

**PROVISIONAL SCOPE OF WORK AND SPECIFICATIONS FOR
AERIAL ORTHOPHOTOGRAPHY, OBSTRUCTION,
AND TOPOGRAPHY
MAPPING OF SELECTED AIRPORTS IN SOUTH CAROLINA**

The South Carolina Aeronautics Commission (SCAC) proposes to acquire high-resolution color aerial orthophotography and Light Detection And Ranging (LiDAR) data, including topographic, obstruction, planimetric, and airport layout plan (ALP) mapping in accordance with the attached specifications. In addition to information requested in the specifications, all proposals should include contractor's previous experience on similar projects (with references); equipment and personnel to be utilized; disadvantaged business enterprise (DBE) subconsultants' proof(s) of SCDOT DBE certification; and proof of insurance. This information shall also be provided for any subcontractor employed for this project.

SCAC will maintain GIS capability using ESRI software, and CAD capability using AutoDesk software. SCAC is currently using ArcGIS for Server Enterprise Standard 10.1, ArcGIS for Desktop Basic 10.1, AutoCAD 2013, and AutoCAD Civil 3D 2013. These software packages are expected to be updated with new versions annually as per SCAC's subscription-based licenses, but no additional licenses, upgrades, or extensions are anticipated.

All deliverables shall be compatible and operational within the system at the time of the task order, and shall be deemed unacceptable until compatibility is assured. All deliverables shall also comply with surveying and data standards as per the following Federal Aviation Administration (FAA) Advisory Circulars (ACs) and successor documents:

- 150/5300-16A, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey*
- 150/5300-17C, *Standards for Using Remote Sensing Technologies in Airport Surveys*
- 150/5300-18B, *General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards*

Vector data deliverables shall be in the following formats, as per the SCAC software platforms and FAA Advisory Circulars listed above:

- ESRI-compliant shapefiles, particularly for data to be uploaded to the FAA Airports GIS (AGIS) system
- File geodatabases for integration into SCAC's existing geodatabase.

- AutoCAD DWG files; SCAC may elect to obtain a Civil 3D-compatible DWG file on a case-by-case basis

Airport Layout Plan (ALP) mapping shall support development of traditional ALP and Master Plan projects and deliverables by airport sponsors and/or their engineering consultants, including but not limited to obstructions to FAR Part 77 criteria and selected airspace surfaces in AC 150/5300-13A, *Airport Design*, topography, and planimetrics. SCAC may, on a case-by-case basis, elect to pursue an electronic ALP (eALP) mapping project, based on consultation with the FAA, airport sponsor, and their engineering consultant, and subject to the capabilities and requirements of the FAA's AGIS system to accept eALPs at the time of the task order.

The basic specifications as outlined below are designed to primarily obtain digital orthophotos utilizing traditional analytical photogrammetric techniques and equipment. The contractor's proposal must address these specifications as stated herein. Nevertheless, SCAC is also anxious to consider new technology such as aerial LiDAR that would provide cost effective alternative methods for obtaining comparable output products and accuracies.

Any contractual modifications to these specifications and/or any deviation from these specifications (unless specifically authorized in writing by the contracting officer or an authorized representative thereof) shall be sufficient cause for rejection of any part or all of the work performed.

The project duration will be for five (5) years. The number of orthophotos, topography and obstruction mapping projects accomplished under this contract will be based upon the availability of funds.

General Project Procedures and Requirements

For the purpose of this project, a digital orthoimage is a digital image, which has the properties of an orthographic projection. It is developed from a vertically oriented perspective aerial image by differential rectification so that the image displacements caused by camera tilt and terrain relief are removed. Imagery rectified from oblique imagery will not be acceptable for this project. Digital cameras must be used for this project. The raw digital image file must be digitally rectified to an orthographic projection by processing each image pixel through the appropriate photogrammetric equations. This process requires as input, control points acquired through ground surveys and developed in aerotriangulation; camera orientation parameters; and a Digital Terrain Model (DTM) or a Digital Elevation Model (DEM). To avoid confusion, the following definitions will apply:

Digital Terrain Model (DTM) - a rigorous data model which incorporates mass elevation points, spot elevations and breaklines at significant terrain breaks at a density level sufficient to support planimetric mapping and contour generation. In this case

planimetric mapping accuracy must be 4 feet RMSE or better (based on ASPRS Standard for Large Scale Mapping). The testing of the geospatial positional accuracy will conform to the NSDI Geospatial Positioning Accuracy Standards, Section 3.2 Table Part 3: Standards for Spatial Data Accuracy (FGDC–STD–007.3–1998).

Digital Elevation Model (DEM) - a less rigorous data model to be used for the purpose of creating a digital orthoimage which will support planimetric mapping accuracy of 4 feet RMSE or better (based on ASPRS Standard for Large Scale Mapping) when compared to image identifiable ground control points.

Survey Control

It shall be the responsibility of the Contractor to specify where image identifiable control points will be required. Upon request the South Carolina Geodetic Survey could supply the coordinates and ground based photography to make identification possible for these points in the digital imagery. Airborne GPS (AGPS) is required for horizontal control densification in support of orthoimage production. Horizontal reference for the project will be NAD 1983/2011, S.C. Single Zone State Plane Coordinate System, with the International Foot (1 foot = 0.3048 meters “exactly”) being used in all conversions. Vertical reference shall be NAVD 1988.

Aircraft

The photographic mapping contractor shall furnish aircraft equipped with all essential navigational and photographic instruments. The contractor shall also furnish a well trained, properly qualified, and experienced crew to operate the aircraft. All operations shall be in conformity with applicable Federal Aviation Administration (FAA) regulations and ordinances. The performance of the aircraft, crew, and equipment shall be adequate for completion of the project in accordance with the requirements of this Agreement.

Conditions During Photography

It shall be the responsibility of the Contractor to obtain aerial photography during the appropriate seasonal timeframe, as per FAA and NGS requirements for AGIS submittal, such as snow-free and leaf-off conditions for topographic mapping, and leaf-on conditions for airspace obstruction mapping. Photography shall be undertaken when skies are clear, free from excessive smoke or haze, and well- defined images can be resolved. The ground shall be free from standing water, and/or snow. Photography shall be flown only during that portion of the day when the sun is 30 degrees or more above the horizon.

Digital Camera

A modern digital aerial camera certified by the USGS is required for the purpose of this project. Digital camera performance, resolution, calibration and metric accuracy must meet or exceed the mapping specifications as stated for 6-inch focal length precision aerial film cameras. The final product obtained from digital camera imagery must be free of any distortions or inaccuracies.

Flight Lines

Flight line specifications shall adhere to the parameters in FAA AC 150/5300-17C, particularly Paragraph 3.3.e. Unless otherwise specified by FAA requirements, the flying altitude shall be determined to obtain 1.0 foot resolution directly from the image for imagery at a scale of 1"= 400', 0.5 foot resolution directly from the image for imagery at a scale of 1"= 200', and 0.25 foot resolution directly from the image for imagery at a scale of 1"= 100'. All re-flights will be at the expense of the Contractor.

Resolution

Final output pixel resolution for each scale digital orthophotos will be depicted in the work authorization contract.

(1"=400' scale – 1.0 feet; 1"=200' scale – 0.5 feet; 1"=100' scale – 0.25 feet)

Analytical Aerial Triangulation

Densification and Field Control - Densification and extension of field control will be permitted by fully analytical aerial triangulation (FAAT) methods and/or softcopy methods that employs qualified operator supervision at all times during the measuring process. The Contractor shall submit a step-by-step narrative of his methodology (including equipment to be used) with the proposal. Full auto-correlation during aerial triangulation may be used however; the results must be verified and sealed by a licensed South Carolina Photogrammetric Surveyor and a copy of the sealed report supplied to SCAC.

DTM/DEM Development - Vertical accuracy of the DTM/DEM shall be sufficient to obtain the required vertical and horizontal accuracies of the final deliverable products. The DTM/DEM shall have a combination of the following - points spaced at regular intervals along a grid; points of significant high or low elevation; and breaklines at significant terrain breaks. It is understood that density of points and the distribution and extent of breaklines is very dependent upon local terrain variations; however, it is requested that each proposal include a basic recommended procedure (minimum grid spacing and standard breaklines features) upon which the project will most likely be based. The following list details the order of preference:

1. The DTM/DEM may be derived from photogrammetric or LiDARgrammetric approaches. If a photogrammetric approach is utilized the DTM/DEM shall be captured by an experienced instrument operator using fully analytical optical photogrammetric stereo plotters and/or softcopy instrumentation and techniques capable of achieving required accuracies. If a LiDARgrammetric approach is utilized the source data and processing techniques must be commensurate with the required accuracies. Each proposal shall include the specific equipment to be utilized in DTM/DEM capture as well as resumes of specific instrument operators to be assigned to the project (not simply a list of all equipment and all personnel).

2. A previously derived DTM/DEM accurate enough to meet required planimetric accuracy.
3. A DTM/DEM captured wholly or in part from autocorrelation may be utilized for this project; however, the contractor will provide a written and sealed statement by a licensed South Carolina Photogrammetric Surveyor attesting to the accuracy of the DTM/DEM.

Rectification - The rectification process shall involve the solution of the appropriate photogrammetric equations for each pixel in the output image. It will not be permissible to solve photogrammetric equations at anchor points and then warp the content of the original image between the anchor points. The interpolation (or resampling) of intensity values from the input image to the output image shall be accomplished using the cubic convolution algorithm or equivalent - use of nearest neighbor will not be acceptable.

Image Quality/Radiometry - Two hundred and fifty-six (256) tonal levels ranging from 0 (black) to 255 (white) of image brightness shall be represented. All intermediate values shall represent continuous tone varying uniformly from black to white. There shall be no areas of an orthophoto where the process was incomplete due to image gaps or lack of data. Image quality of the finished digital orthophoto shall be consistent with the requirements in the Flight Lines and Resolution sections above. All digital orthophotos shall be radiometrically adjusted as necessary so that adjacent digital orthophotos can be displayed simultaneously without an obvious visual edge seam between them. Localized adjustments of the brightness values shall be performed to minimize tonal differences between the join areas. For this adjustment, the orthophoto judged by visual inspection to have the better contrast shall be used as the reference orthophoto. Localized brightness values of the adjacent orthophoto shall be adjusted to that of the reference orthophoto. When possible and feasible, the area adjusted should be bounded by a tonal break ground feature such as a road, field line, shadow line, etc. The radiometric adjustment should not compromise the accuracy, clarity or resolution of the orthophoto. Prior to undertaking full digital orthophoto production, the Contractor shall furnish the SCAC with sample digital images at all scales/spatial resolutions to evaluate and accept as examples of overall image quality. SCAC will select one image each that will become the standard to which all subsequent digital orthophotos will be compared for acceptance/rejection relative to image quality.

Aerial Coverage - The geographic extent of each digital orthophoto shall be as follows:

1"=400' scale	10,000' X 10,000'
1"=200' scale	5,000' X 5,000'
1"=100' scale	2,500' X 2,500'

Approximate locations of mapping are included on the attached index map of the County. The grid defined tiles will cover the entire mapping project area (e.g., airport boundary, Part 77 airspace surfaces, etc.) and beyond as needed to achieve **full tile**

coverage. The digital orthophoto shall contain only the neat image area of the corresponding map unit and there shall be no image overlap between digital orthophotos.

Mapping

All ground control surveys and digital mapping are under the direct supervision of an ASPRS certified photogrammetrist and a South Carolina registered professional land surveyor. All mapping will meet or exceed National Map Accuracy Standards for scale and contour intervals. Mapping will contain full three-dimensional data and be compatible with ESRI and Autodesk software products. All documentation for horizontal control in the triangulation report will be provided to SCAC for future reference. Fully analytical aerial triangulation methods will be used. Mapping must conform to both GIS attribute and CAD layering standards in AC 150/5300-18B. Digital files must have a title block with the following information as a minimum; airport name, location name, date prepared, date of photograph, scale and the name, address, and phone number of the mapping firm.

Topographic Mapping - Topographic mapping will be completed to a distance of one hundred feet outside of the extents indicated on the Airport Layout Plan (ALP) drawings provided. If an area is designated to be mapped but lies outside the existing property line as shown on the ALP, and it is necessary for survey work to be completed in that area, the contractor shall be responsible for determining current ownership of the property and obtaining permission to enter the property, if necessary, prior to beginning any work in that area. All documentation for horizontal control in the triangulation report will be provided to SCAC for future reference. Fully analytical aerial triangulation methods will be used. Digital or conventional photography methods used to establish topography maps must be obtained when the vegetation is leaf free.

Obstruction Mapping – Obstruction mapping will be prepared using orthophotography images depicting surfaces as described in FAR Part 77 and/or selected airspace surfaces in AC 150/5300-13A, and adhering to survey and data standards in FAA ACs 150/5300-16A, 17C, and 18B. Digital or conventional photography methods used to establish obstacle elevations such as the tree canopy must be obtained when the vegetation is full of leaves. Obstruction mapping that adheres to the requirements of FAR Part 77, will utilize approach surfaces and a 7:1 transition zone up to one hundred feet above the runway elevation. Imaginary surface elevations will be shown at ten foot intervals along the transitional surfaces. A compiled survey listing of data shall be furnished in AC 150/5300-18B-compliant ESRI shapefile format. FAA GIS data standards, including information on survey documentation, is available at <https://airports-gis.faa.gov>. Obstacles are depicted in both the plan and profile views. Aerial obstacle identification is to have positive control and be quantified by field surveys. For CAD deliverables, obstacles shall be marked with an “X” identifying the obstacle. Obstacles penetrating Part 77 surfaces as complied by AC 150/5300-18B Standards shall be marked with a circle “X”. Each identified obstacle must have MSL elevations. Data tables depicting the obstruction are to reference the obstacle by station location, type of obstacle, obstacle elevation, and the elevation difference between the required slope

surfaces. Tree elevation tolerance must be within one foot of vertical accuracy. Other stationary obstacles such as antennas, buildings, power lines and power poles, must be within a tenth of a foot of vertical accuracy.

Deliverables – (Digital Orthophotos)

Negative scale of photography shall not be smaller than 1"=2,000' for the 1": 400' scale orthophotos or 1"=1,000' for the 1": 200' scale orthophotos, respectively.

A 30" X 30" color mosaic aerial photo laminated on a clear five mil protective covering for selected airports as authorized in the scope of service contract will be included in the deliverables. Color enlargements will have a legend indicating the airport name, date of photography, and the horizontal scale.

Digital orthophotos will be delivered on DVD, or external drives should additional memory be required, with the contractor being responsible for paying the shipping costs to and from the SCAC office. Images will be delivered in both .tif and .sid formats with .tfw and .sdw support header files, respectively. Additional header information will be included in accordance with FAA AC 150/5300-17C, Section 3.4 and state standards (see Attachment A). DVD's and external drive containers will be labeled in accordance with state standards (see Attachment B). Each label will contain the ortho-images sheet numbers contained on that DVD. In addition to the image (.tif, .sid, .tfw, and .sdw) each orthophoto delivered shall include the appropriate DEM/DTM file in .dxf and .shp format labeled with the same file name as the corresponding orthophoto.

Deliverables – (GIS/CAD Data)

All task orders in this contract that will include topographic, obstruction, planimetric, and/or Airport Layout Plan (whether for a traditional ALP or an eALP) data, shall have deliverables in both GIS and CAD data format. All GIS data shall be submitted in ESRI-compliant shapefile format, and all CAD data shall be submitted in AutoCAD DWG file format. Additionally, GIS deliverables shall also submitted be in ESRI-compliant file geodatabase format for use in SCAC's GIS systems. SCAC shall specify which versions of ESRI and Autodesk products deliverables must be compatible with at the time of each task order. All GIS and CAD deliverables shall completely adhere to data standards, including but not limited to fields, attributes, enumerations, layers, colors, and linetypes, specified in FAA AC 150/5300-18B. GIS data delivered in both geodatabase and shapefile formats shall have consistent data architectures, except for additional data architecture features unique to geodatabases, as required by AC 150/5300-18B data standards. For example, geodatabases must have domains and enumerations as per AC 150/5300-18B standards, but shapefiles will not have them since they do not have domain or enumeration capabilities in their data structure; also, geodatabases must have field names identical to ones in shapefiles, as the latter may have limitations on field name lengths.

Deliverables Processed through FAA AGIS

For task orders that include uploading of data to the FAA AGIS system, the consultant shall coordinate with SCAC in creating an AGIS project appropriate for that task order. Subsequently, the consultant shall upload all pertinent plans, data, and reports to process them through the FAA AGIS and National Geodetic Survey (NGS), in a timely manner in accordance with the task order scope, including but not limited to Statement of Work, Geodetic Control Plan, Imagery Acquisition Plan, Survey & Quality Control Plan, digital imagery, GIS or CAD data, and any final reports and deliverables required by AGIS. The consultant shall also test and validate survey data on the AGIS system before uploading of the data. SCAC prefers uploading vector data to AGIS in ESRI shapefile format, and shall be identical to the AC 150/5300-18B-compliant shapefile(s) delivered to SCAC for that particular task order.

Ownership of Materials

All materials produced as a result of this project including; but not limited to, aerial negatives, diapositives, aerotriangulation data, terrain and elevation models, surveys, and control photographs shall become the property of SCAC.

Attachment A

Header Record Format

The digital image shall be archived on a suitable storage media with informational records appended to the TFW file. The informational shall be written in ASCII nomenclature in the .tfw file. Each ITEM of information shall occupy a separate line(s).

REQUIRED INFORMATION:

ITEM	ABBREVIATION	EXAMPLE
A. Airport Name	LOCATION =	XXXXXX AIRPORT
B. FAA Location ID (4 digits)	FAALOCID=	KXXX
C. Name of firm producing the data	PROD BY =	Amblypia, Inc.
D. Coordinate system	COORD SYS =	S.C. STATE PLANE
E. Datum	DATUM =	NAD 1983/2001
F. Unit of measure	UNITS =	International Foot
G. Date of aerial photography	PHOTODATE =	03/06/04
H. Aerial camera type	CAMERA =	Wild RC-30
photography (RF)	NEG SCALE =	1:24,000
H. Final output pixel resolution	PXL RES =	1 foot
I. Horizontal accuracy (i.e. meets National Standards of Map Accuracy at this HZ scale)	HZ ACCURACY =	1:4,800
J. Source and Vertical accuracy of DEM	DEM =	*

Attachment B

Digital Orthophotos

File Naming Convention

The 1"=400' scale digital orthophotos shall be named using the most significant digits of the southwest corner coordinates arranged in XyXy order. The millions digit of the X value is not used. For example:

X = 1234567

y = 890123

XyXy = 2839

Orthophoto Name = 2839.tif and 2839.tfw

The 1"=100' and 1"=200' scale digital orthophotos shall be named the same as the 1"=400' orthophoto which falls within followed by a dash and a suffix indicating its location within the 400 scale image. For example:

100 Scale name for southeast image = 2839-20.tif and 2839-20.tfw

200 Scale name for southwest image = 2839-03.tif and 2839-03.tfw

1"=100' Scale File Suffix Suffix

05	06	07	08
09	10	11	12
13	14	15	16
17	18	19	20

1"=200' Scale File

01	02
03	04