

Spring 2004

reclamation *matters*

**JOINT CONFERENCE OF ASMR
AND THE WEST VIRGINIA
SURFACE MINE DRAINAGE
TASK FORCE SYMPOSIUM
APRIL 18-22, 2004**

**History of the American Society
of Mining and Reclamation**

**History of the West Virginia
Surface Mine Drainage
Task Force**

**THE SLIPPERY ROCK
WATERSHED COALITION**

**Livestock as an Innovative
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Livestock grazing on reclaimed
land in southwestern Virginia.



BY DR. JEFF SKOUSEN

New Publication Devoted to Reclamation Matters

Welcome to Reclamation Matters, the new American Society of Mining and Reclamation Magazine. The title is an obvious play on the word “matters.” First, all of us would agree that reclamation does indeed matter. Many of our members and readers are employed by mining and reclamation companies or are engaged in supporting these industries. And certainly, we feel strongly about reclamation research, strategy, process, practice, and success. The second part of the name refers to the ongoing activities and new ideas and technologies that are continually being realized and rediscovered. This magazine will be devoted to discussing some of these “reclamation matters” in an open, informal, and illustrative fashion. Therefore, the name of the magazine denotes that we care about reclamation and that we are continually learning more about mining and reclamation issues and technology.

While sitting in one of those recent disturbing meetings giving news of budget cuts and faculty reductions, I was reminded of an experience many years ago. At similar budget cut meetings decades ago, as a young assistant professor, I wondered to myself if the area in which I worked was important. Why should we care about this small acreage of mined or disturbed land since it only amounts to about four percent of the total land area of West Virginia? Certainly this land does not have that significant of an impact on the state as a whole. Nationally, disturbed lands probably account for less than one percent of the total land area. Should there be a position at my university that is largely focused on disturbed lands and reclamation? After all, it is such a small acreage and perhaps we should have faculty positioned to deal with problems that deal with larger geographical areas like foresters, biologists, forage agronomists, entomologists, or economists.

Later that day, being young and easily shaken by news of budget cuts, I asked one of my bosses about my questions. He said, “How can you wonder about this? These disturbed areas

are some of the most significant lands in the state! These areas provide energy, tremendous opportunities for work, and huge financial inputs for this state in taxes and income. Furthermore, these areas can be some of the most significant producers of potential environmental damage and impact to the state’s soil, water, and air resources. These areas are critical to the life of the state, but they can also be extremely crucial to degrading the state’s environment.”

His message rang true to me then and still continues to ring true today. My boss said this to me early in my career, as a reclamation specialist at West Virginia University, and his message has been a clarion call to me over the years. I always remember that our reclamation work does indeed matter, that we can control and reduce environmental impacts on some of the area’s most important lands, and even though the acreages may be small on the total landscape, the disturbance can be potentially very damaging for nearby water and land resources, and for long-term land use development.

The purpose of our society and the reclamation industry is to make a difference, to balance the needs of our society for minerals, energy, and other resources with the need to protect and enhance our environment, to devise and develop new and better ways of reclaiming disturbed lands, and to share this information with each other. We hope that the information in this new reclamation magazine will present innovative ideas and concepts to you, will promote dialogue among reclamation researchers, regulators, and the industry, and will identify and advertise to our readers those individuals and companies that work in this area.

Please let the editor and publisher know of your likes and dislikes about the content of this magazine. The articles and editorials are completely under ASMR’s control and more ideas and articles are always welcome. ■

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A Short History of the American Society of Mining and Reclamation¹

BY BILL PLASS, JEFF SKOUSEN AND DICK BARNHISEL

Introduction

The American Society of Mining and Reclamation (ASMR) is a professional society composed of about 400 people. Members include representatives of mining companies, corporate offices, and consulting services (40 percent); employees of academic and research institutions (25 percent); employees of federal and state regulatory agencies (30 percent); and students (5 percent). A majority of the members are directly involved in activities associated with coal mining and the reclamation of disturbed areas. Membership is increasing for those concerned with the extraction of other minerals.

The objectives of the society are:

- To encourage communication among research scientists, the mining industry, regulatory agencies, and landowners with respect to mining and reclamation research and practices.
- To promote and support research relating to land reclamation.
- To provide technical expertise to those agencies, organizations, or others who seek assistance in the development and execution of research, demonstration projects, or reclamation plans.
- To promote and support educational programs relating to reclamation of lands disturbed by mineral extraction.

Original Organization

The Society developed from smaller organizations, which were initially established in West Virginia. Several foresighted individuals, in the late 1960s, recognized the importance that research could play in the development of mining and reclamation practices and policies, and in the mitigation of environmental impacts from mining.

In 1968, a tripartite agreement was reached among the West Virginia Department of Natural Resources, Division of Reclamation (Ben Greene, chief), the West Virginia Surface Mining and Reclamation Association (Dick Vande Linde, executive director), and the U.S. Forest Service (Bill Plass, reclamation researcher). These three parties agreed to form an advisory board to discuss reclamation research. The Forest Service established an office in Princeton, West Virginia and assigned Bill Plass to devote his position to mine land reclamation research. The three organizations requested assistance from the Soil Conservation Service (represented by Frank Glover) and West Virginia University (represented by Richard M. Smith). These five individuals composed the "Steering Committee for Surface Mine Research in West Virginia."

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TOWARDS A CLEANER ENVIRONMENT

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Figure 1. Reclamation Pioneers. These three gentlemen, (L to R): Bill Plass (USDA Forest Service), Dick Vande Linde (WV Mining and Reclamation Association), and Ben Greene (WV Division of Natural Resources), were responsible for establishing the roots of the organization that would become the American Society of Mining and Reclamation (ASMR).

Organizational Growth

The semi-annual meetings of the Steering Committee were publicized and soon became a popular forum for discussion of reclamation research. After two years, the number of participants increased, and representatives from surrounding states attended the meetings. It became apparent that such meetings were needed to disseminate research results, discuss mutual problems, and coordinate research programs. Since the concept proved successful in West Virginia, the Committee determined that a regional organization with similar objectives could succeed.

Individuals interested in forming a regional organization were invited to attend a meeting in Charleston, West Virginia on May 16, 1973. Ben Greene, chief of WV-DNR's Reclamation Division, invited representatives from WVSMRA (Ben Lusk, president), WVU, USDA SCS, USDA Forest Service, the Tennessee Valley Authority, the Ohio Reclamation Association, and the Interstate Mining Compact Commission. A decision was made to form the "Council for Surface Mining and Reclamation in Appalachia." The basic objectives were the same: 1) to discuss current research; 2) to identify research priorities; and 3) to create opportunities for dissemination of reclamation technology. The Council continued to meet semi-annually within the Appalachian region and interest in the meetings continued and participation expanded.

Expansion Again

During this initial phase of the organization, there were two meetings per year. In November 1978, at Oak Ridge, TN, the decision was made to extend the geographical base of the organization to the 100th meridian. The name was changed to the "American Council for Reclamation Research." Semi-annual meetings were held at locations in the Midwest and Appalachian regions. This group continued to meet twice a year for the next four years. Western reclamationists became interested, and their involvement in Council activities increased during subsequent years.

National Organization

Support and interest in this reclamation council was now national, and in 1982, the Council once again changed its name to reflect the widening scope of its activities. The "American Society for Surface Mining & Reclamation" (ASSMR) was established with Eastern and Western Divisions within the Society. The name was changed again in 2001 to its current one "American Society of Mining and Reclamation" ASMR. The structure of the Society has changed some in the past few years with the adoption of new by-laws in 2002 with a modification of its governing board known as the National Executive Council or the NEC.

Bill Plass served as the Executive Secretary over much of the history of the organization. In 1999, Richard Barnhisel became the Executive Secretary and the office of the Society moved from Princeton, WV to Lexington, KY.

The first annual meeting of ASSMR was held in July 1984 at Owensboro, KY. Annual meetings of the Society have been held since then by alternating between eastern and western locations.

Denver, CO	1985	Gillette, WY	1995
Jackson, MS	1986	Knoxville, TN	1996
Billings, MT	1987	Austin, TX	1997
Pittsburgh, PA	1988	St. Louis, MO	1998
Calgary, AB, Canada	1989	Scottsdale, AZ	1999
Charleston, WV	1990	Tampa, FL	2000
Durango, CO	1991	Albuquerque, NM	2001
Duluth, MN	1992	Lexington, KY	2002
Spokane, WA	1993	Billings, MT	2003
Pittsburgh, PA	1994	Morgantown, WV	2004

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2004 Annual Meeting

The 2004 national meeting of ASMR will be held in Morgantown, WV on April 18-22, 2004. After many years of consistent growth, the Society is returning again to the state in which the basic concepts for the organization originated. It is anticipated that more than 500 people will attend the conference, representing the mining industry, academic and research institutions, regulatory agencies, and watershed organizations. Participants will come from many U.S. coal-mining states, and from countries such as Canada, Mexico, England, Germany, South Africa, Australia, New Zealand, South Korea, and China. Along with research results and application of reclamation technologies in the field, an exhibit of reclamation products and services will be held in conjunction with the meeting. Workshops and field trips are also planned as part of the meeting. ■

Authors

Bill Plass, retired from the USDA, Forest Service, has served as the executive secretary of ASMR from its inception until 2000. He has authored numerous reclamation articles and has devoted his life to conducting reclamation research and getting reclamation information to those who can apply it. He continues to be active in the society and is serving as secretary of the International Affiliation of Land Reclamation. He lives in Princeton with his wife, Lola.

Jeff Skousen is a professor of soil science at West Virginia University, and is a reclamation specialist. He is the president of ASMR in 2004, and the chairman of the 2004 ASMR annual meeting, being held in Morgantown.

Dick Barnhisel is a professor of agronomy and geology at the University of Kentucky and currently serves the Society as its executive secretary. He has published more than 50 articles on reclamation and has over 35 students completing degrees associated with reclamation. For the past 15 years, he has specialized in reclamation of prime farmland disturbed by coal mining.

Footnotes

¹ A more complete history is available on ASMR's web page <http://ces.ca.uky.edu/asmr>. This includes an Expanded History written by Tom Zarger

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 publication possible.



BY JEFF SKOUSEN

History of the West Virginia Surface Mine Drainage Task Force

On September 15, 1978, David Callaghan (WV Department of Natural Resources Director) held a meeting in Elkins, WV, to address the problem of acid mine drainage associated with surface mining the Kittanning coal seams in the central part of West Virginia. At a subsequent meeting, Director Callaghan appointed an interdisciplinary committee composed of industry and regulatory representatives, as well as West Virginia University researchers and persons from consulting firms. The committee was charged with defining the acid mine drainage (AMD) problem in the region and outlining procedures available that would allow mining while maintaining proper water quality of the state before and after mining. Subsequently the committee became known as the West Virginia Surface Mine Drainage Task Force.

After much deliberation at monthly meetings during the next year, the Task Force developed a landmark publication in 1979 entitled "Suggested Guidelines for Method of Operation in Surface Mining of Areas with Potentially Acid-Producing Materials." The bulletin defined several basic characteristics for which a mine site must be examined before mining and included consideration of:

1. Ground and surface water,
2. Overburden analysis,
3. Topography and land use,
4. Geology,
5. Mining equipment, and
6. Economic feasibility.

The bulletin further identified specific techniques for handling surface water, ground water, and overburden during the mining process that would help control AMD. Concepts that were emphasized included:

1. Accurately sampling and analyzing overburden to identify alkaline—or acid-producing materials,
2. Mixing acid materials with alkaline materials or ameliorants for acid neutralization; and
3. Strategically placing acid-producing materials in the backfill where air and water contact are minimized.

The 1979 bulletin represented state-of-the-art technology for the control of AMD and became the standard throughout Appalachia for mining activities that involved handling potentially acid-producing materials.

After writing this bulletin, members of the Task Force realized that many other ideas and procedures were being developed to control and treat AMD. Therefore, the Task Force established new objectives in addition to the original mandate from Director Callaghan. The objectives of the Task Force were to keep current on new developments in AMD research, AMD treatment and control practices, and to present this information at annual symposia.

In April 1980, the first Task Force symposium was held in Clarksburg, WV, to a relatively small audience of 100 people. :



Figure 1. Task Force members in a picture taken during the 2002. Task Force Symposium. Bottom left to right: Randy Maggard, Jeff Skousen, Al Meek, Wayne Stanley, Paul Ziemkiewicz; Middle Row: Bruce Leavitt, Frank Shreve, Jim Ashby, John Belcastro, Charlie Miller, John Sencindiver, Ben Faulkner; Top Row: Jim Seckman, Courtney Black, Mike Isabell, Ken Johnson.

Since 1980, symposia have been held every spring (usually in Morgantown, WV). Attendance has fluctuated over the years, due to changes in the mining and reclamation industry and in regulations, but has steadily grown to annual attendance figures of 250 to 300. Attendees come from all areas of the country and several foreign countries. Many attendees consider Task Force meetings to contain the most current and important work in AMD in the world. Proceedings have been published and given to attendees each year.

An update to the 1979 bulletin was completed in 1987. This update re-emphasized the use of overburden sampling techniques and analysis of overburden materials by Acid-Base accounting and

leaching techniques to predict their acid-producing potential. In addition, new developments in acid prevention such as alkaline trenches, liners and seals, bactericides, special handling procedures, and revegetation practices were detailed. New chemical treatment technologies were also highlighted, as well as introducing the concept of AMD treatment by passive methods such as wetlands.

Today, the 18 Task Force members represent the coal mining industry, regulators, private consultants, and research scientists. The Task Force remains active by holding bi-monthly meetings, sponsoring the spring symposium, and hosting a fall

field tour. In this way, the Task Force members continue to keep current on new technologies and practices in AMD control and treatment.

The Task Force will celebrate its 25th anniversary of annual meetings in April 2004 by combining its meeting with the annual meeting of the American Society of Mining and Reclamation (ASMR). These two organizations have joined to provide one of the most informative and comprehensive reclamation meetings of the year. Presentations will include topics such as mining and reclamation practices, acid mine drainage control and treatment, reclamation regulations, revegetation,

minesoil development, analytical procedures, water quality, and watershed organizations. Information, agendas, presentations, and registration materials for the meeting can be found in this magazine.

If you are interested, CDs containing all the papers from previous Task Force symposiums, as well as the 1978 and 1987 bulletins, can be ordered by calling Jeff Skousen at (304) 293-6256 or emailing jksousen@wvu.edu. There is a small mailing fee for the CD. Papers from the past three symposiums can be viewed or downloaded from the Internet at <http://www.wvu.edu/~agexten/landrec/land.htm#SURFACE> ■

Members who have served on the Task Force:

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Jim Copley*
Joann Erwin
Ben Faulkner*
Dennis Fredericks*
John Freeman

Ben Greene*
Roger Hall
Ron Hamric*
Tiff Hilton*
Ken Johnson*
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Al Meek
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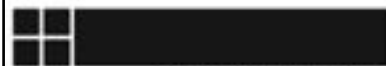


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The Slippery Rock Watershed Coalition: A Watershed Restoration Success Story

Recently, we were thinking about the development and accomplishments of the Slippery Rock Watershed Coalition (SRWC). The reminiscing was initiated while flipping through back issues of our monthly newsletter, *The Catalyst*, which has grown from a simple mailing of the typed meeting minutes distributed to about a dozen participants to a four-page spread reaching over 1,100 people in 10 countries on six continents.

As we flipped through the history of the SRWC, we came across the minutes from the Slippery Rock University's Institute for the Environment organizational meeting for the Slippery Rock Creek Watershed Clean Stream Initiative that took place on December 16, 1994. Although we did not comprehend the significance of that meeting then, it's quite clear to us now that the groundwork, that was being laid that night, ultimately changed our lives and many others forever.



The 410-square mile Slippery Rock Creek Watershed, outlined in red, is located in western Pennsylvania about 60 miles north of Pittsburgh.

The purpose of that organizational meeting was to address abandoned mine drainage (AMD) within the Slippery Rock Creek Watershed. Slippery Rock Creek, located in the Ohio River Basin just north of Pittsburgh in western Pennsylvania, is severely impacted by AMD. Within a 27-square mile portion of the Slippery Rock Creek headwaters, coal mining was conducted for well over 100 years. Approximately 4,000 acres, or 25 percent of the headwaters, are underlain by underground mine workings, while 8,000 acres, or 50 percent of the headwaters, were included in surface mine permits. By 1969, more than 25 million tons of coal were recovered by underground methods and 50 million tons removed through surface mining. In 1970, the headwaters of Slippery Rock Creek were documented by the Pennsylvania's Operation Scarlift program, to be "the most severe condition of coal mine drainage. Indeed, very little drainage from this region is produced exclusive of contact with, or issuance from, mine workings." Many longtime residents of the area have referred to Slippery Rock Creek as "Sulfur Creek," due to the extensive obvious effects of mine drainage upon the watershed.

There were many people there that night to discuss the problem at hand and the exciting possibilities of this essentially new technology called passive treatment, which was said to be capable of abating abandoned mine drainage in an environmentally friendly and cost-effective manner. Several current members of the American Society of Mining and Reclamation (ASMR) were present including Margaret Dunn, Bob Beran, Fred Brenner, George Watzlaf, Bob Hedin, and Cliff Denholm.



Abandoned mine discharges, like this one at the Erico Bridge site, has severely impacted the headwaters of Slippery Rock Creek.

Earlier that year, the Pennsylvania Department of Environmental Protection (PA DEP) Knox District Mining Office began conducting the Slippery Rock Creek Watershed Comprehensive Mine Reclamation Strategy (CMRS). The CMRS identified 74 mine drainage sources with 59 contributing acid loadings. Approximately 90 percent of the acid loading was being released from 35 discharges. On average, more than 2,800 lbs/day of acid was impacting 71 percent of the streams within the 27-square-mile study area. The CMRS, when published in 1998, contained reclamation recommendations for all of the identified priority areas, with a total estimated cost of nearly \$9 million to restore the entire study area.



Quality Aggregates Inc., a mining company and member of the Environmentally Innovative Solutions LLC, has been instrumental in the restoration by removing coal refuse piles, constructing passive treatment systems, and providing limestone at discounted rates.

The participants of that meeting recognized that the problems associated with abandoned mine lands were so extensive that neither federal, state, or local governments, or the mining industry or watershed groups could adequately address the problems individually. However, they also recognized that by forming a public-private partnership effort and pooling resources, including various funding sources, skills, knowledge, experience, materials, labor, and equipment, a plan could be developed and implemented to solve these problems.

As the spring came, the SRWC was preparing to install its first anoxic limestone drain (ALD) in the headwaters of Slippery Rock Creek on Pennsylvania State Game lands #95. The Coalition wanted a baseline study of the watershed completed before the implementation of reclamation activities in order to document the impact of the restoration effort. As providing

educational opportunities was, and still is today, an important goal, the SRWC sought students to conduct the study. That summer, four Slippery Rock University students collected water samples and stream sediment samples for chemical analysis from 13 locations in the headwaters of Slippery Rock Creek. They also collected macro-invertebrate samples and conducted a leaf pack study to determine the state of the watershed's ecological health. The project gave the students an opportunity to be completely involved in all aspects of the study, from the planning process to field sampling to lab work to data analysis to reporting, which provided those students with invaluable experience and insight.

In August, construction began for the installation of an ALD at the Big Bertha site. By the end of 1995, three passive systems were installed near the village of Argentine to treat a total of about 200 gallons per minute of acidic mine drainage. These three systems used ALDs, which were followed by settling/oxidation ponds and wetlands. The three ALDs contained a total of about 3,000 tons of limestone. These systems resulted in the neutralization of about 150 lbs/day of acidity and 100 lbs/day of iron. Restoration of the watershed had begun.

On April 19, 1996, the very first Slippery Rock Watershed Coalition Annual Symposium was held at Slippery Rock University. Speakers presented such topics as the causes of AMD, its impact on stream sediment and aquatic organisms, and the principals of passive treatment to abate it. Slippery Rock University students presented the results of their year-long study and Grove City College students presented the data that they had collected on Seaton Creek, the most heavily impacted tributary to Slippery Rock Creek. A field tour, which has become an important staple of every SRWC symposium, was conducted at the Big Bertha site. The symposium has become an educational/outreach tradition with the SRWC, who have used it, as an effective tool to disseminate information about passive treatment and the accomplishments of the Coalition to date.

The SRWC is not a typical watershed organization. There is no charter. There are no by-laws. There is no incorporation. There is not an executive board, nor any committees. There are only people. People who have come from diverse social, economic, political, educational, and religious backgrounds with different skills, knowledge, and experiences, but have set aside their differences to come together in one concerted team effort to restore the watershed to an ecologically healthy and viable state. The environmental professionals who do the assessments, permitting, design, and monitoring, as well as the mining companies who do the construction, are not paid contractors hired through a low-bid process to provide a service. They are the Coalition. They are truly active participants of the Coalition who live and/or work in the watershed and want to do something positive by giving back to the community. Sure they need to make a living, but they offer their services at often significantly reduced costs and donate as much time, equipment, and materials as their resources will allow. That is part of the essence of the Slippery Rock Watershed Coalition. That, in our opinion, is one of the reasons for its success. The SRWC is a team of dedicated, knowledgeable individuals who are concerned with restoring the watershed and providing educational opportunities to others.



Passive treatment systems, such as the De Sale Phase 1 (bottom right) and Phase II (top left) that were designed by BioMost, Inc. and WOPEC, have significantly improved the water quality at Seaton Creek, the most heavily impacted tributary in the headwaters.

Through this public-private partnership effort, the Slippery Rock Watershed Coalition has successfully built 15 innovative passive treatment systems since 1995 that have included such components as anoxic limestone drains, vertical flow ponds, settling ponds, naturally-functioning wetlands, and horizontal flow limestone-only beds. These 15 systems are treating approximately 750 million gallons per year of AMD from about 20 discharges. That is enough water to fill nine million typical five-foot long bathtubs or provide a small town of about 17,000 people with their annual water supply (based on average U.S. water consumption of 120 gallons/day/person). We are also preventing about 200 tons of iron, eight tons of aluminum, and 335 tons of acidity annually from entering streams within the headwaters of Slippery Rock Creek, which is a public water supply. That is enough iron and aluminum to make approximately 200 small trucks and 273,000 aluminum cans each year. In addition, about



About 125 teenage volunteers helped the SRWC to plant the constructed wetlands at the Erico Bridge passive treatment system with guidance and an educational program provided by Aquascape Wetland and Environmental Services.

200 acres of abandoned mine lands have been reclaimed to productive farms or wildlife habitat, while more than 10 acres of wetlands have been created. These efforts have resulted in an amazing improvement in 11 miles of streams and the observation of fish in six miles of stream, probably for the first time in over a century.

A couple of months ago, Cliff Denholm, who was one of the four Slippery Rock University students who conducted the baseline study in 1995, was standing on Erico Bridge getting ready to take a water sample of Seaton Creek to document the impacts of the Erico Bridge Restoration Area project. The Erico Bridge passive system includes three anoxic limestone drains, including an 8,300-ton ALD that is the largest one known in Pennsylvania. There are also four settling ponds and two constructed naturally functioning wetlands totaling 3.5 acres. Although results are only preliminary, the system appears to be treating an average flow of more than





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Attendees of the SRWC 2003 Symposium participate in the "Build Your Own Passive Treatment System" Workshop and Simulation, which will be conducted again this year as part of the 2004 joint ASMR conference that will be held April 16-22, 2004.

300 gallons per minute emanating from five discharges, neutralizing 830 lbs/day of acidity, and preventing 240 lbs/day of iron and 70 lbs/day of manganese from entering Seaton Creek. In addition, over 25,000 cubic yards of coal refuse piles were removed, neutralized with alkaline circulating fluidized bed (FBC) coal ash and then placed in a nearby abandoned Brookville coal pit that was being reclaimed at the same time. The two-acre footprint was then used to create additional wetlands. In July 2003, 125 teenagers who were participating in a youth conference of a church group volunteered their time to plant wetlands and install bluebird boxes as their service project.

As he stood on the bridge, Denholm, noticed that the color and condition of the water and substrate had already been remarkably improved. The water was clear and, for the first time, he could actually see the stream bottom! Then he stopped and stared. There were fish. Not just a fish, but an entire school of fish swimming around where, the year before, fish shocking

could not even be conducted because there was so much iron in the water that it shorted out the generator every time the probes were placed in the stream. Nobody had ever seen fish in this section of Seaton Creek, which was documented in the CMRS to be the most polluted tributary of Slippery Rock Creek, with 42 percent of the total acid loading and nearly 50 percent of the total iron loading. But, within just a few years, and after the installation of this system and the De Sale Phase I, II, and III passive treatment systems, the water quality of Seaton Creek had been significantly improved, with fish being spotted at several locations for the first time in, probably, 100 years.

This is what the effort is all about. It is an environmental improvement through positive actions, conducted by public-private partnerships that involve all who are interested. Although much improvement has been made, the Coalition will continue its effort to restore the watershed, as well as operate and maintain the systems already in place to ensure a long-term sustainable effort. ■

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ADTI Coal Mining Sector Acid Drainage Technology Initiative

Acid mine drainage (AMD) is a long-term water pollution impact of mining in the coal fields of Appalachia and other areas of coal and metal mining. Above is a typical acid mine drainage discharge from an abandoned underground coal mine.

To combat this problem, the Acid Drainage Technology Initiative (ADTI) was formed as a partnership of technical experts from industry, state and federal agencies and academia who have joined together to combat AMD and related water-quality problems from mining and seek solutions to them.

ADTI members include the Office of Surface Mining (OSM); the U.S. Geological Survey (USGS); the Bureau of Land Management (BLM); the Environmental Protection Agency (EPA); the Department of Energy (DOE); the U.S. Army Corps of Engineers (USACE); the Interstate Mining Compact Commission (IMCC) representing coal mining states; the National Mining Association (NMA) representing mining companies; and the National Mine Land Reclamation Center and associated universities (West Virginia University, Pennsylvania State University and others); and the mining Life-Cycle Center at the Mackay School of Mines, University of Nevada at Reno (and associated universities), representing the academic community.

ADTI provides a forum for collaboration and information exchange on the goals of ADTI, which are to:

- Develop innovative solutions to AMD and related water-quality problems
- Identify, evaluate, and develop “best science” practices to predict AMD prior to mining
- Identify successful remediation practices for existing sources of AMD and describe the best technology for AMD prevention.
- Work cooperatively to develop understanding and applications of proven and innovative technologies to predict, avoid, monitor, and remediate mine drainage.
- Promote transfer of information on mine drainage prediction, monitoring, avoidance and remediation.

Organization of ADTI

- Two major units:
- Coal Mining Sector (CMS)
- Metal Mining Sector (MMS)
- Working groups in each sector focus on Prediction and Avoidance /Remediation.

- An Operations Committee provides overall direction.
- Operational and logistical support for the CMS is provided by the National Mined Land Reclamation Center (NMLRC), at West Virginia University and by the University of Nevada at Reno for the MMS. For more information on the Metal Mining Sector, see the MMS Web site at <http://www.unr.edu/mines/adti>

Coal Mining Sector Projects

A wide variety of mine drainage projects have been, and are being, undertaken by ADTI members. West Virginia University and NMLRC are studying flooded underground mine pools and their potential for contributing new sources of AMD. OSM-funded projects include assessments of abandoned coal mine drainage treatment sites, selenium in coal mine overburden and surface and ground water, field verification of Acid-Base Accounting method to predict AMD and development of standardized lab-based kinetic test methods to evaluate AMD potential using leaching columns and humidity cells to predict the quality of drainage from geologic materials associated with coal mines.

Published Reports

Prediction of Water Quality at Surface Coal Mines (2000). A technical review of techniques and methods used to predict AMD prior to mining. Technical guidelines are included that were developed through consensus.

A Handbook of Technologies for Avoidance and Remediation of Acid Mine Drainage (1998), a user manual/handbook on AMD avoidance and remediation methods for coal mining in the Appalachian region, including case studies.

Both publications can be found online at <http://www.wri.nrcce.wvu.edu/publications.php> - ADTI. Printed copies can be obtained from: NMLRC/WVU, P.O. Box 6064, Morgantown, West Virginia 26506-6064. Call (304) 293-2867, ext. 5450 or request them via e-mail to: pziemkie@wvu.edu. For more information on NMLRC go to <http://www.wri.nrcce.wvu.edu/NMLRC/>. ■

For more information, visit <http://www.wri.nrcce.wvu.edu/ADTI/> or contact John Craynon, coal mining sector chair, Office of Surface Mining, Division of Technical Support at 1951 Constitution Avenue, NW, Washington, DC 20240. His number is (202) 208-2866 or e-mail him at jcraynon@osmre.gov.



BY STUART A. BENGSON²

Livestock as an innovative tool for reclamation¹

Standard methods for reclamation rely almost exclusively on the use of mechanical treatments, seeding, and chemical fertilizers. It involves the use of heavy equipment for regrading and topsoiling; as well as irrigation, fertilizers, and other soil amendments to try and induce plant growth on the reclamation site.

A simpler and perhaps more ecologically sound approach is to use livestock. Livestock can trample organic matter into the mine wastes to build a soil-like medium that will support plant growth. Livestock also help to stabilize slopes with their hoof action by trampling up and down the slopes.

The concept of using livestock for reclamation is not new. After some initial success at revegetating copper tailings by

incorporating manure into the surface six inches at the Silver Bell mine in the late 1970's, we thought about putting a small livestock feedlot on the top of the tailings to spread manure and incorporate organic matter into the tailings (see photo 1). Actually, a few years earlier, the Pima Mine was having success on steep slopes by spraying a slurry of manure and sewage sludge and incorporating the organic matter by rolling a sheepsfoot roller up and down the slope. Then, in 1989, AZ Ranch Management (a private consulting firm) started to successfully use livestock on copper tailings at the Miami Mine to stimulate vegetative growth and to stabilize the steep slopes. Since these early beginnings, many other mines have started using livestock for copper tailings reclamation. Livestock have been

successfully used at the Pinto Valley Mine, Sierrita Mine, Morenci Mine, and Mineral Park Mine in Arizona; as well as several other mines in the western U.S. These new innovative reclamation tools are known today as "FLOSBies" (Four Legged Organic Soil Builders), EMPACT (Environmental Mine Practices and Cattle Treatment), "ASARCOWs", "ecowologists", or "cowtapillars".

The main objective of using livestock for reclamation is to incorporate enough organic matter into the reclamation site to build-up a soil-like medium for plant growth. The hoof action of the animals, contouring the slope as they feed, can actually reduce erosion considerably by creating many small contour benches, which results in numerous depressions that will trap rainfall and enhance plant growth.

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Photo 1: Tailings pile in Arizona where a small feedlot has been placed on the side of the pile with cows incorporating organic matter.

By building up organic matter and contouring the slopes by hoof action, moisture retention is greatly enhanced. The organic matter helps to increase the infiltration of water and reduce evaporation losses. The incorporation of organic matter also helps to alleviate deficiencies in plant nutrients, and helps create the proper habitat for the development of soil micro-organisms that are essential for a well-balanced natural ecosystem.

Electric fences are used to hold the animals in small paddocks of approximately 1/4 - 1/2 acre in size for a very short duration (see photo 3). Generally it requires from 400 to 700 animal units of impact per acre. This would equate to 100 animals on one acre for four to seven days. The site is prepared by spreading hay on the surface consisting mostly of Sudan grass, Bermuda, oats, and barley. The cows are then released onto the site. Besides a base mulch of hay, the cows are fed alfalfa hay for nutrition and growth, as well as salt and other mineral supplements. The hay and alfalfa is spread over the surface of the tailings from the top of the slope to the bottom. More hay is added as the hay gets incorporated into the surface tailings. Water troughs are placed at the top of the slope to enhance the movement of the animals up and down the slope as well as contouring on the slopes.

Organic matter is incorporated into the surface to depths of six to 18 inches (see photo 2). From records that were kept on the daily feeding of the cattle, the amount of hay and alfalfa being fed

to the animals averages approximately 28 tons per acre. The consultants have estimated that approximately 50 percent to 60 percent of this hay gets mulched down into the tailings by the trampling of the animals' hooves. This amounts to over 16 tons/acre of hay mulch that is incorporated into the tailings. In addition each heifer/steer excretes an estimated 33 pounds of green manure/day, and each full-sized cow excretes 65 pounds/day. This amounts to an additional 10 to 20 tons of manure/acre incorporated into the tailings. This can amount to over 190 pounds of nitrogen and nearly 58 pounds of phosphorus/acre. In addition, there are all the enzymes, proteins, minerals, and bacteria added from the urine of the livestock. Despite the fact that these animals are concentrated on a

small area for a short duration, there is very little evidence of any solid manure on the surface. All this organic matter is being incorporated into the tailings and decomposing to start forming the basis of a soil medium.

The impacted slopes show that the livestock have been traversing slopes on the contour preparing small benches running perpendicular to the slope, which dramatically reduces runoff. Also, the hooves of the livestock have produced numerous small depressions on the slope to further reduce runoff and improve the infiltration of rainfall. After a 2.25-inch rainfall event, trampled slopes exhibited very little serious erosion. Transects to monitor the ecological responses have been established and show evidence of vegetation becoming established, beneficial insects thriving in the organic matter, and birds and burrowing animals moving onto the site. This indicates that an ecologically balanced and sustainable ecosystem is beginning to develop.

The monitoring of the health of the livestock indicates that there are no problems with the animals. Analysis of blood samples collected from the livestock before placement on the reclamation site and after removal shows no problems with heavy metals. In fact, blood levels of copper, molybdenum, and zinc show deficiencies of these essential minerals, and we have had to supplement the diet of the cattle with mineral blocks. In fact, many healthy calves have been conceived and born on reclamation sites. Steers that have been taken to sale from the reclamation sites have shown an average weight gain of 0.5 pounds/day.



Photo 2: Small paddocks of 1/4 to 1/2 acre are enclosed with electric fences to hold the animals for short durations.



Photo 3: Organic matter is incorporated to depths of up to 18 inches by the trampling and hoof action of the cows.

The future of reclamation with livestock looks very favorable. We have witnessed a vast improvement in the stability and ecological productivity of reclamation sites impacted by livestock. The slopes have been stabilized and there is far less wind and water erosion, vegetation is becoming established on the natural rainfall, and we see the early stages of establishment of a healthy, fully functioning, viable ecosystem. There has

also been a positive response from the community and public at large, as well as positive media exposure. Recently, the Arizona State Mine Inspector honored the ASARCO Ray Complex with the Annual Reclamation Award for the innovative use of livestock for copper tailing reclamation. As our use and development of this method of reclamation continues, we can anticipate even more positive accomplishments. ■

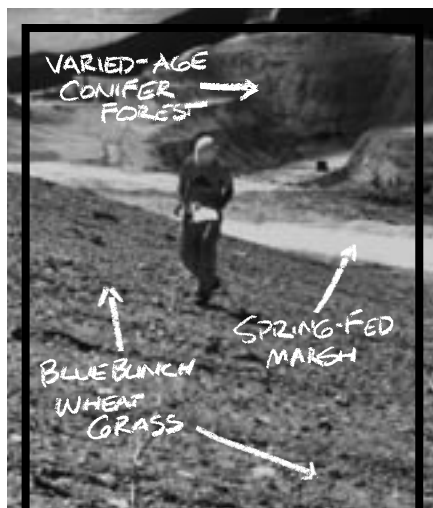
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Footnotes

¹ Based on paper presented at the 16th Annual National Conference of the American Society for Mining and Reclamation, Scottsdale, AZ, Aug. 13-19, 1999.

² Agronomist, ASARCO Incorporated - Copper Operations, 4201 W.Pima Mine Rd., Sahuarita, AZ 85629.



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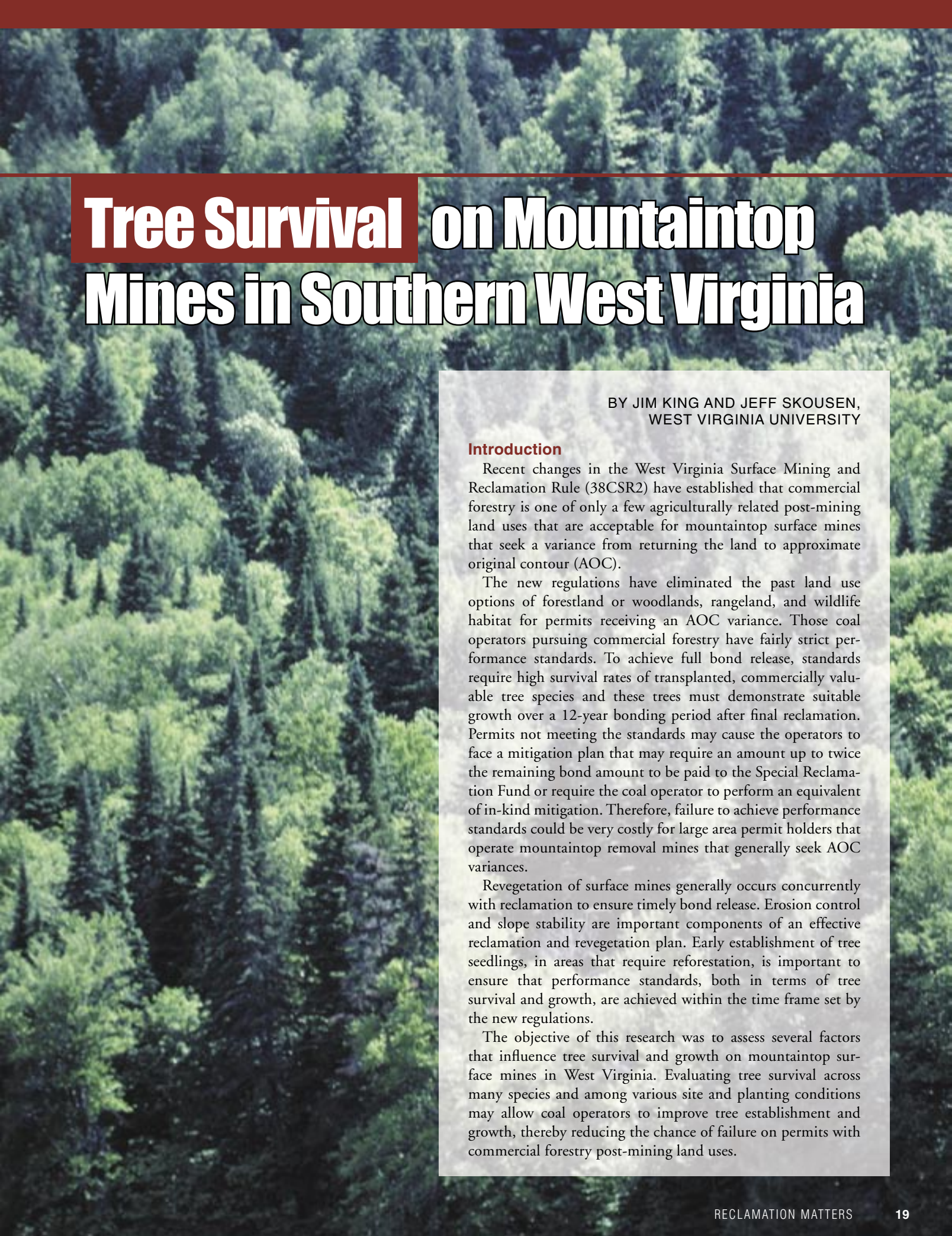
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An aerial photograph of a dense, green forest covering a mountain slope. The trees are mostly deciduous with some evergreens, creating a textured canopy. The lighting suggests a bright day, with some areas of the forest appearing slightly brighter than others.

Tree Survival on Mountaintop Mines in Southern West Virginia

BY JIM KING AND JEFF SKOUSEN,
WEST VIRGINIA UNIVERSITY

Introduction

Recent changes in the West Virginia Surface Mining and Reclamation Rule (38CSR2) have established that commercial forestry is one of only a few agriculturally related post-mining land uses that are acceptable for mountaintop surface mines that seek a variance from returning the land to approximate original contour (AOC).

The new regulations have eliminated the past land use options of forestland or woodlands, rangeland, and wildlife habitat for permits receiving an AOC variance. Those coal operators pursuing commercial forestry have fairly strict performance standards. To achieve full bond release, standards require high survival rates of transplanted, commercially valuable tree species and these trees must demonstrate suitable growth over a 12-year bonding period after final reclamation. Permits not meeting the standards may cause the operators to face a mitigation plan that may require an amount up to twice the remaining bond amount to be paid to the Special Reclamation Fund or require the coal operator to perform an equivalent of in-kind mitigation. Therefore, failure to achieve performance standards could be very costly for large area permit holders that operate mountaintop removal mines that generally seek AOC variances.

Revegetation of surface mines generally occurs concurrently with reclamation to ensure timely bond release. Erosion control and slope stability are important components of an effective reclamation and revegetation plan. Early establishment of tree seedlings, in areas that require reforestation, is important to ensure that performance standards, both in terms of tree survival and growth, are achieved within the time frame set by the new regulations.

The objective of this research was to assess several factors that influence tree survival and growth on mountaintop surface mines in West Virginia. Evaluating tree survival across many species and among various site and planting conditions may allow coal operators to improve tree establishment and growth, thereby reducing the chance of failure on permits with commercial forestry post-mining land uses.

Study Site

Catenary Coal's Samples Mine in southern West Virginia is the largest surface mine in the eastern U.S. with contiguous permits covering more than 7,400 acres. Mountaintop removal is the dominant mining method on this site and several areas have been permitted with commercial forestry as the post-mining land use.

The geology of the area being mined is within the Pennsylvanian system, and the disturbed strata are in the Pottsville, Kanawha, and Allegheny Formations. Seven major coal seams or coal zones (with 14 separate splits) are mined. In descending order, the coal seams are the Freeports, Kittannings, Stockton, Coalburg, and Winifrede. A topsoil substitute has been allowed for use in all permits prior to 2001 with or without an AOC variance. Those areas permitted after 2001, without an AOC variance, also may use a topsoil substitute. The areas sampled, during the summer of 2002, were reclaimed with a topsoil substitute consisting primarily of strata immediately above the deepest coal seam mined, which contains about 80 percent fine-to medium-grained, micaceous, light gray sandstone (unweathered) and 20 percent of a mix of shales and coal. The pH of the surface material ranged from 6.0 to 8.0. With recent regulation changes in 2002, topsoil substitutes are no longer allowed on commercial forestry sites and five feet of the original topsoil combined with weathered brown sandstone is the required growth medium.



The height and diameter of trees in reforestation plots were sampled along transects.

Tree Sampling Methods

The management at Samples has established an aggressive reforestation program where more than 100,000 trees have been transplanted in small blocks during the past five or six years (~20,000 trees per year). These plantations were the focus of this tree survival and growth study.

Tree plantations, one to three years of age, of various sizes and various tree compositions were mapped and evaluated for seedling survival and growth during the summer of 2002. Belt transects (2.4 m wide and of various lengths based on the size of the plantation) were run through plantations perpendicular to planted rows (Table 1). Since plantations varied in size, we first mapped each plantation thereby denoting its size, and then we evaluated about 1/10th of the total area of each plantation by running enough belt transects within the plantation to represent the 10 percent evaluation area. Within transects, each tree was identified by species and its height and basal diameter were measured. In each transect, general site conditions were measured: slope was measured by a clinometer; aspect was determined by compass degree; and groundcover percentage and composition (total and by major species) were visually estimated.

Planting date, slope, aspect, and ground cover were separated into categories for analysis. Statistical analyses were performed using analysis of variance (SAS Institute, 1987) using these factors as main effects on tree survival. Two-way interactions were also tested for their influence on tree survival, but are not shown here.

During 2002, 60 different tree plantations were mapped covering about 50 ha (125 ac) of land area. Of this 50 ha of area, 123 transects were established in these plantations for our tree survival evaluation, which covered 10 percent of the total area. Most transects were between 60 to 100 m in length, or about 0.020 ha. Based on planting records, stocking densities varied from 1,000 to 5,434 trees/ha (400 to 2,200 trees/ac), with an average of about 1,482 trees/ha (600 trees/ac).

Results and Discussion

Tree plantations sampled in this study were established in the spring of 1999, spring of 2001, and fall of 2001. No significant difference in survival was found among the three planting dates (varied between 58 percent to 68 percent average survival), although, as expected, the older planting had slightly less survival (Table 1). Tree survival varied from 9 percent to 98 percent in transects, and averaged 65 percent across all ages of plantations. Tree heights and basal diameters also varied slightly, with the largest trees on the older plantings.

Table 1.

Average survival, height, diameter, and other parameters of all trees transplanted at three dates at the Samples Mine.

	Spring 1999	Spring 2001	Fall 2001
Avg. % Survival	58	68	64
Avg. Ht of all trees (cm)	71	47	44
Avg. Dia of all trees (mm)	12	8	6
# of Species Encountered*	11	8	8
# of Plantations Sampled	6	23	26

* Includes invaders.

We were unable to evaluate the survival of each species because we didn't know exactly how many of any one particular species had been planted in any specific area (we only could determine the general proportion of each species planted during any one year). Tree species and proportions of transplanted trees were calculated based on planting records and included: black alder (seven percent), sycamore (six percent), chestnut oak (five percent), bur oak (11 percent), white oak (24 percent), sawtooth oak (four percent), red oak (one percent), white ash (36 percent), red maple (one percent), pitch x loblolly pine (two percent), white pine (<one percent), dogwood (three percent), and black cherry (<one percent). Therefore, our assessment was based on the total number of planted trees in a specific plantation because we could identify the spacing of planted trees.



Some of the largest transplanted trees were black alder.

Black alder was the largest tree in all plantations and within each planting date (Figure 2). Other species showing good growth were sycamore, pitch x loblolly pine, white ash, red maple, and black cherry (Table 2). In comparing growth between spring 2001 and

fall 2001, very little difference could be found, suggesting that not much growth had occurred during the 2001 growing season. This also demonstrates that the first growing season is an establishment period rather than a growth period.



Slopes were used as surrogates for compaction. Steeper slopes had less compaction, while flatter slopes had more.



Some slopes were less compacted and were only rough graded.

Researchers have studied the negative influence of compaction on survival and growth of trees planted on surface mined land. Compaction, resulting from regrading the topsoil to make it smooth for planting (also referred to as "tracking in"), restricts root growth and retards the establishment and growth of trees (Burger, 1999; Larson and Vimmerstedt, 1983; Torbert et al., 2000). Torbert and Burger (1996) found a significant difference in survival and height growth of commercially valuable trees planted to moderately and intensely graded spoils. Zeleznik and Skousen (1996) found that survival and average height growth of white ash, tulip poplar, and white pine were greater on sites subjected to low grading intensity compared to high grading.

Although no direct measurements of compaction were performed at the time of this paper, the extremes of slope, <30 percent and >50 percent, were considered as analogs to conditions of compaction and a surrogate for soil bulk density (Figure 3). The reason behind designating the lower slope class to represent a more compacted condition comes from observations at the site of the use of heavier equipment to regrade flatter slopes, and the use of lighter equipment on steeper slopes, as well as less truck and equipment traffic associated with steeper slopes (Figure 4). Mean survival was highest in areas with steeper slope (75 percent to 62 percent), but the difference was not statistically significant (Table 3).

Aspect has been long recognized as a factor that influences species composition and forest site quality in the eastern United States. South- and west-facing slopes are generally the least productive, while north- and east-facing slopes are the most productive (Hicks et al, 1982). Soil moisture and energy relationships in native forests have produced environments that favor the establishment and proliferation of certain species. Haynes (1983) found sparser plant communities on drier, south-facing aspects, while northern aspects had more vigorous plant communities, which was related to improved moisture conditions. Recommendations for tree planting suggest that trees adapted to drier site conditions [pines (*Pinus* spp.), black locust (*Robinia pseudo-acacia* L.), and red oak] be established on southern and western aspects. Trees adapted to wetter and cooler climates [black walnut, black cherry, yellow-poplar, cottonwood (*Populus deltoides* Marsh.), green ash (*Fraxinus pennsylvanica* Marsh.), white ash, and sweet gum (*Liquidambar styraciflua* L.)] should be transplanted on northern and eastern aspects.

Table 2.

Average height and diameter of trees transplanted at three dates at the Samples Mine.

Species	Spring 1999		Spring 2001		Fall 2001	
	Avg. Ht. (cm)	Avg. Dia. (mm)	Avg. Ht. (cm)	Avg. Dia. (mm)	Avg. Ht. (cm)	Avg. Dia. (mm)
Black alder	167	29	95	18	124	24
Sycamore	102	19	45	7	45	6
Chestnut oak	23	4	45	8	46	6
Bur oak	61	12	38	8	33	7
White oak	39	6	38	6	42	7
Sawtooth oak	43	5	37	5	39	5
Red oak	29	5	41	6	0	0
White ash	80	12	50	8	46	6
Red maple	77	13	38	6	47	7
Pitch x Loblolly	82	19	25	6	23	5
White pine	64	17	0	0	0	0
Dogwood	36	5	36	5	38	5
Black cherry	63	7	50	5	0	0

Table 3.

Average survival of trees transplanted from 1999 - 2001 on three slope classes at the Samples Mine.

Slope Class	Range	Mean Survival (%)	Standard Deviation
1	0 - 30%	67	19.1
2	31 - 50%	62	21.0
3	> 50%	75	11.5

Table 4.

Average survival of trees transplanted during 1999-2001 on five aspect classes at the Samples Mine.

Aspect Class	Range (°)	Major Direction	Mean Survival (%)	Standard Deviation
1	316 - 45	NW-NE	66	25.6
2	46 - 135	NE-SE	68	17.8
3	136 - 225	SE-SW	65	17.2
4	226 - 315	SW-NW	59	22.0
5	< 30% slope	All	68	18.3

The effects of aspect were considered in this study (survival varied between 59 percent and 68 percent), but no significant differences in tree survival among aspects were found (Table 4). The effect of aspect on soil moisture at Samples may be muted by the fact that the difference in relief of the reclaimed terrain is generally less than 150 feet. More time is probably needed for trees to be exposed to these various aspect conditions for survival differences to show.

The negative effects of abundant and aggressive ground cover on the survival and growth of transplanted trees has long been known. Trees transplanted into introduced, aggressive, annual forages [especially tall fescue (*Festuca arundinacea* L.) and sericea lespedeza (*Lespedeza cuneata* L.)] are often overtopped by the grasses or legumes and are unable to break free through the coverage (Burger and Torbert, 1992; Torbert et al, 1995). The seedlings are pinned to the ground and have little chance for survival.



Trees can be transplanted into areas with no groundcover, and then a tree-compatible, less-aggressive cover can be seeded during the following early spring or late fall before tree leaves have emerged.

Trees should be transplanted into soils with no ground cover (see above photo), and then a tree-compatible ground cover should be seeded afterward that will be less competitive with trees (see photo on page 23). The tree compatible ground cover should be slow growing, sprawling or low growing, not allelopathic, and not compete with trees (Burger and Torbert, 1992). Plass (1968) reported that after four growing seasons the height growth of sweetgum and sycamore planted into an established stand of tall fescue on spoil banks was significantly retarded. Andersen et al (1989) found that survival and height growth for red oak and black walnut was significantly greater on sites where ground cover was chemically controlled.

In this study, ground cover varied from 0 percent to 95 percent, averaging 71 percent. Ground cover species included: annual rye, perennial ryegrass, clovers (red, white, and sweet), birdsfoot trefoil, alfalfa, bicolor and sericea lespedeza, orchard grass, K-31 tall fescue, timothy, and redtop. Trees showed a trend of better survival with low amounts of ground cover (74 percent compared to 62 percent), but the differences were not significant (Table 5). Again, more time will probably be needed for ground cover to have a significantly negative influence. From our observations, it appears that 0 percent to 25 percent ground cover has no influence on tree survival, while there is a slight decrease in tree survival as the ground cover increases to 50 percent. Above 50 percent, a more rapid decline in tree survival is apparent.

Summary

During the summer of 2002, we sampled over 50 plantations at the samples surface mine in West Virginia to determine the effects of planting date, slope, aspect, and ground cover on the survival of transplanted trees. Plantations were established in

Table 5.

Average survival of trees transplanted during 1999-2001 with three ground cover classes at the Samples Mine.

Ground Cover Class	Range (%)	Mean Survival (%)	Standard Deviation
1	< 50	74	5.5
2	50 - 70	67	7.6
3	> 70	62	8.2

spring 1999 and spring and fall of 2001. Average tree survival across these three dates and among all tree species was 65 percent. Black alder was the largest of the transplanted trees, but sycamore, pine, white ash, red maple, and black cherry also showed good growth. Slope was used as a surrogate for soil compaction (steeper slopes had smaller equipment compared to flatter slopes with larger equipment) and tree survival was 75 percent on slopes >50 percent, 62 percent on slopes 31 percent - 50 percent, and 67 percent on slopes <30 percent. Tree survival was not different among five aspect classes (ranging from 59 percent on SW-NW aspects to 68 percent on NE-SE aspects). Tree survival was highest (75 percent) in areas with <50 percent groundcover and lowest (62 percent) in areas with >70 percent ground cover. More time is needed to see if these tree survival trends continue with these site factors.



Trees have grown better where the groundcover was seeded after transplanting.

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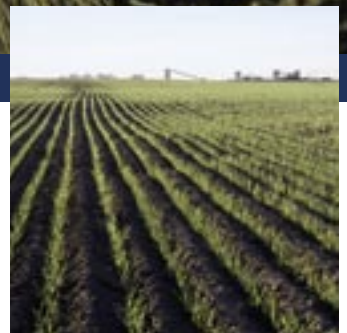


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