

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation *matters*



2009 Joint Conference Program and Registration
A Periodic Table of Passive Treatment for Mining Influenced Water
ARRI – The Forestry Reclamation Approach





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is published by:



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Winnipeg, Manitoba
Canada R3L 0G5

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Publications Mail Agreement #40934510
Return undeliverable Canadian addresses to:
DEL Communications Inc.
Suite 300, 6 Roslyn Road
Winnipeg, Manitoba R3L 0G5
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Printed in Canada | March 2009

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CHANGE WE DO BELIEVE IN

*Vern Pfannenstiel,
ASMR President*



Change – we've heard a lot of talk along those lines over the last year, and we better count on a lot more to come. The economic downturn and all its consequences will result in far reaching and long-term change in our country's future. The mineral extraction industry is a good example of how much change can occur in a relatively short time. Take copper as an example. Not long ago the copper industry was at peak production and prices were at all-time highs. Contrast that now with the much lower prices for copper coupled with idled production facilities and lay offs. ASMR is strongly rooted in the mineral extraction industry and many of its members are, or will be, affected in many ways. Let's continue to support each other.

Another change is the national goal to significantly expand the role that renewable energy resources contribute to our overall energy needs. This is a worthy and necessary goal in order to effectively balance energy production methods and needs, while helping to meet our energy independence goals. To achieve this will require a significant commitment in energy and mineral resources to develop and maintain the necessary infrastructure, while seeking new technologies. It will then take a considerable amount of time and effort to scale up to the levels necessary to replace more conventional energy generation sources. If one looks at the mineral and energy footprint re-

quired to construct just one wind tower producing one megawatt of power and the grid to support it, it should be obvious that mining and energy production will continue to be needed for quite some time. Further, unless a miracle of technology is around the corner, we still need base-loaded power plants that can insure the 24/7 electricity we demand. The bottom line of this change is that mining and reclamation will continue and will help to revitalize our economy.

As a consequence, there remains the need and commitment to achieve the highest levels of reclamation, environmental protection, and associated research and technical development that ASMR and its members strive for. We in ASMR must continue to take the lead. There will likely be increased scrutiny by environmental groups and the public and more regulatory oversight. We will be required to do a better job than ever with greater care and application. I firmly believe we are up to the challenge because we have pushed for change and have provided the necessary leadership and effort for quite some time. ASMR and its members have significantly influenced the level and success of reclamation and environmental stewardship in the mining industry, to date. We at ASMR are, and will continue to be, agents of change and that is something we can – and do – believe in. ■

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MESSAGE FROM THE EXECUTIVE SECRETARY

Dr. Richard (Dick) Barnhisel



Currently, ASMR has nearly 500 members, but we are sending *Reclamation Matters* to nearly 4,500 persons who are not members. I hope you will consider joining ASMR. Our dues are relatively inexpensive – just \$50 for regular members, \$100 for corporate and sustaining members, and \$10 for students. Forms to either join or renew your membership may be found on the ASMR Web page. The simplest way to find this site is to search on Google, or some other search engine, for ASMR or the American Society of Mining and Reclamation.

I would like to make five requests:

1. If you have a change of address, please let me know, as this magazine is not forwarded by the U.S. Postal Service; they simply throw it away.
2. If there are others you believe would benefit from the magazine, send me the names.
3. If you do not want the magazine, let me know and I will remove your name.
4. Won't you consider advertising in our magazine? The rates are listed on the ASMR Web page under "Advertising Rates" on the page where past issues of *Reclamation Matters* may be found.
5. I would appreciate receiving e-mail addresses for all non-ASMR members. These addresses will not be given to anyone and will be used exclusively by ASMR. All messages sent by us will be as blind e-mail messages addressed to Richard Barnhisel at asmr5@insightbb.com. Please send your e-mail address to that address.

Note: *Reclamation Matters* is now published by DEL Communications Inc. ASMR has entered into a three-year agreement beginning with the spring issue 2009.

Look for an announcement and call for abstracts for the next ASMR meetings to be held in Pittsburgh, June 5 to 10, 2010. I expect to post this on the ASMR Web page in July/August. Send them by e-mail to me at asmr5@insightbb.com or call 859-351-9032. Additional materials concerning the meetings in Pittsburgh will be placed on the ASMR Web page after a planning meeting in mid-March and this page will be updated periodically.

The "Assistantships and Job Opportunities" section of our Web site continues to be very popular. If you have an available position, send me the announcement and I will place it on the Web page at no cost. Another advantage of being an ASMR member is that I send out a blind alert to our members each time there is a new listing. ■



WHAT CAN YOU BE?

Jeff Skousen, West Virginia University

While interviewing a potential graduate student recently, I asked what goals she had and where she planned to be in five or 10 years. She did not know exactly what she would be, but she knew land reclamation was fascinating and she wanted to work in this field. I then asked her what skills or traits she possessed that would help her achieve success. She gave some answers and I have since developed my own list of characteristics I wish all students (employees) possessed.

First, the ability to communicate – both by speaking and writing – often separates employees that are good from those who are excellent. Good speech habits and writing skills are critical in today's job market and those with better skills generally outperform and outlast those without. One cannot be overqualified in speaking and writing, and refining these skills is a continual, life-long process.

Second, most positions require the ability to think and make decisions, sometimes on the spot. This requires knowledge, common sense, and the ability to weigh alternatives. Some workers are paralyzed because they are afraid to make a mistake or are reluctant to accept the consequences of an error in judgment. Employees must make the best decisions they can based on the knowledge they possess, take responsibility for their actions, and be able to present their reasoning.

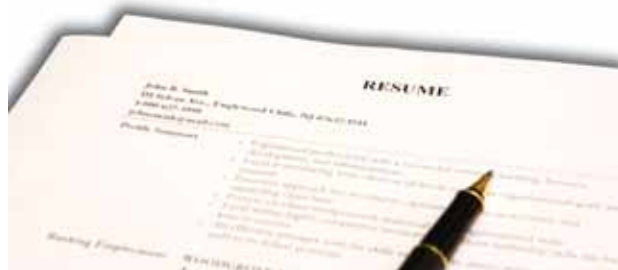
In conjunction with the capacity to make a decision is the willingness to try new things. Workers should look beyond their own experience and knowledge, and be willing to ask for help from others. Listening carefully to other people's perspectives and considering different points of view can provide new ideas and opportunities.

Another trait I consider important is dependability. All employers want someone who is loyal and can be counted on without excuse. When tasks are assigned, the worker gets the job done and can deal with problems he or she encounters in a timely fashion.

I also seek for those who are hard workers and can demonstrate the willingness to push on even when the pushing is strenuous. Character is developed by searching, trying, and refining. Experience comes in no other way. Hard work can often make up for many other skills that a person lacks simply because of persistence.

And last, but certainly not least, I look for a person who gets along well with others, has a pleasing personality, and who is optimistic, cheerful and enthusiastic.

These characteristics are some I consider to be most important when screening applicants for jobs or assistantships. Undoubtedly, other traits are important, but a person possessing these characteristics will be a success in any endeavor. All of us should consider the traits we possess and refine those which will make us better workers and more useful employees. ■



BILL PLASS

RECLAMATION PIONEER AND ASMR FOUNDER

by Carl Zipper, Virginia Tech

Editor's Note: Many of you have heard that William T. Plass, the founder of ASMR, passed away in November 2008. He was a good friend to many of us and I felt that a short biographical sketch of his life would be appropriate. I thank Dr. Carl Zipper for writing this tribute.

William T. Plass was born in 1922 in Detroit, Mich. His family moved to Iowa City, Iowa, where Bill spent his childhood. He served during World War II in the U.S. Army 797 Engineer Forestry Company in the China-Burma-India Theater. After returning from the war, Bill received his Bachelor of Science degree in forestry from Iowa State University in 1948, and joined the U.S. Forest Service (USFS) shortly afterwards. His first USFS assignment was with the Forest Survey in Kentucky. When his wife-to-be, Lola, graduated from Iowa State in December 1949, they married.

Bill was transferred by the USFS to Athens, Ohio, in April 1949, to work at the new Buckeye Research Center. There, Bill served as Superintendent of the Vinton Furnace Experimental Forest, a 1,200-acre tract dominated by native hardwoods. Bill supervised development of the

Experimental Forest's road system and the initial research and monitoring activities.

While in Ohio, Bill also became involved with land reclamation. He visited his first surface mine in 1949, a coal mine in southern Ohio soon after arriving at Athens. At that time, USFS personnel were involved with numerous reclamation studies. When Ohio coal companies asked the Athens staff for advice with local reclamation problems, Bill was assigned to that project. His first reclamation publication, co-authored with Bob Merz in 1952, described a study on a Perry County, Ohio site that had been mined in 1949. Researchers planted pines on the stripped area during reclamation, but noticed that by 1951, natural regeneration by native hardwoods was also occurring. The researchers reported that slope aspect exerted a strong influence on the density of naturally regenerating seedlings.



In 1955, he was transferred to Illinois to serve as supervisor of the larger and well-established Kaskaskia Experimental Forest, nearly 10,000 acres dominated by hardwoods that included some areas of "old growth" timber. According to Bob Merz, Bill's supervisor at that time, the Kaskaskia Experimental Forest was quite active and the superintendent position was a demanding job. A few years later, Bill took a year-long leave of absence from the Forest Service to continue his education. He received a Master of Forestry from the University of Missouri in 1959. His thesis, "A Silvical Analysis of a Virgin Hardwood Forest in Southern Illinois," was based on research conducted at Kaskaskia.

In 1960, Bill joined the USFS Regeneration and Tree Improvement research staff in Carbondale, Ill. There he became re-involved with mine reclamation. During the 1940s, as a response to a



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As depicted in this undated photo on an active mine site, Bill Plass spent much of his career with U.S. Forest Service working with industry and agencies to develop and implement better surface mine reclamation practices.

Congressional appropriation, the USFS had established field trials in eight states, extending from Alabama, Kentucky, and Ohio west to Oklahoma, as an effort to understand factors affecting tree survival and growth on coal surface mines. While at Carbondale, Bill was involved with monitoring of the field trials in Illinois and adjacent states. This entailed frequent travel, sometimes in the company of Dr. Clark Ashby of Southern Illinois University.

Working together, Clark and Bill engaged SIU students in the monitoring of plots located near Carbondale. In 1962, Bill was assigned by the USFS to the agency's surface mine restoration project.

When the USFS Central States Forest Experimental Station was reorganized in 1965 to 1966, Bill transferred to the Northeastern Forest Experiment Station facility at Berea KY as a Plant Ecologist, where he worked with a multidisciplinary team of USFS scientists that were addressing mine reclamation problems. His first major project at Berea was assessment of the extent and characteristics of land disturbance by coal mining in eastern Kentucky. He conducted this work using aerial photographs, applying expertise he had developed in his earlier assignment as a member of the Forest Survey. This was an extensive activity, covering nearly the entire eastern Kentucky coalfield as we know it today. He found that about 60,000 acres, about 1 percent of the coalfield's land area, had been disturbed by surface mining and mine roads. More than 90 percent of the disturbed areas had been contour mined, primarily for coal; about half of those disturbances consisted of the spoils that had



been pushed out and over the slopes below the contour mine bench ("outslopes"), and that about 10 percent of the outslope areas were visibly unstable "slides and slumps," as Bill stated in the publications.

Bill's primary activity during the rest of his USFS career was development of methods for revegetating coal mine spoil materials, such as those he had seen so extensively through the eastern Kentucky survey. As stated by Bill's wife, Lola, "He knew it could be done." He was engaged in this work while at Berea where, according to his former Berea colleague Willis Vogel, he worked cooperatively with the Kentucky Reclamation Association, Tennessee Valley Authority, Kentucky Division of Reclamation, and the coal industry in establishing field trials and conducting research. Bill transferred to Princeton W.Va., in 1968 to work within the context of the "tripartite agreement" among USFS, the West Virginia Department of Natural Resources, and the West Virginia Surface Mining and Reclamation Association to promote cooperative research and information sharing on coal surface mine reclamation.

As a basis for his reclamation studies, Bill participated in studies of surface mine spoil properties in both eastern Kentucky and southern West Virginia. Those studies



Bill Plass (left) speaking to a group on a coal surface mine. Photo is undated, but it appears to have been taken in eastern Kentucky during the early 1960s.

found that both physical and chemical spoil properties were highly variable, a factor that reclamation researchers continue to grapple with today. A major problem in those days, however, was that most of the surface spoils were acidic. While with the Forest Service in West Virginia, Bill established numerous field trials where he was able to monitor and compare survival and growth of woody species on mine spoils of varying properties, and to investigate the influence of management techniques such as fertilization, liming, erosion-control ground-cover establishment, and applications of organic mulches and chemical stabilizers. His studies utilized a full range of species, including both native hardwoods and pines, but his work put greater emphasis on pine species because of the prevalence of acidic soil conditions. Near the end of his career with the Forest Service, a time when Appalachian mining and reclamation were issues of public controversy and much in the public eye, Bill wrote and published several comprehensive overviews of reclamation procedures for use in Appalachia that described many of the approaches and concepts that reclamationists recognize and utilize today. Bill retired from the Forest Service in 1979.

As many readers know, Bill's involvement with reclamation did not end with his so-called retirement from USFS. While still with the Forest Service, he had begun laying the groundwork for what became the ASMR. The Steering Committee for the tripartite agreement evolved into the ASMR's forerunner organization – the Council for Surface Mining and Reclamation Research in Appalachia – in 1973. This organization was formed to support the advance of reclamation practice within cooperative framework involving researchers, government, and industry. Bill served as Council Chair through 1978 when it reorganized, changing its name to the American Council for Reclamation Research and broadening from a regional to a national focus. Bill was named as the new organization's Executive Secretary. He continued in this capacity through another re-organization and name change in 1983, when the American Society

Bill Plass outside his home in Princeton, W.Va., about one year before his death.

for Surface Mining and Reclamation (ASSMR, which became American Society of Mining and Reclamation) was born.

Under Bill's leadership, the ASSMR began pursuing more international activities. The 1989 National Meeting in Calgary, Alta., sponsored jointly with the Canadian Land Reclamation Association, was among the




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first steps in this process. In subsequent years, formal relationships were also established with reclamation associations in Australia, Britain, and China. The International Affiliation of Land Reclamationists (IALR) was formed in 1996, with Bill serving as Secretariat. He continued providing leadership to both organizations through 1999, when he retired from the ASMR, leaving a vibrant organization to his successor, current Executive Secretary Dick Barnhisel. He continued providing leadership of the IALR until 2006, when he turned that organization's leadership over to Lee Daniels.

William "Bill" Plass died after a short illness, on Nov. 19, 2008, at the age of 86 in Princeton, W.Va., leaving his wife of 60 years, Lola; three children, three grandchildren, and one great-grandchild; two organizations dedicated to the betterment of reclamation practices on disturbed lands; and countless friends and colleagues.

Acknowledgements:

Sincere thanks to Bob Merz, Clark Ashby, Willis Vogel, and Lola Plass for their help in preparing this article, and to Lola Plass for the photos.

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THE FORESTRY RECLAMATION APPROACH

by Jim Burger¹, Don Graves², Patrick Angel³,
Vic Davis⁴, Carl Zipper⁵

The Forestry Reclamation Approach (FRA) is a method for reclaiming coal-mined land to forest under the Surface Mining Control and Reclamation Act (SMCRA). The FRA is based on knowledge gained from both scientific research and experience (Photo 1). The FRA can achieve cost effective regulatory compliance for coal operators while creating productive forests that generate value for their owners and provide watershed protection, wildlife habitat, and other environmental services.

The purpose of this Advisory is to describe the FRA, which is considered by state mining agencies and US Office of Surface Mining to be an appropriate and desirable method for reclaiming coal-mined land to support forested land uses under SMCRA (Angel and others 2005). The FRA is also supported by members of the ARRI's academic team, which is drawn from Universities in nine states, and by other groups and agencies.

The FRA's Five Steps:

The FRA can be summarized in five steps:

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



Photo 1. A white oak stand that grew on a pre-SMCRA surface mine in southern Illinois. Observations by reclamation scientists and practitioners of soil and site conditions on reclaimed mines such as this, where reforestation was successful, have contributed to development of the Forestry Reclamation Approach.

Step 1. Create a suitable rooting medium:

Tree survival and growth can be hindered by highly alkaline or acidic soils. During mining and reclamation, all highly alkaline materials with excessive soluble salts and all highly acidic or toxic material should be covered with a suitable rooting medium that will support trees. The best available growth medium should be placed on the surface to a depth of at least four feet to accommodate the needs of deeply rooted trees.

Growth media with low to moderate levels of soluble salts, equilibrium pH of 5.0 to 7.0, low pyritic sulfur content, and textures conducive to proper drainage are preferred. However, where such materials are not available, an equilibrium pH as low as 4.5 or as high as 7.5 is acceptable if tree species tolerant of those conditions are used.

Native hardwood diversity and productivity will be best on soils where the pH is between 5 and 7, and such trees generally grow best in soils with loamy textures, especially sandy loams. Such soils can be formed from overburden materials comprised predominantly of weathered brown and/or unweathered gray sandstones, especially if these materials are mixed with natural soils (Photo 2).



Photo 2. A mixture of brown weathered and gray sandstones, loosely graded to form a soil medium suitable for trees in West Virginia.

Use of materials with soluble salt levels lower than 1.0 mmhos/cm on the surface is preferred when such materials are available.

Step 2. Loosely grade the topsoil or topsoil substitutes:

Excessive soil compaction can have a major negative effect on survival and growth of trees. (Photo 3). Even if a soil's chemical properties are ideal, excessive compaction will create a soil that is poorly suited for trees. The majority of the backfill should be placed and compacted using standard engineering practices – but not the final surface. That surface layer, which will form the post-mining forest's soil, should be at least four feet deep and only lightly graded. Surface grading on longer and steeper slopes should be minimized, provided that doing so does not jeopardize stability.

To re-establish a healthy and productive forest after mining, final grading must minimize surface compaction. This can be achieved by:

- dumping and leveling in separate operations,
- leveling with the lightest equipment available, using the fewest passes possible, and during dry conditions, and
- permanently removing all equipment from an area after leveling.

“Tracking in” operations (Photo 4) compact the soil and hinder tree-growth, and should be avoided unless necessary for slope stability. Rubber tired equipment should not be used in final grading.

Step 3. Use ground covers that are compatible with growing trees:

Ground-cover vegetation used in reforestation requires a balance between erosion control and competition for the light, water and space required by trees. Ground covers should include grasses and legumes that are slow-growing, have sprawling growth forms, and are tolerant of a wide range of soil conditions. Fast growing and competitive grasses such as Kentucky-31 tall fescue and aggressive legumes such as sericea lespedeza and crown vetch should not be used where trees will be planted. Slower-growing grasses such as red top and perennial ryegrass, and legumes such as birdsfoot trefoil and white clover, when used in a mix with other appropriate species will increase seedling survival while controlling erosion over the longer term as the trees and accompanying vegetation mature to form a for-



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Photo 3. Mine soil properties can have a dramatic effect on tree growth. The Eastern white pines in both photos were the same age (8 years old) when the photos were taken; the pines in the left-hand photo grew on compacted alkaline shales, while those on the right grew on a moderately acid sandstone.

est. Fertilizer rates should be low in nitrogen, relative to rates commonly used to establish pastures, so as to discourage heavy ground cover growth while applying sufficient rates of phosphorus and potassium for optimal tree growth.



Photo 4. Soil compaction due to equipment operation on mine soils hinders survival and growth of planted trees. "Tracking in" operations, such as those shown in the photo, are NOT recommended for mine sites on which trees will be planted, unless required to stabilize steep slopes.

Step 4. Plant the right mix of tree species:

To produce a valuable forest that supports multiple uses, plant a mix of native timber species as crop trees. Such species include those that are compatible with the landowner's postmining forest-management goals, have the potential to grow into healthy trees where they are planted, and are found in the local area's mature forests. Depending on local conditions, such species can include the oaks, black cherry, sugar maple, white ash, and/or other species. Reforestation experts recommend that about 1/5 of the seedlings planted should be a mix of species able to survive in the open conditions commonly found on newly reclaimed sites and that support wildlife and soil improvement. Such species might include bristly locust, redbud, dogwood and crab apple, again depending on which are known to do well under local conditions. The species selected should be mixed as they are planted over the site, not planted separately as single-species

blocks. When all FRA steps are used, additional native species with seeds that can be carried by wildlife or wind will volunteer and establish on their own, leading to a species mix similar to the surrounding native forests. Mine operators should work with the State Regulatory Authority to develop reforestation plans that meet State requirements.

Step 5. Use proper tree planting techniques:



Photo 5. Planting a seedling at the White Oak reforestation project in Tennessee. Because the soil has not been compacted, a planting hole of the correct depth for the seedling can be opened easily. The seedling is being planted while still dormant, during the late winter season.



Photo 6. An emerging hardwood forest established on an active mine in Virginia as a demonstration of the Forestry Reclamation Approach.

Poor tree survival is often due to improper seedling handling or planting. Tree seedlings should never be allowed to dry out during storage and handling prior to planting, and should be kept dormant until planted. Seedlings should be kept cool, but should not be allowed to freeze, and should be protected from direct sunlight and high temperatures prior to planting. The

seedlings should be planted in late winter to early spring at the proper depth and firmly enough to ensure survival (Photo 5). Reputable and experienced crews are recommended for broad-scale, operational tree planting.

These five steps have been studied and field tested by ARRI Academic Team members from several of the universities contributing to this advisory (Photo 6), and plantings on active mine sites by coal mining firms using these techniques have been successful. ARRI members have determined that these steps can be implemented under current Federal and State regulations. We expect to provide additional information on each of these 5 steps in future Forest Reclamation Advisories.

The FRA is intended to be compatible with the mine-operator goal of cost-effective regulatory compliance. Avoidance of soil compaction requires that leveling and grading operations be minimized, which helps the operator control equipment operation costs. The species recommended for forest-compatible ground covers are widely available for reasonable costs, and are best seeded with fertilization rates lower than those

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Photo 7. Red oaks established on the Starfire mine in eastern Kentucky using the Forestry Reclamation Approach.

How does the FRA improve value, diversity, and succession of reclaimed forests?

The FRA is designed to restore forest land capability. When these five steps are followed, forest land productivity equal to or better than that which preceded mining can be restored. Furthermore, the FRA accelerates the natural process of forest development by creating conditions similar to those of natural soils where native forests thrive. By limiting compaction during reclamation, the growth medium becomes deep and loose, similar to the best forest soils. Temporary erosion-control ground covers are selected to allow native herbaceous and woody plants to seed-in, emerge, and grow. The ground cover species are meant to be sparse and slow growing in the months after seeding, after which they will yield to a more diverse species mix that will control erosion and will be self-sustaining as required by SMCRA. Over the longer term, the herbaceous groundcover will yield to native forest through the process of natural succession.

Natural succession is further accelerated by planting late-successional, heavy-seeded species such as the oaks, which are not

used commonly for grassland establishment. Selection of surface materials with chemical and physical properties suitable for trees and successful establishment of less-competitive groundcovers will increase survival of planted seedlings while allowing for invasion by native tree species from the surrounding forest. Avoidance of soil compaction will make it easier for tree planters to plant seedlings firmly and at the proper depth, thereby increasing survival rates.

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THE GEOPOLITICS OF ENERGY:
Achieving a Just and Sustainable Energy Distribution by 2040

BookSurge (98 pp.) \$24.99 paperback
ISBN: 978-1-4196-7588-1 Nov. 20, 2007

Geologists Wright and Conca have compiled a colorfully illustrated manual for understanding energy sources, energy usage and its future around the world. The authors take a new tack in exploring future energy needs: They consider the usage that will result when the entire population achieves a reasonable standard of living, as this provides a desirable ethical endpoint as well as a politically secure world. Wright and Conca explore the means of meeting this energy requirement by reviewing energy sources such as fossil fuels; renewables including biomass, hydroelectric, solar and wind; and geothermal and nuclear fuel. The discussion progresses with many details for the average reader, as well as charts and other illustrations. Following a section on energy use around the world and the economics of various power sources, the authors conclude that the future power source distribution should be evenly split among renewables, fossil fuel and nuclear. The final third of the book is primarily devoted to explaining nuclear energy and waste handling, including the use of nuclear power around the world and in the United States. Wright and Conca outline the basic chemistry behind nuclear power and how it differs for weapons versus energy, as well as its impact on carbon dioxide emissions and recycling/waste handling. Drawing on their training and professional experience, the authors explain the geology of the Waste Isolation Pilot Plant and Yucca Mountain Repository in detail that is not often found in energy discussions. Finally, Wright and Conca conclude with recommendations for achieving the desired energy future: educate world citizens, begin building immediately to have needed energy 30 years from now, increase environmental consciousness at the governmental level, help developing nations avoid the mistakes of the past and implement a carbon tax. This is an easily absorbed, knowledge-enhancing introduction to energy usage, distribution and goals. A useful educational title for a classroom or any citizen's home.

The GeoPolitics of Energy
Achieving a Just and Sustainable Energy Distribution by 2040
Judith Wright
James Conca

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dispersed from the native forest easily by wind and wildlife. Planting these heavy-seeded species puts them on site right away, allowing them to emerge with other species that can seed in on their own (Photo 7). When a good growth medium is established, as outlined in Steps 1 and 2 of the FRA, late-successional plants will thrive, especially when native soil is used or mixed with the suitable overburden materials. When native forest soils are used as a part of the growth medium, na-

tive vegetation establishment will be accelerated due to vegetation that sprouts from those seeds of forest understory and tree species that remain viable. Overall, such reclamation practices create a diverse and valuable forest of native trees that produces wood products and habitat for wildlife.

The FRA does not preclude mine operators from establishing tree crops such as biomass plantations, Christmas trees, or nut orchards, if such reclamation satisfies

permit requirements and meets landowner goals. In such cases, all of the above steps apply except that a tree crop is planted instead of a native hardwood mix. Tree crops will benefit from FRA reclamation.

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

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WESTERN RECLAMATION WITH A COMMUNITY EMPHASIS

Partnerships between the Colorado Inactive Mines Program, the Office of Surface Mining, and AmeriCorps “VISTA”

by Torie, Bowman, Support Coordinator, Western Hardrock Watershed Team

Anyone who has ever traveled to or over the rugged Rocky Mountains of Colorado knows the isolation and extreme life that the mountains help create. The communities still nestled in the far reaches of the mountains were established for the rich minerals discovered in the ground. However, the boom-bust economy of a century of mining left many of those remarkable communities struggling to maintain economic viability and to repair the degradation left behind. These communities are small but proud, and their residents have banded together to form community-based watershed groups to examine the quality of the water in their neighborhoods and the options for reclamation, all in areas already hard-pressed for citizen volunteers.

The Western Hardrock Watershed Team (WHWT) is an innovative partnership with the Office of Surface Mining and AmeriCorps*VISTA with partial funding from the Colorado Division of Reclamation, Mining and Safety's Inactive Mines Program, placing college-educated OSM/VISTA volunteers in a year of service with historic mining communities, providing them the support they so desperately need.

Developed and directed by Dr. T. Allan Comp of OSM and strongly supported by Loretta Pineda of the CO Division of Reclamation, Mining & Safety, the WHWT



works in 15 mining-impacted watersheds throughout Colorado with the aim to creatively remediate abandoned mine lands and restore waterways to the pristine “headwaters of the country” that are the Rocky Mountains. Our goals: build local capacity, monitor waterway quality, enhance outreach and education, engage economic redevelopment and promote professional development of our volunteers. Most importantly, OSM/VISTA listens to the community, helps them identify their specific needs and then begins a collaborative process to help these communities address their environmental, social, and economic challenges.

The community effort in Lake City, Colorado

One pristine Rocky Mountain watershed, the Lake Fork of the Gunnison River, has been listed on the U.S. Environmental

Protection Agency's 303(d) list of contaminated waterways and also serves as a major tourist attraction for the town of Lake City. High 14,000-foot peaks ring the upper watershed in the steep, picturesque San Juan Mountains of southwest Colorado. Henson Creek, a major tributary of the Lake Fork, was heavily mined in the late 1800s and early 1900s leaving behind numerous piles of tailings and waste rock, oftentimes with the streambed running immediately through them, especially in upper tributary, Palmetto Gulch. Responding to increasing concern of heavy metal loading from mines in the Upper Henson, the Lake Fork Watershed Stakeholders (LFWS) formed as a group in 2002, composed of community members and interested agency representatives who are dedicated to ensuring the health and maintaining the character of the Lake Fork of the Gunnison River watershed.



The stakeholder group has a long history of, as their OSM/VISTA Camille Richard describes, “community involvement to help bring attention to our troubled areas.” They initiated a basin-wide monitoring effort for Henson Creek, which later triggered the 2008 listing of Henson Creek as impaired. With their monitoring efforts, the Lake Fork Watershed Stakeholders were able to provide important data to the Bureau of Land Management to prioritize the reclamation sites on BLM land in the Henson Creek drainage. To date, up to six sites are either finished or in the process of reclamation. The LFWS began working with the Western Hardrock Watershed Team one year ago, hiring local Camille Richard as their OSM/VISTA. Richard is a former Peace Corps member who has worked internationally in organizational development, fundraising, and coordination of non-profits. Her skill and commitment allowed the Lake Fork WS to refocus their goals on the more challenging task of major reclamation on private land in the upper reaches of the watershed. One such AML site, the Hough Mine, rests on the edge of the 4-wheel/jeep road that summits Engineer Pass and brings thousands of tourists to the area each year. Too often, visitors are drawn to the unstable and toxic remains located less than a hundred yards from the road, posing a significant danger to those curious explorers. The

Hough Mine poses the additional challenge of being located on two different parcels of private land, one of which is a placer claim that lies on the tailings and waste piles and 58 surrounding acres. The full-time presence of the OSM/VISTA working in the watershed allowed the Lake Fork WS to begin dialogues with the landowners, state agencies, and concerned citizens to explore remediation options – first tackling the issues of ownership and liability in regard to cleanup. This enormous undertaking is typical of what communities must deal with before any reclamation can take place, and as Richard notes, “that’s the stickiest part.”

The Lake Fork WS has been working for the past several months to form a committee for the Hough Mine project and to bring the private landowners to the table. They are currently working on ownership options with partnering organizations such as the Bureau of Land Management and a regional land trust, the Trust for Land Restoration. Options at this point vary from land donation or conservation easements to outright purchase of the land. The next step that the Lake Fork WS is preparing to enter will be the burden of liability and legal responsibility for the reclamation work. But OSM/VISTA Richard is committed to working out those details and working to maintain high community interest in the project.

Sharing experiences

Not only is Richard dedicated to seeing the remediation process through to the construction work, but she is committed to including other communities in a dialogue about the burdensome legal processes of voluntary remediation work. In September 2008, the Lake Fork WS held the first state-wide workshop on voluntary mine cleanup titled “Preserving Our Environmental and Mining Heritage: Options for Voluntary Cleanup of Abandoned Mine Sites.” Citizens from around the state, those who have been through the processes and those who hope to tackle these problems in their community watersheds, gathered together to discuss past examples and future options for voluntary cleanup.

The OSM/VISTA’s dedication to replicating the work of the Lake Fork WS proves that the Western Hardrock Watershed Team can help successful remediation of not only one or two watersheds, but hundreds of groups in multiple states. With these tangible successes in our first year of operation, we are looking to expand our programming into other states, and have already piqued the interest of several. The Western Hardrock Watershed Team is working to remediate not only abandoned mine lands, but also the lack of community education and awareness, economic viability, and funding. ■

YES, WE CAN SOLVE URGENT ENERGY CHALLENGES WITH COAL

U.S. President Barack Obama has made his opinion about clean coal clear: “Clean coal technology is something that can make America energy independent,” he recently said. “This is America. We figured out how to put a man on the moon in 10 years. You can’t tell me we can’t figure out how to burn coal that we find right here in the United States of America and make it work.”

The president reminds us that affordable energy is the foundation of our fragile global economy and the engine of our recovery. Coal is already America’s most abundant energy source, which is why it fuels half our electricity at just a fraction of the cost of other fuels. And coal alone has the scale and cost advantages to deliver the “Three Es” – environmental solutions, economic stimulus, and energy security.

The need for affordable energy from coal is urgent. As billions of people awaken to the benefits of modern electricity, global energy demand will grow 45 percent in the next quarter century, according to the International Energy Agency (IEA). World coal use will increase 61 percent during the same period.

America must lead development of the coal-fueled technologies that will meet these enormous energy needs, create jobs, generate growth and improve lifestyles, enabling people to live longer and better. And we can do so while achieving our long-term carbon goals. Coal’s improving environmental track record gives it a new green profile. Clean coal technologies have already improved the “environmental efficiency” of coal resulting in an 84 percent reduction of regulated emissions per ton of coal, based on an analysis of U.S. Environmental Protection Agency data.

Peabody Energy (NYSE: BTU) is a global leader in clean energy solutions from coal, is recognized around the world for creating a model for sustainability, and has a long history of environmental stewardship. Through Operation Green Earth, Peabody began restoration activities two decades before the 1977 Surface Mining Control and Reclamation Act (SMACRA) required reclamation. Mined lands are re-

turned for productive rangeland, farmland, forest, wildlife habitat, wetlands and recreation areas, typically to a condition that is better than before mining occurred. Employees have garnered numerous awards for activities ranging from an innovative American Chestnut recovery program in the U.S. Midwest to a successful sharp-tail grouse wildlife recovery program in the American West to rivulet restoration in Australia. Peabody has also received international acclaim at the Energy Globe Awards in Brussels, Belgium, for developing a sustainable model for community and environmental practices on tribal lands in Arizona over the past 40 years.

The world needs all forms of energy to meet long-term demand. But the alternatives have inherent limitations. The world’s most productive oilfields are depleting. What’s left is harder to find, more difficult to drill, and more expensive to produce. Major oil and natural gas supplies also come from unstable nations that are increasingly willing to use resources for political gain. Other high-profile forms of energy remain too small or too scarce to provide energy at the scale needed to meet growing global needs.

As the world’s largest private-sector coal company, Peabody is uniquely positioned to advance energy solutions. Peabody provides 10 percent of the United States’ electricity and 2 percent of global power and serves customers in 21 countries on six continents representing more than half the world’s population. The company is also the global leader in clean coal technology, advancing the vision of near-zero emissions from coal through projects on three continents: GreenGen in China, Coal21 in Australia and FutureGen in the United States. Each of these projects would capture carbon dioxide (CO₂) for storage or enhanced oil recovery.

Technologies separate the carbon dioxide from coal use and compress it into a fluid-like state that is as dense as liquid, making it easier and less costly to transport via pipelines. The CO₂ is injected deep underground in oilfields, caverns, saline fields and deep beneath the ocean floor in geol-

ogy that has stored methane, coal and oil through the millennia.

The world has ample room for carbon storage. Just as we are blessed with good geology for coal, nature has also bestowed good geology for carbon storage. In the United States, for instance, we could sequester CO₂ for the next century and wouldn’t even use up 10 percent of the potential geology that’s suitable for storage, based on an analysis by Pacific Northwest National Laboratory. We have, in fact, enough capacity for hundreds of years of storage around the world.

CCS can also produce greater supplies of other energy. One of the most promising early applications for carbon storage is in aging oilfields for enhanced oil recovery. This process alone could lead to production of another 2 to 3 million barrels of oil per day in the United States, according to the National Coal Council. Other promising technology paths beyond coal gasification include reducing CO₂ in an oxygen-rich environment during combustion or using scrubbing agents for removal. And studies show that coal with carbon capture and storage is 20 percent to 50 percent less expensive than alternatives such as natural gas with carbon capture and storage, nuclear or wind power.

The clean coal vision for the future is shared: A recent poll by Washington, D.C.-based R.T. Strategies found that 72 percent of U.S. opinion leaders support the use of coal for electricity generation. In the same national poll, 69 percent view electricity as a fuel of the future.

We need all forms of energy to fuel growing global needs, and coal will continue to shoulder the load. The strength of our international economy is linked to our energy choices, and we have the power to make change. Let’s build more wind turbines and solar panels. And let’s also build new coal plants, liquid natural gas terminals and oil refineries. Together we can capitalize on the single resource that is most needed to deliver secure, affordable energy supplies and environmental solutions: our own willpower.

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A CHINESE STUDENT'S ACADEMIC EXPERIENCE IN THE USA

by Jack Nawrot, Southern Illinois University



The Kubota "driving lesson" depicts Robynn Nawrot and Yufen enjoying their last Saturday afternoon together at the Nawrots' home.

Yufen Hao recently spent a year in the United States of America, learning about Illinois reclamation. During this past year with the Southern Illinois University at Carbondale's graduate research program, Yufen had the opportunity to visit reclaimed and active coal mine sites to see first-hand restored croplands, forests, wetlands, restored streams, grasslands, and directly-vegetated coal waste areas that had been established on mined lands in Illinois and Kentucky. Special topics that interested Yufen included site visits of reclaimed croplands, fish and wildlife management areas established on pre- and post-law lands, and underground mines that had experienced both planned and unplanned subsidence. The Illinois' and U.S. regulatory emphasis on protecting versus draining wetlands was probably more of a cultural shock to Yufen than some of our Illinois students' obsessions with pick-up trucks, hunting, guns, and eating wild game.

Discussions with regional and state legal and technical regulatory staff provided Yufen with an interesting perspective of the mine permitting process, as well as legal and technical challenges faced by both the U.S. coal operators and the regulators. Learning that the Illinois permit review process and public input for mine permits may take as much as nine years before a permit is finally approved, emphasized the "openness" and "thoroughness" of our regulatory program that allows other private citizens the right to comment on how privately owned land and privately owned mineral rights are used. Witnessing the progression of land use changes from pre-law forest reclamation practices to post-law agricultural cropland restoration clearly demon-



Yufen samples soil from a switchgrass stand at the reclaimed CONSOL Burning Star 5 Mine in southern Illinois.

strated to Yufen that Illinois' and the U.S. mining and reclamation practices have evolved in response to changing environmental and agricultural interests, and increasingly stringent federal regulations.

Yufen clearly noticed, since she was acquainted with many of our laboratory's traditional "Bugs and Bunnies" graduate students that we are fortunate in the

United States to still have diverse wildlife habitat to be concerned about. Our regulations that protect and restore wildlife habitat along with croplands, forests, streams, and groundwater resources, is a model that Yufen appreciates and hopes to emphasize in her professional career as she continues her work with Professor Zhenqi Hu at China University of Mining

and Technology in Beijing, where she is currently a Ph.D. student.

United States' mining company representatives, as well as other ASMR reclamation scientists should stop in at CUMTB the next time they are in Beijing and visit Yufen and the Institute Director, Dr. Zhenqi Hu. Yufen is now a proficient English-Chinese translator. Yufen has an excellent understanding of English mining and reclamation terminology. Commonly used terms such as "redneck" and unprintable quotes from our former Illinois governor's phone conversations have truly enriched the breadth and depth of Yufen's understanding of our culture and political processes during this most interesting year.

Attending the 2008 ASMR Richmond meeting provided Yufen an opportunity to learn more about RUSLE2 and meet its "very good tempered" author Terry Toy. Attending The Wildlife Society's annual conference in Miami, Fla., with our lab students gave Yufen a road trip adventure that included side trips to Key West and the Everglades. Yufen's "genuine American road trip" during Christmas break ensured that our country's culturally significant landmarks of Bourbon Street, the Alamo, and Elvis's Graceland were not overlooked. Our laboratory's students and staff, and my wife Robynn, truly enjoyed the experience of Yufen's visit this past year. ■

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A PERIODIC TABLE OF PASSIVE TREATMENT FOR MINING INFLUENCED WATER

by James J. Gusek, P.E., Golder Associates

Introduction

The community of regulators and engineers that specializes in passive water treatment should be familiar with the passive treatment “decision tree” that was published by the former U.S. Bureau of Mines about 14 years ago (see Figure 1). The decision tree was originally intended to address mining influenced water (MIW) from coal mines. But since then, the breadth of passive treatment has expanded to embrace precious and base metal mines, uranium mines, and even gravel pits. Each MIW has its unique signature, either imposed by the natural geochemical conditions of the ore body and surrounding mine waste, or by resource recovery processes that may include heap leaching or traditional hydrometallurgical technologies. In the context of the elements of the periodic table, the decision tree is no longer applicable as it was developed to focus on coal geology derived MIW, which typically contains acidity/alkalinity, iron, aluminum and manganese. For example, the decision tree does not consider residual ammonia or nitrates from blasting, cyanide from heap leach pad rinsing, trace amounts of selenium, or other parameters that may require passive treatment at a given mine, coal or otherwise.

With apologies to Dmitri Ivanovich Mendeleev, a “Periodic Table of Passive Treatment” could become a useful design tool. This revised table would focus on identifying passive treatment methods that have been observed to work on specific elements or species of elements based on the

author’s experience or other practitioners of the technology.

Background

The Periodic Table of Elements (PTE) was first introduced by the Russian chemist Dmitri Ivanovich Mendeleev in 1871. Fifty-seven of the elements had been discovered prior to that date, and the rest discovered since then. Mendeleev’s contribution to sci-

ence was monumental. Discovery dates of most of the primary elements associated with MIW are lost in pre-history. Many of these were discovered in the native state: iron in the form of meteorites, native copper, silver, gold, platinum and tin in nugget form in alluvial deposits, carbon in coal form, and native sulfur, the “rock that burns” and appropriately labeled “brimstone.” The scientific and industrial

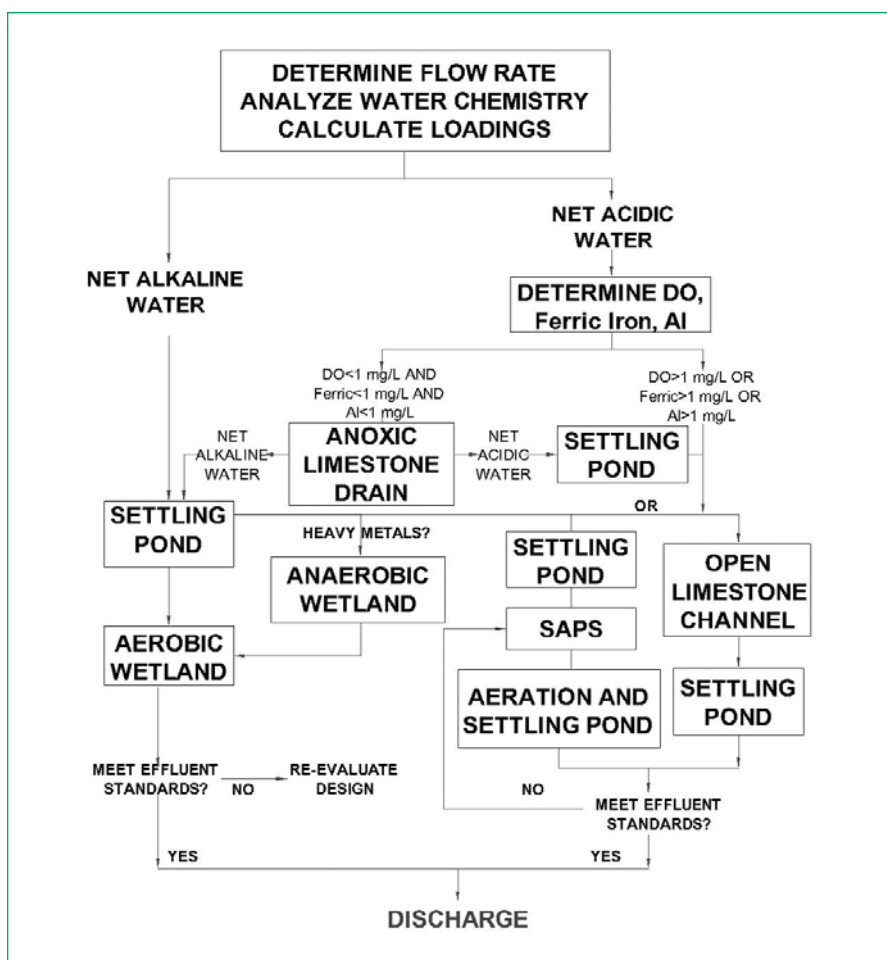


Figure 1. – USBM Passive Treatment Decision Tree (after Hedin)

revolution of the 18th and early 19th centuries yielded most of the rest of the elements that Mendeleev categorized. He brilliantly organized the elements into similar groups, which we now know are governed by how their atomic structures are arranged. The reader need not panic – this is the last and only mention of atomic theory.

The concept of “mining influenced water” was first introduced by Schmiermund, and Drozd (1997). It covers the breadth of solutions ranging from what might be termed traditional acid rock drainage (ARD) and neutral mine drainage to the mining process solutions that may be very alkaline, such as sodium cyanide solutions used in the recovery of gold or silver in heap leaching or milling operations. The multiplicity of MIW sources compounds the problems facing engineers charged with MIW treatment system designs; consequently, every treatment system, whether active or passive, seems to require some site-specific customization. Before passive treatment approaches to various groups in the periodic table can be discussed, it is appropriate to consider the accepted definition of the term “passive treatment.” In the past, “constructed wetlands” was in common usage, but this term carries much regulatory baggage and is not appropriate for many passive treatment unit processes.

To paraphrase Gusek (2002):

Passive treatment is a process of sequentially removing contaminants and/or acidity in a natural-looking, man-made bio-system that capitalizes on ecological, and/or geochemical reactions coupled with physical sequestration. The process does not require power or chemicals after construction, and lasts for decades with minimal human help.

Passive treatment is a sequential process because no single treatment cell type works in every situation or with every MIW geochemistry. It is an ecological/geochemical

process, because most of the reactions (with the exception of limestone dissolution) that occur in passive treatment systems are biologically assisted. Lastly, it is a removal process, because the system must involve the filtration or immobilization of the metal precipitates that are formed. Otherwise, they would be flushed out of the system, and the degree of water quality improvement would be compromised.

Certainly, some MIW elements are considered “easy,” such as iron and hydrogen ion (the basic unit of acidity). These have been the focus of typical coal geology derived MIW since the early 1980s. Conversely, most common anions such as sodium, chloride, and magnesium and other components of total dissolved solids (TDS) are conserved in traditional passive treatment systems and are virtually unaffected. Next are the elements associated with traditional metal mining: iron (again), copper, lead, zinc, cadmium, mercury, and arsenic. These elements are typically found in metal mine ores and wastes as sulfides, and passive treatment designers typically focus on creating conditions favorable to sulfide precipitation, such as those found in biochemical reactors (BCRs). Fortunately, acid rock drainage formation involving pyrite evolves sulfate needed in BCRs, but sulfate in and of itself can become an MIW issue. Aluminum and manganese are special cases worthy of focused consideration.

The compounds associated with MIW that do not receive much attention from a passive treatment perspective might include:

- Ammonia and nitrate (residue from blasting agents).
- Selenium.
- Uranium and radium.
- Cyanide and cyanide complexes.
- Thallium.

The definition of MIW may be driven by regulations. Coal mines need to worry about: pH, aluminum, iron, and manganese. However, it has been this author's experience that coal geology derived MIW



Figure 2. – Fran Coal Site with acidic MIW

typically contains other heavy metals including nickel, copper, zinc, and cobalt. For example, the MIW chemistry from the Fran Coal Mine in Clinton County, Penn., (Figure 2) has much in common with the chemistry of the Berkley Pit MIW in Montana. Fortunately for Pennsylvania, the volume of MIW involved at the Fran Mine is many orders of magnitude less. Regardless, in designing a BCR for the Fran Mine, the non-regulatory parameters needed to be considered. Putting these parameters in proper perspective has been a design challenge for the past 20 years: How can parameters be grouped to streamline the design process? Naturally, revisiting Mendeleev's Periodic Table of Elements (since revised) might be a good place to start.

Periodic Table of Elements Review and Typical MIW Related Elements

Oriented horizontally, the periodic table of the elements (Figure 3) is organized into seven periods or rows of elements and the Lanthanide and Actinide Series (omitted in Figure 3). Oriented vertically, there are 18 groups or columns of elements. The noble gases are found on the right side of the table; hydrogen and the cations such as

Figure 3. – Simplified Periodic Table of Elements sans Lanthanide and Actinide Series

1		Group Numbers										18							
1	<u>H</u>	2											13	14	15	16	17	<u>He</u>	
3	<u>Li</u>	4	<u>Be</u>											5	6	7	8	9	10
11	<u>Na</u>	12	<u>Mg</u>	3	4	5	6	7	8	9	10	11	12	<u>Al</u>	<u>Si</u>	<u>P</u>	<u>S</u>	<u>Cl</u>	<u>Ar</u>
19	<u>K</u>	20	<u>Ca</u>	<u>Sc</u>	<u>Ti</u>	<u>V</u>	<u>Cr</u>	<u>Mn</u>	<u>Fe</u>	<u>Co</u>	<u>Ni</u>	<u>Cu</u>	<u>Zn</u>	<u>Ga</u>	<u>Ge</u>	<u>As</u>	<u>Se</u>	<u>Br</u>	<u>Kr</u>
37	<u>Rb</u>	38	<u>Sr</u>	<u>Y</u>	<u>Zr</u>	<u>Nb</u>	<u>Mo</u>	<u>Tc</u>	<u>Ru</u>	<u>Rh</u>	<u>Pd</u>	<u>Ag</u>	<u>Cd</u>	<u>In</u>	<u>Sn</u>	<u>Sb</u>	<u>Te</u>	<u>I</u>	<u>Xe</u>
55	<u>Cs</u>	56	<u>Ba</u>	<u>La*</u>	<u>Hf</u>	<u>Ta</u>	<u>W</u>	<u>Re</u>	<u>Os</u>	<u>Ir</u>	<u>Pt</u>	<u>Au</u>	<u>Hg</u>	<u>Tl</u>	<u>Pb</u>	<u>Bi</u>	<u>Po</u>	<u>At</u>	<u>Rn</u>
87	<u>Fr</u>	88	<u>Ra</u>	<u>Ac~</u>	<u>Rf</u>	<u>Db</u>	<u>Sg</u>	<u>Bh</u>	<u>Hs</u>	<u>Mt</u>	---	---	---		---		---		---

lithium, sodium, and potassium are found on the left side of the table. The elegance of this organization is that the elements of a single group tend to behave similarly in chemical reactions and that applies to behavior in passive treatment systems, as well. Why this happens is not a concern to passive treatment designers, but the fact that it does has yet to be fully embraced.

For the sake of simplicity, the focus of the discussion will be elements and compounds that are problematic or “interesting” associated with MIW.

Group 1 – Hydrogen (H), Sodium (Na), and Potassium (K)

Group 2 – Magnesium (Mg), Calcium (Ca), Barium (Ba), Radium (Ra)

Group 3 – No traditional MIW elements or compounds

Group 4 – No traditional MIW elements or compounds

Group 5 – Vanadium (V) and Uranium (U) [Actinide Series]

Group 6 – Chromium (Cr), Molybdenum (Mo)

Group 7 – Manganese (Mn)

Group 8 – Iron (Fe)

Group 9 – Cobalt (Co)

Group 10 – Nickel (Ni)

Group 11 – Copper (Cu), Silver (Ag), Gold (Au)

Group 12 – Zinc (Zn), Cadmium (Cd), Mercury (Hg)

Group 13 – Aluminum (Al), Thallium (Tl)

Group 14 – Carbon (C), Lead (Pb)

Group 15 – Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb)

Group 16 – Oxygen (O), Sulfur (S), Selenium (Se)

Group 17 – Fluorine (F)?, Chlorine (Cl)

Group 18 – Noble Gases, No traditional MIW elements or compounds

Periodic Table of Passive Treatment for MIW

From a passive treatment system designer’s perspective, there are several basic components available “off-the-shelf” as shown on the traditional passive treatment “decision tree.”

- Sulfate reducing bioreactors.
- Aerobic wetlands.
- Anoxic limestone drains.
- Oxidation and settling ponds.
- Successive alkalinity producing systems (SAPS).
- Open limestone channels and limestone beds.

Recently, the sulfate reducing bioreactor has evolved into a more universal MIW

passive treatment role. The evolution of the name for this specialized passive treatment unit has included over the years:

- Compost wetland.
- Anaerobic cell or wetland.
- Sulfate reducing bioreactor (SRB or SRBR).
- Vertical flow pond.
- Biochemical reactor (BCR).

Many practitioners agree that the BCR moniker captures many facets of the



Figure 4. - Aluminum, Copper, and Cobalt MIW in Soudan Underground Mine in Tower, Minnesota

The oxidation-reduction potential conditions prevailing in the off-the-shelf components will typically control the bio-geochemical reactions that occur there. Oxides and hydroxides will form in aerobic zones and reducing conditions are favorable for the formation of both oxides and other reduced species such as sulfides. Table 1 characterizes each component with respect to prevailing oxidation-reduction potential conditions. The color coding, when applied to the periodic table, should show at a glance how various elements and groups of elements might be treated passively.

1					
H	2				
Li	Be				
11 Na	12 Mg	3	4	5	6
19 K	20 Ca	Sc	Ti	23 V	24 Cr
Rb	Sr	Y	Zr	Nb	42 Mo
Cs	56 Ba	La*	Hf	Ta	W
Fr	88 Ra	Ac~	Rf	Db	Sg
				92 U	
Actinide Series					

Passive System Component	Aerobic (> zero mv) Oxidizing Conditions	Anaerobic (< zero mv) Reducing Conditions
Biochemical bioreactors	X (upper 2-3 cm)	X (most of the cell mass)
Aerobic wetlands	X	
Oxidation & Settling ponds	X	
Anoxic limestone drains		X
Successive alkalinity producing systems	X (upper 2-3 cm)	X (most of the cell mass)
Open limestone channels and limestone beds	X	

Of course, the red-shaded elements (Na, K, Cl), which may be associated with elevated TDS, are not affected by the off-the-shelf passive treatment processes. Calcium, which is also conserved or involved in the generation of hardness, is a beneficial ion and it is, therefore, color coded in green. There are specialized situations where elevated fluorine (as fluoride) has been a component of MIW. Being immediately above chlorine, passive fluoride removal is not straightforward. In acidic MIW, fluo-

The discussion will now progress through the elements remaining in the various groups as shown in Table 2. The references are provided to provide guidance for cursory additional research and are not intended to be all-inclusive.



Table 2. – Passive Treatment of Typical Elements and Species in MIW

Group	Element or Species	Suspected or Documented Mechanisms/Passive System Components	Reference
1	Hydrogen ion	H ⁺ can be addressed aerobically and anaerobically: limestone dissolution in ALDs, OLCs, BCRs and SAPS and microbial bicarbonate alkalinity in BCRs or SAPS	Conventional Wisdom (multiple refs) Gusek et al. 2000
2	Magnesium	Mg has been observed being removed by the replacement of calcium in limestone to form suspected dolomitic limestone in a pilot BCR in Slovakia	
2	Barium	Dissolved barium can be precipitated aerobically or anaerobically as the insoluble barium sulfate by comingling with slightly elevated sulfate bearing MIW	Unpublished data
2	Radium	Uncertain mechanism – Ra 226 was observed being removed in a BCR pilot in 1993.	Whitmer and Saunders 2000
5	Vanadium & Uranium	V and U occur naturally in uranium roll front deposits which form in reducing conditions prevalent in BCRs	Ozawa et al. 1995
6	Chromium	Reduction to Cr ⁺³ with hydrolysis/ precipitation of chromium hydroxide in BCRs	Unpublished data
6	Molybdenum	Molybdenum removal in a pilot BCR was observed in 1994	Conventional Wisdom, Robbins &
7	Manganese	Precipitation of MnO ₂ facilitated by algae; presence of limestone is recommended but not required; MnCO ₃ (rhodochrosite) formation suspected in over-loaded BCRs	Ziemkiewicz 1999 & Multiple refs Conventional Wisdom (multiple refs)
8	Iron	Fe precipitation as ferric oxy-hydroxide in aerobic wetlands, OLCs, oxidation ponds, and the surface zone of BCRs; iron sulfide precipitation in BCRs and reducing zone of SAPS	Eger 1992 Hammack and Edenborn 1991
9	Cobalt	Cobalt sulfide formation in BCRs	Wildeman et al. 1990
10	Nickel	Nickel sulfide formation in BCRs	
11	Copper	Copper sulfide formation in BCRs	
11	Silver	Silver sulfide formation in BCRs	Wildeman et al. 1990.
11	Gold	Native gold precip. in BCRs is possible but undocumented	Unpublished data
12	Zinc	Precipitation of sphalerite (ZnS)	Unpublished data
12	Cadmium	Cd removal in a pilot BCR suspected to be as greenockite (CdS) observed in 1994	Conventional Wisdom &
12	Mercury	Cinnabar (HgS) in BCRs – some uncertainty of Hg methylation in BCRs	(Thomas, 2002)
13	Aluminum	Al hydroxide (gibbsite) precipitates in well-buffered MIW in aerobic wetlands, OLCs, SAPS, ALDs; aluminum hydroxy-sulfate precipitation in BCRs	(Blumenstein et al. 2008) Cellan et al. 1997
13	Thallium	Tl sulfide co-precipitation with FeS in BCRs	Wildeman et al. 1994
14	Cyanide	CN degradation anaerobically in BCRs	Conventional wisdom (multiple refs)
14	Cyanide	CN degradation aerobically by UV light in aerobic wetland	
14	Biochemical Oxygen Demand (BOD)	By-product of BCRs – polished with aerobic wetlands	Wildeman et al. 1993. EPA 1988
14	Lead	PbS precipitation in BCRs	EPA 1988
15	Ammonia	NH ₃ is oxidized to nitrate in aerobic wetlands and is also utilized by plants	EPA 1988
15	Nitrate/ Nitrite	NO ₃ and NO ₂ are denitrified in BCRs to N ₂	Wildeman et al. 1994
15	Phosphate	Plant uptake in aerobic wetlands	
15	Arsenic	Removal in aerobic conditions adsorbing to iron oxy-hydroxide and anaerobic (BCR) conditions as sulfide	
15	Antimony	Stibnite (Sb ₂ S ₃) formation in hot springs environments may be similar to conditions in a BCR – removal data lacking	Conventional wisdom (multiple refs)
16	Oxygen	Depressed dissolved oxygen from BCRs is polished with aerobic wetlands; oxygen is required in aerobic wetlands and other situations to precipitate iron.	Conventional wisdom (multiple refs) Conventional wisdom (multiple refs)
16	Sulfate	Sulfate is removed by microbial conversion to sulfide in a BCR	Conventional wisdom (multiple refs)
16	Sulfide	Sulfide is scavenged by sacrificial metals such as zero valent iron	
16	Selenium	Selenium is removed by microbial conversion to elemental selenium or iron selenide precipitates in a BCR	



Figure 6. – Author Testing Iron and Zinc Bearing MIW at an Abandoned Pb-Zn Mine in Colorado

Summary

The proposed Periodic Table of Passive Treatment (PT²) offers another view of the sometimes complicated picture of conflicting priorities in treating MIW passively. In some instances, the author has no specific experience with a particular element (e.g., antimony) and was not successful in finding a reference in the over 3,000 technical papers found in the combined proceedings of the American Society of Mining and Reclamation (ASMR), International Conference on Acid Rock Drainage (ICARD), the West Virginia Mine Drainage Task Force Symposia, and the Tailings and Mine Waste Conferences.

As suggested earlier, the proposed PT² is a starting point to a more complete understanding of the complicated bio-geochemistry behind the passive treatment design process. It should be considered a logical expansion of the former USBM passive treatment decision tree, and like Mendeleev's original work over 130 years ago, should be the focus of future enhancement.

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NUTRIENT FLUXES FROM ABANDONED MINE SOILS RECLAIMED WITH POULTRY MANURE AND PAPER MILL SLUDGE

by Ashlee L. Dere, Kirsten E. McDonald, and Richard C. Stehouwer, Penn State University

In Pennsylvania alone, there are over 250,000 acres of unreclaimed surface mine lands. The soil at many of these abandoned mine lands (AML) supports poor vegetative cover due to acidity, limited water holding capacity, degraded soil physical properties, and low levels of organic matter and nutrients, especially N and P (Bendfeldt et al. 2001). In addition, Pennsylvania is home to numerous intensive animal production facilities, which produce large quantities of manure. Poultry manure in particular is a problem, as these enterprises are often concentrated on small parcels of land and lack the land base for the manure produced. These operations have enriched soil N and P levels, creating the potential for these nutrients to reach waterways and, ultimately, the Chesapeake Bay and have forced many operations to transport manure out of the watershed in which it is produced. Often these two environmental problems occur in close proximity, making the use of poultry manure for mine reclamation a logical solution to both issues.

Research and experience in mine reclamation has shown that adding large quantities of organic materials will improve revegetation success. The risk in using poultry manure, however, is that adding enough manure to obtain the desired organic additions greatly overloads the nutrients in the soil, likely creating yet another environmental problem. Our research is investigating methods of processing and utilizing poultry manure for reclamation that will avoid this problem while also creating mine soils that can sustainably produce large yields of biomass crops for biofuel. We are using two approaches to achieve this: one is to compost the fresh manure

with a high carbon material such as leaf and yard waste, and the other is to simply mix a high carbon (C) material with fresh manure during application to the mine soil. This second approach effectively changes the C:N ratio of the manure by applying and incorporating the materials in situ at the reclamation site. Studies done by Daniels et al. (2001) and Schmidt et al. (2001) have demonstrated that the use of high C material (sawdust) can improve both agricultural yields and grass biomass, respectively, and reduce nitrogen leaching loss when co-applied to reclaim soil. Paper mill sludge, a byproduct of the paper industry, is an ideal candidate due to the high carbon content of the short fibers in the material and the wide availability of the waste product. This material, although variable in composition from one source to another, can not only add C to the soil, but also increases pH due to its high calcium carbonate equivalency, helping retain nutrients by adjusting the C:N ratio, and improving vegetative growth (Haering et al. 2000).

We first conducted a greenhouse experiment for initial testing of these ideas. We mixed various rates of composted manure, ratios of fresh manure mixed with paper mill sludge, and fresh manure alone into acidic mine spoil. The columns were planted with switchgrass and periodically leached with water to measure the amount of nutrients lost via leaching. Although fresh manure alone produced good plant growth, it also resulted in very large nitrate (NO_3^-) and phosphorous (P) leaching losses. By contrast, both composted manure and fresh manure mixed with paper mill sludge, greatly decreased nutrient loss and increased vegetative growth compared

to the manure alone amendment. Based on the positive results in the greenhouse, we proceeded with a field experiment on an AML site where we could examine nutrient losses from compost and manure plus paper mill sludge under real world field conditions.

Materials and methods

We started the field experiment in spring 2006, and have continued to monitor nutrient losses and plant growth since. The field site is an abandoned coal surface mine from the 1950s located in Schuylkill County, Pa., (Figure 1.). The soil is classified as an Udorthent strip mine and initial



Figure 1. Photo of the site taken in (top to bottom) April 2006 (before amendment application), August 2006, January 2007, and June 2008. Vegetation is predominantly annual ryegrass in August 2006 and January 2007; switchgrass is dominant in June 2008. A covered dry well can be seen in the foreground.



Figure 2. Pan lysimeter installation in the center of a plot (top). The leveled pan in the foreground drained to a carboy at the bottom of the PVC well in the background. The pan was then covered with the original soil removed from the trench. Plastic carboys were placed in each well to collect the leachate (bottom).

site texture was a very channery sandy loam with a soil pH of 5.1.

Five reclamation treatments were each replicated four times in a randomized complete block design with each plot measuring 6.1 m by 9.1 m. The treatments included the standard reclamation practice control of lime (6 tons acre⁻¹) and inorganic fertilizer amendment (100 lbs N acre⁻¹ as ammonium nitrate; 175 lbs P acre⁻¹ as triple super phosphate; 166 lbs K acre⁻¹ as KCl), two rates of composted poultry layer manure (35 and 70 tons acre⁻¹ dry weight), and two blends of fresh poultry manure (22.5 tons acre⁻¹ dry weight) mixed with paper mill sludge (46 and 82 dry tons acre⁻¹) to achieve C:N ratios of 20:1 and 30:1 (manure+PMS). Rates were chosen based on results obtained in the preliminary greenhouse

study. The poultry manure had an initial C:N ratio of 7.3:1 while the paper mill sludge had a C:N ratio of 126:1. The poultry manure was composted by mixing with leaves, shredded wood and water and placed in an open windrow with regular turning. The fresh manure and paper mill sludge treatments were hauled to the abandoned strip mine and mixed on-site to produce the desired C:N ratio blends. We spread all amendments on the soil surface and mixed them to a depth of about 2 to 3 inches using the teeth on a front-end loader bucket. Due to the extremely rocky nature of the site, it was not possible to achieve deeper incorporation.

Before applying any amendments, we installed 1-ft² zero-tension pan lysimeters 12 inches below the soil surface to allow collection of leachates (Figure 2). Drain lines connected to the pans drained leachate to carboys located in dry wells outside the plot area (Figure 2). Following every rainfall event large enough to generate lysimeter flow, we measured the volume of water collected and brought a sample back to the lab for analysis.

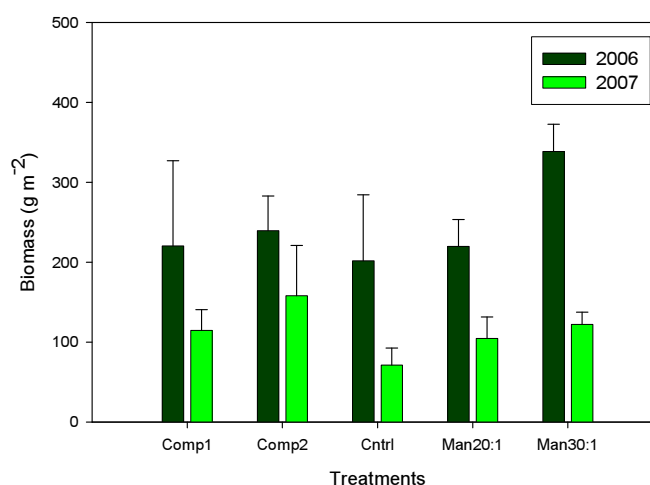
We seeded the plots with 10 lbs acre⁻¹ of switchgrass (*Panicum virgatum* L., var. Cave-In-Rock) and 2 lbs acre⁻¹ of annual ryegrass (*Lolium rigidum* Gaud.) as a nurse crop; plots were then mulched with straw.

Vigorous ryegrass growth prevented the establishment of switchgrass in the first year after planting, therefore plots were reseeded with 20 lbs acre⁻¹ of switchgrass seed in spring 2007 and mowed in May and June 2007 to minimize ryegrass competition. Soil samples were taken in the spring and fall of each year. A soil auger was used to take five random cores from within each plot to a depth of 2 inches, the approximate depth of amendment incorporation.

Grass yields

Four months after amendment application all treatments had good vegetative cover, though annual ryegrass was the dominant species (Figure 1). The 30:1 manure+PMS treatment showed better growth than the other treatments. In the second year, however, the compost treatments and manure+PMS mixes produced larger biomass yields than the control of lime and fertilizer even though overall yields were lower as the grass population shifted from ryegrass to switchgrass (Figure 3). Additionally, the higher rate of compost produced larger yields than the smaller compost application. These data, although clearly preliminary, demonstrate the effectiveness of the organic treatments to improve vegetative growth compared to mine soils reclaimed with customary lime and

Figure 3. Biomass of plants by treatment in 2006 and 2007. Plant samples were collected from a 1-m² quadrant in late summer. Both compost and manure+PMS treatments show significantly more biomass accumulation in the second year of the experiment.



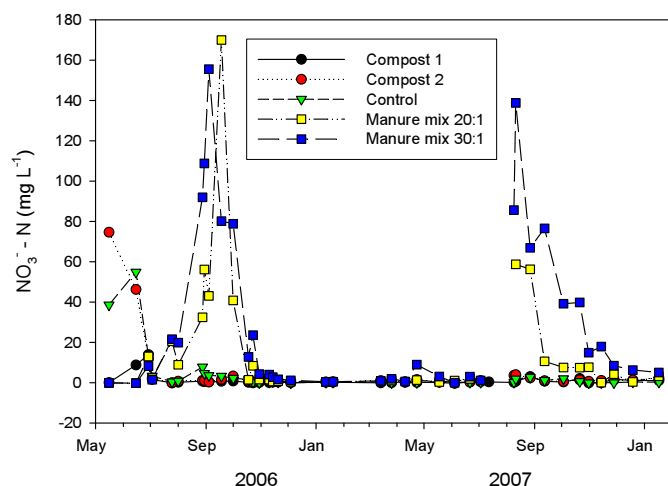


Figure 4. Effect of compost, manure+PMS, and limestone and fertilizer (control) amendment of mine soil on leachate concentrations of NO₃⁻ during 20 months following application. Large spikes of N loss are observed only in the two manure+PMS mixes in September of each year; all other treatments lost minimal NO₃⁻ following initial application of amendments.

fertilizer. We will continue to monitor biomass yields for several more years to determine the long-term effect of these amendments on sustained biomass production.

Leachate analysis

Three months after application, a considerable pulse of NO₃⁻ was observed in leachates from the two manure+PMS treatments, with maximum concentrations reaching 170 mg N L⁻¹ (Figure 4). This pulse subsided after three months and leachate concentrations decreased to below 10 mg N L⁻¹ thereafter. In September of the second year, another large spike of NO₃⁻ was observed in the two manure mixes similar to that observed in the first year (Figure 4). After the small increase of NO₃⁻ leaching immediately after application, both rates of composted poultry manure showed, essentially, no leaching losses of NO₃⁻ throughout the entire length of the experiment. Cumulative labile N losses (NO₃⁻ + NH₄⁺) over 20 months of leachate collection showed large differences between the compost treatments and the manure+PMS mixes. Although the cumulative labile N leached from the two manure+PMS mixes was associated with a high degree of variability, they leached more N during the first 20 months of the experiment than all other treatments (Figure 5).

Comparison of the quantities of N lost by leaching with the initial quantities of N added showed that the control treatment retained the least amount of original N (78 percent). Both rates of compost retained 99 percent of added N, while the two 20:1 and 30:1 manure and paper mill sludge blends retained 93 percent and 86 percent of added N, respectively. Thus the organic treatments are better able to retain N than the inorganic control. This increased ability to sequester added nutrients could have important implications for sustainable vegetative systems on these reclaimed soils.

There is clearly some risk of N leaching from direct application of manure and paper mill sludge mixes. However, losses from this treatment method should be considered in the context of other reclamation and agricultural practices. Biosolids are used for mine reclamation in PA and current practices have been shown to result in N leaching losses of 2078 lbs N acre⁻¹ over a two-year period, with only 44 percent retention of original N added (Stehouwer et al., 2006). The greenhouse study performed prior to this field experiment demonstrated that a straight manure application on mine spoil without adding a C material leached almost seven times more N over a six-month period than a manure+PMS treatment with a 25:1 C:N

ratio. Single growing season leaching losses of approximately 60 lbs N acre⁻¹ have been measured in inorganically fertilized corn fields (Zhu et al 2003). Our experiment showed N leaching losses from manure+PMS of 121 to 256 lbs N acre⁻¹ over two growing seasons (Figure 5). These losses are far smaller than from biosolids applications and only slightly larger than from production corn fields. Furthermore, we expect the amount of N lost to decrease with time. We also think the quantity of manure applied could be cut back without sacrificing revegetation success. This should also reduce the potential for N leaching.

Immediately following application, elevated PO₄⁻³ concentrations were seen in the leachates from the manure blends and from the control, with a maximum concentration of 5.8 mg P L⁻¹ in the control treatment within the first month after amendment application. Thereafter, PO₄⁻³ concentrations dropped considerably and remained low, indicating P leaching is not a major concern with any of these treatments. Cumulative labile P loss shows no significant difference among treatments and all treatments retained approximately 99 percent of the P added with the amendments (Figure 5).

Soils analysis

Soils data showed increases in both soil pH and soil C across all treatments from initial conditions to 24 months after amendments were applied. Initial soil pH at the site was 5.1, with current soil pH measuring 7.0 to 7.5. Soil organic C in the upper two inches of the unreclaimed soil was approximately 3.2 mg kg⁻¹ and has increased to approximately 7.1 mg kg⁻¹ in the lower rate of compost and both manure+PMS mixes. The higher rate of compost showed the largest increase in soil C, reaching 10.0 mg kg⁻¹. The lime and fertilizer control only increased soil organic C to 4.6 mg kg⁻¹. The much larger increases in soil organic C with the organic amendments reflect the initial large inputs of organic C with the amendments and C additions from vegetative growth.

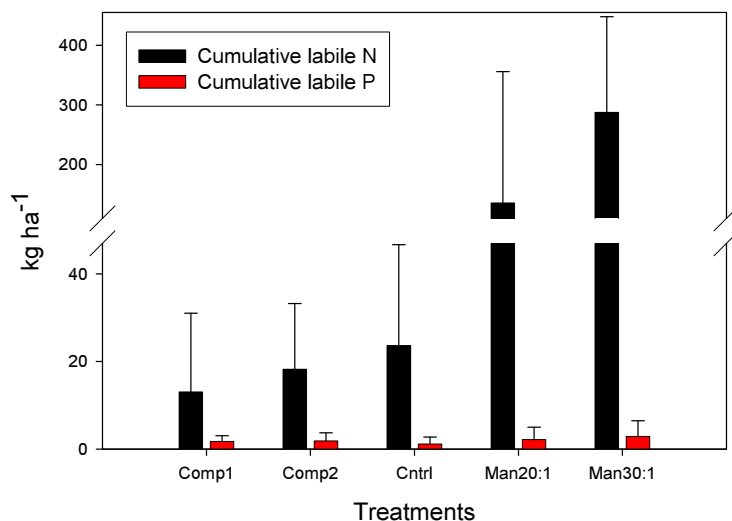


Figure 5. Effect of compost, manure+PMS, and limestone and fertilizer (control) amendment of mine soil on cumulative labile N ($\text{NO}_3^- + \text{NH}_4^+$) and P (PO_4^{3-}) in kg ha^{-1} lost via leaching during 20 months of monitoring. Although manure+PMS treatments have lost more cumulative labile N, they have retained more of the originally added N than the control treatment. Compost treatments have retained approximately 99 percent of N originally added.

Conclusions

We have found that composting poultry manure and mixing fresh manure with paper mill sludge are both effective ways of preparing these materials for use in revegetating abandoned strip mines. Composting maintains the benefits of manure for successful revegetation while essentially eliminating the risk of N and P leaching. Manure+PMS treatments are very effective at limiting P loss, although less effective than composting at limiting N leaching loss. Better vegetative growth was seen with both of the organic treatments than the inorganic control of lime and fertilizer. We believe that the ability of the compost and the manure+PMS treatments to sequester large amounts of the added N will also benefit long-term productivity of these soils and the potential to use them for biomass production.

There may be some additional soil restoration benefits obtained by co-application of manure and a high C material. When fresh manure and a high C substrate are co-applied to the mine spoil, the flush of microbial activity that would have occurred in the compost windrow now oc-

curs in the mine spoil. With this in-situ "composting" the large increase in microbial activity could enhance soil quality improvement by accelerating soil structural formation and stabilization and increasing nutrient and water availability. We will be investigating these ideas in our ongoing research.

Another practical advantage of mixed application of manure+PMS is that it avoids the significant expense associated with composting manure. Furthermore, the cost of paper mill sludge transport, spreading, and incorporating will normally be borne by the paper mill. Our results also suggest that the quantity of manure we used could be reduced without sacrificing revegetation success.

We are beginning a larger scale study in fall 2008 at a re-mining reclamation site in Clearfield County, Pa. In this field study, approximately seven acres of land will be reclaimed with composted poultry manure ($35 \text{ dry tons ac}^{-1}$) and six acres will be amended with fresh manure and paper mill sludge (16 and $42 \text{ dry tons ac}^{-1}$ respectively). These amended areas will be planted to monoculture and mixed stands

of various warm season grasses in spring 2009. Long-term monitoring of the experiment will focus on soil quality development, carbon and nutrient sequestration, and sustainable biomass production.

Literature cited:

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PRESTO PRODUCTS COMPANY

Mining engineers and consultants are often challenged to solve difficult soil stabilization problems, whether from new operation development to maintenance, closure, and site remediation. Presto's three-dimensional Geoweb® cellular confinement system is a proven technology that provides economic, long-term solutions for soil stabilization problems in the mining industry.

The Geoweb system is a three-dimensional, high-strength geocellular structure that dramatically improves the stability of infill materials through confinement. Applications vary from relatively flat surfaces for stabilizing roadways and pavement areas to steep slopes, low-to-high flow channels, dikes and lagoons, pipeline protection, and earth retention. The system solves challenging slope-surface stability problems by confining the infill in

the interconnected cells and stabilizing the upper soil layer. The system permits the full and sustainable vegetation of the slope surfaces that otherwise could not support plant life. Soil, aggregate and concrete protective covers over geomembranes can be secured against known gravitational, hydrodynamic and seismic forces using a geocellular confinement system.

For applications over geomembranes, inclusion of integral tendons and load transfer clips create a suspended protective cover over the geomembrane, preventing sliding, accidental puncturing and natural degradation of the impervious liner. Conventionally, soil and aggregate are used as protective covers over geomembranes with slopes of 3H:1V or less. When slope gradients are greater than 3H:1V, unconfined soil and aggregate cov-



ers are typically unstable and not used. However, the Geoweb® cover system is effectively applied on 1H:1V slopes or greater, reducing land use and cost, and providing additional stability against known sliding forces. An example of a repair of a failed unconfined geomembrane soil cover follows.

After a heavy rainfall, a soil cover on a 3H:1V residue waste slope with heights of 20 meters (66 feet) to 35 meters (115 feet) failed at the geotextile-geomembrane interface. Large volumes of soil slid down the slope from crest to toe and at some locations along the slope-crest, the geotextile tore, exposing the geomembrane.

A relatively low interface friction angle between the geotextile and the textured geomembrane, increased load from the saturated soil, and seepage forces due to water flow within the thick soil cover layer were contributing factors to the slope cover failure. A repair was urgently needed to prevent damage to the geomembrane. The Geoweb slope cover system best addressed all critical details and would provide a self-sustaining vegetated cover and functional long-term life. The new cover consisted of a sand-infilled, perforated 75-millimeter (3-inch) depth Geoweb drainage layer installed directly over the textured HDPE geomembrane. Over the Geoweb layer, topsoil was placed to develop the desired vegetation. This geocellular solution offers high cost benefit and an overall low environmental impact solution and a more stable cover solution for landfill covers, lagoons, storm water containment basins and other geomembrane covered systems. ■

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GEOSYSTEMS

PRESTO GEOSYSTEMS

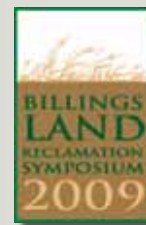
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AP-5893



2009 Joint Conference



Annual Meeting of the
American Society of Mining and Reclamation
and The 11th Billings Land Reclamation Symposium

May 30 - June 5, 2009 — Billings, Montana, USA

ADVANCED PROGRAM AND REGISTRATION INFORMATION

CONFERENCE THEME:

Revitalizing the Environment: Proven Solutions and Innovative Approaches

The Joint Conference of the 26th Annual Meeting of the American Society of Mining and Reclamation and the 11th Billings Land Reclamation Symposium is scheduled for the week of May 30 to June 5, 2009 in Billings, Mont. This combined conference will provide a

forum for the dissemination of information and discussions that may lead to change and innovations in public policy, mining, landscape restoration, and land management issues through research, field tours and technical workshops.

CONVENERS

American Society of Mining and Reclamation
United States Office of Surface Mining Reclamation and Enforcement
Reclamation Research Group LLC, Bozeman, MT

PROGRAM COMMITTEE

United States Bureau of Land Management
Catena Consulting, LLC
CDM Consulting
Montana Bureau of Mines and Geology,
Montana Tech-University of Montana
Montana Department of Environmental Quality
Montana Department of Transportation
United States Environmental Protection Agency
United States Forest Service
University of Wyoming, Department of Renewable Resources
Wyoming Department of Environmental Quality

FINANCIAL SPONSORS (to date)

Gold Level

Buchanan Consultants
Peabody Energy
Inter-Mountain Labs

Silver Level

BHP Billiton

Bronze Level

BKS Environmental
HDR Engineering, Inc.

Copper Level

Arkansas Valley Seed Co.
CDM Consulting
Wind River Seed

Visit the Joint Conference Web Site

<http://billingslandreclamationsymposium.org>
or <http://ces.ca.uky.edu/asmr/>

2009 Joint Conference Overview

Day/Date	Conference Activity
Saturday, May 30	PRE-CONFERENCE FIELD TOURS: 1) Zortman/Landusky and Kendall Gold Mines; Spring Creek Watershed Restoration; Judith Gap windmills (2-day tour) 2) Coal Mine and Coal Bed Methane Development and Reclamation (2-day tour) PRE-CONFERENCE WORKSHOPS: 1) Soil Management for Site Reclamation 2) Remote Sensing
Sunday, May 31	PRE-CONFERENCE FIELD TOURS: 1) Zortman/Landusky and Kendall Gold Mines; Spring Creek Watershed Restoration; Judith Gap windmills – continued 2) Coal Mine and Coal Bed Methane Development – continued 3) Wetland Mitigation near Laurel and Roundup, Montana PRE-CONFERENCE WORKSHOPS: 1) Tool for Selecting Vegetation for Restoring Disturbed Sites 2) Designing Sustainable Cover Systems and Final Landforms for Mine Waste Storage Facilities 3) Test and Treat: Mine Influenced Waters Trials and Tribulations • ASMR National Executive Committee Meeting • Evening Welcome Reception / Exhibit Hall
Monday, June 1	• Welcome and Plenary Session • Panel Discussion • ASMR General Business Meeting • Catered Lunch • Concurrent Technical Sessions • Technical Division Meetings
Tuesday, June 2	• Concurrent Technical Sessions • Poster Session and Conference Social
Wednesday, June 3	• Concurrent Technical Sessions • Evening Social w/Entertainment
Thursday, June 4	• Concurrent Technical Sessions (a.m. only) • ASMR Awards Banquet POST-CONFERENCE TOURS: 1) Pryor Mountains Environmental Disturbances, Rehabilitation, and Recovery 2) Historic Hardrock Mine Sites and Active Gold Mine in Western Montana (2-day tour) • ASMR National Executive Committee Meeting
Friday, June 5	Post-conference Tour: 2) Historic Hardrock Mine Sites and Active Gold Mine in Western Montana – <i>continued</i>

Travel, Lodging and Area Attractions

Transportation

Billings is the center of the resource extraction industries for coal, natural gas, oil, and coal bed methane in southeastern Montana and northern Wyoming. Billings Logan International Airport is serviced by Allegiant Air, Frontier, Horizon, Northwest, Skywest, United, and Corporate Air. Shuttle service from the airport to the conference hotel is available. Vehicle rentals are available through national vendors. The Met Transit provides bus service throughout Billings.

Meeting Venue and Lodging

The Crowne Plaza Hotel in downtown Billings, Mont., will host all meeting functions, technical sessions, and the trade show. A block of rooms has been reserved for conference participants for the conference week. The current Federal Per Diem lodging rate will be the cost of the rooms. Early registration is strongly encouraged to secure a room at the venue hotel. Reservations can be made by calling 1-888-444-0401. **Be sure** to mention the ASMR/BLRS joint conference to secure the conference rate. For online hotel registration go to: www.crowne-plaza.com/Billings and use code **BLR**.

Other hotels within a short walking distance include (note the conference rate **does not apply** at these hotels):

Hilltop Inn	1116 N. 28th St.	406-245-5000
Dude Rancher	415 N. 29th St.	406-259-5564
Howard Johnson	1001 S. 27th St.	406-248-4656
Juniper Inn	1315 N. 27th St.	406-245-4128
Best Western Clocktower	2511 1st Ave. N.	800-780-7334
Rimrock Inn	1203 N. 27th St.	406-252-7107

Pre-Conference Workshops

Title: Soil Management for Site Reclamation

Date: Saturday, May 30, 8 a.m. to 3 p.m.

Lead Instructor: Dr. Peter Stahl, University Wyoming, Department of Renewable Resources

Number of Students: 10 (minimum) to 20 (maximum)

Cost: \$90

Description: The objective of this workshop is to discuss soil related issues of importance to environmental specialists working on reclamation of oil and gas drill pads and surface coal mines. Topics to be discussed include management of soil properties, soil amendments, prevention of soil erosion, soil stockpiling, and seedbed preparation. In addition to the workshop leaders, speakers will include practicing reclamationists with expertise in the given topic areas.

Title: Remote Sensing for SMCRA Applications

Date: Saturday, May 30, 8 a.m. to 5 p.m.

Lead Instructor: Dianne Osborne, Office of Surface Mining

Number of Students: 10 (minimum) to 25 (maximum)

Cost: \$110

Description: This workshop will provide a basic overview of what remote sensing is and how it can be used to support mining and reclamation applications. Attendees will learn what types of remotely sensed imagery are available, what imagery costs, how to decide what type of imagery to use, and how to get imagery. Current remote sensing applications and how to use data mining tools to support these applications will be presented.

Title: A Tool for Selecting Appropriate Vegetation for Restoring Disturbed Sites

Date: Sunday, May 31, 8 a.m. to 5 p.m.

Lead Instructor: Dr. Paul Hansen, Ecological Solutions Group, LLC

Number of students: 10 (minimum) to 30 (maximum)

Cost: \$110

Description: The recently published *Classification and Management of Upland, Riparian, and Wetland Sites of USDI Bureau of Land Management's Miles City Field Office, eastern Montana USA* has great utility in the planning of ecologically successful revegetation projects on disturbed sites in eastern Montana and adjacent areas of the Great Plains Province including Wyoming, Colorado, and the Dakotas. This document has a dichotomous key for naming the type (habitat type or community type) at a site. Restoration planners can confidently prescribe a pallet of species that will establish the foundation of an appropriate natural community on a disturbed site.

Title: Designing Sustainable Cover Systems and Final Landforms for Mine Waste Storage Facilities

Date: Sunday, May 31, 8 a.m. to 5 p.m.

Lead Instructors: Michael O'Kane, P.E., and Mark Phillips, P.E., O'Kane Consultants, Inc.

Number of Students: 10 (minimum) to 20 (maximum)

Cost: \$110

Description: This workshop will provide the opportunity for personnel from different locations and backgrounds to share experiences on waste storage, mine reclamation, and cover systems, while being provided with key theory and background on cover system and landform design. Training and discussion will focus on material characterization, numerical modeling, field performance monitoring, long-term performance, and illustrative case studies. Each participant will be provided with a bound hard copy of all PowerPoint presentations. A list of references will be provided as part of the bound hard copy notes.

Title: Test & Treat: Mine Influenced Waters Trials and Tribulations

Date: Sunday, May 31, 9 a.m. to 5 p.m.

Lead Instructor: Dr. David Reisman, Director of ORD, Engineering Technical Support Center, U.S. Environmental Protection Agency, Jim Gusek and Thomas Rutkowski, Golder Associates

Number of Students: 10 (minimum) to 20 (maximum)

Cost: \$110

Description: This workshop will focus on the U.S. EPA and its contractor, Golder Associates, Inc. testing of various mine influenced water (MIW) and different treatment methods at abandoned and closed mine sites in the United States during the last seven years. The presenters will focus on the water chemistry, the type of treatment used, and the results for several biochemical reactors

ASMR Activities

- National Executive Committee Meeting, Sunday, May 31, Crowne Plaza Hotel, 8 a.m. to 5 p.m.
- Awards Banquet, Thursday, June 4, 12 (noon) p.m.
- Silent Auction Recipient Announcements during Awards Banquet
- Technical Division Meetings, Monday, June 1, 4:30 p.m. to 5:30 p.m.

(BCRs). Emphasis will be placed on lessons learned at each site with specific recommendations regarding future tests that can be used by attendees planning their own testing in the future.

For more detailed descriptions of these workshops go to
<http://www.billingslandreclamationsymposium.org>

Pre and Post-Conference Field Tours

Pre-registration is REQUIRED for all Tours

Pre-Conference Tours:

1. Zortman/Landusky, Kendall Mine, Spring Creek Watershed Restoration (fish hatchery), Judith Gap Windmills

Leaders and Organizer: Peter Bierbach, Bureau of Land Management

General Schedule: Saturday, May 30 and Sunday, May 31

Length: 2 days (leave at 8 a.m. Saturday from hotel – return at 5 p.m. Sunday)

Costs: \$180 Transportation, lodging and meals (except Saturday evening) included in cost

Number of Participants: 12 (minimum), 20 (maximum)

Description: The Zortman/Landusky Mines started as underground workings in the late 1880s. After many years of inactivity, the mines were reopened as cyanide heap leach operations in the 1970s and operated until the late 1990s. Reclamation has been completed, but water treatment is ongoing at the Zortman/Landusky Mines. This tour will showcase the successful reclamation at the mines, explain state-of-the-art water treatment activities, and discuss continuing problems with acid water in Swift Gulch, draining the north side of the Landusky Mine. On the second day, the tour resumes by visiting the Kendall Gold Mine, also a historic underground operation that was later reopened as a heap leach mine from the 1980s until its closure in 1998. In 1997, the company earned the U.S. Bureau of Land Management's Health of the Land Award, the highest environmental award given by that agency, for its successful program to re-introduce the endangered peregrine falcon at the Kendall Mine site and to preserve the historic Kendall town site. Additional stops include the Brewery Flats Restoration Project and the Judith Gap Wind Farm.

2. Wetland Mitigation near Laurel and Roundup, Montana.

Leaders and Organizers: Phil Johnson, Larry Urban, and Tim McNaboe, Montana Department of Transportation

General Schedule: Sunday, May 31

Length: 1 day (leave at 8 a.m. from hotel – return at 5 p.m.).

Cost: \$TBD (lunch/snacks included in cost)

Number of Participants: 10 (minimum), 20 (maximum)

Description: This tour will visit three wetland mitigation sites in the general Billings area. Two sites were historically used as aggregate borrow sites, while the third is a retired sewage treatment lagoon. Of the two borrow sites, one has naturally revegetated on its own and is currently being redesigned to expand mitigation acreages, while the other site was totally regraded and replanted in 2005. Widely fluctuating water tables, conflicts with adjacent aggregate operations, invasive species and public use are ongoing issues with both sites. Efforts to es-

tablish emergent wetland communities have been slow to develop, though wildlife use is at target levels.

3. Coal Mine and Coalbed Methane Development and Reclamation – Powder River Basin in Montana and Wyoming.

Leaders and Organizers: Chris Yde, Montana DEQ, Dave Schellinger, Wyoming DEQ, and John Wheaton, Montana Bureau of Mines and Geology

General Schedule: Saturday, May 30 and Sunday, May 31

Length: 2 days (leave at 8 a.m. Saturday from hotel – return at 5 p.m. Sunday)

Cost: \$180 Transportation, lodging and meals (Saturday evening BBQ) included in cost

Number of Participants: 12 (minimum), 20 (maximum)

Description: This two-day tour will include stops at active coal mines to discuss permitting and reclamation issues, visits to coalbed methane areas where disturbance, reclamation, and water management. The Powder River Basin in northeastern Wyoming and southeastern Montana is the largest coal producing area in the nation. Highlights of this tour include sagebrush reclamation for wildlife habitat; diversion and reconstruction of the Tongue River at allowed mining, and coalbed methane production areas to learn about the approach to, and footprint of, development. Stops will include the Big Horn National Battlefield and the Rosebud Battlefield to discuss energy development issues relative to preservation.

Post Conference Tours:

4. Pryor Mountains (Montana) Environmental Disturbances, Rehabilitation, and Recovery

Leaders and Organizers: Steve Regele, R&R Environmental Consulting and Peter Bierbach, Bureau of Land Management

General Schedule: Thursday, June 4

Length: 1 day (leave at 7 a.m. from hotel – return at 6 p.m.)

Cost: \$80 (lunch/snacks included in cost)

Number of Participants: 12 (minimum), 20 (maximum)

Description: Geology, ecology and natural resources of the Pryor Mountains and surrounding areas of Montana and Wyoming will be discussed and briefly visited during this one day tour. Special features of the Pryor Mountains include proximity to the largest bentonite reserves in North America, limestone canyon lands and uranium deposits, ancestral wild horse herds, diverse and exceptional wildlife and floral populations, abrupt transitions from xeric to coniferous forest ecosystems, regional oil and gas fields, and a rich history of human use.

5. Historic Hard Rock Mine Sites and an Active Gold Mine in Western Montana

Leaders and Organizers: Mike Browne, U.S. Forest Service and Robert Rennick, CDM

General Schedule: Thursday, June 4 and Friday, June 5

Length: 2 days (leave at 8 a.m. on Thursday from hotel – return at 6 p.m. on Friday)

Cost: \$180 Transportation, lodging and meals included in cost

Number of Participants: 12 (minimum), 20 (maximum)

Description: The legacy of historic and current metal mining is visibly evident in western Montana. Much progress has been made in eliminating or significantly reducing impacts to soil systems, surface waters, and groundwater at these historic and active mine sites. Learn first-hand from the experts about metal mine history, current mining activities and reclamation by participating in this two-day, one-night field tour to Butte and other historic and active hard

rock mine sites in western Montana. The agenda includes a tour of Butte to observe the legacy of large mining operations in an urban environment, visits to historic hard rock mining sites in the mountains of Western Montana, and a visit to the Montana Tunnels Gold Mine, a large active mine near Helena, Mont.

**For more detailed description of the field tours go to
<http://www.billingslandreclamationsymposium.org>**

Evening Welcome Reception

The Joint Conference Welcome Reception will be held from 5 p.m. to 8 p.m. on Sunday, May 31 in the Crowne Plaza Hotel Ballroom for all attendees. Items donated for the ASMR Silent Auction will be accepted and will be on display. Light appetizers and refreshments as well as an open bar will be available. Renew old acquaintances and meet new people that share mutual professional interests.

Plenary Session

The Plenary Session for the Joint Conference will be held on the morning of Monday, June 1 in the Crowne Plaza Ballroom. The Keynote Speaker will address the conference theme *Revitalizing the Environment: Proven Solutions and Innovative Approaches*. A panel discussion will follow with three or four speakers presenting their organization's mission, program and current projects focusing on cooperative management to revitalize landscapes.

Poster Session

A Poster Session and Social will be held during the late afternoon and evening of Tuesday, June 2. The authors of over 30 posters will be available for presentation and discussion of their research investigations, results and interpretation during this catered event. Poster titles and authors are provided below.

Concurrent Technical Sessions

The Joint Conference concurrent technical sessions will start on the afternoon of Monday, June 1 and conclude on Thursday at noon, June 4. Nearly 100 paper presentations covering a broad spectrum of topics will be presented during these technical sessions. All presentations will be in the Crowne Plaza Hotel. Descriptions of technical sessions, paper titles and authors are provided below. Visit the Joint Conference web site for any updates and to view the Preliminary Program:

www.billingslandreclamationsymposium.org or <http://ces.ca.uky.edu/asmr/>

Evening Social

An evening social for attendees is scheduled for Wednesday, June 3. Buses will provide transportation to Pompeys Pillar east of Billings. Located along the Lewis and Clark National Historic Trail, Pompey's Pillar was proclaimed a national mon-

CONTACT INFORMATION FOR MEETING DETAILS:

Dennis Neuman, Reclamation Research Group, LLC
406-570-9274;
E-mail: dneuman@reclamationresearch.net

Robert Postle, Office of Surface Mining
303-293-5041; E-mail: bpostle@osmre.gov

Richard Barnhisel, ASMR Executive Secretary
859-335-6529; E-mail: asmr5@insightbb.com

ument in January 2001. During his return trip to St. Louis, Captain William Clark of the Lewis and Clark Expedition climbed the Pillar and carved his signature and the date in the sandstone. Clark wrote, *"This rock I ascended and from it's top had a most extensive view in every direction on the Northerly Side of the river high romantic Cliffs approach & jut over the water for Some distance both above and below...I marked my name and the day of the month and year."* A western style BBQ will include dinner, beer, wine and soft drinks. Special entertainment will feature Crow Tribe Native Dancers and the Black Whistle Drum Group. A bluegrass band will provide musical additional entertainment. This Joint Conference event is not to be missed. Cost is \$40.

Exhibit and Tradeshow

The Joint Conference Exhibit and Tradeshow serves as an important focal point for participant interaction. All coffee and refreshment breaks, as well as the scheduled catered events, are held in the Exhibit Hall. Details as to exhibitors can be found at:

www.billingslandreclamationsymposium.org
or the ASMR Web site at
<http://ces.ca.uky.edu/asmr/>

Catered Events

Continental breakfasts in the morning and coffee, tea, soft drinks and snacks in the afternoon will be available in the Exhibit Hall for all Conference participants. In addition, a Welcome Reception, the ASMR Awards Luncheon, light evening refreshments during the poster session and one catered buffet lunch will be provided to all participants and are included in your registration fee.



REGISTRATION FORM

2009 Joint Conference of 26th Annual Meeting
of the American Society of Mining and Reclamation
and the 11th Billings Land Reclamation Symposium

June 1 through June 4, 2009

Crowne Plaza Hotel, Billings, MT

In order to facilitate transportation, lodging, meeting room space, and catering requirements for conference activities, we strongly encourage pre-registration. Pre-registration cost for the General and Technical Sessions is \$250 until May 15, 2009; late registration is \$285. Student registration is \$25 with I.D. required. Workshop and tour costs are extra and are detailed below.

Name _____ Date _____

Company/Affiliation _____

Address _____

Address _____

City _____ State/Province _____

Zip/Mail Code _____ Country _____

Phone _____ E-mail Address _____

General and Technical Sessions:

Monday to Thursday, June 1 – 4, 2009 Pre-registration (until May 15, 2009)	(\$250)	Yes []	No []
Monday to Thursday, June 1 – 4, 2009 Regular Registration (after May 15, 2009)	(\$285)	Yes []	No []
One Day Registration (Check day) [] Monday [] Tuesday [] Wednesday	(\$100)	Yes []	No []
Student Registration (<i>Submit copy of ID with Registration Form</i>)	(\$25)	Yes []	No []

Workshops:

1. Soil Management for Site Reclamation - Saturday, May 30, 9 a.m. – 3 p.m.	(\$90)	Yes []	No []
2. Remote Sensing - Saturday, May 30, 9 a.m. – 5 p.m.			
<i>Lunch is included in this workshop</i>	(\$110)	Yes []	No []
3. A Tool for Selecting Appropriate Vegetation for Restoring Disturbed Sites – Sunday, May 31, 9 a.m. – 5 p.m., <i>Lunch is included in this workshop</i>	(\$110)	Yes []	No []
4. Designing Sustainable Cover Systems & Final Landforms for Mine Waste Storage Facilities — Sunday, May 31, 9 a.m. – 5 p.m. – <i>Lunch is included in this workshop</i>	(\$110)	Yes []	No []
5. Test and Treat: Mine Influenced Water Trial and Tribulations – Sunday, May 31, 9 a.m. – 5 p.m., <i>Lunch is included in this workshop</i>	(\$110)	Yes []	No []

Tours: PRE-REGISTRATION IS REQUIRED!

1. Zortman/Landusky, Kendall Mine, Spring Creek Restoration
– Saturday & Sunday, May 30 & 31 (\$180) Yes [] No []
Registration cost covers transportation, meals (except Saturday evening),
lodging w/continental breakfast, snacks & beverages.
2. Wetland Mitigation near Laurel and Roundup, Montana – Sunday, June 4
Registration cost provides for transportation, lunch, snacks and beverages. (\$25) Yes [] No []
3. Coal and Coal Bed Methane Reclamation
– Saturday and Sunday, May 30 & 31 (\$180) Yes [] No []
Registration cost covers transportation, meals (except Saturday evening),
lodging w/continental breakfast, snacks & beverages.
4. Pryor Mountains: Environmental Disturbances, Rehabilitation, and Recovery
– Thursday, June 4, Registration cost covers transportation, snacks & beverages. (\$80) Yes [] No []
5. Historic Hardrock Mine Sites and Active Gold Mine in Western Montana
– Thursday and Friday, June 4 & 5, Registration cost covers transportation, (\$180) Yes [] No []
meals (except Thursday evening), lodging w/continental breakfast, snacks & beverages.

Other Functions:

- Conference Social at Pompey Pillar (BBQ, Monument Tour, Crow Tribal Drumming and Dancing, bluegrass music)
– Wednesday, June 7, 5 p.m. – 9:30 p.m. (transportation included) (\$40/ea.) Yes [] No []

Number of Participants _____ Total Amount: \$ _____

Attendance at the Conference Social is limited. Registration by May 15, 2009 is necessary.

- I plan to attend the ASMR Awards Banquet
- Thursday, June 4 (**free for all Joint Conference registrants**) (\$0.00) Yes [] No []
- Number of guests attending _____ Total Amount: \$ _____ (\$20/ea.) Yes [] No []

TOTAL AMOUNT OF REGISTRATION (US DOLLARS) \$ _____

No refunds after May 15, 2009

Method of Payment: [] Check payable to ASMR

Credit Card: [] Visa [] Master Card Card # _____ - _____ - _____ Exp. Date _____

Card Holder Name (print) _____ Signature _____

Note: A \$5 credit card process fee is applicable.

Send check or fax credit card information to: ASMR, 3134 Montavesta Road, Lexington, KY 40502

Registration accepted by e-mail: asmr5@insightbb.com

Contact information: Richard Barnhisel, **Tel:** 859-351-9032; **Fax:** 859-335-6529; **E-mail:** asmr5@insightbb.com

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Raw	2.6	1600	375	16	125	2300
Final	6.8	-34	2	10	2	1258

Phase 2 Installed
Construction completed August 2008



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- Treatment System Restoration
- Passive & Active Treatment
- Operation & Maintenance
- Assessment & Monitoring
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- Post-Mining Trust Funds
- Design & Permitting
- Resource Recovery
- Patented Methods
- Public Relations
- Construction

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

*- Tom Myrah, Design Manager, USACE
(Dents Run Site 3895 - Phase 2)*



Manganese Resource Recovery
Sustainable technology development