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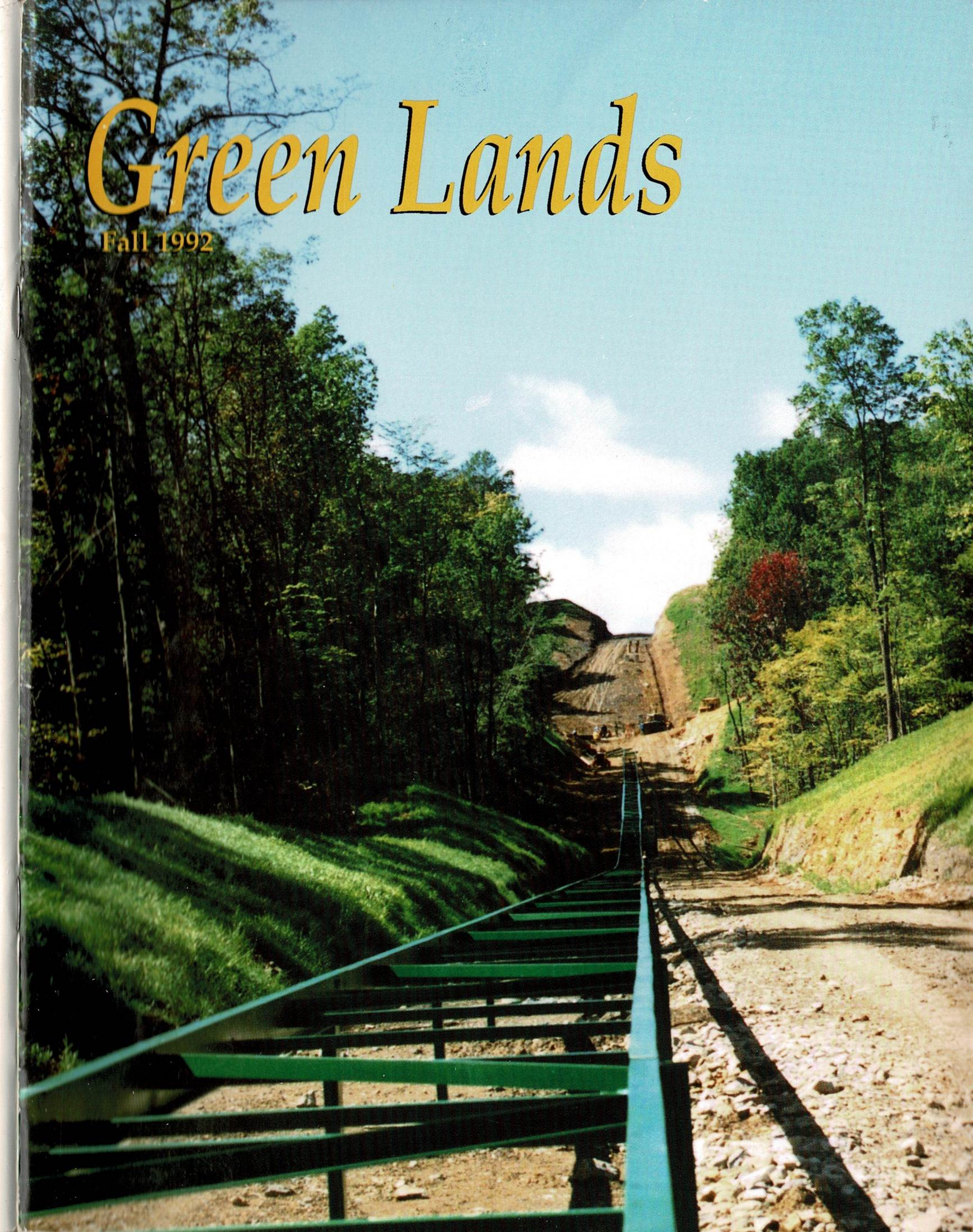
Fall 1992



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*2566	224	25
*2766	237	27.5
*3066	275	30
*4066	359	40

*New Models

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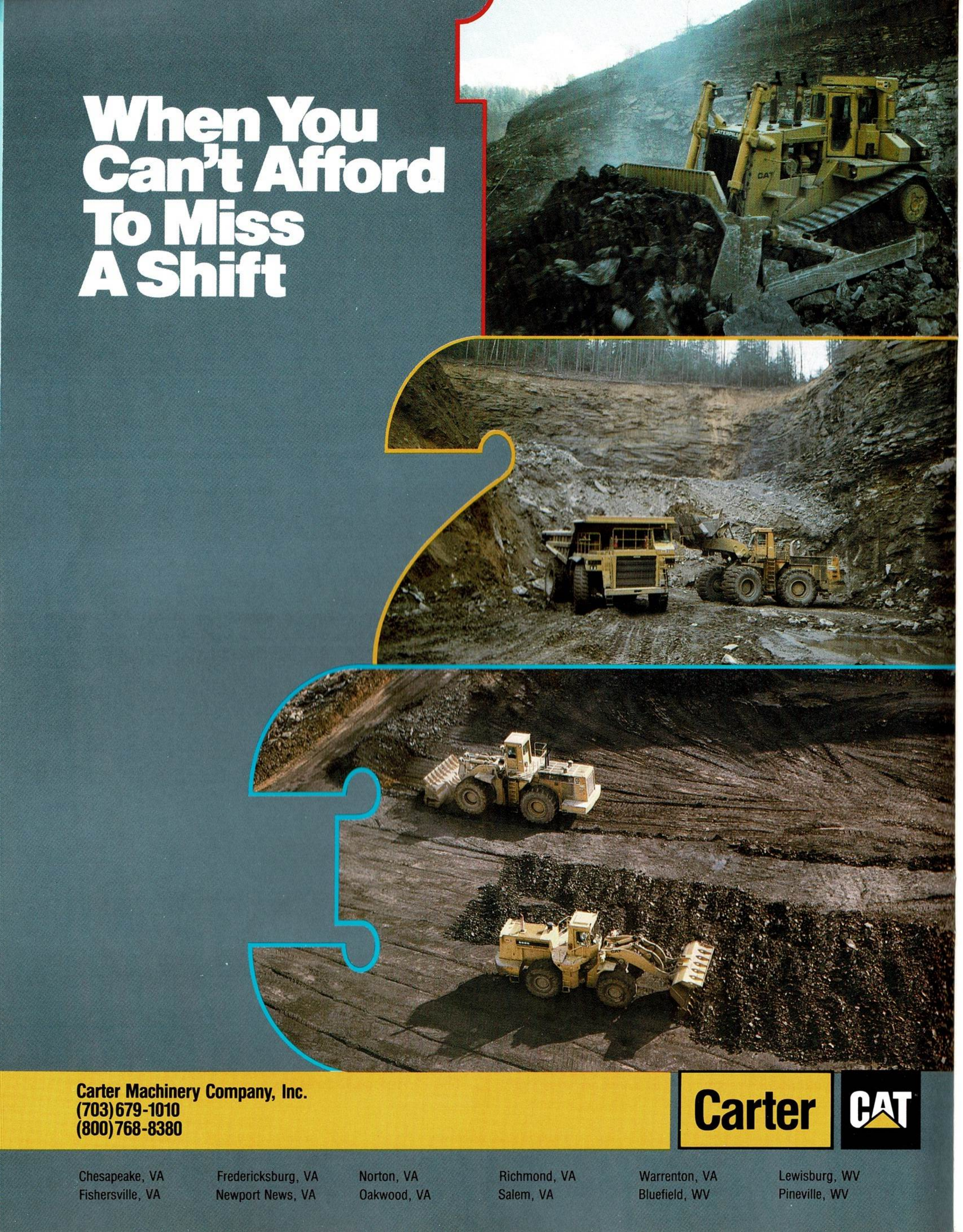

Green Lands

Volume 22 Number 4

Green Lands
is a quarterly publication of the
West Virginia Mining & Reclamation Association,
with offices at 1624 Kanawha Boulevard East
Charleston, West Virginia 25311
(304) 346-5318

Our Cover
Evergreen Mining Co. is making its presence felt in central West Virginia. Its overland conveyer system, now under construction, is symbolic of the company's growing efficiency and its positive impact on the local economy. Cover story on page 22.

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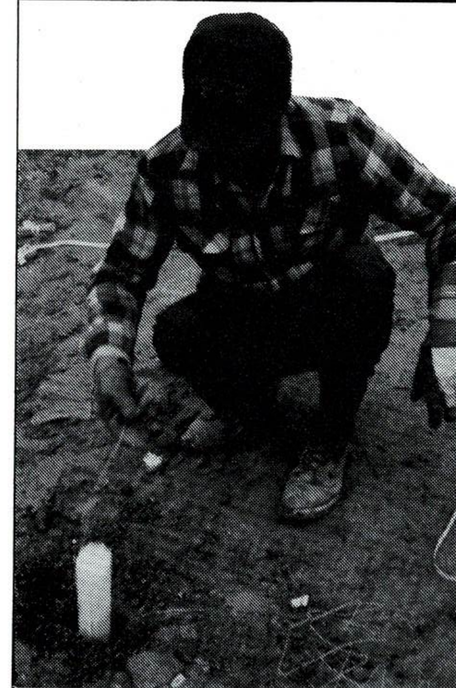

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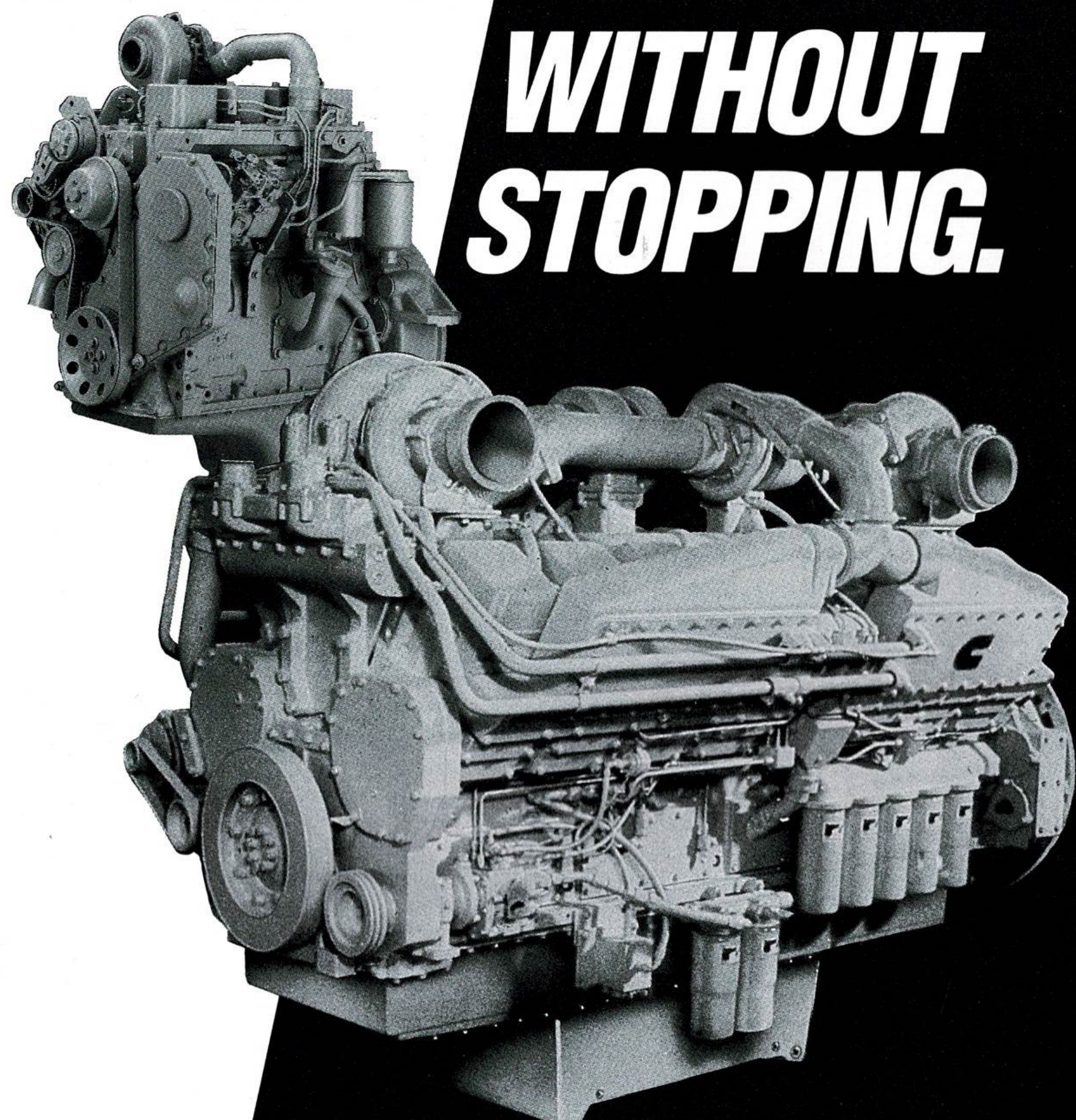

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New WVMRA Chairman is Gerald Ramsburg

Recessions may come and go, but The Greenbrier just rolls on. The popular resort in White Sulphur Springs has been the scene of WVMRA's Annual Meeting for nearly a quarter of a century, and it seems that bellmen can pretty well count on greeting over 500 members of the West Virginia mining community each and every August.

About 550 were on hand for the 1992 gathering. After gray skies forced the Thursday night opening reception indoors, the weekend brought plenty of sunshine to tennis players, runners, golfers, fishermen and trap shooters.

Indoors, a full program of meetings, technical sessions and social events rounded out another successful meeting.

The highlights:

New Chairman

Gerald Ramsburg of C & W Coal Co. is the new Chairman of the Association's Board of Directors. He succeeds **Don Cussins** of Buffalo Coal Co., who served as chairman in 1991-92.

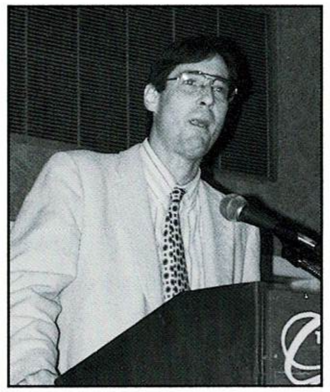
Gerald is a native of Jane Lew, Lewis County, and a graduate of Glenville State College. He got an early start in the industry, hauling coal with his own truck in the Lewis/Harrison county area. In 1974, he went to work for Grafton Coal Co. as a tipple manager. Eleven years later he joined Enoxy Coal in Upshur County and, in 1986, became general manager of C & W Coal Co., a 17 year WVMRA member.

Following a tradition of past chairmen, Gerald has many community interests. For several years he has coached youth sports in Lewis County. He currently serves on the Glenville State College Foundation, as well as the Lewis County Development Authority, and is a former chairman of the Lewis County United Way.

26th Chairman Gerald W. Ramsburg addresses the Association at the the closing banquet on Saturday night.

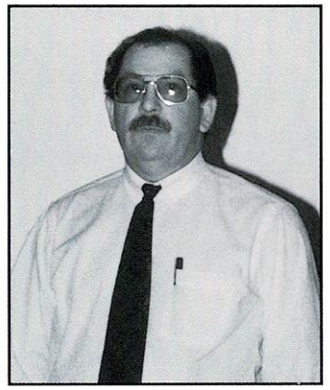
WVMRA Past Chairmen

1966-67	Leo Vecellio, Sr.	1980-81	Lawrence A. Streets
1967-68	F. B. Nutter, Sr.	1981-82	William C. M. Butler, III
1968-69	Arch F. Sandy, Jr.	1982-83	Donald R. Donell
1969-70	John C. Anderson	1983-84	Tracy W. Hylton
1970-72	G. B. Frederick	1984-85	Carl DelSignore
1972-73	James L. Wilkinson	1985-86	Dwight M. Keating
1973-74	Lawson W. Hamilton, Jr.	1986-87	Theodore J. Brisky
1974-75	James C. Justice, Sr.	1987-88	James W. Anderson
1975-76	H. L. Kennedy	1988-89	Roy G. Lockard
1976-77	Frank D. Jennings	1989-90	Paul F. Hutchins
1977-78	James H. Harless	1990-91	Kenneth G. Woodring
1978-79	John J. Faltis	1991-92	R. Donald Cussins
1979-80	Charles T. Jones		

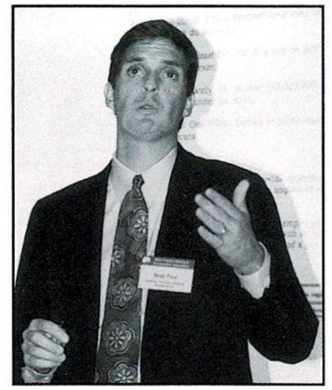


Dr. Stuart McGehee, Archivist of the Eastern Regional Coal Archives in Bluefield, presented an outstanding program on the history of West Virginia's coal industry, attacking the negative images associated with the old coal towns and emphasizing the pride and skill of early miners.

Dave Callaghan, Director of the West Virginia Division of Environmental Protection, provided an update on site specific bonding.



Steve Webber, Director of the West Virginia Office of Miners' Health, Safety and Training, outlined the structure and procedure of his year old agency.



Niall A. Paul, attorney with Spilman, Thomas, Battle & Klostermeyer, spoke on the American Disabilites Act.

Outstanding Speakers

Within the Association, Gerald has been a member of the Board of Directors for the past four years, serving one term as Treasurer and another year as Secretary. He makes his home in Jane Lew with his wife, Pat, and their children, Lara and Jared.

In remarks delivered at the closing banquet of the Annual Meeting, Gerald outlined four goals for the coming year: 1) a major effort to attract and hold new members; 2) implementation of an Association task force to aid member companies which have been targeted for unreasonable regulatory action by government agencies or private sector opponents of the industry; 3) support for the Alliance of Natural Resource Workers, a newly formed coalition of all employees of coal, gas, oil, timber and other related industries; 4) establishment of a strategic committee to develop a long-term public relations program.

Other New Officers

The current 1st vice chairman, **Jim LaRosa** of LaRosa Fuel Co., Inc., Clarksburg, was reelected to his position, as were 2nd Vice Chairman **Don Cooper** of Imperial-Pacific Investments, Inc., Charleston, and Associate Division Chairman **Steve Walker** of Cecil I. Walker Machinery, Inc., Charleston.

The Board will have two new officers, including Secretary **John Bryan** of The Pittston Coal Group, Lebanon, VA, and Treasurer **Jim Compton** of Grafton Coal Co., Clarksburg.

Board Members

Six representatives from the General Division were reelected to the Board including: **Don Cussins,** Buffalo Coal Co., Bayard; **K. O. Damron**, Marrowbone Development Co., Houston, TX; **Don Donell,** Starvaggi Industries, Inc., Weirton; **Buck Harless**, Lynn Land Co., Gilbert; **Lawrence Streets**, New Allegheny, Inc., Mt. Storm; and **Sid Young**, Hampden Coal Co., Inc., Gilbert. **Don Nicewonder** of Premium Energy, Inc., Clintwood, VA, and **Dan Scherder**, Eastern Associated Coal Corp., Charleston, were newly elected to the Board.

The Associate Division elected three members to the Board, including **Bernie Dearth** of Bridgeport Trucking Co., Bridgeport; **John Rader** of Union Carbide Corp., South Charleston; and **Chris Supcoe** of Crown Hill Equipment, Inc., Hansford.

New Member Companies

The Board approved fivecompanies during the Annual Meeting. Added to the General Division were **Peerless Eagle Coal Co.**, Summersville, represented by Jeff Wilson; **Costain Coal Inc.**, Fayetteville, represented by R. James Ballmer.

New Associate Division members are: **Vance International, Inc.**, Oakton, VA, represented by James R. Levine; **Dickirson Drills, Inc.**, Ripley, represented by David L. Dickirson; and **Pounding Mill Quarry Corp.**, Pounding Mill, VA, represented by Howard R. Long.

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Associate Member Welcoming Reception

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Amherst Industries, Inc.
Anderson of West Virginia
Appalachian Tire Products, Inc.
Arcadian Corporation
Austin Powder Company
BBI Environmental
B & M Oil Company
Beckwith Machinery Company
Beitzel Corporation
Black Diamond Construction, Inc.
Bowles Rice McDavid Graff & Love
Brackenrich & Associates, Inc.
Bridgeport Trucking Company
Buckhanan Explosives, Inc.
CAPCO - West Virginia Explosives Division
Cecil I. Walker Machinery Company
Chamberlaine & Flowers, Inc.
Charles Ryan Associates, Inc.
Coal Field Machinery, Inc.
Country Boy Seed, Inc.
Crown Hill Equipment, Inc.
Cummins Cumberland, Inc.
Dickirson Drills, Inc.
EIMCO Coal Machinery Inc.
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Explosives Technologies International, Inc.
Fairchild International
Flat Top Insurance Agency
GAI Consultants, Inc.
Gary W. Turner & Company, P.A.
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Guttman Oil Company
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Midwest Steel
Miller & Miller Auctioneers, Inc.
Mountain Explosives Company
Mt. State Bit Service, Inc.
Nelson Brothers, Inc.
Ohio Seed Company
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RMI, Ltd.
Republic Industries
Rish Equipment Company
Robinson & McElwee
Rudd Equipment Company
Skelly and Loy, Inc.
Spilman, Thomas, Battle & Klostermeyer
Stagg Engineering Services, Inc.
Sturm Environmental Services, Inc.
Sunrise Trucking, Inc.
Toothman Rice & Co.
Triad Engineering, Inc.
Trimble Engineers & Constructors, Inc.
Trojan Corporation
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United National Bank
Van-American Insurance Company
Vibra-Tech Engineers, Inc.
Waters, Warner & Harris
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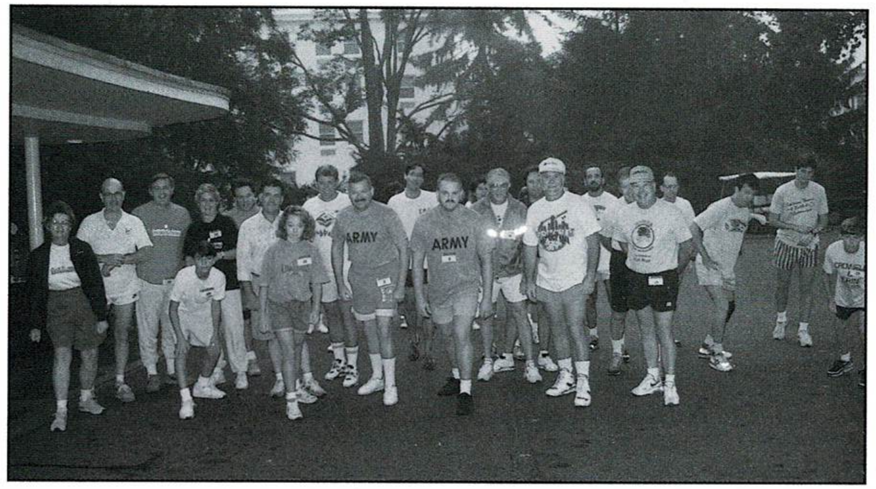


It was a pretty respectable group that got out of bed for an early morning "Fun Run" around the grounds of The Greenbrier. A half an hour or so later, all runners and walkers were accounted for.

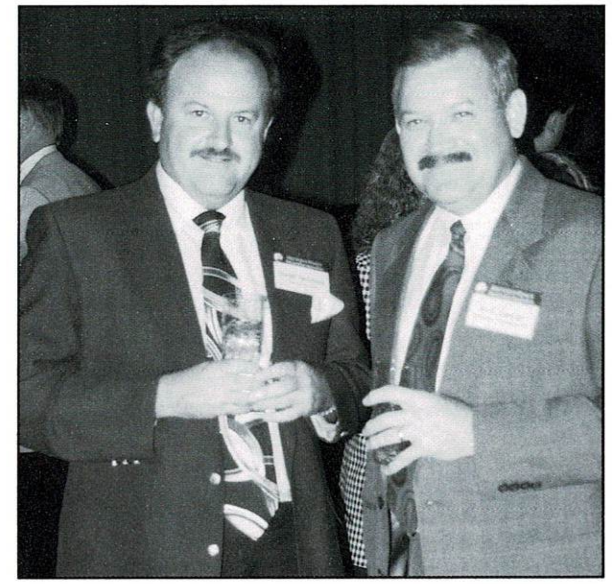
Betty and John Rader were not present at the Fun Run. Their game is golf, and they do a masterful job of chairing the Association's tournaments.

Denny and Bonnie Dolechek, Jerry and Shelby Duckett, of Buffalo Coal Co.

Scenes from *The Greenbrier*

Melvin and Phyllis Judy, Steve and Linda Shaffer, also of Buffalo Coal.

Martha Harless, Lynn Cvechko and Ida Trimble make weekend plans at the opening reception.



New Chairman Gerald Ramsburg (l) and, as it turns out, new Vice President K. O. Damron (see page 43).

Outgoing and outstanding Chairman Don Cussins and his wife Barbara.

Ben Greene says goodbye to Bill Raney after 22 years on the job together . . . .

and Bill formally takes his leave of the Association.

Thanks for the prizes

The Association extends its appreciation for the generosity of the members listed below, which enabled all who participated in the Annual Meeting with ample opportunity to take home a prize.

NAME TAG DRAWING
Bridgeport Trucking Co. (Bernie Dearth) - WVU season tickets
Crown Hill Equipment, Inc. (Chris Supcoe) - $75
Ingersoll-Rand Co. (Jim Green) - $100
Lilly Explosives Co. (Tim Warden) - 19" color television
Rudd Equipment Co. (Roger Fitch) - $100

GOLF TOURNAMENTS
Anderson of West Virginia (Tom Meehan) - $10,000 hole in one
Arcadian Corp. (Tom Dierken) - $50
Beckwith Machinery Co. (Dave Trueman) - $100
Cecil I. Walker Machinery Co. (John Williamson) - $100
Crown Hill Equipment, Inc. (Chris Supcoe) - $100
Cummins Cumberland, Inc. (Dave Hibbs) - $50
Driltech, Inc. (Tim Murphy) - $100
Flat Top Insurance Agency (Ardie McMillion) - $100
Ireco Inc. (Tim Zeli) - $50
Marathon LeTourneau Co. (Earl Beckman) - $100
McDonough Caperton Insurance Group (Charlie Morton) - $50
Mt. State Bit Service (Skeeter Laskody) - Beer cart & blaster's lamp
Penn Line Service, Inc. (Larry Roberts) - Golf balls & umbrellas
Petroleum Products, Inc. (Tom Taylor) - $100
Rish Equipment Co. (Jay Mullen) - Putter
Rudd Equipment Co. (Roger Fitch) - $100
Trimble Engineers & Constructors (Bill Trimble) - $100
Union Carbide Corp. (John Rader) - Putter, Linde Star & trophy
University Tire Center (Dale McBride) - $400
Vencill Corp. (Delmer & Ernest Vencill) - $200

BOWLING TOURNAMENT
Anker Energy Corp. (Bruce Sparks) - $100
Austin Powder Co. (Herm DeProspero) - $50
Beckwith Machinery Co. (Dave Huffman) - $50
Fairfax Fuel, Inc. (Dave Maynard) - $100
Flat Top Insurance Agency (Jack Lee) - $50
Mt. State Bit Service, Inc. (Skeeter Laskody) - $50
Pittsburgh National Bank (Dale Stein) - $50
Spilman, Thomas, Battle & Klostermeyer (John Tinney) - $50
Children's Division
Lilly Explosives (Tim Warden) - Trophies, refreshments, lane fees

FUN RUN
Austin Powder Co. (Herm DeProspero) - $50
ICI Explosives USA (Waller Caldwell) - Running shoes
Sturm Environmental Services, Inc. (John Sturm) - $50

CHILDREN'S PUTTING TOURNAMENT
Akers Supply, Inc. (Dave Akers) - Boom box
Lilly Explosives (Tim Warden) - Trophies, refreshments
Trojan Corp. (Jim Bertiaux) - $50

NEW CHAIRMAN'S BREAKFAST
Crown Hill Equipment, Inc. (Chris Supcoe) - $75
Ingersoll-Rand Co. (Jim Green) - $100
Nelson Brothers, Inc. (Gary Self) - $100

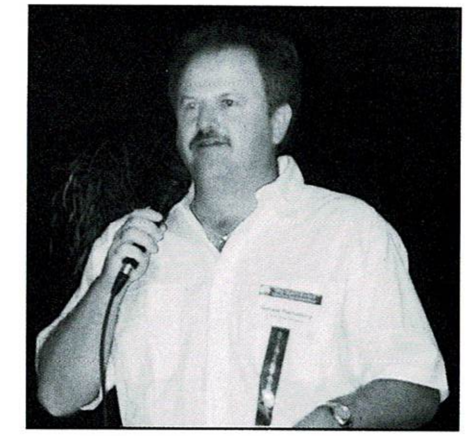
TENNIS TOURNAMENTS
Cecil I. Walker Machinery Co. (John Williamson) - $100
Cummins Cumberland, Inc. (Ed Surgeon) - $50
Green Acres Contracting Co., Inc. (Tom Pisula) - $50
Ingersoll-Rand Co. (Jim Green) - $50 & trophy
Mellon Bank, N.A. (Bob Heuler) - $100
Penn Line Service, Inc. (Larry Roberts) - $100
Skelly and Loy (John Gunnett) - $100
Sturm Environmental Services (John Sturm) - $50

MONTE CARLO NIGHT
Arcadian Corp. (Tom Dierken) - $50
Austin Powder Co. (Herm DeProspero) - Blaster's clock
Crown Hill Equipment, Inc. (Chris Supcoe) - $150
Cummins Cumberland, Inc. (Ed Surgeon) - $100
Ingersoll-Rand Co. (Jim Green) - Electric tools & knives
Ireco Inc. (Tim Zeli) - $100
Marathon LeTourneau Co. (Earl Beckman) - $100
McDonough Caperton Insurance Group (Charlie Morton) - $100
Midwest Steel (Joe Guilfoile) - $100
Mountain Explosives Co. (Eda Bussey) - $50
Nelson Brothers, Inc. (Gary Self) - VCR
Republic Industries (George Sotsky) - Gold coin
Rudd Equipment Co. (Roger Fitch) - $50
Trojan Corp. (Jim Bertiaux) - 2 L. L. Bean gift certificates
University Tire Center (Dale McBride) - $100
Vencill Corp. (Delmer & Ernest Vencill) - $100

FISHING TOURNAMENT
Akers Supply, Inc. (Dave Akers) - Ice chest & boom box
CAPCO - West Virginia Explosives Division (Bruce Wood) - Fishing rods Coleman lantern, Coleman stove, Tackle box
Ingersoll-Rand Co. (Jim Green) - $50
Mountain Explosives Co. (John Bussey) - $50
Nelson Brothers, Inc. (Gary Self) - $50
Penn Line Service, Inc. (Larry Roberts) - Vest
Trojan Corp. (Jim Bertiaux) - $50

TRAP TOURNAMENT
Austin Powder Co. (Herm DeProspero) - $50
Coal Field Machinery, Inc. (Joe Ison) - $50
Mt. State Bit Service, Inc. (Skeeter Laskody) - $50
Nelson Brothers, Inc. (Gary Self) - $50
Nell Jean Enterprises, Inc. (Warren Hylton) - Trophies
Robinson & McElwee (Joe Price) - Shotgun cleaning kit



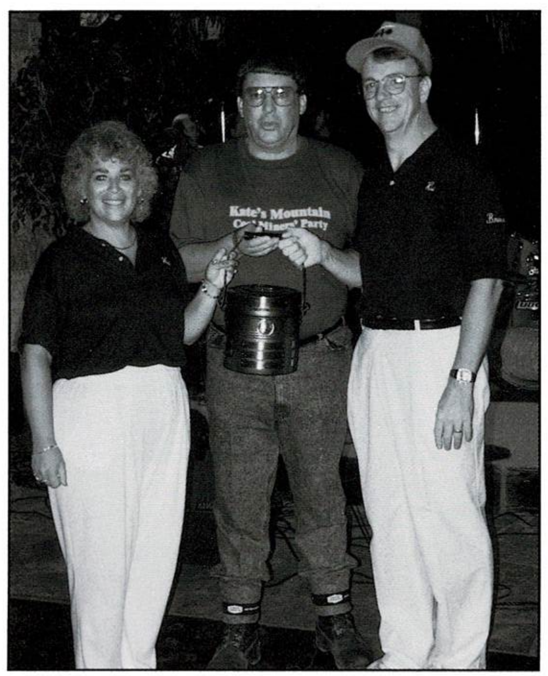


An appreciative audience cleared the dance floor to give full attention to WVMRA's home grown singing talent, in the form of Steve Walker (above), Bunny Fitch (above center), Gerald Ramsburg (above right), and Lawson & Trip Hamilton (below).


Party On Kate's Mountain


Later, the ladies got some "achy breaky" action going, as the latest dance craze made its appearance on Kate's Mountain.

'BUCK'S BUNCH' - General Division Company Pride Champions of 1991 & 1992.



Rish Equipment - Beth and Bruce Meeker accept Rish's first ever, first place award from Association President Ben Greene.

'Buck's Bunch,' Rish win 'Company Pride' awards

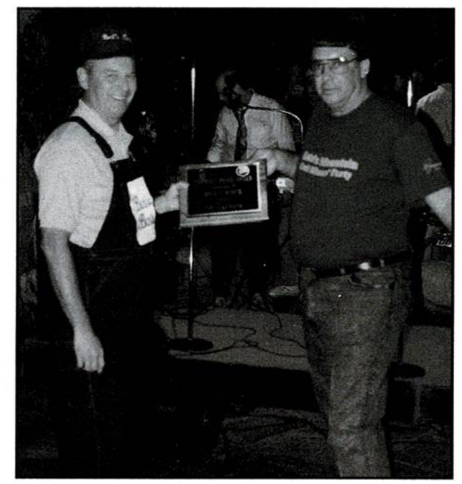
Company pride was shining through again this year as a throng of 500 plus braved threatening skies and made their way to Kate's Mountain for the annual "Coal Miners' Party" and the much anticipated "Company Pride" competition.

"Buck's Bunch," a group that should need no further introduction, successfully defended its General Division lunch bucket trophy. Newcomer Evergreen Mining appropriately took home the newly created silver medal lunch bucket.

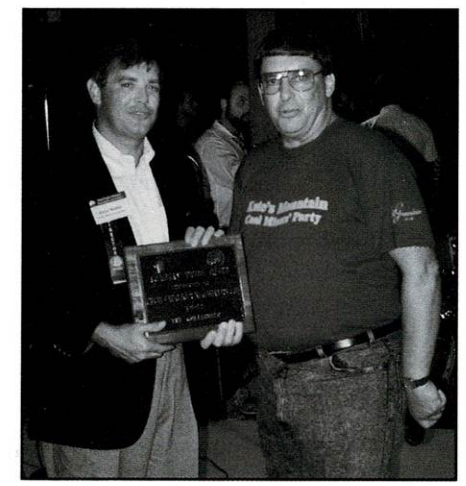
In the Associate Division, long-time competitor Rish Equipment finally broke through to take the title and the bucket. Petroleum Products made a special effort this year and was rewarded with second place and the honor of being the first to inscribe its name on the new runner-up bucket. Traditional "Company Pride" powers Austin Powder and Cecil I. Walker Machinery, which contributed two dozen or more people decked out in full company pride regalia, made their usual strong showings.

EVERGREEN MINING CO. - General Division Runner-up.

PETROLEUM PRODUCTS, INC. - Associate Division Runner-up



Bruce Burgess accepts the permanent plaque symbolizing "Buck's Bunch" 1991Company Pride title.



Steve Walker accepts the 1991 Associate Division permanent plaque for Cecil I. Walker Machinery Co.

John "Bubba" Williamson and Rachel of Walker Machinery promote the "Little Steve Walker World Tour - 1992."

COMPANY PRIDE - Austin Powder Co.

COMPANY PRIDE - WVMRA staff

Crown Hill Equipment, Inc.

We have the following items in stock for exchange or outright sale:

- 992C - 13.5 cubic yard Rock Bucket
- 992C - Upper and Lower oil sealed bucket pins
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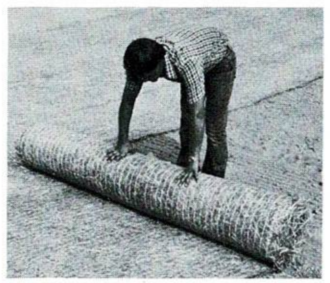

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The best PCCA 1992 foursome at Berry Hills Country Club was (l-r) Henny Weyssinger, Roger Ball, Beverly Parrish and C.W. Fosson (not pictured).

The champs at Edgewood Country Club were (l-r) Jim Walls, TIm Zeli, Paul Goad and Vic Green, Jr. (not pictured).

Peter's Creek keeps it light

Where is Peter's Creek? And why does it have its own coal association?

Peter's Creek winds through Nicholas County West Virginia, emptying into the Gauley River which quickly becomes part of the Great Kanawha, which leads, appropriately enough, to Charleston.

Its appropriate because that's where the Peter's Creek Coal Association gathers its forces twice yearly to alternately ride the river and discover its best golfing foursome.

Peter's Creek has its own coal association because its founders wanted it that way. It started with a meeting in Summersville between Conrail and a couple dozen of its coal customers along the Peter's Creek railroad spur.

The first board of directors included Jack Alexander, John Billiter, Richard Clonch, Jerry Franklin, Ben Greene, Bob Hartman, Jr., Gary White, Flick Goldsmith, Ron Tanner, Kirby Martin, Jerry Friebus, Mike Perilli and Tim Salvati.

Salvati, the original president, hosted the first river party in 1986. Successive presidents Jerry Franklin, Kirby Martin and Richard Clonch have watched the organization grow quickly and steadily, though its format and objectives have not changed at all.

PCCA is strictly a social organization, and its leaders make no apology for that. "We're not political in any way," says co-founder Mike Perilli. "There are other organizations around to meet that need. What we do is to get our members together, show them a good time and let them do a little business with one another. Our idea is to promote the coal industry from within itself."

It seems to be working.

Attendance has grown from a few dozen at the first function in 1986 to over 300 in 1992. The first gathering was a dinner cruise on the Kanawha River. "Charlie Jones got us off to a good start," says Perilli. "He provided the river boats and barges for the first three years. "Eventually, the crowd outgrew Charlie's boat and we moved to the West Virginia Belle. But we wouldn't be where we are today without Charlie's help."

It's the same with golf. The PCCA started its best ball fall tournament on the Edgewood Country Club course and soon spilled over onto Berry Hill Country Club. The evening awards banquet is bursting at the seams.

Though an enormous amount of planning and preparation goes into the day's events, the program is disarmingly simple -- a cocktail hour, followed by dinner and PCCA officials handing out dozens of prizes, mostly donated by the 185 companies now represented. That's it. No speeches, no slide shows, no hidden agenda. Attendance figures indicate it's a formula that works..

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Evergreen Mining

pumps up Webster economy

The 1990 announcement that Evergreen Mining Co. would be setting up shop in Webster County was welcome news to anyone with an interest in the local economy. Evergreen was a newly created subsidiary of the same parent corporation that runs the well known Marrowbone Development Co.

Thus the comning of Evergreen implied all of the good things about coal -- jobs, tax revenue, an overall economic shot in the arm. It also implied all of the other good things about coal -- community involvement, responsible reclamation, and a good work safety record.

So far, things have worked out pretty much as advertised. Evergreen's investment is up over $25 million. And that's not counting land acquisition or employees.

The workforce is presently 85, virtually all from Webster and surrounding counties, many laid off from other mining jobs. These jobs should last awhile, for two reasons.

First, Evergreen has 7,300 acres of good coal, enough to expect producetion of1.25 million clean tons a year for the next quarter century.

Secondly, Evergreen does things right.

Though its new workforce was experienced, not a bucket of coal moved off the property before an intensive four week orientation period, consisting of operational, safety and environmental classes, with state inspectors, vendors and company officials brought in to jointly discuss what the standards were and how to live up to them.

Another example is Evergreen's uncompleted $5 million conveyor system,over two miles long and the largest of its kind in North America. "Its a little chancey," allows President Brian Johnson, "because this conveyor is leading edge technology, and it may take a little fine tuning to make it work. But, we made the decision that our daily truck traffic was putting a little more pressure on the town of Cowen than it really should have. In the long run, the conveyor will certainly benefit us. In the meantime we want to be a good neighbor to the people in this county."

That attitude is an integral component of the Evergreen philosophy, and that's the stuff from which anniversary celebrations are made.

Evergreen Mining Co. has made a major investment in West Virginia and a major commitment to excellence in all phases of mining and reclamation.

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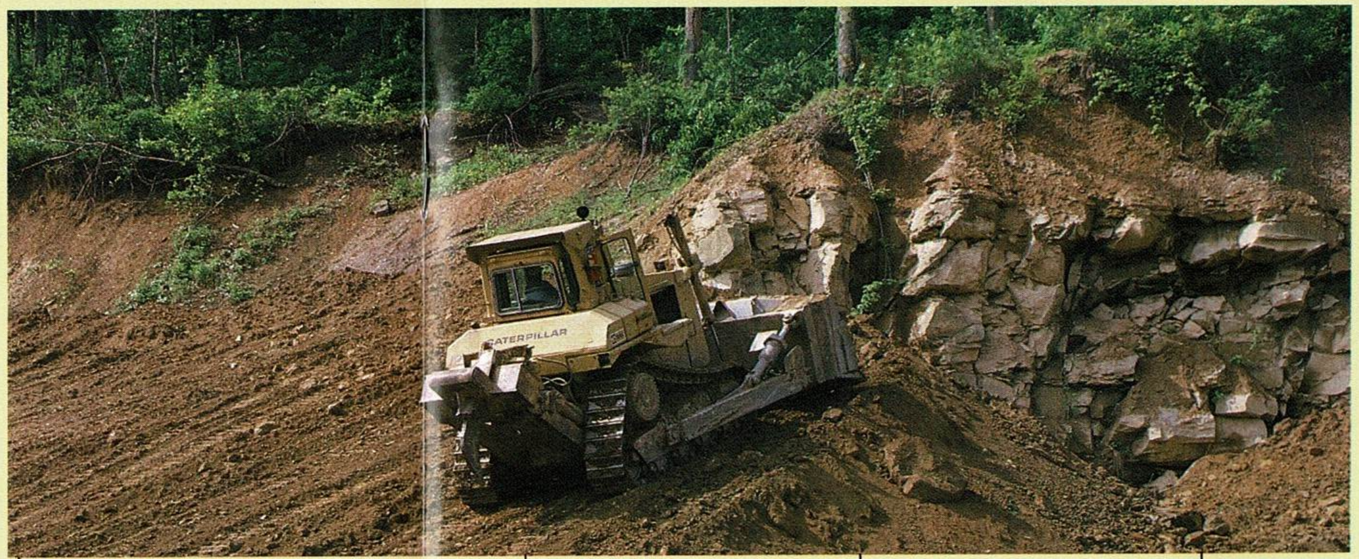
Spill and Water Quality Testing: In West Virginia, a year or more before turning the first blade of earth, a mine must survey a proposed site to ensure that all conditions are present for successful reclamation.

The mine operator develops a detailed plan for reclaiming the site for specific use. The use may be commercial or public land development.

Reclamation Bond: In West Virginia, the mine operator posts a bond per acre to guarantee that reclamation will be completed. If the mine operator forfeits the bond, he may be blocked from mining again.

After the coal has been removed, regrading can actually improve the land's productive value. Slopes are less steep and the soil improved. The objective in most regrading is to restore the "approximate original contour."



A mix of fertilizer, seed and mulch is sprayed on a site. Grass takes root quickly and stabilizes the loose material. After a grass has become established, tree planting begins.

Review: After a minimum of five years from hydroseeding, the post mining land use plan is reviewed to determine if the objectives have been met. In West Virginia, only then may the bond be returned.

Financial Responsibility: Today's mines pay the bill for past abuses. The Abandoned Mine Lands (AML) program is financed by a tax on today's coal—35 cents per ton from surface mines and 15 cents from underground mines.

In the 15 years since the AML program began, West Virginia mines have contributed more than $350 million.

David C. Callaghan Award: Each spring the West Virginia Mining and Reclamation Association presents its David C. Callaghan Award to a mining company that has set a high example for the industry in reclamation, financial commitment, and community involvement.

Since its founding in 1966, the Association has taken an active role in shaping legislation that makes West Virginia reclamation and safety standards a model for others to follow.

In 1977, WVMRA was the only coal industry group to stand up in support of the Surface Mining Control and Reclamation Act, which ensured that all coal mining states rose to the standard established by West Virginia.

Since 1980, WVMRA has supported the Surface Mine Drainage Task Force, a joint effort with states for dissemination of information and technology in the ongoing battle against acid mine drainage.

The West Virginia Mining and Reclamation Association's history is a voice for responsible mining practices.

A mix of fertilizer, seed and mulch is sprayed on the site.

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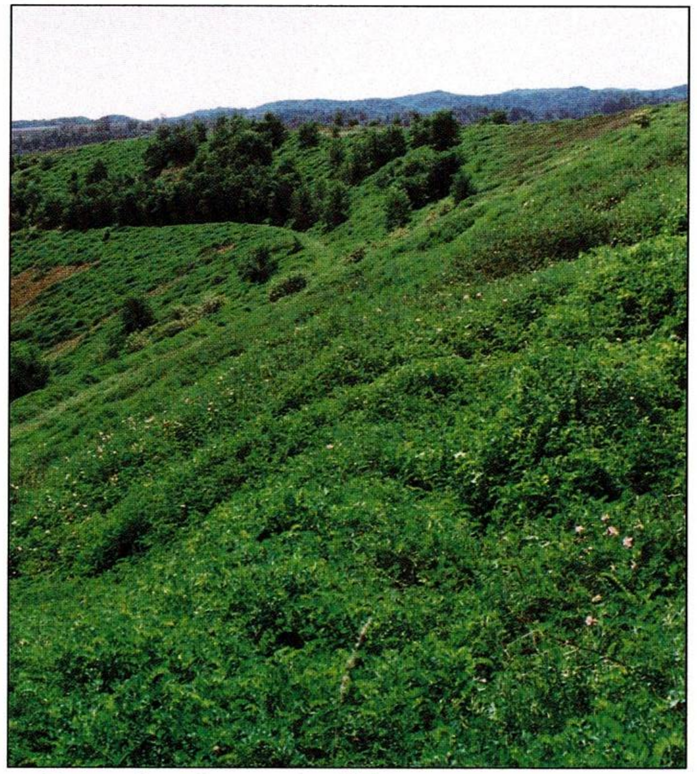
Minimal disturbance and thorough revegetation are the hallmarks of Juliana's valley fill construction.

Juliana comes up green

PHOTO ESSAY

Revegetation is a necessary, expected, everyday part of the reclamation process. That doesn't mean it's easy to do. Juliana Mining Co., operating in Webster County, seems to have the process perfected, as illustrated on these pages.

Whether its seeded crown vetch (left) or natural goldenrod (above), Juliana Mining's revegetation comes up thick and lush.



From a short distance, the hillside appears to be covered with a soft, thick blanket of green with a small floral design.

Daisies have "volunteered"a white splash to the colorful Juliana mix of groundcover.

Juliana Mining's reclaimed mine site is a haven for deer and turkey, which find both food and shelter in its dense foliage.

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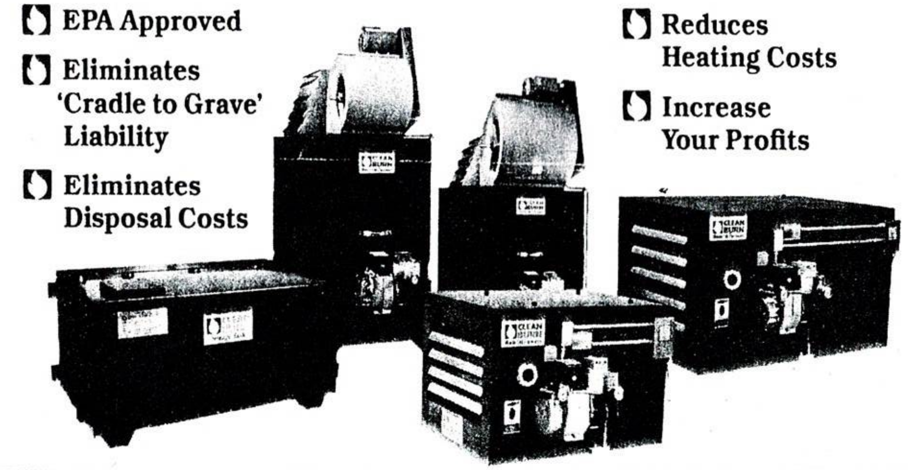

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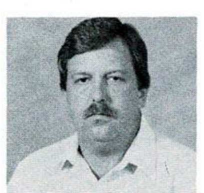

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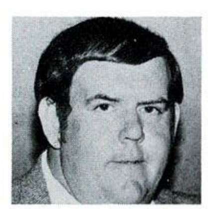

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Wetlands
for treating acid mine drainage

by Jeffrey Skousen, Alan Sexstone, Keith Garbutt, and John Sencindiver, West Virginia University

Introduction

Coal and metal mining disturb large volumes of geologic material and expose them to the environment. Through this exposure to air and water, sulfide minerals commonly associated with coal and metal deposits are oxidized and hydrolyzed resulting in acid mine drainage (AMD). AMD is a low pH, sulfate-rich water with high amounts of acidity. The acidity is comprised of mineral acidity (iron, aluminum, manganese, and other metals depending on the geologic deposit) and also hydrogen ion acidity. Other metals and trace elements in the geologic material may also be solubilized due to the acid leaching conditions. Therefore, the composition and concentration of metals in AMD vary widely but most AMD is characterized by low pH, high sulfate and iron. As contaminated streams flow into larger streams or lakes, dilution occurs making the water less toxic. Also, chemical and biological reactions cause some neutralization of the acidity and precipitation of metals. Oxidized iron precipitates as ferric hydroxide (or yellow boy) as the pH increases above 3.5, while manganese and aluminum hydroxides require a pH of at least 7 and 5, respectively, to precipitate. The traditional approach for treating AMD is collecting the contaminated drainage in ponds and treating with alkaline reagents to neutralize acidity and precipitate metals, and raise pH (Skousen 1988). This treatment method (often called an active system) is costly in terms of equipment, chemicals, and manpower (Skousen et al. 1990). In addition, the treatment system must be continued for an indefinite time period. Estimates of this cost to the coal industry exceed $1 million per day (Kleinmann 1990).

Approximately 20,000 km of streams and rivers in the United States are impacted by AMD, and the majority of these streams receive AMD from old, abandoned surface and deep mines (Girts and Kleinmann 1986). Since no company or individual claims responsibility for reclaiming abandoned mine lands (AML), no treatment of the AMD occurs and continual contamination of surface and ground-water resources results.

Wetlands and anoxic limestone drains provide passive treatment in contrast to continuous chemical additions. Wetlands have been used for decades in the treatment of municipal wastewater (WPCF 1990) but only within the last 10 years have they received serious attention in the treatment of AMD. Researchers at Wright State University and West Virginia University independently noted that AMD from AML was improved after passing through natural Sphagnum wetlands in Ohio and West Virginia (Huntsman et al. 1978, Wieder and Lang 1982). Since then, investigators have documented many other sites where the same phenomenon was observed (Brooks et al. 1985, Burris 1984, Samuel et al. 1988). The next step in using passive treatment processes for reclamation was to construct artificial wetlands on mine sites and determine whether the same treatment benefits were realized. Criteria for building wetlands were developed and eventually refined using trial and error by numerous wetland builders. Research has also helped in the development of construction specifications.

Treatment of AMD by Natural Wetlands

Many studies of AMD treatment by natural and volunteer wetlands show a substantial drop in sulfate and iron concentrations and a concomitant pH rise in the effluent. For example, Tub Run Bog in northern West Virginia received mine drainage from several abandoned deep mines in the area (Wieder and Lang 1982). After flowing through the wetland, pH rose from 3.0 to 5.5, sulfate concentrations were lowered from 250 mg/l to 10 mg/l, while iron was decreased from about 50 mg/l to less than 2 mg/l. Another natural wetland in Pennsylvania received AMD with a pH of 5.5, and removed iron from 25 mg/l to less than 1 mg/l and manganese from 35 to 2 mg/l (Kleinmann 1985). Not all natural wetlands are capable of tolerating AMD. In a study of "volunteer" natural wetlands in West Virginia, remnants of wetlands were found which had been destroyed by AMD (Garbutt, unpublished data). In the same study, an old healthy wetland which had been receiving AMD for approximately 20 years was found to have more iron in the outflow than in the inflow. This suggests that after a certain level of metal accumulation, wetlands may "unload" the metal acc umulated and may decrease rather than improve the water quality over a long time period.

Although natural wetlands have been used for AMD treatment, limitations exist for their continued use as AMD treatment systems (Wildeman et al. 1991). Transmission of water through natural wetland substrates is often restricted, and the water flows primarily across the surface decreasing the potential for anaerobic processes. Also, natural wetlands may be rich in humic acids that lower the wetland's capability to neutralize acid drainage. On the other hand, alkaline mine drainage, which may contain significant amounts of some metals, readily kills natural Sphagnum wetlands. Finally, planned contamination of a natural water ecosystem by AMD may be illegal.

Treatment of AMD by Constructed Wetlands

Construction of wetlands on mined lands is beneficial to reclamation for several reasons. First, wetlands have been recognized as a precious ecological system and, as such, have become a carefully regulated resource. Laws and regulations regarding wetland preservation and use have been passed and promulgated over the past several decades, and several federal agencies have responsibility to carry out legislative action. If wetlands are present on the area to be mined, a special permit is required in order to disturb the site (Skousen 1989). Mitigation after disturbance is required, so wetland construction criteria may be important for reestablishment of a functioning wetland ecosystem. Therefore, creation of wetlands on mined lands (whether or not a wetland was originally present on the site) during reclamation is a commendable activity. Second, wetlands provide important habitat for a number of wildlife species and enhance the aesthetic appeal of the area. Third, wetlands can be used as a relatively inexpensive tool for treating acid discharges or drainage with some dissolved or suspended solids. However, after AMD passes through a wetland, the water may still require additional chemical treatment but will probably require lower amounts of chemical thereby saving money. The U.S. Office of Surface Mining (OSM) currently requires a conventional AMD treatment system to be on site where wetland systems have been built to treat AMD discharges. OSM's policy reflects reservations concerning a wetland's seasonal and long term capacity to treat AMD (OSM 1988).

The first attempts in AMD treatment with wetlands were simply planting a few cattails in old sediment ponds on mined sites. The hope was that the vegetation would spread and the water would be "magically" treated. In many of these early attempts, the vegetation either died or did not proliferate and the wetland was ineffective in treating AMD (Wheeler et al. 1991). Since then, wetland builders have tried to simulate more accurately the substrates and vegetation in effective natural wetlands.

The U.S. Bureau of Mines estimates that over 400 wetlands have been constructed for the purpose of AMD treatment (Kleinmann 1991). Water treatment by constructed wetlands in the U.S. showed iron decreases of 28 to 99% (Brodie 1991, Brodie et al. 1988, Duddleston et al. 1992, Girts and Kleinmann 1986, Hellier 1991, Hendricks 1991, Stark et al. 1988, Stillings et al. 1988, Wieder 1992). During initial stages after construction while vegetation was becoming established, iron removal was generally lower (ranging from 30 to 50%). After vegetation development, iron removal increased to 50 to 90%. Manganese removal by wetlands was erratic and ranged from 8 to 98%, but was generally less than 30%. Strong evidence suggests a sequential removal of metals: iron must be precipitated first, then manganese may be decreased. These same reports found water pH to remain approximately the same after flowing through most wetland sites. The water on a few sites showed lower pH due to iron oxidation and acidity generation. Other sites which showed increased water pH generally had a foundation of limestone in the wetland substrate. On sites where the water pH was increased, the system was better at decreasing manganese and aluminum concentrations.

Sorption onto organic materials by themselves (such as peat and sawdust) was responsible for removing 50 to 80% of the metals in AMD. Brodie et al. (1988) reported that five different substrates (clay, topsoil, mine spoil, acid wetland soil, and non-acid wetland soil) with associated vegetation were no different in iron removal after one growing season. This finding suggests that a particular substrate material, as long as it has metal retention capabilities, may not be as important as the conditions created by wetland plants and the presence of an anaerobic zone. On the other hand, Wieder (1992) reported that straw/manure and mushroom compost wetlands were superior in AMD treatment to Sphagnum peat or sawdust wetlands. Substrate recipies are as numerous as wetland builders, however a mixture of 50% peat/manure, 30% hay, and 20% soil will generally provide sufficient permeability, exchange capacity, and organic matter to produce a functional system. In addition, a sediment slurry from a functioning wetland is beneficial to innoculate the newly constructed wetland with appropriate microorganisms.

Several studies report on the effects of different plant species in wetlands. Sphagnum was the first wetland species examined because it was the most common species found and Sphagnum has a well-documented capacity to accumulate iron (Gerber et al. 1985, Wenerick et al. 1989). However, Spratt and Wieder (1988) found that saturation of Sphagnum moss with iron could occur within one growing season and Wieder (1988) suggested that metal retention capacity in a wetland could be exceeded in a few years. Some have indicated that metal retention is limited in wetlands because organic matter inputs by wetland plants is limited (Kleinmann 1990). Many of the original constructed wetlands were vegetated with Sphagnum but few remained effective. Cattails (Typha) have been found to have a greater environmental tolerance than Sphagnum (Samuel et al. 1988). One of the reasons is because cattails do not accumulate metals into their tissues through uptake. Sencindiver and Bhumbla (1988) found that cattails growing in AMD-fed wetlands did not have elevated concentrations of metals in plant tissues. Algae and a few other wetland species have also received attention due to the observation that enhanced metal removal was associated with algal blooms (Hedin 1989, Kepler 1988, Pesavento and Stark 1986). In Colorado, algal mixtures were found to aerobically remove manganese from mine drainage (Duggan et al. 1992) presumably due to elevated pH resulting from algal growth. Probably the most important role that wetland plants serve in AMD treatment systems may be their ability to stimulate microbial processes. Kleinmann (1991) explains that plants provide sites for microbial attachment, release oxygen from their roots, and supply organic matter for heterotrophs.

Factors Important to AMD Treatment in Wetlands

Several mechanisms of metal retention operate in wetlands including: 1) direct uptake by living plants, 2) exchange plus organic complexation reactions with the wetland matrix, and 3) chemical and microbiological oxidation/reduction reactions which lead to precipitation reactions. The mechanisms are listed in their order of increasing importance, however the relative contribution of each varies with the chemical composition of the influent AMD and the physical composition of the wetland sediment. Retention of iron by these mechanisms has received the most detailed study.

Wetland plant species vary in their ability to accumulate metals (Fernandes and Henriques 1990). Some reports document elevated tissue concentrations (Spratt and Wieder 1988), while others show little metal accumulation (Folsom et al 1981.). On an annual basis, uptake by Typha accounted for less than 1% of the iron removal by a volunteer wetland treating AMD (Sencindiver and Bhumbla 1988).

While it may be true that metal concentration and accumulation in plant tissues may be small in any one year, plant tissue is a renewable resource. Old tissue is senesced yearly and new tissue, with new sites for metal accumulation, is produced. Thus over the entire life of the wetland, plants may accumulate a portion of metals received in a wetland.

Exchange reactions and organic complexation can account for over 50% of metal retention in the wetland (Kleinmann 1991, Bhumbla et al. 1990). These chemical and physical processes are abiotic and do not require microorganisms. Kleinmann (1991) states that adsorption and complexation by organic substrates helps compensate for limited initial biological activity during the first few months of operation in a new wetland system. Although some natural inputs of organic matter occur annually at plant senescence, the physical filtering capacity of a wetland will ultimately be finite as all exchange and complexation sites become metal saturated. Substantial artificial inputs of organic matter have been used as a successful strategy to temporarily renew this filtering capacity, following an observed decline in wetland performance (Eger and Melchert 1992, Haffner 1992, Stark et al. 1991).

Insoluble precipitates represent a major sink for metal retention in wetlands. Approximately 40 to 70% of the total iron removed from AMD by wetlands is found as ferric hydroxides from hydrolysis of ferric iron or from microbial oxidation of ferrous iron (Henrot and Wieder 1990, Calabrese et al 1991, Wieder 1992). Unlike exchange and complexation reactions, iron precipitate formation has no theoretical maximum, but is limited in reality by the physical density and volume of the material produced.

Up to 30% of the iron may be found as reduced iron and may be combined with sulfides (Calabrese et al. 1991, McIntyre and Edenborn 1990, Wieder 1992). Mono and disulfides form as a result of microbial sulfate reduction in the presence of an oxidizable carbon source. In addition to its metal removal potential, sulfate reduction consumes acidity and raises water pH (Hedin et al. 1992a, Rabenhorst et al. 1992).

The long term stability of metal precipitates is unclear. Ferric hydroxides can be reduced with time to ferrous iron by anaerobic iron reducing bacteria in the wetland. Similarly, the use of ferric iron as an pyrite oxidant under anaerobic conditions would result in ferrous iron in wetland effluents.

Wetlands may also be used as post treatment "polishing" systems to remove trace metals or nutrients from previously treated AMD. Currently under investigation is the addition of AMD, pretreated with anhydrous ammonia, to wetlands. Complete precipitation of metals occurs at pH >9 with ammonia addition but the resulting effluent is high in pH, ammonia, and sulfate. Theoretically, wetlands should be able to handle high nitrogen loads, as has been previously demonstrated in wastewater treatment systems (Hammer 1989). Combined nitrification and denitrification coupled with plant uptake should remove significant amounts of excess N and result in a more acceptable effluent following ammonia treatment. The primary limiting factor is establishing conditions which optimize the microbial conversion of ammonia to nitrate.

Acid mine drainage treatment by natural wetlands was observed in the late 1970's and has led to the development of constructed wetland technology. (Photo courtesy of Robert Kleinmann.)

Early attemps at wetland treatment of acid mine drainage involved planting cattails in old sedimentation ponds on surface mines and allowing the cattails to spread.

Residence time in wetlands is important to maximize water contact with the wetland substrate where microbial transformations and oxidation/reduction reactions occur. Sometimes baffles are necessary to facilitate water movement through the wetland.

Constructed wetlands are especially practical when dealing with acid mine drainage from abandoned mine lands. The wetland provides some treatment with little or no maintenance costs.

Wetlands have been constructed in greenhouse troughs where temperature and water flows can be controlled. Some of the troughs receive acid mine drainage while others receive rain water at the same rate. With special equipment and procedures, chemical and physical reactions, microbial processes, and plant productivity can be monitored in these wetlands. An understanding of these processes may help us build more efficient wetland systems.

Anoxic limestone drains are buried cells of limestone. When properly constructed and with the right type of water, alkalinity can be introduced into the water and help passively treat acid mine drainage.

Alkalinity Generation and Anoxic Limestone Drains

Alkalinity generation in a wetland is important for precipitating metals and raising pH. One method of generating alkalinity is through sulfate reduction. This process can generate up to 200 mg/l of sulfides which are available for metal complexation (Rabenhorst et al. 1992). This process requires a source of sulfate (common in AMD), organic matter and a reducing environment. Environmental factors can dramatically decrease the amount of sulfate reduction based on seasonality and with organic matter depletion.

Anoxic limestone drains (ALD) have received much attention recently because they have the potential of adding alkalinity to mine water without the risks of biological limitations (Brodie et al. 1990, Nairn et al. 1990, Skousen 1991, and Turner and McCoy 1990). An ALD consists of high quality limestone buried in a trench, underdrain, or cell. Acid water is intercepted while it is anoxic (underground) and directed into the buried cell of limestone. By keeping the limestone and mine water anoxic, limestone can continue to dissolve without becoming armored. ALDs pre-condition water by the addition of alkalinity which raises pH and buffers the water. The water can then be diverted into a wetland or ditch where oxidation, hydrolysis, and precipitation reactions can occur. By adding alkalinity to AMD, wetland systems can be more efficient in their removal activities.

ALDs require certain water conditions for long term effectiveness. For example, dissolved oxygen (DO) concentrations should be below 2 mg/l, and ferric iron and aluminum concentrations should be below 25 mg/l. Under these conditions, the limestone can continue to dissolve and armoring and clogging with metal hydroxides should be minimized. Selection of the appropriate water and environmental conditions is critical for long term alkalinity generation in an ALD.

Preliminary results showed that eight out of eleven ALDs were functioning properly in West Virginia after one year (Skousen and Faulkner 1992). In all cases, water pH was raised after ALD treatment but three of the sites had pH values less than 5.0, indicating that the ALD was not fully functioning because the pH was not around 6.2. Water acidity was decreased 50 to 80% while iron concentrations, unfortunately, were also decreased, presumably due to precipitation in the drain. Aluminum in inflow water was also not found in outflow water again indicating aluminum precipitation in the drain. With iron and aluminum decreases in outflow water, it is probable that some coating or clogging of limestone is occurring inside the ALD.

Utilization of an ALD is complicated by mixed ferric/ferrous iron concentrations in AMD and/or when DO is found in the water. Current research involves pretreatment of AMD with an anaerobic wetland to strip DO from the water and to convert ferric to ferrous iron (Sextone, unpublished). The anoxic water after passing through an anaerobic wetland can then be introduced into an ALD. There are still many questions relative to the longevity of ALDs and the factors involved in limestone dissolution and metal precipitation in ALD environments. Like wetlands, ALDs may be a solution for AMD treatment for a finite period after which the system must be replenished or replaced.

The mechanisms that operate in these types of passive AMD treatment technologies (aerobic wetland, anaerobic wetland, and anoxic limestone drain) provide for matching a technology or combination of technologies to particular types of AMD. However, not all AMD is suitable for passive treatment systems.

Sizing and Design Parameters

The most comprehensive and practical approach for design of passive treatment systems for treating AMD has been prepared by Hedin and Nairn (1992b). They have developed a decision chart based on AMD flow, water chemistry, and the calculated contaminant loadings (Figure 1). Flows should be measured, not visually estimated, and variation in flows should be accounted for. AMD should be collected as close to the outlet as possible and analyzed for pH, acidity, alkalinity, iron, and manganese. If an ALD is considered, water analysis should also include DO, ferrous iron, and aluminum concentrations. Once the contaminant loadings are calculated based on flow and water analyses, the water can be classified and an appropriate passive treatment system designed.

Alkaline Water - If the water is classified as alkaline (the water has enough alkalinity to buffer the acidity produced by metal hydrolysis reactions), the metals contained in the AMD will precipitate when given sufficient residence time. In this case, an aerobic system or settling pond is necessary. No organic substrate is required in the pond but planting cattails is often helpful in physical filtering processes. Aeration, which is often limiting in such systems, should be maximized by constructing waterfalls or rip rap ditches, and also by maintaining shallow ponds. The key is to retain the water long enough for oxidation and precipitation reactions to occur. Wetland size should be based on 20 grams of iron removal per square meter per day of wetland (20 gmd). For manganese removal, 0.5 gmd is the estimated value for wetland sizing.

Acid Water - If the water is classified as acid, then a system for generating alkalinity must be provided.

A. Anoxic limestone drains (ALD) require specific water conditions for long term effectiveness. Factors that may limit the long term effectiveness of ALDs are the presence of ferric iron, aluminum, and oxygen in the AMD. When water containing any ferric iron or aluminum contacts limestone, both metals hydrolyze and precipitate. Oxidation is not necessary. These metal hydroxides can coat the limestone and cause the drain to plug, hindering dissolution. Small amounts of dissolved oxygen will allow ferrous iron to oxidize to ferric iron causing the above problems. Therefore, determination of these parameters is critical before installing an ALD. Even when these criteria are met, some ALDs have failed (Skousen and Faulkner 1992). Guidelines for ALD sizing and construction are given in Skousen (1991) and also Hedin and Nairn (1992a). The goal, given the right conditions, is to use limestone to generate excess alkalinity in the water and direct the treated water into an aerobic system where metals can oxidize, hydrolyze, and precipitate.

B. 1. If high amounts of dissolved oxygen, ferric iron and aluminum are found in acid water, then construction of an anaerobic/compost wetland is recommended. Compost wetlands generate alkalinity through a combination of bacterial sulfate reduction and limestone dissolution. With a suitable organic substrate and limestone placed in the anaerobic zone, alkalinity can be generated. Various substrate materials have been used but, as mentioned, those with manure or composted materials from 12 to 18 inches deep have shown suitable microbial activities. Limestone should be placed in the substrate if anaerobic conditions prevail. Sizing is based on 5 gmd. If the pH of the water is less than 3.5, then the area calculated above should be multiplied by 4 to account for the much greater acid loadings.

B. 2. If small amounts of oxygen and ferric iron are found in the water, the water can first be directed into an anaerobic wetland to scavenge oxygen from the water and precipitate ferric iron. Conveyance of the slightly oxidized water from the mine or seep to the wetland should be done in pipes or other enclosed system. After passing through the wetland, water from the anaerobic zone can be directed through closed pipes to an ALD where it is more suited for ALD treatment and where some additional alkalinity may be gained. This type of passive system has been operating effectively for over a year on a West Virginia mine site and several other systems are planned for installation.

Selection and Planting of Macro-Flora in Constructed Wetlands - Relatively little work exists on the appropriate selection of plant species for wetlands, yet this can have important implications for the long term success of a project. In constructed wetlands, higher plants serve several purposes.

a) Substrate consolidation - the roots of higher plants hold the substrate together, prevent channels from forming and increase residence time of water in the wetland.

b) Stimulation of microbial processes - plants supply sites of attachment for microbes, release oxygen from their roots , and provide a source of organic matter for heterotrophic microorganisms.

c) Wildlife habitat - wetland plants supply food and shelter for a wide range of game and non-game animals (especially birds).

d) Aesthetics - a wetland filled with plants is considerably more pleasing to the eye than a treatment pond.

e) Metal accumulation - this may play a minor role in the total metal removal of the wetland but may vary with the species and with different water and seasonal circumstances.

The choice of wetland species should be based on a knowledge of local conditions and the relative ability of species to tolerate the conditions found in a particular watershed and their ability to provide the functions listed above. For example, Typha and gustifolia is extremely rare in West Virginia, although it is common in surrounding states. Thus a wetland planted with T. angustifolia in West Virginia is unlikely to flourish, while Typha latifolia does well. Similarly T. angustifolia and T. latifolia have different niches with respect to water depth. In general, the water depths usually employed in wetland systems are more suitable for T. latifolia than T. angust ifolia. It should also be noted that since AMD is extremely variable, a plant community that thrives in one location may be completely inappropriate in a second nearby location if the composition of the AMD is different.

The importation of exotics, even when they have proven effective elsewhere, should be avoided. The choice of local species is also likely to maximize the wildlife habitat component of the wetland.

Poly-cultures may be preferable to moniocultures. Investigations of natural wetlands which are receiving AMD show a tendency for treatment to be higher in wetlands with a higher diversity of species. This is probably due to the increased number of niches found in these wetlands as a function of the metal loading from inflow to outflow, but it also provides a higher diversity of micro-habitats for the microbial community.

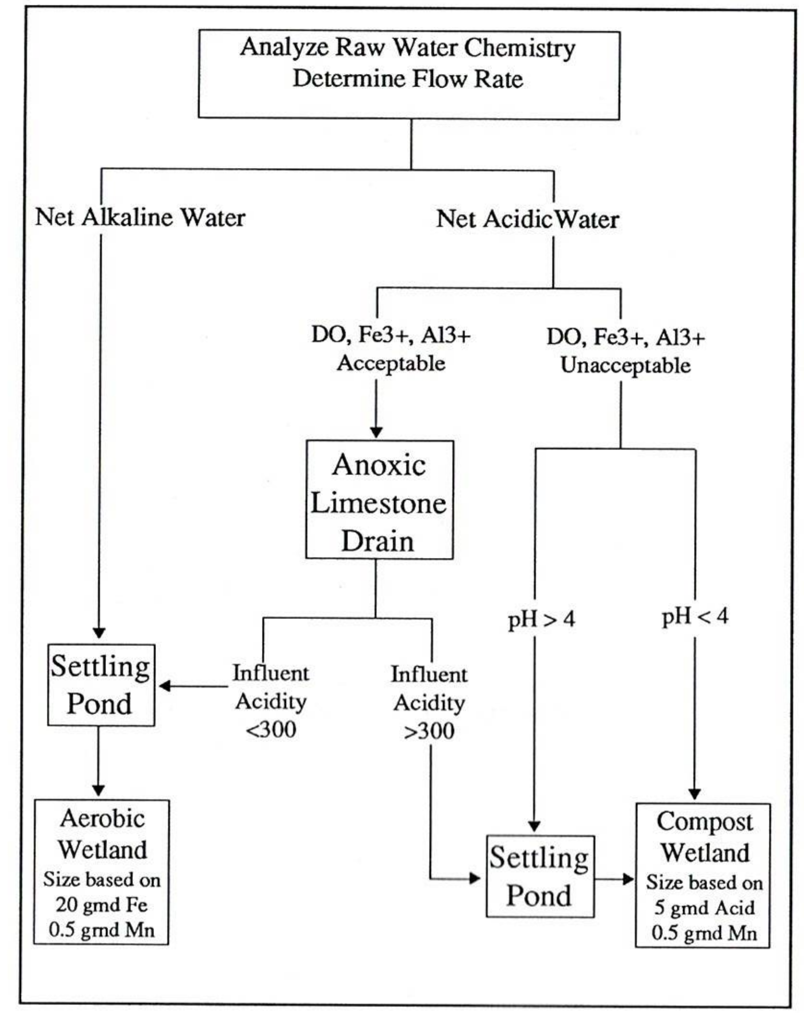

Figure 1. Flowchart for designing and sizing passive mine drainage treatment systems. (Hedin and Nairn 1992a.)

Where information on metal accumulation is available, it should be used in the selection of appropriate species. If a plant species is accumulating heavy metals in plant parts which form an important food resource for wildlife, there is a real possibility of transmission and concentration of these toxic metals through the food chain. For example, an AMD source with high lead content may be an important problem while bioaccumulation of iron or manganese may be of little concern.

Current practice is to plant a fairly dense monoculture of Typha. As passive treatment systems get bigger, the number of plants needed and the manpower required to plant them can lead to prohibitive expense. So some planting designs which do not fill the wetland with plants at its creation should be considered. Slow-growing or annual species may be important components in some wetland systems but these will not form an initial matrix from which a wetland will develop in a useful time frame.

Finally with any constructed wetland, it is important to allow the plants to establish for some time with uncontaminated water before AMD is applied to the system. When plants are transplanted, they suffer "transplantation shock" which makes them particularly susceptible to any environmental shock. Immediate inundation with AMD will certainly slow growth and development and in some cases may kill the entire wetland. If a wetland is built during the early to middle of the growing season, the plants should be given one to two months establishment time prior to AMD introduction into the system. If a system is constructed late in the growing season, AMD flow should not begin until the next growing season.

Summary and Conclusions

Acid mine drainage is a common, intractable problem in many areas of the world where coal and other minerals are mined. Chemical treatment methods are effective, but passive systems offer a low cost, more natural approach to AMD treatment. Mine water flowing through natural and constructed wetlands has generally shown a decrease in metals and acidity. Factors important to AMD treatment by wetlands are initial flow and water chemistry, wetland substrate, wetland vegetation, and microbial composition and activity.

Metal retention in wetlands may be due to direct uptake by plants, exchange reactions with the wetland matrix, and chemical and microbiological oxidation/reduction reactions which lead to precipitation reactions. Based on flows and chemistry, a passive water treatment system (which may include an aerobic wetland, an anaerobic wetland, and anoxic limestone drain or combinations) may be developed to either completely or partially treat the water, thereby reducing AMD treatment costs with chemicals. Based on current knowledge, passive treatment technologies may be a treatment solution for many AMD discharges. However, AMD treatment by such systems appears to be finite after which the system must be replaced or replenished.

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References

Bhumbla, D.K., J.P. Calabrese, J.C. Sencindiver, A.J. Sexstone, and G.K. Bissonnette. 1990. Attenuation of Fe and Mn in AMD appl ied to constructed wetlands. Agronomy Abstracts. p. 33.

Brodie, G.A. 1991. Achieving compliance with staged, aerobic, constructed wetlands to treat acid drainage. p. 151-174. In: Proce edings of 1991 American Society for Surface Mining and Reclamation Conference, Durango, CO.

Brodie, G.A., C.R. Britt, H. Taylor, T. Tomaxzewski, and D. Turner. 1990. Passive anoxic limestone drains to increase effectiveness of wetlands acid drainage treatment systems. In: Proceedings, 12th National Association of Abandoned Mined Land Conference, B reckinridge, CO.

Brodie, G.A., D.A. Hammer, and D.A. Tomljanovich. 1988. An evaluation of substrate types in constructed wetlands acid drainage tre atment systems. p. 389-398. In: Mine Drainage and Surface Mine Reclamation. Vol. I. Info. Circular 9183, U.S. Bureau of Mines, Pit tsburgh, PA.

Brooks, R., D.E. Samuel, and J.B. Hill. 1985. Wetlands and water management on mined lands. Proceedings of a Conference. The Pen nsylvania State University, University Park, PA.

Burris, J.E. 1984. Treatment of mine drainage by wetlands. Contribution No. 264, Department of Biology, The Pennsyl vania State University, University Park, PA.

Calabrese, J.P., A.J. Sexstone, D.K. Bhumbla, G.K. Bissonnette, and J.C. Sencindiver. 1991. Application of constructed cattail w etlands for the removal of iron from acid mine drainage. p. 559-575. In: Proceedings, Second Internation Conference on the Abatemen t of Acidic Drainage, Vol. 3. MEND, Montreal, Canada.

Duggan, L.A., T.R. Wildeman, and D.M. Updegraff. 1992. The aerobic removal of manganese from mine drainage by an algal mixture con taining Cladophora. p. 241-248. In: Proceedings, 1992 American Society for Surface Mining and Reclamation Conference, Duluth, MN.

Duddleston, K.N., E. Fritz, A.C. Hendricks, and K. Roddenberry. 1992. Anoxic catta il wetland for treatment of water associated with coal mining activities. p. 249-254. In: Proceedings, 1992 American Society forSurface Mining and Reclamation Conference, Duluth, MN.

Eger, P., and G. Melchert. 1992. The design of a wetland treatment system to remove trace metals from mine drainage. p. 98-107. In: Proceedings, 1992 American Society for Surface Mining and Reclamation Conference, Duluth, MN.

Fernandez, J.C., and F.F. Henriques. 1990. Metal levels in soil and cattails (Typha latifolia L.) plants in a pyrite mine, Lousal Portugal. Int. J. of Env. Studies 36:205-210.

Folsom, B.L., C.R. Lee, and D.J. Bates. 1981. Influence of disposal environment on availability and plant uptake of heavy metals i n dredged material. In: Tech. Report EL-81-12, U.S. Army Corps of Engineers, Waterway Exp. Stat., ICE, Vicksburg, MS.

Gerber, D.W., J.E. Burris, and R.W. Sone. 1985. Removal of dissolved iron and manganese ions by a Sphagnum moss system. In: Wetla nds and Water Management on Mined Lands. The Pennsylvania State University, University Park, PA.

Girts, M.A., and R.L.P. Kleinmann. 1986. Constructed wetlands for treatment of acid mine drainage: A preliminary review. p 165-17 1. In: National Symposium on Mining, Hydrology, Sedimentology, and Reclamation. Univ. of Kentucky. Lexington, KY.

Haffner, W.M. 1992. Palmerton zinc superfund site constructed wetlands. p. 260-267. In: Proceedings, 1992 American Society for S urface Mining and Reclamation, Duluth, MN.

Hammer, D.A. 1989. Constructed wetlands for wastewater treatment. Lewis Publishers, Chelsea, MI.

Hedin, R.S. 1989. Treatment of acid coal mine drainage with constructed wetlands. p. 349-362. In: Wetlands Ecology, Productivit y and Values: Emphasis on Pennsylvania. Pennsylvania Academy of Science, Easton, PA.

Hedin, R.S., and R.W. Nairn. 1992a. Passive treatment of coal mine drainage. Course Notes for Workshop. U.S. Bureau of Mines, Pit tsburgh, PA.

Hedin, R.S., and R.W. Nairn. 1992b. Designing and sizing passive mine drainage treatment systems. In: Proceedings, 13th West Virg inia Surface Mine Drainage Task Force Symposium, Morgantown, WV.

Hellier, W.W. 1991. Pennsylvania's constructed wetlands: an overview. In: Microbial Technologies of Mineral Pollutants Removal fro m Industrial Wastewater. Moscow, USSR.

Hendricks, A.C. 1991. The use of an artificial wetland to treat acid mine drainage. p. 550-558. In: Proceedings of Second Intern ational Conference on the Abatement of Acidic Drainage. MEND, Montreal, Canada.

Henrot, J., and R.K. Wieder. 1990. Processes of iron and manganese retention in laboratory peat microcosms subjected to acid mine drainage. J. Env. Qual. 19:312-320.

Huntsman, B.E., J.B. Solch, and M.D. Porter. 1978. Utilization of a Sphagnum speci es dominated bog for coal acid mine drainage abatement. Abstracts, 91st Annual Meeting Geologic Society America, Ottawa, Ontario, C anada.

Kepler, D.A. 1988. An overview of the role of algae in the treatment of acid mine drainage. p. 286-290. In: Mine Drainage and Surf ace Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bureau of Mines, Pittsburgh, PA.

Kleinmann, R.L.P. 1985. Treatment of acid mine water by wetlands. p 48-52. In: Control of AMD. Info. Circular No. 9027. U.S. Bure au of Mines, Pittsburgh, PA

Kleinmann, R.L.P. 1990. Acid mine drainage in the United States. In: Proceedings of the First Midwestern Region Reclamation Confe rence, Southern Illinois University, Carbondale, IL.

Kleinmann, R.L.P. 1991. Biological treatment of mine water--an overview. p. 27-42. In: Proceedings of Second International Confe rence on the Abatement of Acidic Drainage. MEND, Montreal, Canada.

McIntyre, P.E., and H.M. Edenborn. 1990. The use of bacterial sulfate reduction in the treatment of drainage from coal mines. p. 409-415. In: Skousen et al. (editors), Proceedings of the 1990 Mining and Reclamation Conference. West Virginia University, Morga ntown, WV.

Nairn, R.W., R.S. Hedin, and G.R. Watzlaf. 1990. A preliminary review of the use of anoxic limestone drains in the passive treatme nt of acid mine drainage. In: Proceedings, 12th West Virginia Surface Mine Drainage Task Force Symposium, Morgantown, WV.

Office of Surface Mining. 1988. Use of wetland treatment systems for coal mine drainage. OSMRE Dir. TSR-10. U.S. OSMRE, Washingt on, DC.

Pesavento, B.G., and L.R. Stark. 1986. Utilization of wetlands and some aspects of aqueous conditions. In: Proceedings of 7th Wes t Virginia Surface Mine Drainage Task Force Symposium, Morgantown, WV.

Rabenhorst, M.C., B.R. James, and J.N. Shaw. 1992. Evaluation of potential wetland substrates for optimizing sulfate reduction. p. 90-97. In: Proceedings, 1992 American Society for Surface Mining and Reclamation, Duluth, MN.

Samuel, D.E., J.C. Sencindiver, and H.W. Rauch. 1988. Water and soil parameters affecting growth of cattails. p. 367-374. In: Mi ne Drainage and Surface Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bureau of Mines, Pittsburgh, PA.

Sencindiver, J.C., and D.K. Bhumbla. 1988. Effects of cattails (Typha) on metal removal from mine drainage. p. 359-366. In: Mine Drainage and Surface Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bureau of Mines, Pittsburgh, PA.

Skousen, J.G. 1988. Chemicals for treating acid mine drainage. Green Lands 18(3): 36-40.

Skousen, J.G. 1989. Wetlands are more than two cattails. Green Lands 19(2): 45-47.

Skousen, J.G. K. Politan, T. Hilton, and A. Meek. 1990. Acid mine drainage treatment systems: chemicals and costs. Green Lands 20 (4):31-37.

Skousen, J.G. 1991. Anoxic limestone drains for acid mine drainage treatment. Green Lands 21(4): 30-35.

Skousen, J.G., and B.B. Faulkner. 1992. Preliminary results of anoxic limestone drains in West Virginia. In: Proceedings, 13th West Virginia Surface Mine Drainage Task Force Symposium, Morgantown, WV.

Spratt, A.K., and R.K. Weider. 1988. Growth responses and iron uptake in Sphagnum plants and their relation to acid mine drainage treatment. p. 279-285. In: Mine Drainage and Surface Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bureau of Mines, Pit tsburgh, PA.

Stark, L.R., R.L. Kolbash, H.I. Webster, S.E. Stgevens, K.A. Dionis, and E.R. Murphy. 1988. The Simco #4 wetland: biological patte rns and performance of a wetland receiving mine drainage. p. 332-344. In: Mine Drainage and Surface Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bureau of Mines, Pittsburgh, PA.

Stark, L.R., W.R. Wenerick, P.J. Wuest, F.M. Williams, S.E. Stevens. 1991. Adding a carbon supplement to simulated treatment wetla nds improves mine water quality. p. 465-483. In: Proceedings, Second Internation Conference on the Abatement of Acidic Drainag e, MEND, Montreal, Canada.

Stillings, L.L., J.J. Gryta, and T.A. Ronning. 1988. Iron and manganese removal in a Typha-dominated wetland during ten months fol lowing its construction. p. 317-324. In: Mine Drainage and Surface Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bur eau of Mines, Pittsburgh, PA.

Turner, D., and D. McCoy. 1990. Anoxic alkaline drain treatment system, a low cost acid mine drainage treatment alternative. In: 1990 National Symposium on Mining, University of Kentucky, Lexington, KY.

Wieder, R.K. 1988. Determining the capacity for metal retention in man-made wetlands constructed for treatment of coal mine draina ge. p. 375-381. In: Mine Drainage and Surface Mine Reclamation, Vol. I. Info. Circular No. 9183. U.S. Bureau of Mines, Pittsburgh , PA.

Wieder, R.K. 1992. The Kentucky wetlands project: A field study to evaluate man-made wetlands for acid coal mine drainage treatmen t. Final Report to the U.S. Office of Surface Mining. Villanova University, Villanova, PA.

Wieder, R.K., and G.E. Lang. 1982. Modification of acid mine drainage in a fresh w ater wetland. p. 43-53. In: Symposium on Wetlands of the Unglaciated Appalachian Region. West Virginia University, Morgantown, WV .

Wenerick, W.R., S.E. Stevens, H.J. Webster, L.R. Stark, and E. DeVeau. 1989. Tolerance of three wetland plant species to acid mine drainage: a greenhouse study. In: Constructed Wetlands for Wastewater Treatment, Lewis Publishers, Chelsea, MI.

Wheeler, W.N., M. Kalin, and J.E. Cairns. 1991. The ecological response of a bog to acidic coal mine drainage - deterioration and subsequent initiation of recovery. p. 449-464. In: Proceedings, Second Internation Conference on the Abatement of Acidic Drainage , MEND, Montreal, Canada.

Wildeman, T., J. Gusek, and G. Brodie. 1991. Wetland design for mining operations. Draft handbook presented at the 1991 American Society for Surface Mining and Reclamation Conference, Durango, CO.

WPCF. 1990. Natural systems for wastewater treatment. Water Pollution Control Federation, Washington, D.C.

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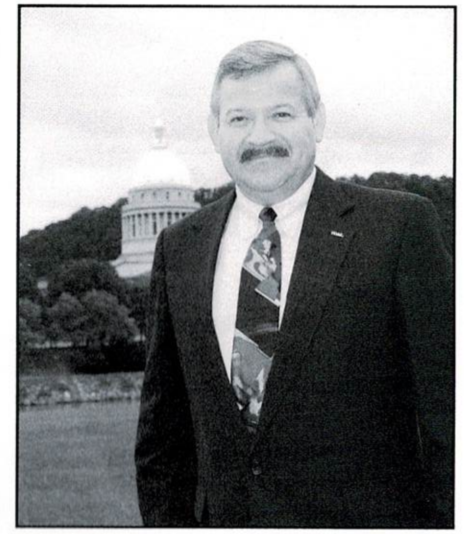
Association Notebook

K. O. Damron accepts VP post

K. O. Damron is the Association's new Vice President. He replaces Bill Raney, who left in May to become President of the West Virginia Coal Association.

K. O. comes to WVMRA from Shell Mining Co. in Houston, TX, where he served for twelve years in human resources and government affairs. He began his coal industry career in 1977 with Pittston Coal Group. In 1980, he moved to A. T. Massey Coal Co. as Director of Human Resources at the Wolf Creek Collieries operation in Kentucky. Shell assumed full ownership of Wolf Creek in 1987 and in 1988 moved K.O. to Houston.



WVMRA Vice President
K. O. Damron

He is a veteran of West Virginia political affairs, serving five terms in the House of Delegates, where he was Vice Chairman of the Judiciary Committee and Chairman of the Coal Mining Committee. As a delegate, he had an 88% voting approval record from the Business & Industry Council. He also ran for Congress in 1976.

K. O. is a native of Mingo County, born in Williamson and raised in Lenore. He is a 1969 graduate of West Virginia University with a degree in business administration and later earned an associate degree in mining technology from Southern West Virginia Community College.

In addition, he is a certified underground assistant mine foreman, surface mine foreman and safety training instructor and serves as a Lieutenant Colonel in the West Virginia Army National Guard.

K. O. and his wife, Pam, have two children, Keith, 23, and Angela, 13. The family will be relocating to the Charleston area in the near future.

Regarding the appointment, Association President Ben Greene said, "Faced with the difficult task of replacing Bill Raney, we feel very fortunate to have secured the services of someone with K. O.'s background and qualifications. With many critical issues and events directly in front of us, we anticipate that K. O. will have an immediate impact."

On assuming his new duties, K. O. commented, "My family and I greatly appreciate the confidence expressed by the Board. WVMRA has evolved into a great organization due to the efforts of the professional staff and the high level of participation by the membership. There are many challenges today dealing with both government and special interest groups.

"I look forward to working with Ben, Dan, Patty, Mary Ann and the membership towards maintaining a safe and competitive environment for West Virginia's mining operations."

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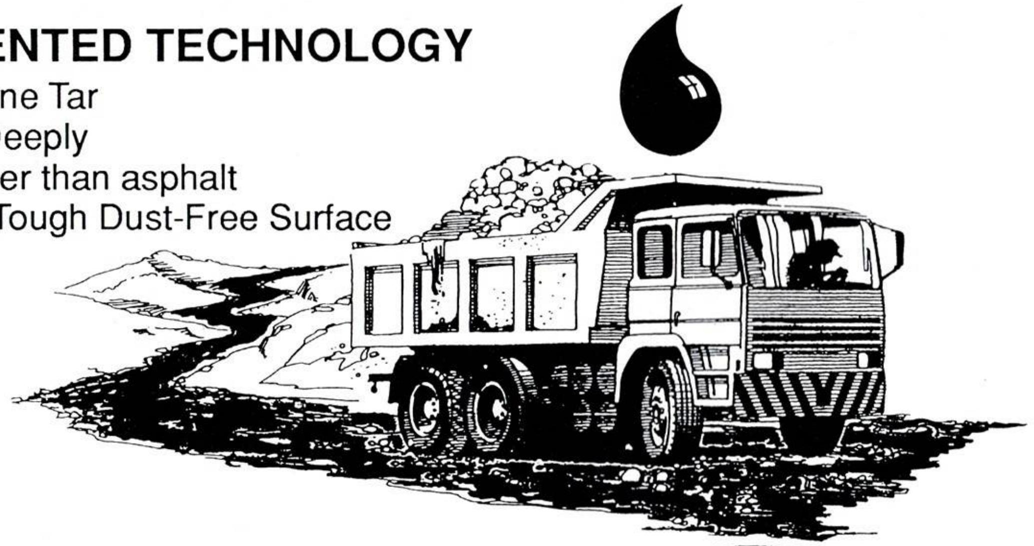

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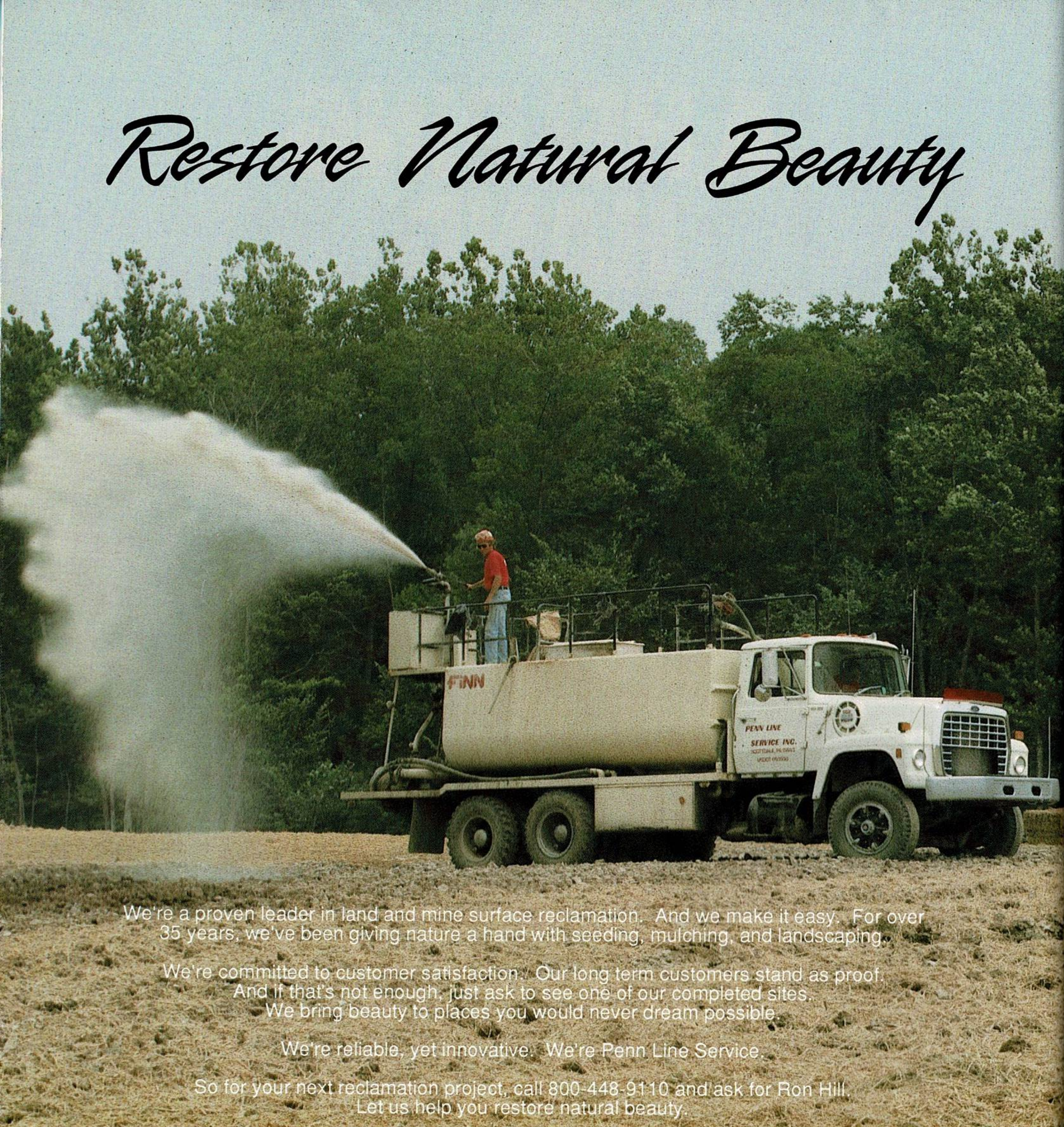

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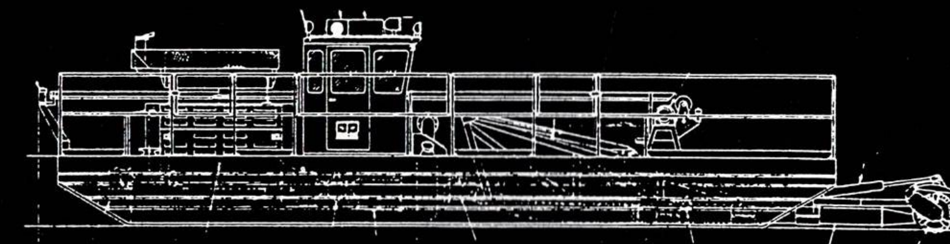

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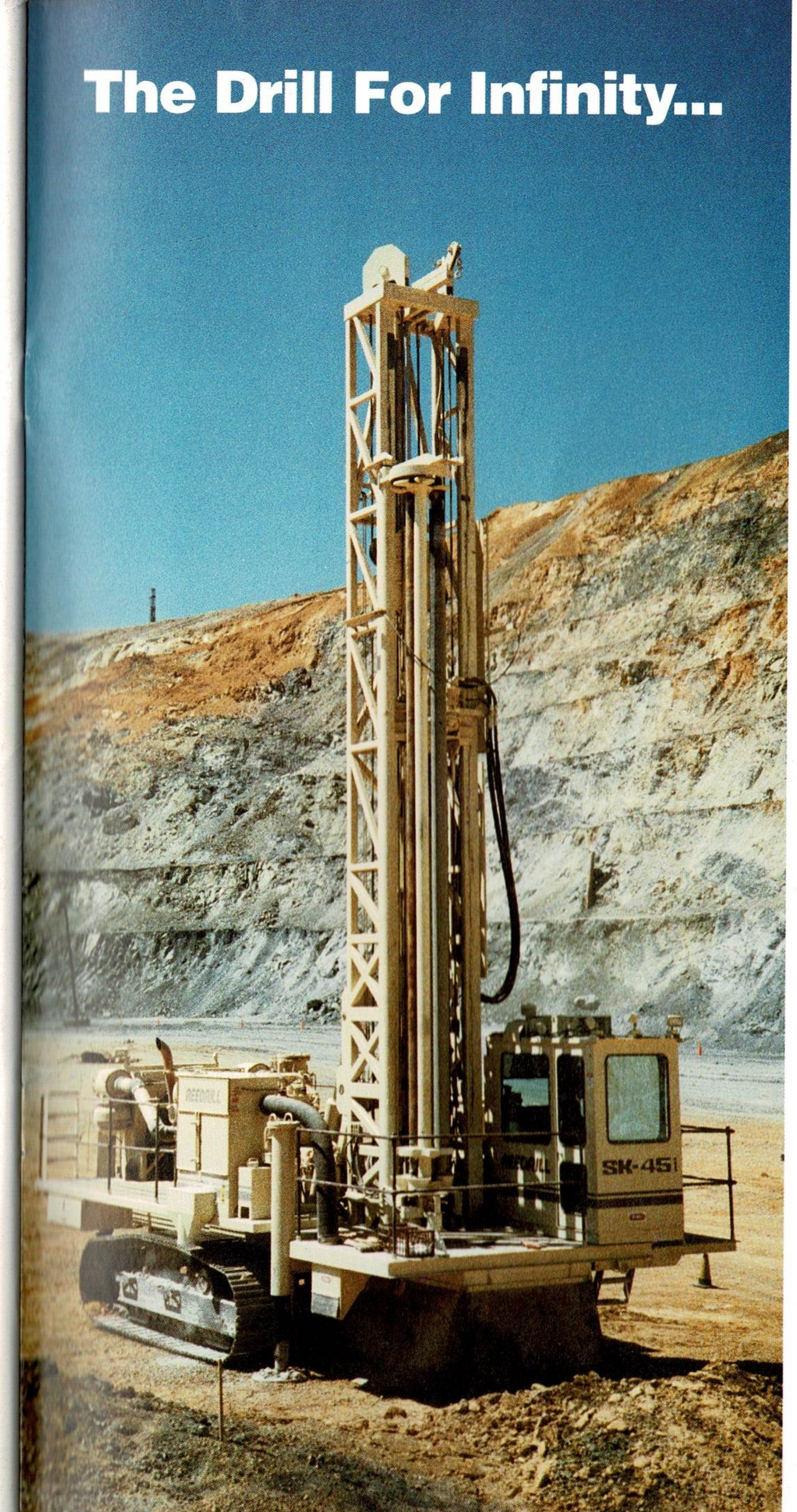

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