Statewide Aerial Imagery Program
Presentation to the Michigan GIS User’s Group
February 7, 2013, 1:00pm

Presented By:

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Manager, GeoData Services

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Senior Project Manager

Brad Arshat, Sanborn
Director, Strategic Accounts
Presentation Topics

• Introduction
• Sanborn Profile
• Imagery Program History
• Orthoimagery Offerings
• Break
• LiDAR Offerings
• Data as a Service
• Pricing
• How to Order
Sanborn – Leader Since 1866

Sanborn Maps™

- Extensive mapping & GIS collection with over 12,000 municipalities nationwide
- Digital Photogrammetric Mapping since 1979
Overview
Sanborn Office Locations

- Portland, OR
- Sacramento, CA
- Colorado Springs, CO
- Ann Arbor, MI
- Pelham, NY
- Charlotte, NC
- Cocoa Beach

- Headquarters
- Sanborn Office
- On-Site Locations

Comprehensive Solutions

- **Decision Support Systems**
  - Wildfire Management
  - Forestry and Ecosystem Management
  - Emergency Response

- **Visualization Systems**
  - 2D
  - 3D

- **Software Applications**
  - GIS Software Development (Enterprise/Desktop/Web)
  - Portals and Distribution Tools

- **Value-Added Services**
  - Consulting
  - Land use and land cover analyses
  - Change detection
  - Other imagery analysis services

- **Mapping & Remote-Sensed Services**
  - LiDAR, Digital Orthoimagery, Photogrammetric, Topographical Maps
Sanborn Company Profile

• Offices in 5 states
• 150 employees
• Services include:
  – Aerial Imagery
  – Aerial & Terrestrial LiDAR
  – Land Surveys
  – Digital Terrain Modeling
  – Planimetric/Topographic Maps
  – 3D Modeling and Simulation
  – Satellite Imagery
  – Remote Sensing
  – Parcel & Utility Conversion
  – GeoIT Services
Information Map Products

Fire Threat Models

Land Cover & Impervious Surface

Agricultural Assessment

Predictive Analysis – Drug Safe Locations
Qualifications: Relevant Experience on Programs in the Region

• Sanborn is presently the statewide imagery and mapping contractor for:
  – Commonwealth of Virginia (2006-2016)

• Prior Michigan projects completed for:
  – Oakland, Manistee, Grand Traverse, Hillsdale, Otsego, Wayne and Livingston Counties
  – City of Ann Arbor

• Imagery and LiDAR under federal contracts in:
  – New Hampshire, Vermont, Massachusetts, and Maine

• Sanborn understands regional challenges
  – Short window of opportunity between snow-free and leaf-on
  – Weather patterns
  – Sanborn’s Ann Arbor office performing final QC of imagery
Project Management

- Rigorously applied Project Management Institute model

Primary Roles:
- Implement ISO 9001: 2008
- Regular status reports and project meetings
- Customer liaison to operations
- Project scope and schedule compliance
- Provide project work plan
- Implement use of P3E® Integrated Scheduling & Productivity Tracking System
- Implement Sharepoint Site
- Implement GeoServe
Krysia Sapeta

• Technical Base; Photogrammetry, Orthoimagery, Planimetric Update
• Over 20 years managing mapping programs
  – Project Management Professional (PMP)
  – Certified Photogrammetrist (CP)
  – GIS Professional (GISP)
• Recent Programs:
  – State Of Virginia
  – FL Department of Revenue (multi-year; Orthoimagery)
  – State of Kansas (Multi-year; FEMA LiDAR)
  – New York City (since 1997)
  – City of Colorado Springs (multi-year; Ortho, LiDAR, planimetric update)
  – LOJIC (orthoimagery, planimetric update, LiDAR)
Tentative Flight Areas

State of Michigan
Center for Shared Solutions
High Resolution Imagery Years

Acquisition Year
- 2004 - 2012
- 2013
- 2013 - Medium Priority
- 2013 - High Priority
- 2013 - Potential Partner

Imagery available for State Agency use only.
For information on how to access, please contact:
Everett Root
root@Michigan.gov
517-335-7180

Center for Shared Solutions
Department of Technology, Management & Budget
State of Michigan
5 February 2013

www.michigan.gov/cgi
ph: 517-335-7110
t: 517-335-2930
Program Details

• Base contract of 3 years, plus 2 option years (2013-2015 base, 2016, 2017 options)
• Imagery, LiDAR, and DaaS
• Can be expanded to other geospatial services, and to meet specialized/custom needs and requirements
• SOM has sole rights to use the data in perpetuity
• Partnership opportunities
  – County
    • Funding from: Federal, COGs, Cities, Townships, Utilities, Tribes, etc.
• Data sharing – At the discretion of the partner
## Feature Comparison

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>PREVIOUS</th>
<th>NEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Domain</td>
<td>No</td>
<td>Partner discretion</td>
</tr>
<tr>
<td>Partner price base product</td>
<td>$28</td>
<td>$28</td>
</tr>
<tr>
<td>Accuracy specification</td>
<td>&lt;6.67 feet @ 90% confidence</td>
<td>&lt;3.8 feet @ 95% confidence</td>
</tr>
<tr>
<td></td>
<td>NMAS standard</td>
<td>NSSDA standard</td>
</tr>
<tr>
<td>Infra-Red (IR or 4th band)</td>
<td>Optional Buyup</td>
<td>Included</td>
</tr>
<tr>
<td>Digital Elevation Model</td>
<td>Optional Buyup</td>
<td>Included</td>
</tr>
<tr>
<td>6” GSD Buyup</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3” GSD Buyup</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Lidar</td>
<td>NA</td>
<td>Yes – 5 buyup options</td>
</tr>
<tr>
<td>AOI Contiguity discount</td>
<td>No</td>
<td>Yes – 16%-17.7%</td>
</tr>
<tr>
<td>Sub-County AOI</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Program Offerings - Imagery

- Intent is to fly ~20% of State per year each spring, leaf-off, snow-free
- Base product is 12-inch pixel resolution
- Buy-up options for 6-inch and 3-inch high resolution areas (HRA’s)
- Accuracy at all resolutions will be NSSDA 1”=100’ @ 95% confidence = 3.8’ absolute accuracy
- Radiometry will be 4-band, 8-bit per channel R/G/B/NIR
- Tiled deliverable (5000’ x 5000’), GeoTIFF format
Data Acquisition
Extensive Sanborn-owned and partner-provided resources

- Fixed-wing aircraft (9), total of (28) on team (Sanborn and Keystone)
  - Includes multi-engine and turbine-powered aircraft
- Digital Aerial Cameras (5), total of (11) on team
- LiDAR sensors (3), total of (4) on team
- ABGPS/IMU-equipped for accurate sensor position & orientation information
UltraCam Eagle - Mapping

• Proven technology from Vexcel family of cameras
  • Third generation of Vexcel System
  • Sanborn has owned and operated Vexcel cameras since 2004
  • Solid state, in-flight exchangeable storage. Higher reliability. Less ground time.
• Large format Metric Camera
  • Larger footprint then Vexcel UltraCam reduces flying time and risk without compromising quality/accuracy
• Improved technology=improved quality
  • 5.2 μm pixel size state-of-the art CCD technology lower signal to noise ratio
Stereoscopic Coverage

• Overlapping images provide 3D viewing (typically 60% forward lap/30% sidelap)

• Adjacent images having overlapping coverage of the ground are known as stereo pairs, with the overlapping area known as a stereo model
Aerial Triangulation

• Ties photo coordinates to real world through AGPS/IMU and ground control
• Locally-based land survey support by *Surveying Solutions, Inc.* – largest survey firm in Michigan
• Forms the basis for the accuracy of all photogrammetric products
• Rigorous Analytical Aerial Triangulation – Least square adjustment
• Control points used as checkpoints to verify quality of the AT adjustment
• AT Report provided with residual values
Radial Distortion
Standard Digital Orthophoto

Photograph

Camera Lens

Radially Distorted above ground feature)

All above ground features displaced

‘Orthogonal’ Correction using Ground Surface (DEM/DTM)
Digital Elevation Model (DEM)

- Sanborn is creating a new DEM in all areas where imagery is ordered
- If a partnering agency has a DEM/DTM available, Sanborn may opt to use and update/enhance it, or replace it as needed
- Suitable for ortho production only
- Enhancement necessary for contour products
Primary Deliverable: 1’ Resolution
6” Buy-Up:
13. Seamless Mosaic (continued)
Seamless Mosaic (continued)
GeoServe – Editing in the Cloud

• Efficient Methodology for Orthoimagery Review
• Quality control of imagery via website interface
  – Login
  – Review data
  – Mark areas of concern
• Sanborn staff receive notifications on areas of concern
  – Corrections are made
  – Corrections posted
  – Issue responded to in the same interface
GeoServe Home Screen

SANBORN GeoServe™ Imagery Review On Demand
Online Quality Assurance Program
GeoServe - Login

Log In

User Name:  
Password:  

Remember me next time.

Log In
Add Point & Select Data Issue
Additional Information Can Be Added
Creator is captured based on login
LiDAR: Light Detection and Ranging

What it is?

Aerial sensor
Collects/scans data, either photons (reflected light) or laser pulses

Aerial GPS (Global Positioning System)
Based on GPS satellite triangulation, measures the location of the aircraft up to 0.1 second.

IMU (Inertial Measurement Unit)
Measures attitude (pitch/yaw/roll) of aircraft every 0.002 second.

Ground GPS
Measures the location of the aircraft up to 0.1 second relative to a known ground position.
LiDAR the Basics
Multiple return data
LiDAR Data

- LiDAR is an optional service offering under the contract
- Base product is Quality Level 2 (QL-2) LiDAR collection:
  - 2pts/m^2, 0.7m NPS,
  - Accuracy RMSEZ = 9.25cm,
  - Supports creation of 1-foot contours
  - Includes collection, delivery of calibrated-unclassified point cloud in LAS V1.1 or 1.2 format, intensity images, metadata, pertinent documentation
- Specifications are based largely on USGS Base Spec V1.0
- Spatial reference system is MSPCS, appropriate zone, units of Int’l Feet, most current realization of NAD83, NAVD88 datums
- Options include higher/lower quality levels, classified point cloud, bare earth DEM, hydro flattening, hydro enforcement, LAS V1.4 data format
Base Product LiDAR Raw Point Cloud

- Calibrated-unclassified point cloud
- Contains all collected points, georeferenced, in 3D
- Accurately Adjusted to ground
- Untiled – delivered by swath
- LAS V1.1 or 1.2 format
- Requires software and expertise to exploit

Hydro-electric dam, Puerto Rico
Option: Level of Accuracy
LiDAR Quality Levels

<table>
<thead>
<tr>
<th>Elevation Quality Levels (QL)</th>
<th>Source</th>
<th>Horizontal Resolution Terms</th>
<th>Vertical Accuracy Terms</th>
<th>Equivalent Contour Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>QL 1 LiDAR</td>
<td></td>
<td>8 pts/m²</td>
<td>0.35 m</td>
<td>9.25 cm</td>
</tr>
<tr>
<td>QL 2 LiDAR</td>
<td></td>
<td>2 pts/m²</td>
<td>0.7 m</td>
<td>9.25 cm</td>
</tr>
<tr>
<td>QL 3 LiDAR</td>
<td></td>
<td>1 – 0.25 pts/m²</td>
<td>1 – 2 m</td>
<td>≤18.5 cm</td>
</tr>
</tbody>
</table>
LiDAR – The Intensity Image
Standard Deliverable under the LiDAR Option

• Each LiDAR return has an intensity value
• Intensity image is a collective display of the intensity values.
• White areas show high reflectance (strong return) while black areas show low reflectance (weak return).
• Useful for:
  • Quality controlling LiDAR
  • Breakline extraction
  • LiDARgrammetry
  • Feature Extraction
• Tiled, 8-bit GeoTIFF
LiDAR - The Classified Point Cloud
Data Upgrade under the LiDAR Option

- Classification process separates LiDAR points into different categories
- Objective for Michigan project is mainly to separate ground points from non-ground points to create a bare-earth surface
- Tiled product deliverable
- LAS V1.1 or 1.2 format

### Minimum Classified Point Cloud Classification Scheme

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not ground (all returns deemed not ground returns)</td>
</tr>
<tr>
<td>2</td>
<td>Bare-earth ground (DEM)</td>
</tr>
<tr>
<td>7*</td>
<td>Noise (low or high; manually identified if needed)</td>
</tr>
<tr>
<td>9</td>
<td>Water (if Hydro-flattened or Hydro-enforced DEM requested)</td>
</tr>
<tr>
<td>10**</td>
<td>Ignored Ground (if Hydro-flattened or Hydro-enforced DEM requested; Breakline proximity)</td>
</tr>
<tr>
<td>11</td>
<td>Withheld (if the Withheld bit is not implemented in processing software)</td>
</tr>
</tbody>
</table>
DTM/DSM Extraction Processing

- Standard methods: filtering and thinning
Digital Surface Model (DSM)

Terrain point

Non-terrain point
LyDAR – The Bare Earth Surface DEM Specification: Data Upgrade under the LiDAR Option

- Bare earth surface DEM contains ground points only – 90-95% removal of other features
- ASCII point file with grid spacing no greater than 3-feet, no less than nominal pulse spacing
- Raster data file in ERDAS .IMG format with grid spacing no greater than 3-feet, no less than nominal pulse spacing
- Tiled delivery
Deliverables for hydro-flattened or enforced DEM’s include:

- ASCII point file with grid spacing no greater than 3-feet, no less than nominal pulse spacing
- Breakline data in Esri shapefile or geodatabase format
- Raster data file in ERDAS .IMG format with grid spacing no greater than 3-feet, no less than nominal pulse spacing
- Tiled delivery

Note that State of Michigan specifications contain some departures from USGS Base Spec V1.0.
LiDAR – Hydro Flattened & Enforced DEM’s
Data Upgrade under the LiDAR Option

- **Hydrological Flattening** - Processing of a DEM so you have a uniform, continuous water surface. Water bodies >2 acres, streams wider than 100 feet.
- **Hydrological Conditioning** - Processing of mapped water bodies so that lakes and reservoirs are level and so that streams flow downhill
Raw Point Cloud (All-Returns)
LiDAR: Bare-earth DEM

Story, Wyoming
Hydro-flattening/Contouring
DEM, DTM, DSM

• DEM: Digital Elevation Model
  – A data structure made up of x, y points with z-values representing elevations
  – No breaklines, mass points only
  – Typically Gridded

• DTM: Digital Terrain Model
  – A data structure made up of x, y points with z-values representing elevations
  – Bridge removal
  – DEM + breaklines = DTM

• DSM: Digital Surface Model
  – A model that includes features above ground (buildings and vegetation)
  – Combine with DTM/DEM for all coverage
LiDAR Processes
LiDAR Calibration

Critical

- Separate sensor collection versus check point survey

- Calibration at installation
- Calibration every three months
- Calibration every mission
- Proper installation and lever Arm survey

Four Runway Calibration Scans
Cleaning the Optical Glass under the aircraft
• Standard methods: filtering and thinning
Manual Editing
Final Manual Edit & QC
Application Trends for LiDAR
Applications
Oblique Views

Hydro-electric Dam, Puerto Rico
Applications LiDAR – Fully Classified Data

- Buildings
- Bare Earth
- Vegetation
Application Trends for LiDAR
Building Extraction

Morris County, NJ

Digital Surface Model

Building Footprints
Application Trends for LiDAR
Simple Building Outline: 2D Polygon with Elevation Attribute
Tom Sauk Reservoir; Rapid Response
Application Trends for LiDAR

Water Body Classification

Lake on map

Lake before classification and elevation averaging

Lake after classification and elevation averaging

ArcTIN surface model
Mapping Solar Insolation
Mapping Solar Insolation
Michigan – DaaS (Option)

- Imagery hosted in the ‘Cloud’
- State to load and test accessibility and performance
- Determine what requirements are met
- Assess viability and cost of implementing additional requirements
- Test and determine course of action
- Possible offering to partners
$28 per square mile for base product:
- 12” GSD
- 4-band
- AOIs defined by County boundary

Detailed specifications in Ortho-Imagery Specifications SOM_CSS.doc

<table>
<thead>
<tr>
<th>Percent Price Reduction for contiguous AOIs – assumes consistent GSD collection over the AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contiguous Square Miles</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>0 – 2,500</td>
</tr>
<tr>
<td>2,501 – 5,000</td>
</tr>
<tr>
<td>&gt;5,000</td>
</tr>
</tbody>
</table>

BUY UPS – Price in addition to base product cost of $28 / sq. mile

6” GSD, 4-band, per square mile price based on the following High Resolution Areas (HRA) values. Detailed specifications in Ortho - Imagery Specifications SOM_CSS.doc - Section 6.1

<table>
<thead>
<tr>
<th>Square Miles</th>
<th>Cost per sq. mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-100</td>
<td>$151.44</td>
</tr>
<tr>
<td>101-500</td>
<td>$94.08</td>
</tr>
<tr>
<td>&gt;500</td>
<td>$82.53</td>
</tr>
</tbody>
</table>

3” GSD, 4-band, per square mile price based on the following High Resolution Areas (HRA) values. Detailed specifications in Ortho - Imagery Specifications SOM_CSS.doc - Section 6.1

<table>
<thead>
<tr>
<th>Square Miles</th>
<th>Cost per sq. mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-100</td>
<td>$359.14</td>
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<tr>
<td>101-500</td>
<td>$243.57</td>
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<tr>
<td>&gt;500</td>
<td>$226.87</td>
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</tbody>
</table>

Updated DEM, per square mile price to be based on AOI. Detailed specifications in Ortho - Imagery Specifications SOM_CSS.doc - Section 6.2

<table>
<thead>
<tr>
<th>AOI</th>
<th>Cost per sq. mile</th>
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<tbody>
<tr>
<td>Equal to AOI</td>
<td>Included in Ortho Prices</td>
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</tbody>
</table>

Compressed Image Mosaics - price per County. Detailed specification in Ortho - Imagery Specifications SOM_CSS.doc - Section 6.3

<table>
<thead>
<tr>
<th>Cost / County</th>
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<tbody>
<tr>
<td>$400</td>
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### 2013 Tentative Flight Areas

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>SQ MILES</th>
<th>PARTNER COST</th>
<th>PARTNER TOTAL</th>
<th>SAVINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST JOSEPH (partner)</td>
<td>521</td>
<td>28.00</td>
<td>$14,588</td>
<td></td>
</tr>
<tr>
<td>CALHOUN (partners)</td>
<td>718</td>
<td>28.00</td>
<td>$20,104</td>
<td></td>
</tr>
<tr>
<td>BRANCH</td>
<td>520</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HILLSDALE</td>
<td>607</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2366</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>SQ MILES</th>
<th>PARTNER COST</th>
<th>PARTNER TOTAL</th>
<th>SAVINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST JOSEPH (partner)</td>
<td>521</td>
<td>23.52</td>
<td>$12,254</td>
<td>$2,334</td>
</tr>
<tr>
<td>CALHOUN (partners)</td>
<td>718</td>
<td>23.52</td>
<td>$16,887</td>
<td>$3,217</td>
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<tr>
<td>BRANCH</td>
<td>520</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>HILLSDALE</td>
<td>607</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KALAMAZOO</td>
<td>580</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2946</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Acquisition Year**

- **2004 - 2012**
- **2013**
- **2013 - Medium Priority**
- **2013 - High Priority**
- **2013 - Potential Partner**

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State of Michigan
Center for Shared Solutions
High Resolution Imagery Years

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Center for Shared Solutions
Department of Technology, Management & Budget
State of Michigan
5 February 2013

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**Lidar Pricing**  
January 30, 2013

Base product collected using specifications defined in Sections 4, 5, and 6 of *Lidar Specifications SOM_CSS.doc* and QL 2 accuracy specifications from Section 4.7 (pg. 5)

**Note:** The total cost for any deliverable is dependent on the Base Product Cost plus the deliverables that precede that deliverable.

For example: Cost of Bare-Earth Surface (option 2) data would equal Base Product cost + Option 1 cost + Option 2 cost for the chosen Area Of Interest (AOI)

<table>
<thead>
<tr>
<th>Base Product Deliverable</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Raw Point Cloud - Calibrated-unclassified</strong> -- see Deliverables Section 7.2</td>
<td></td>
</tr>
<tr>
<td>square miles</td>
<td>Cost per sq. mile</td>
</tr>
<tr>
<td>&lt;100</td>
<td>$248.17</td>
</tr>
<tr>
<td>101-500</td>
<td>$129.31</td>
</tr>
<tr>
<td>501-1000</td>
<td>$122.25</td>
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<tr>
<td>1001-5000</td>
<td>$107.19</td>
</tr>
<tr>
<td>&gt;5000</td>
<td>$99.44</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Deliverable Option 1</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Classified Point Cloud</strong> -- see Deliverables Section 7.3</td>
<td></td>
</tr>
<tr>
<td>square miles</td>
<td>Cost per sq. mile</td>
</tr>
<tr>
<td>&lt;100</td>
<td>$30.03</td>
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<tr>
<td>101-500</td>
<td>$27.02</td>
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<tr>
<td>501-1000</td>
<td>$26.51</td>
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<tr>
<td>1001-5000</td>
<td>$26.13</td>
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<tr>
<td>&gt;5000</td>
<td>$26.06</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Deliverable Option 2</strong></th>
<th></th>
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<tbody>
<tr>
<td><strong>Bare-Earth Surface</strong> -- see Deliverables Section 7.4</td>
<td></td>
</tr>
<tr>
<td>square miles</td>
<td>Cost per sq. mile</td>
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<tr>
<td>&lt;100</td>
<td>$13.97</td>
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<tr>
<td>101-500</td>
<td>$13.97</td>
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<tr>
<td>501-1000</td>
<td>$13.97</td>
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<tr>
<td>1001-5000</td>
<td>$13.97</td>
</tr>
<tr>
<td>&gt;5000</td>
<td>$13.97</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Deliverable Option 3</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydro-flattened Bare-Earth Surface, including Breaklines</strong> -- see Deliverables Section 7.5</td>
<td></td>
</tr>
<tr>
<td>square miles</td>
<td>Cost per sq. mile</td>
</tr>
<tr>
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<td>$10.06</td>
</tr>
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<td>101-500</td>
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<td>1001-5000</td>
<td>$10.06</td>
</tr>
<tr>
<td>&gt;5000</td>
<td>$10.06</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Deliverable Option 4</strong></th>
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<tbody>
<tr>
<td><strong>Hydro-Enforced Digital Elevation Model (DEM)</strong> -- see Deliverables Section 7.6</td>
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</tr>
<tr>
<td>square miles</td>
<td>Cost per sq. mile</td>
</tr>
<tr>
<td>&lt;100</td>
<td>$63.96</td>
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<tr>
<td>101-500</td>
<td>$35.12</td>
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<tr>
<td>501-1000</td>
<td>$29.25</td>
</tr>
<tr>
<td>1001-5000</td>
<td>$29.25</td>
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<tr>
<td>&gt;5000</td>
<td>$29.25</td>
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<table>
<thead>
<tr>
<th><strong>Deliverable Option 5</strong></th>
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<tbody>
<tr>
<td><strong>Lidar Intensity Images</strong> -- see Deliverables Section 7.7</td>
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</tr>
<tr>
<td>square miles</td>
<td>Cost per sq. mile</td>
</tr>
<tr>
<td>&lt;100</td>
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<td>101-500</td>
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<tr>
<td>1001-5000</td>
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<td>&gt;5000</td>
<td>0</td>
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</table>
## Lidar Pricing

<table>
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<tr>
<th>OPTION</th>
<th>TOTAL @ 600 SQ. MILES</th>
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<tbody>
<tr>
<td>Base Product (BP)</td>
<td>$73,350</td>
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<tr>
<td>BP + Option #1</td>
<td>$89,256</td>
</tr>
<tr>
<td>BP + Option #1 + #2</td>
<td>$97,638</td>
</tr>
<tr>
<td>BP + Option #1 + #2 +#3</td>
<td>$103,674</td>
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<tr>
<td>BP + All Options</td>
<td>$121,224</td>
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<table>
<thead>
<tr>
<th>OPTION</th>
<th>TOTAL @ 36 SQ. MILES</th>
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</thead>
<tbody>
<tr>
<td>Base Product (BP)</td>
<td>$8,934</td>
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<tr>
<td>BP + Option #1</td>
<td>$10,015</td>
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<tr>
<td>BP + Option #1 + #2</td>
<td>$10,518</td>
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<tr>
<td>BP + Option #1 + #2 +#3</td>
<td>$10,880</td>
</tr>
<tr>
<td>BP + All Options</td>
<td>$13,182</td>
</tr>
</tbody>
</table>
How to Order

• Work with Everett (roote@michigan.gov)
  – 517-373-7910

• Create Statement of Work (SOW)
  – Identify products
  – Calculate costs
  – Identify partner points of contact

• Implement agreement (still in draft)
  – Partner signatures, Board approvals, etc.
Thank you to State of Michigan for this Opportunity

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