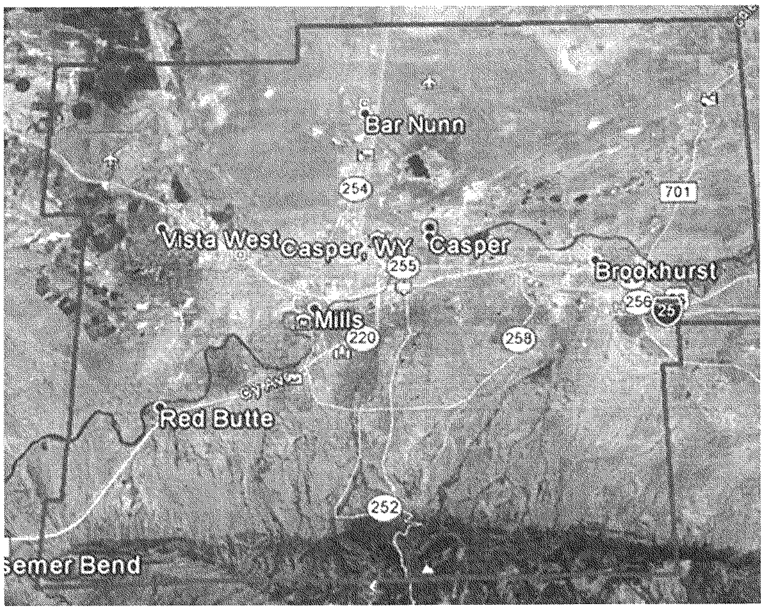
EXHIBIT "A"
SCOPE OF SERVICES

Scope of Work for 3-inch Imagery



Area of interest: Casper MPO 3-inch resolution Area:	207.60 Square miles
Orthoimagery Resolution:	3-inches
Horizontal Accuracy of Imagery:	ASPRS Class I at 1"=50'
Imagery Radiometry:	4-band RGB, 8-bits per channel RGB/NIR
Projection and Datum:	NAD83(86) State Plane Wyoming East Central Zone, US Survey Foot
Tile Size:	TBD

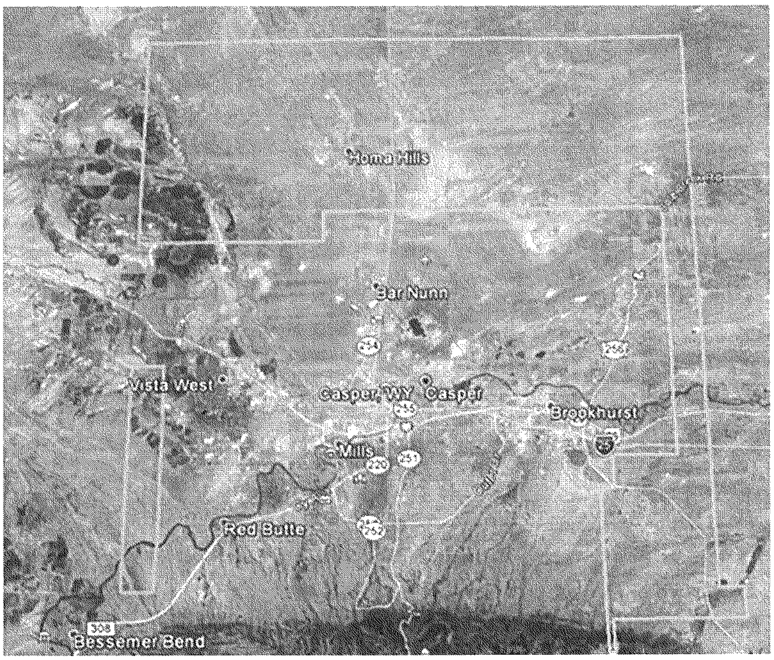
Planimetric Mapping – Sanborn will update planimetric features visible in the imagery commensurate with the following features:

1. Hydrography (HydroLine, HydroPoly, Drainage Basin)
   a. Natural Stream Centerlines or also include storm drainage infrastructure.
   b. Line geometry is to be consistent with the topographic data and digitized direction will be consistent with flow direction.

2. Structures/Buildings
   Feature updates will be extracted from the controlled aerial imagery in a 3D stereoscopic environment, utilizing first-order softcopy workstations and photogrammetrists experienced in photo interpretation. Quality assurance steps will ensure that each required planimetric feature is being collected to correct graphical representation and annotation

requirements. The topological structure of all features will be checked to ensure that no snapping errors or point duplications exist. All newly compiled planimetric data will meet 1"=50' map scale accuracy. Sanborn will work with Casper MPO to ensure updated planimetric data is structured according to the current Casper MPO geo-database model.

Scope of Work for 6-inch Imagery



Area of interest: Casper MPO 6-inch Area:	145.6 Square miles
Orthoimagery Resolution:	6-inches
Horizontal Accuracy of Imagery:	ASPRS Class I at 1"=100'
Imagery Radiometry:	4-band RGB, 8-bits per channel RGB/NIR
Projection and Datum:	NAD83(86) State Plane Wyoming East Central Zone, US Survey Foot
Tile Size:	TBD

Scope of Work for Imagery Regardless of Resolution

Aerial Data Acquisition: Aerial imagery will be collected with full stereoscopic coverage. Sanborn proposes to conduct the flight under optimal, leaf-off conditions in spring, 2015 when:

- In no case less than 30° above the horizon
- The air is burdened with the minimal smoke, smog, haze, fog, dust, or other obscuring phenomena

- No material amount of snow is present on the ground without clients approval
- Rivers, lakes, and other water bodies are within their natural banks

Airborne GPS: Sanborn will provide airborne GPS/Inertial Measurement Unit (AGPS/IMU) data as the primary support for image positioning and orientation, minimizing the required number of ground control points required, while still enabling the creation of orthoimagery and other mapping products that conform to the accuracy standards set for the project.

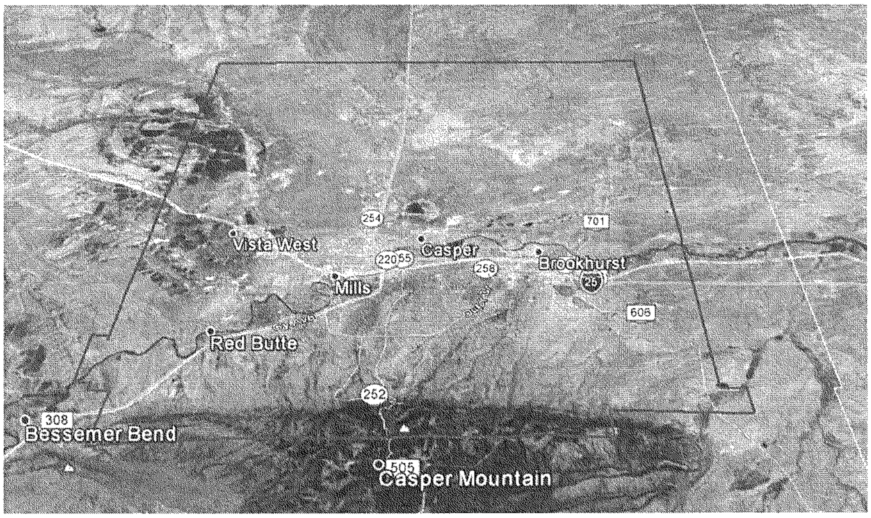
Ground Control Survey: Sanborn's approach will utilize existing, available control points where possible, augmented with newly surveyed ground control points where needed (paneled or photoID), together with AGPS/IMU-controlled aerial photography to accurately control the Fully Analytical Aerial Triangulation (FAAT) solution. Sanborn will evaluate the use of survey control points at PLSS corners and utilize if appropriate and practical.

Aerial Triangulation (AT): Sanborn will complete fully analytical aerial triangulation (AT) to support the production of the orthoimagery and planimetric products. Sanborn will verify and extend control by completing a least squares adjustment using the control points and photo coordinates to derive ground coordinates at individual von Gruber locations. The final adjustment will be reviewed and approved by one of Sanborn's ASPRS Certified Photogrammetrists.

Digital Elevation Model (DEM): Sanborn will use an existing DEM with updates or create a new DEM from the stereo imagery as the terrain input for the orthorectification process. The DEM will be edited as needed to correctly remove sources of distortion on or near the terrain surface. Regardless of DEM processed used by Sanborn the horizontal accuracy will meet the stated standards.

Orthoimagery Creation: Sanborn's orthorectification system draws upon digital elevation models (DEMs), camera information, imagery, and AT data to create orthoimagery products. Color balancing and mosaicking will be performed to ensure a final imagery database that is both radiometrically and geometrically seamless. The imagery will be partitioned as desired, and written out in compliance with the desired naming convention in .TIFF/.TIFW format (GeoTIFFs can also be supported). Tiles will match at the edges with no overlap or gap.

Scope of Work for USGS QL2 LiDAR



LiDAR USGS QL2 Area (red boundary):	353.96 Square Miles
Vertical Accuracy of LiDAR:	USGS QL2 Specifications (meeting USGS 3DEP Compliance)
Projection and Datum:	NAD83(86) State Plane Wyoming East Central Zone, US Survey Foot NAVD88 using the most current NGS Geoid Model, presently GEOID12A, US Survey Foot
Tile Size:	TBD

Aerial Data Acquisition – LiDAR data acquisition will be conducted to support the USGS QL2 3DEP Specifications. Sensor configuration will be setup to deliver a .7m pulse spacing and 2pts/M2. Data will be captured under flight conditions that are void of precipitation above or below the aircraft or clouds/smoke below the aircraft. All missions will be flown with a PDOP less than 3.2 and a KP index of less than 4. Planned overlap will be 30% or greater.

Contour Production – The LiDAR DTM is processed into a TIN model, and 1-foot contours are generated. All contour lines will be solid and unbroken throughout the project, with no gaps or dangles present. Contours will be filtered and smoothed in order to extract redundant point data/vertices, and produce a more aesthetically pleasing appearance.

Ground Control Survey – Sanborn will perform a LiDAR calibration surveys. These survey points will be used in the calibration/boresight process to ensure the vertical accuracy of the LiDAR data, and to test processed LiDAR data and derivative data products prior to delivery. Sanborn's scope of work does not include USGS survey check points or accuracy report. All control and reference points used to calibrate, control, and process, the LiDAR point data or any derivative products are to be delivered and referenced within the control section of the collection report. Sanborn will evaluate the use of survey control points at PLSS corners and utilize if appropriate and practical.

Post-processing and classification – Post-processing of all LiDAR data flight strips is completed to verify quality and coverage of the LiDAR data using a variety of software applications. LiDAR data must be filtered and classified to separate terrain data from other data on land cover and manmade features. Classification for this project will be in accordance with USGS LiDAR Base Specification Version 1.2. Classification will include delivery of all points within a .LAS format coded as follows:

Code Description

- 1 Processed, but unclassified.
- 2 Bare earth.
- 7 Low noise.
- 9 Water.
- 10 Ignored ground (near a breakline).
- 17 Bridge decks.
- 18 High noise.

Hydro Flattened Breaklines – Sanborn will digitize breaklines to ensure hydrography within the project area is flattened (See the "Hydro-Flattening" section and Appendices 2 "Guidelines" and 3 "Hydro-Flattening Reference" in the USGS Lidar Base Specification Version 1.2 for detailed specification). Sanborn will follow the minimum requirements of the USGS LiDAR Base Specification Version 1.2. This does not include single line drains. Monotonicity will be maintained for all hydrography features that are digitized. Additionally, point classification for ignored ground and water will be used in conjunction with breakline placement.

Hydro Enforced Breaklines – Sanborn will digitize breaklines to ensure hydrography within the project area is enforced. Sanborn will follow the minimum requirements of the USGS LiDAR Base Specification Version 1.2. This does not include single line drains. Monotonicity will be maintained for all hydrography features that are digitized. Additionally, point classification for ignored ground and water will be used in conjunction with breakline placement. Breaklines will consist of culverts and underground streams.

Quality Assurance – As a company with ISO-certified quality control procedures, Sanborn will ensure that all deliverables provided to the County adhere to both high aesthetic quality and spatial accuracy standards. All production phases are quality controlled and documented.

Pilot Project

Pilot Project – The Consultant will deliver a prototype project, defined during the kick-off meeting. The prototype project will establish delivery and acceptance standards, and establish policies and procedures to follow throughout the balance of the process. Upon completion of this prototype project, an on-site review will be conducted (post mortem) to assure appropriate expectations and standards.

Third Party Quality Control and Assurance

A third party company will be utilized to perform quality assurance and control on the project. This process will ensure the specifications for the project scope of work including content and accuracy. Sanborn will work with the third party QA/QC vendor to ensure mutually acceptable acceptance criteria and processes are used that meet the specifications outlined in the scope of work. Any non-conformities, data rejections, etc. that do not meet the acceptance criteria will be reviewed by Sanborn and corrected at the cost of Sanborn.

Project Deliverables

All data will be delivered on USB 2.0 portable hard drives. Sanborn will work with the Natrona Regional Geospatial Cooperative to ensure the deliverables are structured and compatible with the current Natrona Regional Geospatial Cooperative's geodatabase model. The deliverables for the project are as follows:

- A flight map/control diagram
    - Project documentation must also include a Pre-Flight Operations Plan and Post-flight Aerial Survey and Calibration Report.
- Survey Report detailing the collection of control and reference points used for photogrammetry, and LiDAR calibration.
    - All control and check points are to be delivered in ESRI Geodatabase format.
- Aerial triangulation report
- 3-inch spatial resolution 4-band, 8-bit RGB/NIR orthoimagery files in .TIFF/.TIFW format for 207.60 square miles
- Project wide MrSID mosaics will be provided in .SID/.SDW format with 20:1 compression for the 3-inch area
- Planimetric updates in ESRI Geodatabase and Autocad v2012 format for 207.60 square miles
- 6-inch spatial resolution 4-band, 8-bit RGB/NIR orthoimagery files in .TIFF/.TIFW format for 145.6 square miles

- Project wide MrSID mosaics will be provided in .SID/.SDW format with 20:1 compression for the 6-inch area
- Raw point cloud in .LAS format
- Classified point cloud in .LAS format
- HydroEnforced breaklines and hydro-flattened breaklines in Esri Geodatabase format
- Hydro flattened bare earth DEM in .IMG format meeting the specifications of the USGS 3DEP program
- Hydro enforced bare earth DEM in .IMG format
- 1-foot contours in Esri Geodatabase and Autocad v2012 format
- Processing Report detailing calibration, classification, and product generation procedures including methodology used for breakline collection, hydro-enforcement and hydro-flattening.
- FGDC compliant (XML format) metadata and other pertinent project documentation including a Topographic Data Production Methodology Report

Project Schedule

Product	Completion Date
Survey, Imagery and LiDAR Acquisition Plan	April 1st, 2015
Survey, Imagery and LiDAR Acquisition	May 15th, 2015
Aerial Triangulation and Survey Report	October 30th, 2015
Orthophoto, planimetric and Topographic delivery	March 31st, 2016
Final Acceptance	April 30th, 2016

EXHIBIT "B"

MPO POLICY COMMITTEE APPROVAL

WHEREAS, on February 26, 2015, the Casper Area Metropolitan Planning Organization Policy Committee approved the hiring of The Sanborn Map Company, Inc. (Sanborn) to complete the 2015 Aerial Photography Update; and

WHEREAS, Sanborn is willing, available and qualified to perform said work.

NOW, THEREFORE BE IT RESOLVED BY THE MPO POLICY COMMITTEE: That the City of Casper, as the AGENT of the MPO, is hereby directed to enter into a Contract with The Sanborn Map Company, Inc. to complete the 2015 Aerial Photography Update in accordance with the scope of work and schedule included in this Agreement, for a contract amount not to exceed Two Hundred and Fifty Thousand Dollars ($250,000.00).

PASSED AND APPROVED THIS 26TH day of February, 2015.

ATTEST:

Liz Becher
Community Development Director

CASPER AREA METROPOLITAN PLANNING ORGANIZATION

Phil Hinds
Chairman

EXHIBIT "C"

NOTICE TO CONSULTANT
COMPLIANCE WITH TITLE VI OF THE CIVIL RIGHTS ACT OF 1984
FOR FEDERAL-AID CONTRACTS

During the performance of this Contract, The Sanborn Map Company, Inc. for itself, its assignees and successors in interest (hereinafter referred to as the Consultant), agrees as follows:

1. Compliance with Regulations.

The Consultant will comply with the Regulations of the Department of Transportation relative to nondiscrimination in federally-assisted programs of the Department of Transportation (Title 49, Code of Federal Regulations, Part 21, hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

2. Nondiscrimination.

The Consultant, with regard to the work performed by it after award and prior to completion of the Contract work, will not discriminate on the grounds of race, color, national origin, or disability in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Consultant will not participate either directly or indirectly in the discrimination prohibited by any state or federal law including, but not limited to, Section 21.5 of the Regulations, including employment practices, when the contract covers a program set forth in Appendix B of the Regulations.

3. Solicitations for Subcontracts, Including Procurements of Materials and Equipment.

In all solicitations, either by competitive bidding or negotiation made by the Consultant for work to be performed under a subcontract, including procurements or materials or equipment, each potential subcontractor or supplier shall be notified by the Consultant of the Consultant's obligations under this Contract and the Regulations relative to nondiscrimination on the ground of race, color, or national origin.

4. Information and Reports.

The Consultant will provide all information and reports required by the Regulations, or orders and instructions issued pursuant thereto, and will permit access to its books, records, accounts, other sources of information and its facilities as may be determined by the MPO Policy Committee, WYDOT, or FHWA to be pertinent to ascertain compliance with such regulations, orders, and instructions. Where any information required of a Consultant is in the exclusive possession of another who fails or refuses to furnish this information, the Consultant shall so certify to the MPO Policy Committee, WYDOT, or

FHWA as appropriate, and shall set forth what efforts it has made to obtain the information.

5. Sanctions for Noncompliance.

In the event of the Contractor's noncompliance with the nondiscrimination provisions of this contract, the MPO Policy Committee shall impose such contract sanctions as it or WYDOT or the FHWA may determine to be appropriate, including, but not limited to:

A. Withholding of payments to the Contractor under the contract until the Contractor complies; and/or,

B. Cancellation, termination, or suspension of the contract, in whole or in part.

6. Incorporation of Provisions.

The Consultant shall include the provisions of Paragraph 1 through 6 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the regulations, order, or instructions issued pursuant thereto. The Consultant will take such action with respect to any subcontract or procurement as the MPO Policy Committee, WYDOT, or the FHWA may direct as a means of enforcing such provisions, including sanctions for noncompliance. Provided, however, that, in the event a Consultant becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Consultant may request the United States to enter into such litigation to protect the interests of the United States.

FHWA as appropriate, and shall set forth what efforts it has made to obtain the information.

5. Sanctions for Noncompliance.

In the event of the Contractor's noncompliance with the nondiscrimination provisions of this contract, the MPO Policy Committee shall impose such contract sanctions as it or WYDOT or the FHWA may determine to be appropriate, including, but not limited to:

A. Withholding of payments to the Contractor under the contract until the Contractor complies; and/or,

B. Cancellation, termination, or suspension of the contract, in whole or in part.

6. Incorporation of Provisions.

The Consultant shall include the provisions of Paragraph 1 through 6 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the regulations, order, or instructions issued pursuant thereto. The Consultant will take such action with respect to any subcontract or procurement as the MPO Policy Committee, WYDOT, or the FHWA may direct as a means of enforcing such provisions, including sanctions for noncompliance. Provided, however, that, in the event a Consultant becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Consultant may request the United States to enter into such litigation to protect the interests of the United States.

EXHIBIT "D"

CERTIFICATION OF CONSULTANT

I hereby certify that I am the President and CEO and duly authorized representative of the firm of The Sanborn Map Company, Inc.; and that neither I nor the above firm I here represent has:

1. Employed or retained for a commission, percentage, brokerage fee, contingent fee, or other consideration, any firm or person (other than a bona fide employee working solely for me or the above Consultant) to solicit or secure this Agreement;

2. Agreed, as an express or implied condition for obtaining this Agreement, to employ or retain the services of any firm or person in connection with carrying out the Agreement; or,

3. Paid, or agreed to pay, to any firm, organization, or person (other than a bona fide employee working solely for me or the above Consultant) any fee, contribution, donation, or consideration of any kind for, or in connection with, procuring or carrying out the Agreement, except as here expressly stated (if any).

I acknowledge that this Certification is to be given to the Casper Area Metropolitan Planning Organization, and is subject to applicable state and federal laws, both criminal and civil.

4|15|2015
Date

[signature]
Signature

John R. Copple
Printed Name

President/CEO
Title

EXHIBIT "E"

CERTIFICATE OF AGENT

I hereby certify that I am the designated AGENT of the City of Casper, Wyoming, a Municipal Corporation, and that the above consulting firm or its representatives have not been required, directly or indirectly as an express or implied condition in connection with obtaining or carrying out this Contract to:

1. Employ or retain, or agree to employ or retain, any firm or person; or,

2. Pay, or agree to pay, to any firm, person, or organization any fee, contribution, donation, or consideration of any kind; with no exceptions.

I acknowledge that this Certification is subject to applicable state and federal laws, both criminal and civil.

ATTEST:

Date 04/21/15

CITY OF CASPER, WYOMING
A Municipal Corporation:

Charlie Powell
Mayor

EXHIBIT "F"

CERTIFICATION OF
SUSPENSION OR DEBARMENT

STATE OF COLORADO)ss

COUNTY OF EL PASO)ss

I, John R. Copple, being duly sworn on oath, certify that neither I, nor any person associated therewith in the capacity of Owner, partner, director, or officer is currently under suspension, debarment, voluntary exclusion, or determination of ineligibility by any state or federal agency; have been suspended, debarred, voluntarily excluded, or determined ineligible by any state or federal agency within the past three years; have a proposed debarment pending; and, nor have been indicted, convicted, or had a civil judgment rendered against (it) by a court of competent jurisdiction in any matter involving fraud or official misconduct within the past three years.

By: [signature]

President/CEO
Title

Subscribed in my presence and sworn to before me this 15th day of April, 2015, by:
John R. Copple, President/CEO.

[signature]
Amy E. Kappel

Notary Public

AMY E KAPPEL
Notary Public
State of Colorado
Notary ID 20014018700
My Commission Expires Jun 18, 2017

6/18/2017
My Commission Expires

EXHIBIT G

Sanborn's Technical and Price Proposal dated December 19, 2014.

sanborn

www.sanborn.com | 1.866.726.2676

Due: 4:00 p.m.

Friday, December 19, 2014

Prepared exclusively for:

The Metropolitan Planning Organization (MPO) of Casper, Wyoming

Professional Services Regarding Geographic Information System 2015 Aerial Mapping Update

Project # MPO 15-02

Copy

sanborn

Corporate Headquarters
1935 Jamboree Drive
Suite 100
Colorado Springs, CO 80920

Phone: 719.593.0093
Toll-Free: 1.866.726.2676
Fax: 719.528.5093
www.sanborn.com

December 17, 2014

Mr. Andrew Nelson
Casper Area Metropolitan Organization
200 North David
Casper, WY 82601

Re: Request for Proposals for Professional Services Regarding Geographic Information System 2015 Aerial Mapping Update for the Metropolitan Planning Organization Casper, Wyoming 82601, Project Number: MPO 15-02

Dear Mr. Nelson:

On behalf of The Sanborn Map Company, Inc. (Sanborn), it is my pleasure to submit this proposal to you for the project referenced above. Sanborn, an ISO 9001:2008-certified company, is excited about the opportunity to again work with the Metropolitan Planning Organization of Casper (MPO) on this program. You should find our proposal complete and compiled in accordance with your request.

Under this project, the MPO desires to obtain high-quality digital color orthophotography, planimetric, topography and elevation/LiDAR data. It is understood that this project will support the ongoing efforts of the Regional Geospatial Cooperative formed by the City of Casper, Natrona County, and the Towns of Bar Nunn, Evansville, and Mills.

Sanborn was established in 1866. Headquartered in Colorado Springs, Colorado, it is the country's oldest map company and one of the largest photogrammetric mapping and GIS data conversion firms in the United States. Sanborn's primary business function is providing professional mapping services to public and private-sector organizations around the world. With over 130 personnel dedicated solely to mapping and GIS activities, Sanborn provides unparalleled depth and technical expertise to its clients.

Sanborn has a long held reputation for excellence. In fact, the Colorado Springs facility was one of the first commercial mapping firms to develop and implement a digital orthorectification production environment. Since that time, the performance and capability of the system has continually been enhanced. Our outstanding production processes have earned us industry recognition in the form of quality and on-time delivery awards from the USGS. With more than 200,000 square miles of orthorectified imagery data created in within the State of California over the past four years alone, Sanborn has an unsurpassed depth of knowledge and experience for the development of remote sensing products directly related to this scope of work. Sanborn owns the required aircraft and sensor systems, and we have developed a variety of custom filters and algorithms for processing data that results in the highest quality mapping products available in the industry.

Sanborn's product excellence combined with a strong project management system will help ensure that the MPO's project will be successfully completed according to your needs. The outlined imagery program will require a project team that has the expertise and resources to complete this project in the timeframe required. You will have an experienced, attentive, and dedicated project management team assigned throughout the entirety of this program.

In addition to our product excellence and strong project management system, Sanborn provides the following benefits.

- **International Standards Organization (ISO):** Sanborn's Total Quality Management System ensures a production flow that produces exceptional quality.
- **Resource Capacity:** Sanborn's proposal leverages our extensive resources in order to provide a service solution with excess acquisition and production capacity. We own the aircraft, sensor equipment and maintain the qualified staff required to make this project a success.
- **Superior Production Experience:** Sanborn has offered aerial photography and photogrammetric mapping services since 1966, and in 1988 became the first private mapping organization in the United States to implement a commercially successful system for the production of digital orthophoto imagery. Sanborn has also invested in new sensors and processing technology to ensure that our LiDAR capabilities are best-in-class, while developing sophisticated processes to integrate multiple sensors into our LiDAR workflow.

Our proposal has addressed the entire Request for Proposals requirements; however, should you have questions or need clarification, please contact Ms. Caroline Tyra, Director of Strategic Accounts, at (719) 264-5511 or ctyra@sanborn.com. We appreciate the opportunity to submit a proposal to you, and we look forward to the results of your evaluation.

Sincerely,

Corporate Secretary

for John R. Copple
President/CEO

Enclosures

Table of Contents

Section 1 – Statement of Project Requirements

Executive Summary

The Sanborn Map Company, Inc. (Sanborn) has thoroughly reviewed the City of Casper Metropolitan Planning Organization's (MPO) Request for Proposal (RFP) for Professional Services regarding Geographic Information System 2015 Aerial Mapping Update. We have carefully considered the project requirements and the technical specifications involved. Our goal is to provide the MPO with accurate, high-quality mapping products and exceptional customer service.

Project Understanding

Sanborn understands that the MPO has made a significant investment in GIS, and supports a variety of applications to enhance the level of service provided by various MPO departments. The foundation of all of these applications is accurate, up-to-date base map data, including digital orthophotography, terrain surface, and planimetric base layers.

The MPO has used digital orthophotography, terrain surface, and planimetric information extensively and has experience with these data layers, having last been updated in 2010, when 12-inch (149 square miles) and 6-inch (207 square miles) resolution orthophotography was obtained.

Scope of Work

Sanborn understands that the MPO wishes to procure:

- New color aerial imagery;
- Establishment or recovery of ground control as needed to support the project;
- Aerial triangulation services as needed to position, orient, and tie the newly-acquired aerial imagery, and verify the integrity of the control solution;
- An updated digital elevation model (DEM) that will support accurate orthorectification and contour production;
- New 3-inch spatial resolution, 4-band, 8-bit-per-channel, color digital orthophotographs;
- New 6-inch spatial resolution, 4-band, 8-bit-per-channel, color digital orthophotographs;
- Imagery that will be delivered in tiled and mosaicked GeoTIFF and MrSID formats, with accompanying world files;
- Updated planimetric data layers consisting of building footprints, pavement edges, and other planimetric features, provided in Esri and AutoCAD formats;
- Options for 1-foot or 2-foot contour data set, to include the outlined area of interest, plus an additional 6.4 mile additional area (Bessemer Bend);

- Supplemental documentation, reports, and deliverables created as a part of the production process for all data layers, as outlined in the RFP, including metadata; and
- Six optional 6-foot x 6-foot full-color prints.

Mapping limit AOI's are understood to be defined according to the 2010 flight boundary, with optional areas of inclusion identified by Natrona County. The data layers are to be georeferenced and projected in the State Plane Wyoming East Central Coordinate System, most recent realizations of the NGS-published NAD83(86) horizontal datum and NAVD88 (Geoid12A)vertical datum, and in units of U.S. Survey Feet.

In order to assist with the project, the MPO has agreed to provide:

- Esri and AutoCAD format files containing its existing planimetric data layers;
- The MPO Flight Technical Advisory Committee (FTAC) will provide attribute and/or place name source materials to the Vendor where appropriate, e.g. hydrographic features.

These data will be integrated into the production process and also used to assist with quality control.

Sanborn will perform or provide for all of the necessary tasks, including but not limited to primary data acquisition (land surveying and aerial imagery), aerial triangulation, digital elevation modeling, orthorectification, planimetric data extraction, contour production, quality assurance and control, project management and administration, and generation of full documentation and metadata for the project. All deliverable data products will be in full compliance with the standards and specifications set forth in the RFP.

Corporate Profile

Sanborn is a geospatial solutions company that specializes in providing a broad range of geographic information products, services, and solutions to government agencies and commercial organizations throughout the United States and abroad. Sanborn was founded in 1866, and is one of the largest mapping companies in the nation. Headquartered in Colorado Springs, Colorado, the firm serves its U.S. clientele from three strategically located technology centers, providing local support, extensive resources, and fast response times for projects ranging in size from a few acres to the national level.

Our capabilities include:

- GPS ground control surveys
- Acquisition of vertical and oblique aerial imagery in color and infrared formats, including airborne GPS and IMU controlled imagery, using advanced digital sensors
- Digital orthophoto imagery creation
- Airborne and terrestrial LiDAR data acquisition for terrain and feature modeling
- Planimetric and topographic mapping
- Acquisition and processing of satellite imagery
- Remote sensing analysis, including change detection, pervious/impervious classification, and land cover/land use mapping
- 3D infrastructure modeling and simulation
- Parcel and facility data conversion

- GeoIT support including data analysis, data hosting, website creation, and custom application development

Sanborn has always recognized the importance of playing an industry-leading role and providing clients with access to the most progressive solutions available, enabling us to deliver products and services in the most timely and cost-effective manner possible. The company has had a number of important "firsts" in aerial mapping and imaging, including pioneering the use of digital terrain modeling techniques and contour interpolation in 1984, and having the first commercial, proprietary, digital orthophoto imagery production system in the country in 1988. Sanborn purchased its first LiDAR system in 1998, and began operating digital aerial camera sensors in 2004.

Relevant Experience

Sanborn has a demonstrable track record of success on large, complex orthoimagery, LiDAR, and photogrammetric mapping projects throughout the United States. The company has extensive experience in the State of Wyoming and the surrounding region, including projects for City of Cheyenne and Laramie County, the Teton Conservation District, the City of Rock Springs, the City and County of Denver, as well as previous work for the City of Casper.

Sanborn's aircrews are highly familiar with the airspace system in the regio, and know how to navigate safely and efficiently within its boundaries. They have the relationships needed to gain access to the sensitive and restricted areas. They know the terrain and local weather patterns, and how to structure mobilizations to take maximum advantage of the limited time window in which to collect leaf-off imagery. Sanborn understands the challenges of performing airborne data acquisition in Wyoming, most notably, the short seasonal window of opportunity between snow-clear and leaf-on conditions, combined with the potential scarcity of weather conditions sufficient to allow collection of quality aerial imagery.

Sanborn has recently completed large orthoimagery creation, LiDAR and photogrammetric mapping projects for the States of New York, Virginia, Michigan, Louisiana, North Carolina, Wyoming, and Kansas. Additionally, Sanborn has performed airborne imagery acquisition and creation of digital orthophotography of the States of Virginia, West Virginia, South Dakota, Arizona, New Mexico, North Carolina, Colorado, South Carolina, Georgia, New Hampshire, Vermont, and Tennessee under contract to the U.S. Department of Agriculture for their NAIP and NAPP programs. Sanborn's recent project involvement has included statewide imagery programs that required collection of imagery for areas exceeding 40,000 square miles, and delivering tens of thousands of orthoimagery tiles within the space of 6-8 months. The company's first-time acceptance rate for orthoimagery submittals has exceeded 98%.

Sanborn has also recently completed major LiDAR mapping projects in and for the States of Kansas, South Carolina, Iowa, and Texas, as well as for many local agencies in those and other states. Additionally, Sanborn has performed LiDAR collection and processing in the States of New York, Virginia, Massachusetts, Maine, Vermont, Iowa, Kansas, Texas, New Mexico, and Puerto Rico under contracts valued over $1.6 Million to provide LiDAR data to the U.S. Federal Emergency Management Agency (FEMA) for their Digital Flood Insurance Rate Map (DFIRM) program.

Sanborn has successfully worked with numerous other consortiums to perform similar projects. Our clients include the State of Virginia's Base Mapping Program, Greater Bridgeport Regional Council, Windham Region Council of Governments, Louisville/Jefferson County Information Consortium, Pikes Peak Geospatial Alliance, and the Houston-Galveston Area Council (HGAC).

In addition to coordinating and communicating as needed to complete their imagery, LiDAR and mapping projects, Sanborn has hosted informational seminars, developed and delivered in coordination with the governing body, that are held prior to the main flying seasons (and off-seasons as appropriate), to aid in educating and supporting the wide-ranging needs of their constituents.

Key Personnel

Sanborn's experience with and ability to manage large, complex orthoimagery and photogrammetric mapping projects is due in no small part to significant investments in human and equipment resources. The Sanborn team of over 130 geospatial technology and management professionals possesses an enviable resume of project experience, significant educational credentials, and registration from government agencies and leading industry associations. Sanborn offers the MPO an exceptionally qualified project team with many years of experience in digital orthoimagery and photogrammetic mapping.

Sanborn's Project Manager, Shawn Benham, will be the MPO's single point of contact and will serve as your primary liaison with Sanborn operations staff and management. Mr. Benham has over 15 years of experience in the geospatial field, including project management and consulting services, quality assurance/quality control management, and data processing. His experience includes managing and implementing large, complex orthoimagery and photogrammetric mapping projects, including multi-year statewide programs for the States of New York and North Carolina, and the Commonwealth of Virginia, as well as many regional and county projects throughout the United States. As project manager, he is directly accountable for project design, program financial design and management, program execution, risk management, and schedule management. Mr. Benham will be responsible for project definition, production oversight, scheduling, quality management, and financial and contractual management.

The Sanborn Solution

The Sanborn team will utilize existing ground control on this project to the fullest extent possible, and augment it with new, photo-identifiable ground control points where needed. Sanborn's approach is to utilize a combination of targeted NGS published control stations, semi-permanent, field-identified control points, and AGPS/IMU-controlled aerial photography to accurately control the Fully Analytical Aerial Triangulation (FAAT) solution. Airborne GPS/Inertial Measurement Unit (AGPS/IMU) data will provide accurate support for image positioning and orientation, minimizing the required number of ground control points while still enabling the creation of orthoimagery and other mapping products that conform to the accuracy standards set by the MPO for the project.

Collection of AGPS/IMU-controlled vertical color imagery for this project will be performed by Sanborn with the advanced UltraCam Eagle digital aerial camera system. Sanborn notes that our digital aerial imagery sensor automatically collects 4-band (color and near-infrared) imagery, and our software enables us to orthorectify all four bands simultaneously, so we are prepared to deliver infrared orthorectified imagery for no additional charge on top of what the MPO would be paying for the color imagery under this proposal.

Sanborn currently owns and operates the Leica ALS-70-MPIA (Multiple Pulse in Air) LiDAR sensor, and proposes to use this system for the MPO's project. Our approach to this project will utilize a digital elevation model (DEM) surface that consists of LiDAR "model key" data points, enhanced with breaklines as needed to support generation of contours and accurate orthorectification.

All of the MPO's data will be maintained on Sanborn's robust, state-of-the-art IT infrastructure, capable of processing, storing, and communicating large volumes of data reliably and securely. Sanborn will use a suite of commercial and proprietary software tools for aerial triangulation, LiDAR processing, contour creation, and planimetric mapping. Sanborn will perform orthorectification of the imagery using its proprietary METRO software suite. Our software and workflow will ensure geometrically accurate and radiometrically pleasing imagery, and will facilitate elimination of defects such as image smearing, bridge distortions, radial distortion, seamline and mosaicking errors, and unsightly image artifacts. Pilot/sample data will be provided to the MPO, and the MPO's project managers will be involved in key decisions regarding subjective aspects of image radiometry.

Rigorous quality control, based upon Sanborn's ISO 9001:2008-based Quality Management Program, is integrated into our workflow, ensuring that any errors are caught and eliminated during the production process, rather than relying on large audits late in the project that result in costly rework and impact to the project schedule. Sanborn management will exercise tight control over the project, and coordinate our efforts with those of the MPO's management and staff to ensure that this project is completed on time, to specification, and within budget. Sanborn's project management approach encompasses best practices of the Project Management Institute, which are applied to meet or exceed the requirements of ISO 9001:2008. Sanborn uses automated software tools to assist with project planning, monitoring, tracking and reporting.

Lessons Learned

Sanborn strives for continuous improvement; therefore, management review meetings are held on a monthly basis to evaluate the Quality Management System's continued effectiveness and suitability in satisfying the requirements of both ISO 9001:2008 and our stated quality policy and objectives. We review the results of audits, all irregularities and comments, external influences on our business, and the effectiveness of the whole Quality Management System. Management review meetings serve as a vehicle where Sanborn may evaluate potential nonconformance and take actions to prevent their occurrence. Topics discussed and action plans resulting from these meetings are recorded in documented minutes, which are maintained as quality records in accordance with procedures.

As every project has its own unique web of issues, Sanborn's Lesson Learned audits examine at the Team (including Subcontractor), Technology, *and* Project levels. In cases where our Subcontractor's services are deemed to be insufficient or not meeting our Quality Standards, Sanborn management re-evaluates any future work with the Subcontractor.

Section 2 – Scope of Work

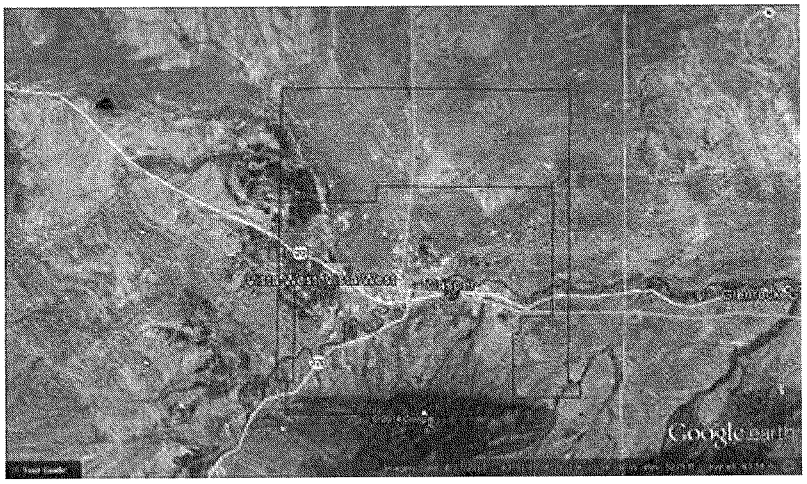
Introduction

This section provides a detailed description of the equipment, methods, and procedures Sanborn will use to collect new digital aerial imagery, and produce the required derivative data products and supporting materials in full conformance with the standards and specifications outlined in the RFP. This includes project management, and the steps taken to provide quality assurance and control throughout the entire process.

Area(s) of Interest

The MPO has used digital orthophotography, terrain surface, and planimetric information previously and has a history with these data layers, having performed an update in 2010, and is now desirous of once more updating these base map data layers.

The 2015 flight area will mirror that of the 2010 boundary, but the MPO now wishes to capture 3-inch and 6-inch resolution imagery. High resolution LiDAR was captured in 2010 for the municipal boundary and totaled 70 square miles, and low resolution LiDAR was captured for the remaining 286 square miles. The 2010 project was also designed to support the compilation of planimetric features to a horizontal accuracy of 1.25 feet within the MPO area, and 2.5 feet for the surrounding region.



Imagery Acquisition

Mobilization Planning

Sanborn will perform mobilization planning to ensure that airborne data acquisition can progress in accordance with the project schedule. This will include:

- Monitoring conditions to determine when the ground is clear of snow, leaf condition of deciduous trees, and the conditions of lakes, streams and rivers.
- Monitoring sun angle in order to determine the time ranges in which flights can be conducted.
- Monitoring weather conditions.
- Locating airports at which to stage aircraft and aircrews, and arranging for their accommodations.
- Making arrangements to access restricted airspace, if needed. Sanborn will coordinate all flight plans with air traffic control (ATC) well in advance of mobilization.
- Ensuring that all needed ground control and base stations are in place prior to the flights.
- Monitoring GNSS satellite configuration

Mission Execution

Sanborn's aircrews will be mobilized to Casper-Natrona County International Airport (CPR). The aerial team will monitor flight conditions and determine, in coordination with Sanborn's project manager and the MPO, when to initiate imagery collection flights. Imagery will be captured for the entire project area at the required level of resolution. Mission profiles will be programmed into the Track'Air Flight Management System, which is integrated with the sensor systems on board each aircraft. This computerized system assists the aircrews with mission navigation and sensor operation, ensuring that imagery is collected in accordance with the flight plan. Aircrews are also able to mark flight lines or exposures where turbulence, clouds, or other factors that bear on the quality of the imagery may be an issue, so it can be accessed rapidly following the flight, and assessed for recollection, if necessary.

Operational Considerations

Sanborn's experienced aircrews are highly familiar with the airspace system in the region, and know how to navigate safely and efficiently within its boundaries. All flights will be coordinated with the appropriate civilian and military air traffic control authorities. Our aerial team has the relationships needed to gain access to sensitive and restricted airspace.

Sanborn's aircraft are equipped with all of the communication and navigation avionics required to operate safely in the federal airspace system. All of our aircrews are appropriately licensed and qualified, and our aircraft are operated and maintained in accordance with applicable Federal Aviation Administration regulations at all times.

While Sanborn does not anticipate any difficulty with regards to airspace access, our aerial team is prepared to make any necessary operational adjustments should airspace changes or temporary restrictions make them necessary. Possible steps to mitigate airspace issues include use of a sensor with a longer or shorter focal length lens, in order to enable operation above or below restricted airspace ceilings, or rescheduling or reconfiguration of flights. Sanborn will provide immediate notification if any of these steps become necessary.

Post-Acquisition

Flight Logs will be prepared following each mission. The pilot or system operator will prepare a flight log for each flight day containing the date, project name, aircraft used, and names of crew members. In addition, the following information is recorded for each flight line: altitude, sensor number and any other comments relative to the flight conditions. These flight logs will be submitted digitally. All airborne GPS (AGPS), inertial measurement unit (IMU), and image data will be downloaded the day of collection. Preliminary processing of the AGPS data is performed to ensure the data is complete and produces accurate photo center coordinates.

Status Reporting

Sanborn requires flight crews to submit a daily status report by fax or email immediately after that day's operations to the Sanborn Acquisition Manager. The report states what occurred during the day. The report includes what area(s) were flown, the weather and ground conditions, and the expected image quality. If relevant, any reasons for not flying are reported. In both cases, they also provide a prediction for the next day's operations.

After receiving the reports from the field, the Sanborn production office in Colorado Springs will compile the results into one daily status report to send to Sanborn's project manager. This report will be reviewed and sent to the MPO on a daily basis.

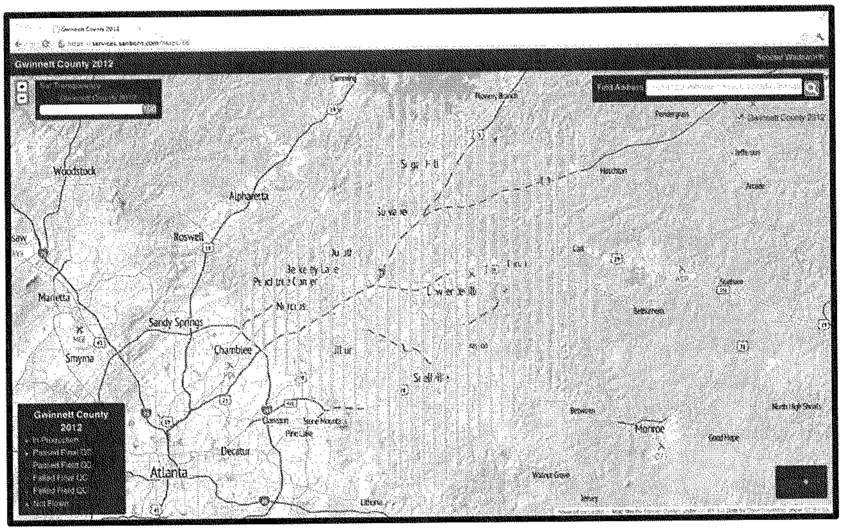
Online Flight Status Tool

Sanborn has developed an online status tool which would be used to report flight status during the acquisition process. The online status tool will update each morning, and will complement the shapefile and reporting information provided daily by the Sanborn Project Manager. The status tool will display the updated version of the flight plan shapefile(s) indicating which frames have been captured, reviewed, and/or accepted.

The MPO can identify the specific stakeholders that they would like to have access to the online status tool. With a unique login, stakeholders have the ability to access the acquisition status at their own convenience. This tool facilitates the sharing of the project information between Sanborn and the MPO's stakeholders.

This technology will benefit this project and the MPO's Project Manager by:

- Providing easy distribution of acquisition status updates, alleviating reliance on email or phone calls,
- Providing information in a format accessible from any internet connected device, and
- Providing access to multiple MPO-approved stakeholders simultaneously, which will relieve the MPO's Project Manager from answering calls from stakeholders regarding status.



Sanborn Online Flight Status Tool

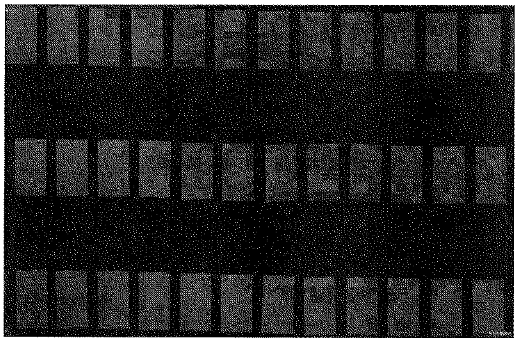
Image Processing and Radiometry

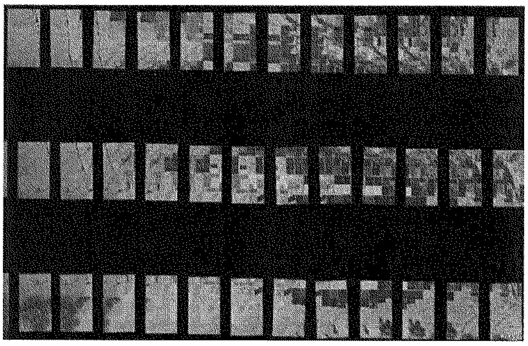
The imagery and peripheral data sets will be downloaded from the on-board data storage system, backed up, and shipped via overnight courier to Sanborn's production facility in Colorado Springs, Colorado. Upon receipt of the newly-collected imagery by the production office, the digital image processing phase is initiated. The following characteristics exist in all camera systems. While each system type has slight variations, all digital frame sensors are fundamentally similar in the way imagery is recorded and processed into useable data.

Each system uses an array of Charged Coupled Devices (CCD) to record panchromatic, RGB, NIR values. Once the images are acquired by each sensor, the imagery and mission parameters are stored in a raw binary format on the flight hardware. Each sensor uses a series of portable hard drives which can be linked to the aircraft-based servers; upon landing, the imagery is downloaded to the portable drives. Once the imagery has been transferred via the portable hard drives to a production facility, post-processing begins. The array of CCD's requires post processing of each individual frame in order to mosaic together a single large format image. Each sensor type has a slightly different CCD layout, but the final frame image is a 4-band, 12-bit image.

Upon receiving the "raw" image data from Sanborn's flight operations, it is downloaded to the server to initialize processing in the Microsoft UltraMap software. Using UltraMap Raw Data Center, the "raw" image data is processed to a DragonFly Project file (.dfP) of the imagery which allows image processing technicians to view and manipulate each imagery mission. The .dfP file is then loaded in the UltraMap AT software in order to run Project Based Color Balancing (PBCB) on the images. PBCB uses tie-point collection which samples the histograms of all images in a block to produce a color balanced set of images. Imagery missions can be merged to provide a continuous color balance across the entire project. After PBCB is ran, the .dfp file is opened in UltraMap Radiometry. UltraMap Radiometry provides tools for detailed and specific radiometric adjustments to the imagery to eliminate such things as hotspots, atmospheric effects, and haze. There are also tools to adjust the gamma, histogram levels, haze, and exposure of the imagery. All adjustments are made while the imagery is still at a 12-bit color resolution allowing for the greatest quality when converted to 8-bit deliverables. After color balancing is complete, the final step is to process out the images to the desired final product. UltraMap provides options for the output type of the images. These options include image Mode (RGB, RGBI, CIR, etc), resolution, file format and Bit Depth (8/16 bit).

In addition, during QA/QC, each image will be displayed and checked for completeness, radiometric acceptance, and any obvious visual problems. Any cause to reject the image will justify the need for a re-processing or re-flight of that particular image. Only after images have been displayed, checked, and accepted will they be released for use in subsequent production procedures.





Before and after Project-Based Color Balancing

Photography Quality Control

Sanborn takes every possible measure to ensure that mission planning, operational conditions, precision aerial cameras, and computerized flight management systems all work together to result in the acquisition of high quality, error-free imagery for the project. We quality check the entire imagery data set three times before accepting it for exploitation.

As each image is acquired, a snapshot of that image is visible to the aircrew on a monitor. Our photographers view this snapshot at the time of capture and then again post-mission, before sending the imagery to the office. Sanborn's photographers identify over 98% of the re-flights in the field through this QA process.

When an imagery data set arrives at the office, it is immediately backed up. Thereafter, it is processed to the final image. This processing occurs quickly, as dedicated, high-capacity workstations utilizing a distributed processing system are used for the task. After the imagery is processed, a technician reviews the imagery a third time. The technician looks for details which may not have been visible in the snapshot and confirms that the image processed correctly. Checks performed by the technicians include:

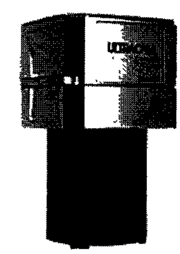
- Review of the imagery for density, contrast, hot spots, clarity, shadow and highlight detail, and overall quality.
- Technicians will also check each line of imagery for:
  - Adherence to the flight plan—the editor will review the imagery to ensure that the specified flight plan has been successfully executed.
  - GSD—the technicians will confirm that the specified GSD has been achieved.
  - Departures from flight heights required to produce the desired image scale shall not exceed minus two percent (-2%) or plus five percent (+5%)

- Crab— Crab in excess of three degrees (3°) may be cause for rejection of a flight.
- Tilt and Tip— Tilt of the camera from vertical at the instant of exposure shall not exceed three percent (3%), nor shall it exceed five percent (5%) between successive exposure stations. Average tilt over the entire project shall not exceed 1%.
- Forward overlap—the forward overlap will be examined to ensure that it falls in the appropriate range for each acquisition area.
- Side overlap—the side overlap will be examined to ensure that it falls in the correct percent range for each acquisition area.
- Anomalies—any other anomalies that could affect the final product will be examined, such as exposures settings, pixel drop out, etc.

If the technicians identify the need for any re-flights, they immediately email the flight crew needed parameters. Our goal is to accomplish this review within three days of acquisition of the photography. Sanborn understands that unacceptable imagery will be re-flown at no additional cost to the MPO. All re-flight coverage will overlap the accepted imagery by at least two exposures, and will be captured using the same sensor type that performed the initial acquisition.

Proposed Sensor Technology

Sanborn has fully implemented digital aerial camera technology and adapted our workflows to maximize the benefits of these systems. Sanborn was one of the first companies in the United States to purchase and operate large-format, metric digital aerial cameras, and over the intervening years, has developed extensive expertise in the implementation and use of digital camera technology. We have worked closely with manufacturers to ensure that our workflow, from acquisition through image processing, supports our subsequent production processes, and Sanborn has been integral in the manufacturer's development of improvements to their technology. Sanborn has been working with the Vexcel Systems (now the Microsoft Photogrammetry Division) since 2004, following our initial acquisition of their UltraCam D camera system. In total, Sanborn has used digital aerial cameras for over 3,000,000 square miles of imagery collection and processing for clients across the United States. A description of the sensor system, as well as quality assurance measures taken to ensure its readiness for use on a project is outlined below.



The Microsoft/Vexcel UltraCam Eagle Digital Aerial Imagery Sensor

Sanborn procured the third-generation Microsoft/Vexcel UltraCam Eagle digital aerial imagery sensor, which it proposes for this project, in February, 2013. The features and benefits of this system include:

- State-of-the-art CCD technology, 14-bit dynamic range, and a lower signal to noise ratio, resulting in nearly twice the brightness values of the sensors previously used for imagery collection by Sanborn, and providing exceptionally sharp, high-quality imagery even in less-than-ideal weather/atmospheric conditions, and better interpretability in areas where shadows are unavoidably present.

- A 5.2 µm pixel size at the sensor, compared to 12 µm for the Intergraph DMC sensor it has replaced. This allows Sanborn to collect imagery at much higher altitudes than was previously possible, while still meeting the accuracy and resolution requirements set for a project.
- The higher imagery collection altitudes made possible by the UltraCam Eagle minimize air traffic control/airspace incursion issues, and result in a much larger (~2.5x DMC) exposure footprint on the ground. This translates to a smaller number of exposures needed to cover a project area, faster collection times, less ground control, and lower cost to the MPO.
- Utilizes the best optics module currently available on the market. Additionally, the 100mm lens system provides a broader "central perspective", resulting in less radial displacement (e.g. "building lean") in the image data.
- Based upon proven, stable, frame sensor technology that results in maximum operational reliability and the most precise image geometry. In contrast to "push-broom" or line sensors that are completely reliant on the AGPS/IMU technology to generate usable data, normal photogrammetric solutions can be applied to the UltraCam Eagle's imagery, enabling normal use of that imagery in the event of problems with the AGPS/IMU sub-systems. While Sanborn operates the best GPS/IMU systems available and failure is unlikely, this mitigates operational risk to Sanborn and the MPO.
- Forward Motion Compensation (FMC) implemented through TDI (Time Delayed Integration) technology.
- Solid state, in-flight exchangeable data storage modules result in higher reliability and longer mission times.
- Suitable for a wide range of applications, from large-scale engineering mapping to low-resolution remote sensing projects.
- Outputs image data in industry-standard file formats can be ingested into and processed with any standard softcopy photogrammetric system on the market
- Can be operated within a wide range of flying heights, and is operationally suitable for operation in both pressurized and unpressurized aircraft.
- Utilizes a modular hardware design, which enables easy replacement or upgrade of components. This includes field replacement of the lens system, enabling utilization of different focal length lenses.
- Extremely rugged camera frame and peripheral hardware design, leading to maximum operational reliability. Constructed of high-grade industry components for safe and reliable aircraft installation (high grade connectors, environment tests against DO160, a minimum of cable connections, crash load tests against DO160) and operation.

The gyro-stabilized camera mounts in Sanborn's aircraft were upgraded to the latest Track'Air systems at the same time as the UltraCam Eagle sensors were acquired, and represent the most advanced technology currently available on the market, ensuring a stable camera platform and high-quality imagery even in the event of unexpected, turbulent flight conditions.

Technical Specifications for Sensor

Technical specifications for the UltraCam Eagle are as follows:

Microsoft/Vexel UltraCam Eagle Specifications	
High-resolution 20K x 13K Panchromatic camera:	Final output image is 20,010 x 13,080 pixels
Field of view:	66° cross track x 46° along track
Panchromatic camera lens system:	f = 100mm 1/5.6 or f = 80mm 1/5.6 Shutter speed 1/500 to 1/32 sec
Multispectral 6.7K x 4.4K cameras (x4):	red, green, blue, and near infrared each 6,670 x 4,360 pixels
Multispectral camera lens system:	4: x f = 33mm/f: 4.0 or f=27mm/f: 4.0 Shutter speed 1/500 to 1/32 sec
Physical pixel size:	5.2 µm
Input data quantity per image:	842 megabytes, 260 megapixels
Maximum frame rate:	<1.8 seconds per frame
CCD signal to noise ratio:	72 dB
CCD image dynamic range:	14 bit; workflow dynamic: 16 bit
In-flight data storage system:	Solid state disc pack, Capacity ~3.3 TB, ~ 3,800 images per swappable unit
Time needed to swap disc pack inflight:	Less than 2 minutes
Data recording time @ 10 cm GSD, 60% forward overlap, 140 kts:	8 hours per disc pack

Radiometric and Geometric Calibration

In order to facilitate collection of imagery with the best possible radiometric and geometric properties, Sanborn ensures the completion and currency of two independent camera calibration/verification processes. The first laboratory calibration is performed by the manufacturer. The second is Sanborn's internal camera calibration/verification procedure. Sanborn will provide current manufacturer calibration certificates for all sensors used on the project, as well as a report based upon Sanborn's own methods and procedures to verify the accuracy of any sensors used on the project. For example, each time a camera is installed in an aircraft, a complete geometric calibration is performed in order to ensure the accuracy of the platform. This process is referred to as a "boresight."

Manufacturer Calibration

Prior to delivering a digital sensor to Sanborn, the manufacturer performs the following calibration procedures. Complete calibration reports are provided on a CD submitted with the hardcopy proposal.

- **Geometric calibration:** The geometric calibration is based upon a set of 84 images of a defined geometry target with 240 control points. The number of point measurements is over 60,000. This calibration procedure guarantees that the remaining lens distortions are less than 0.002 mm.
- **Verification of lens quality and sensor adjustment:** The targets used for the geometric calibration also hold resolution targets, which are used to derive the modulation transfer function (MTF) across the field of view of camera. The MTF is derived for the meridonial (tangential) and sagital (radial) component of signals at frequencies of 10, 20, and 40 line pairs per millimeter for various aperture settings. The MTF is guaranteed to be less than -7dB in the field of view that typically is used for mapping applications, even for the 40 line pairs per millimeter resolution.

- **Radiometric calibration:** The radiometric calibration is based on a series of 60 flat field images for each aperture size and sensor. The flat field is illuminated by two normal light lamps with known spectral illumination curves. These images are used to calculate the specific sensitivity of each pixel to compensate local as well as global variations in sensitivity. Sensitivity tables are calculated for each sensor and aperture setting, and applied during post processing from level 0 to level 1. The resulting image has virtually no vignetting caused by the camera system.
- **Calibration of defective pixel elements:** Outlier pixels that do not have a linear behavior as described in the CCD specifications are marked as defective during the calibration procedure. These pixels are not used or only partially used during post processing and the information is restored by interpolation between the neighborhood pixels surrounding the defective pixels.

Sanborn's Camera Accuracy Testing

Sanborn's image quality criteria require consistent and homogeneous imagery devoid of response gradients and vignetting within an exposure, and unnatural tonal variations across exposures. To ensure that these criteria are met, Sanborn employs a four-step radiometric calibration and processing method. These steps are:

- **Pre-Flight Calibration:** Camera response is calibrated the day of acquisition for the ground reflectance and expected illumination conditions. The calibration process ensures maximum use of the available 14-bit dynamic range and correct color balance. An advantage of the Eagle camera is the ability to respond to changing flight conditions. Camera settings can be changed by the operator within a flight line if required to ensure quality imagery collection.
- **Atmospheric Correction:** Atmospheric correction removes any haze or atmospheric transmission loss using a Modtran4 derived correction function.
- **Sensor Corrections:** Pre-processing to remove any vignette effects producing a homogeneous exposed image.
- **Color Balancing:** Final processing includes local and global color balancing to ensure all image exposures appear to be taken at the same time with no tonal variation across seams.

Digital Aerial Imagery Acquisition

Sanborn recognizes that one of the most critical phases of this project is acquisition of the aerial imagery. Timely collection of consistent, high quality aerial imagery and related data is the foundation for generating high quality digital orthophotography and other derivative data products.

Our aerial team provides the following benefits to the MPO:

- Extensive, wholly-owned data acquisition resources to ensure collection within optimal windows of opportunity;
- A fleet of twelve aircraft, including high performance multi-engine and turbine-powered aircraft and one craft that is equipped with dual ports, and is capable of performing acquisition with multiple sensors;

- Five (5) large-format digital aerial camera sensors, including three new-generation Microsoft/Vexcel UltraCam Eagles to provide a variety of collection options, including simultaneous RBG and NIR capture;
- AGPS/IMU units to collect photo center position and direct exterior orientation data for imagery; and,
- Aircrews and photographers with extensive experience in the State of Wyoming and the surrounding region, including projects for Gillette,

Acquisition Equipment and Resources

A summary of acquisition assets available to the MPO through our airborne data acquisition team is shown in the table below. Sanborn has sufficient aircraft and sensors to complete airborne data acquisition in Spring, 2015, with a very high level of redundancy. Any of the aircraft in the table could be tasked for the MPO's project, as needed to complete acquisition in a timely manner. The listed aircraft are equipped with gyro-stabilized mounts, computerized flight management systems, and AGPS/IMU systems for precise photo-center positioning and orientation.

Sanborn Airborne Data Collection Assets	
Aircraft Type and FAA Registration Number	**Sensor Systems**
Multi-engine Piston Piper Navajo PA-31-325; N27693 Multi-engine Piston Piper Navajo PA-31-310; N278RC Multi-engine Piston Aero Commander 500S; N9UB Multi-engine Piston Aero Commander 500B; 6172X Multi-engine Piston Aero Commander 680FL; N4998E Twin-Turbine Aero Commander 680W; N940U Twin-Turbine Aero Commander 690B; N600WS Twin-Turbine Aero Commander 690A; N892WA Twin-Turbine Aero Commander 690A; N690EH Single-engine Piston Cessna TU206F; N603ET Single-engine Piston Cessna TU206G; N735BT Single-engine Piston Cessna TU206G; N2326B	Three (3) Vexcel UltraCam Eagle Two (2) Vexcel UltraCam D Two (3) MiDAS Oblique Sensors One (1) Visual Intelligence iOne n-Oblique Sensor One (1) Leica ALS-70HP Airborne LiDAR sensor

Pre-Acquisition Planning

Sanborn will carefully plan all missions to ensure that resulting data will be compliant with the requirements set for the project, and review our proposed flight and ground control plans with the MPO FTAC prior to mobilizing any field or airborne resources. Proposed plans will be provided at least one week prior to mobilization. The following table presents our proposed acquisition specifications for the project.

Imagery Acquisition Specifications		
GSD	**3-inch**	**6-inch**
Proposed Sensor	UltraCam Eagle	UltraCam Eagle
Focal Length	100mm	100mm
Flying Height Proposed	4,732' AGL	9,464' AGL
Aircraft Speed	175 kts	175 kts
Sidelap	30%	30%
Endlap	60%	60%
Sensor Platform	Multi-Engine Fixed-Wing Aircraft	
Radiometry	4-band, 14-bit per channel RGB/NIR	
Acquisition Date	~15-March to 30-April, 2015 (Or as conditions permit)	
Acquisition Time	~10am – 2pm	
Sun Angle	30 degrees or greater	
Conditions	Snow free, leaf-off, no flooding, no ice on water bodies. No clouds, cloud shadows, haze, smoke, precipitation, or other ground obscuring conditions on more than 5% of imagery.	

Flight and Control Plans

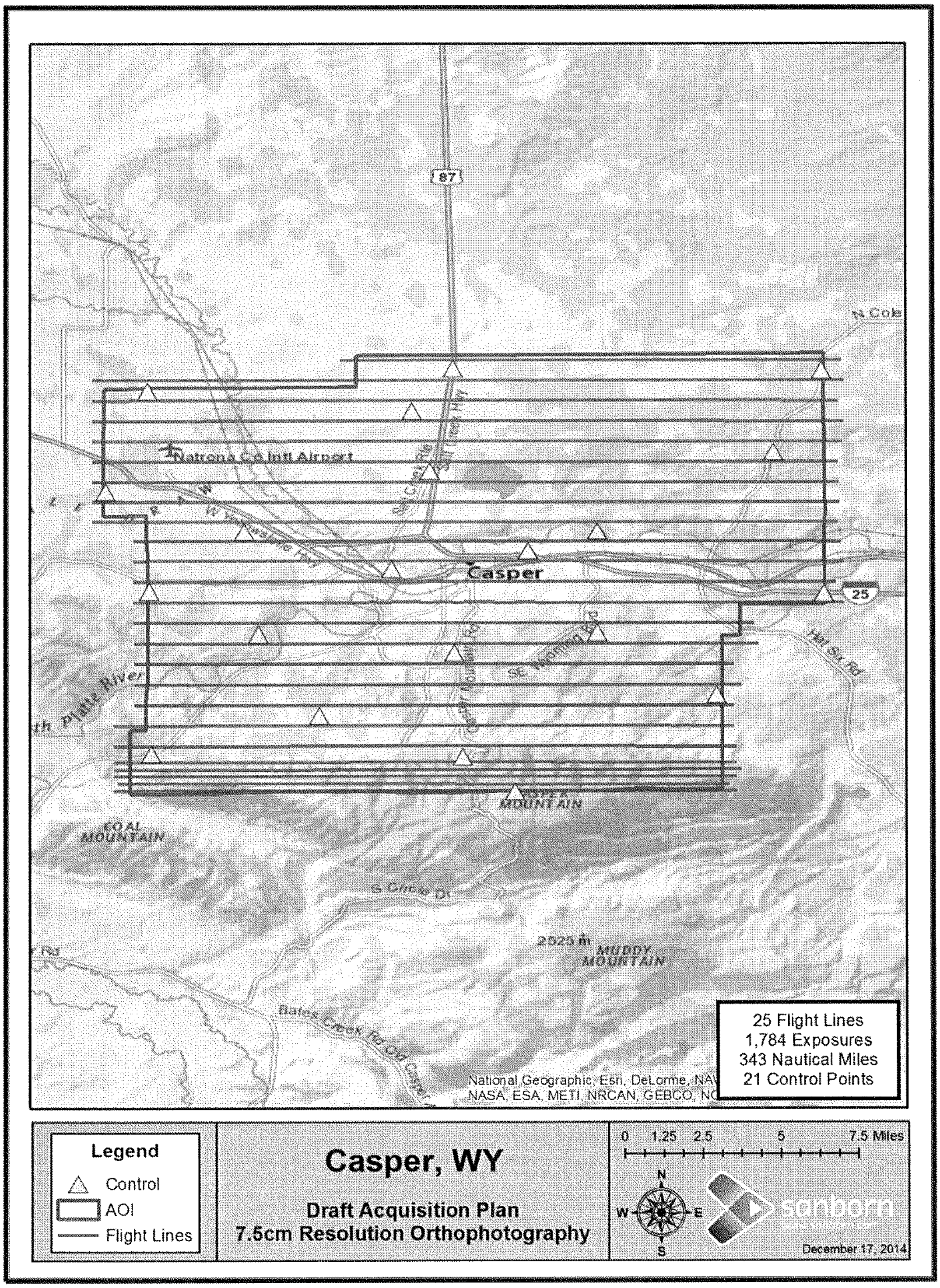
Flight planning and execution will adhere to ASPRS Draft Aerial Photography Standards. All flight and control plans will be reviewed by one of Sanborn's ASPRS Certified Photogrammetrists prior to their release. A summary of procedures and considerations in flight mission planning is as follows:

- Sanborn will prepare a digital flight line layout for the project area(s) using Track'Air software, taking into account the configuration of the UltraCam Eagle aerial camera, and the accuracy and resolution required for the imagery and other data products under the MPO's solicitation. These parameters determine the flight altitude, the footprint of each exposure on the ground, and correspondingly, the quantity of flight lines and exposures, and ground control requirements.
- Flight lines typically extend continuously across the project area. However, lines may be optimized in order to account for terrain, areas with tall structures, water bodies, airspace restrictions, and issues related to sun angle, lighting, and shadows.
- The Microsoft/Vexcel UltraCam Eagle will collect all imagery with 14-bits per channel in all 4 bands – Red, Green, Blue, and Near-Infrared. Our software enables us to orthorectify all four bands simultaneously, so there is no upcharge over collection and processing of 3-band imagery to deliver a 4-band orthorectified imagery product, providing added value to the MPO.
- The principal points of the first two and last two exposures of each flight strip will fall outside the boundaries of the area to be covered by the flight.
- In order to ensure sufficient coverage, Sanborn will plan imagery collection so at least 25% of each outermost line of images extends beyond the boundary of each area of interest.

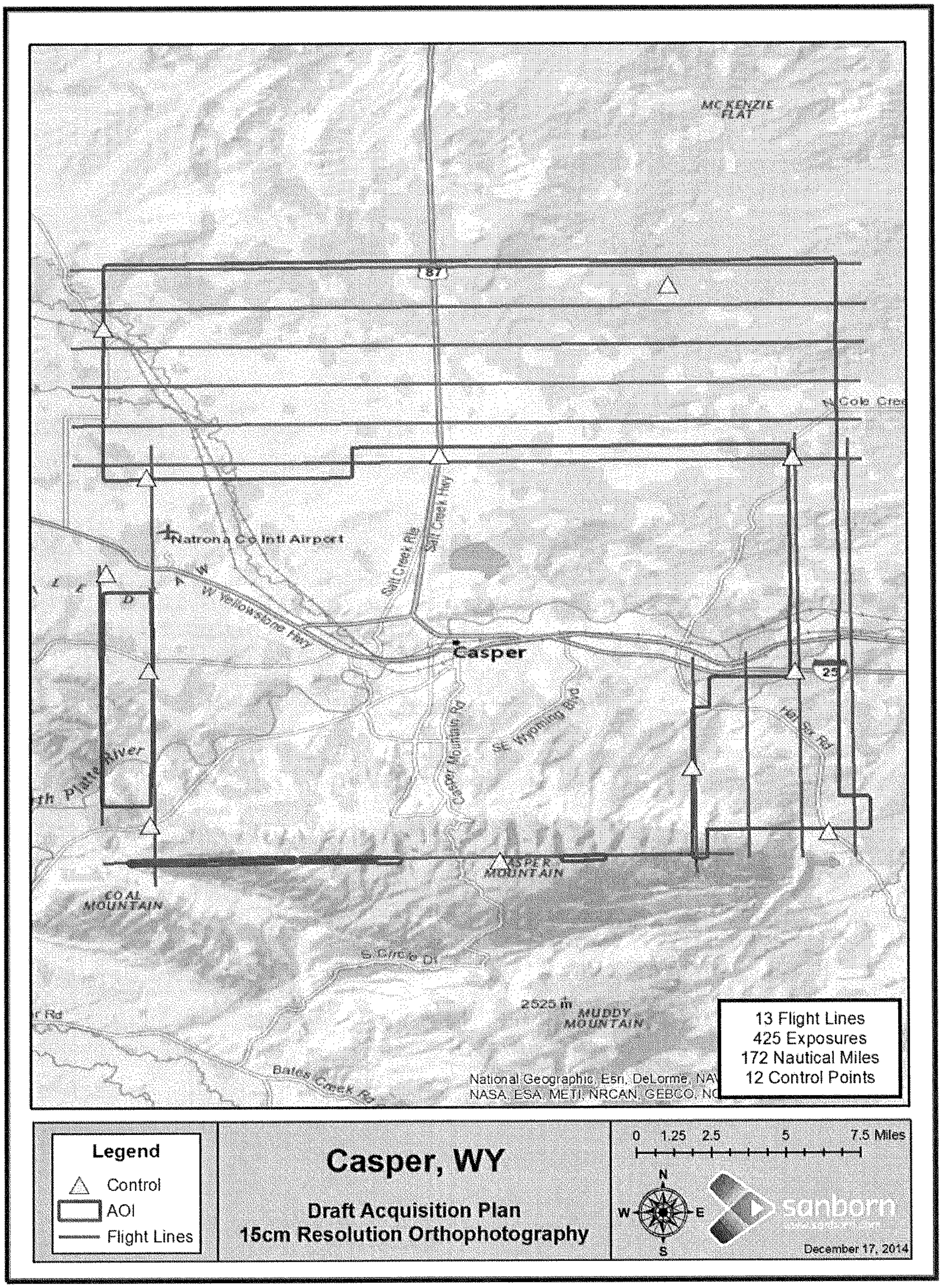
- Forward lap and side lap will be as shown in the Table above, and will be adjusted as needed to ensure collection of quality imagery in areas with unique terrain or built infrastructure considerations.
- Sanborn's flight plan will contain the following information:
  - Projected flight lines
  - Flight line numbers
  - Intended coverage
  - Approximate number of exposures
  - Flight altitude
- Sanborn will overlay the flight line layout over Google Earth imagery, and determine optimum locations for the placement of ground control points, ground checkpoints, and GPS base stations, where these items are needed. Following the MPO's approval, the control locations will be passed along to the Wyoming-licensed project surveyor who will target, survey, and provide any other needed resources or information in support of the airborne acquisition mission.
- The final flight line map/photo index with photo centers will be delivered in Adobe .pdf file format, and in Esri Geodatabase format.

Pro Forma flight maps are provided on the following pages for the MPO's review.

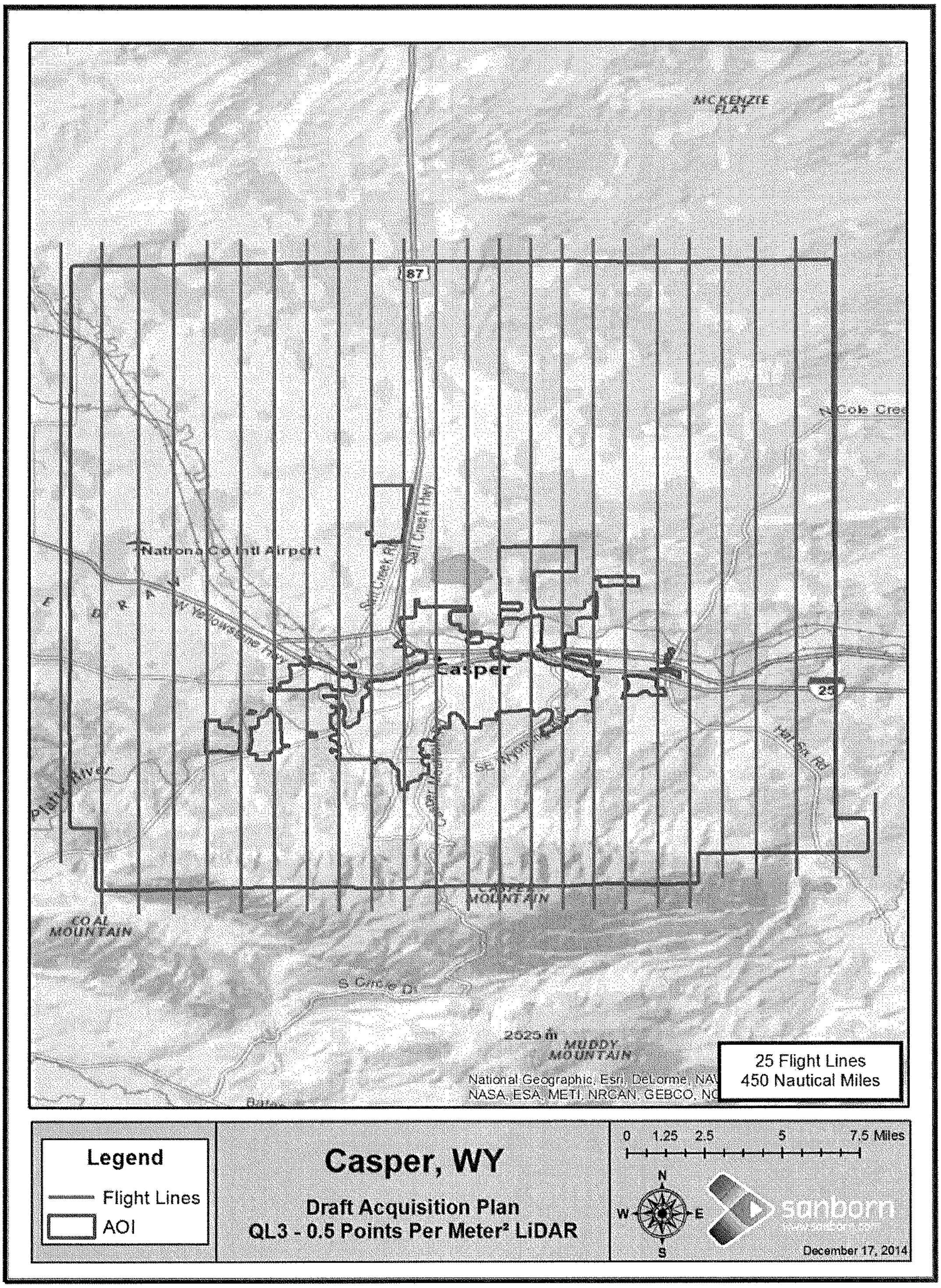
3-inch resolution digital orthophoto base area



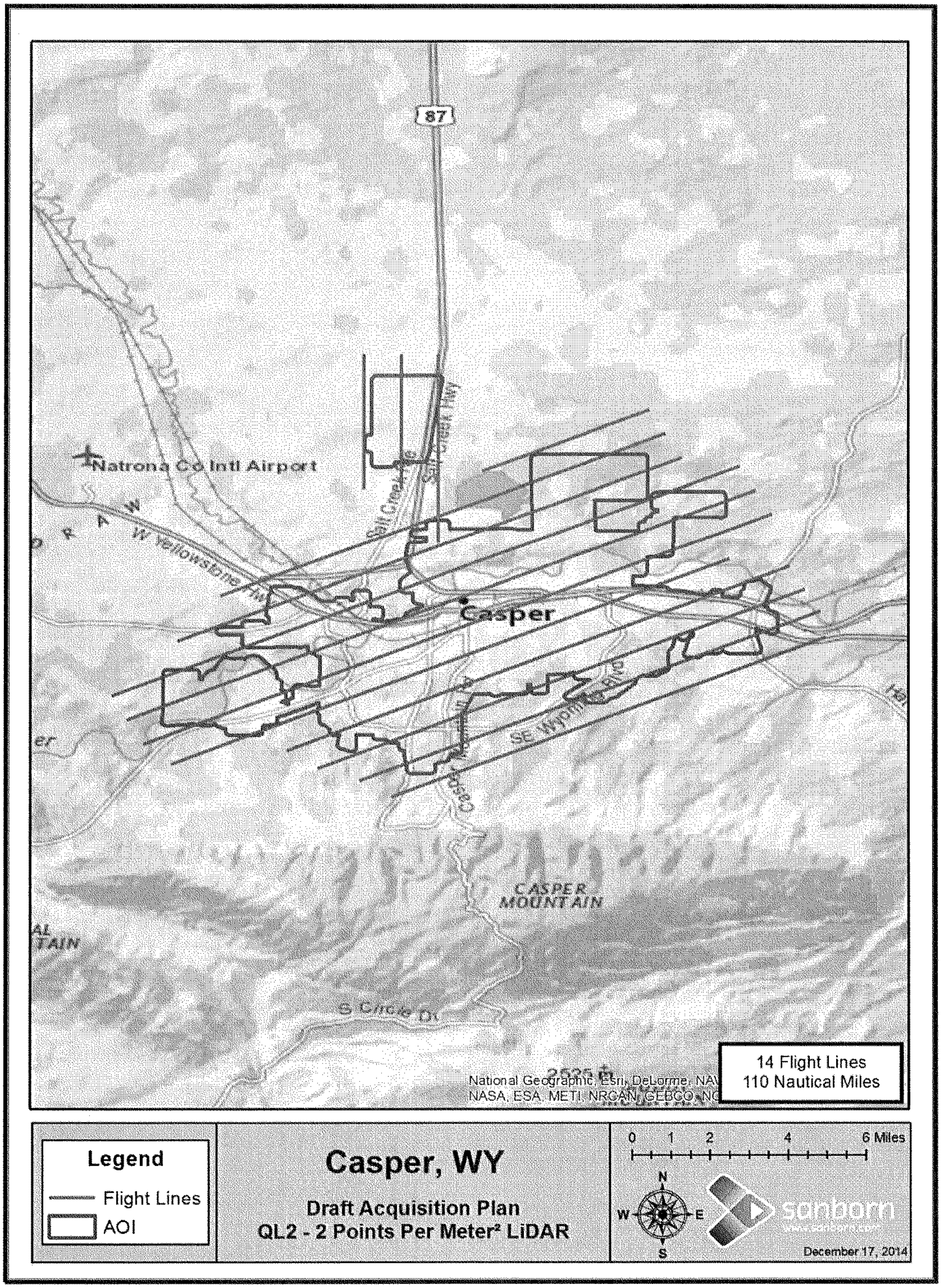
6-inch resolution digital orthophoto base area



QL3 LiDAR Draft Acquisition Plan



QL2 LiDAR Draft Acquisition Plan



Flying Conditions/Requirements

Our aerial team will monitor weather conditions and determine when to mobilize for the aerial missions. The optimal conditions occur:

- When the ground is clear of snow
- When deciduous trees are barren
- When the air is free of smoke, atmospheric haze, fog, and dust
- When the air is free of clouds
- When the sun angle is 30 degrees or more above the horizon
- When streams are within their natural banks

Imagery will be rejected if clouds which impact the orthoimagery product are noted, or if the sun angle is less than 30 degrees, or if there are any other conditions which do not produce consistent, high-quality photography that clearly defines ground features.

Photography is accomplished by flight crews who will be temporarily based in the Casper area in close proximity to the collection areas. We will attempt to acquire imagery in the shortest possible timeframe to minimize radiometric differences in the final image database.

Sanborn relies on a variety of sources to determine the suitability of conditions for acquisition. Our first and primary source is the flight crews and surveyors in the areas of interest. Flight crews are trained to observe and report the conditions as they see them on the ground and in flight. We will also coordinate with and defer to the MPO if there is any question regarding suitability of conditions. Finally, there are a variety of ways to observe conditions remotely, including NOAA weather reporting stations, daily weather satellite reports, weather video cams, and a variety of public sources that can be accessed for detailed observations.

Georeferencing for Imagery

Sanborn's approach will be to utilize existing, available control points, augmented with newly surveyed ground control points where needed, together with AGPS/IMU-controlled aerial photography to accurately control the Fully Analytical Aerial Triangulation (FAAT) solution. Airborne GPS/Inertial Measurement Unit (AGPS/IMU) data will provide primary support for image positioning and orientation, minimizing the required number of ground control points required, while still enabling the creation of orthoimagery and other mapping products that conform to the accuracy standards set by the MPO for the project.

Reference System

Sanborn will ensure that all land survey and airborne GPS/IMU data collection and processing procedures generate control coordinates that result in an aerotriangulation solution that accurately georeferences all deliverable data in the State Plane Wyoming East Central Zone. The horizontal datum will be the most current NAD83 Realization, presently NAD83(CORS96); epoch 2002.0. All vertical control will be referenced to the National Geodetic Vertical Datum of 1988 using the most current NGS Geoid Model, presently GEOID12A. The unit of measurement will be the US survey foot.

Airborne GPS / Inertial Measurement

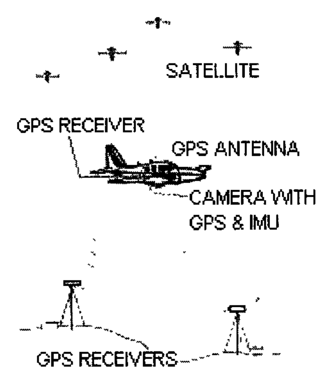
The Microsoft/Vexcel UltraCam Eagle digital camera system utilizes airborne GPS (AGPS) and inertial measurement unit data (IMU) as input for sensor positioning and exterior orientation development. Sanborn's new Applanix Type 46 Non_Itar IMU's, acquired early in 2013 as part of our sensor modernization program, will be used to manage and collect data for this process. Novatel Millenium DL4+ dual frequency GPS receivers collecting P-code pseudo range and L1/L2 carrier signals at a sampling rate of 2 points per second will be used in the aircraft to collect GPS data.

These directly observed exterior orientations will be combined with conventional ground control in an AT bundle adjustment. The statistics derived from the bundle adjustment will provide an accuracy assessment for ortho rectification and/or stereo compilation. The use of AGPS/IMU data has a number of benefits:

- It allows more flexibility in the selection of ground control points, making it possible to work around difficult areas such as forests, private land, restricted areas, and water bodies.
- It enhances the overall reliability of the AT solution.
- It results in bundle block adjustments of greater accuracy and homogeneity.
- Depending on the mapping products, it allows some level of reduction in the amount of ground control, enhancing production schedules.

It automatically determines all six of the parameters required for resolving the exterior orientation of each photograph and allows for more reliable and accurate results from assisted automatic aerotriangulation.

General AGPS Procedures



Sanborn's airborne GPS approach will consist of the following steps:

- Recovering or establishing suitable base station locations within the project area, as appropriate to the accuracy specifications for the project.
- Validating the bore-sighting of the camera and AGPS system. AGPS/IMU boresight calibration is performed at least twice per year. Any time the camera or AGPS/IMU is moved, a new boresight is required.
- Collecting, processing, and interpolating the AGPS data to derive camera station coordinates and rotations at each instant of exposure

During the mission planning process, Positional Dilution of Precision (PDOP) is evaluated using Trimble's Qplan or Ashtech's MPwin GPS planning software. All mission collections will be conducted with a PDOP of 3.2 or lower. The KP index is also evaluated prior to mission collection. KP index is a measurement of geomagnetic activity at the earth's surface that can greatly affect the GPS solution. Therefore, no collection will occur when the KP index is at or above 4.

Prior to the actual AGPS photography missions, Sanborn will also check the AGPS system installation. This involves:

- Checking the GPS antenna location on the aircraft

- Checking the GPS receiver to aerial camera connections
- Re-measuring the offset vector from the antenna to the camera's front lens node

Base Stations

Due to AGPS/IMU technology used by Sanborn, base station distances are not limited to traditional 55km baselines. During the data acquisition missions, multiple National Geodetic Survey Continually Operating Reference Stations (NGS CORS) that are up to 200km from the acquisition area will be logging 1, 2, or 5-second data that will be download and incorporated when processing the airborne GPS solution. In order to ensure mission integrity, Sanborn will be operating base stations (Trimble 4100 or 5700 receivers) on the ground in the proximity of the project area for the duration of the acquisition flight as a backup in case of any failures or problems with the CORS system.

Typically, at least 1 GPS base station will be in operation during each mission. This GPS receiver will be set on a published National Geodetic Survey control point such as the Primary Airport Control (PAC) Station. If for any reason it not be possible to set a GPS base station at a published NGS point, a temporary point will be introduced and marked near the FBO (fixed base of operation) at the airport of departure.

The base station receiver at the airport will be operational prior to starting airborne data collection. All crews will have their base station(s) running at least 7 minutes prior to sun angle and at least seven minutes after sun angle. This provides redundant base station data in the event of a base station failure or other unanticipated GPS issue from one crew. All GPS receivers will be set to an epoch rate of 2 Hz.

In-Flight Calibration

The AGPS/IMU system requires a seven minute "initialization" period for satellite data acquisition prior to takeoff. This seven minute time period will not begin until after the system has been started and data logging has begun. After landing and when the aircraft is stationary, the AGPS/IMU subsystem will continue to collect data for seven more minutes. This procedure ensures that the airborne GPS unit is functioning properly and the solution is fixed. The initialization and termination of the aircraft's data collection will occur as close to the airport base station as possible, but far enough from buildings to prevent multi-path errors.

The ground and airborne GPS receivers will collect data at half- second epochs for the duration of all missions. Aircraft will not be banked more than 20 degrees during data collection to prevent loss of lock with GPS satellites.

AGPS Post Processing Software

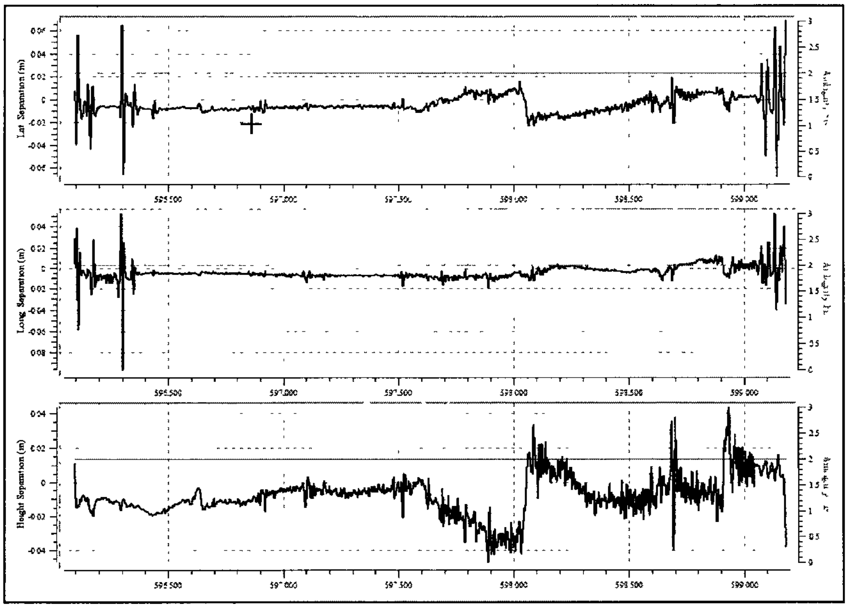
All AGPS/IMU data will be downloaded from the aircraft the day it is collected. Sanborn will use the latest version of Applanix MMS kinematic AGPS post-processing software (currently v6.2) to process all AGPS/IMU data. Sanborn has been using this software since 2008. Applanix MMS software has numerous benefits, including:

- It exports into the proper format for direct input into the Inpho Match-AT software
- Numerous visual displays are available to assess systematic errors as well as to ensure that the requisite accuracy is met

In a combination of AGPS data, the expected accuracy of the orientation of the photo exposures will be 0.10 meters in position and approximately 20 to 30 arc seconds in tilt, roll, and heading. Once a final solution is achieved, the photo center coordinate positions will be exported in the project coordinate system in preparation for use in aerial triangulation (AT).

Airborne GPS QA/QC

Sanborn rigorously checks the quality of the processed airborne GPS and INS data before implementing it into the bundle block adjustment. The kinematic data are processed from a minimum of two base stations, and the solutions are compared. This procedure verifies the integrity of the base station coordinates and elevations. Each processing session is computed in both the forward and reverse temporal directions. The comparison of these solutions provides insight into the quality of the kinematic ambiguity resolution. The below figure illustrates a high quality combined solution - positional information predominantly within the range of 4cm.

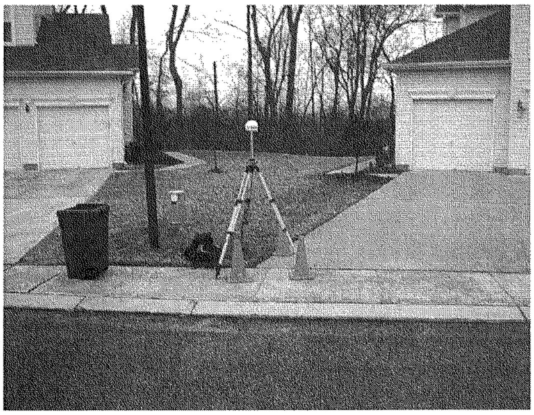


Once a final solution is achieved, the photo center coordinate positions will be exported in the project coordinate system in preparation for use in aerial triangulation (AT). Sanborn will supplement the final AT report with a section addressing the AGPS/IMU component of the acquisition. The information provided will include at a minimum:

- An analysis and write-up of the AGPS/IMU collection procedure, processing, and results
- An index identifying each image, corresponding digital file name, and image acquisition date and time in Esri .shp format.
- All photo centers (X,Y,Z) and the IMU unit rotation values

Ground Control Surveys

While Airborne GPS and IMU technology will serve as the primary means for georeferencing, a framework of ground control is needed to serve as checkpoints and to enhance the control solution. Aerial control or ground checkpoints will be photo-identified or targeted as needed by Sanborn. New control will be established where control from previous projects is unavailable or unrecoverable.



Example of a photo ID control point (intersection of driveway with sidewalk) that could be utilized.

Example of a targeted control point

New Control

Where new control is needed, Sanborn's survey team will perform reconnaissance to determine optimal locations for its placement. Criteria for selection include:

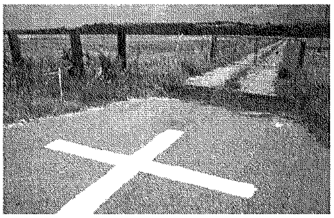
- **Suitability**—for photogrammetric ground control, including good contrast between the ground surface and target material, and a flat ground surface.
- **Safety** – Protection or shielding of targets from disturbance or destruction. Safety of equipment and personnel
- **Recoverability**—ease of recovery
- **Accessibility**—for occupation by GPS and other surveying equipment
- **Locality**—within public rights of way or easements or on public property, where feasible
- **Compatibility**—potential conflicts with future development, including the construction of new highways
- **Visibility** – locations that allow an open and unobstructed view to the sky

New Ground Control Plans will be sent to the MPO FTAC for approval. The Plan will include details regarding the numbers and locations of existing and proposed control monuments that will be utilized in the collection of new imagery and planimetric data production.

Monumentation

When possible, PLSS monuments will be used for control. Newly surveyed points will be semi-permanent, and will either be 5/8-inch rebar with an aluminum cap, or PK nail with and aluminum washer. The intent of these survey monuments will be to meet analytical aerial triangulation and check point requirements only. The MPO will be provided with new GPS data sheets for each newly installed monument, as well as a digital file containing all new monument locations in and Esri format compatible with the Natrona Regional Geospatial Cooperative's software and database version.

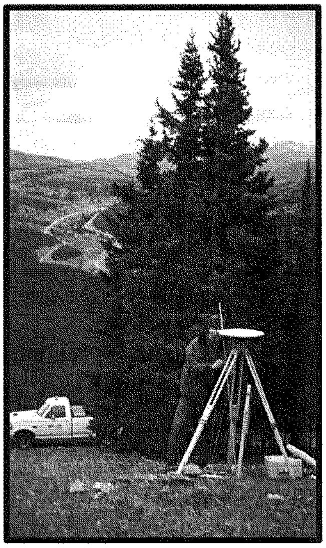
Targeting



Using control point coordinates and/or shape files along with GIS base layers, a location map will be generated for each control point. Survey field technicians will use these maps to reach the vicinity of each point, and then use either mapping grade or RTK GPS units to pin point the monument location. The target placement will be documented with at least three photos: a close-up of the monument, a full frame of the target, and landscape features surrounding the target.

All targeted ground control points will be paneled with material of sufficient color and size to enable ease of identification in the aerial imagery, and use in the aerial triangulation process. Targets may be of an "L", "V" or "X" shape. Painted targets will be placed using pre-fabricated templates and water-based paint. Plastic target material will be used on unpaved surfaces. The Sanborn team will remove all targets upon successful acquisition and notify the MPO when this task is complete.

Control Specifications



All GPS surveys will meet the accuracy standards of at least order C-2-II as defined in "Geometric Geodetic Accuracy Standards And Specifications For Using GPS Relative Positioning Techniques", Federal Geodetic Control Subcommittee, August, 1989. Accuracy will be reported according to the "GEOSPATIAL POSITIONING ACCURACY STANDARDS Part 2: Standards for Geodetic Networks developed by the Federal Geodetic Control Subcommittee (FGCS) and the Federal Geographic Data Committee (FGDC)", 1998.

Horizontal Control

All horizontal control points surveyed will be tied to State Plane Wyoming East Central Zone for horizontal control and reported in the NAD 83(2011) datum in units of U.S. Survey Feet.

Vertical Control

Sanborn will use the Geoid12A model provided by the National Geodetic Survey (NGS) to reduce ellipsoid heights to orthometric heights (NAVD 88), and report them in units of U.S. Survey Feet. Any offsets between paneled targets and ground elevations of vertical control points will be documented and reported.

Surveying Methods: Horizontal and Vertical Control

A GPS Static and Fast Static control network forms the backbone of all location surveys. Sanborn has extensive experience in designing, processing, and adjusting large control networks, and with the coordinate systems on which they are based.

Sanborn has reviewed the MPO'S requirements for survey control, and will ensure that survey operations result in the establishment of control that meets these specifications. A high level of redundancy will be maintained between baselines on all primary networks. Reliability of point positions that have redundant base lines and can be adjusted within a network are stronger than points observed using non-redundant RTK techniques.

Sanborn will submit a control plan prior to proceeding with fieldwork that shows the location of stations to be observed with baselines to be observed during each session. Once targeting is complete, Sanborn will design a final control network which includes all new monuments as well as sufficient HARN monuments to hold as fixed points. Any network or sub-network in a survey will consist solely of independent, non-trivial baselines. Only processed baselines that have fixed ambiguity resolutions will be included in a network.

GPS Data Acquisition Techniques

A two to three person survey crew equipped with differential dual-frequency GPS units will make GPS observations on the network to provide coordinates of the new points. All observations will be conducted with a minimum of 4 observable satellites and maximum PDOP of 7. Data for fast static sessions will be collected for a minimum of 10 minutes at a sampling rate of 15 seconds. All field notes, sketches, adjustments, positional closures, and electronic files for all control and photo control GPS network points will be submitted in the final survey report.

Each new control point will have two or more independent station occupations. Independent occupations will have tripods reset and re-plumbed between sessions. Sessions will be separated by at least twenty (20) minutes.

All GPS surveys will meet the following minimum accuracy standards:

- Independent observations on new control points must agree within 0.08-foot in X and Y
- Observations on existing control of a higher accuracy must agree with the published coordinates within 0.08-foot in X and Y
- Independent observations on new control points must agree within 0.15-foot in Z
- Observations on existing control of a higher accuracy must agree with the published coordinates within 0.15-foot in Z

Antenna Setup—Sanborn will measure the antenna height twice at each setup: once in meters and once in feet. The two measurements will be reduced to a common unit system and compared in the field before leaving the station. This approach eliminates the possibility of observing an incorrect instrument height.

Baseline Processing—all baseline vectors will be post processed nightly using Trimble Geomatic Survey™ software. Fixed bias, double-difference solutions will be determined for all selected baselines. Baselines that do not produce an acceptable solution will be discarded and re-observed on the following day.

Loop Misclosure Analysis—Loop misclosures for all figures in the network will be computed and analyzed on a daily basis. They are the first major indicators of quality, and will be tabulated and compared with the FGCS guidelines. Misclosure table will be included in the Final Survey Report for quality assurance purposes.

GPS Network Adjustments

Minimally Constrained (Free) Network Adjustment—After each day of fieldwork, the complete set of quasi-independent (nontrivial) baselines will be combined in a rigorous, minimally constrained, least squares adjustment. To facilitate the adjustment, the geodetic latitude, longitude, and ellipsoidal height of one existing station will be held fixed.

Sanborn will use Star*Net™ or similar software, which is a three-dimensional least squares adjustment package. The variance-covariance terms from the baseline solutions will be scaled to ensure realistic observation weighting. The estimated (a posteriori) reference variance will be tested using the chi-squared test while the Tau-maximum test will be used for outlier detection. These tests are a direct form of quality control. Baseline component residuals will also be carefully examined.

Sanborn's approach allows for continuous quality assessment, which ensures the attainment of the required accuracy specifications. Analysis of the quality of the network will be based on these criteria:

- **Accuracy Classification**—all directly connected 95 percent relative error ellipses from the minimally constrained adjustment will be analyzed. This examination ensures maintenance of the required internal (relative) spatial accuracy. The network will be deemed acceptable when the relative positional accuracy between all pairs of stations does not exceed Second Order as defined by the FGCS.
- **Station Confidence Regions**—the station confidence regions will also be computed via the minimally constrained least squares adjustment. Examination of these results will reveal the expected horizontal accuracy of each station. Given achievement of the proposed FGCS relative positional accuracy, the final horizontal coordinates of the ground control will be more than sufficient to support the accuracy requirements for this project.

Survey Report

Upon completing the ground control phase, Sanborn's ground control team will prepare and submit a Final Survey Report in .PDF format to the MPO FTAC. At a minimum, the report will provide the following information:

- Executive summary of the survey and its results
- The location and extent of the network
- A narrative description of all aspects of the surveys
- Equipment and software details
- Tables summarizing the GPS misclosures
- Results of the minimally constrained (free) adjustment and the formal classification of the network in terms of the relative spatial accuracy
- Results and associated analysis of the constrained least squares adjustment
- Final coordinate listings

- A network diagram, showing all stations and the measured quasi-independent baselines
- Reference sheets for all ground control points

Permissions, Public Relations and Safety Issues

Sanborn is aware of potential concerns that some members of the public may have regarding field survey operations. Sanborn will ask the MPO for a letter explaining the intent of the survey that can be referenced in the event of queries from the public. All field personnel will dress and conduct themselves in a professional manner. Sanborn will conduct field operations during daylight hours, and observe all laws and regulations pertaining to operations in public rights-of-way, as well as entry to public or private property.

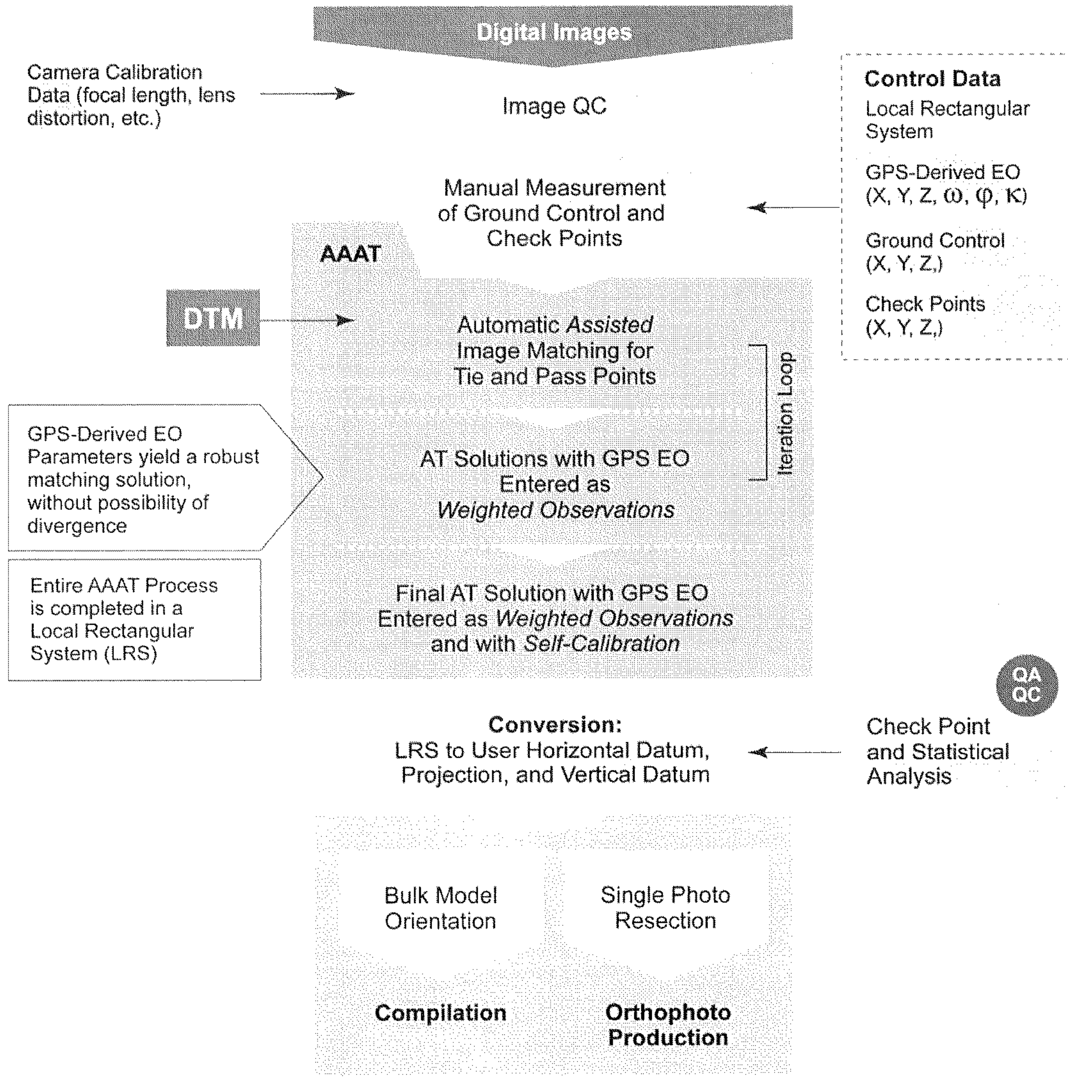
Ground Survey QA/QC

The control survey will be characterized by extensive quality control mechanisms, for example:

- Dual instrument height measurements using different units of measure, or fixed-height tripods.
- Use of redundant, quasi-independent GPS baseline in all loops; loop misclosures
- Least squares adjustments and statistical evaluations
- Use of multiple well distributed existing horizontal and vertical control points as the basis for the new network(s)
- Independent review and checking of all computations
- Supplementing GPS surveys with conventional survey techniques using electronic traversing (total stations) and digital leveling for more precise vertical control.
- Full reporting of all results and the inclusion of all computations, field logs, solution printouts, and any other pertinent information provide quality assurance.

Digital Aerotriangulation (DAT)

Once the processed imagery, AGPS/IMU, and ground control survey data become available, Sanborn's next step will be to complete Aerial Triangulation (AT). Carefully developed and refined procedures will be followed, as the AT solution is the foundation for the accuracy of all derivative data products created from the imagery. Each stereo model will contain between 60 and 120 pixel match points to ensure that the relative accuracy and measurement integrity of the entire block of imagery is achieved. Sanborn's procedure consists of the use of a fully automatic pixel-matching routine, followed by a supervised, manual point selection, introduced strategically where automated routines have difficulty matching pixels (shadows, water, dense trees, etc.). A flow diagram outlining Sanborn's aerial triangulation approach is shown below, and described in the following paragraphs.



Assisted Automatic Aerial Triangulation (AAAT)

AAAT is a refinement of conventional AT in which airborne GPS/IMU data are used for the direct measurement of the position and orientation of every exposure in the photogrammetric block. These data result in highly reliable automatic tie point and pass point measurements, because the directly observed exterior orientation data prevents divergence of the solution. The AAAT process improves upon conventional (manual) aerial triangulation by providing numerous automated tie points and pass points. Sanborn will automatically measure seven or more tie points and pass points in each of the standard Von Gruber locations. The automation of manual point observation within the AT process introduces significant efficiency when adjusting large contiguous blocks.

The benefits of softcopy-based AAAT include:

- Alleviation of the need to perform manual pugging and observation of control points, tie points, and pass points.

- Much greater productivity, a factor that is crucial to schedule adherence and minimizing cost to the MPO.
- Improved accuracy, because the procedure yields many more tie points and pass points than could be practically observed by manual means.

Sanborn will use Inpho's Match-AT software to perform AAAT. On the market since 1996, and in its current version, offering what we believe to be the most evolved aerotriangulation solution available, Match-AT has a proven track record on projects of similar size and scope. The graphical display of adjustment statistics via this software is a highly valuable aid for analysis and quality control. Verification of results and measurement of ground control and check points will be performed using the Match-AT module as well. Match-AT includes bundle block adjustment module which performs least squares block adjustment after automatically matched points are generated and manual measurements are completed. Software has built in tools to flag and eliminate blundered observations.

The benefits of using Inpho's Match-AT software include:

- Match-AT enables the AT technician to use refinement to enhance the matching of a selected point in neighboring images during the mensuration of control and supplementary tie points. Sub-pixel accuracy is achieved on a routine basis.
- Match-AT provides a seamless digital environment because the AT result (namely, the final bundle block adjustment result) is applied directly, yielding single photo external orientations and absolute orientations, which can be used immediately in photogrammetric data capture and orthophoto by using Match-AT's export functions to convert data to be used in data capture and orthophoto production modules.

Absolute Accuracy Check Points

True verification of accuracy requires the use of independent check points – specifically, ground control points withheld from the AT process and used as checks after the initial adjustment. To meet statistical criteria via a sufficiently large sample, Sanborn typically withholds a minimum of one-fourth of the ground control points to be used as check points to verify the quality of the AT adjustment. Since AGPS/IMU will be relied upon as the primary element of control for this project, ALL ground control points may be withheld in order to generate an RMSE for all ground control against an independent AGPS/IMU solution. This process validates the AGPS/IMU as a stand-alone solution for meeting the specified project accuracy. A final AT adjustment will then be made incorporating all of the ground control to arrive at the best possible coordinates for subsequent photogrammetric operations.

Accuracy Standards

ASPRS standards establish a number of production parameters to confine errors within the enumerated limits. These tolerance levels are expressed as the RMSE of all of the test point inaccuracies encountered by field verification. Sanborn will provide, at a minimum, the fit to horizontal and vertical ground control of the digital analytical aerotriangulation solution will meet the following criteria:

- The following table exhibits the expected level of accuracy to be achieved using the proposed AT procedures.

AT Accuracy Standards (Typical)	
Criterion/Standard	Comment
$\hat{\sigma}_o \leq 5\mu m$	A posteriori image coordinate measurement accuracy based on an a priori unit weight
$RMSE \approx 1.9 \rightarrow 3.0 \cdot \hat{\sigma}_o \cdot S$	Planimetric/ortho (X or Y) object space RMSE at independent check points
$RMSE \approx 2.8 \rightarrow 4.5 \cdot \hat{\sigma}_o \cdot S$	Vertical (Z) object space RMSE at independent check points
$RMSE \leq 5\mu m$	RMSE values at image points in x or y

Note: "S" = photo scale

Aerial Triangulation QA/QC

The quality of the aerotriangulation solution is proven by low values of the error residuals in the least squares adjustment. Very low values in the residuals indicate that the ground control is free of survey errors because it fits the photogrammetric measurements. The quality control steps outlined below will be followed to help ensure the best quality adjustment.

AT will be completed under the supervision of Doug Zehr, CP, SP. Mr. Zehr has 24 years of industry experience and is currently responsible for managing Sanborn's photogrammetric team. His responsibilities include overseeing aerial triangulation and the support of photogrammetric and LiDAR production processes. He also works with Sanborn's business development group designing production and cost strategy.

The full and complete documentation of the quality control procedures and results will be presented in the Final AT Report.

- The project boundary will be identified to ensure that triangulation coverage includes the entire project area.
- Checkpoints will be used and evaluated as previously discussed above
- Intermediate triangulation results will be thoroughly reviewed by the Lead Technician and the Data Processing Manager.
- Final triangulation results will be thoroughly reviewed by the Lead Technician, Data Processing Manager, and the Manager of Production.

Aerial Triangulation Report

Upon completion of all AT adjustments, Sanborn will submit a Final AT Report in .PDF format, with relevant portions in ASCII format as required by the MPO. This report will provide a narrative description of all aspects of the AT phase, tabular information for ground control and check point results, and appendices, which include documentation of the full AT solution. The Final AT Report will include the following information:

- An executive summary of the aerial triangulation (AT) and its results
- A narrative description of all aspects of the AAAT and AT bundle block adjustments
- A basic description of the project including ground control, flight planning, aerial imagery, and the airborne GPS observations and results
- Equipment and software details

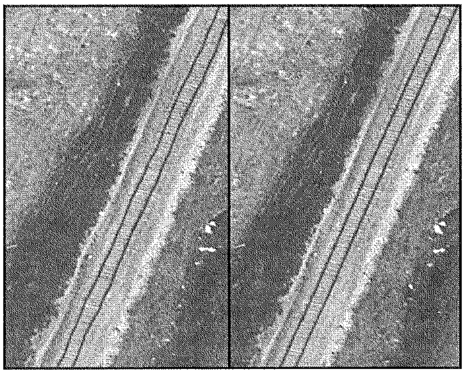
- A description of the AAAT procedures and results including any geodetic considerations such as the use of a Local Rectangular System
- Results of the preliminary check point adjustment, the constrained bundle block adjustment, and the formal classification of the AT in terms of its accuracy
- Raw measured fiducial coordinates for each photo image in the photo coordinate system
- Raw measured control points and pass points in the photo coordinate system
- Adjusted control points, pass points, photo centers and residuals in the NAD 83(2011) SPCS coordinate system with NAVD88 elevations
- The Report will include the coordinated and residual values for all points
- The Report will include RMS values and ground elevations accuracy for the final adjustment
- The Report will note and explain any discarded points
- Standard deviation of the adjusted control point, pass point measurements, and airborne GPS photo center coordinates
- Photo orientation parameters (X,Y,Z, omega, phi, kappa) for each photo image
- Camera focal lengths used in adjustment
- Documentation of the weighting strategy used for ground control points and airborne GPS coordinates
- Final coordinate listings and other associated data in an EXCEL spreadsheet

Ortho Imagery Processing

The creation of ortho imagery involves a number of important steps, beginning with the actual orthorectification, which corrects the geometric distortions inherent in digital aerial imagery, and turns it into a true map product. The process also involves mosaicking, and a variety of radiometric corrections, which turn the numerous individual photo images into one seamless database, with uniform, pleasing, realistic color characteristics. After it has been quality-controlled and any needed corrections made, the database is tiled to the MPO's specifications, and written out in the desired compressed or uncompressed image file format(s) for delivery.

Orthorectification

Sanborn uses a highly sophisticated, proprietary software package called METRO (Method for the Elimination of Tilt and Relief Displacement in Orthophotography) for orthophoto creation. METRO is one of the most robust and feature-rich automated digital orthophoto production software suites in the industry. The METRO system draws upon digital elevation/terrain models (DEM/DTMs), digital sensor information, digital aerial imagery acquired for the project, and aerial triangulation (AT) data to rectify each digital image. The rectification corrects for inherent geometric distortions in the image that are caused by terrain variance, earth curvature, and camera orientation in relation to the ground. The terrain surface used by METRO is in the form of a triangulated irregular network (TIN), not a regular grid DEM or DTM. The TIN provides a more accurate representation of the terrain surface. The TIN eliminates waviness around sharp terrain breaks, such as steep embankments, road edges, railway grades, and hydrographic features, as seen by comparing the rail lines in the pictures above.



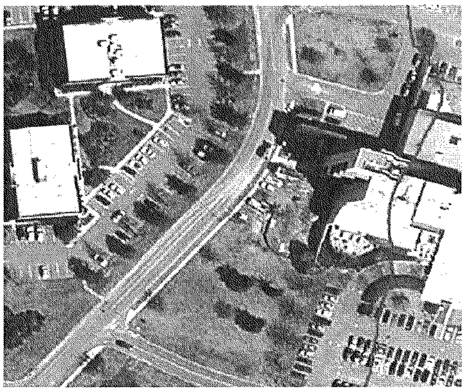
Ortho with DEM *Ortho with TIN*

METRO uses the cubic convolution sampling technique, which yields high accuracy and excellent aesthetic quality. Cubic convolution is the industry standard algorithm for the rectification of digital orthoimagery. It relies on a 4 x 4 (16-pixel) kernel and a cubic algebraic function.

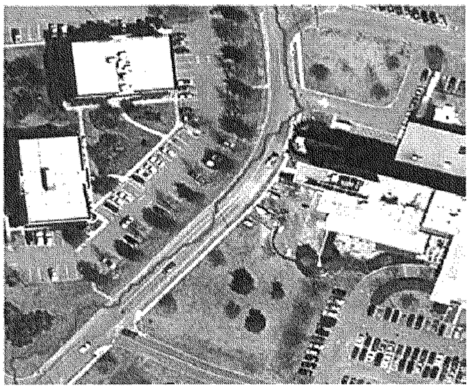
Sanborn has also developed methods and procedures that allow for the processing of the RGB color and near infra-red (NIR) bands within a single rectification. One of the greatest advantages of digital cameras systems is the ability to collect co-registered multi-spectral imagery. Because of this camera design, Sanborn can bring a 4-band image into our software and complete single-step aerial triangulation, orthorectification, and post processing. Prior to this process and the new digital camera technology, imagery providers had to collect RGB and NIR imagery on two separate flights, and perform aerial triangulation and orthorectification twice, doubling the effort, cost, and time to deliver the NIR product. Sanborn believes this new process provides an exceptional value to the MPO, as we will do not charge additional fees for collection, orthorectification, and delivery of the near-infrared data.

Mosaic Processing

Sanborn uses a unique mosaicking process that performs pixel matching along a seam line at ground level. This virtually eliminates image distortions caused by above ground features mosaicked from two adjacent photographs. As part of the mosaicking workflow, experienced imagery technicians review the seams between orthophotos to ensure that adjacent images edge match correctly. The METRO seaming routine avoids elevated structures so that buildings are viewed from only one source image.



Orthophoto without intelligent seams.



Orthophoto mosaic with intelligent seams.

Seamline Generation

Sanborn's production process allows for seamline generation and a seamline deliverable, if desired by the MPO. This is a product that has been delivered to other clients for many years, and is useful to have when performing quality control on the imagery. The following illustration displays how image chips are used to make a larger mosaic. Each color within this sample represents image chips that are mosaicked together to make a single homogeneous image.

Sanborn tracks each image throughout the production process for the metadata requirements. This same information will be applied to the attribution of the seamline database.

One imagery tile with eighteen contributing exposures

Radiometric Balancing

Sanborn's image quality criteria require radiometrically homogeneous imagery that is devoid of response gradients and vignetting within an exposure, and unnatural tonal variations across exposures. A four-step radiometric calibration and processing workflow is followed to ensure that these criteria are met:

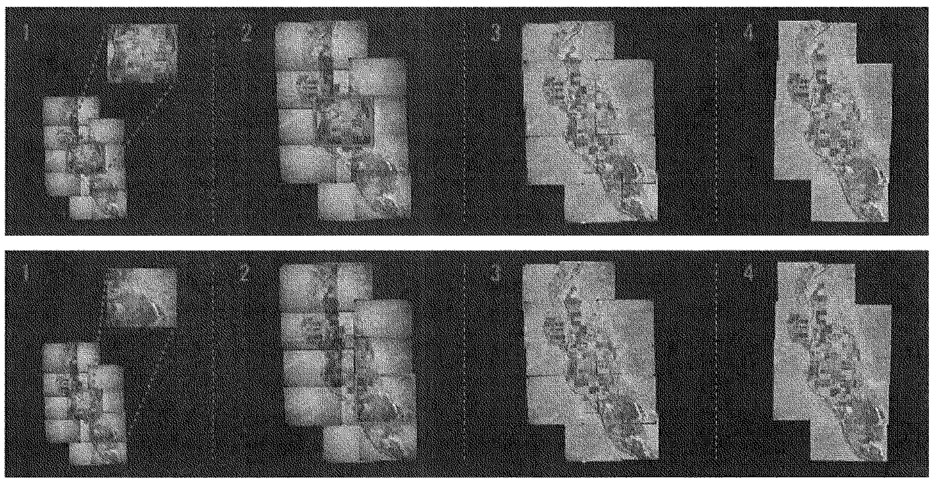
1. **Pre-Flight Calibration:** Camera response is calibrated the day of acquisition for the ground reflectance and expected illumination conditions. The calibration process ensures maximum use of the available 14-bit dynamic range and correct color balance.
2. **Atmospheric Correction:** Atmospheric correction to remove any haze or atmospheric transmission loss using a Modtran4 derived correction function.
3. **Sensor Corrections**: Pre-processing to remove any vignetting effects, resulting in a homogeneously exposed image.
4. **Color Balancing**: Final processing includes local and global color balancing to ensure that all image exposures appear consistent, with no tonal variation across seams.

Final Color Balancing

Sanborn will use tone balancing to even bright and dark areas on the imagery that are caused by changing lighting conditions , such as variance in sun angle, over the duration of the imagery acquisition process. Our procedure enables us to compute an average intensity value for each input image, and ensure that the corresponding output image retains the same average intensity, but with corrections for common photographic problems such as vignetting and uneven exposure. Once dodging has been completed, color balancing is continued using a proprietary color balancing tool called SPICE (Sanborn's Proprietary Interactive Color Editor). This sophisticated tool enables technicians to use an intuitive and interactive methodology to specify the radiometric target characteristics of the final product, allowing the user to specify the radiometric properties of the final orthoimagery using a "what you see is what you get" interface, and also to match easily to client-specified target characteristics. The MPO can provide digital imagery samples as a target, and SPICE will match the characteristics of the target image.

A secondary function of SPICE is to automatically adjust artifacts that typically lead to radiometrically non-homogeneous orthoimagery. This process is particularly important in regional areas with high reflectance, such as water. After selecting mosaic boundaries automatically or manually and defining blend types, either by default or individually, the mosaicking process runs in a batch mode. During the process, the final photos are tone balanced for optimal viewing and seamless mosaicking.

The following images show how this process can provide different radiometric values from the same source imagery based on the selection of different color targets. It is this process that will allow Sanborn to auto-match the radiometry of the prototype signature areas provided by the MPO. Sanborn will ingest the MPO's approved prototypes in stage one of this process to produce the final orthoimagery with similar characteristics. Global tone matching and seamless mosaicking will provide consistent image quality output over the entire project area.

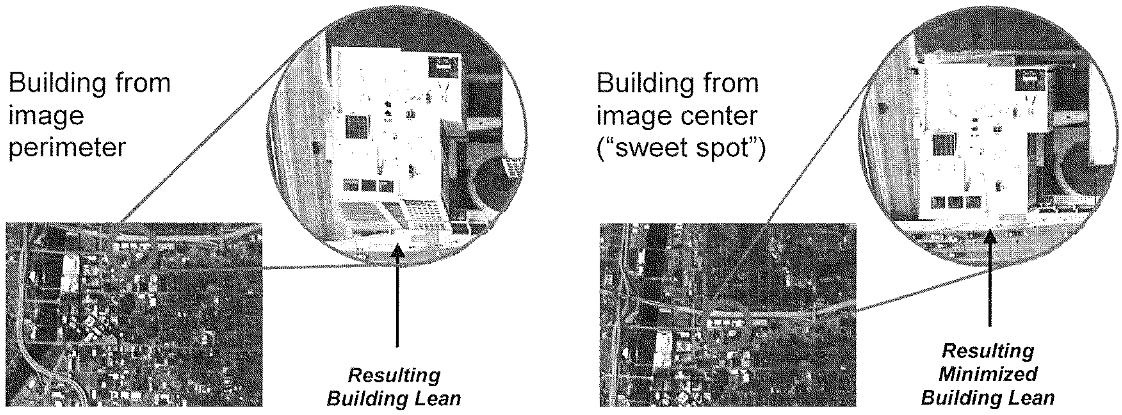


Methods and procedures used in order to ensure a seamless orthoimage database with no discernible differences between adjacent images include:

- Each digital orthophoto will initially be created with a certain amount of overlap between adjoining images. This is necessary for determination of brightness differences between images.
- Pixel groups in adjacent images will be compared to determine the final output values along the seam line.
- Images will be processed so tonal values are consistent across boundaries, with no evidence of a seam.
- All radiometric correction will result in minimally measurable, and visually undetectable radiometric seams within or between flight lines, stereo models, or tiles.
- Sanborn calculates the position of the sun in relation to the camera at the time of exposure. This allows correction for hot spots and reflectance in the photography.
- Radiometric adjustment includes color balancing, overall tone adjustment, and brightness and contrast enhancement of the imagery over the entire project. Client-approved sample data (pilot data set) will be used as reference. There will be no null pixels within tiles.

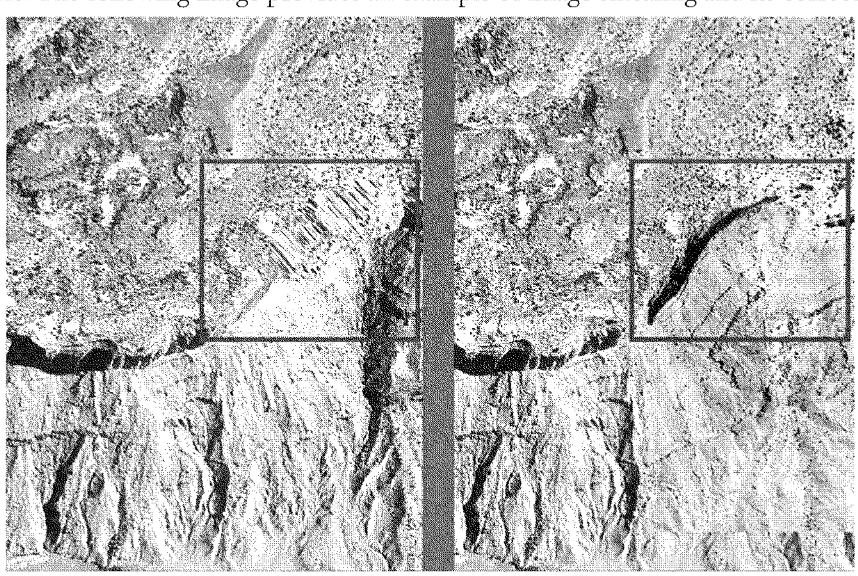
Radial Distortion (Building Lean) Minimization

Radial distortion of above-ground features is a common issue with orthoimagery. Sanborn creates orthophotos using only a relatively small inner area, or so-called "sweet spot," from each available image. This minimizes radial displacement and related problems, which increase toward the outer perimeter of a photograph. Using the "sweet spot" also increases the quality of the color balancing between photos. The high-overlap imagery acquired over major urban areas, as well as the higher acquisition altitude capability offered by the UltraCam Eagle sensor will also contribute significantly to the minimization of building lean and other radial distortion.



Smear Correction Due to Terrain

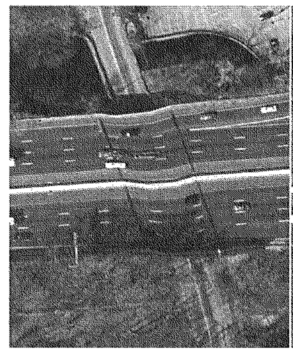
Sanborn utilizes both the "sweet spot" and intelligent seaming to automatically correct for image smears. Image smears typically are found in areas of high relief where the image angle is parallel to the terrain. An accurate digital elevation model is required to correct this problem. As a result of Sanborn's methodology, clients are guaranteed that valleys within high relief areas remain visible. The following image provides an example of image smearing and its correction:



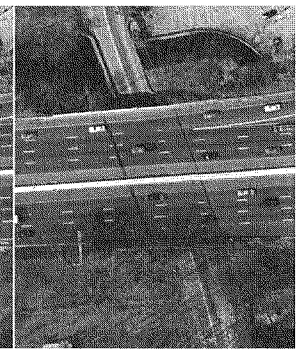
Smeared terrain *Smeared terrain correction*

Correction of Bridges and Other Elevated Highway Features

Distortion of bridges and other elevated highway features occurs when a DTM models the terrain surface, but not elevated features such as bridges crossing over that DTM. Sanborn corrects bridges and elevated highways as a routine step in our orthophoto creation workflow. Sanborn produces a separate DTM for each elevated highway feature, and when used in METRO's rectification process, elevated highway feature displacements will be corrected, with each feature being restored to its true location. Sanborn will deliver a separate bridge DTM file containing all affected bridges and flyovers.



Typical bridge distortion



Following standard Sanborn correction.

Generation of Final Deliverables

A seamless database of orthorectified imagery will be created and final deliverable tiles "cookie-cut" out of it. This results in deliverable digital orthophoto files that match at a neat line with no overlap or gap. The tiles will be cut to conform to the MPO'S tile scheme, and written out in compliance with their desired naming convention. All tiles will be geo-referenced and projected in the specified project coordinate system. A tile index will be provided in Esri Geodatabase format.

All imagery will be delivered at a spatial resolution of X-inches, in .TIFF/.TIFW format, and MrSID .SID/.SDW format with 20:1 compression. MrSID mosaics will be provided for counties or municipalities in .SID/.SDW format with 20:1 compression. Radiometry will be 4-band, 8-bit per channel RGB/NIR. Radiometry will be 4-band, 8-bit per channel RGB/NIR. The database will be delivered on USB External Hard Drives.

Digital Orthophoto Quality Assurance

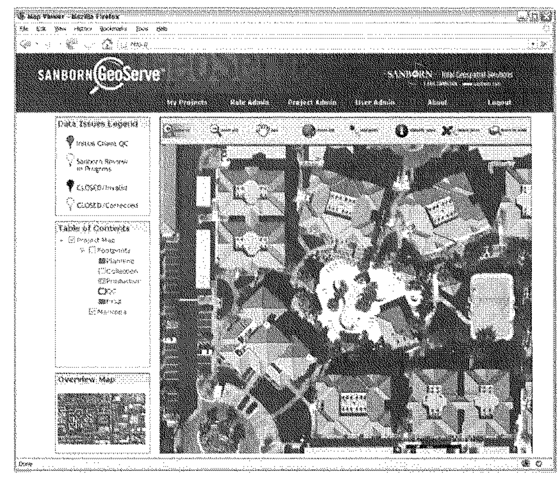
The process involved in producing high quality digital orthophotography is dependent upon the successful execution of many tasks performed by several Sanborn departments. While QA/QC is integrated into the workflow, every orthoimage tiles undergoes a thorough visual inspection by experienced imagery technicians following the conclusion of the production process. Any blemishes or artifacts in the imagery will be corrected prior to submittal. Inspections that will be performed on the orthoimagery include, but are not limited to:

- Visual inspection of geometry—Evaluate final geometric fit for compliance to specifications and/or published data quality statistics:
  - Obvious seams
  - Edgematching (roads, buildings)
  - Bridge warping
  - Excessive radial displacement in buildings

- Visual QC of mosaic—Evaluate product quality and modify as needed to meet project specifications:
  - Blurred imagery
  - Inconsistencies of color balancing
  - Artifacts removed
  - Shadow detail
- Product packaging—Final review of product with regard to content, format, labeling

Sanborn understands that imagery which does not meet quality and accuracy requirements will be rejected and will need to be re-submitted following corrective measures.

GeoServe Online Client QC Tool



Sanborn makes an optional service for web-based quality checking of orthoimagery available to its clients. Data is served from a central data server at Sanborn to the customer-side computer and, uses a mapping interface from within a standard web browser.

Sanborn's GeoServe Online QC tool accelerates the review process and expedites final product acceptance. This web-enabled tool removes the need for the physical transport of initial data to the customer site and allows for data to be reviewed and flagged for correction remotely, which reduces the project timeline. Edit flags are stored in a centralized location where they are immediately available for review by others in the organization.

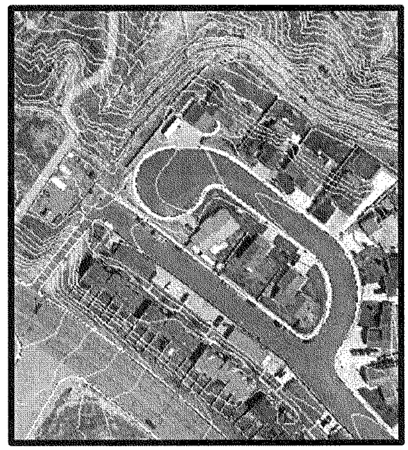
Customer-level login security has been implemented in conjunction with strict firewall functions and policies to help keep unauthorized users from accessing restricted data. Users are able to view available data and add digital issue points to areas which may have perceived problems or errors. These points are submitted directly to a secure centralized database where they are immediately available for others to review. Benefits of this process include:

- Online quality assurance process helps reduce the time needed for review as data can be corrected incrementally with edit calls, often speeding the review schedule.
- Provides ease and standard documentation for data quality review needed for contract monitoring and compliance.
- Facilitates coordination between many data reviewers, even when geographically separated.

Planimetric Mapping

Sanborn has extensive experience extracting planimetric data from aerial imagery for use in creating or updating GIS data layers using photogrammetric techniques. Sanborn will capture all feature layers as detailed in the RFP, depending on which are desired by each participant, in full conformance with the database design provided by the MPO.

Feature Compilation



Sanborn will extract the desired planimetric features from the controlled aerial imagery in a 3D stereoscopic environment, utilizing first-order softcopy workstations operated by photogrammetrists experienced in photo interpretation to update or create the planimetric database, as appropriate to each feature class. The use of softcopy workstations utilizing stereo superimposition technology (planimetric features traced in vector form directly over the top of stereoscopic imagery displayed on the computer monitor) ensures accurate and complete collection of all mapped features. This approach not only provides an accurate horizontal position for the planimetric features, it also provides accurate elevation data where needed, as Sanborn collects a variety of planimetric features such a road edges, retaining walls, and hydrographic features in 3D. Planimetric features for the MPO areas will include those features described in Exhibit H, including:

- Hydrography (HydroLine, HydroPoly, Drainage Basin)
  - Natural Stream Centerlines or storm drainage infrastructure
  - Line geometry will be consist with the topographic data and digitized direction will be consistent with the flow direction
- Structures
  - Structures under 10 square feet shall be omitted from the structures layer. The Vendor will provide building footprints as polygons, with an attribute for both base elevation and building height. Building heights will be determined by the single highest roof line per any given structure. Complex structures with multiple roof heights shall be split so as to provide the best overall representation of the structure.

The MPO should note that there are limitations that impact our ability to fully and accurately capture some planimetric features, including:

- The scale/limits of resolution of the imagery
- Shadows
- Vegetation cover
- Roof overhangs
- Temporary structures such as mobile canopies
- Vehicles driving or parked over features
- Paved-over or dirt-covered features, or features that are very close in color to paved surfaces or dirt.

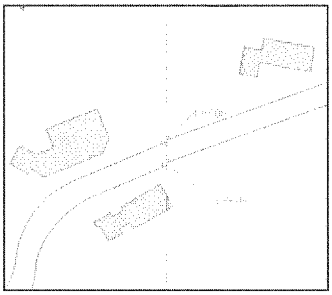
The database structure for the project will be uploaded to each softcopy workstation. Quality assurance steps will be in place during the data capture process to ensure that each required planimetric feature is collected to correct graphical representation, annotation and attribute requirements outlined in the data dictionary.

At the completion of the stereoscopic compilation tasks, the compiled model is reviewed using softcopy stereo-display to ensure that all data was compiled correctly. A senior photogrammetrist performs this review, with the specific responsibility of maintaining quality control of the project. The compiled file is superimposed over the source imagery, and the required planimetric features in areas of change are reviewed. If features are determined to be missing, or not properly merged into unchanged portions of the database, the location is marked in the file in a separate layer and a QC note is inserted with specific comments. The model will be recalled by the stereo compiler and any necessary corrections addressed. This procedure provides two-way communication, ensuring consistency of data collection in terms of content and interpretation. Once the data are complete and correct, the interactive graphic editing phase begins.

Interactive Graphic Editing and Topological Structuring of Data

Graphic editing procedures involve a combination of interactive and programmatic checks to ensure that the data is cartographically correct and aesthetically pleasing, connectivity of linework is complete, and specific layers of line topology are generated. A variety of topology checks are performed to ensure that all features defined as being topologically structured have no snapping errors (overshoots/undershoots). Polygon topology is created, attribution of features takes place, and edge-match checking between tiles of data is performed.

Edge Matching



Checking for tile edge mismatches is a standard part of all Sanborn projects for clients that tile their data. Using an automated process, each tile is checked against its neighboring tiles to ensure that all linework matches exactly. This ensures that attributes of the linework and/or polygon data are also checked. At the conclusion of the process, the graphic technician digitally reviews each tile and corrects any mismatches in line placement or attribution that were flagged by the edgematch routine. This process is repeated until no errors are flagged. Sanborn will ensure that planimetric features will meet all topology requirements when the data is migrated into the target environment, and make the transition to the GIS as efficient as possible.

Layers, Colors, Symbols, Linestyles, and Annotation

Sanborn will format all data layers as detailed in the data dictionary. All symbols, colors, linestyles, and annotation will follow the MPO's desired conventions.

Sanborn's listing of data standards and criteria are summarized in the following table.

Data Standards and Criteria	
Edgematching	All data that crosses a tile/map sheet will be edge-matched and coordinate connectivity present.
Point Duplication	No duplicate structures or graphic entities will be allowed. No points will be duplicated within a data string. Points will not be duplicated across tile boundaries unless it corresponds to a delivery area
Connectivity	Software checkable digitizing errors such as overshoots and undershoots will be eliminated as specified. Lines that intersect will join precisely
Line Quality	All straight lines will contain only two points: beginning and end. A high graphic appearance shall be achieved. Transitions from straight line to arcs shall be smooth.
Segmentation	Linear elements will not be broken unless the break reflects a visual or attribute code characteristic
Precision	All data capture will be accomplished in double precision.
Build and Clean	Data shall be built and clean, and no polygon-label errors will exist. Dangles and intersect errors may exist under certain circumstances in the line data but not in the polygon data.
Annotation Criteria	Placement, where required, will be visually consistent and uniform.
Symbology	All graphics will be consistent with the symbol specifications with respect to the character of the symbols, line weights, annotation fonts and sizes, symbol displacement (cartographic license), and special applications of the symbology.
Spatial Continuity	All delivered files will represent the specified data as spatially continuous. The data will be topologically structured and all polygons will be mathematically closed All polygons have centroid label points.
Graphic Standards	All graphics will be consistent with accepted symbology and a high cartographic appearance shall be achieved.

Translation into Esri Geodatabase Format

Once the planimetric and DEM data are completely structured and edited, they are ready to be translated from MicroStation .DGN to Esri Geodatabase format for delivery. Sanborn has a suite of proprietary translator software that enables the translation to various target systems, including the Esri environment.

As a final check on the deliverable data, and with the MPO's database design as the foundation, Sanborn uses custom software modules to perform QA/QC checks within the Esri Geodatabase environment:

- Features and associated attributes are validated for data integrity
- Checks are performed to ensure consistent assignment of unique ID numbers
- Edgematching processes are run between files
- Data will be verified with the source data and documents for content (missing data) errors, annotation integrity, and aesthetics
- QA/QC reports are generated and checked for errors; they may include:
  - Ensure that all datasets have valid feature attribute tables (FATs)
  - Ensure that all datasets have valid values for fuzzy tolerance, dangle length, and precision
  - Verify point duplication
  - Verify line duplication or incorrect length
  - Verify polygon label errors and dangles

- Verify attribute item definitions
- Verify attribute value ranges
- Verify attribute value combinations for multiple items in an attribute table
- Verify valid annotation levels for a coverage
- Verify pseudo node placement
- Verify data outside appropriate boundaries
- Verify data edgematching across tiles
- Verify value/uniqueness for related tables
- Verify size and symbol for given symbols or annotation

Compiling into Esri Geodatabase Format

Sanborn has the capability of compiling directly into an Esri geodatabase directly from the 3D stereoscopic environment using DAT/EM CAPTURE. All of the compilation methods and topology checks are the same as capture into MicroStation without having to translate the data from a .dgn file into a database.

Planimetric, Contour and DTM Data Delivery

Sanborn will provide final DTM, contour, and planimetric data to the MPO as a seamless Esri Geodatabase. The files will be delivered on USB External Hard Drives.

Airborne LiDAR Acquisition and Processing

Sanborn Team LiDAR Resources

The Sanborn Team owns and operates ALS70-HP LiDAR sensors (see details in the Equipment section, below). Sanborn alone has invested over $5,000,000 in sensors and processing technology to ensure that our LiDAR capabilities are equal to any in the industry. Sanborn has developed sophisticated processes to integrate multiple sensors into our LiDAR workflow and has standardized our data format to maintain data integrity and accuracies.

All of the Sanborn Team sensors are capable of achieving QL2 or better LiDAR products. For large area capture, the Leica ALS70 can operate at higher altitudes than most for comparable point spacing, so it is particularly cost efficient. The Sanborn Team owns five (5) ALS70 sensors.

The specifications of the ALS70-HP sensor are shown in the table below:

Description	Leica ALS70-HP
Maximum average radiant power (per channel)	4.0 W (100 kHz - 300 kHz)
Maximum peak radiant energy (per channel)	13 uJ (at 300 kHz)
Pulse duration	4 ns (100 kHz - 300 kHz)
Pulse repetition frequency, PRF	20 kHz...300 kHz

Description	Leica ALS70-HP
Wavelength	1064 nm (INVISIBLE)
Beam divergence (full angle at 1/e)	0 15 mrad
Nominal Ocular Hazard Distance (NOHD)	159m / 522 ft
Extended Nominal Ocular Hazard Distance (E-NOHD)	1441m / 4728 ft

Flight Planning

Sanborn will carefully plan all missions to ensure that resulting data will be compliant with the requirements set for the project, and review our proposed flight and ground control plans with the MPO prior to mobilizing any field or airborne resources.

Mission and mobilization planning will follow the following workflow of key procedures and considerations:

- Sanborn will prepare a digital flight line layout using Track'Air software.
- Sanborn's flight plan will contain the following information:
  - Projected flight lines
  - Flight line numbers
  - Intended coverage
  - Flight altitude
- Sanborn will overlay the flight line layout over Google Earth imagery, and determine optimum locations for the placement of ground checkpoints and GPS base stations, where these items are needed and will be provided to the MPO for approval.
- Sanborn calculated that it will require about 6 full missions to capture QL-2 LiDAR over the whole county. Considering a weather factor of 2 (1 flight in every 2 days), it will take Sanborn about 12 days to capture the complete AOI with QL-2 density LiDAR.

Sanborn will perform mobilization planning to ensure that airborne data acquisition can progress in accordance with the project schedule. This will include:

- Monitoring conditions within the AOI's to determine when acceptable leaf conditions of deciduous trees, streams, and rivers exist.
- Monitoring weather conditions
- Ensuring that missions will be flown when the PDOP is less than 3.2 and the KP index is less than 4.
- Locating airports at which to stage aircraft and aircrews, and arranging for their accommodations.
- Making arrangements to access restricted airspace

LiDAR Data Acquisition

Sanborn follows a number of key guidelines in order to minimize errors resulting from GPS ground station, Airborne GPS, IMU, and LiDAR operations. GPS data is collected using survey-grade receivers and antennas. Positional Dilution of Precision (PDOP) and satellite availability is forecast using GPS planning software.

The GPS parameters are followed for both the airborne GPS and ground reference GPS collections. In addition, five- to ten-minute static collections are done at the beginning and end of each flight to increase the positional accuracy of the GPS data.

Sanborn's IMU collection process employs both internal and manufacturer-recommended procedures to ensure reliable data collection. The IMU is initialized on the ground, pre-flight, and will be in fine alignment prior to taxiing the aircraft. Procedural S-turns will be conducted prior to collection of LiDAR data to further orient the IMU. The collection of data in a straight line will not exceed 20 minutes, because the IMU tends to drift after this time. During collection, the flight-line will be flown in a back and forth pattern based upon adjacent flight lines, and never in a "race track" pattern, in order to limit IMU drifts. The IMU data is processed during the field QC process for every flight, and verified to ensure a tolerance using the manufacturer's processing software.

Atmospheric conditions prior, during, and after the flight are recorded to account for any atmospheric refraction that might occur during collection. These values are entered into the processing software to account for any refraction. Sanborn's Leica ALS-70-HP LiDAR system has the ability to utilize these values, and they are recorded for every mission flown.

Weather and Timing Considerations

Sanborn has derived from manufacturer's operating specifications and our LiDAR operations history a set of flight mission weather parameters that we will not exceed in order to optimize reliable LiDAR data collection. These parameters include:

- Atmospheric and safety considerations, including relative humidity, clouds and haze conditions.
- If optimal conditions exist at night, operations can be conducted then as well.
- If smoke exists in the collection area, missions will not be flown.
- We will not collect data in moderate to severe turbulence, or with a cross wind of 25 knots or more.
- Aircraft crab angle will not exceed 25 degrees at any time.
- If dew point exceeds or is within two degrees of relative temperature, then no data collection will be performed.
- If any rain or standing water exists in the collection area, then data collection will be postponed.
- No unusual flooding, water inundation, or snow, unless directed and approved by the MPO.
- Ensuring that missions will be flown when the PDOP is less than 3.2 and the KP index is less than 4. This ensures the GPS-IMU data is of good quality and supports the accuracy of the LiDAR acquisition.

General AGPS/IMU Procedures

Sanborn's airborne GPS approach will consist of the following steps:

- Recovering or establishing suitable base station locations within the project area, as appropriate to the accuracy specifications for the project.
- AGPS/IMU boresight calibration is performed at least twice per year. Any time the sensor or AGPS/IMU is moved, a new boresight is required.

- Collecting, processing, and interpolating the AGPS data to derive sensor coordinates and rotations at each instant of exposure.

During the mission planning process, Positional Dilution of Precision (PDOP) is evaluated using Trimble's Qplan or Ashtech's MPwin GPS planning software. All mission collections will be conducted with a PDOP of 3.2 or lower. The KP index is also evaluated prior to mission collection. KP index is a measurement of geomagnetic activity at the earth's surface that can greatly affect the GPS solution. Therefore, no collection will occur when the KP index is at or above 4. Prior to the actual AGPS missions, Sanborn will also check the AGPS system installation.

Base Stations

Due to ABGPS/IMU technology used by Sanborn, base station distances are not limited to traditional 55km baselines. During the data acquisition missions, multiple National Geodetic Survey Continually Operating Reference Stations (NGS CORS) that are up to 200km from the acquisition area will be logging 1, 2, or 5-second data that will be download and incorporated when processing the airborne GPS solution. In order to ensure mission integrity, Sanborn will be operating base stations (Trimble 4100 or 5700 receivers) on the ground in the proximity of the project area for the duration of the acquisition flight as a backup in case of any failures or problems with the CORS system.

Typically, at least 1 GPS base station will be in operation during each mission. This GPS receiver will be set on a published National Geodetic Survey control point such as the Primary Airport Control (PAC) Station. If for any reason it not be possible to set a GPS base station at a published NGS point, a temporary point will be introduced and marked near the FBO (fixed base of operation) at the airport of departure.

The base station receiver at the airport will be operational prior to starting airborne data collection. All crews will have their base station(s) running at least 7 minutes prior to sun angle and at least seven minutes after sun angle. This provides redundant base station data in the event of a base station failure or other unanticipated GPS issue from one crew. All GPS receivers will be set to an epoch rate of 2 Hz.

In-Flight Calibration

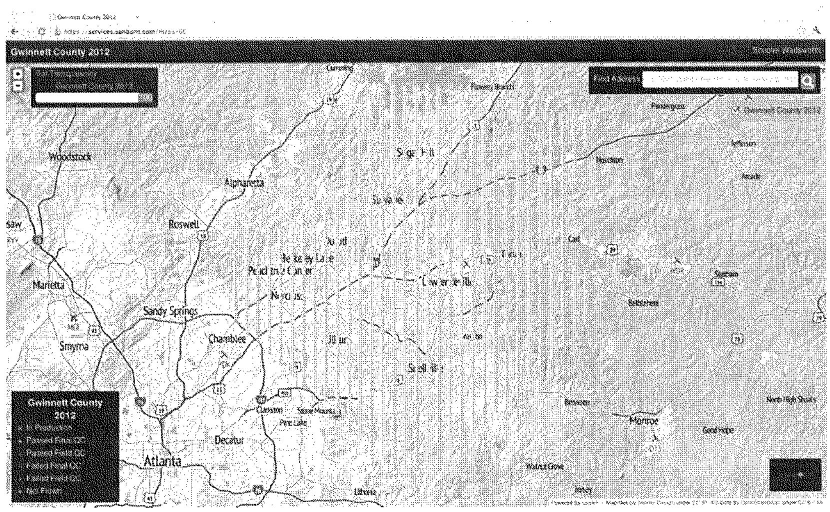
The AGPS/IMU system requires a seven minute "initialization" period for satellite data acquisition prior to takeoff. This seven minute time period will not begin until after the system has been started and data logging has begun. After landing and when the aircraft is stationary, the AGPS/IMU subsystem will continue to collect data for seven more minutes. This procedure ensures that the airborne GPS unit is functioning properly and the solution is fixed. The initialization and termination of the aircraft's data collection will occur as close to the airport base station as possible, but far enough from buildings to prevent multi-path errors.

The ground and airborne GPS receivers will collect data at half- second epochs for the duration of all missions. Aircraft will not be banked more than 20 degrees during data collection to prevent loss of lock with GPS satellites.

Acquisition Tracking, Reporting and Quality Control

Sanborn employs rigorous QC processes within 48-72 hours of data collection to ensure that the data acquired meets the requirements of the project. The acquisition and QC status is updated on a daily basis, and the information will be accessible to MPO via a GIS-based Web page.

- *Field data verification*: The field crew downloads the data, and ships a duplicate set of the data on portable hard drives via next-day courier delivery to the production office. The field crew then processes the approximate GPS-IMU solution, the flight lines, and views the point cloud to confirm the quality of the data collected. This is accomplished within 24 hours of data collection. Special attention is paid to flight lines where any turbulence/disturbance or sensor-related problems are marked on the flight-logs.
- *Office data verification*: The data for each mission arrives in the production office on the day after acquisition. The LiDAR processing team processes the data with precise GPS-IMU solutions and generates the full resolution LAS flight line strips. The team then checks the data carefully for gaps, sensor anomalies, NPS, FOV, side-lap, and other flight-related parameters. Any re-flights needs identified during this QC process are then transmitted back to the acquisition team by the acquisition manager. The office data verification is completed within 24 hours of receiving the LIDAR data in the office.



- *Online flight tracking system:* Sanborn has designed a GIS-based online acquisition system that can be used by the MPO to track the status of acquisition, data validation, QC, and re-flights on a daily basis. This online system is described in the aerial acquisition section of our response.
- *Reporting:* By 10:00 am each day, Sanborn's project manager will send an e-mail to the MPO's project manager to indicate whether any LIDAR acquisition was accomplished during the preceding day.

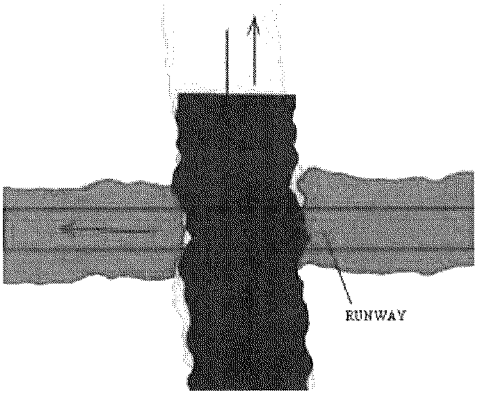
LiDAR Calibration Overview

Horizontal point accuracy is a function of angular origination of the pulse, IMU orientation, and the scanner encoder and ranging function. These will vary depending on the proposed point density selected for the collection. Statistically, the error is roughly one-third of the illuminated foot print on the ground and is a function of the beam divergences. It is also affected by the reflective nature of the surface at which it strikes.

The biggest factor in vertical accuracy is GPS data quality, but it also can be affected by laser range function, IMU orientation, and scan angle. There is a higher percentage of range ambiguity at higher repetition rates. This is further dependent on the distance between returns. Sanborn accounts for this by adjusting the repetition rate of the laser based on collection parameters and desired point sample densities. In addition, during the processing of the LiDAR, the flight line swath data is trimmed to cut off excess errors at the FOV edge.

Installation Calibration

Sanborn conducts extensive calibration and GPS lever arm surveys for all sensors and aircraft installations. The GPS antenna in the aircraft and its reference to the LiDAR sensor head are surveyed using a Leica total station. Several reference points on the aircraft and sensor are measured to validate the location of the sensor GPS antenna in relation to the sensor head. This process consistently yields GPS lever arm offsets (x,y,z) locations within two millimeters or less.



Sanborn has instituted a routine calibration schedule of every three months for every LiDAR sensor. Calibration missions are conducted over a surveyed runway surface and a series of surveyed buildings at three different altitudes. The runway is surveyed using kinematic survey procedures during every calibration. Static GPS validation surveys are conducted to verify the kinematic reference survey.

LiDAR Mission Calibration

In addition to the calibration Sanborn conducts at installation and every three months, Sanborn performs an abbreviated version of the installation calibration process for every LiDAR mission. At every project base of operation, the runway is kinematically surveyed by making three passes down the runway. One pass is down the middle of the runway and two are down the edges of the runway, providing an average of 3000 to 4000 points along the runway. The vertical accuracy will be no less than 3 cm (1 sigma). Elevation points will be sufficiently dense to adequately represent the surface to the required accuracy. The test surface will be approximately 70 meters wide and 500 meters long.

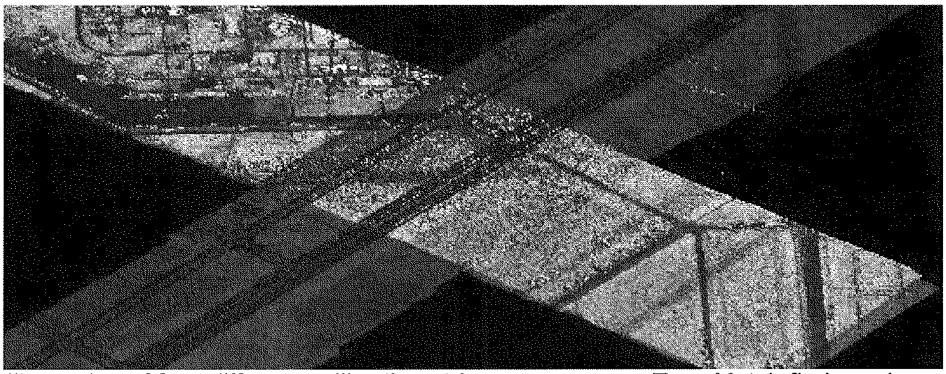


Illustration of four different calibration strips on a runway. TerraMatch finds and corrects errors automatically creating an initially accurate dataset.

Prior to project area collection, two passes perpendicular to the runway in opposing directions are flown. At the end of every mission collection, two additional passes over the runway are flown. One pass is parallel to the runway to detect edge of scan differences in relationship to the runway and other calibration lines. The final line is flown perpendicular to the runway to check the swath repeatability from the beginning to the end of the flight. In addition, a cross flight is flown in all project areas to check flight line repeatability within the project area. The mission calibration is done to verify all the parameters mentioned in the installation calibration section and the graphic in that section is representative of the mission calibration. In addition, the system is run in bit mode for every mission to further valid and adjust the relative relationship of the return as they relate to single pulse or multi-pulse, and Bank A and Bank B. This process ensures both relative and absolute accuracy.

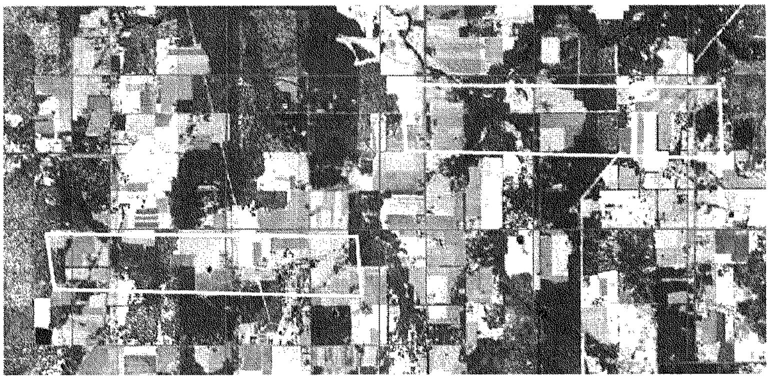
Final LiDAR Calibration Using TerraMatch

Sanborn uses many different calibration techniques to ensure the MPO is getting the most accurate data possible. By implementing the use of TerraMatch, a product from TerraSolid, the dataset can be corrected for systematic biases. These adjustments are almost completely automated, and assist in the accuracy against the surveyed control points. By placing sample tiles perpendicular to the direction of flight, TerraMatch analyzes each swath simultaneously. A file is then output containing each swath's corrections. This correction file is then applied to the entire project and/or block.

Swath to swath systematic errors are shown. TerraMatch uses the sample tiles to find biases between swaths and correct for them.

Final LiDAR Calibration Using TerraMatch

Sanborn uses many different calibration techniques to ensure the client is getting the most accurate data possible. By implementing the use of TerraMatch, a product from TerraSolid, the dataset can be corrected for systematic biases. These adjustments are almost completely automated, and assist in the accuracy against the surveyed control points. By placing sample tiles perpendicular to the direction of flight, TerraMatch analyzes each swath simultaneously. A file is then output containing each swath's corrections. This correction file is then applied to the entire project and/or block.



Swath-to-swath systematic errors are shown. TerraMatch uses the sample tiles to find biases between swaths and correct for them.

Dz Ortho Imagery Process

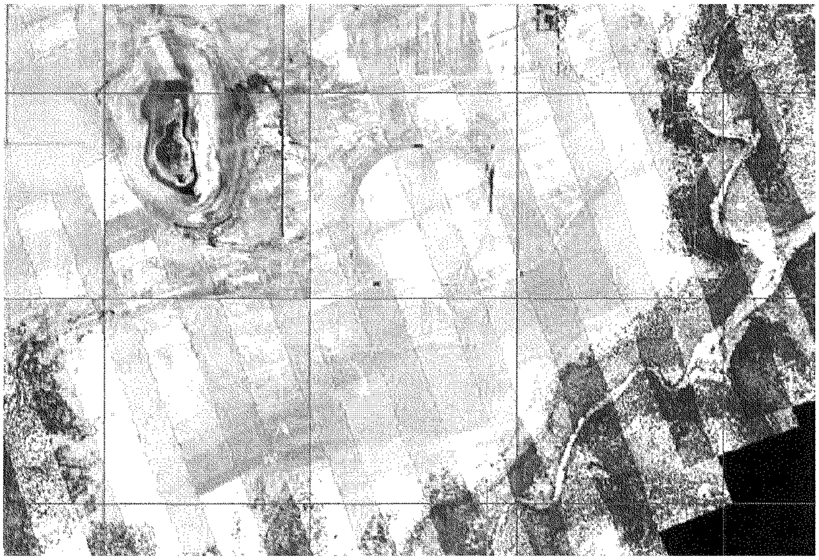
Sanborn uses Dz Ortho images to analyze the calibration. These images are specific to LiDAR processing, and quickly show any potential calibration issues. Dz Ortho's are recreated between the initial runway calibration and again after the TerraMatch step. The coloring of the images indicates degree of offsets between each swath in four intervals, ranging from green to red. Image settings are as follows:

- Green: 0-7cm offset
- Yellow: 7.1-14cm offset
- Orange: 14.1-21cm offset
- Red: >21.1cm offset

After all TerraMatch corrections are applied, the dataset is filtered and manually edited for anomalies to provide a clean, artifact-free bare earth dataset.

Check Point Z Adjustment

Sanborn collects multiple survey control points for each project area to accurately adjust data Z. Once the data has been through the editing process, the bare earth from the LiDAR data is compared to the processed survey points. In order to achieve the lowest RMSE, the data is adjusted to the Average Dz. This is the mean of all points and their offset to the LiDAR. Once the LiDAR is vertically adjusted, it's ready for product generation.



Final calibrated dataset showing swath to swath edge match coloring. Dz coloring indicates degree of offsets between each swath.

Minimum errors, the range, the mean, the Root Mean Square Error (RMSE), and the standard deviation are calculated for every mission. This will be provided to the client in the final LiDAR project report.

The calibration of the LiDAR data will be verified by independently checking the relative and absolute accuracies of the final calibrated dataset. Independent LiDAR check-points will be collected in the recommended NVA (Non-Vegetated Vertical Accuracy) and VVA (Vegetated Vertical Accuracy) land cover classes as per the guidelines of the new USGS LiDAR base specification document V1.2 and the latest version of ASPRS Positional Accuracy Standards for Geospatial Data (Current Version 7. Revision 1). Sanborn is proposing options for LiDAR at QL2 or QL3, which will meet the following accuracy requirements:

Relative vertical accuracy

Quality Level (QL)	Smooth surface repeatability (cm)	Swath overlap difference, RMSDZ (cm)	Swath overlap difference, maximum (cm)
QL2	≤ 6	≤ 8	±16
QL3	≤12	≤16	±32

Absolute vertical accuracy

Quality Level (QL)	RMSEZ (non-vegetated) (cm)	NVA at 95-percent confidence level (cm)	VVA at 95th percentile (cm)
QL2	≤ 10.0	≤ 19.6	≤ 29.4
QL3	≤20	≤39.2	≤58.8

The LiDAR accuracy will be reported as NVA and VVA using the independent LiDAR points collected as per the new USGS LiDAR base specification document V1.2 and the latest version of ASPRS Positional Accuracy Standards for Geospatial Data (Current Version 7. Revision 1)

LiDAR Classification

The first step in the creation of topographic products from LiDAR (following post processing and calibration) is classification of the point cloud.

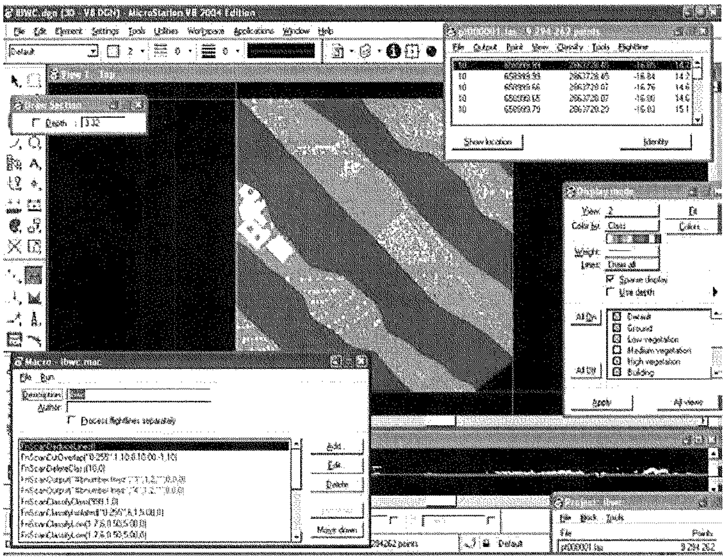
Typical LAS Classification Options	
Code 1	Processed, but unclassified
Code 2	Bare-earth ground
Code 7	Low Noise
Code 9	Water
Code 10	Ignored Ground (Breakline Proximity)
Code 17	Bridge decks
Code 18	High Noise

Sanborn will ensure that the point classification will be consistent across the entire project and there are no noticeable variations in the character, texture, or quality of the classification between tiles, swaths, lifts, or other non-natural divisions exist in the data. Sanborn will make sure that within any 1km x 1km area, not more than 1% of the points will possess a demonstrably erroneous classification value.

The point classification is divided into the following steps:

- Automated Macro Filtering
- Manual QC and editing of the classification
- Final classification QC using the Hillshade surface

Automated Macro Filtering

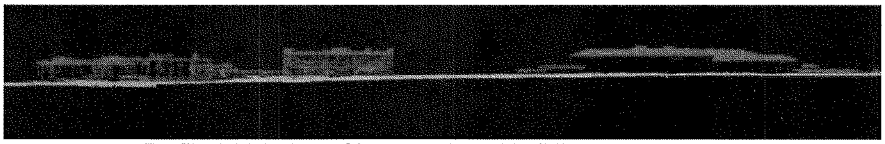


The initial LiDAR point cloud classification is done using the automated TerraScan macros. The macros are designed to classify the points to the classes required for the project. Sanborn uses a variety of commercial and proprietary software to build macros for automated classification. The macros are specific for each type of geography within a project, taking into consideration terrain relief, ground cover, natural and man-made features. The macros exploit the information related to the number of returns of a pulse, elevation, slope, and height from ground and other terrain characteristics to classify the point cloud in an automated fashion. The routines will classify points based upon the laser attributes including intensity, elevation and the numeric value of the return.

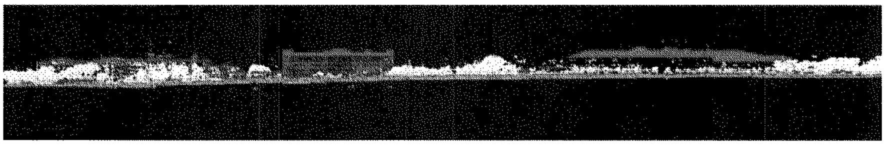
Manual QC and Editing of the Classification

Following the automated classification process, a supervised or manual classification is performed. Sanborn's software can handle an unlimited number of different surfaces in the same digital file. Sanborn's LiDAR editing team goes through the tiles with great precision to make sure that the points are classified correctly. 3D tools include cross-section or profile views of points to aid in classification, surface model visualization with rapid contour development to spot bare earth blunders for re-classification. Color triangles display of TINs, colored grids for shaded relief and other sophisticated visualization tools support the manual classification. The KML file of the project area is made available to the editors so that in case of any confusion in feature identification, they can verify the feature in the imagery and classify the points in the right class accordingly.

The following are classification examples produced by Sanborn:



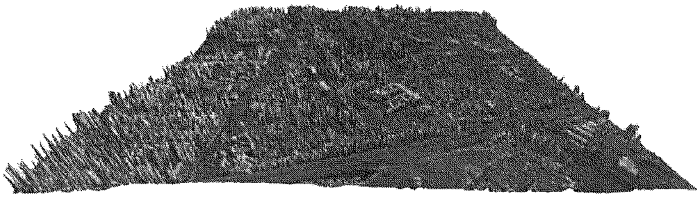
Profile (side) view of bare earth and building structures



Profile view with vegetation classified from low, medium, to high

Final Classification QC Using the Hillshade Surface

Part of Sanborn's QC process is eliminating need for extensive manual editing, and replacing this with an automated way to quickly depict outliers or anomalies in a bare earth dataset. Through the production of hillshaded surfaces, Sanborn's LiDAR team can scroll through hillshades (TIF images) generated from the bare earth. This means quicker file load times and the ability to find errors in the bare earth without manually opening each individual LiDAR tile. The team member can also import these hillshades into Google Earth to provide an even better perspective on the terrain. Hillshades are created automatically and quickly, providing an even more efficient streamline editing process.



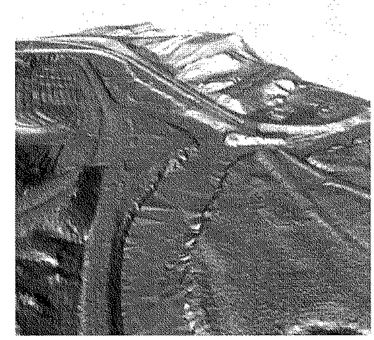
Surface with Non-Terrain Artifacts (green)

Surface with Classified DTM

Hydro-Flattening and Hydro-Enforcement

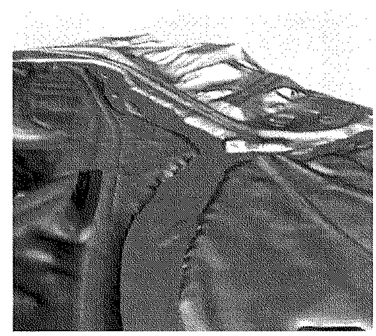
Sanborn has designed custom workflow to produced Hydro-flattened and or Hydro-enforced DEMs as per the specifications of the latest USGS LiDAR base-specification document. Hydro-flattened describes the specific type of DEM required by the USGS National Geospatial Program (NGP) for integration into the NED. Hydro-flattening is the process of creating a LiDAR-derived DEM in which water surfaces appear and behave as they would in traditional topographic DEMs created from photogrammetric digital terrain models (DTMs). A hydro-flattened DEM is a topographic DEM and should not be confused with hydro-enforced or hydro-conditioned DEMs, which are hydrologic surfaces. A traditional topographic DEM such as the NED represents the actual ground surface, and hydrologic features are handled in established ways. Roadways crossing drainages passing through culverts remain in the surface model because they are part of the landscape (the culvert beneath the road is the manmade feature). Bridges, manmade structures above the landscape, are removed.

Hydro-enforcement is an important and useful modification of the traditional topographic DEM (Hydro-flattened DEM) and produces hydrologic surfaces that are fundamentally different at a functional level. Hydrologic surfaces are identical to topographic surfaces in many respects but they differ significantly in specific ways. In a topographic DEM, roadways over culverts are included in the surface as part of the landscape. From a hydrologic perspective however, these roadways create artificial impediments (digital dams) to the drainages and introduce sinks (un-drained areas) into the landscape.



LiDAR surface before breaklines

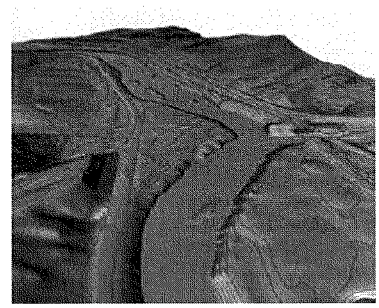
Sanborn digitizes hydrology features and edge-of-water breaklines using stereo-intensity images into a 3D dataset. Planimetric mapping includes all hydrology and select man-made features, such as bridges and dams that affect hydrological flow. During this phase, each tile is viewed in both 2D and 3D perspectives as intensity images, shaded relief maps and/or digital surface models (DSM). Sanborn populates the "Z" value for the points, lines, and polygons referencing the bare-earth LiDAR. Each hydrology feature is digitized in true horizontal position, and the Feature Type and Class are captured along with the X, Y, and Z attributes. Once all of the features have been captured, a second technician performs a review for content and accuracy referencing the collected features to the base LiDAR data and reference imagery before releasing the tile for final edit.



LiDAR surface after breakline enforcement and hydroflattening

Sanborn will produce hydro-enforcement/hydro-flattening to the following parameters as defined in the USGS LiDAR base specification document:

- **Inland ponds** and **lakes**
  - Water bodies of 8,000 m2 (2 acres) or greater surface area at the time of collection are flattened.
  - Flattened water bodies are represented as flat and level water surface (a single elevation for every bank vertex defining the water body's perimeter).



LiDAR DTM surface showing smoothed contours

- The entire water-surface edge is at or below the immediately surrounding terrain
- Long impoundments—such as reservoirs, inlets, and fjords, whose water-surface elevations decrease with downstream travel—are compiled as streams or rivers.

- **Inland** streams **and rivers:**
  - Streams and rivers of a 30-m (100-ft) nominal width are flattened.
  - Streams or rivers whose width varies above and below 30 meters will not be broken into multiple segments;
  - Flattened streams and rivers are represented as flat and level water surface bank-to-bank (perpendicular to the apparent flow centerline).
  - Flattened streams and rivers are represented as a gradient downhill water surface, following the immediately surrounding terrain.
  - In cases of sharp turns of rapidly moving water, where the natural water surface is notably not level bank-to-bank, the water surface is represented as it exists while maintaining an aesthetic cartographic appearance.
  - The entire water-surface edges are at or below the immediately surrounding terrain.
  - Stream channels shall break at culvert locations leaving the roadway over the culvert intact.
  - Bridges in all their forms are removed from the DEM.
  - Streams are continuous at bridge locations.
  - When the identification of a structure as a bridge or culvert cannot be made definitively, the feature is regarded as a culvert.
- **Non-tidal** boundary **waters:**
  - Boundary waters, regardless of size, are represented only as an edge or edges within the project; collection does not include the opposite shore.
  - The entire water-surface edges are at or below the immediately surrounding terrain.
  - The water-surface elevation will be consistent throughout the project.
  - The water surface are flat and level, as appropriate for the type of water body (level for lakes, a gradient for streams and rivers).
  - Any unusual changes in the water-surface elevation during the course of the collection (such as increased upstream dam discharge) are documented in the project metadata.
  - In the event of an unusual change in water-surface elevation, the water body is handled as described in Tidal Waters (below).
- **Tidal** waters:

Tidal water bodies are defined as any water body that is affected by tidal variations, including oceans, seas, gulfs, bays, inlets, salt marshes, and large lakes. Tidal variations during data collection or between different data collections will result in lateral and vertical discontinuities along shorelines. As per the USGS LiDAR base specification guidelines, collections are planned to minimize tidal differences at the land-water interface if possible. In addition to meeting the requirements for inland water bodies listed in Inland ponds and lakes and Inland streams and rivers sections above, as appropriate, the tidal water bodies are compiled to be meet the following requirements:

  - Within each water body, the water surfaces are flat and level for each different water-surface elevation.

- Vertical discontinuities within a water body resulting from tidal variations during the collection are considered normal and are retained in the final DEM.
- Horizontal discontinuities along the shoreline of a water body resulting from tidal variations during the collection are considered normal and are retained in the final DEM.

- Islands:
  - Permanent Islands of 4,000 sq m (1 acre) or larger shall be delineated in all water bodies.

Sanborn's final processing includes the use of custom routines to validate flow direction and monotonicity to ensure all vector nodes are flowing downhill for single- and double-line streams, or are the same elevation for pools of water, including lakes and ponds. Other processing may include using standard Esri tools to eliminate pseudo-nodes that would impair hydrologic analysis. These added-value processing techniques provide a gateway for the datasets to be used for redefining and providing better resolution and accuracy for watershed, lake shed, and boundaries definition.

Contour Production

The LiDAR and breakline DTM will be processed to generate contours. The area of input data will extend somewhat beyond the intended limits of the contouring. This larger-sized area is used so that when the TIN (triangulated irregular network) is created, it extends past the edge of the deliverable area. This is necessary to ensure that proper interpolation of the contours takes place throughout the area being mapped. Once the contours have been created, they are trimmed back to the intended mapping limits.

Since the same set of masspoints and breaklines are used to create the TIN for adjoining map areas, edgematching errors along the area seams are held to a minimum. Sanborn's proprietary processing software will automatically flag all mismatched contours so that a graphic technician can correct any problems. Smoothing and filtering routines will be used to ensure that contours have a pleasing cartographic experience, while still maintaining geometric accuracy and optimizing the size of the contour database by eliminating redundant vertices in the contour strings.

Contour data will meet the following specifications:

- All index contours will be clearly distinguishable and labeled with the their elevations given in full feet;
- Every fifth contour will be an index contour and should be clearly distinguishable as such;
- Contours will be continuous, with no breaks;
- Data will be layered in compliance with the agreed-upon database design, including all symbols, colors, and linestyles.

Contour QA/QC

When they compile DTM data for contour generation, Sanborn's photogrammetric technicians view DTM points (masspoints and breaklines) draped over a stereo image in a 3D softcopy environment, and position individual points or groups of points at positions to correctly model the terrain surface. Operators will generate contours "on-the-fly" at various stages of the stereocompilation editing process to ensure that any final, generated contours will be "on the ground" and within accuracy specifications.

Although normal quality control checks, such as data overlay and aesthetic control are performed iteratively for all datasets, Sanborn has also developed a series of automated software checks. These checks are performed each time a data file is processed, or when data is graphically edited. Having these automated checks in place ensures that all errors are discovered during the production process. Specific routines are used within the processing environment to ensure that connectivity of linework is complete and specific layers of line topology are generated, so that line features are free from dangles, overshoots, and undershoots.

LiDAR Quality Control

Sanborn uses a quality-review process for all data to ensure adherence to product specifications, data formats, and data completeness for all deliverables. All data is post-processed in a controlled environment based on strict ISO 9001:2008 compliant procedures designed to maintain data integrity through highly standardized and controlled procedures for data acquisition, post-processing, and validation. The following table provides an outline of Sanborn quality assurance and control procedures for a LiDAR project:

QC Checklist		Methodology	Contractual Requirements	Department Lead Sign-off
PRE-ACQUISITION REVIEW: These checks are to make sure flight planning is done according to the contractual requirements.	Project Boundaries	Confirmed with the client by the PM and released to the acquisition after sign-off		
	Flight plan	Checked by acquisition manager and Submitted to client for review		
	Sensor Settings	Checked and verified by the acquisition manager		
	Weather conditions	Verified by the operator		
	Survey Plan	Checked and verified by the geomatics engineer		
	Base-station location	Verified by the geomatics engineer against the contractual requirements for the base-line thresholds		
DATA ACQUISITION REVIEW: These checks are to make sure that the contractor collected the data as per the contractual requirements.	Nominal Pulse Spacing	Automated checks done by LiDAR project lead		
	Intensity Values	Automated checks done by LiDAR project lead		
	Data Voids	Visual checks by LiDAR technicians		
	Scan Angle	Automated checks done by LiDAR project lead		
	Swath Overlap	Automated checks done by LiDAR project lead		
	Sensor Anomalies	Visual checks by LiDAR technicians		

QC Checklist		Methodology	Contractual Requirements	Department Lead Sign-off
DATA CALIBRATION REVIEW: These checks are to ensure that the data meets the contractual accuracy requirements.	GPS-IMU Accuracy Review	Analysis of solution graphs		
	Vertical Accuracy	Vertical report against the check points		
	Relative Accuracy	Color coded DZ-Orthos for flight-line mismatches		
SURFACE QUALITY REVIEW: These checks are to ensure that the LiDAR point cloud is classified as per the contractual requirements.	Misclassification	Visual inspection of 100% of the data Final QC is done by reviewing hillshades generated from the classified data		
	Noise			
	Artifacts			
	Surface consistency			
DATA COMPLETENESS & FORMATING REVIEW: These checks are to ensure that all the products listed in the contract are delivered, they are in the right formats and they completely cover the project area.	Delivery Layout	Confirmed by the client and signed off by department lead		
	LAS Format	Automated check done by LiDAR lead		
	Classification Levels	Automated check done by LiDAR lead		
	GPS Time	Automated check done by LiDAR lead		
	Horizontal Datum	Automated check done by LiDAR lead		
	Vertical Datum	Automated check done by LiDAR lead		
	Units	Automated check done by LiDAR lead		
	Coverage checks of deliverables	Visual checks done for each product type by LiDAR lead		
	Deliverables	LiDAR lead verifies that all the deliverables are produced and delivered		
	Breaklines Format	Checked by GIS lead		
	DEM Format and resolution	Checked by GIS lead		
	Metadata	Checked by LiDAR and GIS lead		

Sanborn QA/QC Program and Continuous Improvements

To assure our performance meets or exceeds the MPO's requirements, Sanborn is fully implementing its proven ISO9001:2008 processes to assure all contract materials are delivered in accordance with the MPO's expectations at the required accuracy and quality. Our key is a system that identifies any problems early in the workflow. Quality control validation points are inserted into the overall program process at key points and quality assurance protocols are completed prior to submission of deliverable products.

Sanborn has established key quality audit points in the photogrammetric data creation process. Checks of work products immediately following a key process step provide the opportunity to ensure that the data at that point are of acceptable quality for input to the next process step. Any data found defective are immediately returned to the previous step for correction or recollection.

Listed below are several key steps that will be initiated at the beginning of the project to support our Quality Plan.

- Sanborn will conduct a QA/QC technical work session with appropriate State representatives. This work session will be conducted during the initiation phase of the project. It will enable us to make sure that potential QA/QC issues are adequately addressed by Sanborn.
- Mr. Sanchit Agarwal, Director of Project Engineering and Quality, will be designated an internal, independent Quality Assurance authority for the duration of the program.
- Sanborn will work with the MPO to develop formal acceptance criteria for the final digital orthophotography. These criteria will document production standards for the final imagery.
- A detailed Quality Plan will be developed to be used in concert with the acceptance criteria. This document will include all checklists and forms to be used for quality reporting.
- Sanborn will conduct internal meetings with our managers and staff to ensure all team members have a full understanding of the project and quality control steps. Training sessions will be conducted as appropriate.
- Sanborn will also conduct a pilot program. This pilot will serve to test our QA/QC process and to make any necessary revisions as appropriate.
- The goal of this phase of the program is to implement a QA/QC program that is robust, comprehensive, and complementary of the procedures employed by the MPO.

Sanborn uses an independent internal quality review process for all data to ensure adherence to product specifications, data formats and data completeness for all the deliverables across all phases of the contract. Sanborn spends considerable effort to ensure data quality. All data are post-processed in a controlled environment based on strict procedures, not only designed to maintain data integrity, but also to provide the best possible products. As a result, we use highly controlled procedures for planning, data acquisition, post-processing, ortho-production, product generation and data delivery. The following table is an outline of the Sanborn Quality procedures across all phases of the project.

QC Checklist		Methodology	Contract Requirements	Lead Sign-off
PRE-ACQUISITION REVIEW: These checks are to make sure flight-planning is done according to the contractual requirements.	Project Boundaries	Confirmed with the MPO by the Project Manager and released to the Acquisition Team after sign-off		
	Flight Plan	Checked by Acquisition Manager and submitted to client for review		
	Sensor Settings	Checked and verified by the Acquisition Manager		
	Weather conditions	Verified by the Operator		
	Survey Plan	Checked and verified by the Geomatics Engineer		

QC Checklist		Methodology	Contract Requirements	Lead Sign-off
FIELD DATA REVIEW: These are the preliminary QC steps done by the Operator & Pilot	Flying Height Checks	Double check the flying height		
	Flight Logs	Flag the flight-lines with cloud coverage and turbulence		
	Sun Angle	Cross reference the sun-angle charts with the flight time		
	Coverage & Overlaps	The data is checked for side and forward overlap and any coverage issues		
POST ACQUISITION DATA REVIEW: These checks are to make sure that the collected data meets the contractual requirements.	Resolution	The resolution of the data is confirmed by the Lead		
	Image Quality	Image free of clouds, haze, over-exposure, saturation, artifacts		
	Data Voids	To ensure the coverage		
	Sun Angle	The data meets the sun-angle requirements		
	Overlaps	The data is checked for side and forward overlap		
DATA CALIBRATION REVIEW: These checks are to ensure that the data meets the contractual accuracy requirements.	Initial Orientation Review	The initial orientation is checked for accuracy and completeness		
	Control Network Review	To ensure that the control network residuals are within the error budget		
	AT Accuracy Review	RMSE of the residuals on tie-points and control points		
DTM SURFACE REVIEW: These checks are to ensure that the DTM data going into the orthorectification process is up-to date	Review of the Existing DTM	By surface subtraction between the old and new DTM		
	Update of the DTM	The DTM is updated in the areas of change		
	Horizontal & Vertical Accuracy	Check the horizontal & vertical registration between the DTM and the AT		
ORTHO PRODUCTION REVIEW: These checks are performed during the ortho-production processes	Seamline Editing	All seam-lines are QC'ed and modified accordingly		
	Smearing	The orthos are checked thoroughly for feature smearing		
	Color Balancing	The Orthos are QC'ed and corrected for any color balancing discrepancies		
	Ortho Accuracy	The ortho accuracy is checked by measuring the control and check points on the orthos		
DELIVERY COMPLETENESS & FORMATTING REVIEW: These checks are to ensure that all the products listed in the	Delivery Layout	Confirmed by the MPO and signed off by Department Lead		
	Imagery Format	Confirmed by the Lead		
	Horizontal Datum	Confirmed by the Lead		

QC Checklist		Methodology	Contract Requirements	Lead Sign-off
contract are delivered, they are in the right formats and they completely cover the project area	Vertical Datum	Confirmed by the Lead		
	Unity	Confirmed by the Lead		
	Coverage Check of Deliverables	Visual checks done for each product type by Lead		
	Automated Header Checks	To ensure that all products are generated for delivery in the right formats (including reports)		
	Metadata	Checked by the Lead		

ISO 9001:2008 Certification

Sanborn has earned an ISO 9001:2008 certification and is registered with Platinum Registration, Inc. (Platinum). ISO 9000, a Quality Management System Standard, is a series of five international standards that provide guidance in the development and implementation of a specific Quality Management System.

With Sanborn's ISO 9001:2008 certification, the MPO is assured that:

- The requirements and specifications of the project have been thoroughly and rigorously evaluated and documented
- The production processes and procedures employed for the project are appropriate and adequate to produce the results intended
- The production processes and procedures are controlled and results will be consistent and repeatable
- Documentation will be maintained that allows for evaluation of the processes and procedures to eliminate the sources of nonconformities and to facilitate continual improvement of the processes and procedures
- Adequate facilities are available to meet the needs of the project
- Sufficient numbers of competent and adequately trained employees are working on the project

Quality Management System

Sanborn's Quality Management System (QMS) has been developed to ensure that adequate and continuous control is in operation for all activities affecting product quality. Where specific regulatory requirements affect our processes, our procedures and instructions will be designed or revised to meet such requirements. Sanborn employs methods and techniques that foster continuous improvement and good business practice.

Sanborn places an emphasis on problem prevention rather than dependence on detection after occurrence. Every effort is made to perform operations and quality-related activities correctly the first time. The Quality Management System includes a formal review of the parameters affecting product quality from conception to contractual fulfillment. Whenever necessary, corrective and preventive actions are implemented to ensure continuous improvement.

Sanborn Quality Policy

Sanborn's commitment is to consistently provide the highest value to our customers with quality products, information and services.

Sanborn's quality management process is the foundation for our success. The employees individually and collectively are responsible for the quality of the products, information and services offered by Sanborn by meeting or exceeding the requirements of our customers.

Quality Manual

The Quality Manual contains statements of the company's general policies as specified in the ISO 9001:2008 standard. The Quality Manual is supported by quality system procedures, which are contained in the manual. These quality control procedures are used during each production phase of the project. These procedures are integral components of our production processes and are inserted at strategic points in the workflow. They are designed to detect errors or omissions early in the production cycle where they can be quickly remedied.

Quality Assurance Manager

Sanborn's Project Engineering and Quality Director, Mr. Sanchit Agarwal, will be directly involved with all quality aspects of the project. Mr. Agarwal's responsibilities include monitoring all systematic quality activities to ensure that the products and services provided by Sanborn will satisfy the requirements of the project. Specifically for this project, he will:

- Drive the quality process to ensure that products are produced consistent with Sanborn's established ISO standards and customer standards as contractually agreed.
- Develop the final Quality Plan for the project.
- Coordinate with department managers to define customized QC steps and ensure compliance.
- Attend the Project Initiation Meeting to present, discuss and answer any questions regarding our Quality Plan for this project.
- Communicate with representatives of the MPO as necessary to discuss quality issues.

Responsibilities

Sanborn staff members are aware of what they are authorized to undertake and are responsible for achieving. This is ensured by documentation of responsibilities and authorities in specific procedures. All employees are responsible for following applicable policies, procedures, and work instructions. Additionally, every employee has the responsibility and authority to:

- Initiate action to prevent the occurrence of any nonconformities relating to product, process, and the Quality Management System
- Identify and record any problems relating to the product, process, and the Quality Management System
- Initiate, recommend, or provide solutions through designated channels
- Control further processing and delivery of products until the deficiency has been corrected

- Ensure that the MPO's source materials and other property, including intellectual property, is logged, utilized, stored, and returned in a controlled manner

Resources

The primary processes and procedures for the continued success of our business have been identified and are described in our Quality Manual and departmental procedures. Sanborn project managers are responsible for working with our senior management to ensure that resource requirements, as identified by our project management tracking system, Primavera, are dedicated to the MPO's project. The project manager is also responsible for verifying that the department managers have provided effective training to the personnel who will work on the project. The Quality Management System requires that senior management ensures that personnel at all levels of the organization are hired with appropriate work experience and capabilities and that they receive appropriate specific training for the tasks they are assigned to perform.

Management Review

Sanborn strives for continuous improvement; therefore, management review meetings are held on at monthly to evaluate the Quality Management System's continued effectiveness and suitability in satisfying the requirements of both ISO 9001:2008 and our stated quality policy and objectives. We review the results of audits, all irregularities and comments, external influences on our business, and the effectiveness of the whole Quality Management System.

This review includes quality planning to ensure that changes in our processes are evaluated and that Quality Management System requirements are addressed prior to the implementation of new or revised processes. In addition, management review meetings serve as a vehicle where Sanborn may evaluate potential nonconformance and take actions to prevent their occurrence. Topics discussed and action plans resulting from these meetings are recorded in documented minutes, which are maintained as quality records in accordance with procedures.

Summary of Deliverables

Sanborn will provide a copy of all deliverables as outlined in the table below. All data will be quality controlled and in full compliance with the standards and specifications set forth by the MPO in the RFP.

Summary of Deliverables	
Deliverable	**Description**
Project Control	Sanborn will submit a comprehensive survey report documenting the survey in PDF format, and an Esri Geodatabase file with all of the coordinate data
Flight Plans	Sanborn will deliver the final flight line map/photo index with photo centers in Esri Geodatabase and Adobe PDF formats
Field Survey Report	Sanborn will submit a comprehensive report in PDF format documenting the ground control survey.

Summary of Deliverables	
Deliverable	**Description**
Aerial Triangulation	Sanborn will provide a fully-indexed AT report that will provide a narrative description of all aspects of the AT phase, tabular information for ground control and check point results, and appendices including full AT solution printouts. An Adobe .PDF version of the report and a Microsoft Excel file with the point coordinates will be provided as well.
Digital Orthophotography	Sanborn will provide a copy of all orthoimagery tiles at the desired spatial resolution of 3- and 6-inches in .TIFF/ TIFW format, and MrSID .SID/.SDW format with 20:1 compression. Radiometry will be 4-band, 8-bit per channel RGB/NIR.
MrSID Mosaics	MrSID mosaics will be provided in SID/.SDW format with 20:1 compression Radiometry will be 4-band, 8-bit per channel RGB/NIR.
DEM	Sanborn will provide a copy of the updated digital elevation model created for use in orthorectification in Esri Geodatabase format.
Planimetric Data	Sanborn will provide a copy of the planimetric data in NRGC compatible Esri and AutoCAD formats.
Contour Data	Sanborn will provide a copy of the contour data in Esri Geodatabase format.
Tile Index	Sanborn will provide the final tile layout in Esri Geodatabase format.
Metadata	Sanborn will provide FGDC compliant metadata for the project in the format of the MPO's choosing.
Project Documentation	Sanborn will provide a copy of all required project documentation including reports regarding aircraft and camera operation, calibration reports, QA/QC reports, and management & administrative documents.
Deliverable Media	Final data will be delivered on USB External Hard Drives. DVD 2.0, 4.7 GB single sided (4.3 GB usable) disks or FTP download is also available for interim deliverables, such as pilot data sets.
6' x 6' prints	Sanborn will provide the optional 6' x 6' prints, if the option is exercised by the MPO

Certification of Compliance with Accuracy Standard

Following completion and passage of all internal and independent quality control checks, Mr. Doug Zehr, Chief Photogrammetrist and one of Sanborn's ASPRS Certified Photogrammetrists, will certify the product accuracy as meeting the accuracy requirements as set for the project by the MPO. The detailed project plan prepared by the Project Manager will include comprehensive acceptance criteria, including the information outlined in the RFP, and review of interim products, such as the aerial triangulation results, that align with our rigorous ISO 9001:2008 internal quality control and quality assurance methods. Sanborn guarantees that rigorous testing to meet and certify to these standards for quality control for the project and deliverables will be performed. Sanborn has provided a comprehensive description of our quality control procedures following each production step in our workflow in the technical approach. The use of ground checkpoints to test the accuracy solution is described in the Analytical Aerotriangulation section.

Pilot Project

Sanborn understands the importance of completing and receiving approval for a pilot project prior to proceeding with full production. We feel this is especially critical in orthoimagery programs, which by their nature call upon us to address aesthetic elements, as well as the quantifiable technical requirements of our customers. Therefore, we will work closely with the

MPO during the project initiation phase to obtain feedback on what your ideal is for the appearance of the imagery in terms of color characteristics, and submit pilot data samples for final approval before completing the remainder of the project in order to ensure that all standards and specifications set for the project will be met. Delivery of the pilot project will take place following completion of aerial data acquisition and Digital Aerotriangulation.

Metadata

FGDC-compliant metadata will be provided as part of the project. ArcObjects is used to generate the metadata information in the most efficient manner using semi-automated techniques. At a minimum, the metadata report will contain the following information:

- Date(s) of image collection
- Spatial and spectral resolutions
- Spatial accuracy of image
- Projection and datum of imagery
- Producer contact information for Sanborn
- Orthorectification method descriptions

Sanborn has a staff of programmers who can develop applications as needed to ensure that all expectations for file format and metadata are met. Sanborn will coordinate with the MPO to ensure that all new metadata is compatible with their existing model. We will customize the attributes as needed to include all relevant information and descriptions and ensure that it meets the Federal Geographic Data Committee (FGDC) standards. Metadata files will be delivered in HTML and .XML format.

Section 3 – Personnel and Prior Experience

Project References and Experience

Sanborn has a demonstrable track record of success on large, complex orthoimagery, LiDAR, and photogrammetric mapping projects throughout the United States. The company has extensive experience in the State of Wyoming and the surrounding region, including projects for City of Cheyenne and Laramie County, the Teton Conservation District, the City of Rock Springs, the City and County of Denver, as well as previous work for the City of Casper.

Sanborn's aircrews are highly familiar with the airspace system in the region and know how to navigate safely and efficiently within its boundaries. They have the relationships needed to gain access to the sensitive and restricted areas. They know the terrain and local weather patterns, and how to structure mobilizations to take maximum advantage of the limited time window in which to collect leaf-off imagery. Sanborn understands the challenges of performing airborne data acquisition in Wyoming, most notably, the short seasonal window of opportunity between snow-clear and leaf-on conditions, combined with the potential scarcity of weather conditions sufficient to allow collection of quality aerial imagery.

Sanborn has recently completed large orthoimagery creation, LiDAR and photogrammetric mapping projects for the States of New York, Virginia, Michigan, Louisiana, North Carolina, Wyoming, and Kansas. Additionally, Sanborn has performed airborne imagery acquisition and creation of digital orthophotography of the States of Virginia, West Virginia, South Dakota, Arizona, New Mexico, North Carolina, Colorado, South Carolina, Georgia, New Hampshire, Vermont, and Tennessee under contract to the U.S. Department of Agriculture for their NAIP and NAPP programs. Sanborn's recent project involvement has included statewide imagery programs that required collection of imagery for areas exceeding 40,000 square miles, and delivering tens of thousands of orthoimagery tiles within the space of 6-8 months. The company's first-time acceptance rate for orthoimagery submittals has exceeded 98%.

Sanborn has also recently completed major LiDAR mapping projects in and for the States of Kansas, South Carolina, Iowa, and Texas, as well as for many local agencies in those and other states. Additionally, Sanborn has performed LiDAR collection and processing in the States of New York, Virginia, Massachusetts, Maine, Vermont, Iowa, Kansas, Texas, New Mexico, and Puerto Rico under contracts valued over $1.6 Million to provide LiDAR data to the U.S. Federal Emergency Management Agency (FEMA) for their Digital Flood Insurance Rate Map (DFIRM) program.

Sanborn has successfully worked with numerous other consortiums to perform similar projects. Our clients include the State of Virginia's Base Mapping Program, Greater Bridgeport Regional Council, Windham Region Council of Governments, Louisville/Jefferson County Information Consortium, Pikes Peak Geospatial Alliance, and the Houston-Galveston Area Council (HGAC). In addition to coordinating and communicating as needed to complete their imagery, LiDAR and mapping projects, Sanborn has hosted informational seminars, developed and delivered in coordination with the governing body, that are held prior to the main flying seasons (and off-seasons as appropriate), to aid in educating and supporting the wide-ranging needs of their constituents.

Representative projects that demonstrate Sanborn's ability to deliver projects of this size, scope, and complexity are provided on the following pages, including contact information.

Reference:
City of Durango LiDAR and Multi-Spectral Imagery

In 2012 Sanborn was selected by the City of Durango, Colorado, to complete a 90 square mile project that incorporated both LiDAR and multi-spectral imagery.

Project Scope

Sanborn utilized an Intergraph Digital Mapping Camera (DMC) and a Leica ALS-50 MIPA LiDAR system for the collection of imagery and terrain data. This project design enabled the efficient production of 6-inch orthoimagery for the base map, 2-foot contours, and planimetric mapping meeting 1"=100' map scale. The data was delivered in NAD83 Colorado State Plane, South Zone, US Foot, NAVD 88 with FGDC compliant metadata.

Project Deliverables

Project deliveries included 6-inch TIFF, 4-band orthophotos, ground control and ground control report, LiDAR 0.6 pts/m2 (12cm Vertical Accuracy), DEM/DTM creation, new planimetrics and planimetric updates. All products had 100% first time acceptance.

Contact Name	**Lance Frisby**
Phone	(970) 375-5075
Email	frisbylw@ci durango co us
Customer Name	**City of Durango, Colorado**
Address	924 E 2nd Avenue Durango, CO 81301
Project Term	2012
Project Value	$60,000
Project Area	90 square miles

Reference:
Lewis and Clark County, Digital Imagery and Planimetric Data

In 2012, Sanborn collected and produced aerial photography, LiDAR, and derivative products for Lewis and Clark County, MT, including the City of Helena.

Contact Name	Eric F. Spangenberg
Phone	(406) 447-8389
Email	espangenberg@co lewis-clark.mt.us
Customer Name	City of Helena / Lewis & Clark County
Address	316 North Park Avenue, Rm# 207 Helena, MT 59623
Project Term	March 2012—October 2012
Project Value	$97,348.00
Project Area	367 square miles

Project Background

The purpose of the project was to acquire new (2012) 6-inch resolution natural color digital orthophotos over and around the City of Helena, as well as rural areas surrounding the city that are of interest as identified by the U.S. Geological Survey (USGS) and the National Geospatial Intelligence Agency (NGA). Lewis & Clark County also sought to update its digital planimetrics for the urban areas in and around the City of Helena in order to support city and county government. To achieve this, and meet the needs of local, state and federal agencies, a unique partnership was established between Lewis & Clark County, National Guard Bureau (NGB), National Geospatial Intelligence Agency (NGA), and the United States Geological Survey (USGS).

Sanborn was selected in March of 2012 to acquire, process, and deliver aerial photography, LiDAR, and derivative products to support this need.

Project Scope

New 6-inch resolution 4-band digital orothophotos were acquired over 298 square miles of the Helena area, and 69 square miles of the Limestone Hills Training area. LiDAR was flown at 1.4M NPS for the Helena area to support the generation of 2-foot contours, as well as the creation of a USGS V13 compliant DEM product. The update of transportation and building planimetric features was performed using stereo compilation techniques for the Helena area.

Project Deliverables

- True Color Digital Ortho Imagery, 6-inch pixel, true color, orthorectified digital imagery in GeoTIFF and entire project as mosaic in MrSID format, processed CIR for the two areas noted
- True Color Digital Ortho Imagery, 6-inch pixel, true color, orthorectified digital imagery in TIFF uncompressed with companion world file format, UTM Zone 12 NAD83 meters projection, tiled 1500m x 1500m.
- DTM in Esri file geodatabase format
- Digital planimetric data; 2-foot contours, planimetric data in Esri file geodatabase and AutoCad v2012 drawing file format
- Project level FGDC compliant metadata for the imagery and GIS data
- LiDAR (reference USGS NGP LiDAR Guidelines – Version 12 – ILMF 2010)

Technical Specifications	
Tiling	▪ Single schema as noted, no overlap, tile-based .prj files, edgematch seamlessly in horizontal & vertical; tile size an integer multiple of the cell size of deliverables
DEM	▪ Cell size 1.4 meter; Bare earth DEM-traditional for NED, hydro-flattened, ESRI grid, 32-bit floating point raster with georeference information in raster file
Point Cloud	▪ Raw point cloud: Fully compliant LAS v1.3 ▪ Classified (minimum scheme) point cloud; Fully compliant LAS v 1 3
Breaklines	▪ Breaklines for hydro-flattening Esri feature class, same reference system as LiDAR point. Hydro-enforced / hydro-flattened breaklines at NSSDA accuracy standards for 1:2,400-scale maps

Reference:
City of Bozeman, MT

Contact Name	**Jon Henderson** GIS Manager
Phone	(406) 582-2250
Email	jhenderson@bozeman.net
Customer Name	**City of Bozeman, MT**
Address	20 East Olive PO Box 1230 Bozeman, MT 59771-1230
Project Term	March 2012—July 2012
Project Value	$35,000
Project Area	74 square miles

The City of Bozeman MT regularly uses aerial information to support regulatory, land management, planning and engineering projects. In March of 2012, the City selected Sanborn to acquire aerial imagery and produce orthoimagery for 74 square miles covering the City of Bozeman. All final data was stored in the City's ArcSDE database and was made available to internal and external customers through various client applications and downloadable data files.

Project Scope

Sanborn collected digital imagery using the UltraCAM digital sensor in early May, 2012, which met the following requirements as outlined by the City of Bozeman:

- Sun angle >40 degrees
- Leaf-off conditions
- No clouds or obscured ground
- 60 degree forward, 30 degree side overlap

Ground control locations were targeted and surveyed prior to acquisition, to support the aerotriangulation and rectification process.

Deliverables for the project included:

- True Color Digital Ortho Imagery; 1"=100' map scale, 6" pixel, truecolor, orthorectified digital imagery in GeoTIFF, and entire project as mosaic in MrSID format
- All data in both UTM Zone 12 NAD83 (2011) meters, NAVD88 meters and Montana State Plane NAD83 (2011) meters, NAVD88 meters
- FGDC compliant metadata for the imagery in XML format

Delivery of all products was made within 60 days of acquisition, and acceptance was received upon initial delivery.

Reference:
Greater Bridgeport Regional Council (GBRC) Regional GIS Base Mapping Program

GBRC's GIS group was seeking a comprehensive database of aerially-derived base mapping products in order to provide a uniform land base foundation for their regional GIS program. Sanborn provided high-resolution orthoimagery, LiDAR data, contours, and a planimetric feature database.

Contact Name	**Brian Bidolli, AICP** Executive Director
Phone	(203) 366-5405 x 25
Email	bbidolli@gbrct.org
Customer Name	**Greater Bridgeport Regional Council (GBRC)**
Address	525 Water Street Bridgeport, CT 06604
Project Term	March, 2013 – June, 2014
Project Value	$243,020

Project Background

The Towns within GBRC's jurisdiction had historically been operating individual GIS programs and creating data sets to meet their unique needs. GBRC wanted to begin working towards a common, sustainable program with data generated to uniform standards and specifications in order to enhance operational efficiencies and increase opportunities for data sharing. A Regional Performance Incentive Grant from the Connecticut Office of Policy Management, together with additional funding from individual towns made it possible to proceed with their Regional GIS Base Mapping Program in 10 Towns. Sanborn was selected on a competitive basis to create the initial data set in 2013. The contract also provided for an update in 2018.

Project Scope

Primary data acquisition was performed in April, 2013. Imagery had to be collected not only under snow-free, leaf-off conditions and under clear skies, contractual requirements called for photography along the shoreline to be tide-coordinated as well. LiDAR collection also had to be tide-coordinated, and collected as nearly as possible to the imagery data in order to minimize potential temporal differences in the two data sets. Airborne GPS and IMU technologies were used to collect precise sensor position and orientation information, and Sanborn also conducted field surveys to establish positions and elevations for the needed ground control. Digital analytical aerotriangulation was performed to verify and enhance the imagery position and orientation solution.

The raw LiDAR data, collected at 1-meter nominal post-spacing (NPS), was post-processed by Sanborn's LiDAR technicians to create a calibrated LiDAR data set. Classification was performed in accordance with GBRC's specification, and a hydro-flattened, breakline-enhanced bare-earth digital terrain model was created. A 2-foot contour deliverable data set was generated.

The LiDAR-generated DTM was used to orthorectify the aerial imagery. A 4-band, 8-bit per channel RGB/NIR orthoimagery data set was produced at 3-inch resolution. Orthoimagery tiles were delivered in .TIF/.TFW format, and Town and Regional MrSID mosaics were also produced for delivery.

Sanborn photogrammetric technicians using first-order Z/I Imaging digital photogrammetric workstations extracted all visible planimetric features required by the GBRC data specification. All vector features were delivered to GBRC in Esri Geodatabase format.

Sanborn fulfilled all project management responsibilities, thoroughly quality-controlled all data sets, and coordinated with GBRC GIS staff to process minor corrections. A complete set of FGDC-compliant metadata and comprehensive project documentation was delivered with the data. All data sets met ASPRS Accuracy Standards for Large-scale Class1 maps for 1" = 100' scale mapping with 2-foot contours.

Reference:
GIS Base Map Update, Gwinnett County, GA

The Gwinnett County, Georgia Gwinnett), project is a large GIS program that includes LiDAR, digital camera acquisition, topographic and planimetric mapping, and 6-inch resolution orthoimagery. Sanborn has successfully performed this ongoing program for approximately fifteen years, with 100 percent client satisfaction with quality of all products, including enhanced radiometry of the orthoimagery.

Contact Name	**Sharon Stevenson** ITS Manager
Phone / Fax	(770) 822-8033 / (770) 822-8014
Email	Sharon.stevenson@gwinnettcounty.com
Customer Name	**Gwinnett County, Georgia**
Address	75 Langley Drive Lawrenceville, GA 30045
Project Term	February 1999—Ongoing (through 2015)
Project Value	$ 4,000,000
Project Area	458 square miles

Project Background

Gwinnett County has updated and upgraded their customer service capabilities and applications on a continuing basis since the initiation of their GIS in the 1990's. Gwinnett County uses this information for planning and zoning, property records, parks, transportation planning, traffic and accident analysis, elections administration, public safety (police and fire), public utilities (water and sewer), economic development, and environmental and natural resource management. The update and enhancement of their GIS includes new orthoimagery, LiDAR, topography and base map revisions on a yearly basis. Gwinnett County originally selected Sanborn (previously ASI) in 1999 to deliver digital orthophoto imagery, planimetric, topographic, and cadastral mapping. The contract has been renewed numerous times and is now in effect through 2015, as a direct result of Sanborn's timely, on-budget, and high quality deliveries over the years.

Project Scope

Update Mapping: Sanborn has been updating the mapping for Gwinnett County on a yearly basis since 1999. Each year the mapping update includes new imagery and LiDAR acquisition. A comprehensive update of the planimetric/topographic data is performed in two phases, and includes the LiDAR derivative products in Phase 2.

Phase 1: The first phase of the project requires the update of impervious surfaces and digital orthoimagery for the entire County *within two to three months of flight.*

Phase 2: The second phase of the project requires additional the balance of the planimetric feature update, topographic updates, 2-foot contour update and LiDAR derivative products.

The resultant products meet or exceed ASPRS Class 1 Accuracy specifications for LiDAR products, planimetric, 2-foot contours and digital orthoimagery at 1"=100' scale map accuracy. The LiDAR mission is flown yearly at an average of 1.4 Nominal Point Spacing (NPS) to be used for both digital orthoimagery production and development of a new classified point cloud, intensity images, and Digital Elevation Model (DEM) surface throughout the County. The LiDAR DEM data are edited concurrently with the planimetric data, to support quality 6-inch digital orthoimagery and finalized for NSSDA quality products.

Previous Work for Gwinnett:

Sanborn has been performing photogrammetric work for Gwinnett County since 1999.

Cadastral digital data conversion—Cadastral maps covering over 148,000 parcels were digitally converted and formatted. Deliverables included digital data formatted into 53 database layers, final plots, and linked attribute files.

Overview of Products—Countywide digital camera aerial imagery, ground control survey, aerial triangulation, 6-inch orthoimagery, comprehensive planimetric update, LiDAR acquisition/DEM generation and update of 2-foot contours.

Reference:
Cheyenne / Laramie High Resolution Aerial Photography

Sanborn performed high resolution aerial photography services for the City of Cheyenne and the County of Laramie, Wyoming, through the City of Cheyenne/County of Laramie Cooperative GIS Program (Cooperative), in 2010.

Contact Name	**Joyce Pukash** Cooperative GIS Coordinator
Phone	(307) 633-4314
Email	jpukash@laramiecounty.com
Customer Name	**City of Cheyenne / Laramie County Cooperative GIS Program (Cooperative)**
Address	309 W 20th St., Suite 1200 Cheyenne WY 82001
Project Term	2010 – 2011
Project Value	$175,099
Project Area	3,269 square miles

Project Background

The Cooperative selected Sanborn to 2010 to update and expand the area of high resolution imagery. The Cooperative required true color aerial photography acquisition to augment the GIS Program needs, as well as to provide data and imagery to numerous City and County agencies.

Project Scope

In the spring of 2010, Sanborn collected true color aerial photography at a 1:1200 scale (1"=100'), with a 6-inch pixel resolution for 500 square miles. The project was later increased to over 3,000 square miles, with 1-foot orthophotos produced for the outlying areas. Sanborn ortho-rectified the imagery to minimize building lean and the impact of dark shadows; and, all image tiles were tone matched and contrast balanced so that adjacent images could be displayed simultaneously without an obvious visual edge seam. All final imagery was also color balanced so as not to create obvious lines in the photography due to unbalanced imagery. Sanborn produced the following final deliverables:

- One set of 24-bit, natural color, uncompressed GeoTIFF format with world files
- GPS survey report, including horizontal coordinates, vertical reference to the NAVD88 and NGVD29, and station diagrams
- Complete metadata for the orthophoto process, meeting FGDC metadata standards
- Final DEM used for orthorectification
- Compressed mosaic MrSID format of the Greater City of Cheyenne area (approximately 70 square miles)

Key Personnel

Sanborn's experience with and ability to manage complex orthoimagery programs is due in no small part to significant investments in human resources. The Sanborn team of over 135 geospatial technology and management professionals possesses an enviable resume of project experience, significant educational credentials, and registration from government agencies and leading industry associations. Sanborn offers the MPO an exceptionally qualified project team with many years of experience in digital orthoimagery production.

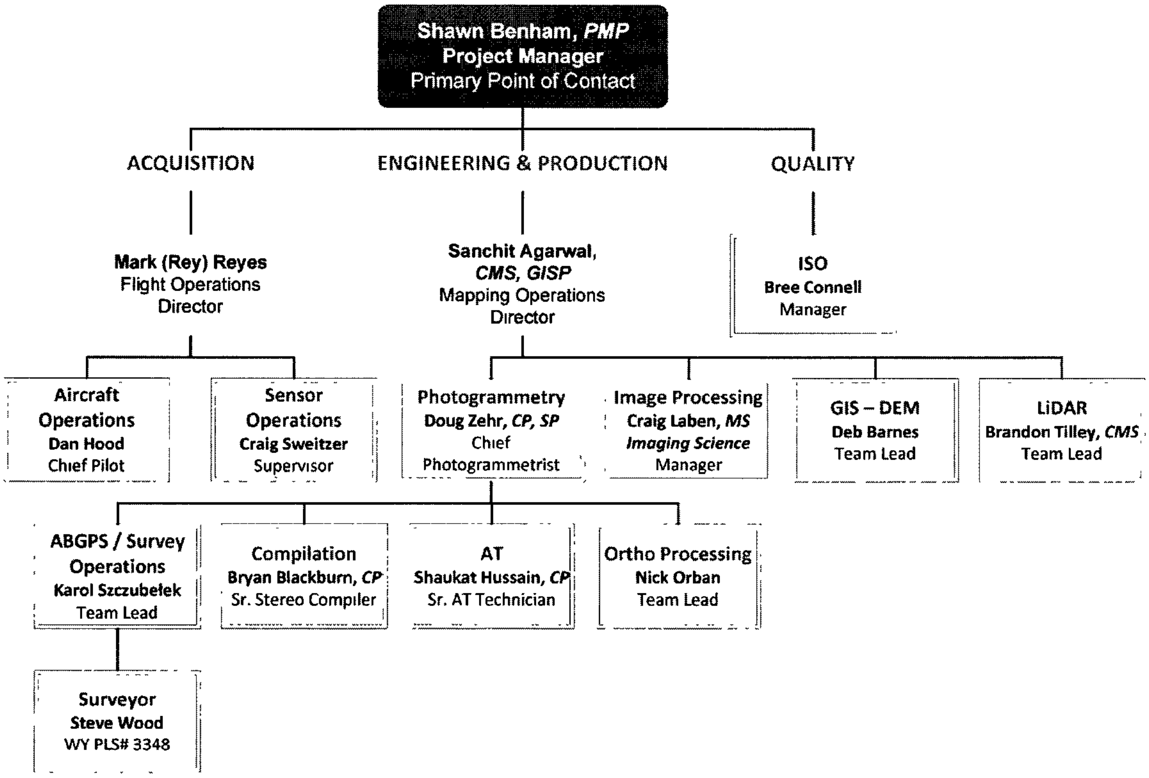
Sanborn employs some of the most talented and dedicated individuals in the mapping industry. Our highly trained staff includes certified photogrammetrists, LiDAR experts, registered land surveyors, survey technicians, pilots, aerial photographers, photo lab technicians, cartographers, photo interpreters, stereocompilers, CADD technicians, image processing specialists, computer programmers, and GIS design professionals. Their vast experience and close attention to detail ensures that the most effective aerial photography and digital mapping solutions are developed in a cost-effective manner.

Sanborn uses established, cohesive teams that streamline the production process significantly. Under this approach the project benefits from the synergy of a proven team, which is critical to achieving maximum efficiency for cost-effective solutions. Sanborn's staffing structure ensures that project requirements are met. We select project team members based on the following criteria:

- Goals of the MPO
- Project management experience
- Reliability in meeting schedules
- Technical expertise
- Commitment to quality

The MPO's project will be completed out of our main production facility and corporate headquarters located in Colorado Springs, Colorado. The technical managers and production staff all work together in a single facility, which creates the ideal conditions for effective communication and productive workflows. Also of note, we have several Certified Photogrammetrists on staff, which will help ensure products conform to the required mapping standards.

The following organizational chart highlights key project personnel and their expertise.



Program Management

Each project is assigned a project manager with responsibilities including customer communication, scheduling, and ensuring adherence to the project specifications. The project manager works with department managers and production staff in establishing an implementation plan that outlines the project's technical requirements. The department managers draw on their production staff, as required, to meet the project objectives. The specific list of employees involved in any given project can be extensive with up to 25 employees or more, depending on the project size and schedule.

Sanborn's Project Manager for the MPO's program will be Mr. Shawn Benham, PMP. Mr. Benham has over 15 years of experience in the field of GIS, including project management and consulting services, quality assurance/quality control management, and data processing. Mr. Benham's experience includes managing and implementing large, complex orthoimagery and LiDAR collection projects. As project manager, he has had direct accountability for advanced project design, program financial design and management, program execution, risk management, and schedule management. Mr. Benham has extensive experience in managing all phases of imagery and mapping projects. As a certified Project Management Professional (PMP), Mr. Benham's skills, knowledge, and abilities are recognized by the Project Management Institute (PMI).

Flight Operations Director

Mr. Reyes has more than 20 years in the Aviation and Logistics industries and more than 10 years of experience in Program Management and Strategic Planning. He joined Sanborn in 2014 and previously served as a career Naval Aviator, flying fighter aircraft from aircraft carriers during multiple combat deployments. Since joining Sanborn, he has had notable success directing a broad range of aircraft and sensor initiatives; participating in planning, analysis, and implementation of solutions in support of business objectives. Mr. Reyes has extensive experience working with executives at all levels of the government to implement the collection of spatial technologies.

Mapping Operations Director

Mr. Sanchit Agarwal, CP, CMS, GISP, is Sanborn's Mapping Operations and Quality Director. Mr. Agarwal has over nine years of experience in the field of Geo-informatics. He is proficient in both production and research & development working environments and has in-depth knowledge of GIS technologies, Aerial Triangulation; GPS-IMU processing; LiDAR data processing; Digital Imaging; Flight Planning; DEM editing and RADAR data processing. He has experience in handling data from multiple sensor platforms: aerial/terrestrial; push-broom/frame sensors; panoramic/oblique imaging systems; and LiDAR/RADAR systems. He has excellent skills in managing large scale projects in production environment and a proven ability to train & develop production teams for new technologies. Mr. Agarwal, an ASPRS Certified Photogrammetrist, will monitor compliance and manage the engineering and quality for the MPO's program.

ISO Manager

Ms. Bree Connell supports all divisions of Sanborn and manages the day-to-day activities for adhering to the ISO 9001:2008 certification requirements. Her experience encompasses multiple orthoimagery projects and she is accomplished at coordinating project efforts with on-site customer staff as well as off-site subcontractors. With 10 years of experience in the GIS and mapping industry, Ms. Connell also coordinates schedules and resources, as well as supports ISO certification.

Aircraft Operations

Mr. Daniel Hood has 40 years of experience in aviation management and as a pilot, both in Alaska and the contiguous US. Prior to joining Sanborn, Mr. Hood gained extensive experience flying digital imagery and LiDAR acquisition missions. Mr. Hood brings over 30,000 hours of total pilot time, and a verifiable perfect safety record. He is competent and knowledgeable in flight operations management, with specific expertise in medium and large aircraft with digital and integrated avionics.

Sensor Operations

Mr. Craig Sweitzer has more than 13 years' experience in Aerial and GPS survey, with deep knowledge in all data acquisition operations that Sanborn performs. Currently, he supervises and coordinates the activities and personnel of the Acquisition Operations department that involve collection of data for aerial imagery, aerial LiDAR and GPS checkpoint location, ensuring production and quality standards are met; and, is responsible for training for all imaging sensors that Sanborn currently owns and operates. Mr. Sweitzer is also involved in all facets of sensor maintenance and operation. He operates, installs, and is trained on all Sanborn sensors including the LiDAR sensor Leica ALS70, and the digital Cameras UltraCam Eagle, UltraCam D and Intergraph DMC. Mr. Sweitzer He has been involved in the majority of all collection projects both large- and small-scale over the last several years for Sanborn. Mr. Sweitzer has developed and documented procedures and processes for all Sanborn camera sensors and has been instrumental in the development of LiDAR procedures and processes.

Photogrammetry

Mr. Zehr has 27 years of industry experience and is a member of Sanborn's photogrammetric management team. His responsibilities include project planning and design, overseeing aerial triangulation, and the support of photogrammetric and LiDAR production processes.

ABGPS/Survey Operations

Mr. Karol Szczubełek has over 12 years of experience in geodectic surveying. As Data Logistics Manager, Mr. Szczubełek is responsible for all aircraft sensors, related equipment, flight planning, and sensor operators. Mr. Szczubełek has been actively involved in the geodetic surveying, aerial photography, and LiDAR data collection. He is responsible for implementing and establishing methods for maximizing accuracies of processing geodetic survey data with impressive results. Mr. Szczubełek is also responsible for documentation, training, and monitoring all QC/QA activities pertaining to geodetic surveying.

Mr. Steven Wood, LS, CP, combines an extensive land surveying and civil engineering background with more than 42 years of project management experience in engineering, land development, surveying and photogrammetry. He has developed several customized solutions for industry-leading photogrammetric projects. His surveying experience is comprehensive and includes many years of practical field assignments and office management of more than a dozen survey field crews.

Compilation

Mr. Blackburn is a Certified Photogrammetrist with over 25 years of experience in photogrammetry and conventional land surveying, including 16 years' experience in management. Mr. Blackburn has extensive experience in photogrammetry and computer technology related to the field of digital mapping, digital terrain modeling (DTM), orthophotography, model preparation, triangulation, and GIS databasing. He has been responsible for project scheduling, triangulation, production and management, initializing new projects, and training new personnel. Mr. Blackburn is proficient with Intergraph ImageStation, ISAT and Microstation.

AT

Mr. Shaukat Hussain supports the team in the role of Senior AT analyst. He has experience with image scanning, digital orthophotography, image processing flight mission planning, and ground control photogrammetric design. His skills include programming, the ability to operate virtually any mainstream CADD and photogrammetric mapping software, as well as the Esri GIS software suite.

Ortho Processing

Mr. Orban has more than 4 years of experience in the GIS industry with experience ranging from basic mapping techniques to advanced orthoimagery production and image processing. Over the last 4 years, Mr. Orban has expanded his skills into the realm of orthoimagery, image processing, and vector-based GIS. Using advanced analysis and project-based coordination, he and his team have successfully honed and streamlined the ortho process. He has also worked as a Senior Imaging Technician and Image Processing Technician for multiple projects and programs. As an Operations Team Lead, he is not only responsible for the execution, processing, and final deliverable generation for assigned ortho programs, he is involved in process development and troubleshooting. Mr. Orban's thorough understanding of each step in ortho and image processing production ensures programs are run effectively and efficiently.

Image Processing

Mr. Craig Laben has over 20 years of experience in remote sensing, GIS, image processing, geospatial analysis and geospatial product quality assurance. He has extensive knowledge of commercial and government satellite and aerial EO, MS, IR and radar imaging systems data and their applications. In addition, Mr. Laben has developed algorithms, techniques, processes and metrics to improve the image quality, accuracy and intelligence value of geospatial products. For all aerial projects within Sanborn's mapping operations, Mr. Laben coordinates activities between the flight acquisition team and the production team, and ensures that image quality and accuracy standards are met. Mr. Laben works with the GPS-IMU and Image Quality Control (QC) teams to optimize workflow and to develop more efficient processes, improving data ingest and QC processing times.

GIS-DEM

Ms. Deborah Barnes has more than 15 years of experience in mapping and data development. She has served as Team Lead in GIS and Photogrammetry. As the GIS Team Lead, she is responsible for training and implementing tools to increase Sanborn's efficiency in meeting the USGS version 13 specifications for hydro production. Ms. Barnes has extensive experience in database management systems and spatial technologies on multiple hardware and software environments and the implementation of new technologies to improve end user productivity. As the GIS lead for the MPO's program, Ms. Barnes will supervise the processing technicians and ensure the project adheres to schedule and production standards; Ms. Barnes will also be responsible for performing quality audits on the data.

LiDAR

Mr. Brandon Tilley has seven years of experience in the GIS division with expertise in LiDAR production workflows, data processing, and a wide range of LiDAR products. He has worked as a LiDAR Analyst for numerous customers providing small and large scale products while meeting or surpassing clients' expectations. Mr. Tilley is responsible for implementing new and faster processes, as well as processing, product generation, problem solving, and quality assurance. Mr. Tilley's knowledge and experience creates a constructive environment and enables projects to be completed with the utmost quality and accuracy.

Resumes

The following are resumes of Sanborn's proposed key personnel and subcontractors.

Shawn Benham, PMP
Project Manager

Mr. Benham has over 15 years of experience in the field of GIS, including project management and consulting services, quality assurance/quality control management, and data processing. Mr. Benham's experience includes managing and implementing large, complex orthoimagery and LiDAR collection projects. As project manager, he has had direct accountability for advanced project design, program financial design and management, program execution, risk management, and schedule management. Mr. Benham has extensive experience managing all phases of imagery and mapping projects. As a certified Project Management Professional (PMP), Mr. Benham's skills, knowledge and abilities are recognized by the Project Management Institute (PMI).

Education

- **BS, Geography**—University of Maryland College Park, MD, 1998

Affiliations and Certifications

- **Certified Project Management Professional (PMP)**—Project Management Institute, No 496774, 2007
- **Project Management Institution**—Member, 2007

Professional Education and Training

- **ESI International:**
  - Managing Projects in Organizations
  - Project Leadership, Management, and Communications
  - Scheduling and Cost Control
  - Contracting for Project Managers
  - Quality for Project Managers
  - Risk Management

Project Experience

- **Virginia Base Mapping Program (VBMP), VA, February 2010—Present.** Program management for the collection, production and delivery of orthoimagery, terrain models and various GIS products of various resolutions and formats for more than 25,000 square miles for the Commonwealth of Virginia's Base Mapping Program. Mr. Benham is also responsible for the coordination of multiple subcontractors, including survey field crews, aerial photography resources, and photogrammetry staff.
- **New York State Orthophotography Program (NYSDOP), NY, February 2008—Present.** Mr. Benham manages the acquisition, processing, and delivery of orthoimagery at various resolutions and imagery types for more than 30,000 square miles in the State of New York. He is responsible for the annual coordination of multiple subcontractors including survey field crews, aerial photography resources, and photogrammetry staff.
- **Greater Bridgeport Regional Council (GBRC) Regional GIS Base Mapping Program, Bridgeport CT, March 2013—Present.** Mr. Benham manages the acquisition, processing, and delivery of high-resolution (0.25') orthoimagery, LiDAR data, contours, and a planimetric feature database for a 10-town region in Southern Connecticut.
- **Manistee County Orthoimagery Program, Manistee County, MI, January 2013—October 2013.** Sanborn was selected in 2013 to update the base layer map for Manistee County, MI. Mr. Benham managed the production and delivery of 6-inch and 3-inch, 8-bit, 4-band orthoimagery for 14 townships (the entire County) and the City of Manistee.
- **Aerial Photography & LiDAR Services, City of Waco, TX, December 2012—June 2013.** Mr. Benham managed the acquisition, processing, and delivery of orthoimagery and LiDAR products for over 1,150 square miles of McLennan County, Texas, including the City of Waco.
- **Aerial Survey and Planimetric Updates, Prince William County, VA, September 2008—April 2009, February 2012—Present.** Mr. Benham managed the production and delivery of high-resolution orthoimagery, planimetric feature updates, hydrology mapping/update, and landcover analysis for Prince William County, VA.
- **Digital Orthoimagery and Basemap Update, Loudoun County, VA, July 2008—Present.** Mr. Benham is responsible for overall management and delivery of 1-foot resolution orthoimagery, planimetric feature and topography updates for Loudoun County, VA.
- **North Carolina Statewide Orthoimagery Program, NC, January 2010—January 2011.** Mr. Benham managed the collection, production and delivery of orthoimagery products at 0.5-foot resolution for more than

9,700 square miles in the State of North Carolina. He was responsible for the coordination of multiple subcontractors including survey field crews, aerial photography resources, and photogrammetry staff.

- **Hunter College (NYC) LiDAR, Research Foundation of the City of New York, Hunter College, NY, April 2010—January 2011.** Mr. Benham managed the collection, production and delivery of high resolution LiDAR (LAS) and bare earth DEM deliverables for the NY City area and surrounding boroughs (362 square miles).
- **Washington DC Orthoimagery, D.C. GIS Office of the Chief Technology Office, Washington, DC, February 2008—November 2010.** Mr. Benham managed the production and delivery of high-resolution orthoimagery, planimetric feature updates, and 2-foot contour data for Washington D.C. as a subcontractor to KCI Technologies, Inc.
- **Digital Mapping Services, Dutchess County, NY, February 2008—July 2009.** Mr. Benham was responsible for project production scheduling, oversight, quality management, and financial and contractual management for the Dutchess County, NY Digital Mapping Project. The project deliverables consisted of county-wide DTM, planimetric and hydrography updates, as well as watershed delineation mapping.
- **Aerial Photography and Digital Mapping Services, Town of Barnstable, MA, February 2008—September 2010.** Mr. Benham was responsible for project definition and production, oversight, quality management, and financial and contractual management for the Town of Barnstable, MA, digital mapping project. The project deliverables consisted of 0.25-foot resolution 4-band orthoimagery, a town-wide planimetric geodatabase, LiDAR DTM and intensity products, and town-wide 2-foot contours.
- **New York Statewide Orthophotography Program (NYSDOP), NY, December 2003—May 2006.** Mr. Benham managed the acquisition, processing, and delivery of orthoimagery at various resolutions and imagery types for more than 30 counties in the State of New York. Responsible for the coordination of multiple subcontractors, including survey field crews, aerial photography resources, and photogrammetry staff.

Work History

- **Project Manager, Sanborn, Colorado Springs, CO, February 2008—Present.** As a Senior Project Manager at Sanborn, Mr. Benham manages complex, statewide, and municipal photogrammetric mapping projects. Such projects typically require multiple deliverables (orthoimagery, LiDAR, topography, and planimetrics) and require the coordination of multiple internal and external resources. Mr. Benham maintains overall direct accountability for advanced project design, program financial design and management, program execution, risk management, and schedule management.
- **Project Manager, CH2M Hill, Chantilly, VA, May 2006—February 2008.** Delivered multiple, concurrent projects totaling over $1M in revenue per year on time and within budget; led the development of RFP, RFQ, and RFI response submittals, directly resulting in over $500K in new business in 2007; established and managed labor and expense budgets for all project tasks; developed project management plans and work plans to ensure successful project execution; provided leadership and management of project teams consisting of internal staff and subcontractor resources; and, communicated project progress to clients through regular written reports and oral presentations.
- **Senior Project Manager, VARGIS, LLC, Sterling, VA, December 2001—May 2006.** Managed complex multi-year imagery projects among multiple subcontractors, customers, and internal staff.; conducted contract administration, including task order and purchase order management; created, maintained, and monitored detailed project schedules to ensure on-time delivery of products; developed and documented product acceptance criteria and quality plans to guarantee compliance to contract standards; monitored project revenue and expenses to maintain profitability of projects; communicated project progress to clients through regular written reports and oral presentations; developed internal project management processes and procedures, including resource analysis, process improvement, and project tracking.
- **GIS Analyst, VARGIS, LLC, Sterling, VA, June 1998–December 2001.** Performed quality assurance and quality control for orthoimagery and planimetric products.

Rey Reyes

Director of Flight Operations

Mr. Reyes has more than 20 years in the Aviation and Logistics industries and more than 10 years of experience in Program Management and Strategic Planning. He joined Sanborn in 2014 and previously served as a career Naval Aviator, flying fighter aircraft from aircraft carriers during multiple combat deployments. Since joining Sanborn, he has had notable success directing a broad range of aircraft and sensor initiatives; participating in planning, analysis, and implementation of solutions in support of business objectives. Mr. Reyes has extensive experience working with executives at all levels of the government to implement the collection of spatial technologies.

Education

- **Master of Business Administration (MBA), Finance**—University of Colorado, 2010
- **Master of Arts, National Security and Strategic Studies**—U.S. Naval War College, 2007
- **Bachelor of Science, Mechanical Engineering**—U.S. Naval Academy, 1993

Affiliations and Certifications

- **Supply Chain Management**—National Defense University, 2013
- **Strategic Planner (Level III)**—U.S. Northern Command—2008
- **Aviation Safety**—U.S. Naval Safety Center—2002
- **Airline Transport Pilot**—Federal Aviation Administration—2002

Project Experience

Department of Defense (DOD) Lead Strategic Planner

- **U.S. Central Command, Tampa, Florida, July 2011–April 2014.** Mr. Reyes served as the project lead for the deployment, sustainment, and redeployment of all US forces in the support of the wars in Iraq and Afghanistan. He developed air, surface and maritime logistics solutions to ensure national security objectives were met while minimizing cost.
- **U.S. European Command, Stuttgart, Germany, May 2013-April 2014.** Mr. Reyes developed the DOD strategic plan for the elimination of Syria's chemical weapons, including mission analysis, course of action development, costing and budgeting, and mission execution resulting in the removal and neutralization of tons of Sarin, VX, and mustard agents at sea.

Work History

- **Director of Flight Operations, Sanborn Map Co, Colorado Springs, CO, Dec 2014—Present.** Mr. Reyes is responsible for the management of all Sanborn aircraft, pilot, sensor, and sensor operator activities, including strategic planning, budgeting, and collection execution.
- **Lead Classified Logistics Planner, U.S. Transportation Command, Belleville, IL, July 2011—April 2014.** Mr. Reyes was responsible for the management of all DOD logistic activities, including maritime, aviation, and surface for the Middle East, Europe, Russia and Africa.
- **Lead Classified Strategic Planner, U.S. Northern Command, Colorado Springs, CO, August 2007—June 2011.** Mr. Reyes was responsible for the management of all classified planning activities for the U.S. and Canada, including Continuity of Operations, Ballistic Missile Defense, and National Security.

Awards/Presentations

- Winner of CEO's Innovation Showcase Award in 2013 for process innovation, customer service improvement, leadership and team building

Sanchit Agarwal, CMS, GISP
Mapping Operations and Quality Director

Mr. Agarwal has over 9 years of experience in the field of geo-informatics. He is proficient in production, research and development environments. Mr. Agarwal's in-depth knowledge of GIS technologies includes Aerial Triangulation, GPS-IMU processing, LiDAR data processing, digital imaging, flight planning, DEM editing and RADAR data processing. He has experience in handling data from multiple sensor platforms, including aerial/terrestrial sensors, push-broom/frame sensors, panoramic/oblique imaging systems, and LiDAR/RADAR systems. He is adept in managing large scale production projects, with a proven ability to train and develop production teams for new technologies. Mr. Agarwal has facilitated requirement gathering and brainstorming sessions for process enhancement and automation, and has exceptional quantitative, analytical and problem solving skills.

Education

- **MS, Geomatics Engineering**—Ohio State University, Columbus, OH, 2006
- **B.Tech., Civil Engineering**—Indian Institute of Technology (BHU), Varanasi, India, 2003

Affiliations and Certifications

- **Certified Mapping Scientist (CMS)**—ASPRS, No. 223, 2010
- **GIS Professional (GISP)**—GIS Certification Institute, No. 64283, 2010

Computer Skills

- **Programming and Database**— VBA, MATLAB, SQL, Geodatabase, Database design and management
- **GIS and Remote Sensing**—ArcMap, ArcCatalog, ArcScene, ArcObjects, ArcToolbox, Map Info, GeoCue, SocetSet, TerraSolid products, MapInfo, MicroStation, ERDAS Imagine, QCoherent, GrafNav, PosPac

Publications / Presentations

- Agarwal, Sanchit. (2008, Sept). ***"Photogrammetric Processing of Rover Imagery of 2003 Mars Exploration Rover Mission,"*** ISPRS
- Agarwal, Sanchit. (2007, July). "***A WebGIS for Spatial Data Processing, Analysis & Distribution for the MER 2003 Mission***," P&RS
- Agarwal, Sanchit. (2007, Apr). "***Rock Modeling & Matching for Autonomous Mars Rover Localization***," Journal of Field Robotics

Project Experience

- **State of Louisiana, LA, November 2010–June 2012.** Mr. Agarwal managed the mapping production for the statewide aerial photography and orthophoto program, including attending customer meetings for assisting with any technical questions on quality, products and services.
- **New York Statewide Orthoimagery Program, NY, May 2010–Present.** Mr. Agarwal is managing the mapping production of orthoimagery at various resolutions and imagery types for more than 30,000 square miles in the State of New York. He is also responsible for the coordination of the mapping division production staff and liaison between operations and the project management team.
- **Virginia Base Mapping Program, VA, May 2010–Present.** Mr. Agarwal manages production and operations, including monitoring the program, tasks, staff, schedule and quality, and reporting conditions to upper management.
- **Gwinnett County, GA, May 2010–Present.** Orthoimagery, LiDAR, and Planimetric Mapping Program. Mr. Agarwal manages production and operations, including monitoring the program, tasks, staff, schedule and quality, and reporting conditions to upper management.
- **Pikes Peak Geospatial Alliance, CO, 2011–2012.** Pikes Peak Area Orthos and LiDAR Program. Mr. Agarwal managed the production and operations team within the mapping division to provide 2,890 square miles of digital orthoimagery over three counties in Colorado.

Work History

- **Mapping Operations and Quality Director, Sanborn, Colorado Springs, CO, January 2013–Present.** Mr. Agarwal monitors compliance and manages project engineering and quality. Mr. Agarwal works with the production team to optimize workflow and set up project processes according to specifications and priorities.
- **Mapping Operations Director, Sanborn, Colorado Springs, CO, February 2012–January 2013.** Mr. Agarwal led the production and operations management team within the mapping division. This responsibility included strategically directing and monitoring budget, schedule, staffing, workflows and training; acting as the

main liaison between the project management and operations staff for setting up the expectations and priorities; ensuring that proper procedures were in place and followed for delivering quality mapping products and services to customers; evaluating the latest technologies for potential implementation in the production processes; leading innovation, process improvement and workflow optimization efforts to gain efficiencies in the production procedures; attending customer meetings to assist with technical questions on quality, products and services; providing production feedback, metrics, insight and support to the proposal, sales and marketing team; and representing Sanborn at industry events.

- **Director of Technical Quality, Sanborn, Colorado Springs, CO, May 2010–February 2012.** Mr. Agarwal worked with the production team for workflow optimization and process improvement, resulting in better quality products at higher efficiencies. In addition, he analyzed the latest technologies for possible implementation in the production processes and conducted internal ISO audits.
- **Director Operations and Chief Technologist, HJW GeoSpatial Inc., Oakland, CA, September 2009–May 2010.** Mr. Agarwal led and managed the production and flight operation activities, executed the complete pre-processing and post-processing workflow of UltraCamX data, tested new technologies for possible new mapping products in the emerging markets, and worked with the sales and marketing team to broaden the portfolio of the products that the company offers to prospective customers.
- **Technical Lead, GeoSAR, Fugro EarthData Inc., Frederick, MD, November 2007–August 2009.** Mr. Agarwal held key responsibilities as lead for the successful delivery of multi-million dollar mapping projects, continuously monitored the projects to identify gaps in meeting the target, reported progress weekly and monthly to managers, accelerated execution of projects to drive faster realization of cost benefits, streamlined the existing workflows to achieve higher efficiency and better quality of GeoSAR products, facilitated the documentation of the GeoSAR processes to comply with the ISO requirements, conducted training sessions in the company, and deployed GeoSAR data processing capabilities at the Chinese division.
- **Senior Analyst, Technology Evaluation Group, Fugro EarthData Inc., Frederick, MD, June 2008–August 2009.** Mr. Agarwal was an active member of the technology evaluation group. He visited vendors to analyze new products and services to determine benefit to the portfolio of the company, conducted the feasibility and statistical analysis of the new technologies from the production viewpoint, and generated reports and delivered presentations that facilitated the decisions of management.
- **Subject Matter Expert & Trainer, QA/QC Procedures, Fugro EarthData Inc., Frederick, MD, June 2008–August 2009.** Mr. Agarwal functioned as subject matter expert on the formalized QA/QC procedures for the production processes and promoted the concept of internal independent review process. This process helped to catch any slips in the production and ensured first time right deliveries. Mr. Agarwal developed the tools and procedures for carrying out the independent review process, developed and maintained the ISO documentation for the QAQC procedures, and prepared training material and delivered training to production staff.
- **Senior AT Analyst, Fugro EarthData Inc., Frederick, MD, May 2006–August 2009.** Mr. Agarwal gained hands-on experience with end-to-end workflow of the Digital Mapping camera systems (ADS40) including flight-planning, GPS-IMU processing, aerial triangulation, orthophoto generation and DEM processing. Mr. Agarwal performed the complete pre-processing and post-processing workflow of the LiDAR (ALS50) data, worked extensively on GPS-IMU processing, boresite, feature extraction and surface-modeling of LiDAR data, played an instrumental role in optimizing the production workflows by customization and automation, and managed and delivered state-wide mapping projects on the production floor under tight deadlines.
- **Graduate Research Associate, Mapping & GIS Lab, Ohio State University, Columbus, OH, August 2004–May 2006.** Mr. Agarwal developed 3D terrain maps, slope maps and orthophotos of the Mars surface. These maps were used by the NASA scientists for safely navigating the rovers on the challenging Martian surface. Mr. Agarwal developed crater models by seamlessly integrating observations from multiple rover locations, and developed a model for the automation of on-board rover localization. This algorithm was designed to provide artificial intelligence to the rovers for auto-maneuvering in future robotic missions.

Bree Connell
PMO Coordinator

With 10 years of experience in the GIS and mapping industry, Ms. Connell possesses the skills necessary to coordinate schedules and resources at Sanborn's Colorado Springs facility. She supports both Project Management and Production technically, scheduling on large projects. She oversees project scheduling as well as resource coordination, to ensure the project team delivers quality products and services within budget and on time. She oversees data flow among departments on large-scale products. Her experience encompasses multiple orthoimagery projects and she is accomplished at coordinating project efforts with on-site customer staff as well as off-site subcontractors. She also has experience as a project lead on large scale orthorectification jobs.

Education

- **BA, Geography and Environmental Studies**—University of Colorado, Colorado Springs, CO, 2003

Technical Expertise

- APS (Sanborn's Proprietary Software)
- ArcGIS 8.3, 9.0, 9.1, 9.2, 9.3, 10.0
- Global Mapper
- Primavera 6.0
- Microsoft Office Suite

Project Experience

- **State of Michigan Program 2014, MI, April 2013—Present.** Supports the Project Manager by providing full project coordination for large statewide multi-year project. Coordinates schedule and delivery milestones to adhere to contract requirements. Communicates resource requirements to production managers. Coordinates shipments, deliveries, schedules and issues with multiple subcontractors. Tracks project progress, metrics, and production issues to ensure that all resources have the materials and information needed to complete the entire project on budget and schedule, while adhering to quality assurance and ISO requirements.
- **Maricopa County, AZ, October 2013–March 2014.** Supported the Project Manager by providing full project coordination for large statewide multi-year project. Coordinated schedule and delivery milestones to adhere to contract requirements. Communicated resource requirements to production managers. Coordinated shipments, deliveries, schedules and issues with multiple subcontractors. Tracked project progress, metrics, and production issues to ensure that all resources have the materials and information needed to complete the entire project on budget and schedule, while adhering to quality assurance and ISO requirements.
- **State of Michigan Program 2013, MI, April 2013—Nov 2013.** Supported the Project Manager by providing full project coordination for large statewide multi-year project. Coordinated schedule and delivery milestones to adhere to contract requirements. Communicated resource requirements to production managers. Coordinated shipments, deliveries, schedules and issues with multiple subcontractors. Tracked project progress, metrics, and production issues to ensure that all resources have the materials and information needed to complete the entire project on budget and schedule, while adhering to quality assurance and ISO requirements.
- **New York State Digital Orthoimagery Program, NY, March 2013—Feb 2014.** Supported the Project Manager by providing full project coordination for large statewide multi-year project. Coordinated schedule and delivery milestones to adhere to contract requirements. Communicated resource requirements to production managers. Coordinated shipments, deliveries, schedules and issues with multiple subcontractors. Tracked project progress, metrics, and production issues to ensure that all resources have the materials and information needed to complete the entire project on budget and schedule, while adhering to quality assurance and ISO requirements.
- **New York State Digital Orthoimagery Program, NY, June 2012—Jan 2013.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.
- **Louisville-Jefferson Information Consortium (LOJIC), KY, May 2012—January 2012.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.

- **Maricopa County, AZ, November 2011–February 2013.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.
- **United States Department of Agriculture (USDA), National Agriculture Imagery Program (NAIP), VA, May 2011—October 2011.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.
- **United States Department of Agriculture (USDA), National Agriculture Imagery Program (NAIP), VA, June 2010—December 2010.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.
- **Maricopa County, AZ, March 2011—June 2011.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.
- **United States Department of Agriculture (USDA), National Agriculture Imagery Program (NAIP), June—September 2009.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.
- **New York State Digital Orthoimagery Program, NY, June 2008—December 2008.** Lead ortho production from setup to verification of final deliverables. Verified data inputs and outputs and updated project status and tracking documents.

Work History

- **PMO Coordinator, Colorado Springs, CO, March 2013—Present.** Ms. Connell coordinates production of large multi-year statewide projects across Sanborn's Mapping division. Ms. Connell supports Project Management, Production, Project Client, and Subcontractors with project scheduling design and statusing. Ms. Connell coordinates projects from inception through full production to completion, to include aerial imagery acquisition, surface compilation and ortho production. Ms. Connell has project involvement in the pilot, production, and final delivery phases by providing support to Project Management and Operations in scheduling, coordination and technical support. She develops project-specific documentation, and works with clients and local management to establish and maintain schedules and ensure the overall success of the project. Ms. Connell coordinates weekly resource and metric meetings, monthly project schedule review meetings and quarterly project budget review meetings with the CEO, General Managers, Accounting, Project Manager and Production. Ms. Connell provides technical support to Project Managers by attending weekly conference calls. Ms. Connell works to document and improve production process flows.
- **Imagery Analyst Team Lead, Sanborn, Colorado Springs, CO, 2012—March 2013.** Ms. Connell designed production work flows to maximize efficiencies with existing and developing technologies. She managed technicians, including daily operations. Performed internal ISO audits and updated ISO documentation as necessary. Managed mapping projects, including technical setup/execution and metric tracking to ensure strict adherence to budgeted hours/schedules.
- **Senior Production Team Lead, Sanborn, Colorado Springs, CO, 2011—2012.** Managed multiple concurrent state, federal and private orthorectification projects. Coordinated technical responsibilities involving project setup, troubleshooting problems, translation of data and verifying client deliveries. Created work instruction and training documents in compliance with internal ISO documentation. Maintained project status and tracking documentation.
- **Project Coordinator, Sanborn, Colorado Springs, CO, 2007–April of 2011.** Managed orthorectification jobs: Rectified, color balanced, seamed and mosaiced orthophotos using proprietary software. Provided support and training to technicians to ensure integrity and accuracy of project deliverables.
- **Senior Digital Imaging Technician, Sanborn, Colorado Springs, CO, 2006—2007.** Assisted Project Coordinators with orthophoto production tasks. Performed and organized data backups/restores to assist IT with data management. Provided support and training to technicians.
- **Digital Imaging Technician, Sanborn, Colorado Springs, CO, 2004—2006.** Applied photo interpretation skills to perform detailed quality control tasks while maintaining aggressive schedules and adhering to budgeted hours.

Daniel E. Hood
Chief Pilot

Mr. Hood has 40 years of experience in aviation management and as a pilot, both in Alaska and the contiguous US. He has served as Chief Pilot for an FAA Part 121 airline and as Director of Flight Operations for an overseas airline. Prior to joining Sanborn, Mr. Hood gained extensive experience flying digital imagery and LiDAR acquisition missions. Mr. Hood brings over 30,000 hours of total pilot time, and a verifiable perfect safety record. He began his flying experience and career at Merrill Field in Anchorage as a Civil Air Patrol Cadet, and is a certified Airline Transport Pilot qualified by a combination of substantial flight time with years of international experience enhanced by specialized professional training. He is competent and knowledgeable in flight operations management, with specific expertise in medium and large aircraft with digital and integrated avionics.

Education

- **Flight Engineering**—Boeing Aircraft Company, Seattle, WA

Licenses and Certifications

- **FAA ATP Certificate**—Airline Transport Pilot, No. 1499590
  - Airplane Single- and Multi-Engine; Land and Sea
  - A-310, B707, B720, B727, B767, CV240, CV340, CV440, DC-8, IA-Jet
- **FAA Certificate**—Flight Engineer, No. 1677110
- **FAA Certificate**—Flight Navigator, No. 1787144
- **Flight Instructor**—Airplane and Instrument

Flight Hours

- **Total Pilot Time: 30,151 Hours**
  - Pilot in Command· 25,900
  - Boeing Aircraft· 19,950
  - General Aviation (Jet and Piston): 7,100
  - Flight Engineer: 4,389
  - Flight Instructor: 2,150
  - Flight Navigator: 1,150

Project Experience

- **Virginia Base Mapping Program, VA, November 2011—Present.** Oversees imagery acquisition by coordinating the pilots and aircraft according to the project schedule, and monitoring the collection window and the quality of acquisition.
- **New York State Digital Orthophotography Program, NY, November 2011—Present.** Oversees imagery acquisition by coordinating the pilots and aircraft according to the project schedule, and monitoring the collection window and the quality of acquisition.
- **Maricopa County, AZ, November 2011—Present.** Aerial Imagery Project. Oversees imagery acquisition by coordinating the pilots and aircraft according to the project schedule, and monitoring the collection window and the quality of acquisition.
- **Saskatchewan Province, Canada, April 2012—Present.** Orthoimagery Program. Oversees imagery acquisition by coordinating the pilots and aircraft according to the project schedule, and monitoring the collection window and the quality of acquisition.
- **Gwinnett County, GA, November 2011—Present.** Orthoimagery, LiDAR, and Planimetric Mapping. Oversees imagery acquisition by coordinating the pilots and aircraft according to the project schedule, and monitoring the collection window and the quality of acquisition.

Work History

- **Chief Pilot, Sanborn, Colorado Springs, CO, November 2011—Present.** As Chief Pilot, Mr. Hood has overall responsibility for pilot training, aircraft maintenance and the safety of Sanborn's flight operations. He develops standard operating procedures, creates and implements training programs, hires and manages pilots, and supervises sensor operators.
- **Pilot, Marc, Inc., Bolton, MS, 2008—2011.** Part-time pilot. Experience flying twin-engine aircraft to support digital imagery and LiDAR acquisition.

- **Captain, Delta Air Lines, Atlanta, GA, 1991—2004.** Captain – Boeing 767ER/757/A-130/727. Line Captain, Instructor, First Officer, Flight Engineer and Navigator. Primarily engaged in international and domestic flight operations with years of experience in Boeing aircraft worldwide. Extensive general aviation experience in single- and multi-engine land and sea in Alaska and lower 48 states.
- **Captain, Pan American Airlines, New York, NY, 1967—1991.** Captain – Boeing 767ER/757/A-130/727. Line Captain, Instructor, First Officer, Flight Engineer and Navigator. Primarily engaged in international and domestic flight operations with years of experience in Boeing aircraft.

Craig Sweitzer
Data Acquisition Supervisor

Mr. Sweitzer is involved in all facets of sensor operation and has more than 12 years of experience assisting in GPS survey and data acquisition activities. He plans flights, operates, installs, and is trained on all Sanborn sensors including the Vexcel UltraCam D, X, and Xp; the Vexcel UltraCam Eagle digital camera; the Intergraph DMC digital camera; the MIDAS Oblique camera system; the Leica ALS50 LiDAR sensor; and, the Optech ALTM 2050 LiDAR sensor. Mr. Sweitzer is responsible for conducting training for all Sanborn's imaging sensors. He has been involved in the majority of collection projects both large and small scale. Mr. Sweitzer has developed and documented procedures and processes for the Sanborn camera sensors and has been instrumental in the development of LiDAR procedures and processes. He is a valued asset to Sanborn's data acquisition and surveying team.

Education

- **BS, Geography**—University of Regina, Regina, SK, Canada, 1998
- **Associate, Survey and Mapping Technology**—Southern Alberta Institute of Technology, Calgary, AB, Canada, 2001

Professional Education and Seminars

- Vexcel UltraCam, manufacturer's training
- Vexcel UltraCam, advanced maintenance training
- RC-30 Camera operations, manufacturer's training
- Optech ALTM operations, manufacturer's training
- Leica Geosystems ALS50, manufacturer's training
- Yearly sensor operation and field procedures and processing internal training
- GPS and Photography Survey, internal training
- ZI Digital Mapping Camera, manufacturer's training
- Track'Air Flight Management System, manufacturer's training
- Track'Air MIDAS Oblique Camera System, manufacturer's training
- Applanix POS-AV manufacturer's training

Project Experience

- **Oblique Imagery Program, Customer Confidential, Multiple Cities, October 2012–Present.** Installs and operates MiDAS oblique camera systems, as well as oversees other camera operators and the data collection field processing operations.
- **Saskatchewan Province Orthoimagery Program, Saskatchewan, Canada, April 2012–Present.** In addition to operating the camera, he oversees other camera operators and the data collection field processing operations.
- **Qatar Petroleum Aerial Photogrammetry-Based GIS Database Updating Program, Qatar, March 2013–June 2013.** Installed and operated DMC camera and assisted with ground control surveys throughout Qatar.
- **Columbia Power Plant, Columbia, WA, June 2013.** Mr. Sweitzer collected and processed LiDAR and imagery data, and performed the field quality control procedures.
- **GEOSYS LiDAR Program, Northwest Territories, Canada, August 2013.** In addition to collecting ground survey data, Mr. Sweitzer collected and processed LiDAR data and performed the field quality control procedures.
- **New York State Digital Orthoimagery Program, NY, 2008–Present.** In addition to operating the camera, he oversees other camera operators and the data collection field processing operations.
- **Virginia Base Mapping Program, VA, 2007–Present.** In addition to operating the camera, he oversees other camera operators and the data collection field processing operations.
- **Louisiana Statewide, LA, February 2010–Present.** In addition to operating the camera, he oversees other camera operators and the data collection field processing operations.
- **Maricopa County, AZ, 2009–Present.** In addition to operating the camera, he oversees other camera operators and the data collection field processing operations.

- **National Agriculture Imagery Program, U.S. Department of Agriculture, Multiple States, 2004–2009.** In addition to operating the camera, he oversaw other camera operators and the data collection field processing operations.
- **City of Dubai, United Arab Emirates, 2005.** In addition to operating the camera, he supervised installation and operation of the sensor systems with foreign aircraft and airspaces.

Work History

- **Data Acquisition Supervisor, Sanborn, Colorado Springs, CO, August 2013—Present.** Supervises and coordinates activities and personnel in acquisition of data for aerial and satellite imagery, ensuring production and quality standards are met. Performs production work in these areas as required.
- **Operations Coordinator, Sanborn, Colorado Springs, CO, October 2008–August 2013.** Responsibilities same as below, and additionally was responsible for all mission planning and project tracking as well as managing all imaging field staff.
- **Senior Geodetic Technologist, Sanborn, Colorado Springs, CO, May 2001–September 2008.** Mr. Sweitzer's years of experience include aerotriangulation, geodetic surveying, GPS RTK surveying; analog photography (RC-30); Vexcel UltraCam-D installation, operation and maintenance; DMC camera installation, operation and troubleshooting; LiDAR collection; and Team Lead for several sensor collections.

Doug Zehr, CP, SP
Aerial Triangulation Manager

Mr. Zehr has 27 years of industry experience and is a member of Sanborn's photogrammetric management team. His responsibilities include project planning and design, overseeing aerial triangulation, and the support of photogrammetric and LiDAR production processes. He also works with Sanborn's business development group designing production and cost strategy.

Project Experience

- **Florida Power & Light, Utility Mapping, FL, March 2013—October 2013.** Color ortho and oblique imagery to support mapping of 1600 miles of transmission lines. Performed image QC, ortho and oblique production for PLSCADD model delivery.
- **Entergy, Utility Mapping, August 2012—March 2013.** Color ortho and oblique imagery to support mapping of 6000 miles of transmission lines. Developed workflow for image QC, ortho and oblique production to meet specific client requirements.
- **Maricopa County Orthophotos, Maricopa County, AZ, November 2007—Ongoing.** Color and NIR digital imagery collected at 0.32', 0.5', and 0.8' resolutions for a total of 27,000 images. Performed image acquisition, GPS surveys, AT, DTM update, and orthophotography.
- **Virginia Base Mapping Program (VBMP), VA, April 2009—Ongoing.** Statewide orthophoto and DTM mapping program involving aerial photography collection, GPS surveys, AT, compilation, and orthophoto generation. Total images 35,000 (eastern half of state).
- **Virginia Base Mapping Program (VBMP), VA, April 2007—February 2008.** Statewide orthophoto and DTM mapping program involving aerial photography collection, GPS surveys, AT, compilation, and orthophoto generation. Total images 47,000.
- **Pikes Peak Area Orthophotos, Colorado Springs Utilities, Colorado Springs, CO, April 2009—December 2009.** Color and NIR digital imagery collected at 0.5-foot and 1-foot resolutions for 3,000 square miles. Performed image acquisition, GPS surveys, AT, DTM update, and orthophotography.

Education

- **Graduate Studies, Geography, Physical Geography/Cartography**—Ball State University, Muncie, IN, 1986
- **BS, Earth-Space Sciences/Math**—University of Indianapolis, Indianapolis, IN, 1984

Affiliations and Certifications

- **Certified Photogrammetrist (CP)**—American Society for Photogrammetry and Remote Sensing (ASPRS), No. R1021, 1997
- **Surveyor Photogrammetrist (SP)**—Virginia, No 0408000061, 2009
- **ASPRS**—Member, 1987
- **North Carolina Linux Users Group (NCLUG)**—Member, 2013

Continuing Education and Seminars

- Photogrammetric Processing Workshop, ASPRS Webinar, 2013
- Assessing Accuracy of GID Workshop, ASPRS Conference, San Antonio, TX, 2009
- Intro to Open Source Workshop, ASPRS Conference, San Antonio, TX, 2009
- Automated Linear Feature Extraction Workshop, ASPRS Conference, Portland, OR, 2008
- Image Enhancement Workshop, ASPRS Conference, Portland, OR, 2008
- Professional Airborne Digital Mapping System Workshop, ASPRS Conference, San Antonio, TX, 2006
- LiDAR Workshop, ASPRS Conference, Charleston, SC, 2004
- IMU Workshop, ASPRS Conference, Washington, DC, 2002
- Windows 2000 Server Training Course, Washington, DC, 2002
- LiDAR Workshop, ASPRS Conference, Washington, DC, 2000
- LiDAR Realm Training, Optech, Toronto, Canada, 1999
- Orthophoto Training, Intergraph, Madison, AL, 1992

Work History

- **Chief Photogrammetrist/AT Manager, Sanborn, Colorado Springs, CO, 2014—Present.** Mr. Zehr manages aerial triangulation operations, and works with a team to support workflow for Sanborn's large-format digital cameras and medium-format oblique sensors. As project designer, he works closely with the business development team and estimator to ensure technical questions, concerns, and strategies are disclosed and discussed. Mr. Zehr performs evaluation of software for production and works with development teams on strategies for process improvement.

- **Production Manager, McKim & Creed, Raleigh, NC, 2012—2014.** As production manager, Mr. Zehr established workflow and managed photogrammetric production for utility mapping programs. He worked closely with the regional manager on estimating, budget management, and scheduling, and provided customers with innovative technical solutions to satisfy needs utilizing existing datasets. Mr. Zehr was responsible for developing production workflows utilizing MIDAS RGB/IR sensors, Harrier 68i RGB sensors and VI Nadir RGB/IR and oblique sensors. This included field and office image processing, QC procedures, AGPS/IMU processing, orthophoto production, and delivery of nadir and oblique imagery in specific projections and formats. He resolved MIDAS sensor orientation issues allowing multiple offices (multiple software packages) to join production efforts.

Publications / Presentations

- Zehr, Doug. (2004, Aug). ***"Softcopy AT,"*** Geospatial Symposium, San Antonio, TX
- Zehr, Doug. (2002, May). ***"Ortho Production Techniques,"*** Alabama Association of Assessing Officials (AAAO), Muscle Shoals, AL

- **Aerial Triangulation Manager, Sanborn, Colorado Springs, CO, 2010—2012.** Mr. Zehr managed aerial triangulation operations, and worked with a team to support workflow for Sanborn's nine large-format digital cameras and facilitate data integration with LiDAR and photogrammetric sensors. As project designer/estimator, he worked closely with the business development team and project managers to ensure technical questions, concerns, and strategies were disclosed and discussed. Mr. Zehr consulted with project managers to ensure all projects' technical specifications were correct and complete. He also participated in proposal meetings to discuss project specifications and to present alternate strategies when appropriate.
- **Photogrammetric Department Manager and Photogrammetric Engineer, Sanborn, Colorado Springs, CO, 2006—2010.** Mr. Zehr led aerial triangulation and compilation operations. In addition, he worked with a team to support workflow for Sanborn's six large-format digital cameras and facilitate data integration with LiDAR and photogrammetric sensors. As project designer/estimator, he worked closely with the business development team and project managers to ensure technical questions, concerns, and strategies were disclosed and discussed. Mr. Zehr worked on the design of specifications for the standardization of select products, and consulted with project managers to ensure all projects' technical specifications were correct and complete. He participated in proposal meetings to discuss project specifications and to present alternate strategies when appropriate.
- **Chief Photogrammetrist/Photogrammetry Department Manager, Atlantic Technologies, Huntsville, AL, 1999—2006.** Mr. Zehr incorporated IMU technology with film cameras. He served as project manager of IMU bore sight. Tasks included project design and specifications, AT measurement and adjustment, and evaluation and analysis of resulting data. Responsible for establishing and supporting LiDAR integration within the photogrammetric workflow with input on accuracy standards, data collection routines, and automation. Assisted in establishing production procedures, quality assurance steps, and accuracy standards. Trained and supervised technicians. Provided AT adjustments of projects ranging from 5–3,000 images using Z/I and BINGO software.
- **Production/Project Manager, Atlantic Technologies, Indianapolis, IN, 1990—1999.** Mr. Zehr managed and supported photogrammetric and GIS mapping; maintained hardware and software proficiency, working with vendors and internal IT department to ensure PC and UNIX systems operated as designed; managed data archiving program, implementing digital tracking system for more effective retrieval; developed workflows to integrate film-based techniques with softcopy technology in AT and stereo compilation areas; managed production personnel (training and evaluations); consulted on marketing, estimating, project design, review, and evaluation of specifications and quality control; and managed 1"=50' engineering scale: 1-foot contour mapping, county-wide mapping with digital orthos, and GIS mapping projects. Mr. Zehr was also responsible for project design and execution.

Karol Szczubełek

AGPS and Operations Team Lead

Mr. Szczubełek has over 13 years of experience in geodetic surveying. As team lead, Mr. Szczubełek provides leadership and technical expertise in ortho photo production and directs and coordinates the daily work of the orthoimagery team in processing of aerial imagery. Mr. Szczubełek has been actively involved in the geodetic surveying, aerial photography, and LiDAR data collection. Office duties have involved GPS/IMU, digital, and analog camera and LiDAR data processing at Sanborn. He is responsible for implementing and establishing methods for maximizing accuracies of processing geodetic survey data with impressive results. He heads and supervises all surveying activities and survey applications development. Mr. Szczubełek is also responsible for documentation, training, and monitoring all QA/QC activities pertaining to geodetic surveying. He was in charge of coordination, execution, and reporting for a multi-year GPS survey project on several military bases throughout the country for the U.S. government.

Education

- **BS, Geomatics Engineering**—University of Calgary, Calgary, AB, 2001
- **Degree, Electrical Engineering**—Zespol Szkol Elektrycznych, Soltyka, Warsaw, Poland, 1990

Professional Education and Seminars

- Vexcel UltraCam, manufacturer's training
- DMC Camera, manufacturer's training
- Optech ALTM operations, manufacturer's training
- Leica Geosystems ALS50, manufacturer's training
- Yearly sensor operation and field procedures and processing

Project Experience

- **Gwinnett County Basemap Update, Gwinnett County, GA, 2010—Present.** Mr. Szczubelek was responsible for designing/planning the LiDAR acquisition throughout the County. His current responsibilities also include Airborne GPS processing and quality review of the ground control network.
- **Oblique Imagery Program, Customer Confidential, Multiple Cities, June 2013—Present.** Process and adjust Ground Control points for AT process. Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Bourbon and Crawford Counties, KS, May 2014.** Process and adjust ground control points for AT process. Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Tennessee Department of Transportation (TDOT) Portland Bypass, TN, April 2014.** Process and adjust ground control points for AT process. Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Pikes Peak Geospatial Alliance (PPGA), Colorado Springs Utilities, Colorado Springs, CO, May 2014--Present.** Process and adjust ground control points for AT process. Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Louisiana Statewide, LA, February 2010—June 2012.** Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Maricopa County, AZ, October 2009—Present.** Processing AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Virginia Base Mapping Program, VA, February 2007—July 2012.** Conducted the establishment of the Statewide GPS control network. Processing AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **Saskatchewan Province Orthoimagery Program, Saskatchewan, Canada, April 2012–Present.** Oversees and coordinates field operations, including flight planning, sensor operators, and network adjustments.

- **Qatar Petroleum Aerial Photogrammetry Based GIS Database Updating Program, Qatar, January 2013–Present.** Oversees and coordinates field operations, including flight planning, sensor operators, and network adjustments.
- **State of Kansas, March 2011–Present.** Oversees and coordinates field operations, including flight planning, sensor operators, and network adjustments.
- **National Agriculture Imagery Program, U.S. Department of Agriculture, VA, 2008.** Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **City of Rifle, CO, April 2009.** Performed Real Time Kinematic (RTK) observations of the following utilities: storm, sanitary, water and traffic signs.
- **US Department of Agriculture Forestry, US Department of Agriculture Farm Service Agency, CO, WY, July 2008–September 2008.** Processed AGPS-IMU airborne trajectory to establish aerial imagery photo centers.
- **EarthTech ACC, US Air Force Bases, February 2004–September 2005.** Established a first order control network for utility data collection for 14 Air Force bases throughout the United States. This included data collection of the following utilities: storm, sanitary, water, electrical, natural gas, and liquid fuels. Performed RTK survey involving Trimble 5,700 receivers.
- **Denver Water Utilities, CO, April 2002.** Established a first order control network for utility data collection and data collection of the water utilities. Performed RTK survey using Trimble 5,700 receivers.
- **Naperville, IL, May 2001.** Utility Project. Established a first order control network for utility data collection and data collection of the following utilities: storm, sanitary, and water. Performed RTK survey involving Trimble 4,000 SSI receivers.

Work History

- **AGPS and Operations Team Lead, Sanborn, Colorado Springs, CO–December 2013 - Present.** In addition to the below responsibilities, Mr. Szczubelek is responsible for the airborne GPS and ground survey operations.
- **Data Logistics Manager, Sanborn, Colorado Springs, CO, June 2012–December 2013.** In addition to the below responsibilities, Mr. Szczubelek is responsible for all aircraft sensors, related equipment, flight planning, and sensor operators.
- **Geodetic Engineer, Sanborn, Colorado Springs, CO, May 2001–June 2012.** Responsibilities include managing/planning, sensor operation, troubleshooting, photography and LiDAR data collection and processing, and quality control. Mr. Szczubelek is also responsible for survey and ground control for all mapping and GPS survey projects.

Bryan Blackburn, CP
Sr. Stereo Compiler

Education

- **Civil Engineering**–Nashville State Technical Institute, Nashville, TN, 1989

Certification

- **Certified Photogrammetrist (CP)**—ASPRS, No. 1246

Mr. Blackburn is a Certified Photogrammetrist with over 25 years of experience in photogrammetry and conventional land surveying, including 16 years' experience in management. In addition to his role as Sr. Stereo Compiler for Sanborn, Mr. Blackburn is currently the Tennessee Councilperson for the Mid South Region of ASPRS (American Society of Photogrammetry and Remote Sensing). Mr. Blackburn has extensive experience in photogrammetry and computer technology related to the field of digital mapping, digital terrain modeling (DTM), orthophotography, model preparation, triangulation, and GIS databasing. He has been responsible for project scheduling, triangulation, production and management, initializing new projects, and training new personnel. Mr. Blackburn is proficient with Intergraph ImageStation, ISAT and Microstation.

Project Experience

- **Bowling Green, KY, Airport, March 2009—April 2009.** This project consisted of collect planimetrics features at 1"=100' and 2-foot contours.
- **Monticello, KY, Airport, April 2009—May 2009.** This project consisted of collect planimetrics features at 1"=100' and 2-foot contours.
- **Columbus, GA, October 2007—December 2007.** This project consisted of collecting bridges, road centerlines, building footprints and updating the 2-foot contours for the county. The imagery was collected with the ADS40 camera.
- **Tennessee Statewide Base Mapping Program, 2000—2003.** This project consisted of mapping the entire state of Tennessee with 100 and 400 scale map sheets. Mr. Blackburn worked in all aspects of this project from sales, setup, production and Quality control.
- **Additional projects executed over the past 25 years include the following:**
  - **Department of Transportation Interstate 840 project, Nashville, Tennessee.** This project consisted of the production of 100-scale planimetric, 5-foot contour topographic maps for the proposed interstate highway, including three different corridors for consideration by the state in determining the most suitable.
  - **US Army Corps of Engineers Jacksonville District.** This project required the creation of digital orthophotos with planimetric and DTM data for use in environmental studies for an area along the Kissimmee River in Florida.
  - **Tennessee Titans NFL Football Team, Nashville, Tennessee.** Created a 40-scale, 1-foot contour map of the proposed site for the new stadium.
  - **Jefferson County, Alabama.** Participated in the production of digital orthophotos. For this project it was necessary to devise a procedure for collecting the information desired to be depicted on the maps to be used for tax mapping purposes.
  - **Koscuisko County, Indiana.** Participated in the creation of digital orthophotos and produced maps with roads, bridges, water features, and DTM data.
  - **Nashville Gas Company, Nashville, Tennessee.** Participated in the generation of a planimetric map depicting gas meters and addresses related to those buildings having gas service. This product was used to enhance emergency response to 911 calls and was updated annually.
  - **Federal Government.** Participated in the production of digital orthophotos and related mapping for a 19-mile section of the Grand Canyon beginning at the Hoover Dam for use in determining the plant life that

would be adversely impacted by flooding of the canyon. This study was endorsed by Vice President Albert Gore.

- **Tennessee Park and Recreation Agency.** Participated in the production of a 40-scale, 1-foot contour topographic map for use in designing a new golf course to be constructed at Tims Ford Lake near Tullahoma.
- **Federal Aviation Agency.** Participated in creating digital mapping containing elevations of the tops of all buildings, structures, utilities, and vegetation existing in the relative proximity of approximately 20 airports throughout the state of Tennessee. This project was related to determining minimum flight path elevations.
- **Municipality of Oklahoma City, Oklahoma.** Participated in the production of a city-wide 3-D GIS land base for multi-purpose uses including tax mapping, site planning and development, utility locations, 911 assistance, and general mapping.

Work History

- **Sr. Stereo Compiler, Sanborn, Colorado Springs, CO, 2013—Present.** Mr. Blackburn assists the Photogrammetric department in the collection of 3D features and in performing Quality Control review of collected data.
- **Owner/ Operator, Mid South Mapping, Shelbyville, TN, 2013—Present.** Mr. Blackburn's duties for Mid South Mapping are to perform Project Setup, Data Collection and Quality Control. He performs all project management for the company, as well as all sales and marketing.
- **Production Resource Manager, The Atlantic Group, Huntsville, AL, 2009 – 2013.**
- **Owner /Operator, Mid South Mapping, Shelbyville, TN, 2006 – 2009.**
- **Mapping Department Supervisor and Triangulation and Control Manager, G-Squared, LLC, Park City, TN, 2005 – 2006.**
- **Business Development Division and Photogrammetry Team Lead, EarthData International of Maryland, Frederick, MD, 2000 – 2005.**
- **Supervisor, Mapping Services Division, Wiser Company, LLC, Murfreesboro, TN, 1996-2000.**
- **Photogrammetrist, Caddum, Inc., Nashville, TN, 1995-1996.**
- **Photogrammetrist, Atlantic Technologies, Ltd., Huntsville, AL, 1989-1995.**
- **Rodman and Draftsman, Jesse Walker Surveying, Nashville, TN, 1987-1989.**
- **Rodman and Draftsman, Doyle M. Caffey Surveying, Shelbyville, TN, 1985-1987.**

Shaukat Hussain, CP
Senior AT Analyst

With over 29 years' experience, Mr. Hussain's career background includes working as a Photogrammetrist for Survey of Pakistan, Saudi Aramco, Geonex International, MAPS UAE, Bahrain Center for Studies and Research, Stewart Geo Technologies, and United Geo Technologies, and is currently with The Sanborn Map Company, Inc. His experience includes shift and production management of photogrammetric operations.

Mr. Hussain's technical background includes extensive project experience performing conventional and softcopy analytical aerotriangulation using seven different programs, and integration of airborne GPS data. He has performed extraction of terrain and planimetric data on analog, analytical and softcopy stereoplotters, including state-of-the-art LH Systems, Intergraph and Leica LPS digital photogrammetric workstations. He has also performed extensive image scanning, digital orthophotography, image processing production, flight mission planning, control layout for photogrammetric blocks, project planning, assistance in proposal preparation, and time and cost estimation management. His skills include programming, the ability to operate virtually any mainstream CADD and photogrammetric mapping software, and experience with the Esri GIS software suite.

Education

- **BS, Mathematics**—Punjab University, Pakistan, 1982
- **MA, Economics**—Punjab University, Pakistan, 1985
- **Post Graduate Diploma, Photogrammetry**—International Institute for Aerospace Survey and Earth Sciences, The Netherlands, 1990
- **Advanced Windows Application Programming Using Visual Basic 6**—University of California, Irvine, CA, 2002
- **Introduction to Python Programming**—NISD San Antonio, TX, 2012

Affiliations and Certifications

- **Certified Photogrammetrist (CP)**—ASPRS, No. 1256, 2005

Project Experience

- As the Senior AT Analyst for Sanborn, Mr. Hussain provides aerotriangulation management and serves as Certified Photogrammetrist for many projects. The following is a list of selected projects:
  - **Oblique Imagery Program, Customer Confidential, Multiple Cities, July 2013—Present.**
  - **Maricopa County, AZ, August 2013—Present.** Maricopa County is a 3-inch Orthoimagery program.
  - **State of Michigan, MI, July 2013**
  - **Metro-2-Metro Aerial Photography Update, MS, June 2013—July2013.**
  - **Virginia Base Mapping Program (VBMP), VA, June 2013—July 2013.**
  - **Manistee County, MI, May 2013—June 2013.**
  - **US Cities, Customer Confidential, Multiple Cities, August 2013—Present.**
  - **Greater Bridgeport Regional Council, CT, May 2013.**
  - **Iredell County, NC, April 2013–Present.** Oblique imagery program. Role: AT manager and certified photogrammetrist.
  - **Southern Nevada Water Authority, NV, April 2013–May 2013.** SNWA is a multiyear orthophotography contract that requires the acquisition of natural color and color infrared digital imagery and the production of 6-inch digital photography. Role: AT manager and certified photogrammetrist.
- **City of Ardmore, OK, United Geo Technologies, March 2012–August 2012.** GIS/Topography update project. The scope of the project was to update topographic and raster layers, and related attributes in existing geo database created in 2007. Roles included flight and control planning, production and outsource management, and quality assurance.

- **Webb County, TX, Stewart Global Solutions, 2009–2011.** GIS Parcels update project. This was an ongoing yearly update of parcels database for Webb County. Roles included outsource management and quality assurance.
- **Floodplain Study GIS Projects, Flood Control District of Maricopa County, AZ, 2003–2011.** Several projects from 2003 through 2011. Scope included preparation of feature classes for client-designed geo database with very strict rules and specifications. Roles included flight and control layout, aerial triangulation, production and outsource management, CAD to GIS translation, and quality assurance. Saved considerable man hours by utilizing scripting and programming.
- **Maricopa County DTM and Ortho Photography, AZ, 2001–2005.** In 2001, collected terrain data and produced/updated orthos yearly for five years. Roles included aerial triangulation, terrain collection supervision, orthophoto production, quality assurance, and mentoring. Saved significant amount of man hours through automation, scripting and programming.
- **Bahrain Island and Territorial Waters GIS Master Plan, Bahrain Center for Studies and Research, Manama, Bahrain, 1998–2000.** GIS master plan for entire country of Bahrain and territorial waters. Color, BW and infrared raster layers, topographic layers including structures, utilities, drainage, pipelines, vegetation, etc. Roles included aerial triangulation, topographic and terrain data collection, orthophoto production, image tone matching, quality assurance and mentoring.
- **Medinah City GIS, Geonex International, Riyadh, Saudi Arabia, 1995–1996.** Project scope was to produce 1:10000 and 1:1000 maps with feature attributes for GIS. Roles included shift and production supervision, aerial triangulation, stereo compilation, quality assurance, and mentoring. The big achievement in this project was to form and train a team of raw graduates who became professional technicians in a very short period of time.

Work History

- **Senior AT Analyst, Sanborn, Colorado Springs, CO, April 2013–Present.** Leadership role in aerial triangulation, control layout and flight planning, workflow streamlining and automation, and other tasks as needed.
- **Production Manager, United Geo Technologies, San Antonio, TX, January 2012–April 2013.** Supervise digital Mapping & Ortho projects to meet specifications, timely completion, quality assurance and quality control. Secondary tasks include computer programming, flight planning, time and cost estimation for business development.
- **Production Manager, Stewart Global Solutions, San Antonio, TX, April 2000–December 2011.** Supervise digital Mapping & Ortho projects to meet specifications, timely completion, quality assurance and quality control. Secondary tasks include computer programming, flight planning, time and cost estimation for business development.
- **Photogrammetrist, Bahrain Center for Studies and Research, Manama, Bahrain, June 1998–March 2000.** Perform aerial triangulation, manual DTM compilation, Ortho rectifications and Mosaicking, image tone matching and image balancing for entire island of Bahrain at three different scales on color, black & white and infrared photography.
- **Photogrammetrist, MAPS Geosystems, Sharjah, United Arab Emirates, August 1996–December 1997.** Aerial Triangulation, Measurements, Analysis and Adjustment. Ortho rectifications and Mosaicking, Image tone matching and image balancing, CAD editing, R & D
- **Photogrammetrist, Geonex International, Lahore, Pakistan, and Riyadh, Saudi Arabia, January 1994–July 1996.** Aerial Triangulation, DTM Auto correlation and editing, Ortho rectifications, High resolution image printing of raster with overlaying vector graphics. Photogrammetric scanning, CAD editing, Archiving, Supervision, Training to fellows, Project & shift management, QA/QC
- **Aerial Triangulation Analyst, Saudi Aramco, Dhahran, Saudi Arabia, August 1992–December 1993.** Aerial Triangulation Analysis and Adjustment, CAD editing, Shift Scheduling, R&D, Project Planning

Nicholas Orban
Ortho Operations Team Lead

Education

- **MGIS, emphasis in Remote Sensing & Image Analysis**—University of Central Arkansas, Conway, AR, Pending (2015)
- **Graduate GIS Certificate** —University of Central Arkansas, AR, 2010
- **BA, Geography & Environmental Studies**—University of Colorado, Colorado Springs, CO, 2009

Mr. Orban has more than 4 years of experience in the GIS industry with experience ranging from basic mapping techniques to advanced orthoimagery production and image processing. Over the last 4 years, Mr. Orban has expanded his skills into the realm of orthoimagery, image processing, and vector-based GIS. Using advanced analysis and project-based coordination, he and his team have successfully honed and streamlined the ortho process. He has also worked as a Senior Imaging Technician and Image Processing Technician for multiple projects and programs. As an Operations Team Lead, he is not only responsible for the execution, processing, and final deliverable generation for assigned ortho programs, he is involved in process development and troubleshooting. Mr. Orban's thorough understanding of each step in ortho and image processing production ensures programs are run effectively and efficiently.

Project Experience

- **McLean County Regional GIS Consortium, IL, April 2014—October 2014.** Mr. Orban served as the project lead in the McLean County imagery project held by Sanborn. He worked with the project managers to take the imagery from a raw product to process, color balance, QA/QC, edit, and arrange the specific deliverables on the project. This project has been delivered, meeting or exceeding the client's expectations in regards to early delivery and higher accuracy.
- **Appomattox River Water Authority, Lake Chesdin, VA, April 2014—August 2014.** Responsible for organizing, executing, and delivering this project. It has been delivered, meeting or exceeding the client's expectations in regards to early delivery and higher accuracy.
- **Province of Saskatchewan, Canada, December 2012—Present.** Performs project setup and design, reviews all images prior to delivering the products to the quality control department, ensures images are compliant with project specifications and quality standards, and develops project documentation and checklists.
- **Qatar Petroleum, Qatar, February 2013—Present.** Responsible for providing an ortho data set. Processing, QA/QC, and editing of the image data sets.
- **New York State Digital Orthoimagery Program, NY, 2010—2013.** Responsible for providing a highly detailed true-ortho data set. Mr. Orban worked on processing, QA/QC, and editing of the image data sets.

Work History

- **Operations Team Lead, Sanborn, Colorado Springs, CO, December 2012—Present.** Mr. Orban is responsible for the productions activities within Sanborn's Mapping Division. He is responsible for the oversight and end-to-end success of multiple projects in the ortho department, in addition to the input and processing of raw data on Sanborn's image processing side. Mr. Orban's other responsibilities include advanced problem solving, software testing, and testing new ortho methods.
- **Government Remote Sensing Analyst, Jeppesen, Englewood, CO, October 2011—December 2011** As a Government Remote Sensing Analyst with Jeppesen, Mr. Orban was responsible for several GIS-oriented tasks surrounding a National Geospatial-Intelligence Agency (NGA) contract with Boeing Defense through Jeppesen. The contract's essential role was using primarily geospatial analysis using ESRI software to extract power/utility infrastructure of various countries from updated satellite imagery.
- **Imaging Technician I, Sanborn, Colorado Springs, CO, April 2010—October 2011.** Processed digital orthophotography and performed quality control, project organization, and scheduling. Responsible for successful job completion.

Steven A. Wood, LS, CP

Registered Land Surveyor

Mr. Wood combines an extensive land surveying and civil engineering background with more than 42 years of project management experience in engineering, land development, surveying and photogrammetry. He has developed several customized solutions for industry-leading photogrammetric projects. His surveying experience is comprehensive and includes many years of practical field assignments and office management of more than a dozen survey field crews. Projects include almost every type of surveying including land boundary, construction staking, flood insurance cross section surveys, ALTA minimum standard surveys, power plant layout, right of way takings, GPS control surveys for control densification and photo control projects, precise second order control surveys, differential and on the fly GPS field inventory of utilities, and Department of Defense GIS mapping and field inventory. Mr. Wood has also served as the Surveyor in Responsible Charge overseeing multi-participant municipal mapping and surveying projects for many countywide landbase mapping projects throughout the US and overseas. Mr. Wood has helped implement innovative surveying uses of current technology to accomplish timely and economical survey solutions throughout his career.

Education

- **BS, Land Surveying**—Purdue University, West Lafayette, IN, 1974
- **AAS, Civil Engineering Technology**—Purdue University, West Lafayette, IN, 1972

Affiliations and Certifications

- **Certified Photogrammetrist (CP)**—ASPRS, No. R899, 1993
- **Registered Land Surveyor**—Licensed in the following 17 states. Arkansas, California, Colorado, Florida, Illinois, Indiana, Kansas, Louisiana, Maryland, Montana, New Mexico, North Carolina, Ohio, Oklahoma, Wyoming, North Dakota, South Dakota

Project Experience and Work History

- **Land Surveyor, Sanborn, Colorado Springs, CO, 2005—Present.** Mr. Wood has performed land survey services for Sanborn for many projects, including Manistee County, Michigan: Lewis and Clark County, Montana; Ellsworth AFB, South Dakota; Clay County, Kansas; and Haskell County, Kansas.
- **Principal in Responsible Charge, privately operated small business, March 2000—Present.** Mr. Wood is responsible for all aspects of geodetic survey control for photogrammetric mapping control of several large projects and county-wide mapping programs, including several public agencies.
  - Several surveying and mapping control projects throughout Oklahoma including work on Oklahoma City and surrounding area mapping control, several lakes throughout Oklahoma for the Corps of Engineering (COE), Fort Sill, McAlester, and various air force bases.
  - Several control projects in Kansas including work in Hays County, Ellis County, Anderson County, Haskel County, Garden City, Finney County and Fort Riley. Mr. Wood also ran several COE lake mapping projects throughout Kansas.
  - Perform surveying and GIS consulting reviews of project deliverables including final aerotriagulation solution for Dekalb County, Indiana work performed by large mapping industry firm.
  - Gps photo control projects for following counties/projects including Wayne County, Indiana; Brown County, Indiana; Brazil, Indiana; Bradford Woods, Indiana; Champaign County, Illinois; Lee County, Illinois; Whiteside County, Illinois; Branson, Missouri; Nauvoo, Illinois; South Lyon, Michigan; Eastern Illinois University, Illinois; Greencastle, Indiana; Alcoa Lafayette, Indiana; Peoria County, Illinois and numerous smaller local sites. Scope includes contracting NGS control recovery and densification, and producing field work and office reports.
  - Gps geodetic survey photo control for DOD Air Force Military Installations in Kansas, Texas, Tennessee, Mississippi, Alabama, Florida, Oklahoma, Ohio, Arkansas, California, Maryland, New York, Pennsylvania, New Hampshire, and Colorado.

- Gps photo control projects in Kansas, Illinois, Maryland, New Jersey, Kentucky, Iowa, California and Missouri.
- Gps route survey control for MODOT highway project in Missouri.
- McAlester Army Depot, Oklahoma gps surveys.
- Dam reclamation rehabilitation surveys in Oklahoma for USDA.
- Gps surveys in Maryland; New Jersey; Missouri; Naperville, Illinois; Canton, Illinois; Butler County, Ohio; and Lucas County, Ohio.
- Gps photo control surveys for Lamar County, Mississippi; Pike County, Mississippi; Jackson Energy, Jackson, Tennessee; City of Cleburne, Texas; Euless, Texas; Norman, Oklahoma; Lubbock, Texas; COE surveys in Bowie County, Texas and Fort Sill, Oklahoma; Gps surveys for Stark County, Illinois; McHenry County, Illinois; Jasper County, Indiana; Wayne Co, Indiana; Dekalb Co, Indiana; and Mesa County, Colorado.
- Extensive LIDAR quality control field checking for imagery along Mississippi River from Cairo to Minneapolis also Illinois River from St Louis to Dekalb.
- Gps control for high speed rail route from St. Louis to Chicago.
- Gps control for MD DOT mass transit lines.
- Gps control for 13 county multi-participant mapping project around Houston.
- Gps control for 4 county multi-participant mapping project east of Dallas.
- Gps control for two county mapping project in southwest Kansas.
- Gps control for mapping projects for dozens of military sites all across the US.
- Extensive LIDAR ground truthing QC surveys in Illinois, Arkansas, California, and Missouri.
- USDA NRCS WRP easement surveys in Indiana, Ohio, and Pennsylvania.

- **Vice President Photogrammetry, MSE Corporation/ASI, Indianapolis, IN, February 1993—March 2000.** Managed production operations of state of the art photogrammetry mapping division, includes survey ground control, ABGPS, aerotriangulation, mapping, softcopy and digital orthophoto production operations. MSE was acquired by ASI in July 1997. Role expanded in 1998 to include management of corporate mapping subcontractors, coordinating work across all ASI mapping locations and reviewing and facilitating implementation of new mapping technology. Travel to New Zealand and Portugal to review mapping vendor capabilities and assist in Sales efforts.
- **Vice President Operations, MSE Corporation, Indianapolis, IN, May 1983—February 1993.** Supervised, managed and administered production operations of over 150 employees involved in civil engineering, transportation, aviation, surveying, photogrammetry and digital computer graphics (GIS) branches of company.
- **Director, Surveying and Mapping Operations, MSE Corporation, Indianapolis, IN, May 1981—May 1983.** Combined management responsibility for all surveying and photogrammetric mapping performed by company.
- **Director, Survey Operations, MSE Corporation, Indianapolis, IN, May 1979—May 1981.** Direct responsible charge all survey operations for 12 crews all types surveying and civil engineering projects.
- **Survey Project Manager, MSE Corporation, Indianapolis, IN, March 1975—May 1979.** Supervised special survey projects, managed field office and supervised field crews.

Craig Laben
Geospatial Data Manager

Mr. Laben has a strong background, with over 20 years of experience in remote sensing, GIS, image processing, geospatial analysis and geospatial product quality assurance. He has extensive knowledge of commercial and government satellite and aerial EO, MS, IR and radar imaging systems data and their applications. Mr. Laben has developed algorithms, techniques, processes and metrics to improve the image quality, accuracy and intelligence value of geospatial products. He also has experience in the processing and analysis of geospatial and natural hazards data for damage assessments, risk and vulnerability assessments and mitigation strategies. Mr. Laben has strong project management and technical leadership experience, and has excellent analytical and problem solving skills.

Education

- **MS, Imaging Science** — Rochester Institute of Technology, Rochester, NY, 1993
- **BS, Computer Science** — Rochester Institute of Technology, Rochester, NY, 1986
- **AAS, Computer Science** — Rochester Institute of Technology, Rochester, NY, 1986

Computer Skills

- **Programming** — MATLAB, Python scripting
- **Remote Sensing and GIS Tools** — ESRI ArcGIS, ERDAS Imagine, ENVI, SocetGXP, Socet Set, RemoteView, QTModeler, ERMapper, Photoshop

Publications

- C. Chiesa, P. Cower, C. Laben (2004, Jul). ***"Mapping Flood Risk and Vulnerability in the Lower Mekong Delta,"*** ESRI Map Book Gallery Vol 20
- C. Laben, (2004, Mar) ***"An Asia Pacific Natural Hazards and Vulnerabilities Atlas Supporting Disaster Management Applications."*** Pacific Disaster Center White Paper
- C. Chiesa, C. Laben, R. Cicone (2003, Nov). ***"An Asia Pacific Natural Hazards and Vulnerabilities Atlas."*** Proceedings, International Symposium for Remote Sensing of the Environment (ISRSE), Honolulu
- C. Laben (2002, Sept) ***"Integration of Remote Sensing Data and Geographic Information System Technology for Emergency Managers and their Applications."*** Optical Engineering, Journal for the International Society for Optical Engineering, Vol 41, No. 9

Patents

- C. Laben, B.Brower (2000, Jan). ***"A Process for Enhancing the Spatial Resolution of Multispectral Imagery using Pan-Sharpening."*** US Patent #6,011,875
- R. Fiete, C. Laben (1999, Mar). ***"An Adaptive Process for Removing Streaks in Digital Images."*** US Patent #5,881,182

Project Experience

- **US Cities Oblique Program, Multiple Cities Across the USA, October 2013–Present.** Mr. Laben currently manages the Quality Control (QC) and delivery of all acquired aerial AGPS-IMU and imagery data for Sanborn's US Cities Oblique Program. He is responsible for ensuring that staffing requirements are maintained and that all project deliveries are made on-time and within budget, while making sure that all customer quality standards are being met. He interacts daily with the Flight Acquisition Team and gives daily status updates and reports to upper management. He is also responsible for identifying areas in the AGPS-IMU and Image Quality (IQ) processing work-flows for improvement and making sure that process enhancements are developed, implemented and documented.
- **Lockheed Martin Corp., Goodyear, AZ, June 2010–August 2011.** Mr. Laben was the technical lead on a government contract and was responsible for developing image quality metrics that are currently being used to assess the quality and accuracy of national geospatial products. These image quality metrics include: visual ratings, local and global statistical analysis, geo-location and mensuration analysis, histogram analysis and metadata verification techniques.
- **Pacific Disaster Center, Maui, HI, October 2002–October 2004.** Mr. Laben was the project lead for the design, implementation and deployment of the Pacific Disaster Center's (PDC) Global Hazards Atlas. The Global Hazards Atlas is an internet mapping application which can be used to display near real-time and historical natural hazards data around the globe. The Global Hazards Atlas may be accessed at: www.pdc.org/atlas.
- **Eastman Kodak Company, Rochester, NY, May 1998–January 2000.** Under a government contract, Mr. Laben developed a Gram-Schmidt transform pan-sharpening technique that improved the spatial resolution of multispectral (MS) imagery using a higher resolution panchromatic image, but maintained the spectral characteristics of the MS imagery. Existing pan-sharpening techniques improved the spatial resolution of the MS imagery, but changed the spectral content of the MS data, thus degrading the quality of the imagery. Mr.

Laben documented, submitted for, and received a patent for this Gram-Schmidt pan-sharpening technique. This algorithm is currently offered in both ESRI's ArcGIS and EXELIS' ENVI remote sensing software packages.

Work History

- **Geospatial Data Manager, Sanborn, Colorado Springs, CO, October 2013–Present.** Mr. Laben currently oversees the day-to-day activities of the Data Ingest and Geo-positioning departments for all aerial projects within Sanborn's mapping operations. Mr. Laben is responsible for coordinating activities between the flight acquisition team and the production team and ensuring that image quality and accuracy standards are being met. Mr. Laben works with the GPS-IMU and Image Quality Control (QC) teams to optimize workflow and to develop more efficient processes and improve data ingest and QC turn-around times and lower associated costs.

- **Signal/Image Processing Engineer, Sr. Staff., Lockheed Martin Corp., Goodyear, AZ, February 2005–August 2012.** Mr. Laben was a member of the Geospatial Product Quality (PQ) group which performed geospatial product quality assurance and accuracy assessments on national remote sensing products/tools for various government and defense agencies. Mr. Laben was technical lead on multiple programs and was responsible for all PQ activities related to these programs to include: developing detailed test plans, assigning tasks, performing manual and automated regression testing, performing geo-location and mensuration accuracy assessments, identifying/logging/tracking issues, performing issue resolution and verification, and performing requirement verification. As a technical lead, Mr. Laben was responsible for ensuring that all projects were staffed appropriately and were completed on time and within budget. In addition, Mr. Laben developed Standard Operating Procedures (SOPs), regression testing checklists and image quality metrics for the testing of baseline and Advanced Geospatial Intelligence (AGI) products.

- **Sr. Imagery Analyst, Lockheed Martin Corp, Kihei, Maui, HI, January 2001–February 2005.** As a subcontractor, Mr. Laben was a member of the Data and Information Resources Division at the Pacific Disaster Center located in Maui, Hawaii. The PDC utilizes remote sensing and GIS data, impact modeling, risk assessment tools, and visualizations to provide emergency managers, decision makers and disaster management professionals with historical and real-time hazards information products. Mr. Laben coordinated with and conducted various remote sensing and GIS projects for local, state and federal emergency response agencies. Mr. Laben processed and analyzed natural hazards and geospatial data for risk and vulnerability assessments and mitigation strategies. He also was responsible for integrating real-time hazards data into PDC geospatial applications. Additionally, Mr. Laben tasked and trained PDC Imagery Analysts and GIS interns.

- **Imagery Analyst, Eastman Kodak Co., Kihei, Maui, HI, February 1999–January 2001.** Mr. Laben joined the PDC in its early years as an Imagery Analyst, where he produced geospatial products for the disaster management community. As an Imagery Analyst, his duties included: base map imagery and GIS data collection, data processing and mosaic generation, metadata documentation and verification, database population, development of change detection techniques and products, damage assessments during and after a hazard/disaster event, geospatial product development, and post-event product generation.

- **Project Engineer, Eastman Kodak Co., Rochester, NY, December 1988–February 1999.** Mr. Laben was a member of the Commercial and Government Systems Division's, Image Chain Analysis (ICA) group. Mr. Laben was an algorithm developer and conducted studies to improve the image quality of government EO, MS, IR and radar satellite data and products for both hardcopy and softcopy display. He developed numerous techniques and algorithms to enhance image quality and improve the intelligence value of imagery products to include: baseline image processing chain improvements, adaptive sharpening and dynamic range adjustment algorithms, data fusion and pan-sharpening algorithms, low light level imagery optimization, atmospheric normalization, and change detection algorithms. Mr. Laben obtained two patents on image processing algorithms that he developed while working in the ICA.

- **Graduate Research Assistant, Rochester Institute of Technology, Rochester, NY, September 1986–December 1988.** While obtaining his Master of Science degree in Imaging Science, Mr. Laben conducted research within the Digital Imaging and Remote Sensing (DIRS) Lab on various remote sensing and image processing projects.

Deborah Barnes

Team Lead, GIS

Ms. Barnes has more than 15 years of experience in mapping and data development, and has served as the Team Lead in the GIS and Photogrammetry departments. As the GIS Team Lead, she is responsible for training and implementing tools to increase Sanborn's efficiency in meeting the USGS version 13 specifications for hydro production. Ms. Barnes has extensive experience in database management systems and spatial technologies on multiple hardware and software environments and the implementation of new technologies to improve end user productivity.

Education

- **Certificate, Noncommissioned Officer—** United States Air Force Noncommissioned Officer Academy, 1994

Affiliations and Certifications

- **American Council of Engineering Companies—**Supervisor Skills I, Certificate, 2003

Project Experience

- **Gwinnett County, GA, June 2013—Present.** Responsible for GIS QC and delivery of updated Planimetric and Topographic data for 1:100' scale mapping for Gwinnett County. Our performance has led to award of additional years of updating projects.
- **Greater Bridgeport Regional Council, Bridgeport, CT, June 2013—Present.** Responsible for GIS QC and delivery of Planimetric data for 1:50 scale mapping, including annotation contours. Also, responsible for creating, editing and QC'ing Topographic data.
- **City of Stamford, CT, May 2012—Feb 2013.** Responsible for GIS QC and delivery of updated Planimetric and Topographic data for 1:50' scale mapping, including annotation for contours.
- **Township of Livingston, NJ, May 2012—January 2013.** Responsible for GIS QC and delivery of updated Planimetric and Topographic data for 1:100' scale mapping.
- **State of Kansas LiDAR, KS, March 2012—Present.** Responsible for delivery of hydro-flattened rivers and waterbodies, and tiled hydro-flattened DEM for three counties. Project accepted with few issues. Our performance led to selection for an additional 6 Kansas Counties for 2013.
- **Louisville and Jefferson County Metropolitan Sewer District, KY, January 2013—Present.** Responsible for delivery of 922 square miles of hydro flattened rivers and waterbodies, and hydro flattened DEM sufficient for 2-foot contours. This project was completed on time under a compressed schedule.
- **Lewis and Clark County, MT, June 2012—September 2012.** Responsible for collection of hydro breaklines, hydro flattening of rivers and waterbodies and creating a hydro flattened DEM and contours. First time acceptance of data.
- **South Carolina Department of Natural Resources 2010, SC, April 2011—February 2012.** Responsible for delivery of GIS products including hydro flattened DEM for seven SC counties. Increased production efficiency by 80%. Used python scripting to decrease the manual labor in pre-production of data. Trained other employees on hydro flattening tasks by implementing the use of tools developed internally.
- **American Samoa Villages, National Oceanic and Atmospheric Administration (NOAA), American Samoa, October 2011—November 2011.** Responsible for creation of all GIS products from a combination of mobile LiDAR and other surveyed points to accurately map the ground up to 30 feet for tidal wave evacuation planning in seven villages hard hit by the 2009 tidal wave.

Work History

- **GIS Team Lead, Sanborn, Colorado Springs, CO, February 2011—Present.** Leads the creation of all products, training and tool implementation for the GIS department. Supervises, monitored, and trained processing technicians; scheduled and coordinated projects; oversaw production standards; coordinated project startups; provided technical support; assisted GIS users; and, performed quality audits.

- **Senior GIS Analyst, Merrick & Company, Aurora, CO, May 1995—August 2009.** Executed multiple projects as Team Project Lead, accomplished 95% accuracy and client satisfaction from data collected, coordinated and facilitated projects while learning new software and training others at the same time, managed quality control efforts, developed and documented procedures. Directed Team performance on data compilation tasks, compiled data from ortho-photos and satellite imagery, edited LiDAR, edited planimetric data and parcel mapping. Instrumental part of two teams that won annual quality awards.
- **Imagery Intelligence Analyst, United States Air Force and Reserves, June 1986—April 1994.** Analyzed information and wrote reports on sensitive intelligence data from Imagery using both 2D and 3D compilation methods. Awarded Airman of the Quarter for outstanding dedication, initiative and professionalism; and, earned an Eagle Eye Award for superlative intelligence analysis.

Brandon Tilley, CMS

LiDAR Analyst

Mr. Tilley has 7 years of experience in the GIS division with expertise in LiDAR production workflows, data processing, and a wide range of LiDAR products. He has worked as a LiDAR Analyst for numerous customers providing small and large scale products while meeting or surpassing clients' expectations. Mr. Tilley is responsible for implementing new and faster processes, as well as processing, product generation, problem solving, and quality assurance. Mr. Tilley's knowledge and experience creates a constructive environment and enables projects to be completed with the utmost quality and accuracy.

Education

- **AAS, Geographic Information Science—** Pikes Peak Community College, Colorado Springs, CO, 2010

Affiliations and Certifications

- **Certified Mapping Scientist GIS/LIS (CMS)**—ASPRS, No. GS267, 2014
- Annual Technical Exchange, GeoCue, 2007, 2011
- Presenter. LiDAR Calibration, GIS in the Rockies, 2009

Project Experience

- **State of Kansas LiDAR, March 2012 to Present.** Responsible for processing and classifying terrain in both bare earth surfaces and water areas, and for adherence to project schedule and specifications.
- **Gwinnett County, GA, February 2008–Present.** Responsible for organizing, executing, and delivering this LiDAR project annually for this returning customer. This project has been delivered meeting or exceeding the client's expectations in regards to early delivery and higher accuracy.
- **Louisville and Jefferson County Metropolitan Sewer District, KY, January 2013–February 2013.** Responsible for providing a dense LiDAR data set. Processed, extracted and classified bare earth surfaces and buildings.
- **Douglas County, GA, February 2013–Present.** Coordinates the LiDAR processes and classification; and, ensures the schedule is met and monitors the quality of the LiDAR products.
- **American Falls, ID, October 2011.** Provided classified LiDAR for a portion of southeastern Idaho. Special techniques in bare earth extraction were used for this high accuracy program.
- **NYC LiDAR, CUNY Solar Project, NY, April 2011–September 2011.** Responsible for providing a dense LiDAR data set for a New York City solar project. Techniques for extracting bare earth surfaces and buildings were used to determine the amount of space available for solar panels within city limits.
- **Pima Association of Governments, AZ, March–August 2011.** Provided an extremely dense set of classified LiDAR and DEM data for Pima County in Arizona. Delivered all products exceeding the planned horizontal and vertical accuracies on-time.
- **Chatham County, GA, February–May 2009.** Responsible for processing and classifying terrain in both bare earth surfaces and water areas while delivering before the client defined project due date.

Work History

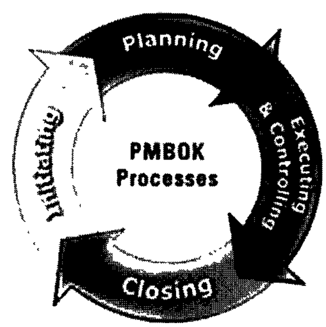
- **LiDAR Analyst, Sanborn, Colorado Springs, CO, June 2011–Present.** Accountable for all tasks as the LiDAR Technician. Other responsibilities include project tracking, budget and metric tracking, and project allocation. Helps manage and troubleshoot with all employees to ensure maximum efficiency is achieved.
- **LiDAR Technician I and II, Sanborn, Colorado Springs, CO, August 2007–June 2011.** Responsible for processing GPS/IMU data, calibration, filtering, and product generation with quality implemented through the entire workflow.
- **LiDAR/Geodetic Technician, Sanborn, Colorado Springs, CO, March 2006–August 2007.** Accountable for the QC of both aerial imagery and LiDAR data. Bare earth editing was used to deliver clean and accurate data to each client.

Section 4 – Project Management Plan

Project Management

Sanborn's project management approach rigorously applies the Project Management Institute (PMI) model, which exceeds the requirements of ISO 9001:2008. Sanborn understands that an upfront investment in planning results in the best outcome for the entire project lifecycle. The PMI model encompasses the following knowledge areas and process phases:

- Integration
- Scope
- Time
- Cost
- Quality
- Human Resources
- Communications
- Risk
- Procurement



Project Manager

Sanborn's Project Manager, Shawn Benham, will be the MPO's single point of contact and will serve as your primary liaison with Sanborn operations staff and management. Mr. Benham has over 15 years of experience in the geospatial field, including project management and consulting services, quality assurance/quality control management, and data processing. His experience includes managing and implementing large, complex orthoimagery and photogrammetric mapping projects, including multi-year statewide programs for the States of New York and North Carolina, and the Commonwealth of Virginia, as well as many regional and county projects throughout the United States. As project manager, he is directly accountable for project design, program financial design and management, program execution, risk management, and schedule management. Mr. Benham will be responsible for project definition, production oversight, scheduling, quality management, and financial and contractual management.

Project Definition

Project definition at Sanborn begins with the preparation of a project charter that encompasses all elements of the program. The project charter establishes the overall goals, vision, organizational structure, project structure, deliverables, management plans and approach, technical baseline, schedule, cost, subcontract management, quality, and other key elements of the program. All the methods used to plan, monitor, and control the project are also identified in the project charter.

A key element of the project definition is the development of the project schedule in our Primavera Enterprise® software (Primavera), in addition to multiple supplementary tracking systems. This project management and production tool is used to develop and track all project resources and the schedule throughout the life of the project. The Primavera schedule is the single source for all project status and tracking throughout the life of the project. A baseline contractual schedule is maintained in addition to multiple scenario schedules.

Project Initiation

Sanborn believes that the key to any successful project is continuous customer communication. Soon after contract award, Sanborn will request a preliminary planning meeting to identify any specific items that may have arisen after reviewing numerous proposals that may not have been in the original RFP. Once this information is gathered and the project charter is complete, Sanborn will request a "kickoff" meeting where Sanborn's management team and appropriate Sanborn production staff will meet with appropriate MPO staff to:

- Review the technical requirements of the project against the proposed technical plan contained in Sanborn's proposal.
- Review the sources that are to be supplied by the MPO against the requirements and expectations of Sanborn's proposed work plan.
- Review the acquisition plan requirements and flight plans.
- Review the preliminary work plan (and the quality control processes and procedures) as presented in Sanborn's proposal against defined delivery areas or work packages.
- Review the estimated resource plan.
- Review the project-specific Quality Plan presented at the meeting by Sanborn. Included will be a review the product acceptance procedures, methods and criteria that will be used by the MPO to determine product conformance with product specifications.
- Review the proposed project schedule and finalize interim and final delivery dates.
- Review the schedule requirements by specific work tasks and the interdependencies of the sources of information to be supplied by the MPO.
- Define the parameters of a pilot or prototype project where the proposed procedures will be tested for their ability to meet product specifications and/or the ability of the product specifications to meet the needs of the MPO.
- Define a formal change management process designed to effectively and efficiently track proposed modifications to contracts. This process will allow the MPO to make cost and benefit tradeoffs based on an analysis of the requested changes. It allows for the design, development, and implementation of modifications to production processes and procedures to be made in a controlled manner.
- Define all communication protocols and procedures that are necessary for effectively ensuring that both parties to the contract are informed about the production departments' progress on each project task, that the sources are effective for the purpose intended, and the status of deliverable product reviews by the MPO.

We anticipate that the kickoff meeting will be held via teleconference, but we welcome a site visit to our production facilities at any time throughout the course of the project. In-person meetings at the MPO offices can also be scheduled as necessary.

Production Schedule

Mr. Benham will review the production schedule contained in Sanborn's proposal during the project initiation meeting. This draft schedule, based upon our review of the RFP, may be re-evaluated after the completion of the pilot or prototype project and before the balance of the project is started, depending upon comments received by the MPO, if they impact the scope of work. It is anticipated that the MPO will review the pilot deliverables and provide comments to Sanborn within two weeks of receipt. If necessary, the resource requirements will be input/revised in the Primavera system at both of these milestones before production of the balance of the project commences.

Proposed Schedule

Sanborn is one of the few firms in the mapping business that has the ability to manipulate large volumes of digital data, which results in quicker turnaround times from acquisition to finished product. Investment in IT infrastructure, qualified staff and a dedication to customer satisfaction is a priority across our corporation. Sanborn has developed a proposed schedule below for the MPO's program:

Proposed Project Schedule	
Activity	**Timeframe**
Paneling and survey of ground control	Complete 1 week prior to acquisition start
Acquisition of aerial photography	April 2015 (exact dates depend on weather and ground conditions)
Acquisition of LiDAR	April 2015 (exact dates depend on weather and ground conditions)
Image processing	Complete 7 days from final flight
LiDAR processing	Complete 7 days from final flight
Aerial triangulation	Complete 30 days from acceptance of imagery
Pilot Study Delivery	Complete 45 days from acceptance of imagery and LiDAR
DEM/DTM production	Complete 3 days from acceptance of LIDAR
Orthoimagery Deliveries	Complete 4 months from acceptance of imagery
Planimetric and Topographic Deliveries	Complete 6 months from acceptance of imagery

Prior to full-scale data production, Sanborn will produce two pilot projects for the orthoimagery, LiDAR, planimetric, and topographic data deliverables. Sanborn will coordinate with the MPO to define the location of the pilot areas. Sanborn will meet with the MPO to formally review the pilot data and complete modifications as necessary, and will receive approval from the MPO prior to full-scale production. It is important to note that certain production activities will overlap throughout the schedule. Sanborn's overall delivery timeframe for the orthoimagery, planimetric, and topographic deliverables is expected to be approximately 6 months from successful completion of acquisition of the aerial and LiDAR imagery. Incremental deliveries will be made based on delivery areas/blocks, which will be agreed upon during the project initiation phase. Sanborn is open to discussing changes to the schedule if required.

Financial Schedule

Mr. Benham will develop an internal set of financial budgets based upon the input into the Primavera system and an invoice and payment schedule that is tied to production and/or terms and conditions in the contract. Mr. Benham is responsible for the timely and accurate submission of invoices to the MPO. The MPO is obligated to remit timely and accurate payments in accordance with the terms and conditions of the contract.

Preferred Payment Schedule

Sanborn proposes a milestone invoice schedule in coordination with the delivery schedule:

- 10% upon survey and flight plan approval
- 30% upon acquisition completion
- 10% upon survey report and AT report delivery
- 40% upon initial orthophoto/Planimetric/Topographic delivery
- 10% upon final acceptance

Sanborn is willing to negotiate other terms for invoicing if desired.

Quality Management System

Sanborn has earned ISO 9001:2008 certification and is registered with Platinum Registration, Inc. ISO 9001, a Quality System Standard, is a series of five international standards that provide guidance in the development and implementation of a specific Quality Management System. With Sanborn's ISO 9001:2008 certification, the MPO is assured that:

- The requirements and specifications of the project have been thoroughly and rigorously evaluated and documented
- The production processes and procedures employed for the project are appropriate and adequate to produce the results intended
- The production processes and procedures are controlled and results will be consistent and repeatable
- Documentation will be maintained that allows for evaluation of the processes and procedures to eliminate the source of nonconformities and to facilitate continual improvement of the processes and procedures
- Adequate facilities are available to meet the needs of the project
- Sufficient numbers of competent and adequately trained employees are working on the project

Sanborn's Quality Management System has been developed to ensure that adequate and continuous control is in operation for all activities affecting product quality. Where specific regulatory requirements affect our processes, our procedures and instructions will be designed or revised to meet such requirements. Sanborn employs methods and techniques that foster continuous improvement and good business practice.

Sanborn places an emphasis on problem prevention rather than dependence on detection after occurrence. Every effort is made to perform operations and quality-related activities correctly the first time. The Quality Management System includes a formal review of the parameters affecting product quality from conception to contractual fulfillment. Whenever necessary, corrective and preventive actions are implemented to ensure continuous improvement.

Responsibilities

Sanborn staff members are aware of what they are authorized to undertake and are responsible for achieving. This is ensured by documentation of responsibilities and authorities in specific procedures. All employees are responsible for following applicable policies, procedures, and work instructions. Additionally, every employee has the responsibility and authority to:

- Initiate action to prevent the occurrence of any nonconformities relating to product, process, and the Quality Management System
- Identify and record any problems relating to the product, process, and the Quality Management System
- Initiate, recommend, or provide solutions through designated channels
- Control further processing and delivery of products until the deficiency has been corrected
- Ensure that the MPO's source materials and other property, including intellectual property, is logged, utilized, stored, and returned in a controlled manner

Roles and Responsibilities of the MPO

Sanborn proposes that the MPO's roles and responsibilities under this program will be to:

- Coordinate and communicate with Sanborn
- Process all contractually-related documents in a timely manner
- Review Sanborn's flight plans and related documents, and provide comments or approval in a timely manner
- Respond in a timely manner to requests for information, data, and meetings or conference calls
- Perform reviews and quality control checks of interim and final deliverables in a timely manner and communicate the results to Sanborn
- Review and pay Sanborn's invoices in a timely manner.

Communications Management

Customer communication and status reporting is the most important aspect of project management. The continuous communication between Sanborn and the MPO will provide insight to the project process and eliminate gaps in communication on technical and schedule issues. Sanborn has a proven method of communication with our customers, and will review with the MPO the best method to ensure constant contact throughout the project lifecycle.

Communication requirements will be incorporated and documented in the work plan. The specific requirements for each project are unique; therefore, the tracking and reporting tools and procedures necessary for effectively managing the project are established specifically for the MPO's project and maintained throughout the term of the contract.

Meetings and Conference Calls

Meeting minutes from project team meetings and conference calls will be produced and distributed by Mr. Benham. These minutes shall include descriptions of the issues discussed during the meeting, their resolutions, and the necessary follow-up. All project records, including correspondence, reports, invoices, and specifications, will be maintained in the project files by Mr. Benham.

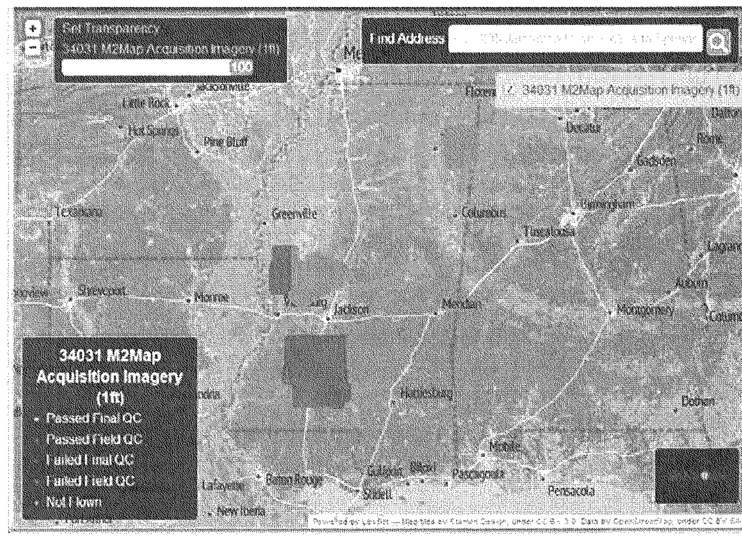
Project Status Reporting

Sanborn is committed to successful internal performance management and to providing customers with easy access to the status of their projects. We accomplish this by using a variety of proven tools.

Project Status Reporting is one of the most critical aspects of communication for large projects with many players and variables. As a result, Sanborn utilizes three primary methodologies to provide update information about the project to the MPO, including real-time web-based tracking reports.

1. **Written Status Reports** – Mr. Benham will submit a weekly Project Status Report to provide project team members with a common understanding of the important issues, procedures, and goals associated with the project. The report summarizes project activities completed over the past reporting period and those planned over the next similar time period. Information addressed in the Project Status Report includes the following:
   - Major activities completed during the most recent reporting period
   - Summary of data production status, including but not limited to listing of data accepted by the MPO and the status of the MPO's review of delivered data
   - Description of current project issues and procedures
   - Activities to be completed over the next reporting period
   - Data production forecasts for the next reporting period
   - List of requested action items
   - List of outstanding issues/action items
2. **Status Calls** – Weekly status calls can also be held with the MPO to coordinate project activities and to review open issues noted in the status report. Exact times will be established with the MPO during the project initiation meetings. It is the Sanborn project manager's responsibility to facilitate this call, document new actions, address the status of open issues, and assign action items. A sample agenda is as follows:
   - Major issues and action items completed for a specified time period
   - Critical issues and actions not completed and their potential impacts including, but not limited to, the MPO's review of deliverables and the schedule for source data delivery
   - Production status
   - Action items for next reporting period
   - Upcoming action items and questions
3. **Web-Based Reporting / Program Status via SanTrack** – Sanborn recognizes the importance of enabling our clients to gather information on the status of their projects during acquisition and production. Being able to anticipate deliveries and to gather information on your projects status without relying on project management or production personnel can be very important (if not critical) at times. Understanding this need, Sanborn developed a system that provides our clients with the ability to view the status of their projects through an Internet connection.

SanTrack is Sanborn's method of visually tracking projects internally while at the same time allowing our clients to view the status of their projects. This browser-based viewing system allows clients to check the status of their projects at any time. SanTrack, which is strictly for viewing purposes, is accessible via the Internet using standard web browser. No additional client-side software is required. SanTrack allows for daily progress from all team members to be entered and displayed. Our Program Manager will ensure the SanTrack website is updated on a daily basis for acquisition and on a weekly basis for all other tasks.



The web-based online status viewer will reflect a status for each tile or block as appropriate. Information posted to the status reporting site includes, but is not limited to, progress for aerial imagery acquisition, imagery processing, analytical triangulation, rectification, and delivery of data.

Quality Assurance/Quality Control Procedures

Sanborn will follow its proven ISO9001:2008 processes to ensure that all contract materials are delivered in accordance with the MPO's requirements. Our key is a system that identifies any problems early in the workflow. Quality control validation points are inserted into the overall program process at key points and quality assurance protocols are completed prior to submission of deliverable products.

Sanborn has established key quality audit points in the data creation process. Checks of work products immediately following a key process step provide the opportunity to ensure that the data at that point are of acceptable quality for input to the next process step. Any data found defective is immediately returned to the previous step for correction or recollection.

Listed below are several key steps that will be initiated at the beginning of the project to support our Quality Plan:

- Sanborn will conduct a QA/QC technical work session with appropriate MPO representatives. This work session will be conducted during the initiation phase of the project. It will enable us to make sure that potential QA/QC issues are adequately addressed by Sanborn.
- Sanborn will designate a Quality Assurance Manager.
- Sanborn will review the MPO's formal acceptance criteria for the final deliverables. We understand that the samples delivered as part of the pilot/prototype phase of this program are an integral part of understanding the acceptance criteria and ensuring they are met. Results of the pilot project will refine production guidelines for full production and creation of final deliverables.

- A detailed Quality Plan will be developed to be used in concert with the acceptance criteria. This document will include all checklists and forms to be used for quality reporting.
- Sanborn will conduct internal meetings with our managers and staff to ensure all team members have a full understanding of the project and quality control steps. Training sessions will be conducted as appropriate.
- Sanborn will also conduct an internal pilot program. This pilot will serve to test our QA/QC process and to make any necessary revisions as appropriate.

The goal of this phase of the program is to implement a QA/QC program that is robust, comprehensive, and complementary of the procedures employed by the MPO. Sanborn has provided a comprehensive description of our ISO 9001:2008-based quality control procedures following each production step in our workflow in the technical approach above. Please see our technical approach for a specific description of quality control procedures for each key step of our production process.

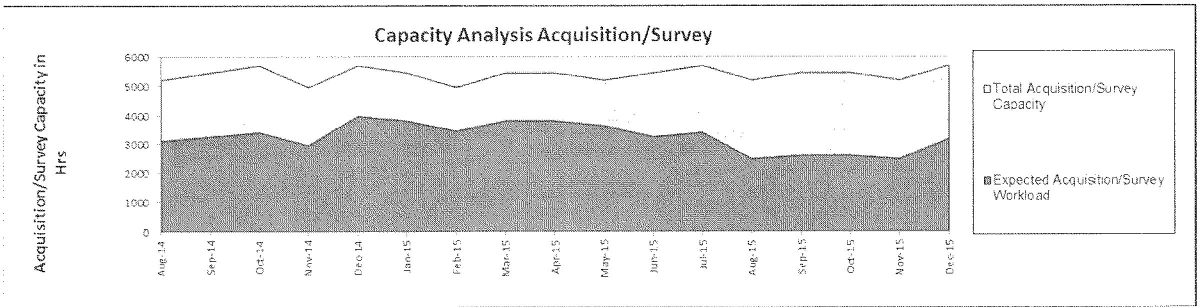
Capacity

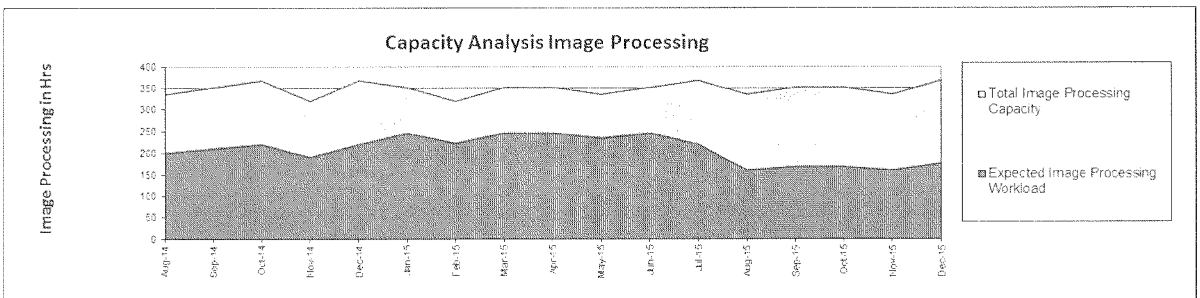
The combination of Sanborn's extensive hardware collection, commercial and proprietary software, and personnel who are experts in their fields, serves to uphold our position as a leading provider of geospatial services and products.

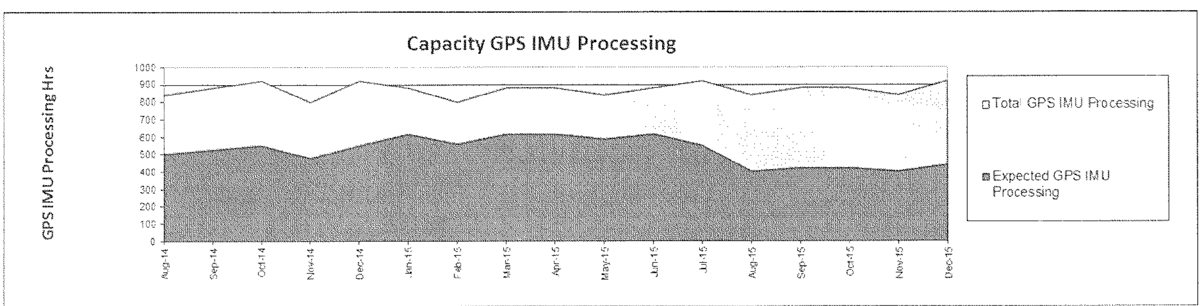
Sanborn's Primavera environment enables integrated management of the entire project lifecycle, from design and proposal development, to implementation, and change management. Project schedules and resource allocations are modeled in Primavera as early as the proposal stage, then developed and maintained over the entire life of the project. For the MPO's program, as the collection and processing moves through the timeframes, updates to Primavera allows Sanborn to reallocate resource if necessary and to direct additional assets to cover equipment failures, weather problems or changes in the capacity plan as a result in changes in the collection activity.

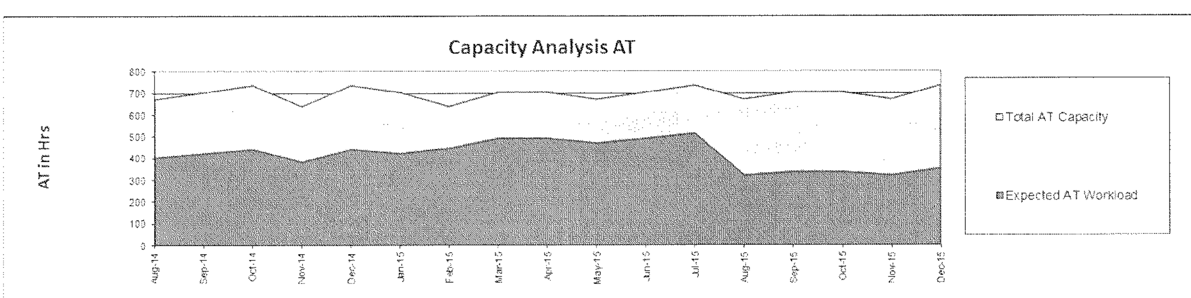
Sanborn has the ability to assume the significant scale of the MPO's project with our available resources and key personnel. Sanborn's current and anticipated workloads do not directly conflict with the MPO's acquisition and production window. Sanborn actively tracks total capacity, capacity against existing workload, and capacity against existing workload with new anticpated programs; and, performs six- to twelve-month look-ahead analyses in order to adjust for variation in the need for production resources proactively and dynamically, and ensure that resource adjustments do not need to be made in "crisis mode" in order to ensure schedule compliance.

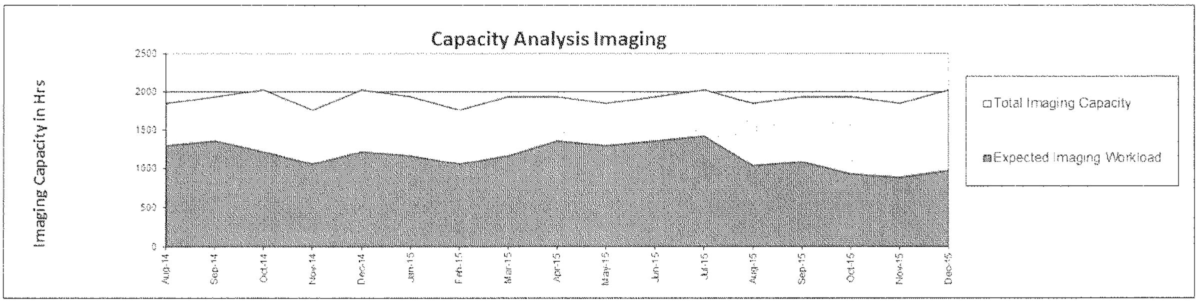
Below are graphs documenting our Primavera resource analyses. The graphs show significant capacity for airborne data acquisition, airborne GPS/IMU processing, image processing (pre-rectification), compilation/GIS (DEM ingest and update), aerotriangulation, and imagery post processing (orthorectification). Based upon this analysis, Sanborn has abundent capacity to take on the proposed scope of work.

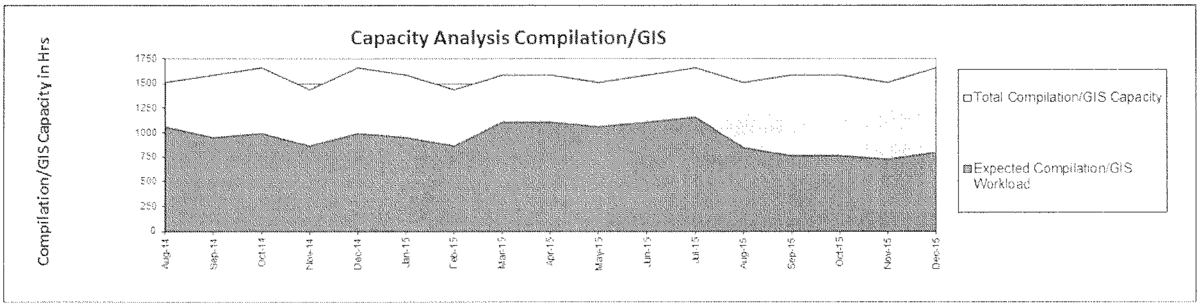

Capacity Analysis Acquisition/Survey
Acquisition/Survey Capacity in Hrs
0
1000
2000
3000
4000
5000
6000
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Total Acquisition/Survey Capacity
Expected Acquistion/Survey Workload


Capacity Analysis Image Processing
Image Processing in Hrs
0
50
100
150
200
250
300
350
400
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Total Image Processing Capacity
Expected Image Processing Workload


Capacity GPS IMU Processing
GPS IMU Processing Hrs
0
100
200
300
400
500
600
700
800
900
1000
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Total GPS IMU Processing
Expected GPS IMU Processing


Capacity Analysis AT
AT in Hrs
0
100
200
300
400
500
600
700
800
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Total AT Capacity
Expected AT Workload


Capacity Analysis Imaging
Imaging Capacity in Hrs
2500
2000
1500
1000
500
0
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Total Imaging Capacity
Expected Imaging Workload


Capacity Analysis Compilation/GIS
Compilation/GIS Capacity in Hrs
1750
1500
1250
1000
750
500
250
0
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Total Compilation/GIS Capacity
Expected Compilation/GIS Workload

Section 5 – Price

Pricing Narrative

Sanborn has prepared the following pricing based upon our understanding of the RFP and technical description provided in our proposal. Sanborn notes that the shapefiles provided had additional 6-inch areas beyond what was defined as the base 6-inch area and the optional Natrona County 6-inch areas. These have been priced below. If only certain blocks of the 6-inch optional areas are desired, a custom quote can be provided. As always, Sanborn is willing to negotiate the scope of work and related fees.

Casper, WY, Pricing			
Product	Sq. miles	$/Mile	Total
3 Inch Base AOI	207.6	$ 267.53	$ 55,539.23
6-Inch Base AOI	145.6	$ 125.61	$ 18,288.82
6-Inch Base AOI + County 6-Inch Options	562.8	$ 101.30	$ 57,011.64
6-Inch Base AOI + County 6-Inch Options + Other 6-Inch Options	652.9	$ 104.81	$ 68,430.45
QL2 LiDAR AOI with HE DEM, 1-foot Contours	70	$ 299.32	$ 20,952.40
QL3 LiDAR AOI with HE DEM, 2-foot Contours	224	$ 162.03	$ 36,294.72
LiDAR Optional Area QL3 with HE DEM, 2-foot Contours	6.4	$ 162.03	$ 1,036.99
Planimetric Update	207.6	$ 308.01	$ 63,942.88
Six 6'X6' Wall Posters	NA	$500 each	$ 3,000.00
Total With All Options			**$ 249,196.67**

Review of Terms and Conditions

Sanborn understands that many of the basic terms and conditions in the RFP are based upon statutory or regulatory requirements and are not subject to negotiation. Sanborn notes that certain terms and conditions may or may not be applicable to this procurement, or may require adjustment based on the specifics of this procurement; and, reserves the right to discuss and negotiate these terms and conditions during the contract negotiation. Sanborn is confident that a mutually acceptable Contract will be negotiated upon selection that is based upon and reflects the final project specifications, deliverables, schedule, and fees.

EXHIBIT

H

sanborn

Change Request Form

Contract/Project Name:	WY Plan/Ortho/LiDAR 2015	Request Number:	312015508-00_
		Date of Request:	__/__/20__
Client Name:	Casper MPO	Requested by:	

Description of Requested Change:	
[insert description of requested change] By signing below, the representative of [client name] warrants: (i) that they have the legal authority to bind [client name][, and (ii) that funds are encumbered to support the new contract value].	
Reason for Change:	
[insert the reason for the requested change]	
Impact of Requested Change On Contract/Project:	
Time Schedule	[insert the change in time schedule (from X to Y) (or) No change in Schedule]
Contract Pricing	[insert the change in contract pricing (from X to Y) (or) No change in Pricing]

Change request approved /incorporated into the Contract as a Change Order ☐

Date approved Change will be implemented/incorporated as a Change Order: __/__/20__

Change request rejected ☐

For City of Casper, Wyoming:	For The Sanborn Map Company, Inc.:
______________________ *Signature*	______________________ *Signature*
______________________ *Printed Name*	______________________ *Printed Name*
______________________ *Title*	______________________ *Title*