

# Geospatial Tools for Tracking Bond Release at a Large Wyoming Surface Coal Mine

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# Goals

- **Create a method for tracking bond release verification requirements and bond release approvals**
- **Improve efficiency of the LQD's and operator's reviews of bond release verification and approval packages**
- **Create a spatial system to combine all data for compliance purposes**
- **Create a spatial system to combine all data that can be retrieved quickly as needed**
- **Improve accuracy and transparency of the collected data**
- **Improve work efficiency of the LQD inspector in the field and office**

## Background

- **Started as Wyoming Pilot Project in 2003 -“Powder River Coal Company GIS/GPS Utilization for Bond Release” for North Antelope Rochelle Mine (NARM) and Caballo Mine**
- **Initial design of the Bond Release Geodatabase completed in 2005**
- **Initial project continued for one mine, NARM**
- **Developed an additional Inspection Geodatabase for NARM**
- **The final Geodatabase called “Bond Requirements Verification and Bond Release” combined with the Inspection Geodatabase was completed in October, 2009**

# Cooperative effort between three parties

- ❖ Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD)
- ❖ Peabody Powder River Operations, LLC (PPRO)
- ❖ Office of Surface Mining/Technical Innovation and Professional Services(OSM/TIPS)



## GIS/GPS Approach

- ▶ **Geographic Information System (GIS) Bond Release Geodatabase to track the verification of environmental performance standards and reclaimed areas that have achieved bond release at NARM.**
- ▶ **Geographic Positioning System (GPS) to verify the reclamation and bond release compliance requirements during inspections.**
- ▶ **A system of spatial data exchange between the LQD and the operator for sending, verifying, and approving features of the Geodatabase.**

# Geospatial Tools

**GIS geodatabase using an ESRI Personal Geodatabase, ArcInfo (ArcMap, ArcCatalog, and ArcTools)**

**Data sources:**

**Mine map layers submitted from the:**

- mine operator,
- inspection reports,
- field collected GPS data

**Mobile GIS function - ESRI ArcPad on a Trimble GeoExplorer Series GeoXM and Juno handheld GPS**

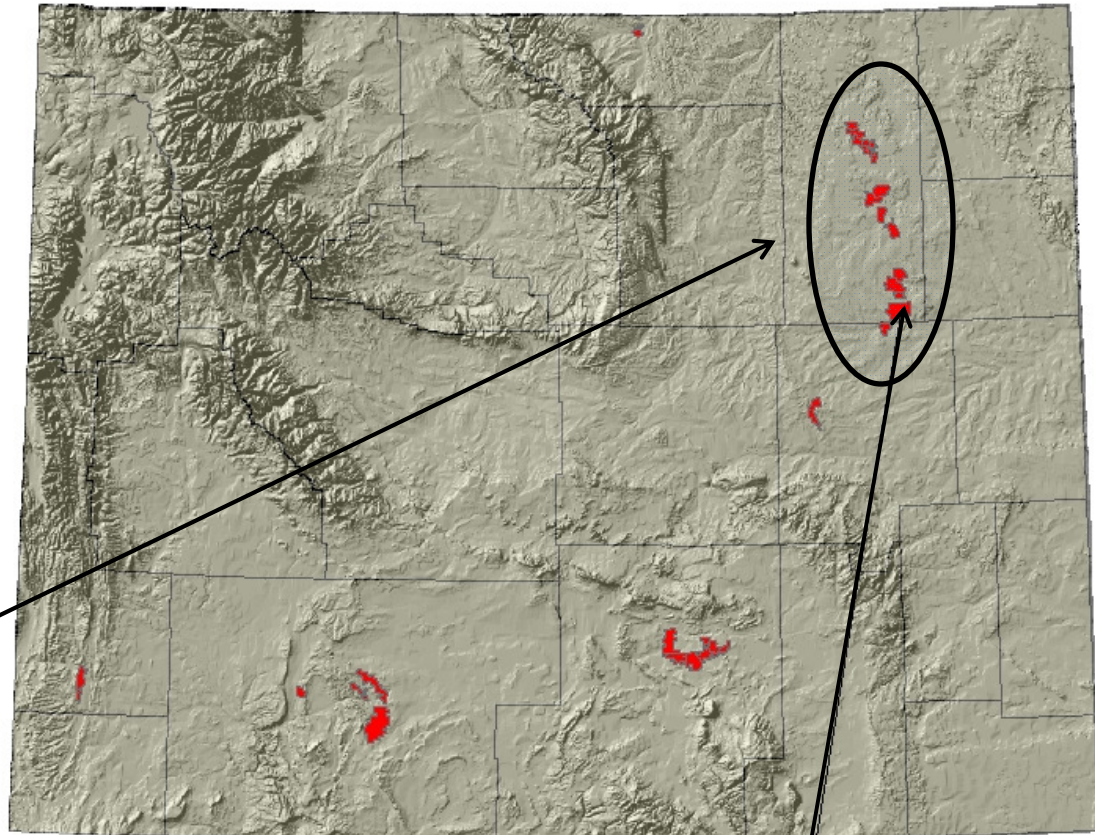


# Coal in Wyoming

0 15 30 60 90 120 Miles



**40% of USA total coal production comes from Wyoming\***



**Powder River Basin**

**NARM**

\* Source: U.S. Department of Energy/Energy Information Administration, Dec. 2011

# Why NARM?

**Three major active pits, produced 109 million tons coal in 2011**

**Permit area: 46,012 acres**

**Total affected: 19,224 acres**

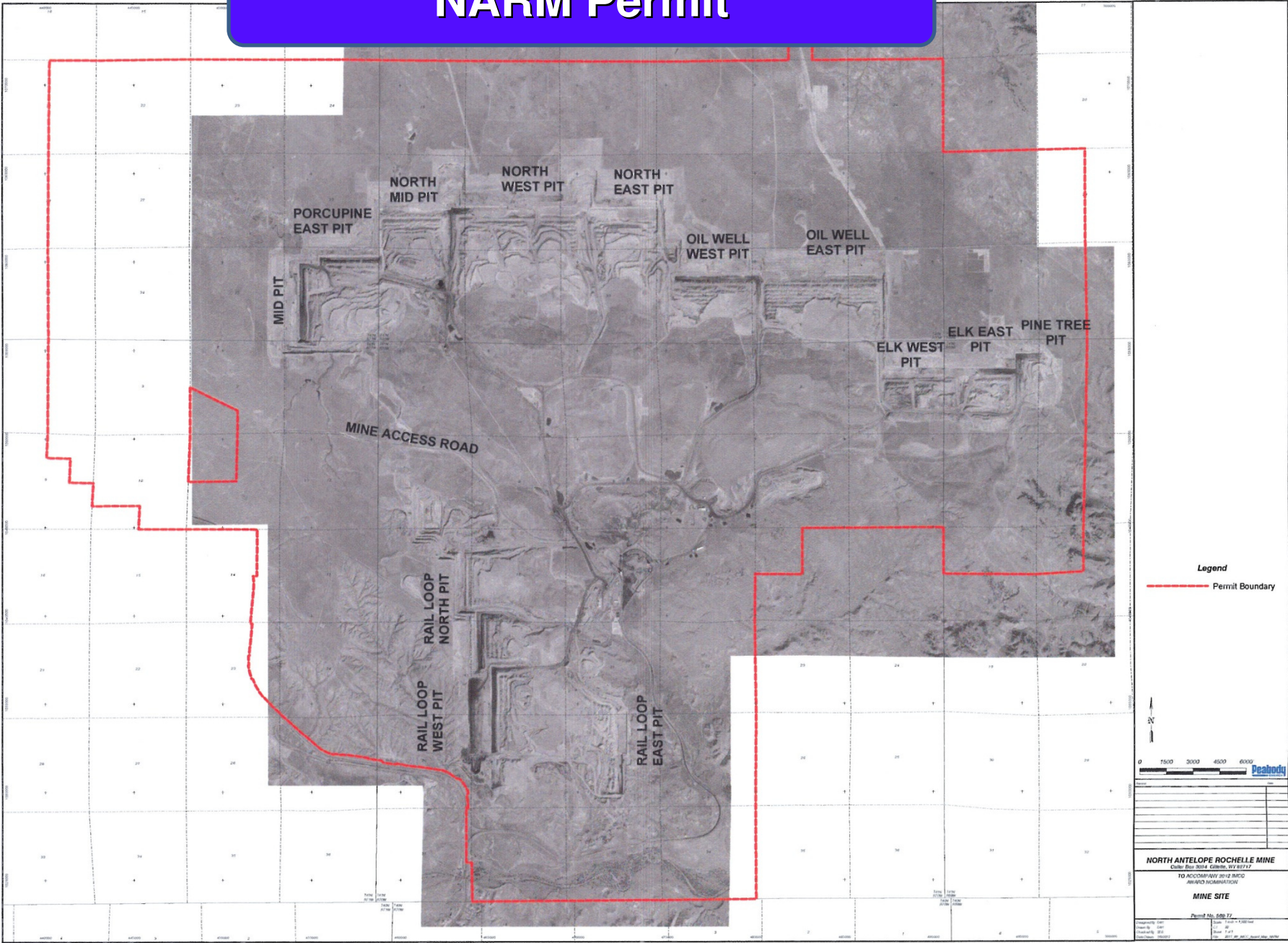
**Current bond: \$315,574,200**

**Employees: 1300**



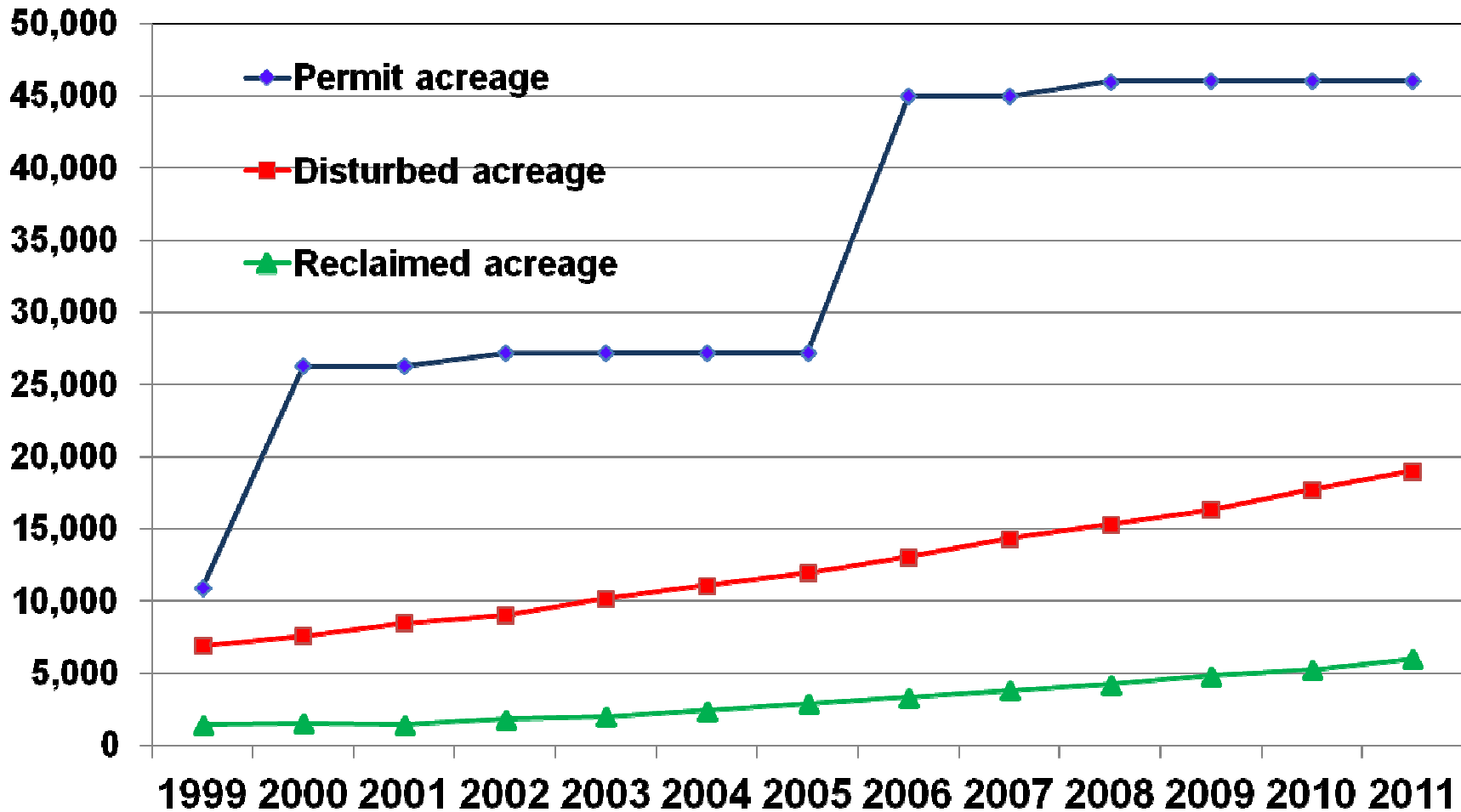


# NARM Permit



# Reasons for developing geospatial tools for NARM

- **Increasing acreage of the permit, disturbed, and reclaimed area**



## Reasons for developing geospatial tools for NARM

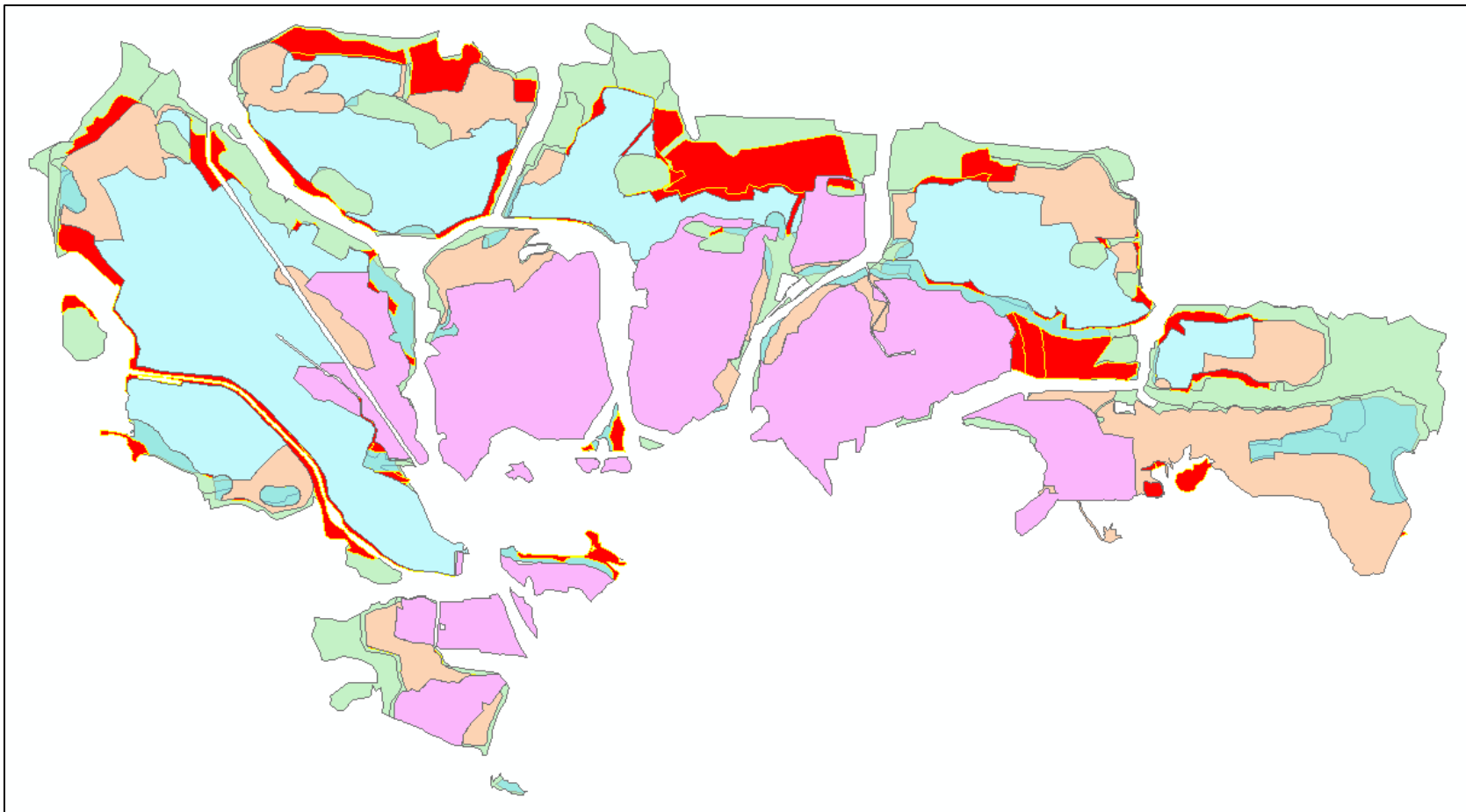
- **Increasing number of compliance features, active coal pit areas, mined and permanently reclaimed areas, etc.**

The inspected features recorded within NARM's permit area, as of March 2012, included:

- **85 topsoil stockpiles**
  - **77 ponds structures (sediment pond, sediment trap, facility, flood control, and backfill ponds and diversion)**
  - **122 culverts**
  - **23 alternate sediment control measure (ASCM's)**
  - **94 groundwater monitoring wells**
  - **8 surface water monitoring sites**
- >400 – total features**

## Reasons for developing geospatial tools for NARM

- Beginning of the development of bond release procedures
- Variable acreage (0.1-481 ac) of rough backfill/quality areas, topsoiled areas, or seeded areas (in a process of verification or bond release) throughout the mine



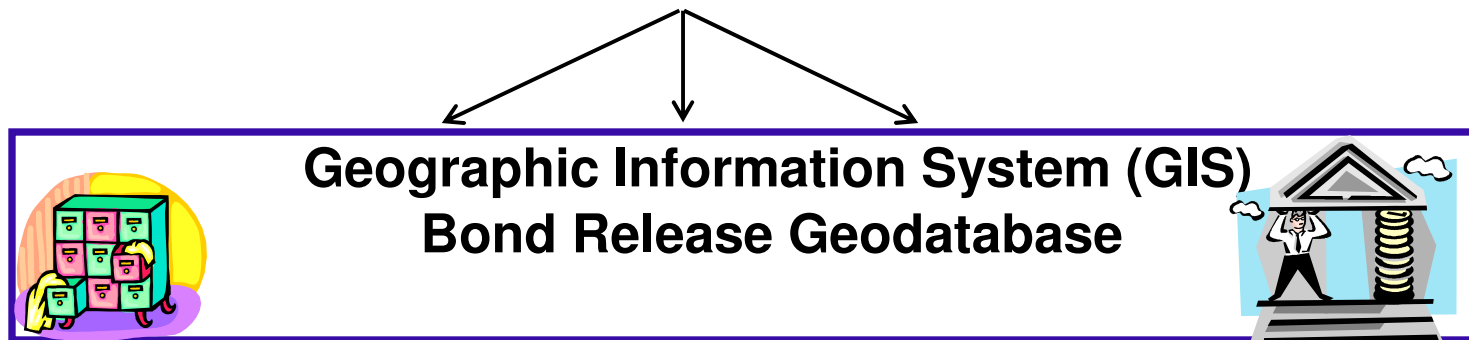
# Bond Release in Wyoming

## Bond Release

- ▶ Area Bond (through backfill graded)
- ▶ Phase I (through topsoil replacement)
- ▶ Phase II (through initial vegetation establishment)
- ▶ Phase III (full release)

## Verification requirements for Phase I

- ▶ Rough Backfill
- ▶ Quality of Backfill
- ▶ Soil Depth
- ▶ Stream Channel Reconstruction
- ▶ Drainage System Functionality



# Geodatabase

A spatial database was structured using tables. Each row represented a record contained within the thematic layer (feature class). Columns (attribute fields) included all required types of information associated with the record (including location).

**Feature Dataset**

**Feature classes**

**Attribute Fields**



















**Domain**



<b>Feature Dataset</b>	<b>Feature classes</b>
<b>Area Bond</b>	<ul style="list-style-type: none"> <li>• Backfilled and rough graded to the approved post-mine topography (PMT)</li> <li>• Drainage divides match those of the approved PMT</li> <li>• Rough backfill quality</li> </ul>
<b>Phase 1</b>	<ul style="list-style-type: none"> <li>• Topsoil replacement according to the permit commitment</li> <li>• Stream channel reconstruction and drainage system functionality restored according to the approved reclamation plan</li> </ul>
<b>Phase 2</b>	<ul style="list-style-type: none"> <li>• Vegetation established for at least two growing seasons. Species composition commensurate with the approved seed mix and supports the postmining land use</li> <li>• Sediment control release approved</li> <li>• Permanent impoundments established</li> </ul>
<b>Phase 3 Full</b>	<ul style="list-style-type: none"> <li>• The approved postmining land use has been restored</li> <li>• Wildlife habitat features restored and shrubs reestablished</li> <li>• Alluvial valley floor established, mitigation wetlands</li> <li>• Achievement of the revegetation standards</li> <li>• Achievement of the shrub establishment goal and/or standards</li> <li>• Achievement of the tree replacement standard</li> <li>• Postmining groundwater supports the land use</li> <li>• Postmining surface water quality and quantity support the approved postmining land use and minimize impact to the hydrologic balance</li> <li>• All approved postmining road are functional</li> <li>• All temporary structures are removed</li> <li>• Permanent impoundments suitable and approved</li> </ul>

## Phase 1 Verification requirements

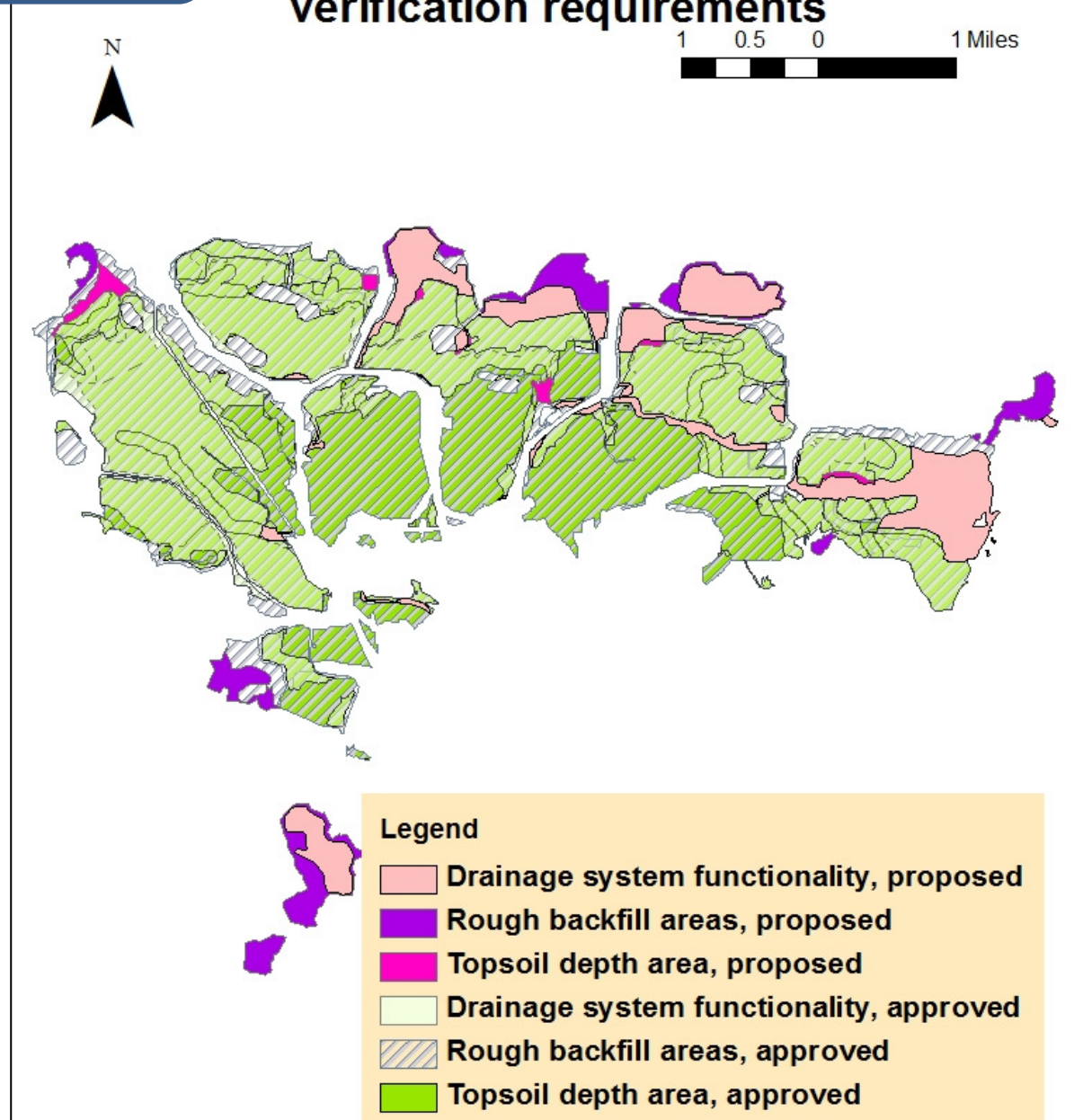
Data sets, feature classes, attribute fields and domains were chosen on the basis of the WYLQD Guidelines.

-  P:\GIS\NARM\Bond\_geodatabase
  - +  Documents\_HotLink
  - +  Template\_GDB\_Verification\_and\_Bond\_Release
  -  NARM\_Verifications\_and\_Bond\_Release.mdb
    -  Approved\_Bond\_Release
      -  Phase\_1\_Partial\_Incremental\_Approved\_Sept\_2011
      -  Phase\_2\_Partial\_Incremental\_Approved
      -  Phase\_3\_Partial\_Incremental\_Approved
    - +  Boundaries
    - +  Compliance\_Inspection
    - +  Existing\_Topography
    - +  Hydrology
    -  Phase\_1\_Verifications
      -  Drainage\_System\_Functionality\_Approved\_2011
      -  Quality\_Backfill\_Approved\_2011
      -  Rough\_Backfill\_Approved\_2011
      -  Stream\_Channel\_Reconstruction\_Approved\_2011
      -  Topsoil\_Depth\_Approved\_2011



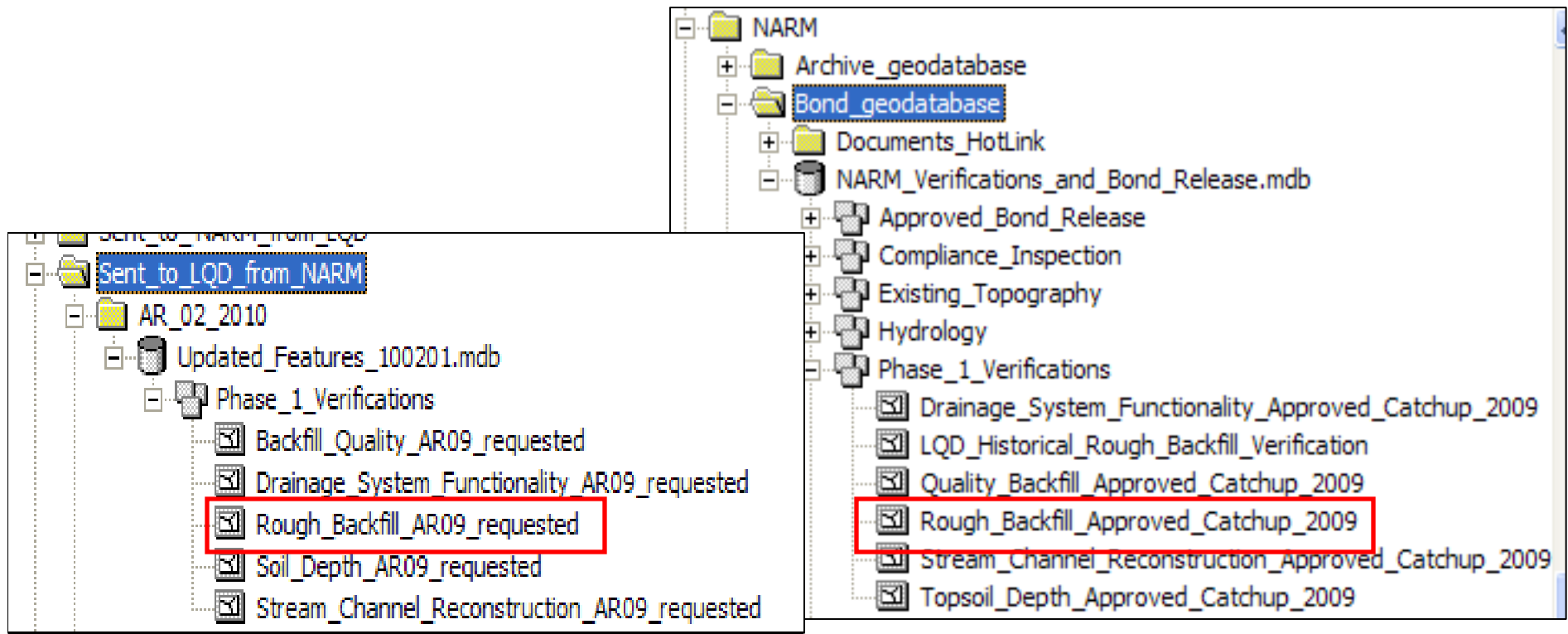
# Example of Phase 1 verification process

## Approved and proposed Phase 1 verification requirements



## Example of Phase 1 Verification process

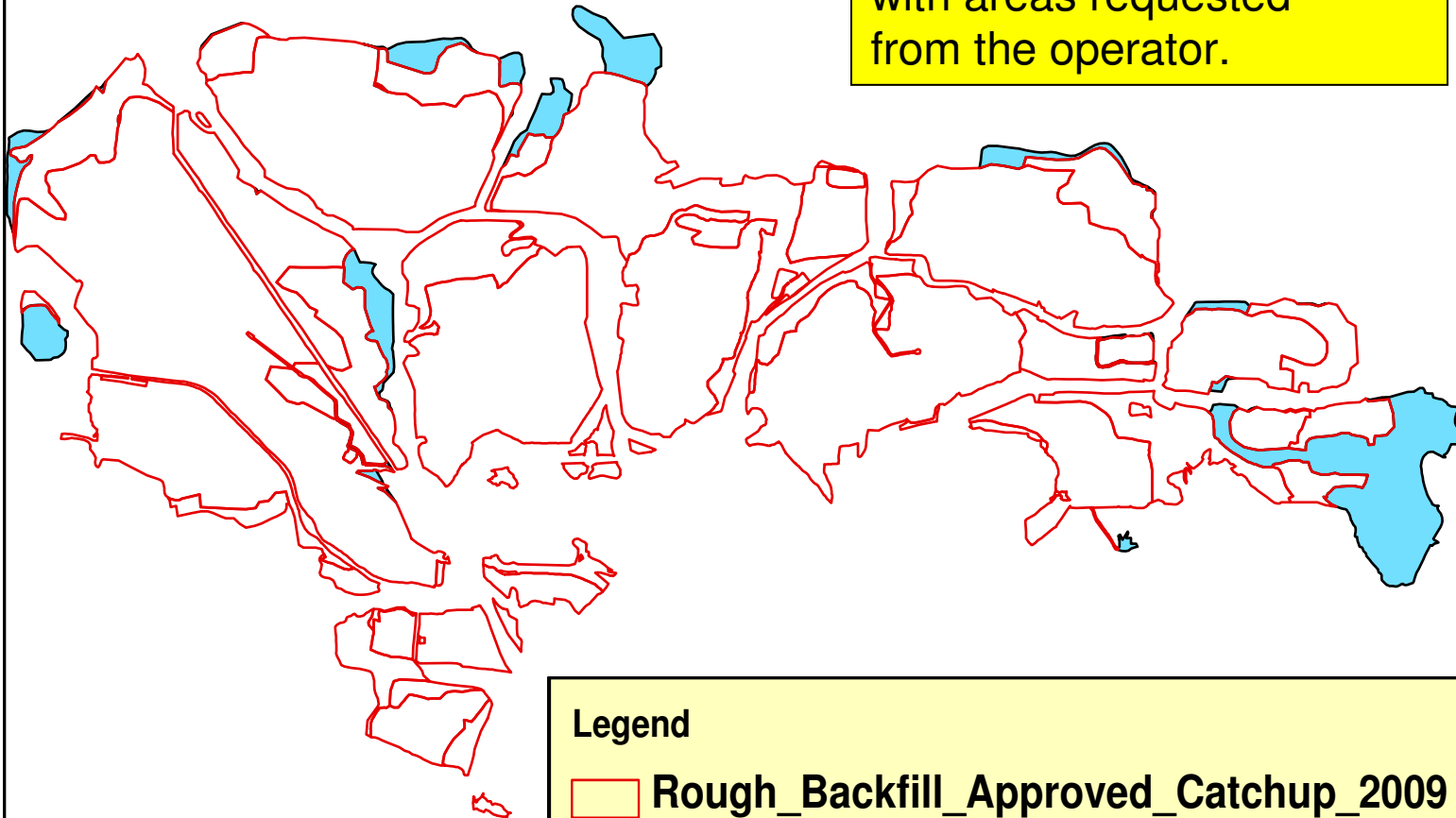
...\_Submitted by the operator feature classes are compared with the  
...\_Approved feature classes



# Verification of rough backfill areas


0 490 980 1,960 2,940 3,920  
Feet

Comparing already verified  
roughly backfill areas  
with areas requested  
from the operator.



## Legend

 Rough\_Backfill\_Approved\_Catchup\_2009



 Rough\_Backfill\_AR09\_requested

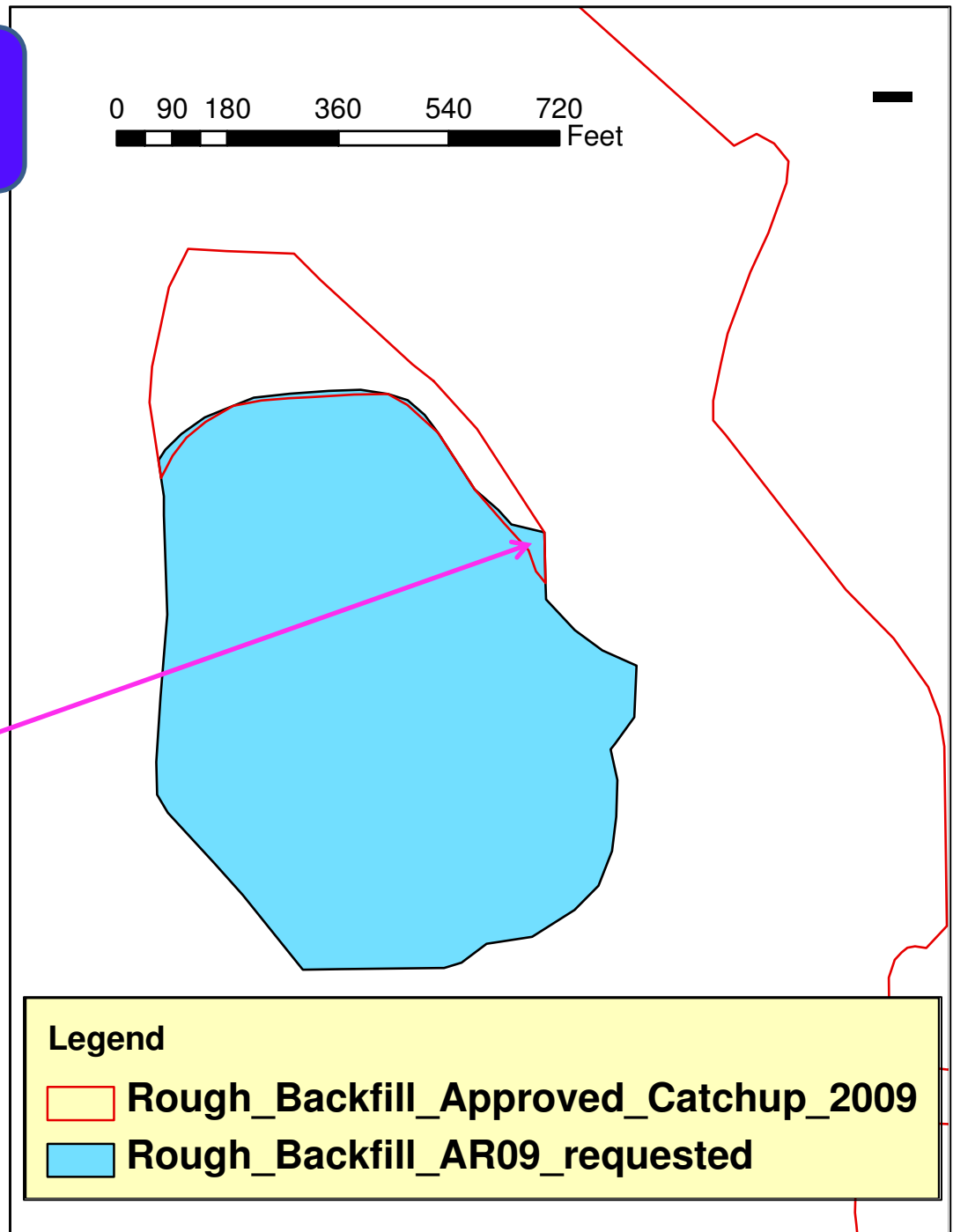
# Tracking of rough backfill areas

0 90 180 360 540 720 Feet

This portion of the area has been already verified.

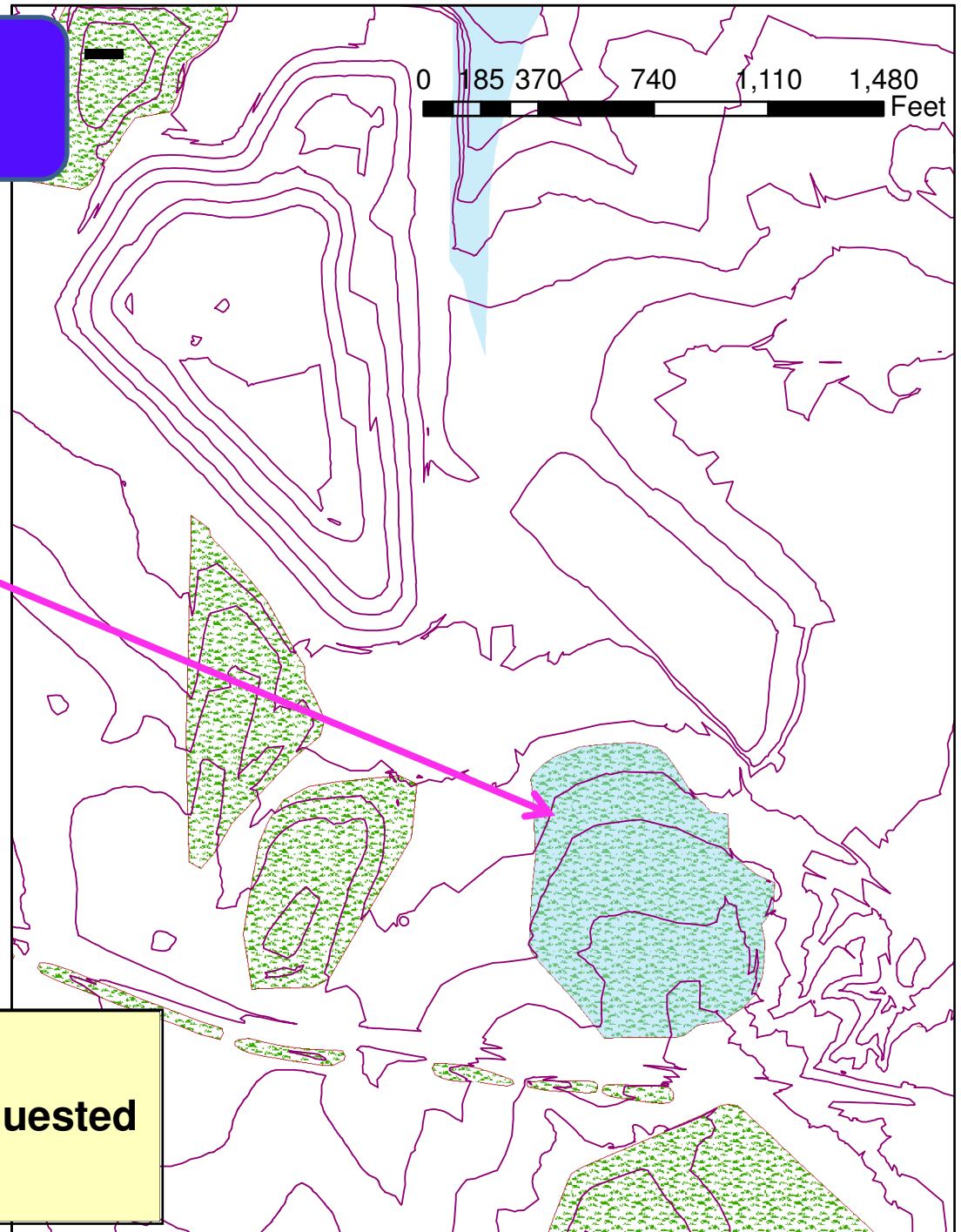
## Legend

-  Rough\_Backfill\_Approved\_Catchup\_2009
-  Rough\_Backfill\_AR09\_requested





## Tracking of rough backfill areas

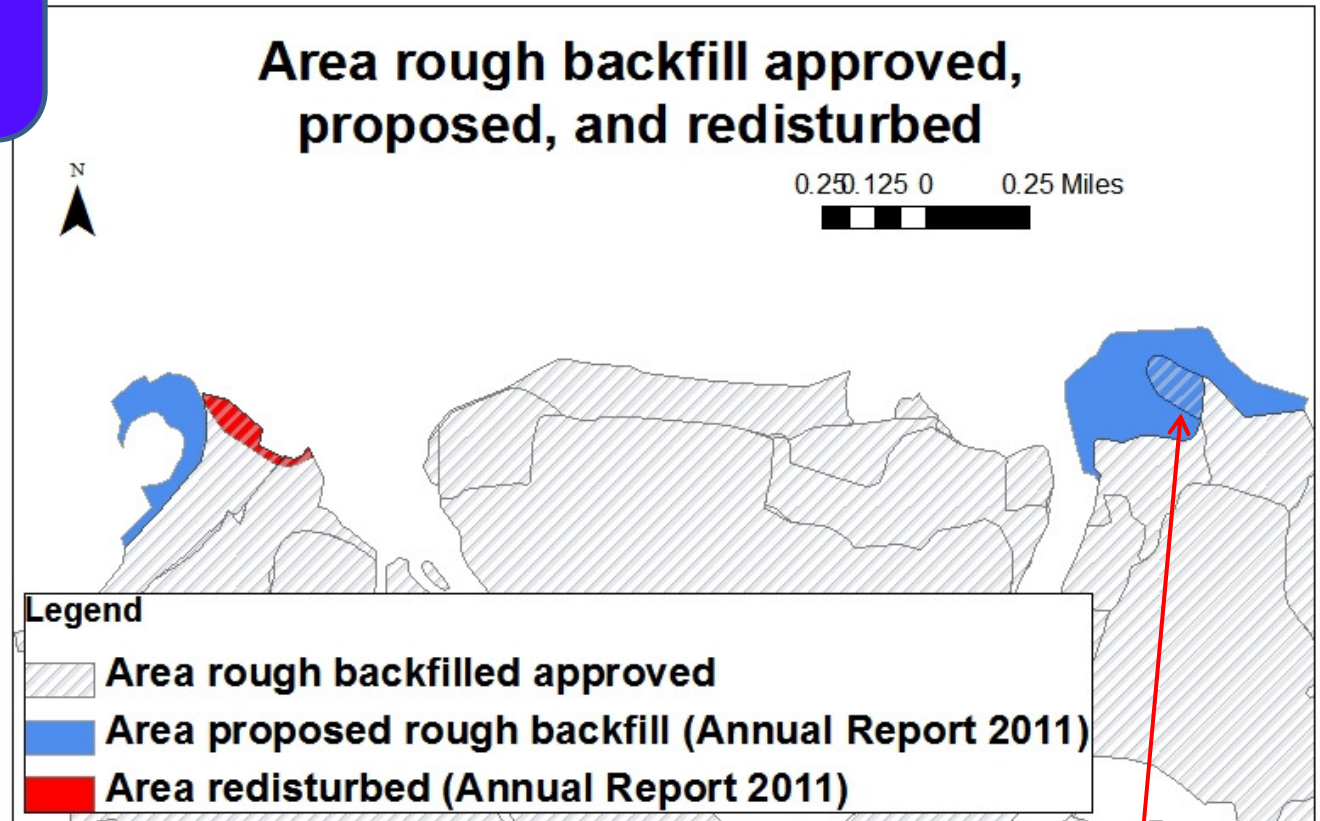
One of the requested area was the same as the topsoil stockpile located on native area. The 40 acres area needed to be removed from the request.



### Legend

-  Rough\_Backfill\_AR09\_requested
-  Topsoil Stockpile

**Tracking of rough backfill areas that have been redisturbed**



Field	Value
Acreage	-8.223797
Comments	Redisturbed in the 2010 AR period
Document_Hotlink	P:\GIS\WARM\Bond_geodatabase\Documents_HotLink\Phase_1_Verification\Rough_Quality_Backfill\2011_approval. ⚡
LQD_Approval_Date	10/20/2010

## Tracking of compliance features



- NARM\_Verifications\_and\_Bond\_Release.mdb
  - + Approved\_Bond\_Release
  - Compliance\_Inspection
    - ASCN
    - Culverts
    - Erosion\_Feature\_Ln
    - Erosion\_Point
    - Generic\_line
    - Generic\_Point
    - Groundwater\_Monitoring
    - Impoundments
    - Other\_Compliance
    - Photo\_pit
    - Rough\_Graded\_Quality\_Compliance\_
    - Stream\_Channel\_Reconstruction\_Compliance
    - Surface\_monitoring
    - Topsoil\_Depth\_Compliance
    - TSP
    - Wildlife\_Feature

## Verification of the topsoil depth compliance





# Verification of the topsoil depth compliance

Using Geodatabase to compare:

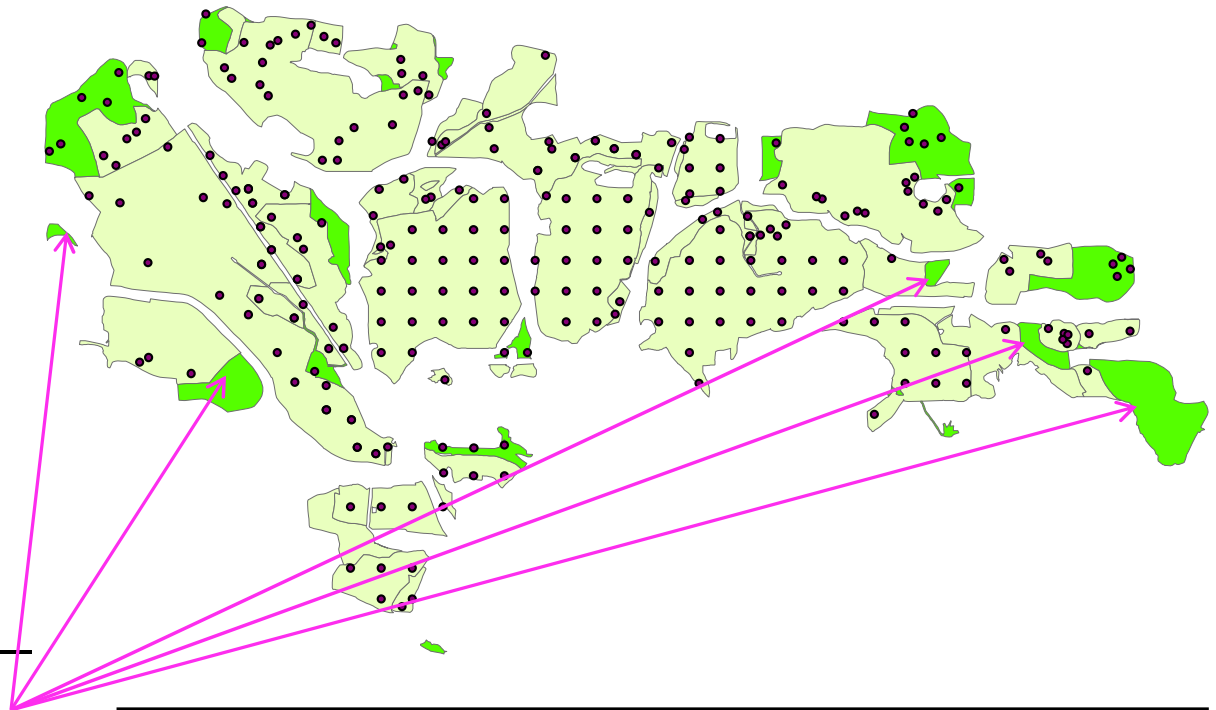
- Topsoil polygons approved, requested and verified in the field

Requested - 654 acres

Verified - 403 acres

Additional verification needed - **251 acres**

0 1,650 3,300 6,600 9,900 13,200 Feet



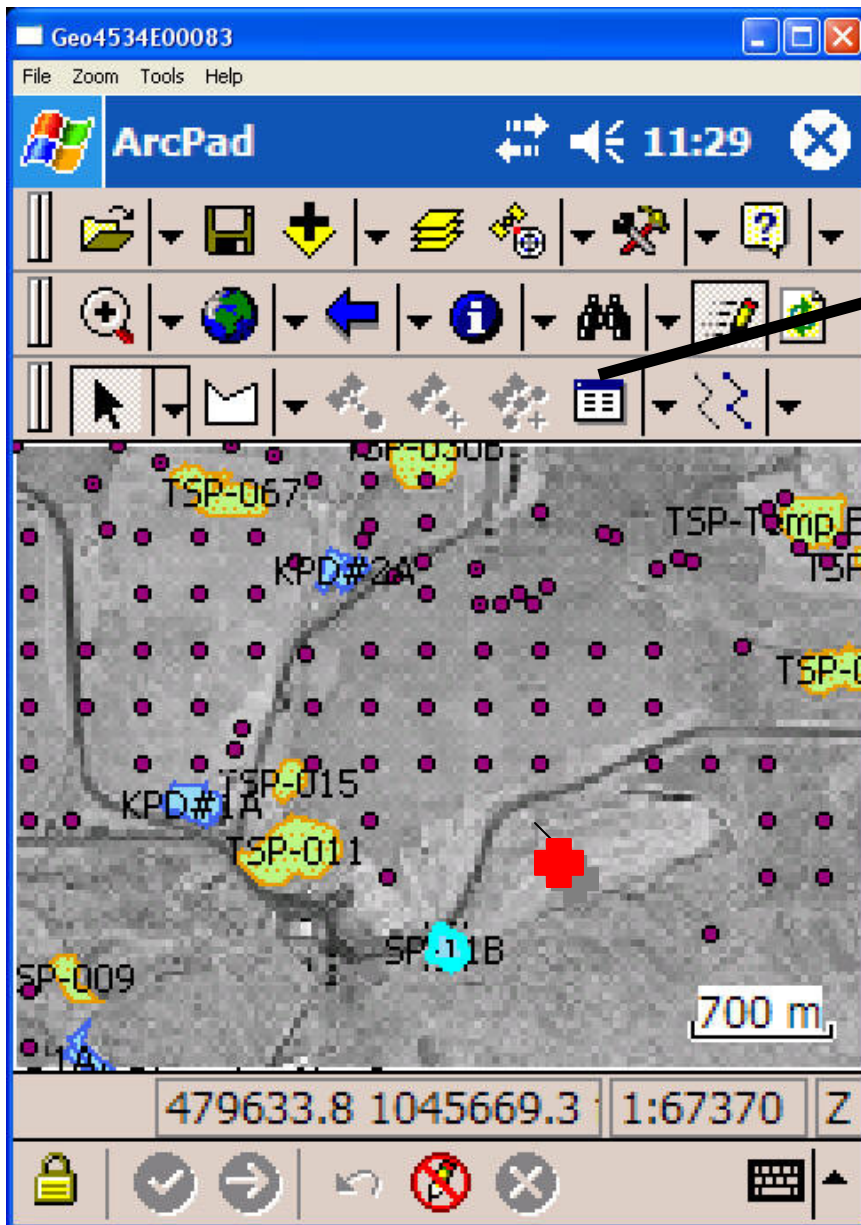
Legend

• Topsoil\_Depth\_Compliance

■ Soil\_Depth\_AR09\_requested

■ Topsoil\_Depth\_Approved\_Catchup\_2009

# Field GPS data collection



The screenshot shows the "Impoundments" attribute table in the ArcPad software. The title bar reads "Geo4534E00083". The menu bar includes "File", "Zoom", "Tools", and "Help". The toolbar contains various icons for navigation and data management. The main area displays a table with the following data:

Property	Value
Impound...	SP-11B
Impound...	Temporary
Impound...	Sediment Control
Construc...	1985-01-01 00:00:00
Removal...	<Null>
NPDES_S...	Yes
Discharge	No
Inspectio...	2008-02-19 00:00:00
Inspector	Waitkus
Eros_Co...	Acceptable
Eros_Co...	<Null>

At the bottom, there are buttons for "Attributes", "Picture", and "Symbols", along with "ok" and "X" buttons.

# Process of transferring data from the field to existing geodatabase

The screenshot displays the ArcGIS Desktop interface. On the left, the 'Table of Contents' pane shows a list of layers, with 'TSP' selected and highlighted in blue. The main map area shows a geographic distribution of TSP data points, represented by small colored diamonds (blue, green, red) scattered across a map of a region with various reservoirs and features. A callout box with a black border and white background contains the text 'Get data from ArcPad' in bold black font. An arrow points from this box to the 'ArcPad Data Manager' toolbar icon in the top right of the software interface.

Layers:

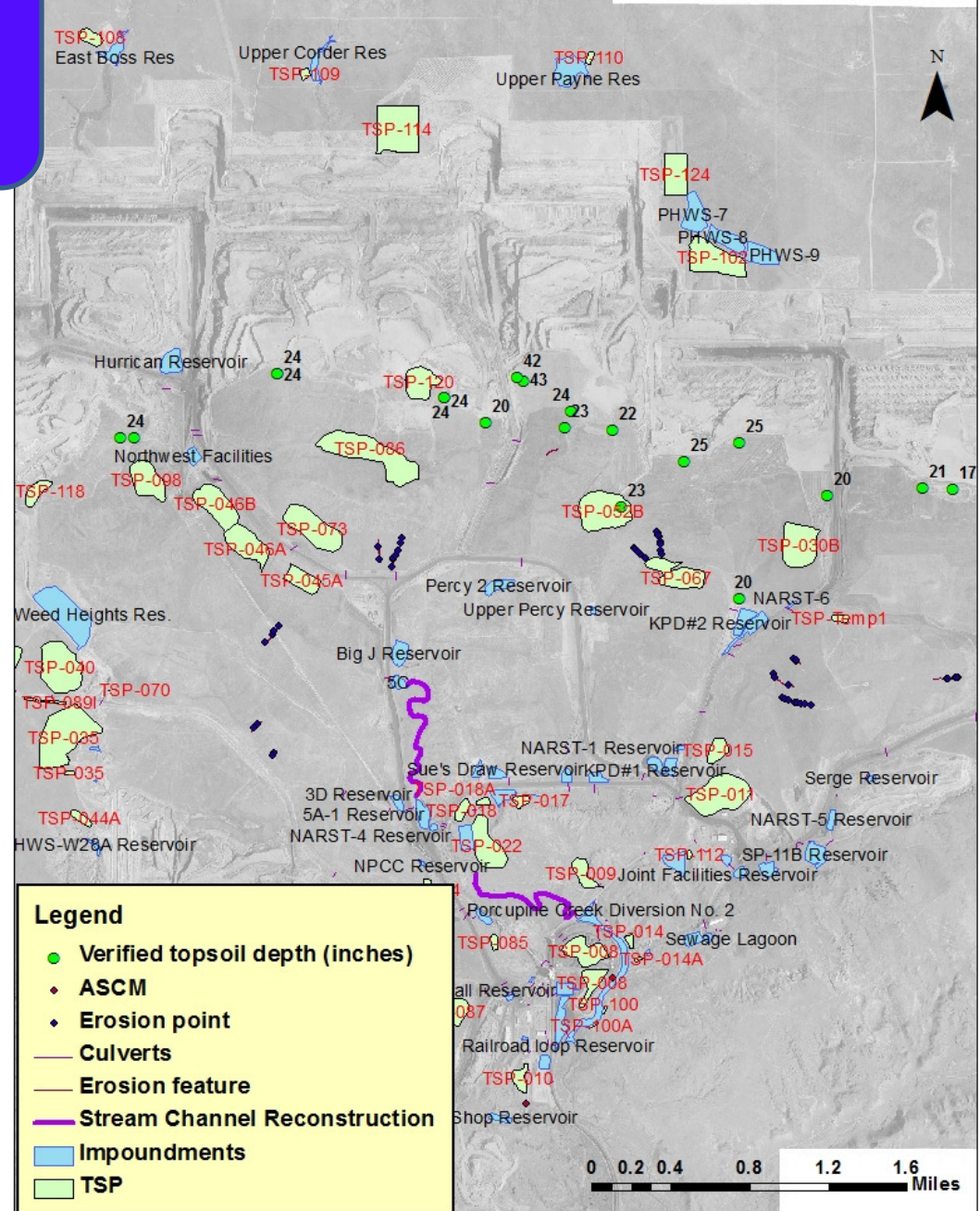
- Topsoil\_Depth\_Compliance
- Other\_Compliance
- Wildlife\_Feature
- Erosion\_Point
- ASCM
- Groundwater\_Monitoring
- Photo\_pit
- Surface\_monitoring
- Generic\_Point
- Stream\_Channel\_Reconstruction\_Compliance
- Erosion\_Feature\_Ln
- Culverts
- Generic\_line
- Impoundments
- TSP
- Rough\_Graded\_Quality\_Compliance\_2009

Get data from ArcPad

## Benefits of Geodatabase: efficiency and quality

- Decreasing time of preparing an inspection report by 50%.
- Compliance assessment - document the location and circumstances of incidents and events for further action or reporting.

### Selected compliance features inspected in 2011



## Photo Hotlink

# Tracking of erosion features

2009 December  
NARM inspection

Photo No. 6 Looking at the gully located in the north eastern portion of the Antenna Mast area.

November 2009



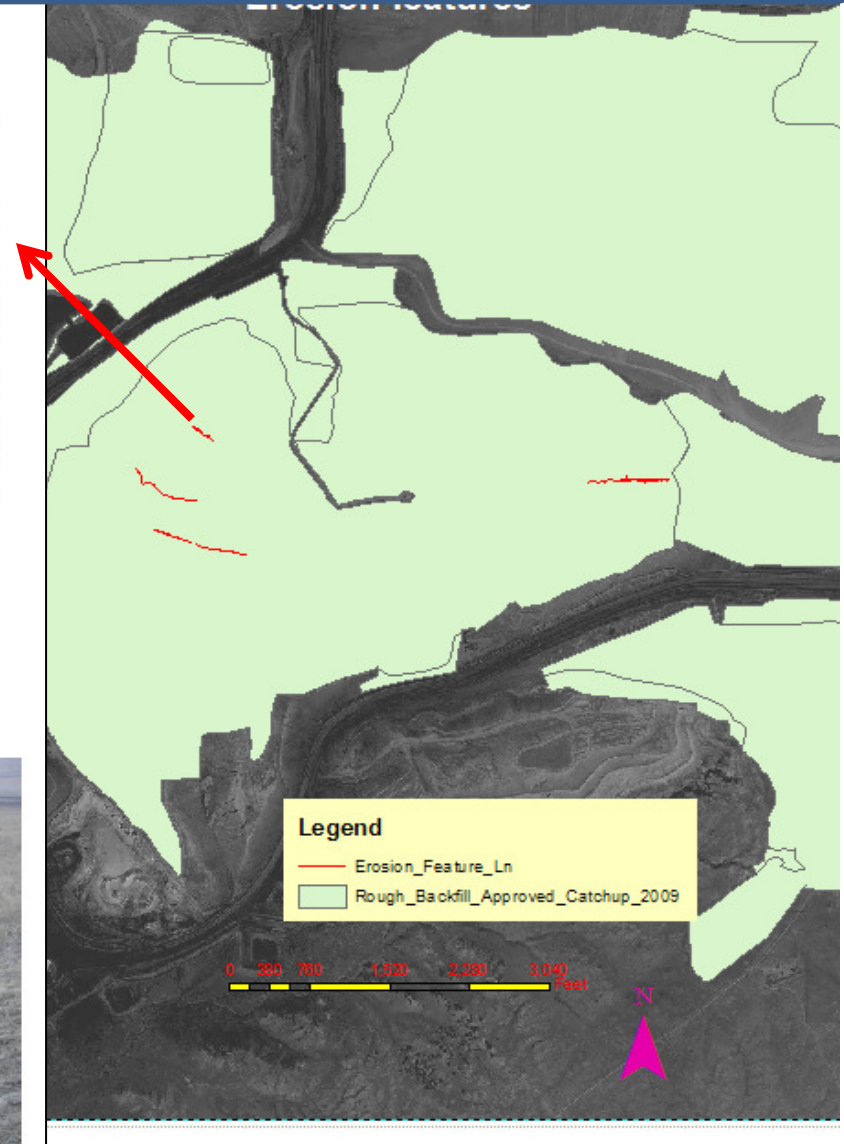
December 2009



November 2009



December 2009



## Compliance assessment-checking for erosion features

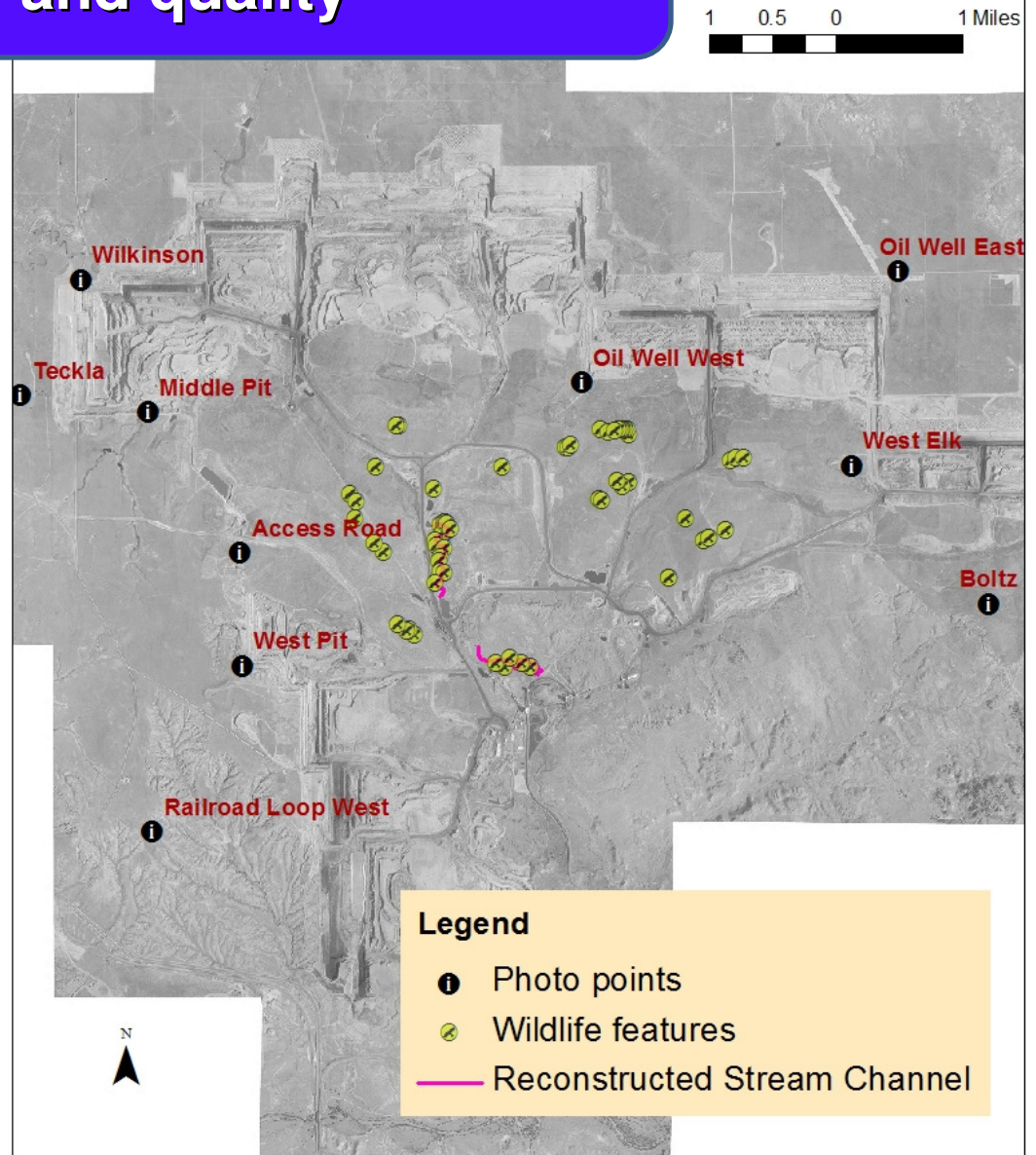
Field name	Data type	Domains	Comments
Feature ID	text		Number
Inspection Date	date	Calendar	Date of the last inspection
Inspector Name	text	Waitkus Buchanan	Choose the inspector name
Erosion Type	text	Rill active, Rill inactive Gully active, Gully inactive	Depth, width
Erosion Compliance	text	Acceptable, Not acceptable	A significant active or inactive feature is not acceptable
Erosion Compliance Date	date	Calendar	A target date when the erosional feature will be repaired
Cover status	text	Permanent seeded Temporary seeded Mulched	
Vegetation present	text	Yes, No	
Comments	text		
Photo_Link	text		Link to the folder: Documents_Hotlink

## Benefits of Geodatabase: efficiency and quality

- Tracking of the permit commitment e.g. creating four rock piles location per 640 acres

- Tracking of the reconstructed stream channel, Porcupine Creek

- Review of contemporaneous reclamation progress through photo sequence



# Contemporaneous reclamation progress

Photos by Anna Krzyszowska-Waitkus, from the same site

May 2005



July 2006





# Contemporaneous reclamation progress

Photos by Anna Krzyszowska-Waitkus, from the same site

September 2007



July 2010



**Constructed wildlife features  
Enhancing post mine land use – rock pile**



**Photo by Monte Buchanan, LQD – July 2009**

# Constructed wildlife features Enhancing post mine land use – Ferruginous Hawk nest platform



Photo by Anna Krzyszowska-Waitkus,  
LQD – December 2011



Photo by Gwyn McKee, Thunderbird Wildlife  
Consulting - June 2010

# Reconstructed Porcupine Creek Reach 1

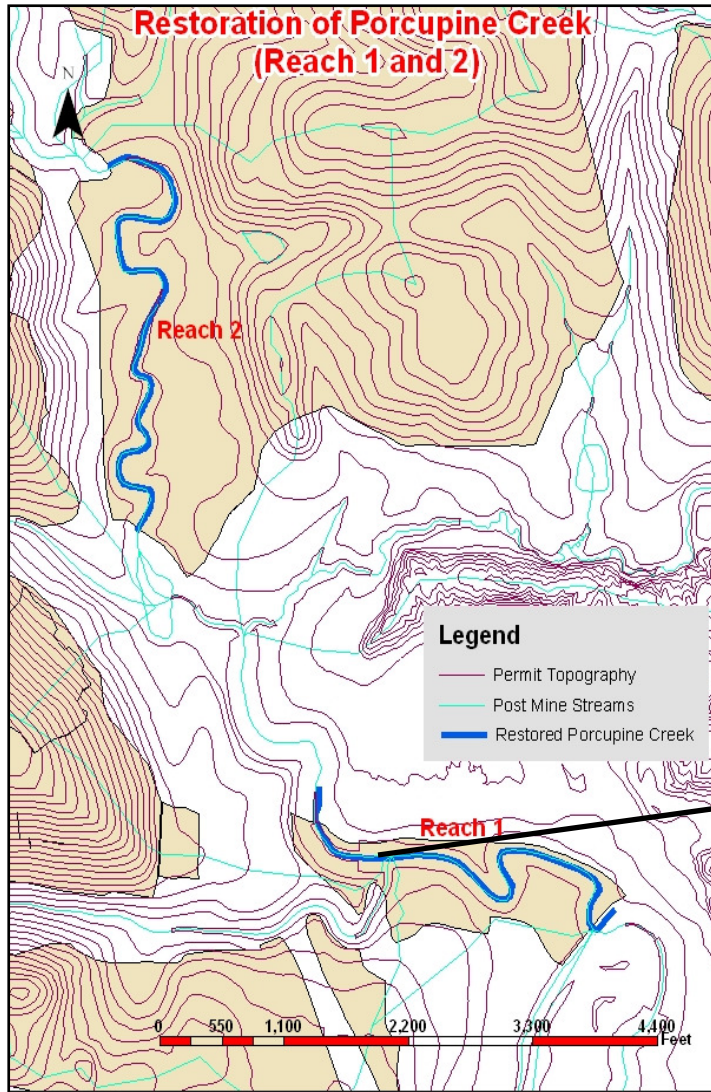


Photo by PPRO – September 2009

# Reconstructed Porcupine Creek Reach 2

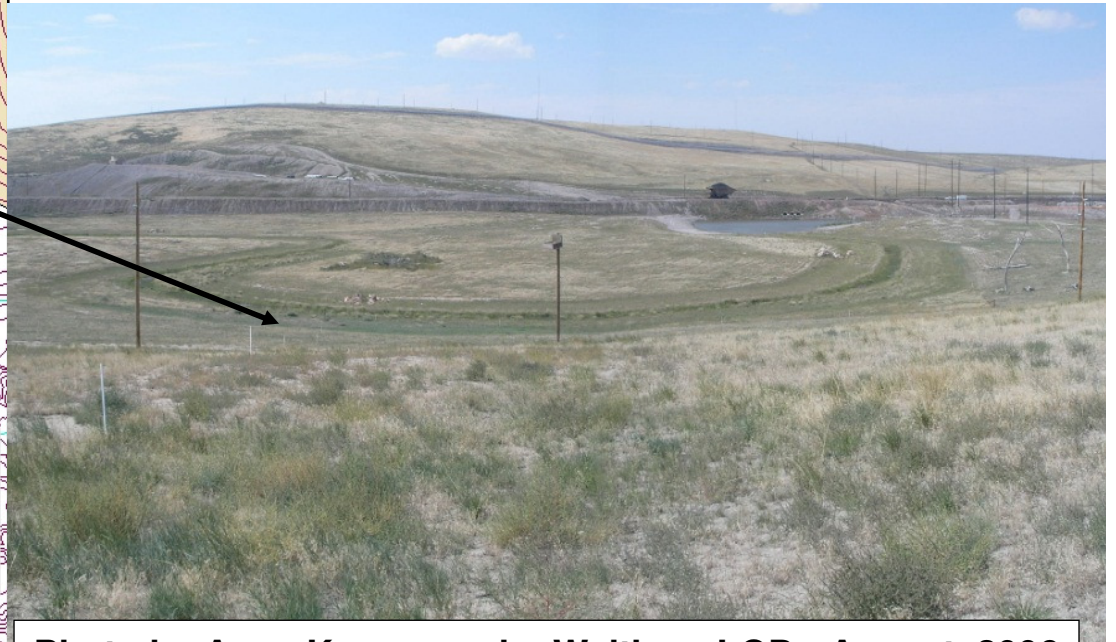
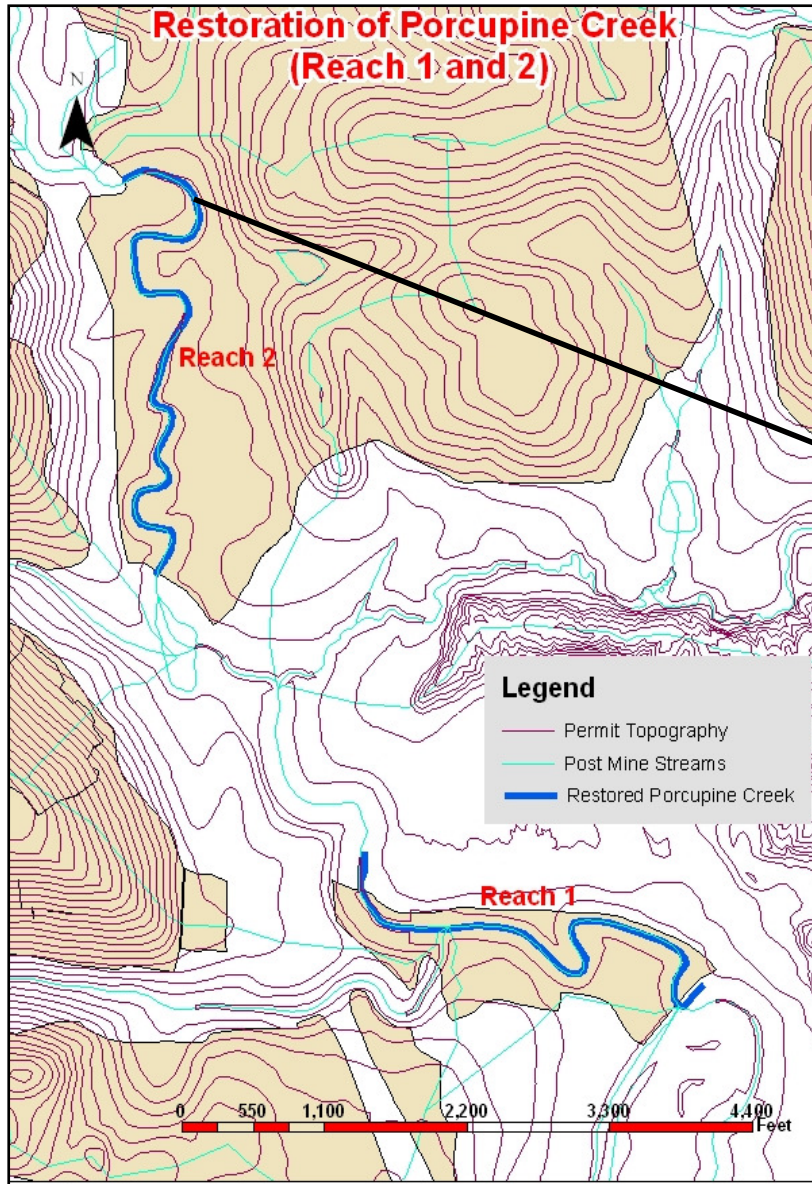
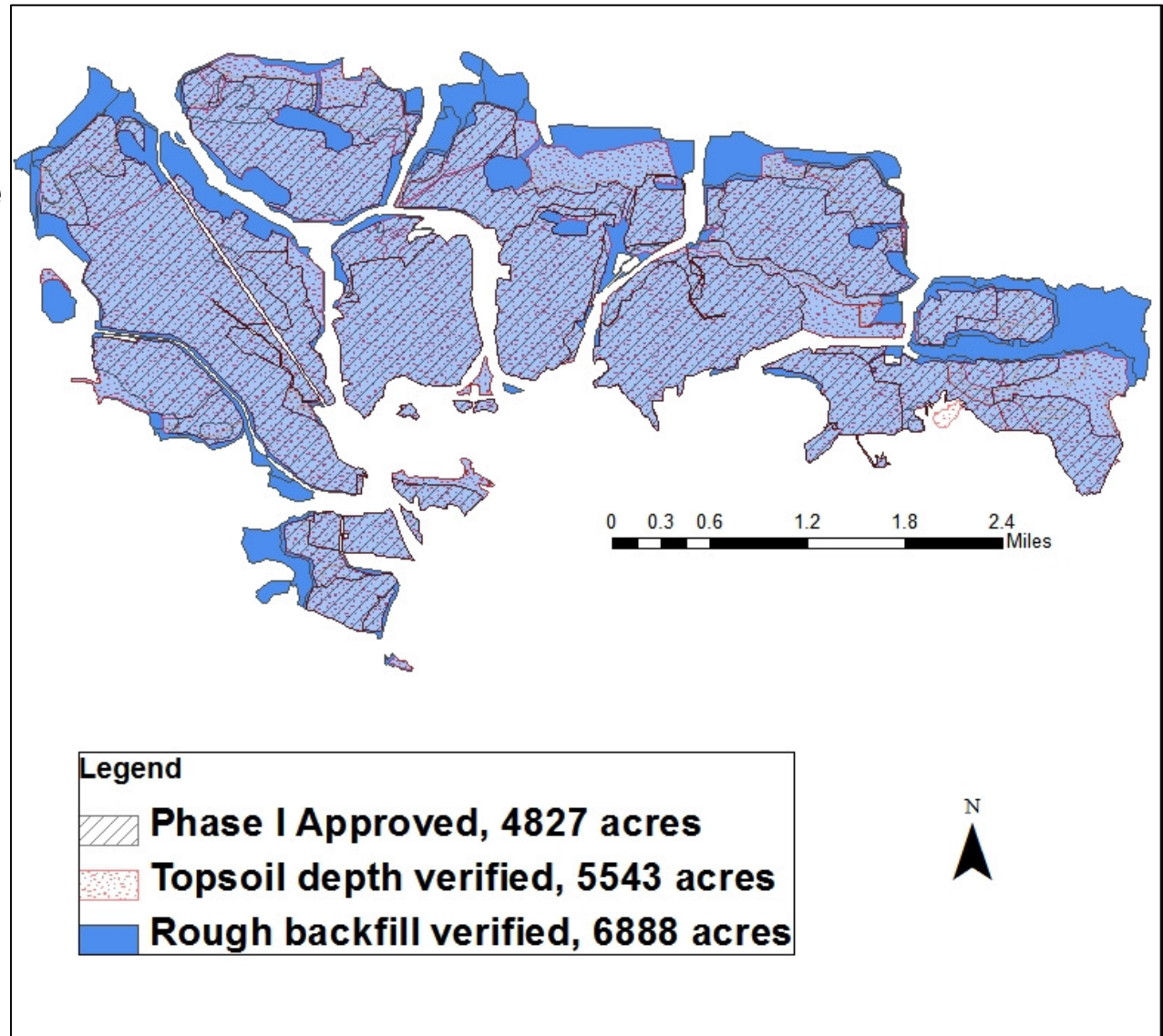


Photo by Anna Krzyszowska-Waitkus, LQD - August, 2006

## Benefits of Geodatabase: efficiency and quality

- Improve accuracy and transparency of the collected data
- Streamlined data retrieval for reports and summaries



## Verification and Bond Release acreage

Type of verification	Area (ac)
Area backfilled and graded to PMT	6,888
Rough backfill quality verified	6,888
Topsoil replacement depth according to permit commitment	5,543
Stream channel reconstruction restored	3,579
Drainage system functionality restored	3,579
Sediment Control Release	85

Type of bond released	Area (ac)	Bond, \$
Phase I	4,827	10,571,342

# CONCLUSIONS

Using geospatial tools are highly effective method to reduce time needed to:

- track the bond release progress,
- reach agreement between the operator and the regulator to approve bond release verification requirements and bond release approval,
- prepare an inspection report.

Additional function of the Bond Release Geodatabase includes:

- improving the inspector's ability to assess reclamation adequacy
- reviewing of mining and reclamation progress
- creating a spatial system combining all data that can be retrieved quickly as needed

The Bond Release Geodatabase approach is used by Peabody for other mines