Proposal for Professional Services for Regional Digital Orthophoto Images and Associated Data

COAGA 2017 RFP # 2017-01

Submitted To:

John Sharp

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Submitted By:

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Due Date/Time:

December 6, 2016 /

2:00 CST

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December 6, 2016

John Sharp
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Oklahoma City, OK 73104-2405

Re: Regional Digital Orthophoto Images and Associated Data

Mr. Sharp,

On behalf of Fugro Geospatial (Fugro), I am pleased to submit the attached response to the Association of Central Oklahoma Governments (ACOG) and The Central Oklahoma Alliance of Government Agencies 2017 (COAGA17) in support of the RFP requirements for collection of orthoimagery for the Regional Digital Orthophoto Images and Associated Data (the Project). We understand this project to consist of acquisition and processing of digital orthoimagery and separately collect, detect changes and update the participating agencies planimetric and topographic data specific project areas.

Fugro has extensive experience acquiring high resolution orthoimagery for large-area projects. Hundreds of federal, state, county, and municipal agencies in Texas, Arkansas, Missouri, Nebraska, Idaho, Louisiana, Tennessee, Mississippi, Massachusetts, Indiana, Florida, North Carolina and South Carolina have trusted their spatial data needs to Fugro. The successful relationships we have forged with these customers allow them to confidently set goals and solve problems in an innovative and cost-effective ways.

Experience Highlights:

- Fugro was the 2014 selected vendor providing digital mapping, imagery, and elevation data to ACOG. Our recent experience, understanding of local conditions and ACOG requirements qualifies Fugro to successfully complete the upcoming 2017 projects.
- Fugro owns and operates ample acquisition resources including seven (7) aircraft, four (4) Leica ADS80-SH82 digital imaging systems, multiple technology Lidar sensor configurations, oblique imagery solutions, and the super-computing resources required for efficient data processing with more than 89 technical staff.
- Fugro has ample workload capacity during the spring 2017 acquisition window allowing for the allocation of resources to meet or accelerate your project schedule, and also allows Fugro to have acquisition resources standing-by in a backup position if weather, unscheduled maintenance, or other factors beyond our control impact the acquisition schedule.
- Fugro maintains full compliance and registration as an ISO 9001:2008 and OHSAS 18001:2008 Certified company. Rigorous quality control and work-flow procedures are applied to all phases of each project and our processes undergo re-certification on a continuous basis.

For additional information or clarification regarding this response, feel free to contact:

Technical and Business Development Manager:
Mr. Keith Owens, (301) 948-8550 Ext 119; email: k.owens@fugro.com

Project Manager: Ms. Megan Blaskovich, (301) 948-8550 Ext 176; email: m.blaskovich@fugro.com

Thank you for considering our proposal. We look forward to your response and would be grateful to have the opportunity to work again with the ACOG on this important project.

Dave White
Senior Vice President

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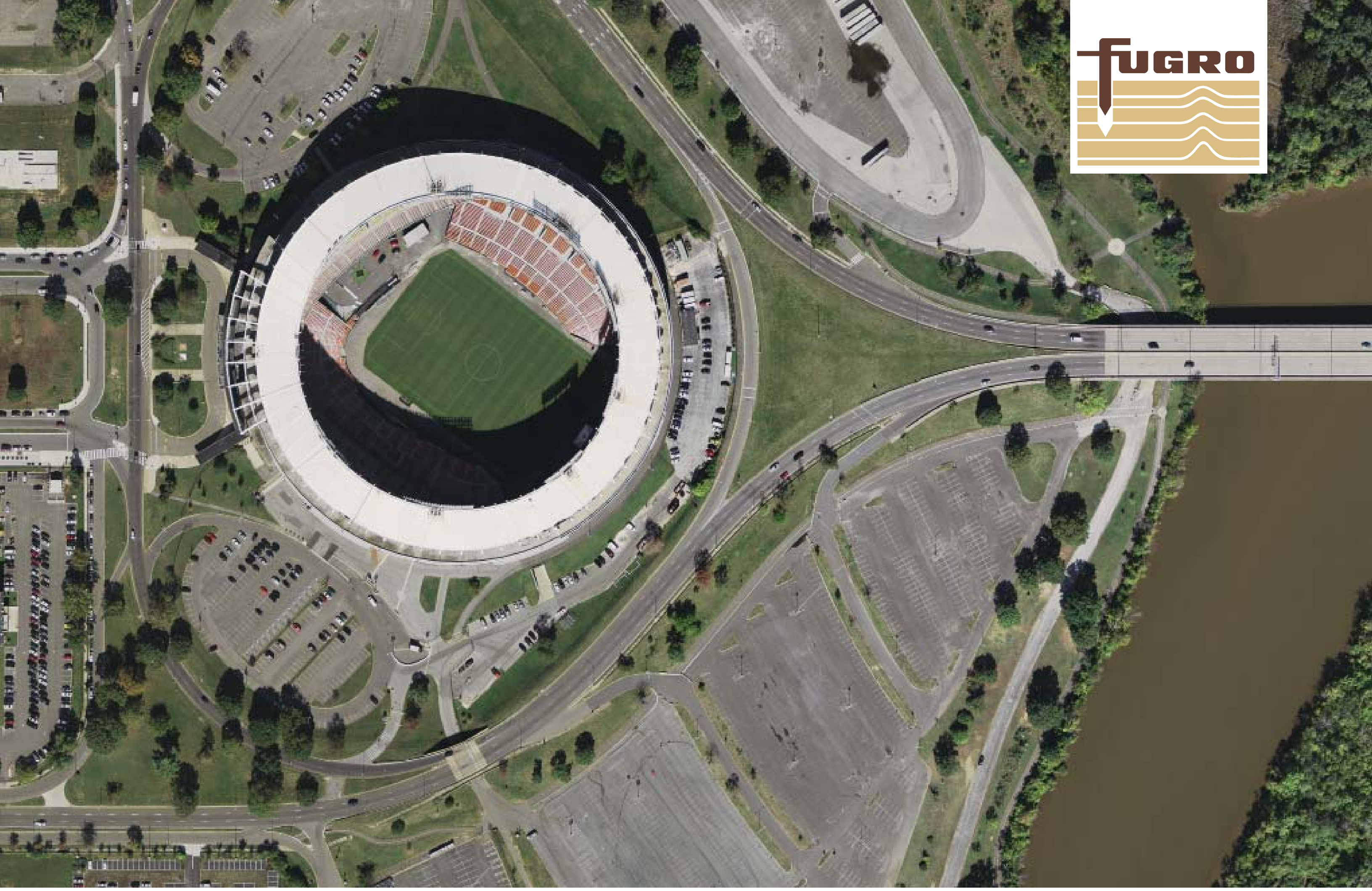


1 PROJECT OVERVIEW

For over 60 years, Fugro has successfully completed thousands of mapping projects for a broad range of public-sector customers, including 13 state-wide projects, and over 70 local government projects in the last five years.

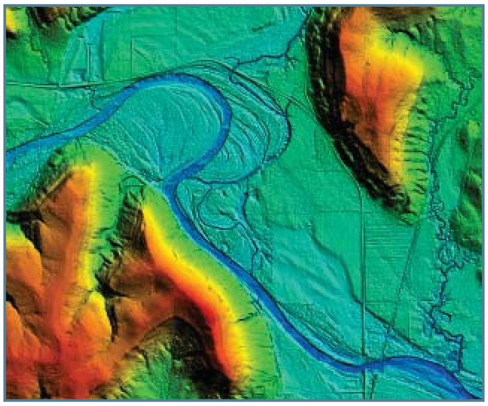
1.1. Company Profile

Fugro specializes in aerial acquisition of orthophotography, oblique imagery, lidar, and processing the data into a wide range of topographic and planimetric mapping products. Working with existing and prospective customers, we aim to develop local partnerships and provide state of the art solutions to the constantly expanding GIS user community.

Fugro's experience is complemented by ample aerial acquisition and production resources, including a fleet of aircraft, digital imagery and lidar sensors, oblique mapping sensors, and more than 90 highly-qualified geospatial professionals in the US and an additional 1,300 in our production facilities throughout the world.

Fugro employs registered ASPRS certified photogrammetrists (CP), ASPRS Certified Mapping Scientists (CMS), professional engineers (PE), Professional Land Surveyors (PLS), GIS professionals (GISP), Project Management Professionals (PMP) and highly qualified and experienced analysts and technical support personnel to ensure all products meet quality and accuracy specifications.

Our employees participate in ongoing, advanced technical training to keep at the forefront of the rapid technological changes that are inherent in the field of surveying, mapping and GIS. This knowledge ensures that we embrace the latest mapping technologies and apply the appropriate industry standards to deliver digital mapping solutions.



1.1.1 ISO9001:2008 QMS

Fugro operates under the ISO9001:2008 certified quality management system (QMS). Since 2000, the QMS governs our procedures for technical and administrative processes. Our QMS is based on the philosophy that customer satisfaction is achieved through excellent communication and reporting, delivery of quality products and services, and constant efforts toward the improvement of qaulity, process, and efficiency.

1.1.2 Financial Stability

Fugro Geospatial is a wholly owned subsiderary of Fugro NV, a company that anulally posts average multi-billion dollar revenues, and a worldwide leader in the collection, processing, and interpretation of data related to the earth's surface and subsurface with offices in more than 50 countries. The acquisiton by Fugro NV in 2007 has served to greatly expand our geographic reach and service offerings. Additionally, our legacy of leadership in mapping technology is secured by the access to the financial resources to undertake complex, long-duration projects, as well as the ability to respond very rapidly to emergency situations with little to no advanced notice.

As part of the Fugro NV organization, Fugro Geospatial is financially stable and is experiencing continuous growth in terms of business development, customer acquisition, and resource capacity.

1.1.3 Nationwide Service

While we directly offer geospatial products and services, the Fugro presence in the US is very large and provides a wide range of engineering and professional services, including land surveying, hydrographic surveying, geotech and environmental engineering. We frequently team with our Fugro partners to provide end-to-end surveying and engineering services to meet the deliverable specifications and the quality requirements of our clients. The map below details the footprint Fugro currently maintains in the US.

Fugro Geospatial Offices:
Corporate Headquarters, Managment and Production Facility
7320 Executive Way
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Tel: 301-948-8550
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Eastcoast Aviation Facility
18227 Airpark Road
Hagarstown, MD 21742
Tel: 301-733-1176
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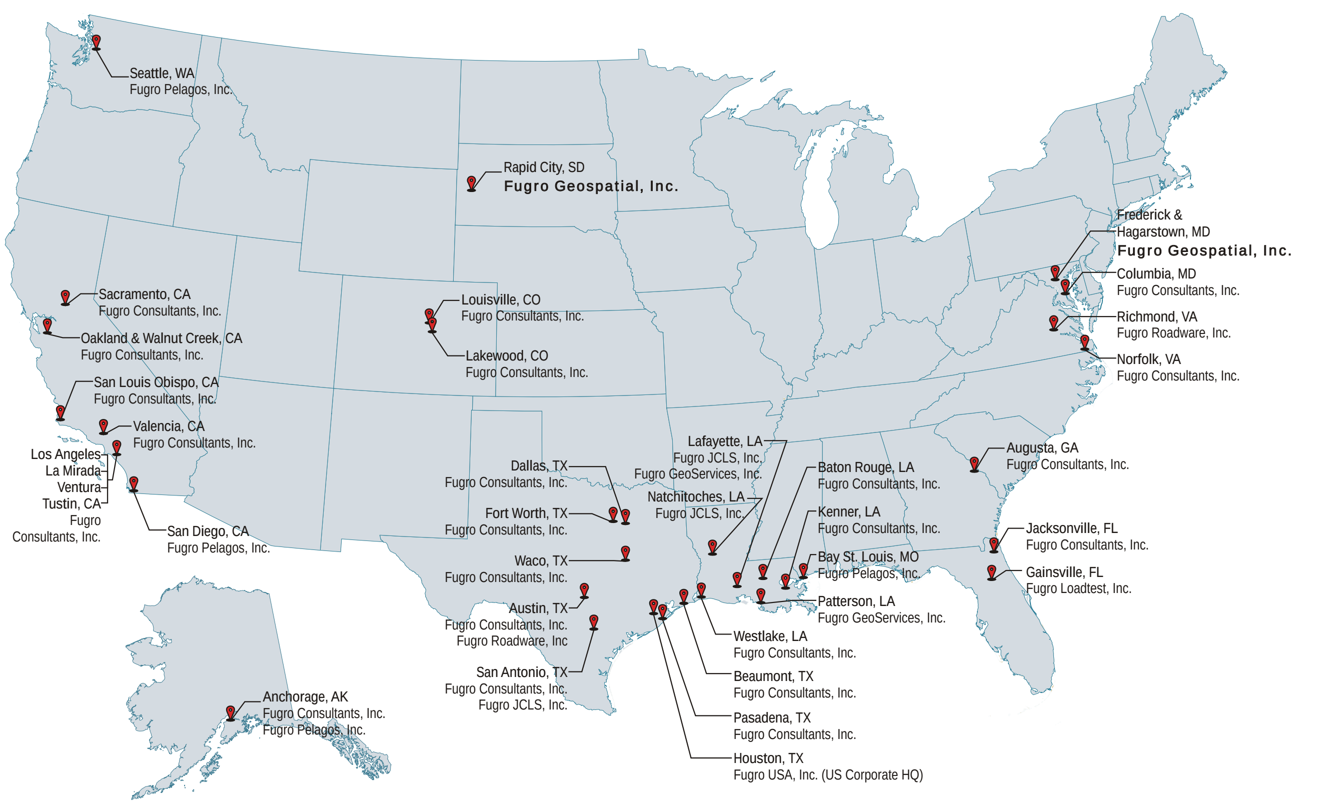
Aviation, Managment, and Production Facility
4350 Airport Road
Rapid City, SD 57703
Tel: 605-343-0280
Fax: 605-343-0305

History of former firm names:
1955-1997: Photo Science, Inc.
1998-2005: EarthData International, LLC
2005-2007 EarthData International, Inc.
2007-2013: Fugro EarthData, Inc.
2013-Present: Fugro Geospatial, Inc.

Type of ownership:
Corporation (Subsidary of Fugro NV)

Number of US based employees: 89



1.2. Project Approach Summary

1.2.1 Project Planning

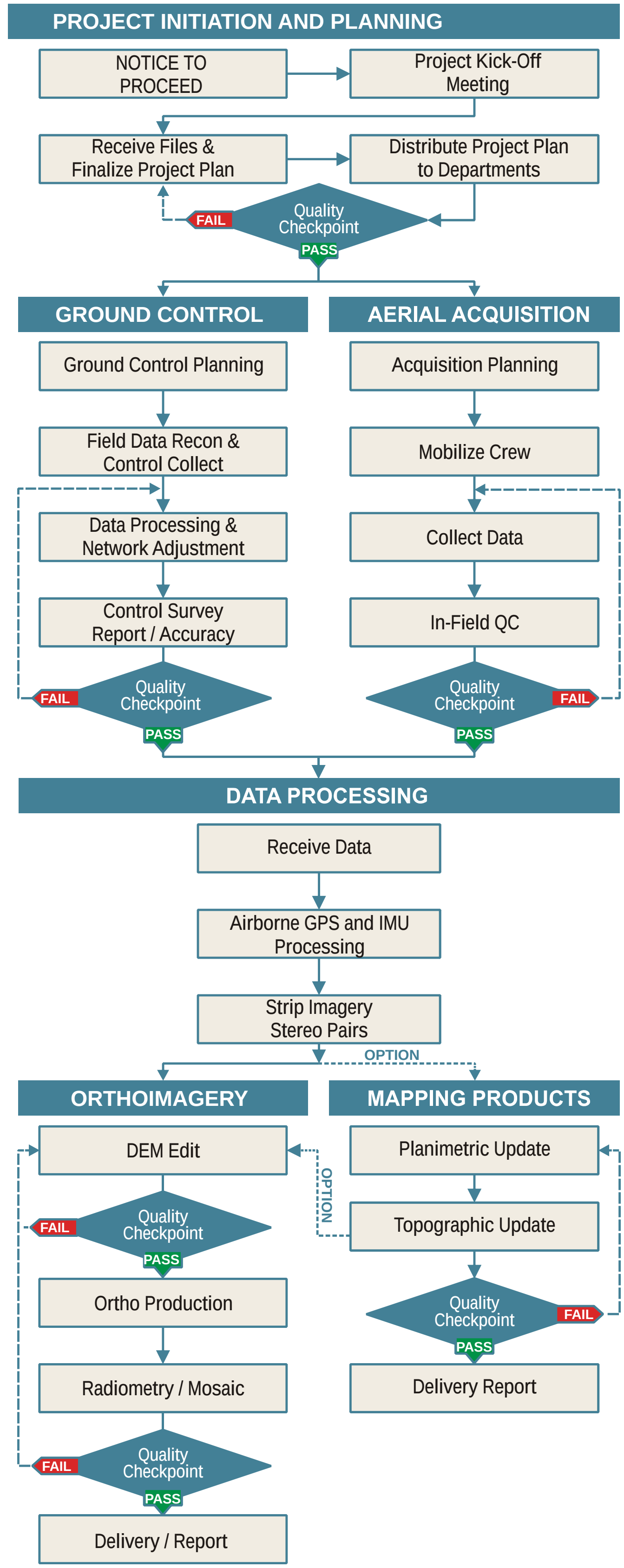
Upfront planning of every aspect the project is critical to the overall success. Identification of associated risk to data quality and the project schedule need to be mitigated early on so they don't become major problems during later stages. Risk factors we address early on include, but are not limited to, areas of restricted airspace, foliage requirements (leaf-on/leaf-off), and climactic/environmental conditions.

We utilize the expertise of our in-house mapping specialists early in the project planning to ensure confidence that all deliverables can be efficiently produced to the high quality for which we strive. Fugro's planning department is staffed with ASPRS Certified Photogrammetrists (CP) who possess the experience and expertise required to design a detailed project plan that is attainable and efficient. Our flight operations department is headed up by pilots who have dedicated their aviation careers to aerial mapping/remote sensing data acquisition for over 40 years. These highly trained and educated professionals, along with the project manager, develop the final project plan which includes all of the processes from flight planning, data acquisition, production to the delivery of high quality orthoimagery.

Following notice to proceed, Fugro recommends a project kick-off meeting with client representatives and Fugro's project management be held as soon as possible This meeting ensures all parties have a solid understanding of all aspects of the project, including schedule, deliverables, and quality expectations. At this meeting Fugro presents our project plan and addresses any comments and concerns the client may have. The result of the kick-off meeting is a final project plan that provides confidence to the client that their project is planned in a professional and efficient manner. Fugro's project manager routes the final project plan around to all applicable Fugro departments including flight operations to prepare for the mobilization to the AOI. The flight crew and maintenance technicians performs flight safety checks on the aircraft and equipment functionality checks on the acquisition equipment/sensors to ensure the data collection meets the required specifications. Flight department supervisors also coordinate with the local air traffic control (ATC) and any other agencies which may have air space restrictions.

1.2.2 Ground Control

An accurate ground control network is critical to the quality of final data products and is necessary to validate the specified accuracy. The final project plan includes the ground control requirements to meet the final data accuracy required. The plan is routed to our land surveying subcon-



sultant, Red Plains Surveying Company to begin collection and inventory of existing ground control point (GCP) monumentation and installation of new, temporary or permanent, GCP monuments to be used for horizontal and vertical control at a project site if required.

1.2.3 Acquisition

Following the project conformance checks, safety audits and communication requirements to the necessary air traffic control, Fugro will mobilize to the AOI and set a base of flight operations at an airport local to the project site. Fugro proposes to use one (1) Leica ADS80-SH82 digital imagery sensor mounted in a Cessna 441 Conquest (twin engine turbo-prop aircraft). Identical aircraft and sensors are available in a contingency position. Daily acquisition flights will begin only in times when atmospheric conditions are ideal for airborne imagery collection (i.e. no haze, fog, dust, snow, floodwaters, etc.). The required sun angle (>35° above the horizon) will be calculated daily to determine the timing of imagery acquisition to conform to the project requirements as detailed in the SOW. We have estimated that the full coverage acquisition will take 10-12 days during ideal conditions. Imagery quality is checked after each day's flight. Quality aspects such as cloud cover, excessive shadows, haze, fog, and other environmental factors are called out and if deem unacceptable, re-flights are scheduled, usually during the next lift. Other in-field raw imagery quality control measures confirm imagery sharpness, clarity, and contrast.

On completion of imagery acquisition the full raw data (verified for quality and completeness in the field) is shipped to Fugro's imagery production facility and another raw imagery quality check is performed by our Raw Data QA/QC inspector, Mr. Doug Johnson, an ASPRS CP. Mr. Johnson brings over 28 years of experience ensuring the quality of Fugro's aerial imagery projects.

1.2.4 Processing

With the data in our production facility, and approval from our raw data quality inspector, digital orthoimagery production will commence. The project plan, developed at the initial stages, has been communicated to the imagery production manager, Mr. Kirk Spell, CP and full orthoimagery production begins.

1.2.5 Full Orthoimagery Production and Delivery

At the end of every step throughout orthoimagery processing a quality control review is performed. If any quality issues are discovered, the data is returned to the processing personnel to mitigate the issue. This process ensures that quality issues, that could be major calls if not remedied immediately, are caught early in the process. This process flows through all steps of imagery processing until all orthoimagery has been processed and passed all internal QA/QC.

2 PROJECT APPROACH

Fugro's imagery-based mapping solutions are founded on 60+ years of aerial imagery acquisition for government clients who rely on highly accurate geospatial data for a variety of photogrammetric mapping activities.

Fugro's aerial acquisition and processing capabilities are supported by a highly experienced team of project managers, pilots, sensor operators, field crews, and production staff who possess the experience and expertise to meet specific project requirements and quality expectations.

The technical approach described in the following section details Fugro's methodology to assure timely completion of all work described in the COAGA 2017 RFP. The approach includes project management techniques to demonstrate the organizational requirements to lead a project of this magnitude to success in addition to personnel / equipment capacity information demonstrating ample resources in primary and back-up positions for a very low-risk exposure for your project. As detailed in the key personnel section to follow, we have included on this project team primary and back-up supervisory personnel for every major area of work.

Your project has highly qualified management and supervisory personnel allocated to lead every phase with back-up and support to mitigate any interruption in the work flow and schedule.

2.1. Project Understanding

By submission of this proposal, Fugro is offering to collect and produce digital orthophoto images; and separately collect, detect changes and update the participating agencies planimetric and topographic data for the project areas defined in the RFP.

Experience gained from the successful COAGA 2014 project is a demonstration of our understanding and ability to perform in 2017. It is further understood the participating agencies that make up COAGA2017 may negotiate a separate agreement.

Fugro is a highly qualified and low risk candidate to ensure COAGA2017 achieves it's ultimate goal of a complete up-to-date accurate digital ortho data set for the entire project area as well as updated planimetric and drainage-enforced contour data sets for the specified municipal areas.

2.2. Project Planning

Fugro's planning department is staffed with ASPRS certified photogrammetrists (CP) who possess the experience and expertise required to design a detailed project plan that is attainable and efficient.

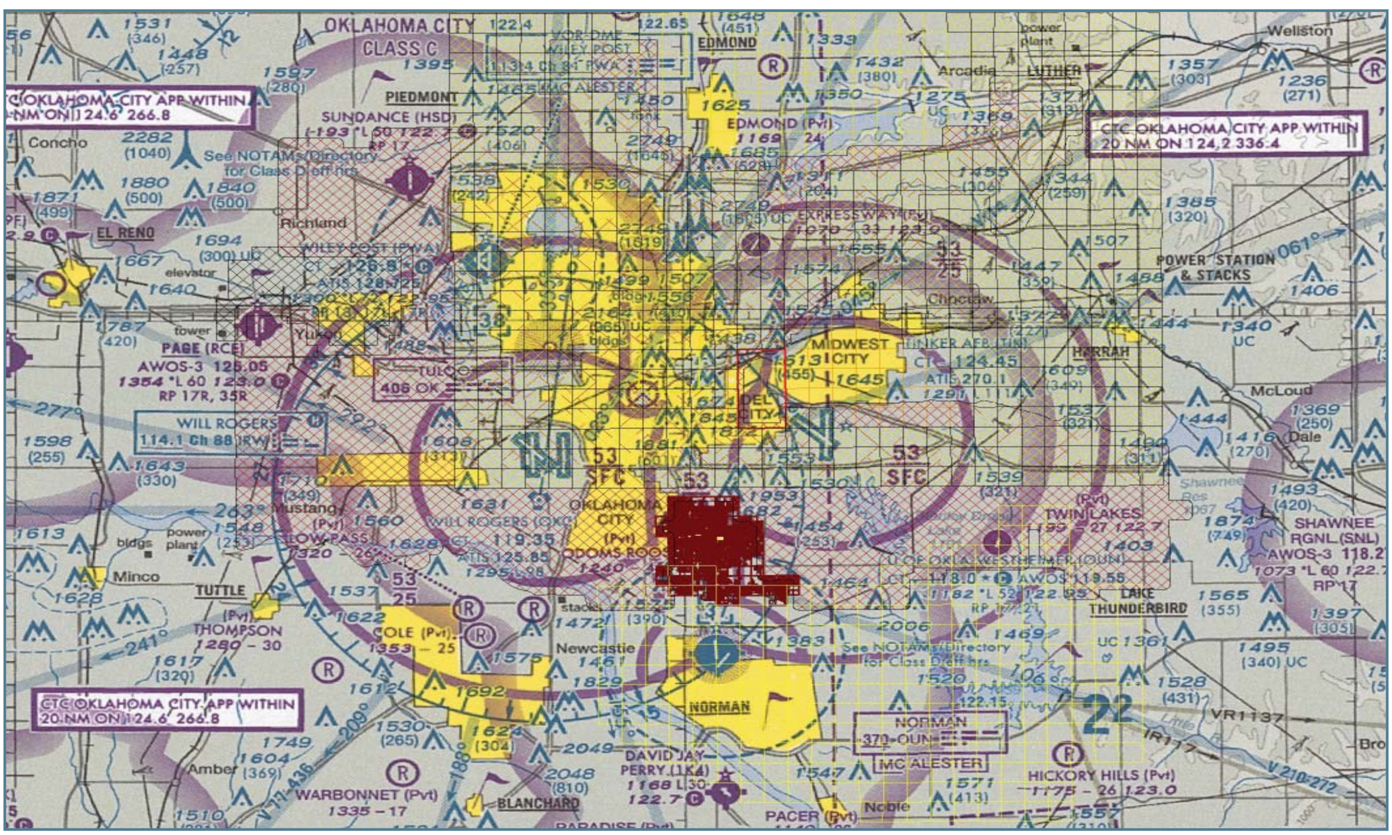
2.2.1 Flight Planning

Flight planning will be performed using Fugro's proprietary planning software J-Flight. The flight altitude is planned to achieve the required data specifications and will adhere to ICAS2000 (International Congress of Aeronautical Sciences) specifications for line following above ground altitude.

The planning process will pay particular attention to the specified area of interest in terms of topography, terrain relief and the inclusion of a 50 meter buffer zone around the external block perimeter. The required flight lines are designed in 2D mode. The J-Flight software uses a height model – (either government existing DEM or one more specific to the area, if available) – to generate 3D flight lines.

The software ensures that data resolution and lateral overlaps remain within the required tolerances. The software pays particular attention to areas of large terrain changes and indicates where adjustments of flight parameters or breaks in flight lines are necessary. This step is seen as a key quality assurance check before finalizing any flight plans.

Should any issues be highlighted during this QC phase, remedial action is taken and the check process repeated until the plan meets specification. The digital files created by the J-Flight application are readable by the Flight Control Management System (FCMS) that is used for operation of the acquisition system. The configuration of acquisition blocks may require modification due to weather or air traffic considerations, and these changes can be easily incorporated into the overall acquisition design using J-Flight and FCMS.



Fugro's Project Planners, Aviation Managers, Project Managers and Technical Staff conduct an internal project evaluation meeting to review and discuss the details of the project prior to mobilizing crews to the project site. This review compares the client supplied SOW/contract with Fugro's project work plan and planning files (flight plans, project boundaries, tile layouts, etc.). Once the review process is complete, all files are finalized and approved for distribution to the appropriate departments.

2.2.2 Preliminary Flight and Ground Control Plans

Preliminary flight plans have been included on the following pages. These will be finalized in the project kick-off meeting.

2.3. Orthoimagery Acquisition

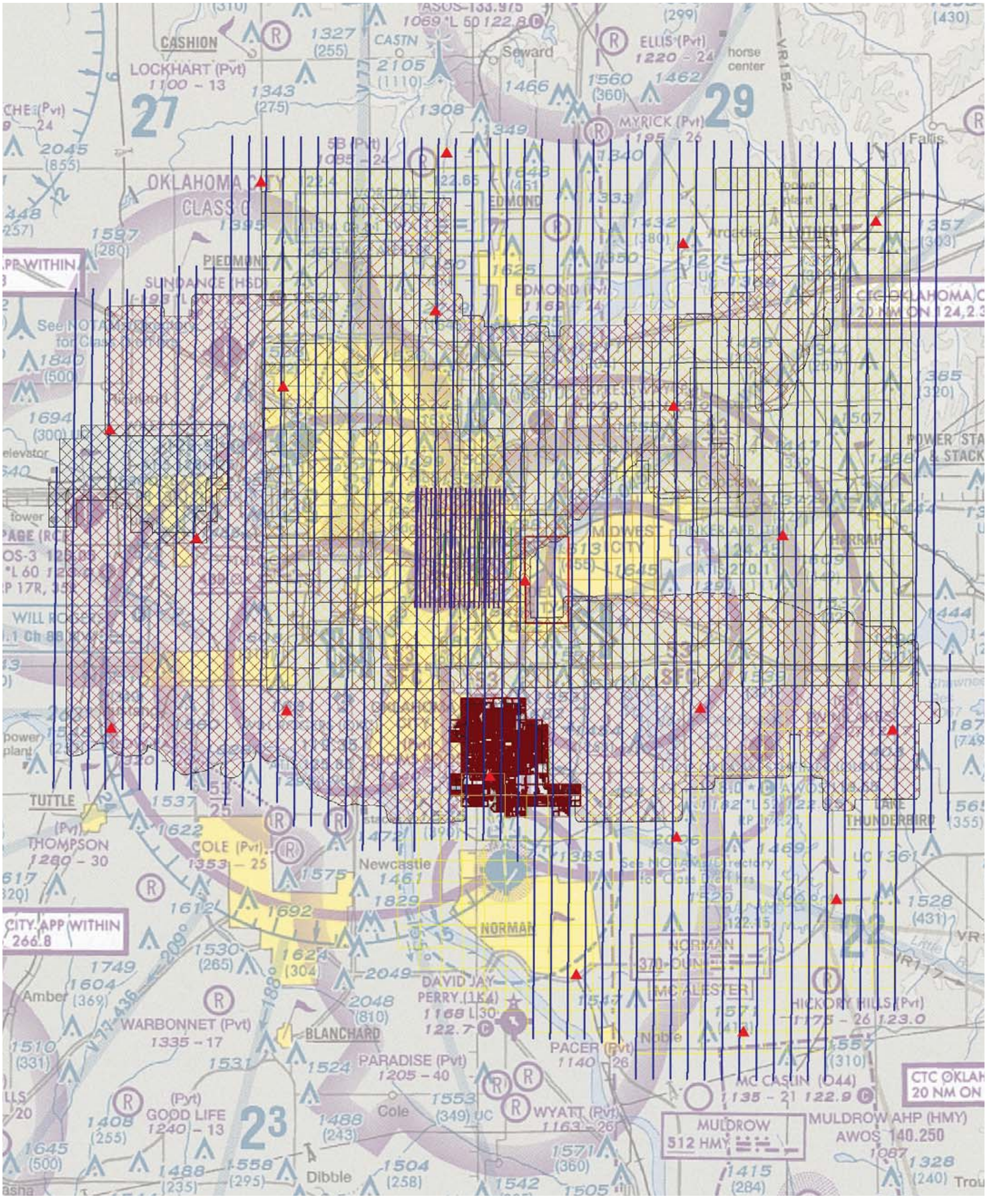
The finalized technical specifications and flight plan layouts for the project will be conveyed to the flight operations department for flight operations to commence. All technical aspects of final deliverables will be reviewed and finalized to ensure goals are met regarding overall project expectations. Acquisition considerations such as airspace restrictions, airport accessibility, terrain, weather patterns, and other customer or special project needs will be addressed.

2.3.1 Technology

For this project, Fugro will operate a Leica ADS80 Digital Camera that has been upgraded with Sensor Head 82 (ADS80-SH82), and incorporates an upgrade in sensor technology, optics, electronics, data transfer, and storage. Fugro has been operating with great success the Leica ADS line of digital imagery sensors for over 14 years.

Orthoimagery Acquisiton Specifications

Camera Type	Leica ADS80
Acquisiton Timeframe	February 1, 2017 through March 15, 2017
Sun Angle	> 35 degrees
Airspace	Fugro will obtain all approvals necessary for all required clearances to cover the AOI.
Tilt	Fugro orthoimagery cameras are mounted in a vertical position and will meet the required limits for tilt as detailed below: Any tilt on the imagery: < four degrees (4˚) Relative tilt between images or strips: < six degrees (6˚). In any 16km (10 mile) section of a flight line: < two degrees (2˚) on average Entire Project: < one degree (1˚) on average
Rainfall Requirement	Photo acquisition will not take place within 2 days after a rainfall of 0.5 inches or greater or within 5 days after a rainfall of 2 inches or greater
Environmental Conditions During Acquisition	Imagery will be captured only when the sky is free from clouds, cloud shadows, high overcast clouds causing low illumination, haze, fog, smoke, and dust. Ground features will be free of excessive waters due to rain or snow. Other environmental factors causing non-manmade obstruction of the ground surface should be minimal. Light conditions will be such that images are free from smear, blur, excessive glare, or noise. Less than 5% cloud cover per final uncompressed image tile AND less than 5% of the entire AOI. "5%" includes cloud shadows.
Forward overlap	Not applicable to Push Broom Sensors as we are proposing
Sidelap	Sidelap minimum of 15%; maximum of 45%; with an average 20-30% over entire flight line
Flight altitude	4,823' AMT providing the required 1:1 ratio between captured pixel size (.5 in) and ground resolution.
Coverage	Quality Control performed before de-mobilization from the AOI ensures no voids due to cloud cover (< 5%), instrument failure, or water bodies will be contained in the imagery.
Airborne GPS	Camera position (latitude, longitude, and elevation) will be recorded with airborne GPS. Airborne GPS data will be differentially corrected and organized as individual datasets grouped by corresponding flight line. Differentially corrected airborne GPS positional data willbe stored on portable media, in a nonproprietary format.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1220 – 24
horse center
MYRICK (Pvt)
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CLASS C
PIEDMONT
SUNDANCE (HSD)
EDMOND
Arcadia
LUTHER
MIDWEST CITY
TINKER AFB
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512 HMY
MULDROW AHP (HMY)
AWOS 140.250
CTC OKLAHOMA CITY APP WITHIN 20 NM ON 124.2
THUNDERBIRD
GOOD LIFE
1240 – 13
23
Amber
Dibble
power plant
Falls

2.4. Flight Operations

Daily flight operation components include accurate weather predictions, proper communication, data collection efforts, project tracking and quality control measures. Weather predictions and monitoring are conducted hourly by Fugro's aviation staff (pilots, sensor operators, managers, etc.) utilizing FAA weather sources (WSI PilotBrief Optima) for detailed analysis of weather patterns and the impact on each project. The analysis of the weather includes a review of the local monitoring stations, radar, visible satellite (for cloud cover), temperature, barometric pressure, winds aloft (wind speed and direction at flight altitude), and forecasts. Additional checks on multiple weather monitoring programs (NOAA, Weather Underground, Weather.com etc.) provide the redundancy on predictions and forecasts which help guide crews and equipment to the project location that will yield the highest level of successful data capture.

Communication is vital when organizing and executing flight operations between the production offices, flight department and local airspace owners. This includes up-front details on project specifications, flight statistics, schedule and deliverables. The flight operations department organizes detailed flight maps overlaid on airspace charts to be used for daily communication with air traffic control, Military Operations Areas (MOA), restricted airspaces and local airports. Prior to the data acquisition, the pilot in command (PIC) sends each airspace owner a flight chart with flight lines (and line numbers) displayed to communicate the crews objectives for the day. The impacted airspace owner is contacted by the PIC (by phone or in person) to discuss the day's events and to prepare for potential hazards or traffic that could interrupt the efforts for acquiring data. This information and communication effort helps organize and guide the flight crew to areas of the project that have the highest potential for a successful acquisition.

Data collection activities consist of safety inspections of the aircraft, operational inspections of the sensors and the ability for the crew to successfully capture the data to the project specifications when weather and airspace present the opportunity. Below is an itemized acquisition scenario for airborne data collection:

- Inspect storage and system components to ensure all units are operational and there is sufficient storage space
- Select and confirm the lever arm coordinates
- Load navigation system and perform system check
- Perform 5 minute static alignment and record PDOP, GPS, and UTC start time
- Ensure IMU is operational
- Ensure all channels are operational, as applicable.
- The crew begins flight line data recording: observe video display, POS status and mass memory screens; record UTC start/stop times, GPS data, ground speed, altitude, concerns, lines, waypoints and times on flight log
- After the flight mission is complete, a 5 minute static alignment will be performed followed by a systematic shutdown of the system
- Collected data is downloaded for in-field QC
- Arrange delivery of data and email flight log to team; perform data backup.

At the end of each day's data collection effort, the sensor operator forwards the completed flight logs to the Aviation and Project Manager to update Fugro's Project Tracking system. This system (Fugro Access) is available for all project participants for up-to-date project relevant information, including flight line status and acceptance.

2.5. Ground Control

Fugro's sub-contracted Oklahoma surveyor will coordinate and oversee the following vital functions for this project:

- Project planning for GPS control and operation of airborne GPS base stations
- Logistics and coordination of survey crews
- Monumentation and reconnaissance
- GPS control surveying
- GPS data processing and quality control
- Preparation of reports and documentation

2.5.1 Reconnaissance and Targeting

Initial field reconnaissance will identify candidate horizontal and vertical control monuments and determine if they are suitable for use. This field reconnaissance will also be used to determine new accessible GPS visible monument locations. Should additional ground control be required, the surveying team will select locations for control points using the approved control layout design. A standard photo control recovery form will be prepared for each new control point established to aid in future control point identification. This information will be used to assist in developing a detailed survey monument recovery sheet for each permanent monument in the network. Survey crews will use a uniform procedure to document new control, which will facilitate record keeping and metadata preparation. Prior to the mobilization of aircraft, the survey project manager will coordinate the targeting and acquisition of all photo identifiable positions.

2.5.2 GPS Control Surveying

Once the monumentation and control identification process is complete, GPS vector measurements will begin. Mission planning for each day's observation schedule is coordinated by the survey project manager. This planning includes scheduled observation time/duration and required travel time buffers for the GPS survey crew. Vertical control monuments will be included in the GPS network to meet the elevation accuracy requirements of the digital orthophotography and elevation development.

2.5.3 Projection / Coordinate System(s)

Edmond, Choctaw, Del City, Midwest City and Oklahoma City
Coordinate system: Oklahoma State Plane, North Zone 3501
Horizontal Datum: NAD83
Vertical Datum: NAVD88
Spheroid: GRS 1980
Map Units: US Survey Feet

Moore and Norman
Coordinate system: Oklahoma State Plane, South Zone 3502
Horizontal Datum: NAD83 (HARN) - 1993 adjustment
Vertical Datum: NAVD88
Spheroid: GRS 1980
Map Units: US Survey Feet

2.5.4 Ground Control Survey Reports

Information collected and included within the final ground control survey report / observation logs:

- Monument name and location
- Name, title of observer
- Time of arrival at monument
- Height of instrument (feet & meters) at beginning of observation
- Type of serial number of GPS receiver
- Type of serial number of Tribrach
- Observation period
- Epoch rate
- Satellites observed
- Height of instrument (feet & meters) at end of observation
- Additional notes describing problems encountered during observation

Where existing control points are recovered in extending supplemental control, the ground control report shall include the following information:

- Information as to the general condition of the recovered mark
- The original description
- Exact letter and numbers stamped on the mark and amended description
- Additional tie data
- Key plan of the location as appropriate to facilitate future recovery

2.6. Orthoimagery Processing and Delivery

2.6.1 Aerotriangulation

Following is a step-by-step description of the aerotriangulation (AT) process:

Step 1: The unprocessed imagery and accompanying GPS and IMU data for one or more airborne missions is downloaded from the portable hard disks and checked to verify that no files are corrupted and that all data is usable. Sample segments of the imagery are inspected in an uncorrected state to verify the integrity of each data set.

Step 2: The GPS/IMU parameters for each airborne mission are optimized using the ground control points and the error calibration map. The horizontal and vertical positions of all ground control points in the block are observed in each panchromatic band.

Step 3: The ground control, GPS, and IMU information is ingested and tie points between strips are identified.

Step 4: The AT produces a bundle adjustment for each data block (consisting of multiple lifts or sorties). A digital file containing the RMSE computations of the adjustment is derived. The results of the adjustment are verified through the development of a sub-sampled panchromatic mosaic chip for the data sortie. The mosaic is corrected using the aerotriangulation points only. This mosaic is inspected by the photogrammetric technician to identify any gross errors in the adjustment, as well as the identification of any voids or image quality problems. A full report on the methodology and results of the AT adjustment is prepared and delivered shortly after completion of this phase.

2.6.2 Initial Radiometric Adjustments

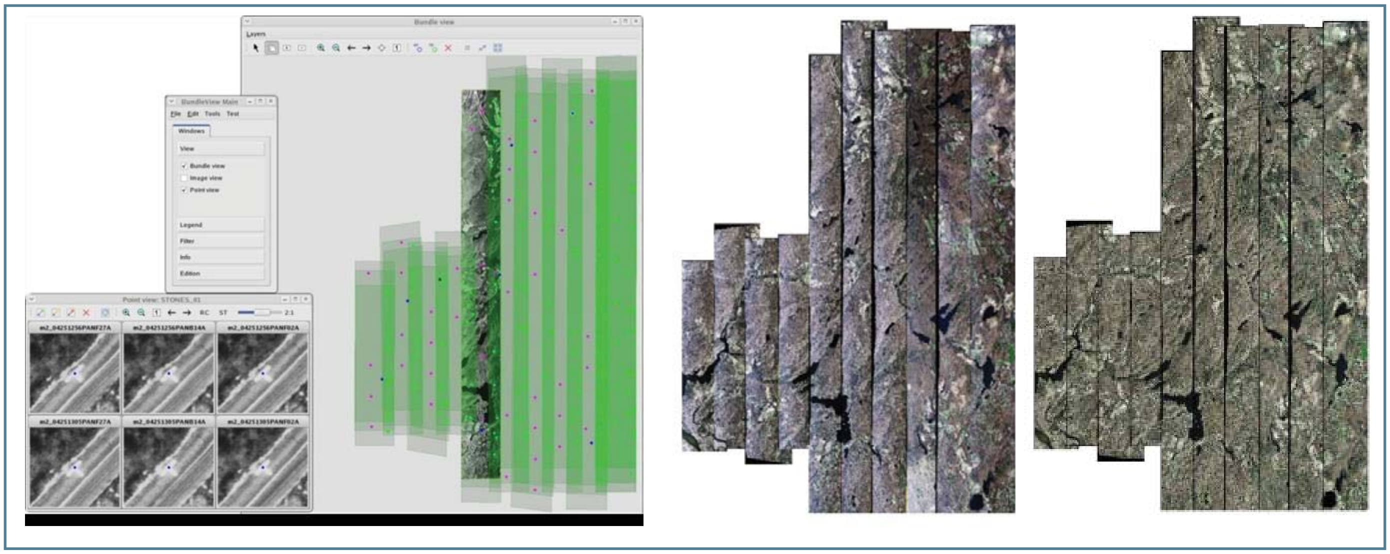
Radiometric processing will compensate for the effects of temperature, aperture, and other radiometric factors. A set of intermediate images are generated from radiometric processing and are written to the intermediate storage on the central server. Using our proprietary image color and radiometric balancing software, we implement a process that reduces the lens vignetting and any image hotspot effects.

The software then applies a global histogram manipulation to balance the image in tone, contrast, and color to re-create the “real world” view of the project area. This is accomplished while maintaining the largest dynamic range possible. This software allows us to easily switch between viewing each individual image and an entire project block for balancing. We use these techniques to confirm the radiometric balance for the AT block on our projects. Prior to full orthoimagery production, Fugro will submit sample imagery to become the standard for which the final orthoimagery will be compared to.

2.6.3 DEM Extraction

Fugro will utilize and update the existing DEM and additional “OrthoDEMs” in order to generate the orthoimagery to the requested scale.

In the absence of an existing DEM, the Socet Set Automatic Terrain Extraction (ATE) program can process the ADS L1 stereo models to produce ortho suitable DEM’s. Typical project methods are to provide the ortho imagery using an auto-correlated DEM. This process would speed up the ortho deliverable without having to wait for a compiled DEM or edited lidar dataset while meeting orthoimagery ASPRS Class I Standards. Typically, grid DEM’s are created and then stereo edited with the Socet Set Interactive Terrain Edit



program (ITE). ITE is also used as a quality control tool to examine the correlated DEM produced by ATE.

2.6.4 Creation of L2 Strip Ortho Images

With the refined orientation data file from aerotriangulation and a suitable DEM, XPro is again used to produce a strip ortho for all or a portion of a flight line. This task is computer intensive and normally the process is divided across many nodes of the Condor computer cluster. Several processing options are available including creation of single band, RGB, FCIR or 4-band ortho images. The factory radiometric calibration is applied and the modified Chavez Atmospheric (haze removal) correction may be applied. The output image is segmented so as to stay under the 4GB tiff file size limit. Each of the segments carries its own geo-reference so further processing may be done on individual segments.

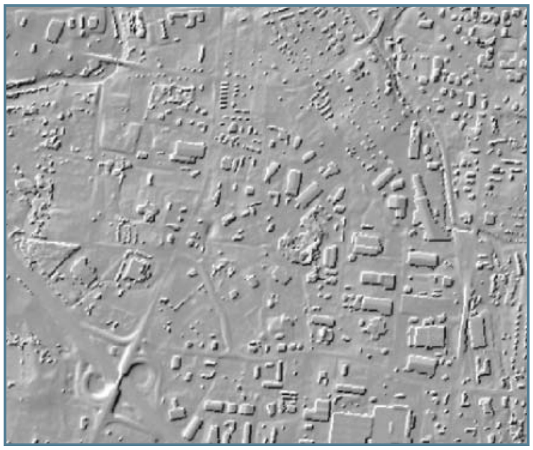
2.6.5 Generate and QA Mosaics

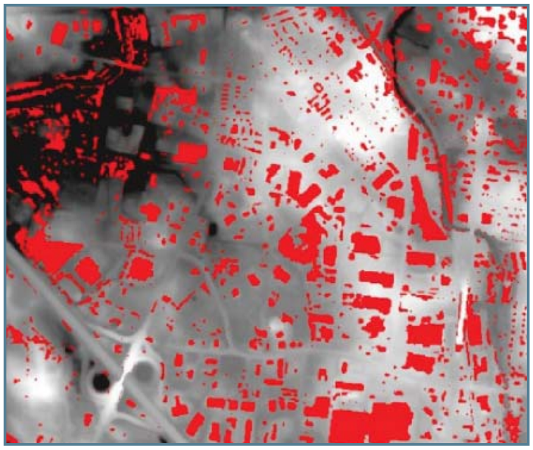
Digital orthos are visually checked for accuracy on the workstation screen, and its absolute accuracy is verified by overlaying and comparing the locations of the paneled control that are visible on the image against a CAD file containing the point locations in vector form. The edge matching of adjacent strips of imagery is accomplished using a single color band from adjoining strips of imagery displaying each strip in alternating colors of red and cyan. In areas where the overlapping images are coincident, the imagery appears in a gray scale rendition while any offset is colored red or cyan . Any offsets are measured to confirm that the offset falls within the accuracy specification for the project.

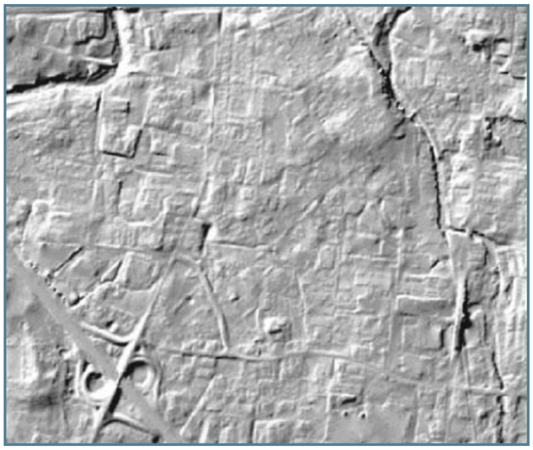
Subsampled L2 strip orthos are exported and parameters are developed. The finishing department radiometrically balances the subsampled L2 tracks while the auto-generated seam lines undergo manual inspections and alterations to prevent splitting buildings and minimizing above ground features from being clipped.

The balanced subsampled L2 tracks are then imported and mosaicked using the final edited seam lines. The subsampled mosaic is then applied to the full resolution tracks and mosaicked.

The final mosaic undergoes another round of inspection and then packaged to the final projection and tile layout. The finishing department performs a 100% final visual check for ortho image quality prior to outputting the approach data to the designated media. The media is then inspected to confirm that there is no corruption within the data files and to confirm that all of the needed data files are on the designated media. The project manager is responsible for conducting a final overview QC of all deliverables leaving the department. A review of the lead technician's QC, file management procedures, and delivery format and coverage are all checked a final time before a deliverable is sent out. Reporting of deliveries and submitting any QC reports is the direct responsibility of the project manager.


DEM Before Filtering


DEM After Filtering


Final DEM

2.6.6 Spatial Metadata

Fugro will develop and deliver metadata for each GeoTIFF, DEM used for production and project wide for the orthophotos in an ArcCatalog compatible XML format using the client's metadata template.

Metadata records will be developed to document each data deliverable in accordance with the FGDC Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998). Compliance with these guidelines will be verified using the MP metadata parser available on the FGDC web portal. Metadata records will be peer reviewed to identify and correct any typographic or other errors that would not be flagged by automated tools.

Fugro has developed proprietary automated metadata tools that greatly increase the speed and efficiency of metadata production. During the imagery production a metadata master file is developed that has input and review from leads at all key phases of production. Once the master file has been submitted and approved by the customer it is used to propagate tile level metadata.

2.7. Planimetric Features

Fugro has extensive experience in the collection of digital planimetric features using stereo compilation techniques to meet National Map Accuracy Standards. From the newly collected airborne imagery, Fugro will deliver planimetric mapping and other forms of feature extraction at the requested scale. Fugro's compilation workstations are capable of clear, precise stereoscopic viewing and quick and efficient processing. Each workstation is equipped with verification and validation software to ensure the quality and accuracy of the data collected meets client expectations. Fugro will deliver each dataset in an enterprise file geodatabase compatible format (ArcSDE and Microsoft SQL Server) which will minimize the effort needed to load the data into the final File Geodatabase design.

2.7.1 Review Existing Data / Geodatabase Design

While building the technical approach and pricing for the planimetric and topographic portion of this project, Fugro has reviewed the provided data dictionaries, design, and explanations for collecting and delivering the mapping data for ACOG with Fugro's map compilation department to be sure our approach meets ACOG's expectations. Before beginning project, Fugro will coordinate with ACOG to establish and finalize the spatial extent and precision for file geodatabase feature classes to be delivered to each participant.

2.7.2 Vector Delivery

The final map scale will meet the National Map Accuracy Standard relevant to the pixel resolution of the source imagery. Vector data will be delivered with the following characteristics:

Format:	ArcSDE 10.1 or 10.2/ MS SQL File Geodatabase
Map Units:	Feet
Coordinate System:	Coordinates/Projection: State Plane Coordinate System, Zone: Oklahoma North, FIPS Zone 3501, 3502 Horizontal Datum: NAD83 (HARN, CORS96)

2.7.3 Planimetric Methodology and Quality Control

Planimetric Methodology / Quality Control: Digital planimetric mapping will be collected in strict accordance with the feature types and formats specified by the County. Fugro will capture planimetric information using KLT Atlas softcopy photogrammetric workstations. Quality control (QC) and editing tasks are performed in the MicroStation environment.

Fugro's technical staff has considerable experience customizing the MicroStation environment and will incorporate client standards into the feature collection tables for each workstation at the start of the project.

Fugro has perfected a "hand shake" transfer of data (which has been refined through completion of numerous projects) from the CAD to the GIS environment. Fugro has a proven production workflow that was designed specifically to maintain the 3D elements and topology of the planimetric mapping once data is migrated to the Esri file geodatabase environment keeping the needed attribute information. The following is a step-by-step description of the planimetric vector compilation, editing and quality control process.

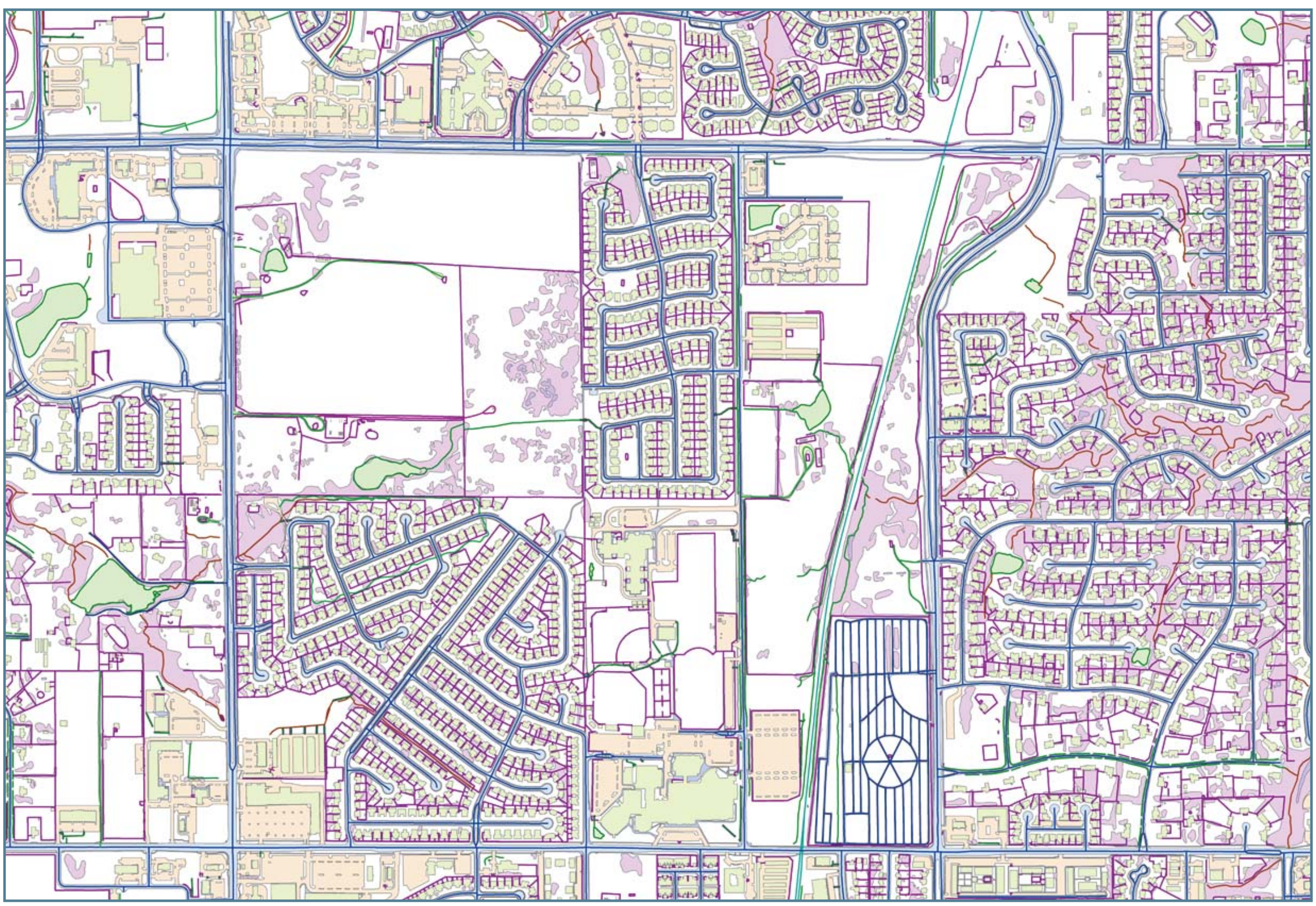
Step 1 The project will be set up on softcopy photogrammetry workstations by the photogrammetric technician who will create a separate project directory for the project. In orienting the models, the technician will select the stereo pair he/she wants to start with and imports the necessary imagery to the workstation. Relative and absolute orientation will be achieved by importing the orientation parameters from the AT results. The software will import the stereo pair and orient the workstation automatically. At this point, stereo model orientation is complete.

Step 2 Prior to the initiation of compilation, a data capture matrix is set up in KLT Atlas on the softcopy photogrammetric and data edit stations by the photogrammetric and edit team members who are assigned to the project. The setup of the project is based on the specifications set forth in accordance with client specifications. The Atlas systems are programmed to support writing data to specific layers of the Atlas design file. The specific design and content of the geodatabase deliverables will be finalized during project planning.

Step 3 The compilation setup is verified through collection and formatting of several test stereo models. Fugro has developed a production workflow that is used when a mapping project requires the development of polygon topology. The photogrammetric technician collects features to be depicted as closed polygons and adds a label point within each feature. Fugro will collect all planimetric feature data in 3D mode. As the technician completes each stereo model, the Atlas file is given a unique name. The photogrammetric technician calls up the adjacent stereo models and performs a preliminary edge match to determine that features tie across model boundaries and to ensure that no features are omitted.

Step 4 As progressive stereo models are compiled, the operator conducts ongoing checks for the X, Y, and Z coincidence between stereo models (sidelap and overlap) verifying that no vertical shift occurs at model boundaries. This is a visual examination that can help identify any offsets attributable to the AT adjustment. All vector data features will be compiled in 3D with one digital file per stereo pair. This will simplify the tracking of the project through production and will eliminate the re-orientation of models. All features will be digitized to the edge of the provided project boundary. Polygons at the edge of the boundary will be closed.

Step 5 Cartographic editors review the compiled data to identify any systematic errors or inconsistencies between the newly collected data and the project's feature table. The datasets are further tested to verify that the conversion routine to produce the final ArcSDE geodatabase format correctly converts all layers of the digital files. The photogrammetric team leader will then review the results. Copies of completed test data with accompanying documentation regarding requirements and routines will be circulated to all Fugro production units for use as a standard in data collection. Fugro's project manager and the photogrammetric team leader will conduct a final review of all planimetric mapping data prior to delivery.



2.8. Contour Production Process

Utilizing Fugro trained cartographic enhancement personnel; the contour production process begins with the input of the Digital Terrain Model (DTM) surfaces as a base and ends with the generation hydro-enforced one foot contours. The production process continues through production and quality control activities and ends when the identified tasks are completed, archived to the network, and the Project Manager, Production Analysts and Geospatial Team Lead conduct a final review/approval of the product.

2.8.1 Input Criteria

An initial inspection of the input data will verify all information received meets the following standards:

- Hydro Breaklines Inspection – Better than USGS 1.2 QL2 Lidar Base Specifications
- Features will be interpreted correctly and QC'd for incorrect elevations. Flagged elevations will be fixed before submission to contour generation steps.
- Data will cover the entire area, without gaps or overlaps, and will contain all data required to fill the client-specified project boundary with any relevant overage.
- Data will adhere to client-specified production parameters (including accuracy standards).

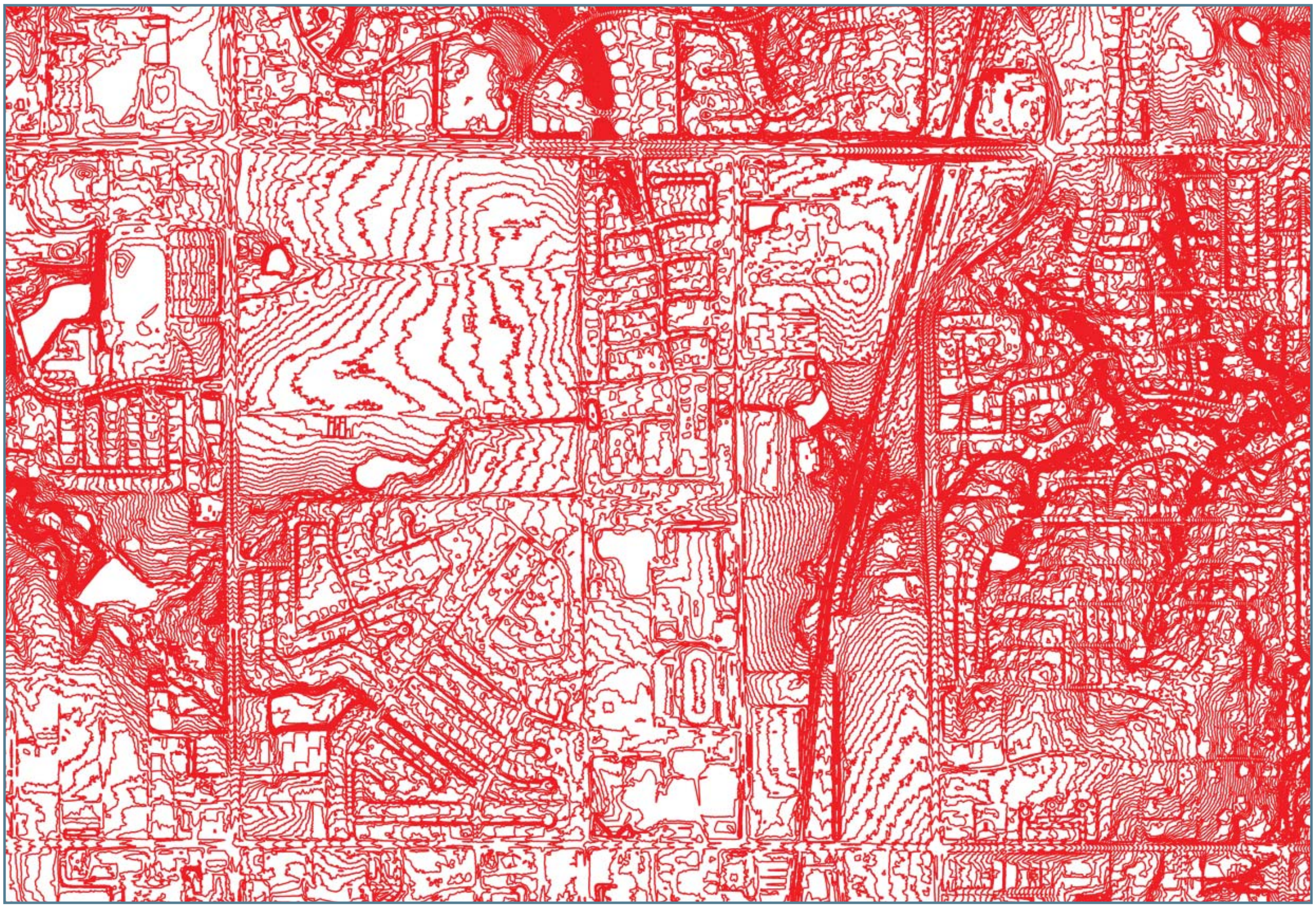
2.8.2 Hydro Analysis

Fugro has conducted a review of the existing data and has determined an updated hydro breakline collection will be required to generate contours to be more aesthetically pleasing.

2.8.3 Preparation Existing Elevation Data and Breaklines for Contour Generation

Preparing the input breakline data for contour generation consists of the following activities:

- Duplicate input dataset to maintain the integrity of the original data.
- Inspect DTM to be sure all elements collected are on the ground. Any features considered floating, digging or do not have an elevation attribute will be removed



from the DTM.

- Perform detailed analysis of the hydro-breakline data. During this process, additional water features may be manually compiled to produce breakline data along narrow rivers, single-line streams, small ponds, etc. that are not typically collected for a hydro-flattened dataset.

2.8.4 Contour Generation

Contour generation in MicroStation using TerraSolid begins with the project setup to include preparing software packages to receive input data, set storage criteria, input tile layouts, project details and the contour keypoint macro creation. The contour keypoint macro parameters are set to select points from the LAS file that best represent the ground features for contour generation.

Contour keypoints are classified as "Class 8" with input criteria that best represents the project specifications and client preferences for contour aesthetics. This process analyzes points on the ground in groups and selects the point that best represents the bare earth while eliminating points unnecessary for generating contours.

- Contour interval set to 1foot
- Adjust contour key processing sensitivity to manage accuracy versus aesthetics Breakline data is imbedded and buffered to two times the density to select and remove key points that coincide with the breakline vector data to force the contour location to the breakline during contour generation.

Internally the program creates a tin overlapping the tiles by using the neighboring points to ensure the contours tie. This overlap is inspected for any anomalies or errors that may cause the contour data to misalign. Any misalignments are corrected for a seamless transition of contour data between tiles.

2.8.5 Contour Finishing

Final products will meet the requirements listed in the client supplied RFP.

- Contour data will depict the surface for hydro-enforced one foot contours
- Contour data will cover the entire area of each sheet for the entire client-specified project boundary.
- Levels and symbology will be classified in accordance with the layering symbology table shown below.
- Topology checks to verify data set will not contain gaps, overlaps, overshoot, undershoot, crossing contours, self-intersect (i.e. butterfly) and multipart errors.

Data leaving the cartographic enhancement department and going to the client will meet the following additional minimum requirements:

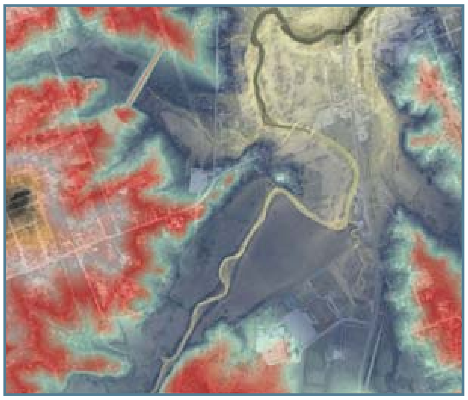
- Contours will be edited as necessary and reflect the ground surface.
- Contours will meet the requested accuracy standards.

2.9. Lidar DATA Acquisiton

Collection activities consist of safety inspections and operational inspections of aircraft and sensors and the acquisiton of data to the project specifications when weather and airspace present the opportunity.

Below is an itemized acquisition scenario for airborne data collection:

- Inspect storage and system components to ensure all units are operational and there is sufficient storage space
- Select and confirm the lever arm coordinates
- Load navigation system and perform system check
- Perform 5 minute static alignment and record PDOP, GPS, and UTC start time
- Ensure IMU is operational
- Ensure all channels are operational, as applicable
- The crew begins flight line data recording: observe video display, POS status and mass memory screens; record UTC start/stop times, GPS data, ground speed, altitude, concerns, lines, waypoints and times on flight log
- After the flight mission is complete, a 5 minute static alignment will be performed followed by a systematic shutdown of the system
- Collected data is downloaded for in-field QC
- Arrange delivery of data and email flight log to team; perform data backup



At the end of each day's data collection effort, the sensor operator forwards the completed flight logs to the Aviation Team and Project Manager to update Fugro's Project Tracking system. This system (Fugro Access) is available for all project participants for up-to-date project relevant information, including flight line status and acceptance.

Quality control measures are performed before the flight/acquisition crew(s) leaves the project area. Issues in terms of gap coverage or quality are identified; re-flight of specific areas will be immediately scheduled. Airborne GPS and IMU data are field processed to ensure that the GPS satellite geometry and that IMU data will support the accuracy requirements. If problems of data quality of raw image data or project coverage are found, re-flights are called for immediately.

2.9.1 Initial Data QC and Positioning

Global Navigation Satellite System (GNSS) and IMU data are the basis for accurate flight line positioning during processing and are critical to the overall accuracy of the final lidar product. Airborne GNSS and IMU data will be processed using either Fugro operated base stations and/or with the use of actively recording GNSS/GPS stations (CORS) located within acceptable baselines of the project area available to the flight crew upon landing to ensure the integrity of all the mission data. These results will be used to perform the initial lidar system calibration test. Immediate processing is necessary to identify any potential issues early so corrective actions can be taken or re-flights can be called with as little impact to the acquisition schedule as possible.

The technician will first process the raw lidar data to LAS format flight lines with full resolution output before performing QC. A starting configuration file is used in this process, which contains the latest calibration parameters for the sensor. The technician will also generate flight line trajectory files for each of the flight lines during this process. The technician will conduct the following checks of the lidar data:

- Trajectory files will be reviewed to ensure completeness of acquisition for project flight lines, calibration lines, and cross flight lines.
- Intensity images will be generated for the entire lift at 1 meter nominal point spacing, visually inspected against the project boundary to ensure full coverage, and have the histogram analyzed to verify the quality of the intensity values.
- Data will be reviewed for gaps in project area.
- Sample TIN(s) will be generated to ensure no anomalies appear in the data.
- Achieved post spacing will be evaluated against the project-proposed post spacing.
- Turbulence is inspected and if quality is impacted the flight line will be rejected and re-flown.

Failure of any of these checks will result in corrective actions or re-flights. Once all checks have been passed, the lidar data is considered ready for boresight calibration and production.

2.9.1.1 GPS Accuracy

The absolute and relative accuracy of the data, both horizontal and vertical, and relative to known control, will be verified prior to classification and subsequent product development. Accuracies will be reported to meet the accuracy requirements listed in the SOW. Two (2) GPS reference stations will be operational during all missions, sampling positions at 1Hz or higher frequency. The GPS baseline lengths will not exceed 40km. Lidar data will only be acquired when GPS PDOP is less than 4 and at least 6 satellites are in view.

GPS Accuracy Specifications

Accuracy: ASPRS Class 10cm	Non-vegetated	$RMSE_z$	<10 cm
		$Accuracy_z$ 95%	<19.6 cm
	Vegetated	$Accuracy_z$ 95%	<29.4 cm
	Horizontal	$RMSE_r$	<25.0 cm
	Relative (swath to swath)	$RMSD_z$/Max Diff	<8.0/16.0 cm

2.9.2 Lidar Data Processing

2.9.2.1 Boresite

The lidar calibration and boresight process is fundamental to achieving the final accuracy of the lidar data by identifying a set of parameters that corrects for misalignment between the lidar flight lines so they can be seamlessly brought together and vertically adjusted to the ground control points.

Calibration lines are identified for each lift and are flown in the opposite direction of the original line; these lines are processed first using the sensor parameters. To begin the boresight, the calibration line, original flight line, adjacent flight line and a perpendicular cross tie are compared to diagnose roll and pitch, and potential heading or scan angle error. The calibration parameters are refined and then applied to the all of the flight lines in the given lift and further refinements may be made.

Once all lifts are completed with boresight adjustment individually, relative vertical misalignment between flight lines will be checked and corrected with a block adjustment. The block adjustment uses the flight lines and ground control points to calculate the bias values for the individual flight lines and the entire block so that all flight lines are aligned vertically. The entire dataset is then adjusted to the ground control points through a z correction.

A final vertical accuracy check will be run after the z correction; the result will be analyzed against the project specified accuracy to make sure it meets the requirement. The accuracy check result is then archived for future reference.

The raw point cloud deliverable is created after boresight and contains uncut flight lines re-projected to meet the deliverable specification.

2.9.2.2 Point Classification

Once boresighting is complete, the project will be set up for automatic classification. First, the lidar data will be cut into production tiles and the flight line overlap points, noise points and ground points will be classified automatically. We utilize commercial software as well as proprietary in-house software for automated filtering. The parameters used in the process are customized for each terrain type to obtain optimum results. These parameters can also be customized (if required) to capture multiple categories of vegetation based on height (low, medium and high vegetation). After all “low” points are classified, points remaining are reclassified automatically based on height from the ground.

The classification algorithm has the ability to process large amounts of elevation point data in batch mode. The goal of this initial automated process is to classify the points to their proper point classification as accurately as possible (during the first pass); thereby reducing the amount of manual editing that is required. The water points will be classified once hydro breakline vector data is collected and checked for quality.

Once the automated filtering is complete, the files are run through a visual inspection to ensure that the filtering was appropriately aggressive. In cases where the filtering is too aggressive and important terrain features have been filtered out, the data is either run through a different filter within a local area or is corrected during the manual filtering process. Interactive editing is completed in commercial and proprietary visualization software that provides manual and automatic point classification tools. All manually inspected tiles will then go through a peer review to ensure proper editing and consistency before a final automated classification routine. This process ensures only the required classifications are used in the final product (all points classified into any temporary class during manual editing will be re-classified into proper customer specified classifications). During this process vegetation points are classified and the flight line overlap points are tagged as withheld points.

The LAS point cloud data will then be packaged to the project specified tiling scheme and clipped to project boundary and LAS delivery format. It will also be re-projected to project specified projection, datum, and unit.

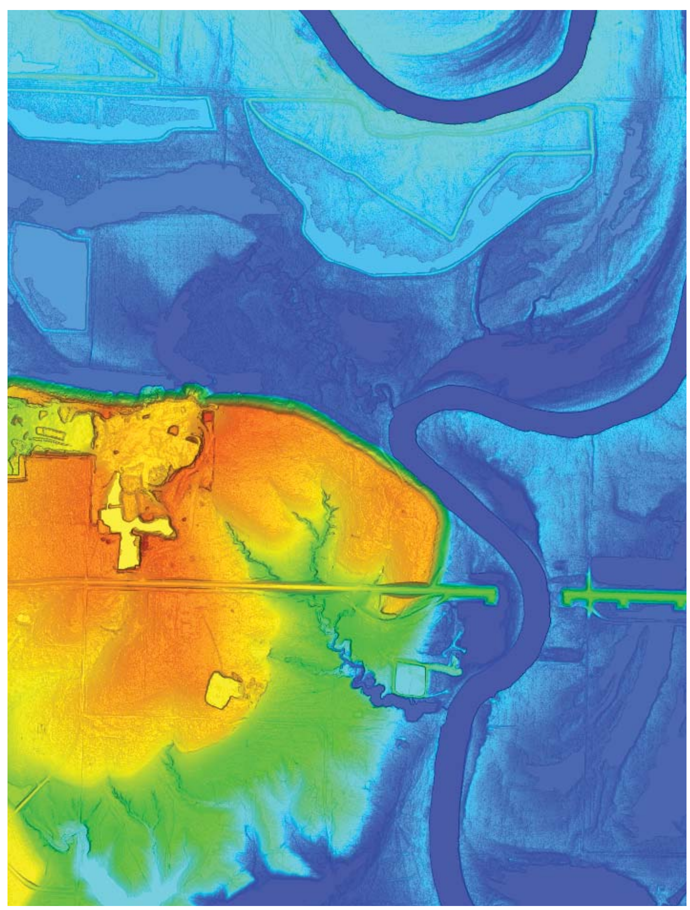
The file header will be formatted to meet project specifications. This ASPRS standard Classified Point Cloud product will be used for the generation of derived products and will be delivered in fully compliant LAS v1.4, Point Record Format 6 with Adjusted Standard GPS Time. Georeferencing information will be included in all LAS file headers. Intensity values will be included for each point and the Point Source ID will match to the flight line ID files.

Fully Classified All-Return Point Cloud

Format	All-return point cloud in fully-compliant LAS version 1.4. All points must be classified according to the ASPRS classification standard for LAS.		
Spatial reference	LAS files will use the Spatial Reference Framework according to project specification and all files shall be projected and defined.		
ASPRS Classifications Required	Class 1. Unclassified Class 2. Bare-earth Ground Class 3. Low Vegetation	Class 4. Medium Vegetation Class 5. High Vegetation Class 6. Building Class 7. Low Point (noise)	Class 9. Water Class10. Ignored Ground Class 13. Bridges Class 14. Culverts
Withheld points	Outliers, noise, blunders, geometrically unreliable points near the extreme edge of the swath, and other points deemed unusable are to be identified using the "Withheld" flag. This applies primarily to points which are identified during pre-processing or through automated post-processing routines. Subsequently identified noise points may be assigned to the standard Noise Class (Class 7), regardless of whether the noise is lower or higher relative to the ground.		
Overlap class	The ASPRS Overlap Class (Class 12) shall NOT be used. All points must be classified unless identified as "Withheld".		
Classification accuracy	Within any sample 1 km x 1 km area, no more than 1% of non-withheld points in the classes listed above will possess a demonstrably erroneous classification value. This includes Unclassified points (Class 1) that should be correctly included in a different class as required by this specification. This requirement may be relaxed to accommodate collections in areas where the TWDB agrees classification to be particularly difficult.		
Classification consistency	Point classification shall be consistent across the entire project. Noticeable variations in the character, texture, or quality of the classification between tiles, swaths, lifts, or other non-natural divisions will be cause for rejection of the entire deliverable.		

2.9.3 Intensity Image Production

Intensity images of the first returns will be created at 1.0 meter pixel DO4Q tiles. As a value added product, Fugro is offering an upgrade to 0.25 meter pixel 400mx400m tiles. Similar in appearance to low-resolution photographs, georeferenced lidar intensity images can be used to extract planimetric features and serve as ancillary input for lidar data processing. They are also used to check the horizontal accuracy of the lidar data and other criteria. Intensity imagery will be delivered as a raster image of first-return intensity values in GeoTIFF format. Radiometric resolution will be 8, 16 or 32 bit containing original digital number values ranging from 0 -100 or greater for ≥ 80% of areas with diverse land cover conditions.



2.9.4 Hydro Modeling

Lidar data consists only of points, which are not suitable to define water flow through the terrain, but hydro breaklines are suitable for current hydrologic and hydraulic (H&H) modeling practices. Hydro breaklines are required to flow in a downhill direction and may deviate from the underlying lidar terrain surface. The elevation components of the breaklines are derived from the lowest adjacent bare earth lidar point. Hydrographic features are collected as separate feature types which can be classified as water body polygons, centerlines and bank lines and digitized into a shapefile.

Hydro-flattened breaklines

SPECIFICATION	DESCRIPTION
Format	All breaklines developed for use in hydro-flattening will be delivered as a non-tiled Esri feature class for the entire AOI in polygon and/or polyline shapefile or geodatabase format. Waterbodies (ponds, lakes, and reservoirs), wide streams and rivers ("double-line"), and other non-tidal waterbodies will be hydro-flattened within the DEM, resulting in a flat and level bank-to-bank gradient. The entire water surface edge must be at or below the immediately surrounding terrain. Bare-earth lidar points that are near the breaklines (proximity not to exceed NPS) shall be classified as Ignored Ground (class value equal to 10).
Spatial reference	Breakline feature class will use the Spatial Reference Framework according to project specification and will be projected and defined.
Stream resolution	Hydro-flattening will be applied to all streams that are nominally wider than 15.25 meters, and to all non-tidal boundary waters bordering the project area regardless of size. Stream features should be made continuous even when a segment narrows below this threshold for a distance of at least 1600 meters to maintain cartographic integrity. Flattened rivers and streams will present a gradient downhill water surface, in accordance with the immediately surrounding terrain. In cases of drought, flood or rapidly moving water demonstrating conditions where the water surface is notably not level bank to bank, the water surface will be represented as it exists during acquisition while maintaining an aesthetic cartographic appearance.
Waterbody resolution	Hydro-flattening will be applied to all water impoundments, natural or man-made, that are nominally larger than 1 hectare in area (equivalent to 10,000 m2 or roughly equivalent to a round pond ~100 meter in diameter). Long impoundments such as reservoirs, inlets, and fjords, whose water surface elevations drop when moving downstream, are required to be treated as rivers.
Non-tidal boundary waters	Represented only as an edge or edges within the project area; collection does not include the opposing shore. Water surface will be flat and level, as appropriate for the type of water body (level for lakes; gradient for rivers). The entire water surface edge will be at or below the immediately surrounding terrain.
Tidal waters	Tidal water bodies are defined as water bodies such as oceans, seas, gulfs, bays, inlets, salt marshes, large lakes, and the like. This includes any water body that is affected by tidal variations. Tidal variations over the course of a collection or between different collections will result in lateral and vertical discontinuities along shorelines. This is considered normal and these anomalies should be retained. The final DEM is required to represent as much ground as the collected data permits. Water surface is to be flat and level, to the degree allowed by the irregularities noted above. Scientific research projects in coastal areas often have specific requirements with regard to how tidal land-water boundaries are to be handled. For such projects, the requirements of the research will take precedence.
Islands	Permanent islands 5,000 m2 or larger will be delineated within all water bodies.
Culverts	Stream channels will break at road crossings (culvert locations). These road fills in Class 14 Culverts will not be removed from the DEM. However, streams and rivers will not break at elevated bridges. Bridges will be removed from the DEM. When the identification of a feature such as a bridge or culvert cannot be made reliably, the feature will be regarded as a culvert.

2D Topological QC: After initial collection, features are combined into working regions based on watershed sub-basins. Line work is then checked for the following topological and attribution rules:

- Lines must be attributed with the correct feature code (stream, stream bank line, etc.).
- Lake and stream bank lines must form closed polygons.
- Non-bank lines must be digitized from uphill to downhill
- Dangles must exist only at upstream headwater end of streams, and at the downstream outfall
- Line intersections must be at nodes
- Non-bank line features must form a dendritic collection network. No line stream may split in its course downhill, and every line in a given network must feed to a common outfall

A bounding polygon, created from the edge of bank lines, is used to remove all points within the channel. Automatic processes assign elevations to the vertices of the centerline based on surrounding lidar points and the lines are then smoothed to ensure a continuous downhill flow.

3D Attribution: Vertex elevation values are assigned using a distance weighted distribution of lidar points closest to each vertex. This is similar to draping the 2D line work to a surface modeled from the lidar points. A series of processes is then applied to the line work for downhill flow enforcement. The output 3D hydro breaklines will be at least slightly lower than the surface created from the lidar points alone. A TIN or GRID surface is created using both the lidar points and the new hydro model lines, the hydro model lines ensure that the surface reflects identifiable flow through the network of hydro model lines. This characteristic of the bare earth surface is critical for the hydrologic and hydraulic modeling that is the primary purpose of the lidar hydro model lines dataset.

2.10. Hydro-flattened Bare Earth DEM Creation

The bare-earth DEM is generated from the bare-earth classified points and the 3D breaklines using commercial off the shelf and Fugro proprietary software. The hydro-flattening process is done by withholding all points within 1*NPS along the hydro breaklines to indicate that these are returns off of water and assigning the lowest elevation value to the DEM within the water feature. The lidar analyst will produce the bare earth DEM surface grid format in the appropriate final tile schema.

The transition of the surface from tile to tile will be seamless and water bodies (inland ponds and lakes), inland streams and rivers, and other non-tidal water bodies will be hydro-flattened.

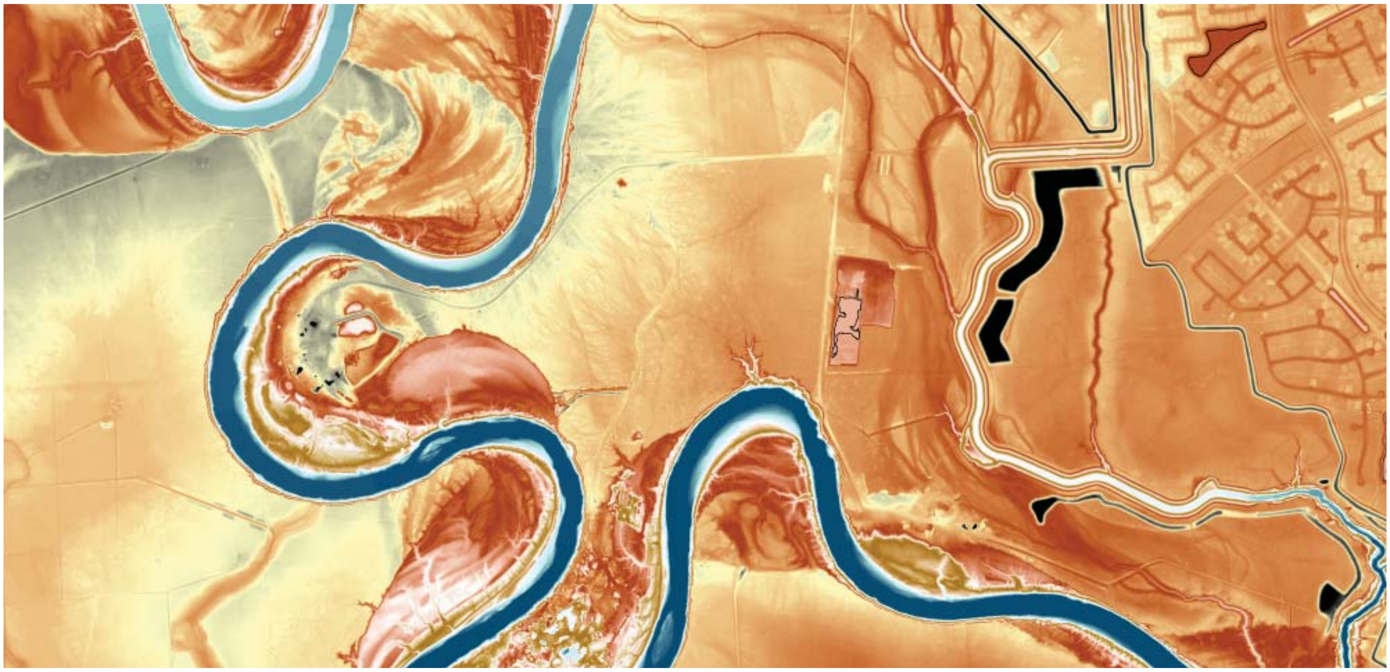
2.11. Metadata

Metadata records will be developed to document each data deliverable in accordance with the FGDC Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998). Compliance with these guidelines will be verified using the MP Metadata parser available on the FGDC web portal. Metadata records will be peer reviewed to identify and correct any typographic or other errors that would not be flagged by automated tools.

Fugro has developed proprietary automated metadata tools that greatly increase the speed and efficiency of metadata production. During the imagery production a metadata master file is developed that has input and review from leads at all key phases of production. Once the master file has been submitted and approved by the customer it is used to propagate tile level metadata.

Product Development Specifications

BARE EARTH LIDAR / DEM RASTER	
Format	Hydro-enforced 32-bit floating point raster DEM in (TBD at kick-off meeting) format to nearest 0.01 m is preferred, however similar raster formats may be permitted at the discretion of the TWDB.
Spatial reference	DEM files will use the Spatial Reference Framework according to project specification and all files shall be projected and defined.
Spatial resolution	1-meter DO4Q tiles
Quality	No seams, gaps, or quilting should be visible (unless naturally occurring), whether caused by differences in processing quality or character between tiles, swaths, lifts, or other non-natural divisions and will be cause for rejection of the entire DEM deliverable. There shall be no “plateau effect” from rounded or integer elevation values (must be floating point). Also see ‘Data voids’ under Project Requirements.
Artifacts	Vegetation, bridges, buildings, and other artifacts must be completely removed from Class 2 Bare-earth Ground. Artificial dams in waterways caused by bridges or other adjacent structures are not permitted with the exception of culverts. See ‘Culverts’ under Hydro-flattening Breaklines for more information.



2.12. Equipment Capacity

Fugro's aerial mapping-based acquisition and processing capabilities include a fleet of aircraft equipped with state-of-the-art computer navigation, gyroscopic mounts, forward motion compensation (FMC), airborne GPS, and inertial measurement unit (IMU) systems. Computer-assisted flight planning software interfaces directly with the onboard flight management system is used for all sensors. In addition, Fugro's state-of-the-art geospatial facilities house ample acquisition resources including multiple digital imagery sensors (ortho and oblique), multiple lidar sensors for any application, and super-computing data processing and storage resources. The following tables detail Fugro's specific assets related to aerial data acquisition and production:

AIRCRAFT

MAKE	TYPE	QYT
Cessna 441 Conquest-II	Turbo Prop	3
Cessna 310-R	Piston	1
Cessna Caravan	Turbo Prop	1
Piper Navajo PA31-350	Piston	2
Gulfstream II	Jet	1

AIRBORNE GPS AND IMU SYSTEMS

MAKE / MODEL	TYPE	QTY
Ashtech Z Extreme	GPS Receiver	13
Ashtech Z Surveyor	GPS Receiver	3
Applanix POS/AV 510	IMU System	5
IPAS10 IMU system	IMU System	2

Aerial Imagery Acquisiton Systems

MAKE / MODEL	TYPE	QTY
Leica ADS80-SH82	Digital Imagery (Sweep/push Broom)	4
PanoramiX (MIDAS)	Digital Imagery (vertical & oblique)	3
PanoramiX (A3)	Digital Imagery (vertical & oblique)	2
Z/I DMC	Digital Imagery (Frame)	1
Zeiss RMK TOP 15	Large Format Film Imagery (Frame)	1

Imagery Processing Software / Hardware

MAKE / MODEL	TYPE	QTY
Pixel Factory	Software	12
Pictovera	Software	12
VisionMap	Software	20
Lightspeed / Finishing Software	Software	22
Leica XPRO	Software	5
KLT Atlas	Software	5
ERDAS LPS	Software	5
Orthovista	Software	5
Intergraph SSK	Software	4
SOCET SET v5.3.1	Software	10
Pixel Factory Servers	Hardware	2
Pixel Factory Blade Computers	Hardware	48 (x2)

Aerial Lidar Acquisiton Systems

MAKE / MODEL	TYPE	QTY
Leica ALS50-II	Topographic Lidar	1
Leica ALS60	Topographic Lidar	2
Riegl LMS Q680i	Topographic Lidar	1
Riegl LMS Q680i (Roames)	Topographic Lidar	6
Riegl LMS Q780i (Roames)	Topographic Lidar	6
Riegl LMS Q1560 (Roames)	Topographic Lidar	1
Fugro FLI-MAP Fx (Fixed Wing)	Topographic Lidar	1
Fugro FLI-MAP 400 (Helicopter)	Topographic Lidar	7
Riegl VQ820 G	Bathymetric/Topographic Lidar	1 (leased)
SHOALS 100-T	Bathymetric/Topographic Lidar	2
LADS Mk III	Bathymetric Lidar	1

2.13. Internal Quality Control

Fugro is committed to providing timely delivery of high-quality geospatial products and services. The success of the project is realized through a combination of comprehensive planning and a structured approach to quality control. With an emphasis on identifying potential risks, mitigations and preventing errors, our planning and assessment procedures ensure that all products delivered under this contract meet the highest possible quality standards.

Fugro's ISO9001:2008-certified Quality Management System (QMS) encompasses all operations—from aviation operations to finance—and provides customers with an added level of assurance in our design, development, production, and delivery processes. Fugro will require inputs from the State personnel to develop quality control acceptance criteria, as well as to provide feedback during the production and review and acceptance processes upon final delivery.

The history of our QMS dates back to 2001 when we first achieved certification for compliance to the ISO9001 quality standard. In November 2008, we achieved OHSAS 18001:2007 certification, and we achieved certification for ISO 9001:2008 compliance in 2010; recertified in 2016.

The success of our QMS system is evidenced by a number of improvements, including our first-time-right delivery rate, which improved to over 99% for orthoimagery since 2009. More importantly, Fugro has realized dramatic and measured improvements for cycle time reduction, reduced rework, improved subcontractor management, and performance. Together, these achievements have benefitted our customers by transferring the burden of quality control from the customer to Fugro. Finally, a key component of our QMS is the mandatory process of auditing and updating production and management procedures and quality metrics. This requirement allows us to continually and efficiently adapt our processes to technology innovations, which then translate into benefits for our customers.

Fugro's commitment to the success of your project includes three (3) separate types of quality control processes to ensure all specifications for quality and timeliness meet or exceed COAGA requirements:

- 1. Quality Control of Subcontractor Work
- 2. Project Management Quality System
- 3. Internal Quality Control Processes

Based on COAGA requirements, specific quality control checks are built into each production process so that quality control occurs throughout the life of a project and not simply as a final review.

2.13.1 Quality Control of Subcontractor Work

Fugro ensures that all team subcontractors abide by the same or similar procedures during their own internal production processes and requests the same level of documentation be submitted to Fugro for review by the project manager. Furthermore, all data produced by any of the State-approved subcontractors is quality-controlled by our staff using the procedures mentioned in the above diagram prior to incorporation into our own production process or prior to submission to the State.

2.13.2 Project Management Quality System

Our approach to project management is based on previous experience serving on multiple contracts similar in nature and scope. Once the project criteria are determined the project manager maintains communications with the team lead throughout the project through weekly production meetings, email, and specific issue calls to ensure the project remains on track and within the project specifications. Building on past success and incorporating lessons learned, our program management plan is designed to meet the following objectives:

- Ensure the successful completion of each task order, on-time, first-time-right.
- Produce quality products and services.
- Provide a central source for all communications between the State and Fugro.
- Track progress against schedule and budget with regular reporting to the State and Fugro.
- Identify technical issues early and resolve them in a timely manner.
- Incorporate lessons learned into subsequent tasks.

2.13.3 Internal Quality Control Processes

As dictated by our QMS, internal quality control procedures are implemented and documented at each step of the project to ensure that all services required by the contract are completed to specification; they include visual (manual) inspections, automated routines, and technical reviews. Fugro's internal quality control procedures are based on the key components outlined in the following section. An overview of our quality policy that drives our continual effort to improve is detailed in the diagram on the following page:

ACCEPTANCE CRITERIA	REMEDIAL ACTIONS	QUALITY METRICS	APPROVALS	REPORTING
Production processes are based on decades of successful completion of projects and acceptance criteria that are incorporated in response to both internal and customer-specified requests.	Any quality issue is of immediate concern and is mitigated at the earliest possible opportunity. Technical staff members identify and resolve various potential issues; documenting both the nature of the problem, probability and severity levels, and the process used to address the issue.	Fugro's QMS contains an array of automated and manual metrics for each production process. Used to monitor cycle times and compliance with project specifications, these metrics provide a means to verify that any risks to quality are mitigated.	Our QMS documents the chain of command for approvals, starting with technical leads at each production phase. The project manager is responsible for making the final decision on any issue that cannot be resolved by the technical leads and may not be covered in the project scope of work.	Every mapping project presents its own unique challenges and technical issues that must be addressed in a timely manner. Open communication is a key element of our project management approach. Clients are informed of any quality issues that threaten the project schedule.

2.13.3.1 Acquisition QA/QC

Our QA/QC procedures for acquisition are broken down into the various phases of flight planning and data acquisition. The QA/QC steps for each acquisition phase are as follows.

Flight Planning

- Establish project boundary and flight plan based on the scope of work (SOW) and send to the client for review and approval
- Finalize flight plan based on approved project boundary
- Import flight plan into the digital flight management system; the following project plans will be reviewed and validated by the lead pilot and project manager:
  - Airspace charts
  - Base station configuration
  - Ground elevations in flight area
  - Solar and/or tidal charts
  - Safety requirements

Ground GPS Acquisition

- Locate monument or establish temporary point
- Record monument onto Survey Control Datasheet
- Assemble GPS equipment and record data
- Check to ensure that PDOP is less than 3.0 (or as required by SOW)
- Ensure receiver is secure and operational
- Download and deliver data

Data Acquisition

- When Air Traffic Control (ATC) or Range coordination is required, the lead pilot will contact the appropriate agency to schedule and coordinate flight.
- Prior to full flight, the following steps will be peformed:
  - Inspect storage and system components to ensure all units are operatinal and there is sufficient storage space
  - Select and confirm the lever arm coordinates
  - Load navigation system and perform system check
  - Perform 5 minute static alignment and record PDOP, GPS, and UTC start time
  - Ensure IMU is operational
  - Ensure all channels are operational, as applicable.
- The crew will begin flight line data recording: observe video display, POS status and mass memory screens; record UTC start/stop times, GPS data, ground speed, altitude, comments/concerns, lines, waypoints and times on flight log
- After the flight mission is complete, a 5 minute static alignment will be performed followed by a systematic shutdown of the system
- Collected data will be downloaded for QC
- Arrange delivery of data and email flight log to team; perform data backup.

2.13.3.2 Ground Control QA/QC

Evaluation steps:

- All planning, reconnaissance, field observations, post-processing, adjustments, and final report development will be performed under the direct supervision of a highly-experienced land surveyor.
- Fixed height tripods will be used during the GPS survey to eliminate antenna height measurement error. Vertical tripod measurements will be taken before and after collection to ensure there are no errors.
- The field crews will perform processing and closure analysis of the data to eliminate field blunders and determine baselines, which do not fit the network or project tolerances and must be re-observed.
- The final adjustment and processing of target locations will be coordinated, directed and completed by a single surveyor to ensure the overall consistency and integrity of the control network required to accurately map an area of this size. These efforts will also facilitate a smoother aerial triangulation process.

2.13.3.3 IMU/GPS Processing QA/QC

Airborne GPS control will be accomplished through the simultaneous observation of five or more satellites in the GPS constellation using the on-board receiver and one or more ground receivers (base stations) located over known control points that are in the vicinity of the project area. The simultaneous collection of airborne GPS and IMU data with the aerial imagery ensures an exceptional level of accuracy in the final product.

Evaluation steps:

- Fugro will coordinate the daily activities of all flight crews. Prior to deployment the project's collection specifications will be explained in detail to the crew members. If accessible to non-airport personnel, the GPS occupation of a primary airport control station (PACS) will be established prior to any airborne GPS collection.
- A GPS receiver will be placed on a temporary marker using PK nails to define the location. The GPS station will record at a one second interval for the duration of the airborne collection. Coordinates for this base station point will be adjusted by the project surveyor and will be tied into the project control network.
- Airborne GPS and IMU data will be immediately processed using the airport GPS base station data, which is available to the flight crew upon landing the plane. This ensures the integrity of all the mission data.
- When necessary, we will use a combination of CORS stations and surveyor established GPS stations to ensure that a base station is operating within range of the aircraft at all times. If this occurs, it will be included in the pre-planning. Once a decision has been made to fly, any GPS stations established for the project area will be activated at a one second interval for the duration of the airborne collection.

2.13.3.4 Aerotriangulation QA/QC

The aerotriangulation process is an invaluable tool in the production process since it ensures that the underlying GPS ground control, airborne GPS and IMU data are sound and will support the accuracy specifications of the project.

Evaluation steps:

- An initial bundle/block adjustment is developed for each data sortie.
- The accuracy of each bundle/block is confirmed through an RMSE evaluation against the project ground control.
- The accuracy of the adjustment is verified through an iterative process where the adjustment is repeatedly run, while progressively increasing the constraints on the ground control.
- The technician applies the bundle adjustment result to the images of each AT block (consisting of multiple lifts or sorties). The results of the adjustment are verified through the generation of the full-resolution panchromatic orthophoto chips over the ground control points for the data sortie.
- The orthophoto chips are inspected by the photogrammetric technician to identify any errors in the adjustment to ensure the accuracy meets project specification. The technician also generates and visually reviews orthophoto strips covers across all flight lines to ensure edge matching between flight lines.
- The adjustment/inspection process is repeated as bundle/block adjustment for adjoining sorties are complete and these small blocks are adjusted to build the overall bundle adjustment.
- Throughout the process, the accuracy of each adjustment is checked against the GPS ground control points.

2.13.3.5 Imagery and Orthophoto QA/QC

Evaluation steps:

- Preliminary field data review to ensure that there are no gaps between flight lines before the flight crew leaves the project site.
- Turbulence will be inspected for and if it affects the quality of the data, the flight line will be rejected.
- Full office visual review to ensure that it is complete, uncorrupted, and that the entire project area has been covered without gaps between flight lines.
- The technician will perform visual inspection of raw images on selected bands of each collected flight lines for completeness. This step will also ensure proper sensor function of the sensor.
- Confirm flight line trajectory files to ensure completeness of acquisition for project flight lines, calibration lines, and cross flight lines.
- The raw RGB images for each collected flight lines will be rectified using the newly created DEM and the GPS/IMU solution in Fugro proprietary software. The technician will visually review all rectified images to ensure completeness of acquisition for all flight lines. The technician will also use these images to identify any gaps, clouds, shadows and any un-predicted issues in project area. All issues that don't meet project specification will be rejected and re-flown.
- The orthophoto production process incorporates the ability to develop a completed digital orthophoto mosaic of all or part of a data sortie at a greatly reduced resolution.
- "Quick look" generation permits the quick assessment of iterative adjustments to finalize the parameters that will be applied to the data for radiometric corrections to the orthophoto while data limiting computer resources by only processing the imagery at full resolution once.
- Quick looks enable the technician to assess the accuracy of the processed imagery as well as identifying areas of distortion that would necessitate regeneration of the DEM or aerotriangulation data.
- Digital orthophotography is visually checked for accuracy on the workstation screen, and its absolute accuracy is verified by overlaying and comparing the locations of the paneled control that are visible on the image against a CAD file containing the point locations in vector form.
- The edge matching of adjacent strips of imagery is accomplished using a single color band from adjoining strips of imagery displaying each strip in alternating colors of red and cyan.
- In areas where the overlapping images are coincident, the imagery appears in a gray scale rendition while any offset is colored red or cyan.
- Any offsets are measured to confirm that the offset falls within the accuracy specification for the project.
- Using the parameters developed from the quick look, the finishing department radiometrically corrects the orthophotos prior to completing the mosaicking and clipping of the final tiles, then the files are returned to digital orthophoto production for mosaicking.
- The finishing department performs a 100% final visual check for orthophoto image quality prior to outputting the approach data to the designated media.
- The media is then inspected to confirm that there is no corruption within the data files and to confirm that all of the needed data files are on the designated media.
- The project manager is responsible for conducting a final overview QC of all deliverables leaving the department. A review of the lead technician's QC, file management procedures, and delivery format and coverage are all checked a final time before a deliverable is sent out. Reporting of deliveries and submitting any QC reports is the direct responsibility of the project manager.

2.13.3.6 Lidar QA/QC

Evaluation steps:

- Preliminary field data review to ensure that there are no gaps between flight lines before the flight crew leaves the project site.
- Turbulence will be inspected for and if it affects the quality of the data, the flight line will be rejected.
- Full office visual review to ensure that it is complete, uncorrupted, and that the entire project area has been covered without gaps between flight lines.
- Confirm flight line trajectory files to ensure completeness of acquisition for project flight lines, calibration lines, and cross flight lines.
- Review and analyze intensity histogram to ensure the quality of the intensity values.
- Generate a sample TIN surface to ensure no anomalies are present in the data.
- Verification of post spacing against project specifications.

- Boresight for the refinement of the initial calibration parameters.
    - o Check and correct the vertical misalignment of all flight lines and also the matching between data and ground truth. This process includes calculating the zbias value for each flight line so that all flight lines are aligned vertically.
    - o The entire dataset is then matched to ground control points within the project specified accuracy range.
    - o The technician will then run a final vertical accuracy check after the z correction. The result will be analyzed against the project specified accuracy to make sure it meets the requirement. The final boresight parameters and accuracy check result will be archived in the project database for future reference.
    - o Once boresighting is complete and all lifts are tied to ground control. The lidar data will be cut to production tiles and clipped to the project boundary.
- The project or block of strips is further examined for the following:
    - o Preprocessing errors (gaps, slivers, missing data, and steps)
    - o Automated vegetation removal errors, including misclassified banks and any other anomalies that are unique to the dataset.
- The general terrain (flat, hilly, steep, swamp) and land cover (forested, agricultural, urban) are assessed. This allows the technicians to set up classification parameters during the manual filtering that closely match the terrain type.
- Creating a color shaded TIN from points that have been classified as bare earth provides a view of the data that is useful in detecting errors in the bare earth product. Color shaded TIN are used both during the manual filtering process and during the peer review after manual editing.
- Another step of the QC process is for the final product to be consistent in quality across the project.
- Each group or number of strips in a project is assigned to a lead technician who is responsible for the quality of the block.
- Once strips in the block have been edited, they are checked over by the lead technician and are either approved or sent back to the editors for further edits.
- Once all strips in a given block have been reviewed, the lead technician then edge matches all the strips to ensure that there is conformity across the block, between strips, and between completed, adjoining blocks of strips.
- The project manager is responsible for conducting a final overview QC of all deliverables leaving the department. A review of the lead technician's QC, file management procedures, and delivery format and coverage are all checked a final time before a deliverable is sent out. Reporting of deliveries and submitting any QC reports is the direct responsibility of the project manager.

2.13.3.7 Final Delivery Quality Control

The project manager for the project is responsible for conducting a final overview QC of all deliverables leaving the department. A review of the lead technician's QC, file management procedures, and delivery format and coverage are all checked a final time before a deliverable is sent out. Reporting of deliveries and submitting any QC reports is the direct responsibility of the project manager.

Some of the additional quality control routines that are incorporated into each phase of lidar processing are:

- Existing ground control and elevation data can be used to verify the accuracy of the lidar data; ensuring that the target accuracies are met.
- The coverage and edge matching of the data are re-checked during the vegetation re-classification process to ensure that the data meets the required accuracy specifications. See process flowcharts below.
- Peer reviews are conducted by the technicians during the entire process.
- The project manager consistently checks on quality during production.

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3 MANAGEMENT PROPOSAL

Ongoing communication throughout the duration of the project ensures that unanticipated issues are immediately and effectively addressed and resolved and potential issues are often prevented as a result.

3.1. Coordination with the participating members of COAGA 2017

We will work with ACOG up front to develop a structured plan with scheduled meetings, status updates, and points of communication so that both parties are able to commit in advance and allocate the resources needed to ensure project success.

Our performance-focused communication plan is based on four premises:

1. The client is best served by a full-time project manager. Our proposed project manager, Ms. Megan Blaskovich, has more than 7 years of experience in all aspects of orthoimagery, photogrammetric and Lidar mapping and GIS, including the management of large City, County and State mapping programs throughout the US. It is Ms. ’s responsibility to ensure that the project is completed on schedule, on budget, and to the required specifications.
2. An up-front investment of time and resources in project planning ensures success. Experience has proven that an investment in planning, establishing and maintaining lines of communication, and customizing our reporting system to fit the project and our clients’ needs serves everyone well throughout the life of the contract.
3. First-time-right, on time means staying on schedule and within budget. Because project events are not always predictable, effective communication ensures that unanticipated issues are immediately and effectively addressed and resolved. In many cases, our project tracking system enables project personnel to avert potential problems.
4. Client involvement is requisite to project success. Fugro project management requires the combined efforts of Fugro and the Client in planning, careful examination and discussion of project scopes of work and specifications, ongoing monitoring of production schedules, and regular communication.

3.1.1 Reporting and Expectation

During the Kickoff Meeting, ACOG will have the opportunity to define the detail to which reporting will be presented. These requirements will be built into the project work plan. This includes the type of information required, the frequency of reporting, and the format of the reports. This enables us to document client expectations up front, and also provides a quality checklist that will be used to verify that all requirements are met.

Status of project phases is generally provided through written reports, email notifications, and daily interactions with the client and Fugro staff. Fugro's Project Manager, Ms. Blaskovich, will be dedicated to this project on a daily basis, and will be available to respond quickly to questions regarding the project status and deliverables.

To further ensure that Fugro meets client requirements and expectations, Ms. Blaskovich will provide oversight and supervision on all aspects of the project and will provide final review and signoff on all deliverables before they leave the facility.

Ms. Blaskovich will document detailed information for each of these items based on careful analysis of the project scope of work and based on discussion with all team participants, including client technical staff. This information will be compiled into the project work plan and ACOG will have the opportunity to review and provide input. Once complete, the project work plan will serve as the basis for managing and executing the project from start to finish.

Our standard Fugro project management work plan is separated into four major components as follows, with specific items to be analyzed and defined for each component:

1. Project Planning
   - Scope Statement
   - Key Personnel Organization Chart
   - Review of Flight/Ground Control Plan
   - Project Schedule w/ Milestones
   - Schedule Management Plan
   - Communications Plan
   - Risk Management Plan
   - Risk Analysis and Response Actions (by project phase)
2. Executing the Project
   - Project Status Review Meetings and Reports
   - Project Status Report
   - Quality Audit Report
3. Controlling the Project
   - Lessons Learned
   - Formal Acceptance of Product or Phase
   - Schedule Change Request
4. Closing the Project
   - Project Closure Checklist
   - Project Wrap Up Meeting
   - Formal Acceptance and Closure

3.1.2 Kick-off and Subsequent Meetings

At the onset of the project, Fugro will establish a custom schedule that includes planned meetings and milestones from project kickoff through final delivery and acceptance. Our staff is committed to adhering to this schedule and work plan throughout the duration of the project.

Fugro will attend a project kickoff meeting held onsite – Date TBD.

3.2. Available Resources

Fugro's team has large acquisition and production equipment and personnel capacity available to support successful acquisition, processing and delivery of mapping data.

Fugro employs a full-time production coordinator who is responsible for maintaining a detailed production schedule that shows, among other things:

1. Available/committed production hours per department.
2. Estimated and actual (accrued daily) hours per production phase.
3. Anticipated projects expected to enter production in the next 30, 60, and 90 days.
4. Their potential impacts on the production schedule.

Fugro uses this master schedule to:

1. Determine if we can take on a new project
2. Evaluate the length of time required for production so we can work to develop a delivery schedule that meets client expectations.

The production scheduling system comprises the number of hours available in each major production department against jobs sold (in hours) and those leads that are rated as highly likely to become jobs. Team members are polled weekly to determine production capacity and ability to perform within the desired timeframe.

Fugro also creates a project-specific production schedule that outlines all major production phases, milestones, interim deliverables and due dates, and final deliverables and due dates. This schedule is developed during the project initiation phase and guides production throughout the life of the project.

3.3. Overview of Proposed Schedule

The following tables presents our preliminary schedule for all base and oprtional deliverabes.

Item	Description	Delivery Date
	Digital Orthoimagery (TIFF)	
City of Edmond	127 miles @ 3" GSD	8/14/2017
City of Del City	8 miles @ 3" GSD	7/31/2017
	12.5 miles @ 3" GSD	7/31/2017
Midwest City	42.3 miles @ 3" GSD	7/17/2017
	42.43 miles @ 6" GSD	7/17/2017
City of Moore	21.9 miles @ 6" GSD	7/17/2017
City of Norman	164 miles @ 6" GSD	7/31/2017
	92 miles @ 3" GSD	7/31/2017
Oklahoma County	552 miles @ 6" GSD	10/16/2017
	552 miles @ 3" GSD	10/16/2017
	718 miles @ 6" GSD	10/16/2017
	718 miles @ 3" GSD	10/16/2017
City of Yukon	35.78 miles @ 3" GSD	8/14/2017
Oklahoma City	712.48 miles @ 6" GSD	10/16/2017
	6.85 miles @ 6" GSD True Ortho	8/28/2017
	Optional Mosaic Products	
City of Edmond	MrSID and JPG2000	9/14/2017
City of Del City	MrSID and JPG2000	8/31/2017
City of Midwest City	MrSID and JPG2000	8/17/2017
City of Moore	MrSID and JPG2000	8/17/2017
City of Norman	MrSID and JPG2000	8/31/2017
Oklahoma County	MrSID and JPG2000	11/16/2017
City of Yukon		9/14/2017
City of Oklahoma City		11/16/2017
Entire Project Area (ACOG)	MrSID and JPG2000 (All TIFFs combined in a single seamless Mr SID)	11/20/2017

Optional Mapping Deliverables		Photogrammetry	
City of Edmond	Planimetric Change Detection & Collection – Pilot Study Area		8/14/2017
	Planimetric Change Detection & Collection – Remainder of the City		9/18/2017
	Change Detection, Collection and Interpolation of the HE-DTM into 1-foot Contours - Pilot Area		8/14/2017
	Change Detection, Collection and Interpolation of the HE-DTM into 1-foot Contours – Remainder of the City		9/11/2017
Del City	LiDAR topographic data with 1' contours, .7m classification, breaklines and hydro enforcement (8 square miles)		6/30/2017
	LiDAR topographic data with 1' contours, .7m classification, breaklines and hydro enforcement (12.5 square miles)		6/30/2017
Midwest City	Digital Terrain Model (DTM)		9/15/2017
	Digital Terrain Model (DTM) with building heights		9/29/2017
City of Moore	Planimetrics – Building footprints, Hydrography –linear and polygon features Street centerlines, Railroads, Edge of pavement, Sidewalks, Parking Lots		7/31/2017
	Topography – raw Lidar, 1 Foot contours, Spot elevation and Hydrologically re-enforced DEM – breaklines and mass points		7/17/2017
City of Norman	Planimetric Change Detection & Collection - Pilot Study Area Cost		8/14/2017
	Planimetric Change Detection & Collection – 82 miles @ 1"=50' & 115 miles @ 1"=100'		9/18/2017
City of Yukon	Planimetric Change Detection & Collection - Pilot Study Area Cost		8/14/2017
	Planimetric Change Detection & Collection - Remainder of the City		9/1/2017
	Change Detection, Collection and interpolation of the HE-DTM into 1 foot Contours - Pilot Area		8/14/2017
	Change Detection, Collection and interpolation of the HE-DTM into 1 foot Contours - Remainder of the City		9/1/2017

CENTRAL OKLAHOMA ALLIANCE OF GOVERNMENT AGENCIES (COAGA), REGIONAL DIGITAL ORTHOPHOTO AND ASSOCIATED DATA, MULTIPLE LOCATIONS IN OKLAHOMA

COAGA contracted Fugro to collect and produce a combination of full color, 3-inch and 6-inch pixel, leaf-off, digital orthophoto images; and separately collect, detect change, and update planimetric and topographic data for multiple project areas in Oklahoma with the agency's jurisdiction. COAGA required a complete up-to-date accurate digital ortho data set for the entire 704 sq. mi. project area as well as updated planimetric and drainage-enforced contour data sets for the specified municipal areas. The area is comprised of five (5) cities and counties each with their own deliverable requirements as detailed below:

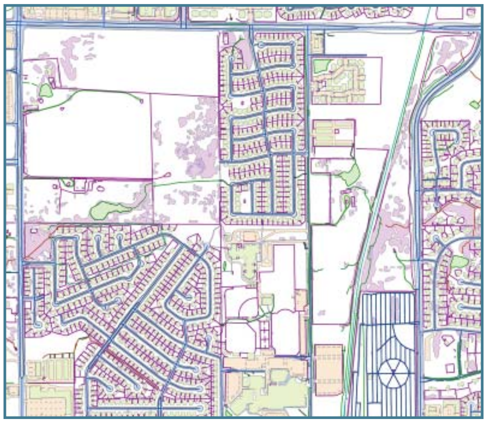
COAGA TASK ORDERS

AREA	SIZE (SQ. MI.)	DELIVERABLE(S)
City of Edmond	110	3-inch pixel color orthoimagery Planimetric Change Detection & Collection 1 foot contours
Cleveland County	539	6-inch pixel color orthoimagery
City of Del City	7.5	3-inch pixel color orthoimagery
City of Moore	22	6-inch pixel color orthoimagery
City of Yukon	27	6-inch pixel color orthoimagery

Reference Information:

Client:
Association of Central Oklahoma Governments (ACOG)
21 E Main St, Suite 100
Oklahoma City, OK 73104-2405

Point of Contact:
Name: John Sharp
Tel: (405) 234-2264
Email: jmsharp@acogok.org



CAPITAL AREA COUNCIL OF GOVERNMENTS AERIAL IMAGERY, LIDAR AND PLANIMETRIC MAPPING VARIOUS LOCATIONS, TEXAS (10 COUNTY REGION)

The Capital Area Council of Governments (CAPCOG) selected Fugro Geospatial to create and update geospatial base map data for the Capital Area. The Capital Area Geospatial Base Map (GeoMap) Project is a two-year, cost-sharing initiative to produce and maintain current geospatial base map data for the 10-county area, roughly 8575 square miles.

The primary focus of the task orders are for orthoimagery, planimetric data and lidar services. CAPCOG has extended the contract for an additional 2 years to allow Fugro to continue supporting the region with basemap services.

- 24-inch 4-band Orthoimagery
- 12-inch 4-band Orthoimagery (Leaf on & Leaf off)
- 6-inch 4-band Orthoimagery
- 1”=100’ scale planimetrics (City of Austin)
- Lidar
- Contours from lidar
- On-line Orthoimagery QA/QC Software (Fugro Access)

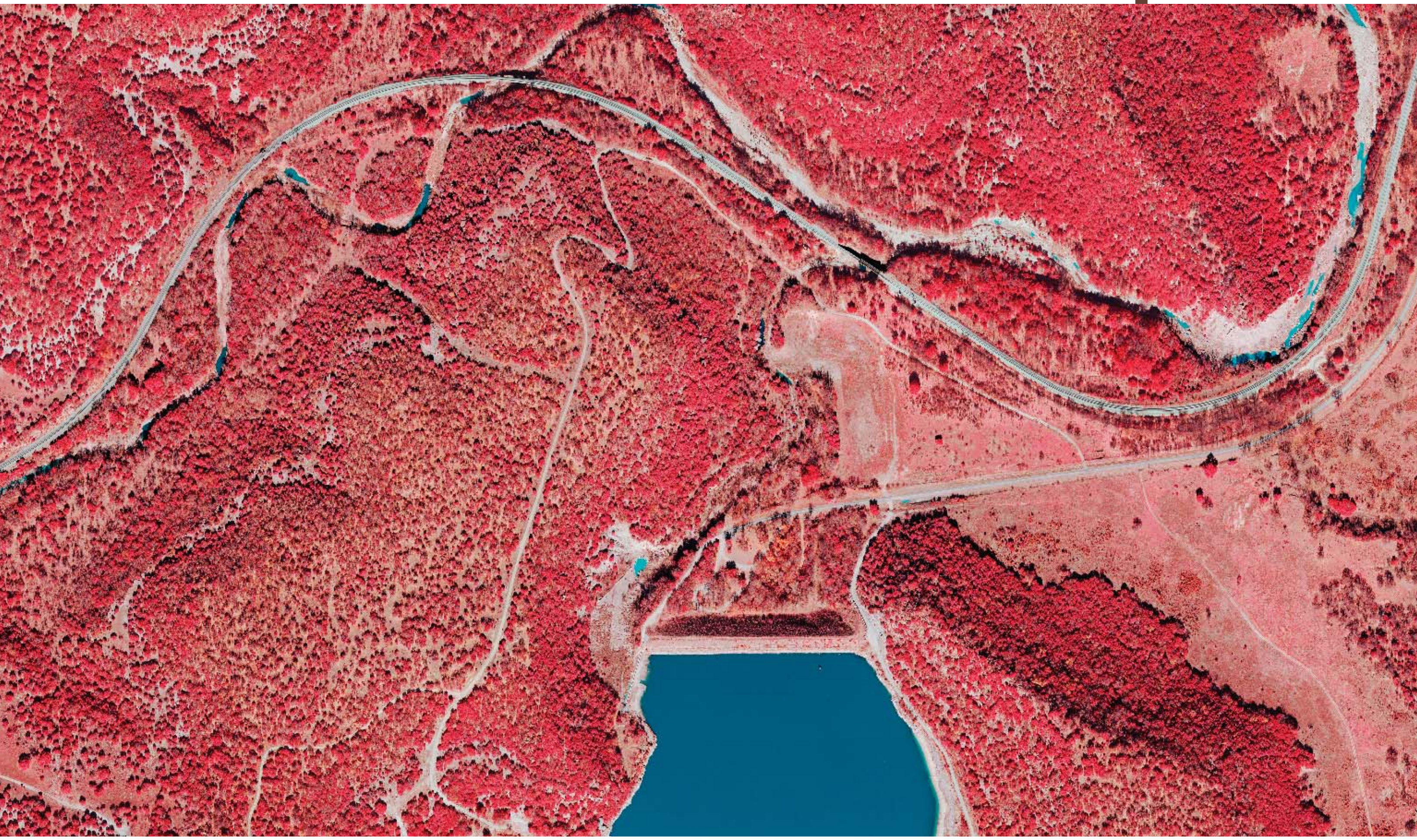
Reference Information:

Client:

Capital Area Council of Governments
6800 Burleson Road
Building 310, Ste. 165
Austin, TX 78744

Point of Contact:

Name: Craig Eissler
Tel: 512-916-6184
Email: ceissler@capcog.org



HIGH PRIORITY IMAGERY AND DATA SETS (HPIDS) CONTRACT VARIOUS LOCATIONS, TEXAS (STATEWIDE COVERAGE)

The Texas Water Development Board (TWDB)'s Texas Natural Resources Information System (TNRIS) administers the High Priority Imagery and Data Sets (HPIDS) contract for geospatial data procurement on behalf of the Texas Council on Competitive Government. HPIDS was awarded to Fugro in 2008 and will be renewed in 2016. Fugro has been awarded multiple task orders under this contract for a variety of services including lidar, orthoimagery, and independent QA/QC review. Specific Deliverables Have Included:

- Flight plan/ground control reports
- Sensor calibration reports
- Ground control
- All-return LAS point cloud
- Hydro-flattening breaklines
- Lidar intensity imagery
- DEM raster
- Contours
- Metadata
- Orthoimagery
- QA/QC reporting and review

Data products generated are used by these entities for conservation practices, engineering studies, soil surveys, floodplain studies, hydraulic & hydrologic modeling and parkland management.

Task orders awarded as part of this contract are described on the following page:

Reference Information:

Client:

Texas Water Development Board

Point of Contact:

Name Felicia Retiz, Deputy GIO
Tel: 512-796-7328
Email: Felicia.Retiz@TWDB.texas.gov

1. 2014 TNRIS and Partners, Central Texas Lidar: The project area of interest covered approximately 3,207 sq. mi. over portions of seven counties in five disparate locations in Central and North Texas. Under Fugro's project management, airborne lidar was acquired at a density of 4 points per square meter and product deliverables included the all-return fully classified point cloud, hydrologic breaklines, 1-meter hydro-flattened DEM, and 1-meter intensity images.

2. 2014 TNRIS and Partners, Northeast TX Lidar Independent QA/QC: Fugro conducted an independent QA/QC review of 2,429 sq. mi. of lidar and associated products collected by Atkins in Northeast Texas. Fugro staff performed independent lidar check point surveys and a 100% review of the lidar data. Fugro produced accurate reports on the vendor's ability to meet specifications for data accuracy, quality and completeness.

3. 2014 TNRIS & FBCDD Fort Bend County, Lidar & Contours: The project area of interest covered approximately 917 sq. mi. over Fort Bend County. Fugro provided project management, airborne lidar was acquired at a density of 4 points per square meter and product deliverables included the all-return fully classified point cloud, hydrologic breaklines, 1-meter hydro-flattened DEM, 1-meter intensity images and 1-foot contours.

4. 2014/15 TNRIS & TPWD Coastal Texas Submerged Aquatic Vegetation Orthoimagery: The project area of interest covers approximately 50 sq. mi. over West Galveston Bay in Brazoria and Galveston Counties, and Christmas Bay in Brazoria County. Fugro provided project management, orthoimagery collected at a 6-inch resolution delivered in GeoTIFF format.

5. 2014 TNRIS & TPWD Palo Pinto Mountains State Park, Orthoimagery & Lidar: The project area of interest covered approximately 50 sq. mi. over portions of Palo Pinto, Stephens and Eastland Counties in North Texas. Fugro provided project management, airborne lidar acquired at a density of 4 points per square meter and elevation product deliverables including the all-return, fully classified point cloud, hydrologic breaklines, 1m hydro-flattened DEM, and 1m intensity images. Orthoimagery was acquired at a 6-inch resolution and delivered in GeoTIFF format.

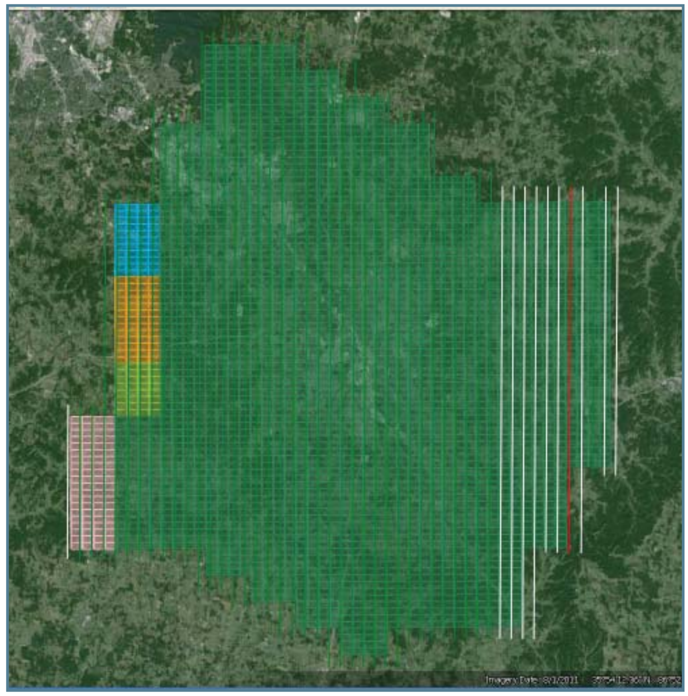
6. 2009 TNRIS Tarrant County Lidar: The project area of interest covered approximately 900 sq. mi. of Tarrant County in North Texas. Fugro provided project management, airborne lidar acquired at a density of 1 point per square meter and product deliverables including the all-return fully classified point cloud, hydrologic breaklines and 5m hydro-flattened DEM.

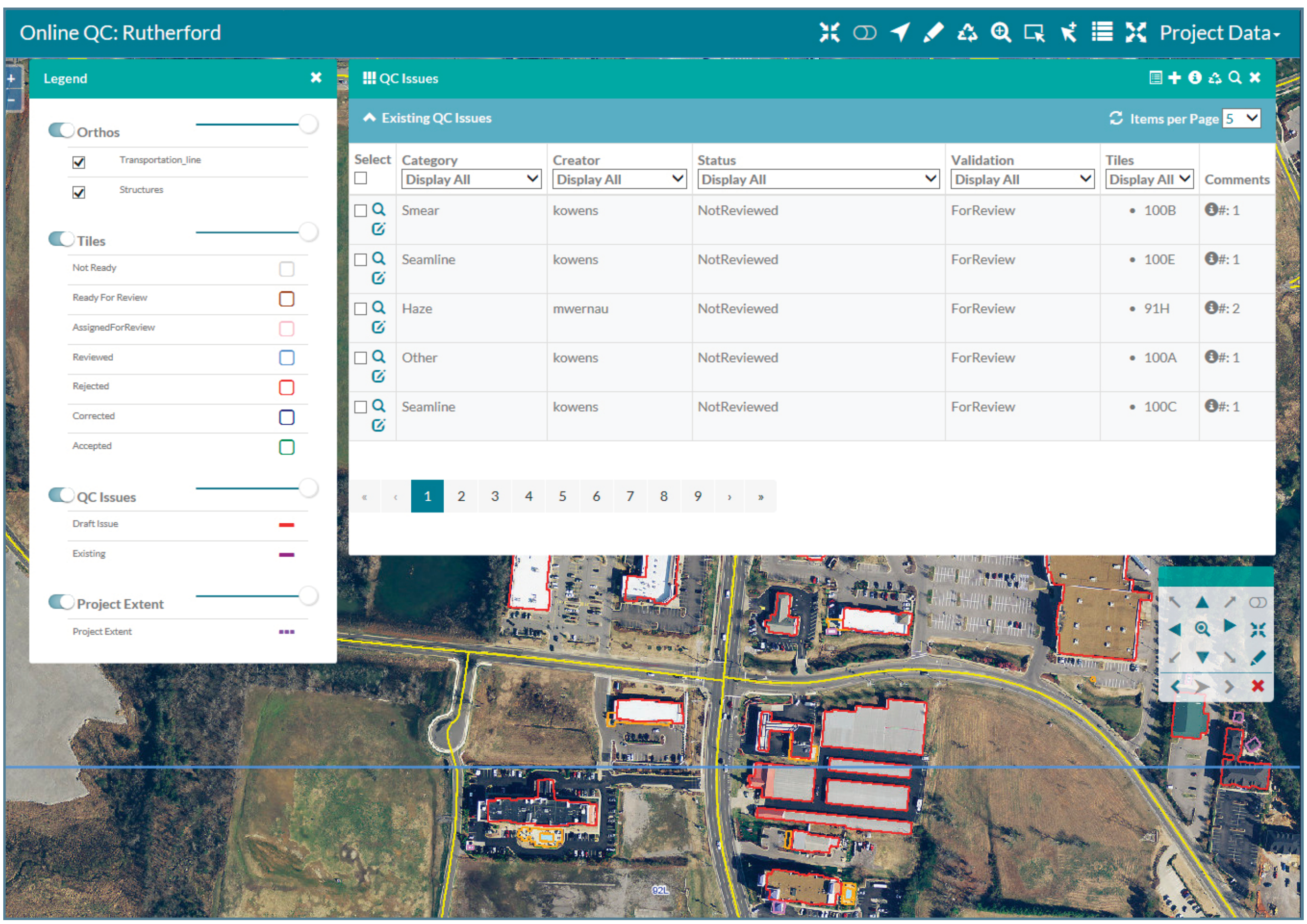
Fugro will issue the lead Project Manager a login and password with permissions to issue other participants login and passwords as necessary.

Users can navigate through the data and mark areas of concern as an attributed polygon. This data is uploaded to Fugro's server or exported as a shapefile and sent to the Manager for final acceptance of the calls. As each tile and issue is inspected, it can be reclassified to represent the real-time status of the tile:

- For review
- Awaiting Validation
- Valid Issue
- Invalid Issue

All review calls are immediately uploaded to the server or exported as a shapefile and sent to Fugro to apply fixes to the data. Fugro will correct discrepancies and provide feedback on the corrective steps taken to resolve the issue.





3.5. Project Tracking and Reporting

Fugro Access is a robust web application that will provide both project tracking and QC review tools.

3.5.1 Project Tracking

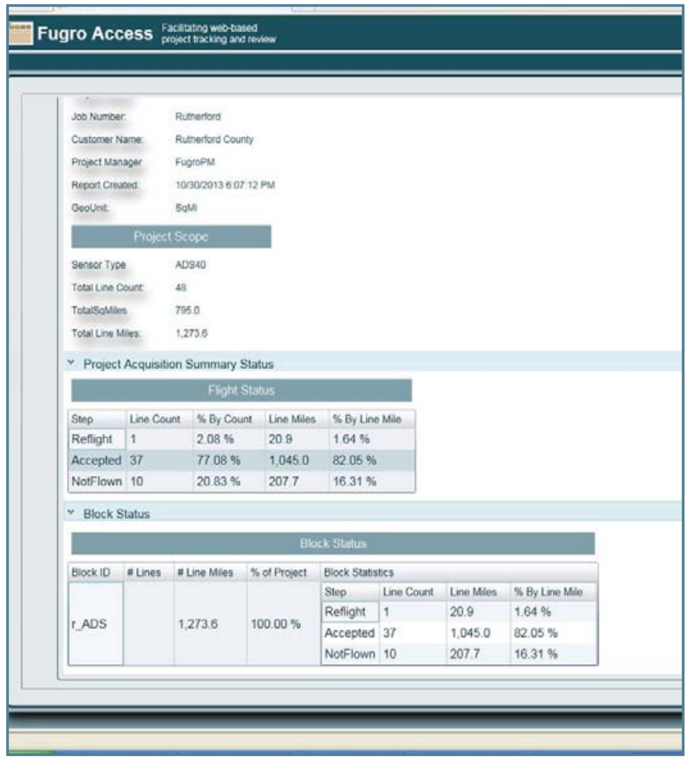
The project tracking capabilities of Fugro Access make project-relevant milestones easily accessible to all project partners and is an excellent supplement to standard communication as identified in the Communication Plan. Each day Fugro Access is updated with project-specific flight line and production status information for immediate review by project participants.

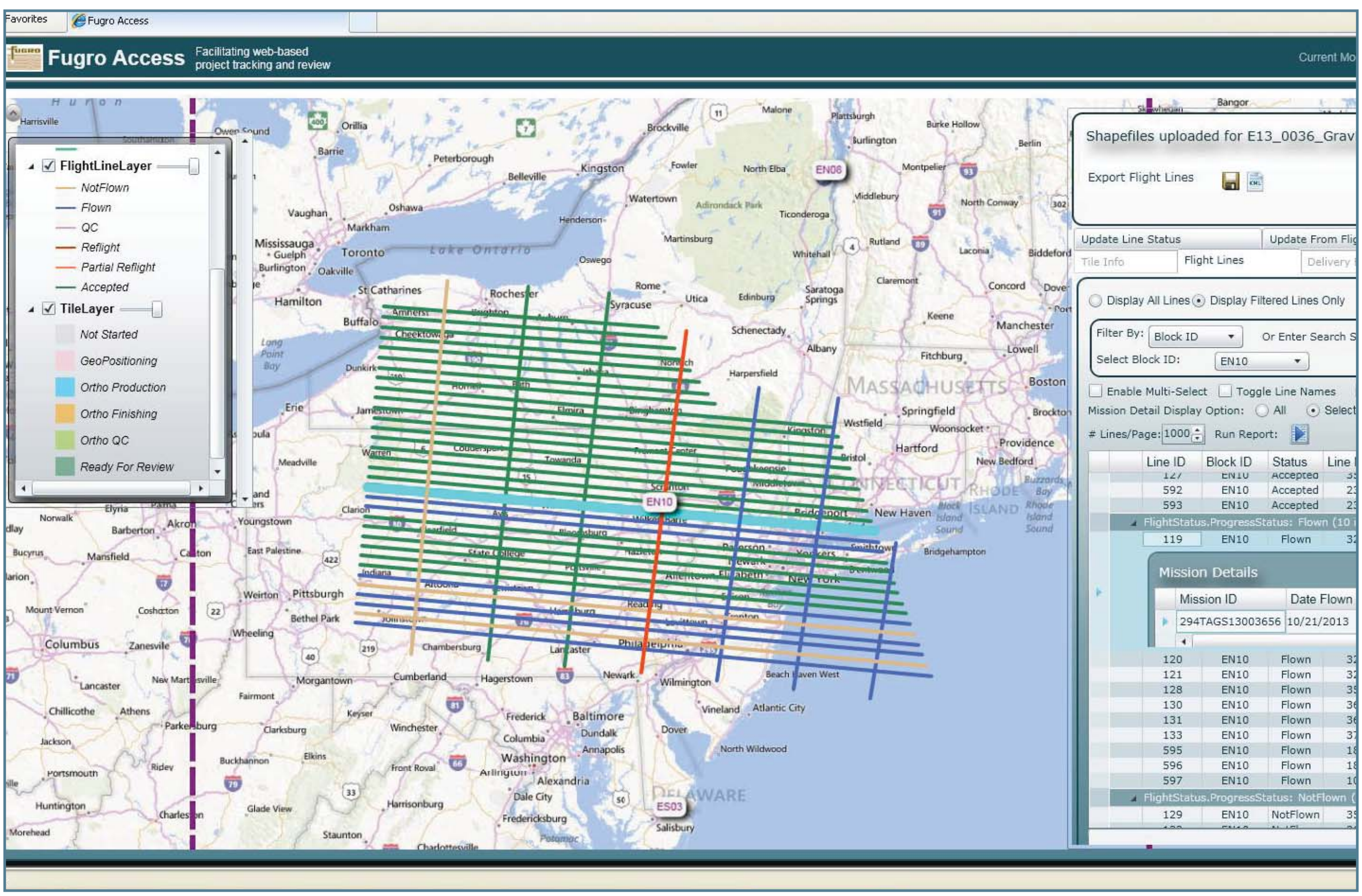
3.5.2 Multi-User QC Review

Because there are typically multiple partners commissioning mapping projects, Fugro Access will be an invaluable tool to streamline and expedite the data review process.

3.5.3 Web-based Quality Control (QC) Review

Fugro Access will allow the ability to review orthoimagery (or lidar-based imagery) and project-relevant shapefiles (boundaries, tiles, flight lines, seam lines, etc.) in a standard web browser.





3.6. Staffing

Fugro's aerial acquisition and processing capabilities for orthoimagery, lidar, planimetric, and topographic map data are supported by a highly experienced team of pilots, sensor operators, field crews, production staff, and project managers who possess the experience and expertise to meet the needs of our customers.

3.6.1 Professional Staff Certifications

One major factor to Fugro's success over the last 60+ years is attributed to employing highly trained Geospatial and GIS professionals. Fugro staff maintains professional licenses, registrations, and certifications related to the surveying and mapping profession. The personnel listed in the table below are utilized in supervisory and management positions and are an invaluable resource ensuring quality products and services are delivered.

Key Personnel Registrations & Certifications

TYPE	NAME
CP	Lynn Baker; Jonathan Helta; Dave Holm; Doug Johnson; Nora May; Suzee Parsons; Kirk Spell; Brian Wegner; Linda Wehner Van Vlack; Michael Wernau
PSM	Brian Wegner: FL
PMP	Shelby Coder
GISP	Shelby Coder; Dave Holm
PE	Guy Meiron
CQM	Dave White (Pending Reinstatement)

3.6.2 Personnel Capacity

Our staff of 89 US based technical professionals has specialized education and experience in data acquisition (flight and sensor operations), photogrammetry, photo interpretation, remote sensing, cartography, GIS, computer science, GPS surveying, and more. Fugro's global processing facilities are available for cost and schedule efficiency, increasing our staff count as shown in the right hand column in the table below.

Technical & Administrative Personnel Capacity

LABOR CATEGORY	QTY (US only)	QTY (Offshore)
Acquisition (Flight operations)	23	N/A
Ortho-production (AT, Finishing, Quality Control)	18	+27
DEM Edit/ Programming (Lidar and Elevation Technicians/Analysts)	20	+116
Project Management / Administrative Staff (Executive, Finance, Sales/Marketing, IT)	28	+3
Total Employees:	89	146

CP: Certified Photogrammetrist **PSM:** Professional Surveyor & Mapper **PMP:** Project Management Professional **GISP:** GIS Professional **PE:** Professional Engineer **CQM:** Certified Quality Manager

3.6.3 Project Manager(s)

Ms. Megan Blaskovich oversees the team of department supervisory personnel and project technicians to manage planning, task execution, and maintain work flow control during acquisition and processing. Each department supervisor has proven proficiency in technical planning to insure the completion of their specific piece of the project in an accurate and timely manner.

3.6.4 Staff Qualifications/Experience

The following table identifies key supervisory staff, including subcontractors, who will be assigned to the contract, indicates the responsibilities and qualifications of such personnel, and includes the % of time each will be assigned to the project during an applicable task order.

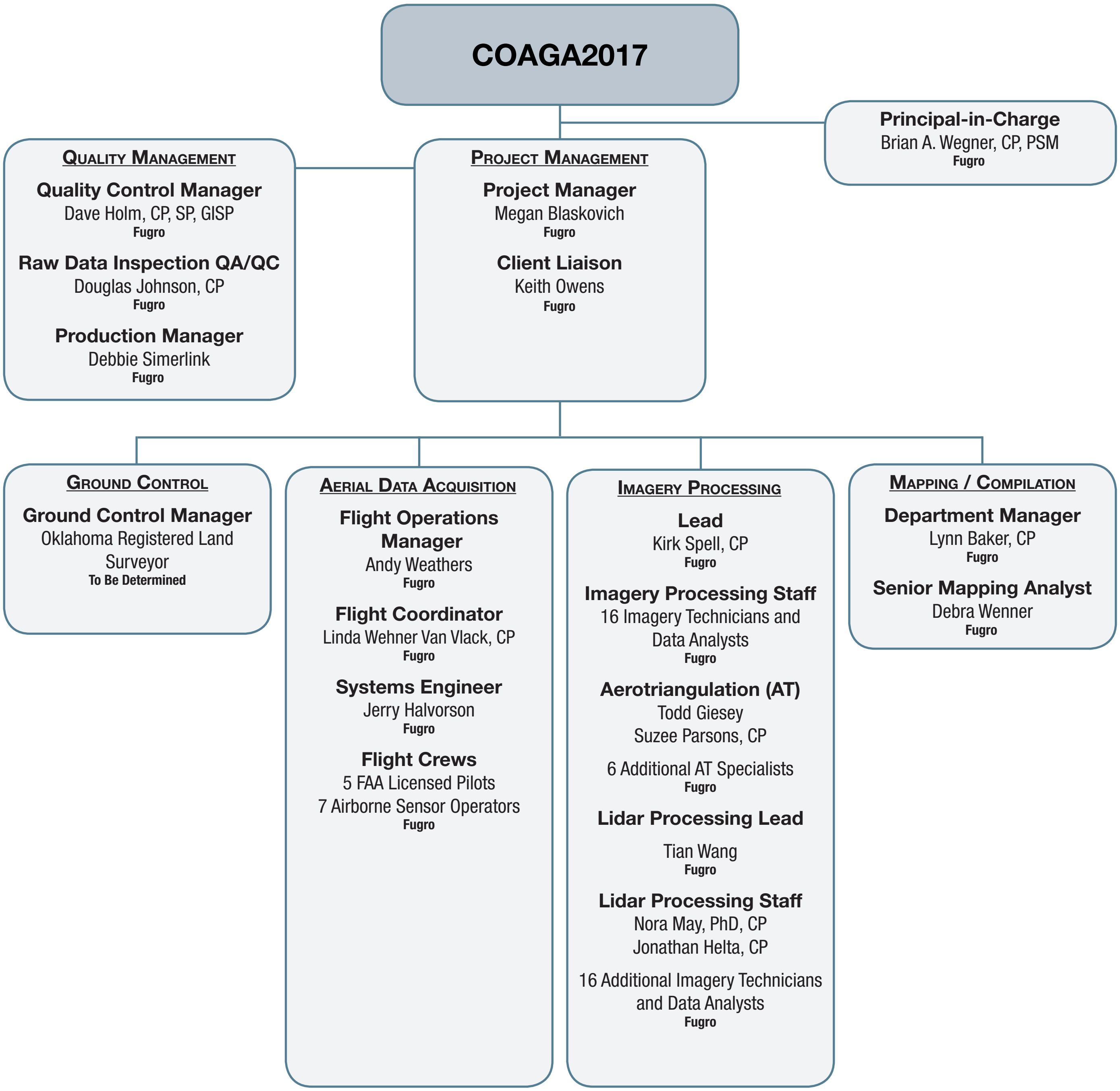
Fugro assures that staff identified in its proposal will actually perform the assigned work and that any staff substitution requires approval.

Staff Qualifications/Experience

Name/Firm	Role/Responsibilities	Qualifications Summary	Time Commitment
Brian A. Wegner, CP, PSM / Fugro	President/ Principal-in-Charge	29 years experience in the mapping industry; Professional Surveyor & Mapper (FL); Certified Photogrammetrist.	5%
Dave White / Fugro	Senior Vice President Operations Manager	26 years experience in the mapping industry; Instrumental in developing Fugro's IS09001:2008 QMS.	12%
Megan Blaskovich / Fugro	Project Manager	8 years experience in the mapping industry; high skilled GIS analyst and mapping professional; Manages task orders on 2 contracts Fugro currently holds with NOAA for lidar and coastal change analysis programs.	20%
Keith Owens / Fugro	Client Liasion	Over 20 years of experience with Land Surveying, Aerial Data Acquisition, Project Planning, Project Estimating, Data Processing, Map Compilation, Project Management and Business Development	15%
Dave Holm, CP, SP, GISP / Fugro	Quality Manager	17 years experience in the mapping industry; Recent oversight of Fugro's largest IDIQ contracts and programs; Certified Photogrammetrist, Surveyor Photogrammetrist and Geographic Information Systement Professional.	15%
Douglas Johnson, CP / Fugro	Raw Data Quality Control	31 years experience in the mapping industry; Certified Photogrammetrist; Involved with virtually every aerial data acquisiton project to ensure data quality and coverage before the flight crews leave the project AOI.	10%
Kirk Spell, CP, CMS / Fugro	Orthoimagery Production Manager	Over 24 years of experience in orthophoto production; Certified Photogrammetrist and Mapping Scientist	22%
Todd Giesey / Fugro	AT Specialist	Over 27 years experience all facets of photogrammetric mapping, digital photogrammetry and softcopy aerotriangulation.	18%
Tian Wang / Fugro	Lidar Processing Manager	15 years experience in the mapping industry; Instrumental in developing and improving Fugro's lidar delivery process. Ensures quality data delivery on Fugro's largest and most complex lidar projects.	25%
Jonathan Helta, CP / Fugro	Lidar Production Team Lead	15 years experience in the mapping industry; Certified Photogrammetrist; Specialist in lidar processing techniques, software, and product development. Leads the lidar processing team to adapt to changes in technology.	25%
Nora May, PhD, CP / Fugro	Lidar Positioning Specialist	16 years experience in the mapping industry; Certified Photogrammetrist; Her research interests include surface extraction and modeling, sensor fusion, calibration of multi-sensor systems, including lidar boresight calibration, and accuracy assessment for digital imagery and lidar.	20%
Lynn Baker, CP / Fugro	Planometric/Compilation Manager	Over 37 years has managing Fugro's cartographic department.	10%

3.6.5 Team Organization

The organizational chart on the following page illustrates Fugro's management structure and communication lines that will be followed by key personnel and subcontractors assigned to this project.



3.6.6 Key Personnel Resumes

Resumes of the management and key supervisory personnel assigned to work on the contract have been included on the following pages.

Brian A. Wegner, CP, PSM - Principal in Charge

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 29
- Years w/ Other Firms: -

Education

- MBA, 1996, J ohns Hopkins University
- BS, Cartography, 1987, University of Wisconsin

Affiliations / Certifications

- ASPRS Certified Photogrammetrist CP # R1113
- Professional Surveyor and Mapper, PSM FL #LS0005422
- Professional Land Surveyor PLS SC #24314
- American Society for Photogrammetry and Remote Sensing, Member

Brian Wegner began his career with Fugro in 1987. Having advanced through both production and management positions, Mr. Wegner became vice president of group subcontracting services, and has since progressed to become president of the company. Mr. Wegner oversees all business development and operations occurring within the mapping division at Fugro. He works closely with sales and project management staff to ensure that all projects are performed to specifications and according to customer expectations. He ensures quality control and facilitates workflow among Fugro divisions and all subconsultants. In addition, Mr. Wegner reviews and oversees all project specifications, development of work schedules and delegation of work programs, and liaises with clients and subconsultants to ensure that client needs are met on time and to specification.

Mr. Wegner's technical understanding of photogrammetric mapping, combined with his expertise in project administration and management, promotes high levels of accuracy and efficiency in production and expands Fugro's capacity to undertake complex acquisition and mapping projects for federal, state, and local government agencies, utility companies, and private engineering firms.

USACE St. Louis District Photogrammetric Mapping IDIQ Contract, Nationwide

Principal in Charge: Mr. Wegner serves as Principal in Charge for this 5-year IDIQ contract for the St. Louis District Army Corp of Engineers. The contract requires aerial photography and airborne GPS data acquisition, remote sensing with hyperspectral and multispectral sensors and passive microwave radiometer, aerotriangulation, large and small-scale topographic mapping, lidar, land-use/land-cover mapping, digital orthophotography, and a variety of advanced mapping and surveying services.

USGS Geospatial Products and Services (GPSCII) IDIQ, Nationwide

Principal in Charge: Mr. Wegner has served as the principal in charge for this contract for a wide range of geospatial products and services, including lidar, imagery and IFSAR data acquisition and processing.

NOAA Coastal Services Center (CSC) Geospatial Services IDIQ, Nationwide Coverage

Principal in Charge: Mr. Wegner has served as the principal in charge for task orders through this nationwide IDIQ contract for a wide range of mapping services related to coastal changes, sea level changes, floodplain mapping and other environmental analyses.

Capital Area Council of Governments (CAPCOG) Aerial Imagery, lidar and Planimetric Mapping, TX

Principal in Charge: Mr. Wegner has served as the principal in charge for task orders for the contract to create and update geospatial base map data for the Capital Area of Texas. The Capital Area Geospatial Base Map (GeoMap) Project is a two-year, cost-sharing initiative to produce and maintain current geospatial base map data for the 10-county area.

2009, 2012, 2015 Aerial Photography, and 2011 Lidar Projects, Thurston County, WA

Principal-in-Charge: Mr. Wegner has served as the principal in charge for all components of the three (3) Thurston County projects. The countywide area is approximately 819 sq. mi. in the south Puget Sound region of Washington State. Six (6)-inch RGB and CIR orthoimagery was delivered in 2009 and 2012 and Lidar for the county was delivered in 2011.

Photo Interpretation and Damage Assessment Response to Hurricane Ike, Gulf Coast Area, TX

Principal-in-Charge: As principal in charge, Mr. Wegner provided contractual and technical oversight and guidance during this DHS/FEMA task order which included photo interpretation and geospatial data development services to aid in the emergency response to Hurricane Ike in 2008. Fugro provided assessment and photo interpretation of approximately 11,000 sq. miles.

Tennessee Statewide Base Mapping Program

Principal-in-Charge: Mr. Wegner provided contractual and technical oversight on this 5-year statewide mapping program requiring digital orthoimagery at 1”=100’ (1’ pixel resolution for urban/suburban areas), 1”=400’ digital orthoimagery (2’ pixel resolution for rural areas), and planimetric mapping including hydrography, roads, and tree lines.

Dave White - Operations Manager

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 26 (7/1990)
- Years with Other Firms: -

Education

- Coursework Information Science, Business
- Coursework Photogrammetry

Affiliations / Certifications

- American Society for Quality (Senior Member)
- American Society for Photogrammetry and Remote Sensing (Member)

David White, Senior Vice President, leads program-based operations, from initiation, to contract/client management and quality management, to production. He is uniquely qualified to serve in this capacity, having advanced through technical and management positions in every Fugro production group since joining the company in 1990. Mr. White began his career with Fugro as a geospatial analyst and quickly advanced to planning, developing, and managing the specialized production processes required for federal, state, and local government agency programs and providing project oversight and coordination, work scope definition and guidance, resource allocation, scheduling of tasks, and quality control / assurance management for programs and clients with large complex IDIQ contracts.

His hands-on experience handling diverse projects for essential clients contributes to overall program efficiencies, and, in compliance with Fugro's ISO9001:2008 quality system, continuous improvement of management and production processes.

USACE St. Louis District Photogrammetric Mapping IDIQ Contract, Nationwide

Contract Manager: Mr. White oversees all technical and contractual aspects for task orders under this 5-year IDIQ contract for the St. Louis District Army Corp of Engineers. The contract requires aerial photography, lidar, and airborne GPS data acquisition, remote sensing with hyperspectral and multispectral sensors, aerotriangulation, large and small-scale topographic mapping, lidar mapping, land-use/land-cover mapping, digital orthophotography, and a variety of advanced mapping and surveying services.

USGS Geospatial Products and Services (GPSCII), Nationwide

Contract Manager / Client Representative: Mr. White oversees program operations for geospatial products and services through the GPSC contract as Prime Contractor as well as IFSAR tasks for the Alaska SDMI.

NOAA Coastal Services Center Geospatial Services, IDIQ, Nationwide

Contract Manager: Mr. White oversees program management and production operations for task orders under this multi-year IDIQ contract for the NOAA OCM. The contract covers a wide range of services, including: acquisition and processing of airborne imagery, lidar, multi-spectral, GRAV-D, and IFSAR data; production of digital orthophotos, DEMs, planimetric and topographic mapping; land-use/land-cover and SAV classification, surveying, bathymetric mapping and hydrographic surveying.

USACE National Coastal Mapping Program (JALBTCX), Nationwide Coverage

Operations and Quality Manager: Mr. White oversees production and project management managing for task orders under this contract. Deliverables include topographic, RBG imagery, and hyperspectral data collection, and topographic and RBG imagery processing for the NCMP. The NCMP's mission is to collect and merge shoreline topographic, bathymetric, and imagery data to create a seamless dataset that accurately represents the coastal condition.

Megan Blaskovich - Project Manager

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 06
- Years w/ Other Firms: 02

Education

- BA Anthropology, 2002, University of North Carolina
- GIS Certification, 2007, University of Connecticut

Affiliations / Certifications

- N/A

Ms. Megan Blaskovich is the project manager for this contract. Ms. Blaskovich is a skilled GIS professional with experience leading GIS and remote sensing teams to project success. Megan worked at as a team lead for Fugro performing GIS analysis and production in the timeframe 2009 -2014. In the five (5) year span while at Fugro, her proficiency and understanding of geospatial products and their production processes provided a vehicle for rapid advancement to leadership roles within the company. She acted as a deputy project manager and point person for customer interaction for many high profile projects leading the development of final deliverables; finishing and packaging deliverables; reporting to management for schedule and percent complete; workflow development, implementation, and documentation for GIS and remote sensing projects; organizing and conducting internal trainings sessions; and creating graphics and presentation materials for marketing purposes.

NOAA Geospatial Services Contract (2016 - Ongoing)

Project/Task Manager: Blaskovich currently manages all task orders under the NOAA Geospatial Services Contract. Three task orders have been for the Coastal Change Analysis Program (C-CAP), one to provide C-CAP data in the Great Lakes region, one for high-resolution C-CAP pilot areas, and one CONUS change mapping for large portions of the coastal United States. Work for the NOAA-NGS GRAV-D program to update the vertical datum has also been tasked under this contract, and Ms. Blaskovich has overseen the acquisition of over 200 hours of aerial gravity survey in support of that program. In managing these projects Ms. Blaskoivch has worked regularly with NOAA officials and employees, subcontractors, and end customers to make sure deliverables are submitted on time, address any issues that may arise, and to ensure open and ongoing communication between all parties under the contract,

Colombia Lidar Project (2016)

Project Manager: Ms. Blaskovich oversaw all aspects of this project which requied the acquisitiond and processing of approximately 350 sqkm of 2ppsm lidar with 10cm RMSEz over a pojrect area in Colombia, South America. She gained international experience working with Colombian contracts and subcontractors for data acquisition and ground control collection. She worked closely with the customer for the duration of the project providing regular updates on acquistion, processing, and was involved in the development of enhanced forest canopy delivery products specified by the customer. The project was delivered first time right in the fall of 2016.

Delaware County Broadband Initiative

Mapping and Facilities Specialist: While at previous employment (2014-2016), Ms. Blaskovich created the GIS data set for the Delhi Telephone Company's participation in the New York State Broadband Program using federal, state, and local resources. The GIS data set has been instrumental in fiber to the home planning and engineering, build estimating, grant and loan applications, and Federal filings.

Alaska Statewide Digital Mapping Initiative (SDMI)

Senior Analyst: Ms. Blaskovich was the point of contact for all customer related data or delivery questions including data corrections and analysis. She led the project finishing and deliverable process which included overseeing the DEM editing and qc team for DSM and DTM products, hydrologic enforcement, generation of supplemental vector data and metadata and reporting for delivery, and was in integral in creating and testing the DSM/DTM generation process for the project.

Keith Owens - Technical and Business Development Manager

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 12
- Years with Other Firms: 08

Education

- Business / 2 Years
- Photogrammetry / 1 Year

Affiliations / Certifications

- N/A

Mr. Keith Owens, Business and Technical Development Manager of Fugro's mapping services, leads program-based communication, from program initiation, to contract negotiations, to production. Mr. Owens' hands on experience with Land Surveying, Aerial Data Acquisition, Project Planning, Project Estimating, Data Processing, Map Compilation, Project Management and Business Development uniquely qualifies him to manage and implement project goals, accuracies, expectations and execution.

Mr. Owens detailed understanding of every aspect of the mapping industry ensures all communication for Fugro's geospatial efforts are clear and accurate.

Texas Water Development Board – TNRIS High Resolution Lidar, Imagery and QA/QC

Client Liaison: Mr. Owens serves as client liaison between TWDB and Fugro to ensure responsiveness to technical and administrative inquires for this contract for acquisition of high resolution lidar data at 4 points per square meter, orthoimagery and 3rd Party QA/QC services. The project area of interest covers approximately 3,207 square miles over portions of seven counties in five locations in Central and North Texas.

Capital Area Council of Governments Aerial Imagery, Lidar and Planimetric Mapping

Client Liaison: The Capital Area Council of Governments (CAPCOG) selected Fugro Geospatial to create and update geospatial base map data for the Capital Area. The Capital Area Geospatial Base Map (GeoMap) Project is a two-year, cost-sharing initiative to produce and maintain current geospatial base map data for the 10-county area. The primary focus of the task orders are for orthoimagery, planimetric data and lidar services. Fugro completed 6", 12", and 24" 4-band orthoimagery (leaf on and leaf off) over the 10 county regions. In addition to the orthoimagery task order, Fugro acquired and processed planimetric data and lidar (Pflugerville) as buy-up deliverables.

5-Year Statewide Orthoimagery Program, State of Vermont

Project Staging and Controls: Mr. Owens designed and estimated the five (5) year statewide project. Vermont's short acquisition window, challenging atmospheric conditions, flood characteristics (from winter snow melt) and heavy terrain required a proper project design and financial understanding from year one. Vermont's statewide project included the base map Ortho deliverable with options for buy-ups.

Central Oklahoma Alliance of Government Agencies 2014 (COAGA14)

Client Liaison: Mr. Owens serves as client liaison between COAGA and Fugro to ensure responsiveness to technical and administrative inquires for this contract for acquisition and processing of orthophotography for municipalities of Edmond, Cleveland County, Del City, Moore and Yukon in Central Oklahoma totaling over 800 sq. mi. The specified resolution ranges from 3-inch, 6-inch and 12-inch GSD.

USACE National Coastal Mapping Program (JALBTCX), Nationwide Coverage

Project Staging and Controls: Mr. Owens designed and estimated USACE National Coastal Mapping Program Task Orders from Flight Planning, Ground Control Layout, to Project Estimating. His experience working in challenging environments paved the way for proper project expectations. Project planning and estimating was clearly laid out anticipating difficult atmospheric conditions, tidal requirements and short flight windows for data acquisition.

Dave Holm, CP, SP, GISP - Quality Manager

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 17
- Years with Other Firms: 04

Education

- MS Geography, 1993, SD State University
- BS Geography 1990, SD State University

Affiliations / Certifications

- ASPRS Certified Photogrammetrist, #1301
- OR Professional Photogrammetrist, #80787RPP
- Surveyor Photogrammetrist VA, # 000120
- Geographic Information Systems Professional #91371

Mr. Holm has over 17 years in the geospatial and remote sensing industry. His time at Fugro has been spent providing quality control and operations oversight of our largest and most complex mapping projects and programs for clients such as the Army Corps of Engineers and the U.S. Bureau of Reclamation. Responsibilities include client coordination; cost analysis; contract interpretation; quality control/quality assurance of product deliverables, and client feedback.

Federal Emergency Management Agency IDIQ: (Regions 5, 6, 8 & 9)

Program/Project Manager: Mr. Holm has managed multiple task orders For FEMA through a Joint Venture (Compass). These task orders include the acquisition and processing of high resolution LIDAR for a detailed surface elevation data of the watershed for floodplain mapping and hydrologic modeling. Projects include both emergency response and disaster mitigation projects often in extreme terrain locations.

USACE St. Louis District Photogrammetric Mapping & Aerial Photography IDIQ Contract, Nationwide Coverage

Quality / Operations Manager: Mr. Holm provides administrative and quality oversight of this 5-year IDIQ contract encompassing photogrammetric mapping, aerial acquisition (conventional, digital, lidar), remote sensing, aerotriangulation, large and small-scale topographic maps, and landuse/landcover analysis and mapping services. Task order under this contract have included rapid response mobilization to areas of flooding, as well as floodplain mapping for the modeling of future occurrences and many locations throughout the United States.

USACE St Louis Dist. Task Order: High Resolution Lidar Acquisition for Upper James Watershed, ND, SD

Quality / Operations Manager: Mr. Holm provides administrative and quality oversight for this task order on Fugro's IDIQ Contract with the St. Louis District COE to provide high resolution lidar and intensity imagery for a detailed surface elevation data of the James River Watershed along with surrounding watersheds in North and South Dakota for use in conservation planning, design, research, delivery, floodplain mapping, and hydrologic modeling. The project area totals over 50,000 sq. mi. for phase 1 - 6 collections. For all areas FEMA Guidelines and Specifications for Flood Hazard Mapping and National Digital Elevation Program (NDEP) specifications will be met.

USACE St Louis Dist. Task Order: Missouri River Flooding Orthophotography, MT, ND, SD, and NE

Quality / Operations Manager: As a task order under the St. Louis COE IDIQ Contract, Fugro provided rapid response aerial imagery acquisition services to capture maximum flow release and flow crest elevations at specific areas designated along the Missouri River in Montana, North Dakota, South Dakota, and Nebraska to the limits of flooding, and related emergencies. The photo collection required multiple planes and sensors deployment because of the small acquisition window.

Bureau of Reclamation – Multi-Region IDIQ Contract(s) for Photogrammetry and Remote Sensing, Western U.S. Coverage

Quality / Operations Manager: Mr. Holm provides administrative oversight of multiple 5-year IDIQ contracts with the USDI/Bureau of Reclamation, Great Plains Region, encompassing aerial photography acquisition, lidar data acquisition and processing, orthophotography, topographic and planimetric mapping services throughout 17 western states.

Douglas Johnson, CP - Raw Data Inspection / Quality Control

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 28
- Years with Other Firms: 09

Education

- BS Geography

Affiliations / Certifications

- ASPRS Certified Photogrammetrist, CP #1512

Mr. Johnson has 31 years of expertise in the mapping industry. He is primarily responsible for the quality control of Fugro's digital imagery and lidar data. He inputs coordinates into the flight management system along with flight maps to be distributed to the flight crews. Mr. Johnson also checks raw imagery/data for contract limits and quality. He performs in-house flight line programming, project coordination and crew dispatching. He also responsible for the QA/QC review of imagery for the United States Department of Agriculture (USDA) and National Agriculture Imagery Program (NAIP).

5-Year Orthophotography Program (2013-2017), Various Locations, Ontario, Canada

Raw Data Quality Control: In early 2013 Ontario Ministry of Natural Resources and Forestry (OMNR&F) awarded Fugro a 5-year contract to acquire haze-free, leaf-off, snow/ice-off (spring) aerial acquisition of digital 4-band (R/G/B/IR/Pan) aerial orthoimagery. The 4-band imagery is acquired with the Leica ADS100 digital sensor and processed to produce 20cm pixel resolution. Phase I- 2013: 33,200 sq. km; Phase II -2014: 37,290 sq. km. Phase III-2015: 49,167 sq. km. Phases IV and V (2016 and 2017) are in the planning stages.

5-Year Statewide Orthophotography Mapping Program (2010-2015), Vermont

Raw Data Quality Control: In December 2010, The State of Vermont awarded Fugro a five (5)-year statewide mapping contract for orthophotography with acquisition and production of ASPRS Class 1, 1"=200' color orthophotography at 50 cm GSD with multiple buy-up areas of higher resolution (15cm, 20cm and 30cm). The new imagery is being used by the planning, engineering, and emergency response departments for master planning and infrastructure management and other State and local agencies. Completed in 2015, the fifth and final year of the program has been accepted, totalling over 9,000 sq. mi. of imagery being delivered.

USDA National Agricultural Imagery Program (NAIP) (2003-Current), Various Locations

Raw Data Quality Control: Operating under consecutive NAIP contracts since 2003, Fugro provides the USDA with county and state wide orthoimagery mosaics and orthoimagery mapping (DOQQs) in support of agricultural monitoring. Fugro manages multiple (4-6) aircraft operating concurrently during a typical NAIP flight season. Imagery acquisition is performed using the Leica ADS100 imagery sensor. Projects require acquisition of aerial imagery, aerotriangulation, and orthorectification. Task orders involve the mapping of 24 states (some multiple times) and production of nearly 396,000 DOQQs; these statewide efforts were made possible through USDA / state partnerships, with states funding data acquisition and deliverable enhancements.

Kirk Spell, CP, CMS - Imagery Department Supervisor

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 22
- Years with Other Firms: 02

Education

- AS (AutoDesk Training Center (AutoCAD Drafting)

Affiliations / Certifications

- American Society for Photogrammetry & Remote Sensing
- ASPRS Certified Photogrammetrist CP #1498
- ASPRS Certified Mapping Scientist CMS) #RS198

Mr. Spell supervises the production of Fugro's digital orthophotography. His responsibilities include maintenance of production for the digital imagery/orthophoto department including organizing, scheduling, image processing, and QA/QC of final imagery products.

Since joining Fugro in 1993 and prior to being transferred to the digital ortho department in 1997, Mr. Spell worked in the data processing department gaining knowledge and skills in Digimap and AutoCAD translations. He also oversees, and manages the final color balance and radiometry imagery, as well as the mosaicking, tiling, and QA/QC of final products.

Concentrated training by Z/I Imaging has resulted in Mr. Spell's quick mastery of digital orthophoto image processing and direct application on the production and delivery of digital orthophotos to the GIS industry. Mr. Spell has incorporated many time saving and product enhancing features to the orthophoto processes.

Capital Area Council of Governments Aerial Imagery, LiDAR and Planimetric Mapping

Orthoimagery Production Manager: The Capital Area Council of Governments (CAPCOG) selected Fugro Geospatial to create and update geospatial base map data for the Capital Area. The Capital Area Geospatial Base Map (GeoMap) Project is a two-year, cost-sharing initiative to produce and maintain current geospatial base map data for the 10-county area.

The primary focus of the task orders are for orthoimagery, planimetric data and LiDAR services. Fugro completed 6”, 12”, and 24” 4-band orthoimagery (leaf on and leaf off) over the 10 county regions. In addition to the orthoimagery task order, Fugro acquired and processed planimetric data and LiDAR (Pflugerville) as buy-up deliverables.

6-Inch Pixel Color Orthophotography, 1”=100’ Planimetric Mapping, Rapid City, SD

Orthoimagery Production Manager: Orthophotography and planimetric mapping (1” = 100’ scale) was performed for the city and surrounding area. The project area was approximately 205 sq. mi. for the orthophotography and planimetric updates features. Digital aerial photography was acquired with the ADS80-SH82 digital sensor. Color and CIR orthorectified imagery was processed and delivered on time at a 6-inch pixel resolution. The imagery was processed in our proprietary database, allowing us to process all four bands simultaneously, and gives the ability to clip each 4-band product (Natural Color and CIR) from the same database.

5-Year Orthophotography Program (2013-2017), Various Locations, Ontario, Canada

Orthoimagery Production Manager: In early 2013 Ontario Ministry of Natural Resources and Forestry (OMNR&F) awarded Fugro a 5-year contract to acquire haze-free, leaf-off, snow/ice-off (spring) aerial acquisition of digital 4-band (R/G/B/IR/Pan) aerial orthoimagery. The 4-band imagery is acquired with the Leica ADS100 digital sensor and processed to produce 20cm pixel resolution. Phase I- 2013: 33,200 sq. km; Phase II -2014: 37,290 sq. km.

Phase III-2015: 49,167 sq. km. Phases IV and V (2016 and 2017) are in the planning stages.

Kirk Spell, CP, CMS - Imagery Department Supervisor

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6-Inch Pixel Orthoimagery, Mid-America Regional Council (MARC)

Orthoimagery Production Manager: Mr. Spell was responsible for the processing of 6-inch, 4-band orthoimagery for MARC, a consortium of 12 counties, three (3) cities, and the USGS. The project area totals 5,253 sq. mi. Acquisition was completed in April of 2014. This project was very challenging with high expectations for data quality, a high degree of accuracy, and a demanding schedule. Orthoimagery was delivered and has been accepted by the counties and cities and is awaiting acceptance from the USGS (full acceptance is anticipated following the USGS review timeline). The imagery is being used by GIS departments throughout the Kansas City Metro area.

1- and 2-Foot Pixel Orthoimagery, Missouri River Flooding, MT, ND, SD, and NE

Orthoimagery Production Manager: Mr. Spell was responsible for the processing of 1 and 2-foot orthoimagery to capture maximum flow release and flow crest elevations at specific areas designated along the Missouri River in Montana, North Dakota, South Dakota, and Nebraska. The acquisition required multiple plane and sensor deployment due to the small acquisition window required to document the maximum flow. The imagery was collected in two (2) phases and include 9,329 sq. mi. of digital 4 band (RGB & IR) imagery for several reaches along the Missouri River and orthorectification at 1' and 2' pixel GSD of all imagery at specified locations.

1-Foot Pixel Digital Orthophotography, Madison and Hamilton Counties, FL

Orthoimagery Production Manager: Mr. Spell was responsible for the processing of 1-foot pixel digital orthoimagery for Madison and Hamilton Counties Florida, an approximate 1,400 sq. mi. area. RGB and CIR imagery was acquired in Spring of 2013. All deliverables were accepted, 30 days early and first-time-right. Although the DOR tasked for acquisition of both natural color (RGB) and color infrared (CIR) imagery, Fugro was only required to deliver RGB to the DOR with possible future processing and delivery of the CIR imagery.

Digital Orthoimagery, Lidar, and Planimetrics Louisville, CO

Orthoimagery Production Manager: Mr. Spell was responsible for the processing of .5-foot orthoimagery, Lidar, and planimetric mapping (1" = 100' scale) for the City of Louisville and surrounding area. The project area was approximately 100 sq. mi. for the orthoimagery and approximately nine sq. mi. for the Lidar contours and planimetric features. The current GIS had sub-standard orthoimagery, contours and a DTM that had mismatched and missing data and documentation. With this new project, Fugro partnered with the City of Louisville GIS department to provide a new base map for a complete rebuilding of the GIS from the ground up.

Base Mapping IDIQ Contract, Rutherford County TN

Orthoimagery Production Manager: In 2009, Rutherford County awarded Fugro a five year base mapping contract with a one year extension to provide a wide range of product services, including 6-inch digital orthophotography, LiDAR, planimetric updates, contours, and oblique imagery. Under this contract, Fugro was awarded a task order in 2012 to provide county-wide, 6-inch orthoimagery and LiDAR data. Mr. Spell led the imagery processing team to produce new high-quality orthoimagery to the required specifications and quality expectations.

State of Massachusetts Statewide Imagery

Orthoimagery Production Manager: Through the USGS GPSCII Contract, Fugro acquired orthoimagery covering approximately half of the State of MA during spring of 2013. The State of Massachusetts, contracted directly with Fugro to acquire and process 4-band CIR imagery at 30 cm GSD, as well as many mapping add on and buy-up products, for the remainder of the state in an a separate mobilization, in spring of 2014. The area acquired in 2014 is approximately 5,605 sq. miles.

Countywide Color Orthophotography, Washington County, IA

Orthoimagery Production Manager: Fugro contracted with the County of Washington, IA for the 2010 leaf-off digital natural color orthophotography project including collection and orthorectification at a 6-inch inch pixel size for the county-wide extend and at a 3- inch pixel size for the City of Washington, IA. The total project area is 595 square miles. A pilot area selected from the City of Washington was delivered for validation of procedures and deliverables review by the County before full countywide ortho production was begun.

Todd Giesey - AT / Compilation Specialist

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 27 (3/1989)
- Years with Other Firms: 0

Education

- AS, Computer Aided Drafting, 1989, Western Dakota Technical Institute

Affiliations / Certifications

- N/A

Mr. Giesey is Fugro's softcopy AT specialist. He is trained in all facets of photogrammetric mapping, digital photogrammetry and softcopy aerotriangulation.

He is responsible for creating rectified imagery for stereo viewing (Level 1) and DEM for orthorectification. He triangulates the imagery for improved ground contro4l utilizing SOCET Set Automatic Point Measurement (APM) tool. To improve accuracy a fully automatic aerotriangulation process can be performed to minimize the residual errors in the GPS/INS derived exterior orientations. The aerotriangulation also allows the introduction of ground control and checkpoints to ensure the accuracy specifications are achieved. From the L1 imagery, Mr. Giesey extracts a fully automated DEM utilizing the SOCET Set Automatic Terrain Extraction (ATE) tool, which fully supports DMC imagery.

6-Inch Orthophotography, 1"=100' Planimetric Mapping, Rapid City, SD

Aerotriangulation and Compilation Specialist: The City of Rapid City contracted with Fugro to provide new orthophotography and planimetric mapping (1"=100') for the city and surrounding area. The project area was approximately 205 sq. mi. for the orthophotography and planimetric updates features.

6-Inch Orthophotography, Lidar, and 1"=100' Planimetric Mapping, Louisville, CO

Aerotriangulation and Compilation Specialist: The City of Louisville, CO, contracted with Fugro to acquire new 6-inch orthophotography, lidar, and planimetric mapping (1"=100') for the city and surrounding area. The project area totaled approximately 100 sq. mi. The existing orthophotography, contours were of substandard quality and the DTM had mismatched/missing data and documentation. Fugro partnered with the City's GIS department to provide a new base map for a complete rebuilding of the GIS from the ground up.

3-Inch Orthophotography, High Density Lidar and 1"=50' Planimetric Mapping, Belden ND

Aerotriangulation and Compilation Specialist: Under contract with Kadrmas Lee & Jackson (KLJ), Fugro acquired approximately 12 miles of imagery and lidar for a highway planning project. High resolution lidar (7ppsm) was acquired using Fugro's FLIMAP Fx system and imagery was acquired with the Zeiss Top15 camera to achieve 3-inch pixel orthophotography. The data was processed to achieve accuracies suitable for development of 1-foot contours. Additionally collection of 1"=50' scale planimetrics was compiled from the orthoimagery.

3-Inch Orthophotography, 1"=40' Planimetric Mapping, NDDOT, Various Locations, ND

Aerotriangulation and Compilation Specialist: Fugro has been very active providing orthoimagery processing and engineering grade mapping services as a subcontractor to multiple engineering firms working for the North Dakota DOT. NDDOT has the capability to acquire their aerial imagery with their aircraft and aerial mapping camera. Fugro was provided the acquired raw imagery to produce 3-inch orthoimagery and compile full planimetric mapping features to the 1"=40' scale delivered in Esri geodatabase format.

Tian Wang - Lidar Processing Manager

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 15
- Years with Other Firms: 13

Education

- BS, Engineering, Tsinghua University, Beijing, China

Affiliations / Certifications

- N/A

Ms. Wang currently manages lidar production operations for Fugro. Ms. Wang has developed significant knowledge, insight, and proficiencies during her 15years in the mapping and GIS industry. She has completed and managed a variety of mapping projects that have involved multiple applications and map scales for clients who include federal, state, and city government agencies and private engineering and development firms.

NOAA Office for Coastal Management: Geospatial Services, Nationwide Coverage

Lidar Production Manager: Ms. Wang manages the Lidar /Terrain production team for task orders under this multi-year IDIQ contract for the NOAA OCM. The contract covers a wide range of services, including: acquisition and processing of airborne imagery, lidar, multi-spectral, and IFSAR data; production of digital orthophotos, DEMs, planimetric and topographic mapping; land-use/land-cover and SAV classification, surveying, bathymetric mapping, hydrographic surveying, and tsunami inundation modeling.

USACE National Coastal Mapping Program (NCMP), Nationwide Coverage

Lidar Production Manager: Ms. Wang managed the topographic Terrain / Lidar processing for USACE Mobile District's National Coastal Mapping Program (NCMP). Fugro is a subcontractor on this program through Fugro Pelagos' USACE Mobile District IDIQ contract. The NCMP's mission is to collect and merge shoreline topographic, bathymetric, and imagery data to create a seamless dataset that accurately represents the coastal condition. Final deliverables, delivered in 2011, are used by the NCMP for coastal monitoring.

USACE St. Louis District Photogrammetric Mapping & Aerial Photography IDIQ Contract, Nationwide Coverage

Lidar Production Manager: Ms. Wang serves as lidar specialist for consulting, quality control, and processing for lidar related task orders under this 5-year IDIQ contract for the St. Louis District Army Corps of Engineers. Fugro has held an indefinite delivery contract with the St. Louis District for more than 20 years and through this IDIQ, supports a wide array of clients, including other federal agencies such as the National Guard, the US Army and Navy, the Departments of the Interior and Agriculture well as state agencies.

USFS Multi-State Lidar Validation of FIA Survey Plots Various Locations in OR, CO, MN, ME, NJ/PA, SC

Lidar Production Manager: Fugro has worked with the Forest Service NW Acquisition Branch on a lidar project involving lidar acquisition and processing of (six) 6 different sites within the states of OR, CO, MN, ME, NJ/PA, and SC. Each area is roughly 8,100 sq. mi. The project has two objectives. The primary objective of the project is to collect regularly-spaced lidar data (4pts/m2) over the entire extent of each study area. The secondary objective of the project is to acquire LIDAR measurements over at least 50 FIA field plots (circular plots, 36.6 meters in radius) within each study site. Data acquired from the FIA plots will be used to develop models relating forest biomass and carbon to lidar forest structure metrics.

Jonathan Helta, CP - Lidar Team Lead / Analyst

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 15
- Years with Other Firms: 04

Education

- BS, Environmental Analysis / Planning, Frostburg State University, 1997

Affiliations / Certifications

- ASPRS-Certified Photogrammetrist CP #1344
- ASPRS-Certified Photogrammetric Technologist CPT #1299

Mr. Helta has over 15 years of expertise in the geospatial industry. He has extensive experience in lidar production techniques, software, and product development. He has participated in a variety of state and federal projects in both secure and non–secure environments.

Mr. Helta's serves as Fugro's lidar processing team lead, responsible for managing multiple analysts, improving productivity, maintaining capacity, establishing workflows, monitoring budgets, responding to technical questions and providing overall direction to the lidar production team. Additionally, he is responsible for exploring new processing methods (hardware, software, and technical approach) to improve data efficiencies. Mr. Helta continually advances his theoretical and technical knowledge of lidar processing by attending annual industry courses (ex. Geocue, Advanced Visualization of Large Point Clouds, Building Classification, etc.).

North Carolina Statewide Floodplain Mapping Program, State of North Carolina

Lidar Specialist: Mr. Helta performed lidar processing for various phases of this project and the most recent delivery of this project which involved collection of lidar data for this first of its kind statewide mapping project for flood plain analysis. In 2005, Fugro Geospatial was tasked to acquire digital imagery over 17 counties (36,602 square miles) to develop color orthoimagery at a 1' pixel resolution in support of the state's program. Digital imagery was collected using Fugro Geospatial's ADS40 digital camera in the spring of 2005 and final delivery of orthoimages for all counties was completed in 2006.

NOAA CSC, Coastal Geospatial Services Contract

Lidar Specialist: Mr. Helta performed lidar processing for the delivery of high quality topographic elevation point data derived from multiple return lidar measurements for an area of approximately 477 square miles encompassing Hancock County and 727 square miles encompassing Jackson County in Mississippi. The contract called for the acquisition of aerial data and digital data processing, including but not limited to analog and digital aerial imaging, lidar, multispectral, and radar; map processing services including development of digital orthophotography, lidar elevation models, radar images and elevation models, and topographic and planimetric mapping. This data was used for flood plain mapping and other coastal management applications.

USACE, St. Louis District IDC - Multiple task orders

Lidar Specialist: Mr. Helta serves as a lidar specialist for consulting, quality control, or processing for task orders under this 5-year IDIQ contract for the St. Louis District Army Corp of Engineers. The contract requires aerial photography and airborne GPS data acquisition, remote sensing with hyperspectral and multispectral sensors and passive microwave radiometer, aerotriangulation, large- and small-scale topographic mapping, lidar, land-use/land-cover mapping, digital orthophotography, and a variety of advanced mapping and surveying services. Fugro Geospatial has held an indefinite delivery contract with the St. Louis District for more than 20 years.

Nora May, PHD, CP - Senior Systems / Geodetic Engineer

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 09
- Years with Other Firms: 07

Education

- PhD Geodetic Science, 2007, Ohio State University
- MS Geodetic Science, 2007, Ohio State University
- MS Surveying/Geoinformatics Engineering, 2001, University of Technology and Economics, Hungary

Affiliations / Certifications

- ASPRS Certified Photogrammetrist CP #1497
- American Society for Photogrammetry and Remote Sensing, Member

Dr. Nora May is Fugro's Senior Systems / Geodetic Engineer, responsible for refining geopositioning workflows and developing new algorithms to improve data accuracy and production efficiency, maintaining a well-calibrated lidar system, dealing with technical issues, as well as leading GPS/IMU processing and boresighting.

Dr. May has over 16 years of experience working on various projects involving lidar and digital photogrammetry. Her research interests include surface extraction and modeling, sensor fusion, calibration of multi-sensor systems, including lidar boresight calibration, and accuracy assessment for digital imagery and lidar. She has been awarded several prestigious awards for her research work. Dr. May has extensive list of publications in both scientific journals and conference proceedings.

USACE St. Louis District Photogrammetric Mapping & Aerial Photography IDIQ Contract, Nationwide Coverage

Geopositioning Lead: Served as geopositioning lead for consulting, quality control, and processing for task orders under this 5-year IDIQ contract for the St. Louis District Army Corps of Engineers. The contract requires aerial photography and airborne GPS data acquisition, remote sensing with hyperspectral and multispectral sensors and passive microwave radiometer, aerotriangulation, large- and small-scale topographic mapping, lidar, land-use/land-cover mapping, digital orthophotography, and a variety of advanced mapping and surveying services.

NOAA Office for Coastal Management: Geospatial Services, Nationwide Coverage

Geopositioning Lead: Dr. May assists in the management of lidar /terrain and geopositioning production team for quality control and processing for task orders under this multi-year IDIQ contract for the NOAA OCM. The contract covers a wide range of services, including: acquisition and processing of airborne imagery, lidar, multi-spectral, and IFSAR data; production of digital orthophotos, DEMs, planimetric and topographic mapping; land-use/land-cover and SAV classification, surveying, bathymetric mapping, hydrographic surveying, and tsunami inundation modeling.

USACE National Coastal Mapping Program (NCMP), Nationwide Coverage

Boresighting Lead: Dr. May serves as boresighting lead and support for the topographic lidar phase of this photography and remote sensing project. Fugro's portion of this one of a kind mapping project includes topographic lidar, RBG imagery, and hyperspectral data collection. Fugro Geospatial is a subcontractor on this program through Fugro Pelagos' USACE Mobile District IDIQ contract. The NCMP's mission is to collect and merge shoreline topographic, bathymetric, and imagery data to create a seamless dataset that accurately represents the coastal condition.

Lynn Baker, CP, CPT - Manager of Cartographic Editing

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 37
- Years with Other Firms: 0

Education

- BA, Fine Arts/Minor in Cartography, 1978 University of Maryland

Affiliations / Certifications

- ASPRS Certified Photogrammetrist CP #1343
- ASPRS Certified Photogrammetric Technologist CPT #1332

Lynn Baker supervises the Fugro cartographic edit team. During more than 37 years with Fugro, Ms. Baker has developed expertise in various phases of map preparation and finalization of topographic map sheets at a variety of scales. Her software proficiencies include, but are not limited to, ArcInfo and ArcView, MGE Base Imager, MicroStation V8, AutoCAD, AutoDesk 2007, TerraSolid-Terrain package for DEMs and DTMs, KORK.

Ms. Baker has manages cartographic edit projects and task orders under Fugro's federal ID/IQ contracts which include multi-year contracts for the USACE, NOAA and USGS. She is well versed in creating a base for GIS analysis including SDSFIE Standards. In addition to coordinating QA/QC procedures, she supervises Fugro's graphics edit technicians and acts as liaison with customers, and in-house project teams and divisions.

Photogrammetric Mapping and Aerial Photography IDIQ Contract, USACE St. Louis District, Nationwide Coverage

Manager of Cartographic Editing: Ms. Baker has managed every cartographic edit program under Fugro's St Louis District IDIQ contracts and is well versed in creating a base for GIS analysis compliant with the Districts SDSFIE Standards. In addition to coordinating quality assurance/quality control procedures, she supervises FGAI's editing technicians and acts as liaison with customers for both in-house teams and divisions.

USACE St. Louis IDIQ Task Order(s): Engineering Route Studies (ERS) and National Guard Bases (NGB) Mapping, Vaious Locations

Manager of Cartographic Editing: The bulk of the 32 task orders have been for ERS and NGB mapping and delivery of photogrammetric mapping projects for select armory sites and military installations. Task orders have been issued for over 230 mapping projects for ERS. These studies are an ArcGIS 10 digital GIS product and graphic that provides the user with strategic terrain, environmental, and route information critical to responding to crisis events or other international situations requiring possible US involvement. Eight task orders have been issued to date for mapping of over 120 NGB and armories (SDSFIE compliant) in the US.

Coastal Geospatial Services Contract, NOAA Office for Coastal Management (OCM), Nationwide

Manager of Cartographic Editing: Ms. Baker served as CADD specialist and cartographic edit team lead for the project that developed a prototype decision-support tool for improved port operations. Based on Fugro's SIMmetry system architecture, the prototype offers 2D GIS fully synchronized with 3D thematic mapping, query and analysis capabilities, and analytical modeling. SIMmetry allows for context-driven queries and data views to serve specific user groups including environmental, property, and port operations managers, among others.

Photogrammetric Mapping and GIS Database Update and Development Services Contract, Distric of Colombia Office of the Chief Technology Officer (DC OCTO), Washington, DC

Manager of Cartographic Editing: Ms. Baker provided technical oversight for the cartographic edit program and directed the GIS database updates from newly acquired 6-inch digital aerial imagery. Products included 1"=100' scale planimetric update collection over the entire area to very specific criteria to meet the DC OCTO GIS program goals. This data passed both internal and external photogrammetric QA/QC measures

Lynn Baker, CP, CPT - Manager of Cartographic Editing

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prior to final acceptance.

3rd Party QA/QC for Planimetric Mapping, City of Austin, TX

Manager of Cartographic QA/QC: Ms. Baker provided technical oversight and management of the City of Austin's 1"=100' scale planimetric update project. Ms. Baker coordinated weekly status meetings, performed automated and manual review of the provided data, and compiled detailed reports outlining project status, quality, completeness and adherence to contract specifications.

Planimetric and Topographic Mapping, Horry County, SC

Manager of Cartographic Editing: Ms. Baker supervised the planimetric feature extraction and topographic mapping data processing used to identify economic development changes in this high growth county and to manage the environmentally sensitive marsh regions surrounding the Myrtle Beach metropolitan area. Data was extracted from imagery acquired by Fugro. During processing of the original contract deliverables, Horry County requested an additional project, utilizing Fugro's land-use/land-cover application over orthoimagery. The land-use/land-cover map is used for hydrologic watershed modeling, and other uses including land use planning, fire fuels modeling, and hurricane debris estimating. Horry County contracted with Fugro for update their orthoimagery and planimetrics again in 2009. Through a USGS GPSC contract task order Fugro updated Horry County's planimetric data for 2015.

Base Mapping IDIQ Contract(s), Rutherford County TN

Manager of Cartographic Editing: Since 2004, Fugro and Rutherford County have engaged in multiple, highly successful imagery and mapping projects beginning with a county-wide (620 sq. mi.) update to the digital orthophoto and topographic base map. Ms. Baker has been an instrumental part of multiple topographic contour and planimetric collection and updates with the initial feature extraction from the newly acquired imagery (by Fugro) to produce a county-wide planimetric base-map (1'=100" scale), including 3D breaklines and 2-foot contours. In 2007 Fugro again acquired 6-inch orthoimagery. Ms. Baker led the cartographic edit team to update the contours and planimetric features. In 2009, Rutherford County awarded Fugro another five (5) year base mapping contract with a one year extension to provide a wide range of product services, including digital orthophotography, LiDAR, planimetric updates, contours, and oblique imagery. Under this contract, Fugro was awarded a task order in 2012 to provide county-wide, 6-inch orthoimagery and LiDAR data. Ms. Baker led the cartographic edit team to produce new breaklines and contours from the newly acquired lidar data.

Additional Project Experience:

3-Inch Orthophotography Processing, 1" = 40' Planimetric Mapping, Boy Scouts Complex, WV

E12-0006-03	CA Coastal Data Merge, Bathy Merge
E11-0041-00	Lower NC McIntosh, LiDAR
E11-0042-00	Lower NC Pottawatomie, LiDAR
E11-0045-00	Mineral, VA FliMap, LiDAR
E09-0005-00	City of Hot Springs, AR, Planimetrics

Debra Wenner - Senior Production Analyst

Fugro Geospatial, Inc.

Experience

- Years with Fugro: 11
- Years with Other Firms: 14

Education

- MS, Geography, 2001, Virginia Polytechnic Institute and State University
- BA Geography, 1995, West Virginia University

Affiliations / Certifications

- N/A

Ms. Wenner joined Fugro in 2005 as a GIS analyst where she processes and edits various types of digital data from different sources to produce a variety of products that meet internal and/or external client requirements. Ms. Wenner also provides training, performs independent quality review of other staff members' work, provides technical support, and performs administrative duties as required.

While working with Fugro, Ms. Wenner has been responsible for using remote sensing and GIS applications for land cover mapping, image-based feature extraction, and processing and analysis of raster and vector data.

NOAA CSC, Coastal Geospatial Services Contract - Ongoing Multiple task orders

Digital Imaging Analyst: This project for NOAA involved mapping benthic (underwater) habitats, primarily seagrasses, along the southern Texas coast using digital true color and color IR orthoimageryimagery. The project developed semi-automated mapping methods (Definiens Professional and Classification and Regression Tree analysis) to map seagrass beds and other underwater habitats in the estuarine systems along the coast. Ms. Wenner was involved in the editing and geoprocessing steps of the project.

Horry County, SC, Land Use Land Cover Mapping

Digital Imaging Analyst: Ms. Wenner was involved in mapping various land use and land cover types for Horry County, South Carolina. Mapping was done from multispectral digital imagery using semi-automated image classification methods developed during the Texas benthic habitat mapping project. Mrs. Wenner performed field data verification and image classification.

Independent QA/QC for the City of Austin, TX, Planimetric Mapping Data

Digital Imaging Analyst: Ms. Wenner provided data QC and validation on this 3rd Party QA/QC contract for 1" = 100' scale planimetric mapping products collected in the City of Austin. Mr. McClellan provided direction and supervision of all Fugro department staff and coordinated the review of the data producing accurate reports on the vendor's ability to meet specifications with data accuracy, quality and completeness.

Photo Interpretation and Damage Assessment Response to Hurricane Ike, Gulf Coast Area, TX

Digital Imaging Analyst: Ms. Wenner was the imagery analysis lead during this DHS/FEMA task order which included photo interpretation and geospatial data development services to aid in the emergency response to Hurricane Ike in 2008. Fugro provided assessment and photo interpretation of approximately 11,000 sq. miles.

3.7. Resolution of Source Anomolies

On projects of this scale it is common for inconsistencies and anomalies between source materials and specifications to occur. Fugro's Project Manager will bring such issues to the attention of each of the participating designated project managers immediatly upon the identification of the anomolie. Fugro and the participating members of COAGA 2017 will work together to resolve issues and problems that arise.

Fugro's ISO9001:2008 Qaulity Management System (QMS) has been developed with input from lessons learned on mapping projects for over 10 years. The QMS is designed to identify potential problems early on and mitigate before they affect the schedule of the project.

Additionally we have developed contingency plans for each major stage of our projects. The folloing section summarizes these procedures that are pre-emptive mitigation standards for common issues that can affect the project schedule and quality.

3.7.1 Contingency Planning

3.7.1.1 Pre-Flight Planning / Project Kick-Off Meeting Lidar Process and Techniques

Our Project Staging and Control (PSC) department has completed a thorough review of the project requirements and has designed the final flight plan, ground control layout and data processing plan to meet the requirements. These planning files are sent to the Project Manager for review and easily adjusted prior to beginning the work. Should alterations to the approach be required after the project has started, PSC can quickly respond to any requests, make the changes and communicate to the land survey crew and flight department for alterations or adjustments to our approach while the team is on-site.

3.7.1.2 Data Acquisition Process and Techniques

Data acquisition processes have many components that can go wrong. During project planning, PSC reviews the project layout with the Flight Operations Manager to set contingency plans for each possible scenario. These scenarios may include:

Aircraft Issues: Fugro has multiple twin engine aircraft outfitted to acquire lidar on standby, in a mission ready position, to mobilize to the project site to back up our proposed aircraft should any unforeseen scenarios occur that would limit the acquisition of data.

Equipment Issues: Fugro has multiple lidar sensors available should our proposed sensor have issues during data collection. In the unlikely event Fugro's own sensors become unavailable; our multiple teaming partners are available to provide their sensors and aircraft to assist with completing the work. Fugro has regular meetings with teaming partners to be ready should any of these scenarios require back-up.

3.7.1.3 Data Processing Process and Techniques

Personnel Issues: A thorough review of the project has allowed our Production Manager, Ms. Debbie Simerlink, to set capacity and a realistic schedule to respond to the project requirements. Additional personnel and subcontractors are available and on standby to assist Fugro in the unlikely event that our proposed schedule and capacity are delayed.

Equipment Issues: Multiple production work stations and software licenses are available to accomplish the tasks listed in the RFP. In the event that Fugro exceeds the current license amount or production equipment fails, Fugro will call upon our global facilities to borrow licenses and equipment to respond to any unforeseen issues that will cause production delays.

3.7.1.4 Final Product Development Process and Techniques

Final Schedule and Delivery: All of the listed contingency plans above will reduce the impact on project deliverables to all parties involved to help keep a smooth and timely product delivery. Clear communication with each project participant on project issues (at the time of the issue) will allow Fugro to set schedules and capacity to respond accordingly to problems that may develop during all phases of the project.

3.8. Exceptions to the RFP

Fugro takes no exceptions to the RFP.

3.9. Additional Pertinent Information

On complete review of the RFP Fugro does not percieve that any omissions are present. We are confident that all specifications and requirements have been included to achieve the goals of the contract.

4 FEE PROPOSAL

4.1. Firm Fixed Unit Costs: Appendix B Digital Color Orthoimagery (TIFF)

City of Edmond (127 miles @ 3”)	$30,266
City of Del City (8 miles @ 3”)	$1,904
City of Del City (12.5 miles @ 3”)	$2,975
Midwest City (42.43 miles @ 3”)	$10,098
Midwest City (42.43 miles @ 6”)	$2,122
City of Moore (21.9 miles @ 6”)	$1,095
City of Norman (164 miles @ 6”)	$8,200
City of Norman (92 miles @ 3”)	$21,896
Oklahoma County (552 miles @ 6”)	$27,600
Oklahoma County (552 miles @ 3”)	$102,672
Oklahoma County (718 miles @ 6”)	$35,900
Oklahoma County (718 miles @ 3”)	$133,548
City of Yukon (35.78 miles @ 3”)	$8,516
Oklahoma City (712.48 miles @ 6”)	$35,624
Oklahoma City (6.85 miles @ 6 True Ortho)	$19,477
Optional mosaic products:	
1. Mr SID and JP2000 of City of Edmond	Complimentary
2. Mr SID and JP2000 of City of Del City	Complimentary
3. Mr SID and JP2000 of City of Midwest City (see Appendix)	Complimentary
4. Mr SID and JP2000 of City of Moore	Complimentary
5. Mr SID and JP2000 of City of Norman	Complimentary
6. Mr SID and JP2000 of Oklahoma County	Complimentary
7. Mr SID and JP2000 of City of Yukon	Complimentary
7. Mr SID and JP2000 of City of Oklahoma City	Complimentary
8. Mr SID and JP2000 of Entire Project Area - ACOG	Complimentary
(All TIFFs combined in a single seamless Mr SID)	

4.2. Optional Mapping Deliverables

City of Edmond

Planimetric Change Detection & Collection - Pilot Study Area Cost	$3,134
Planimetric Change Detection & Collection - Remainder of the City	$15,668
Change Detection, Collection and interpolation of the HE-DTM into 1 foot Contours- Pilot Area	$3,459
Change Detection, Collection and interpolation of the HE-DTM into 1 foot Contours - Remainder of the City	$17,295

Del City

LiDAR topographic data with 1’ contours, .7m classification, breaklines and hydro enforcement (8 square miles)	$22,386
LiDAR topographic data with 1’ contours, .7m classification, breaklines and hydro enforcement (12.5 square miles)	$24,186

Midwest City

Digital Terrain Model (DTM)	$12,089
Digital Terrain Model (DTM) with building heights	$22,064

Moore

Planimetrics – Building footprints, Hydrography – linear and polygon features Street centerlines, Railroads, Edge of pavement, Sidewalks, Parking Lots	$5,499
Topography – raw Lidar, 1 Foot contours, Spot elevation and	
Hydrologically re-enforced DEM – breaklines and mass points	$31,934

Norman

Planimetric Change Detection & Collection - Pilot Study Area Cost	$3,658
Planimetric Change Detection & Collection – 82 miles @ 1”=50’ & 115 miles @ 1”=100’	$40,234

Yukon

Planimetric Change Detection & Collection - Pilot Study Area Cost	$1,360
Planimetric Change Detection & Collection - Remainder of the City	$6,802
Change Detection, Collection and interpolation of the HE-DTM into 1 foot Contours- Pilot Area	$1,470
Change Detection, Collection and interpolation of the HE-DTM into 1 foot Contours - Remainder of the City	$7,352

AFFIDAVIT OF NON-COLLUSION
City of Edmond

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Edmond, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: [signature]

Subscribed and sworn to before me on this Fifth day of December, 2016

[signature] My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
City of Del City

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Del City, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: [signature]

Subscribed and sworn to before me on this Fifth day of December, 2016

[signature] My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
City of Midwest City

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Midwest City, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: ____________________

Subscribed and sworn to before me on this Fifth day of December, 2016

____________________ My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
City of Moore

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Moore, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: ____________________

Subscribed and sworn to before me on this Fifth day of December, 2016

____________________ My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
City of Norman

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Norman, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: [signature]

Subscribed and sworn to before me on this Fifth day of December, 2016

Katie C. Nuckols [signature] My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
County of Oklahoma

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the County of Oklahoma, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: [signature]

Subscribed and sworn to before me on this Fifth day of December, 2016

[signature] My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
City of Yukon

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Yukon, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: [signature]

Subscribed and sworn to before me on this Fifth day of December, 2016

[signature: Katie C. Nuckols]

My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC

AFFIDAVIT OF NON-COLLUSION
City of Oklahoma City

STATE OF Maryland

COUNTY OF Frederick

Dave White, of lawful age, being first duly sworn, on oath says, that (s) he is the agent authorized by the bidder to submit the attached bid. Affidavit further states that the bidder has not been a party to any collusion among bidders in restraint to freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any city official or employee as to quantity, quality, or price in the prospective contract, or any other terms of prospective contract; or in any discussion between bidders and any city official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Oklahoma City, Oklahoma any money or other thing of value, either directly or indirectly, in the procuring of the award of a contract pursuant to this bid.

Fugro Geospatial, Inc.
Bidder

By: ______________________

Subscribed and sworn to before me on this Fifth day of December, 2016

Katie C. Nuckols ______________________ My Commission Expires 11-6-2019

KATIE C. NUCKOLS
COMMISSION EXPIRES
NOV. 06, 2019
FREDERICK COUNTY, MD.
NOTARY PUBLIC