

reclamation *matters*

Issue 2 2007

Meet the Reclamationist of the Year



**2008 – New Opportunities
to Apply Our Science**

**Take a Trip Down
Memory Lane**

**The Rise and Fall of the
Coal Industry in the U.K.**



PRSTD STD
US POSTAGE PAID
FARGO ND
PERMIT #1080



Storm Water Runoff Control Erosion Control • Sediment Control



- Capture sediment
- Shorten slope length
- Slow & spread water flow
- Keep sediment on site
- Protect storm drains, lakes & rivers
- Replace silt fences & straw bale dikes

Straw Wattles™

An economical and efficient
Best Management Practice (BMP) for:

- Construction Runoff Pollution Control
- Streambank Revegetation
- Forest Fire Burn Rehabilitation
- Timber Harvest Erosion Control
- Mine and Land Reclamation
- Vineyard Erosion Control



Which Straw Wattle™ suits your project?

- UV degradable
- 9 inch diameter
- 100% biodegradable
- 12 inch diameter

Certified noxious weed-free straw

California Straw Works

Website: www.strawwattles.com

Fax/Phone: (916) 453-1456 • Email: csw@strawwattle.com

CONTAINMENT BOOMS



We are dedicated to offering a complete line of
environmental protection systems including:

- Floating Silt/Turbidity Barriers
- Custom Containment Tarps
- Absorbents • Geotextiles

Environmental
Protection Systems



P.O. Box 960
Brockton, MA 02303
(508) 583-7850 Fax (508) 583-5231

800-699-2374

CAUDILL SEED

COMPANY, INCORPORATED

Seed Blending Conformity: blends to federal, state, and local specifications;
D.O.T. requirements;
private enterprise and landowners requests.

Site-Specific Blending: specialty mixes geared toward erosion control;
seed mixes for reintroduction/preservation of wildlife;
seed mixes for riparian areas;
mixes for all mining and highway applications.

Call us today and ask for one of our reclamation specialists.

Three logistics-friendly locations serving **KY, WV, VA, OH, PA, IN, TN, IL, NC, AL.**
Ask about our on-site delivery service.

Louisville, KY
800.626.5357

Allen, KY
800.925.6090

Morehead, KY
877.775.7333

Seed Specialists

Published for:
**American Society of
Mining and Reclamation**
3134 Montavesta Road
Lexington, KY 40502
Tel: 859-335-6529
Fax: 859-335-6529
<http://fp1.ca.uky.edu/asmr>

Published by:
Lester Publications, LLC
2131 NW 40th Terrace – Suite A
Gainesville, FL 32605
Main Line: (877) 387-2700

President
Jeff Lester | (866) 953-2189

Sales Director
Sean Davis | (888) 953-2190

Editor
Bonnie Winter Fedak | (866) 953-2181

Graphic Designer
Andy Carney | (204) 953-2180

Account Executive
Shannon Evans | (877) 387-2700

© 2007 Lester Publications, LLC. All rights reserved. The contents of this publication may not be reproduced by any means, in whole or in part, without the prior written consent of the publisher.

PRINTED IN CANADA.
Please recycle where facilities exist.

Statements of fact or opinion are the responsibility of the authors and do not imply an opinion on the part of the officers or members of the American Society of Mining and Reclamation. All rights reserved. Materials may not be reproduced or translated without written permission.

contents

Issue 2 2007
Volume 3
Number 2

- 2 President's Message**
By Paul Eger, ASMR President
- 3 Executive Secretary's Message**
By Dr. Richard I. Barnhisel
- 4 River of Promise: Ten years of progress**
- 9 Reclamationist of the Year**
- 10 Reclamation Researcher of the Year**
- 11 Then and Now: A trip down memory lane**
- 17 The Rise and Fall of the Coal Industry in the United Kingdom**
- 25 2008 ASMR Meeting Announcement: "New Opportunities to Apply Our Science"**
- 28 Can Surface Mine Reclamation Help to Restore American Chestnut?**



BY PAUL EGER



The Times They are a Changin'

Elect a president from Minnesota and get lyrics from Dylan songs! Not only is Hibbing, Minn., the hometown of Bob Dylan, but it's the center of Minnesota's iron mining industry. Five years ago, that industry was suffering. One of our largest companies had gone into bankruptcy and another was down to a skeleton staff of four. Today that company is running at maximum capacity and a previously closed mine will be reopened as Minnesota gets ready for its first integrated operation, taking iron ore to direct reduced iron and steel. The times are truly changing not only for the mining industry, but for those of us in reclamation, as well.

We are all aware of the boom in mining today, driven by high metal prices, the result of the ever-increasing demand in China and India. Deposits that were once just the dreams of exploration geologists are now on the verge of becoming reality. More money means more exploration and more developments. I have several colleagues in the exploration industry – one almost at retirement age and the other well past – who have told me, "I couldn't retire now – it's just too exciting!"

All this excitement brings new challenges for those of us in mine land reclamation. Many of the new prospects are in remote areas where development poses serious environmental challenges. About 10 years ago I was on a field trip at our annual ASMR conference. I asked about a closure plan and a long-term vision for the site. The honest response was that not much was really required; the closure plan just had to be somewhat believable and seen as something more than a joke. Today we are faced with not only serious closure plans, but also a need to address difficult issues like sustainable development. The public is demanding environmental protection, as well as long-term economic and environmental health. While much of our work will still be to continue to reclaim historic and current mine lands, more of us will be called upon to look into the future and prevent problems and design landscapes that fit into long-term visions. It's an exciting challenge, and given the wonderful diversity in our organization, I can't think of a better group to tackle these issues than us! ■

NORTHERN
Analytical Laboratories, Inc.

- Environmental
- Industrial Hygiene
- Products

Kathleen A. Smit, CIH
Lab Manager

PH: (406) 254-7226
FAX: (406) 254-1389
EMAIL: nlabs@wtp.net

602 SOUTH 25th STREET
BILLINGS, MT 59101

*Providing Comprehensive Engineering
and Environmental Services
Specializing in Innovative Reclamation Techniques*

SKELLY AND LOY, INC.

Harrisburg, Pennsylvania
(800) 892-6532 or (717) 232-0593
Fax: (717) 232-1799
www.skellyloy.com

Pittsburgh, PA ♦ State College, PA ♦ Morgantown, WV ♦ Hagerstown, MD



ASMR Membership has its Privileges

2007 has been a very successful year for the American Society of Mining and Reclamation. Our membership has grown over the last few years, but it made the largest increase this past year with 79 additional members. Our roll now stands at 442. The largest increase in membership has been in the number of corporate members with a total of 34. Our goal is to reach 500 members by this time next year. There are approximately 3000 who receive Reclamation Matters, but only about 15 percent of you are ASMR members. Join our society and receive many additional benefits.

Corporate members have the option of completing information for the Mining and Reclamation Services Directory on the ASMR Web page. This section lists services in three categories: consulting services, contractors, and equipment and material suppliers. If you or your company desire such items, go to this section and look in the various categories for items you need, then we hope you will contact these folks first. If you wish to join as a corporate member, contact me either directly (asmr4@insightbb.com) or through the Web page. The simplest way to find the Web page is to search on Google or some other search engine for ASMR or American Society of Mining and Reclamation, as we are usually at the top of these lists.

Another popular service of our Web site has been the assistantships and job opportunities postings. This section has received several thousand hits this year. If you have an available position, send me the announcement and I will place it on the Web page at no cost. One advantage of being an ASMR member is receiving notices that a position has been listed.

Sites have been selected for the 2008 and 2009 ASMR meetings. Proposals are being developed for 2010 and 2011. The 2008 meetings will be in Richmond, Va., and 2009 in Billings, Mo. Suggestions for 2010 have been made for Mississippi and Pennsylvania, but a site has not been officially selected. North Dakota has been proposed for 2011.

A contract has been signed with Curran Associates, Inc. to produce hard copies of the proceedings from our ASMR meetings, since converting to digital in 2002. CDs are available for many of our meetings as well as hard copies of meetings prior to 2002. Members are entitled to choose from these when they pay their dues. The cost will vary depending on the number of pages. Contact either Curran or me if you require a hard copy of proceedings from 2002 to present. ■



PHC Reclamation, Inc.

Complete Engineering, Design and Construction Management Services for Reclamation, Revegetation and Restoration of Minelands and Other Disturbed Sites

Offices:

Cheyenne, WY
877.634.9845

Helena, MT
406.495.9559

Albion, ID
888.673.6707

Frogmore, SC
888.290.2640



Traditional Reclamation Services
Wetland, Upland, Reforestation and Revegetation Services
Hazardous Mine Site Mitigation and Closure
Stabilization of Mine Site Historic Structures
Mycorrhizal Fungis, PUF (polyurethane foam) Closures
For more information visit us at: www.phcreclamation.com



BKS Environmental Associates, Inc.

• Reclamation Planning •
 • Baseline Assessments • Environmental Monitoring

BRENDA SCHLADWEILER, Ph. D.
 P.O. Box 3467 • Gillette, WY 82717-3467 • (307) 686-0800 • Fax (307) 686-0880
 P.O. Box Laramie, WY 82073-0574
 e-mail: bksenvironmental@vcn.com
www.bksenvironmental.com



Figure 1. Location of the Cheat River in northern West Virginia.

River of Promise:

The River of Promise is a coalition of state and federal agencies, academia, industry and environmental groups working to bring expertise, resources and technology to address acid mine drainage (AMD) problems in the Cheat River Watershed of northern West Virginia (Figure 1). Over 20 groups have signed the “River of Promise: A Shared Commitment for the Restoration of the Cheat River, West Virginia.” Meeting quarterly since 1995, and chaired by the director of Friends of the Cheat (FOC), the River of Promise coordinates and initiates AMD remediation projects throughout the watershed. Millions of dollars in projects have been completed or initiated since the inception of the River of Promise, including monitoring sweeps, assessments and on-the-ground reclamation projects.

FOC was formed in 1994 as a group of grassroots stakeholders largely reacting to a colossal blowout of AMD from a recently closed coal mine (Figure 2). The blowout of AMD into Muddy Creek was clearly visible from a well-traveled road just five miles above the confluence of Muddy Creek and the Cheat River. This confluence is the top of Cheat River Canyon, a renowned whitewater run that attracted thousands of people



Figure 2. Acid mine drainage from an underground mine blowout spilled into Muddy Creek, which flowed into the Cheat River.

per season to raft with outfitters or kayak as private boaters. The blowout rendered the Cheat Canyon so acidic that it burned the eyes of boaters. Fish were killed 16 miles downstream to the mouth of the Cheat River on Cheat Lake.

The founders quickly recognized that the scope of the AMD problem in the watershed extended far beyond this single catastrophe, and that all available resources would need to be coordinated to have any impact in dealing with this issue. The striking Cheat Canyon, a major whitewater rafting and kayaking haven, as well as several miles upstream of the Canyon, were effectively dead (Figure 3). The Canyon section was declining as a whitewater destination, but still represented a great potential resource to the area and attracted widespread support.

Over a period of months after the blowout, contacts were made with local industry, state and federal agencies, and other citizen groups. This networking led to meeting with the late John Faltis of Anker Energy. The original request from Faltis was to support the first Cheat River Festival as a fundraiser for FOC. The meeting led to a pledge by Anker Energy to fund a passive treatment system in the watershed, as a demonstration of the industry’s intent to become part of the solution rather than a non-participating stakeholder.

Interest in restoring impaired streams throughout the region spurred development of federal water quality improvement programs. Funding became available from the



Figure 3. Acid mine drainage in Muddy Creek is entering the Cheat River at the beginning of the Cheat Canyon.

Watershed Cooperative Agreement Program through the Office of Surface Mining, which was available only to non-profits and aimed at supporting stakeholder-driven projects in Appalachia. These funds, in turn, could be considered a match for EPA 319 funds, and watershed groups could develop and administer projects.

With Anker Energy’s financial commitment and the funding available from federal and state agencies for treatment projects, other partners were brought in to plan and develop restoration priorities. A partner in this planning was the National Mine Land Reclamation Center (NMLRC) at West Virginia University (WVU), whose mission it is to develop treatment technologies for AMD.

A cooperative effort began with quarterly planning meetings for reclamation projects in the Cheat Watershed and was composed of state and federal agencies, academia, industry and conservation groups. A signing ceremony of the “shared commitment” to restore the Cheat River was held at the first Cheat River Festival in 1995 and included Anker Energy, OSM, WVDER, WVDNR, FOC, and WV Rivers Coalition. Additional

Ten years of progress



Figure 4. John Faltis of Anker Energy addresses the audience at the River of Promise signing ceremony.

signatories at the 1996 Cheat River Festival included: USEPA, USGS, NMLRC, WV Trout Unlimited, USFWS, and Canaan Valley Institute (Figure 4).

During the next few years, funding from Anker, USEPA, and OSM's Watershed Cooperative Agreement Program was used to install remediation projects on Greens Run, Sovern Run, and Beaver Creek, all tributaries of the Cheat (Figure 5). The River of Promise was off and running.

River of Promise goals

- Identify sources of AMD pollution in the Cheat River Watershed.
- Increase public awareness of the extent and impacts of AMD in the watershed.
- Target streams impacted by AMD.
- Secure funding and implement AMD mitigation projects.
- Monitor the status of water quality and fisheries in the watershed.
- Promote recreational use of the river and its contribution to local economies.

To date, FOC has brought over \$1.3 million in reclamation funding and has constructed eight passive treatment projects. This figure does not include other passive treatment systems installed by the AML program in the state (Figure 6). 2006 marked the beginning of a three-year EPA Targeted Watershed Initiative grant of \$835,000 to be matched with \$500,000 in state and federal funds to address impaired streams in Muddy Creek, a tributary of the Cheat that contributes 60 percent of the acid load to the river. Three additional projects, totaling more than \$600,000, are approved for funding and construction in 2007.



Figure 5. Groundbreaking ceremony for installing passive systems in Greens Run.



Figure 6. One of the passive treatment systems installed in the Cheat River watershed.

Improvements in the Cheat are measured by Friends of the Cheat and the WV Division of Environmental Protection, and researchers at WVU monitor biological recovery of streams from treatment projects (Figure 7). Project success is based on miles of stream restored to fish.

It should be noted that the substantial cost of reclamation has contributed to the local economy through employment, taxes, project construction costs, engineering, etc. Either directly or indirectly, reclamation work has represented millions of dollars to the area in the past 10 years.

Stakeholder driven

River of Promise uses a team approach in quarterly meetings to plan and discuss projects and watershed strategy. The members of the team are the pool from which to draw committee-sized work groups for specific projects. The diversity represented across the River of Promise can span agency or political barriers that otherwise could prevent different entities working together. The advantages of a team approach include:

- Promoting communication between interest groups and agencies for solutions.

- Fostering new partnerships between agencies.
- Providing a “critical mass” to gain support for large projects or initiatives.
- Crossing political boundaries in watershed issues.

So...what have we learned?

Based on some River of Promise successes, here are three important factors that must be considered when establishing a watershed group.

- Establish an Identity – The Cheat River had been a whitewater destination for a generation before the formation of River of Promise. Early whitewater equipment and expertise were pioneered in the late ‘60s and early ‘70s at the Cheat River. Adventurous individuals and travel writers were attracted to the river because of the quality whitewater experience, but they asked about the orange rocks at the mouth of Muddy Creek and along the river’s edge for miles downstream. Therefore, we were lucky to have an already well-known location as a resource to restore.
- Embrace Expertise – The closeness of the river to WVU was obviously an

advantage to Friends of the Cheat. The availability of an impaired watershed close to WVU allowed research, design, and monitoring of treatment projects using students.

- Energize the Organization – FOC offered a focal point for gathering people to address AMD in the Cheat Watershed. Members of the organization represented the whitewater industry, local business, local residents and recreational users. This diversity brought a broad base of talent and awareness that served the organization well. The annual Cheat River Festival is not only a celebration of the river to promote awareness, but it raises money to support the organization.

Commonalities for Watershed Groups

From these key conditions, what can be applied to other watershed groups? What are common concerns in all watersheds to focus attention and action? How can watershed groups become effective forces in their communities? Here is a list in order of lowest cost to most expensive.



Figure 7. Aquatic surveys are conducted by state biologists and WVU students to monitor progress of restoration efforts.



Figure 8. Rail trail designations is one way that can bring local citizens and businesses together and can secure further support for stream cleanup efforts.

- Solid waste is a common concern. Volunteer cleanups provide publicity, which conveys the notion that residents are becoming caretakers and watchdogs of their watershed.
- Some groups are concerned with only one particular resource, such as a native brook trout stream. If this is the focus, then let local volunteers inspire efforts to preserve a particular quality of the local environment. This in turn can provide motivation for projects such as tree planting, stream bank stabilization, and installing other conservation projects.
- Access to recreational resources such as a river or an abandoned rail corridor can be a wonderful addition to a community's quality of life (Figure 8). A local group can rally support and partner with local government and/or larger conservation groups to achieve real benefits for the community.

- Sewage treatment issues are common to almost all rivers and streams. Aid to install upgraded or alternative systems can improve water quality, but the cost may be high. Partnerships must be formed with county governments, USDA, Rural Community Assistance Programs, and Regional Development Organizations, etc.
- Mine drainage can be the major water impairment in many locations. This may be from past unregulated mining where no one has responsibility for treatment. These sites often require hundreds of thousands of dollars for construction of treatment projects. Partnerships with agencies and programs with money are critical.

If you are a member of a local watershed group, please consider what you represent. How much geographic area is your organization concerned with? How many people live in this area? Are there stakeholders living outside of the watershed area? Ultimately, is this watershed area being effectively served by the watershed organization?

Following are roles of watershed groups in addressing water quality problems:

- Implement a water quality-monitoring program to develop data that can be used to write a watershed-based plan, guide project design and funding

justification. With proper training, a watershed group can do this as effectively and more cost efficiently than other entities.

- Learn criteria for funding programs, meet reporting requirements, and assist with project construction oversight on a local basis.
- Represent the stakeholders of the watershed in planning or restoration efforts.

These tasks and more require the commitment of either a very dedicated team of volunteers (with flexible time), or at least one paid staff member to coordinate volunteers, agency personnel and funding partners. While volunteerism is both admirable and fulfilling, it usually cannot match the workload of dedicated staff. The work of watershed restoration needs to be locally driven, but it is not an after-hours endeavor. The challenge of achieving that level of capacity is directly connected to defining the proper scale of watershed and watershed organization (Figure 9).

There is nothing quite so fulfilling as achieving a watershed goal like restoring a fishery or making a stream or river swimmable again. Success in this endeavor not only restores our streams and rivers, but revitalizes our communities and promotes a feeling of health and well-being which infuses and invigorates residents. This should be the goal of all watershed groups. ■



Figure 9. Quarterly meetings of Friends of the Cheat include representatives from local businesses, WVU, state and federal agencies, and citizen groups keeps the watershed focused on action and results.



Vern Pfannenstiel – Peabody Investment Corporation

Reclamationist of the Year for the American Society of Mining and Reclamation



Reprinted from Coal People, July 2007

Vern Pfannenstiel is a great promoter of reclamation science as demonstrated by a long career of innovations and creative landscaping that has changed the way reclamation is done at Peabody Energy. Pfannenstiel is at Peabody Western Coal Company's (PWCC) Black Mesa Complex near Kayenta, Ariz.

Gerald Schuman, award committee chairperson of ASMR, says, "Vern has worked closely with Bitterroot Restoration personnel on projects at Peabody Western's Big Sky, Seneca and Black Mesa/Kayenta mines, and is a professional inspiration. He has the ability to carefully examine the problems in reclamation and, utilizing an ecological approach, to design solutions. He has strong communication skills and is able to pull together support for his reclamation efforts from regulators, his corporate management,

vendors, and contractors.

"He has always stayed on top of the latest science, knows how to adapt it to the real world of mined land reclamation in a sensible way, and stands shoulder-to-shoulder with those of us out at the mines to make sure it is the right approach. He constantly seeks feedback from the field hands to improve the results."

Pfannenstiel earned a Bachelor of Science in range ecology (Magna Cum Laude) from Colorado State University in 1978, which included concentrations in mined land reclamation and soils. He has attended numerous other reclamation-oriented courses since that time, which have focused on vegetation and wildlife measurements and rangeland management.

He began his career in June 1978 as range conservationist with the Soil Conservation Service (SCS) at Burlington, Co., responsible for planning and implementation of various range and agricultural conservation practices. From that point on, his experience and hands-on education grew as district conservationist with the SCS in Idaho, environmental scientist with Peabody Coal Company's Rocky Mountain Division in Denver, Co., senior environmental scientist with PWCC and the Black Mesa Mining Complex at Kayenta, Ariz., and more recently as manager of environmental services and reclamation. During these times he was involved in all facets of reclamation planning and implementation, grazing programs, permitting, vegetation sampling and monitoring, and develop-

ment and implementation of new or improved reclamation procedures.

His present duties include technical support for reclamation, environmental studies, and permitting to Peabody's western mines in Montana, Wyoming, Colorado, New Mexico, and Arizona; ensuring that Peabody is applying best technology practices in reclamation programs; scoping environmental baseline projects; and directing work with consultants. He is also involved in regulatory negotiations/oversight and participation in industry and regulatory forums.

Pfannenstiel has distinguished himself over a period of 25 years by his unflagging interest in learning as well as teaching. His interest in the on-the-ground results of particular reclamation techniques and their interaction with the ever-changing circumstances of weather each year takes him into the field on a regular basis. He has routinely accompanied field crews to have personal knowledge of field conditions that will enhance usefulness of eventual written/quantitative documentation.

In learning and education processes, he demonstrates an uncommon enthusiasm and passion for understanding the details of the subject of land reclamation. This passion, along with 25 years of experience, oceans of patience, and a fine intuitive field sense, comes together in Vern Pfannenstiel, an exemplary representative of the profession of land reclamation. ■

Carl Zipper

Virginia Polytechnic Institute and State University

Reclamation Researcher of the Year for the American Society of Mining and Reclamation



Carl Zipper has been a national leader in coal mine reclamation research, energy policy studies, and mine drainage treatment research since the early 1980s. In addition to his research production and accomplishments, Zipper's outreach and technology transfer efforts over the past 15 years have affected the entire Appalachian coal industry.

He received a Bachelor of Science in agronomy from Virginia Tech in 1981, followed by a Master of Science in resource economics and a doctorate in land reclamation. He has been a research scientist and an assistant professor, and is now serving as an associate professor at Virginia Tech and director of the Powell River Project.

Zipper began his mined land reclamation career at Virginia Tech conducting research on approximate original contour variances, which then broadened to include alternative spoil handling procedures and valley fill construction. Further, he became involved with pre-mine planning, cost assessment, permitting and compliance issues, and post-mining land use options.

Zipper has worked on water quality issues including passive treatment innovations, bioassay and biotic assessment procedures, impacts of underground mining on household water supplies by wells and springs, and barriers to reclamation of abandoned mine lands with poor water quality. In all, Zipper has authored over 120 articles including book chapters, journal articles, proceedings papers, and reports.

In policy matters, Zipper assessed the potential for coal-fired power generation in southwest Virginia, the impacts of coal production tax credits, the effects of transmission lines on adjacent property values, and the consequences of deregulated electric power generation.

Much of Zipper's contribution to reclamation science has been associated with his leadership role in the Powell River Project, a state and privately funded research and education initiative. Zipper assumed the director's position in 1997 and has overseen the publication of more than 20 Extension bulletins. Zipper provides tours for approximately 1,000 teenage science students annually, develops the annual Powell River Project field day, and educates other scientists, industry representatives, regulators, politicians, and private citizens about reclamation science and practice. As director, he solicits proposals, builds research teams, coordinates funding with research needs, and formulates plans for the future.

Zipper's colleague Jim Burger, says, "What makes Carl's academic research and outreach activities unique is his follow-through and ability to work with all the major parties in the mining community to apply new knowledge. He can work equally well with landowners, coal operators, regulators, and environmentalists."

ASMR is proud to recognize Carl Zipper as the 2007 Reclamation Researcher of the Year. ■

2007 Student Oral Presentation Award Winners



Nazmul Haque
1st Place



Abbey Wick
2nd Place



Bill Strosnider
2nd Place



Chris Johnston
3rd Place



Jon Anderson
3rd Place



Michael French
3rd Place

ASMR 2007 Scholarship Winners



Abbey Wick
PhD Scholarship



Elan Alford
PhD Scholarship



Carrie Werkmeister
MS Scholarship



Vicki Regula
MS Scholarship

American Society of Mining and Reclamation (ASMR) and International Affiliation of Land Reclamationists (IALR)

Final Call for Papers for 25th Annual Meeting (ASMR) and 10th IALR
And Call for Short Course Proposals

Richmond, Virginia – June 14 - 19, 2008

“New Opportunities to Apply Our Science”

Richmond Virginia, home of the USA's first commercial coal mine, will host the 25th Annual Meeting of the American Society of Mining and Reclamation in mid-June of 2008. This will also serve as the 10th meeting of the International Affiliation of Land Reclamationists (IALR). In addition to ASMR's historical concentration on coal and metal mining applications, this meeting's program and field trips will focus on remediation of other disturbances such as exposure of acid-sulfate materials, mineral sands mining, dredge spoil placement, and wetland impact mitigation. We invite attendees and their families to enjoy the wealth of great attractions in and around Richmond!

Short Course Proposals

Submit one-page summary to W. Lee Daniels by December 15, 2007 – wdaniels@vt.edu

Overall Meeting Schedule:

SATURDAY JUNE 14:	WORKSHOPS AND PRE-MEETING FIELD TRIP.
SUNDAY JUNE 15:	WORKSHOPS, CIVIL WAR BATTLEFIELDS TRIP, AND OPENING MIXER.
MONDAY JUNE 16:	PLENARY SESSION, AWARDS LUNCHEON, AND TECHNICAL SESSIONS.
TUESDAY, JUNE 17:	TECHNICAL SESSIONS AND SOCIETY DINNER @ SHIRLEY PLANTATION.
WEDNESDAY, JUNE 18:	TECHNICAL SESSIONS.
THURSDAY, JUNE 19:	POST-MEETING FIELD TRIPS.
FRIDAY, JUNE 20:	CIVIL WAR BATTLEFIELDS TRIP.

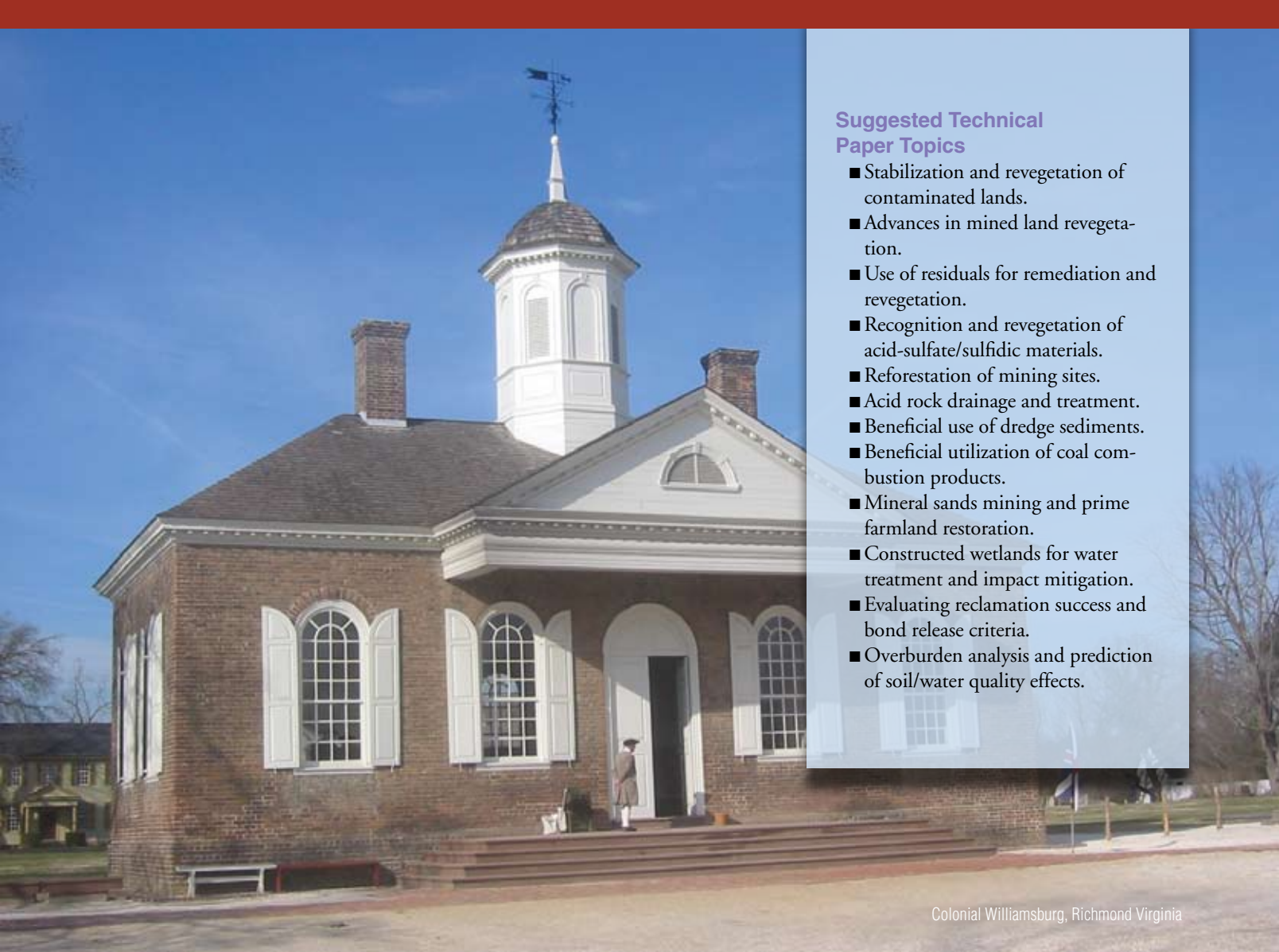
FULL MEETING INFO AT [HTTP://WWW.CSES.VT.EDU/REVEGETATION/ASMR_2008.HTML](http://www.cses.vt.edu/revegetation/asmr_2008.html)

Exhibits and Trade Show:

The trade show and exhibit area will be open throughout the regular meeting hours (M-T-W) and will be fully integrated with reception functions, poster sessions, and technical session coffee breaks. Trade show registrants will receive two full meeting registrations. Additional session and function sponsorships will also be available.

Venue:

The Richmond Marriott will host all meeting functions, technical sessions and exhibits. Downtown Richmond has undergone an impressive rebuilding and revitalization program over the past several years, and provides an impressive array of restaurants, museums, historical attractions, and entertainment options (<http://visit.richmond.com/>). Of particular note are the Virginia Museum of Fine Arts, Lewis Ginter Botanical Gardens, Confederate White House & Museum of the Confederacy, Tredegar Iron Works and Civil War Museum, James River Canal Walk, and numerous Civil War battlefields. Richmond is served by eight major airlines via Richmond International Airport (RIC) and by Amtrak rail service.



Colonial Williamsburg, Richmond Virginia

Suggested Technical Paper Topics

- Stabilization and revegetation of contaminated lands.
- Advances in mined land revegetation.
- Use of residuals for remediation and revegetation.
- Recognition and revegetation of acid-sulfate/sulfidic materials.
- Reforestation of mining sites.
- Acid rock drainage and treatment.
- Beneficial use of dredge sediments.
- Beneficial utilization of coal combustion products.
- Mineral sands mining and prime farmland restoration.
- Constructed wetlands for water treatment and impact mitigation.
- Evaluating reclamation success and bond release criteria.
- Overburden analysis and prediction of soil/water quality effects.



Major Attractions Within One Hour of Richmond

Busch Gardens, Colonial Williamsburg, Jamestown Settlement, Kings Dominion, Shirley Plantation, Yorktown Victory Center, and 10+ Civil War battlefields.

Major Attractions Within Two Hours of Richmond

Quantico Marine Museum, Smithsonian Aviation Museum at Dulles, Virginia Beach, Washington D.C., and many more Civil War battlefields.

Program Chair & Contact:

W. Lee Daniels, wdaniels@vt.edu
CSES Dept., Virginia Tech
540-231-7175

Abstracts due November 15, 2007
 Submit to: ASMR5@insightbb.com
 Draft manuscripts due January 14, 2008
 Final manuscripts due April 7, 2008

Then and Now: A trip down memory lane



I recently had an opportunity to make a presentation to the Casper Chapter of the Society for Mining, Metallurgy & Exploration. The bulk of the presentation was spent on describing what my company – BKS Environmental Associates, Inc. (BKS) – is and what we do. Some of the most entertaining aspects, however, were derived from discussing differences in the current coal boom and the coal boom of the late '70s. As a company, BKS was incorporated in Wyoming in 1981. I attended college during the mid- to late '70s, a time when reclamation was described as the “job of the '80s.” No one at that time foresaw the drop in coal and other commodity prices. To put it all in perspective, here are some of the major differences in “then” and “now.” For some of us who were here both then and now, the optimum phrase is “déjà vu.” Where did that time go? I guess if you wait long enough, fashion and booms come back. ■

THEN (1977)	NOW (2007)
ENERGY DEVELOPMENT	
■ THE SURFACE COAL MINE RECLAMATION ACT (SMCRA) WAS BORN.	■ SMCRA HAS NOW MATURED TO 30 YEARS OLD AND IS NOWHERE NEAR A MID-LIFE CRISIS.
■ THE COST OF A NEW HOME IN GILLETTE, WYO., WAS APPROXIMATELY \$55,000 TO \$65,000.	■ THE AVERAGE PRICE HOME IN GILLETTE IS NOW \$235,608.
■ THE COUNTY ASSESSOR'S VALUATION OF CAMPBELL COUNTY (IN WHICH GILLETTE IS LOCATED) WAS \$349,385,990.	■ THE COUNTY ASSESSOR'S VALUATION OF CAMPBELL COUNTY (IN WHICH GILLETTE IS LOCATED) WAS \$4,263,561,953.
■ INFLATION WAS 11 PERCENT.	■ INFLATION IS AT APPROXIMATELY 4 PERCENT.
■ WORKER SHORTAGES WERE RAMPANT; MANY CAME FROM ADJOINING STATES.	■ WORKER SHORTAGES ARE RAMPANT; MANY COME FROM THE MIDWEST WHERE FACTORY NEEDS HAVE GONE TO CHINA (DIDN'T NIXON GO THERE IN THE '70S?); ALSO SEVERE LABOR SHORTAGES OF SERVICE WORKERS, I.E., FOR RESTAURANTS, MOTELS, ETC.
■ OIL, COAL, URANIUM AND OIL SHALE WERE HOT.	■ OIL, COAL, URANIUM AND OIL SHALE ARE HOT AGAIN
■ TRANS ALASKAN OIL PIPELINE OPENS.	■ OIL CONSUMPTION CONTINUES TO BE AN ALBATROSS AROUND THE NECK OF AMERICANS, BUT NOW WE HAVE TO CONSIDER THE WAR ON TERROR AS AN INCENTIVE TO BE LESS DEPENDENT.
GENERAL	
■ AVERAGE NATIONAL HOUSEHOLD INCOME WAS \$15K.	■ AVERAGE HOUSEHOLD INCOME IN GILLETTE IS \$45,136.
■ COST OF A GALLON OF MILK WAS \$1.68.	■ COST OF A GALLON OF MILK IS \$3.29
■ COST OF REGULAR GAS WAS \$0.62 PER GALLON; LONG LINES AT THE GAS PUMP EARLIER IN THE '70S WERE COMMON; CARS HAD BIG ENGINES AND CONTAINED MORE STEEL.	■ COST OF REGULAR GAS IS \$3.05 PER GALLON; SHORTAGES ARE REPORTED; AMERICANS DO NOT SEEM TO BE CHANGING DRIVING PATTERNS; CARS HAVE SMALLER ENGINES, LESS STEEL BUT MORE COMPUTER CHIPS.
■ COST OF FIRST CLASS POSTAGE STAMP WAS \$0.13.	■ COST OF A FIRST CLASS POSTAGE STAMP IS \$0.41
■ THE U.S. POPULATION WAS 220,239,425.	■ THE U.S. POPULATION IS 301,139,950.
■ THE WORLD POPULATION IN 1970 WAS 3,706,618,163 AND THE GROWTH RATE WAS ESTIMATED AT 20.2 PERCENT.	■ THE WORLD POPULATION IN 2000 WAS 6,082,966,429 AND THE GROWTH RATE WAS ESTIMATED AT 12.6 PERCENT.
■ STAR WARS 1 OPENED IN MOVIE THEATERS AND PEOPLE STOOD IN LINE FOR HOURS	■ THE LARGEST GROSSING MOVIE SINCE THAT TIME HAS BEEN TITANIC IN 1997. STAR WARS 1 IS STILL NUMBER 2.
■ 25-YEAR JUBILEE CELEBRATION OF QUEEN ELIZABETH II.	■ STILL GOING STRONG AT 55 YEARS.
■ WORLD TRADE CENTER IN NEW YORK HAS BEEN COMPLETED.	■ PLANS FOR NEW THE NEW TRADE CENTER CONSTRUCTION ARE UNDERWAY.
■ FIRST APPLE II COMPUTERS WENT ON SALE.	■ BILL GATES RETIRES.
■ NAVSTAR GLOBAL POSITIONING SYSTEM GPS INAUGURATED BY U.S. DEPT. OF DEFENSE.	■ HAND-HELD UNITS COMMONLY AVAILABLE.
■ FIRST COMMERCIAL FLIGHT OF THE CONCORDE LONDON TO NEW YORK.	■ CONCORDE RETIRES.
■ NASA SPACE SHUTTLE MAKES ITS FIRST TEST FLIGHT OFF THE BACK OF A JETLINER.	■ SPACE SHUTTLE FLIGHT REINSTITUTED AFTER THE COLUMBIA DISINTEGRATES ON REENTRY IN 2003.
■ A FORD LTD COST \$5,866.	■ THE BASE PRICE FOR A 2007 FORD CROWN VICTORIA STANDARD WAS \$24,620.
■ HEINZ CATSUP COST \$0.19.	■ HEINZ CATSUP COST \$1.99.
■ 8-TRACK TAPES WERE \$5.	■ CDs ARE OVER \$20.

The Rise and Fall of the Coal Industry in the United Kingdom

Although there is evidence of mining in Britain dating back to the Stone Age, the prevalence of wood and charcoal as a fuel source delayed the onset of coal mining. It is widely believed that the Romans began the first commercial scale coal mining, but coal mining did not become established until the 16th and 17th centuries (Younger 2002).

As early as the late 13th century, warnings against the use of coal were issued in London due to the sulphurous smell when it was burnt. It is said that Queen Elizabeth made a concerted effort to avoid London's smog (Doyle 2005). The smog resulting from burning of coal killed many residents of London before and during the industrial revolution. Thick smog in 1880 killed two thousand people in a single week.

Evidence of the first coal mining shows exploitation of coal exposed on riverbanks and on hillsides. One modern mine in the

Durham coalfield encountered coal seams that had been mined out previously, presumably by the Roman invaders (Doyle 2005).

Early coal mining was performed using the bell pit to access near-surface coal seams. Miners would dig a vertical shaft to reach the coal seam, and then dig away from the shaft with no supports until the pit became too unstable or collapsed. Evidence of bell pits dates back to the 13th century. The coal was removed with buckets, similar to a well, as portrayed in Figure 1. This mining method continued through the early 1700s. With the advent of bell pit mining, the export of coal from the River Tyne to London began.

By 1700, two-thirds of the national output of coal was mined from the Tyne and Wear Valleys, part of the Great Northern Coalfield, which consisted of the Durham and Northumberland Coalfields (Figure 2). These coal fields were the greatest producers of British coal and fueled not only the industrial revolution in Britain, but also technological developments in coal mining. The national annual production of coal in 1700 is estimated at 2.6 million tons. The shafts from which coal was mined in this era were 7 feet to 8 feet in diameter and up to 360 feet deep (Fretwell 2004).

The Great Northern Coalfield

Consisting of the coal fields of County Durham and Northumberland, the Great Northern Coalfield was the first to be commercially exploited due to its maritime links with London and other large European cities. The geology and geography of the region have allowed extensive early mining of coal. The coal measures in most of the Great Northern Coalfield were accessible for several centuries before dewatering technology was developed. In the

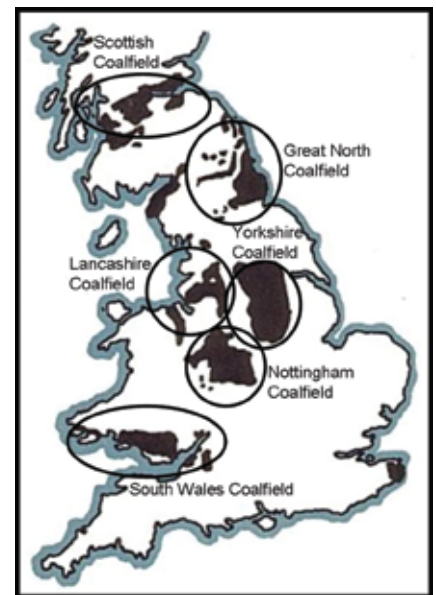


Figure 2. Location of British coalfields.

south and east of the Durham coalfield, the Coal Measures are overlain by Permian carbonates, often referred to as the magnesian limestone. For many years, it was in doubt as to whether coal would be found beneath the limestone and, until steam engines for dewatering were developed, whether shafts could be sunk through the water bearing limestone (Doyle 2005).

As early as 1325, there are records of coal export from the Tyne to France. By the peak of production from the Great Northern Coalfield in 1913, coal from the region was fueling cities and transportation industries across Europe. In 1913, over 56 million tons of saleable coal was produced from the coalfield with nearly 200,000 men employed by the mines (Fretwell 2004).

World War I began the downturn of the coal mining industry in Northern England. The raging war effectively cut off Northumberland and Durham's export markets and many miners lost work in the mines. The conditions of the Treaty of

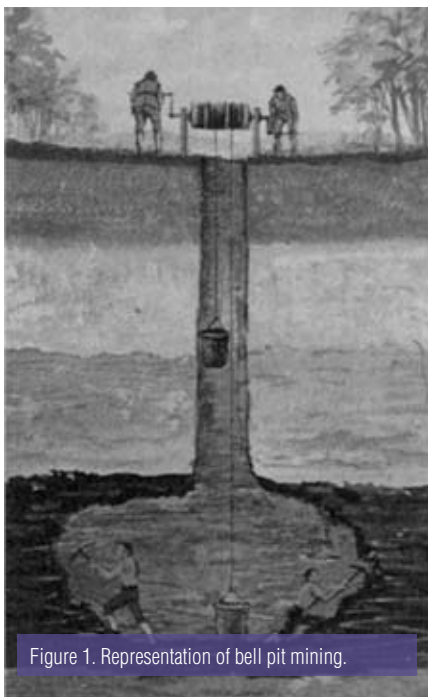


Figure 1. Representation of bell pit mining.

Versailles in 1919 led to further downfall of the Northern industry – Germany was made to make coal reparations to France, Belgium and Italy. The treaty also stated that Germany was not only to forfeit all large merchant ships and many fishing vessels, but also to begin construction of new shipping for the Allies for bare minimum of expense. The shipyards and collieries of Northern England could not compete with the slave wages paid the German employees leading to massive layoffs and a severe depression. Despite an increase in demand for British coal during World War II, the fate of the Great Northern Coalfield was clear and production never again reached the levels of 1913 (Fretwell 2004).

The last deep colliery in County Durham, Wearmouth Colliery was closed in December 1992 and the last deep colliery in Northumberland, Ellington Colliery, was closed in January 2005 (Figure 3). These closures ended an era of coal mining in the northeast of England.

The Yorkshire Coalfield

Mining in Yorkshire dates back thousands of years because the Coal Measures are relatively shallow. Despite the long history of mining in Yorkshire, most of the large collieries were sunk in the late 18th and early 19th centuries. Caphouse Colliery, now the site of the National Coal Mining Museum of England, is shown on plans dating back to the 1780s. This may be the oldest operational shaft in England. Caphouse Colliery was closed as a stand-alone coal mine in 1985 and subsequently it was converted to an underground museum (Figure 4, Foster 2005).

Woolley and Denby Grange Collieries were opened around 1950 and, together with the two shafts on the Caphouse

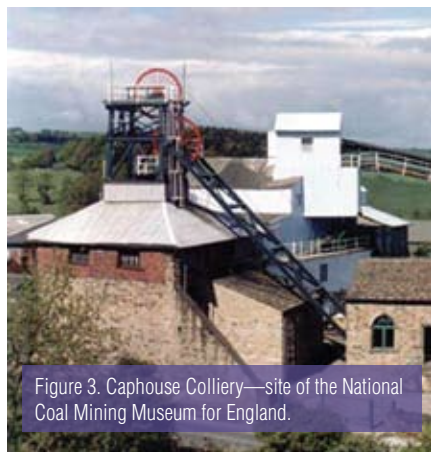


Figure 3. Caphouse Colliery—site of the National Coal Mining Museum for England.



Figure 4. The last shift of miners leaving Ellington Colliery before closure in 2005 (photo courtesy of A. Doyle).

Colliery site, became part of one of the most productive complexes of Yorkshire mines. In the 1980s, production from the four shafts on the Woolley site totaled to about 13,000 tons of coal per week. Woolley Colliery was closed in 1987 (Glyn 1997).

After the mining strikes of the mid-1980s, Denby Grange, Caphouse and Bulcliffe Wood Collieries combined to form Denby Grange Colliery. This amalgamation of three collieries closed in 1991.

Technological Development in the Coal Fields of Britain

Transportation

In order to expand the export and haulage of coal from the Great Northern Coalfield, the steam locomotive was developed. In 1830, worldwide, there were no more than a few dozen miles of railroad.

By 1850, this had increased to over 23,500 miles of railway. This technology allowed coal and goods to be transported nationally and allowed ships to travel to the far reaches of the globe. Coal had become not just the fuel of the nation's homes, but the fuel of an empire (Doyle 2005).

Dewatering

Limitations on the depth and location of shafts were often due to water in the mine. Dewatering technology advanced as the need for deeper shafts in wetter environs increased.

One of the original dewatering methods was simple bailing or "winding water" out of bell pits and shallow workings above the local water table using buckets. As mining progressed below the water table, bailing was used on a larger scale to haul water to surface using "kibbles," essentially large buckets. Winding water using kibbles was

Figure 5. An early example of a Davy Lamp.



advent of steam power. They were usually powered first by horse gins then, later, by water. By the 1600s, evidence exists of rag-and-chain pumps for dewatering. These “drew water up a standing wooden pipe by means of discs mounted on a continuous chain” (Clavering 1994). Water was diverted, sometimes from several kilometers away, to power the pumps. By the mid-1700s, reciprocating engines had widely replaced rag-and-chain pumps. Despite the advent of steam power, many of these continued to be powered by water well into the 20th century (Younger 2004).

In 1712, the Newcomen engine, a steam-powered atmospheric pumping engine, was first introduced to the collieries marking a new era in dewatering technology. The Newcomen engine was used widely for dewatering for nearly 80 years until the Cornish pumping engine, developed by John Watt, was introduced. The Cornish pumping engine was a steam-powered dewatering engine that improved upon the Newcomen engine design by separating the cooling/condensing step from the main piston chamber. This reduced

power usage and created a smoother piston movement compared to the relatively jerky motion of the Newcomen engine.

Safety

The extent of industrialization in the northern coal fields of Britain led to a large number of worker injuries over time, which gradually resulted in developments of mine worker safety. In 1816 the first Davy lamp was tested underground at Hebburn Colliery (Figure 5). In 1881, the first breathing apparatus was used underground. The safety helmet, however, was not introduced to underground mining in Britain until 1930 (Fretwell 2004).

Nationalization of the Coal Mines

On Jan. 1, 1947, all privately owned coal mines were nationalized in an attempt to relieve the post-war financial pressures. At nationalization, the workforce in the coal mines totaled 718,400 men and 21,000 pit

ponies at 980 pits. Unfortunately, the economic downfall of the British coal mining industry could not be staved off by nationalization and by 1958, an average of 34 pits were being closed each year. By 1992, only 50 pits employing less than 50,000 men remained open. The last underground pit in the North was closed in early 2005; a few collieries in the Midlands and South Wales are all that remain of the industry that built the British Empire.

The Longevity of Mine Water Pollution

With the long history of mining in Britain comes a long environmental legacy (Figure 6). Although the coal fields of Britain have been mined for many centuries, most of the recorded discharges are from more modern mines. These mines have a recorded life of up to two centuries, but most have not been abandoned until the 20th century.

There are both time-dependant and time-independent factors that affect the longevity of mine water pollution. The key time-independent factors are lithological setting and extent of workings. Strata associated with marine environments tend to contain pyrite in the more oxidizable

Figure 6. Ferrous ochre at Shilbottle.



calculated to only be able to manage about 2 liters to 3 liters per second of inflow into the mine (Younger 2004).

Drainage adits for coal mines dating back to the Roman times have been discovered in Britain during the development of modern open pit mines. Drainage adits were essentially mine roadways that sloped away from the workings to the surface and used gravity flow to under drain the mine. In Cornwall, the Great County Adit and its tributaries totaled to about 55 kilometers (34 miles) of underground roadways that under drained over 33 km² (13 mi²) of mine workings. Although most of the mines drained by this adit have been closed for over a century, it still intercepts about half of the precipitation falling on the overlying ground surface and is a major element of the area's groundwater system (Younger 2004).

The earliest pumps used in dewatering of mines were developed before the

TABLE 1. SELECTED DISCHARGES AND SEEPS IN COUNTY DURHAM, YORKSHIRE AND NORTHUMBERLAND – MINING HISTORY AND DRAINAGE TYPE (ADAPTED FROM YOUNGER 2002).

COLLIERY	LOCATION	START OF MINING	ABANDON-MENT	TYPE OF DISCHARGE
ST HELEN AUCKLAND	SOUTH DURHAM	1831	1926	NET-ALKALINE DEEP-MINE SHAFT OVERFLOW
BOWDEN CLOSE	WEST DURHAM	1845	1960S	ACID SPOIL LEACHATE OR DRIFT MINE DRAINAGE
MORRISON BUSTY	NORTHWEST DURHAM	1927	1974	ACIDIC SPOIL HEAP LEACHATE
SHILBOTTLE	NORTHUMBERLAND	1882	1982	ACIDIC SPOIL HEAP LEACHATE
WOOLLEY	YORKSHIRE	1850	1987	ALKALINE-PUMPED DEEP MINE WATER
CAPHOUSE COLLIERY/ HOPE PIT	YORKSHIRE	1780S	1985	ALKALINE-PUMPED DEEP MINE WATER

framboidal form when compared with strata associated with freshwater depositional environments. Larger mines have greater surface areas available for oxidation and thus pollution production. Time-dependant factors include the transition from juvenile acidity to vestigial acidity, carbonate dissolution, and changes in water flow rate (Wood et al. 1999). The shift from juvenile acidity to vestigial acidity is based on the observation that the first flush of highly polluted water upon flooding of an abandoned mine is due to the dissolution of efflorescent salts. When these so-called acid generating salts are exhausted, quality of discharges tend to improve and reach a long-term baseline level – the decline from the initial highly polluted levels to the lower baseline contaminant levels marks the shift from juvenile to vestigial acidity (Younger and Banwart 2002). Carbonate dissolution can act to buffer acid produced through mineral oxidation; this process occurs at a faster rate than pyrite oxidation and, therefore, the supply of carbonates may be exhausted before that of acid-producing minerals. Changes

in flow rates through the mine will result in either the concentration or dilution of pollutants in the resulting discharge.

In County Durham, Yorkshire and Northumberland, there are a variety of net acidic and net alkaline drainages. Most of the highly acidic drainages result from spoil piles and shallow drift mines that have passive natural ventilation. Six selected discharges from the area show some of the variation in mining history, discharge quality, and longevity of drainage (Tables 1 and 2). These sites show the trend found in much of the U.K. of alkaline deep mine drainages and acidic shallow mine and spoil pile drainages. These sites are all treated by passive systems constructed by the Coal Authority, Northumberland County Council, Durham County Council or Newcastle University.

Analyses of drainages in Scotland are available for comparison with the age of the drainage (Table 3). The six sites described here are all abandoned, flooded deep mines with no ventilation – the trends shown in these sites do not apply to drift mines, shallow shaft mines or spoil heaps there passive ventilation will cause different trends. Due

to local geology, water pH of the drainages are all circum-neutral and they are all net alkaline. The discharges were observed to reach this circum-neutral state within about 30 years and have high alkalinities for about 25 years. The availability of alkalinity-producing materials is likely caused by the practice in Scottish deep mines of spreading the walls of a deep mine with lime slurry to prevent

ignition of coal dust. Long-term trends in iron and sulphate concentrations are likely related to the rate of groundwater rebound within the mine (Wood et al. 1999).

Post-Mining Site Management

Since most British mines were closed after nationalization, the government holds the responsibility for post-closure remediation. This responsibility is shared between several government agencies including the Environment Agency and the Coal Authority. As more is learned about the nature and longevity of mine water resulting from abandoned underground mines, a holistic method of treatment is becoming more common (Younger 2000).

Mining in the coal fields of Britain has spanned many centuries; even the most modern mines were usually highly interconnected with mines of many eras. In order to continue mining until final coal-field closure, large dewatering schemes were undertaken. In County Durham, the dewatering program of the late 1980s and early 1990s cost £2 million annually. Once the pumps were withdrawn, the mines flooded until the water reached a decanting

level and discharged into surface waters impacting the ecological status of the receiving water (Younger and Sherwood 1993).

Many remediation projects are being undertaken by several authorities and all attempts are made to use passive treatment methods. The HERO (Hydrogeochemical Engineering Research and Outreach) group at Newcastle University has been at the forefront of pas-

TABLE 2. QUALITY OF DISCHARGES FROM SELECTED MINES AND SPOIL PILES IN COUNTY DURHAM, YORKSHIRE AND NORTHUMBERLAND

COLLIERY	PH	ALKALINITY (MG/L CaCO ₃)	ACIDITY (MG/L CaCO ₃)	TOTAL IRON (MG/L)	MN (MG/L)	AL (MG/L)	SULPHATE (MG/L)	SOURCE
ST HELEN AUCKLAND	6.3	500	0	3				YOUNGER 2000
BOWDEN CLOSE	5.0	4	100	20	1.5	8	416	YOUNGER 2000
MORRISON BUSTY	4.5	53	300	10	1	53	631	YOUNGER 2000
SHILBOTTLE	3.5	0	6000	1100	300	700	15000	YOUNGER ET AL. 2006
WOOLLEY	7.5	716	0	3	1	<0.1	722	FOSTER 2005
CAPHOUSE COLLIERY	6.9	362	0	16	1	<0.1	1147	FOSTER 2005

TABLE 3. LONGEVITY OF DISCHARGES FROM ABANDONED UNDERGROUND MINES IN SCOTLAND

(ADAPTED FROM WOOD ET AL. 1999).

DISCHARGE	AGE (YEARS)	FLOW RATE (L/S)	PH	ALKALINITY (MG/L CaCO ₃)	ACIDITY (MG/L CaCO ₃)	TOTAL FE (MG/L)	AL (MG/L)	MN (MG/L)
BLACKWOOD	117	3	7.2	265	3	0.7	0.2	0.3
STAR ROAD	106	3	6.5	173	10	4.0	0.2	0.5
LATHALLAN MILL	100	16	6.1	182	21	10.8	0.1	0.7
ELGINHAUGH	35	55	5.7	207	192	92.8	0.6	11.5
CAIRNHILL	20	1	7.6	80	27	6.7	1.1	4.0
PENNYVENIE #3	18	6	6.9	854	2	0.3	0.2	0.5

Figure 7. Wetlands at Morrison Busty.



approximately 180-meter-long trench filled with 25 percent horse manure, 25 percent green compost and 50 percent limestone gravel. The effluent from the PRB enters a series of three settling ponds before a final polishing reed bed before discharging into the Tyelaw Burn (Younger et al. 2006).

By contrast, Figure 9 shows the reedbeds constructed in conjunction with Durham County Council to treat the net alkaline drainage from a deep mine shaft overflow at St. Helens Auckland. The reedbeds were constructed in 1999 and continue to remove metals and remediate the high flow discharge.

As more European coal fields are closed, pressure mounts to continue development of low-cost, effective treatment systems. With the rapid closure of British mines after nationalization, the social and environmental legacy of the British mining industry is clear. Both universities and government agencies continue to tackle the seemingly insurmountable environmental problem resulting from mine abandonment, while

sive treatment in Europe. Two examples of treatment systems constructed by the HERO group in the northeast of England are presented here.

In 1995, a pilot scale wetland installed at Morrison Busty (Quaking Houses) in County Durham was the first application of its kind in Europe (Figure 7). In 1997, this was scaled up to a full-scale treatment system treating the drainage from the spoil tip from the abandoned Morrison Busty Colliery (Jarvis and Younger 1999). The system of two wetlands in series cost less than £20 thousand to install and has consistently removed high levels of metals and acidity from the water before discharging into the Stanley Burn. Before the treatment wetlands were constructed, the highly acidic drainage from the spoil tip created a streambed with red and white striped bands of precipitates, known locally as the 'Sunderland Scarf' in relation to a local football team whose fans wear red and white striped scarves to matches.

Shilbottle in Northumberland is perhaps one of the most severe examples of discharge from a spoil heap in Britain; the

highly acidic, metal rich drainage emptied into the Tyelaw Burn (Figure 6). Newcastle University installed a permeable reactive barrier (PRB) and settling ponds to treat the leachate from the spoil pile at Shilbottle (Figure 8). The PRB is constructed as an



Figure 8. Settling ponds at Shilbottle



Figure 9. Reed beds at St. Helens Auckland.

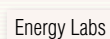
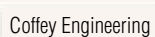
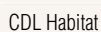
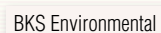
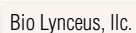
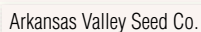
towns and villages that relied solely on mining for their livelihood continue to adapt to post-mining struggles.

Literature Cited:

- Clavering, E. (1994), *Coalmills in Tyne and Wear Collieries: the use of the waterwheel for mine drainage 1600-1750*, *Bulletin of the Peak District Mines Historical Society*, 12, 124-132.
- Doyle, A. (2005), *The Great Northern Coalfield: Mining Collections at Beamish Museum*, Northumbria University Press, Newcastle Upon Tyne.
- Foster, S. M. (2005), *Integrated Water Management in Former Coal Mining Regions: Guidance to Support Strategic Planning*, Mineral Industry Research Organization, Leeds.
- Fretwell, E. T. (2004), *Coal Mining - a general history - Timeline*, in *Durham Miner Project*, edited, Durham, England.
- Glyn, A. (1997), *The economic case against pit closures*, in *The Mining Industry*, edited by T. Boyns, I.B. Tauris Publishers, London.
- Jarvis, A. P., and P. L. Younger (1999), *Design, Construction, and Performance of a Full-Scale Compost Wetland for Mine-Spoil Drainage Treatment at Quaking Houses*, *Journal of the Chartered Institution of Water and Environmental Management*, 13, 313-318.
- Wood, S. C., et al. (1999), *Long-term changes in the quality of polluted minewater discharges from abandoned underground coal workings in Scotland*, *Q. J. Eng. Geol.*, 32, 69-79.
- Younger, P. L. (2000), *Holistic remedial strategies for short- and long-term water pollution from abandoned mines*, *Trans. Instn Min. Metall. (Sect A: Min. technol.)*, 109, A210-A218.
- Younger, P. L. (2002), *Coalfield closure and the water environment in Europe*, *Trans. Instn Min. Metall. (Sect A: Min. Technol.)*, 111, A201-A209.
- Younger, P. L. (2004), *'Making Water': the hydrogeological adventures of Britain's early mining engineers*, in *200 Years of British Hydrogeology*, edited by J. D. Mather, Geological Society Special Publications, London.
- Younger, P. L., and S. Banwart (2002), *Time-scale issues in the remediation of pervasively contaminated groundwaters at abandoned mine sites*, in *Groundwater Quality: Natural and Enhanced Restoration of Groundwater Pollution*, edited by S. E. Oswald and S. F. Thornton, pp. 585-591, International Association of Hydrological Sciences, Wallingford (UK).
- Younger, P. L., et al. (2006), *Coal Mine Sites for Targeted Remediation Research: The CoSTaR Initiative*, 4 pp, Newcastle Upon Tyne.
- Younger, P. L., and J. M. Sherwood (1993), *The Cost of Decommissioning a Coalfield: Potential Environmental Problems in County Durham*, *Mineral Planning*, 57, 26-29. ■



American Excelsior Company





Environmental Solutions



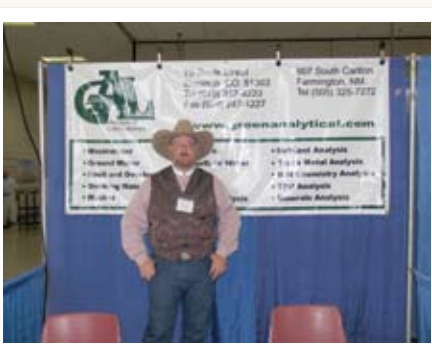
Environmental Products



Forest Concepts



Granite Seed



Green Analytical Labs



Intermountain Labs



JRW Bio Remediation



Knight Technologies



Nilex



Norwest



O'Kane



OSM



Pawnee Butte Seed



Rain For Rent



Rio Tinto



Rocky Mountain Bio Products



Rocky Mountain Reclamation



SIU Coal Research Center



Southern Illinois University



Terex



Truax Equipment



Western States Reclamation Inc.



Wind River Seed



WY Resources

Can Surface Mine Reclamation Help to Restore American Chestnut?



Figure 1. Loggers take a break from their work to pose inside this massive American chestnut.

Mighty Giants

The forests of eastern North America were once home to the American chestnut (*Castanea dentata* [Marsh.] Borkh.), a hardwood species so large that it came to be known as the “Redwood of the East.” These giants averaged nearly five feet in diameter, and attained heights greater than 100 feet tall. Many, however, were much larger (Figure 1). The largest reported chestnut was found in Francis Cove, N. C., and was measured at 17 feet in diameter. So dominant was this tree that it grew in pure stands up to 100 acres, numbered in the billions, and accounted for nearly one out of every four trees throughout its range. Of the seven or so chestnut species worldwide, American chestnut was by far the best timber producer. They grew straight, fast, and often produced three or four 16-foot logs before the first branch was reached. Chestnut timber was prized due to its straightness, beauty, workability, and resistance to rot, even when in contact with soil. These characteristics made it useful for fence posts, railroad ties, telegraph poles, and building construction, as well as furniture and musical instruments. So numerous were its uses, that it has been referred to as a “cradle to the grave” species, because one’s crib and casket might both have been constructed from chestnut wood.

As a nut producer, chestnut was unrivalled (Figure 2). Unlike other nut producing trees such as beech and oak which flower early, chestnut flowers in late spring and early summer, when the blooms are in no danger from frost, so every year



Figure 2. Harvested chestnuts and their protective burs. The burs are a defensive adaptation that prevents most animals from accessing the nuts before they ripen.

a disease which was previously unknown to him. Chestnut blight is a disease caused by a fungus, *Cryphonectria parasitica*, originating in Asia, and likely coming to America on infected Japanese chestnut (*Castanea crenata*) seedlings. It was spread through the forests by wind, insects, and animals, including humans. Traveling about 50 miles each year, the blight left decimated chestnut trees in its wake (Figure 3). By the 1950s, the entire range of the chestnut had been affected. Approximately four billion trees had perished, nearly one-quarter of the canopy cover of our forests was gone, and we lost an important wildlife and timber tree. Many scientists consider the loss of the American chestnut to be the greatest ecological disaster of the 20th century.

The blight fungus infects American chestnut through wounds in the bark. The pathogen then grows in the bark and attacks the vascular tissues of the tree, creating a canker which effectively cuts off circulation to the branches above the canker, while leaving the root system alive (Figure 4). It is fortunate that the disease does not attack the roots, for chestnut trees with healthy root systems have the capacity to sprout from the stump (Figure 5). The ability to sprout has enabled American chestnut to persist in eastern forests, but what was once a dominant overstory tree has been reduced to an occasional understory shrub.

the trees produce a nut crop that could be relied upon by humans and wildlife alike. Railroad cars would be loaded with bushels of chestnuts that would be shipped to cities so that pedestrians could purchase freshly roasted chestnuts from street vendors. Families living within the chestnut range would gather nuts and store them for consumption throughout the winter. Farmers would turn their hogs loose in the hills so they could fatten up on the chestnut crop, which not only added to their weight, but also lent the pork a sweeter flavor. Virtually everyone in Appalachia, the heart of the

chestnuts range, has a story about this once mighty tree. American chestnut was so universally known and loved, that more than 900 places were named after chestnut (e.g. Chestnut Ridge, Chestnut Run, Chestnut Church, etc.) in its natural range, and this does not even include the numerous Chestnut Streets found throughout the United States.

Disaster Strikes

In 1904, a forester at the New York Zoological Park noticed that some of the chestnuts on the grounds were dying from



Figure 3. A pure stand of chestnut completely killed by the chestnut blight.



Figure 4. A blight-induced canker on an American chestnut.



Figure 5. A blighted American chestnut with stump sprouts.

“There’s Hope”

Since 1983, employees and members of The American Chestnut Foundation (TACF) have taken on the task of restoring this once dominant tree throughout its native range. By crossing the few surviving American chestnuts that reach the flowering stage with blight-resistant Asiatic chestnuts, TACF is creating a population of trees that will fill the void in our forests that was created by the loss of American chestnut.

By conducting controlled pollinations through a series of crosses, backcrosses, and intercrosses, TACF is producing backcross chestnuts that incorporate Asiatic chestnuts’ blight resistance, while retaining the desirable timber and nut producing characteristics of the American chestnut (Figure 6). Asiatic chestnuts are multi-stemmed and do not grow as large as the American chestnut. Essentially, TACF would like to breed all Asian chestnut characteristics out of its backcross trees, with the exception of blight resistance. Each family line within a generation is selected for blight resistance by inoculating the trees with strains of the blight fungus and only using those that show high levels of resistance during successive stages of crossing. In this manner, TACF is currently producing trees that are approximately fifteen-sixteenths American chestnut in characteristic and one-sixteenth Chinese chestnut. TACF hopes to begin widespread testing of their final product around 2010.



Arkansas Valley Seed

RELIABLE BRAND SERVICE

*Supplying QUALITY Seed
With INTEGRITY Since 1945*

***Rabbit Ears Brand**
Native Grasses, Wildflowers & Shrubs
***Wide Selection of Site-Specific
Ecotype Species**
***Temporary Cover Crops &
Erosion Control Blankets**
***Custom Mixing to Your
Specification Our Specialty**

**4625 Colorado Blvd
Denver, CO 80216**
Toll-Free 877-95-SEEDS
Proud Member of the
American Society of Mining and Reclamation

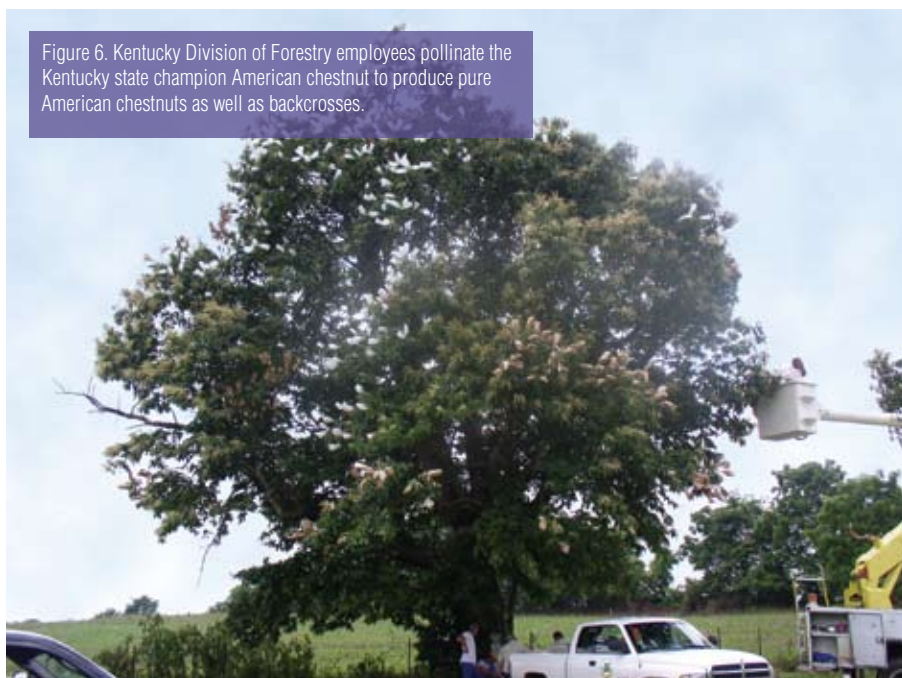


Figure 6. Kentucky Division of Forestry employees pollinate the Kentucky state champion American chestnut to produce pure American chestnuts as well as backcrosses.



Figure 7. Chestnuts planted in mine spoils in Kentucky.

A Tale of Two Pathogens

While the blight was decimating chestnut from the north, a second, lesser known disease had already been killing chestnuts in its southern range. That disease, a *Phytophthora* root rot known as “ink disease” or “ink stain disease” due to the black lesions on the roots and stems of infected trees, likely played a role in the rapid decline of the American chestnut and may influence future stands. Whereas chestnut blight is a canker disease that leaves the tree with a functioning root system, *Phytophthora* attacks the roots, killing the entire tree and rendering it unable to sprout. *Phytophthora* species are classified as water molds and favor poorly drained soils. While TACF has been aggressively breeding against the blight, breeding and screening TACF family lines for *Phytophthora* resistance is still in its early stages, and represents the next hurdle for TACF restoration efforts.

Surface Mines as Springboards for Restoration

The use of reclaimed surface mines for chestnut reestablishment has recently gained attention and there are numerous reasons for planting chestnuts on fresh mine spoils. First, loose mine spoils

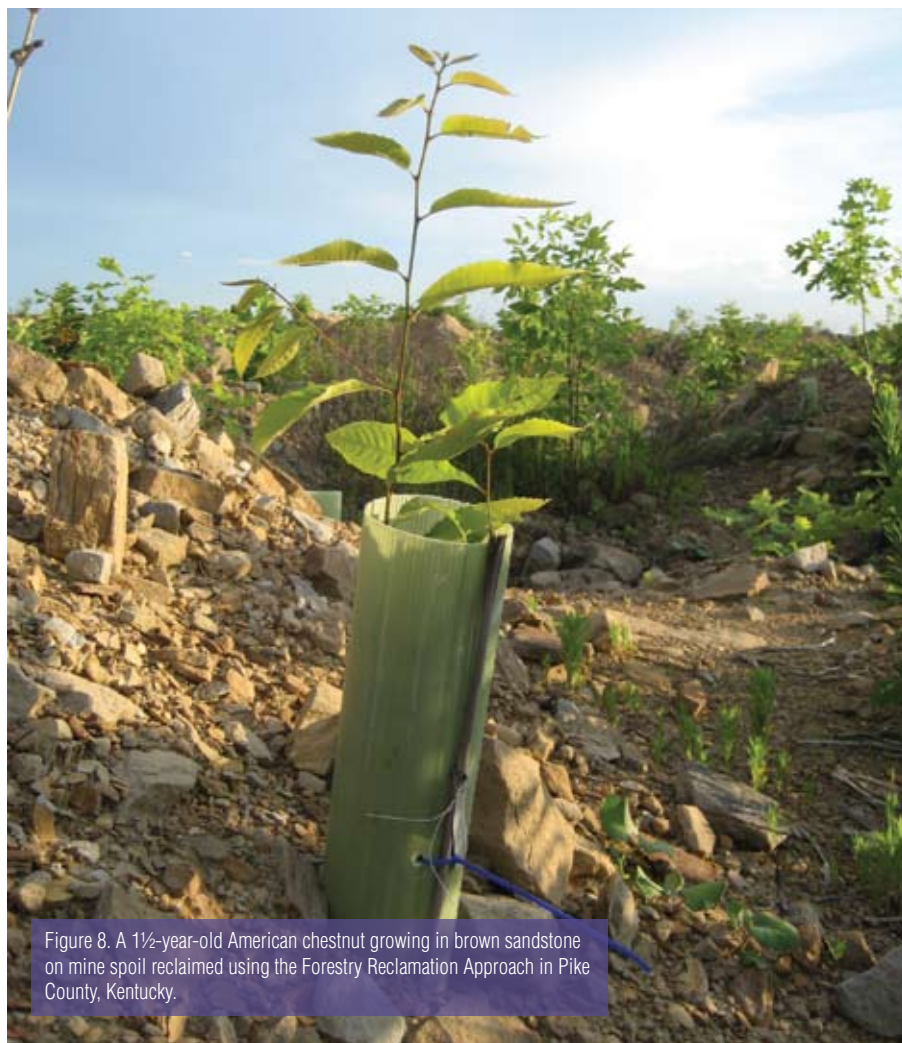


Figure 8. A 1½-year-old American chestnut growing in brown sandstone on mine spoil reclaimed using the Forestry Reclamation Approach in Pike County, Kentucky.

reclaimed using the Forestry Reclamation Approach (<http://arri.osmre.gov/fra.htm>) have shown good growth and high survival rates for other native Appalachian hardwood species and may also be suitable for chestnuts. Second, many surface mines exhibit light and soil chemical characteristics that are similar to higher elevation and ridge top positions where chestnuts were formerly dominant. Third, loose mine spoils are initially devoid of vegetative competition, a hindrance to many reforestation efforts. Fourth, fresh mine spoils may initially be devoid of pathogenic microbial communities such as *Phytophthora*, which have hindered TACF's breeding and restoration efforts elsewhere, especially in the warm southern Appalachians. Moreover, loose mine spoils are well-drained, which may hinder establishment of *Phytophthora*. Lastly, the Appalachian coal region falls almost entirely within the natural distribution of American chestnut. If loose mine spoils prove conducive to chestnut survival and growth, then the establishment and dispersal from founder populations of blight-resistant hybrids throughout the range of the Appalachian coal region would aid TACF's goal of restoring the chestnut throughout its range.

In anticipation of the release of the blight-resistant backcrosses, research efforts are underway to evaluate the suitability of loose mine spoils in the Appalachian coal region for chestnut establishment. Pure American chestnuts and excess TACF backcross seedlings are being grown at the Bent Mountain Mine (Appalachian Fuels) in Pike County, Ky., to serve as proxies for the true-breeding blight-resistant backcrosses which are not yet being produced in sufficient numbers for widespread testing. We have planted container-grown seedlings into three types of spoil material to determine which parent material fosters the best growth and survival (Figure 7). The three spoil types are: weathered brown sandstone, unweathered gray sandstone, and a mixture of shale and brown and gray sandstones (mine-run spoil). Seedlings are measured for height and diameter growth, and causes of mortality are being assessed. After one growing season, survival was high on all spoil types, with the lowest around 80 percent on the brown sandstone plots (Table 1). The three different spoil types are also being baited for *Phytophthora* to see if it can establish on these sites. Thus far, *Phytophthora* has not been detected,

TABLE 1. AVERAGE HEIGHT, DIAMETER AND SURVIVAL OF AMERICAN CHESTNUT SEEDLINGS ON DIFFERING MINE SPOILS.			
	HEIGHT (CM)	AVG DIA. (MM)	SURVIVAL (%)
MIXED SANDSTONE AND SHALE	25.5 A†	4.5 A	100 A
UN-WEATHERED GRAY SANDSTONE	24.0 A	4.5 A	93 AB
WEATHERED BROWN SANDSTONE	27.1 A	4.5 A	80 B
† VALUES FOLLOWED BY THE SAME LETTER WITHIN A COLUMN ARE NOT STATISTICALLY SIGNIFICANT AT P=0.05 LEVEL.			



Figure 9. A germinated chestnut ready for direct seeding. Chestnuts generally do best when direct-seeded but sufficient measures must be taken to ensure that the nuts are not eaten by rodents.

TABLE 2. GROWTH AND SURVIVAL OF AMERICAN CHESTNUT SEEDLINGS BY PLANTING TECHNIQUE				
	HEIGHT (CM)	DIAMETER (MM)	SURVIVAL (%)	STRESS IND. (%)
CONTAINERIZED TRANSPLANTS	29.2 A†	3.8 A	80 A	40 A
DIRECT-SEEDED	33.5 A	3.6 A	80 A	6 B
† VALUES FOLLOWED BY THE SAME LETTER WITHIN A COLUMN ARE NOT STATISTICALLY SIGNIFICANT AT P=0.05 LEVEL.				

and chestnuts have shown good growth in all spoil types (Figure 8).

A second study is aimed at determining the best way to establish *Phytophthora*-free plantings. Most operationally planted reclamation projects use dormant, bareroot nursery stock. However, *Phytophthora* are present in the soil at many nurseries and may be transported to planting sites on the roots of seedlings. Chestnuts can be established from seed on the mine site to avoid *Phytophthora* contamination, but rodent predation of the seeds can be as detrimental to survival as *Phytophthora* (Fig. 9). As such, different planting techniques are being evaluated. Twenty-four plots were established to test growth and survival of direct-seeded chestnuts versus those that were transplanted from containers. All seed and seedlings were protected from herbivory

by 15-inch tree shelters that were staked to the ground. Preliminary findings show no significant differences between the two planting techniques in terms of height, diameter or survival. Survival after one growing season is approximately 80 percent for both planting treatments, however, indicators of stress (i.e. formation of a second leader, multiple stems, and blight infection) were higher on transplanted seedlings than those that were direct-seeded (40 percent vs. 6 percent) (Table 2).

These studies and others by our group will continue and the results will hopefully guide restoration efforts of this important tree. For more information on American chestnut restoration, visit www.acf.org and www.bae.uky.edu/UKReclamation. ■

Index to Advertisers

Aqua-Fix System	IBC
Arkansas Valley Seed	26
Biomost, Inc.	OBC
BKS Environmental	3
Brockton Equipment	IFC
California Straw Works	IFC
Caudill Seed	IFC
Ernst Conservation Seed	OBC
Northern Analytical Lab	2
PHC Reclamation, Inc.	3
Skelly & Loy Inc.	2

Reclaim Mine Lands With Switchgrass!!

Can your mine lands benefit?

- A stand of switchgrass can provide 15+ years of renewable resource.
- Switchgrass is capable of sequestering carbon in soil.
- Switchgrass is an excellent source of renewable energy.
- Switchgrass provides wildlife habitat.
- Switchgrass can be used for grazing.



Call us!
800-873-3321
www.ernstseed.com
ernst@ernstseed.com

ERNST CONSERVATION SEEDS

AQUAFIX

Water Treatment Systems

Treat Acid Mine Drainage Continuously, without Power!



Don't get eaten alive by the cost of treating acid mine drainage. Treat streams with Aquafix, an ingenious device that uses water power to continuously apply dry chemicals to flowing water.

Minimize Labor costs.
Treat water more effectively.
Treat water continuously
with Aquafix.
Write or call for full details.

(304) 329-1056
 (304) 329-1217 FAX
mjj@aquafix.com

www.aquafix.com

mining & reclamation services

Dents Run Site 3895 - Phase 1
Complete Design & Permitting Services
for the US Army Corps of Engineers



PHASE 1 WATER QUALITY

Point	pH	Acid (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	D. Al (mg/L)	SO ₄ (mg/L)
Raw	2.6	1600	375	16	125	2300
Final	6.8	-34	2	10	2	1258

Phase 2 Design Approved
Construction to begin Fall 2007

COMPREHENSIVE MINE **DRAINAGE SERVICES**

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

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

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



RESTORED TREATMENT MEDIA

Manganese Resource Recovery
Sustainable technology development

BioMost, Inc.