

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation *matters*



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ASMR Award and Scholarship Winners
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Bolstering the Society

Dennis Neuman, President

Thanks for electing me president of the Society. I pledge to work closely with the National Executive Committee (NEC) members and with the executive secretary, Dick Barnhisel. The NEC is meeting every two months and has established a significant agenda to accomplish this year. There are several new and exciting initiatives that will energize the Society.

First of all the Society's mission statement is being revised to make sure it accurately represents and defines us. This updated mission statement will be part of the of newly printed tri-fold brochure that is circulated at professional meetings and university campuses. The brochure also contains the Society's history, membership information, and presents the benefits of belonging to ASMR.

The Society's web page is due for an up-

date and the NEC is exploring several options that will bring new ways Society members can communicate. Submitting abstracts, peer review of draft papers, and placing final papers into the annual meeting proceedings are some functions under consideration.

The Society has formed a new assemblage, tentatively called the Young Professional Group (YPG). An ad hoc committee of Abbey Wick, Matt Owens, Chris Johnson and Caley Gasch-Salava developed the goals of this new group:

- To provide insight on career advancement and benefits of being a member of ASMR. A YPG column will regularly appear in *Reclamation Matters*.
- To create networking opportunities. The YPG will sponsor social events at meetings – the first to be held in Pittsburgh

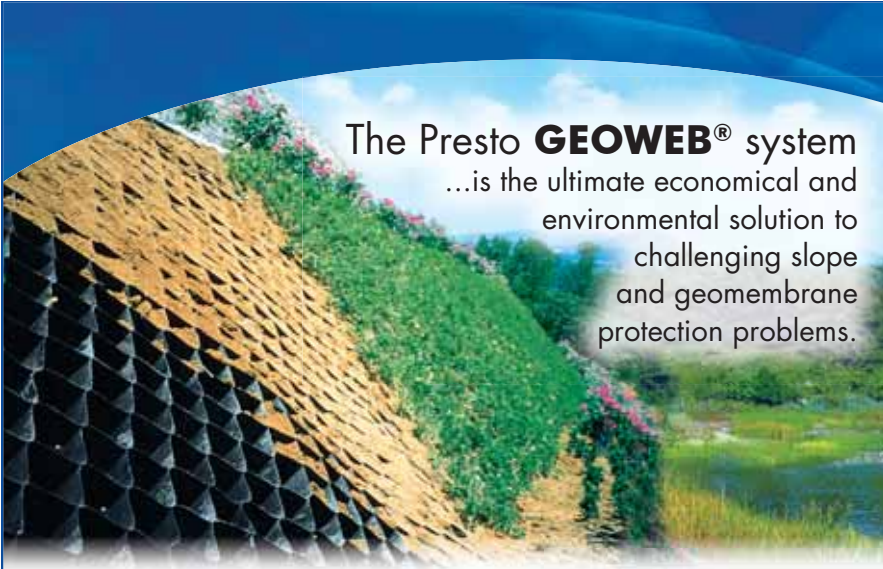


in conjunction with our annual meeting in June 2010.


- To host professional development pre-conference workshops on research and technical paper writing, grant proposal development, field methods, and technological tools.
- To recruit and retain new members by fostering formation of student chapters, internship opportunities and mentoring.

The Society's Student Scholarship Committee will continue to fund student scholarships and to support travel grants to ASMR annual meetings. The NEC is in favor of developing a student research grant program. The Student Scholarship Committee is charged with looking into methods for funding such a program.

I hope you find these initiatives as exciting as I do. Together we can invigorate the Society. To this end I am challenging all members to recruit one, yes just one new member. We all work with colleagues who would benefit from membership in the American Society of Mining and Reclamation. Bolstering our membership is the first and best way of strengthening our Society. ■



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Going Beyond Expectations

Jeff Skousen, West Virginia University



Once a king had a great highway built for the members of his kingdom. After it was completed but before it was opened to the public, the king decided to have a contest. He invited as many as desired to participate. The challenge was to see who could travel the highway best.

On the day of the contest the people came. Some of them had fine chariots and horses, some had beautiful clothing and hairdos, and others brought delicious

food to eat during the trip. A few young men came ready to run the highway and finish first. People traveled the highway all day, but each one, when arriving at the end, complained to the king that there was a large pile of rocks and debris left on the road at one spot and this got in their way and hindered their travel.

At the end of the day, a lone traveler crossed the finish line and walked over to the king. He was tired and dirty, but he addressed the king with great respect and handed him a bag of gold. He explained, "I stopped along the way to clear a pile of rocks and debris that was blocking the road. This bag of gold was under it all. I want you to return it to its rightful owner."

The king said, "You are the rightful owner."

The traveler replied, "Oh no, this is not mine. I have never known such money."

"Oh yes," said the king, "you have earned this gold, for you won my contest. He who travels the road best is he who makes the road smoother for those who will follow."

This well-known story illustrates the in-

fluence of one man's efforts to improve the road for subsequent travelers. This edition of *Reclamation Matters* celebrates individuals who have made extraordinary efforts in reclamation science and who have made it their life's goal to make the road better for those who follow.

The recipients of two of our most prestigious awards are excellent examples of professors and mentors who have paved the way for students to achieve great things. Our other awardee, the Reclamationist of the Year, is responsible for exceptional accomplishments in reclaiming mined land to a higher and better use. The student scholarship winners demonstrate a commitment to academic success and to make reclamation of disturbed lands their life's career and passion. The American Society of Mining and Reclamation has a bright future and we look forward to young professionals of the Society to carry on this rich tradition of going beyond expectations and making the road smoother for those who will follow. ■



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The Next Generation of ASMR

Abbey FosterWick

Lately, I have been thinking a lot about the sustainability of ASMR. I wonder who will be the next generation of people on the National Executive Committee (NEC) and playing active roles in planning annual meetings, presenting papers, and leading field trips. I see a lot of the "older," or perhaps I should say "more established," members serving on committees and going to annual meetings in both the East and the West ... but this devotion to ASMR, in my opinion, is starting to dwindle with the younger generation (I am at fault for this too!). Is it because younger members just don't know how to get more involved? Is it because there isn't the financial support from their companies to attend the meetings? Is it because ASMR isn't geared enough toward younger members and they feel neglected? I don't know all the possible reasons, but I've come to the important realization that we,

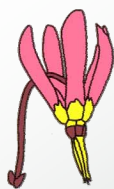
as younger members, really need to start being more involved and active in some way to secure the future of the society.

I brought up this "realization" in the NEC meeting in Billings to see what we could do as a society to solve this problem. At first we laughed at how obvious a realization this was, mainly because most people on the committee and those who plan the meetings have gray hair ... clearly not the "next generation." But these "more established" members are the ones who were instrumental in starting the society, have kept the society running and are some of the best reclamationists and researchers the USA has to offer! A pretty amazing group of people!

After a good laugh about gray hair, we decided the first thing we need to do is define the terms "young" and "next generation." We decided these terms should not be based on an age limit or hair color, but



should define a time in your career. This is much better, especially for those of us who are "graying" at the ripe age of 30! Getting some of us who are just starting our careers involved in the workings of ASMR is critical to the sustainability of the society. Not



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only do we have a lot to contribute because we are either fresh out of school or just fresh in general, we also have a lot to learn from those who are receiving ASMR research and reclamation awards and those who have kept the society running so smoothly. And with that, the "young professionals" group in ASMR got its start.

I quickly grabbed a few of my "younger" colleagues and we worked up some ideas for what we would like to accomplish as a group of "young professionals" to keep the society moving forward to meet career (and social) needs of the next generation. We came up with several goals of this newly formed group:

1) provide **insight** into how being part of ASMR can help young professionals develop their careers,

2) create **networking opportunities** by having a social event at the meetings to form relationships among young professionals,

3) host pre-conference **professional development** workshops on scientific/technical writing, developing innovative management practices and monitoring/sampling techniques based on the countless years of experience currently found in ASMR members, and

4) **recruit and retain** new members by building up student chapters at universities and getting new members involved in the workings of the society. We want to take ASMR to a new era of professionals and to help the society to change with the times.


The response in Billings to the formation of this group was fantastic ... a lot of

ideas out there! To keep getting everyone involved or help you see how you can get involved, we are starting this "young professionals" column in *Reclamation Matters* where we will encourage young professionals to write about how ASMR can benefit them early in their careers (whether it's a student, a person in industry, someone new to an academic career or a regulatory agency). We will also use this column as a way to share ideas and keep us all. Thinking about the development of young professionals in ASMR. Please shoot me an e-mail if you have something you'd like to contribute at afwick@vt.edu. hopefully, by the time we get to the Pittsburgh meeting in 2010, we will all have a better idea of how this society and relationships formed through the society can help us keep ASMR sustainable and reclamation research/practice moving forward. ■



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A Call for Abstracts

Abstracts Due October 19, 2009

Submission details on the Conference website: www.PghMiningReclamationConf.com

Conference Location: Radisson Hotel, Pittsburgh, PA

The American Society of Mining & Reclamation (ASMR), the U.S. Office of Surface Mining Reclamation & Enforcement (OSM), the Pennsylvania Conference on Abandoned Mine Reclamation planning committee, and the Appalachian Regional Reforestation Initiative (ARRI) announce the 2010 Joint Conference entitled, **Bridging Mining Reclamation Science and the Community**. This joint conference is three conferences in one! The idea is to integrate some of the technical and non-technical issues before us with the intention of imparting knowledge, exchanging ideas, and sharing lessons learned—creating bridges.

There will be two types of sessions offered:

Abstract application materials can be found at: www.PghMiningReclamationConf.com.

Technical Sessions

These peer-reviewed presentations, aimed at mining and reclamation specialists, will address existing and emerging technologies. These session presentations are aimed at the information exchange between academic professionals, field practitioners, students, and all other interested persons. Topical areas for oral or poster presentations for the conference are also found on the conference website.

The Science, Community and Reclamation (SCR) Sessions

These presentations, peer-reviewed and/or non-peer reviewed will include a mix of technical and issues-related presentations. These session presentations are geared toward the interests of a broader audience, from community volunteers and the watershed community to professionals in the field. Presentations will cover a wide variety of subject matter relating to the restoration of natural resources impacted by coal mining, the planning process through implementation of mine land reclamation, and reforestation.



CONVENERS: American Society of Mining and Reclamation
PA Abandoned Mine Reclamation Committee
Appalachian Regional Reclamation Initiative
Office of Surface Mining Reclamation and Enforcement

The Program Committee invites submission of abstracts for oral or poster presentations for the Technical and the Science, Community, and Reclamation sessions. ARRI encourages abstract submissions for technical presentations and for presentations describing reforestation practices being used by mining firms, mine planning and permitting for successful reforestation, and other relevant topics. Tentative Workshops and Pre-Conference Field Workshops/Tours are being planned.

The following are potential categories for paper and presentation abstracts. More specific and In-depth topics can be found at: www.PghMiningReclamationConf.com.

Technical Paper Topics

Water Management, Reforestation and Reforestation Practices, Mine Planning and Permitting for Successful Reforestation, Forestry and Wildlife, Refuse and Tailings Management & Reclamation, Geotechnical Engineering, Soils and Overburden, Land Use and Design, Ecological, and Remote Sensing.

Science, Community & Reclamation Presentation Topics

Reclamation Methodologies, Reforestation and Reforestation Reclamation Projects, Policy Changes, Permitting, Legislative Challenges, Prevailing Wage, Sources of Funding, Watershed Group Sustainability, and Developing Partnerships.

Workshop Sessions

Short Courses/Workshops will be presented in the following tentative areas: *Mine Geochemistry; Acid Mine Drainage Treatments; Stream Restoration; Soils Reclamation; Riparian/Wetland; and Coal Mine Reforestation using the Forestry Reclamation Approach.* Proposals for other workshops will be considered.

Field Tours

Potential Pre-/Post Conference activities include five, unique, one- to two-day Field tours, highlighting (1) full-scale implementation of the Forestry Reclamation Approach at a mine site near Cadiz, Ohio; (2) mountaintop mining in Central West Virginia; (3) underground Mine Tour of a nearby active longwall mining operation in the Pittsburgh coal bed; (4) Bennett Branch Watershed Restoration Project, passive treatment system and reforestation at Jennings Environmental Education Center, resource recovery, land reclamation and abandoned mine drainage treatment and elk viewing in the Pennsylvania WILDS; (5) Field Trip to south central PA viewing active and passive mine water treatment sites and the Flight 93 Memorial.

For conference committee contacts and up-to-date conference materials and development, go to:

www.PghMiningReclamationConf.com

For additional information about ASMR go to: www.asmr.us

For additional information about ARRI go to: <http://arri.osmre.gov>

The Appalachian Coal Country Watershed Team

National Service and America's Environmental Challenges

By Jessica Vierling

Coal mining has been ongoing in Appalachia since the first coal seam was discovered in 1750 in Virginia. Mining became a pre-dominant part of the economy of many Appalachian areas in the 1900s, which grew and declined as coal prices boomed and busted. Over time, the coal was mined out or operations shifted to other areas. As mining operations ceased or moved, many of the workers and their families left, leaving barren lands, polluted waterways and a struggling local economy. Hundreds of small towns in Appalachia, often developed from these early coal towns, struggle with the many environmental and economic issues left from pre-regulation coal mining. More than 3.5 million Appalachian residents live within a mile of an abandoned mine land site.

In recent years, watershed groups throughout Appalachia formed independently, all with similar aspirations to repair the environmental degradation left from historic coal mining while creating the economic stability needed in rural communities. These change-minded community improvement groups are typically small in size and rely on community volunteers to bring real change to their community and their economy. Bypassing barriers of age and class, these organizations are uniting communities and working with government to create a stronger future.

The Appalachian Coal Country Watershed Team (ACCWT) was created in response to requests from watershed groups throughout coal country. Founded in 2002 by its director, Dr. T. Allan Comp, the ACCWT is an innovative partnership between AmeriCorps VISTA, concerned with poverty, the Office of Surface Mining, concerned with environmental reclamation and safety, and local watershed/community groups. The ACCWT places determined, energetic college graduates in Appalachian communities for a year or two of full-time service, providing opportuni-



OSM/VISTA's Kelly Martin monitors stream quality in the George's Creek watershed area, Maryland. Martin helped secure the grant that allowed the George's Creek Watershed Association to build the SAPS Railroad AMD cleanup site.



OSM/VISTA's Evan Smith, Head of Three Rivers, Letcher County, Ky., tests water conductivity.



OSM/VISTA's Cassie McCrae plants Chestnuts on Arbor Day at an AML site in the George's Creek watershed area, Maryland.



ties for the community they might not otherwise have. OSM/VISTA write community development grants, they have organizational skills to bring more community members and other partners to the table, education skills to help local citizens break the cycle of poverty and help change attitudes toward the degraded environment that surrounds them. OSM/VISTA address not only immediate and pressing water quality problems, they support their local communities in the longer, more hard-fought struggles of community sustainability, job stability, and successful futures for citizens in rural America. Overall, OSM/VISTA are aiding the transition from mining to other suitable and available economies, driving alternative energy development and reforestation on abandoned mine lands, reconnecting people to their rivers and their environment, and making sustainable change more possible through training and education.

Site specific remediation

The George's Creek Watershed, located in Allegany and Garrett

Counties, Md., serves as an exemplary ACCWT project. Headwaters for George's Creek begin above Frostburg, Md., and the creek ends as it empties into the North Branch of the Potomac River in Westernport, Md. The drainage area for the watershed lies between Danâs Mountain and Big Savage Mountain. Coal mining in the George's Creek region began to boom in the 1830s when the first Maryland Geological Survey reported the area had coal of "extraordinary thickness." By the early 1900s deep mining in the region peaked and 4.5 million tons of coal was being produced annually in Western Maryland. The deep mining that had once almost solely supported George's Creek communities is now the source of environmental problems throughout the area. Because of the mountainous topography of the George's Creek area, many of the deep mines were mined "up dip" from the bottom of the hill, allowing mine water to drain out, thereby polluting George's Creek and its tributaries with acid mine drainage (AMD). AMD has left portions of George's Creek and its tributaries fishless with little hope of re-establishing a fishery in these streams.

The George's Creek Watershed Association (GCWA) began in 1995 and it has been committed to finding solutions to environmental problems in the watershed and assisting other agencies in their efforts to remediate these problems. The GCWA has been effective in determining the extent of AMD, developing passive treatment systems, and evaluating flooding issues in the George's Creek area.

The GCWA first partnered with the ACCWT in 2003 while they were working on the Knapp's Meadow Stream Bank Restoration Area. The Knapp's Meadow site, formerly the Allegany County Garage, was to become a community park that would provide handicapped access to George's Creek. However, human activities over the past years at the site altered the natural floodplain,

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placing half of the planned parking lot in a flood plain. In order to proceed with the park plans, the GCWA partnered with several agencies to secure funding to restore the natural flood plain of the site. OSM/VISTA's Melissa O'Neal wrote and received a Kodak American Greenways

Grant, and a Chesapeake Bay Trust/Fish America Foundation Grant to provide funding for the Knapp's Meadow Stream Restoration and Park Project. The site is an excellent demonstration of stream bank restoration, as well as a park with fishing access to George's Creek.

In 2005, OSM/VISTA's Kelly Martin began her work with the GCWA. Martin helped secure a Watershed Cooperative Grant and applied for a National Fish and Wildlife Foundation/CBT Small Watersheds grant for the construction of a Successive Alkalinity Producing System (SAPS) in the Railroad Street Mine Drainage Remediation Project. This SAPS technology is suited to the Railroad Street Mine site and is incorporated into the drainage remediation design. Martin also assisted in obtaining a Special Project Grant through Canaan Valley Institute (CVI), which funded cleaning and re-design of the Pulse Limestone Bed installed to address the major AMD seep in Mill Run. In February 2005, the Pulse Limestone Bed system earned GCWA with the prestigious Conservation Service Award from the United States Department of the Interior.

The type of successful remediation work accomplished for the GCWA illustrates the hard work of both OSM/VISTA Volunteers and the community groups with whom they work. The Appalachian Coal Country Watershed Team and all its partners continue to make similar accomplishments throughout the Appalachian coal region every year. In the last 12 months alone, ACCWT and its OSM/VISTA, working with their local watershed groups logged 4,200 hours of volunteer time, over a half-million dollars of in-kind services, \$650,000 in cash grants and nearly 400 partnerships – all this in a region where money and time are scarce. For more information please see www.accwt.org. ■

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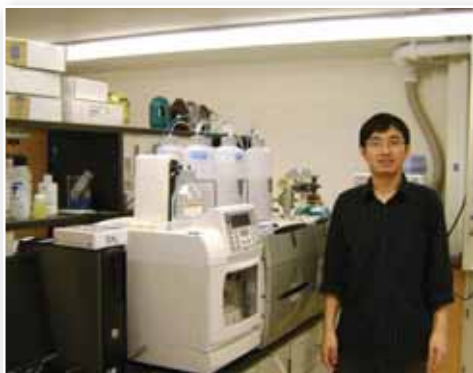


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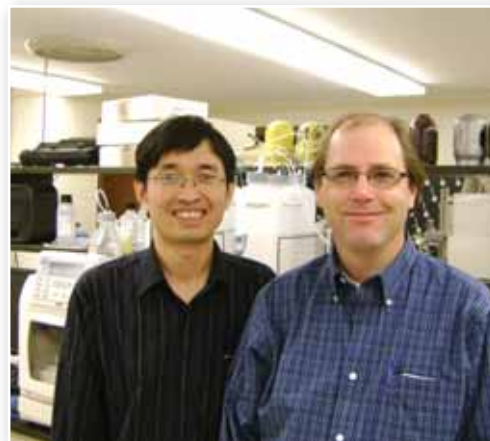
By Louis McDonald and Jeff Skousen, West Virginia University



Several years ago on a trip to China, we met Dr. Zhenqi Hu, a professor at the China University of Mining and Technology in Beijing (CUMTB). We developed a close friendship during our first visit and subsequent visits to China. In 2007, Dr. Hu contacted us about the possibility of sending one of his Ph.D. students to work with us at West Virginia University (WVU) and to conduct some of his doctoral work in our laboratory.

After some preliminary discussions, we developed a contract between WVU and CUMTB, where Mr. Mingliang Zhang would spend a year in the United States at WVU. Mr. Zhang would conduct research under our direction and the data he generated could be used in his dissertation for CUMTB. All financial support for his living expenses, travel, insurance, etc., would be paid by CUMTB under a Chinese graduate student research grant program. Grants at WVU would pay for the research conducted at WVU. Mr. Zhang was not required to enroll in courses at WVU, but he did sit in on two courses.

Mr. Zhang arrived in December 2007, and left in December 2008. During his time here, Mr. Zhang worked in the Environmental Soil Chemistry laboratories of the Division of Plant and Soil Sciences at WVU. He worked on ways to refine Neutralization Potential determinations in the Acid-Base Accounting procedure for prediction of acid mine drainage from rocks disturbed during mining. A draft manuscript has been prepared to be sent to a journal. He also conducted batch and column experiments on the thermodynamics and kinetics of Pb, Zn, Cd, Cu, and Cr removal, singly and in combination, by iron hydroxide, fly ash and compost. Manuscripts for these experiments are also in preparation. Mr. Zhang sat in on two classes while at WVU: "Soil Chemistry"



and "Reclamation of Disturbed Soils." He also attended the American Society of Mining and Reclamation meeting in Richmond, Va., in June 2008. It was a pleasure to have Mr. Zhang spend a year at WVU and we feel that everyone benefited from the exchange. ■

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Top 10 Myths of Midwest Mining and Reclamation

By Jack Nawrot, Southern Illinois University

Dr. W.D. Klimstra founded the Cooperative Wildlife Research Laboratory (CWRL) at Southern Illinois University in 1950 to train graduate students as professional wildlife biologists. Located at the front door of the Shawnee National Forest between the Mississippi and Ohio rivers, and 10 minutes from Crab Orchard National Wildlife Refuge, there were ample opportunities for our Wildlife Lab students to conduct research in unmined habitats. In 1952, Klimstra pioneered a partnership with state and federal natural resource agencies and the coal industry to conduct research on a 950-acre prelaw surface mine. Other faculty turned their backs on local coal mining and considered Klimstra foolish for trying to establish wildlife habitat on areas stereotyped by images of acid soils and acid water. While others viewed the 1930's to 1950's pre-law lakes and spoil banks as wastelands, Dr. Klimstra, the stubborn optimist, envisioned these sites as future wetlands and wildlife habitat. Pyatt's Strip Mine Research area supported many CWRL Masters' and Doctoral students. The hands-on experience, theses, dissertations, and publications of the '50s, and five more decades of research by CWRL students clearly earned Dr. W.D. Klimstra the title of "Father of Wildlife Reclamation." Klimstra's original Pyatt's Research Area is now part of Illinois DNR's 16,000-acre Pyramid Park State Fish and Wildlife Management Area.

When I came to the Wildlife Lab in 1972, Dr. Klimstra gave me a unique opportunity to share his "can do" attitude, and wit-

ness during the next 35-plus years some of the Top 10 myths about Midwest mining and reclamation.



Figure 2 – Pyramid State Park (CWRL Pyatts Research Area) prelaw spoils mined 1938 with 32" DBH red oak.



Figure 3a – Trumpeter swans (>200 swans winter at CONSOL's Burning Star 5 Mine and IDNR's Burning Star 5 Wildlife Management Area (Jackson County, Ill.).

Figure 3b – Bald eagles nesting "immediately" adjacent to Burning Star 5 for >12 years have successfully fledged young for 5+ years. Eagles routinely roost on the mine and forage on wintering ducks and geese.



Figure 1 – Pyramid State Park (CWRL Pyatts Research Area) prelaw spoil mined 1940s (Perry County, Ill.).



Figure 4 – State threatened rice rat which was trapped (August 09) in reedgrass (Phragmites) wetland established on coal slurry (no soil cover ... inundation /saturation prevents oxidation of pyrite) at the Burning Star 5 Mine.

1. Mining destroys wildlife habitat.
2. Coal mines are barren acid wastelands.
3. Coal mines will all produce acid water.
4. Trees will not grow on ungraded spoil banks.
5. Wetlands cannot be mined or restored.
6. Streams cannot be mined or restored.
7. Slurry and gob must be covered with four feet of soil to support vegetation.
8. Eagles will not nest near surface mines.
9. Phragmites marshes are biological deserts.
10. Mining destroys agricultural productivity.

For the most part, many of these myths have been perpetuated by the media, as well as the general public that may have never visited a reclaimed mine after the equipment is gone, the soil has been replaced, and vegetation established. There are many images that we as practicing professional reclamationists see every day that validate our desire to “put it back the way it was,” or better. We proudly share our successful reclamation images with our colleagues and friends.

Visitors to Fish and Wildlife Management areas may not know, or care, if their trophy deer was harvested on a reclaimed mine (Figure 1).

Trees do not know that their roots anchor trunks in soils that have been mixed and replaced by mining (Figure 2).

Bald eagles, ospreys, or trumpeter swans may have never reviewed or approved the reclamation plan before foraging or roosting on reclaimed mines (Figure 3).

Turkeys, least bitterns, and threatened rice rats may have never asked a biologist to verify the scientific name of *Phragmites australis* before building a nest (Figure 4).

A restored stream or wetland may not have asked the Army Corps of Engineers if its functions and values have been restored (Figure 5).

Crops grown on reclaimed mines may need signs ... “Grown on Replaced Topsoil” (Figure 6).

Slurry (the world’s original hydric soil) reclaimed without soil cover, does not know that it has been in storage for 300 million years (Figure 7).

If W. D. Klimstra were alive today he would have proudly shared many more photos of successful reclamation and this thought from his Conservation Challenge lecture of Jan. 21, 1965:

“... conservation is the science of applied ecology, ecology in action, but it is not merely technology. It does not twist natural laws to economic ends, but aligns resource utilization with economic principles ...” ■



Figure 5a



Figure 5b



Figure 7

Figure 5a – CONSOL Burning Star 4 Galum Creek restoration site (active mining integrated channel restoration in 1986).

Figure 5b – CONSOL Burning Star 4 Galum Creek restoration which received OSM National Reclamation Award 2002 (same area as 5a Photo Date 2005).

Figure 6 – Row crop reclamation at IDNR Burning Star 5 Fish and Wildlife Management Area (photo July 2008).

Figure 7 – CWRL's low ground pressure 4WD slurry wetland tractor (ca 1985) amusing state and federal regulators in a no soil cover slurry wetland at AMAX Ayrshire Mine (IN).



Figure 6

Strengthening Scientific Expertise in the Bolivian Andes through Research, Teaching and Outreach:

Tackling severe mining-related pollution in Potosí, Bolivia

By W.H. Strosnider, R.W. Nairn, B. Santamaria, F.S. Llanos, A. Garrido and L.R. Oxenford

Intensive mining and processing of silver, lead, tin and zinc ores have occurred within and around Cerro Rico de Potosí, Bolivia, since 1545. Cerro Rico is the world's largest silver deposit and Charles V of Spain dubbed Potosí the "treasure of the world, the king of mountains, and the envy of kings." In the 17th century as the mining industry boomed, Potosí's population rivaled that of Paris and London (Figure 1). However, over the centuries more than 40,000 tonnes of silver have been extracted without reinvestment for the primary benefit of foreign nations, principally Spain. Currently, the city of approximately 150,000 is economically undiversified and depressed. In addition, centuries of mining without regard for environmental or social consequences have taken an egregious toll on human, terrestrial and aquatic resources. Over seven million forced indigenous and enslaved African laborers died either mining or processing the ores, mainly via inefficient mercury amalgamation. The region around Potosí was nearly completely denuded of timber and combustible biomass for a radius of over 40 kilometers. High strength acid mine drainage, tailings piles and ore processing plant effluents are prime sources of water contamination in the economically and ecologically vital, yet highly impacted, Rio Pilcomayo watershed, of which Potosí sits at the headwaters (Figures 2 and 3). However, the economy of Potosí remains dependent upon mining. The challenge is to reform mining practices and mitigate legacy contamination sources without diminishing the

competitiveness of the mining sector to illuminate a sustainable path forward.

Since 2006, members of the University of Oklahoma Center for Restoration of Ecosystems and Watersheds (CREW) in the School of Civil Engineering and

Environmental Science (CEES) have been working with personnel at the Universidad Autónoma de Tomás Frías (UATF) and Centro Investigación Minera Ambiental (CIMA) in Potosí. Environmental engineering doctoral candidate William



Figure 1: Location of Potosí, Bolivia, in the Andes Mountain Range of South America.

Figure 2



Figure 3



Figure 2: Cerro Rico (elevation 4850 m asml) towering over the colonial city of Potosí (elevation ~3950 m asml).

Figure 3: Acid mine drainage from an adit at the Huari Huari mine near the city of Potosí (pH 4.5-6.3, acidity 4000-5000 mg/L as CaCO_3 , 2-5 mg/L aluminum, 1-2 mg/L arsenic, 2-4 mg/L cadmium, 1000-1200 mg/L iron, 30-40 mg/L manganese, 0.27-0.29 mg/L lead and 900-1400 mg/L zinc).

Figure 4: The Pailaviri tailings deposit on the north slope of Cerro less than 100 m from populated areas. Acid rock drainage, which flows through the city of Potosí, sampled at the toe in May 2007 had pH 0.9, acidity 224,000 mg/L as CaCO_3 , 7500 mg/L aluminum, 900 mg/L arsenic, 5 mg/L cadmium, 65,000 mg/L iron, 100 mg/L manganese, 20 mg/L lead and 1700 mg/L zinc.

Strosnider has led this effort, which now includes three other graduate students, all advised by Robert Nairn, CREW director and CEES associate professor. In 2008, Nairn and Strosnider led a CREW team on a three-week research, teaching and service trip to Potosí. Environmental science doctoral student Leah Oxenford, environmental engineering master's student Alan Garrido, and environmental science master's student Beatriz Santamaria were also key team members (Figure 4). Funding was provided by OU Presidential International Travel Fellowships, an OU Faculty Senate Development Grant, and discretionary funds from CREW, CEES, OU Chapter of Engineers Without Borders and the OU Water Technologies for Emerging Regions Center.

Each member of the team performed research related to mine water environmental impacts and their remediation. In this high-altitude desert environment, research projects included studies on the effects of using contaminated irrigation water on staple crops (e.g., potatoes), how the high altitude and intense solar radiation impact

mine water chemistry, the possibility of using locally available waste products (such as llama dung or municipal wastewater) in mine water passive treatment, and the relative impacts on streams of

mine water and untreated municipal wastewater. Work occurred in close partnership with colleagues at UATF and CIMA, and laid the groundwork for further collaboration between these entities and

Figure 4



Figure 5



CREW. While traveling across Bolivia, the CREW team (Figure 5) also performed project assessment visits for the OU chapter of Engineers Without Borders (EWB) in conjunction with the non-profit Engineers in Action (EiA) group. These projects all address sustainable water-quality improvement technologies for small indigenous villages in the Andes.

Thus far the research has helped reinforce the need for environmental remediation, establish the priority of different remediation efforts and elucidate suitable passive treatment options.

Figure 6



Figure 7



Figure 8



Figure 5: CREW, UATF and EIA personnel near the peak of Cerro Rico. From left to right, Chayla Rowley, Beatriz Santamaria, Alan Garrido, Freddy Llanos, Leah Oxenford, William Strosnider, Robert Nairn, Afnan Agramont, Ruben Mamani, and Milton de la Cruz Rivera.

Figure 6: Soil and potato sampling in acid mine drainage impacted soils.

Figure 7: Cow manure sampling for substrate suitability tests.

Figure 8: Indigenous Bolivians near the shores of Lake Titicaca with a meal of fish and their traditional staple, the potato.



Figure 9



Figure 10

Figure 9: The contaminated St. Catalina Lake (pH 3.5-3.7, acidity 160-310 mg/L as CaCO₃, 10-12 mg/L aluminum, 0.02 mg/L arsenic, 0.1 mg/L cadmium, 2-7 mg/L iron, 5 mg/L manganese, 0.2 mg/L lead and 40-45 mg/L zinc) at the headwaters of Rio Juckucha. An active mine and multiple abandoned mines drain to this lake, which is crucial for animal watering and irrigation.

Figure 10: An abandoned adit that drains to St. Catalina Lake. The proposed action here involves an anoxic limestone drain and oxidation pond.

All research has been guided and enabled by professor Freddy Llanos of UATF. It has been determined that acid mine drainage is a substantial contributor to downstream contamination and that in-stream tailings present yet another metals source. In addition, potatoes grown in fields impacted by acid mine drainage have shown elevated lead, cadmium and zinc concentrations (Figure 6). However, suitable passive treatment substrates are available in Potosí, in the form of llama and cow manure, as well as brewery waste (Figure 7). Experimental results also indicate that acid mine drainage and municipal wastewater from Potosí can be simultaneously and passively treated within the same system. Ongoing research is focused on the risk of human metals exposure via potato consumption and the challenges of passive treatment at high altitude (Figures 8 and 9).

With Bolivian colleagues, the CREW team also taught an intensive bilingual short course on mine water biogeochemistry and treatment. Attended by more than 70 students and professionals, the

four-day course included a full-day field trip to active and abandoned mines and was considered a huge success. The short course helped speed passive treatment technology transfer and foster the development of environmentally-conscious engineers with the ability to apply passive treatment technologies. CREW also donated used scientific monitoring equipment to UATF for use in training the next generation of engineers.

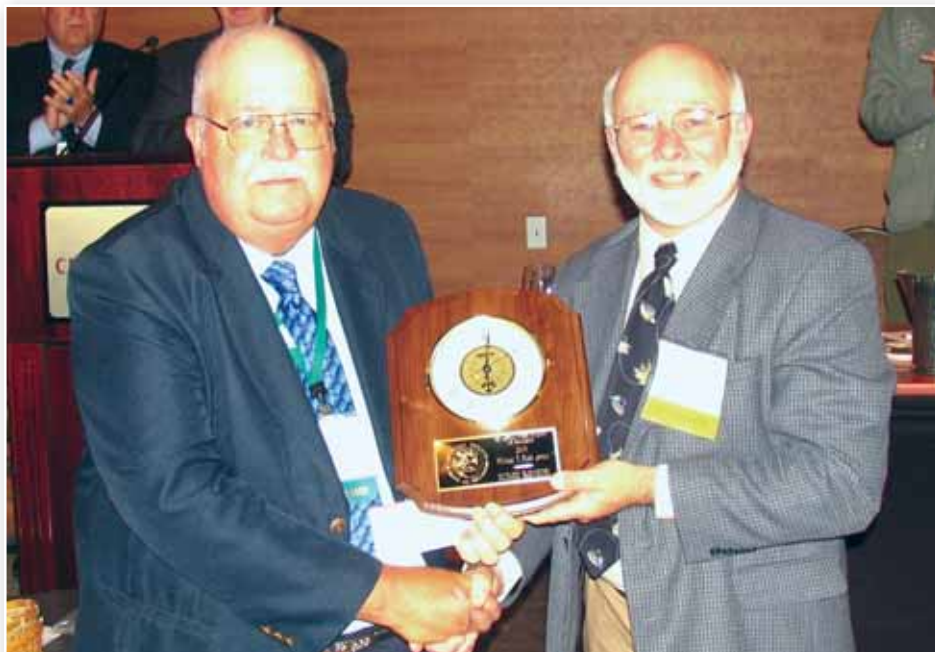
The establishment of an in-situ passive treatment knowledge base is crucial because funds and resources have been secured for an acid mine drainage treatment project, including oxic limestone channels, vertical flow bioreactors, aerobic ponds and anoxic limestone drains. The goal is to demonstrate sustainable treatment technologies by rehabilitating a highly impacted crucial irrigation water resource, Rio Juckucha (Figures 9 and 10). To accomplish this goal, a coalition of higher learning institutions (OU and UATF), non-governmental research institutions (CIMA), non-profit service organizations (Rotary International, EiA

and EWB) and private industry (Kumurana Mining Company and Cardinal Engineering) has been assembled by CREW. Thousands of indigenous residents' lives will be positively impacted by the project, which is slated for construction in 2010. CREW's work in Bolivia over the years has been key in the development of the project for the rehabilitation of Rio Juckucha, which will serve as a demonstration to the Bolivian government of the potential of passive treatment options.

The Bolivian Andes, and especially Potosí, have a rich and storied mining history. Like many mining regions, resource extraction led to significant environmental and human health risks. By working with Bolivian colleagues, and investing in not only research, but teaching and service activities, CREW hopes to not only address some of these problems, but to provide the technology and knowledge necessary for further environmental remediation work by in-country scientists and engineers. ■

Richard I. Barnhisel

Recipient of the William T. Plass Award for 2009



**He is considered
“Mr. Reclamation” in that region.**

This year's recipient of the William T. Plass Award received his B.S. from Purdue University, his M.S. from Virginia Polytechnic Institute, and his Ph.D. from Virginia Polytechnic Institute. He “officially” retired in July 2008 from the faculty of the University of Kentucky, having served for 45 years. He is considered “Mr. Reclamation” in that region. Dick has received the Reclamation Reserarcher of the Year award from ASMR in 1989 and became a Fellow from the American Society of Agronomy and the Soil Science Society of America. He has also served on numerous important committees in the Soil Science Society of America, the American Society of Agronomy, the Clays and Clay Mineral Society, and the American Society of Mining and Reclamation.

Dr. Barnhisel's contribution in mine-land reclamation science has three forms: as teacher/mentor, reclamation scientist, and practitioner to the industry. He

has taught seven different courses at UK, and one titled “Reclamation of Disturbed Lands,” which he taught for 22 years. He has served as mentor in one capacity or the other to 45 M.S. and 36 Ph.D. students.

He is also responsible for 42 refereed journal articles, 16 book chapters, 56 symposia papers, 18 experiment station bulletins, and 21 government reports. One of the paramount contributions to the science and technology of mined land reclamation was his co-editorship of the book: “*Reclamation of Drastically Disturbed Lands*,” 2nd edition, in 2000. This is a highly sought resource on the subject. He co-authored the “*Glossary of Surface Mining and Reclamation Terminology*” with William T. Plass.

He served as vice chairman for three years and Chairman for three years on the Council for Surface Mining and Reclamation in Appalachia, which later became the American Society for Surface Mining and Reclamation. Since 1999, he has served American Society of Mining and Reclamation as its Executive Director. ■



Professor Zhenqi Hu

ASMR Researcher of the Year Award

Dr. Zhenqi Hu is a professor at China University of Mining and Technology (Beijing) and the director of the Institute of Land Reclamation and Ecological Restoration. He has been involved in mine land reclamation in China for 20 years. He received his Ph.D., M.E. and B.E. in mine surveying from China University of Mining and Technology in 1991, 1987 and 1984, respectively. He also studied in the Mining Engineering Department at Southern Illinois University at Carbondale as a joint Ph.D. candidate on land reclamation from 1989 to 1991. Furthermore, he spent one year (1996-97) as an honorary researcher in contaminated soils at Camborne School of Mines, University of Exeter, UK. His major research interests are land reclamation and ecological restoration, application of GPS and GIS in land and environmental science, and use and management of mined lands.

Dr. Hu is well known as the pioneer of mine land reclamation in China. He was the first Ph.D. in land reclamation in China. He was instrumental in developing the China Land Reclamation Society and has promoted collaboration and information exchange with international societies on land reclamation (such as ASMR, BLRS, IALR). He helped the China Land Reclamation Society to join the International Affiliation of Land Reclamationists in 1998 and organized the first International Symposium on Land Reclamation in China in 2000.

Since 1991, he has conducted numerous and wide-ranging research projects on land reclamation. For over 20 years, he has performed regional and international research projects with mining companies, national and local land administration departments, as well as international institutions. Dr. Hu and his team have contributed largely and widely to solve the mining environmental problems.

In recent years, Dr. Hu has conducted research in subsidence issues, coal waste pile revegetation, and contaminated soil remediation supported by the National Science Foundation of China, High-tech Research and Development Program of China, Ministry of Land and Resources, Ministry of Environment, and many mining corporations. His major achievements are:

- 1) developed the method for evaluating environmental effects of underground mining based on GIS technology thereby revealing landscape damage and the impact of mining subsidence on soil properties,
- 2) presented the method of soil reconstruction,
- 3) developed new techniques for reclaiming subsidence land, such as hydraulic dredge pumping and filling without pollution,
- 4) developed techniques of revegetating coal waste piles without soil cover, new techniques for at-source pollution controls, and ecological restoration for acid or spontaneous combustion.





- tion of coal waste piles [Chinese patent ZL200710063475.5],
- 5) invented technologies and materials for remediating heavy-metal contaminated soils with industry minerals and mycorrhizal fungi [Chinese patent ZL200510002116.X],
 - 6) developed methods for monitoring reclaimed soil quality by Ground Penetrating Radar, and

7) invented topsoil alternatives based on coal-related solid wastes (Chinese patent ZL200510063339.7). So far, he has reclaimed more than 3,000 hectares of subsided land for farmland and revegetated four coal waste piles, which resulted in funding of more than 0.8 billion RMB (about 0.1 billion US dollars). He has published more than 200 papers and 10 academic books. In 2008 alone, he published two books and more than 20 papers. One of the published books named "Land Reclamation and Ecological Restoration" is the first textbook in land reclamation for Chinese universities.

Teaching: Dr. Hu's achievements and activities with students are also remarkable. He teaches courses in land reclamation and ecological restoration, mining environment remediation technology, land development and consolidation, land use, and mine surveying. He is widely known as an outstanding teacher and educator, as demonstrated by two teaching prizes awarded by his University. So far, four post-doctorates, 45 Ph.D. and 32 MS students have graduated under Dr. Hu's supervision. Among these graduated students, three were given the outstanding Ph.D. thesis awards of CUMTB.

Awards: In addition to his teaching and leadership, Dr. Hu has received numerous amounts of awards for his achievement and dedication. Dr. Hu and his team have gained one Chinese national technical development award and 12 provincial and administration awards. He is active in many research organizations, such as director of China Land Reclamation Society, the executive member of Environmental Protection Professional Committee of China Coal Society, council member of China Land Society (CLS), member of Soil and Water Conservation Society of China, and member of the Editorial Board of the International Journal of Surface Mining, Reclamation and Environment. ■

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Reclamationist of the Year Winner – Roy Karo

Peabody Energy's Roy Karo Wins Praise from Peers for Environmental Excellence

By Meg Gallagher - Manager, Corporate Communications Peabody Energy

Editor's Note: The following article is reprinted – in part, with permission – from Coal People Magazine, July 2009.

Sunrise over the Aspen-dotted slopes and lush valleys of Peabody Energy's Seneca Complex is a strikingly beautiful sight and home to large herds of elk and mule deer and mountain lion, grouse and other wildlife. It's also a credit to the more than 30-year career of Roy Karo, Peabody Energy Reclamation Manager for Colorado.

Karo's pioneering land restoration programs have helped create thousands of acres of flourishing rangeland and pasture in the semi-arid climate of northwest Colorado. Under his leadership, lands at the company's former Seneca Mine have been restored to a condition that is typically four times more productive for livestock grazing than native range, an accomplishment that has earned national recognition.

Most recently, Karo's peers at the American Society of Mining and Reclamation (ASMR) recognized his achievements with a major annual honor, the 2009 Reclamationist of the Year Award. Karo's initiatives have earned 10 state awards since 1994 and national honors for land restoration from the U.S. Department of the Interior in 2000 and 2006. Interior even singled out the industry veteran with its "Best of the Best Award" for a lifetime of

accomplishments in 2006.

Mining operations have replicated his model across the West. Eric Ford, Peabody's Executive Vice President and Chief Operating Officer, says, "Roy exemplifies a key principle of Peabody's mission to 'leave the land in a condition equal to or better than we found it.'"

Karo could hardly have imagined his career would take such a high-profile course when he accepted his first job at Seneca in 1977. Of course, he had graduated from Colorado State University with a Bachelor of Science degree in Agriculture with a burning desire to "grow things." But no textbook could prepare him for the challenge... and rewards... of his position as Land Restoration and Grading Supervisor at Seneca.

Karo assumed an array of additional duties, including pit supervisor, foreman and safety manager. He supervised more than 50 operators, reclaiming over 150 acres of mined land annually, as well as a small army of subcontractors who aided in everything from revegetation and environmental monitoring to pond construction and heavy equipment maintenance.

Still, perhaps Karo's steepest learning curve involved the rugged territory at Seneca itself. The property's high elevation, mountainous terrain and brief 65-day growing season presented some of the most challenging mining and land restoration conditions in the region. Karo spent hours of personal time gathering native species of plant seeds – which were not commercially available – to ensure the land's unique vegetation was restored using plant materials adapted to the region.

Establishing woody plants in this wintery and wildlife-rich region was also a tough task. For example, Karo and his team dis-



Two bucks in velvet

Reclamationist of the Year Winner



covered that big game browsing was responsible for the failure of some typically hardy and aggressive shrubs to thrive on restored lands. So, he experimented with new techniques, collaborating with engineers, academics and regulators from Office of Surface Mining to Colorado State University to the U.S. Forest Service to the Colorado Division of Reclamation, Mining, and Safety. In the process, he advanced an array of innovative revegetation, soil handling, seedling production, controlled livestock grazing, fencing, erosion control and other techniques that achieved real results.

The Seneca group cooperated with re-



searchers to devise techniques from weed barriers to the carefully timed application of herbicides to local seedling transplanting. Working with the USDA's Forest Service, Karo even launched a successful demonstration project to reintroduce aspen trees to restored land, helping to address years of decline for the majestic trees in the area.

Deer and elk are just some of the species that seem to approve of Karo's efforts: Peabody's Colorado properties boast some of the highest densities of big game in the region. Look no farther than a sensitive local bird: the Columbian sharp-tailed grouse. These animals are particular about the location of their courting practices, and populations of grouse have declined alarmingly throughout the West in recent years as development encroached upon the habitats the birds use for breeding. Karo was the first person to observe that the grouse preferred Peabody reclaimed lands to mate and raise their young, and he led numerous initiatives through the Colorado Division of Wildlife's research team of biologists to successfully establish and document breeding, nesting and brood-rearing habitat. He also employed techniques to support mountain bluebirds. His efforts have been so successful that bird watchers now travel from around the world to observe the rouse in guided tours.

Karo is in good company. He joins a talented, global group of environmental leaders and innovators at Peabody Energy who have earned 16 awards in 2008 for safety, stewardship and good neighbor practices... all while restoring more than 6,100 acres of land over the same period. In 2008, Peabody's operations created more than \$14 billion in total economic benefits around the world, including \$3.5 billion in direct economic contributions. Peabody's operations provide high-paying jobs, fund local institutions and support community organizations.

For Vern Pfannenstiel, a highly decorated Manager of Environmental Services-West for Peabody Energy and current President of ASMR, the greatest achievement of Karo and his colleagues is their example: "The program under Roy's direction is not restricted to only reclaimed lands but also includes more than 30,000 acres of undisturbed lands that are managed to encourage a conservation ethic," says Pfannenstiel. "That means something. Through these efforts, Roy has not only influenced other coal operators in the region but has sent a positive and important message to the public. We all know why we must preserve our environment for the next generation; people like Roy show us how." ■

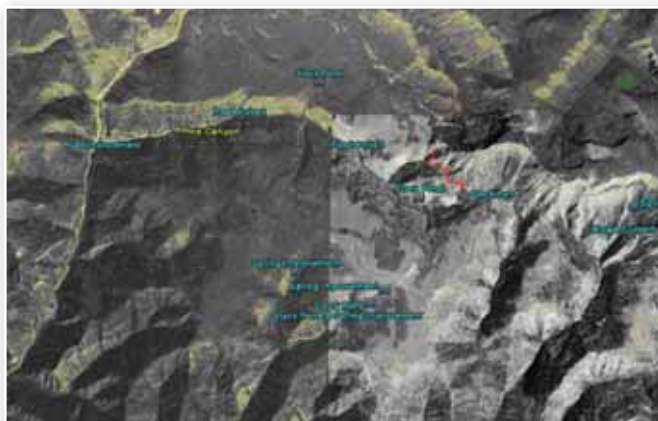
Three-Year Sediment Reduction Project Earns Dugout Mine Earth Day Award

Arch Coal's Canyon Fuel Company and its Dugout Canyon mine recently completed a three year project in Pine Canyon in southeast Utah to minimize the contribution of sediment to Soldier Creek, a tributary to the Price River.

The goals of the project were to ensure that precipitation and spring water would be collected and available for consumption by both wildlife and cattle, to distribute the water throughout the canyon, and to reduce sediment loads.

The canyon is private property and has been home to cattle grazing for approximately six months out of every year since 1986. In addition, the canyon provides habitat for large herds of elk and deer. In 1996 and '97, many of the large conifer trees were harvested from the canyon. "The varied land uses made the watershed rehabilitation within the canyon a challenging project," said Vicky Miller, Dugout Canyon mine's environmental engineer.

Pine Canyon is dependent upon snow and rain to fill stock ponds in the spring and on monsoon storms to refill the ponds in the late summer and early fall. There also are three springs in the canyon, which provide water for the cattle and wildlife species. Due to drought conditions over the past several years,



stocks ponds that typically held water have been dry forcing live-stock and wildlife to concentrate both feeding and watering activities in the immediate vicinity of the springs.

The stock ponds were originally constructed in the early 1990s, but had been reduced to between 25 and 30 percent of their original size due to infilling with sediment. In 2007, Dugout's team rehabilitated one pond to approximately 60 percent of its original size. In 2008, two additional ponds were enlarged and another was completely reconstructed.

During a normal precipitation year, the reconstructed pond would be filled by both precipitation events and by a nearby spring which flows about one gallon a minute. Prior to the completion of the project the spring and pond were typically dry by mid-July.

In 2008, a water collection system was constructed for the nearby small spring. The system included perforated pipe to collect the spring water into an enclosed pipe system that dropped



(Left to right) Dugout Canyon mine's Rob Gray and Vicky Miller install a trough in Pine Canyon, Utah.

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Before:



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into a water trough and the excess reported to the reconstructed pond. After construction of the spring water collection system and reconstruction of the pond, the trough and pond both contained water into November 2008.

A similar collection system was installed on three additional springs. Due to the remote locations of these springs, the supplies were carried in and installation was done by hand.

Two of the enlarged ponds are in series at the headwaters of Pine Canyon Creek. Following the completion of the project they not only captured the runoff for use by livestock and wildlife, but also retained sediment and dissipated energy through their riprapped outlets. The two structures reduced the sediment being released to the stream channel by more than half. In addition, the pond embankments were pocked [roughened] with a backhoe and seeded with native grasses.

By moving the impact of cattle watering from the spring sources to troughs and ponds, Dugout's team successfully restored a stream channel to its previous riparian splendor.

Another important element of this project involved improvements to an existing access road. According to Miller, portions of the road in the bottom of Pine Canyon could best be described as ruts rather than

as road. Precipitation events had eroded areas of the road to a point where the culverts and ditches were not functioning. During 2008, this area of the road was repaired, ditches and water bars were established, and culverts with headwalls and riprapped outlets were installed. "We were proud that during an annual inspection by the NRCS in 2008, the inspector com-

mented that the clarity of the water in Pine Canyon Creek had drastically improved and the sediment load had been reduced by 75 percent," said Miller.

As the capstone to this project, the Utah Department of Natural Resources presented Dugout Canyon Mine with the 2009 Earth Day Award for its voluntary efforts in Pine Canyon and Soldier Creek. ■



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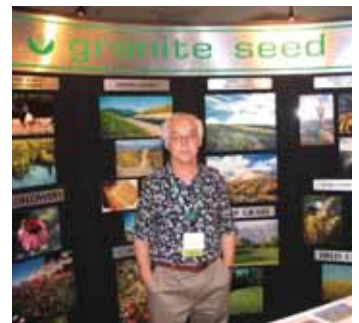
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specializing in mine drainage treatment

DENTS RUN SITE 3895

More data available at:
www.datashed.org



WATER QUALITY SNAPSHOT 6/30/09

<u>RECEIVING STREAM MONITORING</u>							
Downstream Point	pH	Acid (mg/L)	Alk. (mg/L)	T. Fe (mg/L)	T. Mn (mg/L)	T. Al (mg/L)	SO ₄ (mg/L)
21 (Pre Constr. Avg.)	3.0	498	0	51	21	27	1337
21 (6/30/09)	6.5	-16	24	3	12	3	963

Point	Flow (gpm)	pH	Acid (mg/L)	Alk. (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	D. Al (mg/L)	SO ₄ (mg/L)
Raw	n.m.	2.6	1425	0	295	18	70	2933
Ph 1	n.m.	4.7	60	1	1	12	8	1816
Final	25	7.5	-227	280	<1	3	<1	1333

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
- Wetland Planting
- Public Relations
- Construction



RESTORED TREATMENT MEDIA

Manganese Resource Recovery
Sustainable technology development

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