

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

# reclamation *matters*



**2010 Joint Mining Reclamation Conference  
Program and Registration**

**Weathering of Pyrite in Mine Soils  
at Gibbons Creek Lignite Mine**

**Columbian Sharp-Tailed Grouse  
Re-established on Reclaimed Land**





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# Leaders in the Energy and Landscape Restoration Arena



*Dennis R. Neuman,  
ASMR President*

Every day we are exposed to issues of climate change, clean energy, carbon dioxide reduction and sequestration, economic downturn, energy independence, national security, environmental degradation, etc. These issues can be divisive with arguments from all political, social, economic, and scientific standpoints: There are no simple solutions to complex problems. I "Googled" (yes, I made a verb from a noun) "clean energy" and received approximately 50,000,000 hits! According to the U.S. Energy Information Administration, the total consumption of energy in our country in

2007, was 101 quad trillion Btu. Fossil fuels – coal, oil and natural gas – currently provide more than 85 percent of all the energy consumed in the United States, nearly two-thirds of our electricity, and virtually all of our transportation fuels. The U.S. Department of Energy estimates the nation's reliance on fossil fuels to power an expanding economy will actually increase over at least the next two decades, even with aggressive development and deployment of new renewable and nuclear technologies (US DOE 2010). Research, technology development, and large-scale deployment of clean or renewable energy are imperative and we, as a society, must support this shift to a diverse portfolio of energy sources. The continued dependence on, and eventual depletion of, natural and non-renewable energy sources puts America in peril.

Land disturbances are part of nearly every energy source, with the likely exceptions of ocean tides and waves, and placement of wind generators in the seas. As with changes in energy sources, the reclamation and revitalization of impacted landscapes will change, as well. Innovative expansion of fossil fuels in the near term, coupled with maturity of renewable energy sources, will demand new and different approaches to environmental restoration. The American Society of Mining and Reclamation and

our members are in a unique position to be leaders in this changing paradigm. I reviewed the technical papers presented at our last annual meeting in 2009, and found excellent examples of innovative research and technology implementation. For example, scientists and engineers from Arizona presented their work on the use of tailings ponds as solar photovoltaic farms. Concurrently, the ponds are being revegetated to reduce erosion and limit infiltration. This work is the marriage of environmental cleanup and renewable energy production. Costs of reclamation of oil and gas drill pads are being lowered by using new techniques which help preserve the native vegetation. Revegetation of barren post-mining landscapes captures carbon and keeps it in the plant soil system, while providing a source of atmospheric oxygen. I have received several telephone calls regarding the use of mining/smelter impacted areas for installing energy generating wind farms in the windy mining state of Montana.

Society members are actively participating in the changing energy production-environmental protection dialogue through solid research, technology development, and field implementation. Let us keep up the good work and continue to be looked upon as leaders in the energy and landscape restoration arena. ■

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# Message from the Executive Secretary



*Dr. Richard (Dick) Barnhisel*

**F**irst of all, I hope all of you will consider coming to Pittsburgh in June. We expect a large turnout, and there is an excellent program planned as can be seen in the accompanying program. This includes nine workshops and both pre- and post-conference field trips.

Also, be aware that the distribution of this magazine is being limited to active ASMR members and several libraries, so it is important to maintain your membership. There is an option to subscribe to Reclamation Matters, without being a member, at \$10/year.

The election of officers took place in December, and I would like to introduce these people. A brief paragraph is given here with a photo.

**President Elect** – Mr. Eddie Bearden. Eddie has 35 years of experience working in soils, mining, reclamation, permitting, and bond release. He worked as a soil scientist with the USDA-Soil Conservation Service (now the NRCS), then as a reclamation specialist at the TXU (now Luminant) Big Brown Mine in Texas, and in the environmental services department within the same company. He remained with Luminant Mining Company until 2008, when he



began working at HDR Engineering, Inc. in Dallas. Bearden was elected to the ASMR NEC in 2007, and began service at the 2008 ASMR meeting in Richmond, Va.

**NEC Board Member** – Mr. Scott Belden. Scott is currently Sr. Manager-Reclamation for Peabody Energy Corporation's Powder River Coal, LLC in Gillette, Wyo., where he focuses on reclamation success issues, bond release, permitting, reporting, bond liability and mine closure. Scott holds a Master of Science in Agronomy (Soils) and Bachelor of Science in Range



Management from the University of Wyoming. He has been a member of the American Society of Mining and Reclamation since 2001 and received its award for Reclamationist of the Year in 2004.

**NEC Board Member** – Ms. Brenda Schladweiler. Brenda has been a member of ASMR since 1988. She has participated on the planning committees for the meetings in Breckenridge, Colo., in 2005, and Gillette, Wyo., in 2007. She



believes strongly that the "wheel of reclamation knowledge" should not have to be reinvented. We should all build from experience in other industries. She states, "I would like to see the membership rolls of ASMR expand to include other industries. I believe this can occur through workshops or special sessions within the current framework."

**NEC Board Member Technical Division Representative** – Dr. Robert "B.T." Thomas. B.T. first joined ASMR in 1998 and is in his second year as co-chair of the Water Management Technical Division.



He was elected as the representative from the technical divisions to serve on the National Executive Council for a three-year term. He is currently employed as a project consultant with CH2M HILL and serves as their southeast regional leader of the global mining team. He specializes in passive and semi-passive treatment of ARD, as well as ARD geochemistry and related geomicrobiology. ■

# Young Professional's Message



*Abbey Foster Wick*

**W**e're quickly approaching the annual meeting date in Pittsburgh, and gearing up for the first annual social event for the Young Professionals. We'll be hosting the event at Bossa Nova starting at 7 p.m. This is a great venue located in the cultural/theater district of downtown Pittsburgh.

A couple of incentives for you to register for the event:

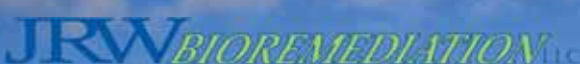
- This is a great opportunity to get to know other members at similar points in their careers.
- Transportation will be provided from the Radisson Green Tree to Bossa Nova starting shortly after the final session on Monday, June 7. We strongly encourage you to grab a bite at Bossa Nova before the event because they have a GREAT menu.
- Hors d'oeuvres will be served throughout the evening and you'll get a couple of drink tickets.
- "Quick order" menu will be available if you decide you need to eat more than hors d'oeuvres during the event.
- Raffle and auction will be held for some pretty amazing stuff local to Pittsburgh (use your imagination here!).
- Several of your favorite members (i.e., president, NEC members and other well-recognized faces of ASMR) will be in attendance to help connect you with other people.

If you consider yourself to be a young professional (i.e., in your career for <10 years), register for this event on your meeting registration form. You won't

want to miss this! It's only \$15 as an ASMR member, or \$20 as a non-member. If your spouse is attending the meeting with you, have them register for this event at the non-member price.

And for the corporate ASMR members out there ... there is still the opportunity for you to contribute monetarily to this event and SUPPORT your young professionals. If you contribute, you can attend for free! This could be your golden ticket into this event, especially if you don't consider yourself to be a young professional anymore. This is also a major opportunity for you to meet new talent and share what you know. Please contact me by email at [afwick@vt.edu](mailto:afwick@vt.edu) or phone 540-231-0793 as soon as possible to arrange contributions.

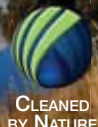
There's been such a great response to the formation of the Young Professionals group thus far. I have gotten several emails from people interested in getting more involved and also expressing how important this group is to ASMR. So let's ensure that this will be a permanent group within ASMR and attend the upcoming social event. ■



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# Weathering of Pyrite in Mine Soils at Gibbons Creek Lignite Mine, Texas

BY JAN K. HORBACZEWSKI

## Introduction

One of the challenges facing reclamation of surface coal mines is dealing with the acid that may form from the weathering of sulfide minerals. During mining operations, the most common sulfide mineral – pyrite ( $\text{FeS}_2$ ) or “fool’s gold” – may be brought to the surface and oxidized by air and water to sulfate. This is not a problem if there are sufficient bases present to neutralize the acidity. But if there are not, the iron and sulfate combine with water to form sulfuric acid and iron hydroxides.

One common method of neutralizing this acidity is to add calcium in the form of calcium carbonate or lime ( $\text{CaCO}_3$ ) to the acid-producing material. Calcium reacts with sulfate to form the relatively inert and, therefore, harmless calcium sulfate or gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ). But there has been a long-standing debate as to whether this solution is effective in the long run. For many years it was feared that the pyrite, especially in the form of nodules, would be resistant to weathering and would persist in mine soils for decades, and that the lime would be leached by rainfall from the mine soils relatively quickly. In effect, the pyrite nodules were viewed as time bombs, slowly releasing acid long after liming and other reclamation operations had been completed.

It is, however, becoming possible to investigate these concerns directly. There are now many reclaimed mine soils that are 20 or 30 years old. This particular story is about the pyrite and mine soils at Gibbons Creek Lignite Mine, owned

by the Texas Municipal Power Agency and located near Bryan-College Station, Texas, about 70 miles northwest of Houston. The mine operated from 1982 to 1996, after which it was permanently closed. It is now in the last stages of monitoring and release from mine reclamation obligations.

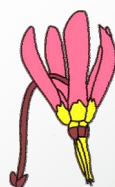
## Field observations

Most of the pyrite at Gibbons Creek Mine is very fine grained and not readily visible to the naked eye. But when it is found in the form of nodules, they are usually of the “framboidal” type (Figure 1), so called because of their supposed resemblance to raspberries (Old French *framboise*).

In the mine soils at Gibbons Creek, such nodules show evidence of consid-



Figure 1 – Unweathered pyrite nodule



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Figure 2 – Pyrite nodules undergoing weathering in five-year-old mine soil



Figure 3 – Radial structure in partially decomposed pyrite nodules

erable weathering after only five years (Figure 2). This photograph shows several pyrite nodules with characteristic yellowish and yellowish-brown coatings. The nodule just to the left of the tape measure, measuring about 1-inch-diameter, is broken open and shows a partly disintegrated interior of grayish pyrite.

Closer inspection of such nodules reveals that they have a radial structure which facilitates weathering (Figure 3).

They also appear to have a microcrystalline structure (as has been reported in the literature, e.g., Dixon et al. 1982). This structure became apparent in an unplanned experiment in the author's garage. A fresh pyrite nodule (similar to the one in Figure 1) had been inadvertently left on a book shelf. After two years all that was left was a loose pile of particles. The particles still exhibited the gray metallic color of pyrite, but were now of a fine sand texture. The physical disintegration had occurred

without any assistance. It appears to have been caused by the temperature and humidity fluctuations of east-central Texas.

In the mine soils, weathering is assisted by water from rainfall. East-central Texas has a sub-tropical climate with an average annual rainfall of 40 inches. Local soils have a "thermic" soil temperature regime (mean annual soil temperature between 15 C and 22 C) and an "ustic" soil moisture regime (soil dry for 90 cumulative days in most years) (U.S. Dept. of Agriculture, 2010). As a result, physical disintegration is accompanied by chemical decomposition. One of the first visible products of this is jarosite  $[\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6]$ , which covers the nodules with a characteristic pale yellowish powdery coating (Figure 3). Over time, some of the iron also becomes oxidized to rust-colored iron oxyhydroxides, such as goethite ( $\text{FeOOH}$ ) (visible in Figure 2 near the pyrite nodule on the left-hand side). As a consequence of both physical disintegration and chemical decomposition, the pyrite nodules lose coherence and smear or fall apart easily when handled (Figure 4).



Figure 4 – Lack of coherence in decomposing pyrite nodule

### Laboratory analyses

Chemical analyses support these field observations. A set of 68 5.7-acre grids at Gibbons Creek mine was sampled first in 1987 and re-sampled in 1997. The pyritic sulfur contents are summarized in Table 1.

The results show that over the 10-year period the pyritic sulfur content decreased in all four depth intervals. (The data for the "0-1 ft" depth interval show very low initial pyritic sulfur contents because in many of the grids non-pyritic native topsoil had been replaced at the surface.) What is interesting is that the rate of decrease (i.e., 0.03 percentage points) does not show a fall-off with depth. This suggests that weathering is proceeding



**Table 1 – Changes in pyritic sulfur content in Gibbons Creek Mine soils over a 10-year period**

| Depth interval | Mean pyritic sulfur content (%) |      |        |
|----------------|---------------------------------|------|--------|
|                | 1987                            | 1997 | Change |
| 0-1 ft         | 0.01                            | 0.00 | 0.00   |
| 1-2 ft         | 0.05                            | 0.02 | -0.03  |
| 2-3 ft         | 0.06                            | 0.03 | -0.03  |
| 3-4 ft         | 0.07                            | 0.04 | -0.03  |

at the same rate down to four feet and probably deeper.

### Conclusions

- In spite of their relatively large size and initial hardness, framboidal pyrite nodules weather rapidly in the east-central Texas mine soil environment.
- This is primarily due to their radial structure and microcrystalline composition.
- Both of these properties ensure that the nodules disintegrate physically to small particles of pyrite (the size of fine sand or smaller).
- Chemical decomposition then proceeds rapidly because of the high surface area of the particles and the sub-tropical climate of east-central Texas.

- Chemical analyses of the mine soils show substantial decreases in pyrite content after only ten years.
- Therefore, it is unlikely that these pyrite nodules will persist for long time periods in this environment.

### References

- Dixon, J.B., L. R. Hossner, A. L. Senkayi, and K. Egashira (1982) – Mineralogical properties of lignite overburden as they relate to mine spoil reclamation, pp. 169-191. *In: Acid sulfate weathering. Special Publication No. 10. Soil Science Society of America.*
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### About the Author

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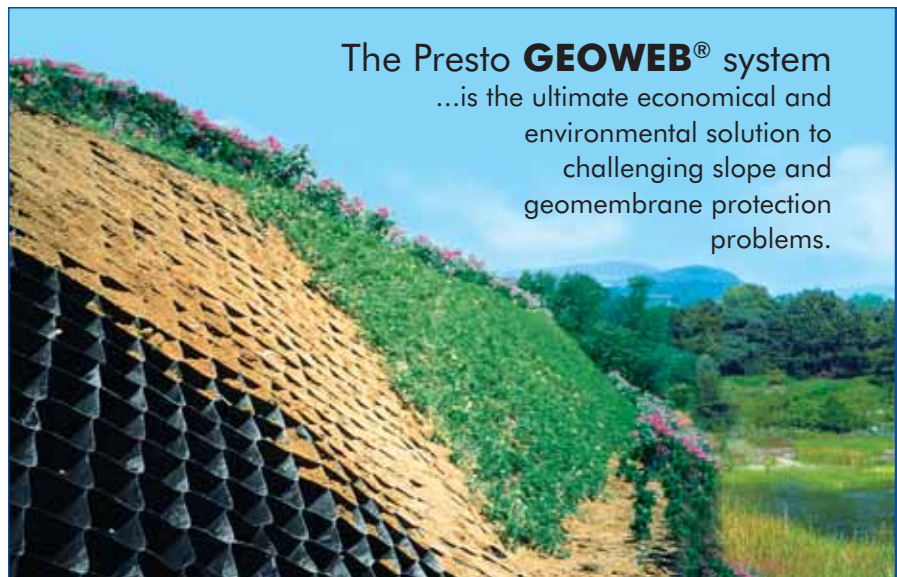
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# Columbia Sharp-Tailed Grouse Re-established on Reclaimed Land

BY VERN PFANNENSTIEL, ROY KARO, JERRY NETTLETON, TOM DOCKSTADER

**C**olumbian Sharp-tailed Grouse (Columbian grouse, for short) were once considered among the most abundant game bird species in the United States. By the mid-1900s, the Columbian grouse sub-species had become so reduced in population size and distribution that it was considered the rarest of all the sharp-tailed grouse sub-species. Since early settlers often preferred grouse habitats for farming and ranching, grouse suffered greatly due to agricultural expansion, over-grazing, alterations in natural fire regimes, and historical over-hunting. Today, Columbian grouse are found in only three counties in Colorado: Moffat, Rio Blanco and Routt. In the early days of mined land reclamation science, many wildlife experts predicted the decline of grouse numbers to be caused by mining operations.

The Columbian grouse was formerly listed as a “Category 2” species (i.e., a species that may be considered threatened or endangered if more information were available) by the United States Fish and Wildlife Service and as a sensitive species by the Bureau of Land Management and the United States Forest Service. Currently, in Colorado, Columbian grouse are considered a “species of concern,” which is not considered a statutory category.

**Description:** There are two sub-species of sharp-tailed grouse found in Colorado: the plains sharp-tail and the mountain, or Columbian sharp-tail. Columbian grouse weigh in at around

1.5 pounds. They have distinct black V-shaped marks on the breast feathers. Compared to other grouse in Colorado, the Columbian grouse have a frosty appearance due to white spotting on the body and wing feathers.

**Habitat/Reproduction/Diet:** This species uses the high mountain shrub-grassland community and associated edges. They are most commonly found in high elevation grassland areas interspersed with serviceberry, chokecherry, oak brush, sagebrush, snowberry, and aspen. Shrubs and small trees play an important role in Columbian grouse ecology, especially in winter when they provide both food and cover.

**Leks/Dancing Ground:** Like sage grouse, Columbian grouse breed on leks or traditional strutting grounds. Columbian grouse leks are typically located on knolls or ridge tops. Males begin displaying in late March or April, and can be seen on leks with 100 percent snow cover. During the breeding season, males exhibit orange eye combs and purple air sacs, which form an integral part of the courtship ritual. These males “dance” by stomping their feet and running in a circle to attract females. After breeding, females build a ground nest in grass or near shrubs. A typical clutch is 10 to 12 eggs and the hen incubates the eggs for approximately 23 days. After hatching, the chicks are tended by the female. Broods are largely dependent for 6 to 8 weeks and then disperse. In late fall and winter, the birds form small flocks and are dependent on shrubs for food



*Close-up of male Columbian grouse bird.*



*CSTG male on lek.*





*Example of cover available to Columbian grouse.*

and cover. As is common with other grouse species, snow roosting is an important means of thermoregulation during the winter months.

### **Reclamation Practices Influencing Columbian Grouse**

For the past 30 years, Peabody reclamation scientists have established landscapes and vegetation communities beneficial to both wildlife habitat and livestock grazing. Columbian grouse, in particular, have benefited from reclaimed mine land. Re-grading has created knolls, benches, and ridges for lek sites. The vegetation is generally laid flat during the heavy winter snows providing the open, good visibility characteristics preferred by grouse during breeding. Tall grasses including intermediate wheatgrass and basin wild rye and large forbs such as alfalfa, provide cover adjacent to the leks and access to taller undisturbed shrub cover. Stock ponds are built as a water source for wildlife and livestock. These measures give Columbian grouse the ability to move in and out of seasonal habitat with ease, never having to leave reclaimed land. These desirable characteristics have resulted in an increased affinity for reclaimed lands by Columbian grouse during the brood rearing season.

Fitness and sustainability of grouse population is met by the characteristics of the reclaimed land. Conservation Reserve Program lands and some of the native sagebrush lands do not always provide adequate levels of these necessary features. Reclaimed lands are dominated by dense herbaceous vegetation with inclusions of big sagebrush and snowberry.






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Example of the "edge" affect at Seneca Yoast.



Horizontal structure or canopy cover of 75 percent is desirable while at least 30 centimeters of vertical structure provides good visual cover. Vegetation monitoring data shows that reclaimed areas fit these criteria well. These characteristics provide excellent nesting habitat and necessary cover from predators and weather. The herbaceous dominated reclaimed area vegetation contains important food from forbs and grass seed. Brood rearing success is greatly enhanced by the many forbs and grasses in the reclamation. During the brood rearing season, cool season vegetation produces an abundance of succulent shoots and buds high in nutrition. The increasing structure from seasonal plant growth provides cover for foraging birds. The increased natality and reduced mortality facilitated by the reclaimed lands has resulted in positive population benefits for Columbian grouse in the region.

Grazing practices on Peabody properties are heavily influenced by grouse habitat needs. During April, Columbian grouse congregate on the leks to begin the breeding season. During the next

four to five weeks, females are laying and incubating eggs. Grazing of Peabody properties where active leks exist is typically not initiated until after grouse are off the nest in an effort to protect the hatchlings and establish a good ground cover to help shelter them from predators and weather. In addition, rotational grazing practices are utilized and grazing is controlled to establish and maintain optimal "stubble height" for grouse utilization.

Columbian grouse are hunted as an upland game bird in Colorado. Lower population numbers in the lower elevation areas, outside of the mine reclamation, may be due in part to hunting pressure. The superior habitat of reclaimed areas combined with the lack of hunting pressure has increased grouse numbers significantly.

#### **Reclamation/Postmine Land Use Success**

Reclaimed mine lands account for only 1 percent (11,118 of 1,831,000 acres) of the occupied range of the Columbian grouse in northwest Colorado, but support about 36 percent

of the known active leks (as of 2004). Mine reclamation lands not only supported proportionally more leks than other habitat types, but also the largest leks. Lek surveys and studies conducted in northwest Colorado suggest that Columbian grouse are actively using post-SMCRA mine reclamation lands for breeding, nesting, and brood rearing. The overall long-term concern is the conversion of native tall shrub dominated communities to a combination of native and non-native grass/forb dominated communities. This has been viewed as negative for wildlife due to the loss of tall shrubs. This view may not be warranted for Columbian grouse. In some cases, the lands being mined are marginal for Columbian grouse or not used at all, whereas the habitat created after reclamation is suitable and desired by grouse. In other cases, suitable habitat is mined, but the habitat created after reclamation is improved.

Findings from Conducted Studies: Studies conducted in 1999 to 2000 in conjunction with the Colorado Division of Wildlife and Northwest Colorado Sharp-tailed Grouse Working



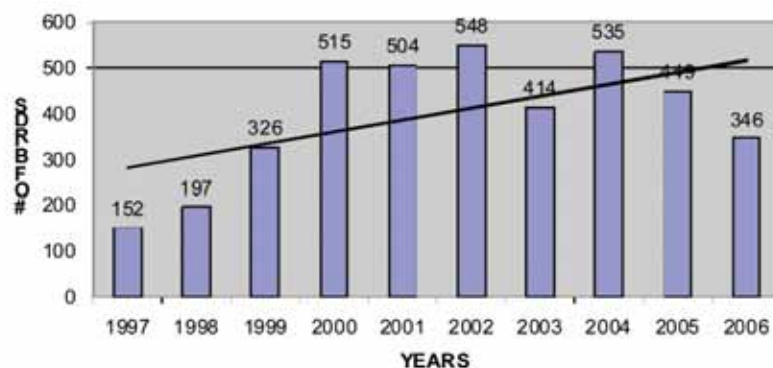
Group showed the following findings:

- Columbian grouse captured and tagged in reclaimed mined lands had higher survival rates in 1999 (28 percent) and 2000 (33 percent) than grouse captured in Conservation Reserve Program lands (14 percent and 8 percent).
- Columbian grouse hens primarily used reclaimed (67.7 percent) over unmined grass, upland shrub, shrub-steppe or aspen forest for brood rearing.
- 43 percent of hens observed in the study nested in reclaimed lands.
- Hens had the highest nest success rate (68 percent) in reclaimed lands.
- Hens that successfully nested in reclaimed lands continue to primarily use these areas (83 percent) for brood rearing.
- Hens exhibited a great deal of variability in use of cover types for nesting, which is common for Columbian grouse. However, it was evident that they had a strong preference for reclaimed land and native shrub-steppe lands over Conservation Reserve and grasslands.
- Vegetative characteristics and management of reclaimed lands provided for a continued increase in dense herbaceous growth, along with minimal disturbance through the brood-rearing season. Thus, it appeared that this was the best vegetative cover in the study area during the brood-rearing season.
- Nest success of Columbian grouse in reclaimed lands was substantially higher, as was their survival, and it is possible that reclaimed lands are acting as a source population of Columbian grouse for the more marginal or less productive habitats in the area.

#### Continuing the Upward Trend in Columbian Grouse Bird Counts

Table 1 shows the increase of Columbian grouse counts found within or near Peabody reclaimed lands. Decreased counts in 2005 and 2006 can

**TABLE 1: CSTG COUNTS ON PEABODY RECLAMATION**




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Columbian grouse on a lek at Seneca II.



be attributed to ongoing drought conditions combined with a severe winter in 2005-2006. In 2004, 2005 and 2006, Peabody properties and leks located on these properties were selected by the Colorado Division of Wildlife to trap Columbian grouse for the purpose of transplanting birds to other regions. These sites were chosen because taking birds from these locations would have the least impact on grouse populations.

### Conclusions

Monitoring data clearly shows that Columbian grouse prefer reclaimed lands to unmined lands including upland shrub and shrub steppe habitats. Bird and lek counts show continued dramatic growth of bird populations on mine reclamation lands that outpace other types of habitats. Reclamation practices implemented by Peabody's reclamation managers in northwest Colorado, particularly the "edge" effect, where islands of native shrub and trees are left intact within the reclaimed lands, along with establishing new shrub plots, have had a dramatic impact on sustainability of Columbian grouse populations. This practice has been recognized as one of the prime reasons that Columbian grouse prefer reclaimed lands. Habitat that provides grouse with their habitat needs for all seasons is a major factor in the grouse seeking out, establishing and remaining on Peabody's reclamation. Limiting grazing to periods that have the least impact on Columbian grouse and managing grazing to provide favorable habitat values are both factors contributing to the establishment of healthy populations on Peabody's reclaimed lands.

The success of Columbian grouse on reclaimed lands is a unique accomplishment brought about by a variety of reclamation and management inputs. This effort is in keeping with Peabody's goal to leave the land in equal or better condition after mining and achieves the intent and spirit of SMCRA and the Colorado Act. ■

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# Bridging the Gap

BY TIM DANEHY, BIOMOST, INC.



**B**ridging the gap between various groups that can influence a project's outcome is becoming increasingly necessary. This approach fits our team at BioMost, as we are staffed by people who have been employees of coal companies, government regulatory agencies, universities, and environmental nonprofits. This broad experience base helps us understand not only what is required by law, needed by industry, and developed through academic research, but also how

to work cooperatively with all groups – including grassroots nonprofits – to restore watersheds.

By design contract or by “design-build” agreement, typically with a highly experienced construction crew from Quality Aggregates Inc., BioMost has worked to implement over 50 passive systems that treat more than a billion gallons of mine water annually. While a number of these installations have been for mining companies that were seeking a more cost-ef-

fective treatment system requiring less maintenance, many have been for grassroots, volunteer-based, watershed groups like the Slippery Rock Watershed Coalition, the Montour Run Watershed Association, and AWARE, who work tirelessly to improve streams in their communities affected by abandoned mine drainage. Many of us at BioMost actually got our first “taste” of mine water and passive treatment as student volunteers with local watershed groups.



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BioMost prides itself on the philosophy that “we know less each day,” meaning that as we continue to learn and try to understand the science (and art) of what we do, we realize how much more there is to know. We are humbled by what we don’t know, while at the same time grateful for what has been accomplished. By developing treatment technologies in the field, we are forced to find viable solutions as problems arise. The experience gained through field application makes us better designers, which has led to three patents with a fourth patent-pending. For instance, as the technology evolved, to address sustainability of both system performance and volunteer watershed

restoration efforts, manganese-bearing solids forming at circum-neutral pH and iron-bearing solids forming at low pH, are being recovered and used in “green” products, with a portion of all proceeds donated to nonprofit watershed groups.

We know that we are not alone in this endeavor and that we are forever grateful to those who came before us and continue to work with us. Through organizations such as the American Society of Mining and Reclamation, we collectively share and discuss our findings. Together as a society, we continue to move forward to conquer the challenges that lie ahead. We must continue to build the bridge between those who search for the answers, those who use the answers, those who want the answers, and those who need the answers.

We hope to see you in June at the 2010 conference in Pittsburgh. Please join us and representatives from the PADEP, Bennett Branch Watershed Association, Slippery Rock Watershed Coalition, and others, to tour passive systems – operational for over a decade – including the system at Jennings Environmental Education Center, as well as other passive systems demonstrating newly developed approaches.

For further information, please contact Tim Danehy, BioMost, Inc., 434 Spring Street Ext., Mars, PA 16046; 724-776-0161, [bmi@biomost.com](mailto:bmi@biomost.com); [www.biomost.com](http://www.biomost.com). ■

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# Drinking the Green Jobs Kool Aid

According to the United Nations Environment Program, a “green job” is “work in agricultural, manufacturing, research and development, administrative and service activities that contribute(s) substantially to preserving or restoring environmental quality.” Reclaiming and restoring surface mines creates hundreds of jobs ... but are they considered “green” jobs?

**F**our billion for the smart grid. Five billion for weatherization. Two billion for wind power. Pretty soon we're talking serious green money.

Stimulating green jobs as a way to wind down the ranks of the unemployed, seemed like a good idea at the time, and remain a recurrent theme inside the Washington Beltway. The problem is, evidence is mounting that it not only isn't turning out as advertised, but many job-creation schemes are proving to be counterproductive.

Whereas President Obama has pointed to Europe as a shining example for America, the EU's experience “shows that for every green job created, a real job is destroyed elsewhere in the economy,” wrote Michael Economides and Peter Glover in an article, “Green Jobs: Fast Tracking Economic Suicide.”

Several studies have hit the street touting the prolific employment opportunities that subsidized green energy will generate, but critics have in many cases dismantled the underlying fuzzy math. The Institute for Energy Research

(IER), in reviewing four such studies, pointed to several recurring shortcomings of the green-jobs push, chiefly:

- Favoring energy sources that require more workers to yield a given amount of energy, which drives down workforce productivity while driving up energy costs.
- Ignoring the role of the private sector, which is normally more efficient at directing labor and capital than the government (a good example of this being the government-led synfuels debacle).
- Double counting jobs and overly simplifying the labor market – IEA found that long-range forecasts of green jobs were inflated.
- Counting job creation, but ignoring job destruction.

IER's research points to Germany as a real life example of the high cost of artificially incenting green employment. They found that German subsidies for solar power have cost \$73 billion since 2000 – a cost of \$240,000 per solar employee. Yet today solar power accounts for less than one percent of Germany's electricity. In nearby Denmark – a



haven for wind power – each green job costs taxpayers \$90,000 to \$140,000 a year (not that it's helped much: Denmark has the highest electricity prices in the EU). Not to be outdone, Spain has spent over \$750,000 in subsidies for each green job created – and lost 2.2 jobs per every new one. Unemployment in Spain approaches 20 percent.

But if this is an inconvenient truth to the green movement, it's becoming

harder to defend as the numbers become more incredulous in a world that's still reeling from the Great Recession. Consider:

- American taxpayers bankrolled \$2 billion of wind subsidies in 2009 and, according to the wind lobby itself, not a single net job was produced.
- The largest solar field in America employs two people full-time (although six landscapers reportedly will be hired to mow the grass every month).

- The \$4 billion in funds earmarked for close to 20 million “smart meters” under the American Recovery and Investment Act funds would result in 1,600-meter-installation jobs, according to an analysis by The Washington Post. Meanwhile, some 28,000 manual meter-reading jobs would be lost. The Post also calls out plug-in hybrids, whose assembly-line jobs promise to cannibalize jobs in factories that produce gas-powered vehicles.

- The beneficiary of a \$1.4-billion conditional government grant, BrightSource's planned solar thermal power complex in the Mojave Desert will create 86 permanent jobs. The world's largest wind farm, the \$2-billion Shepherds Flat project under construction in Oregon, will employ only 35 people once it's operating. Do the math on those projects.

At the end of the day, subsidizing green energy is an extraordinarily expensive way of reducing emissions. According to the National Review, the price for a permit to emit one ton of CO<sub>2</sub> under Europe's cap-and-trade scheme — the market cost of reducing emissions — is about \$20. Reducing emissions by subsidizing wind power works out to a cost of \$80 a ton. For solar power, the cost is a staggering \$1,050 a ton.

So with all this green Kool Aid being passed around, a few green jobs may be needed to measure how contaminated it is. ■

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# Coal-Mac Respects West Virginia's Beauty and Wildlife

**S**ome of the most productive coal areas in the eastern United States are often located in some of this nation's most beautiful countryside. Reclamation of surface mines requires more than just compliance with environmental standards. Successful restoration projects are known for their aesthetic beauty and harmony with the surrounding area.

Arch Coal's subsidiary Coal-Mac, Inc. has received numerous honors for exemplary land reclamation while restoring surface mining operations in Mingo and Logan counties in southern West Virginia. Coal-Mac's efforts reflect the company's philosophy: Mining is just a temporary use of the land. Proper planning and effective site management are paramount to achieving both economical mining and successful reclamation.

Reclamation efforts literally go "from the bottom up." Filling and land-forming start from the lowest areas and then build to higher terrain. The process minimizes impact to surrounding areas and ensures a smooth transition from mining to final reclamation.

Key to the restoration of the mined area is the company's construction of ponds, gently sloping terrain, and grass- and rock-lined waterways to eliminate erosion and sedimentation. The sites are carefully landscaped to attract wildlife and support grazing. Coal-Mac chose to seed the area with a variety of annual and perennial grasses and legumes, including orchard grass, timothy, winter rye, birdsfoot trefoil, clover, redtop, German millet and others, as well as oak, ash, sycamore, pine, locust and cherry trees for both beauty and diversity.

Coal-Mac involved community groups to further enhance the areas. Local Boy Scout Troop 321 installed nest boxes in the ponds to help develop an ideal habitat for wildlife. Islands in the ponds provide nesting and shelter for waterfowl.

The new habitat has attracted a variety of wildlife, including wild turkey, Canada geese, mallards, wood ducks, grebe and other species. Domestic cattle and horses graze in the tall grasses nearby.

Since Coal-Mac began its reclamation efforts in Mingo and Logan counties, the company has been honored 10 times by national and West Virginia state agencies, including three times by the U.S. Department of the Interior. It also has received numerous awards from environmental and industry groups, in-

cluding Ducks Unlimited, the Wild Turkey Federation and the West Virginia Coal Association.

"It's gratifying to see the employees of Coal-Mac earn recognition," says Arch Coal's president and chief operating officer, John W. Eaves. "They are proof positive that we can help meet the world's growing energy needs in economically, environmentally, and socially responsible ways."

St. Louis-based Arch Coal is the nation's second largest coal producer. The company's core business is providing U.S. power generators with cleaner-burning, low-sulfur coal for electric generation. Through its national network of mines, Arch supplies the fuel for approximately 8 percent of the electricity generated in the United States. Learn more about our stewardship at [archcoal.com](http://archcoal.com) and [youtube.com/archcoalcares](http://youtube.com/archcoalcares). ■





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# 2010 JOINT MINING RECLAMATION CONFERENCE

27th Annual Meeting of the American Society of Mining and Reclamation

12th Annual Pennsylvania Abandoned Mine Reclamation Conference

4th Annual Appalachian Regional Reforestation Initiative Mined Land Reforestation Conference

## Bridging Reclamation, Science and the Community



June 5 to 11, 2010 at the Radisson Pittsburgh-Greentree Hotel in Pittsburgh, PA (USA)

Visit the Joint Conference Website at [www.PghMiningReclamationConf.com](http://www.PghMiningReclamationConf.com)

## Advanced Program & Registration Information

The 2010 Joint Mining Reclamation Conference of the 27th Annual Meeting of the American Society of Mining and Reclamation, the 12th Annual Pennsylvania Abandoned Mine Reclamation Conference, and the 4th Annual Appalachian Regional Reforestation Initiative Mined Land Reforestation Conference is scheduled for the week of June 5-11, 2010 in Pittsburgh, Pennsylvania. 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 (ASMR)  
PA Abandoned Mine Reclamation (AMR) Conference Committee  
Appalachian Regional Reforestation Initiative (ARRI)  
US Office of Surface Mining Reclamation and Enforcement (OSM)  
Stream Restoration Incorporated (SRI)





# PROGRAM COMMITTEE

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## Travel and Lodging

### Transportation

The Pittsburgh Airport is an International Airport and serves most major airlines. All vehicle rentals are available through national vendors. The Radisson Pittsburgh-Greentree offers complimentary shuttle service from the airport to the Conference hotel, as well as free parking at the hotel itself. The Radisson can be reached at (412) 922-8400.

### Meeting Venue and Lodging

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101 Radisson Drive

Pittsburgh PA 15205, US

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The Radisson Pittsburgh-Greentree Hotel, located on the southwest side of Pittsburgh, will host all Conference events, meetings and functions. A block of rooms has been reserved for Conference participants at the rate of \$108.00 per night plus tax (\$15.12) until May 22. After May 22, the Conference rate may not be available. Reservations can be made by calling the hotel at 1-800-395-7046. **Be sure** to mention the ASMR Joint Mining Reclamation Conference to secure the Conference rate. For online hotel registration go to <http://www.radisson.com/pittsburghpa> and use code **ASM10** in the promotions code box.

Other hotels within a short driving distance are included below. **The Conference rate does not apply at these hotels.**

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# 2010 Joint Mining Reclamation Conference Overview

## Saturday, June 5

### Pre-Conference Field Tours

- 1) Decade-Old and Innovative New AMD Passive Treatment Systems and Reclamation Methods  
*Note: This is a 2-day Field Tour.*

### Pre-Conference Workshops

- 1) Erosion Estimates for Mined Lands Using RUSLE 2  
*Note: This is a 2-day Workshop.*
- 2) Semi-Arid Mine Land Reclamation "The Past 40 Years"

## Sunday, June 6

### Pre-Conference Field Tours

- 1) Decade-Old and Innovative New AMD Passive Treatment Systems and Reclamation Methods  
*Note: This is a 2-day Field Tour.*

### Pre-Conference Workshops

- 1) Erosion Estimates for Mined Lands Using RUSLE 2  
*Note: This is a 2-day Workshop.*
  - 3) Mine Drainage Treatment: A Detailed Review of Active Treatment Options, Advantages and Challenges
  - 4) Mobile Computing Technology Developments for SMCRA
  - 5) Modeling and Evaluating Mine Drainage Treatment Using Geochemist Workbench
  - 6) Passive Treatment of Alkaline Fe-Contaminated Mine Waters
  - 7) Communication and Presentation Improvement: "Harness The Power Of Words"
  - 8) Remote Sensing for SMCRA Applications
- ASMR National Executive Committee Meeting  
Evening Welcome Reception

## Monday, June 7

Welcome and Plenary Session

ASMR General Business Meeting

Poster Session

*Lunch provided.*

9) ARRI Forestry Reclamation Approach Workshop

Concurrent Technical Sessions

Science, Community and Reclamation Session  
Presentations

Technical Division Meetings

*Dinner on your own.*

ASMR Young Professionals Social

## Tuesday, June 8

Poster Session

Concurrent Technical Sessions

ARRI Mined Land Reforestation Session  
Presentations

Science, Community and Reclamation Session  
Presentations

*Lunch provided.*

ARRI Excellence in Reforestation Awards

Three Rivers Boat Cruise on the Monongahela  
River with the Pennsylvania AMR Mayfly Awards  
Presentation

## Wednesday, June 9

Concurrent Technical Sessions

Science, Community and Reclamation Session  
Presentations

*Lunch provided.*

Poster Session Social

ASMR Awards Dinner

## Thursday, June 10

Concurrent Technical Sessions (ending at 12 noon)

*Lunch on your own.*

ASMR National Executive Committee Meeting (pm)

### Post Conference Field Tours

- 2) Oxford Mining Company, LLC's Jockey Hollow Mine Site (Forestry Reclamation Approach Demonstration Site) (ARRI)
- 3) Mine Drainage Remediation in the Chartiers Creek Watershed
- 4) Consol Energy Research and Development
- 5) Active Marcellus Drill Site and Consol Energy/PA Game Commission Conservation Area

## Friday, June 11

- 6) West Virginia Mountaintop Surface Mining, FRA Reforestation and Stream and Wetland Mitigation



# Pre-Conference Workshops

**Pre-Registration is REQUIRED for all Workshops.**

**Unless otherwise indicated, lunch is on your own.**

Workshops are subject to cancellation if the minimum number of students is not met by May 10, 2010. All Workshop attendees will be notified in the event of a cancellation. Substitutions and/or refund options will be available.

## **Workshop 1: Erosion Estimates for Mined Lands Using RUSLE 2**

Instructor: Dr. Terry Toy  
Minimum 10, Maximum 25

Saturday and Sunday, all day.

Erosion control remains the best method of sediment control. And the Revised Universal Soil Loss Equation, version Version 2 (RUSLE 2) is the best, practical, method of soil-loss estimation for erosion-control planning and plan evaluation. Now, RUSLE 2 has been updated and adapted for severely disturbed conditions, including mine sites. In this introductory course, you will receive a free copy of the new RUSLE 2 program; learn where to find additional RUSLE 2 databases for your site, and how to tailor RUSLE 2 for erosion-control planning and plan evaluation. Most importantly, you will gain hands-on experience with RUSLE 2 by loading it onto your laptop computer and working through several common erosion-control scenarios under the guidance of your instructors. You will learn how to compare various erosion-control strategies for your site. Along the way, you will also learn how environmental conditions affect erosion processes and rates. The NRCS has adopted RUSLE 2 for use in soil-conservation planning. Other federal agencies and several states are encouraging the use of RUSLE 2 for erosion-control planning for all types of disturbed lands. RUSLE 2 puts the consultant, reclamationist, and regulator on the same page.

Workshop Cost: \$170 per person

**Attendees need to bring own laptop;**  
attendees will receive course literature and software.

## **Workshop 2: Semi-Arid Mine Land Reclamation "The Past 40 Years"**

Instructors: Bruce Buchanan, Adam Buchanan  
Minimum 15, Maximum 30

Saturday (8 hours).

The Workshop will discuss the do's and don'ts of reclamation and what we have learned over the past 40 years. A panel of western experts will provide a Q&A session and share their experience, advice and recommendations. This Workshop is a necessity for the reclamationist who wants to do it once, and do it right.

Workshop Cost: \$140 per person

**Attendees need to bring own laptop;**  
attendees will receive course literature.

## **Workshop 3: Mine Drainage Treatment: A Detailed Review of Active Treatment Options, Advantages and Challenges**

Instructors: Bernard Aubé, Janice Zinck  
Minimum 10, Maximum 100

Sunday (8 hours).  
**Lunch provided.**

Neutral mine drainage or acid rock drainage (ARD) formation cannot always be prevented economically, particularly in older mine sites. In many cases, the most economical solution is that of treatment. There are many treatment options available. This course will be primarily on active treatment technologies and what is new in treatment processes. The course will focus on treatment system design and performance, as well process and cost optimization as they relate to actual existing systems. The basics and challenges of active treatment and water management will be discussed along with specific active technologies such as lime neutralization, membrane separation, the treatment of molybdenum, selenium, arsenic, and sulfate. Lime treatment sludge stability and management will also be examined.

Workshop Cost: \$200 per person

**A computer is not needed;** attendees will receive a CD.

**Workshop 4:  
Mobile Computing Technology  
Developments for SMCRA**

Instructors: Min Kim, Julian Calabrese, Leslie Bright  
Minimum 10, Maximum 40

Sunday afternoon (4 hours).

Recent advances in mobile computing and GPS have provided important applications for real time mapping and data collection in surface mine reclamation. A variety of field devices offer features that improve the reliability, flexibility, and convenience of GIS data collection. Implementation of the Bluetooth communication now allows for wireless operation. Remotely-sensed and aerial imagery in a variety of formats are supported across multiple form factors and displays. Software functionality has been enhanced to incorporate more data formats and better integrate real-time GPS positioning with GIS data sets. The Workshop will describe and demonstrate new devices and supporting software from GIS arena. Live data collection and imagery display will be performed in short field sessions during the last part of the Workshop.

Workshop Cost: \$35 per person

**Attendees need to bring own laptop;**  
attendees will receive course literature.

**Workshop 5:  
Modeling and Evaluating Mine  
Drainage Treatment Using Geochemist Workbench**

Instructor: Brent Means  
Minimum 3, Maximum 15

Sunday (8 hours).

This class is aimed at providing attendees with an understanding of how to apply the geochemical modeling program, Geochemist Workbench, to model the treatment chemistry of active and passive treatment systems. The class is focused on the practical application of modeling and will use data collected from various mine discharges and treatment systems to cover the following topics:

- Creating activity and Eh/pH diagrams to identify solubility controls on mine drainage;
- Developing strategies to constrain a model to produce usable “real-world” results;
- Modeling chemical consumption, treatment pH, and effluent chemistry for NaOH, CaO, Ca(OH)<sub>2</sub>, lime slurry, CaCO<sub>3</sub>, and Na<sub>2</sub>CO<sub>3</sub> treatment systems and predicting the treatment costs;
- Modeling the effect of CO<sub>2</sub> pre-aeration on chemical consumption and treatment costs (chemical savings versus mechanical aerator operation);
- Using a model to develop a comprehensive watershed restoration strategy to achieve in-stream restoration goals for abandoned mine land scenarios;
- Evaluate the performance of VFP, ALD, and bioreactors;
- Modeling CO<sub>2</sub> exsolution kinetics for passive and active aeration devices;
- Modeling heterogeneous and homogenous iron oxidation to size ferrous reactor tanks and passive treatment.

Because of time constraints, the class is more geared-towards watching instructor-led examples than learning the software. However, attendees are invited to follow along using their own laptop and a supplied trial-version of Geochemist Workbench, if desired.

Workshop Cost: \$50 per person

**Attendees need to bring own laptop;**  
attendees will receive course literature and software  
(trial version).



### **Workshop 6:**

#### **Passive Treatment of Alkaline Fe-Contaminated Mine Waters**

Instructor: Bob Hedin  
Minimum 8, Maximum 26

Sunday (8 hours).  
**Box lunch provided.**

The most successful use of passive treatment has been in the treatment of alkaline Fe-Contaminated waters. This chemistry is typical of many deep mine discharges in Western PA and is also common wherever mining occurs in alkaline strata. Hedin Environmental is a leader in the design and construction of passive systems for these waters. The morning session will present design considerations including: passive treatment background; chemical characterization; pretreatment with ALDs; loading measurements; design and sizing of passive systems; cost estimation; operation and maintenance requirements; sludge recovery and sale; and NPDES compliance. Experiences and data from existing systems will be highlighted.

The afternoon session will be at the Wingfield Pines Passive Treatment System, which is located 10 miles from the Conference venue. The system contains innovative aeration and design features. The system's design, construction, and performance will be detailed. Its evolution into a regional educational and artistic asset will be highlighted.

Workshop Cost: \$205 per person

**A computer is not needed;** attendees will receive course literature.

### **Workshop 7:**

#### **Communication and Presentation Improvement: "Harness The Power Of Words"**

Instructors: Adam Buchanan, Bruce Buchanan  
Minimum 10, Maximum 40

Sunday (8 hours).

Refine your presenting skills by learning the do's and don'ts of public speaking and presenting information. Learn how to analyze your audience and how to best communicate using "The Platinum Rule". Learn PowerPoint skills to spice up your presentations. Learn how to get more out of meetings to increase productivity and reduce stress. Presenters will also be offering PowerPoint consultations provided throughout the week of meetings that is included in the registration fee.

Workshop Cost: \$160 per person

**A computer is not needed;** attendees will receive course literature.

### **Workshop 8:**

#### **Remote Sensing for SMCRA Applications**

Instructors: Dianne Osborne, Janine Ferarese, Lukus Monette  
Minimum 10, Maximum 40

Sunday (8 hours).

This Workshop will provide a basic overview of what remote sensing is and how it can be used to support SMCRA Title IV and V 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 SMCRA projects and the use of data mining tools to support these applications will be presented.

Workshop Cost: \$50 per person

**A computer is not needed.**

### **Workshop 9:**

#### **ARRI Forestry Reclamation Approach Workshop**

Instructors: Dr. Jennifer Franklin, Dr. Jeff Skousen, Dr. Rick Sweigard, Ron Rathfon, Vic Davis  
Minimum 5, Maximum 50

Monday (3 hours).

This Workshop will provide an overview of the Forestry Reclamation Approach (FRA). Each of the FRA's five steps will be described and discussed, and examples demonstrating step-by-step field application will be presented.

Workshop Cost: Free

**A computer is not needed;**  
attendees will receive course literature.

**For more detailed descriptions of these Workshops go to:**

**[www.PghMiningReclamationConf.com](http://www.PghMiningReclamationConf.com)**

# Pre- and Post-Field Tours

**Pre-Registration is REQUIRED for all Tours.**

**All Field Tours depart from the Radisson, see final program for final departure times.**

Field Tours are subject to cancellation if the minimum number of students is not met by May 10, 2010. All Field Tour attendees will be notified in the event of a cancellation. Substitutions and/or refund options will be available.

## Pre-Conference Tours

### 1. Decade-Old and Innovative New AMD Passive Treatment Systems and Reclamation Methods

Coordinator: Margaret Dunn  
Minimum 30, Maximum 55

Saturday, June 5 to Sunday, June 6:  
Depart 9 am, Saturday morning - Return 5 pm, Sunday evening.  
**Box lunches and snacks provided 1st and 2nd days of the trip.**  
**Saturday night dinner will be on your own.**

Join us for a two-day Field Tour of sites illustrating various approaches to restore land and water resources impacted by abandoned coal mining activities in Pennsylvania. Described will be "lessons-learned", upgrades to older systems, and long-term maintenance requirements. The first day will highlight the 13-year old passive system treating iron- and aluminum-bearing acidic drainage and a demonstration of the Appalachian Regional Reforestation Initiative. Resource recovery of manganese-bearing solids will also be demonstrated at a passive system in the Slippery Rock Creek Watershed. The evening of June 5 will be spent enjoying the beautiful rustic town of St. Mary's including a Tour of the Straub Brewery, which boasts of an "Eternal Tap" for sampling. Overnight accommodations will be at the Best Western in St. Mary's PA.

The second day will include the Dents Run Watershed in the Pennsylvania Wilds to visit both active and passive systems (we may also see an elk herd!!) with a guided Tour by the PA Bureau of Abandoned Mine Reclamation. This two-day Tour is hosted by the PA Department of Environmental Protection, PA Department of Conservation and Natural Resources, Bennetts Branch Watershed Association, Slippery Rock Watershed Coalition, Stream Restoration Inc., and BioMost, Inc.

Cost: \$180 per person

Attendees bring: overnight bag that includes appropriate June hiking clothes; boots/walking boots, insect repellent and a hat.  
Binoculars and cameras recommended.

## Post-Conference Tours

### 2. Oxford Mining Company, LLC's Jockey Hollow Mine Site (ARRI Tour) (Forestry Reclamation Approach Demonstration Site), Cadiz, OH

Coordinators: Mike Hiscar and Jeff Emmons  
Minimum 14, Maximum 200

Thursday, June 10: Depart 8 am - Return 5 pm.  
**Lunch and snacks provided by Oxford Mining, LLC.**

The Oxford Mining Company, LLC, the winner of ARRI's 2008 Regional Excellence in Reforestation award, has reclaimed the Jockey Hollow permit using the Forestry Reclamation Approach (FRA). The FRA reclamation method complies with state and federal regulations, and is intended to ensure that trees planted will not only survive but will thrive. The state of Ohio owns the surface of the mine site, which is managed by the Ohio Department of Natural Resources' Division of Wildlife as part of the Jockey Hollow Wildlife Area. The area was surface mined in the 1950's and 1960's leaving over 10,000 feet of exposed highwall, ungraded spoil piles, barren areas, and numerous water-filled pits. The vegetation found onsite was a combination of early successional and second growth hardwoods and grasses such as fescue. The original topsoil and subsoil were absent from this site as a result of the pre-law mining. Oxford was able to create an excellent growth medium for planting trees by identifying an alternative re-soiling material consisting of a mixture of sandstones and shales, and end dumping the material to create loose and uncompacted soil materials. The reclaimed site features a variety of planted and volunteer hardwood trees (including American chestnut) with a ground cover that is comprised of planted and volunteer species; early survival and growth of the planted hardwoods is excellent, as expected. The Tour will visit the award-winning reclaimed site, which was planted in 2008 and 2009, and an active Oxford mining site, where reclamation operations are also reestablishing native hardwood forest as the post-mining land use using the FRA reclamation technique.

Field Tour Cost: No charge

**Attendees need to bring: steel toed boots.**

Attendance limited to the 1st 200 people signing up for the trip.



### 3. Mine Drainage Remediation in the Chartiers Creek Watershed

Coordinators: Bob Hedin and Rich Beam  
Minimum 8, Maximum 26

Thursday, June 10: All day.  
**Box lunch included.**

This Field Tour will expose participants to mine drainage remediation projects in the Chartiers Creek watershed. The Conference is taking place in the Chartiers Creek watershed and the Tour stops are all within 20 minutes of the hotel. The trip stops will include a passive system that treats a 1500 gpm discharge, a 200 gpm discharge where a system will be constructed in 2010; a discharge that is the largest source of mine drainage pollution in the watershed; and a reclamation project that eliminated a major inflow to a deep mine. Each site visit will be led by one of the project organizers. The participants will receive handouts and have a chance to review construction plans.

Field Tour Cost: \$60 per person

### 4. Consol Research and Development

Coordinator: Consol Energy  
Minimum 29, Maximum 50

Thursday, June 10: Depart 8 am - Return 2 pm.  
**Lunch provided.**

Presentation on research projects and a Tour of CONSOL's R&D campus. Visitors will learn about CONSOL's various research projects, the majority of which are focused on pollution reduction, greenhouse gas reduction and carbon capture and sequestration, and our state-of-the-art analytical lab. Visitors will tour CONSOL's analytical lab, metallurgical coke lab, and pilot plants. Our most recent pilot plant project is a pressurized fluidized bed combustion unit designed to burn waste coal and includes CO<sub>2</sub> capture technology.

Field Tour Cost: \$50 per person

Consol Energy will be providing hard hats and safety glasses;  
closed toed shoes only - no heels.

### 5. Active Marcellus Drill Site and Consol Energy/PA Game Commission Conservation Area

Coordinators: Consol Energy and the PA Game Commission  
Minimum 10, Maximum 20

Thursday, June 10: Depart 8 am - Return 5 pm.  
**Lunch provided.**

During the morning, visit an active Consol Energy Marcellus Shale Drill Site in near-by Green County and observe the technologies behind the removal of natural gas from shale. Experts will be available to explain all aspects of the gas removal process including drilling techniques, hydraulic fracturing, and disposal of used fracture water.

The afternoon will consist of a visit to PA State Game Lands 245 where Consol Energy, in conjunction with the PA Game Commission, has constructed a stream remediation and created wetlands project after longwall mining. When subsidence of the surface occurs after longwall mining under streams in Pennsylvania, permit provisions require a plan to address the impacts to the original stream channel gradient. CONSOL Energy requested and received approval for an alternative to traditional re-grading of the stream channel to take advantage of the new wetland habitats that are sometimes created in stream valleys after longwall mining. This Field Tour will view a project where prior to mining earthwork was completed to create stabilized wetlands adjacent to the stream channel after mining and subsidence occurred on State Game Lands 245 in Washington County Pennsylvania.

Field Tour Cost: \$50 per person

Attendees bring: field clothes and boots.  
Consol Energy will provide hard hats when needed.

### 6. West Virginia Mountaintop Surface Mining, FRA Reforestation and Stream and Wetland Mitigation

Coordinator: Jeff Skousen  
Minimum 25, Maximum 47

Friday, June 11: Depart 6 am - Return 6 pm.  
**Breakfast and lunch provided. Dinner on your own.**

ICG Eastern – Birch River operates a large mountaintop mining complex near Cowen, WV. The operation takes four seams of coal using a dragline and a suite of excavators and trucks. Topsoil handling, overburden blasting and special handling, reclamation, and water management will be observed and discussed. Coal removal and equipment used on the mine will be seen.

We will also observe reforestation plots established 5 years ago. We will also observe a new planting using the FRA approach: substrate selection, minimal compaction, low amounts of ground cover, and hardwood tree plantings. Our last stop will observe stream and wetland mitigation, and discuss revised wildlife plans for post-mining land use.

Field Tour Cost: \$87 per person

**Attendees bring: a hard hat and boots.**

**For more detailed descriptions of the Field Tours go to: [www.PghMiningReclamationConf.com](http://www.PghMiningReclamationConf.com)**

**Preregistration is REQUIRED for all Tours.**

**All Social Tours depart from the Radisson, see final program for final departure times.**

Social Tours are subject to cancellation if the minimum number of attendees is not met by May 10, 2010. All Social Tour attendees will be notified in the event of a cancellation. Substitutions and/or refund options will be available.

## Meadowcroft

Coordinator: Jeff Trump  
Minimum 24, Maximum 55

Sunday, June 6: Depart 10:30 am - Return 4 pm.  
**Lunch provided.**

Meadowcroft Rockshelter, the oldest site of human habitation in North America, provides a unique glimpse into the lives of prehistoric hunters and gathers. This National Historic Landmark features a massive, 16,000-year-old rock overhang used by our earliest ancestors for shelter and the new enclosure provides visitors with a unique, never-before-seen perspective into the oldest and deepest parts of this internationally-renowned archeological excavation.

In addition to ancient history at the Rockshelter, visitors can step back in time to experience rural life over 150 years ago. Meadowcroft Village recreates all of the charming qualities of an Upper Ohio Valley village from mid-19th century.

Tour Cost: \$57 per person

## River of Steel Tour

Coordinator: Jeff Trump  
Minimum 24, Maximum 55

Thursday, June 10: Depart 9:00 am - Return 3:00 pm.  
**Lunch is on your own.**

Pittsburgh - a dynamic place - is located at the confluence of the Allegheny, the Monongahela and the Ohio. There is a certain flavor about Pittsburgh that tells visitors that it is alive and exciting!

This Tour follows the experiences and the stories of the immigrant workers and their families that poured into this region, from the heights of Mount Washington to the heart of the Monongahela Valley. The Tour will start at the top of Mt. Washington (have your camera ready for this stop!), continue to the Cookie Table, one of Pittsburgh's famous ethnic traditions, and finish at the site of the 1892 Battle of Homestead, where a young struggling union stood its ground against the titans of industry, Andrew Carnegie and Henry Clay Frick. Following the Tour we will visit the Strip District, the center of wholesale produce marketing in Pittsburgh, and you will have a chance to wander through the outdoor produce markets, bookstores, ethnic foods specialty shops, fish markets and restaurants. It is here that the uniqueness of Pittsburgh history becomes evident. You will have time to shop and have lunch on your own. We will provide guide books for the area so we can make your stay a productive one.

The bus will then pick everyone back up and return to the hotel.

Tour Cost: \$34 per person

## Falling Water and Flight 93 Memorial

Coordinator: Jeff Trump  
Minimum 24, Maximum 55

Thursday, June 10: Depart 8:30 am - Return 5:00 pm.  
**Box lunch provided.**

At the Flight 93 Memorial, you will be greeted by a guide who will tell you the story of that fateful Sept. 11th day. During the visit, you will be updated on the plans for a more permanent memorial and visit the Flight 93 Chapel to learn more about the crash victims. A boxed lunch will be served on the bus following the Tour.

Fallingwater - This breathtaking house was judged by the American Institute of Architects in 1986 to be the nation's most successful example of architectural design. It is described as the clearest expression of Wright's ideal...that man can live in harmony with nature. Your guide will provide interesting background about the home, the Kaufmann family, and the colorful Frank Lloyd Wright and his other architectural works during the scenic drive to the home.

Tour Cost: \$ 75 per person

**For more details go to: [www.PghMiningReclamationConf.com](http://www.PghMiningReclamationConf.com)**



## Evening Welcome Reception

The 2010 Joint Mining Reclamation Conference Welcome Reception is open to all attendees and will be held from 6:00 pm to 8:00 pm on Sunday, June 6 in the Junior Ballroom of the Radisson Pittsburgh-Greentree Hotel. Light appetizers and refreshments as well as a cash bar will be available. Renew old acquaintances and meet new people that share mutual professional interests.

## Vendors and Exhibitors

The Conference's vendors and exhibitors serve as an important focal point for participant interaction. All coffee and refreshment breaks will be held in the Junior Ballroom alongside the exhibits and displays. All exhibit arrangements should be made through the ASMR website: [www.asmr.us](http://www.asmr.us). The information for this year's Conference can be found under Annual Meetings, 2010 Pittsburgh PA. Exhibitor and Vendor details can also be found at:

[www.PghMiningReclamationConf.com](http://www.PghMiningReclamationConf.com)

## Plenary Session

The Plenary Session will be held Monday morning, June 7 at 8 am in the Radisson Pittsburgh-Greentree Hotel. The Keynote Speakers will address the Conference theme.

## Concurrent Technical Sessions

The concurrent technical sessions will start on the afternoon of Monday, June 7 and conclude on Thursday, June 10 at 12 noon. Paper presentations covering a broad spectrum of topics will be presented during these technical sessions. All presentations will take place onsite. Descriptions and additional information for the technical sessions, paper titles and authors can be found on the Conference's website:

[www.PghMiningReclamationConf.com](http://www.PghMiningReclamationConf.com)

## ASMR Young Professionals Social Event

The ASMR Young Professionals group will be hosting their first annual social event in a "night on the town" on Monday, June 7, from 7 pm to 12 am. During this event, you will have a chance to meet, socialize and network with other young professionals as well as a select group of our more seasoned ASMR members. It will be a great opportunity to meet the people you will see throughout the week, share tips on advancing your career and find out how to get more involved with ASMR. Transportation to and from this event will be provided. Hors d'oeuvres, beer, cocktails and soft drinks will be served all for the low ticket price of **\$15 for ASMR members and \$20 for non-members**. If you want to bring your spouse, you are encouraged to do so. (They would pay the non-member price.)

Wondering if you're a young professional and should attend this event? If you've been doing reclamation at a mine, conducting research or teaching at an academic institution, consulting, regulating or doing anything reclamation associated as a career for **<10 years**, you're invited!

## CONFERENCE ACTIVITIES

### ASMR National Executive Committee Meeting

*Sunday, June 6  
9:00 am - 5:00 pm*

### Welcome Reception

*Sunday June 6  
6:00 pm - 8:00 pm*

### ASMR Young Professionals Social

*Monday, June 7  
7:00 pm - 12:00 am (midnight)*

### ARRI Excellence in Reforestation Awards

*Tuesday June 8  
12:00 pm*

### Three Rivers Boat Cruise and PA AMR Mayfly Awards

*Tuesday June 8  
5:30 pm - 11:00 pm  
(shuttle service starts at 5:30 pm)*

### Poster Session Reception

*Wednesday, June 9  
5:00 pm - 6:30 pm*

### ASMR Awards Banquet

*Wednesday, June 9  
7:00 pm*

**Technical Division Business Meetings**  
*(will be taking place; see details in final program)*

### ASMR National Executive Committee Meeting

*Thursday, June 10  
1:30 pm - 4:30 pm*

## ARRI Mined Land Reforestation Conference and the Excellence in Reforestation Awards

On Tuesday, June 8, ARRI speakers will present information concerning mined land reforestation. Invited speakers include past winners of ARRI's Excellence in Reforestation Awards and other experts in the field of reforestation on mined lands. The session will highlight award winning reclamation using the Forestry Reclamation Approach (FRA) from mine operators throughout the Appalachian Region and will also discuss innovative applications of the FRA. During the regular lunch, ARRI will present the Excellence in Reforestation Awards. Also, the State award winners from the past year will be recognized and the Regional Award Winner will be announced. The Regional Award is presented to the State Award Winner that best exhibited use of the FRA during reclamation. **The luncheon is open to all registered Conference participants and the cost is included in the registration fees.**

## Three Rivers Boat Cruise and the PA AMR Mayfly Awards

The Ohio River Watershed – Fuel for a Nation: Hosted By Consol Energy  
June 8, 2010: Departs 7:00 pm - Docks 10:00 pm.

Hosted by Consol Energy (the nation's largest producer of high-Btu Bituminous coal), the Three Rivers Boat Cruise is an opportunity to see Pittsburgh from a unique vantage point while learning about the region's rich past, mingling with representatives from the energy and mining industries, watershed organizations, municipal and state and federal agencies all while enjoying the flavor of Pittsburgh with an excellent Captain's Buffet in the company of local entertainers under a sparkling skyline. The PA Abandoned Mine Reclamation Conference Committee will highlight the evening with the awarding of its Mayfly Award to an individual for their lifetime commitment to reclamation in PA.

For over 250 years, Pittsburgh and its rivers have been the gateway through which coal, oil, steel, and other commodities have made their way to the rest of the country. Even today, the region's extensive network of waterways continues to be the lifeblood for commercial transportation--providing "Fuel for a Nation". This Cruise will include locking through the Braddock Lock and Dam with an explanation by the USACOE and the Port of Pittsburgh Commission. Join us and see why Pittsburgh is called, "The City of Bridges"!

Cruise departure from Station Square, Pittsburgh, PA on the Gateway Clipper's Empress. Transportation provided to and from Radisson Hotel.

**Shuttle service to the dock starts at 5:30 pm.  
Return shuttle service starts at 10:15 pm.**

Cost: \$60.00 per person

Casual Attire.

## Poster Session

The posters will be on display from Monday, June 7 through Wednesday evening, June 9. A Poster Session and Social will be held Wednesday evening, June 9 at 5:00 pm to 6:30 pm. The authors will be available for presentations and discussions of their research investigations, results and interpretation during the social. Poster titles and author information can be found on the Conference website <http://www.pghminingreclamationconf.com/>. Light appetizers and refreshments will be available.

## Catered Events

Continental breakfasts in the morning and coffee, tea, soft drinks and snacks in the afternoon will be available in the Junior Ballroom for all Conference participants. In addition, a Welcome Reception, the ARRI Reforestation Awards Lunch, the ASMR Awards Dinner, light evening refreshments during the poster session and catered buffet lunches will be provided to all participants and are included in your registration fee.

## TECHNICAL SESSIONS

**ARRI - FRA Workshop**

**Ecology: Establishment and Evaluation of Switchgrass**

**Ecology: Oil and Gas Reclamation; Carbon Storage**

**Ecology/Land Use: Geomorphology, Stream Habitat, and Endangered Species**

**Forestry and Wildlife: Reforestation, Reclamation and Post Mining Land Use**

**Forestry Reclamation Approach Success Stories (ARRI)**

**The Forestry Reclamation Approach Today (ARRI)**

**Innovative Applications (ARRI)**

**Science, Community and Reclamation**

**Soil and Overburden: Mine Refuse Reclamation**

**Soil and Overburden: Soils and Land Cover**

**Water Management: Biological and Biochemical Reactors**

**Water Management: Metal Removal**

**Water Management: Passive Treatment**

**Water Management: Alkaline Additions; Treatment Costs**

**Water Management: Watershed Studies**

**Water Management: Flow Models**

**Water Management: Policy, Guidance, and Alternative Analysis**

# 2010 JOINT MINING RECLAMATION CONFERENCE

## 27th Annual Meeting of the American Society of Mining and Reclamation 12th Annual Pennsylvania Abandoned Mine Reclamation Conference 4th Annual Appalachian Regional Reforestation Initiative Mined Land Reforestation Conference

Radisson Hotel, Pittsburgh-Greentree (USA)  
June 5 - June 11, 2010

### REGISTRATION FORM

In order to facilitate transportation, lodging, meeting room space, and catering requirements for Conference activities, we strongly encourage Pre-Registration. Pre-Registration for the entire Conference is \$270.00 or \$100.00 per day until May 10, 2010; Late Registration for the entire Conference is \$325.00 or \$125 per day. Student and Non-Profit Registration is \$135.00. Workshop and Tour costs are extra and are detailed below.

|         |                     |               |         |
|---------|---------------------|---------------|---------|
| Name    | Company/Affiliation |               |         |
| Address |                     |               |         |
| City    | State/Province      | Zip/Mail Code | Country |
| Phone   | Email Address       |               | Date    |

### GENERAL AND TECHNICAL SESSIONS

- Pre-Registration** (until May 10, 2010) ..... (per person) **\$270.00** ☐  
*Includes Monday, June 7 to Thursday, June 10, 2010.*
- One Day Registration** (until May 10, 2010)..... (per person) **\$100.00** ☐  
Check day/s: ☐ Mon ☐ Tue ☐ Wed
- Late Registration** (after May 10, 2010) ..... (per person) **\$325.00** ☐  
*Includes Monday, June 7 to Thursday, June 10, 2010.*
- Late One-Day Registration** (after May 10, 2010) ..... (per person) **\$125.00** ☐  
Check day/s: ☐ Mon ☐ Tue ☐ Wed
- Student Registration** ..... (per person) **\$135.00** ☐  
(Submit copy of ID with Registration Form.)
- Non-Profits Registration**..... (per person) **\$135.00** ☐  
(Submit copy of the 501(C)(3) Letter of Determination.)

### WORKSHOPS

**Pre-Registration is requested prior to May 10; otherwise first-come, first-serve basis.**

Check the box beside the Workshop you are interested in, in order to sign up.

- Erosion Estimates for Mined Lands Using RUSLE 2** ..... (per person) **\$170.00** ☐  
*Saturday, June 5, to Sunday, June 6, 8:00 am - 5:00 pm.*
- Semi-Arid Mined Land Reclamation "The Past 40 Years"** ..... (per person) **\$140.00** ☐  
*Saturday, June 5, 8:00 am - 5:00 pm.*
- Mine Drainage Treatment: A Detailed Review of Active Treatment Options, Advantages & Challenges** (per person) **\$200.00** ☐  
*Sunday, June 6, 8:00 am - 5:00 pm. Lunch provided.*
- Mobile Computing Technology Developments for SMCRA**..... (per person) **\$35.00** ☐  
*Sunday, June 6, 12:30 pm - 4:30 pm.*
- Modeling and Evaluating Mine Drainage Treatment Using Geochemist Workbench** ..... (per person) **\$50.00** ☐  
*Sunday, June 6, 8:00 am - 5:00 pm.*
- Passive Treatment of Alkaline Fe-Contaminated Waters**..... (per person) **\$205.00** ☐  
*Sunday, June 6, 8:00 am - 5:00 pm. Box lunch provided.*
- Communication and Presentation Improvement: "Harness the Power of Words"** ..... (per person) **\$160.00** ☐  
*Sunday, June 6, 8:00 am - 4:00 pm.*
- Remote Sensing for SMCRA Applications** ..... (per person) **\$50.00** ☐  
*Sunday, June 6, 8:00 am - 5:00 pm.*
- ARRI Forestry Reclamation Approach Workshop** ..... **\$0.00** ☐  
*Monday, June 7, 1:30 pm - 4:30 pm.*



## REGISTRATION FORM (continued)

### FIELD TOURS

**Pre-Registration is requested prior to May 10; otherwise first-come, first-serve basis.**

Check the box beside the Field Tour you are interested in, in order to sign up.

1. Decade-Old and Innovative New AMD Passive Treatment Systems and Reclamation Methods..... (per person) \$180.00 ☐  
Saturday, June 5, 9 am to Sunday, June 6, 5 pm.  
Registration cost covers transportation, meals (except Saturday evening), lodging with continental breakfast, snacks & beverages.
2. (ARRI Trip) Oxford Mining Company LLC's Jockey Hollow Mine Site .....\$0.00 ☐  
Forestry Reclamation Approach Demonstration Site, Cadiz, OH  
Thursday June 10. Includes transportation, lunch, snacks & beverages. (Limited to the first 200 people who sign up.)
3. Mine Drainage Remediation in the Chartiers Creek Watershed ..... (per person) \$60.00 ☐  
Thursday June, 10. Registration cost provides for transportation, lunch, snacks and beverages.
4. Consol Energy Research and Development ..... (per person) \$50.00 ☐  
Thursday, June 10. Registration cost provides for transportation, lunch, snacks and beverages.
5. Active Marcellus Drill Site and Consol Energy/PA Game Commission Conservation Area..... (per person) \$50.00 ☐  
Thursday, June 10. Registration cost provides for transportation, lunch, snacks and beverages.
6. West Virginia Mountaintop Surface Mining, FRA Reforestation and Stream and Wetland Mitigation ..... (per person) \$87.00 ☐  
Friday, June 11. Registration cost provides for transportation, breakfast, lunch, snacks and beverages.

### SOCIAL TOURS

**Pre-Registration is requested prior to May 10; otherwise first-come, first-serve basis.**

Check the box beside the event you are interested in, in order to sign up.

1. Meadowcroft ..... (per person) \$57.00 ☐  
Sunday, June 6. Registration fee provides for transportation, tour and lunch.
2. Rivers of Steel Tour ..... (per person) \$34.00 ☐  
Thursday, June 10, 9 am - 3 pm. Registration fee provides for transportation and tour. Lunch is on your own.
3. Falling Water and Flight 93 Memorial ..... (per person) \$75.00 ☐  
Thursday, June 10, 8:30 am - 5 pm. Registration fee provides for transportation, tours and lunch.

### OTHER FUNCTIONS

Check the box beside the event you are interested in, in order to sign up.

- Three Rivers Boat Cruise: Come Experience the City of Bridges ..... (per person) \$60.00 ☐  
Tuesday, June 8, 7 pm – 10 pm (transportation included).  
Number of Guests: \_\_\_\_\_ Total Amount: \$ \_\_\_\_\_  
**Attendance for the Boat Cruise is limited. Registration by May 10, 2010 is necessary; first-come, first-serve basis.**
- ASMR Young Professionals Social ..... ☐  
Number of Guests: Members: (\$15.00 per person) \_\_\_\_\_ Non-Members: (\$20.00 per person) \_\_\_\_\_ Total Amount: \$ \_\_\_\_\_
- ASMR Awards Banquet.....\$0.00 ☐  
Wednesday, June 9 (free for all Joint Conference Registrants).  
Number of Additional Guests: (\$25.00 per person) \_\_\_\_\_ Total Amount: \$ \_\_\_\_\_

**TOTAL AMOUNT OF REGISTRATION .....US DOLLARS \$**

No refunds after May 10, 2010.

### METHOD OF PAYMENT

Check payable to ASMR ☐ Credit Card: Visa ☐ Master Card ☐ Card # \_\_\_\_\_ - \_\_\_\_\_ - \_\_\_\_\_ - \_\_\_\_\_ Exp. Date \_\_\_\_\_  
Card Holder Name (print) \_\_\_\_\_ Signature \_\_\_\_\_

**Note: A \$5.00 credit card processing fee will be added to all Registrations if paid by credit card.**

### REGISTRATION AND PAYMENTS

Mail checks or credit card information to:  
ASMR, 3134 Montavesta Road, Lexington, KY 40502  
Or fax all payment information to: 859.335.6529

### CONTACT INFORMATION

Richard Barnhisel  
Phone: 859.351.9032 (cell)  
Fax: 859.335.6529 (located in my home)

Registration also accepted by email: [asmr5@insightbb.com](mailto:asmr5@insightbb.com)



**Alpha** Natural Resources  
***RUNNING RIGHT.***

[www.alphanr.com](http://www.alphanr.com)



# INVESTING IN THE ENVIRONMENT...

and ***RUNNING RIGHT***

We balance our investment in production with an investment in the environment. From planting half a million trees a year and building the first natural stream channel on a coal mine site in Virginia, to participating in leading-edge research on safe underground storage of greenhouse gas emissions from power plants, we are committed to doing more than our part.

## Did you know...

Alpha Natural Resources has won numerous state and national recognitions, including the Greenlands award, West Virginia's top award for environmental excellence in reclamation.



Alpha Natural Resources | One Alpha Place | P.O. Box 2345 | Abingdon, VA 24212



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

## specializing in mine drainage treatment

### DENTS RUN SITE 3895

More data available at:  
[www.datashed.org](http://www.datashed.org)

SITE INCLUDED ON 2010  
PRE-CONFERENCE TOUR



#### RECEIVING STREAM MONITORING

| Downstream Point      | pH  | Acid<br>(mg/L) | Alk.<br>(mg/L) | T. Fe<br>(mg/L) | T. Mn<br>(mg/L) | T. Al<br>(mg/L) | SO <sub>4</sub><br>(mg/L) |
|-----------------------|-----|----------------|----------------|-----------------|-----------------|-----------------|---------------------------|
| 21 (Pre Constr. Avg.) | 3.0 | 498            | 0              | 51              | 21              | 27              | 1337                      |
| 21 (2009 Average)     | 6.5 | 12             | 22             | 2               | 13              | 3               | 829                       |

#### WATER QUALITY (AVERAGE)

| Point | Flow<br>(gpm) | pH  | Acid<br>(mg/L) | Alk.<br>(mg/L) | D. Fe<br>(mg/L) | D. Mn<br>(mg/L) | D. Al<br>(mg/L) | SO <sub>4</sub><br>(mg/L) |
|-------|---------------|-----|----------------|----------------|-----------------|-----------------|-----------------|---------------------------|
| Raw   | n.m.          | 2.6 | 1383           | 0              | 279             | 18              | 115             | 2673                      |
| Ph 1  | n.m.          | 4.7 | 54             | 9              | 3               | 10              | 8               | 1387                      |
| Final | 41            | 7.2 | -180           | 209            | <1              | 8               | <1              | 1097                      |

## COMPREHENSIVE MINE DRAINAGE SERVICES

- System Evaluation & Optimization
- Treatment System Restoration
- Stream & Wetland Mitigation
- Passive & Active Treatment
- Assessment & Monitoring
- Operation & Maintenance
- Performance Guarantees
- Post-Mining Trust Funds
- Design & Permitting
- Resource Recovery
- Patented Methods
- Public Relations
- Construction



RESTORED TREATMENT MEDIA

**Manganese Resource Recovery**  
*Sustainable technology development*