Contract
by and between

Cuyahoga County, Ohio

and

Kucera International Inc.

THIS AGREEMENT (the "Contract") is made and entered into this _____ day of _____, 2013 by and between Cuyahoga County, Ohio ("the County"), on behalf of the Department of Information Technology and **Kucera International Inc.**("Kucera"), a Ohio corporation with principal offices at 38133 Western Parkway, Willoughby, Ohio 44094 ("the Provider").

WHEREAS, the County issued a Request for Proposal Number 26543("RFP # 26543") for Aerial Photography and Related Photogrammetric Services, for the County Department of Information Technology /GIS Department, and

WHEREAS, Kucera is the RFP awarded provider of Aerial Photography and Related Photogrammetric Services; and

WHEREAS, Cuyahoga County desires to avail itself of such services of Kucera and Kucera is willing to provide such services to the County all upon the terms and conditions set forth in this contract, as further supplemented herein;

NOW, THEREFORE, in consideration of the mutual promises contained herein and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, Kucera and the County agree as follows:

ARTICLE I – AGREEMENT AND TERM

1.1 Scope of Agreement. During the term of this Contract, Kucera shall provide the County with Aerial Photography and Related Photogrammetic Services as outlined in Schedule A of this agreement. If in the event that a discrepancy exists between the terms of Schedule A and this agreement, the terms of this agreement will be controlling and binding.

1.2 Term. The initial term of this Contract shall commence as of March 18, 2013 and, unless earlier terminated in accordance with the provisions of this Contract, shall continue in effect for a period of 12 months from the commencement date (3/18/2013 through 3/17/2014) at a cost not to exceed Sixty Five Thousand Five Hundred Dollars and Zero Cents. ($65,500.00).

ARTICLE II - SCOPE OF WORK

2.1 Rendering of Services. Kucera hereby agrees to render the services identified in Article 1.1 the initial term which shall in no event exceed the amount of Sixty Five Thousand Five Hundred Dollars and Zero Cents ($65,500.00). County agrees to pay all Charges invoiced by Kucera.

ARTICLE III - PAYMENT AND INVOICING

3.1 Payment. During the term of this Contract, the County shall pay Kucera for the services rendered to Cuyahoga County upon the completion of the project Pricing Schedule attached hereto as Schedule B.

3.2 Invoicing. Kucera shall invoice the County for services rendered hereunder upon the completion of services. Said invoice shall describe, on a line item, the services rendered, the date rendered. Kucera shall submit original invoice(s) to the following address:

Cuyahoga County Department of Information Technology
Business Department
1255 Euclid Avenue, 4th Floor
Cleveland, OH 44115

3.3 Record Audit Retention. Kucera agrees to make all pertinent contractual books and records and other documents pertaining to this Contract available to the County and its designated agents for purpose of audit and examination upon reasonable request during the term of this Contract and for a period of one (1) years from the expiration date or final payment under this Contract, whichever is later; provided however, that should Kucera be notified that an audit has been commenced pursuant to Ohio Revised Code §117.11 during said period, for which the aforesaid books and records are material, the aforesaid records shall be retained pending the completion of said audit.

ARTICLE IV - INDEMNITIES AND WARRANTIES

4.1 Indemnities and Warranties. Kucera shall indemnify and hold Customer and its Agencies and their respective officers, directors, partner, principal, employees, agents, successors and permitted assignees harmless against damages arising out of third party claims resulting from injury to or death of any person (including injury to or death of their respective subcontractors or employees) or loss of or

damage to tangible real or tangible personal property, to the extent that such liability, loss, damage or expense was proximately caused by the negligent act or omission or the willful or intentional misconduct of the party from whom indemnity is sought, its agents, employees or subcontractors, in connection with the provision or use of Services. Kucera shall not be liable under this Section 4.2 for damages caused by service or equipment that is not furnished by Kucera under this Agreement.

4.2 Condition Precedent to Indemnification. The indemnities in Article IV are conditioned upon the County providing Kucera prompt written notice of the claim, allegation or action for which indemnification is sought, together with full information and reasonable cooperation and full opportunity to control the response thereto and the defense thereof.

ARTICLE V - CHANGE ORDERS AND APPROVAL PROCESS

5.1 Change Order. Any change order or amendment requiring, or necessitating, an increase beyond the not to exceed price limit listed in section 2.1 of this contract, shall require the approval of the Cuyahoga County Executive. If Kucera chooses to provide services in excess of the price limit, Kucera shall provide such services at its risk.

ARTICLE VI - DISPUTE RESOLUTION AND TERMINATION ARTICLE VII - DISPUTE RESOLUTION AND TERMINATION

6.1 Dispute Resolution.

a) In the event of any dispute or disagreement between Kucera and the County, either with respect to the interpretation of any provision of this Contract or with respect to the performance by Kucera or the County hereunder, which cannot be resolved in the normal course of business, then upon written notice of either party, each party will appoint a designated officer whose task it will be to meet for the purpose of endeavoring in good faith to resolve such dispute or to negotiate for an adjustment to such section or provision of this Contract. The designated officers shall meet as often as the parties reasonably deem necessary in order to gather and furnish to the other all information with respect to the matter in issue which the parties believe to be appropriate and germane in connection with its resolution. Such officers will discuss the problem and/or negotiate the applicable section or provision without the necessity of any formal proceedings relating thereto. During the course of such negotiation, all reasonable requests made by one party to the other for information will be honored in order that each of the parties may be fully advised in the negotiations. The specific format for such discussions will be left to the discretion of the designated officers but may include the preparation of agreed upon statements of fact or written statements of position furnished to the

other party. No formal proceedings for the binding arbitration of such dispute may be commenced until (i) resolution as contemplated in this clause has been unsuccessful and (ii) either of the parties concludes in good faith that amicable resolution through continued negotiation of the matter in issue does not appear likely and so notifies the other party.

(b) The rights and obligations of the parties under this provision shall not limit either party's right to terminate this Contract as may be otherwise permitted hereunder.

6.2 Termination for Default. Either party may terminate this Contract, in whole or in part, whenever such party determines that the other has failed satisfactorily to fulfill its obligations and responsibilities hereunder and is unable to cure such failure within a reasonable period of time, not to exceed thirty (30) calendar days or such longer period of time as may be specified in writing by the terminating party, taking into consideration the gravity and nature of the default. Such termination shall be referred to as "Termination for Default". Upon determination by either party hereto that the other has failed to satisfactorily perform its obligations and responsibilities hereunder, the party seeking termination shall notify the defaulting party in writing of the failure and of the time period that has been established to cure such failure, which time period shall be not less than ten (10) days. If the defaulting party is unable to cure the failure within the specified time period, the party seeking to terminate may, by giving written notice thereof to the defaulting party, terminate this Contract, in full or in part, as of the date specified in the notice of termination. Kucera, however, shall be paid for all services and/or materials provided on or prior to the date of termination.

6.3 Termination for Financial Instability. In the event that Kucera becomes financially unstable to the point of (i) ceasing to conduct business in the normal course, (ii) making a general assignment for the benefit of creditors, or (iii) suffering or permitting the appointment of a receiver for its business or its assets, or there is a filing by or against Kucera of a meritorious petition in bankruptcy under any bankruptcy or debtor's law, the County may, at its option, immediately terminate this Contract under Section 6.2, the "Termination for Default" clause, by giving written notice thereof.

6.4 Termination for Convenience. The County may terminate this Contract or any order under this Contract for its convenience and without cause. Any notice of termination will be effective 30 days after the Contractor receives it. If the termination is for the convenience of the County, the Contractor will be entitled to compensation for any Deliverable that the Contractor has delivered before termination.

ARTICLE VII – MISCELLANEOUS

7.1 Schedules Incorporated by Reference. The following Schedules are attached hereto and are incorporated herein:

Schedule A – Kucera - Project Understanding, (including Statement of Work) and Methodology

Schedule B - Cost / Invoice / Payment Schedule

7.2 Relationship of Parties. Kucera is performing pursuant to this Contract only as an independent contractor. Kucera has the sole obligation to supervise, manage, contract, direct, procure, perform or cause to be performed its obligations set forth in this Contract, except as otherwise agreed upon by the parties. Nothing set forth in this Contract shall be construed to create the relationship of principal and agent between Kucera and the County. Neither party shall act or attempt to act or represent itself, directly or by implication, as an agent of the other party or its affiliates or in any manner assume or create any obligation on behalf of, or in the name of the other party or its affiliates.

7.3 Force Majeure. Neither party will be liable to the other party hereunder or be deemed to be in breach of this Contract for any failure or delay in rendering performance arising out of causes beyond its reasonable control and without its fault or negligence. Such causes may include but are not limited to, acts of God or the public enemy, acts of the government, the other party hereto, or third parties (excluding subcontractors or agents), fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes and unusually severe weather.

7.4 Notices. Wherever one party is required or permitted to give notice to the other pursuant to this Contract, such notice shall be deemed given when delivered by hand, via certified mail with return receipt requested, via overnight courier with signature required, and addressed as follows:

In the case of the County:
Jeff Mowry, CIO
Cuyahoga County Department of Information Technology
1255 Euclid Avenue, 4th Floor
Cleveland, OH 44115

In the case of Kucera:
Kucera International Inc.
Ronald Martin
38133 Western Parkway
Willoughby, Ohio 44094-7589

Either party may from time to time change its designated recipient or address for notification purposes by giving the other party written notice of the new designated recipient or address and the date upon which it will become effective.

7.5 Severability. If, and only to the extent that, any provision of this Contract is declared or found to be illegal, unenforceable or void, then both parties shall be relieved of all obligations arising under such provision, it being the intent and agreement of the parties that this Contract shall be deemed amended by modifying such provision to the extent necessary to make it legal and enforceable while preserving its intent. If that is not possible, another provision that is legal and enforceable and achieves the same objective shall be substituted. If the remainder of this Contract is not affected by such declaration or finding and is capable of substantial performance, then the remainder shall be enforced to the extent permitted by law.

7.6 Waiver. No delay or omission by either party in the exercise of any right or power shall impair any such right or power or be construed to be a waiver thereof. A waiver by either of the parties of any of the covenants, conditions or agreements to be performed by the other or any breach thereof shall not be construed to be a waiver of any succeeding breach thereof or of any other covenant, condition or agreement herein contained. No change, waiver, or discharge hereof shall be valid unless in writing and signed by an authorized representative of the party against which such change, waiver, or discharge is sought to be enforced.

7.7 Survival of Terms. Termination or expiration of this Contract for any reason shall not release either party from any liabilities or obligations set forth in this Contract which (i) the parties have expressly agreed shall survive any such termination or expiration, or (ii) remain to be performed or by their nature would be intended to be applicable following any such termination or expiration.

7.8 Headings and Interpretation. The article and section headings used herein are for reference and convenience only, and shall not enter into the interpretation hereof.

7.9 Governing Law. This Contract shall be subject to interpretation under the laws of the State of Ohio, and is subject to the review of the County Prosecutor's Office as to legal form and correctness. Venue in any action brought under this Contract shall be in Cuyahoga County.

7.10 Security Standards. If applicable, Kucera shall maintain reasonable security standards consistent with the security of the Cuyahoga County Information Services Center, upon receipt of such standards by the addressee identified in Section 7.1. These include strict control of access to data and maintaining confidentiality gained while carrying out its duties.

7.11 Social Security Act. Kucera shall be and remain an independent contractor with

respect to all services performed hereunder and agrees to and does hereby accept full and exclusive liability for payment of any and all contributions or taxes for social security, unemployment insurance, or old age retirement benefits, pensions, or annuities now or hereafter imposed under any Local, State or Federal Law which are measured by the wages, salaries, or other remuneration paid to persons employed by the Kucera for work performed under the terms of this contract and further agrees to obey all lawful rules and regulations and to meet all lawful requirements which are now or hereafter may be issued or promulgated under said respective laws by and duly authorized State or Federal officials; and said Kucera also agrees to indemnify and save harmless Cuyahoga County from such contributions or taxes or liability.

7.12 Assignment. Kucera shall not assign, transfer, convey or otherwise dispose of this Contract, or its right to execute it, or its right, title or interest in or to it or any part thereof, or assign, by power of attorney or otherwise, any of the monies due or to become due under this Contract without approval of the County Executive by resolution.

7.13 Contract Processing. Kucera shall submit one (1) original contractual agreements with original signatures to the following:

Cuyahoga County Department of Information Technology
Business Department
1255 Euclid Avenue, 4th Floor
Cleveland, OH 44115

7.14 Commencement of Contract Performance. In order to protect the interest of Cuyahoga County this contract must be executed by the County Executive before compensation for the services or products set forth in this contract can be provided. In the event that services are provided by Kucera prior to the execution of this agreement by the County Executive, the same will be provided at Kucera's risk, and payment therefore can not, and will not, be made unless and until this agreement is approved by the County Executive. Upon approval by the County Executive of this contract, however, any and all prior performance under this contract shall be deemed ratified and said performance shall be deemed to be included in this contract. Payment(s) for said prior performance shall not increase the amount of the contract limit.

ARTICLE VIII – ADHERENCE TO ELECTRONIC SIGNATURE POLICY OF COUNTY

8.1 Electronic Signature. By entering into this Contract, Kucera, its officers, employees, subcontractors, sub-grantees, agents or assigns, to conduct this transaction by electronic means by agreeing that all documents requiring county signatures may be executed by electronic means, and that the electronic signatures

affixed by Cuyahoga County to said documents shall have the same legal effect as if that signature was manually affixed to a paper version of the document.

8.2 Compliance with ORC. Kucera further agrees to be bound by the provisions of Chapter 304 and 1306 of the Ohio Revised Code as they pertain to Electronic Transactions and to comply with the electronic signature policy of Cuyahoga County

IN WITNESS WHEREOF, the County and Kucera have each caused this Contract to be signed and delivered by its duly authorized representative as of the date first written above.

Kucera International Inc.

BY: _____
John Antalovich Jr.
President

Cuyahoga County, Ohio

Edward FitzGerald, County Executive

BY: _____
Edward FitzGerald, County Executive

Proposal for 2013 Aerial Photography and Related Photogrammetric Services Cuyahoga County, Ohio

PROJECT UNDERSTANDING

Statement of Work:

The primary services and associated data products Kucera International Inc. will provide to Cuyahoga County for this project will include new (Spring 2013) leaf off, 4-band digital aerial photography, airborne and ground control surveying, aerotriangulation, digital elevation model (DEM) review and update stereocompilation, and color and infrared digital orthophotography at 1"=100' scale, 0.5' resolution covering the County and 500' buffer.

The aerial imagery will be captured in 4-band (R,G,B,IR) digital form directly at the 0.5' target resolution using Kucera's Leica ADS40 large format digital line sensor/aerial camera technology. The imagery will be georeferenced to airborne GPS/IMU and ground-based control. The georeferencing will be checked and refined as needed using a softcopy aerotriangulation process. The triangulated imagery will be rectified to source DEM data, which will be photogrammetrically reviewed and updated as needed to support the image rectification. The ortho-rectified imagery will be batch and manually processed to the final orthophotography.

Note that Kucera has developed a thorough understanding of the 2013 project requirements by having performed the same countywide orthophoto project for Cuyahoga County in 2011.

Project Standards/Accuracy:

The project work will be accomplished in full accordance with Cuyahoga County's 2013 Aerial Photography and Related Photogrammetric Services RFP Scope of Work, including conformance with ASPRS Class 1 Large Scale Map Accuracy Standards. By the ASPRS Class 1 accuracy standard, the measured ortho image positions of well defined, ground based features will have a limiting RMSE displacement in relation to their "true" (accurately surveyed) positions of within 1' (1/100 target map scale), with no individual point displacement exceeding three times the limiting RMSE (i.e., 3').

Conformance with the project accuracy standards will be internally verified through review of aerotriangulation results and comparison of image/map coordinates for ground-surveyed control and photo identifiable triangulation points against their corresponding field/GPS-surveyed and computed values. An accuracy RMSE will be determined using points spread through the County, and documentation of results included in project metadata. Note that the accuracy specifications will not apply to structure tops and other elevated features represented in the orthophotography due to inherent radial distortion/"feature lean" effect, although Kucera will utilize technologies and processes as subsequently described which reduce this effect.

Kucera assumes that the County will be performing an independent accuracy check in the same fashion as done for the County's 2011 project and can incorporate the results of this accuracy check in the project metadata. The project orthophotography will only be considered acceptable if meeting the specified accuracy requirements, as verified by accuracy testing.

Project Datums/Units:

The datums used for the capture/measurement and delivery of the project data will be the NAD83 Ohio North State Plane coordinate system horizontal and NAVD88 vertical datums as specified. All measurement units will be in US survey feet.

County Support:

The support Kucera would request of the County other than designating persons of contact would include:

- Designating pilot area and reviewing/approving pilot area deliverables.
- Timely review of deliverables to ensure that all data listed in the transmittal is received and no data is missing, corrupted, improperly formatted, etc.
- Providing any source materials available for the project work and assistance in answering any general questions regarding the source materials
- Consistent and thorough QC review of data submissions

In relation to all of the above, Kucera will work cooperatively with the County and adjust processes as required to best accommodate the County's support capabilities.

Approach:

In order to complete the work in a timely, organized, and cost-effective manner while maintaining a high level of quality and accuracy, Kucera will utilize a systematic, phased approach incorporating the most advanced available, proven photogrammetric, control surveying, and aerial imaging technologies and procedures. The major phases of Kucera's approach in general order of performance will be as follows:

1. **Project Initiation** – Finalize scope of work and document in project plan. Review and organize project source data.
2. **Ground Control Surveying** – Survey photo-id or targeted ground-based control points throughout the County for use in georeferencing/ aerotriangulation of the aerial photography and accuracy testing/quality control of the orthophotography.
3. **Aerial Photography/Airborne GPS-IMU Survey** – Perform aerial flyover/photography of the project area using Leica ADS40 digital aerial cameras interfaced with airborne GPS/IMU systems. Process and check the aerial imagery and airborne GPS/IMU results. Provide preliminary orthophotography.

4. **Aerotriangulation** – Use a softcopy aerotriangulation process with ground and airborne GPS/IMU control survey input to check and finalize the georeferencing of the project aerial imagery.

5. **DEM Update Stereocompilation** – Photogrammetrically review the existing/source DEM data and update/augment as needed to support the ortho image rectification.

6. **Digital Orthophoto Production** – Orient triangulated digital photo imagery and ortho rectify to reviewed/updated project DEM. Batch and manually process rectified imagery into final ortho-photography.

7. **Project Wrap-Up/Metadata** – Review project specifications and transmittal/deliverable records to ensure all specified data has been received and approved. Provide FGDC metadata.

The work phases will be performed concurrently to the maximum extent possible to maximize efficiency and accelerate turnaround/completion times. **Descriptions of the procedures, technologies, and quality control measures for the various phases of the project are provided in Section 3 (Methodology) of this proposal submission.**

Potential Issues/Concerns:

Kucera is highly experienced in the work to be performed and has more than sufficient capacity and capability to successfully complete this work. Kucera has no major concerns regarding completion of the work on schedule and in conformance with the County's specifications and expectations. Kucera performed the same project in 2011 for the County and is very familiar with the potential issues and means of addressing. These potential issues include:

- **Airspace access around Cleveland Hopkins and Burke Lakefront Airports** - Kucera's flight crews have extensive experience performing aerial flyovers over large city, large airport, military base and other areas having restricted airspace access and regularly perform aerial flyovers in Cleveland Class B airspace. Kucera's flight crews will provide the appropriate air traffic control centers with copies of the project flight plans and a detailed description of the flight parameters, and will work closely and cooperatively with the centers throughout the flyover period to determine optimal periods of airspace access and to take advantage of all available windows of access availability in periods of suitable weather conditions. Aircraft assignments will be made so as to prioritize completion of the flyover work in restricted areas when windows of access are open and to redirect to-from restricted and non-restricted areas as necessary to ensure restricted area coverage is obtained as early in the flight season as possible while simultaneously making maximum progress on non-restricted image coverage.

- **Elevated feature distortion** – Kucera will add breakline data to the source DEM as needed to ensure proper rectification of elevated liner features, such as bridge decks and overpasses. Kucera's Leica ADS camera technology will eliminate distortion for a significant number of elevated features by providing "nadir" (straight down) images of the features for the ortho rectification process.

- **Downtown area shadows from tall buildings** – to minimize shadows from tall buildings in the downtown Cleveland area, Kucera will plan the flyover so that the image capture of this area occurs close to mid-day when the sun height is greatest.

- **Lake Erie water area color/tone** – the continuous strip image capture characteristic of the Leica ADS40 aerial camera technology Kucera will use will help eliminate un-natural tone/color shifts in the Lake Erie water area. Kucera will also use image processing techniques as described in Proposal Section 3 (Methodology) to provide optimal water area image radiometry.

- **Tall Structure "lean"/displacement** – Kucera's Leica ADS40 continuous strip image camera technology helps to significantly reduce tall structures "lean" by providing a high percentage of nadir/straight down views of features. Kucera will decrease the flight line spacing and increase sidelap between flight lines for the image capture over tall structure areas (e.g., downtown Cleveland, Lakewood "Gold Coast") to provide additional feature centered views and support production of "true" orthophotography covering designated tall structure areas.

Deliverables:

The primary project deliverables by production phase for this contract will be as follows:

Project Initiation:

- Project procedure plan with flight/control plan, master tile index, project outline, schedule, quality control plan, equipment calibration reports, aircraft FAA certifications as needed

Ground and Airborne Control Survey:

- Control survey report
- Ground control point file in ESRI shapefile format

Digital Aerial Photography:

- Flight swath index in ESRI shapefile format with attributed flight date, altitude
- Preliminary color orthophotography

Aerotriangulation:

- Digital aerotriangulation reports

Digital Elevation Model (DEM):

- Updated DEM data used for orthorectification in ESRI raster TIFF or other specified format

Digital Orthophotography:

- Uncompressed, tiled 3-band color (RGB) orthophotography in TIF/TFW format
- Uncompressed, tiled 3-band CIR (RGI) orthophotography in TIF/TFW format
- SID-compressed, tiled 3-band (RGB) color orthophotography
- SID-compressed, tiled 3-band (RGI) CIR orthophotography
- JPEG 2000-compressed, tiled 3-band (RGB) color orthophotography

- JPEG 2000-compressed, tiled 3-band (RGI) CIR orthophotography
- Countywide SID-compressed 3-band (RGB) color ortho mosaic
- Countywide SID-compressed 3-band (RGI) color ortho mosaic
- Seam line files
- FGDC-compliant metadata
- Note: Alternative to separate 3-band color and CIR image deliverable is combined, 4-band imagery

All project deliverables will be owned by the County.

The numbered subsections describe Kucera's methodology for each phase of project, followed by Kucera's proposed completion schedule.

1. PROJECT INITIATION

1.1 Project Review/Startup:

Immediately upon notice of award, Kucera's Project Manager will convene members of the project management team to review the scope of work, specifications, deliverables, schedule, and administrative requirements. At this project review meeting the Project Manager will solicit questions and recommendations to be presented to the County

The Project Manager will subsequently schedule a "kickoff" meeting or phone conference with the County as needed to establish lines of communication, review the scope of work, and address any outstanding questions/issues related to the project.

1.2 Procedural Plan:

Following the kickoff meeting/conference the Project Manager will prepare a comprehensive job write-up and project procedural plan. The procedural plan will include a summary of project procedures and deliverables, project completed schedule and milestones, flight and control network diagrams, master sheet tile/index, and quality control plan/acceptance criteria for the project. The plan will be revised/updated as needed over the course of the project to reflect approved procedural changes and additional procedures/information as required.

1.3 Tile System:

Kucera assumes the tile dimension used for the County's 2013 project will be the same as used for the County's 2011 project, i.e., 2500' x 2000' coordinate grid bounded. A representation of the 2011 project tile scheme is shown on the flight/control diagram provided at the back of this proposal section. In the initiation phase for the 2013 project Kucera will review the 2011 tile scheme with the County to determine if any changes are desired and will adjust the flight/control as needed for any changes. The finalized tile scheme will be included in the project work plan and used where applicable for tracking and reporting the project status.

In the same fashion as 2011, the tile scheme will provide coverage of the Lake Erie "crib" area, breakwalls, and surrounding water area as required by the County.

1.4 Flight/Control Plan:

Kucera will provide the County with a flight and ground control plan for the project in GIS and/or hardcopy form for the review and approval. The flight/control plan will provide suitable/full coverage of all tiles and will show the tile system in relation to flight line and control locations.

Kucera uses the Leica FCMS flight management software suite for flight plan development. The FCMS program incorporates the tile index/project boundary and references a digital elevation model (DEM) of the project terrain to ensure proper flight line location/spacing and sidelap is maintained.

1.5 Source Data Review:

In the project initiation phase Kucera will review and organize/document the available source data, request clarifications as needed, and will report any possible anomalies and missing data to the County for review and resolution. Any source data found/determined to possibly allow a significant cost and/or time savings on the project will be brought to the County's attention for further review.

The primary source data for the 2013 project will include:

- Ground control monument and point locations –Kucera retains records from 2011 project
- Existing DEM – Kucera retains copy from 2011 project
- Tile scheme – Kucera retains copy from 2011 project
- Bridge and overpass location data/file – if available
- Construction project location data/file – if available

Note that Kucera already retains a copy of much of the project source data as produced/acquired for the County's 2011 project and will not require any significant time to recall and organize this data as needed for the 2013 project.

2. GROUND CONTROL SURVEY

2.1 Overview/Ground Control Plan:

The flight/control diagram provided at the back of this proposal section shows Kucera's initially proposed network of ground control points in relation to the projectwide aerial photography flight lines and project area.

The project ground control will be spread through the County in a fashion which supports accurate georeferencing of the aerial photo coverage and thorough accuracy testing of the projectwide orthophotography. The ground control will be newly surveyed and/or existing photo-identifiable feature or targeted monument points. The ground control points will be combined with airborne GPS/IMU-based sensor position data for input to an aerotriangulation process to finalize the image georeferencing. A total of approximately 15 ground control points will be used for the project.

2.2 Survey Conduct:

The ground control survey work will be performed/overseen by a licensed Ohio surveyor and experienced geodesist. The work will be conducted in a manner ensuring maximum safety and minimal disruption of traffic, disturbance of private property, etc. Survey crews will carry proper identification and an official letter of authorization from Kucera and/or the County as needed. The survey crew will report to the County offices if needed for briefing and data as needed before going into the field. The ground survey work will be predominately confined to public rights-of-way or areas of property-owner permitted access.

2.3 Existing Control Reconnaissance/Recovery:

Existing control stations which are used in the project control network will be of appropriate accuracy (second order or higher horizontal, third-order or higher vertical) and will be located/recovered using to-reach descriptions obtained from the County, NGS database, or other known sources. Photo documentation/reference for each recovered point will be obtained and included in the project control report.

2.4 Targeting:

Targets used for marking of existing ground monuments will be in the shape of crosses or tees with legs approximately 18" – 24" wide and 6'- 8' long. Targets on unpaved areas will be durable vinyl properly affixed to the ground, while targets on paved areas will be painted. The targeting work will be performed so as to assure maximum possible visibility and pointing accuracy on the aerial photography, with target color being white on darker surfaces (e.g., grass, asphalt, older pavement) and black on lighter surfaces (e.g., sand, new pavement) and the control point being located at the outside apex of the target legs. The targets will be monitored until the aerial flyovers and any necessary reflights are completed. Unpainted targets will be removed within 2 – 3 weeks of flyover completion or sooner as needed.

2.5 Photo-Identifiable Feature Points:

Photo-identifiable control points will be distinct, GPS-occupiable feature point locations visible in the aerial imagery, e.g., corners of paint stripes in roads, corners of concrete pads and sidewalk blocks, etc. Field reference photos of all photo-id points will be included in the project ground survey report.

2.6 New Point Marking/Referencing:

Any newly surveyed control point locations will be field-marked with pk nails, chiseled crosses, or other such semi-permanent marks. Photographs and/or descriptions of the point locations will be prepared for field reference and included in the project control report.

2.7 Control Datum/Accuracy:

All new ground control points will have coordinates established on the NAD83 Ohio North Zone State Plane Coordinate System and elevations established on the NAVD88 vertical datum. The coordinates and elevations will be surveyed to within 3 - 5cm accuracy. All survey measurements will be in US Survey feet.

2.8 Survey Observation and Reduction Technology/Procedures:

New control points will be GPS surveyed in kinematic fashion (1 – 2 minute observation time) using TOPCON or Trimble dual frequency GNSS/VRS receivers operating on the Ohio Virtual Reference System (VRS). Kucera has previously used and is currently registered for the Ohio VRS. In the event of an issue with the VRS or other cause of non-usability, static GPS observation procedures (20 – 30 minute observation time) will be used. The processing of all GPS observations will be performed using Novatel/Waypoint GrafNet network adjustment software, with output of point coordinates, elevation, and accuracy residuals. The observation data is also submitted to the NGS OPUS network adjustment service as a check of computed coordinates and elevations.

2.9 Survey Report:

A survey report will be furnished as a project deliverable and will include a summary of procedures used, listing of points and corresponding surveyed coordinates and elevations, and photos/descriptions of new point locations.

2.10 County Checkpoint Surveying:

For the County's 2011 project, the County targeted/surveyed ground points to be used for the County's accuracy verification purposes. Kucera assumes the County will do the same for the 2013 project and will coordinate with the County surveyor with regard to the locations of the County's checkpoints in relation to Kucera's ground control as needed to ensure the checkpoints are targeted prior to the aerial flyover. It is generally assumed that the control and checkpoint locations for the 2013 project will be essentially the same as for the 2011 project.

3. AERIAL PHOTOGRAPHY / AIRBORNE GPS-IMU SURVEY

3.1 Season/Environmental Conditions:

The project aerial photography will be performed on a first-priority basis in the spring 2013 flight season (approximately April 1 – April 20) after grass "green-up", before significant emergence of tree vegetation, and as soon after flight plan approval and target placement as weather (clear, no excessive cross winds) and ground (no smoke, snow cover, fog, flooding) conditions permit. The photography will only be taken during the time of day (approximately 9 a.m. to 3 p.m.) when the sun angle is greater than 30° to minimize shadows. For the downtown Cleveland tall structure areas, Kucera will perform the photo flyover closer to the noon hour when the sun is at peak height, so as to help minimize tall structure shadows. For the airborne GPS/IMU work, the aerial photography will be taken only at times when at least five satellites are observable with a PDOP of less than 3 and the cutoff angle/elevation mask is greater than 15°.

Weather conditions will be monitored via direct observation and weather forecasts obtained through computer access to the National Weather Bureau, the Weather Channel, and local flight service centers. The Project Manager will maintain regular contact with the County throughout the aerial photography periods to report on flight conditions and completed flying. Computer printouts of weather sequences will be maintained as a record of photography conditions.

3.2 Aircraft Commitment/Flight Time:

The aerial flyover will be performed from Kucera's twin-engine Piper Navajo Chieftain aircraft. These are FAA airworthiness-certified, low-wing, turbo-charged aircraft with a cruise speed of 180 to 200 mph, fuel capacity for six hours of continuous flight, and IFR weather instrumentation. The aircraft can be operated efficiently and safely at speeds down to 130 mph as needed for high quality aerial data capture. The aircraft are equipped with GPS-based flight management and navigational systems and have Novatel dual-frequency antennas mounted above the camera port for airborne GPS. The aircraft have two sensor ports, providing the ability to concurrently carry both the digital camera and another sensor system (e.g., oblique camera, lidar system).

The projectwide aerial photo flyover will require approximately 42 flight lines and 700 flight line miles, translating to approximately 7 "on-line" flying hours. Kucera will be committing one or more of its twin-engine aircraft to the flyover and with these aircraft will be able to complete the photo flyover within 1 - 3 flight sessions. Kucera's aircraft will remain based within a few minutes flying time of the County until the flyover is complete to ensure the flyover is performed in the shortest possible timeframe with consistent ground and lighting conditions. By minimizing flight sessions Kucera will better ensure ability to readily achieve consistent tone and color balance in the projectwide orthophoto coverage.

3.3 Airspace Access:

Kucera's flight crews have extensive experience performing aerial flyovers in class B/C airport/city, (e.g., Cleveland Hopkins Airport) military operations areas, and other restricted airspace. Kucera's flight crews will provide the appropriate flight control centers with copies of the project flight plans and a detailed description of the flight parameters, and will work closely and cooperatively with the centers throughout the flyover period to determine optimal periods of airspace access and to take advantage of all available windows of access availability in periods of suitable weather conditions. Aircraft assignments will be made so as to prioritize completion of the flyover work in restricted areas when windows of access are open and to redirect to-from restricted and non-restricted areas as necessary to ensure restricted area coverage is obtained as early in the flight season as possible while simultaneously making maximum progress on non-restricted image coverage.

3.4 Aerial Camera/Sensor Systems:

The project aerial imagery will be acquired in direct 4-band/RGBIR digital form using Kucera's Leica ADS40 large format digital aerial cameras. The ADS40 technology meets all project sensor specifications and represents the most advanced of direct digital aerial image capture technologies using continuous sweep/pushbroom line scanning for acquisition of the aerial imagery in continuous flight strips ("pixel carpets") as opposed to individual exposures. The imagery is captured with 10 (6 panchromatic, 3 color, and 1 infrared) 12000 pixel CCD lines oriented for nadir (straight down) and forward and aft-looking views. Kucera's ADS40 cameras have 51 series sensor heads featuring improved image quality/flight condition latitude and capture of the color IR image band at the nadir position in full alignment with the color band. The ADS40 continuous strip imaging technology has a number of advantages over frame-type digital cameras (eg. DMC, UltraCam) for a project of this nature (i.e., predominately urbanized terrain), including the following:

- Significantly reduced seam lines in the captured imagery, only between strips and not between individual exposure frames. Reduces time needed to process/mosaic the imagery and reduces occurrence of mosaic/seam line anomalies. Supports expedited creation/delivery of orthophotography in a preliminary form.

- Significantly reduced overall feature lean within the captured imagery, due to capturing a true vertical view of each feature at the center of the flight swath within the line of flight.

- The ADS40 color imagery is captured by a single CCD line in the nadir position as opposed to by multiple digital cameras as are used by frame digital camera systems, and is not susceptible to image "fringing" caused by slight mis-alignments of the component cameras.

- The ADS40 provides multiple sets of "complete" stereo coverage of various vertical exaggerations, which allow for optimal stereo viewing and increased vertical pointing accuracy in various types of terrain (e.g., urban canyons, flat residential or farm areas, steep terrain, etc.)

Note that Kucera used the ADS40 digital camera technology for orthophoto surveys of 15 counties in Ohio (including Cuyahoga County in 2011) with excellent results.

3.5 Flight Height/GSD and Exposure/Integration Time:

The flying height used for capture of the aerial imagery will be approximately 4800' above mean ground, yielding a ground sample distance (GSD)/image resolution of slightly higher than the designated 0.5' target resolution. The exposure/integration time used in capturing the digital imagery will be in the 1.5 - 4 millisecond range and will be determined by the image resolution flying altitude, camera settings, scene and lighting conditions, and aircraft speed used. The integration time will be adjusted as needed for lighting conditions during the flyover sessions to ensure proper CCD-line based image capture. The sensor operator views histograms of the imagery as captured and adjusts the camera imaging/integration settings to provide even exposure throughout each flight strip. Special attention will be given to areas of significant transition in scene color/reflectance (e.g., land area to Lake Erie) to ensure proper exposure is maintained in the image capture.

The ADS40 camera technology does not require forward motion compensation (FMC) because the ADS40 camera captures imagery continuously as the plane travels down the flight line, as opposed to a series of instants/stills in time. In the continuous capture process the image and plane motion area always synchronized, and there are no discrete instants of image capture requiring forward motion compensation for synchronization with the aircraft motion.

3.6 Flight Plan, Sidelap, Endlap:

Kucera's proposed flight plan for the projectwide aerial photo flyover is shown on the flight/control diagram provided at the back of this proposal section.

The flight lines of the aerial photography will be oriented in a north-south direction for efficiency of coverage and to minimize bi-directional illumination. The photo flight lines will generally be spaced apart so as to yield a side image coverage overlap of at least 30% between adjacent image strips. With the ADS strip image capture process, the 30% sidelap provides sufficient coverage for elimination of

excessive lean of trees and other vertical features at the edges of the flight swaths. Over the downtown Cleveland and other designated tall structure areas, the flight line spacing will be reduced and side coverage overlap increased to approximately 80% provide optimal feature centered image views and support creation of "true" (no radial distortion/lean) or near true orthophoto coverage for the areas..

The flight lines of digital photography will be extended and increased in number sufficiently to provide stereo image coverage beyond the project area boundaries (including designated buffer) and of all extraneous ground control points, and also ensure that all orthophoto coverage can be prepared as full modular image tiles. In the line of flight the digital photography will be taken with continuous (100%) stereo coverage at varying vertical exaggerations through the digital camera's forward and aft looking CCD lines.

3.7 Crab and Tilt Control:

With the ADS40 digital camera systems, camera tilt and crab are extremely limited and will be well within 3° at any point in a flight line and 1° average for an entire line. Tilt and crab correction are achieved using the camera's internal IMU linked to the camera's Leica PAV30 gyrostabilizing mount, providing very fast and accurate response to any altitude changes of the aircraft. Any residual crab is minimal and is removed from the oversampling of the push broom sensor head.

3.8 Image Band Acquisition:

The ADS40 digital camera imagery will be simultaneously captured in registered 12-bit panchromatic, RGB/color, and NIR/near infrared wavelength bands in the 465-885 nm spectral range (835-885 nm for NIR). The ADS40's "beam-splitting" telecentric/trichroid lens system will provide exact separation of the PAN, R, G, B, and NIR wavelengths.

3.9 Image Data Recording/Downloading:

The digital camera imagery is initially captured on the camera's removable mass memory units (MMUs). Within 24 hours of capture the imagery is downloaded from the MMUs to hard drive and shipped or otherwise delivered to Kucera's headquarters office for downloading on to Kucera's dedicated Condor network server for initial review and further processing. The imagery is saved on the MMUs until it has been successfully downloaded and reviewed at Kucera's headquarters.

3.10 Airborne GPS/IMU Control Survey/Image Georeferencing:

Throughout the aerial photo acquisition the position and orientation of the ADS40 cameras is accurately measured using Leica IPAS airborne GPS/IMU technology integrated with the camera systems. These measurements are applied to the captured imagery to initially establish the image georeferencing, which is checked against ground based control and refined as needed through the aerotriangulation process.

During the AGPS post-processing, a very robust KAR –kinematic ambiguity resolution (fixed integer solution) – is implemented, along with an analysis of the day's satellite configuration and PDOP, satellite signal standard deviations, atmospheric interferences, and forward/reverse plotsto attain the most accurate GPS solution available. The GPS and IMU data are processed together, with the IMU data being

used to fill in and adjust the GPS results as needed and the GPS data being used to minimize the effects of aircraft "drift" in the IMU measurements. The result is a GPS solution that is over more refined than the initial processing (the inherent drift is also removed) along with a highly accurate set of orientation angles for each exposure (a Smoothed Best Estimate of Trajectory). The AGPS/IMU reduction results are thoroughly analyzed to ensure proper IMU behavior and accuracy with the data graphs also being used to ensure that the proper flying parameters are followed for each mission. The AGPS/IMU survey results can be furnished as part of the project control survey report and can include photo coordinate listings, data accuracy output, PDOP conditions, flight trajectory plots, and other relevant survey data.

3.11 Image Processing Chain/Inspection:

The Leica ADS40 digital camera's raw (Level 0) captured digital aerial imagery is downloaded from the camera's mass memory units (MMUs) and combined/processed with the airborne GPS/IMU data using Leica XPRO software to yield initially georeferenced (Level 1) image swaths. The Level 1 image swaths are checked for acceptable coverage, exposure/radiometry, resolution, crab and tilt level, absence of image anomalies, etc. For each flight swath image block the stereo imagery will be analyzed on a stereoplotter to verify residual parallax or bias due to airborne GPS/IMU or other georeferencing anomalies. An aerial image quality report is prepared documenting the image inspection results and provided as a deliverable in hardcopy and digital form along with the corresponding flight logs. All rejected imagery reflown at the first possible opportunity using the same camera as used for the balance of the flight swath or block. Reflights will be made in the same flight pattern as the accepted imagery and will overlap into the accepted imagery as necessary to provide continuous photographic coverage.

3.12 Flight Report and Index:

As a deliverable from the completed aerial photography the County will be furnished with an aerial flight report of the completed photo acquisition and corresponding resolution and flight date attributed index of the actual flight line center locations (as determined from the AGPS/IMU observations) in shapefile or other GIS/CAD form.

3.13 Preliminary Ortho Deliverable:

Being in the form of continuous image strips for entire flight lines as opposed to many individual exposures (i.e., frame camera imagery), the Level 1 georeferenced ADS40 camera imagery can be readily rectified to the source DEM and composited into a preliminary "draft" version of the orthophotography for delivery to the County. For this project Kucera can rectify the Level 1 imagery to the source (2011) DEM to produce a "draft" version of the orthophotography and furnish this draft copy within 2-3 weeks time of the aerial flyover for the County's general inspection and preliminary use prior to receipt of the finalized orthophotography. This "draft" orthophotography will be accurate to within 5' and can be used by the County for review of the aerial image quality and as interim orthophotography for suitable applications.

3.14 Image Storage:

Kucera's raw and processed digital camera imagery is stored on 400 GB DLT tape with a 20-year expected shelf life. Copies of imagery are maintained in both on-site and off-site storage and treated as the property of the County.

4. AEROTRIANGULATION

4.1 Procedures and Technology:

A softcopy aerotriangulation process will be used to check the AGPS/IMU-derived georeferencing/orientation of the aerial imagery and refine/finalize the same as required for the DEM review/stereocompilation and final ortho image rectification work. The initial input to the triangulation process will include the ground-based control points and the camera location/position and orientation data from the airborne GPS/IMU survey, which together will allow the process to converge to a final solution with a minimal number of iterations being required.

For the softcopy process a Leica ORIMA softcopy aerotriangulation workstation will use image correlation technology to derive from the stereo aerial imagery coordinates/elevations for manually selected and/or automatically generated triangulation points. ORIMA is designed specifically for processing of strip-capture image flight swaths and typically generates hundreds or thousands of triangulation points for each triangulation block, with the number of high multiple ray/image points being maximized to maximize the triangulation accuracy. The points are run through a preliminary triangulation adjustment with a limited number of measured control points to determine the point residuals, with points having greater than a designated minimal residual being filtered out. The final triangulation is performed with the accepted points and all control points being subject to thorough manual review and adjustment as needed to achieve the optimal point location and distribution. Kucera recognizes that the autocorrelation-based automated triangulation point generation process typically used in softcopy aerotriangulation may not work well in terrain lacking availability of district, ground-based feature points, such as over larger expanses of wooded areas, open water, or heavily urbanized areas. For such areas Kucera will use a manual triangulation point selection as needed in the softcopy process.

The ORIMA triangulation software produces a rigorous simultaneous polynomial solution with output of RMS residual values and statistics as required for robust accuracy assessment. The triangulation software applies corrections for systematic errors resulting from systematic distortion using sensor calibration data, and atmospheric refraction based on the flight height and ground level. All imagery will be triangulated in single large contiguous area coverage blocks, which will be rigorously tied through triangulation of common flight swaths to maximize triangulation accuracy/consistency throughout the project area.

4.2 Error Tolerances:

The triangulation will support ortho image rectification meeting the project (ASPRS Class 1) accuracy standards, with the following individual point and RMS horizontal and vertical accuracy residual limitations being observed:

Data Deliverable	*Flying Height/ Capture Resolution*	*Individual Point Residual Limit (1.5 pixel)*	*RMS Residual Limit (1 pixel)*
1"=100' scale orthophotography	4800'/0.48'	0.72'	0.48'

Designated redundant targeted control stations will be used as check points in the aerotriangulation process. These points will have triangulated coordinates determined for them, which will be compared against the actual coordinates for the points with the expectation of RMS errors not exceeding the specified tolerances. The checkpoint triangulation sessions will be re-run until results are satisfactory.

Note that a high vertical accuracy will be maintained in the aerotriangulation process so that the triangulated aerial photo imagery can be directly used for new or updated 2' contour topo and/or 1"=100' scale planimetric feature mapping for any portions of the County.

4.3 Triangulation Report:

For the completed triangulation blocks digital and hardcopy triangulation reports will be prepared and furnished as a deliverable. The triangulation reports will include a summary of triangulation procedures used and triangulation adjustment output showing residuals and accuracies achieved.

5. DEM UPDATE/PRODUCTION

5.1 Overview/Procedures and Technologies:

In the DEM update/production phase of the project Kucera will use the triangulated aerial imagery to photogrammetrically review and update/augment the source (2006 OSIP lidar/2011 County) DEM data where needed to support the new ortho image rectification.

The photogrammetric update process will involve reviewing the source DEM points in 3D on top of the stereo image of the triangulated aerial photography using BAE Socet Set digital stereoplotters. The Socet Set stereoplotters are also specially designed for highly efficient stereo viewing/panning and data capture directly from the large files of the continuous strip-captured digital camera imagery. All data is captured in three dimensions from parallax-cleared stereo imagery, and is compiled in intelligent, manual fashion. To facilitate the photogrammetric update process, major changes of change are identified using a surface elevation based change-detection process as subsequently described.

Kucera prepared/updated the 2006 OSIP lidar source DEM for the County's 2011 project with good accuracy results and anticipates the same for the 2013 project. It is understood that the 2011 DEM will need reviewed and updated/augmented in areas of major feature change and/or where DEM breaklines were missed in the 2011 project. Kucera will utilize any available information on bridge and overpass locations and areas of major construction for reference in the DEM review/update process and will use surface modeling with change detection as needed and subsequently described to flag other areas of significant landscape change.

5.2 DSM Generation and DEM Change Detection/Update :

To find areas of major terrain/feature change for the DEM update process, Kucera will batch-generate an autocorrelated digital surface model (DSM) coverage of the project area from the newly acquired and triangulated digital aerial imagery using advanced Leica DSM technology. This technology is unique in

performing very efficient processing of strip-captured digital aerial imagery to create a DSM having the same resolution as that of the aerial imagery, i.e., an elevation is determined for each pixel of the aerial imagery. The DSM elevations have a vertical accuracy of within 1.5 times the image resolution.

The newly generated DSM will be compared with source DEM data in Global Mapper software to determine/flag areas of change based on elevation differences, (i.e., elevation-based change detection). If the flagged change areas are extensive, the source DEM will not be used and a new DEM will be produced from the DSM. If the change areas are not extensive, Kucera will update the DEM by removing the existing data from change areas and replacing this with DEM data newly stereocompiled from the triangulated aerial imagery and/or extracted/classified from the corresponding DSM. In the update process Kucera will also add DSM-derived points to elevated features such as bridge decks to ensure these features are properly rectified.

The classification/reduction of the DSM to an ortho grade DEM is performed using TerraSolid digital modeling technology, the same technology used by Kucera for lidar data classification. The classification is performed so as to yield bare earth ground surface points and points representing elevated features requiring rectification, such as bridge decks and overpasses. Where required, the DEM will be augmented with elevated feature and grade break breaklines stereocompiled from the triangulated aerial imagery using Kucera's BAE Socet Set softcopy stereoplotters.

5.3 DEM Quality Control and Deliverable:

Following initial production and/or review and before being used for the image rectification, the updated project DEM data will be subject to several quality control checks, including direct digital review of the data as a 2D point file and as 3D visuals to check for anomalies such as data gaps or data spikes, and use of Terrasolid Terrascan software to compare elevations of surveyed control and triangulation points to DEM surface and report displacement/vertical DEM accuracy over the project area. Where anomalies/inaccuracies in the DEM data are found, the data is reviewed and restructured/recompiled as needed.

The final updated DEM data files used for the final ortho image rectification will be furnished as a deliverable in shapefile, DXF and/or other specified digital formats on DVD or USB drive. The data will be in separate files/layers corresponding to mass point and breakline elements using the specified layering scheme.

6. DIGITAL ORTHOPHOTO PRODUCTION

6.1 Overview:

Kucera's digital orthophoto production is a multiple-stage process consisting primarily of:

1. Initial image rectification and quality control review
2. Image mosaicking/tone balancing using advanced Inpho OrthoVista image processing technology

3. Final, thorough interactive/manual quality control inspection/mosaic/edit of individual image tiles.

The process includes a complete manual quality control review and mosaic/edit as needed of each image tile. Kucera's numerous city and countywide orthophoto clients will readily attest to the superior quality/accuracy and low rejection rate of the orthophoto imagery generated by Kucera using this process.

6.2 Digital Image Rectification:

The digital orthophoto image rectification of the individual triangulated pixel carpets/swaths of the triangulated digital aerial photography to the source lidar DEM data will be accomplished on Leica XPro digital orthophoto systems running on dedicated workstations.

In performing the rectification work, the imagery is subjected to an initial visual quality control review and the project DEM data is processed via Trimble Terramodel software to a TIN model and point grid supporting the rectification. The imagery is oriented using digital camera calibration data and orientation parameters derived from the aerotriangulation process, with QC reports being produced and exterior orientation residuals being held to a 10-micron maximum tolerance. The oriented imagery is pixel-rectified to the processed point grid using a high-grade radiometric interpolation, with resampling to the target pixel resolutions being performed as needed using a cubic convolution resampling algorithm. For this project, the finished pixel resolution will be 0.5' as specified.

Quality control procedures used in the rectification process includes:

- Visual inspection of imagery for observable distortions and other anomalies, with special attention given to DEM quality "indicator" features, such as railroads, highways, and bridge overpasses.
- Check geometric accuracy "fit" of imagery to project survey control and available existing planimetric feature data of equal or higher accuracy – expecting matching with specified tolerances.
- Check of ties with adjacent images within and between flight lines, expecting fit within specified tolerances.
- Selection of imagery with minimal "hot spots"/glare off of water bodies and other significant reflective surfaces.

Where rectification-related image deficiencies are found, the DEM data is reviewed and modified as necessary and the rectification is repeated. A rectification QC signoff report is generated for each rectified image and maintained by the orthophoto department manager.

6.3 Automated Image Processing – OrthoVista and Seam Line Deliverable:

Following rectification, the imagery is tone balanced and processed into the final seamless image tiles using Inpho OrthoVista, an automated orthophoto image processing program which performs optimized

image tone adjustment, resampling, and tile formation in a batch mode. With the OrthoVista technology, image processing and tiling procedures which previously took weeks to accomplish and review manually are now carried out in a matter of hours or days with minimal need for operator interaction. Note that the OrthoVista program is among the most mature of its type and produces excellent results with virtually no image anomalies.

In performing the automated processing, sample images are run through the OrthoVista program and used to adjust the automated image dodging and seam removal intensity in relation to the tone of the imagery and the terrain being covered. With the parameters defined, a block of images are then batch processed to a seamless overall image representation, from which coordinate-defined tiles and/or resampled imagery is copied/extracted and output in the appropriate format. The seam lines are selected in specified/optimal image locations, with a "seam editor" feature being used for manual adjustment of seam lines where required. The OrthoVista software uses advanced feature detection (vs. more rudimentary adaptive feathering) and automatically selects areas of limited tone transition for seam line placement so as to avoid having seams placed through buildings and other areas where seams would be evident. Digital shapefiles of the OrthoVista seam line locations can be furnished to the County in shapefile form for quality review and accuracy checking. Kucera will also perform an internal quality control review of all seam line locations.

For this project Kucera will be using OrthoVista to produce the specified 2000' x 2500' grid-defined tiles. Manual edit measures will also be used to minimize image "density shifts" at seam lines so that any effect is primarily non-observable. OrthoVista will also be used to create the resampled/retiled township mosaic versions of the orthophoto imagery as needed for delivery.

6.4 Image Mosaic Block Matching:

Kucera will review the individual initially OrthoVista-processed ortho image mosaic blocks as a projectwide image mosaic and perform additional OrthoVista processing to ensure there are no significant tone differences or color shifts between the mosaic blocks which can result in a "banding" effect in an areawide mosaic. This process will ensure seamless projectwide imagery with an even tone and color balance throughout.

6.5 Radiometric Processing:

When processing digital camera imagery into orthophotography, a 3-stage process is implemented to ensure maximum image detail and consistency. First, a curved image stretch is applied to the raw 16-bit imagery, yielding a smooth bell-shaped histogram without losing any information on the high or low end. The image strips are then matched to each other in OrthoVista using the radiometrix adjustment tool. Following this process, Adobe Photoshop is used to stretch the histogram for the 8-bit mosaicked imagery to the selected color and contrast, keeping the mean DN value within approximately 108 and 147. The dataset before this final adjustment is maintained as needed for fine-tuning of tones for increased shadow or highlight detail.

6.6 Water Bodies:

Polygon outlines of significant water bodies will be input to OrthoVista and used by the program to specially treat these areas to achieve a consistent tone and color balance within the areas without losing shoreline, island, and shallow submerged feature detail. Image processing procedures such as use of image "masks" will be used to keep color/tone consistency of Lake Erie to the extent possible and desired although some degree of color/tone variation is generally unavoidable for large open water bodies due to lack of color shift/seam hiding features.

6.7 Image Ghosting:

Kucera's post-mosaicing quality control includes full manual review for "ghosting"/image duplication, mosaic anomalies and correct of the same. Kucera uses manual seam line delineation in areas which are more prone to ghosting (e.g., built-up areas) to minimize occurrence of this anomaly.

6.8 Bridges/Overpasses, Elevated Features:

In areas where there are significant (> 12') bridges/overpasses, two sets of rectified imagery will be prepared, one rectified to the DEM representing the ground beneath the bridge as needed for proper representation of the same, and one rectified to DEM breakline data representing the bridge deck, again as needed for proper representation of the same. Using OrthoVista and manual image editing techniques, the images will be merged/mosaicked to produce the final proper image rendition. Breaklines will be introduced in the image rectification as needed to minimize (within 3 pixel) "waviness" of roads, railroads, and other linear elevated features.

6.9 Feature Lean Control:

For taller structure areas feature lean effects will be minimized using a semi-automated process involving piecing together portions of rectified imagery on which the individual tall structures are best centered and absent of lean. The editing work will be conducted by experienced image processing technicians who will make use of the OrthoVista technology's "QC" feature which automatically retrieves all available views for a particular feature for selection of the best view for subsequent mosaicking. The process is facilitated as needed (e.g., for downtown Noblesville area) by the use of feature-centered/increased overlap aerial flight lines. For structures which are not tall but cover large areas (e.g., manufacturing plants, transfer facilities, etc.), a similar process will be used to ensure that the image coverage has minimal and consistent lean and that the appearance of the building is proper and not distorted due to image seams or differences in lean direction between sides.

Kucera's general criteria for structure lean control is to have no more than one quarter of adjacent features obscured and to provide a "true" or near-true (4 – 6 pixel maximum horizontal displacement) representation of all identified significant structures/landmarks or designated tall structure areas. To produce the "true" orthophotography with no feature lean for the downtown Cleveland area, Kucera will use the following procedures in the orthophoto production:

1. Aerial photography of area captured with 60% - 80% side overlap coverage.

2. A digital surface model (DSM) of all structures and ground will be created using Leica DSM software. Seam lines will be generated using slope values derived from the DSM.

3. The generated seam lines will be manually checked using OrthoVista seam line edit tools before measuring is performed.

4. The DSM will be used to quality control check for proper "true" structure placement in the ortho-rectified imagery.

6.10 Image Finalization:

The image tiles produced through OrthoVista will be thoroughly manually inspected individually and together, with a quality certification for each batch of images passing inspection. Elements of the final inspection and quality certification process will include:

Characteristic	*Acceptance Criteria*
Automated processing artifacts (e.g., image smears)	100% absent
Tone transition	< 10% variance
Image artifacts (e.g., speckling)	0% visible at target scale < 5 artifacts per tile
Control target image position offset (from survey coordinates)	within 2'
Elevated features (bridges, railroads, etc.)	No breaks/warping, <3 pixel waviness
Shadow/highlight areas	Good detail visible at target and magnified viewing scales
Color/contrast/radiometry	Match with approved/pilot sample Mean DN 108-147
Building Lean	< 25% of adjacent features obscured

In general, Kucera will process the imagery in contiguous blocks and expect these to have a seamless appearance throughout when viewed at the target and reasonably (e.g., 2x) enlarged scales and have control/triangulation point displacement and seam mismatches/offsets within the target horizontal accuracy tolerance. Displacement from stereocompiled breaklines and planimetric features in the orthoimagery will be no more than twice the tolerances indicated above, accounting for the accuracy level of both the imagery and the compiled features. Correction of minor image imperfections and "sharpening" of tone as needed will be performed as needed using Adobe Photoshop software.

6.11 Pilot Project:

Kucera will initially produce and deliver the final orthophotography covering the County's designated pilot area. The pilot project will be used to validate all procedures and verify that orthophotography

meets County specifications and expectations. The pilot image submittal can include samples of tiles with variation in color/contrast for selection of the preferred image radiometry.

Following County QC review and comment, the pilot area imagery will be adjusted if needed and resubmitted for verification of changes. The fully approved sample imagery will be used as a standard for the balance of the image delivery and integrated with this delivery.

6.12 Uncompressed and Compressed Ortho Delivery:

The final uncompressed digital orthophoto image tiles will be furnished in 3-band 24 bit natural color (RGB) and color IR (RGIr) form on USB drive media. The image file names will correspond to the specified grid-defined modular tile numbering/naming system. A digital vector tile index in shapefile GIS format will also be provided as needed.

Following general acceptance of the uncompressed imagery, 20:1 SID V.3 and JPEG2000 compressed versions of the color and IR tiles will be furnished along with a countywide color SID mosaic.

6.13 Data Warranty:

Kucera provides a perpetual data warranty for any major errors/anomalies/gaps found in the orthophotography, i.e., such errors/anomalies/gaps will be promptly corrected at no added cost whenever they are found. Kucera will perform minor image edits/aesthetic adjustments and replace lost data at no charge for three months from final data delivery and at a minimal charge based on Kucera's cost after three months.

7. PROJECT WRAP-UP / METADATA

7.1 Overview/Procedures:

In the project wrap-up phase of the project Kucera will review the project transmittals/records and specifications to ensure that all deliverables were received by the County. The County will also be requested to review its records as well to ensure all deliverables are accounted for. Project materials retained by Kucera (e.g., raw aerial imagery, backup DEM files, etc.) will be recorded and appropriately stored at Kucera's headquarters facility or forwarded to the County.

The County will be furnished with FGDC metadata in XML and/or HTML formats for the orthophotography. A client metadata questionnaire will be provided to the County to complete and return indicating the points of contact, distribution process, and other County-specific information as needed to complete the metadata. Kucera will provide all technical/process details required in the metadata, e.g., aerial photo date, technologies/methodologies used, accuracy assessment, etc.

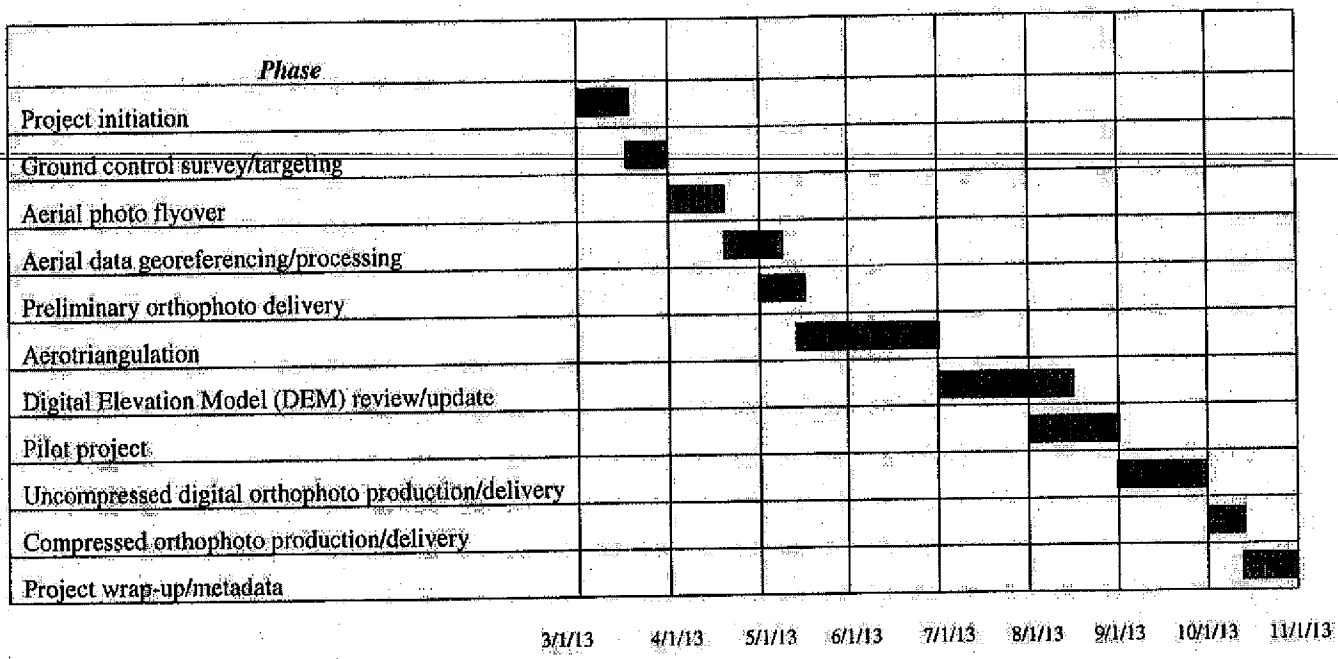
COMPLETION SCHEDULE

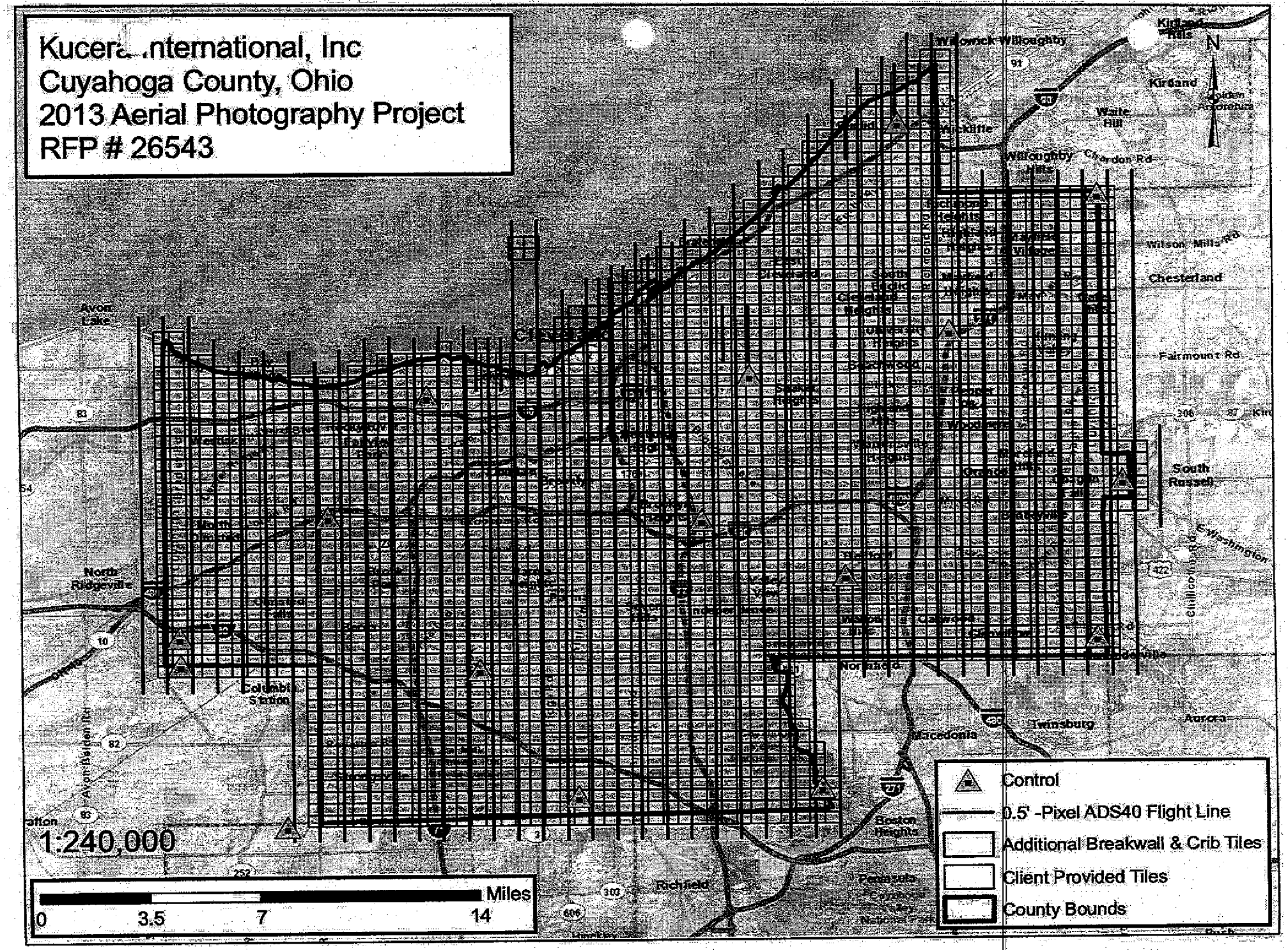
As described in Section 6 (Qualifications and Experience) of this proposal submission, Kucera is in an excellent position to make a major commitment of resources to the Cuyahoga County project work and complete the work on schedule. Kucera's proposed completion schedule by phase, assuming a contract start/notice to proceed date of approximately March 1, 2013 is as follows:

Phase	***Start***	***Complete***
Project initiation	3/1/13	3/15/13
Ground control surveying/targeting	3/15/13	3/30/13
Aerial photo flyover	4/1/13	4/20/13
Aerial image processing and inspection	4/20/13	5/10/13
Preliminary orthophoto delivery	5/1/13	5/15/13
Aerotriangulation	5/10/13	6/30/13
Digital Elevation Model (DEM) review/update	7/1/13	8/15/13
Pilot Project	8/1/13	8/30/13
Uncompressed digital orthophoto production/delivery	9/1/13	9/30/13
Compressed orthophoto production/delivery	10/1/13	10/15/13
Project wrap-up/metadata	10/15/13	10/30/13

A GANTT chart of the proposed completion schedule is provided on the following page. Kucera will perform the aerial image capture in April after grass "greenup" as desired by the County, and will provide a preliminary version of the project orthophotography to the County in May. A pilot project for the initial delivery and County review of the finalized ortho imagery will be performed in August. The countywide finalized uncompressed ortho tiles will be progressively delivered weekly or semi-monthly in September – October, followed by delivery of the compressed ortho imagery in early October. The latter half of October will be used for project wrap-up activities and submission of the project metadata.

Throughout the contract period Kucera's management team will meet weekly to review the project status and make adjustments as needed to maintain the project schedule and specifications. Kucera's President will serve on the management team and issue corporate directives as needed. The Project Manager will provide semi-monthly or more frequent progress reports to the County detailing the work completed, work planned, and conformance with the project schedule. Every attempt will be made to complete the project work and finished product deliverables ahead of schedule.




Kucera International, Inc
Cuyahoga County, Ohio
2013 Aerial Photography Project
RFP # 26543
1:240,000
Miles
0
3.5
7
14
Control
0.5' -Pixel ADS40 Flight Line
Additional Breakwall & Crib Tiles
Client Provided Tiles
County Bounds
N
Willowick
Willoughby
Kirtland Hills
Kirtland
Waite Hill
Willoughby Hills
Chardon Rd
Wilson Mills Rd
Chesterland
Fairmount Rd
South Russell
Avon Lake
North Ridgeville
Columbia Station
Macedonia
Twinsburg
Aurora
Boston Heights
Peninsula
Cuyahoga Valley National Park
Richfield
Hinckley

Proposal for 20131 Aerial Photography and Related Photogrammetric Services Cuyahoga County, Ohio

COST PROPOSAL

Item/Phase:		Fee
1.	Aerial image capture and preliminary orthophoto image delivery	$ 20,000
2.	Ground control survey/and report	2,500
3.	Aerotriangulation and report	5,500
4.	DEM update/augmentation and delivery of project DEM	4,500
5.	Uncompressed color and CIR orthophotography, including "true" orthophotography of downtown Cleveland area	30,300
6.	Compressed color and CIR orthophotography	2,400
7.	FGDC metadata	300
	Total base fee	$ 65,500

Notes:

- The project work will be progressively invoiced over the course of the contract by phase completion as evidenced by data delivery for each phase.
- Reduce Item 1 fee by $1,000 if preliminary orthophotography not required.
- Reduce Item 5 fee by $1,000 if true orthophotography of downtown area not required.