (888) 390-4918, and be sure to mention the group code.

Workshop 1: ASMR 2015 ArcPAD and IOS based geodatabase collection for active and abandoned coal mining sites Sunday, June 7, 1:00 pm to 4:00 pm with Andrew Schaer as lead instructor.
Workshop 2: Implementing the Forestry Reclamation Approach on active and legacy mine sites, Monday, June 8, 2:00 pm to 5:30 pm. This is one of the forestry sessions.
Workshop 3: Overview of EarthWorks Capabilities, Tuesday, June 9, 1:00 pm to 4:30 pm, with Richard Warner as the instructor.
Symposium on Bats: Wednesday, June 10, 10:30 am to 5:30 pm.

Financial Sponsors (to date)

PLATINUM
Opportunities still exist!

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Office of Surface Mining

SILVER
Green Forests Work

BRONZE
Alabama Coal Association

Other Sponsors (to date)

BKS Environmental Associates, Inc.
Pacific Inter-Mountain Distribution
Rainier Seeds, Inc.

ASMR – ARRI Field Tour

Tuesday – June 9, 2015

7:00 – Board bus and travel to the eastern Kentucky coal field.

9:30 – Arrive at the PVB Wildlife Management Area that was mined and reclaimed in the early 2000s.

Activities:

- Invasive species removal
- American chestnut plantings
- Climate change adaption study
- Native warm-season grass experiment

11:30 – 12:30 lunch provided by Green Forests Work.

1:00 – Arrive at the Little Elk mountaintop removal surface mine.

Activities:

- Pine Branch mining will demonstrate grading techniques used in the Forestry Reclamation Approach (FRA)
- Visit 18-year old forest planted on low compaction (FRA) spoil plots

3:00 – Leave and return to Lexington.

Contact: barton@uky.edu

Historic Tour of Central Kentucky

Hunt-Morgan House

In the midst of Lexington's historic antebellum Gratz Park, the Hunt-Morgan House stands as a reminder of early 19th century life, when Lexington was known as The Athens of the West. The Hunt-Morgan House, historically known as Hopemont, was built by John Wesley Hunt in 1814. Hunt was known as the first millionaire west of the Alleghenies. The Federal style Hunt-Morgan House has many beautiful architectural features, including the Palladian window with fan and sidelights that grace its front façade.

Dr. Thomas Hunt Morgan

Dr. Morgan brought international fame to the family and the Bluegrass by becoming the first Kentuckian to win a Nobel Prize. Morgan graduated in 1886 from the State College of Kentucky, later the University of Kentucky, and received his doctorate from Johns Hopkins University.

The Confederate General John Hunt Morgan was christened "Thunderbolt of the Confederacy" by an adoring south and described as "King of the Horse Thieves" by Northern sympathizers. Morgan legends abound from his dramatic escape from a federal prison to a ride through the Hunt-Morgan House on horseback to kiss his mother goodbye. He was John Wesley Hunt's great grandson.

Henry Clay Estates

Ashland is the name of the plantation of Henry Clay, the 19th-century Kentucky statesman, and is located in Lexington. Henry Clay came to Lexington from Virginia in 1797 and he began buying land for his plantation in 1804. The Ashland farm, which during Clay's lifetime was outside the city limits, at its largest consisted of over 600 acres. Kentucky University purchased Ashland and used it as part of its campus. University founder and regent John Bryan Bowmen occupied the mansion. The Agricultural and Mechanical College (Kentucky A & M) was situated on Clay's former farm. Kentucky University split into what became Transylvania University and the University of Kentucky, and sold Ashland in 1882.

Shaker Village of Pleasant Hill Kentucky

In 1805, a group of Shakers came to central Kentucky and established a village known as Pleasant Hill, now America's largest restored Shaker village. Their numbers peaked at 500 in 1820. The village preserves 34 original buildings on 3,000 acres.

The Early Career Professionals' Social

Will be on Monday, June 8, 2015, 6:00 to 9:00pm, at a location to be determined. Transportation will be provided. This is for those just beginning their reclamation career (<10 years), with the "mature folks" that have a great deal of experience and knowledge in the field of land reclamation. In other words, everyone really qualifies to interact at this social. The maximum number allowed in this establishment is 70, so register early.

Tuesday Evening Social

Will be at the Kentucky State Horse Park, 1,250 acres, located about four miles from the Clarion Hotel. We will begin providing transportation about 4:30 pm with the last bus leaving about 6:30. The cost of the evening is $60, which includes the entry fee of $16. However, if you choose to drive yourself, you will need to pay that extra amount. The evening includes a few options. 1) Tour of International Museum of the Horse, within one block of the visitor center, which could take you as much as one hour. 2) Tour of the American Saddlebred Museum, two to three blocks away. Allow at least one hour for this tour. 3) Visit the Big Barn, one of the largest in the world, 463 feet in length and 74 feet in width (probably four blocks to walk). There is also a golf cart tour of the farm; ask at the visitor center, as availability is unknown at this time. There is a gift shop near the Visitor Center. We will eat near the Visitor Center or in the Alltech arena depending on the number wishing to attend this event. The meal will take place about 7:30 pm along with entertainment, clogging by 4 to 8 persons to country and bluegrass music. The location will be determined by the number of registrations received by **May 1**. After that, additional persons may sign up to attend up to the capacity of Bit and Bridle Restaurant, which is limited to 120 on a first-come first-served basis.

Silent Auction

Please bring items to contribute to the ASMR Silent Auction. Items will be displayed and bidding will begin on Monday and continue until Thursday at 10:30 am. This event is used to raise money for the ASMR Student Travel Fund to help students attend future meetings! Successful bidders can pick up their items immediately following the morning sessions.

Sponsor and Exhibitor Information

This is an exceptional opportunity for your company or organization to interface with mining reclamation professionals and those who influence decisions about the purchase of products and services for the land reclamation industry. Register now to be a sponsor and/or to bring your company exhibit to Lexington, KY in June 2015! We are expecting between 200 and 250 to register and we have received more than 100 abstracts. There will be an Exhibitor reception Sunday evening and all breaks will take place in the exhibit area. See exhibitor map on the ASMR website (http://www.asmr.us/Meetings/UpcomingMeetings.htm). Exhibitors will be listed on the ASMR website by name/logo, which includes either a link to the company's website or short listing of contact information. Details as to setup and take down are in the expanded version of the preliminary program.

SPONSORSHIP DETAILS

Platinum Level Sponsors – $10,000 and up

- One free exhibit booth (Please complete the exhibitor form)
- Four free registrations
- Meal tickets for all meals
- Choice of one of the three tours on Tuesday and all social events including the Tuesday evening at the Horse Park
- Special recognition and award at Awards Luncheon
- Your logo will appear on the inside cover of the program
- Display of your logo on the ASMR web page for one month prior to the 2015 Lexington Meeting and will continue until one month prior to the 2016 meetings.
- Full-page ad in the final program (Please complete the sponsor form indicating your preference on the location of this ad)

Gold Level Sponsor – $5,000 up to next level

- One free exhibit booth (Please complete the exhibitor form)
- Two free registrations
- Meal tickets for all meals, and Tuesday evening social event
- Special recognition and award at Awards Luncheon
- Your logo will appear on the inside cover of the program
- Display of your logo on the ASMR web page for one month prior to the 2015 Lexington Meeting and will continue until one month prior to the 2016 meetings.
- Half-page ad in the final program (Please complete the sponsor form indicating your preference on the location of this ad)

Silver Level Sponsor – $3,000 up to next level

- Exhibit booth at a reduced rate (if exhibiting) cost is $750, normally $1,000 (Please complete the exhibitor form)
- One free registration
- Special recognition and award at Awards Luncheon
- Your logo will appear on the inside cover of the program
- Display of your logo on the ASMR web page for one month prior to the 2015 Lexington Meeting and will continue until one month prior to the 2016 meetings.
- Quarter-page ad in the final program

Bronze Level Sponsor – $1,000 up to next level

- Exhibit booth at a reduced rate (if exhibiting) cost is $750, normally $1,000 (Please complete the exhibitor form)
- Special recognition and award at Awards Luncheon
- Your logo will appear on the inside cover of the program
- Display of your logo on the ASMR web page for one month prior to the 2015 Lexington Meeting and will continue until one month prior to the 2016 meetings
- Eighth-page ad in the final program

Break and Meal Sponsors

- Your company's name will appear on a board next to the food and beverage area as well in the program.
- Meal Sponsorships: Awards Luncheon $1,000; Wednesday or Thursday Lunch $750
- AM Break $300 PM; Break $350

Other Sponsorships Available

- Sponsor of one of the various tours $200 to $400
- Early Career Professionals $200 to $400
- Ads in the program:
  Full page – $500 | 1/2 page – $250
  1/4 page – $125 | 1/8 page – $75

Please fill out the Sponsor/Exhibitor Registration Form and return with payment prior to April 15, 2015:

American Society of Mining and Reclamation (ASMR)
c/o Dr. Robert G Darmody, 1305 Weathervane, Champaign, IL 61821
Phone: (217) 493-7847 | Fax[1]: (217) 244-3219
Email: rdarmody@illinois.edu

Richard Barnhisel's Email is asmr@twc.com
Phone: (859) 351-9032 | Secure Fax: (859) 266-3941

[1] Note: This fax is not secure so do not send registration payments without first calling Dr. Darmody.

Sponsor/Exhibitor Registration Form

Company Name: ______________________________

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

Address: ______________________________

City/Province: ______________________________

State: ______________ Zip: ______________ Country: ______________

Phone: ______________ Fax: ______________ E-Mail: ______________

Company Web Page Address: ______________________________

Sponsor and Exhibitor Booth Selections and Costs

Platinum $10,000 ______________ **Gold $5,000**______________ **Silver $3,000** ______________ **Bronze $1,000**______________

(Platinum and Gold Sponsors will receive one free booth, Silver and Bronze sponsors may reserve one booth at a discounted price of $750)

Silver or Gold Sponsor Booth $750 ______________ **Non-sponsor Booth $1000** ______________

(The above two items includes 2 non-refundable complete registrations)

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Meal Sponsorship: Lunch: $750.00 ______________ **Awards Luncheon: $1,000** ______________

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NOTE: For additional information concerning exhibit booths, please contact:
Dr. Richard Barnhisel at asmr@twc.com or call (859) 351-9032. Send this form with payment to Dr. Robert Darmody whose email address is rdarmody@illinois.edu as well as to Richard Barnhisel who assigns booth spaces and updates the web page as to "sold" booth spaces.

Payment by check to: American Society of Mining and Reclamation (ASMR)
c/o Dr. Robert G Darmody 1305 Weathervane, Champaign, IL 61821.

Preliminary Agenda *(all times and days of presentations are subject to change)*

Sunday, June 7, 2015			
6:30 am – 9:00 am	**Breakfast – Clarion Hotel** (Included with room registration)		
11:30 am – 5:45 am	**Registration** – Convention Center Lobby		
10:00 am – 3:00 pm	**Golf Outing – Griffin Gate Golf Course – Limited to First Twelve to Register**		
1:30 pm – 5:00 pm	**Workshop 1** Session Room 2		
1:30 pm – 3:30 pm	**Tour of a local distillery -- Alltech**		
6:30 pm – 8:30 pm	**Exhibitors' Welcome Reception – Exhibit Hall**		
Monday, June 8, 2015			
6:30 am – 10:00 am	**Breakfast – Clarion Hotel** (Included with room registration)		
7:30 am – 5:00 pm	**Registration** – Convention Center Lobby		
	Plenary Session – Session Rooms 2 and 3		
8:45 am – 9:00 am	**Welcome** ASMR President Joe Friedlander		
9:00 am – 9:15 am	**Welcome** ASMR Executive Secretary Robert Darmody		
9:15 am – 9:30 am	**Welcome** ARRI Paul Rothman		
9:30 am – 9:45 am	Mayor Jim Gray (tentative)		
9:45 am – 10:00 am	Dean of Agriculture, Nancy Cox		
10:15 am – 10:45 am	**Break** - ***Exhibit Hall***		
10:45 am – 11:15 am	**Senator Mitch McConnell or Governor Steve Brashear**		
11:15 am – 11:45 am	**Director OSMRE (Tentative)**		
11:45 am – 2:00 pm	**Awards Luncheon** – Included in Meeting Registration		
Technical Sessions			
	Soils and Overburden Reclamation in Arid or Semi-Arid Environments **Moderator** **Session Room 3**	**Water Management Sulfate Removal** **Moderator** **Session Room 2**	**Forestry — FRA** **Moderator** **Carl Zipper** **Session Room 1**
2:00 pm – 2:30 pm	Soil erosion risk at the basin scale in a semi-arid continental monsoon environment with Antaibao opencast mine site in Shanxi Province, China **by Ling Zhang (Student)**	Sulfate Removal from Coal Mine Water in Western PA: Regulatory Requirements, Design, and Performance: Part 1 **by William J Walker**	FRA Step 1-Create a suitable growth medium **by Jeff Skousen**

2:30 pm – 3:00 pm	Defining Restoration Success in Wyoming's Natural Gas Fields: Suggestions for Using Reference Sites and Ecological Site Descriptions **by Michael Curran (Student)**	Sulfate Removal from Coal Mine Water in Western PA: Regulatory Requirements, Design and Performance: Part 2 **by William J Walker**	FRA Step 2-Create a suitable growth medium **by Scott Eggerud**
3:00 pm – 3:30 pm	Break – *Exhibit Hall*		
	Soils and Overburden Continued	**Water Management Continued)**	**Forestry — ARRI Continued**
3:30 pm – 4:00 pm	Selenium Bioavailability in Calcareous Soils **by Jessica E. Favorito (Student)**	Biotic and Abiotic Treatment Methods for Remediation of Low Sulfate and Hard Rock Mining-Influenced Water **by Nathan Smith**	FRA Step 3-Use compatible ground covers **by Jennifer Franklin**
4:00 pm – 4:30 pm	Construction and Testing of a Low Permeability Barrier Using Weathered Mine Spoil **by Sarah Smith (Student)**	Evaluating the Impact of Na-$SO4^{2-}$ Dominated Ionic Strength on Trace Metal Removal in Vertical Flow Bioreactors **by Julie LaBar (Student)**	FRA Step 4-Tree Species Selection **by Ron Rathfon**
4:30 pm – 5:00 pm	Sand Capillary Barriers Increase Water Retention and Facilitate Salt Leaching in Arid Disturbed Lands **by Seth Cude (Student)**	Iron Oxide Accumulation Profiling Within the Initial Oxidation Unit of a Passive Treatment System **by Leah R. Oxenford (Student)**	FRA Step 5-Proper tree planting techniques **by Chris Miller**
5:00 pm – 5:30 pm	**Soils and Overburden, Geotechnical Engineering, Land Use Planning and Tailings Technical Division Business Meeting**	Passive Water Treatment of Iron, Arsenic and Manganese at the Empire Mine State Historic Park in Grass Valley, California **by Neal Gallagher**	Legacy mine reforestation **by Michael French**

6:00 pm – 9:00 pm	**Early Career Reception** – Location to be announced

Tuesday, June 9, 2015	
6:30 am – 9:00 am	**Breakfast – Clarion Hotel** (Included with room registration)
8:00 am – 9:00 am	**Registration** – Convention Center Lobby
7:00 am – 5:00 pm	**Forestry Field Trip – Eastern Kentucky Research Sites**
10:00 am – 4:30 pm	**Tour of Historical Sites, *Lunch at Shaker Village***
10:00 am – 3:00 pm	**Golf Outing – Griffin Gate Golf Course – Limited to First Twelve to Register**
12:00 noon	**Lunch on your own**
1:30 pm – 4:00 pm	**Tour of local Distillery -- Woodford Reserve**
4:30 pm – 9:00 pm	**Social Evening at the Kentucky State Horse Park**

Wednesday, June 10, 2015			
6:30 am – 8:30 am	**Breakfast** – *Clarion Hotel* (part of room rate)		
7:30 am – 5:00 pm	**Registration** – Convention Center Lobby		
	Forestry – Wildlife Moderator Steve Felch Session Room 3	**Federal and Energy Issues Moderator Session Room 1**	**Water Management Moderator Session Room 2**
8:30 am – 9:00 am	Bird Diversity and Abundance on Reclaimed Surface Coal Mines in Alabama: Temporal and Habitat Related Variations **by Richard R. Borthwick**	Appalachian Coal Mining Related Research at US EPA **by Brian Topping**	Recovery of North Potato Creek, Copper Basin, Tennessee **by Ben B. Faulkner**
9:00 am – 9:30 am	Validation of a stream and riparian habitat assessment protocol using stream salamanders in the southwest Virginia coalfields **by Sara Sweeten (Student)**	Coal Combustion By-Products and SMCRA Coal Mines: The Case for and against new Federal Rules **by Kimery C. Vories**	Case Study: 20 Years of ARD Mitigation after a Bactericide Application **by James Gusek**
9:30 am – 10:00 am	Genetic Diversity of Brook Trout (Salvelinus fontinalis) Populations Isolated Due to Abandoned Mine Drainage in the West Branch Susquehanna River Watershed, PA **by Frederic J. Brenner**	Federal energy regulatory commission licensing formicrohydropower utilizing mine drainage **by Tim Danehy**	Assessment of Performance of a Passive Treatment System over a Twenty Year period in East Central Tennessee **by Terry W. Schmidt**
10:00 am – 10:30 am	**Break** – *Exhibit Hall*		
	Forestry – Wildlife (Continued)	**Bat Symposium Craig Walker, Moderator Session Room 1**	**Water Management (Continued)**
10:30 am – 11:00 am	American Elm as a Tool in Mineland Reforestation **by Mary Beth Adams**	Bat News: The U.S. Fish and Wildlife Perspective **by Carrie Allison**	Watershed Restoration via Ecological Engineering: The Role of Passive Treatment **by Robert W. Nairn**
11:00 am – 11:30 am	Shortleaf Pine as a Reclamation Species on Former Mining Sites **by J. Holly Campbell**	Update on bat survey guidelines - FWS	Replacing an Active AMD Treatment System with Semi-Passive Techniques **by Tyler Chatriand**
11:30 am - noon	**Forestry-Wildlife and Ecology Technical Division Business Meeting**	Update on White Nose syndrome - FWS	Evaluation and restoration of Passive treatment System performance in Pennsylvania **by Ryan M. Mahony**

12:00 noon – 1:00 pm	**Luncheon** – Included in Meeting Registration – Pre-function Area		
	Ecology Moderator Session Room 3	**Bat Symposium (Continued) Session Room 1**	**Water Moderator Session Room 2**
1:00 – 1:30 pm	Suggestions for Improvements to Restoration Monitoring **by Michael Curran (Student)**	Brandenbark™: Mitigation Tool for Projects Involving Federally Listed Bark Roosting Bats **by Josh Adams**	Influence of water chemistry and sediment transport on biological recovery downstream of lime dosers **by Henry Bedu-Mensah (Student)**
1:30 – 2:00 pm	Benthic Algae, Leaf Breakdown, and Litter fall In Constructed Streams: The Case for Riparian Reforestation to Replicate Headwater Organic Matter Functions **by Robert J. Krenz III (Student)**	Northern long-eared bat (Myotis septentrionalis) management: Insights from a multi-year study at Fort Knox, Kentucky **by Alexander Silvis**	Total Dissolved Solids and Biotic Condition in Central Appalachian Headwater Streams Influenced by Coal Mining **by Anthony J. Timpano (Student)**
2:00 – 2:30 pm	Development of Ecosystem Structure and Function on Reforested Surface-Mined Lands **by Brian D. Strahm**	Bat Use of Culverted Gates at Abandoned Underground Portals in West Virginia **by Craig A. Walker**	Effect of Leaching Scale on Prediction of Total Dissolved Solids Release from Coal Mine Spoils and Refuse **by Lucas C. Ross (Student)**
2:30 – 3:00 pm	The Assessment of Dump Ecosystem Services Value: Exemplified by West Dump of ABT Open-pit Mine **by Yuanqing Lu (Student)**	To be determined	Quantitative sampling to detect invertebrate community change in mine-influenced streams with elevated TDS **by Damion Drover (Student)**
3:00 pm – 3:30 pm	**Break** – *Exhibit Hall*		

	Geotechnical Engineering Moderator Session Room 3	**Bat Symposium Beth A. Botsis Moderator Session Room 1**	**Water (Continued) Session Room 2**
3:30 pm– 4:00 pm	Zero Slump Grout for Remote Closure of Mine Openings **by John Morgan**	State Perspectives on Bat Protection Issues at Mine Sites **by Beth A. Botsis**	Hydrologic Assessment of a Stream Created on Mined Land **by Whitney Blackburn-Lynch (Student)**
4:00 pm– 4:30 pm	Geomorphic Reclamation Design and Construction of the Teach AML Site **by Derrick Thompson**	Panel on Bats	Prediction of Acid-Producing Potentials for Coal Overburden and Waste by Static Geochemical Methods **by Louis M. McDonald**

4:30 pm – 5:00 pm	Slippery Rock Creek Stream Bank Stabilization **by Daniel Guy**	Panel on Bats	The Impact of Surface Coal Mining on Water Quality in the Northern Great Plains **by Joseph D. Friedlander**
5:00 pm – 5:30 pm	McKinley Mine: A Commitment to Stable Land Forms utilizing Geomorphic Principles **by Kyle Kutter**	Panel on Bats	**Water Management Technical Division Business Meeting**

SPONSORS' SOCIAL & POSTER SESSION

Wednesday, June 10, 2015 5:00 pm – 7:00 pm Henry Clay Room

Poster Session -
Effects of organic and inorganic amendments on soil C and N dynamics in a reclaimed coal mine soil **by Ardeshir Adeli**
Effectiveness of 10 Plant Species in the Removal of Selenium from Soil **by Matt Aldrovandi (Student)**
Use of a Dispersed Alkaline Substrate and Limestone Beds to Treat Acid Mine Drainage at Soudan Mine, Minnesota **by Kristen Dieterman (Student)**
Eighth International Acid Sulfate Soils Conference at University of Maryland, July 17-23, 2016 **by Delvin S. Fanning**
The Influence of Vegetation on TDS Generation in Reclaimed Mine Land **by Amy C. Gondran**
The Appalachian Forest Renewal Initiative: Demonstrations of Legacy Mine Land Reforestation across Appalachia **by Tiffany Heim**
Geochemical Characteristics of Low versus High TDS Potential Strata in Central Appalachian Surface Coal Mines **by Daniel K. Johnson (Student)**
Alternate Sediment Control Rules Allow Accelerated Sediment Pond Removal Schedule **by William R. Kirk**
Occurrence of Native Species Following Lignite Mine Land Reclamation in Mississippi **by David J. Lang**
Identifying and Resolving Passive Treatment System Hydrologic Operation and Maintenance Issues **by Bryan J. Page**
Animal Waste and FGD Gypsum Effects on Bermudagrass and Soil Leachate Nutrient Contents **by John J. Read**
Green Remediation of Acid Mine Drainage Impacted Water Using an Industrial Byproduct: Filter – Column Study **by Abhishek RoyChowdhur (Student)**
Soil and Water Quality in an AMD-Impacted Abandoned Mine Site in Southern Illinois **by Abhishek RoyChowdhur (Student)**
Re-establishment of Wyoming Big Sagebrush Using Container Grown Seedlings **by David Casey Balthrop (Student)**
Improving Remedy Sustainability Through Use of Local Construction Materials **by Todd Bragdon**

Thursday, June 11, 2015

6:30 am - 8:30 am	**Breakfast – Clarion Hotel** (Included with room registration)			
7:30 – 8:30 am	**Registration** – Convention Center Lobby			
	Forestry Moderator Session Room 1	**Water Moderator Session Room 2**	**Grasslands Moderator Session Room 3**	**Soils Moderator Session Room 4**
8:00 - 8:30 am	Ecosystem Evolution and Ecological Storage in Opencast Mining Area: A Case Study of Pingshuo Coal Mine in China **by Xiaoran Zhang (Student)**	The Role of Manganese in Trace Metal Removal **by Paul Eger**	Invasive Species on Reclaimed Native Grasslands in North Dakota **by Guy A. Welch**	Evaluation of Appalachian Mine Spoil Leachate Chemistry and Its Associated Geochemical Influences **by Elyse Clark (Student)**
8:30 - 9:00 am	Effects of Soil Amendments on the Growth of Hardwood Trees on Reclaimed Mines in West Virginia **by Kara Dallaire (Student)**	Biochemical Reactor/Anaerobic Wetland Design/Startup Issues **by Ben B. Faulkner**	Forage Nutritive Value and Productivity of Grass on Reclaimed and Undisturbed Lignite Land by David J. Lang	So Where IS that Treatment Sludge Going in the Waste Rock? **By Michele Coleman**
9:00 - 9:30 am	Engaging the Public in Mine Land Reforestation: Volunteer Tree Planting Projects and Events in Appalachia **by Hannah Angel (Student)**	Bioremediation of selenium in valley seep coal mining effluents using charophytes (stoneworts) **by Robin W. Scribailo**	Switchgrass and Miscanthus Yields on Reclaimed Surface Mines for Bioenergy Production Capabilities **by Steffany Scagline (Student)**	Effects of quarry treatment on the attractiveness of reclaimed limestone quarries **by Israel A Legwaila**
9:30 - 10:00 am	Climate Change and Native Forest Establishment on Surface Mines: A Case Study from Eastern Kentucky **by Elizabeth Rose Hansen**	An Innovative Package Treatment System for the Orcutt-Smail Discharges; a Moderate Flow High Strength Acid **by Jonathan M. Dietz**	Opencast Mine Reclamation in Arid Grassland Area: A Case Study of the Second East Shengli Opencast Coal Mine in China **by Xiang Fan**	Ecological Risk Assessment of Land Destruction in Large Open-pit Coal Mine – Exemplified for AnTaiBao Open-pit Mine, China **by Qi Sun (Student)**
10:00 - 10:30 am	**Break** –			

	Forestry (Continued)	**Water** (Continued)	**New Technologies Moderator**	**Soils** (Continued)
10:30 - 11:00 am	Application of the Forest Reclamation approach To establish Nothofagus in Chilean Patagonia **by Eduardo Arellano**	Cost Saving and Performance Enhancing Modifications at a Lime-Based Treatment System: Rushton Treatment Plant Case Stud **by Jonathan M. Dietz**	Using Electrical Resistivity Imaging to Track Water Movement through Surface Coal Mine Valley Fills **by Breeyn M. Greer**	Applying of Geomorphic Reclamation to Excess Spoil Fills in West Virginia **by Peter R. Michael**
11:00 - 11:30 am	Productivity and Site Index Data Support the Efficacy of Luminant's Forestry Reforestation Approach in Texas **by Jeremy Stovall**	Reclamation of Abandoned Mine Land Using Stabilized Flue Gas Desulfurization Material to Mitigate Acid Mine Drainage **by Chin-Min Cheng**	Testing Unmanned Aerial Systems for Surface Coal Mine Oversight Inspections **by Natalie Carter**	Managing Closure and Reclamation Liabilities: Closing the Gap – and Improving the Process **by Mike Slight**
11:30 - 12:00 am	An Overview of Lignite Mine Reforestation at Luminant's Martin Lake Mines in Eastern Texas **by Sid Stroud**	Impact of Coal Mine Reclamation Using Coal Combustion By-products (CCBs) on Groundwater Quality: Two Case Studies **by Chin-Min Cheng**	Dynamics of Spatial-temporal Pattern of Vegetation and Soil Quality during the Restoration in Opencast Coal Mine Dump **by Zhongke Bai**	Using Nationwide Permit 49 to Obtain Corps Permit for Minin **by Eddie Bearden**
12:00 noon - 1:00	**Luncheon** – Included in Meeting Registration			
	Forestry (Continued) **Session Room 1**	**Ecology Moderator Session Room 2**	**New Technologies Moderator Session Room 3**	**Soils Moderator Session Room 4**
1:00 – 1:30 pm	Bur production and canker incidence on backcrossed restoration chestnut trees **by Jenise Bauman**	One Step Forward – Two Backward: evaluating and measuring ecosystem function and completion criteria in mine rehabilitation **by Harley Lacy**	Case Study: Utilizing In-Situ XRF Field Measurements, Mobile Gamma Radiation Survey Systems and Geostatistical Techniques to Predict Heavy Metals and Radionuclide Soil Concentrations in Surface Soils at an Abandoned Uranium Mine in Custer National Forest, SD **by Aaron S Orechwa**	Successful Reclamation of a Fly Ash Landfill with Alternative Funding Approach **by Andy Willis**

1:30 – 2:00 pm	Identification of Ectomycorrhizal Fungi Forming Symbolic Associations with the American Chestnut **by Shiv Hiremath**	OSMRE/VISTAS at Work: Building Capacity to Meet Challenges in Pre-Regulatory Mining Areas **by T Allan Comp**	Environmental Data Analysis Using R, a Free, Open-Source Statistical Software Package **by Joshua Voss**	Delineation of Surface Coal Mining and Reclamation History in Appalachia Using Satellite Imagery **by Jing Li**
2:00 –2:30 pm	Some Lessons from Long Term Monitoring of Forest Rehabilitation at Three Surface Mine Complexes in Australia **by Neil Humphries**	Trees Carbon Sequestration of different Reclamation Patterns in Antaibao Opencast Mine, Shanxi, China **by Zhongqiu Zhao**	Delineation of Surface Coal Mining and Reclamation History in Appalachia Using Satellite Imagery **by Jing Li**	The Temporal and Spatial Variation of Vegetation Carbon Storage in Mining Areas: A case study at Dongtan Coal Mine in Yanzhou Mining Area **by Yanhua Fu**
2:30 – 3:00 pm	Review of Reforestation efforts of the Bituminous District for Abandoned Mine Land Reclamation of PA **by Dean Baker**	Development and Application of a Remote Sensing Based Ecological Index for Opencast Mine Area **by Xuejiao Song**	Application of Remote Sensing for Mine Revegetation Mapping in the Fire Affected Areas of Jharia Coalfields, India: A Case Study **by Pradeep Kumar**	Current Land Reclamation Policy and the Facing problems in China **By Zhao Shu-qin**
3:00 – 3 30 pm	Some Lessons from Long Term Monitoring of Forest Rehabilitation at Three Surface Mine Complexes in Australia **by Neil Humphries**	Frac Sand Mining and Reclamation in Wisconsin **by Tom Hunt**		China's Abandoned Mining Land Reclamation System And Best Practices of Diversified Reclamation Purposes **by Luo Ming**

2015 Joint Conference ASMR and ARRI

32nd Annual Meeting of the American Society of Mining & Reclamation

9th Annual Meeting of the Appalachian Regional Reforestation Initiative

June 7-11, 2015 – Clarion Hotel – Lexington, Kentucky (USA)

Reclamation Opportunities for a Sustainable Future

REGISTRATION FORM

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-registering for the Conference prior to May 1, 2015. Costs for registration, the various workshops and tours, plus other events are listed below.

Name ______________________________

Company/Affiliation ______________________________

Address ______________________________

Address ______________________________

City __________ **State/Province** __________ **Zip/Mail Code** __________

Country ______________________________

Phone __________ **E-Mail Address** __________

GENERAL AND TECHNICAL SESSIONS, Monday June 8 through June 11, 2015

		Number	Total
ASMR Member Pre-**registration** *(until May 1, 2015) Includes Awards luncheon ticket*	$250/person		$
ASMR Member Late registration *(after May 1, 2015) Includes Awards luncheon ticket*	$300/person		$
Non – ASMR members[2]) Pre-**registration** *(until May 1, 2015) Includes Awards luncheon ticket*	$300/person		
Non – ASMR members Late registration *(after May 1, 2015) Includes luncheon ticket*	$350 /person		$
Accompanying Person/Spouse registration	$75 /person		$
ASMR Awards Luncheon *(for those not registered in one of the above)*	$30 /person		
One Day Registration[3] *(check day) [ ] M [ ] W [ ] Th.*	$150 /person		$
Student Registration *(submit copy of student ID with the registration form)*	$125 /person		$
Student Late registration *(after May 1, 2015)*	$175 /person		$

WORKSHOPS

		Number	Total
Workshop 1: ArcPAD and IOS based geodatabase collection for active and abandoned coal mining sites Sunday, June 7, 1:00 to 4:00 pm **Andrew Schaer Instructor**	No Cost		$
Workshop 2**:** Implementing the Forestry Reclamation Approach on active and legacy mine sites Monday, June 8, 2:00 pm to 5:30 pm	No cost		$
Workshop 3: Overview of EarthWorks Tuesday, June 9, 1:00 pm to 4:30 pm **Richard Warner Instructor**	$75 / person		$

SUBTOTAL: REGISTRATION AMOUNT (US DOLLARS) **$**__________

[2] Go to www.asmr.us under Forms to obtain an ASMR Membership Application Form.

[3] There are no technical sessions on Tuesday, only tours and one workshop.

TOURS *(First-Come, First-Served Basis)*

		Number	Total
Tour of local Distillery (Sunday) – Alltech Minimum 5 Maximum 28	$ 20/person		$
Forestry Field Trip – (Tuesday) Eastern Kentucky Research Sites Minimum 30 Maximum 100 Lunch and breaks included	$30 /person		$
Tour of local Distillery (Tuesday) – Woodford Reserve Minimum 5 Maximum 28	$25 /person		
Tour of Historical Sites, includes entry fees and Lunch at Shaker Village. Minimum 10 Maximum 33	$40 /person		

OTHER FUNCTIONS

		Number	Total
Golf Outing (greens fee paid at club house $25 to $35). Check which day(s) you plan to play *[ ] Sunday [ ]Tuesday Minimum 4/day and a Maximum 12/day*			
Early Career Social (< 10 years) *(2 drinks, appetizers)*	$20/person		$
Early Career Social (> 10 years) *(2 drinks, appetizers)* Combined with the above, Minimum 30 Maximum 70	$40/person		
Evening Social, Kentucky State Horse Park *(tour of horse museum and grounds, dinner, entertainment, and transportation)* Minimum 75 Maximum 250	$60/person		$

SUBTOTAL: TOURS & FUNCTIONS AMOUNT (US DOLLARS) **$**____________

TOTAL REGISTRATION AMOUNT (US DOLLARS) $____________

NO REFUNDS AFTER MAY 1, 2015 without approval of Dr. Darmody/Barnhisel

Method of Payment:
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TOTAL Amount: **$__________**

_____ ***Check here if you need a receipt now, however, one will be included in the registration packet when you arrive in Lexington***

____ Check here if have special dietary needs and describe here. ______________________________________

Send check or credit card information to: American Society of Mining and Reclamation (ASMR), c/o Dr. Robert G Darmody, 1305 Weathervane, Champaign, IL 61821
Registration accepted by **email**: rdarmody@illinois.edu Phone: (217) 493-7847
Questions related to program – Richard Barnhisel, Email asmr@twc.com Phone (859) 351-9032

Research, Teaching and Service with Open Limestone Channels and Undergraduates in the Allegheny Highlands

Charles Spellman Jr., Sergio Carvajal, Caleb Weyant[1], James Krug, Rebekah Krupa, David Wolfe[1], Ying Li[2], Edward P. Zovinka[3], Arthur Rose[4], William Strosnider[5]

[1] Undergraduate Environmental Engineering, Mathematics, and Chemistry Students at Saint Francis University.
[2] Assistant Professor, Saint Francis University Mathematics Department.
[3] Professor, Saint Francis University Chemistry Department.
[4] Professor Emeritus, Pennsylvania State University Department of Geosciences.
[5] Director, Center for Watershed Research & Service, Saint Francis University.

Figure 1. Art Rose of the Clearfield Creek Watershed Association guest-lecturing environmental engineering students about water quality measurements and environmental chemistry at the head of the OLC.

Introduction

Open limestone channels (OLCs) are common acid mine drainage (AMD) treatment tools and have been widely applied across Appalachia, yet there is relatively little literature concerning design guidance and performance. OLCs use $CaCO_3$ dissolution to raise pH, decreasing the solubility of various metals of interest (aluminum, iron, manganese, etc.). It is known that these systems perform better on steeper slopes and produce alkalinity at greater rates when treating more acidic waters (Ziemkiewicz et al., 1997; Zipper and Skousen, 2010). Armoring with iron hydroxides is commonly an issue of concern because it lowers dissolution rates greatly (Santomartino and Webb, 2007). Despite the aforementioned studies and other related literature, relatively little guidance exists for the proper sizing of OLCs. In order to address this lack of information, the Swank 13 Mine OLC

Figure 2. Limestone sample collection for the laboratory experiments by pre-undergraduate students.

Figure 3. Rhodamine dye being added to the channel at the top weir to begin a tracer test to accurately determine residence time.

located in Northern Cambria County on Pennsylvania State Game Lands 108 in Reade Township (latitude 40.634N, longitude 78.4877W) has been intensively monitored in the years since its construction. The OLC was constructed by the Clearfield Creek Watershed Association in 2011 with help from the Pennsylvania Game Commission. The 300 m channel is lined with coarse limestone of > 85% $CaCO_3$ and has a slope of 6 to 9%. It treats flows that range from 60 to 3800 L/min of AMD that average pH 3.3, Fe 0.6 mg/L, Mn 0.9 mg/L and Al 9.2 mg/L. This OLC has not only improved water quality at a relatively low cost for years, it has also served as a research, teaching and service opportunity for undergraduate students and advising faculty (Figure 1). The research being done by undergraduate students at Saint Francis University is furthering the understanding of treatment dynamics and can help refine sizing models to allow practitioners to develop more reliable and efficient OLC designs.

Research

Over the past two summers, groups of five incoming freshman participated in a Pre-Undergraduate Research Experience

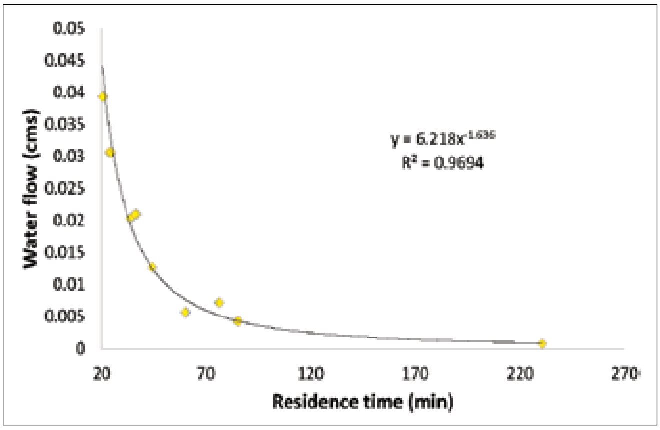


Figure 4. Residence time model constructed with multiple tracer tests at varying flow rates.

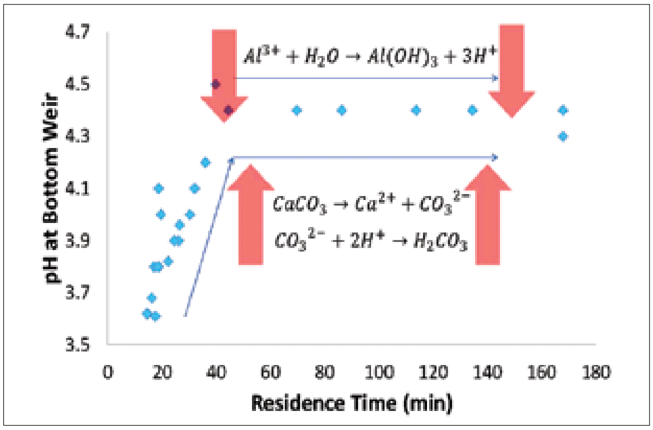


Figure 5. Results showing pH versus residence time at the channel's bottom weir. At longer residence times in the Swank OLC the hydrolysis of aluminum mitigates pH increase from calcite dissolution, indicating very similar reaction rates.

(PURE) at Saint Francis University funded by the National Science Foundation. The 2013 PURE students tested the dissolution efficiency of limestone within different reaches of the OLC, finding that armoring was indeed significantly decreasing treatment (Figures 1 and 2). These results were presented at the 2014 ASMR Conference. The 2014 group of pre-undergraduate students investigated whether chloride ions increased dissolution rates, finding a substantial increase which may be due to increased activity via ionic strength and/or chloride pitting of the armored layer.

Undergraduate upperclassmen and supervising professors in environmental engineering, chemistry, and mathematics have coordinated to deepen the investigation into OLC dynamics. The environmental engineering team periodically performed rhodamine dye tracer tests at different flow rates in order to develop an accurate model of residence time in the channel (Figures 3 and 4). The chemistry team gathered field water quality data (Figure 5) and analyzed for metal and anion concentrations in the lab. The mathematics team has developed preliminary models linking residence time with changes in water quality observations and reaction rates from the literature. This effort is intended to create simple models which will help estimate treatment efficiency and guide future designs for OLCs treating similar low pH and iron, yet high aluminum, waters. The multidimensional nature of OLCs has helped bring faculty and students together on this project.

Teaching

A well-maintained and monitored OLC within a few miles of campus has proven itself to be a valuable teaching tool. The OLC has been a regular field trip for the sophomore-level Environmental Engineering Field Measurements classes that run each fall semester. During these field trips, students are taught proper sampling methods, as well as how to use field equipment for taking pH, alkalinity, and turbidity data. Additionally, the field data collection provides a tangible tool to demonstrate that the chemistry they are learning in lecture and lab is real and has important real-world applications. The students have given rave reviews to the hands-on learning that systems like this OLC help to deliver.

Service

In addition to students and undergraduate researchers, the OLC has been periodically monitored by interns for the Saint Francis University Center for Watershed Research & Service. Frequent monitoring has led to regular maintenance on the channel by our students. For example, the weirs have been resealed and breaches in the channel berm repaired when students conducting experiments or monitoring have noticed issues. These regular repairs have lightened the work load of the Clearfield Creek Watershed Association's volunteers as well as allowed students to gain valuable hands-on work experience in the field.

Moving Forward

The site will continue to be used to research passive treatment, teach applied geochemistry, and serve as a resource for others to do work. Students from Saint Francis University will continue to monitor and repair the site for the Clearfield Creek Watershed Association, establishing it as a long-term research site that can help illuminate further questions. ■

References:

Santomartino, S., J.A. Webb. 2007. "Estimating the Longevity of Limestone Drains in Treating Acid Mine Drainage Containing High Concentrations of Iron". *Applied Geochemistry* 22:2344-2361.

Zipper, C.E., J.G. Skousen. 2010. "Influent Water Quality Affects Performance of Passive Treatment Systems for Acid Mine Drainage". *Mine Water and the Environment* 29:135-143.

Ziemkiewicz, P., J. Skousen, D. Brant, R. Lovett. 1997. "Acid Mine Drainage Treatment with Armored Limestone in Open Limestone Channels". *Journal of Environmental Quality* 26:1017-1024.

Stream Recovery of a Heavily Coal Mined Watershed in Ohio

Natalie Kruse-Daniels, Ohio University, Athens, OH

Introduction

Like many streams across the Appalachian coal fields, Raccoon Creek in southern Ohio was heavily impacted by pre-regulation coal mining. Nearly 50,000 acres of abandoned underground and surface mines led to extensive acid mine drainage that impaired biological communities throughout the 684 square mile watershed. Since 2000, seventeen reclamation and treatment projects have been completed in the watershed. Treatment projects include steel slag leach beds, successive alkalinity producing systems, wetlands, and a lime doser. As of 2013, all 117 stream miles monitored met the pH target of 6.5 (Bowman and Johnson, 2014). While pH improvement is promising, the ultimate goal of treatment and reclamation is the recovery of stream ecology.

Treatment and reclamation projects are clustered in the most heavily mined parts of the watershed: the headwaters in the north and Little Raccoon Creek in the west. Mining in the headwaters included a combination of underground and surface coal mines, while Little Raccoon Creek was primarily surface mined. Some land reclamation was completed in the 1980s and 1990s, while larger scale reclamation and treatment projects were installed primarily since 2004. Treatment projects in the headwaters include a lime doser, land reclamation and steel slag leach beds. Treatment projects in Little Raccoon Creek subwatershed include land reclamation, steel slag and limestone leach beds, successive alkalinity producing systems and a wetland.

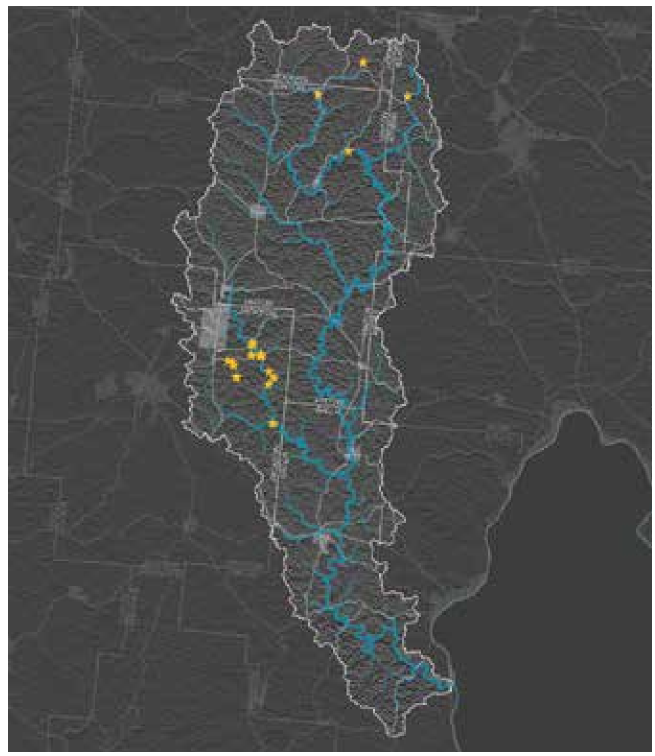


Figure 1. Raccoon Creek watershed is a direct tributary to the Ohio River flowing from headwaters in Hocking County, Ohio south to Gallia County, Ohio. Yellow stars show completed treatment and reclamation systems. *(Image credit: Voinovich School, Ohio University)*

Figure 2. Macroinvertebrates are sampled from a one-square-meter area of each of three riffles in a stream reach. *(Photo credit: Amy Mackey)*

Figure 3. Macroinvertebrates are picked from the kick net and preserved in ethanol. *(Photo credit: Amy Mackey)*

To date, about $12 million has been spent on treatment and reclamation projects in the watershed.

Methods

In Ohio, fish, macroinvertebrates and habitat are used to determine stream health. Annually, teams from Ohio University, Ohio Department of Natural Resources, and Raccoon Creek Partnership monitor fish and macroinvertebrate communities alongside water chemistry to assess the success of treatment and reclamation efforts. Boat and longline electrofishing are used to sample fish communities at selected sites. Dip and kick nets are used to sample macroinvertebrates in all habitats represented at each site

Figure 4. Macroinvertebrates are sampled using a dip net from other habitats represented in the stream reach. *(Photo credit: Amy Mackey)*

Figure 5. A sampling crew uses longline electrofishing to sample fish communities. *(Photo credit: Sarah Landers)*

following the Macroinvertebrate Aggregate Index for Streams (MAIS) protocol (Smith and Voshell, 1997; Johnson, 2007). Macroinvertebrate sampling methods are shown in Figures 2-4. Fish are identified to species level and enumerated while macroinvertebrates are preserved in ethanol before being identified to family level. Multimetric indices calibrated to the ecoregion, specifically Ohio's Index of Biotic Integrity (IBI, OEPA, 1988) and MAIS, are used to develop a score that can be compared with biological targets and to measure changes over time.

Results

Annual macroinvertebrate monitoring has shown consistent improvement as reclamation and treatment systems have been installed. Of the twenty sites monitored annually since 2006, seven

Figure 6. A team uses an electrofishing boat to sample a site too deep for wading. *(Photo credit: Sarah Landers)*

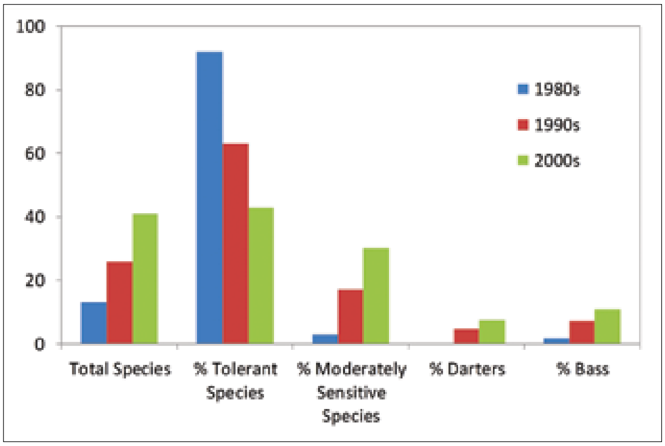


Figure 7. Fish community improvement in Little Raccoon Creek sub-watershed since the 1980s.

have shown statistically significant improvement (Bowman and Johnson, 2014). Of the sites that have not shown improvement, half had already shown significant chemical improvement before biological monitoring began. Continued treatment and reclamation projects aim for further biological recovery. The sites close to treatment systems may never improve. In Ohio, many treatment systems discharge water with high suspended metal content which settles out in the stream, allowing the stream to recover further downstream, but preventing recovery close to the treatment system in what was the most impaired part of the stream pre-treatment.

While macroinvertebrate communities have shown improvement across a large number of sampling locations, fish community data dates back to the 1980s for the largest sub-watershed of Raccoon Creek, Little Raccoon Creek. Figures 5 and 6 show Raccoon Creek sampling crews using longline and boat electrofishing methods to sample fish communities. Key fish community indicators, shown in Figure 7, suggest consistent improvement over time from early land reclamation projects in the 1980s and 1990s to the installation of large treatment projects in the 2000s. Another large land reclamation project and several wetland installations are slated for completion in 2015 which will hopefully continue the trend of stream recovery.

In total, seventeen treatment projects have been installed in Raccoon Creek watershed costing a total of nearly $12 million. These projects remove nearly 6,000 lbs/day of acidity from the watershed when compared to baseline conditions in 2001. Overall, 42 stream miles have been restored to the state goal of warm water habitat. All 117 stream miles that are monitored for chemical water quality met the pH target of 6.5 in 2013. Continued treatment and reclamation aim to build upon the stream recovery achieved to date. ■

References:

Bowman, J.R., K.S. Johnson. 2014. An evaluation of water quality, biology, and acid mine drainage reclamation in five watersheds: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek. Nonpoint Source (NPS) Monitoring Project for Acid Mine Drainage, www.watersheddata.com

Johnson, K.S. 2007. Field and laboratory methods for using the MAIS (Macroinvertebrate Aggregated Index for Streams) in rapid bioassessment of Ohio streams. Athens: Ohio University Department of Biological Sciences.

Ohio Environmental Protection Agency (OEPA). 1988. Biological criteria for the protection of aquatic life: volume 2: user's manual for biological field assessment of Ohio surface waters. Technical report. http://www.epa.state.oh.us/Portals/35/documents/Vol2.pdf.

Smith, E.P., and J.R. Voshell. 1997. Studies of benthic macroinvertebrates and fish in streams within EPA region 3 for development of biological indicators of ecological condition. http://www.epa.state.oh.us/portals/35/credibledata/references/SmithandVoshell1997.pdf.

Challenges for Native Forest Establishment on Surface Mines in a Time of Climate Change

Elizabeth Hansen[1], Christopher Barton[2], and Andrea Drayer[3]

[1] *Undergraduate Student, Pomona College, Claremont, CA, 91711.*
[2] *Professor of Forest Hydrology and Watershed Management, University of Kentucky, Lexington, KY, 40546.*
[3] *Research Analyst, University of Kentucky, Lexington, KY, 40546.*

Introduction

Reclaimed mine soils in Appalachia often exhibit physical and chemical properties dissimilar to native topsoils. As such, the native forest species that occupied a site prior to mining may not be suitable for establishment under conditions found within the post-mining soil environment. In a time of climate change, native species establishment may be further hindered on these disturbed landscapes. Species distributions are expected to change under current climate models (Prasad et al., 2007). Regardless of which climate change scenario used, pine forests are speculated to be much more responsive to climatic variation than deciduous forests. In the central hardwood region that includes Kentucky, oak distribution is projected to move northward due to climatic change and could be replaced by southern pine

Figure 1. Study area in 2004 after amendment application and deep ripping. The site is located in Knott Co. Kentucky.

Species	N	P	K	Ca	Mg	Zn
	(%)			(mg/kg)		
NRO	0.14	11	67	723	179	4.0
LP	0.11	8	63	640	170	3.5

Table 1. Mean soil nutrient analysis on 11 year old reforested coal mine.

Figure 2. Study area in winter 2008. The LP plots can be clearly seen in the photo. Even though oaks are dormant and have dropped leaves, extensive ground cover is visible in the NRO plots.

species. The consequence of combined land use disturbance from mining and climate change on native forest establishment has not been studied.

Loblolly pine *(Pinus taeda)* is native to the southeastern US, but its current range does not extend as far north as Kentucky. Loblolly pine is relatively fast to mature and has a wide range of uses from pulpwood to plywood to lumber. For these reasons, it is one of the most important commercial timber trees in the US (Burns and Honkala, 1990). Northern red oak *(Quercus rubra)* is a large tree, with a native range that spans from the southeastern US into southeastern Canada and is found throughout Kentucky. Northern red oak is relatively slow to mature, but is also an important tree for timber and can have even higher value as lumber and veneer. Oaks provide around half of the annual production of hardwood lumber in the US (Petrides, 1998). In Kentucky, the economic impact of the timber industry was estimated at $12.8 billion in 2013, of which oak species comprised about one-third of timber sales (Stringer et al., 2014). Even though both species are economically important, the trees are structurally different (conifer versus hardwood), provide distinct timber products, and each provides a unique set of ecosystem services specific to their native range. Loss of northern red oak (NRO) and replacement with loblolly pine (LP) will have significant short-term economic impacts, with potentially long-term environmental consequences for plant community development, soils, wildlife, and watershed characteristics.

Study Description and Methods

An experiment to examine the suitability for species replacement due to climate change was initiated in 2004 on a

Figure 3. Study area in fall 2014. LP plots have reached canopy-closure while NRO is still open. The exotic shrub Autumn Olive (Elaeagnus umbellate) has invaded areas where pines are not present (silver/whitish plant on plot edge and spread throughout NRO plots).

reclaimed coal mine in eastern Kentucky. The project was initially set up as a factorial experiment so that we could examine the need for soil amendments (mulch, fertilizer, mycorrhizae) on initial native NRO and LP establishment (Barton et al., 2008). A study with 48 plots each measuring 15 by 15 m was created. All plots were ripped to a depth of approximately 2 m using a dozer. After ripping, half of the plots received an application of 40 tons per acre of a wood chip/manure compost mixture (Figure 1). In each plot, 80 bare-root seedlings of an individual species were transplanted. Survival, diameter and height of trees were measured after the 4th and 10th growing seasons. Diameter^2 and height were used to determine volume growth (cm^3). Herbaceous ground cover was clipped during the 10th growing season within two randomly-placed $1m^2$-quadrats in each plot. Samples were dried to obtain g/m^2 of herbaceous production. During the 11th growing season, soil samples were collected from three locations to a depth of 10 cm in each plot and composited. Analysis consisted of pH and selected nutrients during the 11th growing season (2014).

Results

Four years after planting, mean survival was 77% for LP and 60% for NRO. Mean tree growth after the 4th year was 2,532 cm^3 for LP and 62 cm^3 for NRO (Figure 2). After 10 years, dramatic differences in mean tree growth were observed between LP (199,144 cm3) and NRO (1,250 cm^3) (Figure 3). Mean survival after 10 years remained higher for LP (63%) than NRO (38%).

Shade from the closed-canopy LP stand resulted in much lower mean herbaceous cover (39 g/m^2) than that observed on the open-canopy NRO plots (171 g/m^2). Moreover, the rapid growth and shade development in the LP plots provided much more resistance to invasive species colonization than that observed in the NRO plots (Figure 4). Given the low survival of NRO and high levels of competition, future success of these plantings is severely compromised.

Soil pH was similar in the mine soils for both tree types (pH 5.41). Analysis of soil nutrients, however, showed consistently lower values in the LP plots as compared to the NRO plots for all elements examined. Differences are likely due to resource utilization by the faster growing LP stand.

Results clearly showed that conditions on the mined land favor establishment and growth of the non-native LP over that of the native NRO. Although return of the native forest ecosystem is often a reclamation goal, pressure from non-native species could be problematic on disturbed mine lands if climate change species distribution models prove to

Figure 4. (a) Author standing in the middle of a NRO plot in summer 2013. Note excessive herbaceous and shrub competition in the plot. (b) LP plot from the interior. Note canopy closure and lack of competitive vegetation.

be accurate. This issue could be exacerbated on mined sites over that of an undisturbed forest because the disturbance regime may favor colonization of species that are more adapt to dealing with the combined stress of a new climate and a new soil environment. A concern that mined sites may be compromised by climate change seems warranted; thus, management practices to deter and prevent species loss and replacement are needed. ■

References:

Barton, C.D., D. Marx, R. Sweigard and W. Barton. 2008. "Evaluating Spoil Amendment Use and Mycorrhizal Inoculation on Reforestation Success in the Eastern and Western Kentucky Coalfields. In: Proceedings of 2008 National Meeting of the American Society of Mining and Reclamation, Richmond, VA, New Opportunities to Apply Our Science. June 14-19, 2008. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502. pp 98-111.

Burns, R. and B. Honkala. 1990. Silvics of North America; Volume 2, Hardwoods. Agricultural Handbook 654. Department of Agriculture, Forest Service, Washington, DC, 877 p.

Petrides, G.A. 1998. A Field Guide to Trees and Shrubs: Northeastern and North-Central United States and Southeastern and South-Central Canada. Boston: Houghton Mifflin.

Prasad, A. M., L. R. Iverson., S. Matthews., M. Peters. 2007. A Climate Change Atlas for 134 Forest Tree Species of the Eastern United States [database]. http://www.nrs.fs.fed.us/atlas/tree, Northern Research Station, USDA Forest Service, Delaware, Ohio.

Stringer, J., B. Thompson, B. Ammerman and A. Davis. 2014. Kentucky Forestry Agriculture Impact Report 2013-2014. University of Kentucky, Cooperative Extension Service. FORFS 14-01. http://www2.ca.uky.edu/forestryextension/Economic%20Impact/Economic%20report%202013-2014.pdf.

Are Acidity Levels at the Fire Road Mine Really Dropping?

M. Coleman[1], K.E. Butler[2], E. Mott[2], K. Phinney[3]

[1] *NB Power, Fredericton, New Brunswick, Canada.*
[2] *Dept. of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick, Canada.*
[3] *Consulting Chemical Engineer/Chemist, Halifax, Nova Scotia, Canada.*

Introduction

Between 1982 and 1985, the Fire Road mine was an active surface coal mine located in south central New Brunswick, in eastern Canada. Mining was halted after the identification of acid mine drainage caused by the presence of pyrite nodules in the sandstone and conglomerate overburden that were exposed during the strip mining operation. All of the waste rock was then reclaimed back into the strip mine and the surface was contoured to approximate original grade. Consideration of abatement options for the site has precipitated many research projects including a comparison of three decades worth of water chemistry data illustrating that acid mine drainage has diminished significantly at the mine. Since the mine operator ceased all coal mining in the area in 2009, the question "How soon until acid mine drainage is no longer an issue?" has become more pressing. Discussions now are about how we can predict and or hasten the end of chemical treatment at the site.

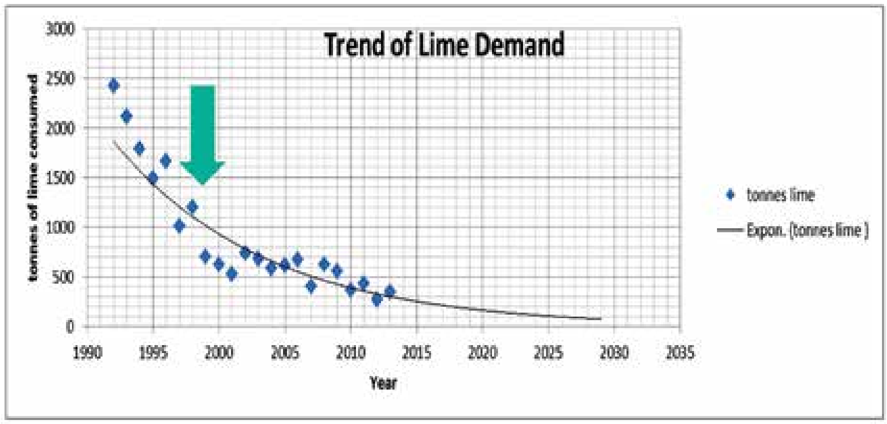


Figure 1. Decreasing lime demand for treating mine water.

Treatment Sludge Impact on Waste Rock and Mine Water Chemistry

Although several options to address acid generation at the mine were considered, hydrated lime has been used to neutralize the acidic mine water since the mid-1980s. Dredging was the approved method to transfer the large volume of neutralization sludge being generated each year back into the mine site waste rock. We knew that most of the water used in the dredging operation would eventually make its way back to the mine water holding pond where it would be treated again. So to minimize the amount of water being pumped, dredging was scheduled for late summer or early fall when natural recharge through precipitation and groundwater influx is typically low. The low water table at that time of year also provided more space in the vadose zone for sludge storage.

Disposing of lime neutralization sludge into acid generating rock has provided several benefits: introducing excess alkalinity in the sludge to the waste rock, providing a final disposal area, decreasing personal liability, minimizing land disturbance, and reducing oxygen diffusion into the waste rock. Since dredging was initiated, no additional ponds have been constructed and several have been identified to be reclaimed as part of final mine closure preparations.

Over the past two decades during which neutralization sludge has been dredged and pumped back into the waste rock, the chemistry of mine water and ground water has been tracked. The most

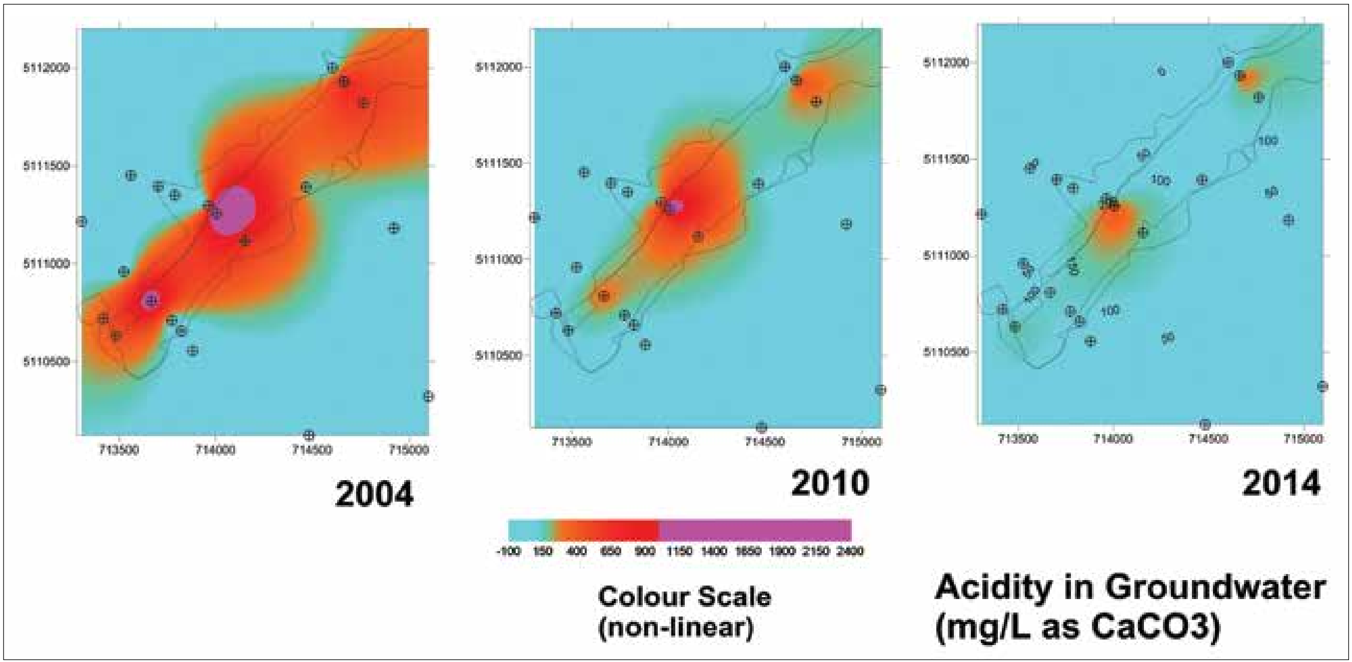


Figure 2. Acidity in groundwater June 2004, June 2010 and May 2014. (Pelkey, 2015). The mine is outlined as the interior tracing while the exterior tracing is the undisturbed forest line (Gemtec, 1988).

obvious change has been the decreasing lime demand required for neutralizing the mine water. Although detailed chemical analysis is scant from pre-1990, early 1990s' records indicated lime demand was reported as approximately 2,400 tonnes per year, which has decreased to 300 to 400 tonnes per year currently (Figure 1). With less acidity, less lime is used and less neutralization sludge is being produced.

During the later stages of each dredge operation and up to three months afterwards, the acidity of the mine water decreases, resulting in lower lime demand for treatment. It has not been determined what portion of the long term decreased demand is due to the deposition of sludge on the waste rock and which portion is due to the weathering out of the reactive minerals in the waste rock. Earlier studies in West Virginia indicated a large drop in acidity after 15 years before it starts to level off (Ziemkiewicz and Meek, 1994). This is exactly what was noticed in the late 1990s. Fifteen years after the closure of the mine in 1985, acidity decreased to much lower levels in 1998 (Figure 1).

Is the Mine Water Chemistry Homogeneous Within the Mine Site?

Phinney and Coleman (2014) reported that the decrease in acidity can be attributed to three factors. First, less exposed sulphide mineral surfaces as oxidation proceeds are available for reaction. Second, the effectiveness of the sludge placement within and on the waste rock

Figure 3. Layout of EM survey lines acquired on Fire Road Mine in early May 2014. Twenty-one EM31 survey lines were laid out at 40-m spacing with additional cross-lines in areas of special interest.

surface is reducing the rate of transfer of atmospheric oxygen to the sulphide minerals. Third, possible leaching of excess alkalinity in the sludge into the groundwater zone is neutralizing acidity. Their recent comparison of lime consumption to the acidity of ground waters extracted from monitoring wells within the waste rock concluded that the level of acidity would be reduced sufficiently to modify the treatment operations or to switch to spot treatment in high acidity areas possibly within the next decade. Ground water monitoring in wells has illustrated a decrease in the acidity levels over the past few decades (Pelkey, 2015). As the groundwater acidity survey presented in Figure 2 illustrates, acidity has decreased at the well locations, but interpolation of those data over the mine site is limited by the spatial distribution of the wells. Spacing between well lines is approximately 500 metres.

Figure 4. EM31 apparent conductivity surveying, May 2014. EM31 readings were integrated with positioning data from a differential GPS mounted on hard hat. Data were displayed and stored on a hand held data logger. *(Photo KE Butler)*

Groundwater sampling was always conducted between late May and the end of June, which is shortly after the spring snow melt. The 2014 sampling should have exhibited the largest impact of the snow melt as it was conducted the earliest, in late May. However spot sampling throughout the year has never exhibited evidence that ground water quality chemistry is impacted by any seasonal mecha-

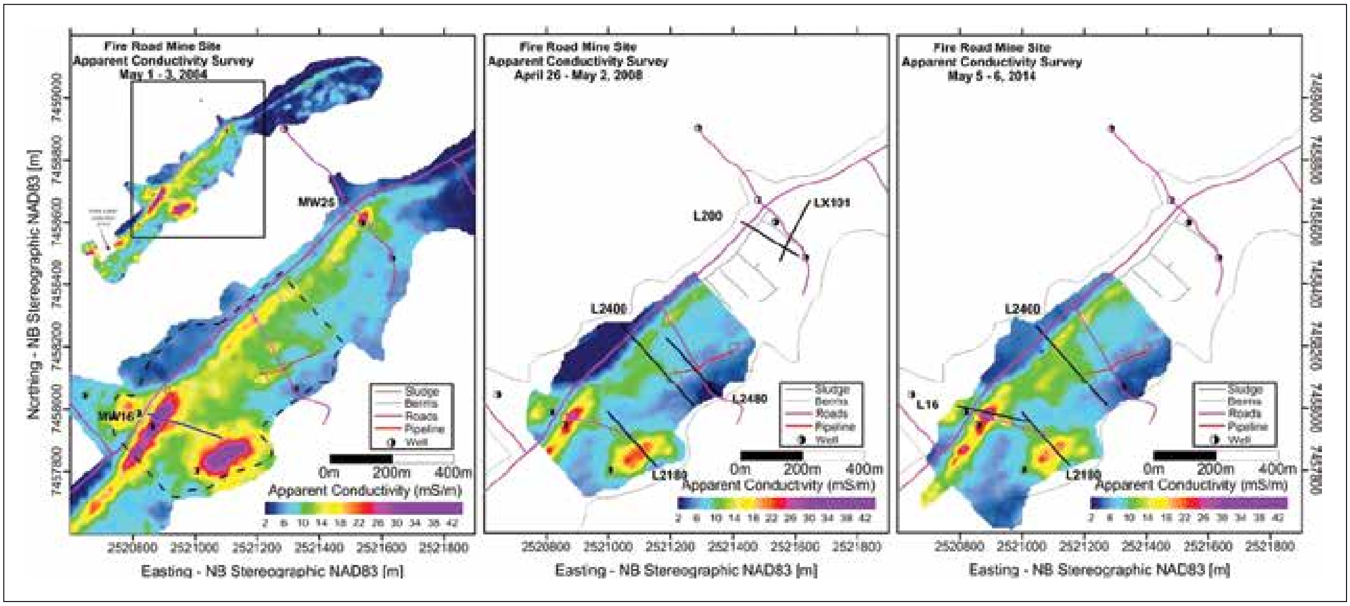


Figure 5. EM31 apparent conductivity maps from 2004, 2008 and 2014, showing reduction in conductivity of the waste rock backfill over the past decade.

nism other than dredging. Dredging was always initiated after the ground water sampling was completed.

Can we map the acid generation distribution?

Geophysical parameters can perform non-destructive evaluations across an area limited only by the depth of penetration of the method and the selected spacing of the traverses. Apparent conductivity and electrical resistivity surveys are two methods that have been used to collect a more complete representation of the distribution of high conductivity zones within the waste rock (Coleman et al., 2005). It is expected that regions of high electrical conductivity within the waste rock will correlate with regions of high acidity.

Geophysical Investigations

The Department of Earth Sciences at the University of New Brunswick had been conducting geochemistry and geophysics field camps at the mine since the mid-1990s (Al and Butler, 2001). In order to determine whether subsurface electrical conductivities – like acidity – were decreasing in intensity over the past decade, the May 2014 field camp was designed to retrace survey lines first monitored in 2004 and 2008. Electrical resistivity imaging (ERI) surveys, which estimate subsurface conductivity variations both laterally and with depth along individual lines, were acquired in addition to electromagnetic apparent conductivity mapping surveys that can cover large areas more quickly but lack information on how conductivities vary with depth and are more prone to instrument drift.

Apparent Conductivity Mapping

Apparent conductivity surveys have

Figure 6. MSc student Eric Mott (at computer) and some students of ESCI 3713 Geoenvironmental Field School, May 2014. Two 24 electrode switchboxes, wrapped for protection from the elements, are displayed adjacent to the hand held electrical resistivity meter. *(Photo KE Butler)*

been acquired using the Geonics EM31 (Figure 3). This instrument measures apparent conductivity which, under normal near-surface conditions, is a sort of weighted average of the electrical conductivities of subsurface layers (McNeil, 1980). The weights vary with depth and the effective depth of averaging/exploration is normally considered to be within six metres of the surface. Thus apparent resistivity measurements depend on the true electrical conductivities of subsurface layers (which increase with water saturation, porosity, ionic concentrations, ionic valence, and ionic mobility), but also depend on the depths and thicknesses of such layers. Acid mine drainage and sludge have high electrical conductivity compared to natural ground waters. Hence, apparent conductivity mapping measurements can reveal regions with high concentrations of AMD and/or sludge. Interpretations must also, however, take into account variations in depth to the water table and moisture/sludge (ionic) content in the vadose zone above the water table.

The 2004, 2008 and 2014 apparent conductivity maps in Figure 5 illustrate diminishing electrical conductivities over the decade across the 800m x 350m area surveyed. Purple and red zones represent areas with the highest apparent conductivities (as high as 44 mS/m) and their decrease in spatial extent mimics the decline in acidities illustrated in the ground water monitoring data presented in Figure 2. Elevated conductivities along the northeast-southwest trending hardwall (the left side) may be a consequence of higher porosity backfill which allows more O2 infiltration and AMD production, and corresponds to a higher ratio of conductive water to resistive solid rock below the water table. Apparent conductivities are also elevated in the green and yellow areas where sludge has been pumped onto the middle of the mined area. Sludge would be expected to increase apparent conductivities where it infiltrates into the vadose zone and acts as a water retentive layer with high ionic content. An exact correlation with sludge deposition is, however, hampered by incomplete historical records.

Electrical Resistivity

2D Electrical resistivity imaging (ERI) surveys were also conducted in May 2014, repeating lines first acquired in 2008. These surveys (Figures 6 and 7) utilized an array of 48 electrodes at 5 m spacing (235 m line length) and both Wenner and Dipole-Dipole survey geometries to provide depths of exploration up to 30 to 40 m, well in excess of the maximum 20 m depth to the bottom of the original coal seam at Fire Road Mine.

The location of survey line 2180 is identified on Figure 5 maps (years 2008 and 2014) and the results are presented in Figure 8. Note that low resistivities or high conductivities are deep blue in the

Figure 7. ERI survey line showing multi-conductor cable connected to 40 cm long stainless steel electrodes driven into the ground at 5 m intervals.
(Photo KE Butler)

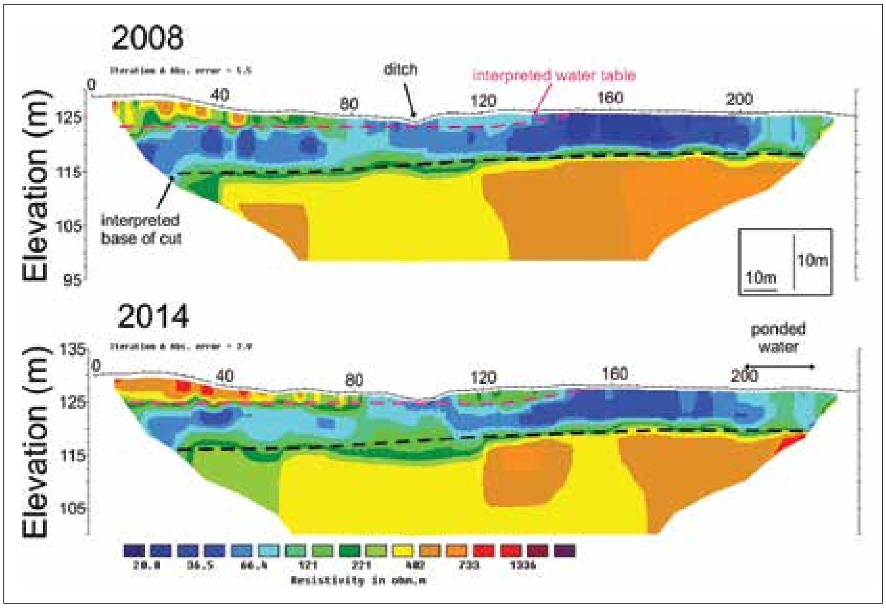


Figure 8. Electrical Resistivity Imaging Line on 2180; 2008 to 2014 Comparison. Note that the low resistivities (high conductivities) are deep blue in the ERI cross sections, which is opposite to the EM map color scheme. The location of the survey line, in the southeastern portion of the EM31 map, is shown in Figure 5.

ERI sections (i.e. opposite to the EM31 map colour scheme). The water-saturated waste rock backfill (i.e., the region between the interpreted water table and base of cut) is less conductive (less deep blue) in 2014 compared to 2008. This confirms that the trend towards lower conductivities observed in apparent conductivity maps (Figure 5) is not an EM31 calibration problem.

Conclusions

Acidity is decreasing overall in the mine site based on reduced lime consumption, trends observed in annual ground water acidity measurements, and trends observed in apparent conductivity and electrical resistivity surveys. The geophysical surveys provide a more complete picture as the measurements are much more closely spaced and broadly distributed compared to the groundwater wells.

It is difficult to determine the exact impact of sludge deposition into the waste rock but the benefits of decreased personal liability, decreased land use, and short term acidity declines are significant enough to continue with the practice.

Future research direction

While it seems reasonable to interpret the reduced electrical conductivities in May 2014 as being a consequence of reduced AMD production, we have to acknowledge it might be at least partly due to how heavily "flushed" the system is by snowmelt and rain each year, since these geophysical surveys are usually conducted in early May. Further investigations conducted in the fall and early winter of 2014/2015 will attempt to determine whether this impact is significant. That survey will also attempt to measure how sludge deposition during the fall dredging program affects waste rock conductivities in the targeted area. ■

Bibliography:

Al, T. and K.E. Butler. 2001. Environmental Geoscience: Acid Mine Drainage in the Minto Coal Fields. In: R.K. Pickerill and D.R. Lentz, eds., Guidebook to Field Trips in New Brunswick and Western Maine: 93rd Annual New England Intercollegiate Geological Conference, Sept. 21 - 23, 2001, Fredericton, New Brunswick, Canada, p. A3-1 to A3-10.

Coleman, M.M., K.E. Butler, A. Mersich, and T.A. Al. 2005. Tracking sludge disposal using electrical conductivity mapping, Proc. of the 2005 National Meeting of the American Society of Mining and Reclamation, June 19-23, p. 236-254.

Coleman, M., K. Butler, E. Mott, K. Phinney, and S. Pelkey. 2014. Towards Closure of the Fire Road Mine. American Society of Mining and Reclamation 31st National Meeting. Oklahoma City, Oklahoma, USA. June 14-20, 2014.

Gemtec Ltd. 1988. Surface and Groundwater Hydrology of the Fire Road Mine Site Minto, NB. Report prepared for NB Coal Ltd. File 269.01. December 12, 1988.

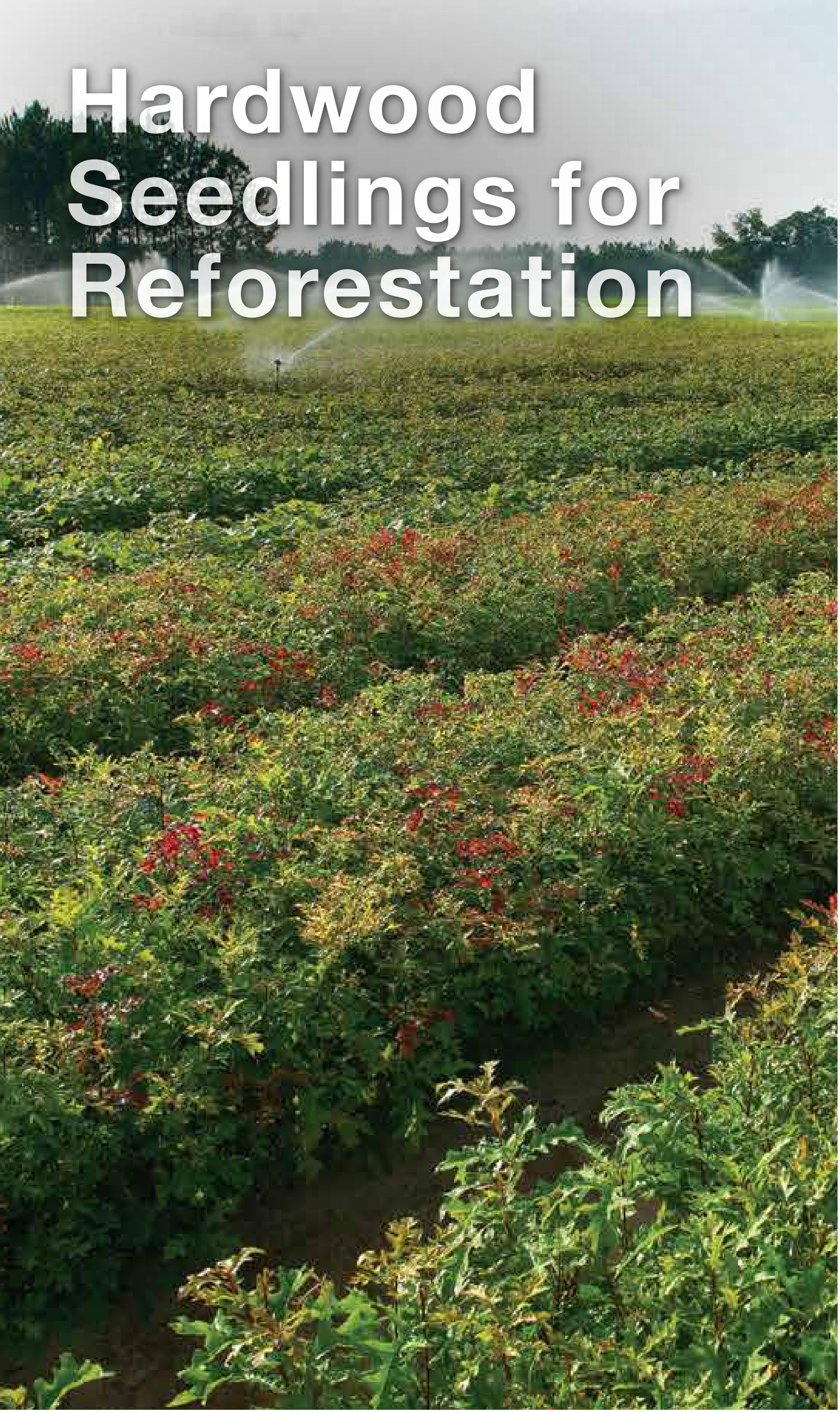
McNeill, J.D. 1980. Technical note TN-6, Electromagnetic terrain conductivity measurements at low induction numbers: Geonics Limited, 1745 Meyerside Dr., Missisauga, Ontario, Canada.

Pelkey, S. 2015. Groundwater Sampling and Analysis Report for the Fire Road Mine. Gemtec Consulting Engineers prepared for NB Power. January, 2015.

Phinney, K.D. and M. Coleman. 2014. Towards Closure of the Fire Road ARD Site in New Brunswick. Presented and published at 38th Annual British Columbia Mine Reclamation Symposium. Prince George Civic Centre. Prince George, BC. September 22-15, 2014.

Ziemkiewicz, P.F. and F.A. Meek. 1994. Long term Behavior of Acid Forming Rock: Results of Twelve Year Field Studies. Proceedings, International Land Reclamation and Mine Drainage Conference and the Third International Conference on the Abatement of Acidic Drainage, Pittsburgh PA, April 24-29, 1994.

Hardwood Seedlings for Reforestation



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