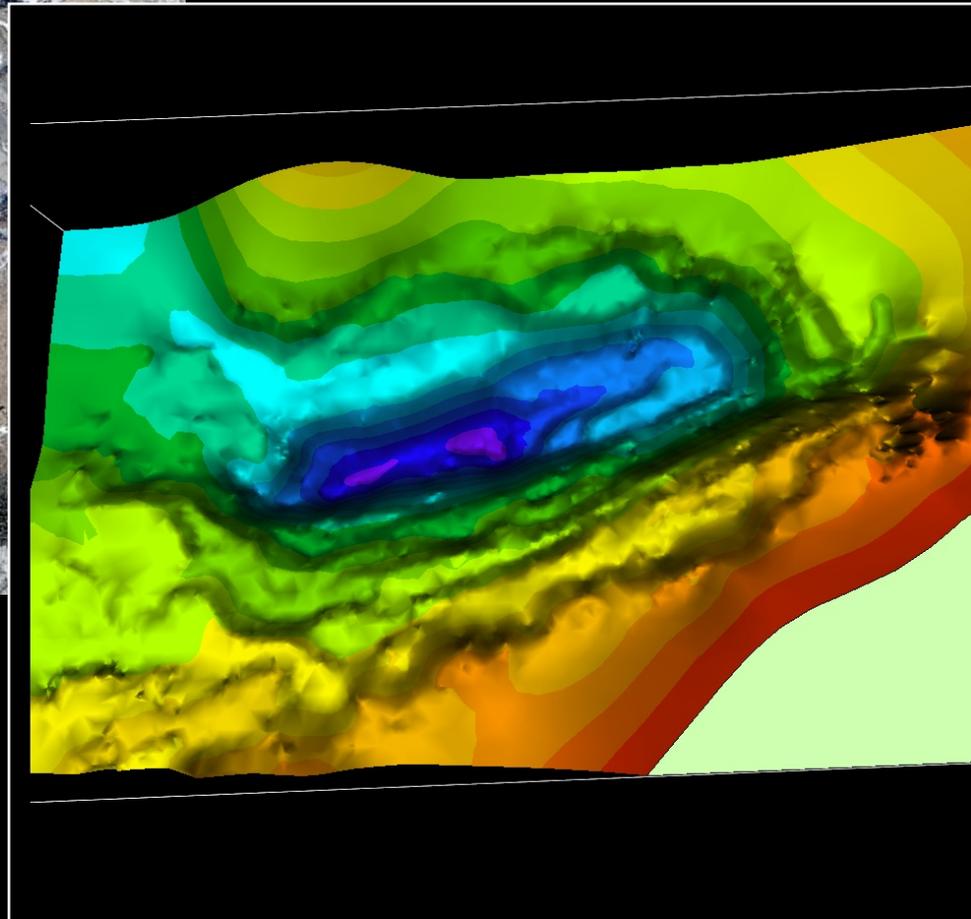
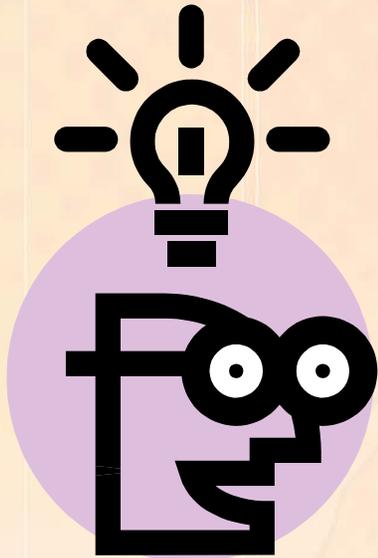


3-D Modeling of Large Anthracite Open Pit Mining Operations to Assist in Pennsylvania's Conversion to Conventional Bonding



TIPS to the rescue



- In 2001 PA was gearing up for a major overhaul of its bonding mechanism.
- A TIPS demo in the fall of 2001 gave us an idea to use 3-D modeling in order to better evaluate operator's cost estimates of large anthracite open pit.

Project Objectives

- Use TIPS software
- Deliver results on time
- Limit cost
- Verify or challenge operator's estimated reclamation liability

Project Phases

- Acquire imagery
- Establish ground control points (GCPs)
- Perform Digital photogrammetry
- Build 3-D models
- Calculate Volume

Map of Project Area

0 5 10 15 Miles



Gowen Mine

Lattimer Basin
Jeddo Basin West
Jeddo Refuse Area 1
Jeddo Refuse Area 2
Jeddo Basin East
Stockton Mine

Primrose Mine

Sayre Stripping

Continental Mine

B D Overall

LCN

Logan Surface Mine

Pine Knot Pott Bannon P-50

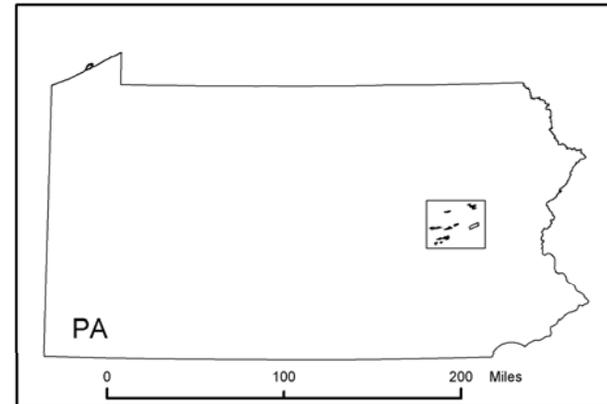
Buck Run

Wadesville P-33

Wadesville

Baby Boy Jarvis

Peach Mountain

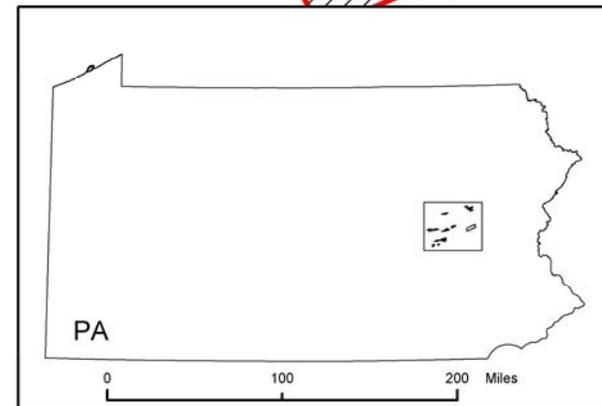
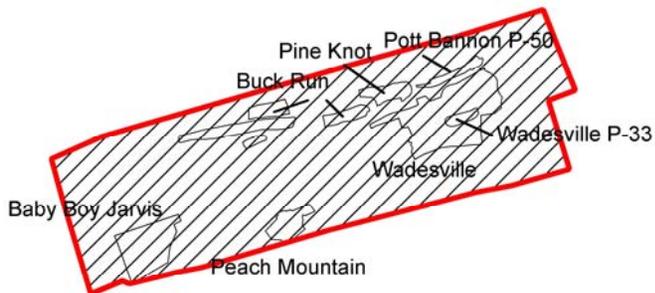
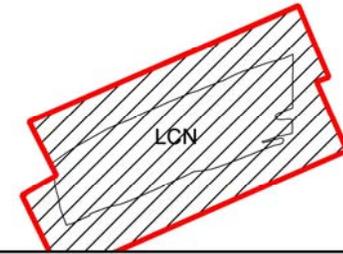
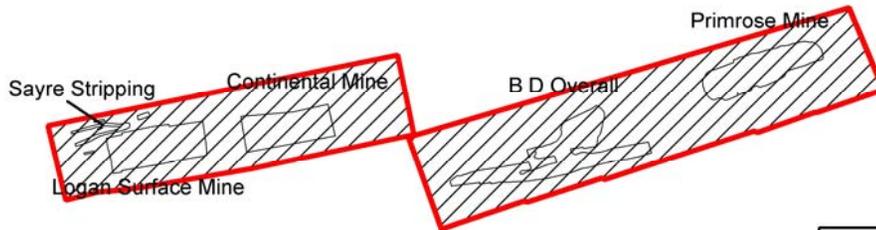


Acquiring Imagery

- Choose aerial photography due to cost and the ease of selecting just the areas we needed.
- OSM contracted the aerial surveyor, Keystone Aerial Surveys from Philadelphia.
- Hi-res color imagery was acquired on Jan. 26, 2002 for 75,000 acres at under \$15,000
- By mid-Feb., Keystone delivered color scans (on CDs) in TIFF format; Scale 1:15000

Extent of Flight Lines

0 5 10 15 Miles



Ground Control Points (GCPs)

- Used two GPS units (Trimble ProXRS and Ashtech Z-Surveyor), one as a rover and the other as a base.
- 2 GCPs were collected at each end of the flight line.



Trimble GPS (rover) at a road sign



Ashtech (stationary) at Hazleton Airport

Digital Photogrammetry

- OSM used ERDAS IMAGINE OrthoBASE software
- A mosaic were created for each flight line
- Each mosaic contained several orthorectified images or tiles, georeferenced in UTM 18N, WGS84
- Each tile covers an area of 2500m by 2500m at 1-meter pixel resolution
- Millions of raw data points were delivered in shapefiles containing x,y,z data

Mosaic with index file overlay



Orthophoto Formats



Mr. Sid format (.sid) 2-6MB

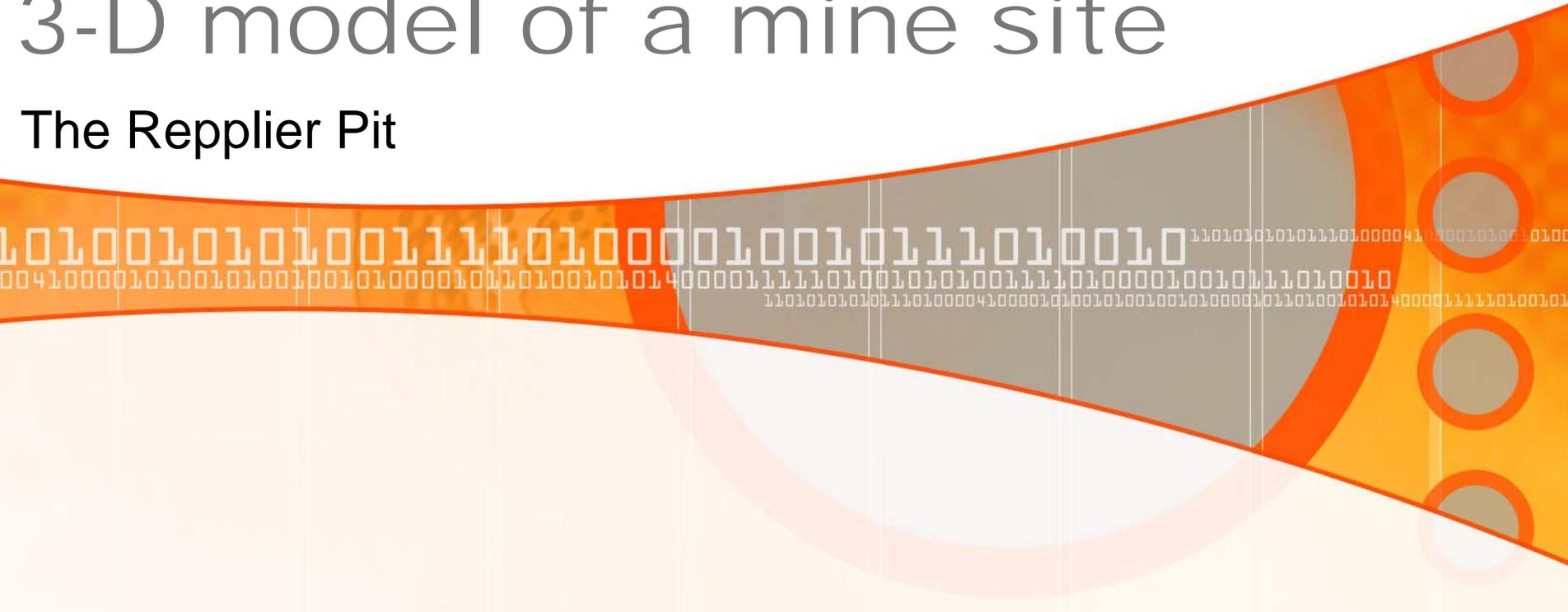


Imagine format (.img) >100MB

3-D model of a mine site

The Repplier Pit

101001010100111101000010010111010010
004100001010010100100101000010101001010140000111101001010100111101000010010111010010
1101010101011101000041000010100100100101000010110100101014000011110100101

A decorative graphic on the right side of the slide. It features a large, stylized orange shape that tapers from left to right, resembling a funnel or a lens. The shape is filled with a gradient of orange and yellow. Overlaid on this shape are several vertical lines and a large, faint, light-colored circle. The background of the slide is white, and the overall aesthetic is clean and modern.

The Repplier Pit



- Located in Schuylkill Co., PA near Pottsville
- Surface mining dates back to the 1940s
- Owned and operated by the Reading Anthracite Co.



Buck Run/Repplier

Pott & Bannon

Wadesville

Figure 5

Aerial Photography Acquired January 26, 2002

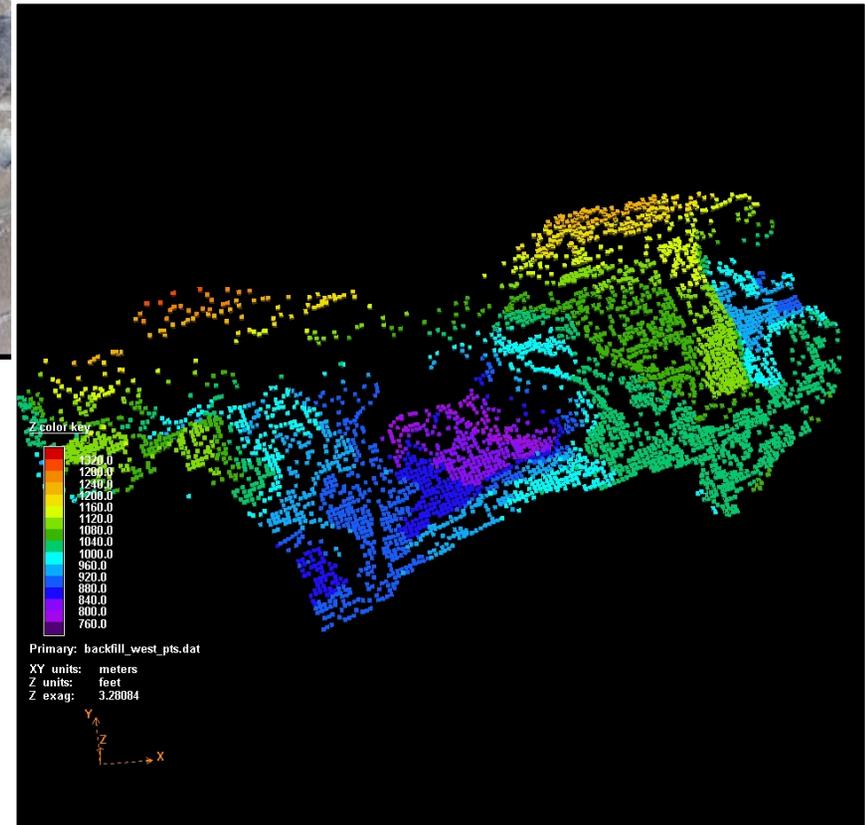
1,000 500 0 1,000 2,000 Feet



Raw Data Points (Spot Elevation)

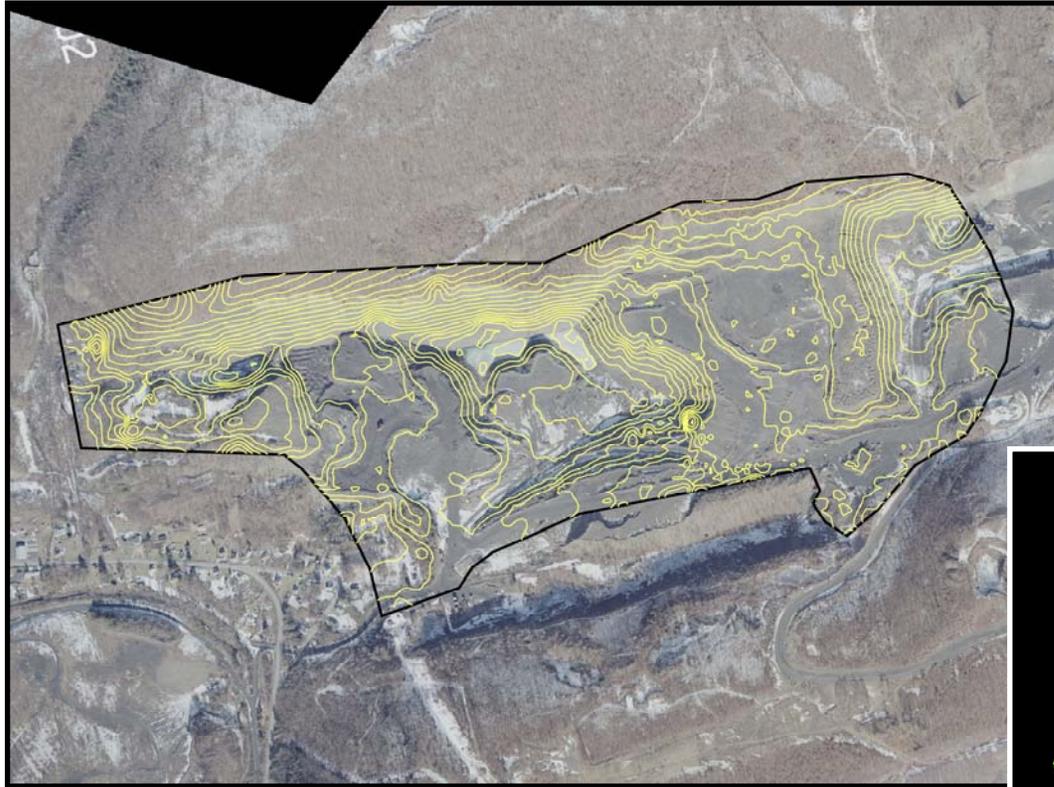


The raw data points clipped from the shapefile created by the digital photogrammetric process



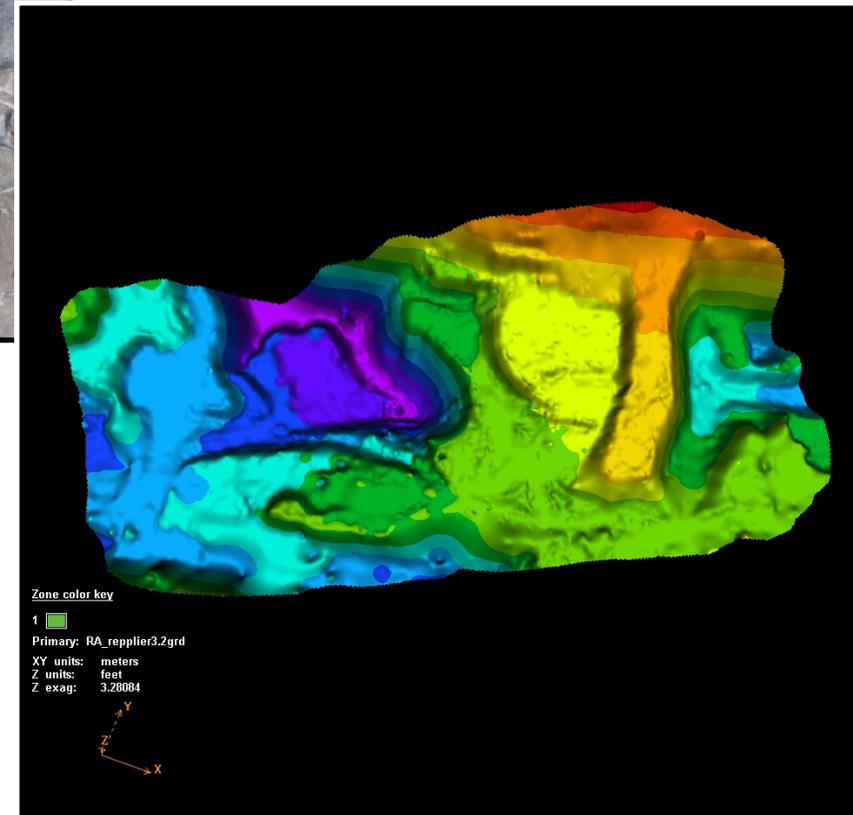
Same data points in EarthVision

Surface Topography



Surface contour lines
in ArcView

2D grid “existing” of surface topography
in EarthVision

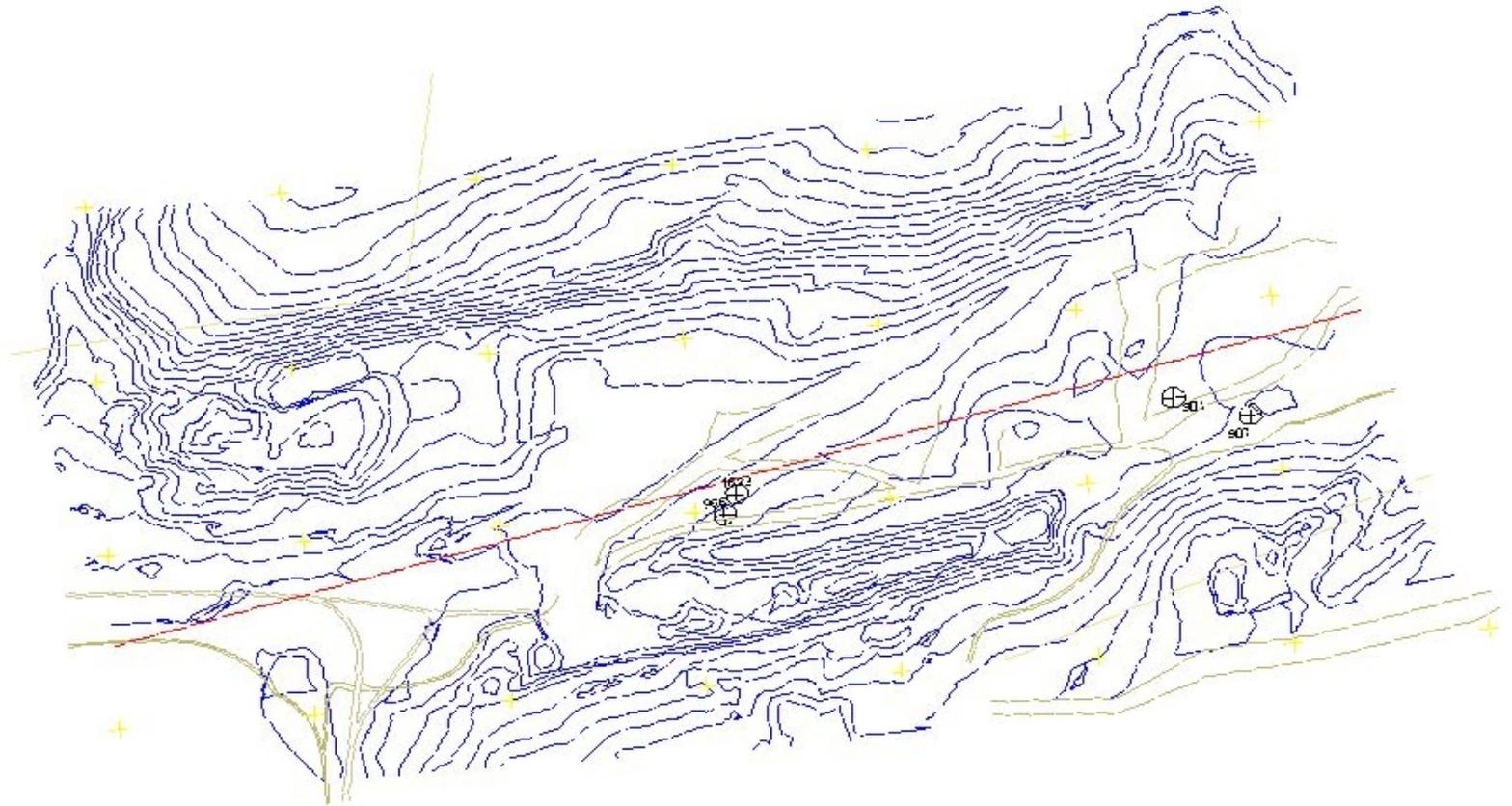


Now comes the hard part

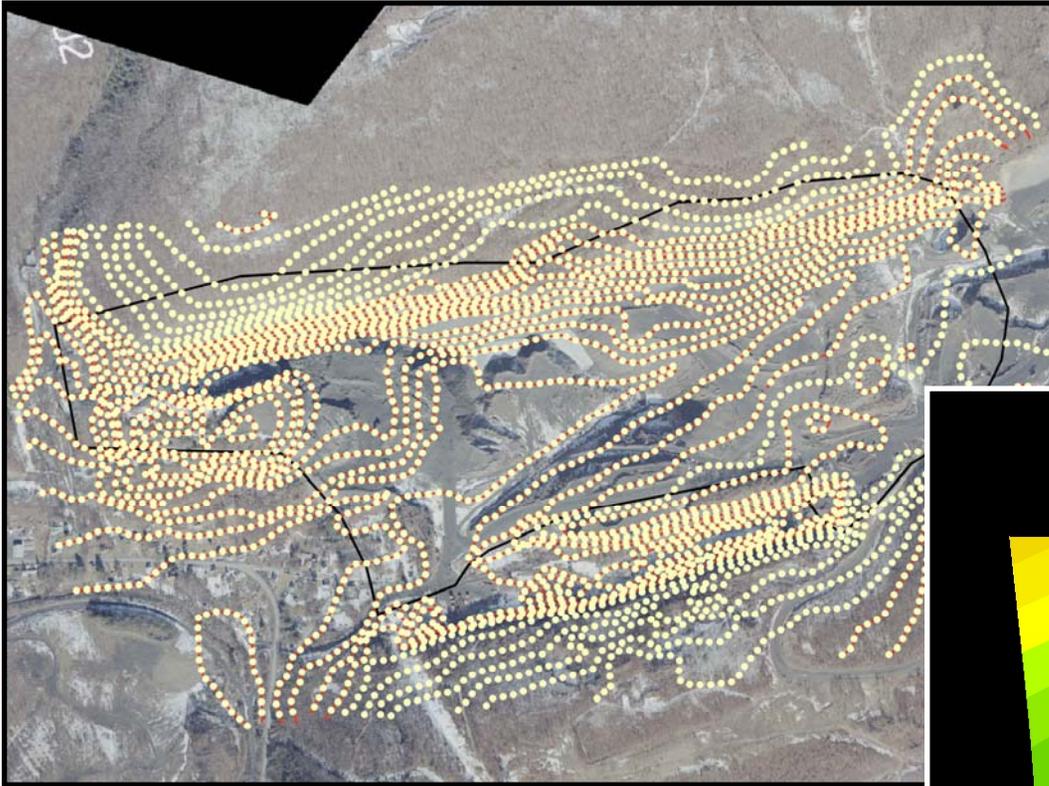
Defining the reclamation grades



Operator's CAD Recl. Plan

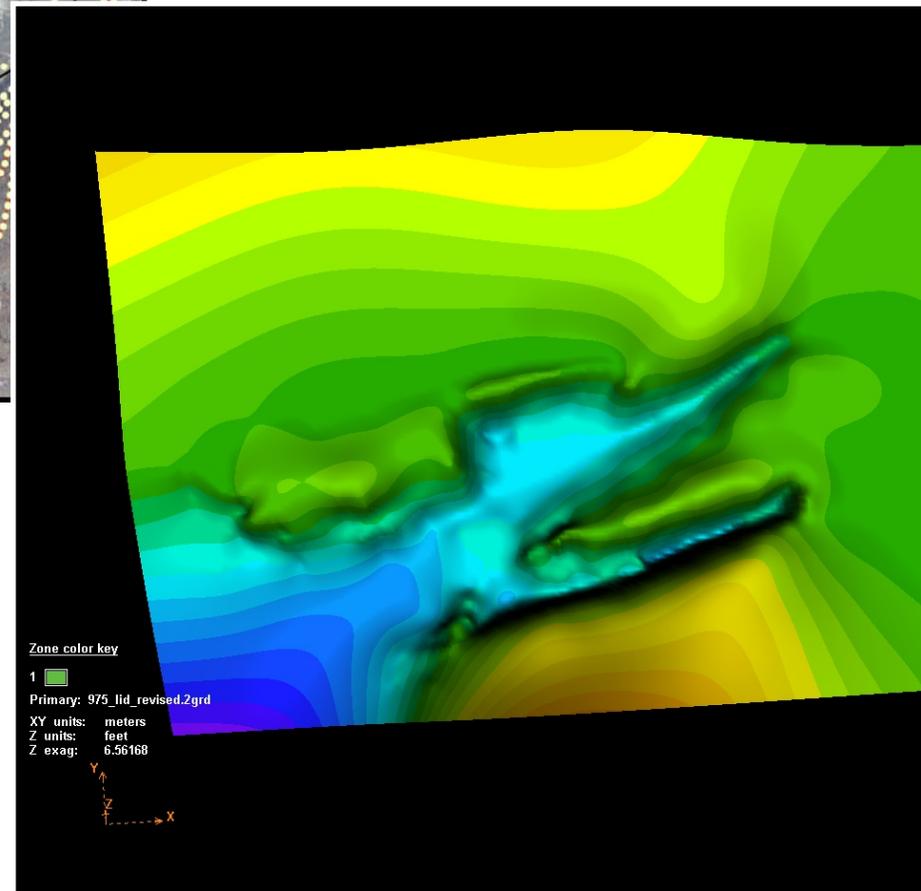


Reclamation Contours



Reclamation topography
in ArcView

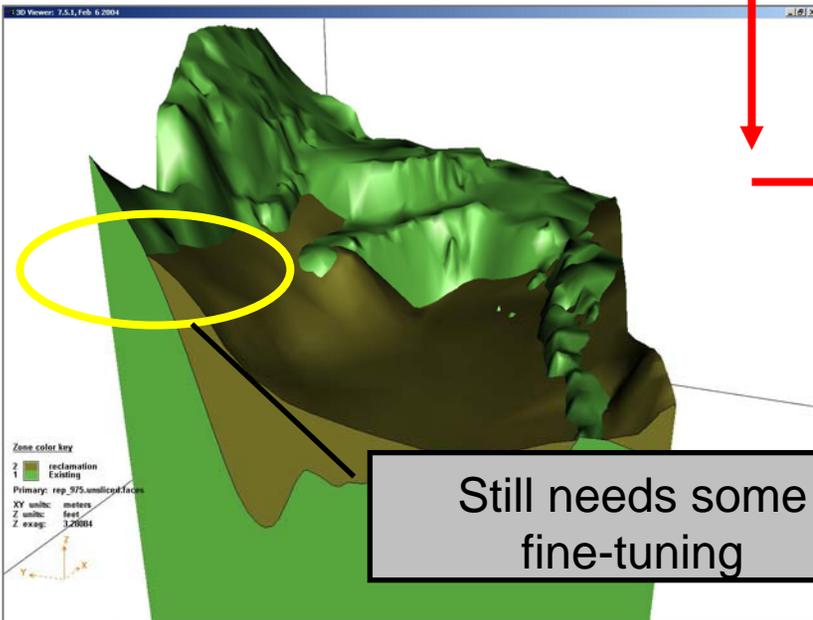
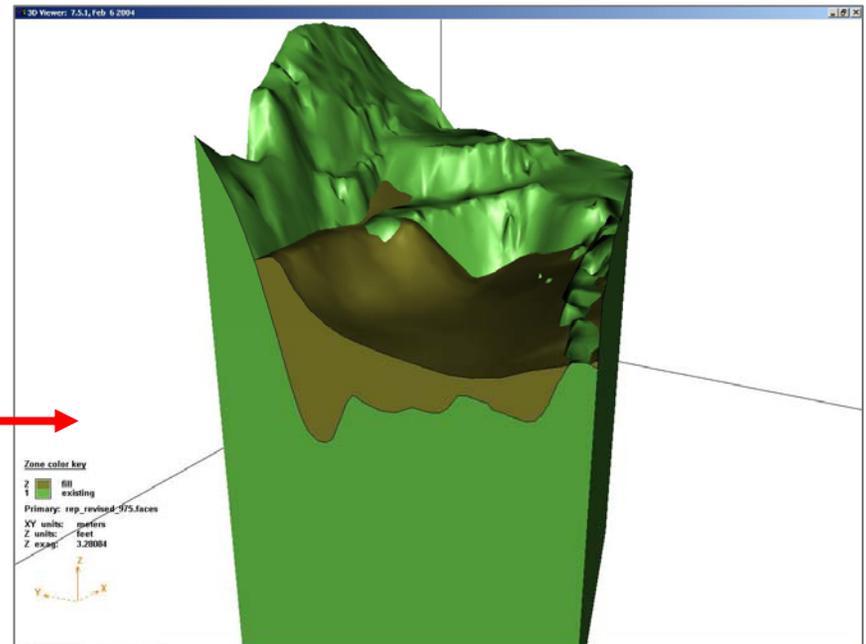
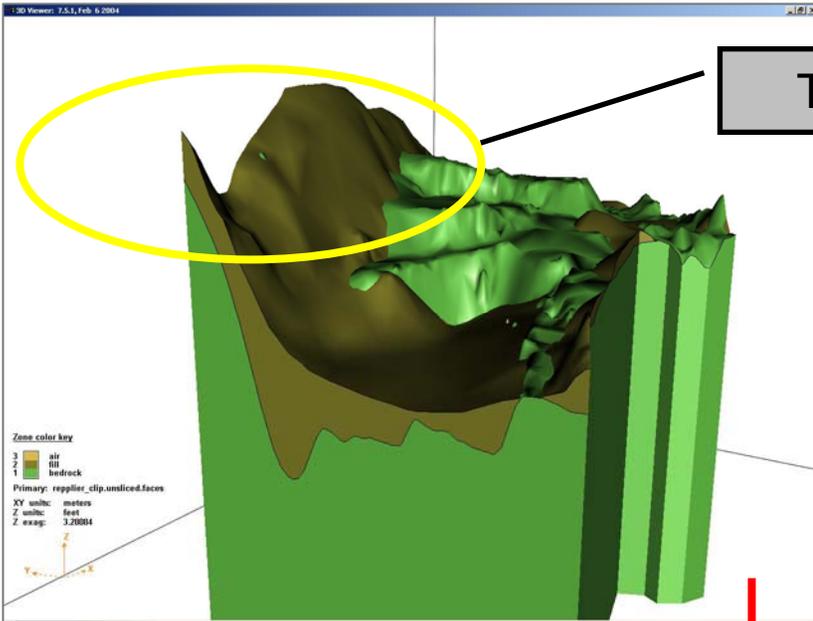
2D grid “final” of reclamation
topography in EarthVision



Layer Volumetric

- Defined two 2D grids: “existing” and “final”
- Closely define the volume area with a polygon
- Simulate the “final” grid as a depositional environment
- View model to find problems areas

Editing the Model



Volume Report

975_lid_revised.2vrpt - WordPad

File Edit View Insert Format Help

2-D Volumetrics Report

VOLUMETRICS REPORT

Run by: mihill
Version: 6.0.1
Date: Tue May 07, 2002
Report file: 975_lid_revised.2vrpt

Polygon file: repplier pitPolygon2.ply
Zone definition: Operational
Deposition operation: 975_lid_revised.2grd
Deposition operation: repplier\rep_pit_air_elev.2grd
Global yield factor: 1.0
Primary field: Polygon ID
Sorting method: Polygon order
Input units: meters square by feet
Volumetrics conversion factor: .398663348703
Output units: Cubic yards
Global minimum thickness: 0.0

----- Zone name: 975_lid_revised -----

Minimum z: none
Maximum z: none
Minimum thickness: 0.0
Yield factor: 1.0

2-D Volumetrics Report

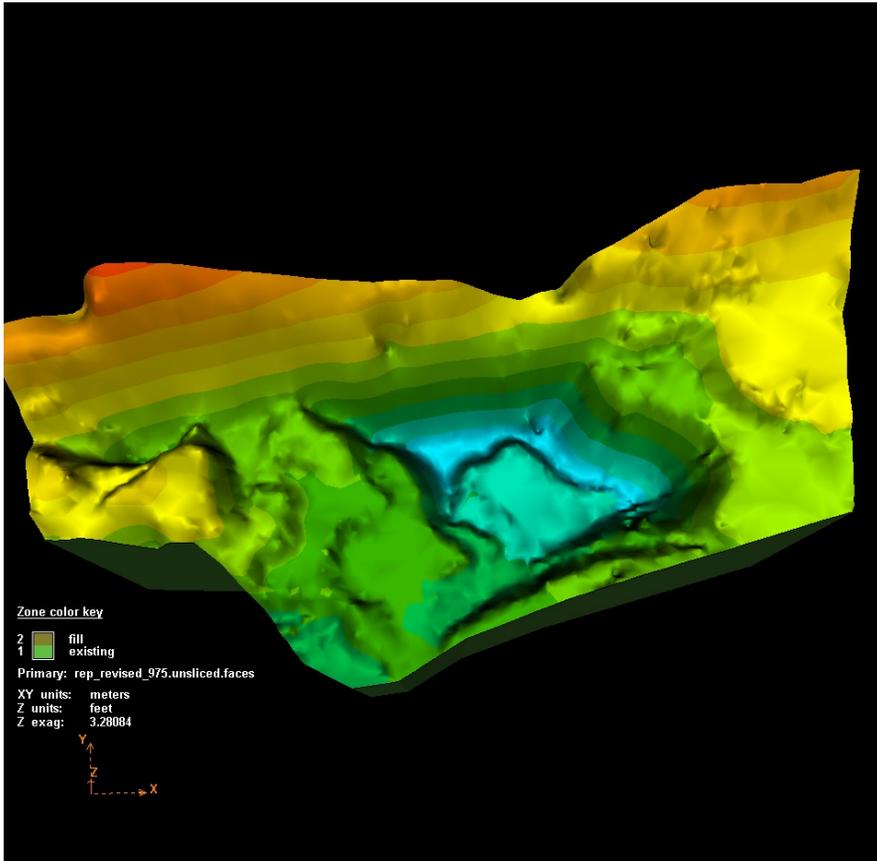
Zone name: 975_lid_revised

Polygon ID	Polygon Class	Area	Volume	Positive Area
		567,834.411379	4,613,092.5216	210,520.581314
Total for 975_lid_revised		567,834.411379	4,613,092.5216	210,520.581314
Total Volume		567,834.411379	4,613,092.5216	210,520.581314

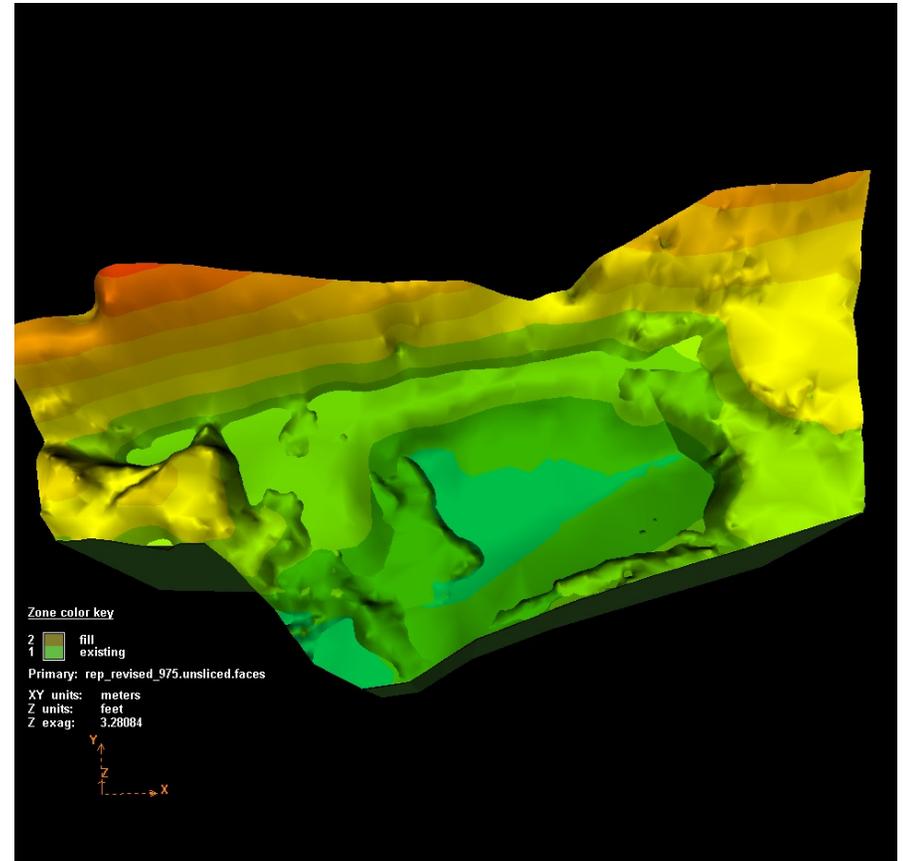
For Help, press F1

NUM

EarthVision 3-D Models



Surface topography of the Replier Pit



Reclaimed topography of the Replier Pit

Conclusion

- Replier Pit
 - Calculated volume was more than 3 times operator's estimate
 - 3-D model was very convincing in negotiating an additional \$2.3 million in bond
- 6 other sites were modeled
 - 3 verified the operator's estimates within 10%
 - Other 3 allowed us to require an addition \$2.7 million in bond

Questions



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