

# ABANDONED UNDERGROUND MINES GIS FOR OHIO

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**The AUM**  
**Historic Development,**  
**Development Methods,**  
**GIS Data,**  
**and**  
**Challenges**

# Scanned Mylar of The Abandoned Underground Mine Map Series

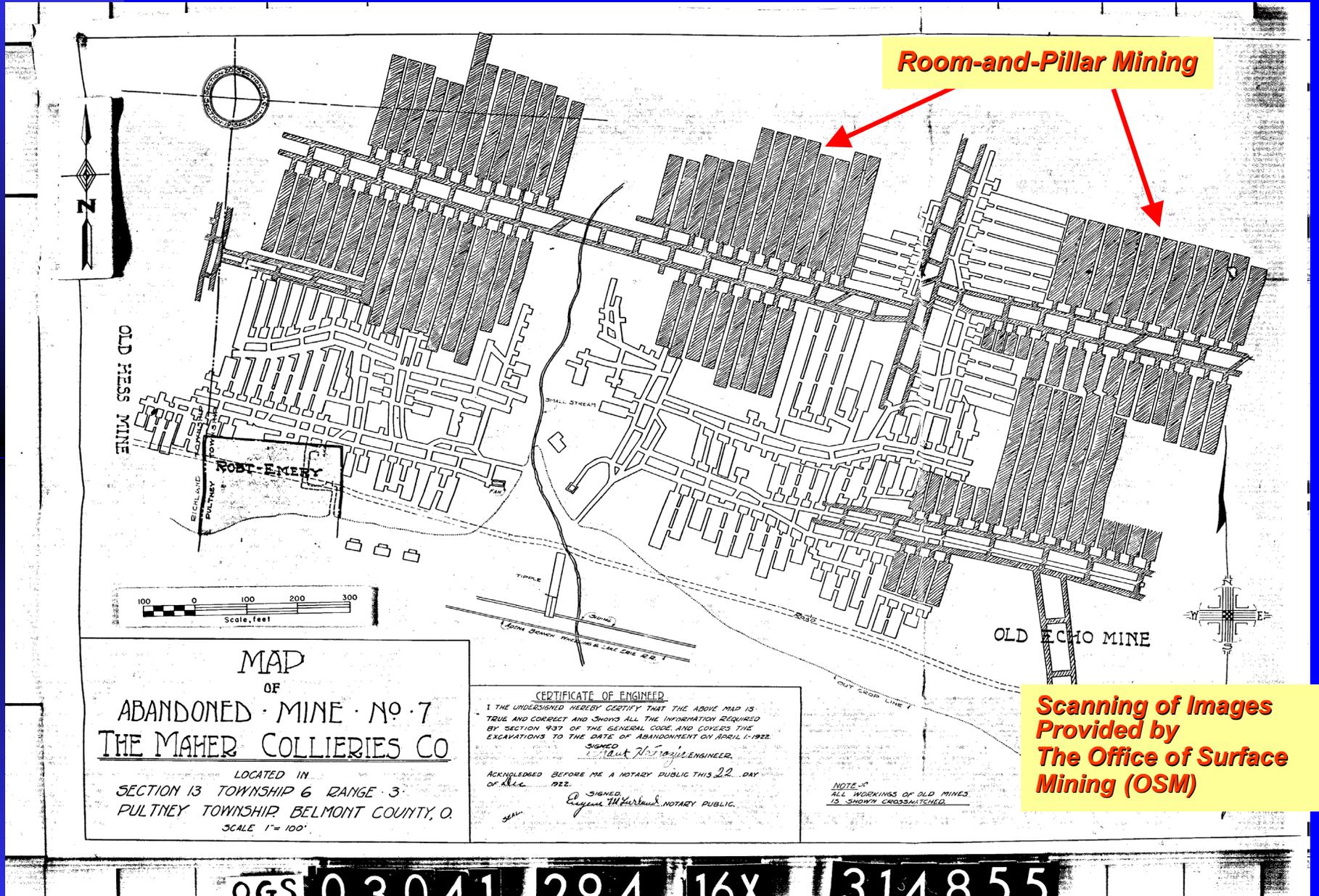
Mine Entry

Surface  
Mine

7 1/2-minute  
Quad base  
map

Individual mine maps, along with  
a Superimposed Mine Polygon  
U.S. Geological  
Survey 7 1/2-minute topographic  
quadrangle maps.

# Scanned Image of Abandoned Underground Detailed Mine Map

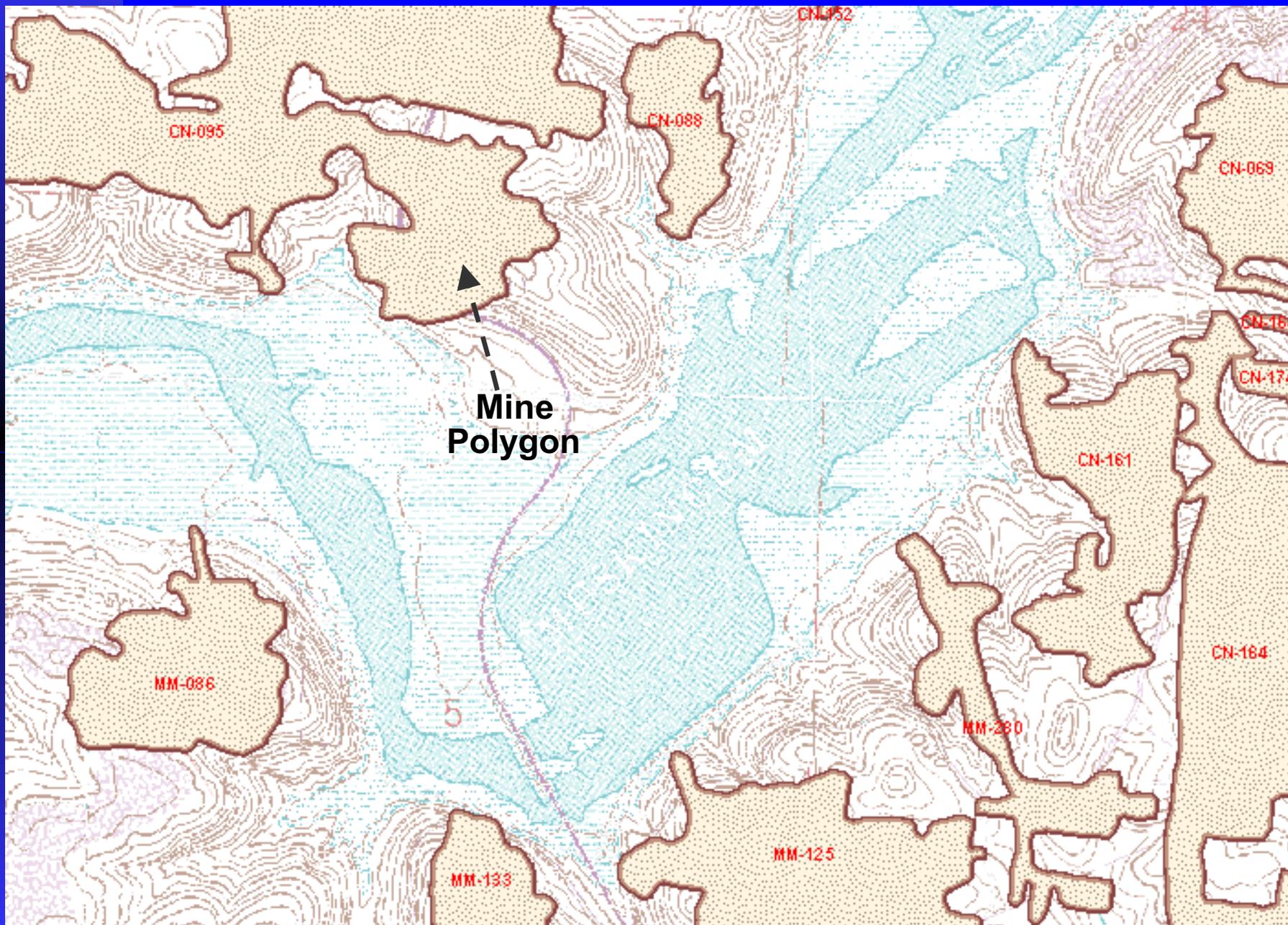


**Scanning of Images Provided by The Office of Surface Mining (OSM)**

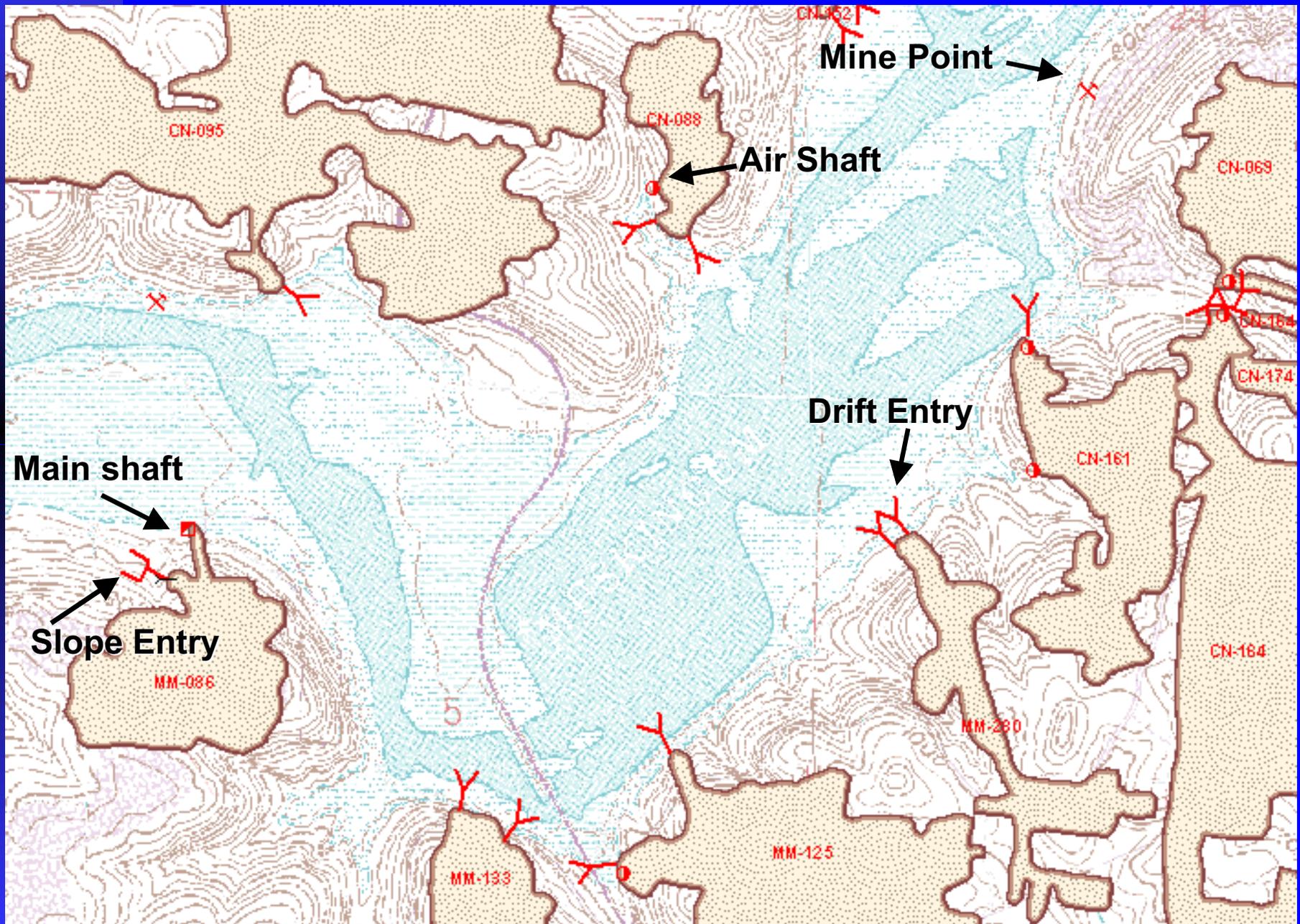
**Abandoned Mine BT-005, Pultney Township, Belmont County, Ohio**



# Digitized Mine Polygons



# Digitized Mine Points and Entry Points



# Original AUM Personal Geodatabase

ArcCatalog - ArcInfo - D:\UNDERGROUND MINE FILES\UAM\UAM.mdb

Location: D:\UNDERGROUND MINE FILES\UAM\UAM.mdb

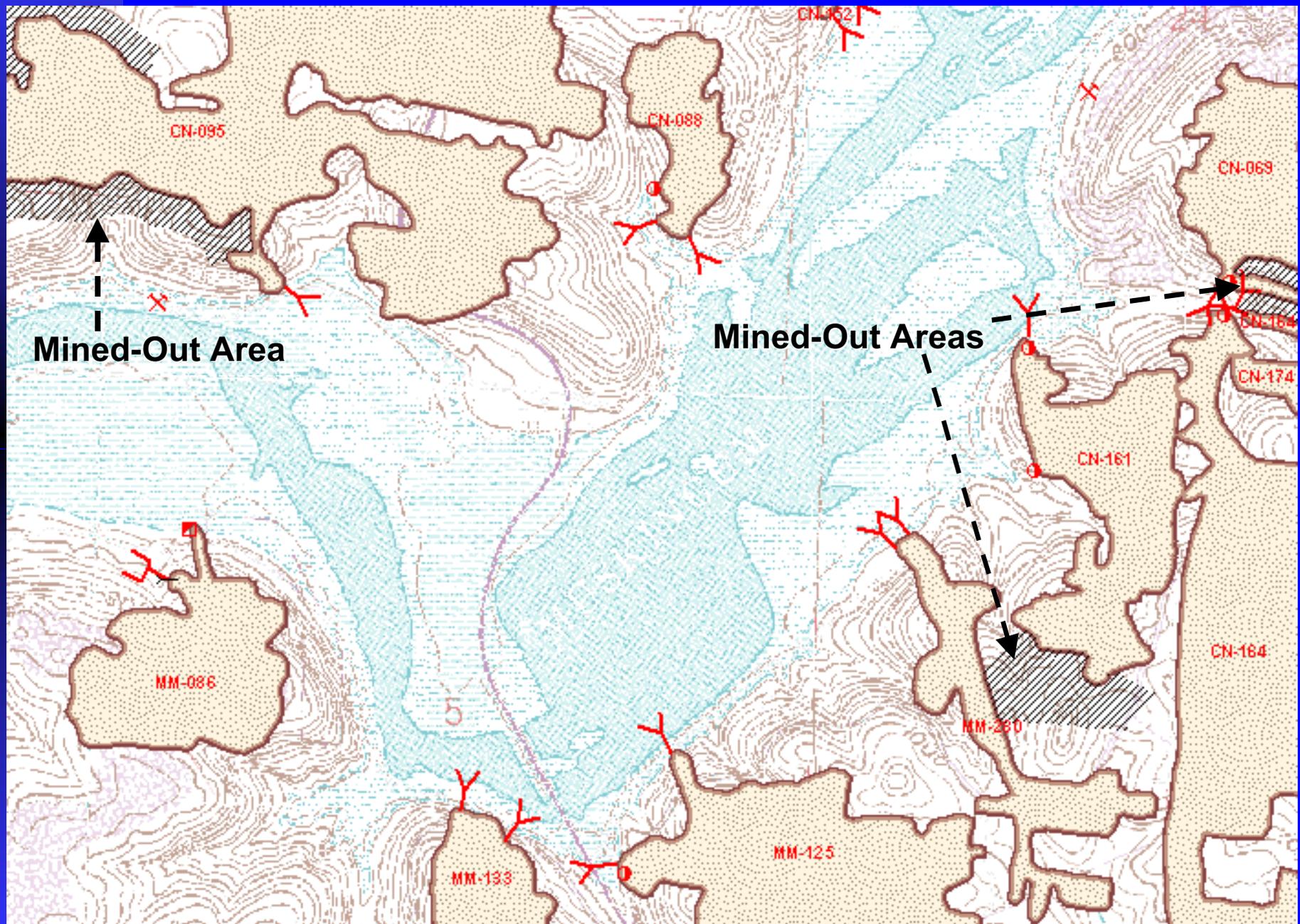
Stylesheet: FGDC ESRI

Name	Type	Size
entry_line	Personal Geodatabase Feature Class	
entry_pts	Personal Geodatabase Feature Class	
mine_images	Personal Geodatabase Table	
mine_pts	Personal Geodatabase Feature Class	
mines_poly	Personal Geodatabase Feature Class	
shafts_pts	Personal Geodatabase Feature Class	
TBLMINES	Personal Geodatabase Table	

Personal Geodatabase selected

Start | Inbox - Mi... | BBC World... | Thesaurus... | Desktop | ABANDON... | Microsoft ... | ArcCatalo... | 4:37 PM

# Mine Polygons and Mined-Out Areas



# Original AUM Feature Class Attribute Tables

The screenshot displays two windows: ArcMap and Microsoft Access. The ArcMap window shows the 'Layers' panel on the left with a tree view containing 'mines\_poly', 'entry\_pts', 'entry\_line', 'shafts\_pts', 'mine\_pts', and 'TBLMINES'. A red dashed arrow points from 'mines\_poly' to the 'Attributes of mines\_poly' table in the Microsoft Access window. Another red dashed arrow points from 'mine\_pts' to the 'Attributes of mine\_pts' table. A yellow arrow points to 'TBLMINES' in the layers panel.

**Attributes of mines\_poly**

MINE_CODE	MULT	MC_2	MC_3	MC_4	DRAIN	TYPE	Shape_Length	Shape_Area
LS-015	1				B	LPGAS	1861.521144	118712.206122 <Null>
CYA-030	1				B	SALT	78810.339586	89995920.570085 <Null>

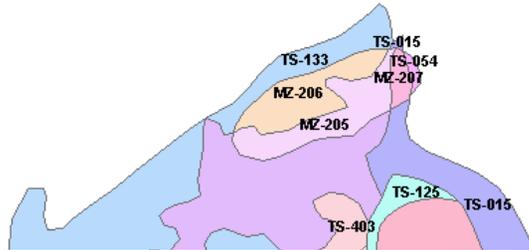
**Attributes of mine\_pts**

OBJECTID*	Shape*
1	Point
2	Point
3	Point

**Microsoft Access - [TBLMINES : Table]**

ANN_MAPS	RNG_FRM	RNG_TO	OPEN_TYPE	ELEV	AB_DT	MAP_DT	OSM_DOC_NO	DEM_ELEV
1	11/1920	2/1923	DRIFT		0	2/1933	313492	0
1	3/28/1907	5/1914	DRIFT	757	1915		313493	0
1	5/31/1909	12/1914	DRIFT	0	1916		313494	0
1	6/10/1897	5/1912	DRIFT	0	1913		313495	0
1	1874		DRIFT	0	1916		313496	0
0			DRIFT	784	1919		313497	0
0			DRIFT	0			NoMap	0
1	12/1916	5/1921	DRIFT	0	1918		313498	0
0			SHAFT	681	1913		313500	0
1	1/1918		DRIFT	0	1920		313499	0
0			DRIFT	0	1923		313501	0
1	1/1911	12/1920	DRIFT	0	1922		313502	0
1	6/4/1895	2/1916	DRIFT	684	1923		313503	0
1	1/1903	3/1927	SLOPE	674	1928		313504	0
1	8/1920	8/1922	DRIFT	763	1923		313505	0
0			DRIFT	0	1922		313506	0
1	6/1904	5/1923	SLOPE	550	1919		313507	0
1	4/1914	10/1922	SHAFT	689	1923		313508	0
1	10/1921		DRIFT	0	1922		313509	0
1	4/9/1907	12/1920	DRIFT	700	1923		313510	0
0			DRIFT	0	1925		313511	0
1	7/19/1918	5/1923	DRIFT	0	1924		313512	0
1	10/1914	4/1924	SLOPE	0	1925		313513	0
0			DRIFT	0			313514	0
1	7/1902		DRIFT	0	1925		313515	0
1	12/1918	12/1922	SHAFT	618	1923		313516	0
1	1/13/1905	11/2/1925	DRIFT	0	1926		313517	0
1	12/23/1907	1/2/1912	DRIFT	747	1916		313518	0
0			DRIFT	0	1923		313519	0
1	3/21/1908	1/1925	SHAFT	0	1927		313520	0
1	9/30/1904	1/1924	SLOPE	0	1925		313521	0
0			SHAFT	653	1930		313522	0
1	12/7/1903	1/5/1929	SHAFT	618	1929		313523	0
1	12/1917	10/11/1929	DRIFT	755	1929		313524	0

# Issues with Overlapping Mines --- MZ POLYGONS AND "OUT" AREAS



Attributes of Mine\_temp\_new

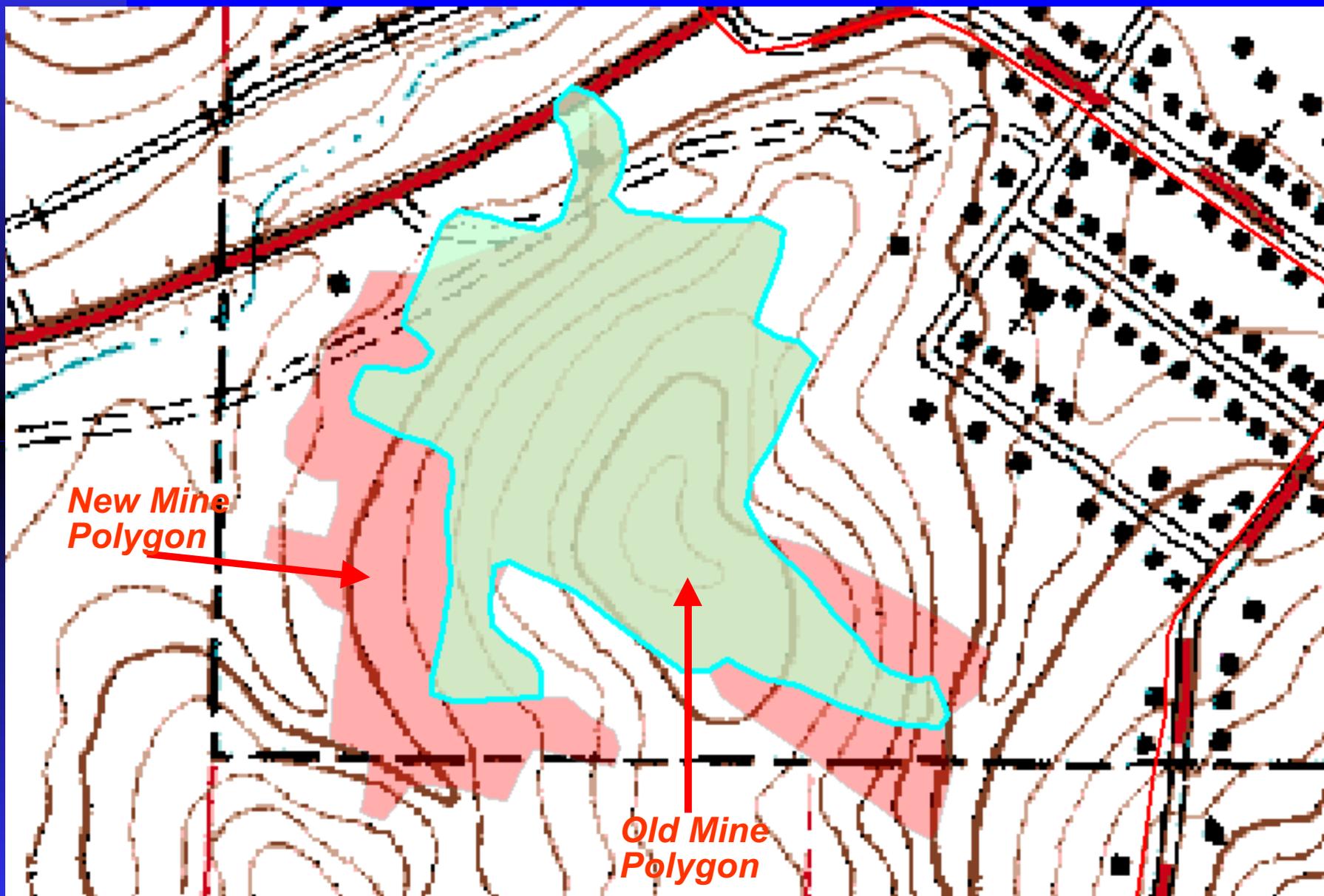
FID	Shape*	OBJECTID	MINE_CODE	MULT	MC_2	MC_3	MC_4	DRAIN	Shape_Leng	Shape_Area	MINE_API
0	Polygon	5318	TS-113	1				A	10307.528009	2734091.09605	341578011302
1	Polygon	5320	TS-133	1				A	16754.692306	4735654.50535	341578013302
2	Polygon	5321	TS-403	2	TS-113	TS-403		A	13528.463440	2708229.90325	341578040302
3	Polygon	5322	TS-015	1				A	5737.191397	906893.86735	341578001502
4	Polygon	5323	TS-015	1				A	835.660227	29214.36755	341578001502
5	Polygon	5324	TS-039	1				A	3178.682121	502278.0266	341578003902
6	Polygon	5325	TS-125	1				B	4118.097432	844539.4124	341578012502
7	Polygon	5326	TS-401	2	TS-401	TS-062		A	11685.311356	1929930.00625	341578040102
8	Polygon	5327	TS-062	1				A	14696.417275	4365297.09005	341578006202
9	Polygon	5419	TS-054	2	TS-403	TS-054		A	2201.343978	261912.0351	341578005402

Record: 1 Show: All Selected Records (0 out of 10 Selected.) Options

Overlapping Mines



# Re-Digitizing Mine Polygons

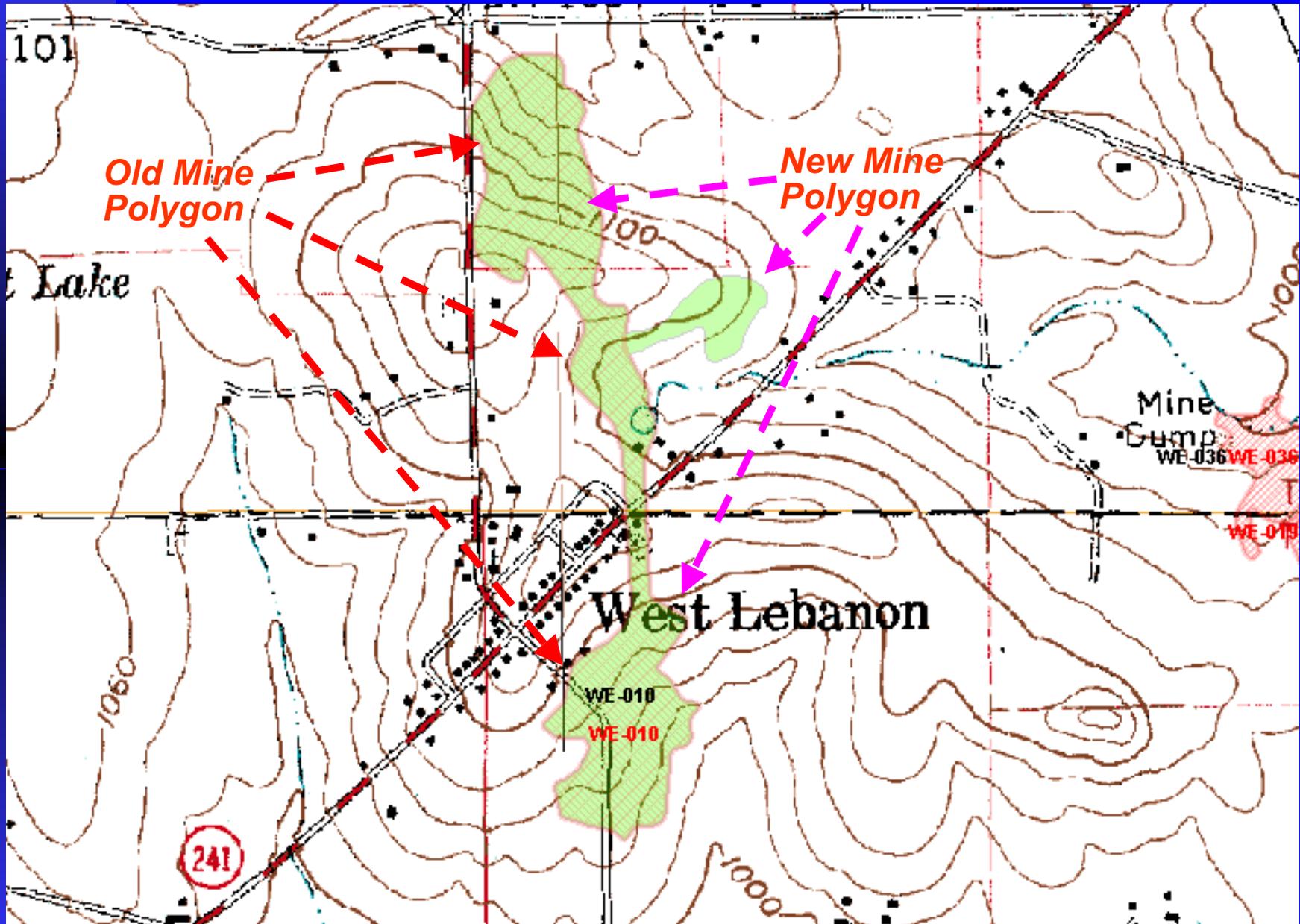


*New Mine Polygon*

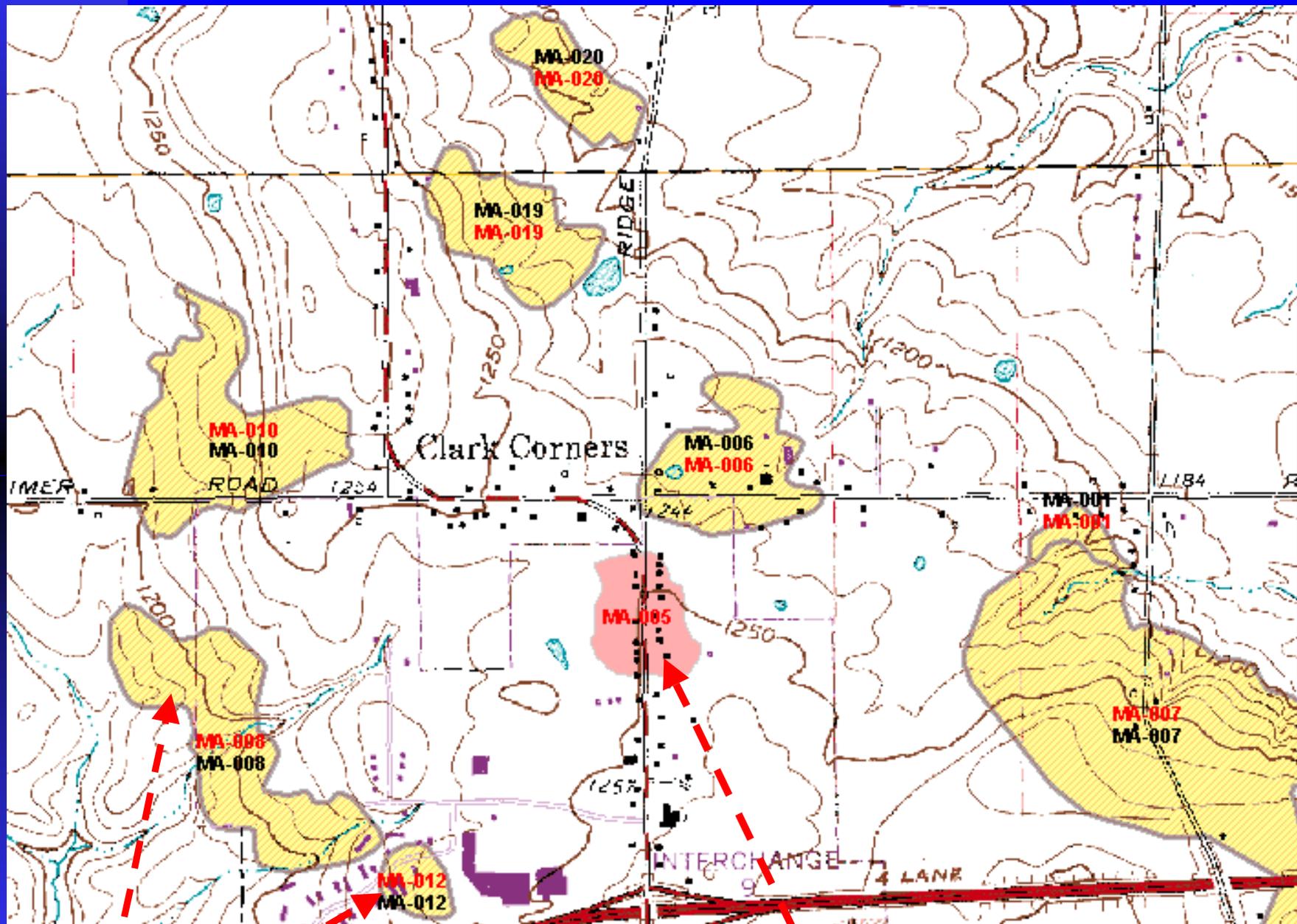
*Old Mine Polygon*

*HN-002, Bowerston Quadrangle, Ohio*

# Reshaped and Additional Mine Polygons



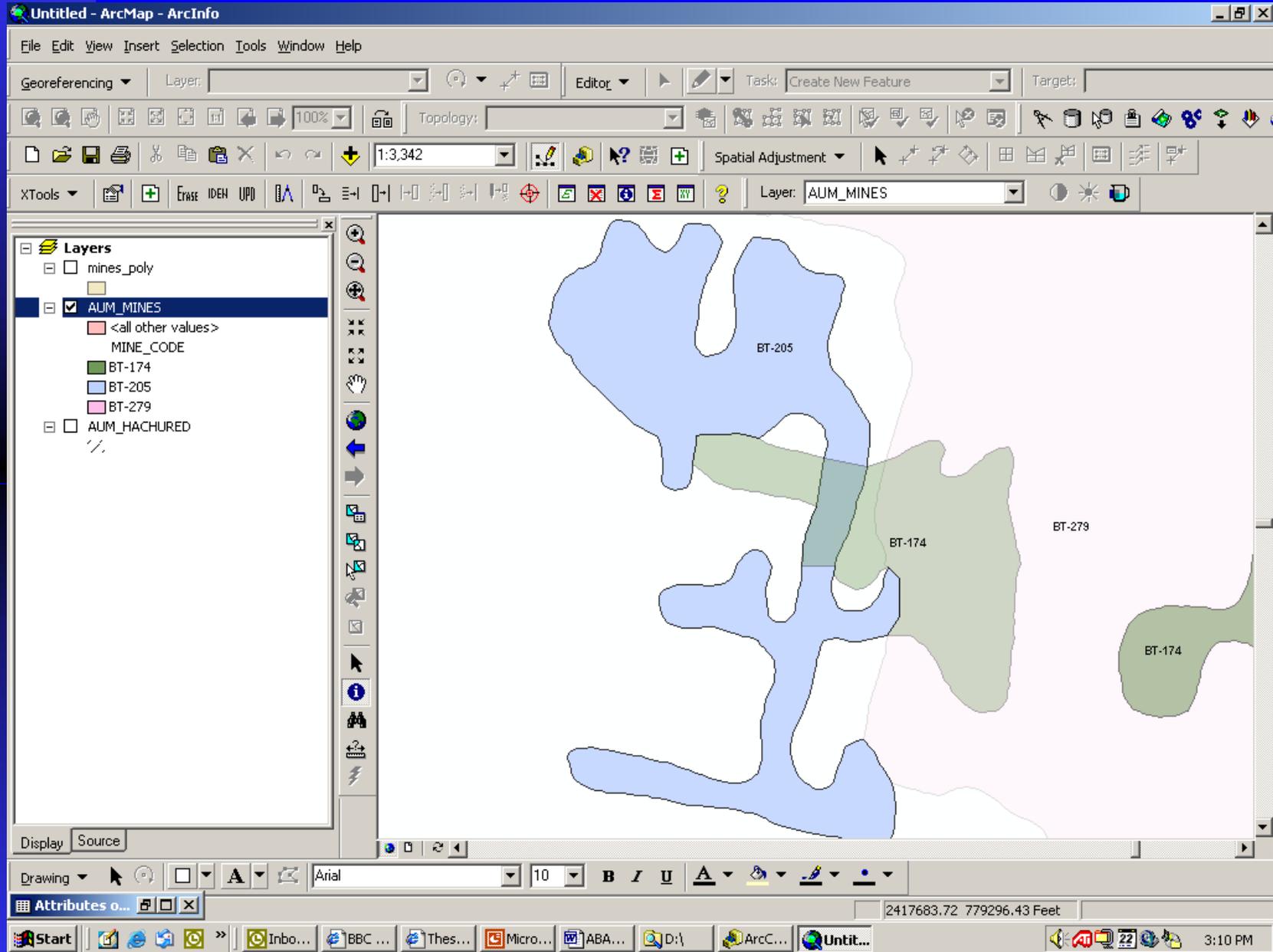
# Addition of Mine Polygons



Original Mine Polygons

Added Mine Polygon

# Displaying Superimposed Mine Polygons



**The New  
AUM Feature Classes,  
Geodatabase,  
and  
Data Storage**

# AUM Points Symbology and Feature Class Attribute Table

The screenshot displays the ArcMap interface with the 'Attributes of AUM\_PTS' table open. The table lists various mine features with their attributes. The 'MAIN MAP' legend on the left shows the symbology for the 'AUM\_PTS' feature class, including 'Air Shaft or Pumping Shaft' (green circle), 'Drift Entry' (orange line), 'Mine Location' (orange cross), 'Shaft Entry' (blue square), and 'Slope Entry' (purple line). A red dashed arrow points from the title to the table, and another points from the title to the legend. A red arrow also points from the legend to the text 'Adopted Mine Color'.

OBJECTID*	Shape*	MN_NO	ENTRY_CD	TYPE_CDE	MINE_API*	PNT_API*	ANGLE
917	Point	CL-041	DR	DR	<Null>	34019802040	355
1230	Point	MG-044	SL	SL	<Null>	34099800850	355
3890	Point	GY-080	DR	DR	<Null>	34059801110	355
4587	Point	GY-002	DR	DR	<Null>	34059802190	355
4653	Point	BT-139	DR	DR	<Null>	34013811160	355
4670	Point	BT-267	SL	SL	<Null>	34013809200	355
7300	Point	AS-133	DR	DR	<Null>	34009801050	355
7314	Point	WN-004	DR	DR	<Null>	34167800090	355
8420	Point	MS-104	DR	DR	<Null>	34105805670	355
8425	Point	MS-104	DR	DR	<Null>	34105805870	355
8426	Point	MS-104	DR	DR	<Null>	34105805880	355
8435	Point	MS-028	SL	SL	<Null>	34105803470	355
8440	Point	MS-014	DR	DR	<Null>	34105803410	355
8532	Point		DR	DR	<Null>	34053803050	355
8603	Point	GA-050	DR	DR	<Null>	34053801350	355
9222	Point	LE-004	DR	DR	<Null>	34087804900	355
9343	Point	HS-035	DR	DR	<Null>	34157812180	355
9362	Point	HN-084	DR	DR	<Null>	34067803390	355
9388	Point	GY-145	SL	SL	<Null>	34059803490	355
17046	Point	MS-001	DR	DR	34105800010	34105806320	355
25	Point	SK-189	DR	DR	<Null>	34151805250	353
30	Point	SK-021	DR	DR	<Null>	34151805170	350
911	Point		DR	DR	<Null>	34019802270	350
3880	Point	GY-074	DR	DR	<Null>	34059801010	350
8419	Point	MS-104	DR	DR	<Null>	34105805810	350
8421	Point	MS-104	DR	DR	<Null>	34105805830	350
8665	Point	MS-039	DR	DR	<Null>	34105803500	350
8730	Point	MS-006	SL	SL	<Null>	34105803350	350
9351	Point	HN-084	DR	DR	<Null>	34067804180	350
9352	Point	HN-084	DR	DR	<Null>	34067804190	350

Adopted Mine Color

# The New AUM Personal Geodatabase

The screenshot displays the ArcCatalog interface for a Personal Geodatabase named 'AUM.mdb'. The left pane shows a tree view of the database structure, and the right pane shows a detailed list of the contents with their types. Red annotations highlight specific categories:

- A double-headed red arrow points between the tree view and the detailed list.
- Red dashed arrows point from the text 'Coverages Shapefiles Raster Dataset and dBase Tables' to various data types in the detailed list, including 'Personal Geodatabase Feature Data...', 'Personal Geodatabase Feature Class', and 'Personal Geodatabase Table'.

Name	Type
ANNOTATION	Personal Geodatabase Feature Data...
lines	Personal Geodatabase Feature Data...
Points	Personal Geodatabase Feature Data...
Polygons	Personal Geodatabase Feature Data...
Shields	Personal Geodatabase Feature Data...
AUM_HACHURED	Personal Geodatabase Feature Class
AUM_MINES	Personal Geodatabase Feature Class
aum_out	Personal Geodatabase Table
AUM_PTS	Personal Geodatabase Feature Class
btcontours	Personal Geodatabase Feature Class
BTPOINTS	Personal Geodatabase Feature Class
county_83_v2	Personal Geodatabase Feature Class
entry_line	Personal Geodatabase Feature Class
MN_POINTS	Personal Geodatabase Feature Class
OSM DocNum	Personal Geodatabase Table
quad24k_83	Personal Geodatabase Feature Class
RTE_LOCAL	Personal Geodatabase Feature Class
RTE_MUNI	Personal Geodatabase Feature Class
RTE_STATE	Personal Geodatabase Feature Class
STR_CONTOURS	Personal Geodatabase Feature Class
STR_POINTS	Personal Geodatabase Feature Class
tblComments	Personal Geodatabase Table
tblCommodity	Personal Geodatabase Table
tblCounty	Personal Geodatabase Table
tblMineOpenings	Personal Geodatabase Table
TBLMINES	Personal Geodatabase Table
TBLMINES1	Personal Geodatabase Table
tblOperator	Personal Geodatabase Table
tblQuad	Personal Geodatabase Table
tblRemainingImages	Personal Geodatabase Table
tblSeam	Personal Geodatabase Table
tblTownship	Personal Geodatabase Table
twp_83_v2	Personal Geodatabase Table
UsersTbl	Personal Geodatabase Table
hatch.dbf	Personal Geodatabase Table
nh_dem	Personal Geodatabase Table

**A Single Data Repository !!!**

# The AUM Data Storage Folder -- on the NR728Mather Server

The screenshot displays the ArcCatalog interface with the following components:

- Location:** G:\
- Left Pane (File Explorer):** Shows a tree view of folders and files. A red box highlights the 'G:\' folder, which contains subfolders like 'AUM', 'AUM POINT SYMBOLOGY', 'AUM\_GEOREF\_IMAGES', 'AUM\_IMAGES', 'DIGITIZER\_TICS', 'DMRM Surface Mines', 'JAMIE POINT SYMBOLOGY', 'Sample Problems', 'TEMPLATES', 'WayneNF', and files 'AUM.mdb', 'hatch.dbf', 'oh\_dem', and 'OHIO\_DEM\_earthtones.lvr'.
- Right Pane (Contents):** Shows a list of folders with columns for Name, Type, and Size. A red box highlights the 'AUM' folder. A red double-headed arrow points from the 'AUM' folder in the left pane to the 'AUM' folder in the right pane.
- Table of Contents:**

Name	Type	Size
AUM	Folder	
Basemap	Folder	
Cartography	Folder	
d0a97f50d58101dbca	Folder	
Export	Folder	
Geophysics	Folder	
GRCSales	Folder	
Images	Folder	
Landslide	Folder	
msdownld.tmp	Folder	
NewberryData	Folder	
SanduskyData	Folder	
WUTemp	Folder	
XML_Dir	Folder	

The taskbar at the bottom shows the Start button and several open applications, including ArcCatalog, with the system clock displaying 1:23 PM.

# **ODNR (OGS)/ODOT Application Development Contract --- Assisting Efforts for the AUM Inventory and Risk Assessment (AUMIRA) Program**



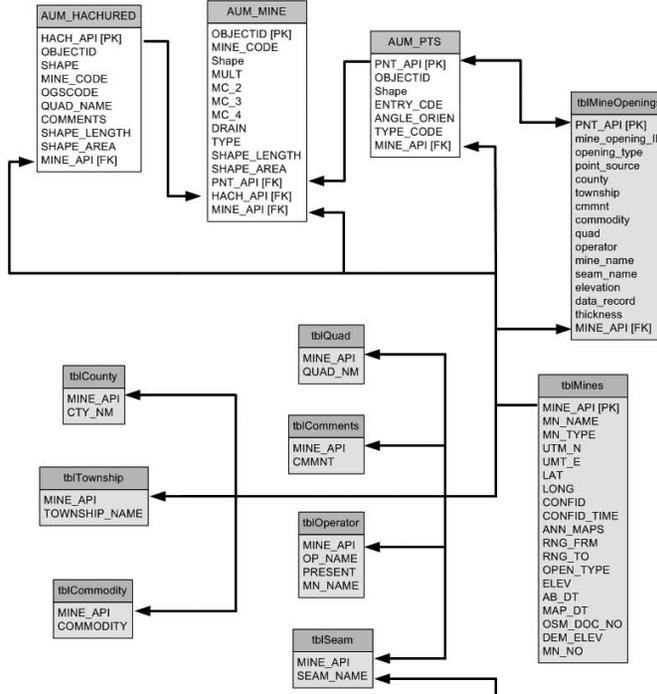
## **Development of the AUM Application :**

- *Application Tools*
- *Mapping Tools*
- *Templates*

# AUM Data Model

## AUM System & Overburden Application Data Model

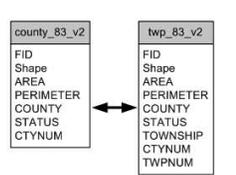
### AUM Application Feature and Attribute Tables



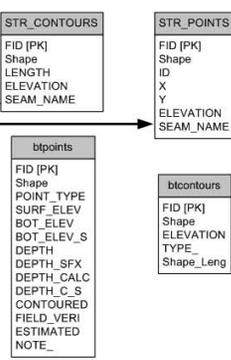
Relationship Links

AUM Feature and Attribute Tables

### Base Map Feature and Attribute Tables



### Overburden Feature Tables

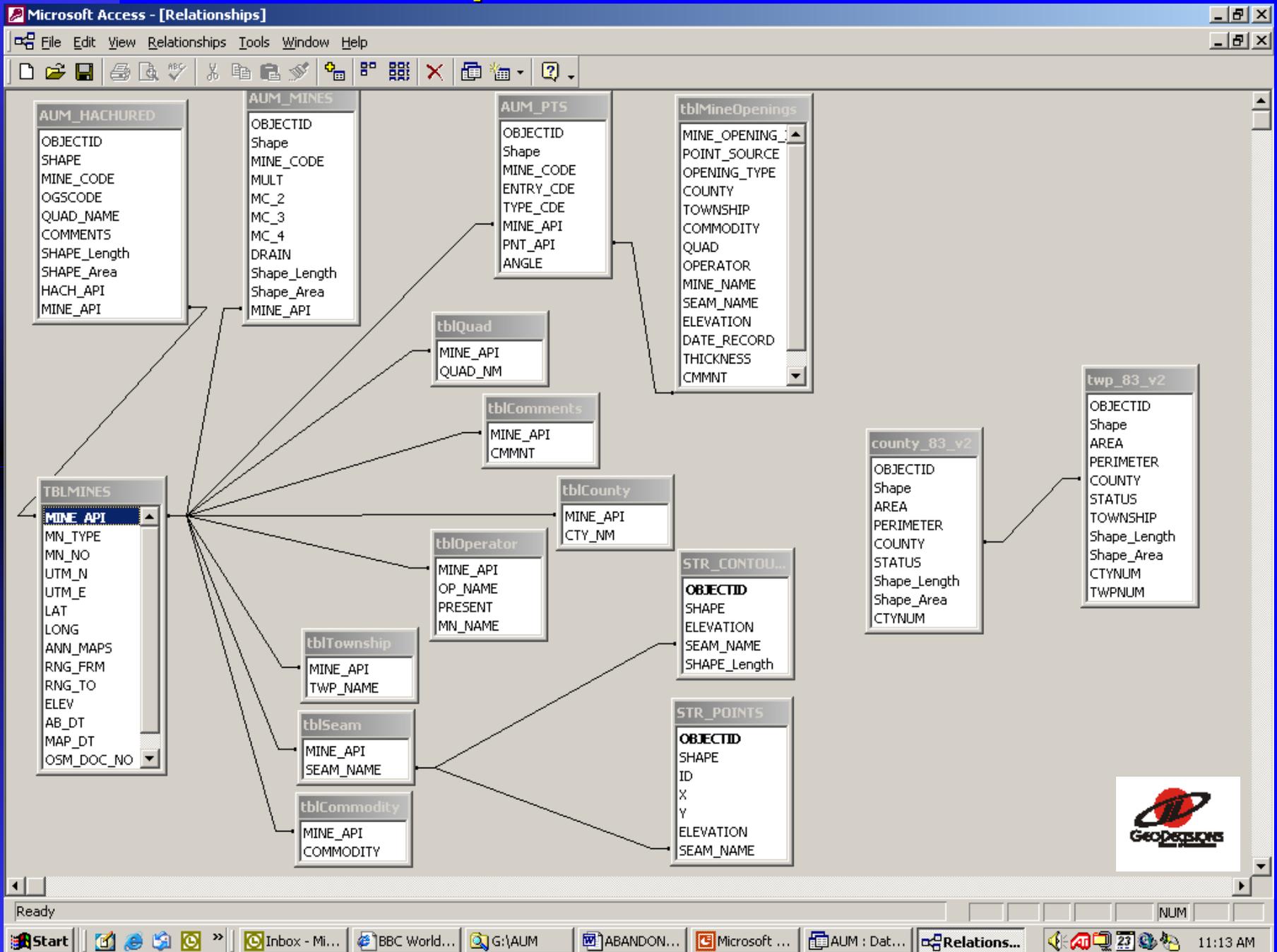


Overburden Feature Tables

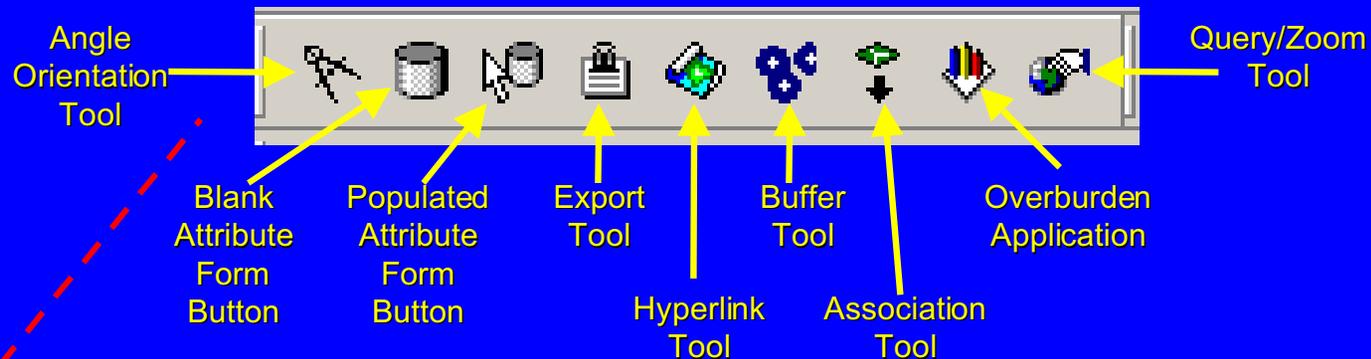
Base Map Feature and Attribute Tables



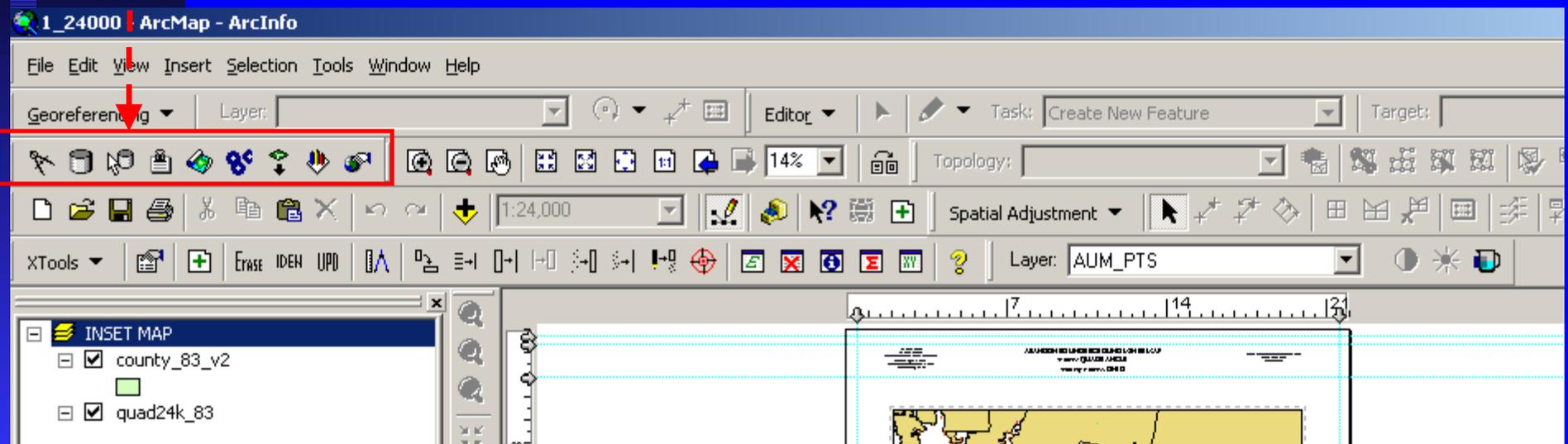
# AUM Data Model Implementation in Microsoft Access



# The AUM and Overburden Application Toolbar



## Placement Within the ArcGIS ArcMap Environment

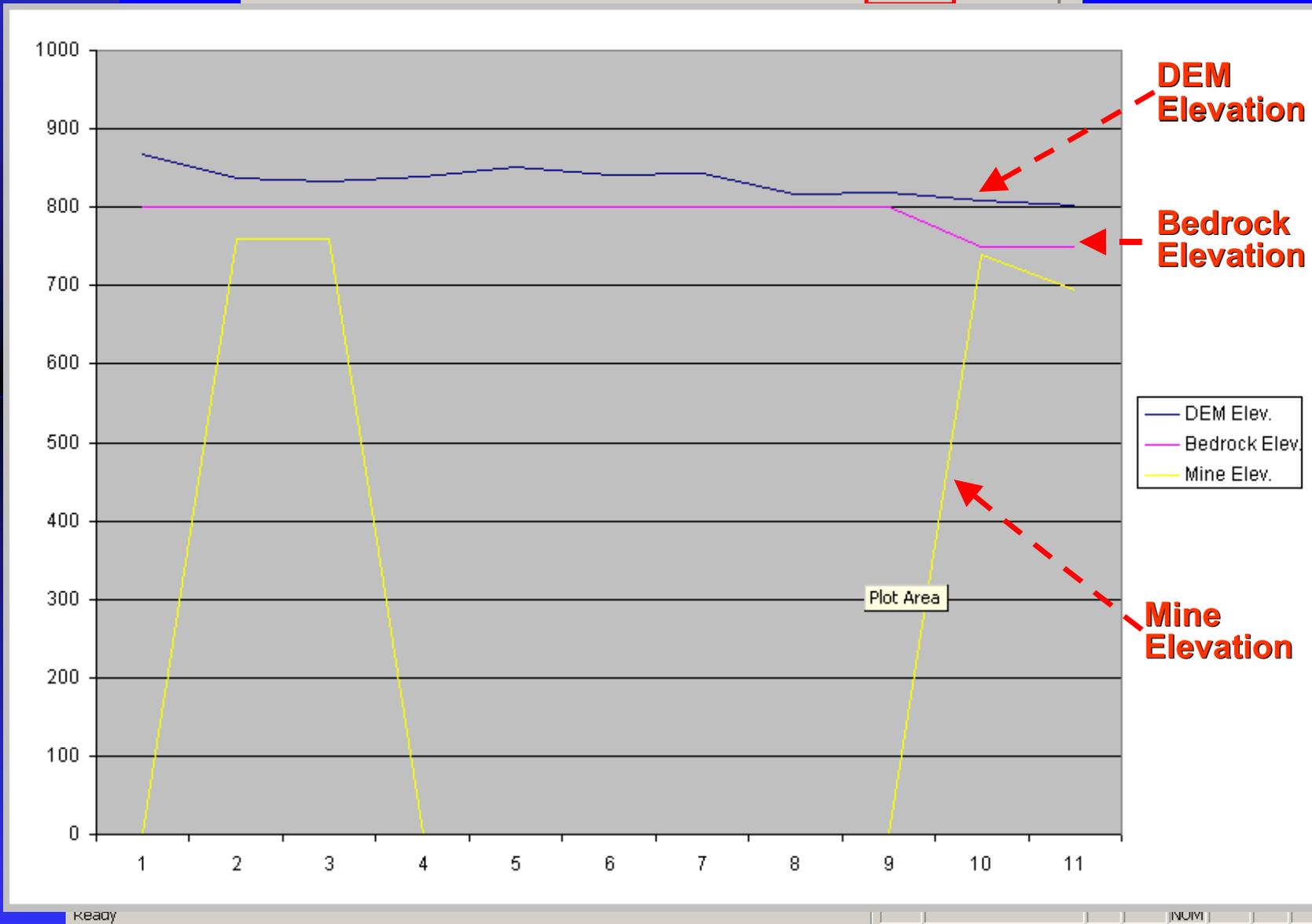




# The AUM Overburden Application Tool



Query/Zoom  
Tool



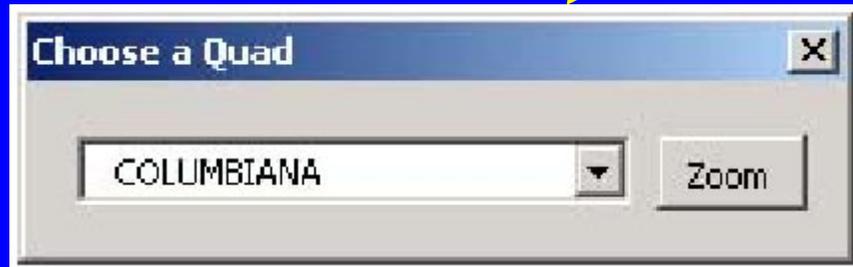
Ready

NUM

# The AUM Plotting Tools



← The 'DRG', 1:24000 Loader



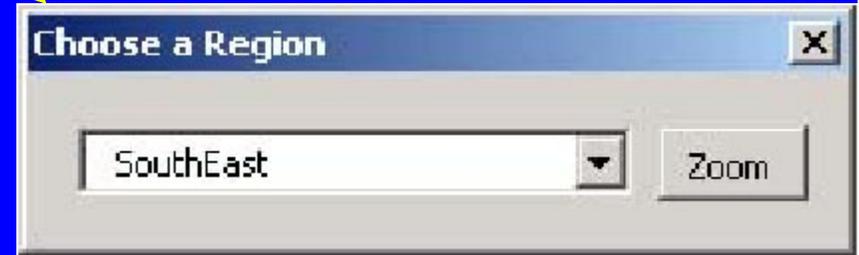
Quadrangle Selection Box



← Mine Images  
Tool for the  
1:24000 Map



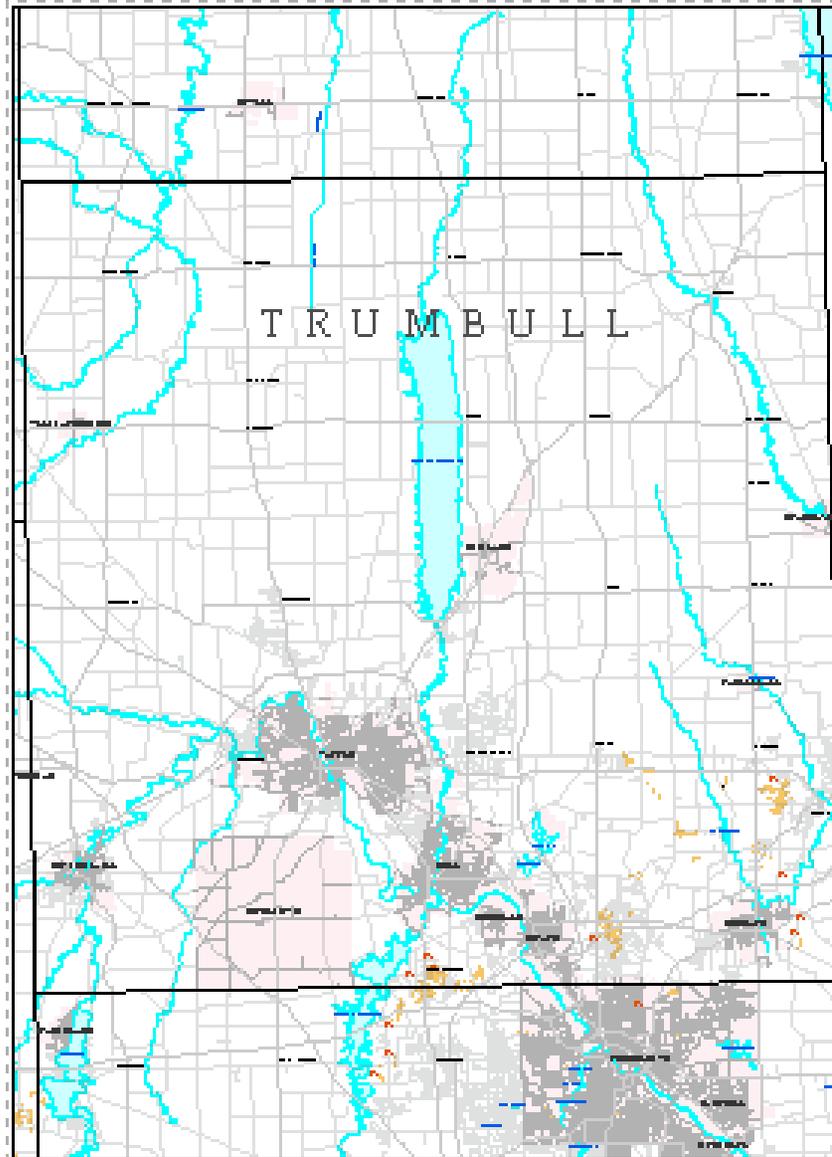
← County or  
Region  
Selection Tool



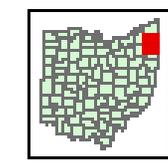
- **AUM Final Map Products**
- **Counties with AUM's**
- **Statistics**
- **Future Work**

# The AUM Maps

ADVANCED TECHNOLOGICAL SURVEYING AND MAPPING, INC. TRUMBULL COUNTY, OHIO



- Explanation
- Mine Location
  - State Road
  - Municipal Road
  - Local Road
  - Mine Extension Area
  - AUM
  - Other

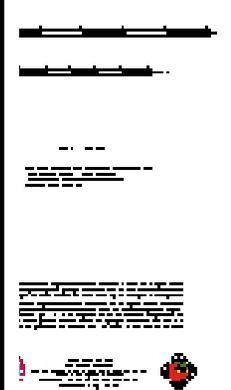


SCALE: 1:24000

**Scale**  
1:24,000  
Line Map

- Explanation
- Mine Location
  - Mine Extension Area
  - AUM

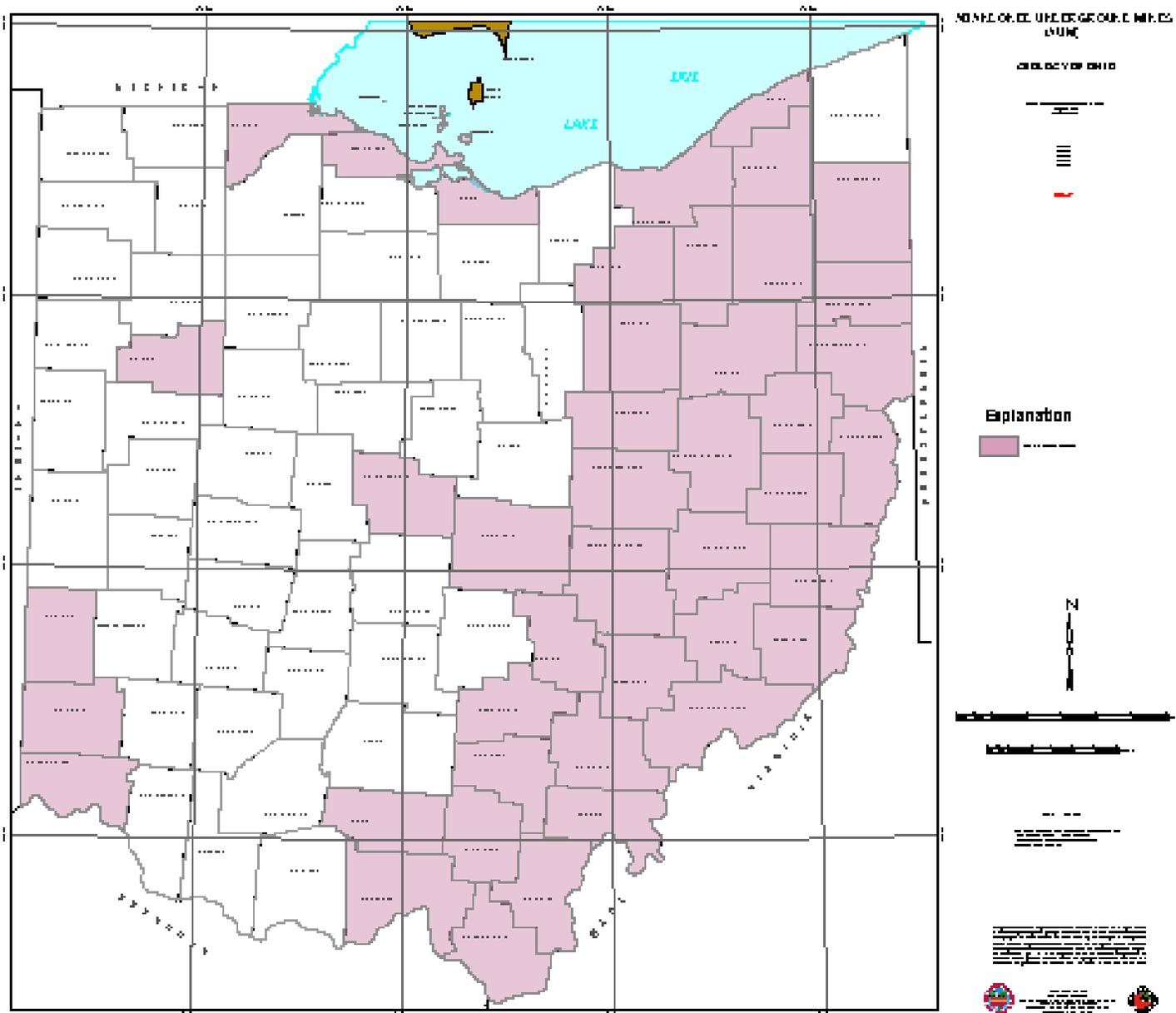
Scale	1:62,500
Scale	Portrait 1:100,000
Scale	and Landscape 1:150,000
Scale	County 1:250,000
Scale	and 1:500,000
Scale	County 1:1,000,000
Scale	Regional (quarters of state) 1:2,000,000
Scale	Statewide 1:4,000,000



Scale  
1:24,000  
Line Map

Scale  
Portrait 1:100,000  
and Landscape 1:150,000  
County 1:250,000  
and 1:500,000  
County 1:1,000,000  
Regional (quarters of state) 1:2,000,000  
Statewide 1:4,000,000

# State of Ohio Counties with known AUM's



**43 Counties  
with AUM's**

# AUM Statistics

- Approx. Number of AUM Polygons = 4,166
- Mined-Out Areas = 889
- Mine Point Locations = 1,945
- Air/Pumping Shaft entry points = 2,878
- Main Shaft entry points = 585
- Drift entry points = 9,475
- Slope entry points = 564

# Recent Undertakings.....

- **AUM Geodatabase:** Migration from a personal geodatabase to a multi-user geodatabase in ArcSDE running on a SQL Server DBMS.

- **OGS/ODOT Cooperative Agreement :**

- Field mapping and data collection (GPS data) of mine subsidence-related information.

- Geo-referencing and rectification of all AUM map images (TIFF images) of mines that are located within 500 feet of any state or federal roadway. The geo-referenced images will be used in both ESRI and GeoMedia software environments.

- **The Ohio Subsidence Insurance Underwriters Association (OMSIUA) and ODNR, Division of Geological Survey and Division of Mineral Resources Management (DMRM)**

- Currently initiating the development of an ESRI ArcIMS Property Location Web Application for the State of Ohio.

# Now Available..... AUM ArcIMS Website

## State of Ohio - Abandoned Underground Mine Locator

Overview Legend Zoom In Zoom Out Pan Full Identify Query Clear Print Help

Locate Address

Refresh Map

Layers

Visible Active

- Interstates Info
- Cities Info
- Counties Info

Copyright (C) 2003 Ohio Mine Subsidence Insurance Underwriting Association 60mi

On the Ohio Geological Survey Website --- <http://www.dnr.state.oh.us/geosurvey/index.html>

# Future Work Includes:

**Geo-referencing** and Rectification of Mine Map TIFF Images.

**Rescanning** of TIFF Images.

**Re-organizing** the AUM Data to Assign Unique Identifiers to Mine Polygons for Mines having Multiple Polygons.

**Locating** Additional Mine Maps from the Public, Institutions, Private Companies, Conservation Societies, Historical Societies, Etc..

**Additional QA/QC** on AUM Data Including Certifying which Coal was Mined and Insuring Each Mine has a Proper Depth

# Geo-Referencing of Scanned Mine Map Images

The screenshot displays the ArcMap interface for geo-referencing. The title bar reads "AUM\_SOFTWARETEST - ArcMap - ArcInfo". The menu bar includes "File", "Edit", "View", "Insert", "Selection", "Tools", "Window", and "Help". The Georeferencing toolbar is active, showing "Layer: 340678007002.tif" and "Spatial Adjustment" options. The Editor toolbar shows "Task: Create New Feature" and "Target:".

The Layer List on the left contains the following items:

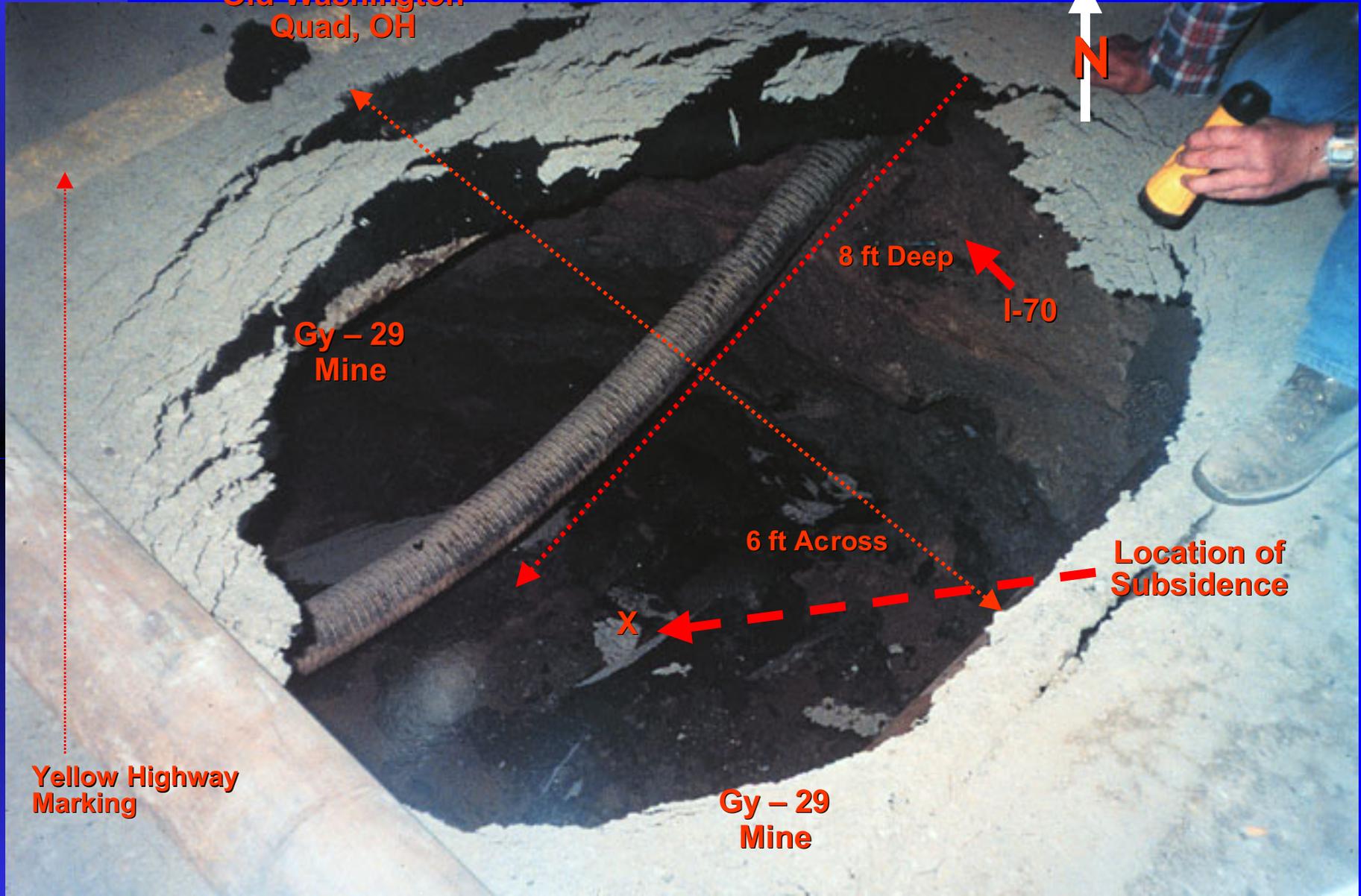
- AUM\_HACHURED
- AUM\_MINES
  - <all other values>
  - MULT
  - 0
  - <Null>
  - 1
  - 2
- 340678007002.tif
  - Value
  - High : 1
  - Low : 0
- rectify340138005402\_BT\_0...
- rectify340678006602\_hn\_0...
- rectify340138018502\_bt\_16...

The main map area shows a scanned image being aligned with a red-hatched background map. A red arrow points to a text box that says "Scanned Image Adjustment Using Referenced Points". A black line connects a point on the scanned image to a corresponding point on the background map. The status bar at the bottom shows coordinates: 2352926.31 786726.65 Feet.

**Images of Mine Entrances  
and AUM Related Hazards  
in Ohio**

# Interstate 70 Abandoned Underground Mine Subsidence

Old Washington  
Quad, OH



1995, I-70, Pit subsidence in the eastbound lane, OH

Photo Courtesy: OGS (ODNR) / ODOT

## Mine Repair Work by ODOT on Interstate 70, Ohio, 1995



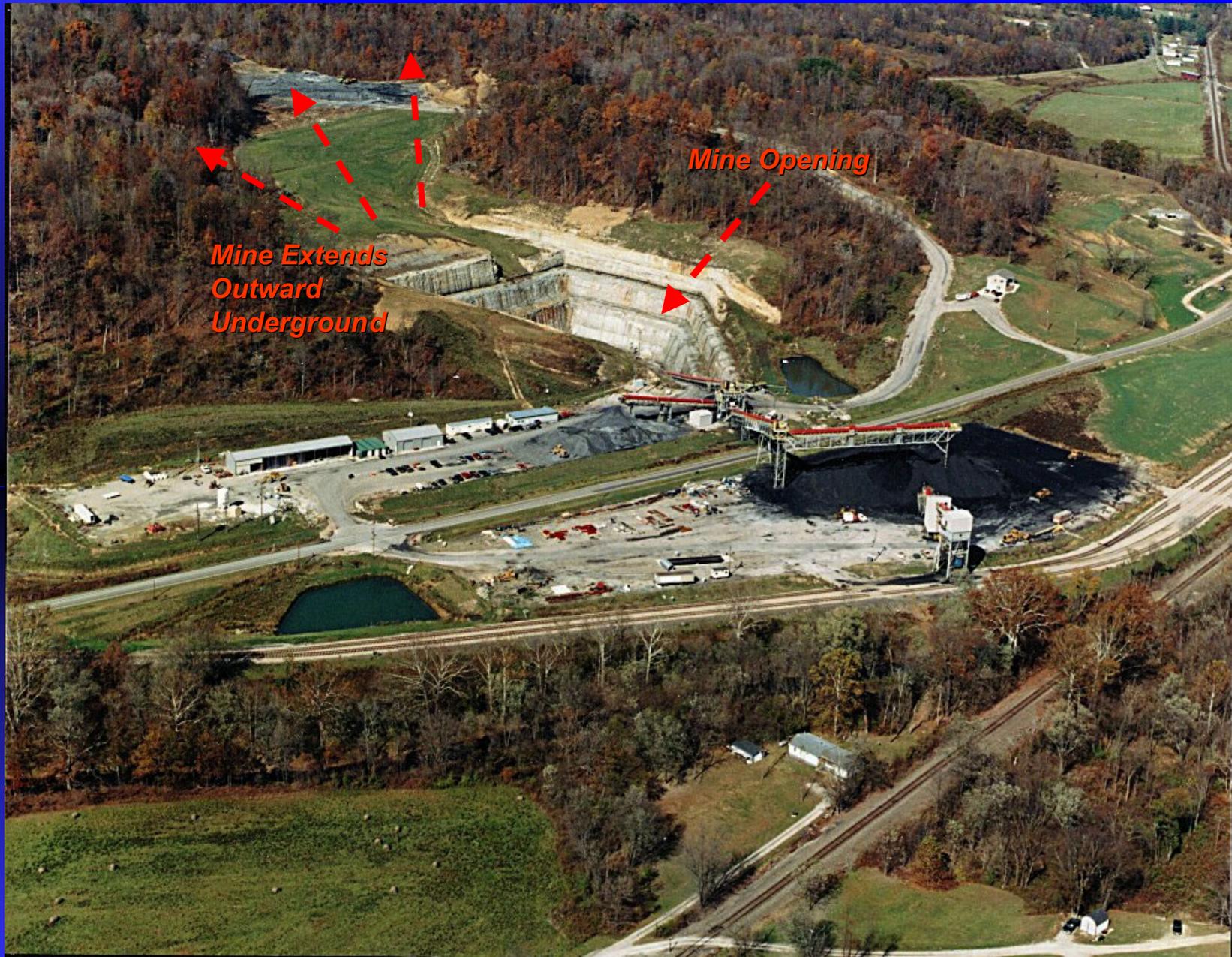
***Repair Totaled 3.6 Million Dollars***

*Photo Courtesy: ODOT*

# Entrance to an Abandoned Underground Mine



# Room-and-Pillar Underground Mine



**View from the Buckingham Mine Area and Mine Entrance**

*Photo: Dave Clarke, DMRM*

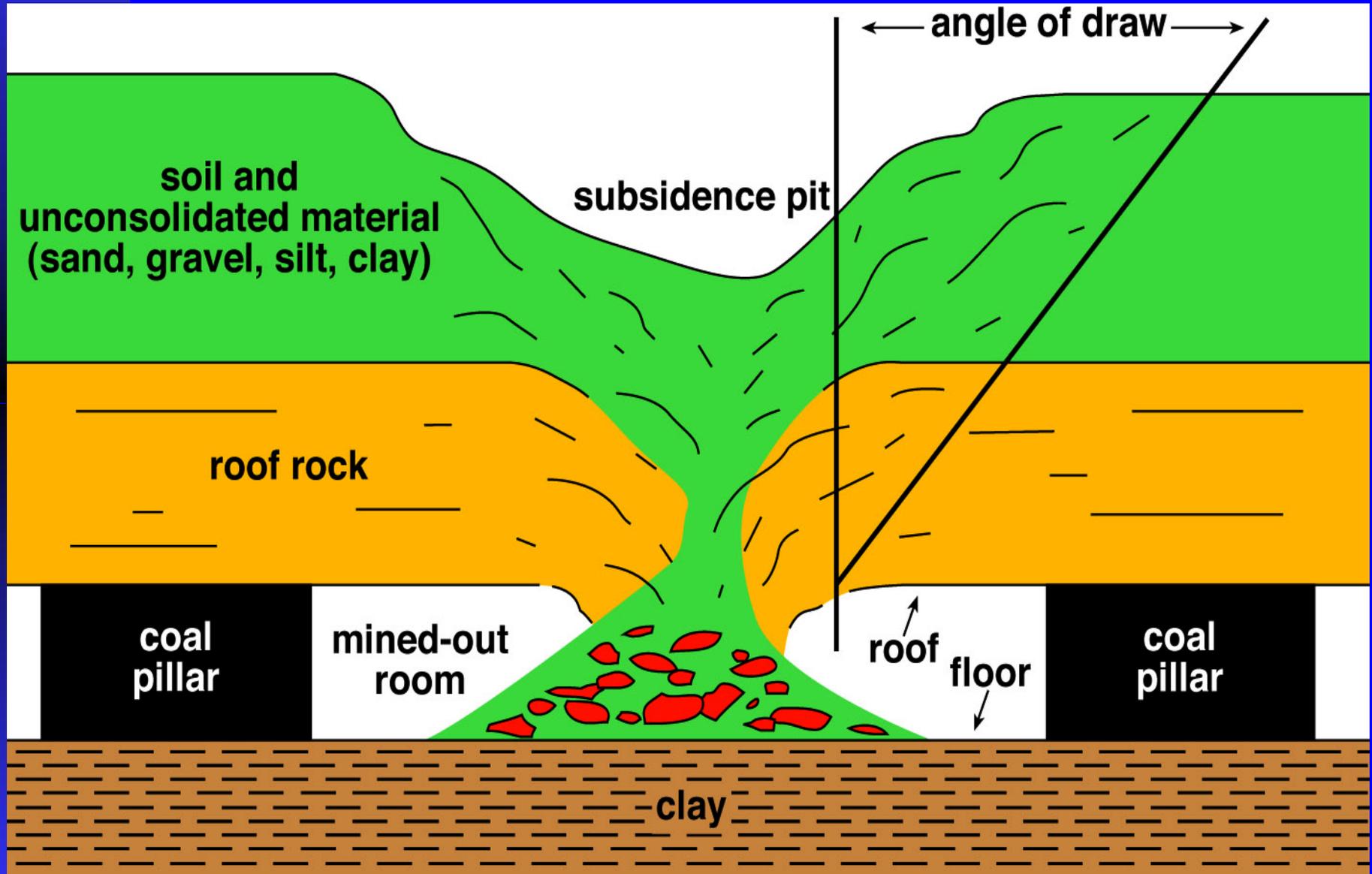
## Mine Void along a Roadside



Jackson County Roadside Void along SR - 327, Wellston, OH

Photo: DMRM

# Diagrammatic Cross Section of Typical Subsidence resulting from Mine-Roof Collapse.



No scale implied.

## Pit Subsidence in Residential Area



**North Canton, Stark County in 1995. Subsidence pit measured: 35 feet across and 25 feet deep.**

*Photo: DMRM*

## Structural Damage due to Mine Subsidence



**Two Homes in Wellston, Jackson County , 1994.**

## Tension-Surface Cracks Developed over a Longwall Mine, 1983.

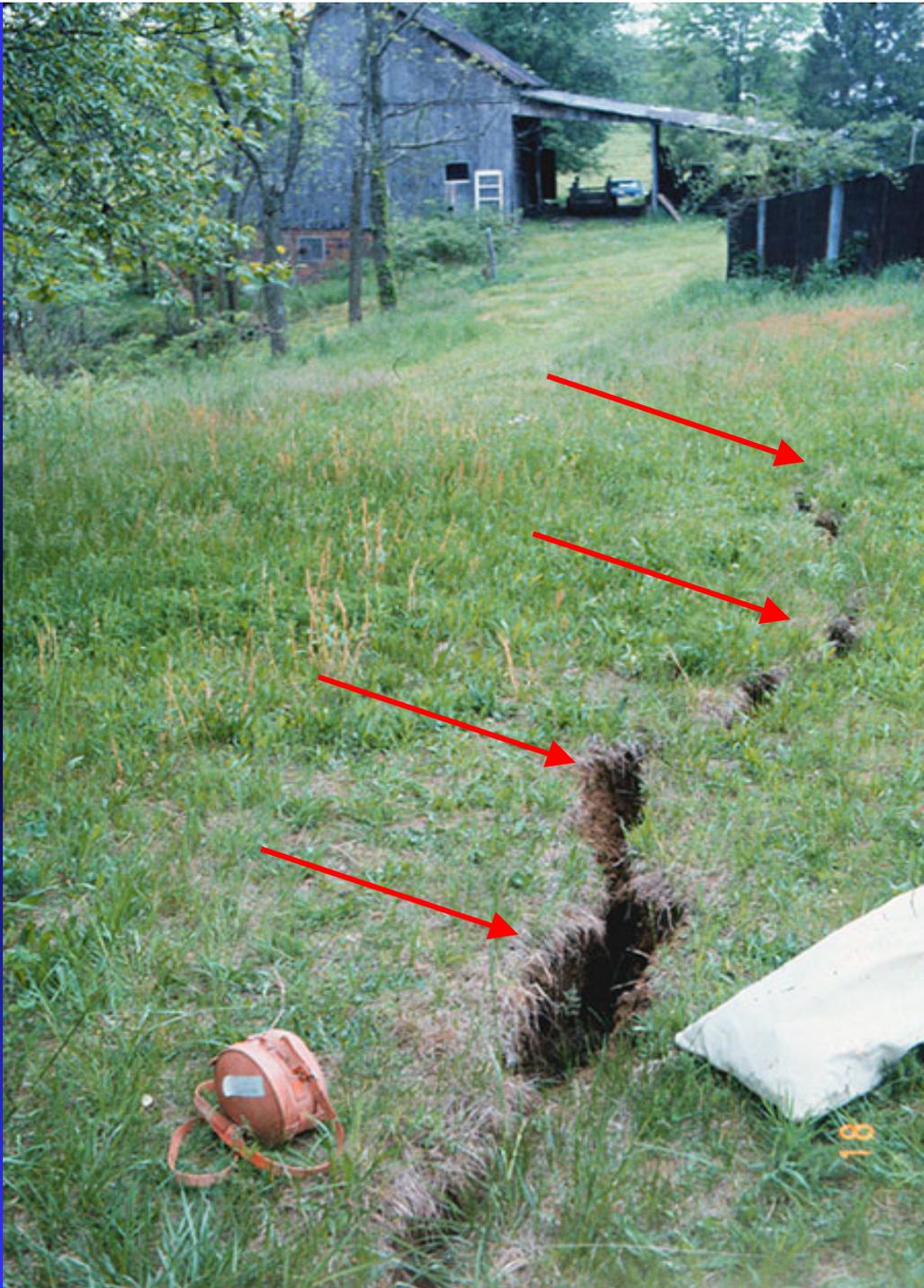


Photo: OSMRE

# Entrance to a Flooded Abandoned Drift Mine



*Hocking County, OH*

*Photo: OSMRE*

# Interior of a Flooded Abandoned Underground Mine



*Mine Located Beneath the Playground at Curtis Elementary School, Brookfield Township, Trumbull County, 1979.*

*Photo: DMRM*

# Acid Mine Drainage from Abandoned Underground Mines



Photo: DMRM



**East PA Mine**

*Courtesy of AMLIS Website*

**Rice Mine, Carbondale,  
Athens County, OH**