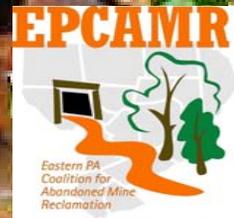


Inventory and Analyses of Abandoned Mine Drainage Iron Oxide Deposits in Northeastern Pennsylvania for Resource Recovery Potential

Robert Hughes
Regional Coordinator; EPCAMR

Jeffrey Frank
Watershed Mine Drainage
Specialist Intern; EPCAMR/OSM



HedinEnvironmental

LIST OF PARTNERS

- **Office of Surface Mining (OSM)**
- **Luzerne Conservation District (LCD)**
- **Earth Conservancy**
- **PA Department of Environmental Protection- Bureau of Abandoned Mine Reclamation (BAMR)**
- **USGS**
- **US EPA, Region 3**
- **Hedin Environmental/EnvironOxide™**
- **GEMARK**
- **Participating Watershed Groups**

ABOUT EPCAMR & OSM

-Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) is a non-profit organization covering 16 counties in the eastern Pennsylvania coalfields. Since 1996, EPCAMR has been working in Appalachian coal communities to assist under-served populations, community groups, and local governments to reclaim abandoned mine lands, restore streams, and build community support for education programs in watersheds impacted by acid mine drainage (AMD).

-The Office of Surface Mining (OSM) provides limited financial assistance and fosters development and implementation of watershed planning through the Summer Watershed Internship Program. OSM encourages innovative approaches to the Summer Watershed Internship Program and watershed efforts to address environmental challenges in coalfield areas.

Abandoned Mine Land Problem Areas



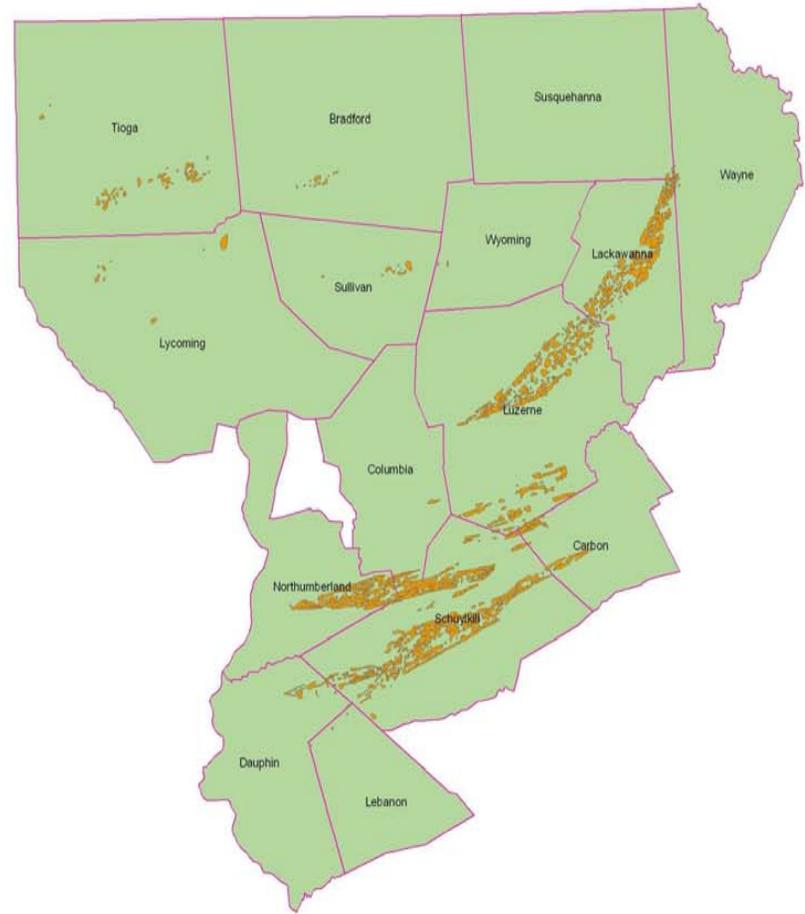
EPCAMR



Eastern PA
Coalition for
Abandoned Mine
Reclamation



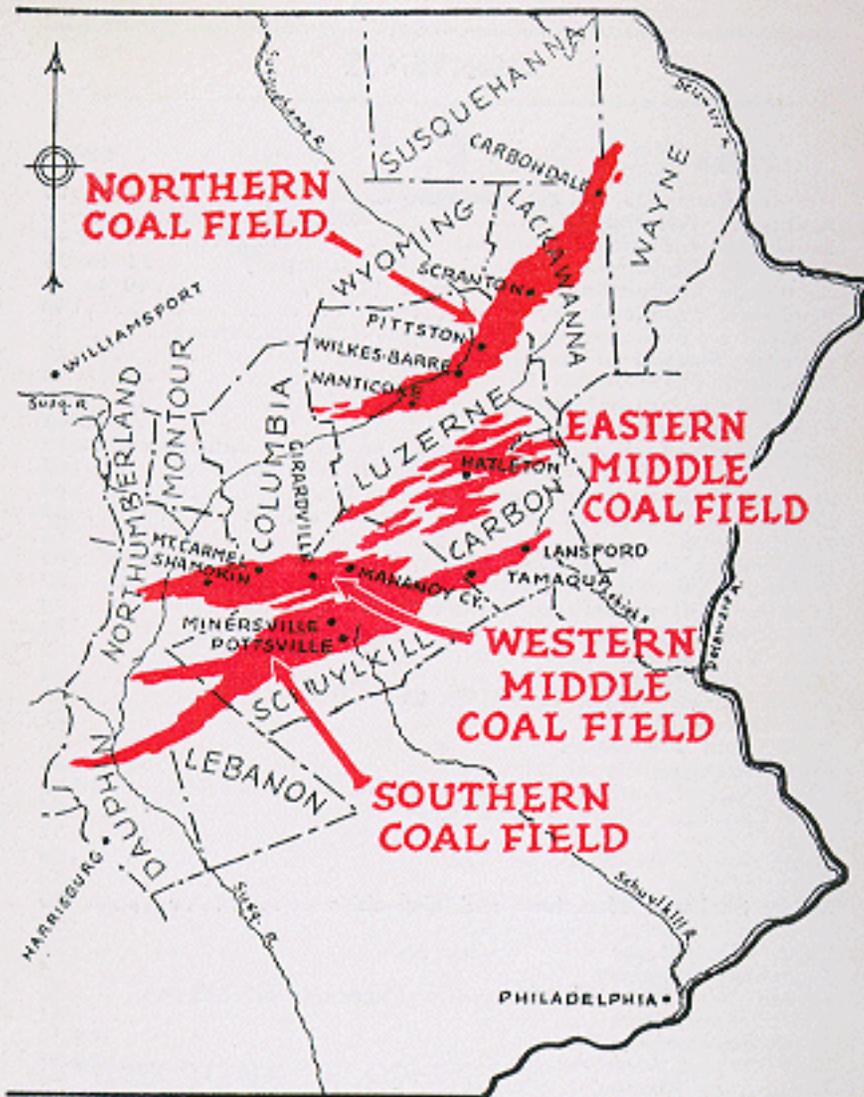
- AML Problem Areas
- Wilkes-Barre District - Eastern PA Coalition for Abandoned Mine Reclamation
- Cambria District - Western PA Coalition for Abandoned Mine Reclamation
- County Boundaries
- BAMR Offices



Bureau of Abandoned Mine Reclamation Districts

Pennsylvania

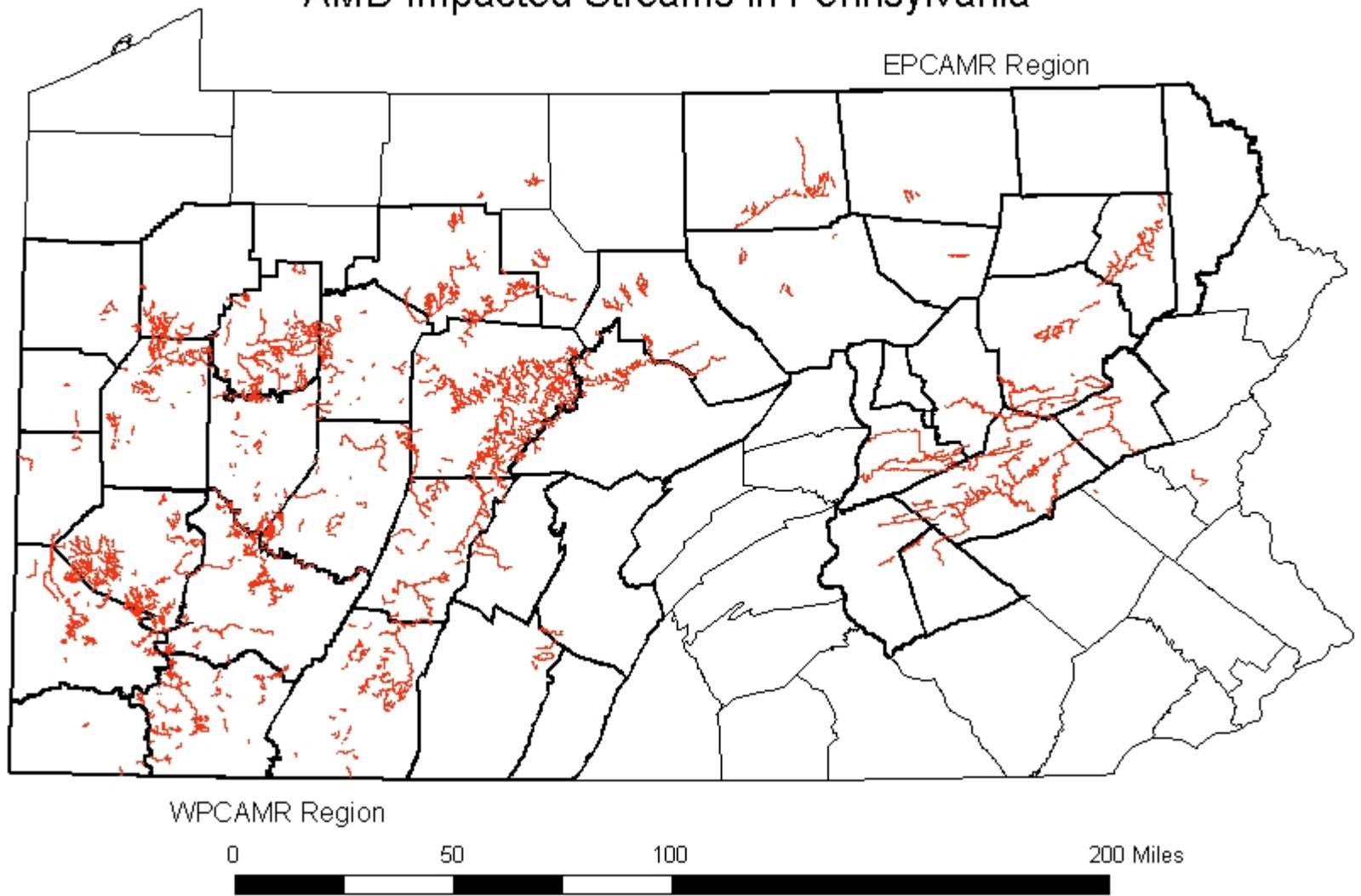




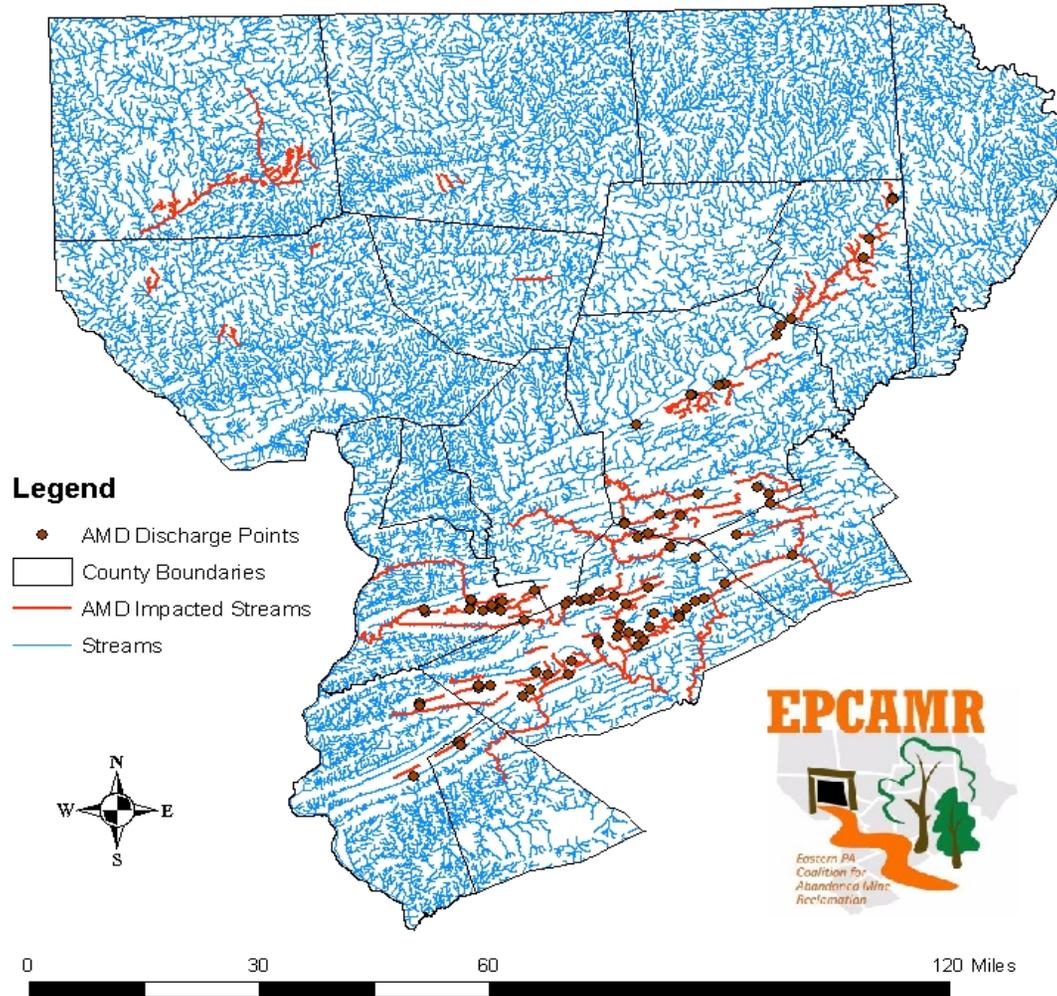
THE PENNSYLVANIA
Anthracite
 COAL FIELDS

GEOGRAPHICAL LOCATION OF PROBLEM AREAS IN PENNSYLVANIA

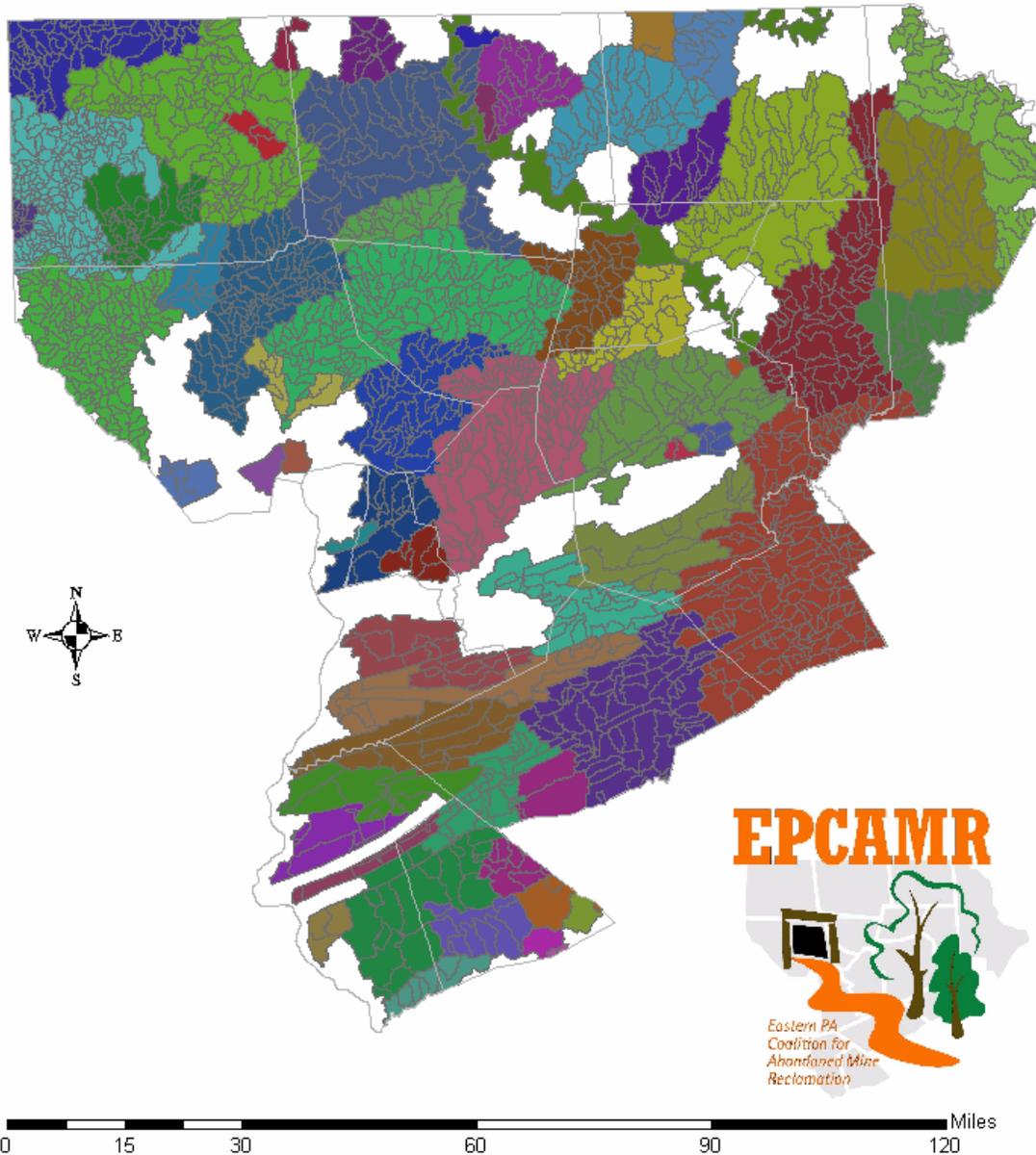
AMD Impacted Streams in Pennsylvania



Abandoned Mine Drainage Impacts in the EPCAMR Region: Discharge Points and Impacted Streams



EPCAMR Watershed Groups



**WATERSHED
GROUPS
CLIPPED TO
EPCAMR'S
COVERAGE
AREA**

** White areas indicate
no representation*

Goals and Objectives Of Iron Oxide Resource Recovery Project

- Assess project data parameters**
- Contact affected watershed groups**
- Sample and photo inventory sites**
- Incorporate into a GIS/GDB**
- Send samples for testing**
- Receive results of testing**
- Compile results of chemistry/metals analysis**
- Develop markets interested in iron oxide product**

Assessment of Project Data Parameters

Iron Oxide Sampling Criteria

- **High volume iron discharges***
- **Instream Abandoned Mine Drainage discharges**
- **AMD treatment systems**
- **No sampling of permitted discharges on active mines**

***At the outset of the project, it was hoped to locate sites that included high alkaline water quality as specified by Bob Hedin.**

Assessment of Project Data Parameters

- Consult with Bob Hedin of Hedin Environmental concerning data parameters in assessing each sampling site, including:

- Discharge Type**...is it emanating from a tunnel, shaft, borehole, or is it an instream discharge?

- Field Stream Flow**...was the stream at high, medium, low flow, or stagnant?

- Particulate Matter**...were there any leaves, rocks, sticks, or trash in the stream that may affect the quality of the sample?

- Treatment System Type**...if the sample was taken from a treatment system, was it an aerobic wetland, anoxic limestone drain, a diversion well, or successive alkalinity producing?

Assessment of Project Data Parameters

After much tinkering, the data form used for sampling was completed

IRON OXIDE DEPOSITS SAMPLING PROJECT RESOURCE RECOVERY POTENTIAL OF AMD DISCHARGES IN THE EPCAMR REGION

EPCAMR

Discharge ID: _____ Discharge Name: _____

Discharge Type: _____ AMD Source: _____

Date of Sample Collection: _____ Sample Location #: _____ Collector Name: _____

Organization Represented: _____ Watershed Name: _____ Tributary Name: _____

County: _____ Municipality: _____ TMDL Segment: _____

Active Watershed Assoc: _____ If Yes, list Assoc Here: _____

Watershed Contact Information: _____

Primary Funding Partners: _____

IRON OXIDE DEPOSITS SAMPLING PROJECT RESOURCE RECOVERY POTENTIAL OF AMD DISCHARGES IN THE EPCAMR REGION

EPCAMR

Discharge ID: Discharge Name:

Discharge Type: AMD Source:

Date of Sample Collection: Sample Location #: Collector Name:

Organization Represented: Watershed Name: Tributary Name:

County: Municipality: TMDL Segment:

Active Watershed Assoc: If Yes, list Assoc Here:

Watershed Contact Information:

Primary Funding Partners:

Midpoint Sample #N:

Field pH:

Field Acidity:

Field Alkalinity:

Width, in feet: Length of Segment: Sludge Depth, in inches: Field Stream Flow:

Particulate Matter: Impediment: Road Access:

Latitude: Longitude: USGS Quadrangle:

Midpoint Sample #N:

Field pH:

Field Acidity:

Field Alkalinity:

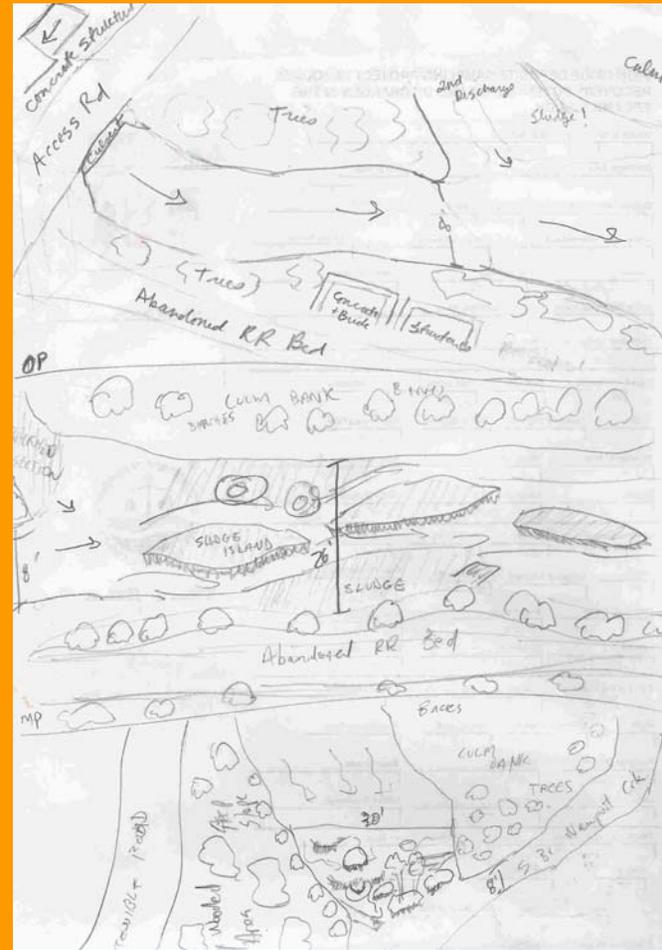
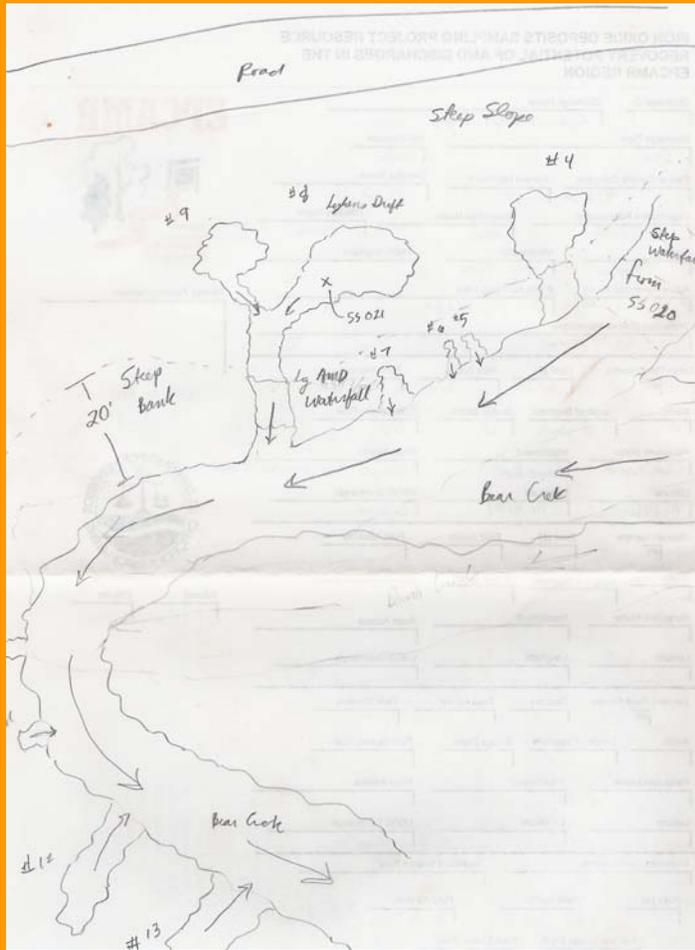
Width, in feet: Length of Segment: Sludge Depth, in inches: Field Stream Flow:

Particulate Matter: Impediment: Road Access:

Latitude: Longitude: USGS Quadrangle:

HedinEnvi

Site Sketch Plans



Assessment of Project Data Parameters

- **Most important to Hedin Environmental was the approximate calculation of the tonnage of potential iron oxide that could be extracted from the sites.**
- **Since the majority of samples sent for analysis would come from either in or near streams, a volumetric calculation of stream channel deposition capacity was needed to help determine approximate tonnage of iron oxide.**
- **Assisting with this calculation was the taking into account of each site's channel dimensions. We used the trapezoidal channels' dimension list from the USDA-SCS, 1947 publication and assigned each site with a dimension as listed in the publication that most closely resembled it's actual dimensions.**

Assessment of Project Data Parameters

$$t = b + 2zd$$

$$A = (d(b+t))/2$$

$$V = Al$$

where:

t = Top width (feet)

b = Bottom width (feet)

z = Stream channel shape and run ratio (i.e., Trapezoidal 1:1)

d = Depth of sludge (feet)

A = Cross sectional area (square feet)

V = Volume of sludge (cubic feet)

l = Length of discharge before it meets a stream, another discharge, etc. (feet)

- **We had to convert from cubic feet to tons in order for Hedin Environmental to be able to make a decision concerning feasibility of extraction.**

GIS/GPS Equipment Used

The following GIS and database software and GPS equipment was used throughout the project:

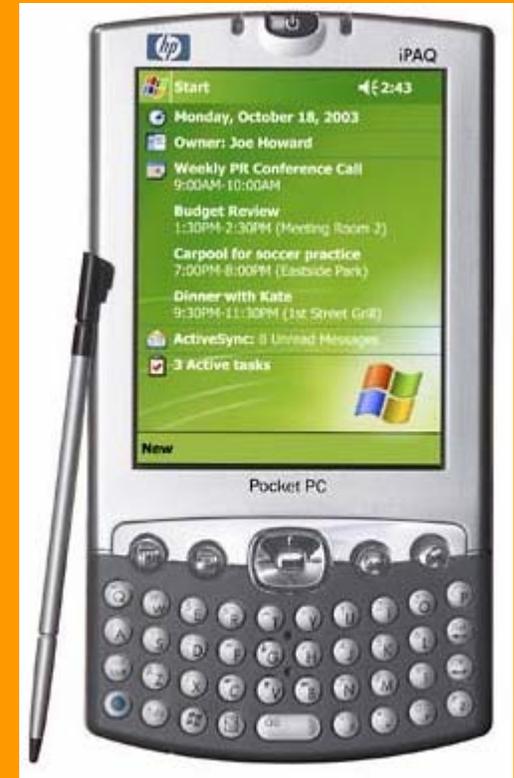
- **ArcGIS 9.0**
- **ArcPad 6.0**
- **Microsoft Access Dbase**
- **Hand-held GPS Magellan Meridian Platinum Unit**
- **HP IPAQ 4500 Handheld Unit**



ArcPad & IPAQ

- **ArcPad[®] is mobile GIS software for field mapping applications. By integrating geographic information system (GIS) software with global positioning system (GPS) technology, ArcPad dramatically improves field data collection. ArcPad offers support for vector and image data; map navigation; and query, find, and measure and is highly customizable for industry specific applications.**

- **Use ArcPad for:**
 - Performing reliable, accurate, and validated data collection
 - Integrating GIS and GPS with real-time position information
 - Sharing enterprise data with field workers for updating and decision making
 - Improving the efficiency of data collection
 - Deploying mobile GIS applications customized for specific industries



Access

- **After assessing and evaluating the types of data parameters that would be needed for the data form to document each individual sampling site, it was determined that using Microsoft Access[®] would provide EPCAMR with the flexibility needed to design a base data form and table that could accommodate several types of data formats, as well as eventually be exported into a GIS for data manipulation in mapping.**

Access

- When entering the data on Access, we had several categories utilizing drop-down lists from which the person transferring the data from the data forms to electronic format could select

Discharge Type
Borehole
Shaft
Borehole
Drift
Slope
Seep
Toe of Spoil
Instream
Other

Field Stream Flow
Stagnant
Low
High
N/A

Particulate Matter
Both Sticks/Rocks
Both Leaves/Sticks
Sticks
Rocks
Both Leaves/Sticks
Both Leaves/Rocks
Both Sticks/Rocks
Leaves/Sticks/Rocks
Trash
All

Treatment System Type
Aerobic Wetland
Aerobic Wetland
Anaerobic Wetland
Successive Alkalinity Producing
Diversion Well
Sulfate-Reducing BioReactor
Active Chemical Treatment
Capping
Alkalinity Injection

Access

The Final Table

Microsoft Access - [SludgeDischarges : Table]

File Edit View Insert Format Records Tools Window Help

Type a question for help

Discharge ID	Discharge Name	Discharge Type	AMD Source	Sample Location ID	Watershed
2	Dundee Outfall	Borehole	Underground	SS002-TS	Nanticoke
3	Beaver Dam Outfall	Instream	Underground	SS003	Nanticoke
4	Espy Run Treatment Wetlands	Shaft	Underground	SS004-TS	Nanticoke
5	Espy Run Discharge	Instream	Underground	SS005	Nanticoke
6	Site 19- Scot Ridge Mine Tunnel	Seep	Underground	SS006-TS	Shamokin C
7	Site 20 - Coalbert Mine Breech	Borehole	Underground	SS007	Shamokin C
8	Site 21- Maysville Borehole/Discharge	Borehole	Underground	SS008	Shamokin C
9	Site 15- Corbin Mine Drift	Drift	Underground	SS009-O	Shamokin C
10	Site 12- Excelsior Stripping Pit	Tunnel	Underground	SS010-O	Shamokin C
11	Site 49- Sterling Discharge	Shaft	Underground	SS011-O	Shamokin C
12	Site 57- Cameron Discharges	Shaft	Underground	SS012-O	Shamokin C
13	Site 52- Cameron Discharges	Shaft	Underground	SS013-O	Shamokin C
14	Site 42- Carbon Run Treatment	Shaft	Underground	SS014-O	Shamokin C
15	Old Forge Borehole	Borehole	Underground	SS015-O	Lackawann
16	Duryea Outfall	Shaft	Underground	SS016-O	Lackawann
17	Gravity Slope Outfall	Slope	Underground	SS017-O	Lackawann

Materials Used

In addition, the items used for the iron oxide sampling at the selected stream sites were:

- Cabela chest waders
- Sony Mavica digital camera
- Tupperware containers
- Mesh screen
- Aluminum forms holder
- Ice cream scooper
- Quart-size storage bags
- Family-size empty chicken soup can
- 10-pk. floppy diskettes
- 8-pk. AA batteries



- 15' extendable pole
- HACH Kit
- Igloo cooler



In the field

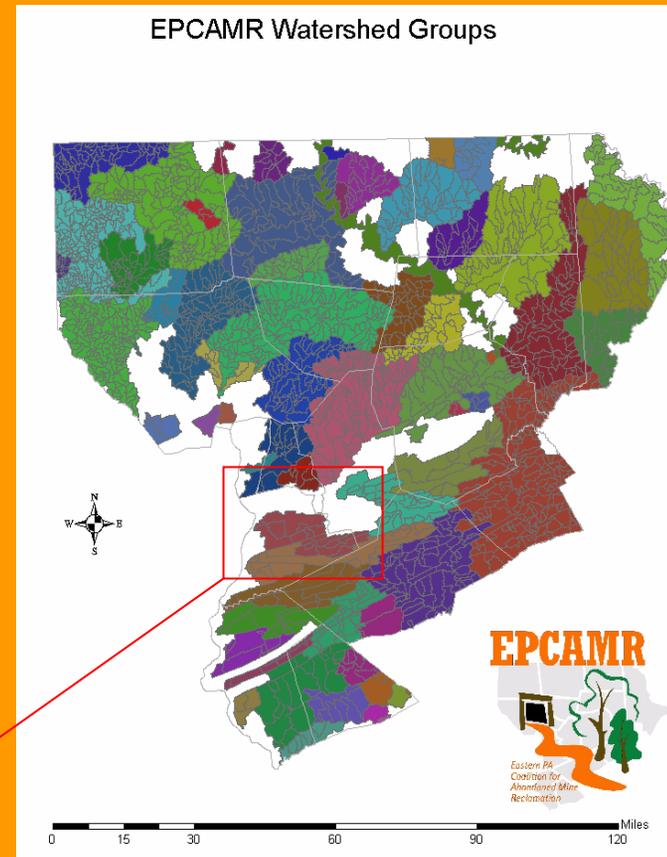
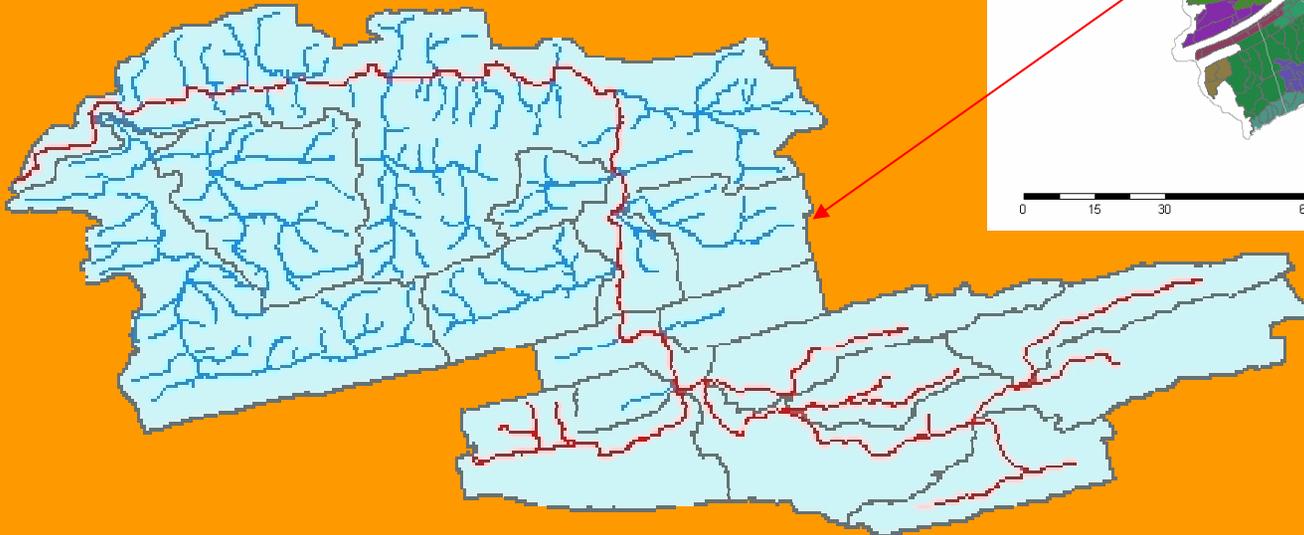


Contacting of Affected Watershed Groups

- **Once the data parameters, the data sampling form, and sampling equipment were in place, the next step was the notification of those watershed groups affected by AMD within EPCAMR's coverage (out of ~70 on our listserve).**
- **Mass email was sent to initially contact those group representatives of the watersheds that contained stream sites that were assumed to have met the iron oxide sampling criteria.**
- **Follow-up phone contact was made to schedule dates/times for EPCAMR staff to meet with these representatives to assist in sampling sites.**

Shamokin Creek Watershed

- Red streams indicate those on the 303(d) list



Shamokin Creek Watershed

Corbin Mine Drift, Coal Township; Northumberland County, PA



Discharge Name	Sample ID	County	Ph	Acidity	Alkalinity	Sludge Depth (In.)	Tons
Site 15- Corbin Mine Drift	SS009-O	Northumberland	4.2	290.7	0	36	6.73

Shamokin Creek Watershed

Excelsior Stripping Pit, Coal Township; Northumberland County, PA

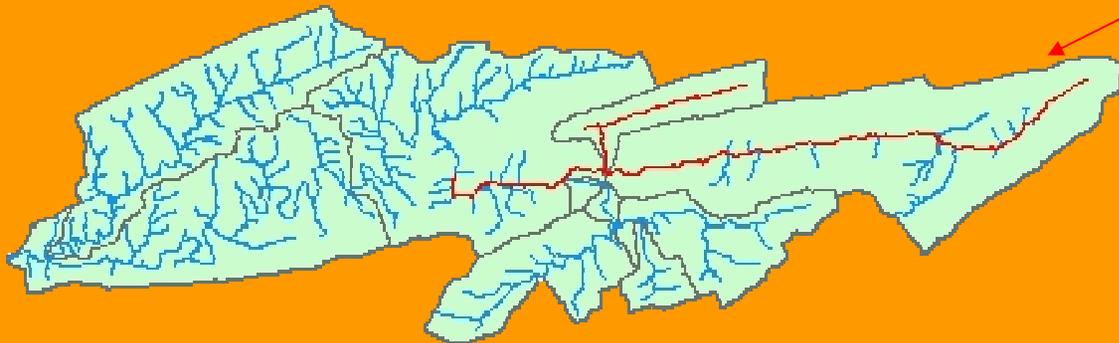
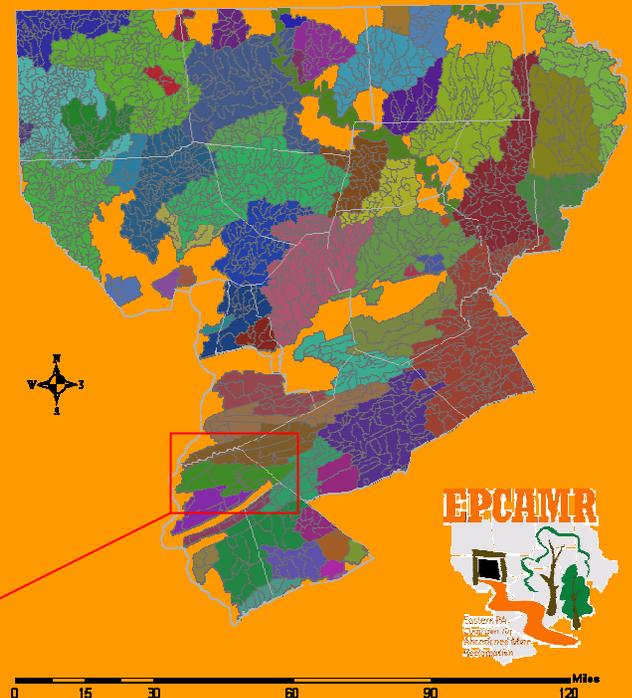


Discharge Name	Sample ID	County	Ph	Acidity	Alkalinity	Sludge Depth (In.)	Tons
Site 12- Excelsior Stripping F	SS010-O	Northumb	5.6	222.30	51.30	30	56.10

Wiconisco Creek Watershed

- Red streams indicate those on the 303(d) list

EPCAMR Watershed Groups



Wiconisco Creek Watershed

Lykens Water Level Tunnel, Wiconisco Township; Dauphin County, PA



Discharge Name	Sample ID	County	Ph	Acidity	Alkalinity	Sludge Depth (In.)	Tons
Lykens Water Level Tunnel	SS018-O	Dauphin	6	76.95	17.10	12	98.74

Wiconisco Creek Watershed

Unnamed Seep, Wiconisco Township; Dauphin County, PA



Discharge Name	Sample ID	County	Ph	Acidity	Alkalinity	Sludge Depth (In.)	Tons
Unnamed Seep	SS019-O	Dauphin	6	68.40	17.10	36	100.99

Final Product

The image shows a screenshot of the ArcMap - ArcView interface. The main map displays a network of streams overlaid on a green background. The streams are color-coded according to a STRAHLER stream order legend. The legend shows red lines for orders 1 through 6, and blue lines for orders 0, 1, and 2. The map also features several yellow and black striped markers along the stream network.

An "Identify Results" window is open in the upper left, showing the "SludgeDischargesExport" layer. It lists three entries for "Site 20 - Coalbert Mine" with associated coordinates and values. The location is given as (-76.500625 40.789581).

An inset window in the center of the map displays a photograph of a stream with a reddish-brown color, likely due to sediment discharge, flowing through a grassy field.

The software interface includes a toolbar with various navigation and analysis tools, a legend, and a status bar at the bottom showing the current coordinates as -76.49 41.16 Decimal Degrees and the time as 4:04 PM.

Iron Oxide Uses



IMAGINE THE POSSIBILITIES

- Paints
- Coatings
- Stains
- Plaster
- Cement
- Concrete
- Pavers
- Roof tiles
- Stucco
- Mortar
- Grout
- Plastics
- Paper
- Mulch

Problems and Realizations

- **IN THE FIELD...**
 - **Lack of alkalinity at most sites due to lack of limestone geology that acts as a buffer for the chemistry of the streams affected**
 - **Utilization of ArcPad toward the end of the initial stage of project that reduced field time**
 - **Site accessibility**
 - **Lack of knowledge of discharge information in areas without watershed group stewardship**
 - **Site and instream hazards (i.e., Solomons Creek boreholes, trash)**

Problems and Realizations

- **IN THE OFFICE...**
 - **Transferring of data written on forms to electronic format**
 - **Calculating of cross sectional area of iron sludge at sample points required assistance**
 - **Developing of standard, though project is young and not an “exact science”**
 - **Converting data into ArcPad**

What's next?

- **Continuation of project with next Watershed Intern(s)**
 - **Submission of Innovative Grant proposal to DEP**
 - **Submission of grant to OSM to fund future interns**
- **Continued expansion of markets for iron oxide product (Eastern PA)**
- **Watershed group support**

Contact Information

- EPCAMR's website www.orangewaternetwork.org
- Robert Hughes rhughes@epcamr.org
- Jeffrey Frank jfrank@epcamr.org
- Hedin Environmental/Environoxide™ www.environoxide.com

Questions?

