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Green Lands

Volume 29 Number 3

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Green Lands
is a quarterly publication of the
West Virginia Mining & Reclamation Association,
with offices at 1624 Kanawha Boulevard East
Charleston, West Virginia 25311
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On the Cover
Trees dominate a former surface mine site at Hobet 21's pit #4 in Boone County. A subsidiary of Arch Coal, Hobet completed mining on this area in 1986. After just a few years, an abundance of trees and a variety of wildlife have become well established on this site.

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Three Inducted Into WV Coal Hall of Fame

Three pioneers who helped shape West Virginia's coal industry were inducted into the West Virginia Coal Hall of Fame on Friday, May 7th at the Marriott in Charleston.

Herbert E. Jones, Jr., chairman of Pittsburgh & West Virginia Railroad, Charleston, WV; F.B. "Fil" Nutter, retired president and chief executive officer of Hobet Mining & Construction Company, Inc., Charleston, WV; and John L. Schroder, Jr., retired president of U.S. Steel Mining Company, Inc., Morgantown, WV were inducted into the second class of the West Virginia Coal Hall of Fame.

Each person honored there that evening was, is and always will be, a mentor to some, admired by many and respected by everyone, for their dedication and high regard for the coal industry.

Last year was the first year for the Hall of Fame in which 10 coal industry leaders were inducted.

They were: B. R. "Bobby" Brown - chairman of the board of Consol, Inc. and Consol Energy, Inc., Pittsburgh; Charles E. "Jim" Compton – founder of FIVE-J Energy, Inc. and Grafton Coal Company, Bridgeport; Lawson W. Hamilton, Jr. – president of Ford Coal Company, Hansford; James H. "Buck" Harless – chairman of the board of International Industries, Inc., Gilbert; Tracy W. Hylton – president of WRM, Inc., Beckley; James C. Justice, Sr. late president and chief executive officer of Bluestone Coal Corporation, Beckley; E. Morgan Massey – chief executive officer of Evan Energy Company, Richmond; Allen C. Pack – retired chairman of the board of Cannelton Holding Company, Charleston; Robert H. Quenon – retired chairman of the board and chief executive officer of Peabody Holding Company, St. Louis; and Raymond E. Salvati – late chairman of the board and chief executive officer of Island Creek Coal Company, Pond Creek.

The home of the West Virginia Coal Hall of Fame is the Mineral Resources Building at West Virginia University, Morgantown.

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Arch Coal Subsidiary Receives National Honors

Catenary Coal Company's Samples Mine Complex, located in Kanawha and Boone counties and a subsidiary of Arch Coal, Inc., recently received recognition from two national organizations for its work in reclamation and community commitment.

Catenary Coal Company was recognized for its achievements in environmental reclamation, community commitment, and pollution prevention. The Cinergy Corporation, parent company of the Cincinnati Gas & Electric Company and PSI energy, Inc. recognized Catenary Coal Company with honorable mention in the *Community Commitment* and *Pollution Prevention* categories of the 1998 Cinergy's Supplier Environmental Excellence Award.

Receiving the award for its comprehensive waste management plans, proactive pollution prevention and outstanding community commitment and outreach programs. Included in the selection process were several site visits by Cinergy environmental specialists.

Catenary also received honorable mention for the 1998 Interstate Mining Compact Commission's Kenes C. Bowling Award. This is the third time in three years Catenary has been recognized by the IMCC. In 1996, Catenary was awarded top honors by the IMCC.

Mining practices at Samples are eliminating abandoned highwalls, re-mining coal refuse and reclaiming abandoned coarse refuse piles left by mining operations prior to the 1977 Surface Mining Control and Reclamation Act. Also recognized were achievements by Catenary in its Tenmile Fork Reclamation Project and Kayford Project involving a cooperative effort between WVDEP and Catenary Coal Company in which the sites were integrated into the ongoing surface mining operations for refuse reclamation accelerating the process at a lower cost than if handled entirely under the AML Program thus benefiting the state as well as improving water quality.

Catenary was the 1998 recipient of the Callaghan award, the top honor given by the West Virginia Mining and Reclamation Association, in January.

Dan Rimstidt (far right) presents Jim Felber (center) with Cinergy Corporation's honorable mention for the Community Commitment and Pollution Prevention awards. Jim's son, Charles looks on.

Benny Wampler (left), of the Interstate Mining Compact Commission presents Chris Sykes of Catenary Coal Company Honorable Mention for the Kenes C. Bowling Award.

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The Coal Industry in the 21st Century:

An Assessment of a Work Now in Progress

By: Richard Lawson

Editor's Note: *The following comments were made by Richard L. Lawson, president of the National Mining Association during the Twentieth Annual Eastern Mineral Law Institute of the Eastern Mineral Law Foundation meeting at Washington, D.C. on May 27, 1999. The entire speech can be read on the NMA's web page www.nma.org.*

Not long ago I was given a remarkable book that might make a good point of beginning for our evaluation of the things that may come to pass – a popular-seller entitled *Energy in the Future*.

It is remarkable for the perspective it offers. You see, this book is close to 50 years old.

The future to which *Energy in the Future* referred was 50 years hence – that is, about now. It is the commercial version of a report commissioned by the Atomic Energy Commission in 1949. It was a brisk seller. My edition is a third printing.

Embedded in it was the notion that about now nuclear production would be rising toward predominance in the generation of America's electric power; and that coal generation would be in decline along with the industry.

Coal use was to have peaked about 1990. Expense was supposed to consign coal to disuse – relatively high prices brought about by high production costs brought about by a combination of circumstances: The depletion of easy-to-get reserves and no change in the operations of production.

Something like this might have happened. It did not happen because:

- First, the coal industry's productivity increased by almost 600 percent between 1950 and 1997 – the result of a still-ongoing modernization;
- Next, coal is a competitive industry;
- Next, the combination of productivity and competition mean the average price of coal at the minemouth in adjusted-for-inflation dollars is only 60 percent of the 1950 price;
- And, thus, in today's best power plants the cost of a kilowatt-hour works out approximately as follows:
- Natural-gas generation – 1.4 cents;
- Nuclear generation – 1.35 cents;
- And coal – 1.02 cents.

It also means the average price of electric power has fallen for several years running.

Coal use did peak in 1990, as foreseen. It also peaked 1994, 1995, 1996, 1997 and 1998. It should peak again in 1999. It peaks every time the economy demands more power. The power burn has set new records in 41 of the last 49 years, and this year should be no exception.

Coal today delivers 57 percent of utility-generated power, and the output of coal generation is on the rise. The opposite of common expectations also befell nuclear generation. As recently as 1980 it was said with confidence that by the year 2000 as much as 35 percent, and rising, of the requirement could be nuclear generated.

However, nuclear power is at 20 percent of requirement and waning. It did, in fact, peak about 1996. The projections foresee absolute declines in output of 16 percent through 2010 and 45 percent through 2020 – that is, to 14 percent of requirement and then to 8 percent.

My point is not that the projection was wrong. Most over-the-horizon forecasts are thrown off by something that can't be foreseen. The decline of nuclear power can and ought to be reversed. America requires diversity in the power supply for flexibility in all circumstances.

At the same time it must also be recognized that there is in the story of nuclear power a caution for the surviving sources of additional high-volume power generation – coal and natural gas.

The higher costs mean that as much as half of nuclear output may be unable to compete in the coming deregulated market for power.

Without substantial change a new nuclear plant probably could not be put into operation by 2020 – could not gain the necessary governmental permissions, be built and be brought on line by 2020 without profound change in policy, in regulatory practice, and in due process. Not even one plant could run this course, let alone a fleet.

Coal, too, faces such campaigns – campaigns of political and ideological persuasion and opinion, of litigation, and of regulation. These campaigns are meant to impart a certain direction to future – movement toward a system in which resources are allocated by government rather than by competition and the normal operations of the market.

And so, I see the last week's Court of Appeals decision on the Environmental Protection Agency's distortion and diversion of the Clean Air Act to other purposes as one of the potentially most important since I joined the mining industry.

The NAQS regulations were generally perceived to be part of an attempt to enact by regulation a *de facto* national policy in accord with the unratified Kyoto agreement on climate – a policy that the administration could never persuade the Congress to pass or the people to accept; in essence, backdoor legislation. The NOx regulations arose differently but followed the Kyoto style and went to like purpose.

Deep reductions in energy use would have been required to meet commitments the administration has made under the Kyoto addendum to the United Nations Framework Agreement on Climate Change. One 1998 study found that full compliance would bring about a 19 percent shortfall in meeting the power requirement projected for 2010.

In the chain of cause and effect, the now-rejected air standards followed roughly this path as they applied to coal and electric power:

- The National Energy Policy Act of 1992 set down a requirement for competition and restructuring in power to drive down oil imports and to bolster major, critical sectors of the economy;
- The professional green lobby discovered a few years later that price competition would lead inescapably and unavoidably to increased use of coal;
- Next, EPA discovered a need for sweeping new regulations on industry that included coal-generated electric power;
- And, finally, EPA uncovered interpretations of science and the law that gave a plausible excuse for moving ahead – interpretations to which the agency's own panel of scientific advisors objected.

. . . in today's best power plants the cost of a kilowatt-hour works out approximately as follows:
- Natural-gas generation – 1.4 cents;
- Nuclear generation – 1.35 cents;
- And coal – 1.02 cents.

It also means the average price of electric power has fallen for several years running.

Whatever else they may have done, or been meant to do, the rejected regulations had the clear potential to do the following:

- First, to quickly raise the cost of power generated with coal, thus distorting the onset of competition;
- And then, of equal importance, the poten-

tial of deepening concerns about the security of investments in coal-fired capacity, thus affecting long-term decisions as the power industry restructures to engage in competition.

EPA has announced that the decision will, in turn, be appealed; and I have no way to speculate on the outcome.

Meantime, the absence of regulation means the economy is free to continue turning to coal for immediate growth in the electric power supply at no penalty in price of power; and the requirement for power continues to grow.

Electric power is the principal and most versatile commodity in the U.S. economy – an item of at least $200 billion. It is the most widely used energy – industrial, commercial, and personal.

Almost every new kind of economic activity or amusement or convenience requires electric power, and it improves the performance of most existing ones. It is the feed stock of much activity and the genesis of more. It is the force that drives virtually all advanced technology.

To underscore the point: Estimates in the most recent *Forbes* magazine suggest that it takes about 1.5 pounds of coal to operate a personal computer and all its peripherals for an hour.

The magazine further estimated that 13 percent of the national power requirement is taken up by all the activities associated with computers, their fabrication, and the operations of the Internet; and the amount is growing each year.

An abundance of electric power is a condition requisite for a modern economy. Its presence is required for strength and growth, its absence a predicate for decline.

If power is not in the right place at the right time in the right amounts at the right price, everything either slows down or – in the case of computers – goes down. Abundant, reliable, and low cost electric power is one of the productivity advantages mining imparts to American workers. In the global economy the U.S. average of industrial power rates, with coal predominant, has been:

- 37 percent below the average for Europe;
- 49 percent below Germany, where subsidized coal and nuclear power are the mainstays;
- And 73 percent below Japan, where nuclear and imported liquid natural gas predominate.

A comparison of average international rates in dollars per thousand kilowatt-hours works out as follows:

Coal is 95 percent of the U.S. recoverable reserve of fossil fuel and natural gas is 3 percent.

- Japan — $269 for household power and $185 for industrial power;
- Germany — $204 for households and $101 for industry;
- The European average — $137 for households and $79 for industry;
- And the U.S. – $84 for households and $47 for industry.

Electric power from coal is one of America's competitive and comparative advantages – a global edge for the goods and services of American workers whether they are produced on a personal computer or an arc welder. Each of the factors affects the others – each of the others affects any given one. Electric power influences the performance of the economy – the performance of the economy influences the requirement for electric power. Coal influences the performance of electric power – the performance of electric power in the economy influences the demand for coal.

The situation in electric power is as follows:

- The economy is strong and growing, and Americans want to keep it that way;
- Power demand is strong;
- The annual requirement may grow by 45 percent through 2020;
- The combined requirement of growth and replacement may call for an additional output of 1.7 trillion kilowatt-hours a year — more than the present output of Japan and Germany combined;
- There will be direct, price-driven competition in the sale of this power at all levels – wholesale, retail, industrial, commercial, and residential;
- Only two fuels are available to supply additional power in large amounts – coal and natural gas;
- Coal is 95 percent of the U.S. recoverable reserve of fossil fuel and natural gas is 3 percent;
- Coal is the low cost fuel for power generation;
- Competition is expected to result in a near-term increase in coal use in existing power plants;
- All current environmental goals are being met and exceeded – all reasonable concerns will be addressed;
- And there should be a longer term trend to coal-based generation when the time comes to add baseload capacity.

Last year the price paid by utilities for fuel per million British thermal units was as follows:

- Coal – 125 cents;
- Natural gas – 238 cents;
- And petroleum – 214 cents.

Thus, regional and national competition should extend the reach and expand the demand for coal-fired power in the baseload requirement.

The first increments of growth will come from present fleet of coal-fired plants – from under-utilized capacity. The average utilization rate is expected to rise from 67 percent to about 80 percent. It has been rising steadily through the 1990s. Only a few years ago it was barely 50 percent.

In addition, many power producers are expected to improve existing capacity with equipment upgrades that raise efficiency. Upgrades and improved operations can deliver efficiency increases of 2-to-4 percent, which translate into effective capacity increases of 10-to-13 percent. One big producer sees a gain of 1,500 megawatts in these means alone.

Some project that the power-generation requirement for coal may rise as much as 30 percent on this wave – that increased use of existing capacity could result in annual demand for an additional 200-to-300 million tons as we move through the opening decades of the century.

Competition to sell coal into an expanding market should, in turn, bring about:

- Greater efficiency in coal production;
- Greater efficiency in transportation;
- And more competitive coal prices.

The momentum imparted will carry forward. As the time to add capacity comes on coal will be growing more competitive as a power fuel in a competitive power market.

Meantime, the coal industry is doing all it can to ensure that the possibilities and probabilities of today are not spoken of 50 years hence as just another version of the 1949 report *Energy in the Future*.

. . . *Forbes* magazine suggest that it takes about 1.5 pounds of coal to operate a personal computer and all its peripherals for an hour.

The magazine further estimated that 13 percent of the national power requirement is taken up by all the activities associated with computers . . .

Let's look at some of the other considerations that relate to economic structure and public policy.

Companies that mined coal as only an adjunct to their business are leaving the industry, especially oil companies. Coal-only and mining only companies are beginning to consolidate and the emphasis is on productivity.

Many expect the coal industry to come to resemble the oil industry in structure – 5-to-10 very large and very efficient companies delivering over half of production.

Many expect the coal industry to come to resemble the oil industry in structure – 5-to-10 very large and very efficient companies delivering over half of production. The large companies and the smaller survivors will compete intensely.

There will be fewer and larger mines. Surface mines of 25-to-50 million tons in annual production may be common, and deep mines of 5-to-10 million tons. The National Coal Council has suggested that in due time 100, or so, mines may deliver annual production of up to 1.3 billion tons. Preparation and other beneficiation will increase.

New mines will have to be opened. Many present mines were opened more than 20 years ago to answer a surge in demand, and are nearing the end of productive life. Much of the present workforce was enrolled in response to the same surge, and a new cadre will have to enrolled and trained as the present one retires.

The new mines and the training of the new miners will be centered on the most advanced technology, which means greater productivity and further improvements in miner safety and health. It also means more automation and emphasis on computers and high-tech processing.

Power producers will focus on costs and reliability, and their concerns will tend to become the concerns of their fuel suppliers. There will be *de facto* partnerships with power producers and, probably, formal partnerships. Some coal companies are becoming power brokers and graders – electric power.

In time coal companies may become energy and resource companies that supply an array of products.

We've touched on climate policy through the backdoor.

At the front door, the Kyoto protocol to the U.N. agreement must be ratified by the Senate if it is ever to apply; and then specific policies must be enacted by the Congress to apply it.

The protocol will not be ratified in the Senate as the Senate is now constituted and the question now stands. Due to almost unanimous opposition the administration will not even submit it. Ninety-six of 100 Senators sitting in the last Congress voted in favor of the Byrd-Hagel Resolution that warned against agreement. None voted against the resolution. All but a few of the 96 are still in office.

Both the Senate and the House have made note of this contradiction: That any and all reductions of fuel use and carbon dioxide output made by the United States and the industrialized nations will be soon erased and then swamped by the energy use of developing nations.

Both Senate and House also have taken strong exception. If anthropogenic carbon dioxide is causing the climate to change, the protocol will do nothing to usefully alter the trend in concentrations.

However, the protocol's restrictions can level a technology-oriented economy that increasingly depends on electric power at the right time at the right place in the right amounts at the right price. That 1998 study I mentioned also found that full compliance would shut down 36 percent of America's coal-fired generation.

At the same time the mining industry is promoting a technology-oriented approach to recognizing and constructively resolving concerns that relate to electric power; and this approach is receiving support both in the Congress and the Department of Energy. It builds and capitalizes on that which exists.

To change the way America lives and works, a substantial number of Americans and their representatives must be convinced there's great danger in what's being done.

And so, the programs *Industries of the Future* and *Vision 21* both go to the point. The point is to put performance in place ahead of the extremes of speculation – to be able to prove by performance that the reasonable concerns of reasonable people are being addressed.

Industries of the Future joins the mining industry with the national laboratories and others in the early identification, timely development, and orderly deployment of the technologies that will advance the human condition in the 21st century.

The effort is taking shape now. The response this month to the first call for proposals was strong – strong in the tradition of the clean-coal response. The objectives for mining include:

- Advanced production – minimum ground and community disturbance, lower energy consumption, improvements in miner safety and health;
- Advanced reclamation and remediation with an emphasis on more efficient and cleaner production;
- Greater utility of products and recycling where possible;
- Lower cost products in support of America's participation in the global economy and an ever-improving standard of living.

Vision 21 looks to the future by integrating the high-efficiency coal technology of integrated-gasification-combined-cycle generation with other elements in the clean coal program and new ideas.

One goal is 60 percent generating efficiency as soon as possible in the new century. Another is effectively to reduce to near zero the output of carbon dioxide associated with coal-fired generation – to do so by 2035 in conjunction with sequestration and other activities. Yet another is to look to the deployment of these technologies both domestically and internationally.

The coal industry is committed to *Vision 21*. Our vision includes complexes based on coal and high-efficiency technology that deliver at low cost an array of essential material resources that include:

- Electric power;
- Natural gas, other fuels, and fuel additives;
- Chemical products;
- Higher levels of recovery from existing oil and gas fields;
- And, through re-use of heat, 85 percent overall energy efficiency.

It's hard to argue waste and resource depletion to reasonable people if the technologies of production and recovery and use have just combined to expand the utility of the recoverable reserve by two or three hundred billion tons and two or three centuries.

It's hard to convince reasonable people that

(Continued on page 33)

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The DML comprises a family of diesel-powered blasthole drills mounted on a heavy-duty excavator-type undercarriage for nominal hole sizes from 6 to 9-7/8 in. (152-251mm). It is available in multi-pass versions of 30 or 35 ft. (9.1 or 10.7m) steel changes with bit loading forces for rotary drilling of 60,000 lb. (27,000kg) at up to 1,900 CFM bailing air capacity. High production downhole drilling is also attainable with high pressure compressor options of up to 1250 CFM at 350PSI.

For more information on Ingersoll-Rand Blasthole Drills, contact Anderson of West Virginia.

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White Flame Energy:

Making the Grades at Varney Grade School

"What are you going to be when you grow up?"

That question is often asked throughout any grade school in any town in any state. And, Varney Grade School in Mingo County, is not any different.

White Flame Energy, which started mining in the Varney area more than a year ago, understands the importance of companies and residents existing in complete harmony within the community.

Realizing this, employees from White Flame Energy were happy to visit Varney Grade School and be a part of the school's "Career Day."

"One of the things we emphasized was how important it is to finish school," said Mike Vines, White Flame's superintendent of operations.

But that is only one way for White Flame Energy to be involved with the community of Varney. Another is to have the school's students and teachers visit its site to get a better understanding what goes into such an operation.

And they did.

On the morning of June 2nd, as a continuation of Career Day, close to 300 students with 27 teachers and aides from Varney Grade School, assembled into six buses and traveled to see White Flame Energy's mountaintop mining operation, which is just a mere 5 minutes away.

"We can see the top of the school from the operation," Vines said.

Once on the operation, the students, ranging from kindergarten to 3rd grade, walked around, strained their necks as they stared in awe of the enormous equipment on display.

The equipment on show included a: 5230 Cat Shovel; 789 Cat 200 ton truck; 785 Cat 150 ton truck; 777 Cat 100 ton truck; and D-11 dozer.

Varney Principal, John Hatfield, is to be applauded for organizing and managing with great efficiency such a large group for this tour.

Varney Grade School students walked around and strained their necks as they stared in awe of the enormous equipment on display at the White Flame operation in Mingo County as a part of the school's Career Day.

Also, Varney teachers and aides did an excellent job keeping their classes together while walking around and learning more about the equipment.

Most especially, all Varney students were very well behaved as they proceeded around the equipment in an orderly manner. They asked many thoughtful questions and showed great interest in the operation, equipment and the environment.

After all questions were answered, the group traveled to a different location on the site to watch a valleyfill in progress. They were informed on the environmentally sound work what was being done on the site. As they looked down the hollow where the fill eventually would be, they noticed everything was dry and wondered were was the stream that was supposedly being covered.

All along the tour, guides were on each bus explaining to the students and teachers the operation and answering all questions.

While riding along the site, it is easy to see that Don Nicewonder, president of White Flame Energy, takes great pride in this operation as he does with all his operations throughout state.

In Varney, paving the road from the operation to Rt. 52 and washing it at least twice a day to minimize the dust are just two more ways Nicewonder makes the extra effort to be a part of the community.

A special congratulations to the people of White Flame and Walker

(Continued on page 33)

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WVMRA Publication Wins Excellence Award

A West Virginia Mining and Reclamation Association publication was recognized for outstanding excellence by the state's public relations organization.

The Public Relations Society of America's West Virginia chapter, presented WVMRA with the 1998 PRSA Crystal award, in the brochure category, for the publication ***IMPACT: The Importance of Coal to West Virginia.***

The award was presented during the PRSA banquet on May 21 in Charleston.

Now in its third edition, ***IMPACT*** was originally published by WVMRA in 1990. However, last year the publication was created in a different format than in the past years.

IMPACT is a publication filled with current industry statistics, benefits, issues, accomplishments including a section on mountaintop mining.

It has become the association's most popular publication.

While developing the brochure's new look, WVMRA received tremendous help from Chapman Printing's graphic designers, in creating the brochure's front cover.

An annual event, the PRSA's Crystal Awards program, showcases the best public relations campaigns and projects conducted in West Virginia for the previous year.

WVMRA will receive a crystal prism that reflects the long tradition of glass-making in the Mountain State and is etched with the Association's name and category.

PRSA chapter members are public relations professionals throughout West Virginia and come from all areas of business, government, nonprofit and institution of high learning.

With nearly 300 members, WVMRA is the largest state coal association in the nation.

The association was formed in 1966 from two regional organizations, the Southern West Virginia Mining Institute, and the North Central West Virginia Surface Mining Association.

Wal-Mart, the major part of Newpointe Mall, can be seen at the bottom of the photograph. The Eastpointe Mall, U.S. Post Office and a part of the interchange can be seen in the top portion.

reclamation

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Independence High School

Raleigh County

Independence High School in Raleigh County, completed 20 years ago, was built in concert with a mountaintop mining operation. The lower photograph demonstrates land stabilization techniques of mountaintop mining to be so effective that Sterling Smokeless Coal Co. was able to complete its operations while construction of the high school was in process.

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Helping Nature by Using Sawdust in Place of Topsoil

Reclamation methods and uses for completed surface mining operations, come in a variety of shapes and sizes.

Economic development has taken advantage of the now-usable land that includes building malls, hospitals, correctional facilities and schools which have sprouted up from Hancock to Mingo counties.

Outdoor recreation is coming more into play by creating campgrounds and golf courses on these sites with more being planned for the near future.

Now, post-mining methods have crossed a new horizon, using a form of sawdust as a topsoil replacement. A new source that can be used in areas such as farming resulting in life for many future generations.

In 1995, Eastern Hardwood Inc., a subsidiary of J.C. Hamer Company, located near Mt. Hope in Raleigh County, came upon a problem that plagues numerous sawmills, what to do with its sawdust.

The solution seemed simple to Lawrence Beckerle, forester for Jim C. Hamer, Company - use the material as topsoil for reclamation on surface mined sites.

Beckerle, who had previously been employed as mine reclamation manager, has written several proposals including how sawdust can be suitable for surface mines.

"This is the first project of its kind," said Beckerle "and I regarded this as a unique opportunity."

And the idea seemed like a logical as well as a practical one. Built on an old mine site itself, Eastern Hardwood's sawmill was less than two miles away from the old Harvey Energy's surface mine.

Beckerle said that the advantage of sawdust is that it will hold up to six times its weight in water. So plants such as clover that can fix nitrogen can then thrive in a weed free environment.

As a result, moisture retention has visibly benefited downslope vegetation during dry periods.

Several different clovers were planted throughout the area. Crimson clover will reseed itself year after year until competition shades it out. As a large clover, it is fairly easily established and fast growing.

White clover stays short, tolerates compacted soil very well, and is compatible for growing trees.

Sweet clover, in conjunction with white clover, is an excellent combination for wildlife species, especially turkey.

Red patches of Crimson clover can easily be seen throughout the reclaimed mined site.

Different species of clover were planted as well as agriculture crops such as watermelon and canteloupe.

In all, a total of 45 acres of the mined site were covered in sawdust.

"The seven mountaintop fields are now supporting a much more diverse and lush growth of plants than existed before the mining operation," Beckerle said.

As the project increased, several perennials garden-type crops were established, asparagus horseradish, rhubarb, strawberries, just to name a few.

Cantaloupe and watermelon were also successfully grown in the sawdust that had decayed about two inches which was enough to establish the roots of these pioneer plants.

"There are more mustard greens, turnips, and sunroot growing than any one man could harvest and eat," Beckerle said.

He also noted that both crimson and white clover produced enough seed that Eastern Hardwoods officials are looking at harvesting the seed, which would help reduce costs in future revegetative work.

(Photograph by Lawrence Beckerle)

In a separate test, Beckerle discovered that Black cherry seed would survive a hydroseeder.

"In this project there was enough survival of the Black Cherry seed that at less than $7 a pound," Beckerle said, "some companies may want to consider adding it to their hydroseeding mixes at the rate of 4 to 8 ounces per acre."

As a first-of-its-kind project, using sawdust may open doors to future reclamation projects that can provide for future generations.

(Below) A sample of the sawdust mixture that was spread over 45 acres of the old Harvey Energy site. This project is the first of its kind to use sawdust as topsoil on old surface mining sites.

(Lower left) A turkey searches for grasshoppers in a field of white clover.
(Bottom) Lawrence Beckerle shows Amanda Acord of Nicholas County High School the new growth of Big Tooth Aspen and Black Walnut trees grown in sawdust.

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Standard	17 yd^3 (13.00 m^3)	22 yd^3 (16.82 m^3)	28 yd^3 (21.4 m^3)
High Lift	16 yd^3 (12.00 m^3)	20 yd^3 (15.29 m^3)	26 yd^3 (19.9 m^3)
Dump Heights			
Standard	18'-5" (5.61 m)	18'-10" (5.74 m)	21'-6" (6.55 m)
High Lift	19'-10" (6.04 m)	20'-0" (6.10 m)	23'-6" (7.16 m)

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21st Century

from page 15

America is the cause of the world's carbon dioxide concerns at efficiency rates of 60 and 85 percent and emissions near zero.

This will be our response to the doomsday forecasters of the 21st century.

When the report *Energy in the Future* first postulated a limited future for coal the following facts applied:

- There were 151.3 million Americans;
- Each one required almost 2,200 kilowatt-hours of power a year at work and at home;
- The average efficiency of generation was 16 percent;
- The output of one miner produced 373-thousand kilowatt-hours;
- Each miner supplied the power requirement of 170 fellow Americans;
- The nation required 329-billion kilowatt hours – less than half from coal;
- And our inflation adjusted gross economic output was $1.6 trillion.

Almost 50 years later in 1997 the following facts applied:

- There were 267.6 million Americans – a 75 percent increase;
- Each one required 11,600 kilowatt-hours at work and at home – a 5-fold increase;
- The efficiency of conventional coal generation averaged 33 percent and at its best hits a reported 38 percent – more than double;
- The output of one miner produced almost 23-million kilowatt-hours – more than 60 times greater;
- Each miner supplied the power requirement of almost 2,000 fellow Americans – almost 12 times;
- The nation required more than 3-trillion kilowatt-hours – 10 times, and well over half of it from coal;
- And our gross economic output was $7.2 trillion – 6 times.

Electric power is the indispensable ingredient for a modern economy, and coal is the indispensable fuel for electric power.

The *Coal Industry in the 21st Century* is a work in progress.

The industry won its place in the present by performance in the market, and it intends to keep performing.

Success requires good managers and good miners to deliver the product and good lobbyists and, especially, good lawyers to keep the way clear.

Let all of us in the coal chain resolve now to do all we can to deliver to our fellow Americans their *Energy in the Future* on the best possible terms. They're counting on us whether they know it or not.

Performance will prevail over the critics every time.

White Flame Energy

from page 20

Machinery for all the hard work putting this tour together and continuing to make the concerted effort in working with the local community.

At the end of the visit, see-through back packs were given to all the students, compliments of White Flame Energy and Walker Machinery.

Donations were also contributed by: Nelson Brothers, Robertson and Associates, Two-Way Radio, Goodyear, Sauls Engineers, Inc., Cintas, Logan Corporation and the WVMRA.

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Coal Calendar 1999

July

12 **Coal Foundation Golf Tournament,** The Virginian, Bristol, VA. Contact Patty Bruce (304) 346-5318.

19 **Tug Valley Mining Institute 5th Annual Everett Thompson Memorial Golf Classic,** Lavalette Golf Course, Lavalette, WV. Contact Dave Akers, (304) 426-4422 or John Hubbard (304) 235-1400.

26-29 **Coal in the Classroom,** Mining Health and Safety Administration Academy, Beckley, WV. Contact Sandi Davison (304) 342-4153.

August

3-5 **18th International Conference on Ground Control in Mining,** Lakeview Scanticon Resort & Conference Center, Morgantown, WV. Contact Karen Centofanti, (304) 293-7680.

5-8 **West Virginia Mining and Reclamation Association Annual Meeting,** The Greenbrier, White Sulphur Springs, WV. Contact Patty Bruce, (304) 346-5318.

13-15 **14th Annual Historical Construction Equipment Association National Convention & Old Equipment Exposition**, National Pike Steam, Gas & Horse Association Grounds, West of Brownsville, PA.

18 **Fourth Health and Safety Seminar for Small Mines,** Ramada Inn, Somerset, PA. Contact Mary Ann Sherburne (814) 865-7472.

19 **Tug Valley Mining Institute Meeting, Brass Tree Restaurant.** For reservations, call (304) 946-4100.

20 **12th Annual Kentucky Professional Engineers in Mining Seminar**, Holiday Inn North, Lexington KY. Contact Geaunita Caylor (606) 257-2820.

21-28 **46th Annual Pennsylvania Bituminous Coal Show,** Carmichaels Fire Hall and High School, Carmichaels, PA.

September

2 **Kanawha Valley Mining Institute Dinner/Meeting,** Heart-of-Town Motel, Charleston, WV.

8-10 **23rd Annual Mine Rescue, First-Aid, Benchman & EMT Contest**, The Birmingham/Jefferson Civic Center, Birmingham, AL.

14 **Pittsburgh Coal Conference,** Pittsburgh, Marriott Hotel, Greentree, PA.

15-17 **The Bluefield Coal Show**, Bluefield Armory-Civic Center, Bluefield, WV. Call (304) 327-7184.

16 **Tug Valley Mining Institute Meeting, Brass Tree Restaurant.** For reservations, call (304) 946-4100.

21-23 **West Virginia Safety Council Conference/Training & Exhibit and Awards Banquet,** Charleston Civic Center, Charleston, WV.

27 **Coal Foundation Golf Tournament,** Pete Dye Golf Club, Bridgeport, WV. Contact Patty Bruce, (304) 346-5318.

JULY

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

AUGUST

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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

SEPTEMBER

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

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Coal Industry Now Included in TRI

On July 1, 1999, the U.S. coal and metal mining industry, as well as the coal burning utilities, will be required to provide to the Environmental Protection Agency and state and local agencies data gathered as a part of the Toxic Release Inventory.

Often referred to as the Community-Right-to-Know Act, the EPA requires certain manufactures to submit "releases" of chemicals into air, water and land annually for public consumption.

In 1994, the Clinton administration doubled the original number of chemicals that must be reported, to nearly 650.

When the Act first passed in 1986, Congress intended that the TRI apply only to manufacturing industries such as chemical plants, smelting operations, petroleum refiners, paper manufacturers and makers of transportation equipment.

Then on Earth Day 1997, the administration directed that six new industrial sectors, that included coal, utilities and metal mining operations, begin reporting in July 1999.

According to the EPA, approximately 30,000 facilities will report this year.

TRI is used to inform the public about operations in their state or community. TRI is a volume or weight-based report. It is not intended to asses risk. The data cannot be used to determine actual toxicity, exposure, or risk associated with the release that are reported.

Under the TRI law, all mines must report the amount of naturally occurring metals and other substances present in the rock materials they manage as well as other substances covered in the TRI.

Coal mining operations that wash and/or dry coal to improve its burning qualities before it is shipped to electric power plants will report the listed substances that are used or emitted during these processes.

Unlike copper and gold, coal occurs in more nearly uniform deposits. As a result, coal mines will not have large volumes of listed substances embedded in unneeded rock to report under the TRI as in the metal mining industry.

However, coal powered utilities are expected to head the TRI list when the EPA releases its final numbers.

Nationwide, these utilities had taken the initiative and announced their 1998 releases on June 4 instead of waiting until July 1.

"AEP is one of the largest coal-burning utilities in the country," said Dale Heydlauff, vice president - environmental affairs for AEP, "and our releases are a direct result of the coal combustion process. We burned about 108 billion pounds of coal in 1998 to meet our customers' needs for electric energy; the magnitude of these releases correspond with that amount."

Nonetheless, the National Mining Association notes that by the year 2010, a utility burning a ton of coal will emit 82 percent less sulfur dioxide than in 1970.

Even with the controversies that surround the coal industry, coal is a necessity of today's society.

According to AEP, one kilowatt-hour of electricity - one 100 watt light bulb left on for 10 hours - burns about one pound of coal and that a typical person consumes about 18,000 kilowatt-hours, or about 18,000 pounds of coal a year.

Nine of every 10 tons of coal used in the U.S. are for electricity generation.

More than 57 percent of the electricity used in the U.S. is generated from coal. The demand increases every year and is expected to continue.

In West Virginia, more than 99 percent in West Virginia, is generated from coal.

Consequently, these releases reported in the TRI are an unavoidable consequence of burning coal and an example of the public's demand for efficient, cheap electricity.

The demand for coal will continue to rise. And, coal will be continue to be a major source of electricity generation, especially in West Virginia.

LONG TERM EFFECTS OF TWO ACID MINE DRAINAGE REMEDIATION PROJECTS ON STREAM QUALITY

By
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Introduction

In 1998 and 1999, water samples were taken in streams surrounding two acid mine drainage (AMD) remediation projects in West Virginia. Based on the results, the remediation projects on each of these two sites were evaluated as to their effects on water quality. The two projects were the Webster Refuse abandoned mine land (AML) Project in Preston County and the Douglas Highwall AML Project in Tucker County. More remediation projects are being evaluated in this study, which is funded by the West Virginia Division of Environmental Protection, Office of Water Resources and the Office of Abandoned Mine Lands and Reclamation.

Webster Refuse AML Reclamation Site

The Webster Refuse site, located near State Route 26 about 5 miles south of Bruceton Mills in Preston County, was about 35 acres in size. Three underground mine portals in the Upper Freeport Coal were discovered on the property and large piles of waste coal and gob were located immediately below the portals (Figure 1).

A broken-down tipple was surrounded by the large piles of gob. Surface mining had been conducted along the contour, leaving a highwall of about 40 feet. Water from the portals and runoff water from the site drained into Webster Run. Webster Run flows into Little Sandy Creek, which then flows into Big Sandy Creek, and then into the Cheat River.

The West Virginia Division of Environmental Protection, Office of Abandoned Mine Lands and Reclamation initiated a project to reclaim this site. Construction was completed in the summer of 1988 by the Green Mountain Company at a cost of $519,333. The work performed on this project consisted of installing three non-calcareous gravel bulkhead mine seals, eliminating about 1,200 linear feet of highwall ranging between 20 and 50 feet high by excavation and backfilling, regrading mine spoil and coal refuse piles, constructing diversion ditches and rock underdrains, building a sedimentation pond, erecting a temporary acid mine drainage treatment facility, covering refuse and spoil materials with soil material, and establishing vegetation (Figure 2).

The most innovative aspect of the reclamation project involved the construction of an alkaline leach bed, a passive acid mine drainage treatment technique designed to treat water coming from the deep mine portals (Figure 3).

The contractor was careful in the sequence of reclamation events because the bulkhead seals, the underdrains, and the leach bed had to be tied together at one time (Figure 4).

The alkaline leach bed has dramatically changed the deep mine water quality from acid to alkaline (Table 1). The portal water quality varied between 1988 to 1994 from a pH of 2.9 to 3.9, and acidity from 60 to 200 mg/L as $CaCO_3$. The last sampling in February 1999 showed a much higher pH and lower acidity than those parameters as previously measured. It is possible that the wet seal and the climatic conditions at the time of sampling had some effect on the portal water quality.

Table 1. Water quantity and quality from Upper Freeport underground mines at the Webster Refuse AML reclamation site (portal water). The alkaline leach bed has received the drainage from these deep mines since 1988 and water quality is given for water exiting the leach bed (leach bed effluent).

Location and Date	Flow	pH	Acid	Fe	Mn	Al	Sulfate
	cfs	s.u.	mg/L as $CaCO_3$	mg/L			
Portal Water							
8/86	—	3.7	129	2.4	3.3	7.7	1280
2/88	0.1	3.9	62	6.1	1.8	2.9	1000
8/88	0.1	3.3	140	14.5	4.8	17.0	1400
8/94	0.1	3.1	208	23.0	7.1	21.1	1040
2/99	0.1	5.6	15	0.6	1.3	0.2	—
Leach Bed Effluent							
8/88	0.2	7.7	-50	0.4	0.8	0.8	1000
2/89	0.1	7.1	-20	0	0	0.3	—
8/89	0.1	6.6	-40	0	0	0.2	1200
8/92	0.1	7.0	-65	0.1	0.3	0.5	1050
8/94	0.1	6.9	-127	0.1	1.1	0.4	1040
2/99	0.1	7.3	-89	0.1	0	0.3	—

The limestone leach bed has generally raised the portal water from pH 3.5 to 7.0 and generated net alkaline water. This leach bed is very large and contains much more limestone than would be normally used to treat an acid mine drainage flow of this size and magnitude.

It has been extremely successful in treating the small quantity of water from the portals. It is expected to continue discharging alkaline water for many more years and has been a very successful passive acid mine drainage treatment method.

Water quantity and quality data from Webster Run, both above and below the alkaline leach bed, are given in Table 2. Webster Run above the AML project had a low pH and low acid concentrations before the project was initiated (1/83 and 8/86 sampling dates), and it has remained unchanged until the last couple of years.

The alkaline water from the leach bed has had a noticeable effect on Webster Run downstream. In all cases since 8/88, the water pH increased and acidity decreased between downstream and upstream of the alkaline leach bed.

Our sampling in February 1999 showed almost no acidity in Webster Run above the project, and the limestone leach bed improved Webster Run to an alkaline stream. This improvement upstream over time may be due to other land reclamation activities above the AML site since 1988.

Douglas Highwall AML Reclamation Project

The Douglas Highwall project is located along the North Fork of the Blackwater River between Thomas

Table 2. Water quality of Webster Run both upstream and downstream of the inlet of the alkaline leach bed water at the Webster Run AML Project.

Location and Date		Flow	pH	Acid	Fe	Mn	Al	Sulfate
		cfs	s.u.	mg/L as $CaCO_3$	mg/L			
Webster Run Above and Below Leach Bed								
1/83	Above	—	4.4	43	0.4	2.3	5.1	—
1/83	Below	—	4.3	40	0.4	2.0	3.9	—
8/86	Above	—	4.6	98	0.5	5.9	15.0	460
8/86	Below	—	5.5	31	0.2	4.6	3.4	450
2/88	Above	5.0	4.6	57	0.6	2.1	5.8	240
2/88	Below	7.0	4.7	40	0.5	1.8	3.5	240
—Alkaline Leach Bed Installed—								
8/88	Above	0.3	4.4	113	1.1	9.0	12.5	700
8/88	Below	0.7	6.5	17	0.2	4.5	0.3	650
6/96	Above	1.8	5.9	32	0.5	0.1	0.3	—
9/96	Below	1.9	6.7	0	0.7	1.2	0.6	—
2/99	Above	—	5.8	2	0.3	0.5	0.3	—
2/99	Below	—	6.0	-5	0.3	0.5	0.3	—

and Douglas on County Route 27 in Tucker County. The site was the location of the Davis Coal and Coke Company's cokeyards. It is not clear how many coke ovens were located within the project site, but a conservative estimate predicted more than one hundred ovens. The Western Maryland Railroad had an abandoned line which parallels the river. The track has been removed and the smooth, nearly level rail bed attracts hikers and all-terrain vehicle riders.

Highwalls for the Bakerstown coal seam were found along the southern edge of the property, located several hundred feet above the river bed on the contour.

One very large and several smaller refuse piles were within the project boundaries (Figure 5). Many abandoned coke ovens were covered by the refuse, while a few were still visible at the time of project construction. At the upstream end of the project, the #29 underground mine portal was open and discharged large quantities of acid mine drainage directly into the North Fork of the Blackwater River.

The amount of water coming from the portal varied between 250 to 3,000 gpm, and the water had a pH between 2.8 and 3.1, acidity concentration of about 500 mg/L as $CaCO_3$, Fe of 40 mg/L, Al of 55 mg/L, Mn of 10 mg/L, and sulfate of 900 mg/L.

Reclamation of the 60-acre site included excavating and regrading 360,000 cubic yards of spoil and refuse, and constructing subdrains along the base of the highwall to discharge water into several fabriform ditches and convey water safely down the slope to the river. About 4,000 feet of highwalls were eliminated and five mine openings were closed (Figures 6 and 7). The contractor was Breckenridge Corporation and the entire project cost about $1.4 million.

The innovative aspect of this project was the construction of a large bulkhead seal for the large #29 mine opening and stabilizing the road above the portal. About 240 gpm of acid mine drainage from the portal was piped to an experimental wetland/anoxic limestone drain (WALD) system to treat the water. The WALD was 2800 feet long, composed of two cells, with about 16,000 tons of limestone and 6,600 cubic yards of organic material (Figures 8 and 9).

A previous article in Green Lands (see Skousen 1995, Volume 25, Winter Issue) provided an original description of the site and the passive treatment design.

Water quality data have been collected in the Northfork of the Blackwater River both upstream and downstream of the reclamation activities and also from the influent and the effluent of the WALD system. The acid mine drainage from the portal was introduced into the WALD system starting in August 1994.

The WALD system raised the pH of the 240-gpm flow from an average of 3.0 to a maximum of 7.3 during the first year (Table 3). After one year, effluent pH declined from 5.2 after 13 months (9/95) to 3.0 after 19 months (3/96).

Effluent pH in 1998 (after approximately four years of operation) was about 3.5. Acidity decreased from the original 500 mg/L as $CaCO_3$ to an average net alkalinity of 127 mg/L as $CaCO_3$ during the first year. During the last three years, the acidity of the portal water decreased to around 300 mg/L as $CaCO_3$ and the water exiting the WALD averaged 170 mg/L as $CaCO_3$. Even though alkalinity is not measurable in the water exiting the WALD, precipitation of metals in the system has caused a reduction in total acidity.

Iron and aluminum, the metals of primary concern, did not exit the WALD system during the first year and ferrous iron was not generated in the system by iron-reduction reactions. Manganese was also removed by the system during the first year and this was probably due to co-precipitation of the Mn with Fe and Al hydroxides. The pH and mV values measured in the wetland should not have been high enough for Mn precipitation by itself, but Mn is often reduced in treatment systems where Fe and Al are being precipitated.

The high mV and dissolved oxygen readings in water throughout the WALD system confirmed our observations of surface rather than subsurface water flow in the system (data not shown). Most of the water flowed across the surface of the WALD in Cell I, rather than migrating downward through the organic matter. The low permeability of the organic substrate lead to short circuiting of the flow and little contact with organic matter was attained with the majority of the water. These data and our observations suggest that the Douglas WALD system acted as an aerobic, Fe-oxidizing system rather than an anaerobic, Fe-reducing system as originally intended.

After a few months of operation (in November 1994), we attempted to reduce the surface flow and encourage ponding and downward movement of the water into the organic substrate by installing a series of hay bale dikes every 10 m in Cell I (Figure 10). However without an outlet for the water below the limestone and organic substrate (such as a drainage system), the water simply ponded behind the dikes and exited at the dike's lowest point. Beavers have since taken up the task of ponding the water in the WALD system (Figure 11).

Although the effluent water quality from the WALD was greatly improved during the first year, the longevity of treatment was compromised since Fe and Al in the water precipitated in the system. The system has not generated measurable alkalinity, but metals are continuing to precipitate in the system thereby reducing the

Table 3. Water quality of the acid mine drainage coming from the underground mine portal and exiting the WALD from 1994-1998.

Location and Date	Flow	pH	Acid	Fe	Mn	Al	Sulfate
	cfs	s.u.	mg/L as $CaCO_3$	mg/L			
Portal Water							
9/90	1.3	2.9	575	48	10	57	920
7/93	2.2	2.9	491	36	11	56	720
4/94	4.8	3.0	345	25	6	35	660
8/94	1.3	3.1	240	22	6	28	690
2/95	0.2	3.0	300	15	7	30	550
8/95	0.8	3.1	290	21	7	30	406
2/96	5.0	3.0	383	20	7	36	630
8/96	5.9	3.0	237	10	6	23	518
3/97	3.1	3.0	219	10	4	19	335
9/97	0.2	3.0	253	9	4	21	347
3/98	2.8	2.9	245	9	4	22	445
7/98	4.5	2.9	206	13	6	27	816
9/97	0.2	3.0	253	9	4	21	347
Water exiting the WALD							
8/94	0.5	7.3	-60	20.0	6.0	35.0	249
11/94	0.5	7.0	-231	0.3	0.2	0.3	625
3/95	0.5	6.8	-90	0.0	1.2	0.1	423
6/95	0.5	6.8	-120	0.2	14.0	1.5	395
9/95	0.5	5.2	-45	0.3	5.3	1.8	503
11/95	0.5	4.5	80	3.8	5.6	23.9	569
3/96	0.5	3.0	165	12.3	5.5	21.0	490
6/96	0.5	3.3	198	14.0	4.8	18.8	415
3/97	0.5	3.0	165	11.5	5.8	22.5	460
11/98	0.5	3.7	147	1.8	4.9	15.1	480

acidity of the water and the metal load to the river.

During 1994 to 1995, a 100% reduction of acidity and net alkaline water was introduced into the river from the WALD. In other words (at 240 gpm and 300 mg/L acidity as $CaCO_3$), 158 tons of acid did not enter the river.

An additional acid reduction estimate can be made for later years (1995-1998) assuming the average influent acidity value was 300 mg/L as $CaCO_3$ and the average effluent acidity value was 170 mg/L as $CaCO_3$ at the 240-gpm flow. Without treatment, about 158 tons of acid per year entered the river. After passing through the WALD, only 89 tons of acid per year entered the river. This represents 69 tons less acid per year (or about a 44% reduction), and multiplying that amount for the past three years equals more than 200 tons of acid that have not entered the river. The system may continue to reduce the acidity of the water to this level for many more years. So while the system may not be introducing net alkaline water into the river, significant amounts of acid and metals are not entering the river due to the WALD system.

The Northfork of the Blackwater River has excellent water quality before it is degraded by the #29 portal water at Douglas. Remember that only a small fraction of the water exiting the portal is piped through the WALD system, so most of the portal acid mine drainage, still untreated, flows directly into the river.

Land reclamation activities at both the Douglas and Albert AML projects have reduced sediment and coal waste from eroding and reaching the river.

Since 1993, more than $4 million has been spent on reclamation activities in the Northfork area. As mentioned, nearly $1.4 million was spent at the Douglas Highwall project, which included the WALD passive treatment system and land reclamation.

At the Albert Highwall AML project, just downstream from the Douglas project, another $2.2 million was spent on land reclamation, coal waste covering, highwall backfilling, and revegetation. More than 15 passive treatment systems including anoxic limestone drains (ALDs), anaerobic wetlands, and successive alkalinity-producing systems (SAPS) were constructed at Albert to treat AMD.

Water quality improvement of the Northfork of the Blackwater due to reclamation is masked because of the large acid mine drainage flow that continues into the river from the #29 portal at Douglas.

Water quality of the Northfork is sparse before reclamation and we have only a few samples of the water quality before 1991.

In Table 4, three sampling dates have water quality data before AML work for the Northfork of the Blackwater River downstream from both of these AML projects. If these data represent the water quality of the river at this point, then an average of about 160 mg/L of acidity as $CaCO_3$ was found in the river water. Since 1993 after AML work began, the average acidity has been about 70 mg/L as $CaCO_3$. This is a loss of 90 mg/L of acid or about a 56% acid reduction. So close to 60% of the acidity that was entering the river before AML work may have been eliminated due to land reclamation activities and passive treatment systems placed at these two AML sites.

Acknowledgments

We express our thanks to the West Virginia Division of Environmental Protection for giving access to files and data from these two sites. Special acknowledgment is extended to Lyle Bennett, Mike Sheehan, Sheila Vukovich, Dave Broschart, Marshall Leo, Ben Faulkner, and Charlie Miller.

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Table 4. Water quality and quantity in the North Fork of the Blackwater River both abovestream and downstream of the Douglas and Albert AML projects.

Location and Date	Flow	pH	Acid	Fe	Mn	Al	Sulfate
	cfs	s.u.	mg/L as $CaCO_3$	mg/L			
North Fork of the Blackwater Upstream of WALD							
2/94	31.9	7.1	-14	0.5	0.4	0.9	40
8/94	24.4	7.4	-19	0.7	0.3	0.6	41
2/95	2.1	7.2	-21	0.9	0.4	1.0	37
8/95	1.9	8.1	-34	0.8	0.3	0.3	60
2/96	19.1	7.0	-28	0.5	0.2	1.1	25
8/96	79.9	6.8	-18	1.2	0.2	0.7	22
3/97	10.5	6.9	-17	0.4	0.2	0.4	26
9/97	3.4	6.9	-40	0.3	0.2	0.1	77
3/98	45.8	7.0	-19	1.9	0.2	1.6	21
7/98	26.7	7.4	-28	0.7	0.2	0.6	24
North Fork of the Blackwater Downstream of WALD							
7/80	16.9	3.6	153	10	2	—	310
9/85	6.5	3.4	220	13	3	14	365
9/91	22.5	3.5	100	12	3	8	275
——AML Projects——							
9/92	7.2	3.5	88	7	2	6	185
2/93	26.9	3.7	68	4	2	7	170
7/93	2.8	3.2	147	5	3	13	294
3/94	—	4.8	19	2	1	3	54
2/95	29.2	3.9	43	5	1	8	153
8/95	11.9	3.7	80	5	3	12	317
3/96	50.3	3.6	71	6	2	9	149
8/96	15.9	3.6	72	4	2	8	156

Figure 1. The Webster Run AML site in Preston County had three underground mine portals, an old broken-down tipple, and numerous areas of wasted coal gob. This picture was taken in January 1988 at the pre-bid construction site tour.

Figure 2. Reclamation activities at Webster Run included regrading the highwalls, covering the coal gob, topsoiling, and revegetating the site.

Figure 3. A large alkaline leach bed was constructed at the Webster site. This excavation was filled with large 2 to 4-inch limestone rock and covered. Acid mine drainage from the portals was directed into the leach bed and treated.

Figure 4. The Webster Run leach bed, completely covered, as it looks today. Water continues to flow into the limestone and exit through a pipe at the far end of the leach bed.

Figure 5. The Douglas AML site in Tucker County as it looked before reclamation. Highwalls and benches of the Bakerstown Coal are located on the left, and a large refuse pile is located on the right. The Northfork of the Blackwater River is in the center paralleled by an old railroad line. This picture was taken in May 1992.

Figure 6. Reclamation at Douglas included eliminating the highwalls, regrading and covering the refuse, topsoiling, and revegetating the site. This picture was taken in August 1993.

Figure 7. Fabriform ditches convey water to the river and erosion control structures help reduce the movement of sediment into the river.

Figure 8. A section of the 2700-ft long wetland-anoxic limestone drain (WALD) system constructed to treat some of the acid mine drainage. This picture was taken in September 1994.

Figure 9. A wetland developed in many parts of the WALD.

Figure 10. Due to surface flow of the water, hay bales were placed to slow down the flow and pond the water on top of the organic substrate.

Figure 11. Beavers have constructed dikes in the WALD system and ponded the water up to three feet deep in several places along the length of the system.

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