



LiDAR Quality Assessment Report

The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset and the Center for LiDAR Information Coordination and Knowledge. The USGS recognizes the complexity of LiDAR collection and processing performed by the data suppliers and has developed this Quality Assessment (QA) procedure to accommodate USGS collection and processing specifications with flexibility. The goal of this process is to assure LiDAR data are of sufficient quality for database population and scientific analysis. Concerns regarding the assessment of these data should be directed to the Chief, Data Operations Branch, 1400 Independence Road, Rolla, Missouri 65401 or NGTOCoperations@usgs.gov.

Materials Received:

11/9/2011

Project Type: GPSC

Project ID:

OK_GrandLake_Lidar_Products_2_2011

Project Description:

The Grand Lake OK Lidar Products task order consists of processing and creating various derivative products of lidar to V13 lidar specifications from lidar data recently acquired under contract with the Federal Emergency Management Agency (FEMA). The task order applies to a project area of 348 square miles. There is no acquisition associated with this task order.

Project Alias(es):

Grand Lake, OK Lidar Products

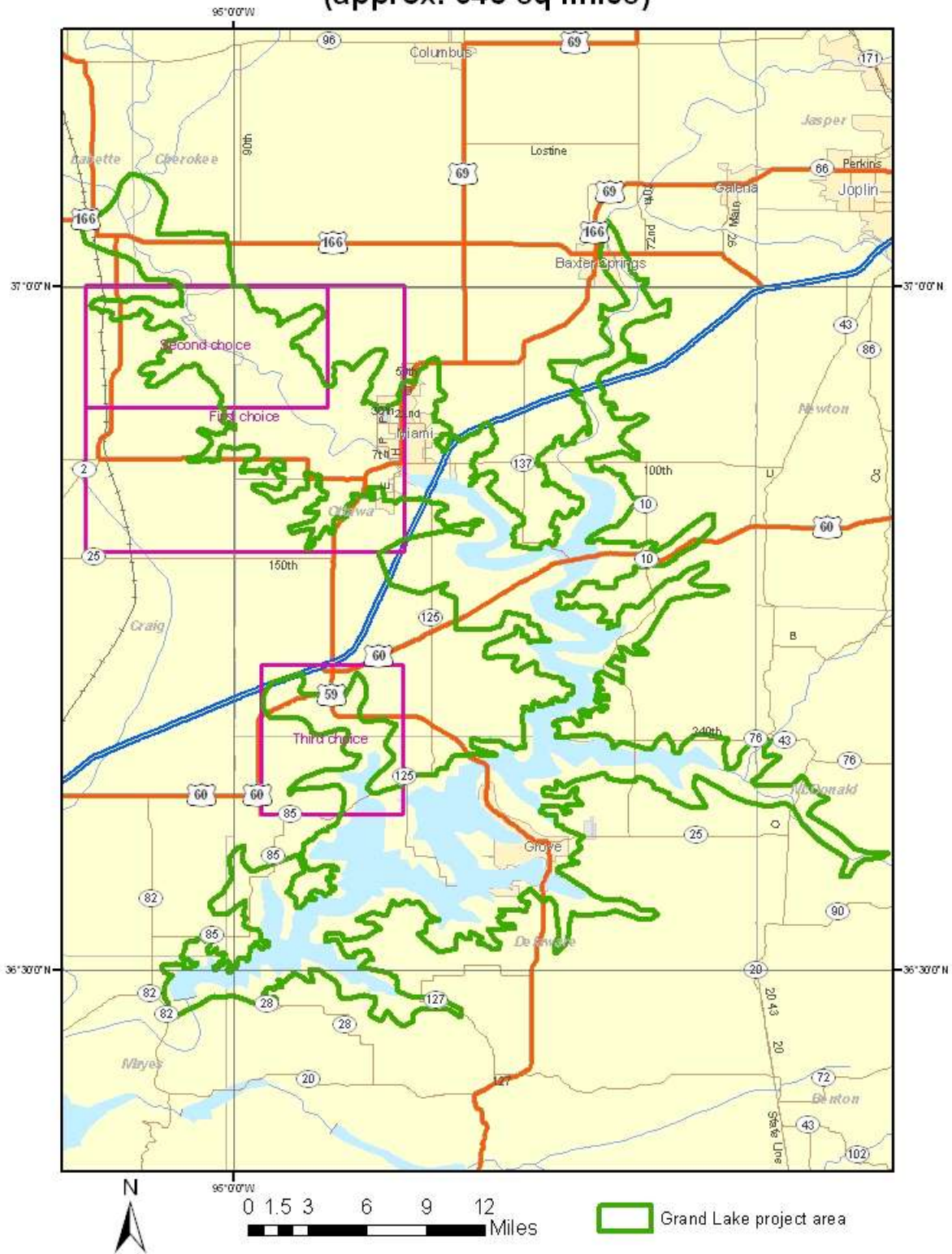
Year of Collection: 2011

Lot 2 of 2 lots.

Project Extent:

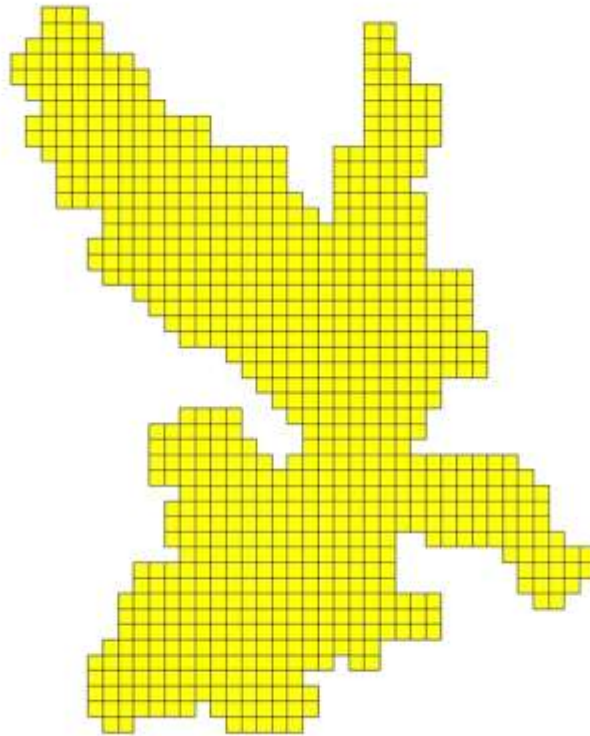
Project Extent image?

Grand Lake OK lidar products (approx. 348 sq miles)



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

Dewberry

Applicable Specification:

V13

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Joe Scott	CPT	573-308-3700	jwscott@USGS.gov

Project Deliverables

All project deliverables must be supplied according to collection and processing specifications. The USGS will postpone the QA process when any of the required deliverables are missing. When deliverables are missing, the Contracting Officer Technical Representative (COTR) will be contacted by the Elevation/Orthoimagery Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

- Collection Report
- Survey Report
- Processing Report
- QA/QC Report
- Control and Calibration Points
- Project Shapefile/Geodatabase
- Control Point Shapefile/Gdb
- Project Tiling Scheme Shapefile/Gdb
- Breakline Shapefile/Gdb
- Project XML Metadata
- Swath LAS XML Metadata
- Classified LAS XML Metadata
- Breakline XML Metadata
- Bare-Earth DEM XML Metadata

Multi-File Deliverables

File Type	Quantity
<input checked="" type="checkbox"/> Swath LAS Files	179
<input checked="" type="checkbox"/> Intensity Image Files	631
<input checked="" type="checkbox"/> Tiled LAS Files	631
<input checked="" type="checkbox"/> Breakline Files	2
<input checked="" type="checkbox"/> Bare-Earth DEM Files	631

Additional Deliverables

	Item
<input checked="" type="checkbox"/>	Contours metadata file in XML format
<input checked="" type="checkbox"/>	1-foot contours shapefile
<input checked="" type="checkbox"/>	shapefile containing points within AOI demonstrating anomalies
<input checked="" type="checkbox"/>	intensity images

Errors, Anomalies, Other Issues to document? Yes No

This task involved reprocessing already acquired lidar data to V13 specifications.

The control used for the acquisition was not required to be submitted but has been requested to accompany the deliverables.

Project Geographic Information

Areal Extent: 348 Sq Mi
Grid Size: 5,000 U.S. Feet
Tile Size: 5,000 U.S. feet
Nominal Pulse Spacing: .7 meters
Vertical Datum: NAVD88 Select...
Horizontal Datum: NAD83_HARN Select...

Project Projection/Coordinate Reference System:
State Plane Oklahoma North Lambert Conformal U.S. feet.

This Projection Coordinate Reference System is consistent across the following deliverables:

- | | |
|---|--|
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase | <input checked="" type="checkbox"/> Breaklines XML Metadata File |
| <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata File |
| <input type="checkbox"/> Checkpoints Shapefile/Geodatabase | <input checked="" type="checkbox"/> Swath LAS Files |
| <input type="checkbox"/> Project XML Metadata File | <input checked="" type="checkbox"/> Classified LAS Files |
| <input checked="" type="checkbox"/> Swath LAS XML Metadata File | <input checked="" type="checkbox"/> Breaklines Files |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File | <input checked="" type="checkbox"/> Bare-Earth DEM Files |

Check Point Shapefile/Geodatabase CRS

Project XML Metadata CRS

Review Cycle

This section documents who performed the QA Review on a project as well as when QA reviews were started, actions passed, received, and completed.

Reviewer:

T. Jerris

Review Start Date:

11/14/2011

Action to Contractor Date	Issue Description	Return Date
11/17/2011	Floating (high) water and bridge errors	

Review Complete: 12/8/2011

Metadata Review

Provided metadata files have been parsed using 'mp' metadata parser. Any errors generated by the parser are documented below for reference and/or corrective action.

The Project XML Metadata file parsed without errors.

The Swath LAS XML Metadata file parsed without errors.

The Classified LAS XML Metadata file parsed without errors.

The Breakline XML Metadata file parsed without errors.

The Bare-Earth DEM XML Metadata file parsed without errors.

Project QA/QC Report Review

ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the dataset. National Standards for Spatial Data Accuracy (NSSDA) guidance states that checkpoints may be distributed more densely in the vicinity of important features and more sparsely in areas that are of little or no interest. Checkpoints should be distributed so that points are spaced at intervals of at least ten percent of the diagonal distance across the dataset and at least twenty percent of the points are located in each quadrant of the dataset.

NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be selected near severe breaks in slope, such as bridge abutments, edges of roads, or near river bluffs. Checkpoints are an important component of the USGS QA process. There is the presumption that the checkpoint surveys are error free and the discrepancies are attributable to the LiDAR dataset supplied.

For this dataset, USGS checked the spatial distribution of checkpoints with an emphasis on the bare-earth (open terrain) points; the number of points per class; the methodology used to collect these points; and the relationship between the data supplier and checkpoint collector. When independent control data are available, USGS has incorporated this into the analysis.

Checkpoint Shapefile or Geodatabase:

Checkpoint Distribution Image?

The following land cover classes are represented in this dataset (uncheck any that do not apply):

- Bare Earth
- Tall Weeds and Crops
- Brush Lands and Low Trees
- Forested Areas Fully Covered by Trees
- Urban Areas with Dense Man-Made Structures

There are a minimum of 20 checkpoints for each land cover class represented. Points within each class are uniformly distributed throughout the dataset. USGS Select... able to locate independent checkpoints for this analysis. USGS accepts the quality of the

checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document? Yes No

Image?

The submission of control points was not required. However, this information is being requested to accompany the deliverables.

Image?

Classification codes 1, 2, 7, 9, & 10 are present

Image?

The reviewer should make contact with the contracting POC for this task prior to reviewing the data to note special conditions.

Image?

Per the project report, the following statements regarding absolute accuracy were made by the contractor:

"Prior to delivery the elevation data was verified internally to ensure it met fundamental accuracy requirements of 18.5cm vertical accuracy at the 95% confidence level ($2 \text{ sigma} = \text{RMSE} * 1.96$) in when compared to LMSI (the acquisition contractor) kinematic and static GPS checkpoints. Data is compiled to meet 1m horizontal accuracy at the 95% confidence level ($2 \text{ sigma} = \text{RMSE} * 1.96$):

(1) The Lidar dataset was tested to 0.043m vertical accuracy at 95% confidence level based on consolidated RMSEz ($0.022\text{m} \times 1.960$) when compared to 10 GPS static check points.

(2) The Lidar dataset was tested to 0.16m vertical accuracy at 95% confidence level based on consolidated RMSEz ($0.083\text{m} \times 1.960$) when compared to 6 GPS kinematic cross sections.

Image?

Control points were not collected by Dewberry. Vertical accuracy test was not required by the NGTOC per Joe Scott.

Accuracy values are reported in terms of Fundamental Vertical Accuracy (FVA), Supplemental Vertical Accuracy(s) (SVA), and Consolidated Vertical Accuracy (CVA).

Accuracy values are reported in:

Required FVA Value is U.S. feet or less.

Target SVA Value is U.S. feet or less.

Required CVA Value is U.S. feet or less.

The reported FVA of the LAS Swath data is .

The reported FVA of the Bare-Earth DEM data is .

SVA are required for each land cover type present in the data set with the exception of bare-earth. SVA is calculated and reported as a 95th Percentile Error.

Land Cover Type	SVA Value	Units
Tall Weeds and Crops	<input type="text" value="0.13"/>	<input type="text" value="U.S. feet"/>
<i>Brush Lands and Low Trees</i>	<input type="text" value=""/>	<input type="text" value="U.S. feet"/>
Forested Areas Fully Covered by Trees	<input type="text" value="0.13"/>	<input type="text" value="U.S. feet"/>
Urban Areas with Dense Man-Made Structur...	<input type="text" value="0.15"/>	<input type="text" value="U.S. feet"/>

The reported CVA of this data set is: .

LAS Swath File Review

LAS swath files or raw unclassified LiDAR data are reviewed to assess the quality control used by the data supplier during collection. Furthermore, LAS swath data are checked for positional accuracy. The data supplier should have calculated the Fundamental Vertical Accuracy using ground control checkpoints measured in clear open terrain. The following was determined for LAS swath data for this project:

LAS Version

- LAS 1.2 LAS1.3 LAS 1.4

Swath File Characteristics

- Separate folder for LAS swath files
 Each swath files <= 2GB
 *If specified, *.wdp files for full waveform have been provided

The reported FVA of the LAS swath data is .

Based on this review, the USGS accepts the LAS swath file data.

Yes No

Image?

LAS Tile File Review

Classified LAS tile files are used to build digital terrain models using the points classified as ground. Therefore, it is important that the classified LAS are of sufficient quality to ensure that the derivative product accurately represents the landscape that was measured. The following was determined for classified LAS files for this project:

Classified LAS Tile File Characteristics

- Separate folder for Classified LAS tile files
- Classified LAS tile files conform to Project Tiling Scheme
- Quantity of Classified LAS tile files conforms to Project Tiling Scheme
- Classified LAS tile files do not overlap
- Classified LAS tile files are uniform in size
- Classified LAS tile files have no points classified as '12'

- Point classifications are limited to the standard values listed below:

Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored ground (breakline proximity)
11	Withheld (if the "Withheld" bit is not implemented in processing software)

Buy up?

Based on this review, the USGS accepts the classified LAS tile file data.

Errors, Anomalies, Other Issues to document? Yes No

None.

Breakline File Review

Breaklines are vector feature classes that are used to hydro-flatten the bare earth Digital Elevation Models.

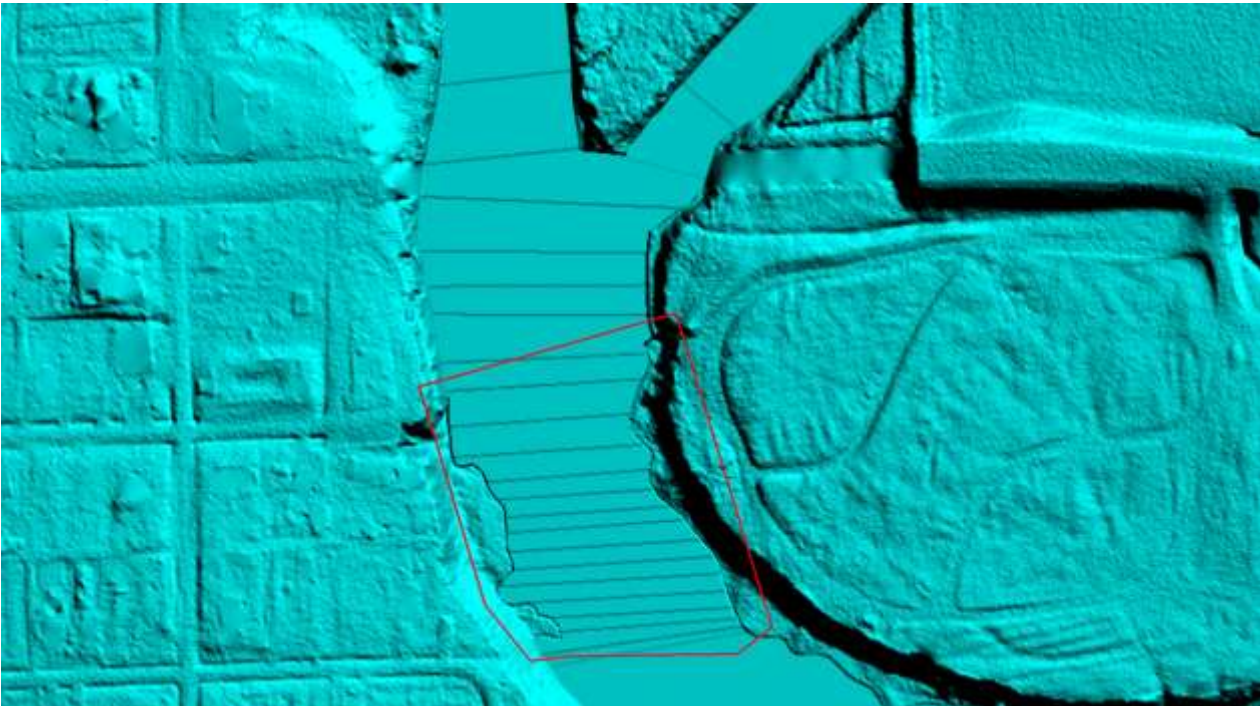
Breakline File Characteristics

- Separate folder for breakline files
- All breaklines captured as PolylineZ or PolygonZ features
- No missing or misplaced breaklines

Based on this review, the USGS accepts the breakline files.

Errors, Anomalies, Other Issues to document? Yes No

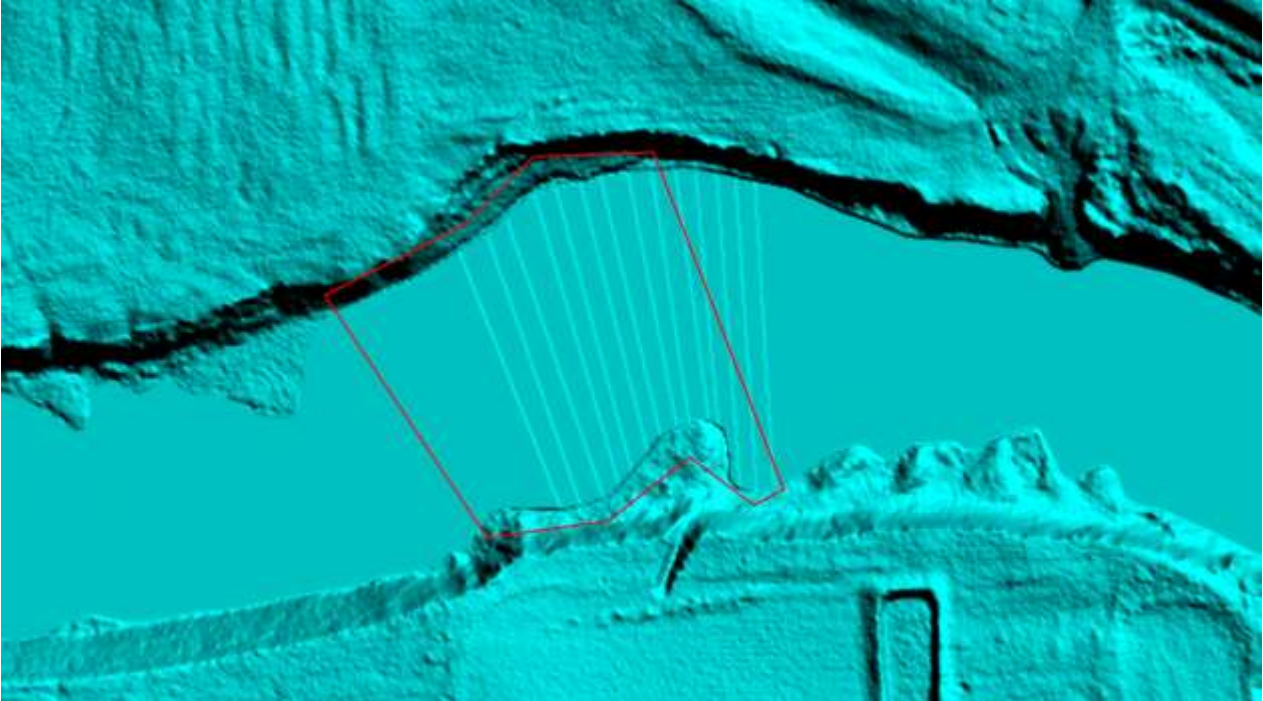
Image for error?



high_water_1: 37° 02' 7.9" N, 95° 04' 50" W

This error fixed (12/1/2011).

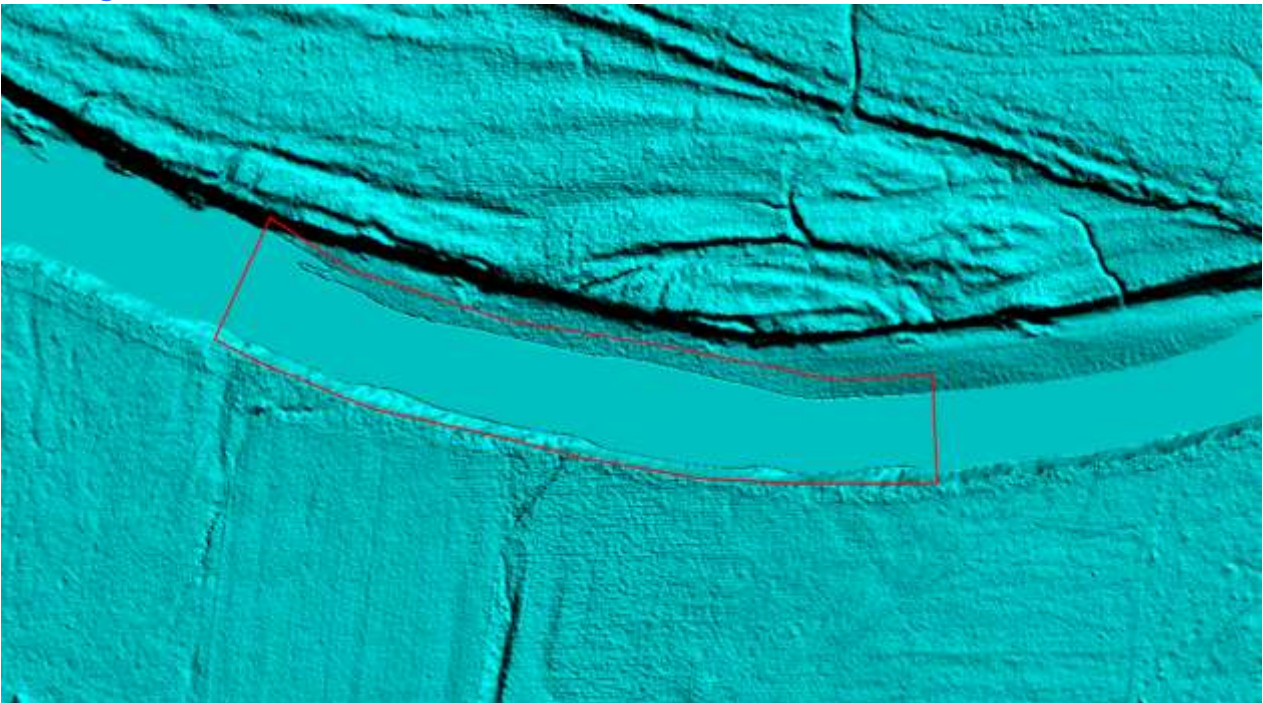
Image for error?



high_water_2: 37° 02' 4.3" N, 95° 04' 31.7" W

This error fixed (12/1/2011).

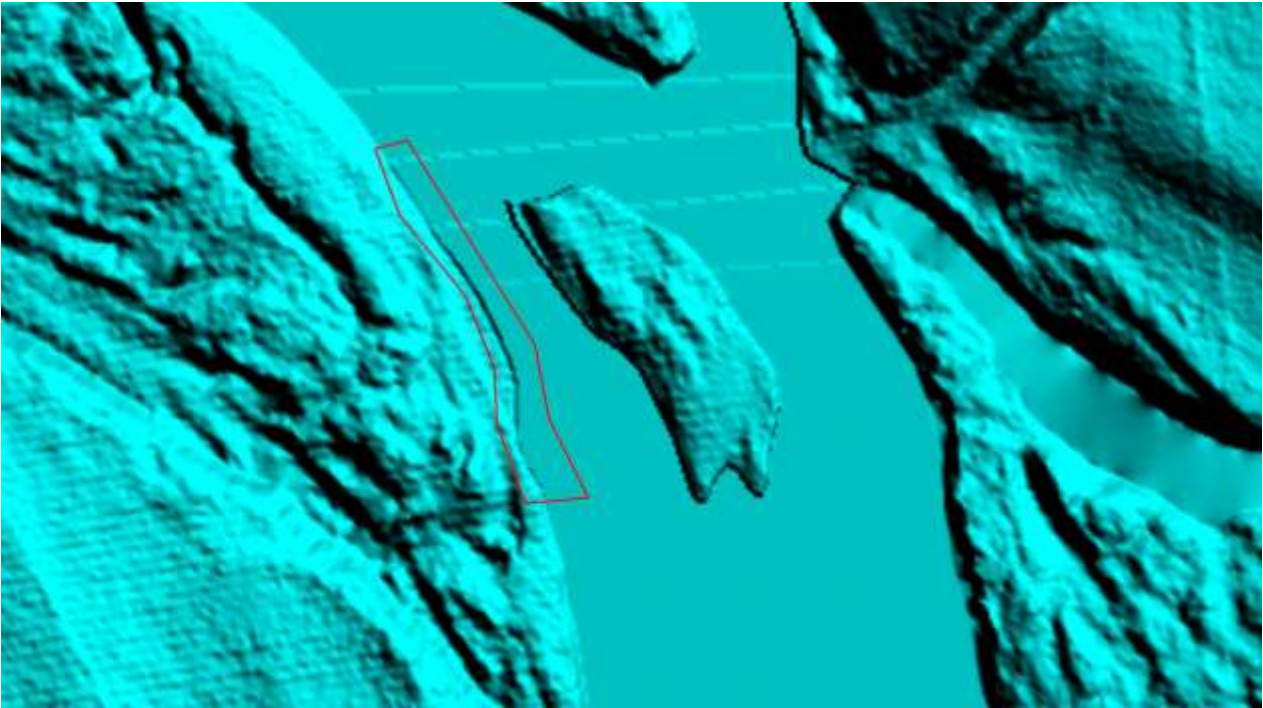
Image for error?



high_water_3: 36° 53' 29.1" N, 94° 56' 27.0" W

This error NOT fixed due to "monotonicity and connectivity" per Dewberry

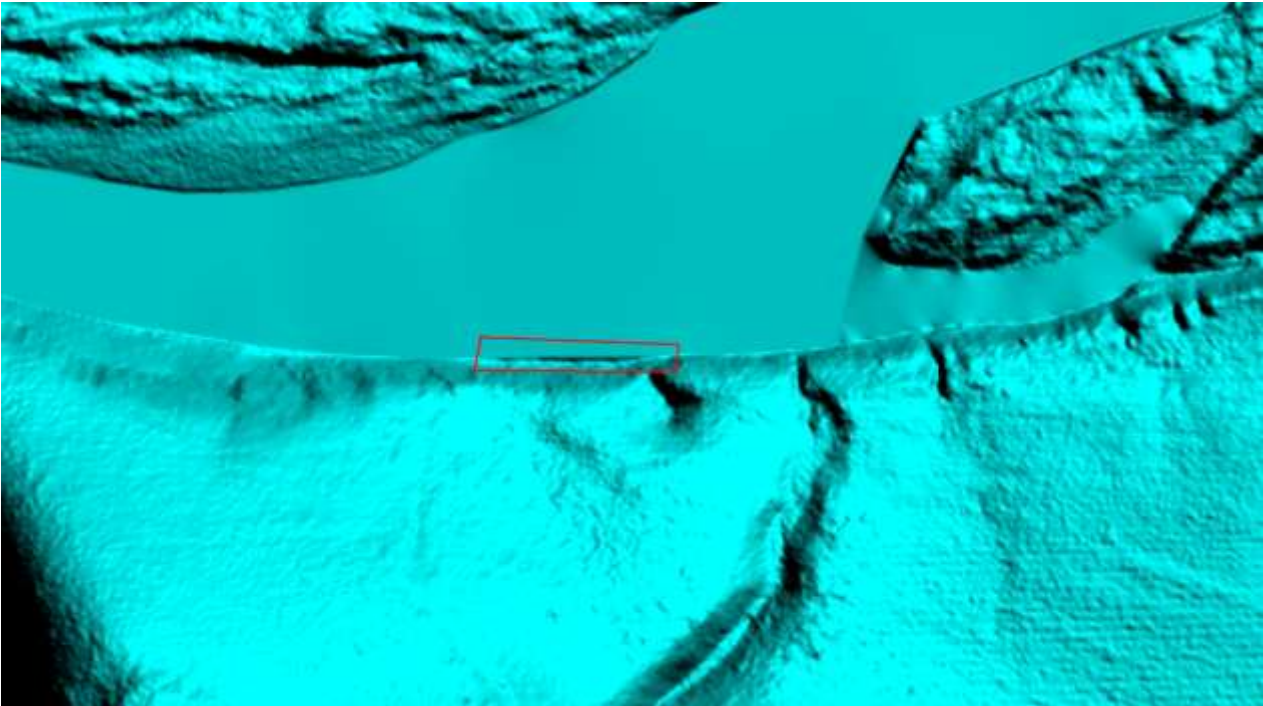
Image for error?



high_water_4: 36° 36' 10.6" N, 94° 34' 22.5" W

This error fixed (12/1/2011).

Image for error?



high_water_5: 36° 34' 52.4", 94° 32' 39.0" W

This error not fixed; original better than fix (replacement).

Bare-Earth DEM Tile File Review

The derived bare-earth DEM file receives a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by USGS using supplied and independent checkpoints, and a manual check of the appearance of the DEM layer.

Bare-Earth DEM files provided in the following format:

Bare-Earth DEM Tile File Characteristics

- Separate folder for bare-earth DEM files
- DEM files conform to Project Tiling Scheme
- Quantity of DEM files conforms to Project Tiling Scheme
- DEM files do not overlap
- DEM files are uniform in size
- DEM files properly edge match
- Independent check points are well distributed

All accuracy values reported in .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy _z) Required FVA = 0.804 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 1.19 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 1.19 or less.
Open Terrain	6	0.5		
Tall Weeds and Crops	5		0.13	
<i>Brush Lands and Low Trees</i>	1		1	
Forested Areas Fully Covered by Trees	8		0.13	
Urban Areas with Dense Man-Made Structures	8		0.15	
Consolidated	27			0.14

QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy _z) Required FVA = 0.804 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 1.19 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 1.19 or less.
Open Terrain	6	0.402		
Tall Weeds and Crops	5		0.324	
<i>Brush Lands and Low Trees</i>	1		1	
Forested Areas Fully Covered by Trees	8		0.491	
Urban Areas with Dense Man-Made Structures	8		0.602	
Consolidated	27			0.528

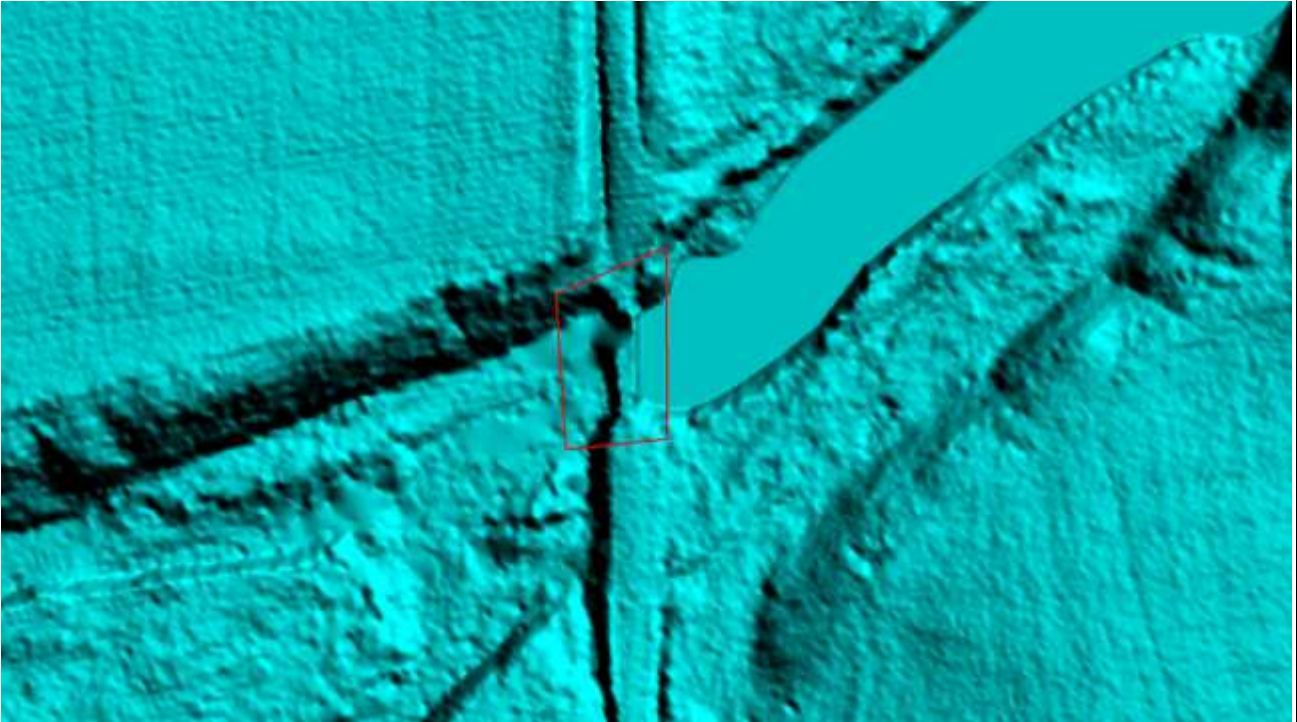
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

Based on this review, the USGS accepts the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? Yes No

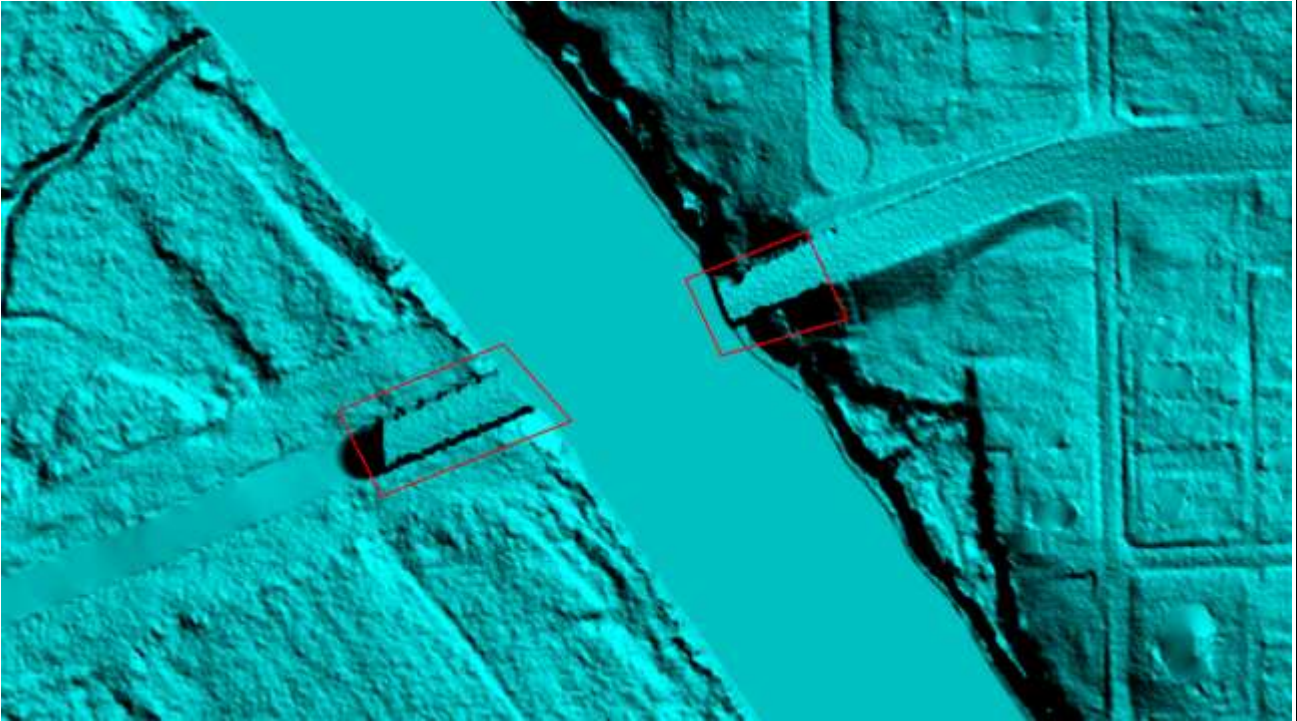
Image?



bridge_1: 36° 48' 48.1" N, 94° 50' 14.0" W

This error fixed (12/1/2011).

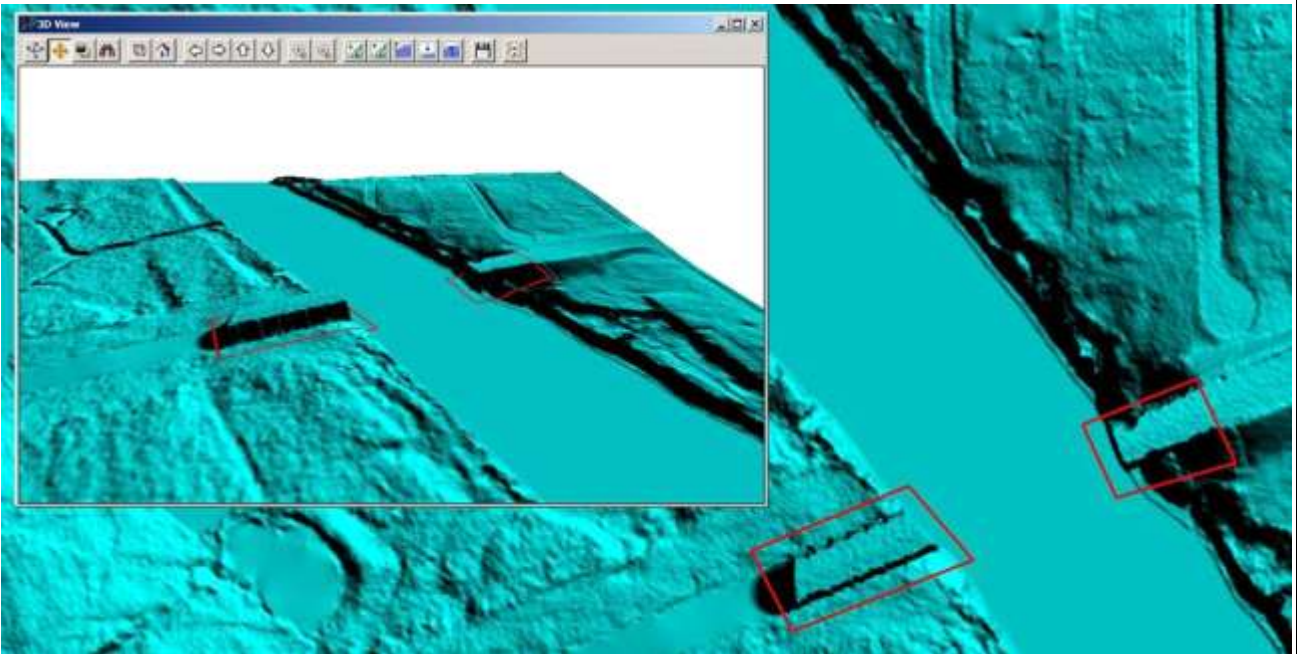
Image?



bridge_remnants: 36 ° 52' 13" N, 94° 53' 2.1" W

This error fixed (12/1/2011).

Image?



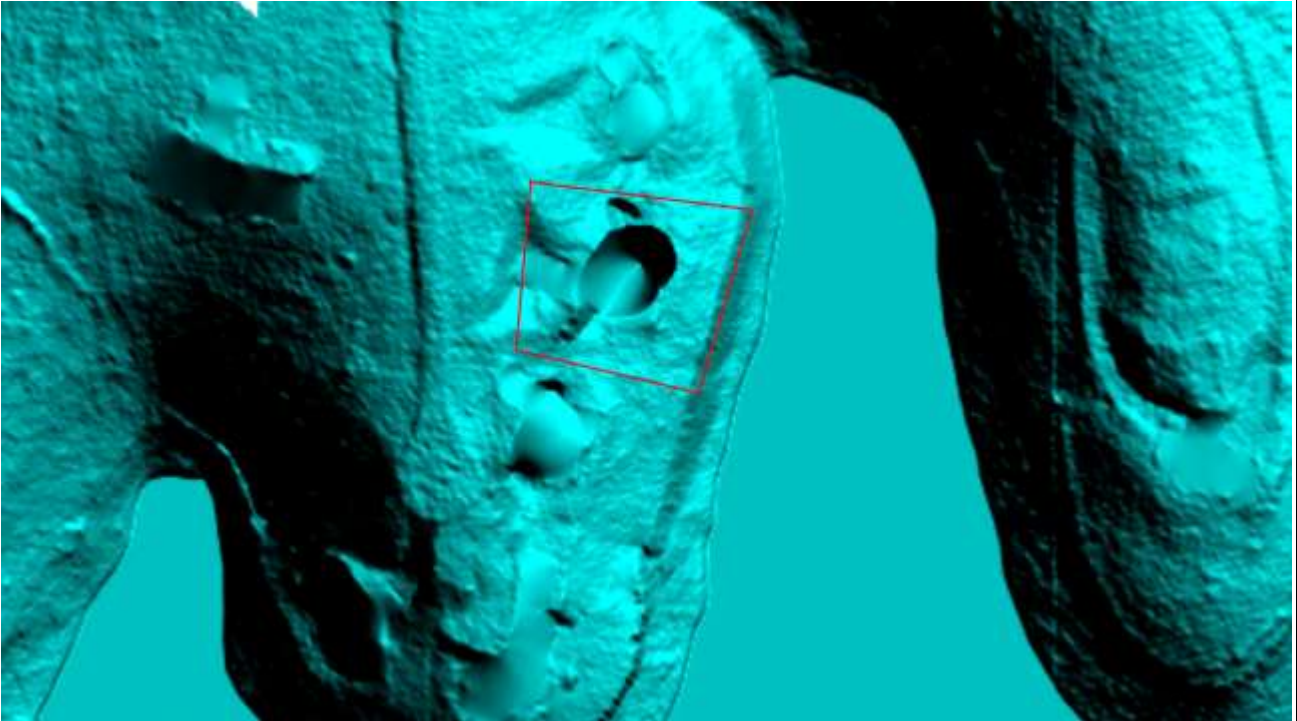
bridge_remnants_3D

Image?



bridge_remnants_StreetView: Google Earth Street View looking southwest

Image?

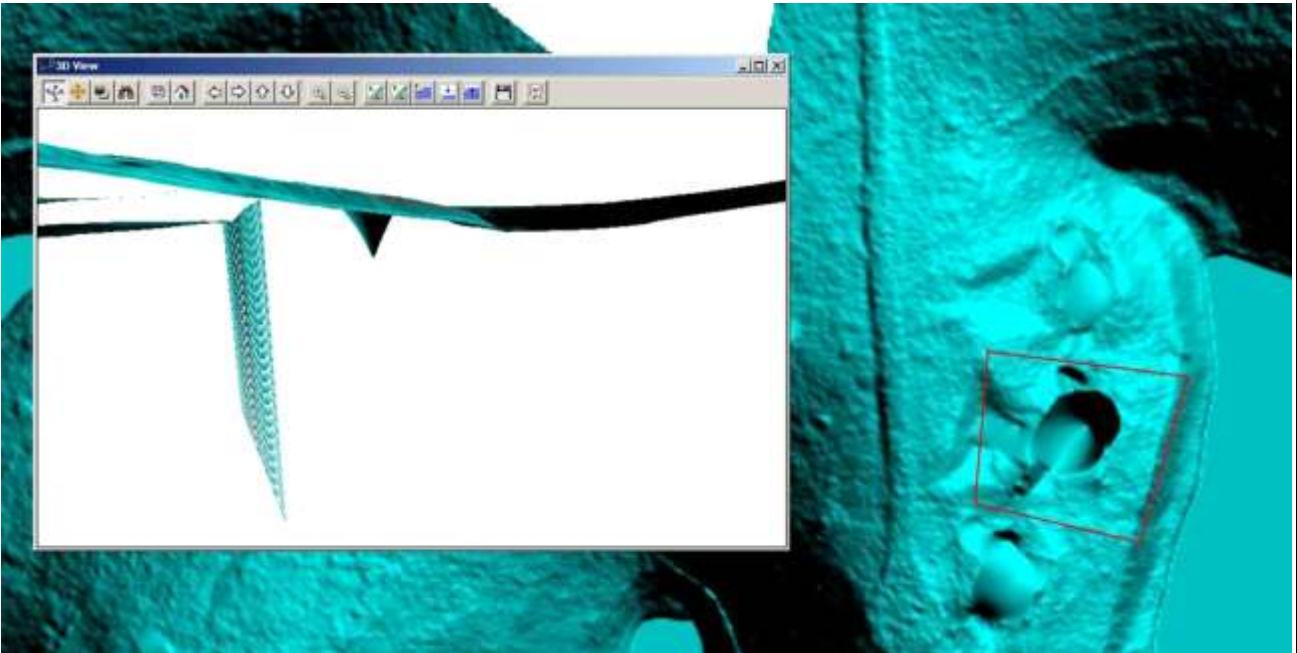


pit_1: 36° 29' 50.9" N, 95° 00' 06" W; ~ 53 ft deep.

This error will "fixed" by NGTOC personnel so as to be acceptable for the NED.

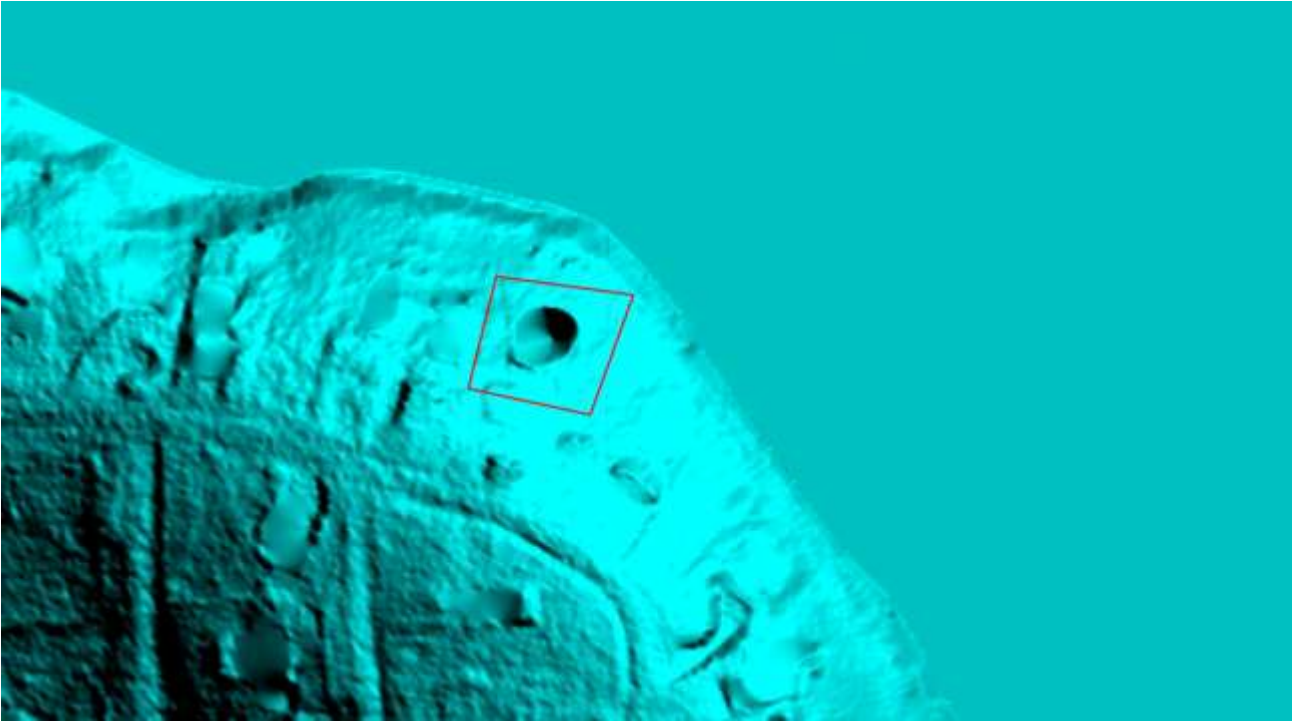
This error fixed (12/1/2011).

Image?



pit_1_3D

Image?

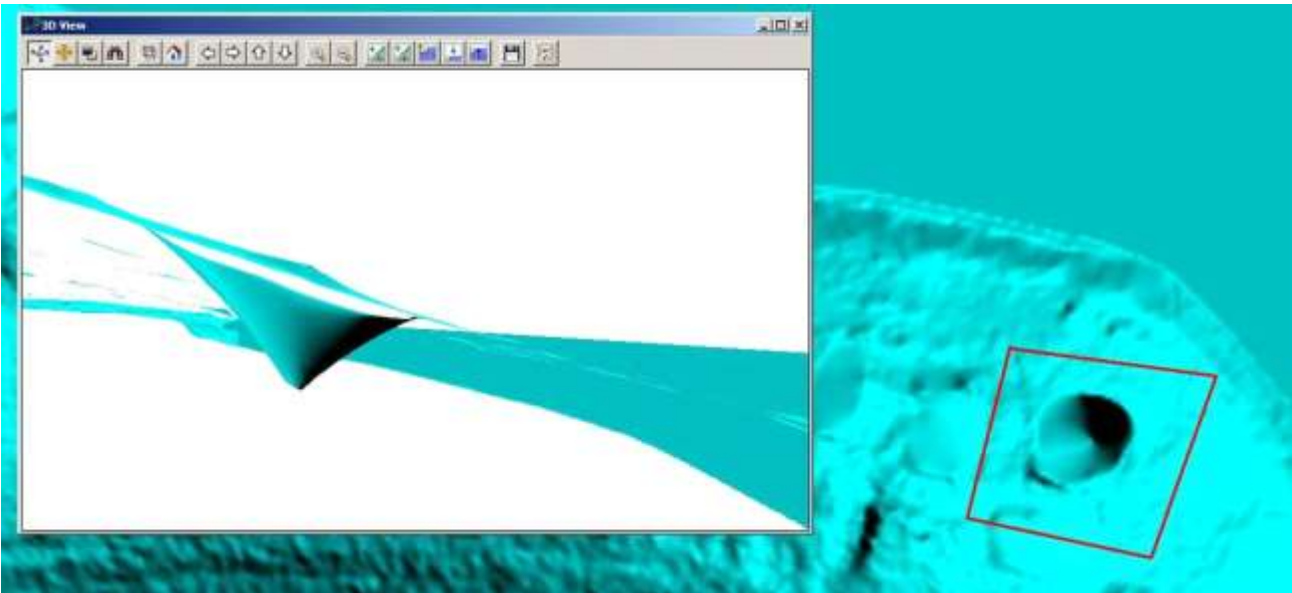


pit_2: 30° 34' 17.8" N, 94° 54' 45.6" W; ~ 26 ft deep.

This error will "fixed" by NGTOC personnel so as to be acceptable for the NED.

This error fixed (12/1/2011).

Image?



pit_2_3D

Based on this review, the deliverables provided meet the Task Order requirements.

Internal Note:

This is the end of the report.

QA Form V1.4 12OCT11.xsn