

New York State Department of Environmental Conservation

Division of Water

Bureau of Flood Protection & Dam Safety, 4th Floor

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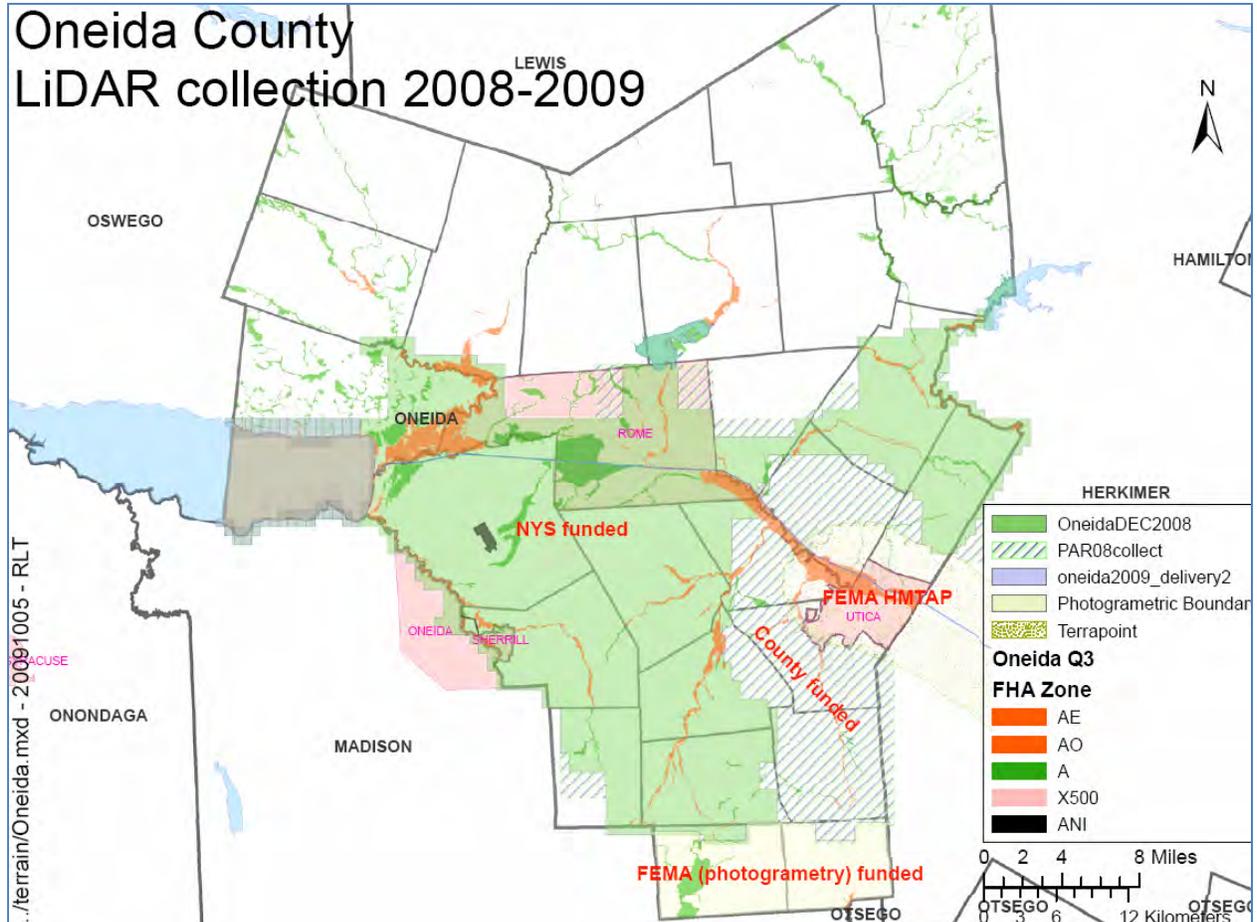


Alexander B. Grannis
Commissioner

2008 LiDAR Elevation Data Collection
Accuracy Assessment and Quality Control Report
Oneida County, NY

Summary

LiDAR for Oneida County, New York was acquired in April/May of 2008 by New York State and Oneida County. The collection includes approximately 550 square miles of southern Oneida County. An additional approximately 20 square miles was acquired in May of 2009 to include the shore areas around Oneida Lake. Part of the area of interest was already covered by an existing LiDAR collection, acquired by FEMA in May 2007. The portion of this collection in Oneida County was also evaluated for accuracy.



Accuracy Assessment

Accuracy assessment was performed by the New York State Department of Transportation on all collections. Points consisted mainly of targeted photo control points used in Aerotriangulation to support Design Scale (1:250 and 1:500 large scale) mapping (see Appendix A for details).

An approximately 0.6 meter vertical shift was noted along an approximately north-south line in the 2008 collection (see Appendix A for details). The LiDAR vendor reprocessed

the data to the east of the shift to correct this error, and redelivered the affected portion of the data. The 2009 collection was found to be consistently higher than the 2008 collection by approximately 10 cm, and not consistent between the portions of the data north and south of Oneida Lake (see Appendix B for details). The LiDAR vendor reprocessed the entire 2009 collection to correct these issues and redelivered the data.

All final delivered data was found to be in compliance with the FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, with an RMSEz of 0.185 meters or less. A summary table is provided below (see Appendices A and B for details).

Collection	NYSDOT RMSEz (meters)
2007 Mohawk (FEMA HMTAP), Oneida County portion	0.094
2008 Oneida (NYS, Oneida County)	0.110
2009 Oneida (NYS)	0.179

Quality Control

Quality control checks on the 2008 collection were done by PAR Government Systems Corporation, including visual review of all delivered tiles for point classification errors (artifacts) and void areas (see Appendix C for details). Problems with point classification were noted on a number of tiles and these tiles were reprocessed by the vendor to correct them. Final delivered data was found to be in compliance with the FEMA Guidelines and Specifications for Flood Hazard Mapping Partners.

The 2007 Mohawk collection was checked for quality as part of the original, larger collection (Dewberry, 2007). No additional checks were performed. The 2009 collection, which is small in extent, was checked for quality in conjunction with the accuracy assessment process and no issues were found.

References

Map Modernization Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying, Federal Emergency Management Agency (FEMA), April 2003.

LiDAR QA/QC - Quantitative and Qualitative Assessment Report - NY FEMA Flood Mitigation, LiDAR. Dewberry, Fairfax, VA, September 14, 2007.

Appendix A – 2008 Accuracy Assessment

**Oneida County
Aerial Lidar by Sanborn
Flown in the Spring of 2008**

**Collaborative Quality Assurance Evaluation by the
Department of Environmental Conservation and
New York State Department of Transportation**

Quality Assurance (QA) Point Data

NYSDOT QA points consist mainly of targeted photo control points used in Aerotriangulation to support Design Scale (1:250 and 1:500 large scale) mapping. The Aerotriangulation process here is used as a QA step for the survey control. The control points are typically located on road surfaces.

Photo Control Points are surveyed to C2-II order (1:20,000) horizontally and Third Order (maximum misclosure error = 8 mm times the Square Root of Distance in km).

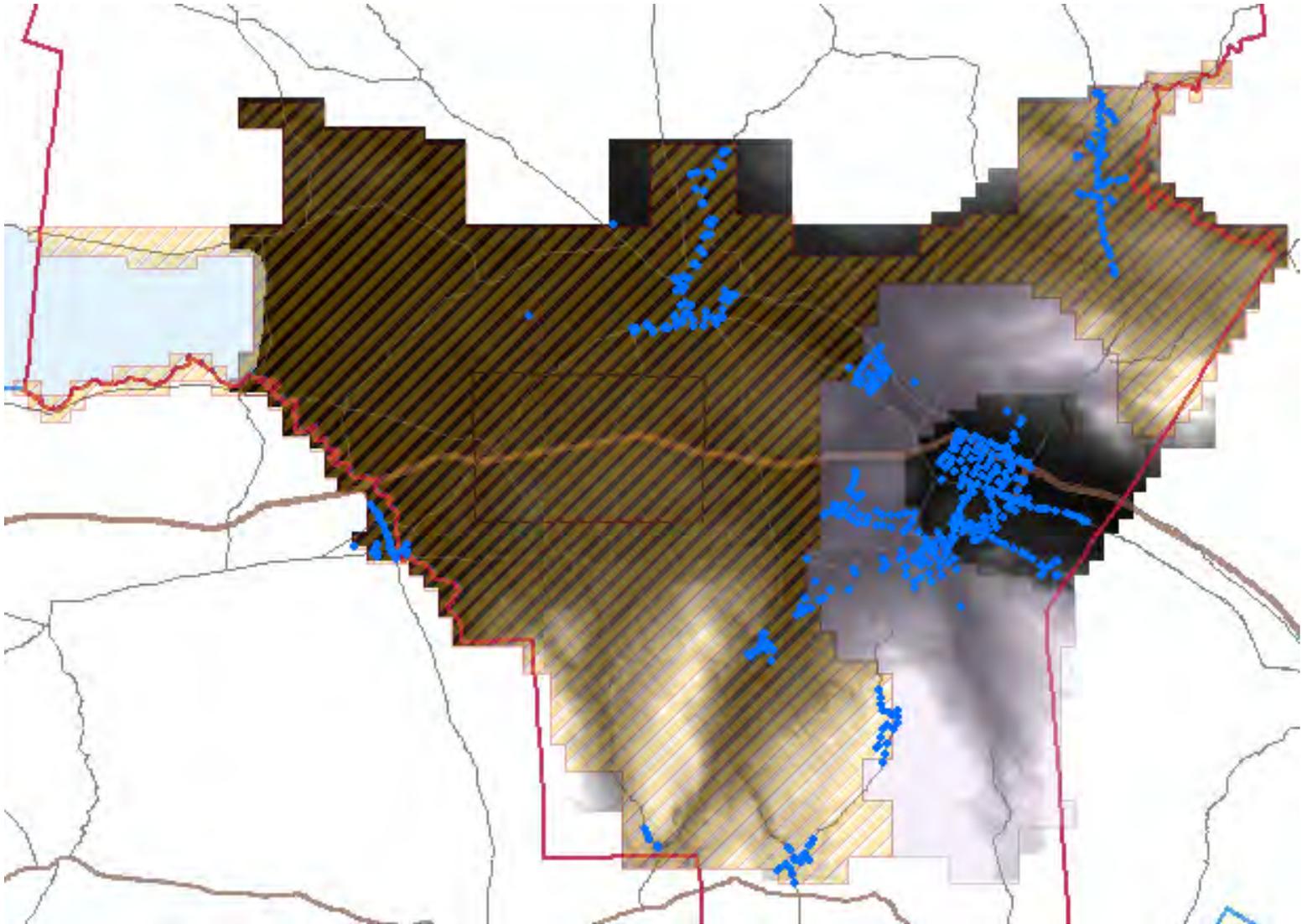
Using the National Standard for Spatial Data Accuracy (NSSDA) methodology the Lidar was tested to have the following accuracy for all QA Points

Combined :

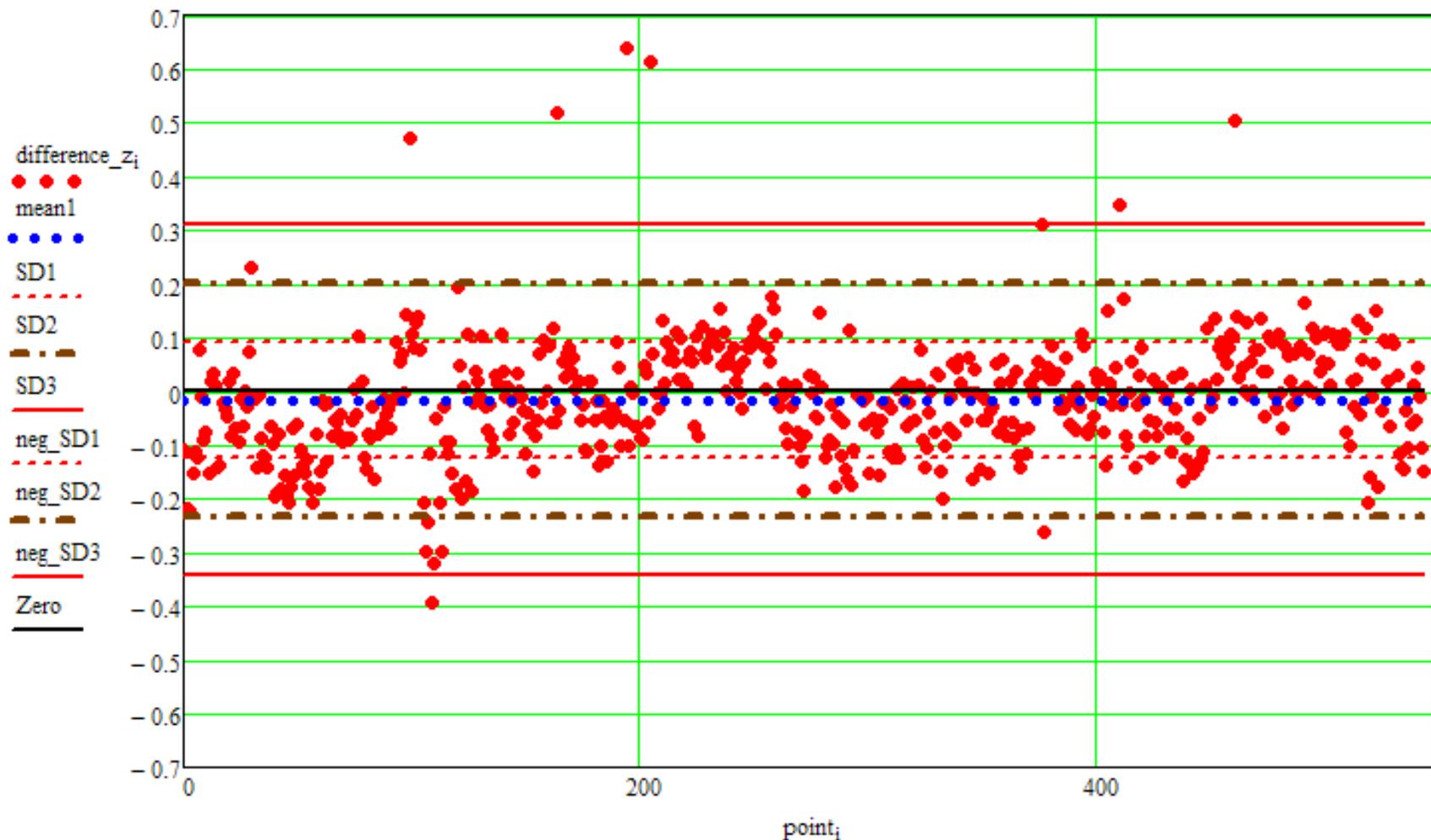
- Tested at **0.22 m** vertical accuracy at 95% confidence level
- RMSE = 0.110 m
- Mean = -0.017 m
- **545** check points

Tested accuracy meets the vertical specification of <0.185 m RMSE

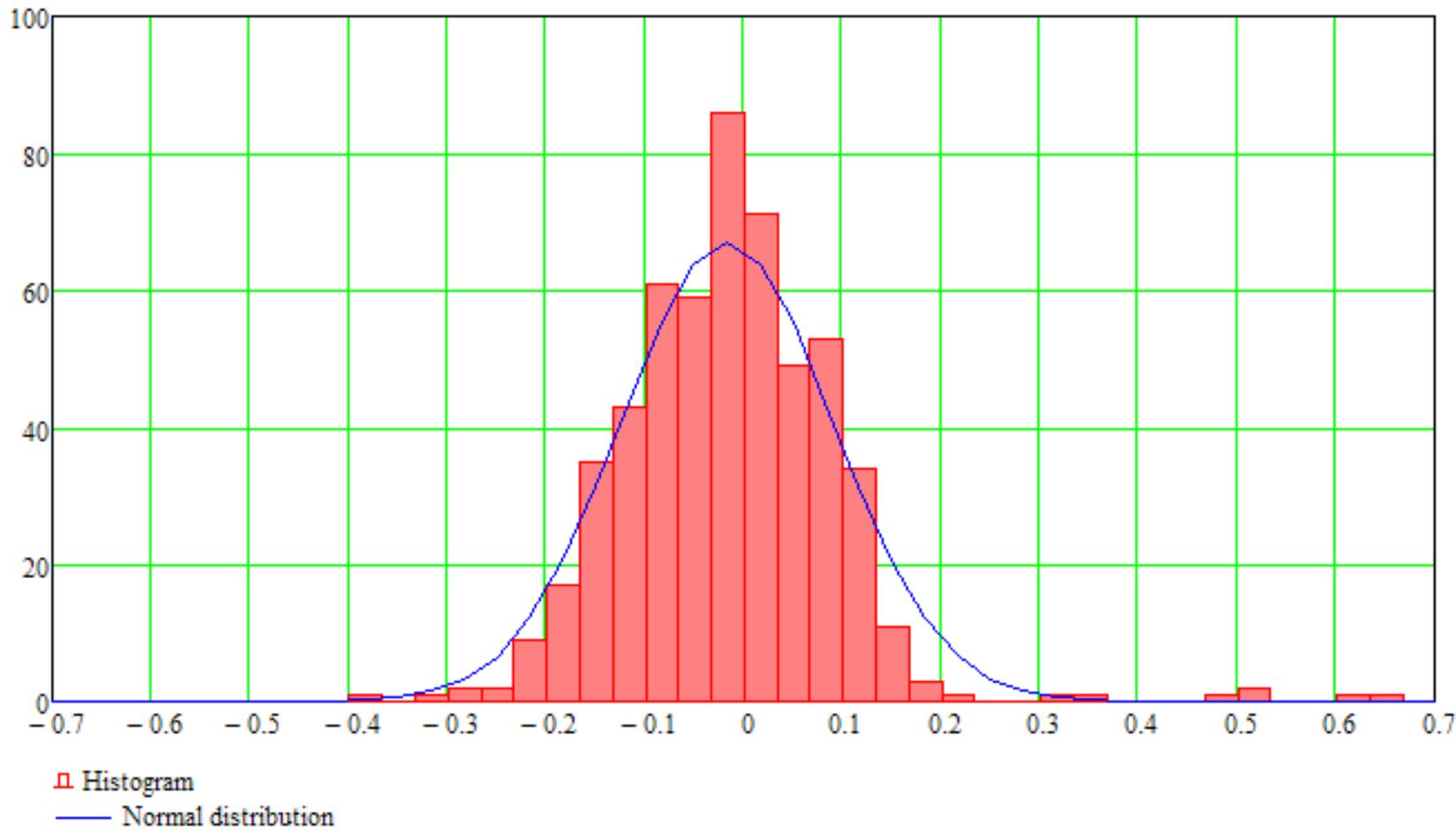
All 545 QA points combined



Oneida County check point analysis where the lidar measurement elevations is subtracted from survey point elevations. Individual differences are shown (red dots) with an overlay of the 1,2 and 3 standard deviation lines. Points outside of the red lines are deemed to be in error if the data only has random errors remaining and is normally distributed.



Oneida County histogram comparison showing elevation differences (the lidar grid elevations subtracted from the survey point elevations) with the normal distribution overlay (blue line). Data is close to normal distribution. The 545 points collected are an excellent sample size. The mean of the data set is **-0.017 m**.



Oneida County Overall statistics of Survey vs Lidar point to point comparison

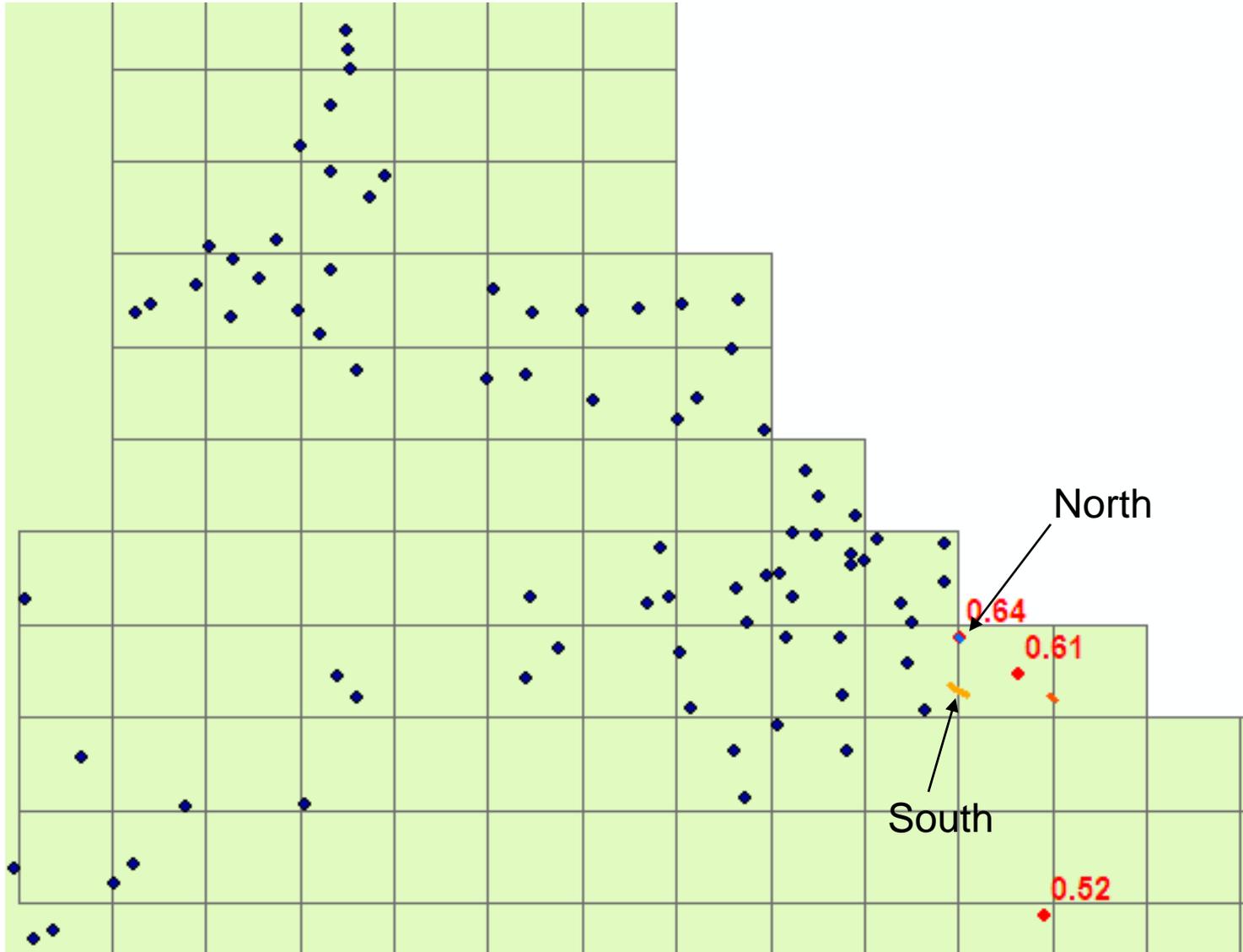
Number of points in the dataset	number_points = 545	* minimum 20 testpoints	
Mean	mean(difference_z) = -0.017 m		Skewness (measure of symmetry)
Median	median(difference_z) = -0.016 m		skew(difference_z) = 1.168 =0 Data Normally Distributed <0 Skew to the left >0 Skew to the right
Mode	the data set is multimodal		
Maximum Difference	max(difference_z) = 0.638 m		
Minimum Difference	min(difference_z) = -0.393 m		Kurtosis (measure of peak)
Standard Deviation	stdev(difference_z) = 0.108 m		kurt(difference_z) = 6.44 =0 Data Normally Distributed >0 Data Peaked <0 Data Flat
Variance	var(difference_z) = 0.012 m		
Square Mean of the Difference	SMD = 0.11 m		
Root Mean Square Error	RMSEz = 0.11 m		* A maximum of 0.185 m is allowable in flat terrain
Vertical Accuracy at 95% confidence	Vertical_Accuracy = 0.215 m		

Seven points (1.2% dataset) fall outside of the 3 standard deviations.

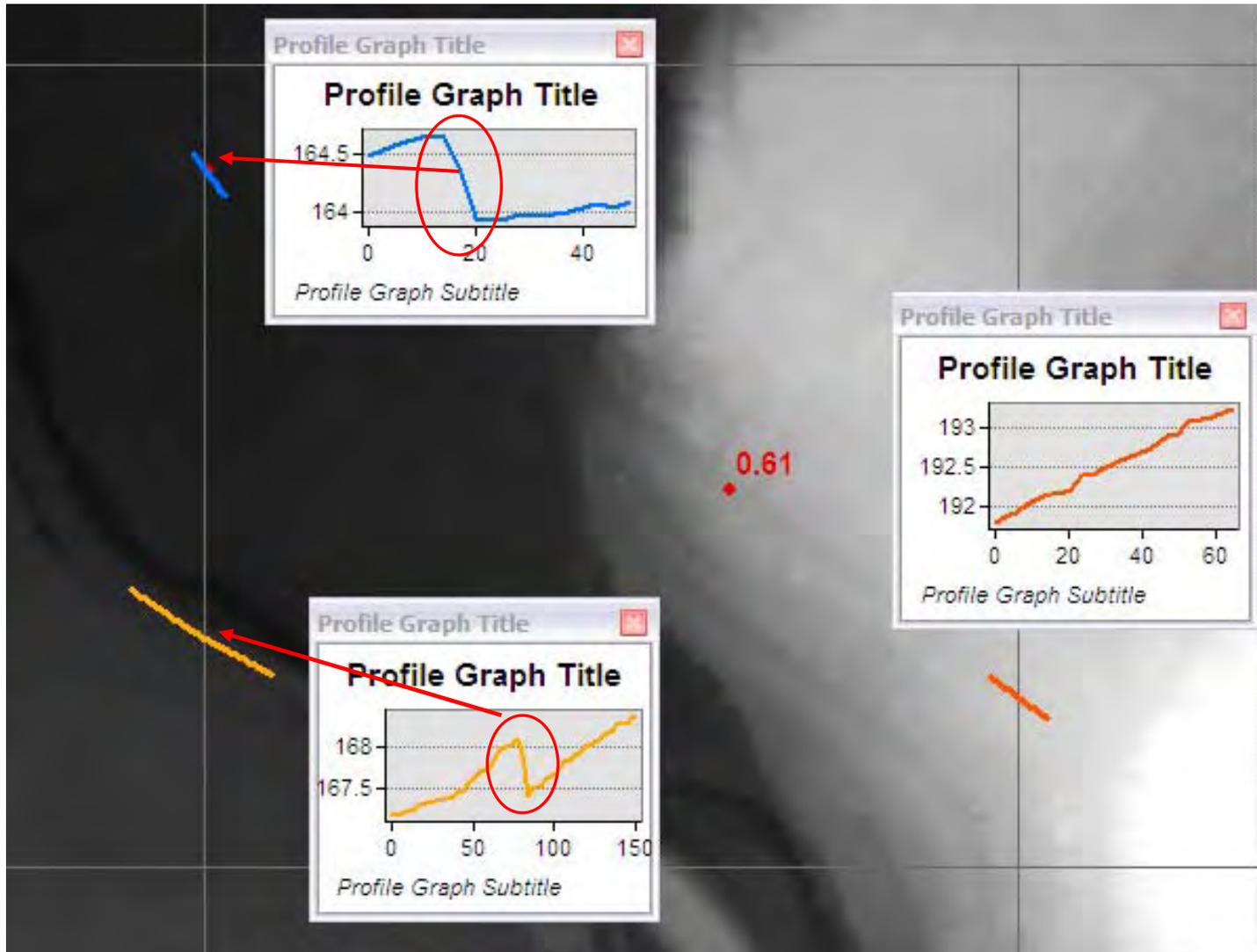
* minimum specification requirements according to Guidelines and Specifications for Flood Hazard Mapping Partners
from Map Modernization, FEMA's Flood Hazard Mapping Program

Area of interest

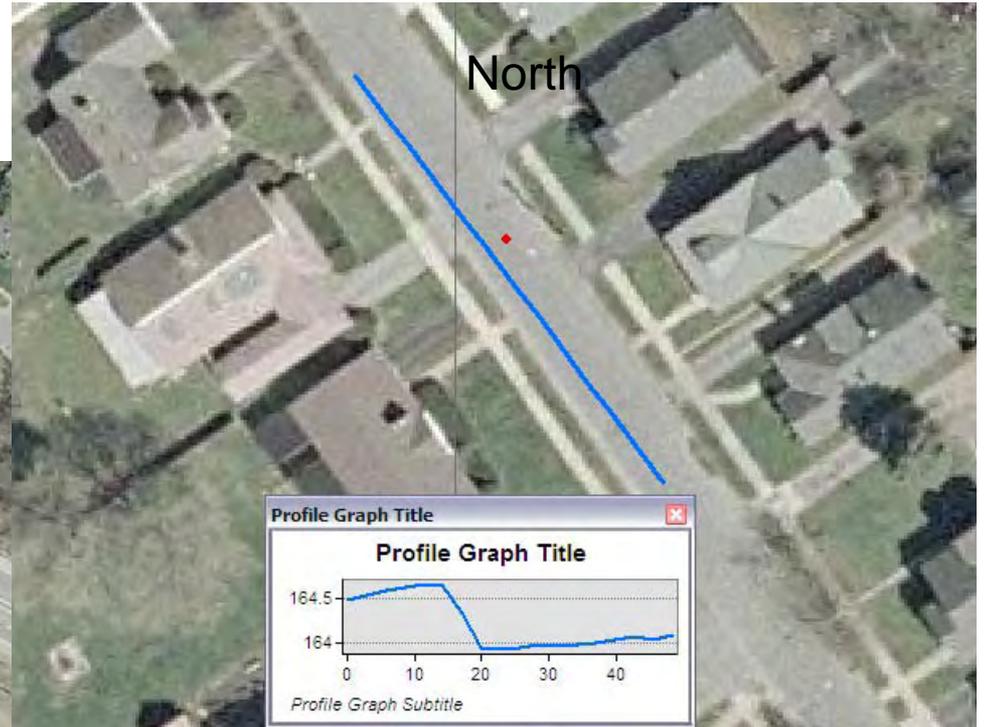
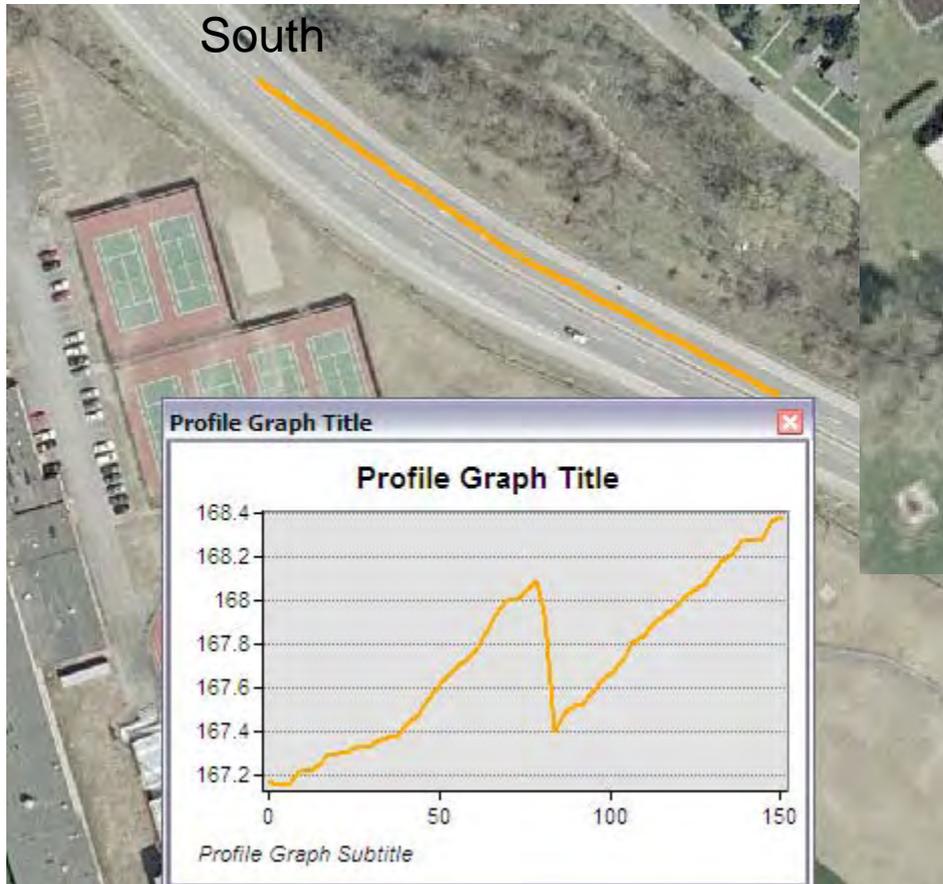
(red = difference in m)



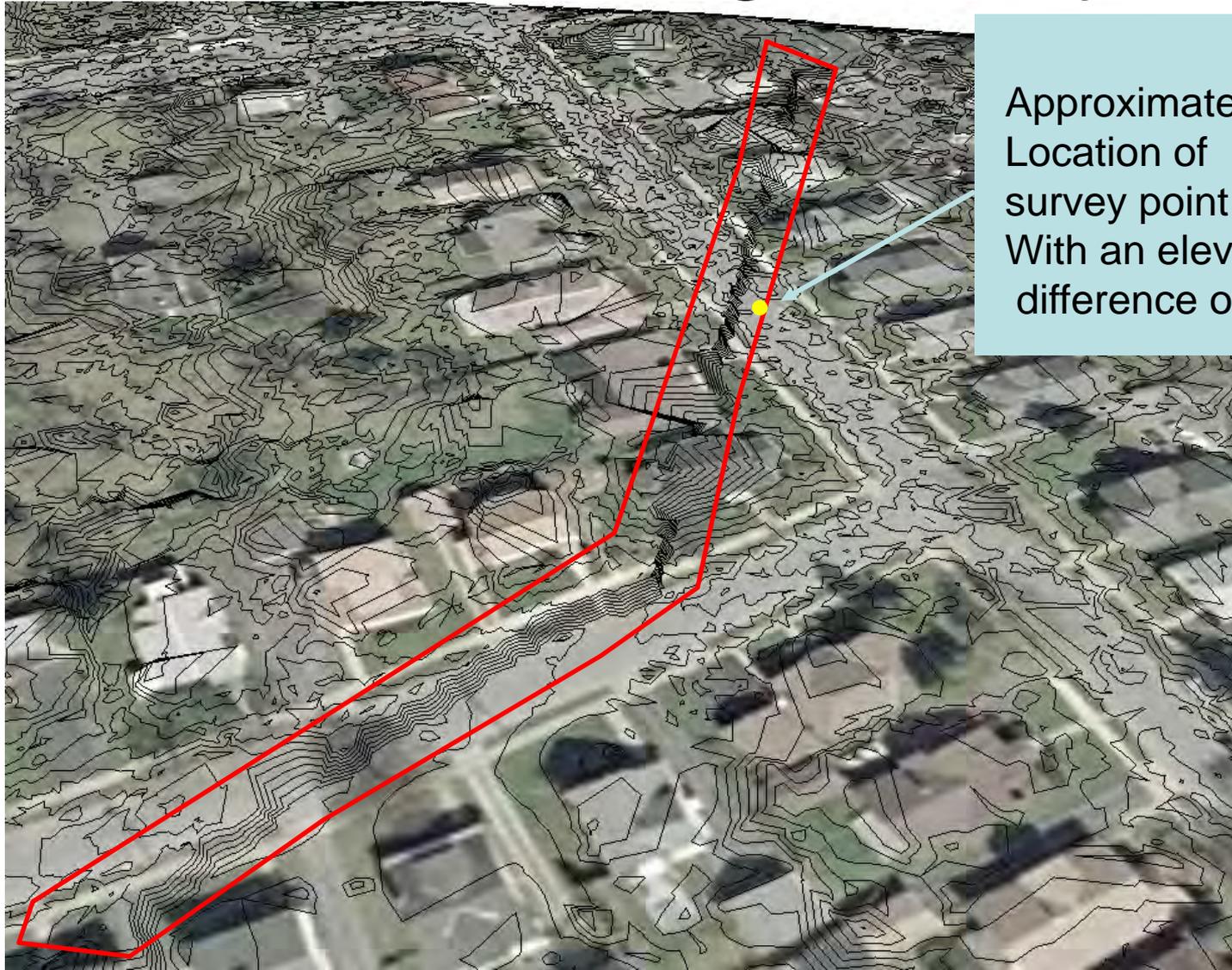
Cross Sections



Tile U_4770076850

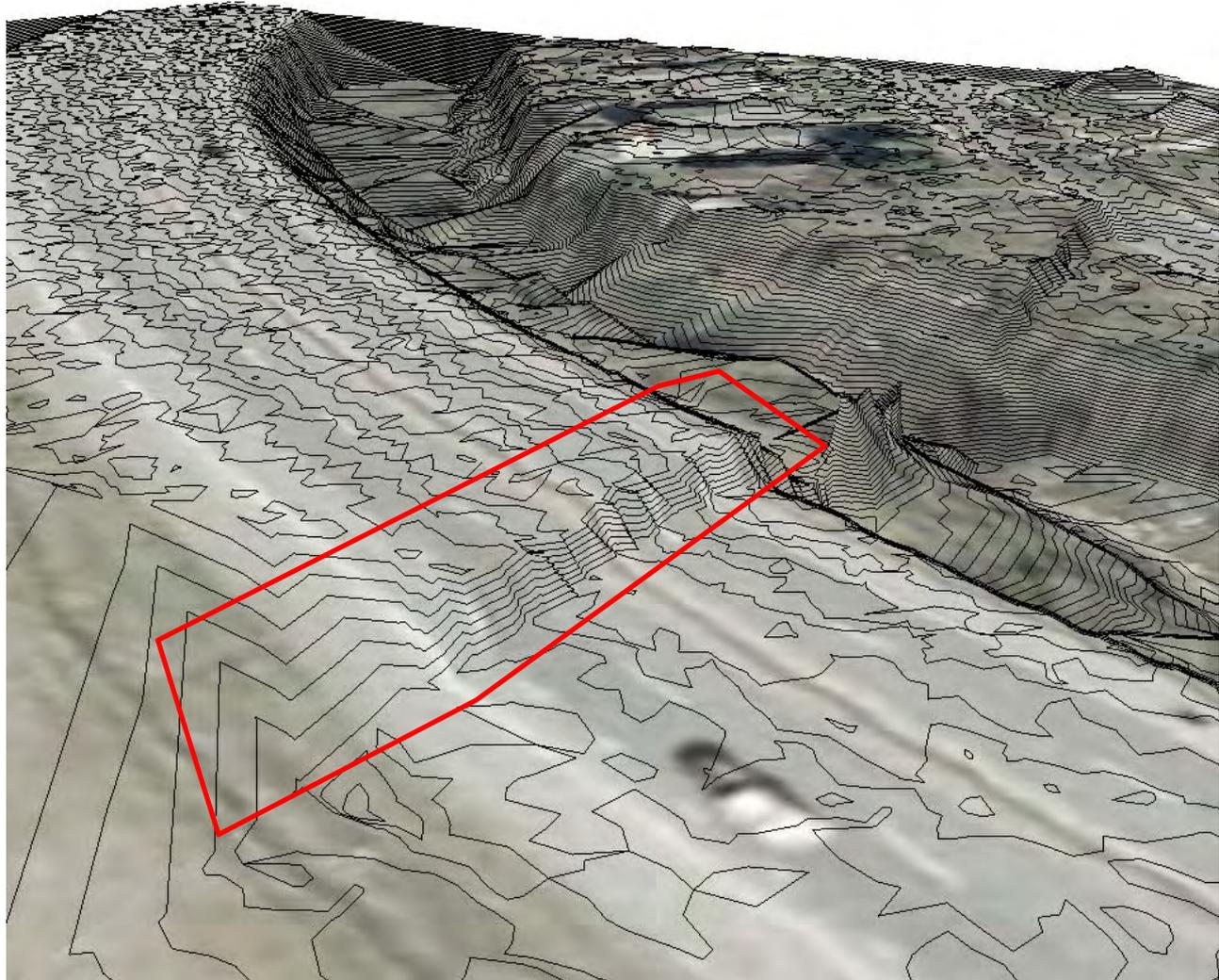


North 3d from LAS file with 0.1 m contours confirms grid analysis

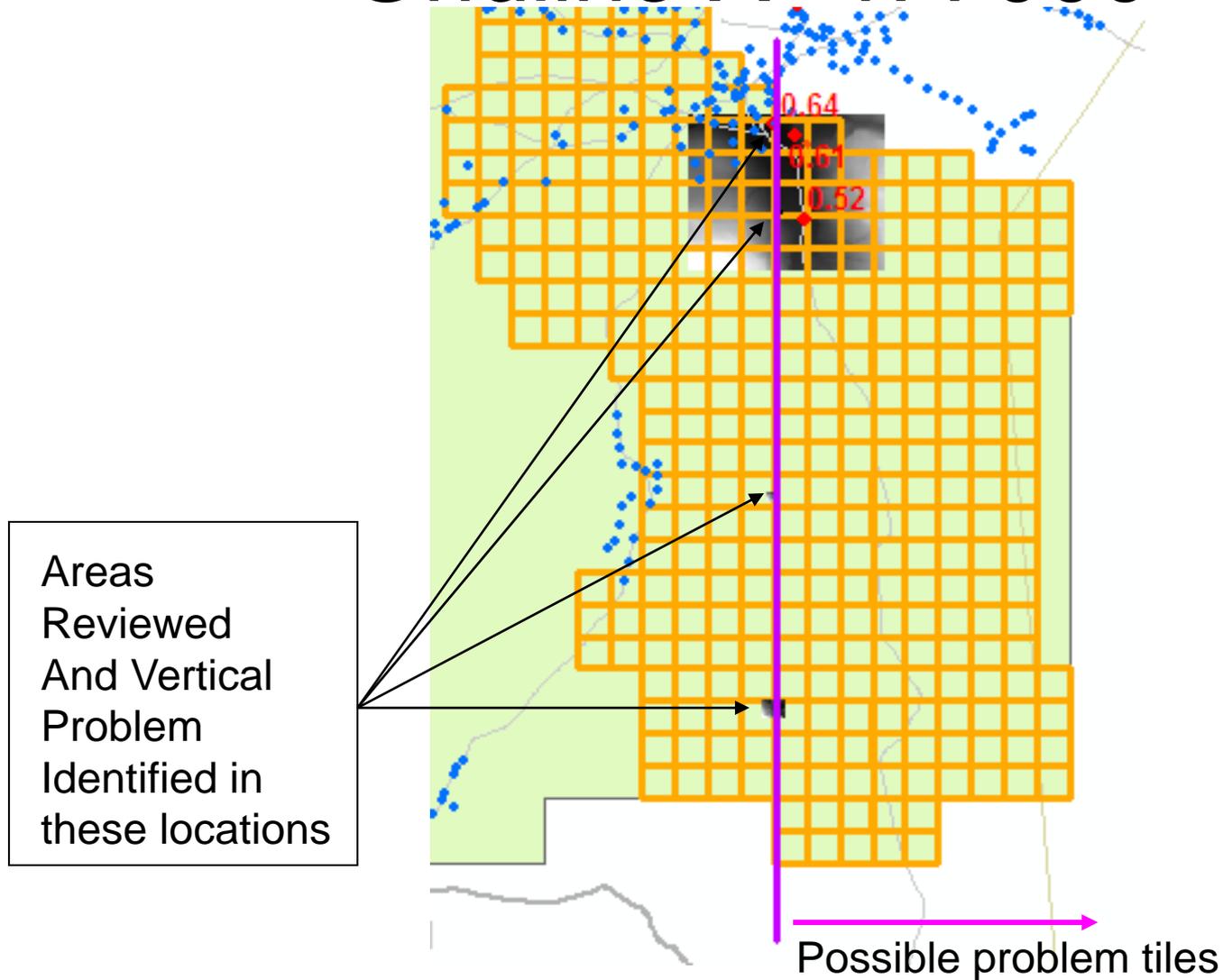


Approximate
Location of
survey point
With an elevation
difference of 0.64m

South 3d from LAS file with 0.1 m contours confirms grid analysis



Vertical shift Problem Along Gridline X=477000

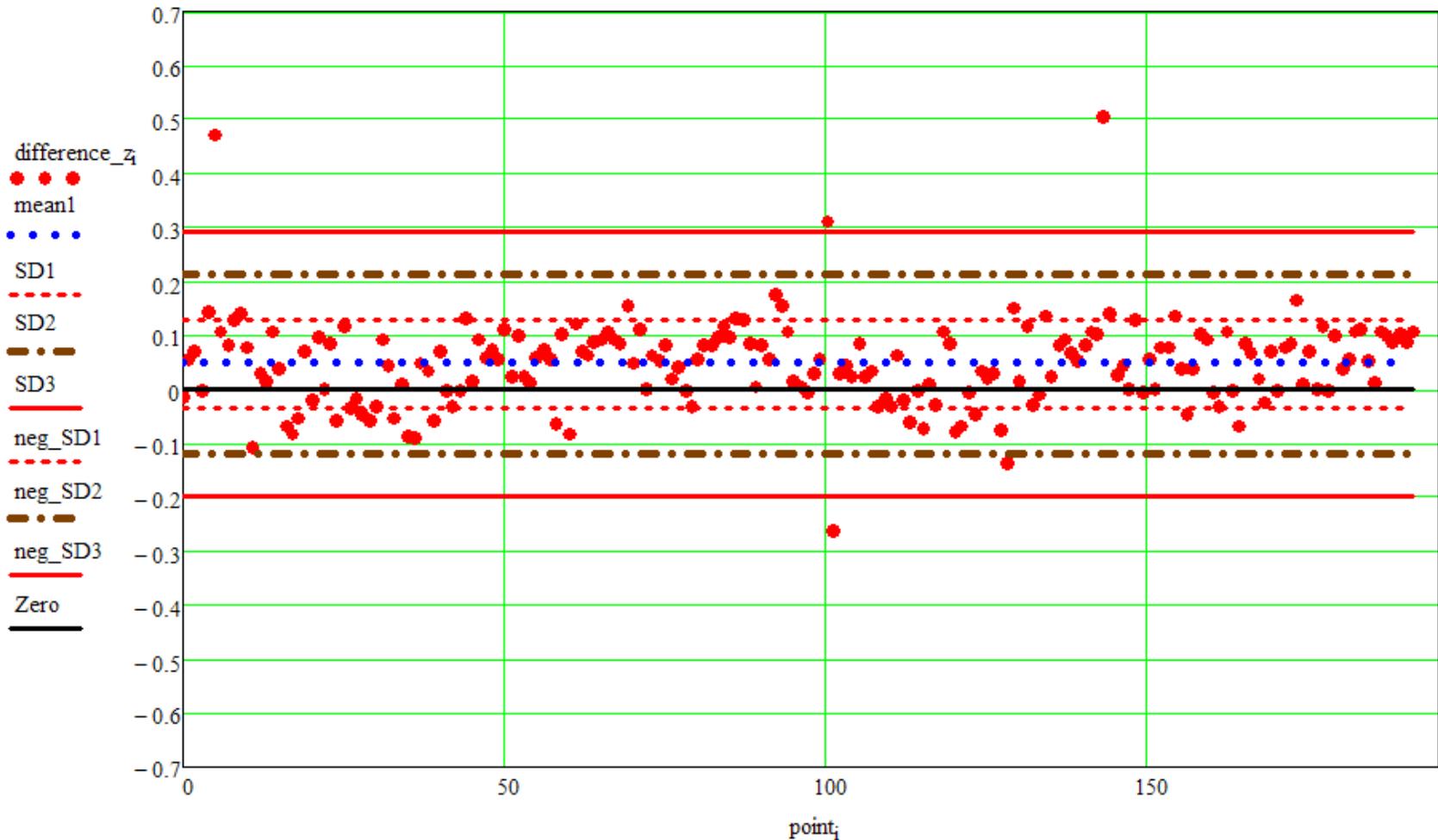


Using the National Standard for Spatial Data Accuracy (NSSDA) methodology the Lidar was tested to have the following accuracy for the **Mohawk 2007 Area** QA Points:

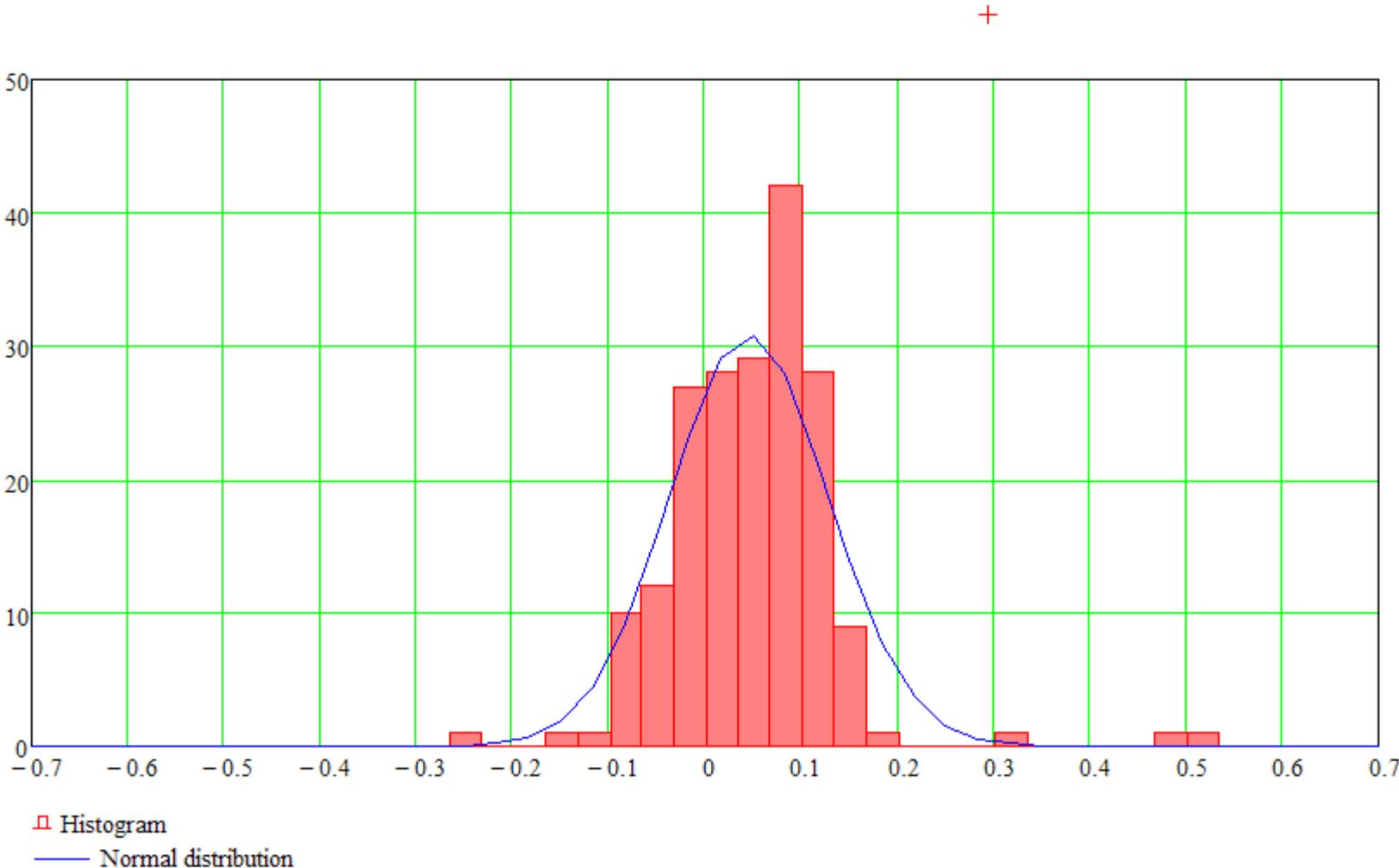
- Tested at **0.19 m** vertical accuracy at 95% confidence level
- RMSE = 0.094 m
- Mean = +0.046 m
- 192 check points

Tested accuracy meets the vertical specification of <0.185 m RMSE

Mohawk2007 Area Oneida County check point analysis where the lidar measurement elevations is subtracted from survey point elevations. Individual differences are shown (red dots) with an overlay of the 1,2 and 3 standard deviation lines. Points outside of the red lines are deemed to be in error if the data only has random errors remaining and is normally distributed.



Mohawk 2007 Oneida County histogram comparison showing elevation differences (the lidar grid elevations subtracted from the survey point elevations) with the normal distribution overlay (blue line). Data is close to normal distribution. The **192** points collected are an excellent sample size. The mean of the data set is **+0.046 m**.



Mohawk 2007 Overall statistics of Survey vs Lidar point to point comparison

Number of points in the dataset	number_points = 192	* minimum 20 testpoints	
Mean	mean(difference_z) = 0.046	m	Skewness (measure of symmetry)
Median	median(difference_z) = 0.053	m	skew(difference_z) = 1.258
Mode	the data set is multimodal		=0 Data Normally Distributed <0 Skew to the left >0 Skew to the right
Maximum Difference	max(difference_z) = 0.503	m	
Minimum Difference	min(difference_z) = -0.261	m	Kurtosis (measure of peak)
Standard Deviation	stdev(difference_z) = 0.082	m	kurt(difference_z) = 8.21
Variance	var(difference_z) = 0.007	m	=0 Data Normally Distributed >0 Data Peaked <0 Data Flat
Square Mean of the Difference	SMD = 0.094	m	
Root Mean Square Error	RMSEz = 0.094	m	* A maximum of 0.185 m is allowable in flat terrain
Vertical Accuracy at 95% confidence	Vertical_Accuracy = 0.185	m	

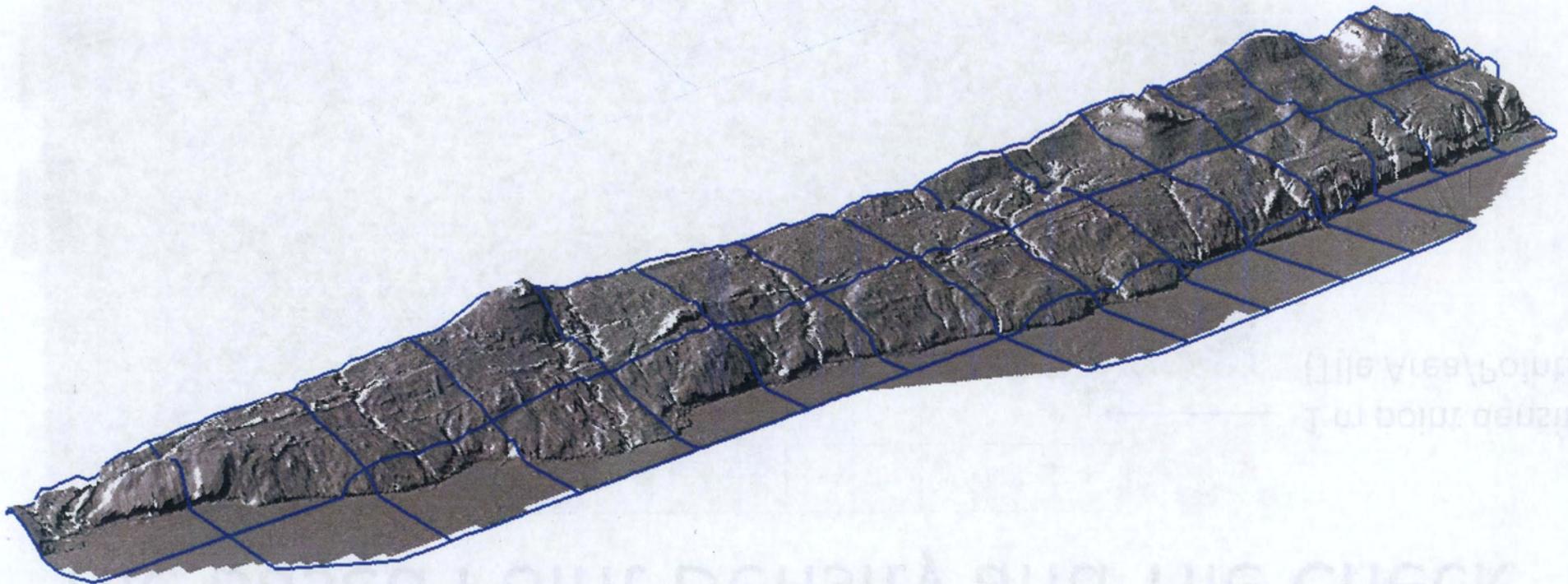
Four points (2.0% dataset) fall outside of the 3 standard deviations.

* minimum specification requirements according to Guidelines and Specifications for Flood Hazard Mapping Partners from Map Modernization, FEMA's Flood Hazard Mapping Program

Appendix B – 2009 Accuracy Assessment

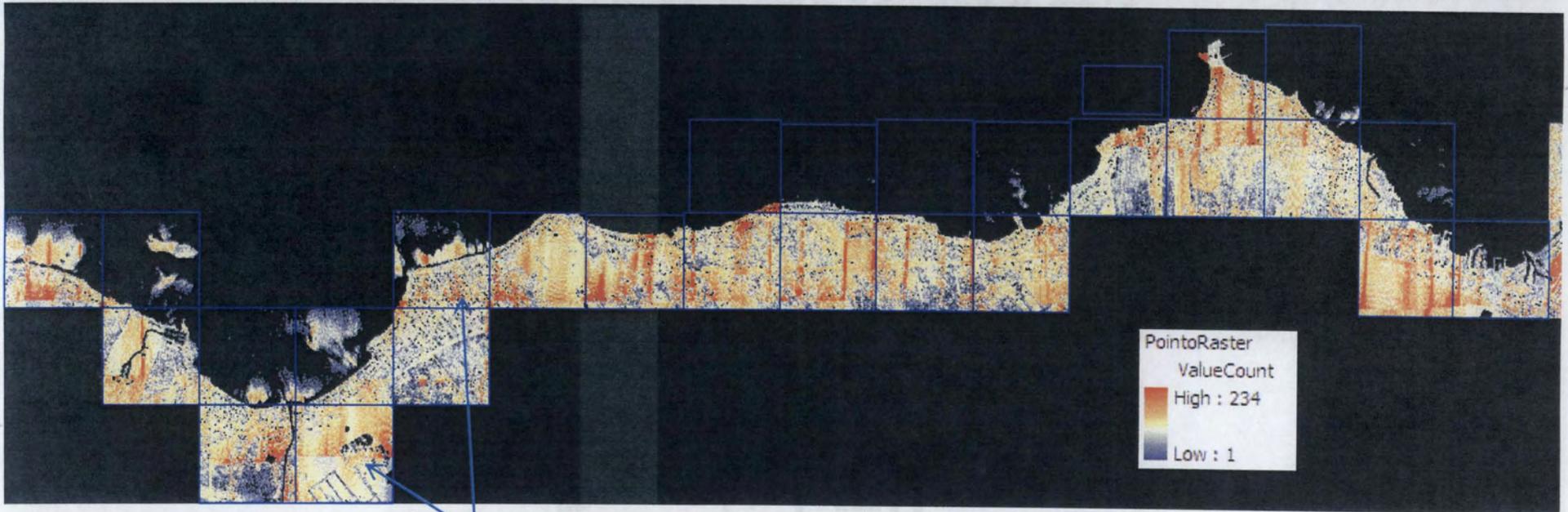
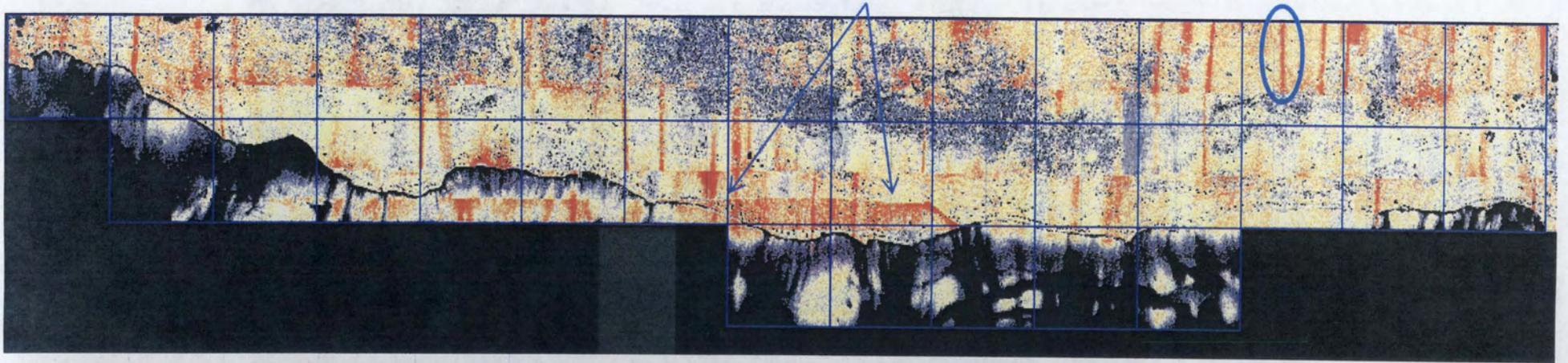
Quality Assurance

2009 Oneida County LiDAR



Point Density

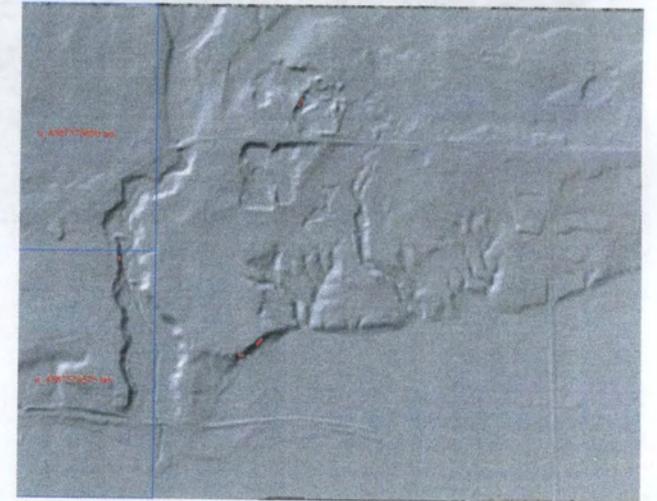
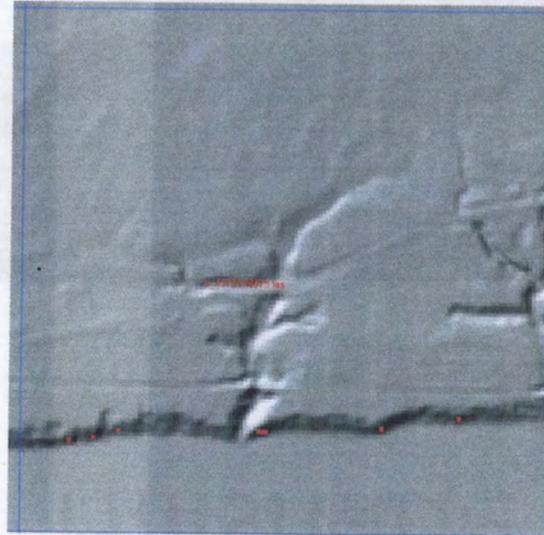
boundary



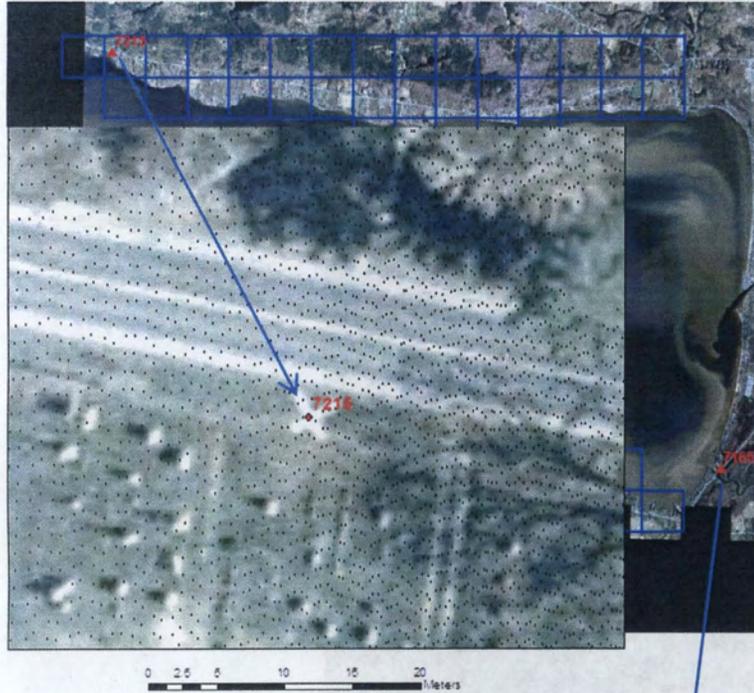
boundary



Greater than 40 Degree Slope Analysis



Survey Control

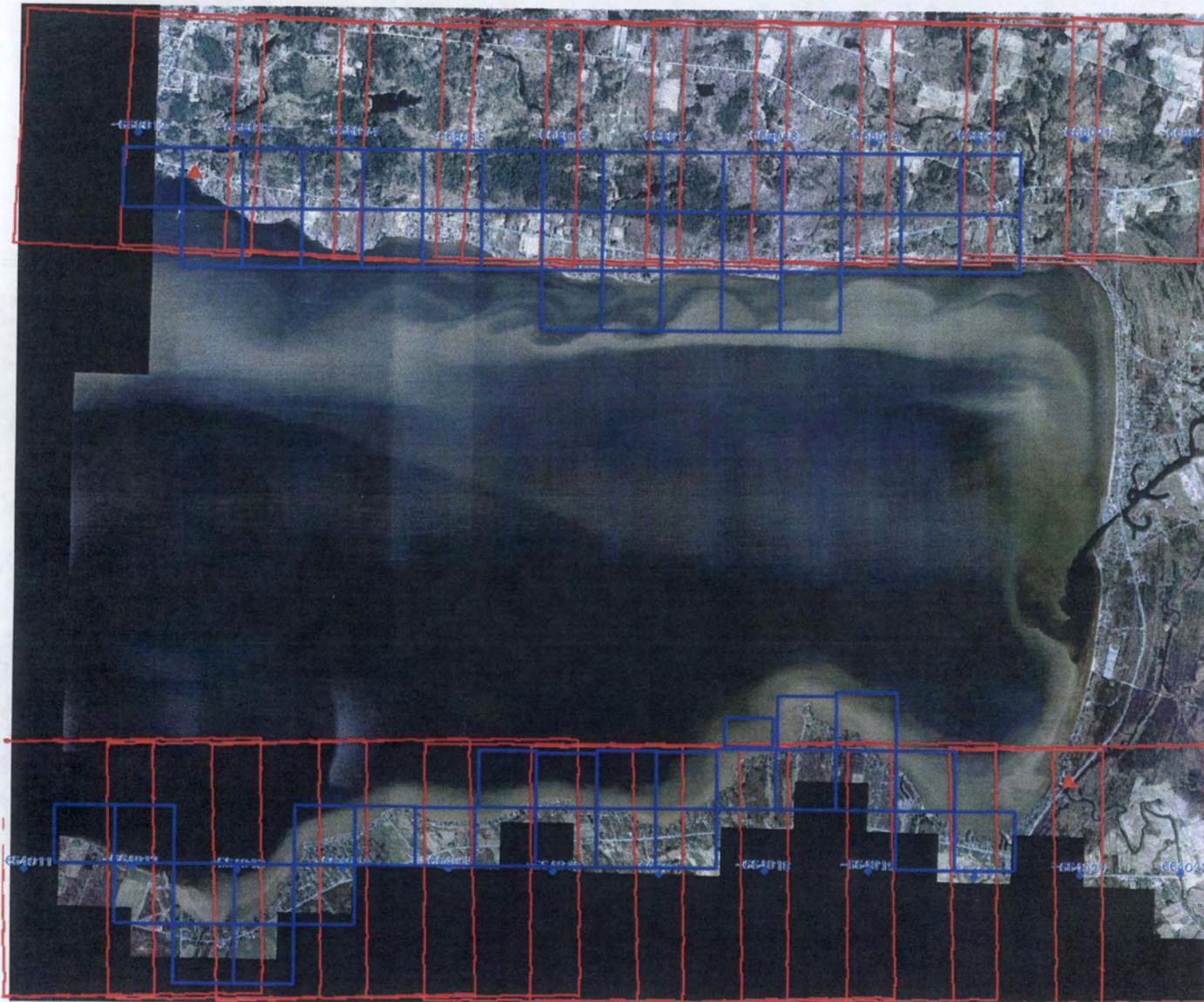


Point 7215	Elevation G1999(E)	Elevation G2003	Lidar (L) elevation	Difference E-L
Survey	128.68	128.72	128.80	-0.12
AT	128.70	128.74	128.80	-0.10
Stereoplotter	128.72	128.76	128.80	-0.08
Point 7165				
Survey	115.88	115.30	115.92	-0.04
AT	115.84	115.89	115.92	-0.08
Stereoplotter	115.81	115.86	115.92	-0.11

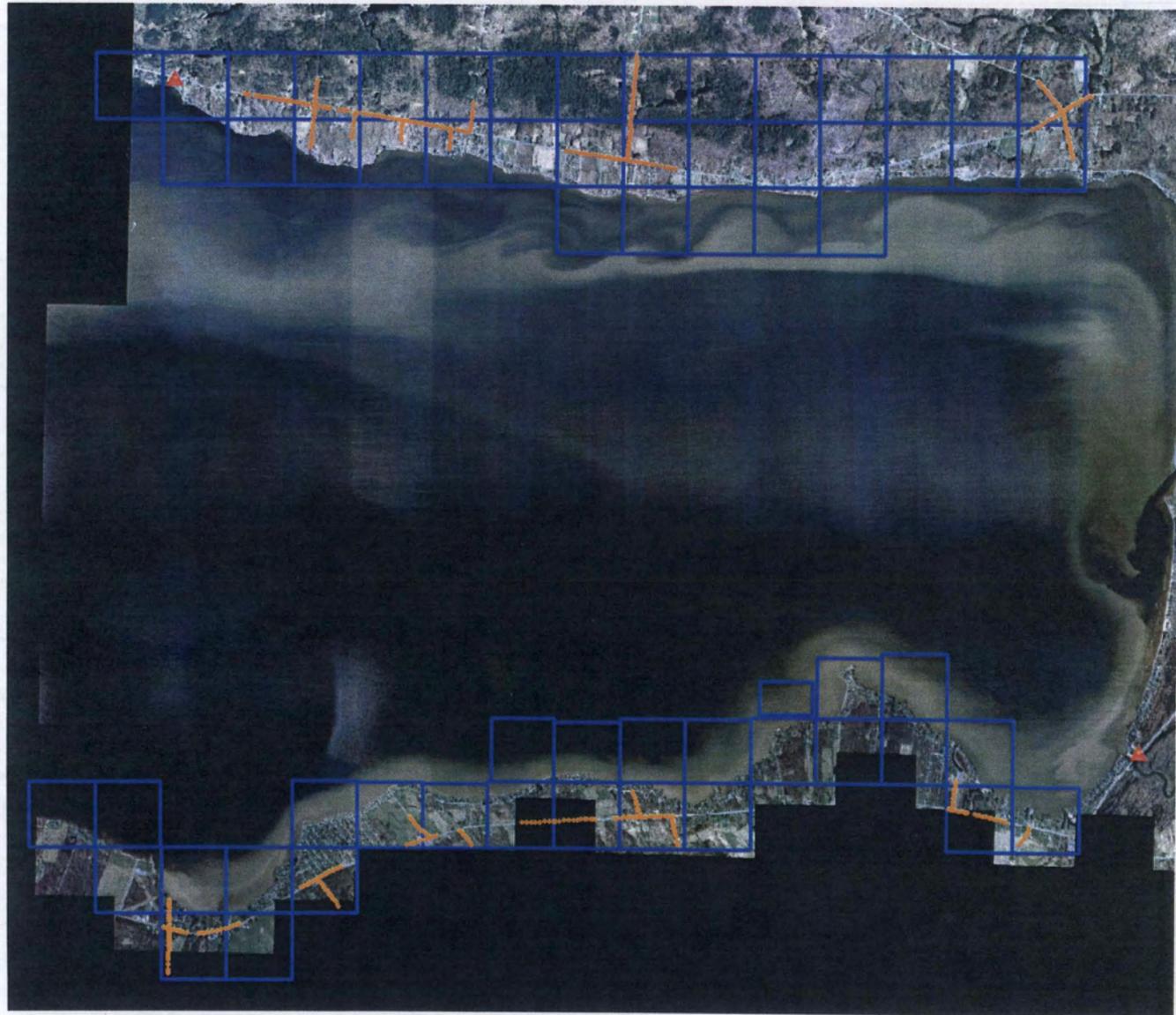


Point	Geoid99	Geoid03	Difference
7215	-33.28	-33.32	0.04
7165	-33.00	-33.05	0.05

Vertical QA Profiles from 2003 Orthoimagery program Stereo Models

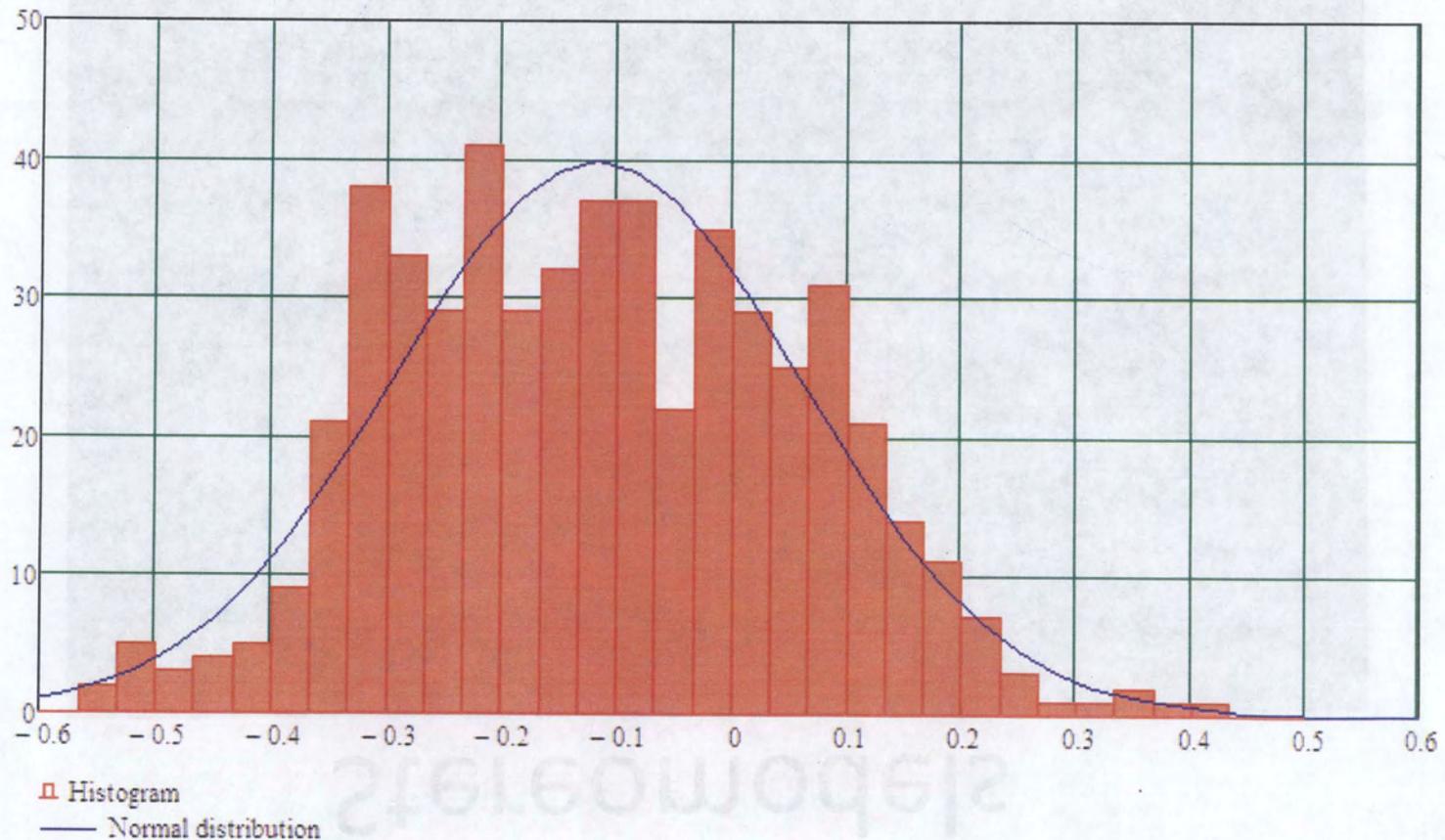


Photogrammetry Points from 2003 Stereomodels



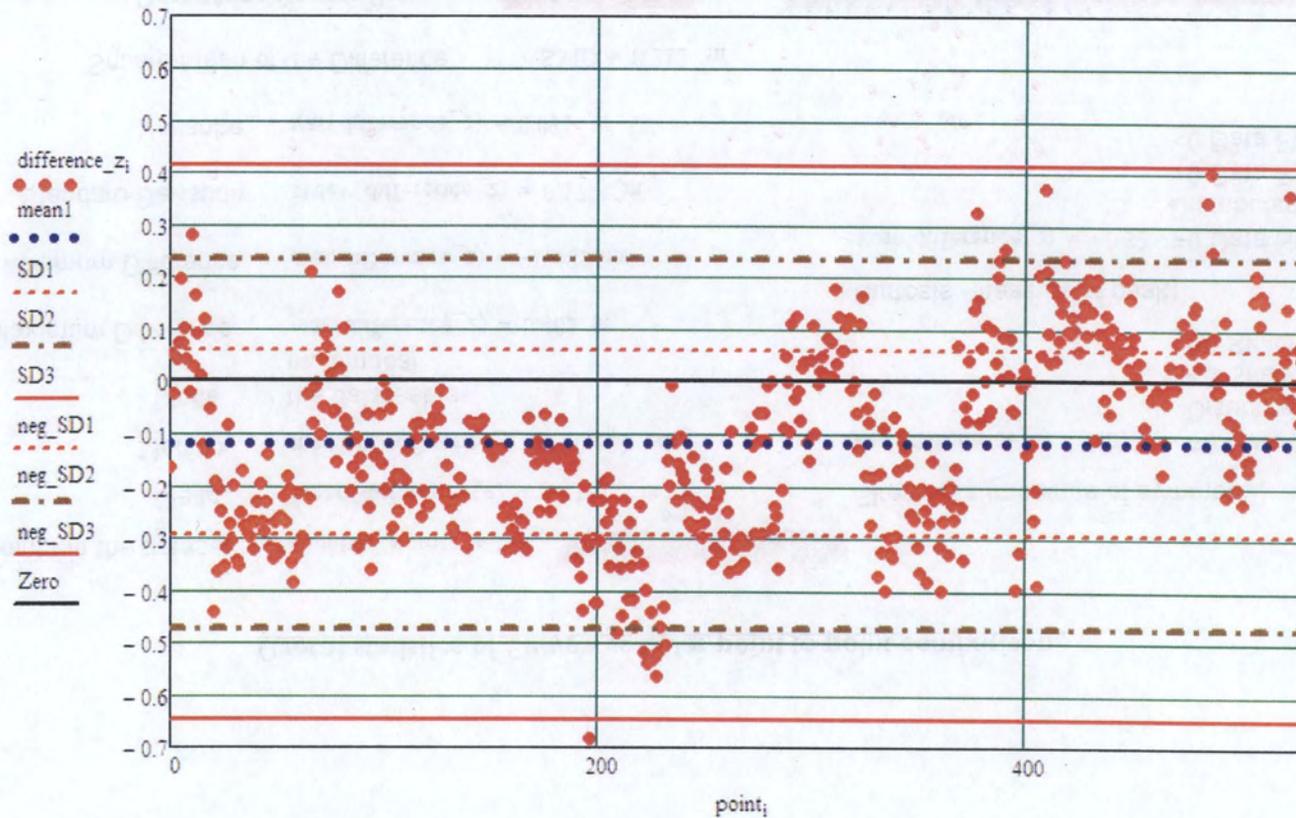
Histogram

Oneida County 2009 histogram showing comparison of elevation differences (the lidar grid elevations subtracted from the photogrammetry point elevations) with the normal distribution overlay (blue line). Data is close to normal distribution. The 530 points collected are an excellent sample size.



Scatterplot

Oneida County 2009 check point analysis where the lidar measurement elevation is subtracted from photogrammetric point elevation. Individual differences are shown (red dots) with an overlay of the 1,2 and 3 standard deviation lines. Points outside of the red lines are deemed to be in error if the data only has random errors remaining and is normally distributed.



Summary Statistics

Overall statistics of Survey vs Lidar point to point comparison

Number of points in the dataset	number_points = 530	* minimum 20 testpoints
Mean	mean(difference_z) = -0.117 m	Skewness (measure of symmetry)
Median	median(difference_z) = -0.123 m	skew(difference_z) = 0.077
Mode	the data set is multimodal	=0 Data Normally Distributed <0 Skew to the left >0 Skew to the right
Maximum Difference	max(difference_z) = 0.403 m	
Minimum Difference	min(difference_z) = -0.682 m	Kurtosis (measure of peak)
Standard Deviation	stdev(difference_z) = 0.177 m	kurt(difference_z) = -0.32
Variance	var(difference_z) = 0.031 m	=0 Data Normally Distributed >0 Data Peaked <0 Data Flat
Square Mean of the Difference	SMD = 0.212 m	
Root Mean Square Error	RMSEz = 0.212 m	* A maximum of 0.185 m is allowable in flat terrain
Vertical Accuracy at 95% confidence	Vertical_Accuracy = 0.416 m	

* minimum specification requirements according to Guidelines and Specifications for Flood Hazard Mapping Partners from Map Modernization, FEMA's Flood Hazard Mapping Program

Offset Applied

Overall statistics of Survey vs Lidar point to point comparison with 0.09 m offset applied

Number of points in the dataset	number_points = 530	* minimum 20 testpoints
Mean	mean(difference_z) = -0.027 m	Skewness (measure of symmetry)
Median	median(difference_z) = -0.033 m	skew(difference_z) = 0.077
Mode	the data set is multimodal	=0 Data Normally Distributed <0 Skew to the left >0 Skew to the right
Maximum Difference	max(difference_z) = 0.493 m	
Minimum Difference	min(difference_z) = -0.592 m	Kurtosis (measure of peak)
Standard Deviation	stdev(difference_z) = 0.177 m	kurt(difference_z) = -0.32
Variance	var(difference_z) = 0.031 m	=0 Data Normally Distributed >0 Data Peaked <0 Data Flat
Square Mean of the Difference	SMD = 0.179 m	
Root Mean Square Error	RMSEz = 0.179 m	* A maximum of 0.185 m is allowable in flat terrain
Vertical Accuracy at 95% confidence	Vertical_Accuracy = 0.351 m	

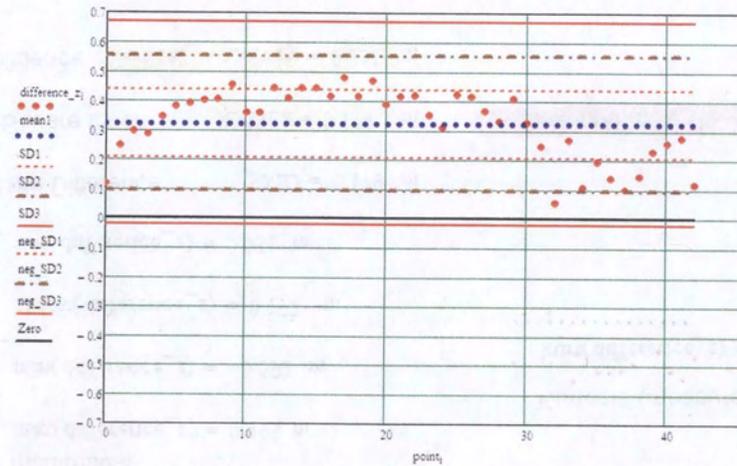
* minimum specification requirements according to Guidelines and Specifications for Flood Hazard Mapping Partners from Map Modernization, FEMA's Flood Hazard Mapping Program

Photogrammetry Points from 2003

Stereomodels



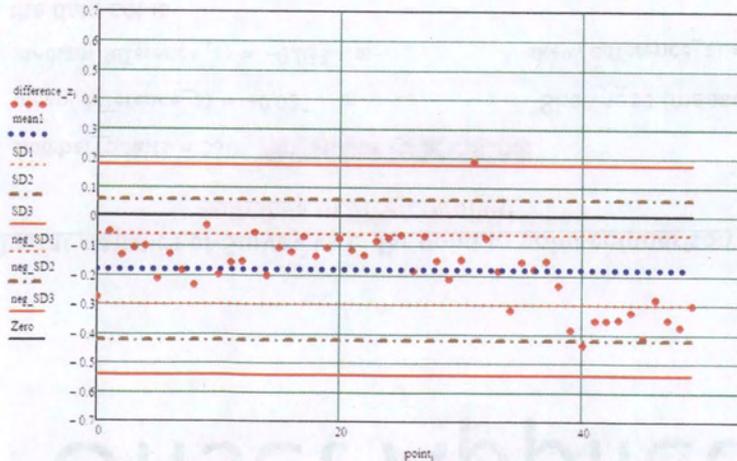
Oneida County 2008 check point analysis where the lidar measurement elevation is subtracted from photogrammetric point elevation. Individual differences are shown (red dots) with an overlay of the 1.2 and 3 standard deviation lines. Points outside of the red lines are deemed to be in error if the data only has random errors remaining and is normally distributed.



North

Mean = +0.32 m

Difference = 0.5 m



South

Mean = -0.18 m

2008 Summary Point Statistics

North

Overall statistics of Survey vs Lidar point to point comparison

Number of points in the dataset	number_points = 43	minimum 20 testpoints
Mean	mean(difference_z) = 0.323 m	Skewness (measure of symmetry)
Median	median(difference_z) = 0.36 m	skew(difference_z) = -0.797 =0 Data Normally Distributed <0 Skew to the left >0 Skew to the right
Mode	the data set is multimodal	Kurtosis (measure of peak)
Maximum Difference	max(difference_z) = 0.478 m	kurt(difference_z) = -0.47 =0 Data Normally Distributed >0 Data Peaked <0 Data Flat
Minimum Difference	min(difference_z) = 0.056 m	
Standard Deviation	stdev(difference_z) = 0.115 m	
Variance	var(difference_z) = 0.013 m	
Square Mean of the Difference	SMD = 0.343 m	
Root Mean Square Error	RMSE _r = 0.343 m	A maximum of 0.185 m is allowable in flat terrain
Vertical Accuracy at 95% confidence	Vertical_Accuracy = 0.672 m	

South

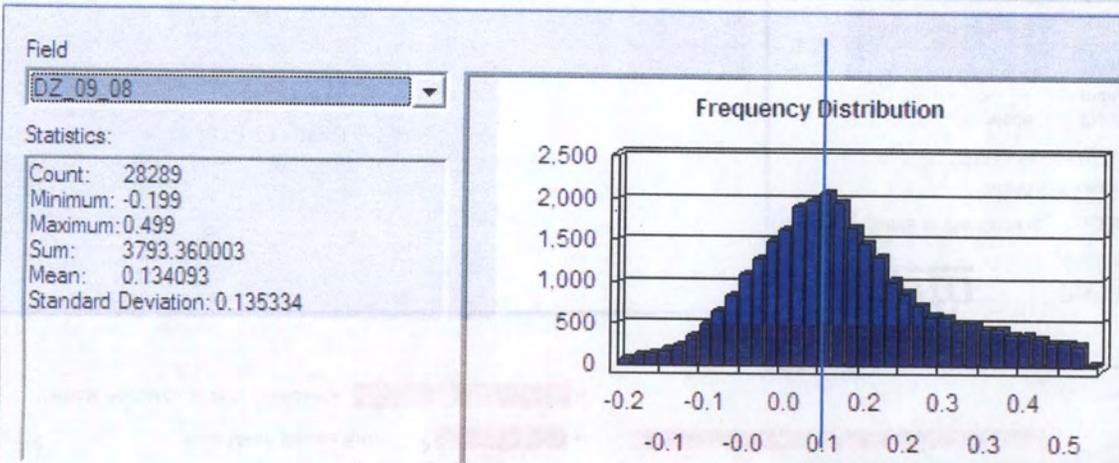
Overall statistics of Survey vs Lidar point to point comparison

Number of points in the dataset	number_points = 50	minimum 20 testpoints
Mean	mean(difference_z) = -0.182 m	Skewness (measure of symmetry)
Median	median(difference_z) = -0.153 m	skew(difference_z) = -0.025 =0 Data Normally Distributed <0 Skew to the left >0 Skew to the right
Mode	the data set is multimodal	Kurtosis (measure of peak)
Maximum Difference	max(difference_z) = 0.189 m	kurt(difference_z) = 0.69 =0 Data Normally Distributed >0 Data Peaked <0 Data Flat
Minimum Difference	min(difference_z) = -0.439 m	
Standard Deviation	stdev(difference_z) = 0.12 m	
Variance	var(difference_z) = 0.014 m	
Square Mean of the Difference	SMD = 0.218 m	
Root Mean Square Error	RMSE _r = 0.218 m	A maximum of 0.185 m is allowable in flat terrain
Vertical Accuracy at 95% confidence	Vertical_Accuracy = 0.423 m	

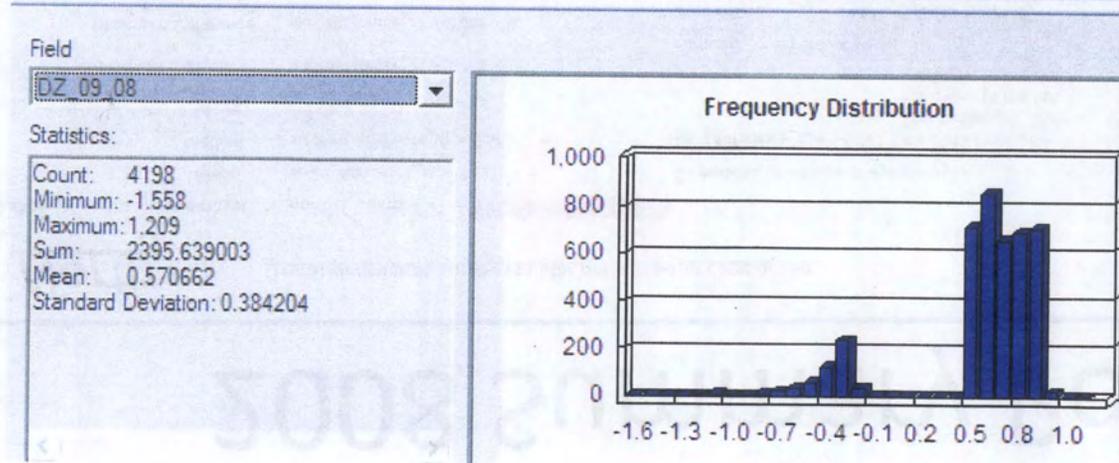
South Verticals Tie to 2008 LIDAR Collection

South Vertical Tie to 2008 LiDAR Collection (2009 – 2008 Elevations)

Statistics of Southpnts3dET

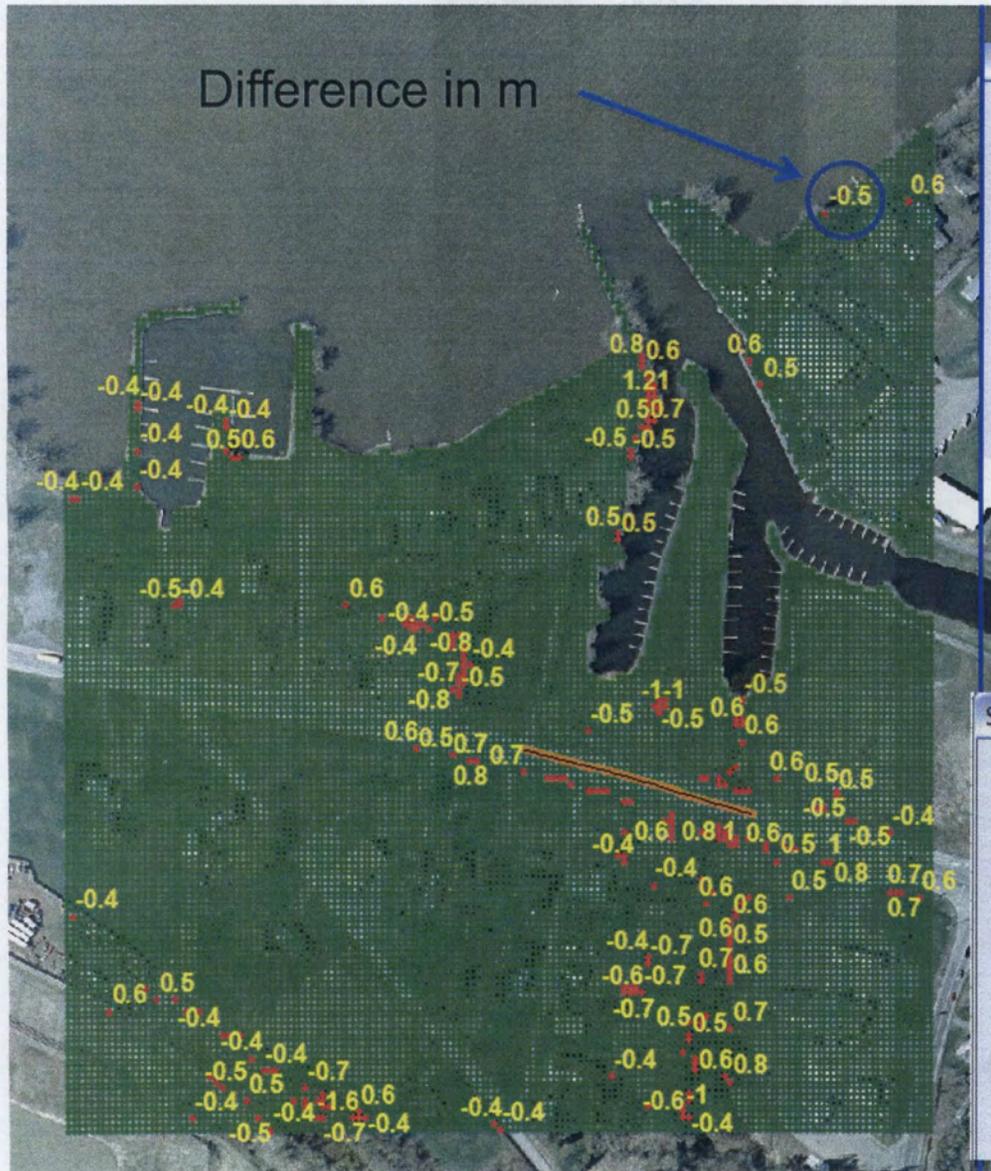


Statistics of Southpnts3dET

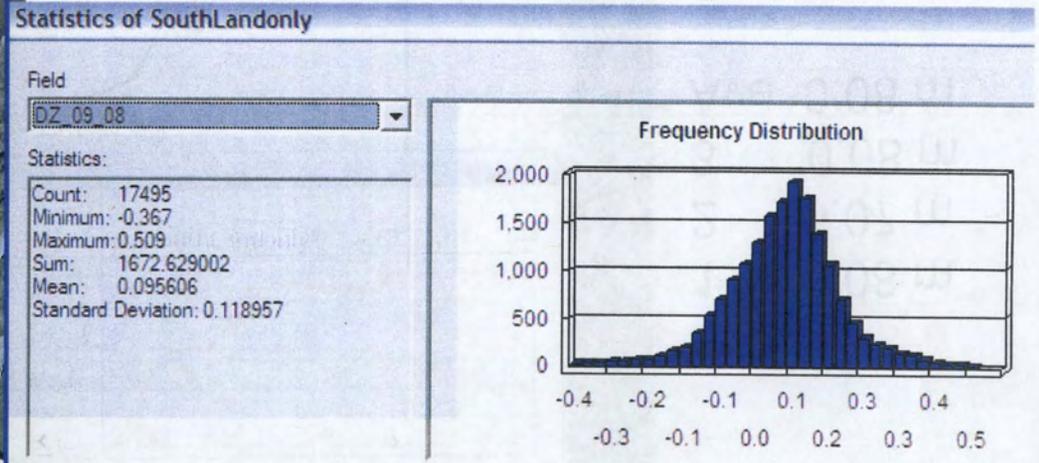


South vertical Tie Land only 17742 points

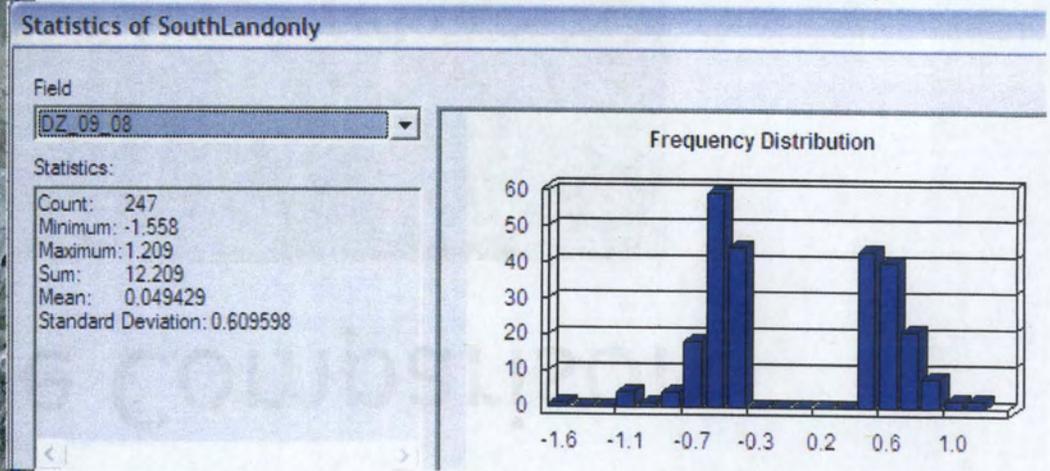
96% of points have differences between -0.2 m and 0.4 m



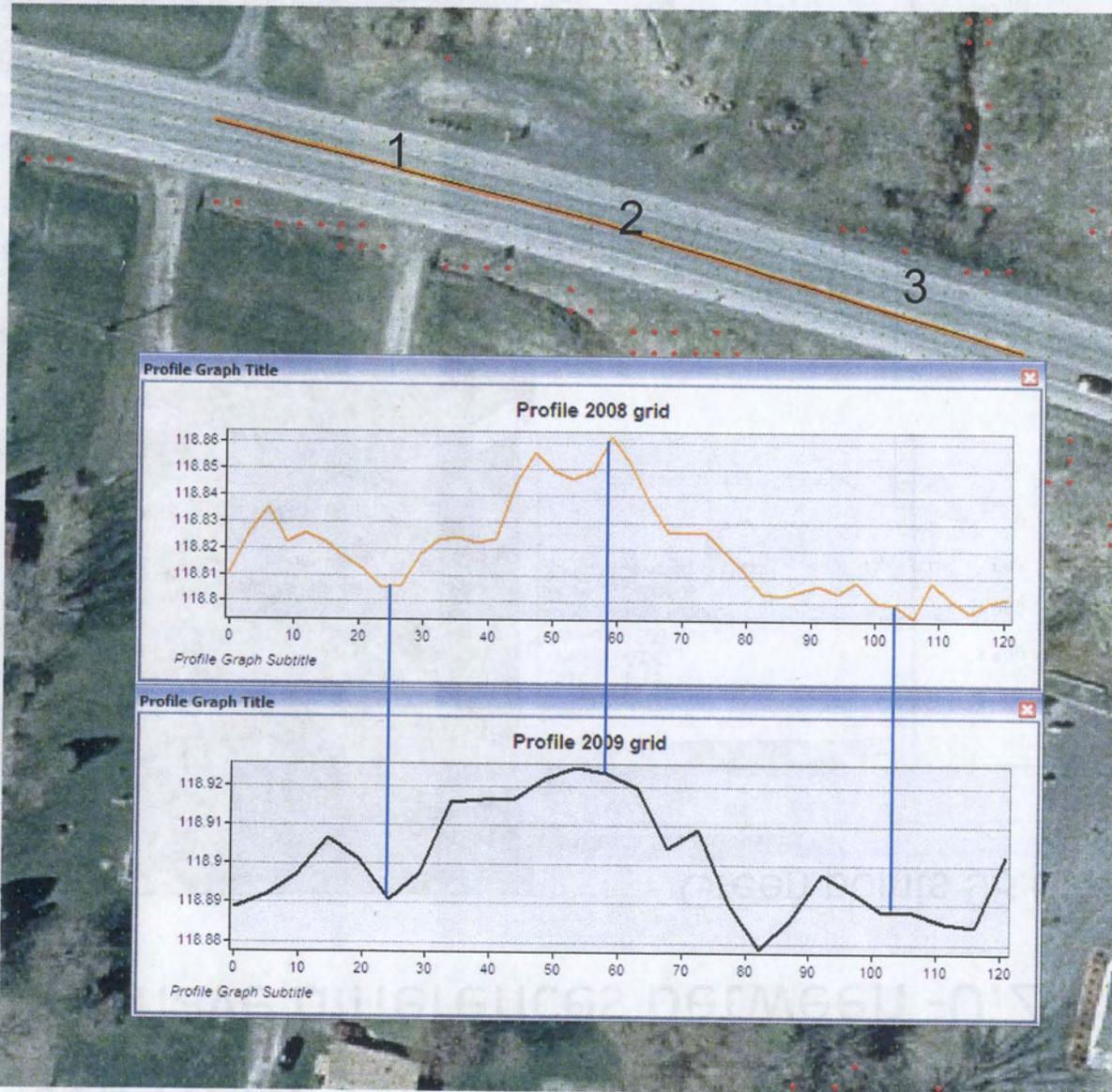
Green points 98.6% of points



Red points (1.4% of points)

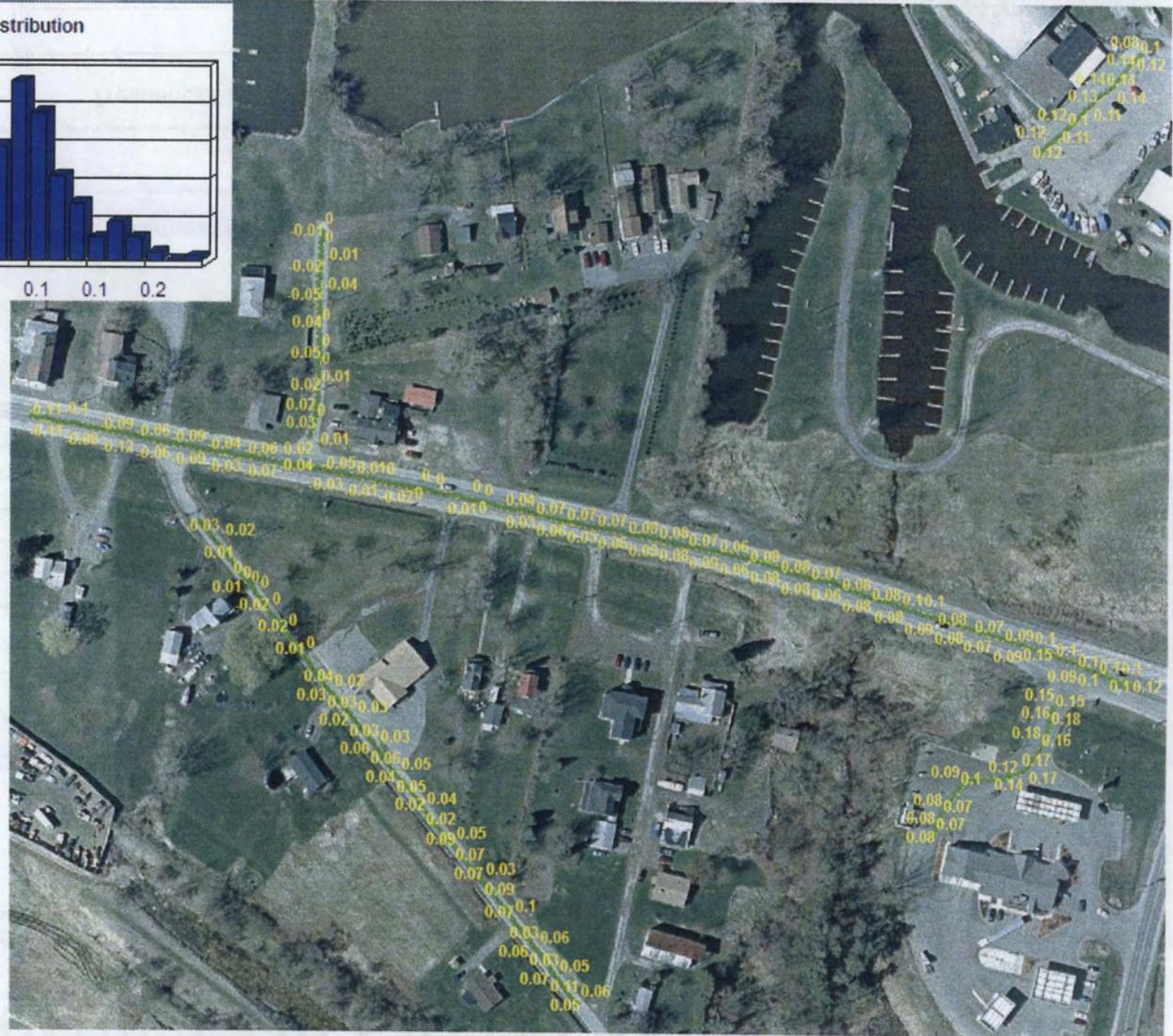
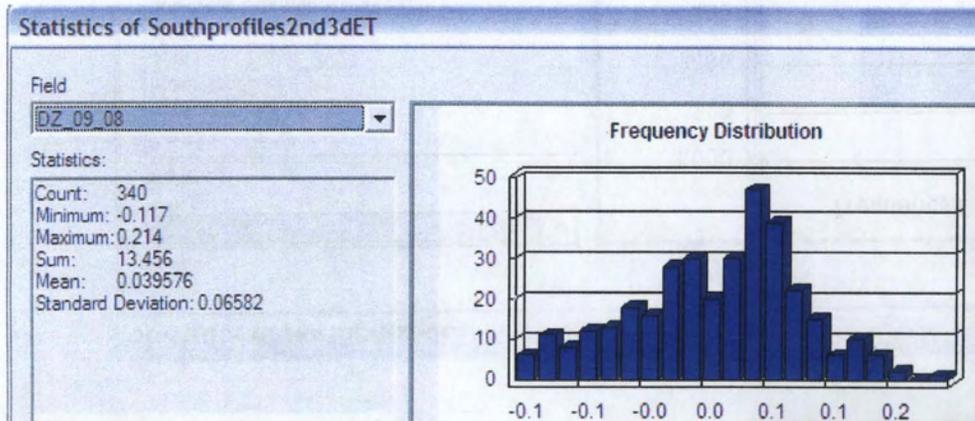


South Profile Comparison



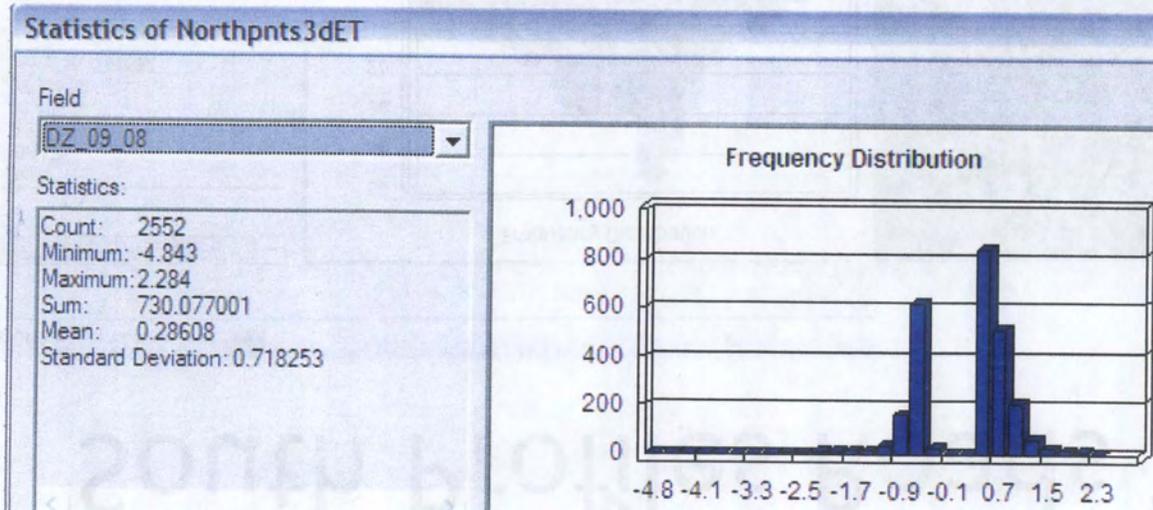
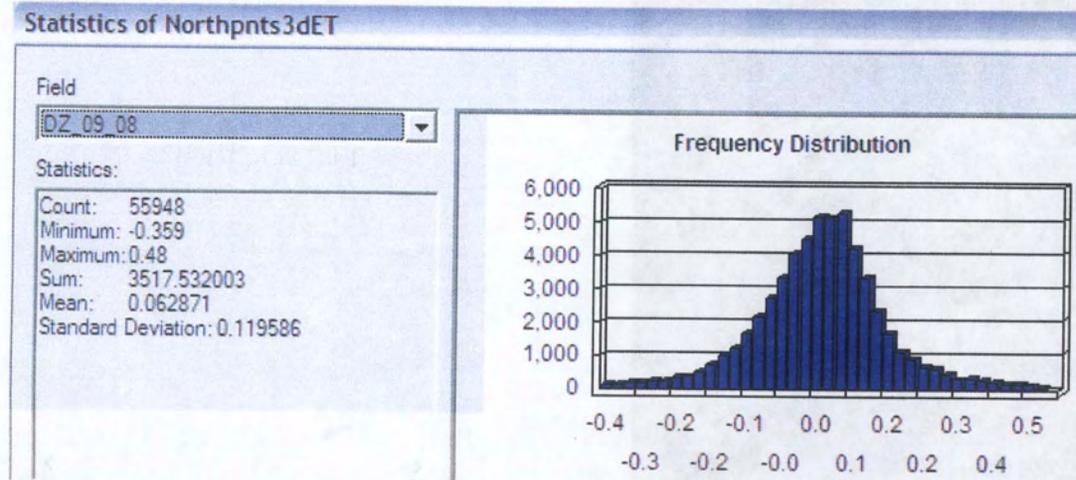
1 0.08 m
2 0.07 m
3 0.08 m
Ave 0.08 m

South Profiles Roads 2009-2008



North vertical Tie 58500 points

96% of points have differences between -0.4 m and 0.5 m



NorthProfiles 2009-2008

Statistics of NorthProfiles3dpnts2nd3dET

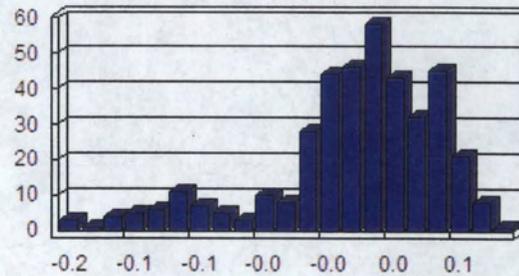
Field

DZ_09_08

Statistics:

Count: 389
Minimum: -0.174
Maximum: 0.116
Sum: 6.102
Mean: 0.015686
Standard Deviation: 0.054123

Frequency Distribution



Appendix C – 2008 Quality Control



8 May 2009

Jeff Quackenbush
Herkimer-Oneida Counties Comprehensive Planning
Boehlert Center @ Union Station
321 Main Street – Third Floor
Utica, NY 13502

Subject: Oneida County LiDAR-based Terrain Elevation Data Project

421 Ridge Street

Dear Jeff,

Rome

New York 13440

In accordance with the terms of the subject contract, PAR Government Systems is pleased to submit the following deliverable: One (1) hard drive containing approximately 609 square miles of Multiple Return LiDAR data (LAS format), the Quality Control Report, and GIS DEM products.

Tel 315.339.0491

Should you have questions of a contractual nature you may contact the undersigned at 315-356-2266. All other questions/requests can be directed to Verne LaClair at 315-356-2130.

Fax 315.356.2208

www.partech.com

Sincerely,

PAR GOVERNMENT SYSTEMS CORPORATION

Trisha Rivers
Contract Administrator

cc: Elisabetta DeGironimo - MVWA
Tim Daly - NYSDEC

Project Name: 2008 Oneida County LiDAR	Project Number: 313179
Producer: V LaClair	Completion Date: 1/14/09

Original : **Rework:**

Item	Topic	QC Findings/Comments	
1	LiDAR Vendor	Sanborn Map Company	
2	Sensor System	Optech ALTM 2050, Leica ALS50	
3	Source Media Identification	Maxtor External Hard Drive	
4	Delivery Media File Contents (Yes/No)	Readme Files:	No
		Supporting Metadata Files:	Yes
		Random Point Files:	No
		Grid Files:	No
		Other Files:	LAS 1.1 (2,533 Tiles)
		Incremental Delivery:	No
5	Key Dates	Aerial Acquisition Dates:	4/30/08-5/09/08
		Vendor Processing Dates:	8/15 – 10/03/08
		Source Media Date:	8/15 - 10/22/08
		Received Date:	10/30/2008
6	Coverage Extents	Refernce Attached	
7	Collection Area (in square miles)	Requirement:	563 sq miles
		Delivered:	550 sq miles
8	Total Number of LIDAR Points	Number of Random Points:	1,150,460,500 BE
		Number of Total Points:	3,039,600,000
9	Average Point Density (Random Data)	1.0 - 1.4 meters	
10	Confirm compliance of projection, vertical or horizontal datum, and units of measure (Yes/No)	UTM Zone: 18N	yes
		NAD83:	yes
		NAVD88:	yes
		Meters:	yes
11	Confirm completeness of vendor processing	Confirmed see attached map	
12	Elevation Values Round-off Check		
13	Range of Elevation Values	Random:	107 meters to 591 meters