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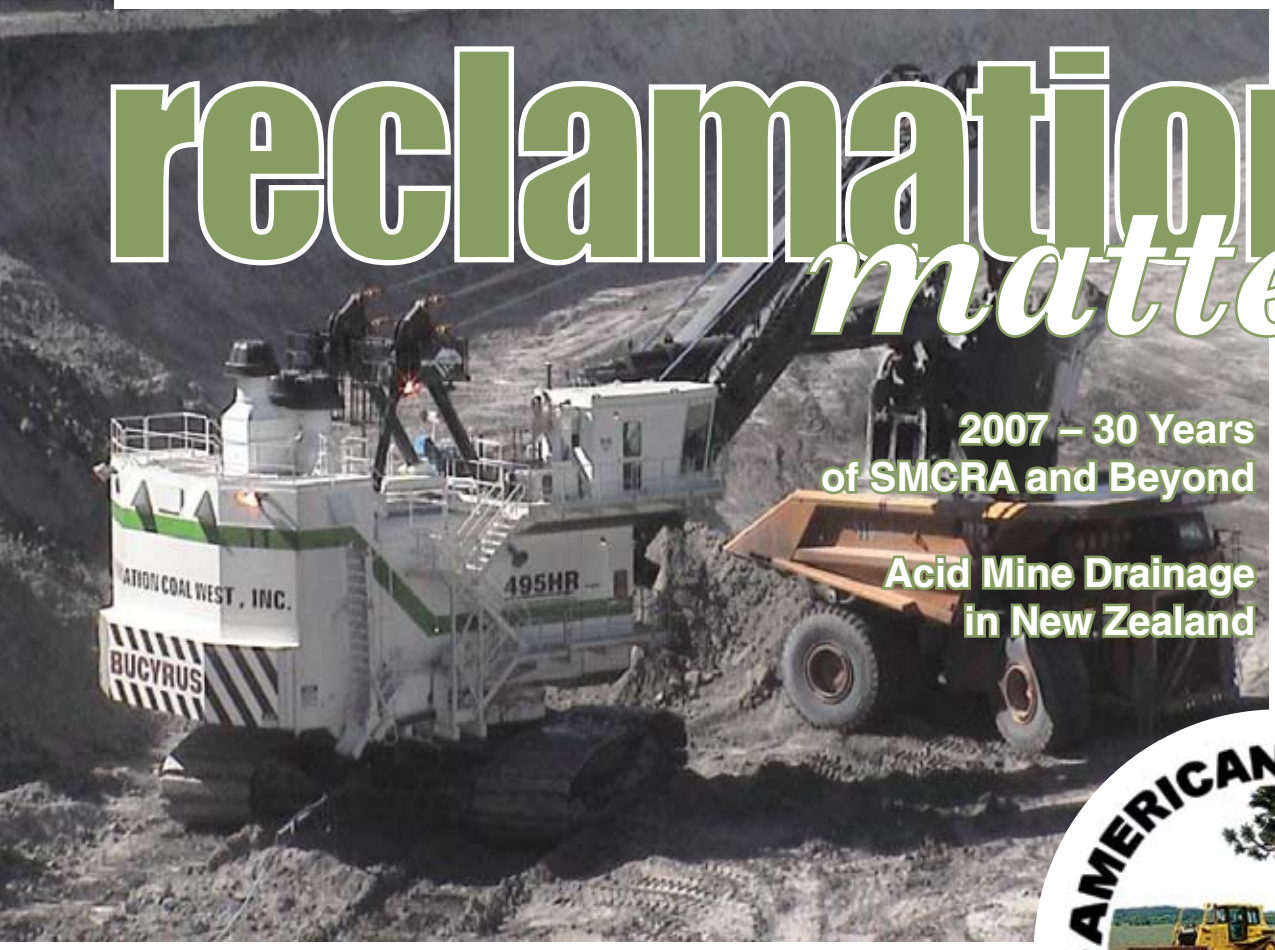
reclamation matters

Issue 1 2007



2007 – 30 Years of SMCRA and Beyond

Acid Mine Drainage in New Zealand

Meet the Reclamationist of the Year

Flooded Underground Coal Mines: Inexpensive geothermal energy

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BY DR. ROBERT DARMODY, ASMR PRESIDENT
UNIVERSITY OF ILLINOIS

Making it Work

"What goes around, comes around." That was a saying my friends in graduate school used to favor to explain how the world works, or should work. That expression has an implied moral message, i.e., the golden rule – treat others like you would wish to be treated – but it could also be taken in a different way – "It's like déjà vous all over again!" It is in the latter vein that I write this, my last message, as ASMR president. It is also early in January as I write – a time for reflection on a gloomy winter day. My relationship with mining and reclamation goes back to my graduate school days when I took a soils class from Dr. Del Fanning. He took me on my first visit to a surface mine area in West Virginia. At the time, SMCRA was being developed and discussed. Dr. Fanning commented that one of the provisions of the act stated the post-mining landscape had to be restored to the pre-mining topography, which he thought was not a good provision in the act. According to him, this presented a lost opportunity for places in West Virginia to get what they needed most – some flat ground. This was before Wal-Mart came on the scene with their huge parking lots, but even back in the mid-70s Del recognized that businesses favor flat ground. A post mining economy would benefit from some creative earth moving, and when the mines were active the equipment was available to do the job. This issue is still with us in the Appalachians.

When I came to Illinois in the early 80s, the Illinois Mine Reclamation Research Program was in full swing. Its goal was to determine the best way to reclaim Illinois' soils after surface mining. Dr. Ivan Jansen took me on a trip to visit the surface mines in southern Illinois. The landscape and land-use issues are quite different from West Virginia; there were no concerns for loss of mountains or the need to produce flat ground. It is mainly flat before and after mining. The issue was whether the land could be restored to agricultural productivity. Illinois' soils are among the best in the world for agriculture and it would be a crime to permanently destroy their productivity. National CBS News did a documentary about reclamation while I was there. The local mining representatives were afraid it would be a "sting" operation, where Dan Rather would show up and hold their feet to the fire for a "60 Minutes" interview. It turned out to be a straightforward news piece on mining and reclamation that I thought was fair and balanced, although it would have been more interesting had Rather actually shown up. The surface mining industry was under a lot of pressure from citizens' groups at the time. There were petitions to declare large sections of Illinois unsuitable for mining because the petitioners felt the soil productivity could not be restored. Dr. Jansen's work demonstrated that reclamation could be successful. To my knowledge, all the petitions were unsuccessful.

A few years later, I was asked to investigate the agricultural impact from high-extraction underground coal mining in Illinois. Again, the industry was under pressure from citizens' groups, who did not approve of high-extraction methods. In their view, high-extraction mining resulted in immediate subsidence, which in Illinois means that large water-filled depressions suddenly appear above the mines. It was felt that reclamation of subsided areas was not possible and consequently high-extraction mining should be outlawed. Our research demonstrated that the fears were largely groundless and that subsided areas could, generally, be restored to agricultural productivity. Ironically, an unintended consequence of high-extraction mining is the production of wetlands, a long-lost commodity in Illinois, where we have been very efficient at destroying them.

In closing this little rambling essay, I note that the temperature so far this winter has been unusually warm – a consequence of global warming, they say. Indeed, polar bears may be listed as an endangered species due to global warming. This, of course, is largely associated with combustion of fossil fuels – in particular, coal – the subject of much of ASMR's interest and activities. I remember back to the time when SMCRA was new – the winter of 1977-1978 – which was one of the coldest on record. At the time, fears were that we were entering into a new ice age. So, what's next? Only time will tell. "What goes around, comes around." ■

BY DR. JEFF SKOUSEN
WEST VIRGINIA UNIVERSITY

Want to Help the Environment?

I saw a bumper sticker recently that read:
"WANT TO HELP THE ENVIRONMENT?
LAY ON THE GROUND AND DIE!"

After my initial amusement upon reading this and then recognizing the sentiment may be offensive to some, I began to reflect on who would make such a declaration and who could take such a stance. On one hand, I suspected an environmental activist could have authored the sticker with a philosophy that all environmental issues are a result of exponential population growth, and the only way to curb the impending disaster is to have fewer people on the planet. On the other hand, I also imagined the sticker could have been written by a company president who is sick and tired of the barrage of environmental laws and regulations that impact the company and drive up costs. Such a person might respond with this statement as the best way environmentalists could help the environment.

We all use natural resources and, therefore, we must all accept some responsibility for the environmental impacts of acquiring these resources for our use. Sometimes this concept skips some people. For example, a student from Rhode Island recently contacted me about mountaintop mining practices in West Virginia. She is appalled by the devastation and destruction and has decided – for her graduate work – to research the loss of aesthetic and cultural values due to the obliteration of these mountains. I asked if she had ever been on a mountaintop surface mine before. She said "No." She accepted my invitation to visit one of the sites in West Virginia where we are conducting forestry reclamation research.

During our visit, I tried to help her understand she is partly responsible for coal mining because she contributes to the demand for coal and energy that comes from this resource. The resources taken from the earth provide many benefits to each of us and furnish the standard of living to which we've become accustomed. Most of us appreciate the discoveries and wonders of an industrialized society, and we all take advantage of the conveniences it offers. Few of us are willing to regress to "hunters and gatherers," where we use no electricity, plumbing, or medicine, and live in caves. After her visit, I am confident she has adjusted her thinking about energy, coal, surface mining and reclamation, and post-mining land use as a result of seeing an actual surface mine and talking with those who do the reclamation.

The most willing and able people to help the environment are those actively working in the environment, which include farmers, land managers, federal and state regulatory personnel, consultants, researchers, and company employees. These are the people who can help the environment by reclaiming and restoring ecosystems to productive uses. These are the people who have a personal and professional responsibility to teach others about natural resource use, environmental impacts, and conservation and reclamation. These people are you and me.

So, I return to the bumper sticker's original question, "WANT TO HELP THE ENVIRONMENT?" I say to those of us who work in the reclamation industry, "DO YOUR JOB!" ■

BY GEORGE R. WATZLAF AND TERRY E. ACKMAN
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Flooded Underground Coal Mines:
A Significant Source of Inexpensive Geothermal Energy

Introduction

Many mining regions in the United States contain extensive areas of flooded underground mines. The water within these mines represents a significant and widespread opportunity for extracting low-grade, geothermal energy. Based on current energy prices, geothermal heat pump systems using mine water could reduce the annual costs for heating to over 70 percent compared to conventional heating methods (natural gas or heating oil). These same systems could reduce annual cooling costs by up to 50 percent over standard air conditioning in many areas of the country.

Background

Lord Kelvin first developed the concept of heat pumps in 1852 (Lund et al. 2004). In the 1940s, Robert Webber modified the concept by using the ground as the source of heat (Lund et al. 2004; IGSHPA 2005). These ground source or geothermal heat pump systems gained popularity in the 1960s and 1970s due to oil shortages, and many alternative types of energy systems were developed (Bloomquist 1999). Today, 500,000 geothermal units are used for residential heating and cooling in the United States and Canada with an additional 400,000 units in Europe (Manitoba Budget Papers 2004). Geothermal heat pumps are one of the fastest growing types of renewable energy in the world, with annual increases of 10 percent in approximately 30 countries in the last 10 years (Lund 2001). Right now, interest is very high due to the high prices of natural gas, heating oil and propane. The cost effectiveness of geothermal heat pump systems is directly related to the ratio of the cost of conventional heating fuels (such as natural gas, heating oil and propane) to the cost of electricity (needed to drive the heat pump). Currently, this ratio is the highest it has ever been.

A heat pump moves heat from one place to another. It can be used for either heating, by moving heat into an area, or cooling, by moving heat out of an area. A re-

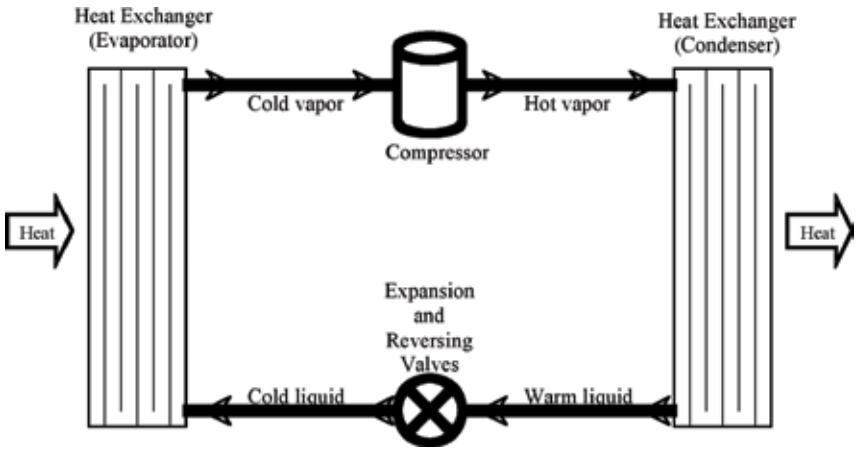

Figure 1. Schematic of a heat pump system in heating mode. Heat source is in contact with the evaporator.

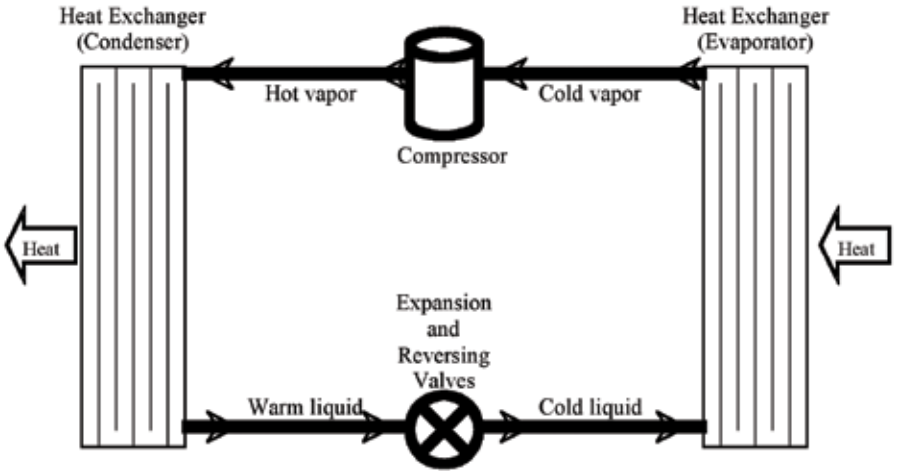

Figure 2. Schematic of a heat pump system in cooling mode. Heat sink is in contact with the condenser.

frigerator is an example of a heat pump. It moves heat from inside the box to outside the box. Within the heat pump, a refrigerant is used that absorbs heat when going through a phase change from a liquid to a vapor. A compressor is used to compress this vapor, thereby increasing its temperature. Then, an expansion valve allows for the vapor to be converted back to a liquid. Figure 1 shows a diagram of a heat pump system. A heat pump is made up of two heat exchangers, a compressor, an expansion valve and a reversing valve. In heating mode, the refrigerant – in a cold liquid form – gains heat from the outside source (air or ground) in a heat exchanger (evaporator), where it is converted into a cold vapor. After the liquid absorbs heat and is converted to a vapor, it is then compressed (requiring an input of electrical energy), converting it to a hot vapor. The hot vapor is sent to another heat exchanger (condenser). Here, the hot vapor gives up the heat that was gained from the source in the evaporator and, in the process, is condensed to a hot liquid (the heat given up is used to heat the interior space). The hot liquid goes through an expansion valve where the drop in pressure converts it to a cold liquid and the process is repeated. In heating mode, the evaporator is placed in contact with the heat source. In cooling mode, the above process is reversed with the use of a reversing valve (Figure 2).

Ground source or geothermal heat pumps use the near-constant temperature of the earth (in soil/rock, groundwater or deep surface waters). During winter months, the earth is at a higher temperature than the outside air and, therefore, acts as a heat source. In summer, the earth is at a lower temperature than the outside air and, therefore, can act as a heat sink. Because of this, geothermal heat pump systems are much more efficient than air source systems for both heating and cooling. For heating, the amount of heat generated divided by the amount of energy needed to operate the heat pump is known as the coefficient of performance (COP). A typical COP value for an air source heat pump is about 2, while geothermal systems have COP values commonly between 3 and 4, with values as high as 6 reported in the literature (Sound Geothermal Corporation 2003; O'Connell and Cassidy 2003). Geothermal heat pumps typically use about half the energy needed for cooling with air source systems.

A ground source heat pump can be designed in a variety of styles based on groundwater access, land availability and drilling costs. The two main categories of ground source heat pumps are closed loop and open loop systems (U.S. DOE 2001). In a closed loop system, no fluid is extracted or discharged to the environment. Pipes, which are filled with an antifreeze solution, are buried in the ground in either a horizontal or vertical format. The antifreeze solution is pumped through these pipes exchanging heat with the ground. An average-sized house in the northeastern United States may require over 1,500 linear feet of pipe. The horizontal format requires a significant amount of area to bury the pipes. If there is not sufficient area for use of the horizontal piping, a vertical system must be used. In the vertical format, 100- to 400-foot deep boreholes must be drilled and pipes are placed in a U-shape within the boreholes. An average home may require two to eight boreholes. The cost of installing the closed loop piping system is the most significant cost of the geothermal system and can exceed $10,000 for an average-sized home. An open loop system eliminates the expense of loop installation. In the open loop system, groundwater or deep surface water is extracted from the environment and subsequently discharged back into the environment. The typical flow rate for an open loop system is about 1 to 3 gallons per minute per ton (1 to 3 liters per minute per kilowatt-hour) of heating and cooling (PADEP 2001) (One ton of heating and cooling is equivalent to 12,000

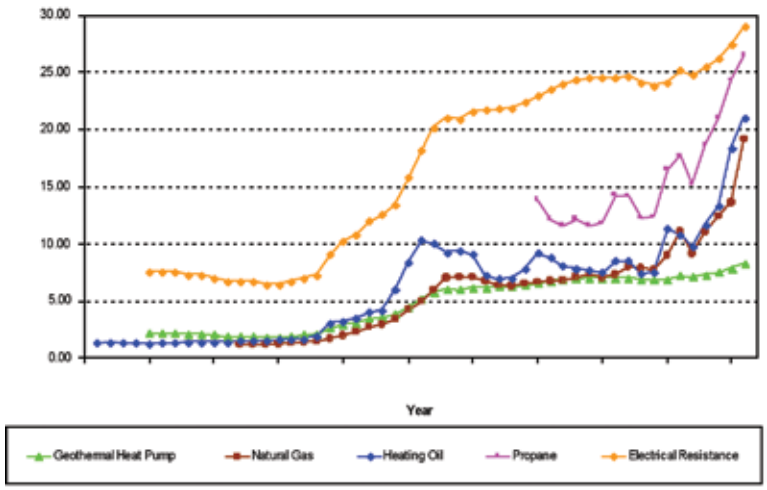

Figure 3. Costs for using these typical heating systems based on average U.S. energy prices from 1990 to 2006. Furnaces using propane, natural gas or fuel oil, were assumed to be moderately efficient (84 percent). Coefficient of performance (COP) of geothermal heat pump was assumed to be 3.5.

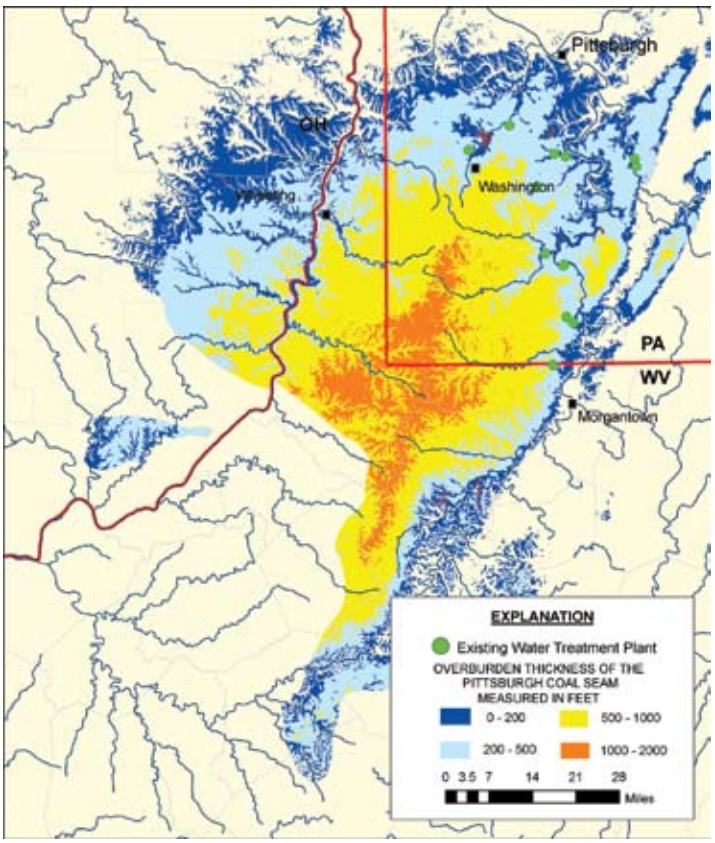

Figure 4. Overburden depths above the Pittsburgh coal seam in Pennsylvania, West Virginia and Ohio and location of existing water treatment facilities in Pennsylvania.

British thermal units per hour). If the quality of the water is such that it could cause scaling or corrosion within the heat pump, an additional heat exchanger filled with antifreeze solution may be used.

Cost Effectiveness of Geothermal Heat Pump Systems

The cost effectiveness of geothermal heat pump systems for heating is directly related to the cost of electricity (to operate the heat pump) compared to the cost of the other conventional fuels: natural gas, heating oil and propane. Figure 3 shows the costs over the past 50 years for electricity, natural gas, heating oil, propane, as well as the cost for the electricity required for a geothermal heat pump system. To get a true representation of the actual cost to the consumer, the efficiencies of each system utilizing the fuel/energy source must be taken into account. In Figure 3, an assumed 84 percent efficiency is used for furnaces/boilers burning natural gas, heating oil or propane, and a relatively conservative COP of 3.5 is used for a geothermal heat pump (Sound Geothermal Corporation 2003).

Use of Mine Water in Geothermal Heat Pumps

There have been a few examples of the successful use of mine water in geothermal heat pump systems. Systems using water from abandoned mines have been installed in Canada (Jessop et al. 1995), the United States (GHPC 1997) and the United Kingdom (John Gilbert Architects; John Gilbert Architects 2002).

Potential of the Pittsburgh Coal Seam Mine Pool for Heating and Cooling

A significant volume of the Pittsburgh coal seam in Pennsylvania, West Virginia and Ohio is currently flooded. As shown in Figure 4, the availability of underground mine water in the Appalachian coal region is very widespread. Approximately 5,000 square miles (13,000 km^2) have been mined in the northern portion

Table 1. Energy costs for use of typical heating systems in southwestern Pennsylvania.

Energy source	Formula for cost per 10^6 Btu	US$/$10^6$ Btu*
Propane	(11.1 x cost/gallon) / efficiency	32.11
Electrical Resistance	293 x cost/kWh	20.80
Fuel Oil	(7.25 x cost/gallon) / efficiency	20.28
Natural Gas	(970 x cost/cubic feet) / efficiency	20.81
Geothermal Heat Pump (COP = 3.0)	(293 x cost/kWh) / COP	6.93
Geothermal Heat Pump (COP = 3.5)	(293 x cost/kWh) / COP	5.94
Geothermal Heat Pump (COP = 4.0)	(293 x cost/kWh) / COP	5.20
Geothermal Heat Pump (COP = 6.0)	(293 x cost/kWh) / COP	3.47

*Cost of fuels and electricity were based on actual delivered cost to the Pittsburgh, Pennsylvania area during the winter of 2006. Propane = $2.43/gallon, electricity = $0.071/kWh, fuel oil = $2.35/gallon, and natural gas = $0.01802/cubic feet. Furnaces using propane, natural gas or fuel oil were assumed to be moderately efficient (84 percent). Most geothermal heat pumps operate at a coefficient of performance (COP) between 3.0 and 4.0 with values as high as 6.0 reported in the literature. In addition to the electricity cost to operate the geothermal heat pump, there would be a cost to pump the water to the system. To pump the water from a discharge to the system from depths of 100, 250, 500 and 1000 feet would add an estimated $0.46, $0.92, $1.69 and $3.23 per million Btu, respectively.

of the Appalachian coal fields and nearly 2,000 square miles (5,000 km^2) are currently flooded (Donovan et al. 2004). The heating and cooling capacity of this underground mine water is an extremely valuable resource that is not currently being utilized. Throughout the Pittsburgh coal basin region, the water is easily accessible and maintains a constant temperature of 50 F to 55 F (10 C to 13 C) (USDOE 2001). The total volume of water estimated to be stored in the Pittsburgh coal seam is 1.36 x 10^{12} gallons (5.15 x 10^{12} liters) (Donovan et al. 2004). About 4 percent of this volume is discharged at the surface each year by treatment plants and abandoned discharges, which total about 5.3 x 10^{10} gallons per year (Donovan et al. 2004). This current amount of discharged water could potentially be used to heat and cool up to 40 million square feet (3.74 million m^2) of interior space, roughly equivalent to 20,000 homes. As the mines in this area continue to fill with water and with new voids being created by active mining, the volume of stored and discharged water from these underground mines will continue to increase into the future.

Table 1 shows the cost for generating 1 million Btu of heat for geothermal heat pump systems compared to conventional heating technology using actual energy costs in the southwestern Pennsylvania area. Electricity and natural gas costs were calculated using the actual residential utility bills in southwestern Pennsylvania by dividing the total cost (including distribution, taxes and other incidental charges) by the amount of the commodity received (kilowatt-hour for electricity or cubic feet for natural gas). Heating oil and propane prices were based on actual delivered cost to a consumer in the area, again dividing the total cost by the volume received.

Because mining companies are required to treat mine water, it has always been considered a liability. If the technology of using mine water in geothermal heat pump systems proceeds, clarifications of legal rights for mine water may need to be addressed. Given the geothermal potential of mine water, non-mining entities may be enticed to use mine pool water for heating and cooling capabilities. If mine water were brought to the surface, the water would be either returned directly back into the mine pool or treated and discharged at the surface.

Summary and Conclusions

Use of underground mine water in geothermal heat pumps could be extremely cost effective, particularly at existing mine water treatment sites where the mine water is already being pumped and treated. Operational costs for geothermal heat pumps are much lower than that of conventional heating and cooling options. Costs per unit of heat for geothermal heat pumps (COP=3.5) using underground mine water are only 29 percent, 29 percent, and 18 percent of the costs incurred using fuel oil, natural gas or propane, respectively. Cooling costs using mine water and geothermal heat pumps should be less than 50 percent of the costs associated with conventional air conditioning systems.

The availability of mine water in the Appalachian coal region is widespread. The heat content of the mine water is a valuable resource that is not currently being utilized and is simply being discharged with the treated mine water to a receiving stream. The amount of water that is currently being discharged from underground coal mines in just the Pittsburgh coal seam, could potentially be used to heat and cool up to 40 million square feet of interior space, roughly equivalent to 20,000 homes. Using the additional water stored in the mines could conservatively extend this option to an order of a magnitude of more homes. Because most mines are currently filling, the volumes of discharged and stored water will continue to increase in the future. Research is needed to demonstrate and develop this extremely valuable resource.

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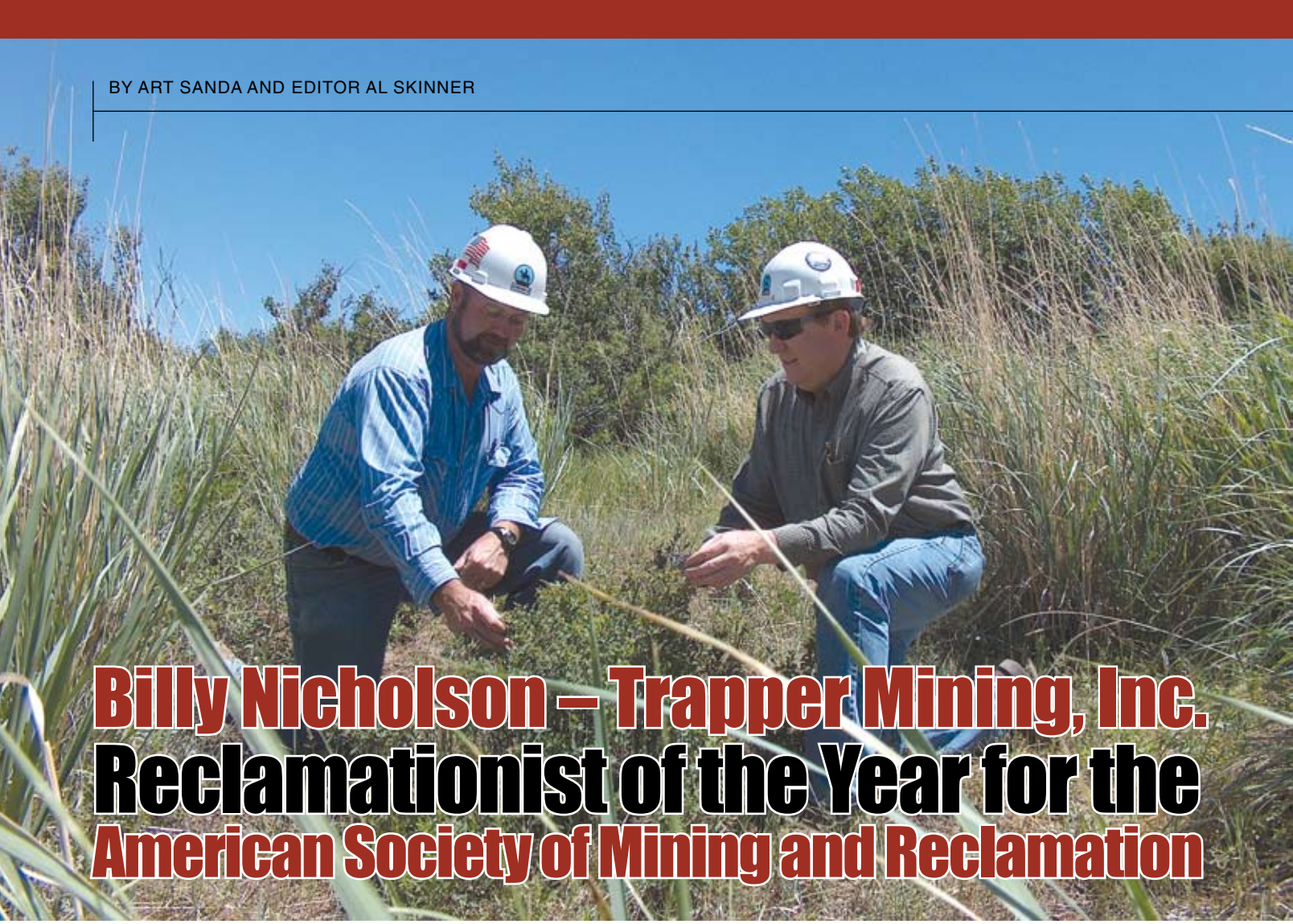
BY ART SANDA AND EDITOR AL SKINNER



Billy Nicholson – Trapper Mining, Inc. Reclamationist of the Year for the American Society of Mining and Reclamation

Reprinted from Coal People Magazine, *July 2006*

As their Reclamationist of the Year, the American Society of Mining and Reclamation cited Billy Nicholson for his contributions made over 26 years with Trapper Mining Inc. But the foundation upon which that career was built was laid years ago on the family farm in Walsh, Colo.

"That's where I grew up," Nicholson noted, "where my Mom and Dad were a great influence in my life. That's where my passion for reclamation comes from. They instilled in me a love and respect of the land. They taught me we are merely stewards of what has been given to us."

Nicholson's only admitted greater passion than that for the land is for his family, his wife of 21 years, Susan, "with whom I truly am blessed," and daughters Amber, 17, and Heather, 14, "the real achievements of my life, the achievements of which I am most proud."

Nicholson, who joined Trapper Mining out of Brinker School of Mapping and Surveying in 1980, is responsible for the reclamation efforts for a mine that covers 10,300 acres, or about 16 square miles. Named after the area's early fur trading industry and incorporating a fur trapper in its logo, Trapper has 34 salaried and 126 hourly employees, members of Operating Engineers Local 9.

The mine is jointly-owned by Salt River Project, Platte River Power Authority, Tri-State Generation and Transmission and PacifiCorp. It lies 45 miles west of Steamboat Springs and 6 miles southwest of Craig in northwest Colorado.

In keeping with its Old West flavor, Trapper Mine's draglines are named after three noble, or ignoble, women: The Molly Brown, after the indomitable and unsinkable Titanic survivor; Baby Doe, "Baby" Doe Tabor, wife of Horace Tabor, wealthy owner of a silver mine, but who died a pauper widow and recluse; and The Queen Anne, after "Queen of the Cattle Rustlers" Anne Basset, whose home was located about 90 miles west of Trapper Mine. The "Queen" was never found guilty of cattle rustling, which is perhaps the reason for the title "Queen."

Trapper Mine has surface reserves of 21.5 million tons and underground reserves of 100+ million tons, and produces nearly two million tons a year from the Williams Fork Formation H, I, K, L, M and Q seams of coal. Sulfur averages 0.44 percent, moisture 16.7 percent, ash 6.5 percent, and Btu 9,800.

Overburden is removed by three Page Model 752 LR (30- to 32-cubic-yard capacity) walking draglines and the coal is extracted and loaded with two Cat 5130 backhoes with 24-cubic-yard buckets. Six Cat 777 95-ton haul trucks, each loaded in five passes, haul the coal between 3 and 5.5 miles to the primary crusher, a 36-inch x 72-inch Hercules Single Role Model 4273 Pennsylvania Crusher located at the mine-mouth Craig

Generating Station Power Plant. The mine currently has contracts extending through 2014. The power plant also receives 2.5 million tons a year from a Rio Tinto Energy America surface mine and spot shipments from a Peabody Energy underground mine.

Within the operation, Nicholson is responsible for the topsoil stripping and replacement, regrading, drainage construction and stabilization, weed control, pond construction and seeding. Two elements add to the challenge: 1) reclaiming steep slopes averaging 14 percent grades; and 2) overgrazing by the herds of elk, deer and antelope.

"Through our reclamation efforts," Nicholson said, "we quite literally create thousands of acres where the deer and the antelope play. It's what we set out to do. But, at the same time, heavy grazing creates problems of its own, particularly because the animals don't allow the reclaimed areas time to establish themselves completely and for woody plants to take hold." Reseeding predominantly is done with a heavy-duty range land drill, utilizing a seed mixture of over thirty native-plant species.

Nicholson said it takes three years for the reclaimed plant community to take hold and become capable of sustaining the wild game, and to become self-sustaining. To help give it this time for establishment, employees and their immediate families are allowed to hunt on the mine site. Nicholson also mentioned a program called "Hunting Buddies," where disabled hunters are given the opportunity to harvest an animal to which they normally wouldn't have access. Trapper's employees volunteer their time to escort and guide these hunters on mine property. To date, the disabled hunters have had a 100 percent success rate.

Working with steep slopes, which account for 95 percent of the 150 acres reclaimed annually, the primary concern is to minimize erosion and sediment transport. To accomplish this, Nicholson said Trapper has employed numerous techniques including the use of synthetic erosion control fabrics, rock check structures, brush matting, brush filters, and woody seedling transplants to stabilize and armor reclaimed drainage channels.

Water harvesting techniques, such as contour ditches, feed newly-constructed livestock water tanks. This helps minimize the sediment run off until the vegetation has had a chance to establish and stabilize the slopes. Also, the livestock tanks help to capture the run off, providing a sediment deposition site (until the vegetation is established) and watering area for wildlife and livestock, which helps to diversify the grazing on reclaimed sites. The water harvesting areas are later re-evaluated as to their usefulness, and removed or left in.

The steep slope situation exacerbates problems resulting from excessive rain, Nicholson said.

"Just about the most challenging problem we faced occurred Sept. 18, 1997, or actually, the 19th. On the 18th, we were hit by what was labeled a 100-year flood and, the very next day, we again were hit with heavy rains. We were just buttoning up our 1997 field season (stripping 217 acres, reclaiming 77 acres, transplanting two mature shrub clumps, construction of 13,000 linear feet of contour ditches, 7,500 linear feet of re-established drainage channels and one sediment pond). The flash floods particularly damaged the areas where the vegetation had not firmly established itself and the areas that had been stripped in preparation for mining. We had roads washed out, head cuts in reconstructed drainage channels, dozer basins and livestock tanks filled to capacity with sediment, rills and gullies created on reclaimed areas, culverts scoured out or plugged, sediment ponds filled to 60 percent capacity, outfall of sediment pond spillways damaged,

and Parshall Flumes plugged up with debris. An assessment of the damages and repairs required to each site filled a four-page report.

"With winter bearing down on us we had to act fast to prepare for the spring run off. We hired a contractor to clean out the four sediment ponds using a Bucyrus Erie 30BHD Dragline with four 10-yard Dump trucks. Trapper leased a Cat 322L Excavator and two Cat 950F Wheel Loaders to work with our four Euclid R-50s, a 10-yard dump truck, a Cat 416 Backhoe and a Cat 988B Wheel loader. We cleaned out dozer basins, livestock tanks, we hauled rock and brush to eroded sites, and we reseeded repaired sites seven days a week from sun-up to sundown for 45 days straight.

"It was the most challenging event of my career," Nicholson noted, "but it also was the most fun. It was hard work, but gratifying at the same time to see so many people pulling together to make it happen. It was almost heroic."

Extraordinary circumstances required extraordinary effort, Nicholson noted, but in the daily routine of managing the mine's reclamation program the ASMR Reclamationist of the Year quickly credits two mentors for having contributed to his continued success: Bill Agnew, environmental manager from 1989 to 1992, and Forrest Luke, environmental manager from 1992 to present.

"Bill was my erosion control mentor and Forrest is consistently giving me sound advice on any topic over the years," Nicholson said. "Their support, encouragement and sage counseling have resulted in Trapper being able to achieve final bond release on 2,631 out of 3,833 total disturbed acres. That, I believe, has been one of our greatest achievements and exemplifies the emphasis

and effort Trapper Mining puts into reclamation."

And how do you top being named Reclamationist of the Year? Nicholson said his immediate personal goal is to simply "get through another field season in a safe and productive manner. Long term," he added, "it's to investigate better topographic diversity for regraded landscapes, to improve how we accomplish erosion control, wildlife habitat and seeding and, generally, to continue to evaluate improved techniques and practices for reclamation. One thing I have learned over 26 years in this business, there's always something on which you can improve." ■

Preliminary Program

Thirty Years of SMCRA and Beyond

You and your family are cordially invited to join us for the 24th American Society of Mining and Reclamation National Meeting in Gillette, Wyoming, June 2 – 6, 2007 The heart of U.S. coal mining

Transportation

Gillette is located in the Northeast region of Wyoming. Apart from driving or flying into Gillette directly, the closest major towns to fly into are Casper, WY or Billings, MT. There are numerous flights each day from Denver on Great Lakes Airlines. Please see Page 4 for more details on how to get there.

Hotel Accommodation

It is very important that you make room reservations as early as possible because Gillette is experiencing a major energy boom at this time and lodging accommodations are in short supply. Therefore, if you wait until the last minute and after our room block expires, you will have great difficulty in getting an accommodation in Gillette. So make your reservation now and, if necessary, you can cancel it. Do not procrastinate!!!! Please see Page 4.

Contact Information:

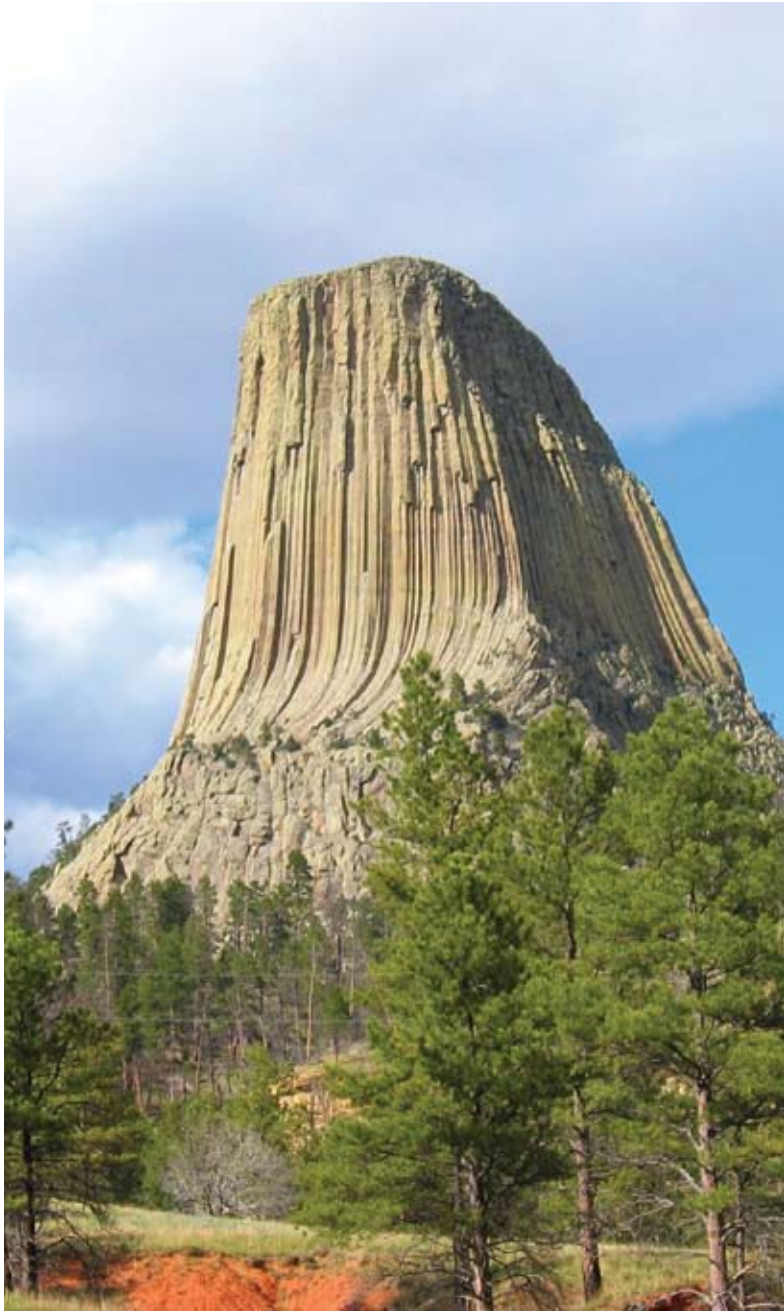
Exhibitors should contact Dick Barnhisel at:
asmr5@insightbb.com or 859-351-9032 for specifics of the exhibitor packages

Meeting Sponsors should contact Wanda Burget at:
wburget@peabodyenergy.com
or 307-687-3920 for specifics of sponsorship packages

For Additional Meeting Information

ASMR Web site: http://ces.ca.uky.edu/asmr/
Richard Barnhisel: asmr5@insightbb.com
Jerry Schuman: jerryschuman2@msn.com

In addition to the technical program, don't forget



Pre-Conference Workshops

(Held at the Clarion Hotel)

Workshop 1: Soil Management in Surface Mining

Instructors: Dr. Anna Krzyszowska (Wyoming Department of Environmental Quality)
Dr. Peter Stahl, Soil Ecologist (University of Wyoming)

Date, Time, Cost: Saturday, June 2, 2007, 8 a.m. – 5 p.m.
Cost: $65 / Students $25

Minimum/Maximum Attendees: 5/20

Includes Lunch

This workshop will discuss relevant practical issues in the management of soils for successful surface mine reclamation. Topics may include: soil amendments, alteration of soil properties in stockpiles, variable topsoil depth, seedbed preparation, and the influence of management practices on soil bulk density and infiltration. We are planning to format this workshop as a panel discussion and will be soliciting suggestions for discussion topics from participants. Those involved will include reclamation practitioners, regulators, and researchers.

Workshop 2: Designing Sustainable Cover Systems and Final Landforms for Mine Waste Storage Facilities

Instructors: Brian Ayres, P. Eng. (O'Kane Consultants Inc.)
Mike O'Kane, P. Eng. (O'Kane Consultants Inc.)

Date, Time, Cost: Sunday, June 3, 2007, 8 a.m. – 5 p.m.
Cost: $150

Minimum/Maximum Attendees: 5/20

Includes Lunch

Constructing cover systems over waste rock or tailings has become a viable alternative to mitigate against the effects of acid rock drainage. The primary purpose of placing cover systems over reactive waste material is to minimize further degradation of the receiving environment following closure of the waste storage facility in the short term; and facilitate recovery of the receiving environment in the long term. This workshop will present theoretical and case study examples, as well as facilitate discussion.

Workshop 3: Mobile Computing Technology Developments for Reclamation Applications

Instructors: Robert Welsh (Office of Surface Mining)

Date, Time, Cost: Saturday, June 3, 2007, 8 a.m. – 1 p.m.
Cost: $50 / Students $15

Minimum/Maximum Attendees: 5/15

Lunch Not Included

Recent advances in mobile computing technology have important implication for point-of-use applications in surface mine reclamation. New-filed devices offer features that improve the reliability, flexibility, and convenience of GPS and CAD data collection. Implementation of the Bluetooth communication protocol now allows cable-free operation. Remotely sensed and aerial imagery in a variety of formats is supported across multiple forma factors and displays. Software functionality has been enhanced to incorporate more data formats and better integrate real-time GPS positioning with GIS and CAD data sets. The workshop will describe and demonstrate new devices and supporting software from the GIS and CAD arenas. Live data collection and imagery display will be performed in short field sessions during the last part of the workshop. ■

Pre-Conference Technical Tours

Technical tours are limited to 40 people with the exception of the Coal Bed Methane Tour that is limited to 30 people. So register early! Minimum number of 10 people for all tours.

Technical Tour 1: Dave Johnston Mine – Glenrock

Tour Guide: Chet Skilbred, Reclamation Specialist, Dave Johnston Mine

The Dave Johnston Coal Mine is located in the far southwest corner of the Powder River Basin. The surface mine was a mine mouth operation, shipping approximately 104 million tons of coal from 1958 to September 2000 to the Dave Johnston Power plant. In December 1998 PacifiCorp announced their plans to close this mine. With this announcement, Glenrock Coal Company, operators of the Mine, began in November 1999 final reclamation of all disturbed lands. In November 2005 these reclamation operations were completed. Approximately 4,700 acres have been reclaimed at the mine. Many of these acres have been reclaimed to a Sagebrush/grassland vegetation type. Large stands of big sagebrush are prevalent on reclamation at this mine. Also prevalent on the mine are rock piles, trees, nesting platforms, and springs that have been established to enhance the post-mining utility of these reclaimed lands.

Date, Time, Cost, Details: Saturday, June 2, 2007, 8 a.m. to 5 p.m. Cost: $60

Buses will pick up attendees in front of the Clarion Hotel at 8 a.m. Lunch, snack, drinks, and transportation included in the cost.

Technical Tour 2: Coal Bed Methane – Gillette and Sheridan Area

Tour Guide: John Wheaton, Montana Bureau of Mines and Geology, Billings, MT.

This field tour will emphasize successful reclamation in alternative types of coal industry in the Powder River Basin: coal bed methane. Stops will include active drilling and producing areas to learn about the footprint and approach to development. Reclamation includes drilling pads and linear trenching for water and gas pipelines. Produced-water management is a major expense and concern. Among the water management options we plan to see are stock-watering facilities, infiltration ponds, irrigation sites and water treatment facilities. A landowner will join us and be able to answer questions from the ranching perspective for part of the tour.

Date, Time, Cost, Details: Sunday, June 3, 2007, 7:30 a.m. to 5 p.m. Cost: $50

Buses will pick up attendees in front of the Clarion Hotel at 7:30 a.m. Lunch, snack, drinks, and transportation included in the cost.

Technical Tour 3: Belle Ayr Mine and North Antelope-Rochelle Mine, Gillette

Tour Guides: Laurel Vicklund (BA Mine) & Scott Belden (NA-R Mine).

This tour visits two large coal mines in the Powder River Basin. The first, Belle Ayr Mine, owned by Foundation Coal West Inc, is a truck-shovel mining operation that produced over 24 million tons of coal in 2006. Participants will visit several reclamation sites to view plant species diversity, Caballo Creek channel restoration, and the mining process. The second, North Antelope-Rochelle Mine (NARM), owned by Powder River Coal Co., is about 45 miles south of Belle Ayr Mine in the southern end of the Powder River Basin. NARM features several draglines and produced over 88 million tons of coal in 2006. Soils at this mine are more diverse and the precipitation less than at the Belle Ayr Mine. Participants will visit several reclamation sites, Porcupine Creek channel restoration, and the mining process.

Date, Time, Cost, Details: Sunday, June 3, 2007, 8 a.m. to ~5:30 p.m. Cost: $55

Buses will pick up attendees in front of the Clarion Hotel at 8 a.m. Lunch, snack, drinks, and transportation included in the cost. ■

Transportation

Gillette is served by Great Lakes Airlines. During weekdays, there are four flights daily and during the weekend, there are three flights daily from Denver, CO to the Campbell County Airport (http://ccg.co.campbell.wy.us/departments/airport/air_service.html). Great Lakes code share with both United and Frontier Airlines. Their toll free numbers/web pages are:

Great Lakes Airlines: 800-554-5111
http://www.greatlakesav.com/

United Airlines Reservations: 800-241-6522
http://www.united.com/

Frontier Airlines Reservations: 800-423-1359
http://www.frontierairlines.com

Shuttle bus services are available between the airport and all major hotels.

Rental Cars

Avis and Hertz Rental cars are available from the Gillette Airport.

Avis: 307-682-8588; Nationwide Reservations: 800-331-1212

Hertz: 307-686-0550; Nationwide Reservations: 800-654-3131

Enterprise rental cars are located at 1401 W. Second St., Gillette: 307-686-5655; Nationwide Reservations: 800-261-7331.

Accommodation

We have a block of rooms reserved for the conference at four hotels. To get the contract rate listed make sure you state that you are reserving your room under the ASMR block. This block of rooms is reserved until May 5, 2007 at which time they will be released to the public. The rooms are reserved/available from June 1-7, 2007.

Clarion Hotel and Conference Center (307-686-3000) - Flat rate: $60 + tax

Days Inn (307-682-3999) - $90 single/$99 double + tax

Wingate Inn (307-685-2700) - Flat rate: $139 + tax

Holiday Inn Express (307-686-9576) - Flat rate: $129 + tax

Note: A shuttle bus service will run between all the major hotels (Clarion, Days Inn, Wingate Inn, Holiday Inn) and the Cam-Plex every morning and evening. Please check your hotel lobby for times and pick-up locations.

Boxelder RV Park

The Boxelder Park has 688 full-service sites, 30-amp and 50-amp electrical hookups, sites 18 feet x 50 feet. Close proximity to all Cam-Plex facilities, three restroom and shower facilities, pay phones available with advanced request, Native grass common areas, lawn sports and picnic areas, additional vehicle parking, campground-wide sound system, registration/information hut, ice vending available. $20 per day for full service. To book an RV site, please contact Barbara Steele at 307-682-0552 or barbara@cam-plex.com ■

Annual Society Social Dinner

The Annual Society Social Event will be held on Wednesday, June 6, 2007 at Boss Lodge, north of Gillette. The menu will include barbecue chicken, boneless barbecue beef ribs, roasted red potatoes, homemade potato salad, rolls and butter, iced tea, water and desserts. Beverages include soft drinks (pop, sodas) and the traditional barbecue libation, namely beer. Festivities begin at 6 p.m., leaving from the Cam-Plex at 5:30 p.m., and ending whenever the beer runs out, or upon the first arrest.

In addition, there will be entertainment for your dancing pleasure; Eric May and Center Lane will play '60s, '70s, and some country and western. Cost is a nominal $30 per person for dinner, drink, and entertainment. Available space requires that we limit this event to the first 300 spirited revelers. Buses will leave every half-hour between 9 p.m. and 10 p.m.

Things to Do Before, During, and After the Meeting

Gillette is located in the northeast of Wyoming. At this time of the year, the climate will be pleasantly warm, so be prepared to bring a good hat (and hope it doesn't get blown off) and some sunblock. Because of its location, there is a great deal to do while you are in the area. Some of the well-known points of interest include (times are from Gillette and approximate only):

Devils Tower National Monument – The site of the first U.S. national monument (1-½ hrs.)

Mount Rushmore National Monument – What more needs to be said? (2-½ hrs.)

Little Bighorn National Monument – The site of Native America's most famous victory (2-½ hrs.)

Yellowstone National Park – America's first National Park (6-½ hrs.)

Grand Teton National Park – Is this America's most impressive National Park? (8 hrs.)

On June 2nd and 3rd, the Crazy Horse Volksmarch will be held. This 6.2-mile round trip is the only time you can walk to the mountain carving of the Crazy Horse Monument located in the southern Black Hills of South Dakota. For further details see the Web site:

http://www.crazyhorse.org/events/volks-02.shtml

Numerous other points of interest are present in this area and we would recommend that you check out some of the local tourism Web sites:

Wyoming	http://www.wyomingtourism.org/
Montana	http://visitmt.com/
South Dakota	http://www.travelsd.com/

Tentative Program Schedule

American Society of Mining and Reclamation
2007 National Meeting, Gillette, Wyoming

(Student presentations are highlighted) All Sessions will be held at the Cam-Plex

Saturday, June 2

	Capone Room, Clarion Hotel
8 – 10 a.m.	Workshop 1 (full day): Soil Management In Surface Mining
10 – 10:30 a.m.	Morning break
10:30 a.m. – 1 p.m.	Workshops continue
8:30 a.m. – 5 p.m. Leaves from Clarion	Technical Tour 1: Glenrock Coal Mine (8 a.m. start, full day)

Sunday, June 3

8 a.m. – 5:30 p.m. National Executive Council Meeting: Bugsy Room, Clarion Hotel

	Session and Room: Capone Room, Clarion Hotel	Bonnie & Clyde Room, Clarion Hotel
8 – 10 a.m.	Workshop 2: Designing Sustainable Cover Systems and Final Landforms for Mine Waste Storage Facilities (full day)	Workshop 3: Mobile Computing Technology Developments for Reclamation Applications (half day)
10 – 10:30 a.m.	Morning break	
10:30 a.m. – 12 p.m.	Workshops continue	
12 – 1 p.m.	Lunch break	
1 – 3:15 p.m.	Workshops continue	
3:15 – 3:45 p.m.	Afternoon break	
3:45 – 5 p.m.	Workshops continue	
7:30/8 a.m. – 5:00 p.m.	Technical Tour 2: Coal Bed Methane (7:30 a.m. start, full day)	Technical Tour 3: Belle Ayr and North Antelope/Rochelle Mines (8 a.m. start, full day)
12:30 – 6 p.m.	Exhibit Setup: Cam-Plex	
6 – 8:30 p.m.	Welcome Reception: Cam-Plex	
12 – 6 p.m.	Registration: Cam-Plex	

Monday, June 4

7 – 9 a.m.	Continental Breakfast: Cam-Plex
7 – 9 a.m.	Poster set up: Keyhole Meeting Room Plenary Session: Cam-Plex Theater
9 – 10 a.m.	Governor Dave Freudenthal, Wyoming – Invited "Wyoming's Role in Providing Energy for the U.S."
10 – 11 a.m.	Mr. Greg Boyce, President and CEO, Peabody Energy St. Louis, MO "Thirty Years of SMCRA and Beyond"
11 a.m. – 12 p.m.	ASMR General Business Meeting and Announcements
12 – 1:30 p.m.	Lunch Buffet: Cam-Plex

Session and Room:

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	Session A: Soil Reconstruction Gillette Meeting Room	Session B: Forestry: Reclamation and Revegetation DeSmet Meeting Room	Session C: Bioreactors Agricultural Meeting Room
1:30 – 2 p.m.	Improved Final Landform Designs for Mine Waste Stockpiles for Better Erosion Control Over the Short and Long Terms *B. Ayres, M. O'Kane, and M. Fawcett*	Evaluation of Mine Spoil Suitability for the Introduction of American Chestnut Hybrids in the Cumberland Plateau *M.E. French, C.D. Barton, D. Graves, F.V. Hebard, and P.N. Angel.*	Evaluation of a Two-Stage Passive Treatment Approach for Mining Influenced Waters *L. Figueroa, A. Miller, J. Blois, M. Zaluski, and D. Bless*
2 – 2:30 p.m.	Evaluation of a Mechanical System for Reconstructing Soil Without Traffic Compaction *L.J. Wells and S. Bodapati*	Evaluation of Low Spoil Compaction Techniques for Harwood Forest Establishment on an Eastern Kentucky Surface Mine *A. Michels, C. Barton, T. Cushing, P. Angel, R. Sweigard, and D. Graves*	Ethanol-Fed or Solid-Phase Organic Sulfate Reducing Bioreactors: Finding the Better? Option for the National Tunnel Drainage, Clear Creek/Central/City Superfund Site *E. Buccambuso, A. Ruhs, L. Figueroa, J.J. Gusek, T. Wildeman, M.Homes, and D. Reisman*
2:30 – 3 p.m.	Influence of Physiochemical Properties of Loose-Graded Brown and Gray Sandstone Spoils and Mixed Sandstone/Shale Spoils on Surface Mine Reforestation in Kentucky *P.N. Angel, C.D. Barton, R.C. Warner, C. Agouridis, R.J. Sweigard, and D.H. Graves*	Comparison of Forest Regeneration in a Subsidence Zone to a Reference Area *A. Wagner, J. Niemeier, and B. Buchanan*	Comparison of the Peerless Jenny King Sulfate Reducing Bioreactor Microbial Ecology Over Time Using Activity-Based Functional Characterization *E. Buccambuso, L. Figueroa, J. Ranville, T. Wildeman, and D. Reisman*
3:30 – 4 p.m.	The Role of Large Storms in Determining Mean Annual Sediment Yield and Landscape Stability *L.J. Lane*	Appalachian Regional Reforestation Initiative and the Forestry Reclamation Approach *V.M. Davis*	Passive Removal of Selenium From Gravel Pit Seepage Using Selenium Reducing Bioreactors *J. Pahler, R. Walker, T. Rutkowski, and J.G. Gusek*
3 – 3:30 p.m.	Afternoon Break		
4 – 4:30 p.m.	Making and Building a Fluvial Geomorphic Reclamation Design at an Active Dragline Mine Using the GeoFluvTM Design Method *D.Measles*	Survival and Growth of Commercial Hardwoods in Brown vs. Gray Sandstone on a Mountaintop Mine in Southern West Virginia *P. Emerson and J. Skousen*	
4:30 – 5 p.m.		Hardwood Tree Survival After Five Years in Heavy Groundcover in West Virginia *J. Skousen, J. Gorman, and P. Emerson*	
	Session and Room:		
5 – 6 p.m.	**Soils And Overburden Technical Division Meeting Gillette Meeting Room**	**Forestry and Wildlife Technical Division Meeting DeSmet Meeting Room**	**Geotechnical Engineering Technical Division Meeting Agricultural Meeting Room**
7 – 9 p.m.	Exhibitor Reception And Poster Viewing (Presenters with their posters during this time): Keyhole Meeting Room		

Implications of Sustainability on Mine Reclamation: Michigan Case Studies
S. Bruch and J.B. Burley

The Impact of Small Rodent Browsing on Vegetation Success on a Reclaimed Mine in New Mexico
T.R. Ramsey, B.A. Buchanan, J. Haen

Tentative Program Schedule

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	Recolonization of Reclaimed Coal Mine Land in Wyoming by Arthropods and Nematodes *V.A. Regula and P.D. Stahl*		
	Assessing Visual Quality Through AGIS-Based Remote Access Methodology *A. Mazure and J.B. Burley*		
	Rooting Depth of 3-Year-Old Seedlings into Overburden Piles at a High Elevation Hard Rock Mine *A. Wagner, B.A. Buchanan, and S. Buchanan*		
	Visual Impact and Reclamation of Limestone Quarries in Algarve, Portugal *T. Panagopoulos, R. Matias, and B. Ramos*		
	Zinc Increased Rooting by 280 Percent in Transplants *J. Paternoster, J. Wheeler, K. Peterson, and H. Jensen*		
	Racoon Creek Restoration Project *K.J. Durrett, T.P. Danehy, and B.K. Leavitt*		
	Assessment of Inocula to Enhance Startup of Ethanol-Fed and Solid-Phase Organic Sulfate Reducing Bioreactors for the National Tunnel Drainage, Clear Creek/Central City Superfund Site *A. Ruhs, J. Bolis, L. Figueroa, T. Wildeman, and D. Reisman*		
	Survey of Low Flow Drainages and Seeps in Colorado to Assess Implementability of Passive Treatment Options *J. Bolis, L. Figueroa, M. Zaluski, D. Bless, and M. Holmes*		
	Biological Source Treatment of Acid Mine Drainage *J.M. Morris, S. Jin, and J.S. Copper*		

Tuesday, June 5

7 – 8:30 a.m.	Continental Breakfast: Cam-Plex		
	Session and Room: **Session A:** **Acid Mine Drainage I** **Gillette Meeting Room**	**Session B:** **Soil Properties** **DeSmet Meeting Room**	**Session C:** **Coal Bed Natural Gas (CBNG) Produced Water Project Funded by the Dept. of Energy (DoE)** **Agricultural Meeting Room**
8:20 – 8:30 a.m.			Introduction to CBNG Produced Water Investigations at the Univ. of Wyoming *H.L. Bergman 8:20 – 8:30 a.m.*
8:30 – 9 a.m.	A Laboratory Study of Contaminated Mine Waste Subaqueous Disposal *J.A. LaBar and R.W. Nairn*	Genetically Engineered Mycorrhizal Fungi for Reforestation *S. Hiremath and G. Podila*	Estimation of Groundwater Recharge in the Powder River Basin (PRB) *F.L. Ogden and K. Puckett*
9 – 9:30 a.m.	Comparison of Sludge Characteristics Between Lime and Limestone Treatment of Acid Mine Drainage *A.W. Miller, T.R. Wildeman, and P.L. Sibrell*	The Influence of Management Practices on Microbial and Total Soil Nitrogen *L.J. Ingram, J.D. Anderson, and P.D. Stahl*	Isotopic and Geochemical Monitoring of the Powder River *S. Carter, J. Mailloux, C. Frost, S. Sharma, and M. Meredith*
9:30 – 10 a.m.	Pilot Testing of a Passive Periodic Flushing Technology to Improve the Performance of Vertical Flow Reactors for the Treatment of Acid Mine Drainage *R.J. Russman, C.B. Bott, and B. Vinci*	Red Oak Seedling Response to Different Topsoil Substitutes After Five Years *J. Burger, D. Mitchem, and L. Daniels*	Monitoring of Groundwater Contamination by Trace Elements From CBNG Disposal Ponds Across the PRB, Wyoming *C. Milligan and K.J. Reddy*
10 – 10:30 a.m.	Morning Break		
10:30 – 11 a.m.	Changes In Fe/Al Ratios In Acid Mine Drainage Over Time From Underground Mines In West Virginia *B. Mack and J. Skousen*	Soil Microbial Community Structure And Diversity Under Different Vegetation In Wyoming Minelands *S. Rana, P.D. Stahl, L.J. Ingram, and A.F. Wick*	Modeling Of Groundwater Contamination By Trace Elements From CBNG Disposal Ponds Across The PRB, Wyoming *B. Chen-Charpentier and F. Furtado*

Tentative Program Schedule

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11 – 11:30 a.m.	Solving Mine Drainage Problems – Why Murphy was an Optimist *P. Eger*	Carbon Accumulation Potentials of Post-SMCRA Coal-Mined Lands *C.E. Zipper, J.A. Burger, J.M. McGrath*	*Getting the Salt Out: Technologies and Costs to Treat CBNG Waters* *E.T. Sajtar, D.M. Bagley, and D.W. Johnson*
11:45 a.m. – 1:45 p.m.	Annual ASMR Award Luncheon: Cam-Plex		
	Session and Room:	**Session B: Soil Properties DeSmet Meeting Room**	**Session C: CBNG Produced Water Project - DOE Agricultural Meeting Room**
	Session A: Acid Mine Drainage I Gillette Meeting Room		
2 – 2:30 p.m.	A Legacy of Nearly 500 Years of Mining in Potosí, Bolivia: Acid Mine Drainage Sources and Stream Water Quality *W.H. Strosnider, R.W. Nairn, and F. Llanos*	The Importance of Soil Aggregate Recovery in Reclaimed Lands *A.F. Wick, P.D. Stahl, S. Rana, and L.J. Ingram*	Reduction in CBNG Water Sodicity Using Zeolites *G.F. Vance, H. Zhao, G. Ganjegunte, and M.A. Urynowicz*
2:30 – 3 p.m.	The Use of Watershed Cooperative Agreement Program Funds to Reclaim Small Acid Mine Drainage *J.W. Coleman*	Constraints on Natural Revegetation of Hard Rock Mining Tailings Impoundments *R.L. White and R.W. Nairn*	Using Strontium Isotopes to Evaluate CBNG Irrigation Amendments *E. L. Brinck and C. D. Frost*
3 – 3:30 p.m.	Treatment of Metal Mine Effluents by Limestone Neutralization and Calcite Co-Precipitation *P.L. Sibrell, T.R. Wildeman, and M. Deaton*	Assessment of Time Trends in Bioavailable Metals in the Tri-State Mining District Through Analyses of Tree Rings and Soils *W.J. Andrews, R.W. Nairn, and A.E. Koenig*	Longitudinal Changes in Toxicity of CBNG Produced Water Along Beaver Creek in the PRB, Wyoming *L. Johnson, C. Boese, and J. Meyer*
3:30 – 4 p.m.	Afternoon Break		
4 – 4:30 p.m.	The Use of Steel Slag in Passive Treatment Design for AMD Discharge in the Huff Run Watershed Restoration *J.S. Hamilton, J. Gue, C. Socotch*	Geologic-Engineering and Chemical Properties of Topsoil in Forming Process for Biological Restoration of Coal Mine Waste-Based Structures in the Upper Silesian Coal Basin in Poland *A. Patrzalek and M. Pozzi*	Identifying Mosquito Larvae Habitat Created by CBNG Discharge Waters Using Remote Sensing *S.N. Miller, H.R. Griscom, R. Sivanpillai, L. Zou, D. Wu, J. Cicarelli*
4:30 – 5 p.m.			Aspects of CBNG Water and Oil Recovery *X. Xie, H. Pu, and N.R. Morrow*
5 – 6 p.m.	**International Tailings Technical Division Meeting** Gillette Meeting Room	**Ecology Technical Division Meeting** DeSmet Meeting Room	**Water Management Technical Division Meeting** Agricultural Meeting Room
5 – 6 p.m.	Land Use Planning and Design Technical Division Meeting Devils Tower Meeting Room		

Wednesday, June 6

7 – 8:30 a.m.	Continental Breakfast: Cam-Plex			
	Session and Room:			
	Session A1: Revegetation: Establishment, Design, and Evaluation Gillette Meeting Room	**Session B: Reclamation Policy and Standards** DeSmet Meeting Room	**Session C: Water Chemistry** Agricultural Meeting Room	**Session D: Coal Bed Methane Production and Reclamation** Devils Tower Meeting Room

Tentative Program Schedule

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8:30 – 9 a.m.	The Influence of Different Ground Cover Treatments on the Growth and Survival of Seedlings on Remined Sites in Eastern Tennessee *J. Rizza, J.A. Franklin, and D. S. Buckley*	A Technical Review of the Final Report of the National Academy of Sciences "Managing Coal Combustion Residues in Mines" *K.C. Vories*	Mode of Gypsum Precipitation in Vertical Flow Ponds *A.W. Rose, T. Morrow, M. Dunn, and C. Denholm*	Soil Physical Impacts of a Natural Gas Drill Pad Construction Technique Using Oak Mats *C.S. McWilliams, D.J. Dollhopf, K.C. Harvey, and D.J. Dale*
9 – 9:30 a.m.	Amending Bauxite Residue Sands With Altered Residue Fines (Red Mud) to Enhance Growth Potential: A Three-Month Glasshouse Study *J.D. Anderson, R. Bell, and I. Phillips*	Reclamation Programs at Cleveland-Cliffs Michigan Operations *A.E. Koski*	Controls on Acidity Removal in Vertical Flow Ponds *A.W. Rose.*	Changes in Soil Physical and Chemical Properties of a Cropland Irrigated With CBNG Produced Water *C.R. Johnston, T.H. Brown, S. Jin, and G.F. Vance*
9:30 – 10 a.m.	Determination of Phytoremediation Potential of Desert Plants Grown in a Mine Tailings Reclamation Project *N. Haque, J.R. Peralta-Videa, G.L. Jones, J. L. Gardea-Torresdey*	The California State Mining and Geology Board: Regulation of Mine Reclamation in California *S.M. Testa*	Aeration of Net Alkaline Mine Drainage to Degas CO2, Increase pH, and Iron Oxidation Rates *C.S. Kirby, A. Dennis, and A.K. Kahler*	
10 – 10:30 a.m.	Morning Break			
	Session A2: Abandoned Mine Projects Gillette Meeting Room			
10:30 – 11 a.m.	Nickle Plate Abandoned Mine Pool "Blowout". Washington and Allegheny Counties, Pennsylvania *T. Danehy, R. Beam, S. Horrell, R. Dolence, J. Ankrom, B. Leavitt, W. Fuchs, S. Busler, C. Denholm, M.H. Dunn*	Backfilling of Open-Pit Metallic Mines Regulations *S.M. Testa*	Examination of Water Quality in the Backfill Aquifer, Eastern Powder River Basin, Wyoming, 2005 *K.M. Ogle*	Effect of Coal Bed Methane Produced Water Discharge on Native and Reclaimed Stream Channels and Aquifers at Coal Mines in the Powder River Basin, Campbell County, Wyoming *P.A. Murphree*
11 – 11:30 a.m.	Evaluating Alternative Fluvial Geomorphic Reclamation Designs at an Abandoned Mine Site *T. Kostubala and N. Bugosh*	California's Statewide Reclamation Standards, a Quantitative Approach to Measuring Reclamation Success *J.S. Pompy*	Role of Accelerated Oxidation for Removal of Metals From Mine Drainage *D. Budeit*	Beneficial Uses of Water Produced by Coal Bed Natural Gas Development: More Surface Water Can be Good for Frogs and Other Wildlife *W. Vetter and K. Brown*
11:30am-12:00pm	Assessment Of The Revegetation Potentially In The Lignite Mines Of Northern Greece *T. Panagopoulos*	The Office Of Surface Mining's Technical Innovation And Professional Services (TIPS) *L. Hamm*		Considerations For Evaluating Coalbed Methane Infiltration Pond Sites Based On Site Studies In The Powder River Basin Of Montana And Wyoming *J.R. Wheaton, A.L. Bobst, and E.L. Brinck*
12 – 1:30 p.m.	Lunch Buffet - Student Paper Awards and Exhibitor Raffle: Cam-Plex			

Tentative Program Schedule

American Society of Mining and Reclamation
2007 National Meeting, Gillette, Wyoming

	Session A: Watershed Hydrology Gillette Meeting Room	Session B1: Wildlife and Reclamation DeSmet Meeting Room	Session C: Landscape Structure and Patterns Agricultural Meeting Room	Session D: Coal Bed Methane Production and Reclamation Devils Tower Meeting Room
1:30 – 2 p.m.	Evaluation of Early Successes of an Iterative Watershed Management Approach in the Copper Basin *K.Y. Bell, F. Miller, E.G. Wyatt, and K.L. Faulk*	Wildlife Mitigation Techniques and Long-Term Trends in Wildlife Use of Reclamation at Surface Coal Mines in Northeast Wyoming *G. McKee*	Managing the Large-Scale Reclamation Monitoring Network at Syncrude Canada Ltd. *M. Phillip, R. Lewko, C. Qualizza, L. Barbour, and M. O'Kane.*	Groundwater Monitoring at Coal Bed Natural Gas Produced Water Impoundments: The Wyoming DEQ Database *T. Osborne, M. Smith, D. Fisher, U. Williams, K. Frederick*
2 – 2:30 p.m.	Design and Reporting Criteria for Reed Bed and Fen Restoration in Mineral Workings *R.N. Humphries and R. Meade*	Impact of the Surface Mining and Reclamation Act on Species of Special Concern in Pennsylvania *F.J. Brenner*	Excess Spoil Minimization and Fill Stability *P. Michael and M. Superfesky*	
2:30 – 3 p.m.	Watershed-Scale Environmental Monitoring to Examine Remediation and Restoration Success: Water Quality and Hydrology *R.W. Nairn, K.A. Strevett, J.A. LaBar, D. Ertugrul, K. Walker, B. Winfrey, D. Hensley, M. Roberts, D. Lutes, T. Traw, P. Baczynski, and B. Johnson*		Effects of Soil Properties, Climatic Factors, and Landscapes Features on Revegetation of Prime Farmland Soils on Reclaimed Coal Surface Mined Soils *H.R. Sinclair and R. R. Dobos*	
3 – 3:30 p.m.	Afternoon Break			
		Session B2: Data Analysis DeSmet Meeting Room		**Session D2: Acid Mine Drainage II** Devils Tower Meeting Room
3:30 – 4 p.m.	Conversion of Potomac River Dredge Spoils to Productive Agricultural Soils *W.L. Daniels and G.R. Whittecar*	My Data Aren't Normal, But My Tests Are: Weighting Individual Data for Non-Parametric Analysis *J.A. Tucker and M. Oritz*	Inverse Box-Counting Method: A Fractal-Based Procedure to Create Biospheric Landscape Patterns *C. Fleurant and J.B. Burley*	Stability of Passivated Acid Rock After Intensive Root System Exposure *C.E. Werkmeister, D.D. Malo, T.E. Schumacher, J.J. Doolittle, and G.C. Miller*
4 – 4:30 p.m.		Coal Mining Geospatial Data for the Nation *B. Card and L. Meier*	Egg-Crate Mine Subsidence *M.L. Dunn.*	Assessment of Ecotite for Use in Acid Rock Drainage *T.W. Schmidt and B.R. Schultz*
4:30 – 5 p.m.			Historic Climax Communities as Reference Areas *B. Buchanan and J. Tucker*	
6 – 10 p.m.	Annual Society Social Dinner: Boss Lodge Buses leave at 5:30 p.m. from Cam-Plex			

Note: A shuttle bus service will run between all the major hotels (Clarion, Days Inn, Wingate Inn, Holiday Inn) and the Cam-Plex every morning and evening. Please check your hotel lobby for times and pick-up locations.

American Society of Mining and Reclamation

24th National Meeting, Gillette, Wyoming
June 2-6, 2007
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Early Registration (access to all sessions and exhibition hall, 3 continental breakfasts, 3 lunches, 2 receptions, morning and afternoon break refreshments)	$260	____	_____
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Spouse/guest Awards Luncheon (Tuesday)	$32	____	_____
Social Dinner	$30	____	_____
Spouse Registration (includes breakfast, breaks, lunches & awards luncheon)	$150	____	_____

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			Regular/Student	
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Workshop 2	Designing Sustainable Cover Systems and Final Landforms for Mine Waste Storage Facilities	$150/150	____	_____
Workshop 3	Mobile Computing Technology Developments for Reclamation Applications	$50/15	____	_____
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BY DAVE TRUMM, CRL ENERGY LTD., CHRISTCHURCH, NEW ZEALAND

Acid Mine Drainage in New Zealand

Figure 3. AMD at the abandoned BlackBall mine near Greymouth. Flow rates vary between 30 and 100 L/s.

Introduction

Acid mine drainage (AMD) associated with coal mining has been a difficult problem to solve in much of the world. Although research and application of remediation systems has been ongoing for over 40 years in the eastern USA (Ziemkiewicz et al. 2003; Sengupta 1994), other places in the world have not been so lucky. This can be for various reasons, including: little money available for research and remediation, minimal or no regulations for AMD discharge to river systems, or possibly no recognition that it is even a problem. AMD has become a serious problem in New Zealand over the last few decades, and efforts to curb the pollution have begun. This article provides a brief background on the extent and importance of coal mining in New Zealand and a short review of research and remediation efforts which have aimed to solve the AMD problem downunder.

Extent of Coal Mining in New Zealand

New Zealand agriculture, cement, timber, and general industrial processing all rely on coal to power their plants. Coal use for electricity generation has always been relatively low, however, in recent years with low levels of water in hydroelectric lakes, coal has been increasingly used to meet growing energy requirements. Permitting for a new coal-fired power plant has recently begun for the West Coast on the South Island. Although coal use is prominent in New Zealand, the majority of the high quality coking coal is exported to steel mills in Japan.

In New Zealand, coal is mined using two basic extraction methods: surface mining (open cast) and underground mining (hydromining and bord and pillar methods). Most of the historic mining was un-

derground, while most of the current mining today is by open cast techniques.

Most of the economic coal resources of New Zealand are restricted to the northern and western regions of both the North Island and the South Island. The seven coal regions of the country are: Northland, Waikato, Taranaki, Nelson, West Coast, Canterbury, Otago, and Southland (Figure 1). Large lignite resources occur in Central Otago and Eastern Southland, whereas sub-bituminous coal is located in the Waikato Coal Region, the Taranaki Coal Region, and in Western Southland. Bituminous coals are located primarily in the West Coast Region. Quality values for typical bituminous coal are: 13,000 Btu/lb, 58 percent carbon, 7 percent moisture, 0.8 percent to 4 percent ash, and 0.2 percent to 1.6 percent sulfur. For sub-bituminous coal, typical values are: 9,300 Btu/lb, 38 percent carbon, 23 percent moisture, 2 percent to 11 percent ash, and 0.1 percent to 3 percent sulfur (Barry et al. 1994).

The Waikato Region in the North Island and the West Coast Region in the South Island are the biggest suppliers of coal and the majority of the high-quality bituminous coal comes from the Buller Coalfield in the West Coast Region (Figure 1). Within the Buller Coalfield, the Denniston and Stockton areas have been the most extensively mined using both underground and open cast methods. The Stockton Plateau contains the location of the biggest coal mine in New Zealand (Stockton No. 2). The mines on this plateau are currently operated by Solid Energy New Zealand Limited (SENZ). Approximately 40 million tons of coal was mined in New Zealand in 2005, with 60 percent being exported and the rest going to domestic uses for heating (10 percent), manufacturing and other industrial domestic uses (30 percent).

Figure 2. Typical West Coast topography.

Occurrence of AMD

As would be expected, the majority of AMD coincides with the major coal-producing region in New Zealand, the West Coast of the South Island. Within this region, however, lithologic variation and mining techniques influence the occurrence and chemistry of AMD (Pope, Newman and Craw 2006).

Coal dominantly occurs on the West Coast within the Brunner Coal Measures (mostly to the north) and the Paparoa Coal Measures (mostly to the south). Differences in depositional environments and diagenetic processes between these two formations result in a generally greater occurrence of AMD from the Brunner Coal Measures. The Paparoa Coal Measures were deposited in a fluvial to lacustrine environment, where rapid accumulation of sediments preserved co-deposited carbonate rocks, whereas the Brunner Coal Measures were deposited in an estuarine environment, in which reworking of sediments was unfavorable for the preservation of carbonate- bearing rocks (Pope, Newman and Craw 2006). Post deposition, the Paparoa Coal was enriched with carbonate minerals, whereas the Brunner Coal was enriched with pyrite from overlying marine sediments. Therefore, the absence of carbonate rocks and enrichment with pyrite results in a greater occurrence of AMD from the Brunner Coal Measures.

AMD from open cast mines hosted in the Brunner Coal Measures typically has a higher aluminum to iron ratio than AMD from underground mines (Pope, Newman and Craw 2006). The Al:Fe ratio is typically greater than two in open cast mines and less than four in underground mines. It is hypothesized that the reaction between H2SO4 (produced by pyrite

Figure 4. AMD at the abandoned Sullivan Mine north of Westport. Flow rate averages about 30 L/s and is considered a low-flow site.

oxidation) and aluminum-bearing silicate minerals in the coal measures – such as clays and feldspars – proceed more rapidly and to a greater extent in open cast mines because coal measure sediments are more disturbed in mine pits compared to underground mines.

Difference between AMD in New Zealand and Eastern USA

There are two major differences between the dominant AMD-producing region in the USA (Pennsylvania and West Virginia) and New Zealand, which affect the AMD: topography and climate. The topography along the West Coast rises steeply from sea level to over 700 meters (2,300 feet), and is mostly cloaked in thick, protected, native rainforest (Figure 2). Mining sites are usually situated in the higher reaches and are often very remote. The dominant westerly winds off the Tasman Sea results in a high-rainfall climate with very low temperature seasonality. Rainfall on the Stockton Plateau is, approximately, 7 meters (275 inches) per year.

This topography and climate results in AMD with very high flow rates, sometimes coupled with rainfall events, in locations with very limited space for remediation (Figures 3, 4, 5, 6). The isolation of mining sites, along with the low population on the West Coast, results in an AMD legacy that is largely hidden from public view and does not impact on the clean-green image of New Zealand. It is estimated, however, that approximately 125 kilometers of streams are adversely affected by AMD (James 2003; Figure 7).

State of Assessment and Remediation of AMD

AMD in New Zealand has been studied for many years. Most of these studies either focus on the geochemistry of AMD or the effects of the AMD on the aquatic ecosystem, and the majority of the research is conducted by academics from various universities in New Zealand. A few non-governmental research organizations, such as CRL Energy Limited, also conduct AMD research. Some of the more significant publications on these subjects are Winterbourn (1998), Lindsay, Kingsbury, and Pizey (2003), Harding and Boothryd (2004), Hughes et al. (2004), Harding (2005), and Pope, Newman and Craw (2006).

In contrast to assessment of AMD, very little remediation has been accomplished in New Zealand. The majority of attempts have consisted of small-scale pilot studies. An early reference to AMD treatment is an active treatment system that was constructed at the Golden Cross Mine site to treat AMD with moderate pH levels (about 5) but high concentrations of iron and manganese (Goldstone and MacGillivray 2002). The treatment consisted of aeration followed by addition of calcium oxide to raise the pH and promote removal of iron and manganese. A bioreactor was also constructed at the site, but results to date show that the system was not adequate for removal of manganese. Internal reports have been produced for SENZ regarding installation and performance of an anoxic limestone drain (ALD) that was installed at the Bennydale Mine site, but no external publications on the success of this system are known. Periodic dosing

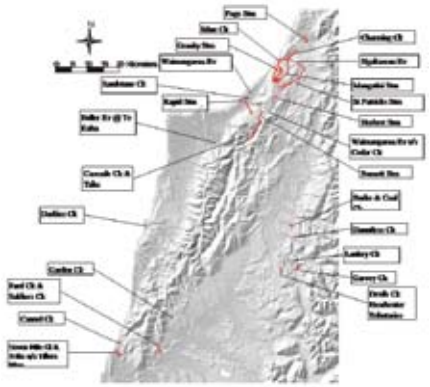

Figure 7. Map of known streams impacted by AMD in the West Coast Region.

of low-flow, moderate pH AMD (pH 4) with calcium oxide has been reported at the Malvern Hills Coal Mine (Bell and Seale, 2004). Small-scale trials of an ALD and limestone dosing system are currently underway at the Stockton Mine site.

Aside from the above-referenced work, other remediation attempts include several pilot studies and one full-scale system by the author. Small-scale remediation systems consisting of an ALD, vertical flow wetland (VFW), and an open limestone channel (OLC) were constructed at the abandoned Sullivan Mine (Figure 4) with the goal of determining an optimum remediation strategy for full-scale implementation (Trumm, Black and Gordon, 2003; Trumm et al. 2003; Trumm, et al. 2005). The results of this work indicated that a VFW may be the best solution for the Sullivan Mine, however construction of the full-scale system has not yet begun. Laboratory experiments were conducted suggesting that a limestone leaching bed may be successful in treating AMD from the abandoned Blackball Mine near Greymouth (Figure 3; Trumm and Gordon, 2004). Another small-scale VFW was constructed at the Pike River Coal Mine adit and operated successfully for six months (Trumm, Watts and Gunn, 2005; Trumm, Watts, and Gunn, 2006). A full-scale VFW was constructed at the site in July 2006, however no publications have yet been produced on the success of the system. Finally, small-scale systems consisting of a limestone leaching bed (LLB), a VFW, an OLC, and a diversion well were constructed at the Herbert AMD site at the Stockton Mine in 2006. Both the VFW and the LLB performed well and a full-scale LLB is currently being constructed at the site.

Why is there so Little AMD Remediation in New Zealand?

There are several reasons. There is no remediation fund specifically for AMD. Therefore, any efforts toward remediation are funded completely by the mining companies. Although New Zealand has a strong clean-green image overseas and has a strong green movement (the Green Party actually form part of the current government), regulations for AMD treatment and prevention are vague and enforcement is lacking.

Environmental regulations are driven primarily by the Resource Management Act 1991 (RMA; New Zealand Government, 1991) which does not specifically refer to AMD. Rather, the RMA states that contaminants cannot be discharged to the environment unless the local regional environmental authority (a regional council) has granted consent or unless the discharge is considered a permitted activity under the regional plan of the regional council. Mines existing prior to publication of the RMA have been allowed to continue to discharge AMD under their previous discharge agreement (if there was any in the first place). The regional council for the dominant AMD-producing area in New Zealand, the West Coast Regional Council (WCRC) has been in negotiations with mines existing prior to the RMA to help set limits for AMD. The process has encountered many difficulties as both the mining companies and the WCRC try to determine appropriate background levels for specific sites and appropriate and achievable targets.

For mines started after publication of the RMA, the WCRC typically sets discharge limits based on various water quality targets. These targets are sometimes site specific or are based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). Inconsistent guidelines for setting discharge limits currently plague the industry and the WCRC. A research program is currently underway to help streamline this process (Black, Clemens and Trumm, 2004; Cavanagh et al. 2005). This program aims to incorporate a database of known AMD risk based on geology with threshold levels that affect the aquatic ecosystem and with known AMD treatment technologies. The database, along with the ecological work, will provide a tool that can be used by the mining industry and regulators to set appropriate resource consents for new mines.

Figure 1. The coal regions of New Zealand.

Aside from the obvious difficulties with funding, regulations, and enforcement, there are other, perhaps more important reasons that the AMD situation in New Zealand has not improved much over the years. Coal mining is the backbone of the West Coast economy. Coal mining is the largest employer in the region and has been a respected industry for over 100 years. The effects of coal mining (such as AMD) are largely hidden from public view in a low-population region and the effects of AMD in local watersheds are not commonly recognized as a problem. The source of AMD is typically in steep terrain surrounded by protected native rainforests, which limits remediation options. Times, however, are changing. Current mining companies are volunteering to reduce impacts from active mine sites and the regional council is enforcing discharge limits for new mines. Abandoned mines with AMD will likely be the next target.

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