# CONTRACT AGREEMENT


**KUCERA** INTERNATIONAL INCORPORATED

AERIAL PHOTOGRAPHY - DIGITAL PHOTOGRAMMETRY - GIS SERVICES

| | | | |
|---|---|---|---|
| **MAIN OFFICE:** | 38133 Western Parkway | Willoughby, Ohio 44094 | (440) 975-4230 |
| **BRANCH OFFICES:** | 3889 Grove City Road | Grove City, Ohio 43123 | (614) 539-3925 |
| | 2215 South Florida Avenue | Lakeland, Florida 33803 | (941) 686-8640 |
| | 1121 Boyce Road, #3100 | Pittsburgh, Pennsylvania 15241 | (724) 942-2881 |


This Agreement is made this 19th day of March, 2009, between Scott County Information Technology, 600 W 4th Street, Davenport, Iowa 52801, hereinafter referred to as the "County," and Kucera International Inc., an Ohio corporation, 38133 Western Parkway, Willoughby, OH 44094, hereinafter referred to as the "Consultant."

**WHEREAS,** the County desires to engage the Consultant to provide professional services in connection with the project as outlined in the Bi-State Commission's Quad Cities Aerial Mapping Project Request for Proposals (Bi-State RFP) issued January 15, 2009; and

**WHEREAS**, the Consultant desires to render those services as described in Section 1: Scope of Services;

**NOW, THEREFORE,** the County and the Consultant in consideration of the mutual covenants contained herein agree as follows:

## SECTION 1: SCOPE OF SERVICES

The Consultant will provide to the County aerial photogrammetric services which will generally consist of new aerial photography, airborne control surveying, aerotriangulation, digital orthophotography, and digital planimetric feature mapping covering the County and area as defined in the Bi-State RFP. The aerial photography will be acquired using digital aerial camera technology in direct RGBIR digital form at a 0.4' (flying height ~4000' above ground) image resolution and will be georeferenced to a combination of airborne GPS/IMU and targeted ground control using a softcopy aerotriangulation process. The georeferenced imagery will be ortho-rectified to existing County or State digital elevation model (DEM) data, which will be photogrammetrically updated as needed to support the rectification. The digital orthophotography will be furnished in color at 1"=100' scale, 0.4' image resolution. The planimetric feature mapping will be performed at 1"=100' scale and will include structures, centerlines for long (>300') single structure driveways, and all driveway centerlines serving multiple residences as specified.

In addition to the Bi-State RFP-specified deliverables, the County will receive a preliminary copy of the project orthophotography, GIS change area polygons from change analysis procedures, and updated project DEM mass point and breakline data.

Optional services/data products will include duplicate color infrared orthophotography, duplicate black and white orthophotography with a 0.25' resolution, and building height and/or elevation attributes.

The project ground control surveying and targeting work will be accomplished by the County.

The services to be performed are more specifically described in the Bi-State Commission's January 15, 2009 Quad Cities Aerial Mapping Project RFP and Kucera's proposal response dated February 5, 2009, attached hereto as Exhibits A and B, respectively. Where changes to the project scope of work and associated deliverables are set forth in the Agreement, such will have precedence over the scope and deliverables as indicated in Exhibits A and B. All other Bi-State RFP and Kucera proposal details, terms, and conditions apply to this Agreement.

## SECTION 2: DEFINITION OF TERMS

A. **Contract Officer** - shall refer to the duly designated County official charged with general administration and coordination of matters related to this Agreement on behalf of the County.

B. **Project Coordinator(s)** - shall refer to the County's or Contract Officer's designated person or persons responsible for coordinating all aspects of work to be performed with the Consultant's assigned Project Manager. Such coordination shall include, but not be limited to, the review and acceptance of any hardcopy and computer digital file samples submitted by the Consultant.

C. **Project Manager** - shall refer to the person assigned by the Consultant to oversee the Consultant's work, coordinate with the County, and periodically report the status of the work to the Contract Officer or the County's Project Coordinator.

D. **Project Area** - shall refer to the areas designated for which the Consultant shall perform the services referenced and described in this Agreement.

E. **Work/Deliverables** – shall refer to all data provided to the County corresponding to the contracted services and described herein, e.g., imagery, reports, digital mapping, etc.

F. **Delivery** - shall mean the receipt in good order and condition, by the County Contract Officer or Project Coordinator(s), of all deliverables for services purchased by County from Consultant under this Agreement.

G. **Acceptance** - shall refer to the County's written or verbal acknowledgment of its approval in adequacy, accuracy, and quality of deliverables submitted by Consultant, following the County's review of deliverables.

H. **RFP** - shall refer to the Bi-State Commission's Quad Cities Aerial Mapping Project request for proposals dated January 15, 2009 and associated addendums and correspondence.

I. **Proposal** – shall refer to Kucera International's proposal to the Bi-State Commission for the project work dated February 5, 2009.

## SECTION 3: RESPONSIBILITIES OF THE COUNTY

A. The County shall assign a Project Coordinator(s) with the authority to review and approve materials and deliverables submitted by the Consultant to act as liaison between the County and Consultant.

B. The County shall within ninety (90) days of receipt review any samples or deliverables and approve or comment on same.

C. The County shall within a reasonable time after a request is received from Consultant answer or address any unforeseen questions that may arise during the course of the work to be performed by Consultant.

D. The County shall provide any designated County-owned source materials to the Consultant required to complete the project work and shall apprise the Consultant as possible of other known available source materials which may aid in the performance and check of the work.

E The County at its expense shall pay for the shipment of any materials to the Consultant.

## SECTION 4: RESPONSIBILITIES OF THE CONSULTANT

A. The Consultant agrees to perform in a professional manner all of the services outlined in Section 1: Scope of Services and as further described in Exhibits A and B.

B. The Consultant agrees that no changes shall be made in the services outlined in Section 1: Scope of Services and/or Exhibits A and B without the express written prior consent and Agreement of the County and the Consultant.

C. The Consultant shall be fully responsible for the technical adequacy and accuracy of the work. No action by the County in its review, approval and/or acceptance or by any payment made hereunder shall be construed as a waiver of the technical adequacy and accuracy of the Consultant's work.

D. The Consultant shall assign to the work a Project Manager whose duties will be to oversee and coordinate the work with the County's Project Coordinator(s) and make regular status reports to the County.
E. The Consultant shall pay for the shipment of all deliverables and materials to the County.

F. The Consultant shall begin to perform the services upon receipt of the County's notice to proceed signed by the Contract Officer or designee of the same and shall complete such work as outlined in <u>Section 5: Time of Completion</u>.

G. The Consultant will retain a backup copy of all significant interim and final data produced for the contract, e.g., raw aerial imagery, lidar DEM, digital orthophoto imagery, etc. at no added cost to the County.

H. The Consultant shall obtain any non-County owned/outside source materials designated for use in the completion of the contract work.

## SECTION 5: TIME OF COMPLETION

The Consultant agrees to complete the project work according to the following schedule as outlined in the Consultant's proposal:

| ***Phase*** | ***Start*** | ***Complete*** |
|---|---|---|
| Project initiation | 2/23/09 | 3/9/09 |
| Ground control survey/targeting | 3/9/09 | 3/23/09 |
| Aerial photo flyover | 3/24/09 | 4/24/09 |
| Aerial data processing/reduction and review | 4/24/09 | 5/30/09 |
| Preliminary orthophoto delivery | 5/1/09 | 5/8/09 |
| Aerotriangulation | 5/24/09 | 7/15/09 |
| Pilot project | 7/15/09 | 8/15/09 |
| Planimetric and DEM stereocompilation | 8/15/09 | 9/30/09 |
| Digital orthophoto production and delivery | 9/1/09 | 10/15/09 |
| Planimetric feature mapping | 10/1/09 | 12/15/09 |
| Project wrap-up/metadata | 12/15/09 | 12/31/09 |

The contract work shall be completed by December 31, 2009, with the exception of add-on work mutually agreed to be subsequently completed and any revisions or additions to the work required for contract compliance determined subsequent to completion/delivery.

The Consultant agrees to exercise reasonable care and diligence in anticipating potential problems and delays in completing the work. Such care shall include anticipating and making provision for loss of critical employees, normal failure of equipment, and other such schedule-disrupting occurrences normally experienced and reasonably capable of being anticipated by like organizations.

Extensions of time can be granted by the County upon written request of the Consultant, provided such request is made prior to the expiration of this Agreement, do not involve acts of failure by Consultant to exercise reasonable care and diligence as noted above, and are based on documented evidence of need under one of the following criteria:

1. Any required aerial photo reflights which may be necessary and cannot be completed during the calendar year in which the Project Area work is authorized.

2. Delays by the County in providing notices to proceed, County-designated source materials, or review/acceptance of the Consultant's work.

3. Significant changes in the scope of work/project parameters which affect scheduling.

4. Acts of nature or other circumstances beyond the control of the Consultant which is not due to its negligence or that of its employees, agents or assigns, but which affect the Consultant's ability to perform.

## SECTION 6: PROGRESS REPORTS

Following the first day of execution of this Agreement, the Consultant shall submit reports of progress at least monthly which describe work completed up to the date of such report.

## SECTION 7: DELIVERY OF WORK/DELIVERABLES

Consultant shall certify to the County when the work or any portion thereof has been completed and products of such work have been delivered to the County for inspection.

## SECTION 8: INDEPENDENT CONTRACTOR STATUS

The status of the Consultant under this Agreement with respect to the services to be performed by the Consultant hereunder shall be that of "independent contractor." Nothing herein shall be construed to create an employer/employee relationship between the County and the Consultant or any other subconsultant hired by the Consultant.

## SECTION 9: COVENANT AGAINST CONTINGENT FEES

The Consultant warrants that it has not employed or retained any company or person other than a bona fide employee working solely for the Consultant to solicit or secure this Agreement, and that Consultant has not paid or agreed to pay any company or person, other than a bona fide employee working solely for the Consultant, any fee, commission, percentage, brokerage fee, gifts, or any other consideration, contingent upon or resulting from the award or making of this Agreement. For breach of violation of this warranty, the County shall have the right to annul this Agreement without liability, or, at its discretion, to deduct from the Agreement price or consideration, or otherwise recover, the full amount of such fee, commission, percentage, brokerage fee, gifts, or contingent fee.

## SECTION 10: INSURANCE

Consultant shall take out and maintain during the life of this Agreement such public liability and property damage insurance as shall protect Consultant, its subcontractors, and the County from claims for damages for personal injury, including accidental death, as well as for claims for property damage, which might arise from operations under this Agreement, whether such operations be by Consultant or its subcontractor, or by anyone directly or indirectly employed by either of them.

Consultant shall also take out and maintain for the term of this Agreement the following coverages: $2 million general aggregate general liability; $1 million combined single limit automobile liability; $3 million aircraft insurance; $5 million excess liability; statutory workers' compensation liability; and professional liability in the amount of not less than $1 million. The County, its elected officials and employees are to be named as additional insureds.

All insurance coverages required in this Agreement shall be maintained in force for one (1) year after final payment of purchases made thereunder. The Consultant shall provide the County with certificates of insurance on all policies required under this Agreement within ten (10) days of execution of this Agreement and prior to the start of work.

All insurance policies shall be issued by responsible companies who are acceptable to the County. The Consultant shall not cause any insurance to be canceled nor permit any insurance to lapse. All insurance policies shall contain a clause to the effect that the policy will not be canceled, reduced, restricted, or limited until thirty (30) days after the County has been notified in writing by registered or certified mail, return receipt requested. Certificates of insurance shall contain transcript from the proper office of the insurer, the location, the operations to which the insurance applies, the expiration date, and the above-mentioned County notification clause.

Consultant shall indemnify and hold County harmless from any damages, cost, claims or expenses which may arise as a result of any failure on the part of the Consultant to provide accurate and/or complete data and information to the County as outlined and required by the terms and conditions of this Agreement except as may be defined in Section 11: Warranty.

## SECTION 11: WARRANTY

The Consultant, by signing this Agreement, acknowledges full understanding of the extent and character of the work required and the conditions surrounding the performance thereof. The County will not be responsible for any alleged misunderstanding of conditions surrounding the performance thereof. It is understood that the execution of this Agreement by the Consultant serves as its stated commitment to fulfill all the conditions referred to in this Agreement.

Consultant warrants that the work performed and deliverables provided under this Agreement shall conform to the County's specifications. The orthophotography and planimetric mapping produced will meet ASPRS Class 1 and National Standards for Spatial Data Accuracy (NSSDA) as applicable, i.e., having a root mean square horizontal displacement error (RMSE) within 1' and individual feature displacement within 2' at 95% confidence for ground-based locations determined from the imagery/mapping in relation to their "true" (accurately surveyed) positions. The work shall be of high quality, and shall be within the tolerances allowed by the above-cited references. If the Consultant is notified in writing by County of a discrepancy, deficiency, inaccuracy, or fault in the work, within thirty (30) days of such notice the Consultant shall re-perform such portions of the work necessary to correct the fault. If the fault requires a repeat of the aerial flyover of the project area, the repeat flyover will be performed at the first available opportunity at a time of the year mutually agreed upon with and approved by the County. All rework shall be made at no additional cost to the County.

The warranty will apply indefinitely for major errors/defects found in Consultants' mapping and for one year from the time of final delivery for cosmetic/minor revisions and replacement of lost data files previously documented to be delivered. The Consultant shall not be liable for secondary, incidental or consequential damages of any nature resulting from any work performed under this Agreement.

## SECTION 12: INSPECTION AND CORRECTION

The Consultant shall correct any major defects/errors in the work found following the County's review period, and shall make accessible to the County whatever information, data, materials and processes the County deems reasonably necessary to evaluate and confirm the accuracy and quality of Consultant's work. The Consultant shall not be liable for any expense of the County's review or inspection processes.

The County shall promptly following its inspection notify the Consultant of the nature of any work deemed non-acceptable. Upon such notification Consultant shall within sixty (60) days replace, modify or adjust its work to meet specifications, at its expense. Work shall be considered acceptable if indicated as such in the absence of other notification.

## SECTION 13: ACCEPTANCE

The County shall give written notice of its acceptance or non-acceptance of work to Consultant within ten (10) working days of the 90-day review period. If no such notice is given to the Consultant, the work shall be deemed accepted by the County.

## SECTION 14: USE OF PROJECT DATA

A. The Consultant hereby understands and acknowledges that any and all information gathered, generated and delivered to the County as outlined in the Scope of Services is for the exclusive use and benefit of the County, and shall be the sole property of the County, and that such information shall not be disseminated by the Consultant without the express written consent of the County.

B. All information, data, designs, plans, drawings, maps, photographs, specifications or other work furnished to or developed for the County by the Consultant, its employees, agents, or assigns, pursuant to this Agreement, shall be the sole property of the County, and all rights therein are reserved by the County. The Consultant, its assigns, employees, or agents shall not provide any imagery or map data developed under this Agreement to any party other than the County without the County's consent.

C. During the course of the work, the Consultant, upon the express written consent of the County, may fill requests by non-County agents, business entities or individuals for imagery or mapping not part of this Agreement or not as yet delivered to the County. Should this occur, the Consultant shall charge a reasonable fee for its service and at the County's option will credit the County an agreed upon percentage of such fees.

D. Upon the completion of the work, the County may at its option enter into a contract with the Consultant to supply products and services which the County may not be equipped to furnish to non-County agencies or individuals. The Consultant will furnish a list of products and services over and above those furnished to the County along with fees for such products and services, and the County may direct the Consultant to charge such fees for them, as the County deems appropriate.

E. The Consultant hereby agrees to maintain one copy of all information gathered, generated and delivered to the County within its office in digital computer file form to serve as a backup to the data furnished to the County. Should the County suffer the loss of any of its data the Consultant agrees to replace same from its files at a reasonable fee for a period of ten years.

F. The County shall be entitled to rely on the technical accuracy of the data furnished by the Consultant with the understanding that the Consultant is not responsible for alterations made to and/or improper interpretation/use of the data by the County, e.g., image enlargement significantly greater than the specified map scale scales and associated accuracies.

## SECTION 15: COPYRIGHTS AND DISCLAIMERS

A. Copyright and title to all final deliverable products (e.g., aerial imagery, digital orthophotography, planimetric mapping) shall pass from the Consultant to the County upon the County's payment for the deliverables.

B. Use by a third party of the project aerial photography and associated digital imagery while in the Consultant's processing shall require advance approval from the County.

C. If the project data is to be made available by the County for use by outside entities, the County and Consultant shall prior to entering an Agreement with said outside entity prepare a statement/disclaimer as to its proper use/interpretation for the protection of both the County and the Consultant.

## SECTION 16: COMPENSATION FOR CONSULTANT'S SERVICES

In consideration for the services performed hereunder, Consultant shall be paid the following by project phase:

| | | |
|---|---|---|
| 1. Digital aerial photography at 0.4' resolution | $ | 41,500 |
| 2. Color digital orthophotography at 1"=100' scale, 0.4' resolution | | 52,200 |
| 3. Planimetric feature mapping | | 26,900 |
| Total base fee | $ | 120,600 |

Optional Services:

| | | |
|---|---|---|
| 4. Black and white orthophotography with 0.25' resolution | $ | 8,500 |
| 5. Color infrared orthophotography with 0.4' resolution (uncompressed and compressed form) | $ | 14,000 |
| 6. Building feature elevation and height attribute | $ | 11,000 |

Invoicing for each phase will be based upon documentation of completion and/or transmittal of phase deliverable or substantial portion thereof. The fees listed above include all ancillary services/products required for each cost item as defined in Exhibits A and B. Optional services will only be performed by the Consultant with written authorization of the County.

## SECTION 17: INVOICING

The Consultant's invoices shall be submitted over the course of the contract and reflect work completed and delivered and/or documented by percentage of project phases as indicated in Section 16 (Compensation) of the Contract Agreement. The County agrees to review and process/pay the Consultant's invoice within thirty (30) days of receipt. If an invoice is validly disputed by the County or otherwise found to be in error, the invoice will be voided out and a new invoice submitted at the agreed amount with a new thirty (30) day payment period.

## SECTION 18: PRICE PROTECTION

The fees quoted for work contracted for by the County as part of this Agreement, or quoted by Contractor for additional services during the course of this Agreement shall be applicable until March 1, 2010. Should the County defer any portion of the work beyond this date, the fee for such work deferred will be adjusted by the consumer Price Index (CPI) for the prior year or other mutually agreed upon factor.

## SECTION 19: COMPLIANCE WITH THE LAW

A. The Consultant shall not discriminate by any reason of age, color, handicap, national origin, race, religion or sex which is unrelated to the duties or position of applicants for employment by the Consultant.

B. The Consultant shall at all times observe and comply with all applicable statutes, ordinances, rules and regulations of federal, state and local governments in effect at the execution of this Agreement.

## SECTION 20: TERMINATION

This Agreement shall terminate upon the County's acceptance of and payment for all authorized deliverables and services. The Consultant will retain a backup copy of all final and significant interim data deliverables for the contract, e.g., aerial film, digital orthophoto imagery, etc.

The County may terminate this Agreement with 60 days written notice to the Consultant for reasons unrelated to the Consultant's performance (e.g., lack of adequate funding for continuation). In the event of such termination, the County shall be liable for the payment of all work properly performed prior to the effective date of termination, including all portions of work which were partially completed.

If for any cause the Consultant shall default in the performance of this Agreement or any part thereof and has failed to cure such default within sixty (60) days after receipt of written notice sent by certified mail, return receipt requested, specifying such default, the County may terminate this Agreement at its option and sue the Consultant based upon a failure of the Consultant to adhere to this Agreement.

## SECTION 21: AMENDMENTS

No amendment to this Agreement shall be effective unless it is in writing and signed by duly authorized representatives of each party hereto.

## SECTION 22: AGREEMENT INTEGRITY

This document and attachments represent the full and final Agreement between the Consultant and the County. If any provisions of the Agreement are deemed void or unenforceable, all other provisions will remain in effect.

## SECTION 23: ATTORNEY FEES

In the event either party has to institute any legal action for breach of this agreement or to enforce the terms thereof, the prevailing party shall be entitled to recover any and all costs associated with having to institute such action, including, but not limited to, attorneys' fees and all costs as a result of the action

## SECTION 24: JURISDICTION AND SIGNATURES

This contract is hereby signed in the State of Iowa and the laws of the State of Iowa shall be applicable hereto.

**IN WITNESS WHEREOF,** the parties have executed this Agreement on the date hereinabove first written.

| SCOTT COUNTY | KUCERA INTERNATIONAL INC. |
|---|---|
| By: ________________ | By: ________________ |
| Authorized County Representative | John Antalovich, Jr., PE<br>President |

## 2.10 Responses to this Proposal (Continued)

Vendors are to submit questions related to the specific project requirements and contents of proposals in written form only (no phone calls) and submitted by fax, U.S. Mail, or e-mail by 2pm CST on January 23, 2009. The responses to all of the questions shall be sent to all vendors via fax or e-mail by January 28, 2009. No oral questions will be entertained prior to or after the deadline for written questions specified above. Submit all questions to:

Lisa J. Miller, GIS Director
Bi-State Regional Commission
1504 Third Avenue, P.O. Box 3368
Rock Island, IL 61204-3368
E-mail: lmiller@bistateonline.org
Fax: (309) 793-6305

***Please do not attempt to contact the staff of any of the agencies participating in this consortium; all inquires should be submitted through Ms. Miller as stated above.***

## Section 3: Aerial Photography

### 3.1 Scope of Work

The vendor shall acquire new, color aerial photography of the project area during the spring of 2009. This photography will primarily be used to produce digital ortho-rectified imagery which will subsequently be used to support computerized geographic information systems and other government mapping applications. In addition to the digital orthos, the project aerial photography will be used to support planimetric feature stereocompilation.

Photography shall be obtained from a flight height of 4,800ft AMT covering all of the project area. This photography will be used to produce 100sc digital ortho-rectified imagery with 0.5ft ground sample distance (GSD) pixel resolution. The specific project area requiring coverage at 4,800ft AMT is shown on Attachment 11.1. Photo coverage shall be designed to provide "neat model" production of digital ortho-rectified photography for a minimum of one-eighth mile outside of the project boundary.

### 3.2 Aircraft and Crew

The Vendor shall be responsible for operating and maintaining all aircraft used in conformance with all governing Federal Aviation Administration and Civil Aeronautics Board regulations over such aircraft. Any inspection or maintenance of the aircraft resulting in missing favorable weather will not be considered as an excusable cause for delay.

Preference may be given to vendors who own the aircraft and aerial camera system(s) used on this project. All respondents must identify the firm that will actually be acquiring the aerial photography, the relationship that firm has with the vendor, and the ownership of the aircraft and camera equipment to be used.

All flight crew members must have two years or more experience flying precise photographic missions for aerial surveys. Individual resumes of the flight crew members shall be included with the proposals.

The aircraft furnished shall be capable of stable performance and shall be equipped with essential navigation and photographic instruments and accessories, all of which shall be maintained in operational condition during the period of the contract. No windows or glass, except for optically flat glass shall be interposed between the camera lens system and the terrain. The camera lens system shall not be in the direct path of any exhaust gasses, effluence, or oil from aircraft engines.

### 3.3 Acquisition Delays

The Vendor shall inspect and constantly monitor the photographic coverage and film quality and shall undertake immediate reflights of areas wherein coverage does not meet specifications. Rejection of photography by the Vendor or a Consortium agency shall not in itself be a reason for granting a delay or of another photo season.

### 3.4 Environmental Conditions during Photography

The following weather conditions are a minimum which shall be met or exceeded during the photo missions:

1. *Sun angle.* Photography shall be taken when the sun angle is 30 degrees or greater above the horizon. There shall be no objectionable shadows created by relief or low solar altitude.
2. *Cloud cover.* Images shall be free of clouds and cloud shadows. No photography will be accepted with clouds or cloud shadows appearing on more than 5 percent of the area in any one final ortho-rectified image tile.
3. *Season.* Photography shall be acquired during the leaf-free season in the spring of the year. Deciduous trees must be barren. Acquisition of the color photography shall not begin until after March 24th or in the event of an early spring until after the grass has turned green.
4. *Turbulence.* Photography will not be taken during adverse conditions when wind and thermal currents are causing excess tilt, crab, or drift in the photography.
5. *Haze.* Photography will not be taken when the ground is obscured by haze, fog, or dust.
6. *Snow cover.* Photography will not be taken when snow is present on the ground.
7. *High water.* Photography will not be taken when the ground is obscured by flood water. Streams must be in their normal banks.
8. *Ground conditions.* Conditions that might obscure ground detail shall be the responsibility of the vendor.

### 3.5 Aerial Camera

The aerial camera used for this project shall be a fully calibrated precision analog mapping camera equipped with a single low distortion, high resolution lens, forward motion compensation (FMC), and a gyro-stabilized mount designed for vertical aerial photography with a 9" x 9" format. A USGS camera calibration report, no more than three years old shall be submitted with the response to these technical specifications for each camera system to be used on this project. The absence of a calibration report verifying that the camera meets the specified requirements may be cause for disqualification of the Vendor. The alternate use of a digital camera must be clearly defined in the proposal and shall include the proposed process, equipment, specifications, and manufacturer's camera calibration.

The calibration report must document the camera system meets or exceeds the following requirements:

1. A calibrated focal length of 153 mm ± 3.0 mm
2. A minimum aperture of *f*4.5
3. Radial distortion in the usable angular field does not exceed 10 micrometers for any tested point. In addition, at least 15 of the tested points shall have radial distortion values of 5 micrometers or less.
4. A usable angular field of view of at least 90 degrees
5. A minimum area weighted average resolution (AWAR) of the camera lens of 90.0 line pairs per millimeter
6. Eight fiducial marks recorded on each negative
7. A between-the-lens variable speed shutter with a minimum efficiency rating of 70 percent at a speed of 1/200 or 1/250 of a second
8. An appropriate glass filter with a metallic anti-vignetting coating and with surfaces parallel within 10 seconds of arc
9. Film magazine platen upon which the film is flattened at instant of exposure shall not depart from a true plane by more than 13 micrometers when the camera/magazine vacuum is applied.
10. Stereo model flatness:
    a. Average departure from flatness not to exceed 13 micrometers
    b. Difference between highest and lowest value not to exceed 25 micrometers
    c. Average values for tested points not to exceed 6 micrometers

### 3.6 Photographic Coverage

1. Each vendor shall prepare a flight plan for the aerial photography and include the flight plan with their response to the RFP. All flight lines must extend at least two exposures beyond the required coverage boundary.
2. The photographic survey areas of the project shall be stereoscopically covered by successive and adjacent overlaps of photographs within the usable portion of the field of the lens.
3. Lack of acceptable stereoscopic coverage shall be corrected by reflights at the vendor's own expense.
4. Except on short flight lines, a minimum of two runoff or blank exposures is required between usable frames immediately prior to the start of the photography for each flight line or part of a flight line.
5. Any exposures within the project area with a color balance shift compared to the remainder of the roll will result in unacceptable exposures.
6. Forward overlap in the line of flight shall average not less than 57% or more than 62% at mean elevation of the terrain, unless otherwise specified. Individual overlaps shall not be less than 55% or more than 68%, excepting the situation where in a forward overlap in areas of low elevation must exceed 68% to attain the minimum 55% forward overlap in adjacent areas of higher elevation.
7. Junction areas between adjoining flight lines shall be covered stereoscopically by both lines (wherever there is a change in direction between two flight lines).
8. Side overlap between adjacent parallel flight lines shall be 30% +/- 10% at the mean elevation of the terrain.
9. Flight line deviation shall not exceed a distance greater than 10% of the width of the coverage of the photograph.
10. Departures from flight height required shall not exceed –2% or +5% unless changed by Air Traffic Control Centers.

11. Changes in the course of the aircraft between successive overlapping photographs within a flight line shall not exceed 3 degrees.
12. While exposing aerial photography, the camera shall be compensated for crab of the aircraft, with a resultant error not exceeding 3 degrees.
13. The tilt within a single frame shall not exceed 4 degrees nor shall the difference in tilt between two consecutive overlapping frames within a flight line exceed 4 degrees. The average tilt for all negatives of the same nominal scale shall not exceed 1 degree.
14. The combined effect of aircraft course corrections, crab, and tilt shall result in an apparent crab not greater than 5 degrees on successive photographs. Apparent crab is defined as the angle between the indicated principal point and the conjugate image of the indicated principal point of the adjacent photograph within the same flight line.
15. Exposure of the film shall be in accordance with the manufacturer's recommendations. The negatives shall be clear and sharp in detail, free from light streaks and static marks, and of uniform tone and degree of contrast to permit ground details to show clearly in all scene reflectance, with particular emphasis on pattern recognition in the shadow areas.
16. The photo missions shall be executed within the shortest possible timeframe to insure consistent ground and lighting conditions.

### 3.7 Reflights
Unacceptable aerial photography shall be re-flown at the earliest opportunity, weather permitting by the vendor at no additional cost to the Consortium agency, with the reflight coverage overlapping the accepted photography by at least two stereo models.

### 3.8 Airborne GPS
Airborne GPS technology may be used to capture the photography and reduce the amount of ground control necessary to perform the project. In such instance, the vendor shall describe the onboard equipment which it owns and is installed in the aircraft. <u>The type of receivers, number of ground base stations, and locations to be used shall be described.</u> The vendor shall also list the AGPS data processing software and procedures.

### 3.9 Aerial Film
The natural color negative film used shall be KODAK Aerocolor III Negative Film 2444 or AGFA Aviphot Color X100 PE1 or approved equal. Outdated film shall not be used. The film must be stored and handled in accordance with the manufacturer's recommendations.

Aerial film that remains in the camera overnight must be rolled forward a minimum of three exposures immediately before additional photography is exposed on a subsequent date.

All aerial negatives for each flight line shall be exposed from the same aerial camera.

### 3.10 Film Processing
Film processing, including developing, fixing, washing, and drying of all exposed film, must be performed in modern automatic aerial film processor. The resultant processed original aerial film negatives shall be clear and sharp in detail and uniform in density. The negatives must be free of static marks, tears, scratches, or other blemishes. The Vendor must provide quality assurance of the aerial photography and photo laboratory procedures. The Vendor shall outline the Quality Assurance / Quality Control program used during photo processing.

### 3.11 Film/Digital Image Inspection and Flight Log Report

Immediately after the film has been processed the aerial photography will be checked for acceptable exposure, resolution, contrast, overlap, crab and tilt level, absence of foreign markings, etc. For each roll of film, two consecutive stereo models shall be analyzed on a stereo plotter to verify that there was no residual parallax due to vacuum loss in the camera magazine during the aerial photography. An image quality report shall be prepared documenting the film and or digital image inspection results. Copies of the image quality report and flight logs indicating exposures taken, photographic parameters/ conditions, etc, shall be provided to the Bi-State Regional Commission for review by an independent photogrammetric consultant.

### 3.12 Flight/Photo Index

In lieu of contact prints a flight/photo index shall be delivered in a geo-referenced AutoCAD version 2008 DWG file and ESRI shape file formats. Photo center point locations (derived from the airborne GPS/IMU survey) and image foot prints or edge of image swath shall be included. The photo center locations shall be attributed with the roll, flight line, and frame number. The flight lines shall be attributed with the acquisition date, time, flight height, line number, camera serial number, and direction of flight. Two copies of the flight/photo index shall be delivered to the Bi-State Regional Commission for review by an independent photogrammetric consultant as soon as possible after the acquisition of the aerial imagery.

### 3.13 Film Ownership and Storage

All aerial film acquired as part of this project is the explicit property of the individual Consortium agencies. The Consortium agencies may elect to have the successful vendor store the aerial film at the vendor's facility. The Vendor will store the film in environmentally safe, humidity controlled conditions for a period up to ten years at no additional cost to the Consortium agencies.

## Section 4: Digital Orthophotography Production

### 4.1 General

A set of color digital orthophoto tiles will be created by scanning the negatives produced from the aerial photography and processing the image files using the latest, state-of-the-art technology. Orthophotos will be generated using the digital terrain model, control, and aero-triangulation data. A complete orthorectification will be carried out with a specifically developed set of algorithms that remove image displacement due to topographic relief and the tip and tilt of the aircraft at the moment of exposure. Every effort should be made to minimize the effect of building lean on the usability of the orthophotos.

### 4.2 Project Diagram

The project area described in this RFP includes all of Scott County, the City of Davenport, IA; the City of East Moline, IL; the City of Silvis, IL; the Village of Carbon Cliff, IL; the Village of Coal Valley, IL; and a one-eighth mile border area outside the project limits. Attachment 11.1, "Project Diagram" delineates the project area.

## 4.3 Control Requirements

### 4.3.1 Coordinate Datums

1. The horizontal datum for the jurisdictions in Iowa shall be the Iowa State Plane South Zone, NAD83 (1996 HARN Adjustment).
2. The horizontal datum for the jurisdictions in Illinois shall be the Illinois State Plane West Zone, NAD83 (1997 HARN Adjustment)
3. The vertical control for both Iowa (except for the City of Davenport) and Illinois shall be based on NAVD88.
4. All mapping data (planimetric, DTM, and contour) for the City of Davenport shall be provided in the City of Davenport vertical datum.
   a. Conversion: (NGVD 1929) – 537.36ft = Davenport Datum (1992 GPS Survey)
   b. Conversion (NAVD 1988) – 537.13ft = Davenport Datum (2005 GPS Survey)

5. All units of measure shall be based on U.S. Survey Feet.

### 4.3.2 Scott County

Scott County has existing permanent 3D GPS monuments located on an approximate 3 mile grid. Twenty-six (26) monuments in Scott County will be targeted by Scott County prior to the aerial flights.

The aerial targets will be in the form of a 4-way cross with a panel width of 12 to 18 inches and an overall target length of ten feet. The targeting material will be 3 ply harlequin vinyl as manufactured by Mutual Industries and will be securely fastened to the ground. Where the existing ground conditions will not permit the use of a cross shaped target, a "T" shaped target will be placed. Vertical offsets will be measured and digital pictures of each target site will be captured during the field targeting and provided with the control data to the aerial vendor.

Additional existing 3D GPS monuments will be targeted. The coordinates of these points will be withheld from the vendor and used as independent checks of the horizontal accuracy of the digital orthophotography.

The mapping vendor shall give Scott County a minimum three week notice prior to beginning the aerial flights.

See Attachment 11.2 for a layout of the Scott County ground control targeting.

### 4.3.3 The City of Davenport, IA

The City of Davenport has existing permanent 3D GPS monuments. Seventeen (17) monuments will be targeted by the City prior to the aerial flights.

The aerial targets will be in the form of a 4-way cross with a panel width of 12 to 18 inches and an overall target length of ten feet. The targeting material will be 3 ply harlequin vinyl as manufactured by Mutual Industries and will be securely fastened to the ground. Where the existing ground conditions will not permit the use of a cross shaped target, a "T" shaped target will be placed. Vertical offsets will be measured and digital pictures of each target site will be captured during the field targeting and provided with the control data to the aerial vendor.

The mapping vendor shall give the City of Davenport a minimum three week notice prior to beginning the aerial flights.

See Attachment 11.3 for a layout of the Davenport ground control targeting.
Note: Both the Davenport Datum and NAVD 1988 Datum are available for the seventeen Davenport monument sites.

### 4.3.4 The City of East Moline, IL; The City of Silvis, IL; The Village of Carbon Cliff, IL; and The Village of Coal Valley, IL.

It is the vendor's responsibility to furnish the necessary ground control/targeting for the City of East Moline, IL; the City of Silvis, IL; the Village of Carbon Cliff; and the Village of Coal Valley, IL. Respondents shall identify in their proposal the number and layout of ground control targets required. It is the vendor's responsibility to remove all of the targeting materials after the flights.

## 4.4 NSSDA Accuracy Statements

1. The 100 scale digital orthos shall be compiled to meet 3.0 feet horizontal accuracy at 95% confidence level. The horizontal accuracy of the digital orthophotos will be tested using the NSSDA standards.
2. The 100 scale planimetric features shall be compiled to meet 2.0 feet horizontal accuracy at 95% confidence level. The horizontal accuracy of the planimetric features will be tested using the NSSDA standards.
3. The 2ft contours produced from the DTM shall meet 1.0ft vertical accuracy at 95% confidence level. The vertical accuracy of the digital terrain model will be tested using the NSSDA standards.
4. The NSSDA positional accuracy testing will be performed by an independent consultant.

## 4.5 Aerotriangulation

### 4.5.1 General

The aerial vendor may use either fully analytical aerial triangulation (FAAT) techniques or softcopy (DAAT) to extend and densify ground control for the aerial photography. The use of airborne GPS/IMU technology is suggested in lieu of conventional aerial triangulation as long as project accuracy standards are maintained. The vendor shall provide a complete description of their methodology for performing the aerial triangulation adjustment including the equipment and software used.

### 4.5.2 Horizontal and Vertical Control

All horizontal ground control positions computed by analytic triangulation must be in the appropriate state plane coordinate system and referenced to NAD83 (HARN). All vertical control except for the City of Davenport must be referenced to NAVD1988. Distance units shall be US Survey feet.

### 4.5.3 Software

An industry-standard software program must be used for analytic aerial triangulation computations. The package used must be capable of strip adjustments, as well as large bundle (blocks of photos and strips) adjustments and should also have gross error detection facilities. The proposal should describe the package used for adjustment computations on this project.

### 4.5.4 Aerial Triangulation Report

Upon completion of all aerial triangulation work, the contractor will prepare a formal aerial triangulation report for delivery to the Consortium. The deliverables and report will include, but not necessarily be limited to, the following:

1. All misclosures at ground control points with and without use of checkpoints.
2. Final adjusted aerial triangulation solution to horizontal and vertical ground control.
3. Control point residuals and average residuals for each adjustment.
4. An ASCII file containing all points and their corresponding final adjusted State Plane Coordinate values.
5. A narrative of any problems that arose during the aerial triangulation and how they were resolved.

### 4.6 Film Scanning

Scanning devices used shall be precision photogrammetric scanners capable of capturing 256 levels of color and capable of scanning at resolutions finer than needed to obtain the output resolution requirements listed below. Interpolation from a finer input resolution to a coarser output resolution is allowable, but interpolation from a coarser input resolution to a finer output resolution is specifically prohibited. The proposal shall state the scanning resolution planned for this project. The final ortho-rectified imagery shall contain 0.5ft GSD pixels.

Film negatives from each flight line shall be pre-scanned to determine the optimum scan parameters for contrast and brightness. The optimum scan parameters shall produce full depth image histograms with emphasis on feature recognition in the shadows and the light areas of the image. During the scanning process, the contrast and brightness of the images shall be closely monitored. Each flight line shall be compared to the adjacent flight lines to ensure a uniform consistency throughout the entire project. The respondents shall discuss the particular scanner to be used as well as its geometric accuracy.

### 4.7 Surface Model

1. The existing surface models from the 2005 project will be made available to the successful vendor.
2. The 2005 surface models supported different levels of accuracy. 400sc ortho-rectified imagery was produced for the rural areas of Scott County. 100sc ortho-rectified imagery and a 2ft contour capable DTM was produced for the City of Davenport and surrounding urban areas. A 4ft contour capable DTM was produced for Rock Island County, Illinois, which includes East Moline, Silvis, Carbon Cliff, and Coal Valley.
3. The Bi-State Regional Commission is furnishing the 2005 surface model on an "as is" basis without any support whatsoever, and without representation or warranty, including but not in any manner limited to fitness and completeness of the surface model. It is the responsibility of the successful vendor to update the existing surface model as required to meet the accuracy standards as specified in this proposal.
4. Proposals shall include a complete description of the procedure for updating the existing surface models and collecting new surface models where required. The vendor shall describe the quality assurance measures used to verify the accuracy of the surface models.
5. Surface models must contain mass elevation points taken at uniform grid spacing and 3D break lines as required.
6. The grid spacing of the mass points and collection of break lines will be designed to meet the accuracy standards as specified in this proposal.
7. The vertical accuracy of the surface models shall be sufficient to obtain the required horizontal accuracies of the mapping.

## 4.8 Orthorectification

1. Vendors shall describe in detail the technical procedures, equipment, and software to be used for the production of digital orthophotos. A complete description of the digital orthophoto technical methodology will include but not be limited to compilation of the terrain model, ortho rectification process, image mosaicking, radiometric accuracy, estimated file size, and all quality control procedures. Vendors should provide any relevant detail about image processing techniques that they propose to use to enhance the usefulness of the digital image.

2. The orthophotography produced must be mosaicked with consistent tonal and color scale ranges within and between images. Details in dark toned and highlighted areas should be preserved. Match lines created for mosaicking shall be selected interactively. Match lines are only allowed where adjacent images lie at the surface of the DTM used to create the orthorectified images and are at the same elevation.

3. Mosaic lines shall not cross through buildings, bridges, or any other structure not at ground level. Join lines between overlapping images shall be interactively selected by the Vendor to minimize tonal variations and visible join lines.

4. There shall be no "ghosting" or distortion of buildings, bridges, overpasses, etc. Buildings, bridges, and overpasses must be spatially correct and not contain bends, breaks, or discontinuities.

5. To minimize distortion of above ground features, the Vendor shall restrict ortho-rectification primarily to neat model areas, using the centers of each photograph rather than every other photograph.

6. The images shall be edge matched so that tonal values are consistent across the edges and there is minimal evidence of the join. Radiometry must be balanced between neighboring tiles.

7. The final ortho-rectified tiles must tile together seamlessly.

8. In addition to any of the above listed image defects, visible seams between orthophoto images that evidence a noticeable edge or a feathering effect will be grounds for rejection.

### 4.8.1 Grid-Based Image Tiles

1. The delivery of the orthorectified photography shall be tiled and provide seamless coverage for each agency's specified coverage area (See Attachments 11.1 and 11.5). The digital images are to be edge-matched with no pixel gaps between geographic partitions. Density matching of the digital ortho images is required to create the appearance of a seamless mosaic.

2. The tiling scheme shall be based on the existing 2005 scheme of 1,500ft x 1,500ft even coordinate grids. The Bi-State Regional Commission will provide a digital copy of the 2005 tiling scheme.

3. The final ortho tiles created for this project shall cover an area 1,500ft x 1,500ft square and contain 0.5ft GSD pixels.

4. The entire range of a 1,500ft by 1,500ft tile shall be filled with ortho-rectified imagery.

5. The final orthorectified image tiles shall be provided in uncompressed TIF files with the associated world files.

6. Image tiles that include coverage of two or more jurisdictions shall be provided to each of the included jurisdictions.

### 4.8.2 Section-Based Image Tiles (City of Davenport)

1. The City of Davenport image tiles will be based on their existing ¼ section coverage including a 200ft buffer on all sides. This same coverage area will be provided to Scott County in the grid based image tiles as specified in 4.8.1 above. (See Attachment 11.4)

## Section 5: <u>Topographic Mapping</u>

### 5.1 Data Collection

1. The topographic mapping features shall be 3D stereo compiled from the triangulated project aerial imagery and positional accurate to the project accuracy standards.

2. Appropriate ESRI utilities shall be utilized to topologically structure the vector data. This shall include complete mathematical closure of all contiguous features.

3. No duplicate structure or graphic entities are allowed.

4. No duplicate vertices are allowed within features.

5. All vector information crossing tile edges shall be edge-matched and coordinate connectivity must be present. True mathematical closure is required for features that cross tile boundaries. All digitized features that are continuous across map boundaries shall be edited to effect smooth, continuous lines.

6. Where graphic elements visually meet, they must also digitally meet. All confluences of line, area, and polygon data must be exact mathematically, that is, no "overshoots," "undershoots," or "offsets" are permitted. Lines that intersect must join precisely.

7. Line Quality - A high cartographic appearance shall be achieved. Transitions from straight line to curvilinear line segments shall be smooth and without angular inflections at the point of intersection. The digital representation must not contain extraneous data at a non-visible level. There should be no jags or hooks or zero length segments. Curvilinear graphic features should be smooth, with a minimum number of points. When appropriate, line smoothing programs should be used to minimize the angular inflection in curvilinear lines. Any lines that are straight, or should be straight, should be digitized using only two points that represent the beginning and ending points of the line.

8. Linear elements should not be broken or segmented unless that segmentation reflects a visual or attribute code characteristic or unless the break is forced by database limitations.

9. Area and Polygon Closure and Centroids - For area features being digitized, the last coordinate pair must be exactly (mathematically) equal to the first coordinate pair.

10. Features that cross map sheet or model boundaries shall not have duplicate data points at those boundaries except where those boundaries coincide with delivery areas. Post-processing procedures shall be used as necessary to minimize data redundancies.

11. Road centerlines must be continuous 3D polylines, thinned and noded at street intersections.

12. Railroad centerlines must be continuous 3D polylines, thinned and noded at street intersections.

13. Prior to beginning full production of the planimetric mapping, the project vendor shall provide Pilot Projects for review and acceptance by the Consortium.

14. Individual layers shall be provided for each unique feature. The layer names, line styles, and colors shall be approved during the Pilot Project.

**5.2 Digital Terrain Model with 2ft Contours (City of Davenport)**

1. The City of Davenport is requesting a digital terrain model (DTM), which will support the generation of 2ft contours. Attachment 11.3 details the DTM Mapping Limits for the City of Davenport.

2. The DTMs shall match the City of Davenport tiling grid scheme and shall tile seamlessly.

3. The DTMs shall contain mass elevation points taken at uniform grid spacing and 3D break lines compiled on photogrammetric workstations.

4. The grid spacing of the mass points and collection of break lines shall be designed to meet the accuracy standards as specified in this proposal.

5. Break lines shall not intersect or begin and end at the same x,y coordinates. The break lines shall include the following features:

    a. Defined breaks in grade
    b. Drainage
    c. Edge of banks
    d. Edge of roads
    e. Centerline of roads
    f. Centerline of railroads
    g. Surface water boundaries
    h. Other linear features defining a change in slope
    i. Obstructed areas

6. Road centerlines must be continuous 3D polylines, thinned and noded at street intersections.

7. Railroad centerlines must be continuous 3D polylines, thinned and noded at street intersections.

8. The contours shall be provided as continuous 3D polylines, thinned and smoothed. All contours shall have the elevation specified as a property of attribute. Break contours for buildings and other man-made structures that do not conform to the ground.

9. Contours shall portray the shape of the terrain within specified accuracy standards. Accuracy standards notwithstanding, contours shall clearly reflect the crown or cross slope of all paved areas, and will truly depict all drainage ways.

10. Every fifth contour will be shown as an index contour (10 foot intervals). All index contours shall be clearly distinguishable and labeled with their elevations given in full feet. Labels will be oriented to follow the contours and shall be readable looking uphill. The index contours shall be annotated and not clipped.

11. Spot elevation data shall be used to supplement elevation data provided by contours, generally where exact elevations are needed and in areas of relatively flat terrain and where the contours are widely spaced.

    a. At all road/railroad intersections
    b. On the road centerline at the center of bridges and similar structures
    c. On the road centerline over all culverts
    d. At the crest of all closed contours
    e. At the lowest point of all closed depressions, contours, significant saddles, cuts and depressions
    f. In visible areas of dense vegetation where ground control is visible
    g. The surface elevation of all open water bodies shall be indicated by one or more water elevation readings near the center of the water body, or the portion of the water body shown on the map
    h. Spot elevations shall be shown in other areas with sufficient frequency so that there is a maximum map distance of one inch (1" = 100' scale) in any direction between a contour or spot elevation
    i. All spot elevations shall be labeled with decimal values giving their elevation to the nearest one-tenth of a foot
    j. Spot elevation labels shall be placed so that they do not obscure other map details and will read from west to east

12. Prior to beginning full production of the digital terrain models, the project vendor shall provide a Pilot Project for review and acceptance by the City of Davenport.

13. Individual layers shall be provided for each unique feature. The layer names, line styles, and colors shall be approved by the City of Davenport during the review of the Pilot Project.

### 5.3 Planimetric Mapping (City of Davenport)

1. The City of Davenport is requesting 100scale planimetric mapping for the area shown and labeled on Attachment 11.3 as "Planimetric Limits."

2. If required, a separate flight height for the City of Davenport shall be designed to capture the entire list of planimetric features listed and meet the specified accuracies.

3. Planimetric data and Contour data shall be collected for the entire City of Davenport plus 200 feet outside of the City's corporate boundaries.

4. Planimetric and Contour data shall be delivered in AutoCad format with the data being tiled in accordance with the grid provided by the City of Davenport.

5. All AutoCAD drawing and layers shall meet the standards of the AutoCAD drawing file examples provided by the City of Davenport.

6. Symbology for planimetric data shall meet the standards of the AutoCAD drawing file examples provided by the City of Davenport.

7. The planimetric features shall be 3D stereocompiled from the triangulated project aerial imagery and positionally accurate to the project accuracy standards. The feature stereo compilation must be performed for general GIS compatibility and <u>specifically supporting impervious surface area determination.</u> The features shall be collected as closed shapes/polygons, and attributed if and as required.

8. The elevation (z) component of the 3D compiled features shall be maintained and provided in the final deliverables.

9. Road centerlines must be continuous 3D polylines, thinned and noded at street intersections.

10. Railroad centerlines must be continuous 3D polylines, thinned and noded at street intersections.

11. Building outlines shall be topologically clean with no over and/or under shoots.

12. Apparent residences shall be differentiated from "out buildings."

13. The planimetric feature compilation and conversion process shall ensure duplication of feature data in CAD and GIS versions.

14. Prior to beginning full production of the planimetric mapping, the Vendor shall provide a Pilot Project for review and acceptance.

15. Individual layers shall be provided for each unique feature. The layer names, line styles, and colors shall be approved by the City of Davenport during the review of the Pilot Project.

16. The following features shall be collected:

a. Land use facilities
   1) Parks and recreational facilities
   2) Golf courses
   3) Cemeteries
   4) Athletic fields
   5) Shopping centers
   6) Airports
   7) Schools

b. Natural features
   1) Trees (individual, approximately 6" in diameter or larger)
      a. Coniferous and Deciduous
      - (small, medium, large, and extra large)
   2) Wooded areas (groups of trees)
   3) Rivers
   4) Streams
   5) Lakes and ponds
   6) Swamps, marshes, and wetlands
   7) Creeks
   8) Cultivated areas
   9) Drainage ditches

c. Structures
   1) Buildings
   2) Houses
   3) Garages and sheds (approximately 100sq ft or larger)
   4) Roads, Urban (back of curb)
   5) Roads, Rural (driving surface)
   6) Railroads (both rails)
   7) Mobile trailers
   8) Paved trails
   9) Parking areas
   10) Driveways
   11) Culverts (flared end section) and headwalls
   12) Alleys
   13) Retaining walls
   14) Fences (all)
   15) Bridges
   16) Towers
   17) Utility poles
   18) Manholes
   19) Sidewalks (public)
   20) Catch basins/storm intakes
   21) Major signs
   22) Tanks

23) Dams and concrete structures
24) Electrical substations
25) Swimming pools
26) Luminary poles
27) Transmission towers
28) Fire hydrants
29) Large electrical and telephone boxes

d. Miscellaneous
   1) Golf course features including green, tees, bunkers, and sand traps.
   2) Field control points
   3) Detention ponds

**5.4 Planimetric Mapping (Scott County)**

1. Scott County is requesting the compilation of "limited feature" 100sc planimetric mapping from the 4,800ft AMT flights for the entire county minus the area included in the City of Davenport Planimetric Mapping.

2. The planimetric features shall be 3D stereocompiled from the triangulated project aerial imagery and positional accurate to the project accuracy standards. The feature stereo compilation must be performed for general GIS compatibility. The features shall be collected as closed shapes/polygons, and attributed if and as required.
3. The elevation (z) component of the 3D compiled features shall be maintained and provided in the final deliverables.
4. The following planimetric features shall be collected:

   - Building roof prints for all structures
   - Centerlines of residential and commercial entrances/driveways

5. Building roof prints shall be topologically clean with no over and/or under shoots.

6. Apparent "residences" shall be differentiated from apparent "out buildings."

7. Driveway centerlines are for the purpose of identifying 911/emergency access points.
   a. Driveway centerlines less than 300ft in length are not required.
   b. All shared driveways leading to multiple residences/businesses are to be shown regardless of minimum length requirement.

8. The planimetric feature compilation and conversion process shall ensure duplication of feature data in CAD and GIS versions.

9. Prior to beginning full production of the planimetric mapping, the Vendor shall provide a Pilot Project for review and acceptance.

10. Individual layers shall be provided for each unique feature. The layer names, line styles, and colors shall be approved by Scott County during the review of the Pilot Project.

## 5.5 Planimetric Mapping (East Moline, Silvis, Carbon Cliff, and Coal Valley)

1. The above Cities are requesting the compilation of 100scale planimetric mapping from the 4,800ft AMT flights for the area shown and labeled on Attachment 11.5 as "Coverage Areas."

2. The planimetric features shall be 3D stereo compiled from the triangulated project aerial imagery and positionally accurate to the project accuracy standards. The feature stereo compilation must be performed for general GIS compatibility and specifically supporting impervious surface area determination. The features shall be collected as closed shapes/polygons, and attributed if and as required.

3. The elevation (z) component of the 3D compiled features shall be maintained and provided in the final deliverables.

4. The following impervious features shall be collected:

   - Building roof prints for all structures 100sq ft or greater
   - Non-building features, such as pavilions, awnings, gas pump area overhead roofs, etc.
   - Driveways
   - Parking lots
   - Edge of curb/bridges
   - Edge of sidewalks in public ROW and at commercial/industrial structures
   - Airport runways, taxiways and ramps
   - Miscellaneous features 100sq ft or greater such as tennis courts, patios, swimming pools, etc.
   - Obstructed areas

5. Building outlines shall be topologically clean with no over and/or under shoots.

6. Apparent residences shall be differentiated from "out buildings."

7. The planimetric feature compilation and conversion process shall ensure duplication of feature data in CAD and GIS versions.

8. Prior to beginning full production of the planimetric mapping, the Vendor shall provide a Pilot Project for review and acceptance.

9. Individual layers shall be provided for each unique feature. The layer names, line styles, and colors shall be approved by the City of East Moline during the review of the Pilot Project.

**Section 6: LiDAR (optional)**

1. LiDAR may be used to produce the digital terrain models (DTMs) if the resulting product is supplemented by the necessary 3D stereocompiled break lines (as listed in paragraph 5.1.5) and mass points to meet the accuracy standards for the project.

2. The LiDAR produced terrain models must be edited so that the resulting contours meet the horizontal and vertical accuracy as well as cartographic standards pertaining to jaggedness and islands. A sufficient number of properly placed LiDAR ground control points will be used to vertically bias the LiDAR dataset to the project's vertical coordinate system. Checkpoints must be obtained and used throughout the project area.

3. The final QC on the LiDAR elevation models and the addition of the required break lines in the elevation models will be performed on photogrammetric workstations. The processes for LiDAR capture, enhancement, editing, checkpoints, and equipment shall be clearly defined in the proposal.

**Section 7: Pilot Projects**

After the acquisition of the 2009 photography and prior to beginning full production of the digital ortho imagery, the vendor shall provide three separate pilot projects: one for Scott County, one for The City of Davenport, and one pilot project for the City of East Moline, Illinois. The pilot project areas are approximately 2 sq mi x 2 sq mi and are shown on Attachments 11.1 and 11.5. The pilot projects shall include the color digital orthos and planimetric mapping. The pilot projects will be used to validate all procedures and verify that the project deliverables meet the specifications. The tonal qualities of the imagery in the approved pilot projects will become the standard for the remainder of the project.

## PROPOSED APPROACH

## PROJECT OVERVIEW

### Statement of Work:

The primary services and data products Kucera International Inc. will furnish for the Bi-State Regional Commission's 2009 Quad Cities Aerial Mapping Project will include new (spring 2009) leaf off digital aerial photography, aerial lidar surveying, ground and airborne GPS/IMU control surveying/georeferencing, aerotriangulation, digital elevation/terrain model (DEM/DTM) and planimetric feature stereocompilation, digital orthophotography at 1"=100' scale, 0.5' resolution, planimetric feature mapping at 1"=600' scale, and two foot contour topography mapping covering all or designated portions of the 2009 Bi-State region, including Scott County and the City of Davenport, Iowa, the cities/villages of East Moline, Silvis, Carbon Cliff, and Coal Valley, Illinois, and a one eighth mile periphery buffer.

The digital aerial photography will cover the entire 2009 region and will be taken simultaneously in color, black and white, and infrared using Leica ADS40 digital camera technology.

The aerial lidar survey will cover the designated City of Davenport area and will capture bare earth terrain return used in the production of DTM and 2' contour topography covering the City area. The lidar survey and 2' contour mapping will also optionally be performed for the various Illinois cities/villages.

The project digital orthophotography will be furnished in color and black and white and optionally furnished in color infrared.

The planimetric mapping will include the features specified by each of the participating agencies for their corresponding area of jurisdiction. All planimetric and topographic mapping will be delivered in AutoCAD and ESRI geodatabase digital formats.

All project deliverables will be as listed in Section 8 (Deliverable Items) of the RFP.

### Project Standards and Accuracies:

The project work will be performed in full accordance with the Bi-State Regional Commission's 2009 Quad Cities Aerial Mapping Project RFP work specifications, including conformance with National Standards for Spatial Data Accuracy (NSSDA) as applied to the work. By Bi-State/NSSDA requirements, positions and elevations determined from the various data products for well defined, ground-based features will be accurate at the 95% confidence level to within the following tolerances in relation to the "true" (accurately surveyed) feature positions and elevations:

| Data Product | Accuracy (95% confidence) |
|---|---|
| 1"=100' scale orthophotography | 3' horizontal |
| 1"=100' scale planimetrics | 2' horizontal |
| DTM/2' contours | 1' vertical |

## PROPOSED APPROACH

Conformance with the accuracy standards will be internally verified through review of aerotriangulation residuals and comparison of image/map coordinates for targeted ground control and photo-identifiable triangulation points against their corresponding ground-surveyed or triangulated values. Kucera assumes that an independent accuracy verification will be performed by Bi-State consultant Dan Corbin, Inc. The results of the accuracy testing will be included in the project metadata.

Note that the vertical accuracy specifications do not apply to topographic mapping areas where the ground is predominately obscured by vegetation and the horizontal accuracy specifications do not apply to structure locations represented in the orthophotography due to inherent radial distortion/"feature lean" displacement effects, although in both cases (vegetation coverage and feature lean) Kucera uses technologies and processes which help to minimize affected areas.

**<u>Project Datums/Units:</u>**

The datums used for the delivery of the various data products will be as follows:

- Scott County – NAD83/96 IA SPC South Zone horizontal, NAVD88 vertical
- Davenport – NAD83/96 IA SPC South Zone horizontal, Davenport City vertical
- IL cites and villages - IL SPC west zone horizontal, NAVD88 vertical

To maximize project consistency, accuracy, and efficiency the projectwide aerial data will be georeferenced on the predominate datum (NAD83/96 IA SPC South horizontal, NAVD88 vertical) and transformed by tile/area coverages to the datums as needed using proven Global Mapper and/or other photogrammetric data processing softwares and checked against comparable existing map coverages to ensure proper datum alignment. The vertical datum conversion for the City of Davenport appears to be a straight vertical shift, although Kucera will review the conversion with the City and obtain additional information as needed to validate.

**<u>Agency Support:</u>**

The support Kucera would ask of the various participating Bi-State agencies other than designating persons of contact would include:

- Provide targeted project ground control (Scott County and Davenport only).
- Designating pilot areas and reviewing/approving pilot area deliverables.
- Promptly reviewing 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
- Assisting in resolution of discrepancies/issues relating to agency directives as needed.

## PROPOSED APPROACH

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

**Approach:**

In order to complete the project 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, remote sensing, surveying, digital imaging, and CAD/GIS conversion technologies and procedures. The major phases of the approach in general order of performance will be as follows:

1. **Project Initiation** – Finalize scope of work and document in project procedure plan. Acquire and review source materials.

2. **Ground Control Targeting/Surveying** – Select, recover/establish, and target ground-based control points throughout the project area as needed for georeferencing/ aerotriangulation of the aerial photography and quality control of the orthophotography. Coordinate with Scott County and Davenport survey consultant to indicate scheduling and completion of aerial flyover in relation to control targeting and to receive ground control data.

3. **Aerial Photography/Airborne GPS/IMU Survey** – Perform aerial flyover/photography of the project area using ADS40 digital aerial cameras interfaced with airborne GPS/IMU systems for in-flight position/attitude georeferencing measurement. Process and check the aerial imagery and airborne GPS/IMU survey measurements. Optionally furnish preliminary version of project orthophotography.

4. **Aerial Lidar Survey and DEM Production** – Perform new aerial lidar flyover of designated areas as needed to acquire terrain data supporting two foot contour topo generation. Process/filter lidar data to produce a digital elevation model (DEM) bare earth mass point component of a digital terrain model (DTM) supporting the contour generation.

5. **Aerotriangulation** – Use a softcopy aerotriangulation process to check and finalize the georeferencing of the project aerial imagery.

6. **Pilot Project** – Produce finalized orthophotography and planimetric feature mapping for the three designated pilot areas and submit for agency review/approval.

7. **Stereocompilation** – Using triangulated aerial imagery, photogrammetrically review/update existing/source DEM data as needed for ortho image rectification, using BAE NGate technology for change detection. In conjunction with update process, photogrammetrically stereocompile new planimetric features and/or breaklines for 2' contour DTM as needed.

8. **Digital Orthophoto Production** – Orient digital photo imagery using aerotriangulation results and rectify to the project DEM. Batch and manually process rectified imagery into final orthophotography.

9. **Planimetric/Topographic Mapping** – Batch and manually edit stereocompiled planimetric feature data. Generate 2' topography as needed and process together with planimetry. Convert to and conduct final QC in AutoCAD and ESRI geodatabase.

10. **Project Wrap-Up/Metadata** - Review project specifications and transmittals/ deliverable records to ensure all specified data has been received and approved. Produce and furnish FGDC metadata.

The work phases will be performed concurrently to the maximum extent possible to maximize efficiency and accelerate turnaround/completion times. Kucera's proposed project completion schedule is provided in Section 7 of this proposal submission.

**Descriptions of the procedures, technologies, quality control measures, and deliverables for the various phases of the project are provided in the following numbered subsections of this Proposed Approach.**

## 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 participating agencies.

The Project Manager will subsequently schedule a "kickoff" meeting or phone conference with the agencies 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 procedural plan for the members of the project management team. The procedural plan will include the following, as needed:

- Summary of project procedures and deliverables
- Work flowchart indicating phases, milestones, points of acceptance
- Flight and control network diagrams
- Master sheet tile/index
- Quality control criteria
- CAD/GIS data layering scheme
- Equipment calibration reports

The plan will be revised/updated as needed over the course of the project to reflect approved procedural changes and additional procedures/information.

### 1.3 Sheet/Tile Scheme:

The orthophotography and mapping will be produced/delivered n the specified/existing Bi-State 1500' x 1500' modular tile scheme for all areas except the City of Davenport, where the tile scheme will be the City's existing PLS quarter section-based scheme. As part of the project initiation process Kucera will review the area tile layouts with the associated agencies and make adjustments for coverage as needed, with the project flight and control plans being likewise adjusted to ensure fully controlled aerial photo coverage is acquired for all tiles, including full tiles at the area peripheries. Kucera will use a digital version of the finalized areawide tile layouts to graphically report and track the project status.

### 1.4 Quality Control Plan:

Kucera will develop a quality control plan specifically for the project, which will include the following elements:

- Quality control checklists and acceptance criteria (quantitative and/or qualitative) for each phase of the project. Checklists prepared by project manager and QC manager, completed by phase managers, and reviewed by QC manager.
- Procedures supporting prompt internal reporting of QC issues found to QC manager and project manager.
- Test/calibration of project equipment to ensure proper working order and operating characteristics within designated tolerances before use on project.
- Review of project specifications and standards by all project management team members.
- Pilot project for Agency review and approval/selection of sample final project deliverables.
- Report deliverable for each project phase documenting procedures used and results achieved.
- Review of all project source data and prompt reporting of anomalies/deficiencies found.
- Full manual review of all project data deliverables before transmittal.
- Procedures/technologies for support of and response to each Agency's quality control review process and for prompt addressing of quality control issues, including documentation of nature of issue, cause, and method of resolution.

Kucera can facilitate each Agency's quality inspection of the project orthophotography through a variety of digital data exchange methods, including:

- Standard full rasters/vector to Agency's server
- Hybrid web-based – ArcMap w/WMS server
- Full web-based utilizing ERDAS APOLLO geospatial business system

Edit calls can be made through tagged/coded datasets. Note that Kucera has an excellent track record for very low rejection rate – virtually always under 5% of delivered data.

### 1.5 CAD/GIS Data Layering:

In the project initiation phase Kucera will review the AutoCAD and geodatabase data layering schemes for each relevant Agency and help as needed to modify/develop the layer schemes as needed to accommodate the planimetric/topographic feature mapping. Conversion processes based on the finalized data layering will be developed for the plan/topo mapping areas.

### 1.6 Source Data Review:

In the project initiation phase Kucera will thoroughly review and organize/document any available source data, (e.g., existing control records, DEM data, etc.), request clarifications as needed, and will report any possible anomalies and missing data to the Agency for review and resolution. Any source data found/determined to possibly allow a significant cost and/or time savings on a project will be brought to the Agency's attention for further review.

The primary source data will be the existing lidar DEM data from the 2005 Bi-State project, which will be updated and used for the ortho image rectification. Kucera acquired/produced this DEM data and retains a copy of the same, so will require no time to acquire/review this data and will have no issues in using the data for the 2009 project. Other source data will include any available comparable existing orthophotography and/or plan/topo feature mapping available for the project areas, which will be used for quality control checking of the new orthophotography and mapping.

## 2. GROUND CONTROL TARGETING/SURVEYING

### 2.1 Ground Point Network:

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

The project control will consist of the targeted ground points combined with accurate photo-center coordinates and orientations determined through the airborne GPS/IMU survey. The combined ground and airborne control data will support the production of the project mapping to the project accuracy standards with accuracy verification of the same. The ground-based control will generally be spread uniformly around the periphery and through the interior of the project areas to prevent control extrapolation and, where possible, will be located so as to fall in the sidelap area between flight lines to strengthen the ties between lines in the aerotriangulation process.

## PROPOSED APPROACH

The project ground point network will consist of a combination of recovered/targeted existing control stations from the Scott County and Davenport existing monument networks and newly established and targeted control stations where ground control is needed but existing monuments are unavailable. The project network will be subject to geometric strength analysis and revised as needed during/following the project initiation phase and control recovery work, with a final control plan being presented to the agencies as needed and included in the project work plan. A total of approximately 42 (38 existing and 4 new) targeted ground control points will be used for the project control network.

Note that because Kucera is using airborne GPS/IMU as the primary means of controlling/georeferencing the aerial imagery, there is considerable flexibility in the selection of locations for ground-based control. This flexibility will allow Kucera to make more use of existing control monuments and limit the locations of any new ground-based points to readily accessible locations within the project areas.

### 2.2 Survey Conduct/Coordination:

Kucera understands that Scott County and the City of Davenport will be performing the control targeting for the Iowa project areas and will work closely with the designated survey personnel to ensure the control targets are in place and monitored prior to the aerial flyover. The County/City survey personnel will be apprised of the approximate timing of the flyover weeks in advance to provide sufficient time for the target placement. Kucera will also promptly notify the County/City surveyor of the completion of all flyover work so that target removal can proceed as needed.

The ground control survey/recovery and targeting work for the Illinois areas will be performed by Kucera and will be overseen by an experienced geodesist and licensed surveyor, and will be conducted in a manner ensuring maximum safety and minimal disruption of traffic, disturbance of private property, etc. Survey vehicles will be clearly marked and at all times the survey crews will carry proper identification and an official letter of authorization from Kucera or Bi-State as needed. The survey crews will report to the various agency offices as needed for briefing and data as needed before going into the field.

### 2.3 Existing Control Reconnaissance/Recovery:

The existing ground points used for the project network will be appropriate (i.e., 2nd order or higher horizontal, 3rd order vertical) points from the existing county/city networks, US NGS, and/or and other appropriate existing geodetic control networks. The existing control will be researched, recovered, and converted as needed for datum compatibility with the project control network.

### 2.4 New Control Marking:

All newly established ground control stations will be marked in the field with Pk nails, capped iron pins, or other semi-permanent monumentation. Selected new ground stations can be alternatively set with more permanent (e.g., NGS Class "C") type monumentation at an Agency's option. The stations will generally be set at locations which offer a high degree of permanence, stability, access, satellite reception, and intervisibility as required for future surveys and azimuth marks. For each monument set, to-reach descriptions and recovery sketches will be prepared and included in the control survey report.

### 2.5 Targeting:

The project ground stations will be targeted prior to the aerial flyover. The targets will be in the shape of crosses, tees, or chevrons with legs approximately 18" wide and 8' to 10' long. Targets on unpaved areas will be durable vinyl properly affixed to the ground, while targets on paved areas will be painted if permitted. 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 shape of the target used for each control station will be recorded for reference in the aerotriangulation and mapping work. The targets will be monitored until the aerial photography and any necessary reflights are completed and will be removed within a few weeks of the flyovers.

### 2.6 Alternative Photo-Identifiable Control:

Where targets are destroyed prior to the aerial flyover or where critically located ground control points cannot be targeted, new project ground control can be surveyed coordinates for photo-identifiable feature points selected on prints of the completed aerial photography. The points will be selected at distinct, occupiable locations (e.g., sidewalk corner intersections, ends of paint stripes on roads) and will have detailed survey descriptions prepared to ensure their accurate use.

### 2.7 Survey Technology/Receiver Calibration:

All new control point coordinates and elevations will be surveyed using geodetic-grade, dual-frequency Trimble 5700 GPS receivers. The receivers will be calibrated and checked on site if possible by observing vectors between available first-order control stations. The vectors observed between the stations will verify that the instruments meet or exceed the accuracy required for a first-order (10 ppm) survey.

### 2.8 Control Accuracy/Datum:

All new control points for the Illinois areas will have coordinates and elevations established on the NAD83/96 Illinois West Zone State Plane Coordinate System horizontal and NAVD88 vertical datums, as specified. The coordinates will be surveyed to at least second order Class II (1:20000) accuracy and elevations surveyed to at least third order, 3 cm-equivalent accuracy. All survey measurements will be taken in US survey feet.

### 2.9 GPS Field Procedures:

The ground GPS survey work for new control/checkpoint establishment will be conducted using static differential carrier phase techniques, which are least susceptible to error sources such as multi-path and unmodeled geoidal undulation. The carrier phase will be measured and recorded at 15-second intervals for a period of not less than 20 minutes with a four or more satellite simultaneous observation. Between 30% and 50% of the new stations will be occupied two or more times. A direct connection will be made between points whenever the distance between them is less than 20% of the distance between those points traced along new or existing connections. Repeat measurements, approximately equal in the north-south and east-west directions, will be taken on at least 5% of the baselines.

Quality control of the vertical GPS readings will be achieved by double occupations for a number of points and by tying them to a number of existing benchmarks within/around the area. The published/computed elevations of the area's existing benchmarks will be compared with those derived from the GPS to determine if all new points meet the accuracy specifications.

After performing loop closures, the data will be input to the FGCS-certified, three-dimensional least squares TRIMNET Plus program for a correctly weighted, minimally constrained "free" adjustment, a partially constrained adjustment on the NAD83 datum, and a final, fully constrained adjustment on the NAD83 datum holding all available vertical as well as horizontal control.

In the vertical control GPS reduction process, the undulation of the geoid as predicted using the NGS GEOID program will be applied. A specific project area geoid model will be derived as a residual model of the combination of NGS GEOID and the large number of existing benchmarks which are occupied. The residual model is applied to all vertical control points, resulting in elevations with 3 cm or better accuracy.

### 2.10 Control Report:

At the completion of the ground survey work Kucera will provide the Illinois agencies with a ground survey report that will include a summary of the survey procedures and technologies used, final control listings, new control description sheets, existing control recovery sheets, GPS observation and reduction data, network diagram, and other relevant survey documentation as required.

## 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 winter 2009 flight season (approximately March 24 – April 24) after grass "green-up", before significant emergence of tree/brush vegetation, and as soon after flight plan approval and target placement as weather (clear, no excessive cross winds) and ground (no smoke, snow, fog, flooding) conditions permit. The photography will only be taken during the time of day (approximately 10 a.m. to 2 p.m.) when the sun angle is greater than 30° to minimize shadows. For the airborne GPS/IMU work, the aerial photography will be taken at times when five or more satellites are observable with a PDOP of less than 5 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 agencies throughout the aerial flyover period 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:

The aerial photo 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 knots, fuel capacity for six hours of continuous flight, and IFR weather instrumentation. The aircraft are equipped with the Garmin-based flight management and navigational systems and have Novatel dual-frequency antennas mounted above the camera port for airborne GPS.

The projectwide aerial photo flyover will require approximately 44 flight lines and 944 flight line miles. Kucera will be committing two or more of its twin-engine aircraft to the flyover and with these aircraft will be able to complete the photo flyover within two to three flight sessions. Kucera's aircraft will be based on or near the project area 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 countywide orthophoto coverage.

### 3.3 Aerial Camera Systems:

The project aerial imagery will be acquired in direct RGBIR digital form using Kucera's Leica ADS40 large format digital aerial cameras. The ADS40 technology has received US Geological Survey's digital camera "manufacturer certification" 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 georeferenced 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. The ADS40 camera technology has a number of advantages over both film cameras and frame-type digital cameras (eg. DMC, Vexcel) for a project of this nature (i.e., mixed urban + rural terrain) including the following:

Advantages over film camera imagery:

- Better image resolution and radiometry/color due to being "first generation" (vs. second generation film-based) image capture.
- Eliminates film scanning-induced image anomalies such as newton rings and pixelization.
- Mimimized "noise" and specular highlights, increased detail in shadow and highlight areas.
- Faster/more efficient image processing/orthophoto production.

Advantages over frame digital camera imagery:

- The ADS40 image strips are more readily processed directly into usable image mosaics and orthophotography with modern computer/image processing technology, requiring much less image "stitching" and seam lines than required for individual frame-based digital camera imagery.

- The ADS40 acquires imagery with significantly reduced structure feature lean since it automatically captures a true vertical view of each feature in 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.)

- The ADS40 uses interference filters to capture/sense visible and infrared wavelengths in narrow, non-overlapping spectral bands as opposed to overlapping bands as captured with frame camera technology. The narrow bands allow for separate remote sensing analysis of each captured wavelength.

**Samples of Kucera's digital orthophotography recently produced from ADS40 digital camera imagery can be viewed at the following websites. Kucera has used ADS40 camera technology for flyovers of four Iowa counties and believes use of this camera technology will result in significant improvements in overall image quality and completion time in comparison with Bi-State's 2005 film-based camera project. Samples of Kucera's digital orthophotography produced from ADS40 digital camera imagery can be viewed at the following websites:**

**http://www.co.moore.nc.us/main/page.asp?rec=/pages/planning/PlanGIS/index.html (Moore County, NC)**

**http://hoke.connectgis.com/Default/Default.aspx (Hoke County, NC)**

**http://www.gcgis.org/webmappub/ (Greenville County, SC)**

### 3.4 Flight Height/GSD and Exposure/Integration Time:

The aerial photo flyover will be performed from an altitude of approximately 4800' above the mean terrain, resulting in direct RGBIR digital image capture at a 0.5' resolution/ground sample distance (GSD). The exposure/integration time used in capturing the digital imagery will be determined by the camera settings 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.

Note that Kucera can photogrammetrically observe all planimetric feature detail required by the City of Davenport in digital aerial imagery taken from this altitude and will not require imagery acquired from a lower altitude for the Davenport planimetric mapping work. The ADS40 camera's ability to provide increased vertical exaggeration will be used to help identify smaller raised features such as hydrants and signs.

### 3.5 Flight Plan, Sidelap, Endlap:

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

The flight lines will be oriented in a north-south direction for efficiency of coverage and to minimize bi-directional illumination. The lines will be spaced apart so as to yield a side image coverage overlap of approximately 30% between adjacent flight lines. Over any designated tall structure areas, the flight line spacing can be reduced and side coverage overlap increased to 50 – 60% to provide optimal "feature" centered image views and support creation of "true" or "near true" (i.e., minimal feature lean) orthophoto coverage.

The flight lines of digital photography will be extended and increased in number sufficiently to provide stereo image coverage beyond the project area boundaries and of extraneous ground control points, and to ensure that the orthophotos at the project periphery can be prepared as full (vs. partial) 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.

### 3.6 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 form the oversampling of the push broom sensor head.

### 3.7 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.

### 3.8 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.

### 3.9 Airborne GPS/IMU Control Survey/Image Georeferencing:

Throughout the aerial photo and lidar acquisition the position and orientation of the sensor 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.

The IPAS units include a Novatel GPS receiver linked to a GPS antenna mounted on the aircraft above the camera port for measuring position and a gyro-based inertial measuring unit (IMU) for measuring angular orientation. The airborne GPS survey is performed in a traditional kinematic fashion with simultaneous satellite position recording by the roving, camera-integrated IPAS receiver and multiple stationary ground "base station" receivers, or by using Terra POS GPS processing technology which eliminates the need for ground base stations and only requires three hours of uninterrupted IPAS GPS receiver recording. In the former case, at least two base stations are operated over known/surveyed positions within approximately 50Km of the aircraft throughout each flight session. The base station recordings are independently processed together with those of the roving IPAS receiver and compared/adjusted, with further processing/comparison using recordings from any closely availably and appropriate (0.5 or 1 second recording interval) continuously operated reference stations (CORS).

In all airborne GPS survey processes the primary receivers are operated at a half second epoch/recording interval to support measurement of the camera position to within 10 cm. Flight time directly "on-line" without a re-initializing "jog" to the IMU unit is limited to 20 minutes to prevent inaccuracies in orientation measurement resulting from IMU "drift". Following each flight session, the GPS/IMU observation data is immediately downloaded and processed sufficiently to ensure data viability/integrity and detect any significant data "gaps" or errors requiring the reflight.

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.

### 3.10 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 GPRO 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.

### 3.11 Optional Draft/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 this project Kucera can rectify the Level 1 imagery to the available existing 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 agencies' general inspection and preliminary use prior to receipt of the finalized orthophotography. This "preliminary" version of the orthophotography will be horizontally accurate to within approximately 5'.

### 3.12 Flight Index:

As a deliverable each agency will be furnished with a digital index to the completed aerial imagery. The index will consist of the georeferenced raster image swaths for each flight line or a vector representation of the same. The indexes will have appropriate title information/metadata and will be furnished in ESRI shapefile, TIFF, or other specified vector or raster data format.

### 3.13 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 agencies.

## 4. AERIAL LIDAR SURVEY AND DEM PRODUCTION

### 4.1 Overview:

Kucera will perform an aerial LiDAR survey of Davenport and optionally of other cities/villages to acquire new digital elevation model (DEM) data supporting 2' contour topography generation. The advantages of the use of an aerial LiDAR survey over other, photo-derived methods of contour grade DEM production area as follows:

- The lidar acquired terrain data is "first generation" in nature (i.e., captured directly during the flyover) with improved accuracy over "second-generation" image-derived DEM.

- The LiDAR survey can be performed in significantly less time and at less cost than required for traditional compilation, given the automated nature of the terrain point collection/processing and the fact that the LiDAR survey can be performed at the same time as the aerial photo flyover (as opposed to after the flyover as required for conventional compilation). The LiDAR DEM and bald-earth mass point data will be available for use in contour DTM production much sooner than corresponding stereocompiled data.

- The LiDAR survey produces a significantly denser terrain point spacing (5' to 10') than can cost effectively be achieved using conventional stereocompilation (35' to 50' spacing) and typically provides greater penetration/terrain surface data in wooded areas which are prevalent in the region – thus supporting faster and more accurate orthophoto production and contour topography.

- The aerial LiDAR survey provides returns/data for surfaces above the ground (e.g., tree canopy, building roofs) which can be classified and provided as an optional deliverable.

### 4.2 Flyover Conditions:

The aerial lidar flyover will be performed on a first priority basis, with the following conditions/constraints being observed:

| | |
|---|---|
| Flyover period: | 3/24/09 – 4/24/09 (same as aerial photo) |
| Weather: | No precipitation, no excessive cross winds, no clouds below 5000' |
| Ground: | No significant smoke, fog, snow, flooding |
| Satellite configuration: | 100% of flyover w/PDOP < 3, 5 or more observable satellites cutoff angle/elevation mask 10° |

Note that the lidar flyover can be accomplished at any time of the day or night since the lidar sensor is not light-dependent. Note also that the lidar survey is not sun angle or target placement, dependent, allowing Kucera to perform the survey in advance of the aerial photo acquisition in order to start the lidar processing phase as early as possible and optimize the project time schedule.

### 4.3 LiDAR Technology:

The LiDAR survey will be accomplished using Kucera's in-house Leica ALS50 LiDAR system. The ALS50 is the latest in Leica's line of aerial LiDAR technology and among most advanced LiDAR systems currently available. Features of Kucera's ALS50 system include a laser pulse rate of up to 150 kHz and increased pulse rate at any flying height – resulting in ability to achieve dense point collection rate from higher flight altitudes, automated roll stabilization to maintain the proper scan swath width and increase flight efficiency, up to four returns per laser pulse, with one return always being the last or latest return to maximize potential that a ground-based point will be recorded, and video and "Intensity" return visual image capture corresponding to the LiDAR survey flight swaths.

### 4.4 System Calibration:

Before or after every LiDAR survey project, Kucera performs a LiDAR flyover of a preset calibration site to precisely model the positional relationship (i.e., "boresighting") between the ALS50 laser scanner head and the Applanix IMU for entry in the post-processing software, and to monitor the behavior characteristics of the system over time. The flyover covers a carefully designed calibration pattern consisting of four crossing flight lines at low and high altitudes to precisely measure the roll, pitch, and heading correction parameters. Kucera's main calibration site, Lost Nation Airport in Willoughby, Ohio, has been carefully surveyed to locate highly accurate control points for determination of the LiDAR data elevation offset value during calibration.

### 4.5 Flight Plan/Operational Settings:

Kucera's flight plan/operational settings proposed for the aerial LiDAR survey flyover will be as follows:

- Flight altitude — 5500'
- Aircraft speed — 140 knots
- Scan FOV — 44°
- Scan rate — 33 Hz
- Pulse rate — 55.4 kHz
- Sidelap/flight line spacing — 30%/3150'
- Swath width — 4400'
- Post spacing — 7.7'
- Cross flights — 3
- Returns/pulse — 4, w/last return
- Flight line limitation — 20 minutes/50 miles

The flight parameters will result in collection of surface data supporting production of new 2' contour topography. The use of cross-flights to check boresight/system orientation and flight line time limitation to prevent AGPS/IMU 'drift" inaccuracies are in conformance with FEMA lidar survey specifications. The lidar flight sessions will be accomplished over the shortest possible time span to maximize terrain condition consistency. During each lidar flight session, the lidar operator closely monitors the system to ensure proper operation of the laser scanner, GPS signal lock and acceptable PDOP. Four data returns and corresponding intensities will be measured for each pulse, with the system set to always include the "last/latest" return with greatest probability of representing the "bare-earth" location. Post-mission data is compared to ground-surveyed checkpoints in the project area as a final system calibration and data accuracy check.

Immediately following each day's flying, Kucera's flight crews perform initial processing of the lidar and airborne GPS data to generate trace/route logs and review these to ensure proper system operation and data capture coverage. Areas having data gaps or anomalies are flagged for reflight in the next flyover session. The flight crews will also review the initially acquired, unclassified lidar point cloud for proper coverage with no obvious data gaps or anomalies.

### 4.6 Lidar Data Reduction:

Office processing of the lidar survey data begins within days of the data acquisition. Initially, the AGPS survey measurements are fully reduced, reviewed, and applied to the multi-return lidar point cloud, with a check of the overlapping point coverages from cross-flights and adjacent swaths being performed to confirm accurate lidar system calibration. Terrasolid Terramodeler and Terrascan software with in-house Kucera customizations are used in an iterative fashion to filter/classify/separate returns from major structure and vegetation features, water, and ground features and code the data in accordance with the ASPRS lidar data exchange (LAS) classification system (1=unclassified, 2=ground, 9= water). The surface data/DEM used for the ortho image rectification will include points on elevated bridge decks and overpasses as well as the underlying terrain to ensure proper rectification of the features. The lidar DEM data will be filtered/regridded to a larger spacing as needed over highway and large building areas to prevent "warping" of these features due to excessive terrain point density. To produce the bare earth "mass point" DEM needed for contour generation the classified lidar data will be further refined/processed by removing elevated feature points and other smaller, non-surface features and artifacts. The bare earth mass point data will be checked and augmented with breaklines to produce a digital terrain model (DTM) form which 2' contours can be generated as described in Subsection & (Stereocompilation) of this Approach.

Quality control exercised in the lidar data processing includes review of 3D visuals/perspective views of the lidar surfaces, review of the Lidar data against corresponding existing digital orthophotography and newly acquired intensity return and/or web cam imagery, and comparison of lidar surface elevations with surveyed elevations at all ground control point locations. Artifact removal will be 100% or near 100%, with all significant artifacts eliminated from the data. The elevation displacement between the lidar surface and surveyed elevations at ground control points will be limited to a 15cm (~0.5') tolerance.

### 4.7 Lidar Deliverables:

The Lidar raw point cloud and/or classified ground and non-ground return can be furnished as a project deliverable on DVD or USB in LAS, generic ASCII or other specified format. The data will be delivered by individual tile or in larger coverage blocks as specified. A breakline-augmented contour-grade DTM will also be provided as a deliverable as described in Subsection 7 (Stereocompilation) of this Proposed Approach. Other data capture deliverables optionally available from the Lidar survey will include georeferenced laser "intensity return" data with feature visibility, and classified digital surface models (DSMs) of structures and/or canopy.

# 5 AEROTRIANGULATION

## 5.1 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 DTM/plan feature 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 7-micron 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.

## 5.2 Error Tolerances:

The triangulation will support ortho image rectification mapping meeting the project accuracy standards, with the following individual point and RMS horizontal and vertical accuracy residual tolerances being observed:

| *Data Deliverable* | *Flight Height* | *Individual Point Residual Tolerance (1:6000 Flight Height)* | *RMS Residual Tolerance (1:10,000 Flight Height)* |
|---|---|---|---|
| 1"=100' scale orthos and plan DTM and 2' contours | 4800' | 0.8' | 0.5' |

Note that a high vertical accuracy will be maintained in the projectwide aerotriangulation, which will allow the triangulated imagery to be used directly for current or future 2' contour DTM/topographic feature mapping covering any areas of the region on an as-needed basis.

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.

### 5.3 Triangulation Report:

For the completed triangulation blocks a digital triangulation report will be prepared and furnished as a deliverable. The triangulation report will contain summaries of the procedures used and results achieved, triangulation adjustment output showing accuracies achieved and a digital graphic showing the distribution of triangulation points across the project area. The triangulation report will include a digital file of the triangulation points and adjusted values.

## 6 PILOT PROJECT

### 6.1 Pilot Project Procedures:

Following the data acquisition and preparation phases of the project (aerial flyover, control survey, aerotriangulation), Kucera will produce the finalized orthophotography and planimetric feature mapping covering the three designated pilot areas. The pilot project will be used to validate all procedures and verify that the project deliverables meet specifications and each Agency's approval. The pilot project deliverables will include the planimetric feature mapping in the target CAD/GIS formats and samples of the orthophotography at various grades of color/contrast for review and selection of the preferred radiometry. Note that generally the same radiometry will need to be used for each jurisdiction to best achieve consistency across the region.

## 7 STEREOCOMPILATION

### 7.1 Overview/Compilation Technology:

In the stereocompilation phase of the project Kucera will photogrammetrically review the existing/source DEM data for the project areas and will augment and/or update this data where needed to support the new ortho image rectification. In conjunction with the DEM review/update Kucera will also for authorized/designated areas photogrammetrically compile the specified planimetric feature data and review/augment the new lidar bare earth DEM data to produce a digital terrain model (DTM) supporting 2' contour topography generation.

The stereocompilation technology used will be Kucera's BAE Socet Set and/or Cardinal Systems VR2 softcopy stereocompilation systems, which allow the existing DEM data and newly compiled planimetry and DTM breaklines to be viewed in three dimensions on top of the corresponding triangulated stereo image swaths of the digital aerial photography. The Socet Set stereoplotters are specially designed for highly efficient stereo viewing/planning and data capture directly from the large files of the continuous strip-captured digital camera imagery. All data is compiled in three dimensions from parallax-cleared stereo imagery.

Note that no 2D, "heads-up digitizing" from the project orthophotography will be used for the planimetric and DTM feature capture, given the reduced horizontal and vertical accuracy (due radial distortion of elevated/raised surfaces and lack of direct visual stereo elevation perception) associated with the 2D digitizing process.

### 7.2 DEM Update:

The source DEM for the ortho image rectification will be the lidar DEM produced by Kucera for the 2005 Bi-State project. This DEM fully supports aerial image rectification to the project accuracy standards. For project areas having availability of more current and/or accurate DEM data – such as the Iowa State lidar DEM or newly captured lidar DEM – Kucera will use this data for the image rectification.

To find areas of major terrain/feature change, Kucera will batch-generate an autocorrelated DEM coverage of the project area from the newly acquired and triangulated digital aerial imagery using advanced BAE N-GATE technology, and will use N-GATE to compare the autocorrelated and existing DEM surfaces and highlight areas of significant displacement between surfaces. The existing DEM for highlighted areas will be subsequently photogrammetrically reviewed against the aerial imagery and updated/augmented as needed to support the new ortho image rectification. The continuous strip form of the ADS40 imagery and 100% stereo coverage of all features with multiple vertical exaggerations makes the imagery superior for use in a photogrammetric autocorrelation process. The BAE N-GATE technology is designed specifically to take advantage of the ADS40 image characteristics to efficiently generate accurate autocorrelated surface data.

In performing the photogrammetric DEM check and update in support of the ortho image rectification, the stereocompilers will thoroughly review all of the existing DEM data against the corresponding new stereo imagery. In identified areas of significant terrain change or where the existing DEM otherwise does not sufficiently match the terrain, the existing DEM will be "windowed out" and replaced by newly compiled DEM data, with the operators making sure to tie into the surrounding unchanged data as required to maintain a seamless terrain representation. The newly compiled DEM data will generally consist of a grid of "mass points" at a spacing of approximately 30' along with breaklines and skeletal lines for all major abrupt (e.g., major road edges/crowns, major streams, elevated railroads, etc.) surface interruptions/breaks in grade, which would affect the image rectification. The breakline data will include bridge decks and overpasses as well as the underlying terrain to ensure proper depiction of these features in the orthophotography. The DEM update process will include breakline augmentation of the existing DEM in areas where it does match the terrain but may not adequately support proper rectification of major elevated features such as major freeway bridges/overpasses and major linear grade-breaking ground features, such as raised highways and railroads.

### 7.3 Planimetric Feature Mapping:

The planimetric feature mapping for the City of Davenport will include all features listed in Section 5.3, Item 16 of the RFP. The high resolution of the ADS40 camera imagery and varying degrees of available vertical exaggeration will be used to properly identify smaller features, such as hydrants and signs.

## PROPOSED APPROACH

Kucera is recommending that the Davenport planimetric mapping be newly produced as opposed to an update of the existing city mapping, due to the age of the existing mapping and possible absence of some of the currently specified features. If the City proceeds with new DTM and contour topography, Kucera will need to newly compile a number of the planimetric features which represent breaks in grade (e.g., as road edges, hydrography), making a further case for newly produced mapping. Kucera can, however, using the procedures subsequently described perform an update of the existing Davenport mapping as a means of reducing costs.

The limited planimetric feature mapping for Scott County will include building/structure roofprints and centerlines of residential and commercial entrances/driveways over 300' in length. Kucera will optionally also compile road centerlines and create intersection nodes with the compiled driveway centerlines.

The planimetric mapping for the Illinois cities and villages will include the impervious surface features specified in Section 5.5., paragraph 4 of the RFP.

All planimetric feature compilation will be performed in a fashion which supports the Agency's data structure/layer scheme and intended applications, such as impervious surface measurements. Each feature type will be compiled in a separately coded file/layer. Line features (e.g., streams) will be compiled in a continuous network fashion with directionality as required, and area features (e.g., building footprints, parking areas) will be compiled as closed polygons.

Feature transition criteria (e.g., road vs. parking edge) will be reviewed with the agencies as part of the initiation/pilot mapping phase as needed. Features which are compiled as digital terrain model (DTM) breaklines (e.g., pavement edges, retaining walls, hydrography) will be copied into separate planimetric feature layers (as opposed to being recompiled) in order to maximize compilation efficiency and data consistency.

The building footprints will include all permanent, completed structures occupying over 100 square feet, including qualifying sheds and detached garages and non-building features such as pavilions and awnings. Trailer homes will be included in the compilation except where in obvious temporary locations, such as construction sites. Large tanks will be included in the structure footprint mapping where specified or desired. Building footprints will be attributed by use class (e.g. residential, commercial/industrial, outbuilding, etc.) to the extent interpretable where specified or desired. As an optional service, Kucera can also provide building height and/or rooftop elevation attributes for each structure – these being measured from the stereo aerial imagery and/or derived from the new lidar survey return.

The hydrographic feature mapping will include bodies of water greater than approximately 1/4 acre in size and natural and manmade features. (e.g., streams, rivers, canals) which have flowing water for significant periods of the year. Intermittent streams will be defined by contours to the extent apparent. The hydro feature mapping will include drainage or irrigation ditches where specified.

Paved parking areas will be defined as having places for five or more vehicles at commercial and industrial establishments. Sidewalks will be compiled where in the public ROW and at commercial/industrial structures.

In performing any planimetric update mapping work, Kucera's stereocompilers will thoroughly scan each image swath of the new aerial photography for the area, with special attention being given to any designated known areas of major change. Updates to the existing data will be made directly on the softcopy plotters as they are identified, with the stereoplotter operators making sure to "snap"/tie into surrounding unchanged data as required to maintain seamless data representation.

The update compilation will be performed on separately established data layers (e.g., REMOVED and ADDED 2009) to allow for clear distinction between changed and unchanged features and "date stamping" in the data edit and conversion process. All features will be updated and maintained in their current data type, i.e., area, line, or point. A "key" will be assigned to each feature layer which is maintained in the update compilation process and used to link the updated and corresponding existing mapping for transfer of attributes as needed. If a 3D version of the existing digital planimetrics is not available, a "draping" process with the new lidar DEM will be performed in order to create the 3D planimetric version which is required for the proper display and update on the softcopy stereoplotter. The update will include correction of minor errors/anomalies found in the existing mapping. If major projectwide anomalies are found (e.g., all existing buildings shifted, skewed, or displaced, not squared, etc.) such will be brought to the City's attention and either left as is or corrected as negotiated.

### 7.4 LiDAR DEM Review/Upgrade to Contour DTM:

For the City of Davenport and agencies desiring 2' contour topography, Kucera will photogrammetrically check and upgrade/augment the optional new lidar bare earth DEM data to produce a new projectwide DTM from which accurate 2' contour topography can be generated.

For the photogrammetric check the LiDAR bare earth points will be reviewed in 3D on top of stereomodels of the new aerial photography, with LiDAR points displaced from the stereo view of the ground by more than approximately 1' being "windowed out" and recompiled as needed.

For the photogrammetric augmentation, 3D spot elevations, breaklines and void/obscured area outlines will be stereocompiled. The spot elevations will be compiled at all significant high and low points (peaks, troughs, saddles, etc.) missed in the LiDAR DEM. The breaklines will include hydrography (streams, rivers, ponds, etc.), road edges and centerlines, railroad centerlines, significant drainage features, major cliffs/bluffs/high walls, and other breaks in grade where distinct changes in contour topography occur and are not adequately represented by the LiDAR DEM points. Void/obscured areas will include water bodies and areas of dense vegetation where the DTM elements may inadequately represent the ground surface. The end product of the upgrade process will be a digital terrain model (DTM) supporting accurate 2' contour generation.

### 7.5 DTM Quality Control and Deliverable:

Following updating/production and before being used in subsequent mapping processes all DTM 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
- Generation of "check" contours from the data and review for proper formation

- Use of Terrasolid Terrascan software to compare elevations of surveyed control and triangulation points to DEM/DTM surface and report displacement/vertical DEM/DTM accuracy over the project area

Where anomalies/inaccuracies in the DTM data are found, the data is reviewed and restructured/recompiled as needed. The finalized DTM data files will be furnished as a deliverable in generic ASCII, geodatabase, and/or other specified formats on CD or DVD. The data will be in separate files/layers corresponding to mass point and breakline elements using the specified layering scheme.

## 8. DIGITAL ORTHOPHOTO PRODUCTION

### 7.1 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 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.

### 8.2 Digital Image Rectification:

The digital orthophoto image rectification of the individual triangulated pixel carpets/swaths of the aerial photography to the updated source DEM data will be accomplished on Leica GPro 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 scanned exposures are oriented using camera fiducial readings (exterior orientation) and orientation parameters derived from the aerotriangulation process (interior orientation), 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.

### 8.3 Automated Image Processing – OrthoVista:

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 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 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 PLS quarter section based tiles for the City of Davenport area and 1500' x 1500' coordinate grid-clipped tiles for the balance of the project area as specified. The Davenport quarter-section tiles will overlap as needed to ensure full coverage of the quarter section and to "square up" the image, but will still tie seamlessly (match perfectly) since they are being extracted by OrthoVista from the same master image mosaic. 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 resampled/retiled and/or block mosaic versions of the orthophoto imagery as needed for resampled data sets and/or compressed image mosaic files.

### 8.4 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 a countywide mosaic. This process will ensure seamless projectwide imagery with an even tone and color balance throughout.

### 8.5 Shadow/Highlight Detail

When processing ADS40 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. Finally, Adobe Photoshop is used to stretch the histogram for the 8-bit mosaicked imagery to the selected color and contrast. The dataset before this final adjustment is kept in case of any loss of shadow or highlight detail, if necessary.

### 8.6 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.

### 8.7 Bridges and Building Lean:

For bridges/overpasses, two sets of rectified imagery will be prepared as needed, one rectified to the DEM representing the ground beneath the bridge for proper representation of the same, and one rectified to DEM breakline data representing the bridge deck, again 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.

For downtown/designated taller structure areas feature lean effects will be minimized or eliminated ("true" orthophotography) 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 will be facilitated by the use of flight lines with increased side overlap and, as needed, by the use of feature-centered aerial flight lines taken for tall structure areas. For buildings 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 between sides.

### 8.8 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., dust, lint, etc.) | 0% visible at target scale<br>< 5 artifacts per tile |
| Control target image position offset (from survey coordinates) | < 3' offset |
| Elevated features (bridges, railroads, etc.) | No breaks/warping |
| Shadow/highlight areas | Good detail visible at target and magnified viewing scales |
| Color/contrast | Match with approved/pilot sample |

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 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 "spiffing" of tone will be performed as needed using Adobe Photoshop and Image Alchemy softwares as needed.

### 8.10 Comparison with Existing Orthophotography/Mapping:

As a quality control process Kucera will review the 2009 orthophotography against any available existing Agency orthophotography (including Kucera's 100 scale 2005 orthophotography) and other available comparable existing planimetric map coverages.

The check will include general review of the image quality, degree of radial distortion, degree of geometric displacement between datasets and specific improvements sought by the Agency (e.g., greater image resolution and accuracy). Note also that the cumulative geometric displacement will be as much as the sum of the allowed displacement accuracies of each ortho dataset. Where a significant discrepancy between ortho image datasets exists which cannot be accounted for, such will be reported and further reviewed to ensure the adequacy of the newly produced ortho imagery.

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### 8.11 Uncompressed Data Delivery:

All final uncompressed digital orthophoto image tiles will be furnished in 24-bit RGB color form in georeferenced TIF (TIF/TFW) format on USB drive media. The image file names will correspond to the Agency's specified numbering/naming system. The delivery media and containers will have Agency specified labeling indicating the area name, tiles contained, etc. The ortho image delivery will include a ESRI GIS version of the master tile index showing the individual tile locations and naming convention. Three sets of uncompressed imagery will be furnished, with delivery of two copies following approval of the first set. Each Agency will receive a full ortho tile coverage of its designated area, with duplicates of tiles being provided at boundaries between areas.

### 8.12 Compressed Data Delivery:

Areawide and townshipwide scene compressed color and black and white mosaic versions of the digital orthophotography will be provided in MrSID Generation 2 or 3 and/or other desired compressed image format. Each agency will be furnished with samples of the imagery at various compression factors (e.g., 20x, 30x, 40x etc.) for review and selection of the preferred compression. Note for areawide compressed image mosaics in SID Gen. 2 format Kucera recommends that the file size be kept under 3 GB to avoid exceeding the Gen. 2 compression software output limitations. Three sets of compressed imagery will be furnished.

### 8.13 Color Infrared Ortho and Radiometric Resolution Options:

Since the ADS40 digital camera system simultaneously acquires imagery in the near infrared as well as visible, natural color wavelength bands, a duplicate, registered version of the digital orthophotography can optionally be furnished in color infrared. The infrared imagery can be provided in RGIR or RGBIR form, the former being optimal for general viewing and the latter being optimal for remote sensing analysis. The infrared imagery can be provided at the same resolution as the color imagery or at a reduced resolution. The Scott County optional infrared imagery will be furnished as uncompressed tiles and in townshipwide and countywide compressed mosaic form.

The ADS40 digital camera imagery is acquired and can optionally be delivered at a 16-bit/channel radiometric resolution as opposed to the standard 8-bit resolution. The increased radiometric resolution would double the image file size but would provide increased radiometric/color accuracy with more distinguishable gradients/differences in tone/color.

In conjunction with the 0.5' resolution color ortho imagery Kucera can optionally furnish 0.3' resolution orthophotography produced from 0.3' resolution b+w imagery simultaneously captured with the ADS40 camera system. The 0.3' resolution b+w imagery can be used by an Agency to pan-sharpen the color ortho imagery to 0.3' resolution on-the-fly as needed using ArcMap.

### 8.14 Agency Review/QC Tracking Application:

Kucera has a very robust internal quality control process for digital imagery/mapping and an excellent reputation for high quality deliverables with a very low rejection rate (virtually always

<5% of delivered imagery). All Agency edit calls will be promptly addressed, with revised/replaced and/or missed tiles being posted to Kucera's FTP site for downloading and delivered on DVD.

To facilitate the retrieval, quality control review, and communication of inspection results, Kucera can provide licensed copies of advanced and versatile Global Mapper Software. Using Global Mapper, the simple QC edit calls can be made and easily transmitted between Kucera and the Agency. The software eliminates the need for other expensive or proprietary software, and can also be used by the agencies in other capacities.

Setting up display parameters is straightforward for the orthoimagery. An image catalog is rapidly created in Global Mapper using the provided tools. Once this is complete, red polygons represent the boundaries of the individual ortho tiles while viewing at a small scale. A user- defined scale can then be set that allows full viewing of the rasters at a large scale. Planning and zooming is accomplished using a combination of mouse gestures and keyboard shortcuts (e.g., the arrow keys on standard keyboards). To mark a QC call involves selecting the digitizing tool and right-clicking on the area in question. A dialog box displays options for a point type and text for a description. Global Mapper supports downloading raster data directly from a WMS-compliant server. This allows the Agency to view the orthophotos form Kucera without actually receiving a USB drive.

## 9. TOPOGRAPHIC/PLANIMETRIC FEATURE MAPPING

### 9.1 Overview:

In this phase of the project Kucera will generate new 2' contour topography from the new lidar DTM for the City of Davenport and other designated areas and will batch and manually edit this data together with the new/updated planimetric feature mapping, and convert the data to AutoCAD and ArcGIS format for delivery.

### 9.2 Contour Generation:

The updated 2' contour topography will be generated in continuous form from the project DTM using Inpho SCOP, a modified TIN-based contour interpolation program which has an advanced "floating Z" contour-smoothing (splining) algorithm and residual output for a high degree of quality control. The SCOP program has a number of features which make it superior to other TIN-based programs for the generation of contours which are smoothed and which require minimal post-generation editing for acceptable cartographic appearance. SCOP uses horizontal and vertical splining in contour formation, as opposed to the more rudimentary horizontal, straight-line, point-to-point process, producing a smoother, more accurate contour representation.

### 9.3 Data Edit:

The contour topography will be batch and manually edited initially on dedicated Cardinal Systems VR1 editing workstations to produce a clean, seamless, layered feature database.

The editing process will include:

- Tagging/labeling of feature names from available source data;
- Snapping/joining of data compiled from adjacent flight lines/image swaths;
- limination of dangling nodes and undershoots/overshoots
- Addition of spot elevations at high and low points of closed contours, intersections, saddles/troughs, water body centroids
- Tagging of hidden contour lines where passing through existing structure footprints as needed;
- Review of layering assignment, directionality, node location, polygon closure, cartographic appearance, compilation consistency;
- Review against corresponding digital orthophoto image backdrop for completeness (i.e., no features missed) and overlay accuracy (i.e., minimized displacement between image and vector feature location); and
- Creation of coordinate grid layer, sheet tiles, sheet index as needed
- Check of hidden contours in bridge overpass areas to ensure proper representation of underlying terrain
- The plan mapping between project areas

All batch edit functions performed are subject to manual review and edit as needed before proceeding with the data conversion. As the initial editing work is completed, paper checkplots of the mapping will be produced for internal review and can be furnished as a deliverable for Agency review.

### 9.4 Data Conversion:

The final planimetric/topographic data files will be converted to and delivered in AutoCAD 2008 and ArcGIS V.9 geodatabase in individual tile, single areawide files, or other units as specified. Before commencing with the data conversion work, translation tables will be developed based on the specified layering scheme/database design and reviewed with each Agency for approval.

For the conversion to AutoCAD format, the mapping will be imported into AutoCAD via direct binary data translator. The data will be checked for line work and logical errors in AutoCAD using customized programs and manual review. Lines will be filtered with acceptable tolerance to eliminate any point duplication. Overshoots, undershoots and pseudo nodes will be eliminated where necessary. Polygon closure and exclusiveness will be ensured and all graphic features sharing a common boundary will have the same exact graphic representation.

For the conversion to ESRI geodatabase the following process will be used:

1. Set up template Personal Geodatabase files based on the GIS project database design.
2. Use direct shapefile translator to convert edited digital map sheet files to GIS format.
3. Load data from shapefiles to Personal Geodatabase for each feature class. Create polygons in ArcMap for polygon layers.
4. Review mapping directly in ArcMap with ortho backdrop for conversion problems/edits.
5. Populate attribute fields, using database linkage to retrieve attributes from existing mapping as needed.
6. Perform attribute quality control review using database management tools.

In the conversion process, topology rules are established for certain feature layers in the geodatabase and corrections will be made if the topology rules are violated. For example, parking lot polygons cannot overlap with other transport feature polygons, e.g., driveways or paved roads.

All final GIS/CAD data files will be furnished on CD or DVD along with a corresponding master sheet/coverage index file. Sample final data files will be provided for review and approval before proceeding with deliveries. Backup copies of all intermediate and final digital files will be maintained indefinitely.

## 10. PROJECT WRAP-UP / METADATA

### 10.1 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 each Agency. The agencies will be asked to review their records as well to ensure all deliverables are accounted for. Project materials retained by Kucera (e.g., aerial film, raw image scans, backup DEM files, etc.) will be recorded and appropriately stored at Kucera's headquarters facility or forwarded to the agencies.

Each agency will be furnished with FGDC Version 2 metadata in HTML and/or XML format for the orthophotography and mapping. A client metadata questionnaire will be provided to complete and return indicating the Agency's points of contact, distribution process, and other Agency-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. A summary report can also be provided, although much of the information contained will be duplicated in the project metadata.