



**Please include the following attribution when using any part of this presentation information in a report, presentation, article, etc.**

***Presented by Paul Ziemkiewicz, National Mine Land Reclamation Center, at the Coal Utilization Technologies Workshop on September 22, 2004 at the National Research Center for Coal & Energy, Morgantown, WV. This meeting was part of the Energy Roadmap Workshop Series commissioned by West Virginia Governor Bob Wise.***



# Use of Coal Ash for Mine Reclamation

Paul Ziemkiewicz, PhD

Director, National Mine Land Reclamation Center

West Virginia University

Morgantown, WV



## Beneficial Subsurface Applications of Industrial Wastes in Coal Mines

- Coal ash can be used to neutralize acid forming materials
- Low permeability ashes can be used as barriers to AMD formation and transport
- Fill material for subsidence control
- Pit filling: surface and underground mines



# Environmental Issues

- Transportation
- Groundwater contamination
- Surface water contamination
- Risk assessment



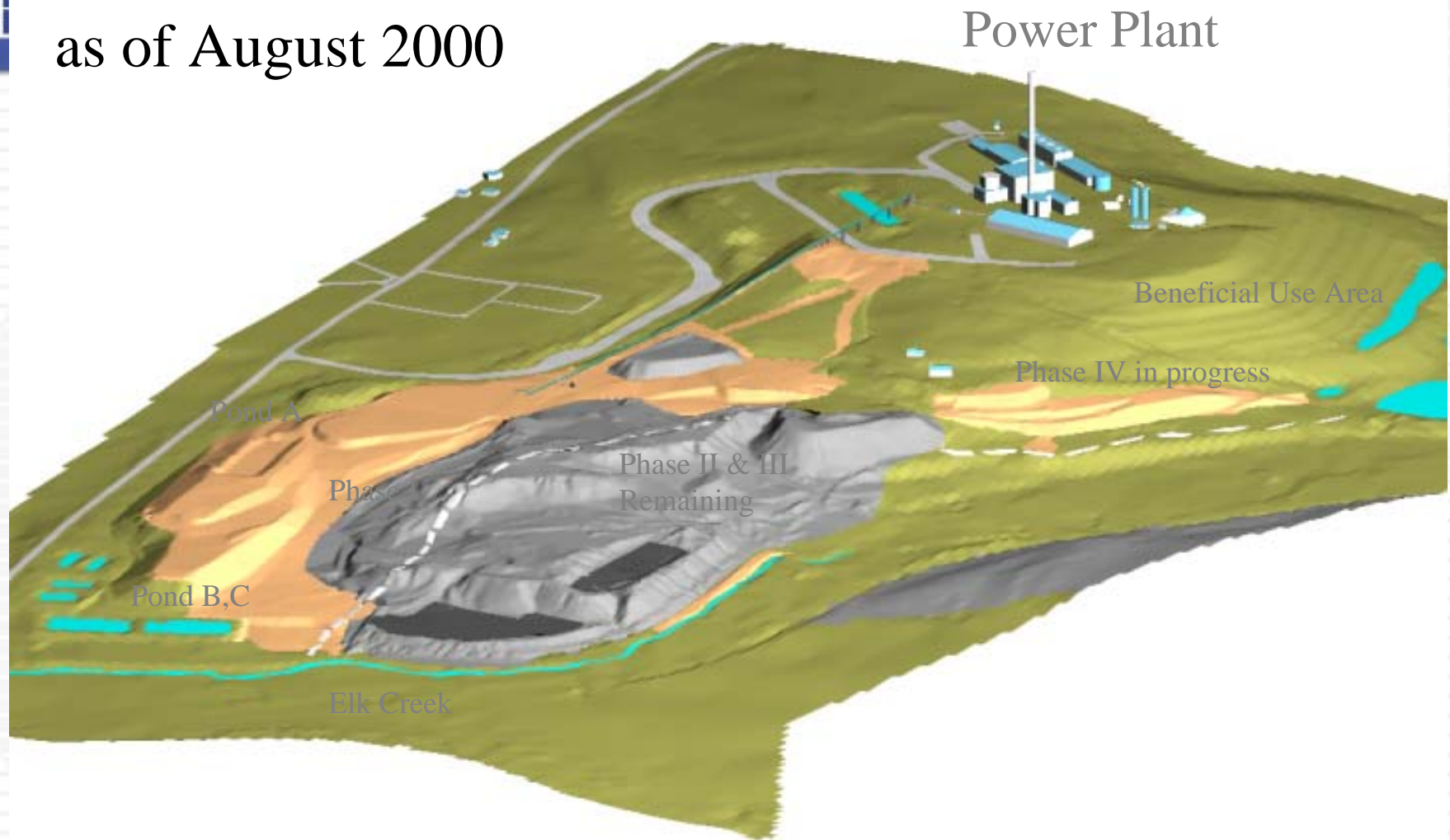
Example:

Burning Pyritic Coal Tailings as Fuel  
Replacement of tailings with alkaline coal ash

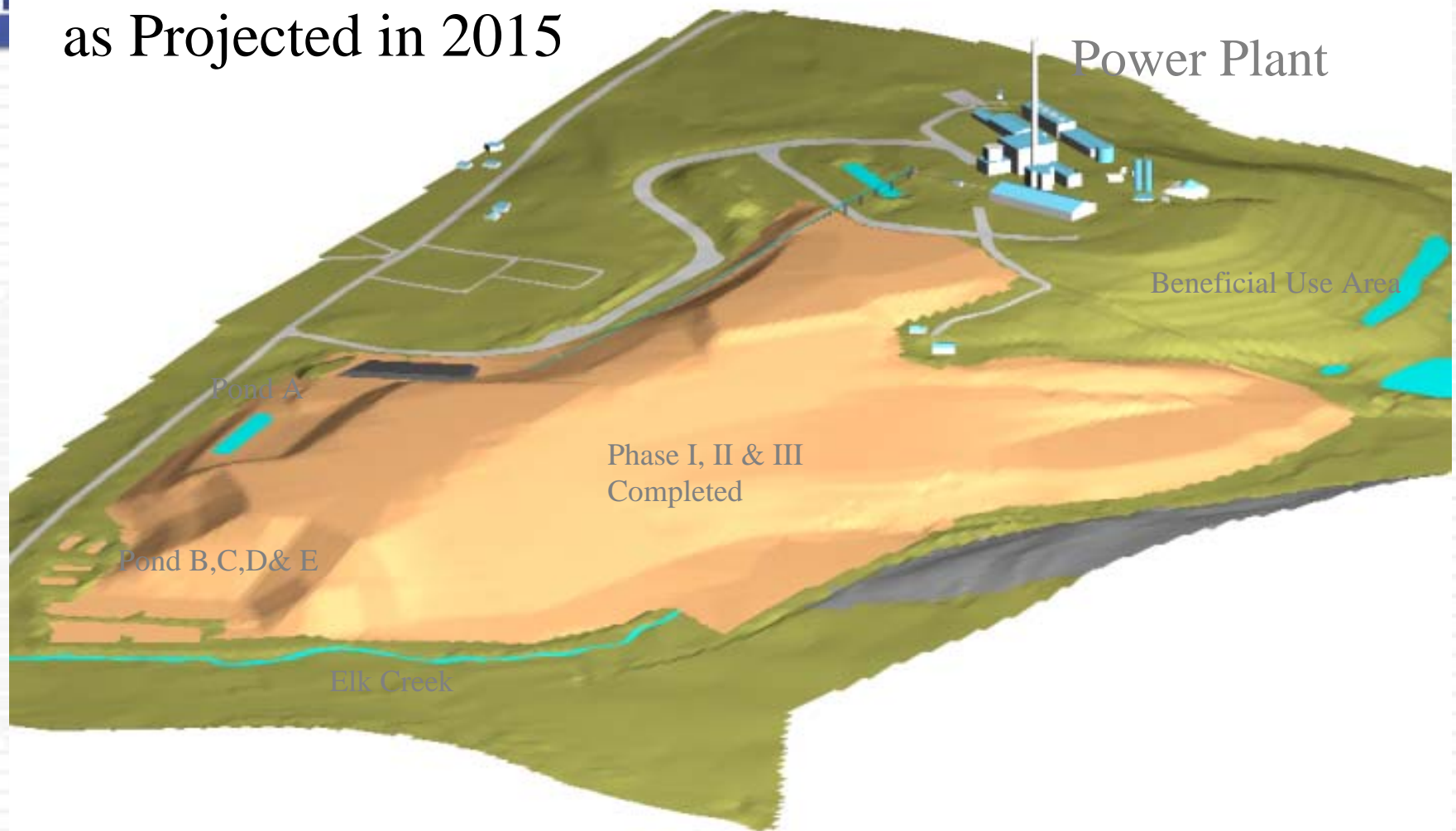
Colver Power Plant, Pennsylvania

- Ground water quality improvement at Monitoring Well
- Mine discharge quality improvement
- Surface water quality improvement in receiving stream

# Colver Refuse Site as of August 2000

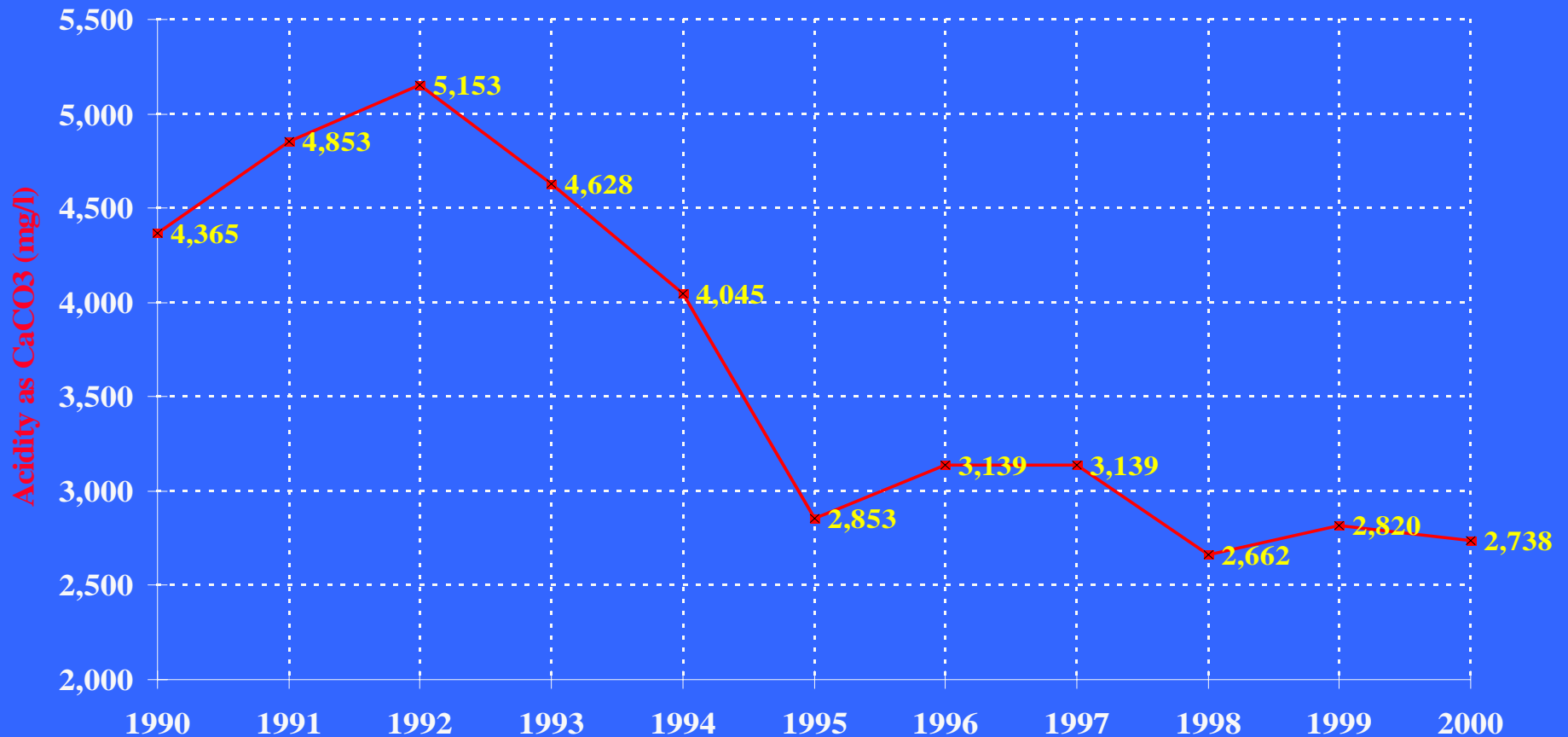


# Colver Refuse Site as Projected in 2015





# Colver Refuse Site Acidity Reduced in Ground Water



*Average Acidity @ MW-3*

## Pit Floor and Highwall Barrier – FBC Ash



# FBC Ash placement on pit floor





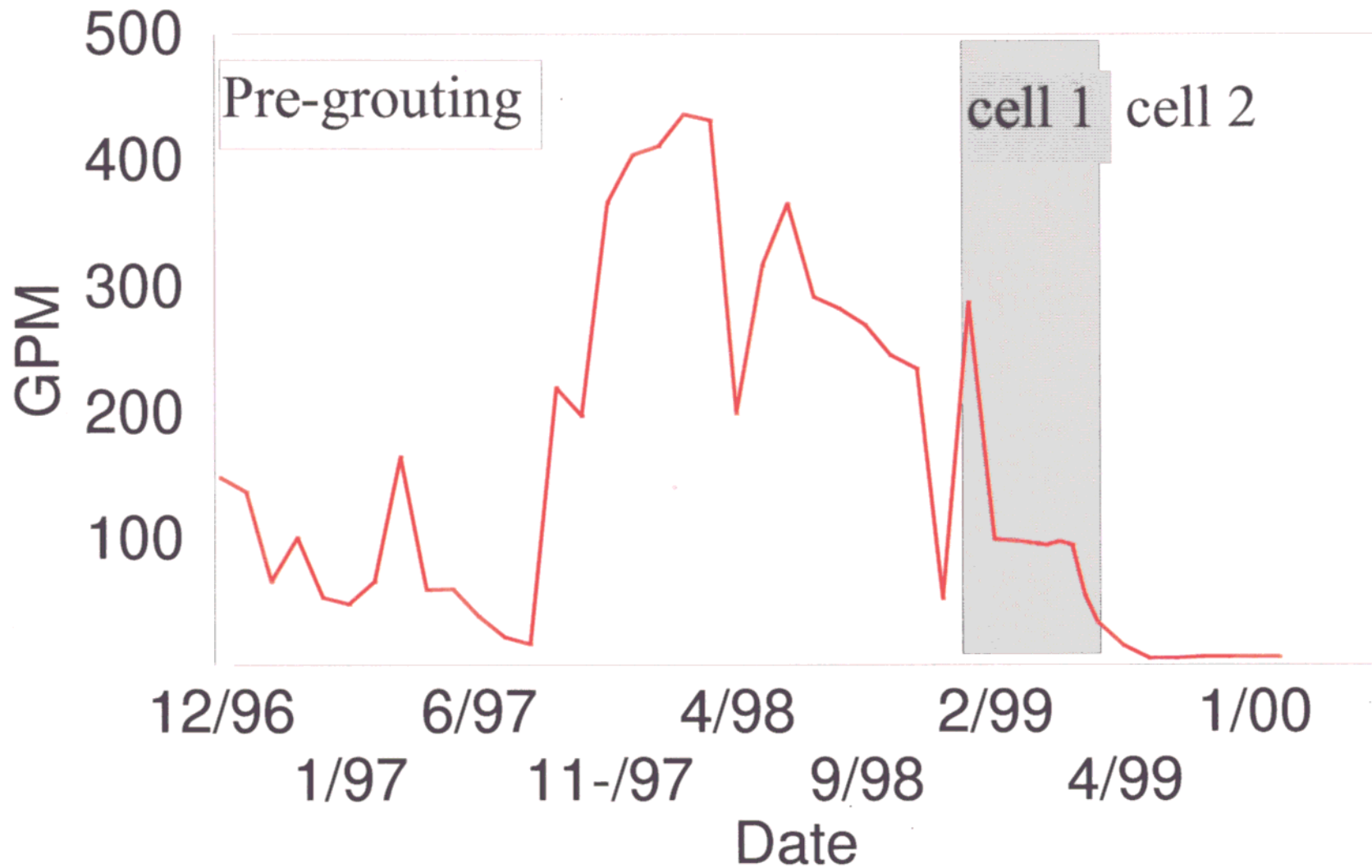
# Underground Mine Grouting



# Grout Injection Borehole



# Longridge Mine Flow



# Longridge Water Quality:

increases in Ba, Cd, Pb  
decreases in Al, As, B, Fe, Mg, Mn, Se

pH	Alk	Acid	Al	As	B	Ba	Cd	Fe	Mg	Mn	Pb	Se
S.U.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2.99	0	631	47	0.540	0.127	0.024	0.011	90	59	18	0.155	0.422
6.90	216	254	27	0.058	0.049	0.060	0.015	42	45	10	0.246	0.424
2.85	0	571	24	0.110	0.063	0.062	0.047	53	33	11	0.187	0.337
				0.02		2	0.005				0.015	0.05
				5		100	1				5	1

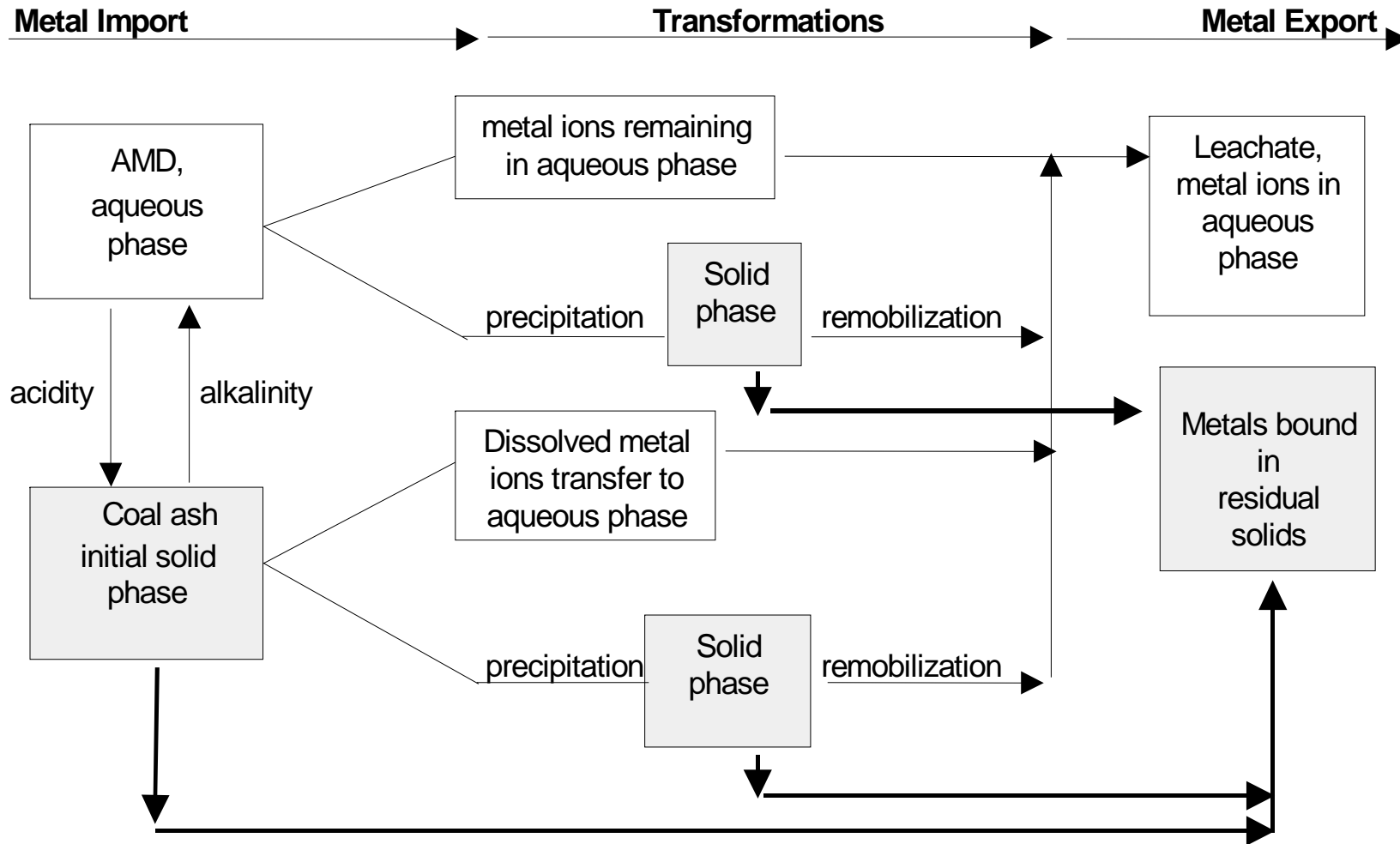
# Evaluating the Risk of Backfilling a Mine

- Leachant: Mine Water
  - strongly acid, with high metal concentrations
  - net alkaline with low contaminant concentrations
- Coal ash: Wide range of Properties
  - weakly alkaline
    - Eastern class F ash
    - FGD solids
  - strongly alkaline
    - Western class C ash
    - FBC ash

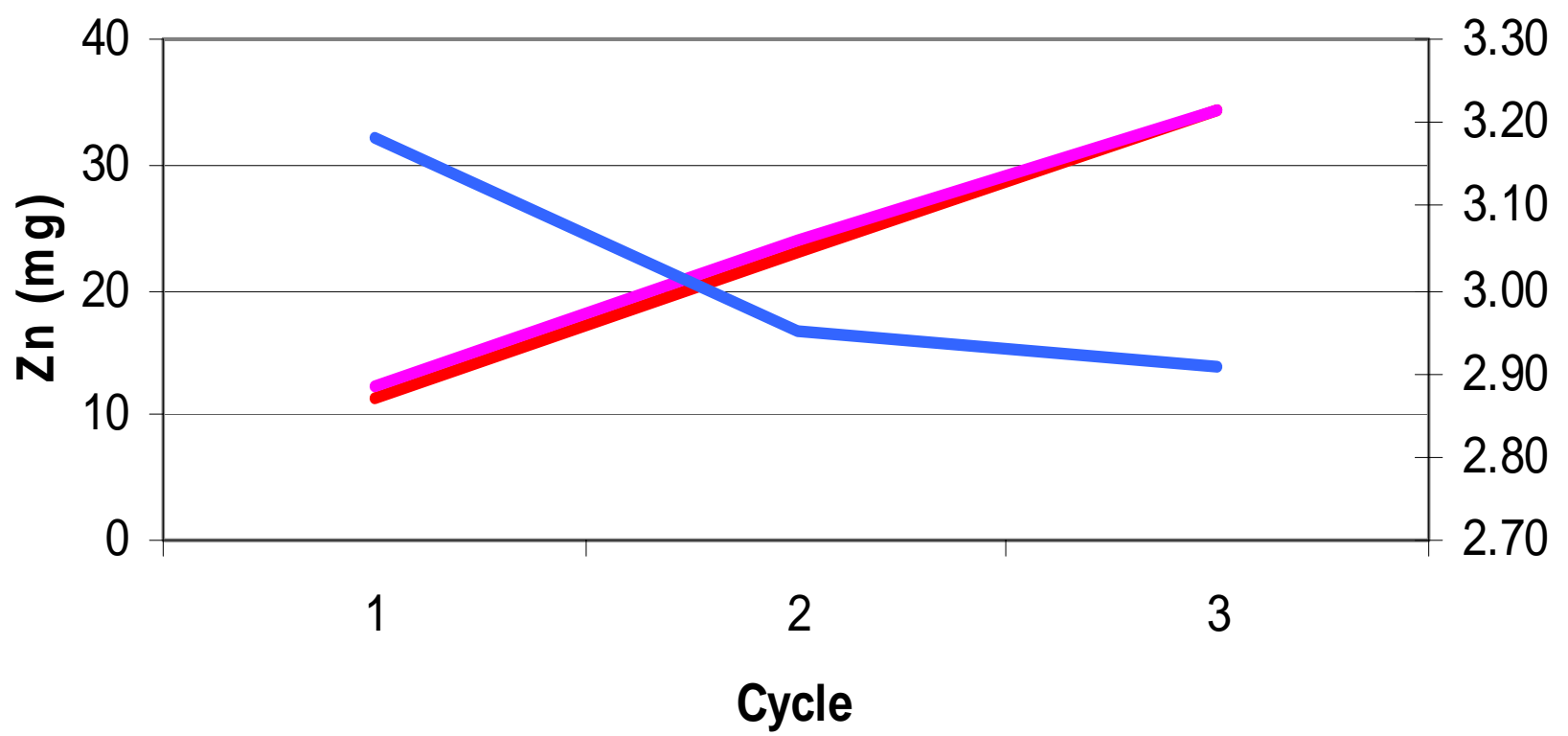
# Data Analysis and Interpretation

- The mass of metal imported via the mine water is compared to the mass exported via the leachate

# Metal Transfers: CCB added to Groundwater



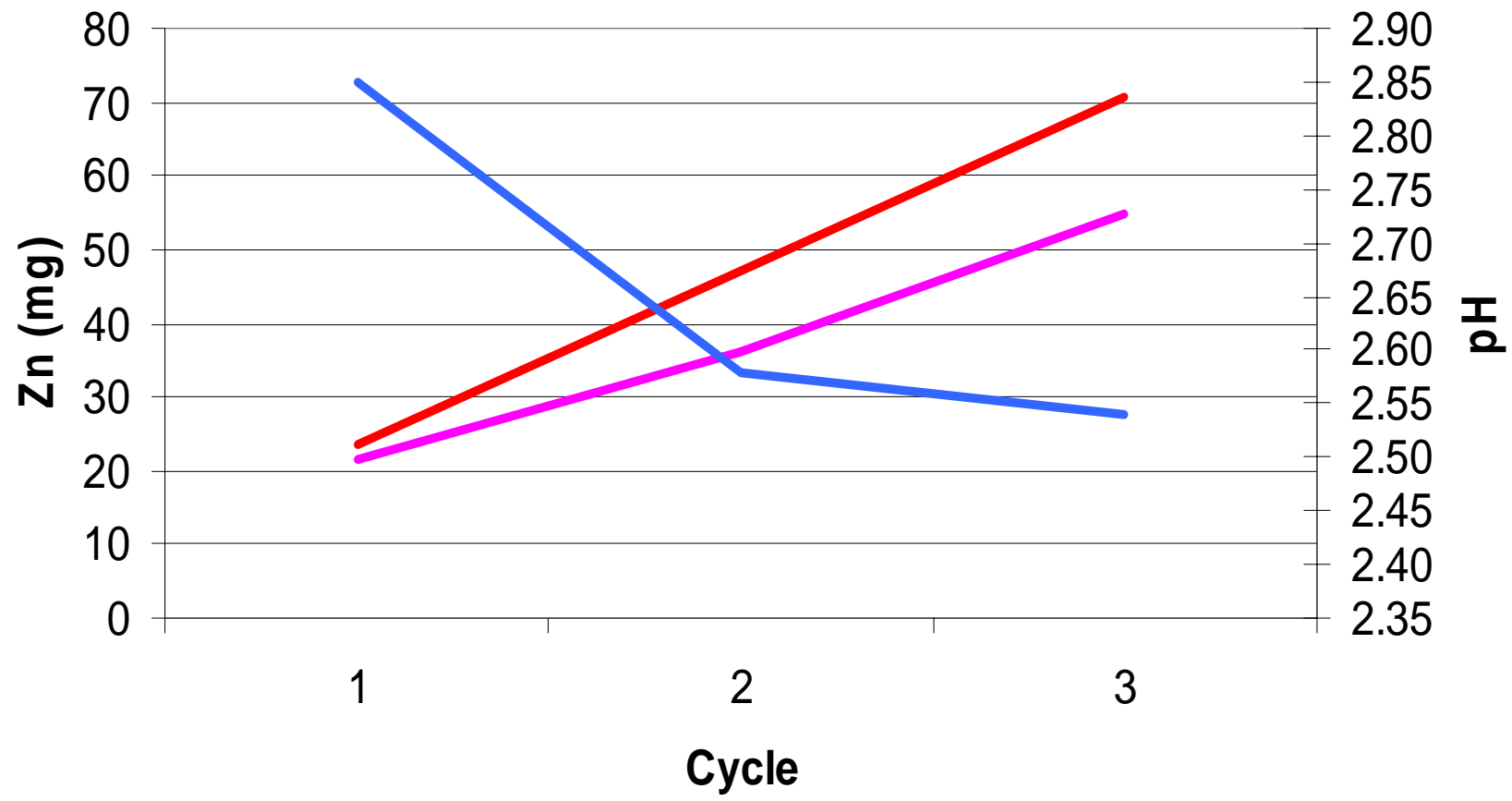
### Pit 1 water + Fly ash Zinc



— Zn In (mg) — Zn Out (mg) — pH



### Pit 4 water + Fly ash Zinc



— Zn In (mg) — Zn Out (mg) — pH



Leaching behavior of coal ash leached with mine pit water.

**Leachate concentrations which exceed raw water are in bold.**

	<b>Ni</b> (mg/L)	<b>Pb</b> (mg/L)	<b>Se</b> (mg/L)	<b>Sb</b> (mg/L)	<b>Tl</b> (mg/L)	<b>V</b> (mg/L)	<b>Zn</b> (mg/L)
<b>Detection limit</b>	0.001	0.001	0.001	0.001	0.001	0.001	0.001
<b>Pit 1 Water (Raw)</b>	0.97290	0.02820	BDL	BDL	BDL	0.49170	5.73000
<b>Pit 4 Water (Raw)</b>	3.25700	0.04360	0.03650	BDL	BDL	0.01260	11.80000
<b>Pit 1 water + Fly ash</b>							
Cycle 1	<b>1.98550</b>	BDL	<b>0.01533</b>	BDL	<b>0.00730</b>	0.02977	<b>6.13640</b>
Cycle 2	<b>1.87930</b>	0.00831	<b>0.01224</b>	BDL	<b>0.00543</b>	0.03523	<b>5.77140</b>
Cycle 3	<b>1.69170</b>	BDL	<b>0.01150</b>	BDL	BDL	0.05920	5.28370
<b>Pit 4 water + Fly ash</b>							
Cycle 1	<b>3.74570</b>	BDL	<b>0.04941</b>	BDL	<b>0.01297</b>	<b>0.28460</b>	10.70700
Cycle 2	2.93130	BDL	0.01926	BDL	<b>0.00732</b>	<b>0.15450</b>	7.41350
Cycle 3	<b>3.28470</b>	BDL	0.02760	BDL	BDL	<b>0.17700</b>	9.24220
<b>DI H2O + Fly ash</b>							
Cycle 1	0.01075	BDL	0.00985	BDL	BDL	BDL	0.03781
Cycle 2	BDL	BDL	0.00110	BDL	BDL	0.00224	0.00169
Cycle 3	BDL	BDL	BDL	BDL	BDL	BDL	BDL

\* BDL= Below detection Limit

# Conclusions

- CCBs can have positive or negative effects on groundwater
- Controlling factors are highly localized:
  - Groundwater flow regime
  - CCB permeability
  - Groundwater chemistry
  - CCB chemistry