

**Technical Specifications for Base, Cadastral  
and Digital Mapping (Orthophotos)**

Land Records Management Division  
North Carolina Department of  
the Secretary of State

Spring 2007

## PREFACE

The "Land Records Management Program" (LRMP) was established in 1977 by the North Carolina Legislature in order to provide technical and financial assistance to local governments for the modernization of their land records systems. The Technical Specifications for Base, Cadastral, and Digital Mapping (Orthophotos)" is thus prepared as an essential element of the LRMP and is applicable to all county or municipal mapping projects. To the maximum extent practicable, these specifications should also be utilized by state agencies involved in mapping operations. Section 6, "Digital Orthophotos", was adopted on August 18, 2004, by the North Carolina Geographic Information Coordinating Council (GICC).

Invaluable guidance and assistance have been provided by the Standards Committee of the North Carolina Property Mappers Association and by representatives of local governments. Assistance was also provided by the North Carolina Geodetic Survey (NCGS), the Center for Geographic Information and Analysis (CGIA), the North Carolina Department of Transportation, and the North Carolina Department of Revenue.

# TECHNICAL SPECIFICATIONS FOR BASE, CADASTRAL, AND DIGITAL MAPPING (ORTHOPHOTOS)

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# **SECTION 1**

## **GENERAL**

## 1. **GENERAL**

### 1.01 **Definitions:**

- a. The Contracting Officer is the officially designated representative of the local government obtaining the mapping products or other services. This individual's authority and responsibilities shall be as prescribed by the County Board of Commissioners or appropriate municipal authority.
- b. The Contractor is that firm, company, or organization to which the mapping or service contract has been let. References to the Contractor in these specifications shall also apply in full to any subcontractor working for the named Contractor.
- c. References to "the County" shall be construed to include not only county governments, but also municipal governments or any other agency or party wishing to enter into a mapping contract with a Contractor under the provisions of these specifications.

### 1.02 **Work Statement:**

The Contractor shall furnish all materials, superintendence, labor, equipment, and transportation and shall execute and complete all of the work required by the contract in conformance with these specifications and any contractual modifications to these specifications. Any deviation from these specifications, unless specifically authorized in writing by the Contracting Officer or his representative, shall be sufficient cause for rejection of any part or all of the work performed.

### 1.03 **General Mapping Specifications:**

- a. The Contractor will supply the Contracting Officer with a sample format of each hardcopy map/overlay type and/or softcopy map/overlay mask type showing the placement and content of all border information for approval prior to final map and/or overlay production.
- b. All deliverable hardcopy maps/overlays and/or softcopy maps/overlays shall contain the following statement:  
This map/overlay is correlated to the North Carolina State Plane Coordinate System, NAD83(NSRS2007) North American Datum.

- c. All lettering on all deliverable hardcopy maps/overlays and/or softcopy maps/overlays shall be done by mechanical means only - freehand lettering will not be accepted.

**1.04 Visits to Contractor's Site:**

The Contract Officer or an officially designated representatives or agents of the County may visit the Vendor's site to inspect work in progress and verify that the procedures and equipment being used are in compliance with these Specifications and contract requirements. The Contractor agrees to allow access to its production facilities for periodic visits by the County representatives or agents. These visits may be unannounced and/or may be upon short notice.

**1.05 Surveying Activities:**

All surveying activities, as defined in NC GS 89C, undertaken by the Contractor shall be conducted by surveyors licensed by the North Carolina Board of Engineers and Land Surveyors. Photogrammetry services shall only be provided by licensed surveyors who are competent by virtue of education and experience in the discipline of photogrammetry. At the beginning of a project involving photogrammetric services, the Contractor shall identify the licensed surveyor who will sign and seal the completed project, and, as such, will have direct supervisory control of the project.

**1.06 Traditional Cadastral Mapping Activities:**

Traditional cadastral mapping activities as detailed in these Specifications are not surveying services as defined in NC GS 89C and, as such, do not need to be provided by surveyors licensed by the North Carolina Board of Engineers and Land Surveyors.

**SECTION 2**  
**AERIAL PHOTOGRAPHY**

## **2. AERIAL PHOTOGRAPHY**

### **2.01 Project Area and County Contract Map:**

The location, size, and boundaries of the areas to be mapped will be outlined on a county map and further subdivided and designated in a way to show the number and scales of the final base maps to be prepared; the map shall be at a scale adequate for its purpose and shall be in hardcopy and electronic format. When the mapping project includes the entire county or portions along county boundary lines, the area to be mapped shall extend 2,000 feet beyond the county boundary. This marked county map shall be entitled the "County Contract Map" and shall be attached to and become a part of any contractual agreement. The flight plan proposed by the Contractor shall be drawn on a copy of this map and submitted to the Contracting Officer for approval prior to flying aerial photography (see subsection 2.04). The County Contract Map may be prepared by the County or by the Contractor at the request of the County.

### **2.02 Conditions During Photography:**

Vertical photography shall be flown during the period when deciduous trees are barren, between the hours of 10:00 a.m. and 2:30 p.m. Eastern Standard Time and when the sun angle or elevation is not less than 33 degrees above the horizon. The Contracting Officer may require a higher sun angle to reduce the risk of long or objectionable shadows caused by relief or low solar angle. Photography will not be undertaken when the ground is obscured by snow, haze, fog, or dust; when streams are not within their normal banks; or when the clouds or cloud shadows will appear on more than five percent (5%) of the area in any one photograph. Photography shall be undertaken only when well-defined images can be obtained.

**2.03 Scale of Aerial Photography Negatives:**

The altitude above average ground elevation for aerial photography shall be such that the negatives will be at the scale specified in the following schedule:

<u>Description</u>	<u>Map Scale</u>	<u>Negative Scale</u>
Rural	1" = 400'	1" = 2,400'
Semi-Rural	1" = 200'	1" = 1,200'
Urban	1" = 100'	1" = 600'
Urban	1" = 50'	1" = 300'

Negatives deviating from the above scales by more than five percent (5%) may be rejected.

**2.04 Flight Plan:**

The Contractor's flight plan shall be drawn on a copy of the County Contract Map. Each flight line will be flown continuously across the project area. Every effort shall be made to avoid breaks within individual flight lines. When breaks within a flight line are necessary, the entire flight line composed of the resulting segments shall meet all of the requirements set forth in these Specifications. Where breaks occur, there shall be an overlap of at least four frames to ensure a stereo model of overlap or tie. All photos within a single flight line shall be acquired with the same aerial camera and with the camera oriented in the same direction. The principal points of the first two and the last two exposures of each flight strip shall fall outside the boundaries of the area to be mapped. All side boundaries shall be covered by a minimum of twenty-five percent (25%) of the photo image format.

**2.05 Re-flights:**

Within one week of the flight mission, the Contractor shall submit a detailed quality control report to the Contracting Officer confirming compliance to the aerial photography specifications. Unacceptable aerial photography shall be corrected by the Contractor at no additional cost to the County, with re-flight coverage overlapping the accepted photography by at least two stereo models. Replacement exposures shall be acquired with the same camera and magazine used to acquire the original exposures and shall be exposed as nearly as possible to the same day and lighting conditions as the original

exposures. Re-flights shall be flown immediately (ideally within one week of the original flight), provided ground conditions have not yet terminated the photographic “season.”

**2.06 Spacing of Photographs:**

Overlapping photographs in each flight line shall provide full stereoscopic coverage of the area to be mapped.

**2.07 Forward Overlap:**

Photography used in the development of orthophoto maps shall have an endlap of sixty percent (60%). Forward overlap in the line of flight shall average not less than fifty-seven percent (57%) or more than sixty-three percent (63%) at the mean elevation of the terrain, unless otherwise specified. Individual forward overlaps shall not be less than fifty-five percent (55%) or more than sixty-five percent (65%), excepting the situation where in a forward overlap in areas of low elevation must exceed sixty-five percent (65%) to attain the minimum fifty-five percent (55%) forward overlap in adjacent areas of higher elevation. Wherever there is a change in direction between two flight lines (other than between adjacent parallel flight lines) junction areas between the adjoining flight lines shall be covered stereoscopically by both lines.

**2.08 Sidelap:**

Sidelap between adjacent parallel flight lines shall average thirty percent (30%) plus or minus three percent ( $\pm 3$  percent). Any parallel flight lines having sidelap of less than twenty-five percent (25%) shall be rejected and reflown.

**2.09 Crab:**

Crab in excess of three degrees ( $3^\circ$ ) measured with respect to both lines of flight may be cause for rejection of a flight line or any portion thereof in which the excess crab occurs. This includes relative crab between any two successive exposures.

**2.10 Tilt:**

Tilt of the camera from verticality at the instant of exposure shall not exceed three (3) degrees, nor shall it exceed five (5) degrees between successive exposure stations. Average tilt over the entire project shall not exceed one (1) degree.

**2.11 Aircraft:**

The aircraft to be used shall be equipped with all essential navigational, geodetic, and photographic instruments and accessories necessary to satisfactorily produce the required photography and shall be operated by a well-trained and experienced crew. Aircraft is required to have airborne global positioning system (ABGPS) software and hardware capability for real time aircraft positioning and navigation. The ABGPS must also have the capability to capture and store spatial positioning information for determining exterior orientation of the camera and geographic location of the photo center at the instant of exposure. The contractor's ABGPS hardware and software must incorporate the ability to spot process the airborne data in order to provide a computer derived GPS photo control point at each exposure center to supplement ground surveys in accomplishing aero triangulation procedures. The design of the aircraft shall be such that, when the camera is mounted with all of its parts above the outer structure, an unobstructed view is obtained, shielded from exhaust gases, oil, effluence, and air turbulence. No window of glass or other material shall be interposed between the camera and the ground to be photographed. The camera shall be mounted vertically in the aircraft in a mount designed to isolate the camera from vibration of the aircraft. Angular vibration of the camera shall be reduced to such a level so as to have no significant detrimental effect on resolution. The aircraft shall have a proven service ceiling with an operating load of not less than five percent (5%) above the highest altitude requirements to secure the specified photography. It shall be the responsibility of the Contractor to secure all licenses and authorizations for overflight of areas in the County and to secure necessary permits or clearances for controlled or restricted airspace areas. If the flight area includes a military installation, the Contractor must comply with security regulations. The Contractor shall notify the Contracting Officer as soon as possible if difficulties in obtaining the appropriate authorizations are encountered. The Contractor shall be responsible for operating and

maintaining the aircraft in accordance with the regulations of the Federal Aviation Administration and the Civil Aeronautics Board.

**2.12 Aerial Camera:**

The aerial camera used must be a precision aerial mapping camera equipped with a low distortion, high-resolution lens. Camera characteristics must be such that the aerial photographs taken can be satisfactorily used in hardcopy and/or softcopy analytical measuring instruments and equipment. The camera system must be equipped with forward motion compensation (FMC). The camera system must be interfaced with airborne global positioning system (ABGPS) technology to provide horizontal and vertical control on each aerial exposure. A U.S. Geological Survey (USGS) camera calibration report no more than three years old is required for each camera used to obtain aerial photography. The camera calibration report shall be submitted to the Contracting Officer for approval before proceeding with work. Calibration reports shall include calibration results for any film magazines to be used with the camera. Only those combinations of cameras and magazines shown on the calibration report shall be used in the project. If there is any reason to believe the dimensional stability of the camera has been disturbed by partial disassembly or unusual mechanical shock since its last calibration, the Contractor should have the camera recalibrated prior to acquisition of photography. The Contractor shall be ultimately responsible for errors caused as a result of incorrect calibration of the camera. The methods, procedures, and requirements described in this subsection shall be those utilized by USGS and will be included in the camera calibration report.

a. Camera and Lens.

The aerial camera shall be a precision aerial mapping camera equipped with a low distortion, high resolution lens. The calibrated focal length of the lens shall be 153 millimeters  $\pm$  3 millimeters (6 inch focal length). The characteristics of a nominal 6-inch camera shall be as follows:

1. Focal Length - 153  $\pm$  3.0 mm Universal Aviogon, Pleogon A, or equivalent.
2. Usable Angular Field - At least ninety degrees.
3. Radial Distortion – The radial distortion in the usable angular field based on the calibrated focal length referred to the calibrated principal

point (point of symmetry) shall not exceed ten microns (10 um) for any tested point. In addition, at least fifteen of the tested points shall have radial distortion values not exceeding five microns (5 um).

4. Resolution – The lens shall have an area weighted average resolution (AWAR) of at least ninety (90) line pairs per millimeter as determined by the USGS calibration report.

- b. Filter. An appropriate glass filter with a metallic antivignetting coating shall be used. A microdensitometer trace shall be made and recorded of the antivignetting coating located on the lens side of the filter. A copy of this trace shall accompany the report of calibration to determine if any deterioration has occurred to the coating that would affect the uniformity of illumination in the image plane. The filter shall have surfaces parallel within 10 seconds of arc, and its optical quality shall be such that its addition to the camera shall not cause an undesirable reduction of image definition. A minus-blue glass filter shall be used with panchromatic emulsions.
- c. Shutter speed and efficiency.
  - 1. The camera shall be equipped with a between-the-lens shutter of variable speed as approved by the Contracting Officer. The range of speed settings shall be such that in conjunction with flight height and aircraft speed, the camera will produce negatives that will result in high definition photographs. The shutter shall also have a speed of 1/200 second or slower for laboratory testing.
  - 2. The effective exposure time and the efficiency of the shutter as mounted in the camera will be measured at maximum aperture and the shutter shall have a minimum efficiency of 70 percent at a speed of 1/200 second.
  - 3. This test shall be made in accordance with "Method I", American National Standard PH3-48-1972 (R1978).
- d. Platen flatness and identification. Cameras shall be equipped with an approved means of flattening the film at the instant of exposure. The platen against which the film is pressed shall not depart from a true plane by more than 13 um (0.0005 inch) when the camera/magazine vacuum is applied. The lens number, an alphanumeric mark (or symbol) which identifies the platen used, and the most recent calibrated focal length shall be recorded clearly on the film for each negative

either on the inside of the focal plane frame or on a data strip between frames. Data markers that protrude inside the focal plane frame shall not exceed 6.35 mm (0.25 inch) in height and 25.4 mm (1.0 inch) in length and shall not obscure any part of the fiducial mark or reduce the usable image area.

- e. Fiducial marks.
1. Each camera body shall be equipped with means of recording eight fiducial marks on each exposure, the marks to be located in each corner of the format and at the center of each side.
  2. The corner fiducial marks shall form a quadrilateral whose sides are equal within 0.500 mm. The midside fiducial marks shall be equidistant within 0.500 mm from the adjacent corner fiducial marks. Lines joining opposite pairs of fiducial marks shall intersect at an angle of 90 degrees  $\pm$  1 degree and indicate the position of the principal point of autocollimation within 0.030 mm. The fiducial centers and the point of symmetry shall fall within a 0.030 mm radius circle around the principal point of autocollimation. For cameras with projection type fiducial marks, the projected images of all marks must be in focus on the emulsion surface. Any camera containing glass or plastic mounts of the fiducial marks will not be accepted.
  3. All fiducial marks and other marks intended for precise measuring shall be clear and well defined on the negative and shall be of such a form that the standard deviation of repeated readings of the coordinates of each mark made on a comparator shall not exceed 0.002 mm.
  4. The size of the negative image shall be 23 x 23 cm (9 x 9 inches).
- f. Stereomodel flatness. Cameras will be tested for stereomodel flatness by exposing two film negatives in the camera while mounted on the USGS multifollimator camera calibrator and analytically forming two stereomodels from them, using different halves of the exposures for each model. Each model thus formed will consist of a small fixed number of symmetrically arranged points. In either model, the deviation from flatness (elevation discrepancy at photography scale) at measured points may not exceed  $\pm$  1/5000 of the focal length of

nominal 6-inch ( $153 \pm 3.0$  mm) cameras. If elevation discrepancies exceed this value, the camera will not be acceptable.

**2.13 Digital Sensor:**

A digital sensor (digital camera) may be used instead of a traditional aerial camera and film for the project with the expressed written consent of the Contracting Officer. The Contractor must describe in writing to the Contracting Officer the specifications of the sensor to be used and how the sensor will meet or exceed all of the traditional camera and film requirements for digital orthophotos.

**2.14 Aerial Film:**

All film utilized for this contract shall be from the same manufacturer and from the same lot or batch to insure minimal variation in chemical composition. The aerial film shall be a fine grain, high speed photographic emulsion on a dimensionally stable polyester base and shall be recognized within the photogrammetric industry as a source for the creation of digital orthophotos. Outdated film shall not be used. The film must be stored and handled in accordance with the manufacturer's instructions. Each roll of aerial film shall have an unexposed leader of at least ten frames in length. Whenever a roll of aerial film is used in a discontinuous fashion such as from one day to the next or from a morning flight to an afternoon flight, a spacer of at least four frames in length shall be rolled forward just prior to the commencement of taking new photographs. An unexposed trailer of at least four frames or more in length shall be included at the end of each roll or partial roll of film.

**2.15 Flight Data:**

The following data will appear on the inter-frame margin of each negative as clear, uniformly illuminated images of the actual display instruments.

- Time of day clock, set to local time
- Altimeter reading in feet or meters above mean sea level
- Platen ID number
- Exposure counter, which shall also display the cameras identification number and the lens focal length in inches or millimeters

**2.16 Disposition of Aerial Film:**

The exposed aerial film and any interim or final products are the property of the County. The Contractor will be responsible for storage of the film under proper conditions of controlled temperature and humidity at no cost to the County for a period of at least five years. The Contractor shall not make, sell, or loan copies of the aerial negatives or any other products without the expressed written approval of the Contracting Officer. The film shall be handled carefully before, during, and after authorized use to ensure that the quality is not degraded and is safeguarded from defects.

**2.17 Roll Film Container:**

The container for each roll of aerial film shall be made of plastic, shall not exceed 6 inches in diameter, shall contain no more than 500 feet of film, and shall become the property of the County. It shall be clearly labeled with the name of the County; name of the Contractor; date of photography; flight and exposure numbers (sequential numbers of the first and last exposures); type and serial number of the camera; the type, serial number and calibrated focal length in millimeters of the camera lens; film roll number; and the approximate scale for the negatives. The film shall not be rolled tightly on spools or in any way stretched, buckled, or distorted.

**2.18 Flight Log:**

For each flight day, the pilot or cameraman shall prepare a flight log containing the date, project name, aircraft used, and names of crew members. In addition, the following shall be prepared for each flight line: altitude, camera, magazine serial number, f-stop, shutter speed, beginning and ending exposure numbers and times, and any other comments relative to the flight conditions. These flight logs, or copies, shall be delivered to the Contracting Officer at the end of the project flights.

## **SECTION 3**

# **PHOTO LABORATORY PROCEDURES**

### **3. PHOTO LABORATORY PROCEDURES**

#### **3.01 General:**

All film and materials to be processed will be in accordance with the film manufacturer's recommended procedures for processing and developing. The film shall be handled as little as possible and as carefully as possible when laboratory processes are required. The Contractor is expressly forbidden to utilize this film for the production of any products not specified in these Specifications or in the contract with the County.

#### **3.02 Image Quality:**

Images on the aerial negatives shall be clear and sharp in detail and free from light streaks, static marks, scratches, and other blemishes. Special care shall be exercised to insure proper developing and thorough fixing and washing of all film. The development, fixing, washing, and drying of all exposed photographic film shall result in a quality image with optimal contrast, tone, balance, resolution, uniformity in range density, and fine grain quality. All film processing must be performed in a state-of-the-art processor. The imagery of the film shall be clear and sharp and evenly exposed across the format. Special care should be exercised to prevent distorting the film during processing or drying. Film shall be exposed and processed with a target density range of  $1.0 \pm 0.2$  as measured in the neat image areas of each roll of film. Minimum density should not be less than 0.3 and the maximum density should not be greater than 1.5 as measured with a densitometer with a scale range of 0 to 3.0. *Color film will be processed in accordance with the film manufacturer's recommendations. The color balance will be such that the highest level of detail will be maintained throughout the full extent of the color spectrum.* All fiducial mark images shall be clear and sharp.

#### **3.03 Film Labeling:**

Each exposure shall be clearly labeled by mechanical means in ink, or foil transfer if using a film titler, at the edge of the negative just inside the image area on the north edge for north-south flights or the west edge for east-west flights; no thermal processes shall be used. This labeling shall be at least 0.14 inches in height and shall include the following information as a minimum:

Date of            Scale of  
Photography    Photography    County Name    Flight Strip    Exposure No.

The "Scale of Photography" shall be given in inches and feet, e.g., 1" = 600', etc. "Flight Strip" numbers are not to be repeated anywhere within the photographic coverage of the contract, but will be numbered consecutively starting with Strip No. 1 and continued sequentially over all flight lines and scales. "Exposure Numbers" for any flight strip will be numbered consecutively from "Exposure No. 1" and continued to the end of that flight line. On north to south flight lines, exposure numbers will begin at the north end of the flight line, and on east to west flight lines, exposure numbers will begin on the east end of the flight line.

**3.04    Photo Center Index:**

Coordinates derived from the ABGPS and/or FAAT will be used to produce a photo center index showing the locations of all photo centers. The photo center index will be in a format that can be used on the County's GIS system or in an acceptable standard data exchange format. Each photo center shall be annotated with the x and y coordinates of its photo center point (nadir) and with its flight strip and exposure number. Each photo center index shall also include the following title information: name of the County, name of the Contractor, date (month and year) and scale of aerial photography, type of camera and the focal length of its lens, the scale of the photo index, and a north arrow. In the event two or more photo indexes are required for the County at any one scale, a diagram showing the relationship of one photo index to the others will be drawn in each photo index's margin. Photo indexes shall be oriented to the north, and the title information should appear in the south or east margin of each index. All reflights of aerial photography will be indexed. A paper plot of the photo center index as well as the photo center index digital file shall be delivered to the County.

**3.05    Contact Prints of Aerial Photography:**

If contact prints are produced as a part of the project, the contact prints of the original aerial negatives shall be prepared on double-weight, semi-matte paper or equivalent weight resin-coated paper. All prints will be clear and free from chemicals, stains, blemishes, fog, streaks, or any defects which

would render them unusable. Processing, including exposure, development, fixation, washing, and drying of all photographic materials, shall result in finished photographic prints having a fine grain quality, a normal, uniform density, and such tone and contrast that all photographic details shall show clearly within the dark and light tone areas as well as in areas with intermediate tones. All prints shall show camera fiducial marks. Contact prints shall be prepared for the County only if requested by the Contracting Officer in writing.

## **SECTION 4**

# **HORIZONTAL AND VERTICAL CONTROL**

#### **4. HORIZONTAL AND VERTICAL CONTROL**

##### **4.01 General:**

Sufficient horizontal and, if applicable, vertical control surveys shall be established by the Contractor for all photogrammetric mapping purposes. Prior to the establishment of the necessary basic horizontal and vertical control, the Contractor shall make a thorough search of the project area for existing control of second order accuracy or better, as established by the National Geodetic Survey (NGS, formerly the United States Coast and Geodetic Survey [CGS]), North Carolina Geodetic Survey (NCGS), or the North Carolina Department of Transportation (NC DOT). Additional control points established by the Contractor will be monumented with permanent monuments as described in subsection 4.05. All such control recovered or established shall be utilized to the fullest extent. All control used in the project will be paneled prior to flying the aerial photography. The Contractor will indicate on a copy of the County Contract Map the horizontal control stations (existing and to be established) that will be paneled. Control previously established in an adjacent county will be utilized by the Contractor to the fullest extent possible to assure compatibility of maps from county to county. The Contractor will provide the Contracting Officer a brief description of the equipment and methods to be used for new ground surveys prior to conducting any control surveys. All horizontal and vertical control surveys shall be performed using procedures and/or accuracy standards consistent with professional surveying and photogrammetric practices. The use of airborne GPS (ABGPS) in combination with ground survey is required; the amount of ground control may be reduced but not eliminated by the use of ABGPS technology. All surveying activities will be directed, approved, and certified by a North Carolina Professional Land Surveyor whose area of expertise is surveying.

##### **4.02 Horizontal Control Surveys:**

All basic horizontal control shall be established by GPS (Global Positioning System). At a minimum, all horizontal ground control placed as a result of this project shall be established at an accuracy level of First Order or better. NCGS and FGDC standards as applicable to the order and class of survey shall be followed. All horizontal control shall be correlated to the North Carolina State Plane Coordinate System, North American Datum NAD83(NSRS2007).

**4.03 Vertical Control Surveys:**

All basic vertical control shall be established by GPS (Global Positioning System) using NGS-58 guidelines. At a minimum, all vertical ground control placed as a result of this project shall be established at an accuracy level of Third Order Class I or better. NCGS, NGS, and FGDC standards as applicable to the order and class of survey shall be followed. All vertical control shall be correlated to the North Carolina State Plane Coordinate System, National Geodetic Vertical Datum (NAVD), 1988.

**4.04 Photo Control Contact Prints:**

If analog analytic triangulation is used in the project, all targets and horizontal and vertical control shall be located and identified on contact prints (see Section 3.05) by the Contractor. Targets and control points will be finely pin-pricked and symbolized on the face of the appropriate aerial photograph, and the locations will be precisely described on the back of the photo. Photo control prints will be black and white contact prints.

**4.05 Permanent Monuments:**

If requested by the Contracting Officer in writing, some or all control points established by the Contractor will be monumented with permanent monuments which meet the requirements for permanent monuments established by the NCGS.

**4.06 Survey Records:**

The following information shall be delivered to the Contracting Officer as hard copy and a digital (ASCII) file:

a. Field Notes and Observation Logs. Field Notes and Observation Logs shall be carefully and neatly prepared, identified, indexed and preserved. All data regarding the establishment and extension of horizontal and vertical control, including descriptions of all established and recovered monuments, shall be recorded. Where existing control points are recovered by the Contractor in extending the basic control, the field notes shall contain:

- (1) Information as to the general condition of the recovered mark,
- (2) The original description,
- (3) Exact letter and numbers stamped on (not cast in) the mark;
- (4) Amended description, if applicable,
- (5) Additional tie data, if any,
- (6) A sketch of the location as appropriate to facilitate future recovery.

Observation Logs shall contain:

- (1) Monument name and location
- (2) Name and title of the observer
- (3) Time of arrival at monument
- (4) Height of instrument at beginning of observation (in feet and meters)
- (5) Type and serial number of the GPS receiver(s)
- (6) Type and serial number of the Tribrach(s) or type of fixed height pole
- (7) Observation period (indicate if programmed)
- (8) Epoch rate
- (9) Satellites observed
- (10) Height of instrument at end of observation (in feet and meters)
- (11) Additional notes describing problems encountered during the observation period

An additional sheet containing an obstruction diagram shall be provided for each existing and/or new monument observed. Each baseline shall be identified by a number and brief description in the field notes. If the field notes are electronically recorded, printouts of the electronically recorded field notes shall be provided.

b. Computations. The Contractor shall provide Least Squares adjustments of all horizontal control data. Adjustment output for both unconstrained

and constrained adjustments shall contain the following information referenced to observed stations:

- (1) Fixed coordinates (Northings and Eastings) in U.S. Survey feet
- (2) Adjusted coordinates (Northings and Eastings) in U.S. Survey feet
- (3) Station error ellipse values (semi-major and semi-minor axis values) in feet
- (4) Relative (baseline) error ellipse values (semi-major and semi-minor axis values) in feet
- (5) Precisions (ppm) of observed baselines
- (6) Number of Degrees of Freedom (Redundancy).

All field records and computations, and all results, shall be delivered to the County with the control data upon completion of the work. Computations must be made in accordance with the published standards of the FGCC

- c. Control Diagram. The Contractor shall furnish a schematic control diagram indicating all horizontal and vertical control pertinent to this project on a copy of the County Contract Map (subsection 2.01). This schematic diagram shall show all existing and established control points properly identified in their approximate location. It shall also show all observed baselines with their designations to include the beginning and ending points.
- d. Control Data. The Contractor shall provide the Contracting Officer with the complete information as listed below for all monumented control points established and/or recovered by the Contractor:
  1. Information on control points established by the Contractor shall include the following information.
    - (a) Designation of station (County name and sequential number).
    - (b) Establishing agency (name of Contractor or subcontractor who established the control point).
    - (c) Date of establishment.
    - (d) Horizontal and/or vertical control data.
    - (e) A complete description of the nature and location of the point to include a "to reach" description referenced to nearby landmarks (e.g. proceed from the intersection of Aker Road [SR 1010] and Stagecoach Road [SR 1012]...; proceed from US 64 bridge over Neuse River...) and identified by field survey ties (bearing and distance) to

three or more definable photo image points in the immediate vicinity.

- (f) The location of each marked horizontal control point, symbolized on the face of the appropriate photograph by a triangle and annotated on the back with reference to its station designation as in (a) above.

2. Information on existing points recovered by the Contractor. The information will be submitted on a completed NCGS Station Recovery Form (see the web based form at NCGS's web site).

- e. GPS Observation Summary. The observation summary shall contain a discussion of the results of the ground GPS survey, including accuracies achieved, problems encountered, and a statement of the overall quality of the survey. The summary must contain the signature and seal of the Professional Land Surveyor certifying that the survey meets accuracy requirements and is tied to the proper datums.

#### **4.07 Feet/Meter Conversions:**

The U. S. Survey Foot (1 meter = 3.2808333333 feet) shall be used in all conversions of North Carolina State Plane Coordinates from meters to feet or feet to meters. All final control data shall be in feet, and the datum used (e.g. NAD83(NSRS2007)) will be noted on any sheets bearing coordinates.

#### **4.08 Global Positioning System (GPS):**

All basic horizontal and vertical control shall be established by GPS (Global Positioning System). All GPS network design, observation techniques, and data

adjustments must be according to the specifications in the most current FGCC

“Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative

Positioning Techniques” and the specifications and standards of the NCGS.

#### **4.09 Airborne GPS (ABGPS)**

The use of airborne GPS (ABGPS) in combination with ground survey is required; the amount of ground control may be reduced but not eliminated

by the use of ABGPS technology. The following specifications shall be met for airborne GPS:

- (a.) General. Airborne GPS solutions shall be required to utilize dual-frequency GPS systems during the aerial photography missions. The Contractor shall post-process the airborne GPS data relative to simultaneous observations collected at fixed land-based reference stations. Geodetic positions corresponding to the photo centers at the instant of exposure shall be calculated and (later) combined with ground control point values in an analytical aerotriangulation solution.
- (b.) Accuracy. Camera perspective centers must be accurate to within .10m in X, Y, and Z. GPS antenna positions shall be accurate to within .05m.
- (c.) Ground Stations. Simultaneous to the aerial photography and use of airborne GPS, a minimum of two static GPS reference receivers must be used to record satellite data over known geodetic control points on the ground. These additional receivers must be active during the entire flight mission. The base stations must be in the most appropriate locations within the project area.
- (d.) Satellite Geometry. The PDOP or GDOP shall not be greater than three (3) for 90 percent of the flightlines and not greater than five (5) for the remaining 10 percent.
- (e.) Post-processing Software. The GPS post-processing software must be capable of backward and forward processing.
- (f.) Reporting. At the conclusion of Airborne GPS collection, the Contractor shall be required to submit a report of GPS observations and results data, observation logs, and data analysis and adjustments. This report shall be kept for reference. The County reserves the right to obtain any and all data, readings, records, or any other information relating to the conduct of the survey for this project from the Contractor, should there be a question about the validity of the survey.

#### **4.10 Targeting:**

The Contractor is required to target a sufficient number of control points to meet the accuracy requirements of the project prior to the acquisition of

photography. It is the responsibility of the Contractor to place the ground control targets (panels), to monitor and repair the targets to ensure that targets have not been damaged or removed before the aerial photography has been completed, and to remove the targets in a timely fashion once the aerial photography has been completed. Targets shall be of an appropriate size, color, and shape to adequately appear on the selected scale of aerial photography. If the targets are painted, the paint should be such a type that is biodegradable and will wash away over a relatively short time. Control points may be marked and targeted for aerial photography and then surveyed after the photography has been flown.

**4.11 Property Entry:**

Targets and ground control points should be placed on public property whenever possible; however, it is recognized that it may be desirable or necessary to locate some targets and control points on private property. It is the Contractor's responsibility to obtain owner's permission when it is necessary to pass through or locate targets or control points on private property. At the written request of the Contractor, the Contracting Officer will assist in any reasonable effort to attain permission for entry to private property.

## **SECTION 5**

# **ANALYTICAL TRIANGULATION**

### **5. ANALYTICAL TRIANGULATION**

**5.01** Aerotriangulation is essentially an interpolation tool, capable of extending control points to areas between ground survey control points using several contiguous uncontrolled stereomodels. The Contractor shall use fully

analytical aerotriangulation to extend the horizontal control from relatively few ground survey control points to additional supplemental control points – pass points. Each stereomodel is to be scaled and leveled using the adjusted coordinate values of the pass points located in the stereomodel. Ground control should be located along the perimeter of the project area; within the project area, ground control should be added as necessary to limit error propagation in the adjusted pass point coordinates. The use of airborne GPS (ABGPS) in combination with ground survey is required; the amount of ground control may be reduced but not eliminated by the use of ABGPS technology. An aerotriangulation solution should never be extended beyond the ground control of the project area. In conducting the aerotriangulation, the Contractor shall perform a fully analytical simultaneous bundle adjustment using a weighted least squares adjustment to meet accuracy requirements.

**5.02 Nominal Scales for Triangulation:**

Aerial triangulation may be used for horizontal scaling to produce maps of 1" = 400', 1" = 200', and 1" = 100'. The nominal scale of the mapping photographs will be 1" = 2,400' for 1" = 400' maps, 1" = 1,200' for 1" = 200' maps, and 1" = 600' for 1" = 100' maps.

**5.03 Ground Coordinate Systems:**

All ground positions determined by aerial triangulation will be in the North Carolina State Plane Coordinate System, NAD83(NSRS2007) and NGVD 1988.

**5.04 Standards:**

- a. Positional Accuracy. The root-mean-square error (vector of both northing and easting coordinate errors) of passpoints established by aerial triangulation shall not exceed 1/8,000 of the flight altitude.
- b. Elevation Accuracy. The elevation accuracy of passpoints shall not exceed 1/6,000 of the flight altitude.

**5.05 Softcopy Aerotriangulation**

Aerotriangulation shall be accomplished by softcopy procedures that involve softcopy workstations, fully analytical aerotriangulation software, and high-resolution scanners. All interior, exterior, and control point mensuration shall be read from the scanned images. The Contractor must follow accepted softcopy aerotriangulation procedures and utilize equipment that will achieve the aerotriangulation accuracy required to meet or exceed required orthophoto accuracy standards. Software and hardware used by the Contractor must be capable of model orientation in both the stereo and monoscopic modes, capable of interior, relative, and absolute orientation, as well as single photo resection. Once acceptable scanned images are created, the softcopy aerotriangulation process used by the Contractor shall conceptually follow the process used with a traditional analytical stereoplotter. Latitude will be used in allowing the Contractor to use specific expertise in softcopy aerotriangulation as it relates to the number and type of pass points selected. Individual scanned photo frames will carry a minimum of nine (9) pass points, with the exception of end frames of flight lines which will carry a minimum of six (6) pass points; however, it is assumed that more pass points per frame will be selected to improve the triangulation solution. The Contractor is ultimately responsible for designing the aerotriangulation scheme that will meet the accuracy requirements of the project.

**5.06 Aerial Triangulation Report:**

Immediately upon completion of all aerial triangulation, the Contractor will prepare a formal aerial triangulation report for submission to the Contracting Officer. Two copies of the report are required and shall include, but not be limited to, the following:

- a. Control and Flight Line Indexes. Control and flight lines indexes
  - Flight lines
  - Exposure stations or model layout
  - All control points appropriately labeled with station designations, computer designations (if any), agency responsible for establishing the stations, and orders of accuracy

All indexes will be generated on suitable materials at a scale suitable for presentation. The indexes will contain grid lines labeled with their corresponding northing and easting coordinate grid values. The indexes will also be labeled with the County name, map scale, title, and date.

b. Aerial Triangulation Results.

1. Sigma naught.
2. GPS accuracy of camera station.
3. Standard errors of adjusted tie-point terrain coordinates (RMS errors in x,y for horizontal coordinates) referenced to photo scale in micron and ground units.
4. Standard error of adjusted tie-point terrain coordinates (RMS errors of z vertical coordinates) referenced to photo scale in micron and ground units.
5. RMS errors (absolute accuracy) of x,y and z at independent checkpoints in microns at photoscale and in ground units.
6. Space resection parameters for each frame of aerial photography included in the aerial triangulation adjustment.
7. Photogrammetric measurements for each camera fiducial mark and photo center measured for each frame included in the aerial triangulation adjustment.
8. All misclosures at ground control points with and without use of checkpoints.
9. Computer printout of the final adjusted aerial triangulation solution to horizontal and vertical ground control. The printout should contain the final State Plane Coordinates for all ground control points, pass points, and checkpoints.
10. Identification of all points which were included in the initial solution and were subsequently discarded, with an explanation of the reasons for being discarded.
11. Identification of the weighting factors applied to all points used in the final solution.
12. An ASCII file on CD containing the coordinate data and the results of the FAAT adjustments.

c. Narrative. The report shall include a brief narrative tying together items 5.05 a. and b. as well as descriptions of equipment, procedures, and computer programs used. Root-mean square (RMS) error

summaries shall be provided for bundle adjustment photographic measurement residuals or strip tie point residuals and misclosures and misclosures at control/check points. In addition, significant misfits encountered at control points, and steps taken to analyze such misfits and to rectify the discrepancies, will be described. All control shall be listed in the report with an explanation of how the control was used in the FAAT. Also, the report shall contain a statement signed and sealed by the land surveyor/photogrammetrist in charge of the project that the aerial triangulation solution will provide sufficient control to produce orthophotos that meet the accuracy requirements of the project.

**5.07 Drop Points:**

Drop points may be used to control lower altitude flights for direct compilation from photography of smaller scale. These points shall be marked, measured, and carried as extra passpoints in the aerial triangulation of the higher altitude photography.

**5.08 Checkpoints:**

Checkpoints are horizontal control points that have been established through ground control procedures by the Contracting Officer for accuracy checking purposes and will not be used in the analytical adjustment.

**SECTION 6**  
**DIGITAL ORTHOPHOTOS**



## 6. DIGITAL ORTHOPHOTOS

### 6.01 General:

A digital orthophoto is a digital image that has the properties of an orthographic projection. It is digitized from a perspective aerial photograph by differential rectification so that image displacements caused by camera tilt and relief terrain are removed. The digital orthophoto is created by scanning an aerial photograph diapositive transparency or an aerial photograph negative with a precision image scanner. The scanned data file is then digitally rectified to an orthographic projection by processing each image pixel through photogrammetric space resection equations. This process requires, as input, ground control points acquired from ground surveys and airborne GPS and developed in aerotriangulation, camera orientation parameters, and a digital terrain/elevation model. A digital image, developed by scanning a traditional hardcopy orthophoto, is not considered a digital orthophoto under these specifications and is not acceptable as a digital orthophoto.

### 6.02 Orthophoto Accuracy Standards:

Orthophotos shall meet the ASPRS Class II horizontal accuracy standards as follows:

<u>Orthophoto Scale</u>	<u>ASPRS Limiting RMSE in X or Y (Class II)</u>
1" = 400'	8.0'
1" = 200'	4.0'
1" = 100'	2.0'
1" = 50'	1.0'

All orthophotos may be subject to quality control testing by the Contracting Officer, by independent third parties, and/or by the Contractor working under direct Contracting Officer review to ensure that orthophotos comply with the accuracy requirements listed above.

### 6.03 Aerial Photography:

The aerial photography used to develop digital orthophotos shall be vertical photography flown during the period when deciduous trees are barren and when the sun angle or elevation is not less than 33 degrees above the horizon. The photography shall have an endlap of sixty percent (60%);

sidelap between adjacent parallel flight lines shall average thirty percent (30%); crab shall not be in excess of three (3) degrees; and, tilt of the camera from verticality at the instant of exposure shall not exceed three (3) degrees.

**6.04 Scale of Aerial Photography Negatives:**

The altitude above average ground elevation for aerial photography shall be such that the negatives will be at the scale specified in the following schedule:

<u>Description</u>	<u>Orthophoto Scale</u>	<u>Negative Scale</u>
Rural	1" = 400'	1" = 2,400'
Semi-Rural	1" = 200'	1" = 1,200'
Urban	1" = 100'	1" = 600'
Urban	1" = 50'	1" = 300'

Negatives deviating from the above scales by more than five percent (5%) may be rejected

**6.05 Negatives/Diapositives For Scanning:**

The original aerial photography negatives and/or one set of diapositives made from the original aerial photography negatives (not from duplicate negatives) shall be used for the scanning operation.

- a. Original aerial photography negatives. The negatives are to be handled with the utmost care to ensure maximum image quality. The scanned images will preserve the clarity and detail of the original negatives to the maximum extent possible. The scanning process will be done in such a manner (dodging) as to eliminate the incidence of “hot spots” in the resulting scanned images. Care will be taken to prevent lint from collecting on the original negatives. Fiducial marks shall be included in the resulting scanned images.
- b. Diapositives. The diapositives are only to be used for scanning and are to be handled with the utmost care to ensure maximum image quality. The diapositives shall not contain defects such as out of focus imagery, dust marks, scratches, extraneous marks or annotation, discontinuities in tone, or other inconsistencies except those resulting from corresponding defects in the original aerial negatives which cannot be remedied during image processing. The diapositives and the resulting scanned images will preserve the clarity and detail of the original negatives to the

maximum extent possible. Care will be taken to prevent lint from collecting on the original negatives and diapositives. Fiducial marks shall be included in the diapositives and the resulting scanned images.

**6.06 Scanning Device:**

The device used for scanning shall be a precision instrument designed and manufactured for use on aerial film and/or diapositives with an aperture which can produce a scanning resolution of at least 9.5 microns (approximately 2600 dots per inch), geometric accuracy of less than 5 microns RMSE, and a capability of resolving 256 levels of gray and 256 hue levels each of red, green, and blue bands. Scanner specifications, a camera(s) calibration report, diagnostic reports, and/or other test results showing accuracy, resolution, and ability to distinguish tonal qualities shall be submitted to the Contracting Officer for approval before proceeding with the scanning phase.

**6.07 Scanning Resolution:**

Negatives and/or diapositives will be scanned so that the resultant pixel resolution for 1" = 600' aerial photography shall be .25 foot, 1" = 1200' aerial photography shall be .50 foot, and 1" = 2400' aerial photography shall be 1 foot. Pixel resolution shall not be interpolated to a finer resolution than that developed through the initial scanning; interpolation of pixel resolution to a coarser resolution is allowed.

**6.08 DTM/DEM:**

- a. A Digital Terrain Model (DTM)/Digital Elevation Model (DEM) shall be developed at a density level necessary to support the orthophoto production. Terrain/elevation data used in the development of the DTM/DEM shall be captured by photogrammetric techniques using a 1st order analytical stereoplotter or a softcopy workstation or derived from recent LIDAR data. The DTM/DEM will consist of points spaced at regular intervals along a grid, points of significant high or low elevations, and ortho specific breaklines at all significant terrain breaks. It is not necessary to capture breaklines at all curbs, ditches, stream

banks, or other similar minor terrain breaks. Elevation/terrain data shall be captured at a density level sufficient to accurately represent the shape of the ground and to meet the required orthophoto accuracy standards of ASPRS Class II. A DTM/DEM developed either wholly or in part from autocorrelation shall not be utilized in the production of the digital orthophotos.

- b. The DTM/DEM data is not to be stored as a record (Z component) for each pixel of the orthophoto image.
- c. The Contractor shall provide to the County the DTM/DEM in a format that can be used on the Counties' GIS system or in an acceptable standard data exchange format. Note: The DTM/DEM data will be used for the draping of images and data sets, and it is acknowledged that the DTM/DEM is not suitable for detailed engineering activities.
- d. DTM/DEM data from a prior orthophoto project shall not be used for a new project. If approved by the Contracting Officer, DTM/DEM data from a prior ortho project may be used for a new project after extensive updating by the Contractor.

**6.09 Image Radiometry:**

There shall be no areas of an orthophoto where ortho production process was incomplete due to incomplete data (i.e., lack of DTM/DEM data, image gaps, etc.). The finished digital orthophoto shall have an image quality the same as or better than the original unrectified input image.

**6.10 Ground Resolution:**

The horizontal ground resolution (x and y components) of the finished digital orthophoto image (both hardcopy and softcopy) shall be at a minimum of 1 foot for 1" = 400' orthophotos, .50 foot for 1" = 200' orthophotos, and .25 foot for 1" = 100' orthophotos.

**6.11 Image Rectification Algorithm:**

Image rectification shall be carried out using either cubic convolution or better algorithm.

**6.12 Softcopy Coverage Area:**

The geographic extent of each softcopy digital orthophoto shall be based on the North Carolina Land Records Management Program's "Basic Modular Unit" and shall cover the same geographic area. The softcopy digital orthophoto shall only contain the neat image of the corresponding map unit, and there shall be no image overlap between adjacent softcopy digital orthophotos.

**6.13 Image Mosaicking:**

Mosaicking shall be accomplished using both automated and interactive (manual) methods; the sole use of fully automated methods is not acceptable. Mosaic join lines shall not cross through building, bridges, or other structures or items which could be considered as a visual entity and shall try to follow features such as roads, tree lines, water bodies, etc when possible. Acceptable mosaicking must produce quality orthophoto imagery of consistent tone and contrast and must do so without obvious join lines.

- a. Interior mosaicking. Interior mosaicking occurs when an orthophoto cannot or is not made from a single scanned aerial photograph, and the orthophoto is made from two or more scanned aerial photographs. The join line between photograph images shall be chosen so as to minimize the obtrusiveness of the join itself and to reduce the difference in tone and contrast between the different photograph images. Interior mosaicking shall not affect the positional accuracy of the orthophoto. The Contractor shall provide the Contracting Officer with sample softcopy images to evaluate. The Contracting Officer will select one mosaicked image that will become the reference to which all subsequent softcopy orthophotos will be compared for interior mosaicking acceptance/rejection.
- b. Edge mosaicking and feathering. Mosaicking and feathering at/near the edge lines of adjacent orthophotos is permitted in order to create a nearly seamless image of the entire project area and to minimize any visual edge lines of adjacent orthophotos due to tonal variations. The mosaicked edge line between adjacent orthophotos shall be chosen so as to minimize the obtrusiveness of the edge line itself. If feathering (a process used on the join between two adjacent orthophotos to help reduce the difference in tone and contrast between the adjacent orthophotos) is used along the edge line, it shall not result in any

noticeable image degradation such as image blurring or double imagery. Edge mosaicking and feathering shall not affect the positional accuracy of the orthophoto. The Contractor shall provide the Contracting Officer with samples of edge mosaicking and feathering to evaluate. The Contracting Officer will select one image set (four adjacent orthophotos) which will become the reference to which all sequent softcopy orthophotos will be compared for edge mosaicking and feathering acceptance/rejection.

**6.14 Border Data:**

Traditional hardcopy map border data such as map number, north arrow, grid ticks, grid coordinate values, etc shall not be a part of the softcopy digital orthophoto image.

**6.15 Sample/Pilot Products:**

Prior to initiating check plots and final softcopy production, the Contractor shall provide the Contracting Officer with sample softcopy image sets to evaluate and accept as examples of overall image quality. The Contracting Officer will select one or more image sets that will become the reference to which all subsequent softcopy orthophotos will be compared for image quality acceptance/rejection. The sets will consist of four or more adjacent, like scale orthophotos and also three or more adjacent, unlike scale (e.g. 100' and 200') orthophotos.

**6.16 Orthophoto Image Quality:**

- a. The softcopy orthophoto image shall be compared to the original aerial negative image to determine if the orthophoto image has the same, or better image quality as the original aerial negative. The softcopy orthophoto shall not contain defects such as out of focus imagery, dust marks, scratches, discontinuities in tone, or other inconsistencies except those resulting from corresponding defects in the original aerial negatives which cannot be remedied during image processing.
- b. All softcopy 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.

**6.17 File Compression:**

The Contractor shall deliver to the County a complete set of uncompressed digital orthophoto images in a format (e.g. TIFF, BIL) and media (e.g. CD-Rom, tape, DVD) selected by the Contracting Officer. In addition to the uncompressed images, the Contractor shall also deliver to the county two sets of compressed orthophoto images using an industry accepted compression tool agreed upon by the Contracting Officer. The Contractor shall prepare a set of sample compressed images of two adjacent orthophotos with compression ratios of 1:10, 1:20, 1:30, 1:40, and 1:50 on the media. The Contractor shall create two sets of the compressed orthophotos using the Contracting Officer's chosen compression ratios for delivery to the county on the media.

**6.18 Softcopy Mask (Optional):**

A softcopy mask may be prepared for each digital orthophoto. The softcopy mask will consist of the items required on a North Carolina Land Records Management Program hardcopy orthophoto and these items will be in the same proportions and locations as found on the hardcopy orthophoto. When a digital orthophoto image and its corresponding softcopy mask are plotted together at regular hardcopy scale, the result will be a product that is similar in size, shape, content, and item location to a North Carolina Land Records Management Program hardcopy orthophoto.

**6.19 Deliverable Product Format:**

- a. The Contractor will only provide digital data to the County in a format that can be used on the County's GIS system or in an acceptable standard data exchange format. If the Contractor's GIS system either uses or can produce digital files in the same format that is used by the County, the information shall be transferred in that format. If there is a specific intermediate format that will facilitate the transfer of the data between the two computer mapping systems, then the intermediate format may be used with the written approval of the Contracting Officer. Care will be taken by the Contractor in the construction of the data files to assure that data is compatible with and will work on the County's GIS system. Data will not be considered as delivered until the data has been successfully loaded and utilized on the County's system.

(This assumes that the County has an operating GIS system at the time of delivery and that problems are wholly data related and not hardware or software related)

- b. The Contractor shall transfer the digital data to the County on a media agreed upon between the Contracting Officer and the Contractor. Each media item will be accompanied by a report or label that specifies the name of each file, the size of each file, the map number of each map on the media, and the name of the Contractor.

**6.20 Deliverable Items by Contractor:**

At the completion of the mapping project or at a time which facilitates the flow of work, the Contractor shall deliver to the Contracting Officer for his/her acceptance the following items:

- a. One copy of each digital orthophoto image and its associated georeferencing/header file on the selected media. The georeferencing/header file shall contain the following items and shall be in the format as shown in attachment 1:
  - (1) Georeferencing information
  - (2) Map name or number
  - (3) Nominal map scale
  - (4) Location of Map - (county)
  - (5) Name of Contractor
  - (6) Name and license number of land surveyor/photogrammetrist in charge of project
  - (7) Coordinate system of map - (NC State Plane)
  - (8) Horizontal datum
  - (9) Map unit - (feet)
  - (10) Feet / meter conversion – (US Survey Foot)
  - (11) Image pixel resolution
  - (12) Lower left map coordinate
  - (13) Upper left map coordinate
  - (14) Upper right map coordinate
  - (15) Lower right map coordinate
  - (16) Aerial camera type
  - (17) Lens serial number
  - (18) Lens resolving power (AWAR)

- (19) Lens focal length
- (20) System resolving power (AWAR)
- (21) Photography film type
- (22) Negative scale of photography
- (23) Photography date
- (24) Map horizontal accuracy
- (25) DEM development
- (26) Mapping standards used – (NC Land Records Management Mapping Specifications, 2007)

- b. One copy of each softcopy mask on the selected media (Optional).
- c. One Mylar copy of each digital orthophoto with its corresponding softcopy of mask if specified by the Contracting Officer at the beginning of the project.
- d. One copy of the DTM/DEM used in the development of the digital orthophotos in uncompressed ASCII format on the selected media.
- e. FGDC compliant Metadata (See sample provided – Attachment 2).
- f. Map index in hardcopy (paper) and digital form showing the layout/location of the orthophotos.
- g. Two compressed files at the specified compression ratios for each orthophoto on the specified media.
- h. Project Report as described in Section 6.23.
- i. The original aerial film.
- j. The diapositives as described in Section 6.05, if made.

**6.21 Hardcopy Orthophotos:**

If specified by the Contracting Officer at the beginning of the project, one positive reproducible of each digital orthophoto shall be provided on polyester material with a minimum thickness of .003 inch. The hardcopy orthophotos shall be prepared from the digital orthophoto files and the corresponding softcopy masks. The hardcopy orthophotos are to be high quality products using a “filmwriter” or a comparable photographic imaging process; hardcopy orthophotos produced from a plotter are not acceptable.

**6.22 Media/Packaging:**

The Contractor will deliver the digital orthophoto image files on the exchange media as agreed upon between the Contracting Officer and the Contractor.

### **6.23 Project Report:**

At the completion of the project, the Contractor shall deliver to the Contracting Officer two copies of a project report. One copy of the project report shall be hardcopy (paper); the second copy of the project report shall be softcopy (as a PDF file) and shall accompany and be a part of the digital orthophoto delivery. The project report shall contain the following information:

- (1) Date of photography by scale.
- (2) Altitude of camera and camera focal length.
- (3) Date of data set compilation by scale.
- (4) Coordinate system for horizontal and vertical control denoting metric or English units (i.e., NAD83(NSRS2007), assumed, or other coordinate system).
- (5) A list of the ground control points used for the project. The minimum data shown for each point shall include: physical attributes (i.e. iron rod, railroad spike, etc), X and Y Grid coordinates, and elevation, as applicable.
- (6) A statement of accuracy of the orthophotos.
- (7) A county map of suitable scale and detail depicting the individual orthophotos prepared by scale and map number and a count of the total number of orthophotos prepared by scale.
- (8) Company name, address and phone number.
- (9) The name of the County agency for whom the project was conducted.
- (10) A statement that the orthophotos meet the Land Record Management Program Mapping Specifications and, if applicable, a listing of exceptions to the Mapping Specifications.
- (11) A certificate, substantially in the following form or a form required by the North Carolina Board of Engineers and Land Surveyors, signed, sealed, and dated by the surveyor in control of the project:

“ I, \_\_\_\_\_, certify that this project was completed under my direct and responsible charge from an actual photogrammetric survey made under my supervision: that

this survey was performed to meet Land Records Management Program Standards as applicable; that the imagery and/or original data was obtained on \_\_\_\_\_; that the survey was completed on \_\_\_\_\_.”

A project is not considered completed until a Project Report has been submitted to and accepted by the Contracting Officer.

# Attachment 1

## ORTHOPHOTO GEOREFERENCING/INFORMATION HEADER FILE

1.0000000000000000  
0.0000000000000000  
0.0000000000000000  
-1.0000000000000000  
2000000.500000  
439999.500000  
MAP NAME/#=040301  
NOMINAL MAP SCALE=1 INCH EQUALS 200 FEET  
LOCATION=CUMBERLAND COUNTY, NORTH CAROLINA  
IMAGE PRODUCED BY =ORTHO MAPPING CO. RALEIGH, NC  
LAND SURVEYOR/PHOTOGRAMMETRIST IN CHARGE=JOE CAROLINA, NC PLS #123456  
COORDINATE SYSTEM=NC STATE PLANE  
HORIZONTAL DATUM=NAD83(NSRS2007)  
MAP UNIT=FEET  
FEET/METER CONVERSION=US SURVEY FOOT (1 METER = 3.2808333333 FT)  
IMAGE PIXEL RESOLUTION=0.50 FOOT  
LOWER LEFT MAP COORDINATE=E2000000 N435000  
UPPER LEFT MAP COORDINATE=E2000000 N440000  
UPPER RIGHT MAP COORDINATE=E2005000 N440000  
LOWER RIGHT MAP COORDINATE=E2005000 N435000  
AERIAL CAMERA TYPE=WILD RC-30  
LENSE SERIAL NUMBER=13328  
LENS RESOLVING POWER (AWAR)=113 CYCLES/MM AREA-WEIGHTED AVERAGE RESOLUTION  
LENS FOCAL LENGTH=153.462 MM  
SYSTEM RESOLVING POWER (AWAR)=55 CYCLES/MM AREA WEIGHTED AVERAGE RESOLUTION  
PHOTOGRAPHY FILM TYPE=KODAK 2405, BLACK & WHITE  
NEGATIVE SCALE OF PHOTOGRAPHY=1:14000 (1"=1200')  
PHOTOGRAPHY DATE=03/08/2008  
MAP HORIZONTAL ACCURACY= LIMITING RMSE IS 4 FEET IN X OR Y; MEETS OR EXCEEDS ASPRS  
CLASS II ACCURACY STANDARDS  
DEM=THE DIGITAL ELEVATION MODEL FOR THIS ORTHOPHOTO WAS DEVELOPED FROM LIDAR  
DATA FROM THE NC FLOODPLAIN MAPPING PROJECT. BREAKLINE DATA WAS COMPILED USING  
ANALYTICAL DIGITAL PHOTOGRAMMETRIC TECHNIQUES AND IS INTENDED TO SUPPORT  
ORTHOPHOTO PRODUCTION ONLY - IT IS NOT SUITABLE FOR THE CREATION OF ACCURATE  
CONTOUR MAPPING.  
MAPPING STANDARDS=MAP COMPILED AND PRODUCED TO NC LAND RECORDS MANAGEMENT  
PROGRAM MAPPING SPECIFICATIONS, 2007

Example Metadata Record

## Attachment 2

### Digital Black and White Orthophotography for County A, North Carolina, March 2001 (1-foot pixels)

Metadata also available as:

#### Metadata:

- Identification\_Information
- Data\_Quality\_Information
- Spatial\_Data\_Organization\_Information
- Spatial\_Reference\_Information
- Entity\_and\_Attribute\_Information
- Distribution\_Information
- Metadata\_Reference\_Information

#### *Identification\_Information:*

##### *Citation:*

##### *Citation\_Information:*

*Originator:* County A GIS Department

*Publication\_Date:* 20040301

##### *Title:*

Digital Black and White Orthophotography for County A, North Carolina, March 2001 (1-foot pixels)

*Online\_Linkage:* <<http://www.countya.nc.org/gis.html>>

*Online\_Linkage:* getmap request

##### *Description:*

##### *Abstract:*

An orthoimage is remotely sensed image data in which displacement of features in the image caused by terrain

relief and sensor orientation have been mathematically removed. Orthoimagery combines the image characteristics of a photograph with the geometric qualities of a map. For this dataset, the orthoimages were produced at a 1-foot pixel resolution for County A, North Carolina, flown in March 2001. Mapping scale is 1"=200' (1:2400). Negative scale of the photography is 1"=1200'.

##### *Purpose:*

This data was developed to provide a spatially accurate, high resolution imagery to be used in the creation of

other data layers, including the parcel layer. This Aerial Photography layer is also a primary base layer.

##### *Supplemental\_Information:*

These orthophotos were produced from an aerial flight in March 2001. Mapping scale is 1"=200' (1:2400). Negative scale of the photography is 1"=1200'.

**Note:** Many of the entries in this sample metadata record were based upon actual information found within Henderson County's and Johnston County's metadata records.

Thanks to both North Carolina Counties for allowing their metadata records to be referenced for this sample.

##### *Time\_Period\_of\_Content:*

##### *Time\_Period\_Information:*

##### *Range\_of\_Dates/Times:*

*Beginning\_Date:* 20040301

*Ending\_Date:* 20040309

2

*Currentness\_Reference:* publication date

##### *Status:*

*Progress:* Complete  
*Maintenance\_and\_Update\_Frequency:* Unknown  
*Spatial\_Domain:*  
*Bounding\_Coordinates:*  
*West\_Bounding\_Coordinate:* -82.745135  
*East\_Bounding\_Coordinate:* -82.249892  
*North\_Bounding\_Coordinate:* 35.502228  
*South\_Bounding\_Coordinate:* 35.140195  
*Keywords:*  
*Theme:*  
*Theme\_Keyword\_Thesaurus:* None  
*Theme\_Keyword:* Orthophotos  
*Theme\_Keyword:* Digital Ortho  
*Theme\_Keyword:* Photography  
*Theme\_Keyword:* Photo  
*Theme\_Keyword:* Ortho  
*Theme\_Keyword:* Orthophotography  
*Theme\_Keyword:* Aerial Photography  
*Theme\_Keyword:* Orthoimagery  
*Theme\_Keyword:* Ortho Photo  
*Theme:*  
*Theme\_Keyword\_Thesaurus:* ISO 19115 Topic Category  
*Theme\_Keyword:* imageryBaseMapsEarthCover  
*Place:*  
*Place\_Keyword\_Thesaurus:* None  
*Place\_Keyword:* County A  
*Place\_Keyword:* North Carolina  
*Access\_Constraints:* None  
*Use\_Constraints:*  
County A GIS Department shall not be held liable for any errors in this data. This includes errors of omission, commission, errors concerning the content of the data, and relative and positional accuracy of the data. This data cannot be constructed to be a legal document. Primary sources from which this data was compiled must be consulted for verification of information contained in this data. This data may not be resold.  
*Point\_of\_Contact:*  
*Contact\_Information:*  
*Contact\_Organization\_Primary:*  
*Contact\_Organization:* County A GIS Department  
*Contact\_Position:* GIS Coordinator  
*Contact\_Address:*  
*Address\_Type:* mailing and physical address  
*Address:* 123 Main St  
*City:* City A  
*State\_or\_Province:* North Carolina  
*Postal\_Code:* 12345  
*Country:* USA  
*Contact\_Voice\_Telephone:* (987) 654-3210  
*Contact\_Facsimile\_Telephone:* (123) 456-7890  
*Contact\_Electronic\_Mail\_Address:* gisordinator@countya.nc.org  
*Hours\_of\_Service:* Monday - Friday 8:00am - 5:00pm  
*Contact\_Instructions:* Email is preferred.  
*Data\_Set\_Credit:*  
Orthophotos were flown and processed by Aerial Photos, Inc under contract to County A, North Carolina.  
*Native\_Data\_Set\_Environment:*

Microsoft Windows 2000 Version 5.1 (Build 2600) Service Pack 1; ESRI ArcCatalog 8.3.0.800

*Data\_Quality\_Information:*

*Logical\_Consistency\_Report:*

All orthoimages are individually inspected for content, misalignments along mosaic seamlines, and void areas.

No digital image dodging or enhancement was performed. Source information was collected and verified manually during the production process.

*Completeness\_Report:*

All imagery is visually inspected for completeness to ensure that no gaps or image misplacements exist in coverage area. Source photography is leaf-off.

*Positional\_Accuracy:*

*Horizontal\_Positional\_Accuracy:*

*Horizontal\_Positional\_Accuracy\_Report:*

Map horizontal accuracy: the limiting RMSE is 4' in x or y; meets or exceeds ASPRS Class II Accuracy Standards

*Lineage:*

*Process\_Step:*

*Process\_Description:*

Each image was scanned from film-stable source at a resolution of 20 micrometers. Airborne GPS provided the camera station X, Y, and Z coordinates and was used as control. Available ground control was used to test

the results of the aerotriangulation adjustment. External orientation parameters derived from the aerotriangulation solution were used to provide the horizontal control for each photograph. Vertical control for the orthorectification process was obtained from both LIDAR and existing Digital Elevation Models (DEM). During the orthorectification process, elevation data were extracted and resampled to meet userspecified

intervals and bounds. Orthophoto creation complies with "2004, Land Records Management Program Mapping Specifications."

*Process\_Date:* 20020310

*Process\_Contact:*

*Contact\_Information:*

*Contact\_Organization\_Primary:*

*Contact\_Organization:* Aerial Photos, Inc

*Contact\_Position:* Land Surveyor

*Contact\_Address:*

*Address\_Type:* mailing and physical address

*Address:* 555 Church St

*City:* City A

*State\_or\_Province:* North Carolina

*Postal\_Code:* 12345

*Country:* USA

*Contact\_Voice\_Telephone:* (333) 222-1111

*Contact\_Facsimile\_Telephone:* (333) 111-2222

*Contact\_Electronic\_Mail\_Address:* landsurveyor@aerialphotos.org

*Hours\_of\_Service:* Monday - Friday 8:00am - 5:00pm

*Contact\_Instructions:* Email is preferred.

*Cloud\_Cover:* 0-5%

*Spatial\_Data\_Organization\_Information:*

*Indirect\_Spatial\_Reference:* 37089

*Direct\_Spatial\_Reference\_Method:* Raster

*Raster\_Object\_Information:*

*Raster\_Object\_Type:* Pixel

*Row\_Count:* 130000

*Column\_Count:* 145000

*Vertical\_Count:* 1

4

*Spatial\_Reference\_Information:*  
*Horizontal\_Coordinate\_System\_Definition:*  
*Planar:*  
*Grid\_Coordinate\_System:*  
*Grid\_Coordinate\_System\_Name:* State Plane Coordinate System 1983  
*State\_Plane\_Coordinate\_System:*  
*SPCS\_Zone\_Identifier:* 3200  
*Lambert\_Conformal\_Conic:*  
*Standard\_Parallel:* 34.333333  
*Standard\_Parallel:* 36.166667  
*Longitude\_of\_Central\_Meridian:* -79.000000  
*Latitude\_of\_Projection\_Origin:* 33.750000  
*False\_Easting:* 2000000.002617  
*False\_Northing:* 0.000000  
*Planar\_Coordinate\_Information:*  
*Planar\_Coordinate\_Encoding\_Method:* coordinate pair  
*Coordinate\_Representation:*  
*Abcissa\_Resolution:* 0.000256  
*Ordinate\_Resolution:* 0.000256  
*Planar\_Distance\_Units:* US Survey Feet (1 meter = 3.2808333333 feet)  
*Geodetic\_Model:*  
*Horizontal\_Datum\_Name:* North American Datum of 1983  
*Ellipsoid\_Name:* Geodetic Reference System 80  
*Semi-major\_Axis:* 6378137.000000  
*Denominator\_of\_Flattening\_Ratio:* 298.257222  
*Entity\_and\_Attribute\_Information:*  
*Detailed\_Description:*  
*Entity\_Type:*  
*Entity\_Type\_Label:* Black and White MrSID Raster Mosaic  
*Entity\_Type\_Definition:* County-wide compilation of 1-foot pixel images  
*Entity\_Type\_Definition\_Source:*  
 Multiresolution Seamless Image Database (MrSID). A compression technique designed specifically for maintaining the quality of large images. Allows for a high compression ratio and fast access to large amounts of data at any scale.  
*Attribute:*  
*Attribute\_Label:* ObjectID  
*Attribute\_Definition:* Internal Feature Number  
*Attribute\_Definition\_Source:* ESRI  
*Attribute\_Domain\_Values:*  
*Unrepresentable\_Domain:*  
 Sequential unique whole numbers that are automatically generated.  
*Attribute:*  
*Attribute\_Label:* Value  
*Attribute\_Definition:* Number from 0 to 255 indicating shade of pixel  
*Attribute\_Definition\_Source:* County A GIS Department  
*Attribute\_Domain\_Values:*  
*Range\_Domain:*  
*Range\_Domain\_Minimum:* 0  
*Range\_Domain\_Maximum:* 255  
*Attribute:*  
*Attribute\_Label:* Count  
*Attribute\_Definition:* Number of pixels with that value  
*Attribute\_Definition\_Source:* County A GIS Department  
*Attribute\_Domain\_Values:*

*Unrepresentable\_Domain:* The count of pixels for a certain value is unique.

*Distribution\_Information:*

*Distributor:*

*Contact\_Information:*

*Contact\_Organization\_Primary:*

*Contact\_Organization:* County A GIS Department

*Contact\_Position:* GIS Coordinator

*Contact\_Address:*

*Address\_Type:* mailing and physical address

*Address:* 123 Main St

*City:* City A

*State\_or\_Province:* North Carolina

*Postal\_Code:* 12345

*Country:* USA

*Contact\_Voice\_Telephone:* (987) 654-3210

*Contact\_Facsimile\_Telephone:* (123) 456-7890

*Contact\_Electronic\_Mail\_Address:* gisordinator@countya.nc.org

*Hours\_of\_Service:* Monday - Friday 8:00am - 5:00pm

*Contact\_Instructions:* Email is preferred.

*Resource\_Description:*

*Downloadable Data:* <<http://www.countya.nc.org/gis/download.html>>

*Distribution\_Liability:*

County A GIS Department is charged with the development and maintenance of the county's corporate geographic database and, in cooperation with other mapping organizations, is committed to offering its users

accurate, useful, and current information about the county. Although every effort has been made to ensure the

accuracy of information, errors and conditions originating from physical sources used to develop the database

may be reflected in the data supplied. The user must be aware of the data conditions and bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of date, and other conditions specific to certain data. The use of trade names or commercial products does not constitute their endorsement by the county. Data may not be resold.

See the Disclaimer: <<http://www.countya.nc.org/gis/disclaimer.html>>

*Standard\_Order\_Process:*

*Digital\_Form:*

*Digital\_Transfer\_Information:*

*Format\_Name:* ArcGIS Shapefile

*Transfer\_Size:* 416.878

*Digital\_Transfer\_Option:*

*Online\_Option:*

*Computer\_Contact\_Information:*

*Network\_Address:*

*Network\_Resource\_Name:* <<http://www.countya.nc.org/gis/download.html>>

*Digital\_Form:*

*Digital\_Transfer\_Information:*

*Format\_Name:* ArcGIS Shapefile

*Transfer\_Size:* 416.878

*Digital\_Transfer\_Option:*

*Offline\_Option:*

*Offline\_Media:* CD-ROM

*Recording\_Format:* ISO 9660

*Compatibility\_Information:* Data CD for the most compatibility

*Fees:* Please contact distributor for pricing information

*Ordering\_Instructions:* Contact distributor via email requests.

*Turnaround:* Turnaround times are dependent upon the project.

6

*Custom\_Order\_Process*: Please contact distributor for ordering information

*Metadata\_Reference\_Information*:

*Metadata\_Date*: 20040806

*Metadata\_Future\_Review\_Date*: 20040713

*Metadata\_Contact*:

*Contact\_Information*:

*Contact\_Organization\_Primary*:

*Contact\_Organization*: County A GIS Department

*Contact\_Position*: GIS Coordinator

*Contact\_Address*:

*Address\_Type*: mailing and physical address

*Address*: 123 Main St

*City*: City A

*State\_or\_Province*: North Carolina

*Postal\_Code*: 12345

*Country*: USA

*Contact\_Voice\_Telephone*: (987) 654-3210

*Contact\_Facsimile\_Telephone*: (123) 456-7890

*Contact\_Electronic\_Mail\_Address*: gisordinator@countya.nc.org

*Hours\_of\_Service*: Monday - Friday 8:00am - 5:00pm

*Contact\_Instructions*: Email is preferred.

*Metadata\_Standard\_Name*: FGDC Content Standards for Digital Geospatial Metadata

*Metadata\_Standard\_Version*: FGDC-STD-001-1998

*Metadata\_Time\_Convention*: local time

**SECTION 7**  
**CADASTRAL MAPS**

## 7. CADASTRAL MAPS

### 7.01 Definitions:

- a. Cadastral Map. A cadastral map or cadastre is a line-drawn-to scale depiction of the parcel boundaries within a governmental jurisdiction, as covered by the map's image area. It is normally a multi-purpose public record designed to show (1) real property ownership within the jurisdiction; (2) the basis for real property valuation and taxation; and (3) geographical information for use by planners and other governmental officials, as well as the general public.
- b. Parcel. A parcel is that portion of land, commonly referred to as real estate or realty, which has been or may be legally conveyed to a new owner by deed in its existing configuration, and is continuous within its outer boundaries.
- c. Deed Acreage. Deed acreage is the acreage stated in the recorded deed.
- d. Computed Acreage. Computed acreage is the acreage calculated by the Contractor from the parcel as shown on the finished cadastral map.
- e. Assessed Acreage. Assessed acreage is the acreage that the County Assessor uses for listing and appraising a parcel for tax purposes.
- f. Exempt Parcels. Exempt parcels are those parcels that the County Assessor exempts from County property tax such as churches; schools; charitable properties; and state, County, and city properties.
- g. Parcel Identifier Number (PIN). The parcel identifier number (PIN) is a number assigned to each parcel. See subsection 7.06 for the derivation of the parcel identifier number.

### 7.02 Project Area & County Contract Map:

The location, size, and boundaries of the areas to be mapped will be outlined on a county map and further subdivided and designated in a way to show the number and scales of the final cadastral maps to be prepared; the map shall be at a scale adequate for its purpose and shall be in hardcopy and electronic formats. The electronic version shall be geo-

referenced and at the request of the County may contain the major county road network. This marked county map shall be entitled the "County Contract Map" and shall become attached to and part of any contractual agreement. Priority areas to be incorporated in the contract delivery schedule will be shown on the County Contract Map.

**7.03 General:**

The cadastral map is primarily intended to depict property boundaries and related information and will be produced as described in Section 8. It should not be cluttered with symbols for such natural and man-made features as are normally found on planimetric base maps for the same area. Nevertheless, certain other descriptive and identifying features will be included on cadastral maps or associated overlays, namely:

- a. Names, boundaries, and identification of subdivisions and plats.
- b. State, County, township, municipality, special districts, and public land boundaries and names.
- c. Boundaries of all known rights-of-way and major easements.
- d. Delineation and identification of all streets, roads, highways, alleys, railroads, rivers, lakes, canals, seaports, and airports.

**7.04 Content and Format for Hardcopy Maps:**

- a. Size. The standard map size is 30 inches by 42 inches and will contain a neat image area of 25 inches by 25 inches. The sample cadastral maps cited in Appendix B are incorporated into these specifications by reference, and bear the same weight of authority as the written specifications.
- b. Materials. The map will be prepared on a stable polyester material suitable for overlay printing of the orthophoto base map. The material will be cronaflex or ultra-translucent Mylar film with a minimum thickness of .003 inch and having a matte surface on both sides.
- c. Legend & Marginal Information. Marginal information consisting of north arrow, disclaimer note, map index, bar scale, map number, map scale, map title, subdivision index, mapping Contractor, grid coordinate values (north coordinate values labeled across east side of map and east coordinate values labeled across south side of map), and

border lines will appear in the 9 inch right-hand margin border of the map. The chart for record of revisions will be placed in the left hand margin. All marginal information will be placed on the cadastral map in such a way that when this map is overprinted with its respective base map, all marginal information from both maps will be clearly legible. The map number on the cadastral map will be the same as the map number for its respective, or "matching," base map. The legend and marginal information may be created with a digital template. The following marginal information shall also appear on the map:

1. Map title. The map title will contain the County and State names. The Contracting Officer may require the County seal to be included in the map title.
2. Subdivision index. The subdivision index will contain the following information for each subdivision shown on the map: the index number, the main PIN number, the subdivision name, and plat book and page number.
3. Legend. The legend will contain as a minimum the following: state, county, city, township, Indian reservation (when appropriate), and national forest (when appropriate) boundary lines; property boundary lines; parcel hook; original lot number; original lot lines; interstate, US, NC, and secondary roads; road and railroad rights-of-way; streams and shorelines; block number; parcel identifier; computed acreage; scaled dimensions; acres in county; utilities easements; property corners with grid coordinates; and a note stating that dimensions are in feet.
4. Disclaimer note. The disclaimer note will read as follows: This map is prepared for the inventory of real property found within this jurisdiction and is compiled from recorded deeds, plats, and other public records and data. Users of this map are hereby notified that the aforementioned public primary information sources should be consulted for verification of the information contained on this map. The County and the mapping companies assume no legal responsibilities for the information contained on this map.

Located with the disclaimer note will be the following statement:

Grid based on the North Carolina State Plane Coordinate System, NAD83(NSRS2007), North American Datum.

5. Map index. The map index will show the relationship of the map to all adjacent surrounding maps.
- d. Scale of Maps. The scales of the County's cadastral maps will be the same as the scales of the underlying base maps which are normally prepared at nominal scales of 1" = 400', 1" = 200', 1" = 100', and in special situations 1" = 50'.
- e. Block Lines and Block Numbers. On all scales of cadastral maps, the neat image area will be sub-divided into so-called "map blocks" for the purpose of building the parcel identifier number (PIN). The map block will be a 1,000-foot square whose boundaries will conform to the even thousand-foot divisions of the North Carolina State Plane Coordinate System and will be delineated by fine block/grid lines running north-south and east-west across the entire neat image area. The two-digit block number derived from the PIN system will be printed in the center of each block using "hollow" numbers. Details of the size and style of annotation will be determined by the County and Contractor.
- f. Grid Ticks. On all scales of cadastral maps, the 25 inch by 25 inch neat image area will be further subdivided with "grid ticks" (1/2 inch crosses) placed where north-south and east-west grid coordinate lines drawn every 5 inches on the image area would run or intersect. On 1" = 100' or larger scale maps, grid ticks will be shown on those points where intersecting block lines do not appear. Grid ticks will appear as black lines on the finished map.
- g. Adjoining County Maps. A county contracting for cadastral maps under these specifications shall determine if any of its adjoining counties have already been mapped in conformance with these state specifications. The contracting County shall obtain copies of all existing maps adjoining its County boundaries for delivery to and use by the Contractor as source materials.

**7.05 Project Procedures:**

- a. The Contractor will conduct all field investigations necessary to obtain property boundary and cadastral information. Such field investigations may include visiting properties, contacting property owners, contacting neighboring property owners, etc.
- b. The Contractor will prepare all property boundaries and cadastral information on the digital orthophoto base map. The location and plotting of the parcel boundaries shall be accomplished through the use of recorded source maps and plats and the deed descriptions in conjunction with photo images on the orthophoto base maps. In the event parcel ownership boundaries cannot be delineated or plotted through the use of deed descriptions, existing source maps, or recorded plats and surveys, the following priorities of calls shall be utilized:
  - 1. Natural Boundaries
  - 2. Natural Monuments
  - 3. Man-made Boundaries
  - 4. Adjacent Owners
  - 5. Course (bearing or direction)
  - 6. Distance
  - 7. Area

Leaseholds, lessor estates, and mineral interests will not be included in this location and plotting process. Major cross-country utility easements as agreed upon between the Contracting Officer and the Contractor are included in this location and plotting process.

- c. The Contractor shall submit a working file with corresponding source material for each cadastral data layer. The source material shall include but not be limited to deed(s) of each parcel, plats, etc. that were used in the compilation of the parcels and associated data layers. The County may require the scanning of all deeds, and surveys as well as link the property record cards to the GIS database. If hard copies are used, the deed(s) and plot shall be attached to a copy of the parcel's property record card. Any other documents used in the compilation of the checkplot of the cadastral map such as plats, wills and estates, surveys, etc. will be numbered with the corresponding subdivision index number or PIN number and will be included in the file as well as digitally linked to associated PIN. This

working file may be scanned and delivered to the County in an electronic format consistent with the County's computer system. The Contracting Officer will review the map and corresponding work files, note any corrections to be made, and return a narrative of the corrections to be made to the Contractor.

- d. The Contractor will deliver the finished cadastral maps to the Contracting Officer for review. All transfers, splits, and combinations of parcels will be included on the final deliverable cadastral map and will be current to within sixty (60) days of the final delivery schedule. The Contracting Officer will review the final cadastral maps for adherence to specifications including the location and correctness of PIN's, location and correctness of acreages, etc., note any corrections, and return a narrative of the corrections to be made to the Contractor.

**7.06 Derivation of Parcel Identifier Number (PIN):**

The parcel identifier number (PIN) is constructed from the North Carolina State Plane Coordinates of the visual center of a parcel. The following is the procedure for determining the PIN.

- a. Grid Coordinates of the visual center of the parcel are measured from the cadastral map:

"x" coordinate (easting) - E 2,715,569  
"y" coordinate (northing) -N 0,756,737

- b. The digits in each coordinate value are paired by taking each digit separately from the east-coordinate and matching it with the corresponding digit of the north-coordinate.

20 77 15 56 57 63 97  
EN EN EN EN EN EN EN

- c. With this arrangement, the above example of a parcel identifier may be sorted as follows:

20            7715            56            5763            97

Redundant lead number for any one county	Number of basic map module (1" = 400')	Block number	Lot or parcel number	Utilized only to extend the capacity of system
---	---	-----------------	----------------------------	--

- d. The North Carolina "Parcel Identifier Number" or "PIN" is obtained by recording the middle three sets of numbers (ten digits), and is written with dashes as follows:

7715 - 56 - 5763

- e. Records of condominiums, townhouses or other cases of diverse ownership on one parcel of land will be further identified by the use of a decimal at the end of the PIN with three (3) digits to the right of the decimal. The records for a condominium unit or units built on the above-described hypothetical parcel could be assigned a suffix number to the Pin of .001 through .999. For example, a condominium unit could have the following PIN number:

7715 - 56 - 5763.008

**7.07 Mapping of Subdivisions:**

- a. Subdivision plats or maps on file in the Register of Deeds Office will be mapped by the Contractor according to one of the following two options:

Option #1 - All Inclusive– The subdivision will be mapped as recorded with all interior lot boundary lines shown by solid lines. A PIN will be assigned and depicted on the map for each of the interior lots (parcels).

Option #2 - Status Dependent Subdivision – Subdivisions will be mapped in stages directly related to activity as shown in the following categories:

- A. Undeveloped subdivision. The owner of a particular tract or combination of tracts or parcels has designated his property as a "subdivision" by filing a plat or map showing that property as a subdivision. However, the owner has made no physical

improvements, as defined below, to this "subdivision" and no lot or lots have been sold from this "subdivision." No interior lot lines will be shown in the mapping.

B. Improved subdivision. The owner has taken the step described in (A) above and, in addition, has made some physical improvement to the property in preparation for development. This "improvement" may take the form of one or more of the following: land clearing or grading operations; construction of roads or streets, whether paved or unpaved; installation of utility services of any kind; or the building of any new structures on the property. No lot or lots have been sold. Interior lot lines will be shown as dashed lines and all interior boundary dimensions will be shown. No PIN's will be placed on the map for any of the interior lots.

C. Active subdivision. The owner has taken the step described in (A) above and has also sold one or more of the lots of the "subdivision". The owner may or may not have made any "improvements" to the subdivision property; improvements are not a criterion for subdivision category C. All interior lot boundary lines will be shown by solid lines. A PIN will be assigned and depicted on the map for each of the interior lots (parcels).

b. The following mapping requirements will apply to all subdivision categories described in subsection 7.07 a. The entire outer boundary of the subdivision will be shown by a **bold** solid line. Numerals placed inside the corners will be keyed to an index of subdivision names in the margin. When a subdivision is plotted on more than one map, the subdivision's index number will be the same on all maps. An index number may not be duplicated on any map. When a subdivision is plotted on more than one map, the main PIN will be placed on the map that contains the largest area of the subdivision, or on the map that contains the majority of the common-user property. All parcels should get their own unique identifier as per common mapping standards, however, if specified in writing by the County, one main PIN can be determined and can be utilized as the land records system's link to all common-user property (playgrounds,

pools, clubhouses, greenways, wells, maintenance facilities, sanitation facilities, parks, etc.) within the subdivision or to subdivision documents such as the subdivision plat or maps, restrictive covenants, association by-laws, etc. The last four digits of the main PIN will be shown on the map by an enclosing oval. Main PIN's will be assigned to those subdivisions that are recorded and have been given a public name such as McGregor Downs Subdivision or Sunset Hills. See Appendix H for drafting specifications.

**7.08 Drafting Specifications:**

- a. Method. It is desirable for state, county, municipality, and all special districts and their annotations; block lines; block numbers; and grid ticks to be drafted or plotted on separate layers.
- b. Symbols. All symbols, numbers, letters, and lines will be shown, insofar as possible. Cross-country utility easements as agreed upon between the Contracting Officer and the Contractor are to be shown by dashed lines at the boundaries of the easement's limits and annotated with the width of the easement and the kind of utility. All special district lines will be shown by dashed lines, and labels identifying the district will be placed in the breaks of the dashed lines. The Contracting Officer will supply the Contractor with proper source material that will permit the Contractor to accurately locate and identify the special district lines on the cadastral maps.
- c. Parcels.
  1. General. All parcel boundaries will be delineated with solid lines. When a parcel is made up of a combination of two or more previously separate tracts or parcels, the interior tract boundaries will be delineated with dashed lines. A black dot marking the visual center of the parcel, the parcel identifier number (last four digits), and the acreage of the parcel will be entered inside the parcel's boundaries. If the parcel identifier number and/or acreage cannot be entered inside the parcel boundaries, they will be placed on an adjoining space and arrowed into the parcel. All parcels having corners tied to the North Carolina State Plane Coordinate System in conformance

with North Carolina General Statute # 47-30 (f) (9) shall have such corners depicted on the cadastral map. All parcels that are exempt from taxation shall have their common names labeled inside their boundaries or arrowed in if necessary. The labeling of bearings along parcel boundaries is an optional feature (see Appendix H). See Appendix B for illustrations of the proper entry of parcel information.

2. Dimensions. All dimensions will be shown for parcels five (5) acres or less in size. The County and the Contractor may agree to the option that all dimensions be placed on all parcels regardless of acreage. Regardless of parcel acreage, dimensions will be shown for all parcel boundaries that front on roads. Dimensions of parcel boundaries that front road rights-of-way will be measured to the limits of the rights-of-way, thereby indicating that the area covered by the entire road right-of-way is excluded from the parcel's acreage calculation. Deed dimensions will be shown except where the discrepancies between deed and scaled dimensions exceed two (2) feet at 1" = 100', four (4) feet at 1" = 200' and eight (8) feet at 1" = 400', in which cases the scaled dimension will be shown.
3. Acreages. All parcels one (1) acre and larger in size will show their computed acreage on the final cadastral map. Acreages will be shown to the nearest one-hundredth (0.01) of an acre on all scales of maps. A county can request in writing to the contractor to supply deeded acreage instead of the computed acreage.
4. Hydrographic features. Lakes, ponds, streams, rivers, and large bodies of water will be labeled with their names inside or along their boundaries.
5. Roads. All roads, streets, and highways will be labeled with their names or numbers inside or along their boundaries.
6. Inter - county parcels. All boundaries of a parcel that extend into another county will be shown on the map whenever it is possible. The parcel's acreage within the County and the parcel's total acreage will be indicated on the map. Unless otherwise noted, the assessed acreage and the computed

acreage required in subsection 7.11 refer to a parcel's assessed and computed acreage within the County.

**7.09 Delivery Schedule:**

The Contracting Officer and the Contractor shall develop a delivery schedule, with cut-off dates for map updates (e.g., property lines, subdivision lines), for all the deliverable products of the project. Prior to preparation of the contract, the cut off dates will be determined and included in the contract delivery schedule.

**7.10 Cadastral Database Maintenance:**

The Contractor shall maintain all digital cadastral data until all deliverable products are received and accepted by the Contracting Officer in accordance with the contract delivery schedule and subsection 7.05 c. and 7.05 d.

**7.11 Deliverable Items by the Contractor for Cadastral Maps:**

At the completion of the mapping project, the Contractor shall deliver to the Contracting Officer for his acceptance the following items:

- a. An index map as described in subsection 7.02.
- b. A computer-generated database consistent with the County's computer system for all parcels in the County, including the following information at a minimum:
  - (1) Full name(s) of parcel owner(s)
  - (2) Parcel identifier number (PIN)
  - (3) Parcel dimensions (deed or scaled)
  - (4) Parcel acreage (as shown on the map)
  - (5) Conveyance records (book and page of deeds and/or will abstract)
  - (6) Date of recordation
  - (7) Any prior identification (tax number, etc.)
  - (8) Subdivision name (if applicable)
  - (9) Plat book and page (if applicable)
  - (10) Map Number

(11) Township code or name

The Contractor will submit a sample format of the database to the Contracting Officer for written approval prior to any data entry activities.

- c. Computer generated "Property Index Files" consistent with the County's computer system. There shall be a digital file of the "Property Indexes" for each cadastral map in use. In the headings of the Indexes will be the complete description of the cadastral map to which each Index is keyed. The property Indexes will list all parcels by parcel identifier numbers in numerical sequence. The second set of Property Indexes will list the parcel owner(s) name(s) in alphabetical sequence. Exempt properties will also be included in these "Property Index Sheets" and will be identified by their common names. Column headings on each sheet will be as follows:

- 1. Property index by PIN

OWNER(S) CONVEYANCE  
PIN NAMES(S) INFORMATION (BK/PG) DATE  
RECORDED

- 2. Property index by owner(s) names(s)

OWNER(S) CONVEYANCE  
NAMES(S) PIN INFORMATION (BK/PG) DATE

RECORDED

A sample of the "Property Indexes" format will be submitted by the Contractor to the Contracting Officer for approval.

- d. The working file for each map as described in subsection 7.05 c.
- e. Errata or reconciliation lists. All errata or reconciliation lists will be computer printout pages with all lines double-spaced. These lists will be delivered in accordance with the contract delivery schedule. Master files of these lists will be kept current during the entire project and a composite listing in alphabetical or numerical order will be delivered to the Contracting Officer at the end of the project. A sample of the format of each list will be submitted to the Contracting Officer for approval prior to the development of the lists. For quality control purposes an "in process" copy of Errata Lists will be made

available upon request by the Contracting Officer and may be in digital or hardcopy form.

1. Unlocatable Parcels. Unlocatable parcels are all parcels that are assessed or on the tax scrolls but are not locatable by the mapping Contractor. A list will be prepared that shows the names of owners as found on the Assessor's Roll and the assessed acreages; the list shall also show the total acreage of all such properties in the County. The total number of parcels on this list shall not be greater than one percent (1%) of the total number of parcels in the County without the written approval of the Contracting Officer.
2. Parcel Discoveries/Owner Known. Parcel Discoveries/Owner Known are those parcels found and mapped by the Contractor for which the owner name are known but are not on the Assessor's Roll. A list will be prepared that will show the name(s) of owner(s), PIN, deed acreage, and computed acreage for each parcel; the list shall also show the total deed acreages and computed acreage of all such properties in the County.
3. Parcel Discoveries/Owner Unknown or Doubtful. Parcel Discoveries/owner Unknown or Doubtful are all parcels found and mapped by the Contractor for which the true owner cannot be satisfactorily determined and which are not on the Assessor's Rolls. A list will be prepared which shows the PIN, deed acreages, and computed acreages; the list shall also show the total acreage of all such properties in the County. The total number of parcels on this list shall not be greater than one percent (1%) of the total parcels in the County without the written approval of the Contracting Officer.
4. List of Acreages (Deed, Computed, and Assessed.) A list will be prepared that shows the deed acreage, computed acreage, and assessed acreage for each parcel in the County. There shall be one separate List of Acreages for each cadastral map in use, and in the heading of the List will be the complete description of the cadastral map to which the List is keyed. Column headings on each List will be as follows:

Old Parcel	Owner(s)	Assessed	Deed
Computed			
<u>Number</u>	<u>PIN</u>	<u>Name(s)</u>	<u>Acreage</u>
<u>Acreage</u>			<u>Acreage</u>

The Contractor will also provide the total assessed acreage, deed acreage, and computed acreage for the entire County.

5. List of Divergent Parcel Acreages. A list will be prepared for all parcels where the computed acreage varies from the assessed acreage by at least the percent shown in the following chart:

<u>Parcel Acreage</u>	<u>Percent of Divergence</u>
1.01 - 5.00	10%
5.01 - 20.00	8%
20.01 - 50.00	6%
50.01 & Greater	4% to a maximum of 5

acres

The County may require a different Parcel Acreage/Percent of Divergence if agreed in writing with the Contractor. There shall be one separate List of Divergent Parcel Acreages for each cadastral map in use, and in the heading of the List will be the complete description of the cadastral map to which the list is keyed. The column heading on each list will be as follows:

Owner(s)	Assessed	Deed	Computed	Amount of Divergence
PIN	Name(s)	Acreage	Acreage	Acreage
Assessed/Computed				

(in acres)

- f. Two sets of exempt parcel lists. One set will contain lists of exempt parcels and will be delivered in accordance with the contract delivery schedule. The second set will contain a list of all exempt parcels in the County and shall be delivered at the end of the project. Both sets of lists will be digital as well as computer printout pages with all lines double-spaced. Column headings for both sets of lists will be as follows:

Owner(s)	Computed		
<u>Common Name</u>	<u>PIN</u>	<u>Name(s)</u>	<u>Acreage</u>

- g. Media for storing the data generated in the preparation of the database and maps described in subsections 7.11 b., c., e., and f. shall be in compliance with section 8.05. All base maps and associated materials, including microfilm provided to the Contractor by the County, and/or all other materials used by the Contractor in the completion of the project. All such returned materials shall be organized according to their respective maps. Microfilm will be boxed and identified by microfilm reel number.

**7.12 Materials/Information/Assistance to be Provided or Made Available by the County:**

In addition to all necessary base maps for the cadastral mapping project, the County shall be responsible for providing the Contractor with the following:

- a. Copies of assessment rolls and/or tax scrolls for each year during the duration of the project. These may be provided in a digital format consistent with the computer system of the contractor.
- b. Access to all existing photography, maps, deeds, and records necessary for cadastral mapping within the County government's jurisdiction. The Contractor shall be responsible for the cost of making copies of these materials and records.
- c. Assistance in gaining access to all available information regarding the location of state highway rights-of-way and other public lands such as parks.
- d. A listing, as complete as possible, of all "exempt" parcels in the County (e.g., churches, schools, other charitable or non-profit owners) including the parcel's common name and street address or other locational information.
- e. All adjoining counties' cadastral maps along the County's boundary lines.

# **SECTION 8**

## **DIGITAL MAPPING**

### **8.01 Introduction:**

The purpose of this section is to provide the Contracting Officer and Contractor with a set of standards for digital mapping. This section also provides descriptions of terminology, data structure, accuracy, and data exchange specifications.

Information to be used in a digital mapping system will be stored in X and Y North Carolina State Plane Coordinates. The process of capturing the coordinate points and storing them in a computer or computer-readable format is called digitizing. The digitization of cadastral, soils, land use, and topographic information should be based on existing maps, GPS, Orthophotography, stereo models, etc..

The product of digital mapping must be topologically structured digital data sets.

## **8.02 Data Definitions:**

The following definitions of map data are presented to clarify their usage and meaning in these specifications.

- a. Layer. (Layers are described by one of the following): Vector data such as roads, rivers, or political boundaries which is organized by subject matter. Vector can be described as digital transparencies that can be overlaid for viewing or spatial analysis; a raster data set represents a particular geographic area, such as an aerial photograph or a remotely sensed image. Raster and vector data, covering the same geographical space, are registered to one another by means for a common coordinate system; a file that stores and displays symbology and information for a given vector or raster data set. The layer points to it's physical location but does not actually contain the data.
- b. Component. A component is a discrete type of data that, in combination with other components, creates a layer. Examples of components include soil lines, soil labels, PIN numbers, and right-of-way lines. Each component is composed of objects (see definition below) that graphically represent a component's extent (lines or area) or that present information (symbols or text). Subsection 8.10 contains a listing of components by layer.
- c. Objects. Objects are the basic graphic elements that are the "building blocks" of geographic data files. The primary objects used to create components are points, nodes, lines, and areas. Objects are interrelated in a "topological" structure that defines the relationships

of the objects to each other. Topological data structures are defined below.

1. Points: Points are used to represent the location of objects defined by a single set of X and Y coordinates (see Figure 8.02.1). In some cases, these are feature points that can be identified on the surface of the earth (e.g., benchmarks). In other cases, they are arbitrarily placed label points (e.g., locations for the placement of text). In other cases, they are attribute points for areas or lines (e.g., PIN's). The locations of attribute points may be digitized or may be calculated by computer software, GPS, etc.
2. Nodes: Nodes represent the ends or intersections of lines (linear objects). Nodes exist at the first (beginning point) and last (ending point) set of X and Y coordinates of a line. Each node may also reflect an intersection with one or more additional lines (see Figure 8.02.1). A node plays an important role in topological definition and, as such, should reference each line that intersects it.
3. Lines: Lines are strings of coordinates that run between nodes. Each line has a minimum of two X and Y State Plane Coordinate pairs (straight line). Lines also include references to attribute points, the beginning and ending node numbers, and identifiers of areas (when applicable) on the right and left of the line (see Figure 8.02.1).
4. Areas: Areas are polygons which are defined by a series of lines. These lines must, in combination, totally encircle or close the area they represent. Areas also include references to attribute points and other associated data. The boundary of an area is defined by a listing of the lines that comprise the area's border (see Figure 8.02.1).

OBJECTS	GRAPHIC REPRESENTATION	COORDINATE REPRESENTATION
POINTS		X1, Y1
NODES		Xa, Ya Xb, Yb Xc, Yc Xd, Yd
LINE		X1, Y1; X2, Y2; X3, Y3; X4, Y4; X5, Y5
AREAS		X1, Y1; X2, Y2; ...; X8, Y8
ISLANDS		X11, Y11; X21, Y21; X31, Y31; X41, Y41; X51, Y51

Figure 8.02.1 Graphic and Coordinate Depictions of Objects.

- d. **Topological Data Structure.** Topology is the study of the mathematical properties of geometric figures; it is a means of mathematically describing the relationship among points, lines, and areas used to define geographic entities. The use of a topological data structure is important for the effective creation and manipulation of geographic data. Topology allows the interrelationships of graphic objects to be specified. It also prevents the necessity of storing repetitive data. Thus, one line can represent a stream and the boundary of each of two adjacent areas or parcels. This structure allows the computer to generate areas based on node and line information. Topological structures allow the efficient analysis of lines or areas. Thus, road networks stored in a format with topological structure can be used for school bus routing, garbage truck routing, or emergency service routing. Topology requires that several data items be maintained with relation to each node, line, and area. Figure 8.02.2 illustrates these relationships.

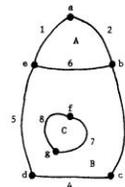


Figure 8.02.2 Diagram illustrates topological relationships of areas, lines, and nodes in both graphic and tabular form.

- e. **Digital Data Sets:** Digital data sets are computer files that store geographic data. Each data set may contain components from one or

more layers. For example, a data set may contain the hydrographic names component associated with the hydrographic layer and the road names component from the cadastral layer. Or a data set containing soils lines components would also contain soil labels. A roads data set could contain pavement width, right-of-way limits, and road labels. The Contracting Officer should define the components that will be contained in each digital data set before requesting proposals for digital mapping.

- f. Digital Labeling: There are two methods of digital labeling: (1) attaching attribute data to points, lines, and areas, and (2) attaching text labels to points.

Attribute data may be stored and linked to each line, area, or feature point to allow users to select the specific objects that they wish to plot, report on, or analyze. Thus, all of the lines that are State Road 1010 could be extracted and plotted because they each have State Road 1010 as an attribute.

Text label points are used to locate labels for an object or a series of objects on a map. Thus, two different text label points may be used to graphically label State Road 1010 as it crosses a map. Thirteen lines, each with data associated with its attribute points, are used to draw State Road 1010 on the map. Figure 8.02.3 illustrates the utility of text label points as opposed to attribute points in producing a readable map.

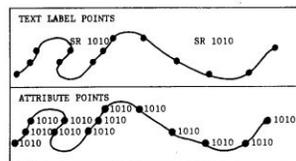


Figure 8.02.3 Illustration of State Road 1010 identified by text label points and by attribute points.

- g. Edge Matching: Edge matching is the matching of lines and areas between adjoining maps. With digital data, the match implies that each line ends with a node that has the same coordinates as the end point or node of the line that continues on the adjoining map (see Figure 8.02.4).

BEFORE EDGE MATCHING		AFTER EDGE MATCHING	
Crop Land	Crop Land	Crop Land	Crop Land
Forested	Forested	Forested	Forested
Residential	Residential	Residential	Residential

Figure 8.02.4 Illustration of edge matching.

- h. **Digital Mapping Product:** The product of digital mapping must be topologically structured digital data sets that store map objects using North Carolina State Plane Coordinates and associated attribute information with each object. Each object (e.g., point, line, area) of a component must have associated attributes. These attributes will be agreed to by both the Contracting Officer and the Contractor before digitizing begins. The digital mapping product that a County receives may include a number of individual data sets (computer files), or all data may be integrated in a single database for use in a Database Management System.

Attribute data may be stored as part of the geographic data set or in an associated database. Each graphic object must be assigned attributes according to a labeling scheme agreed on by the Contracting Officer and the Contractor. Thus, a road could have only the road name stored as an attribute of a road line (e.g., SR 1010) or it could have road name, road number, type of road, road width, road owner, etc. stored for each line that represents a road. Similarly, an area representing a parcel might only have the PIN associated with it, or it might have all information that the County maintains on that property associated with it. Associated information may be keyed in or merged into a data set from information that has already been stored in a computer-readable format.

**8.03 Digital Accuracy:**

A number of issues must be addressed to ensure the accuracy of the digital product. Each map to be digitized should have been created using a Lambert conformal conic projection. The North Carolina State Plane Coordinate System is based on the Lambert conformal conic projection. If the map to be

digitized uses another projection, it should be digitized using the map's projection and then converted to the Lambert conformal conic projection. The following digital accuracy requirements must be fully met to ensure product acceptability:

- a. Scaling Accuracy: Scaling refers to the initial setup of a map on a digitizing table. A minimum of three corner points (e.g., lower left, lower right, and upper right) of the map will be used to scale or tie the map to the surface of the earth through coordinate transformation algorithms. After a map is scaled, the accuracy of the transformation must be tested by digitizing a minimum of three points that were not used in setting up the map but have known X and Y North Carolina State Plane Coordinates. The digitized coordinates will be checked against known coordinates to verify that they are within the acceptable tolerance. The maximum tolerance will be one-fiftieth (1/50) of an inch (.02 inch). The maximum tolerance at map scale is listed by scale in Table 8.03.1.

TABLE 8.03.1 MAXIMUM ALLOWABLE SCALING ERRORS

Maximum Error	Scale of Map	Scaling (at map scale)
1:4800 or 1" = 400'	$\pm 8.0'$	
1:2400 or 1" = 200'	$\pm 4.0'$	
1:1200 or 1" = 100'	$\pm 2.0'$	
1:600 or 1" = 50'	$\pm 1.0'$	

- b. Digitizing Accuracy: Digitizing accuracy refers to the results of comparing a check plot of a digitized line to the same line on the source map. This is accomplished by making a check plot of the digitized data at the same scale as the source map. The line width used for the check plot will not exceed .010 inch. The resulting plot is laid on the digitized source map, and the two are placed on a light table. If any light can be seen between the digitized line and the source map line, the line must be re-digitized.

One special case exists with regard to line accuracy requirements. If the source map's lines are greater than 0.020 inches in width, the center of the lines must be digitized. The lines on the check plot of

the digital data must overlay and not extend beyond the width of the original lines on the source map. Line smoothness and consistency shall be evaluated when reviewing line accuracy. Digitized data will form smooth lines and curves that are aesthetically pleasing and follow the lines they represent.

- c. Attribute Accuracy: After attributes are assigned to a source map (file), the map will be checked for accuracy, and all errors will be corrected.
- d. Edge Matching Accuracy: No edge match tolerance will be allowed in digital mapping. The Contractor and Contracting Officer shall agree on methods and procedures to be used for accomplishing edge matching.

#### **8.04 Data Format:**

The Contractor will provide digital data to the County in a format that can be used on the County's system or in an acceptable standard data exchange format. The Contractor may produce data by any software program or package so long as the final delivery of the data is delivered in the format specified by the County. This data then must be linked to the County's existing database as specified by the County. Each digital data set must be accompanied by reports that specify the labeling scheme used and provide summary statistics on each type of data object (e.g., total label points, total attribute points, total number of lines, total number of areas, total area, total length).

#### **8.05 Transfer Media**

The digital data will be transferred from the Contractor to the Contracting Officer in a format specified by the County. The format and media of this transfer of digital data between the Contractor and the County shall facilitate the efficient exchange of data. Some examples of media that can be used are: tapes, CD's or DVD's, a hard drive, etc.

#### **8.06 Delivery Schedule:**

The Contracting Officer and the Contractor shall develop a delivery schedule, with cut-off dates for map updates (e.g., property lines, subdivision lines), for all the deliverable products of the project. Prior to preparation of

the contract, the cut off dates will be determined and included in the contract delivery schedule.

**8.07 Cadastral Database Maintenance:**

The Contractor shall maintain all digital cadastral data until all deliverable products are received and accepted by the Contracting Officer in accordance with the contract delivery schedule and subsection “7.05 c” and “7.05 d”.

**8.08 Deliverable Products:**

The final deliverable digital products shall include tapes or other media of digital data sets and documentation of the information contained on each data set. Documentation will include but not be limited to: (1) a listing of all data stored on a given data medium including file names and descriptions of the data stored on each file; (2) a summary of the format or formats of the data files; (3) a summary of the format of the digital labels used in each file, their type (e.g. character, Integer, real), and their length in characters; and (4) Metadata for each data layer to comply with the Content Standards for Geospatial Metadata as specified by the Federal Geographic Data Committee (FGDC)(for an example see Attachment 2). One copy of the digital data will be generated by the Contractor for delivery to the Contracting Officer. It is preferable that the digital data media be hand delivered to the Contracting Officer. If the digital data media must be commercially delivered, the digital media must be shipped in a protective container with tracking information readily available. Each media to be delivered shall contain a label that includes the following: County name, media contents (e. g. cadastral map, soil map), cadastral data base cut-off date, media specifications (see subsection 8.05), name of Contractor, and the date of delivery to County. If the County receives a computer mapping system as part of the contract, the Contracting Officer shall require that all computer hardware and software be installed and in working order before accepting any digital data set tapes or other media. The Contractor shall maintain a duplicate of all digital data sets until the project is satisfactorily completed.

### **8.09 Project Procedures:**

The Contracting Officer will review data and associated material for line placement, line quality, and labeling accuracy. All lines will be examined for accuracy against the source maps as described in subsection 8.03 b. If more than five (5) percent of the lines are in error, review will stop and the maps will be returned to the Contractor. All maps that have line accuracy problems will be returned to and corrected by the Contractor.

Label points and attribute points will be reviewed for labeling accuracy. If the Contracting Officer identifies that more than one (1.0) percent of the attributes on a map are incorrect, the review will stop and the maps will be returned to the Contractor for correction. The resulting final attribute accuracy shall be less than three-tenths of one (1) percent (0.3%), or 3 errors in 1,000 attributes.

All data that has been returned to the Contractor for editing must be, after correction, resubmitted to the Contracting Officer for review.

After digital data have been reviewed and accepted by the Contracting Officer, the Contractor will prepare and transmit the digital data in the format specified with its associated documentation to the Contracting Officer. The Contracting Officer will then load, review, and accept or reject the data.

### **8.10 Components Of Maps:**

The following are components of various map layers. The same component may appear in more than one layer; however, in a digital mapping environment, the component need only be digitized once. Each map layer may include other components that may be identified by the Contracting Officer.

- a. Cadastral Map Layer
  1. Road and street rights-of-way
  2. Property lines excluding rights-of-way
  3. Interior lot lines (dashed)
  4. Road-front and street-front dimensions
  5. Property line dimensions excluding road-front and street-front dimensions
  6. Parcel acreage

7. PIN including dot (PIN - 10 or 13 digits, last 4 or 7 to be plotted)
  8. Private roads or streets
  9. Private road or street names with annotation indicating that the road or street has not been dedicated to the city or state (private ownership)
  10. Road or street names (e.g. Lake Wheeler Road or Main Street)
  11. Road numbers (e.g. SR 1007, NC 98, US 64, I-40)
  12. Hydrography
  13. Hydrography names
  14. Gas line easements (cross-country lines, ownership name, and easement width)
  15. Power line easements (cross-country lines, ownership name, and easement width)
  16. Telephone easements (cross-country lines, ownership name, and easement width)
  17. Railroad rights-of-way
  18. Railroad ownership name
  19. Railroad right-of-way width
  20. Subdivision limit lines (corners)
  21. Subdivision index numbers (reference numbers)
  22. Subdivision lot numbers (original lot numbers)
  23. Subdivision names
  24. Tied-in corners (North Carolina State Plane Coordinates of property corners established by field survey methods)
  25. Parcel hooks
  26. Exempt property names
  27. City limit lines
  28. City names
  29. Township lines
  30. Township names
  31. County boundary lines
  32. County names
  33. Subdivision PIN's
- b. Soil Map Layer
1. Soil lines

2. Soil labels
3. Border data - soils disclaimer note
- c. Topographic Map Layer
  1. Index contour lines
  2. Intermediate contour lines
  3. Index contour line values
  4. Spot elevations (includes "X" for location)
  5. County boundary lines
- d. Hydrography
  1. Hydrography
  2. Hydrographic names
- e. County
  1. County Boundary Lines
- f. Plot Layer Template/Program
  1. Grid lines
  2. North Carolina State Plane Coordinate values
  3. Block Lines
  4. Interior and exterior block numbers (exterior block numbers below and beside easting and northing grid coordinates, respectively)
  5. Border data - topographic accuracy statement
  6. Border data - contour information (contour interval, map scale)
  7. Border data - County seal (optional)
  8. Border data - County map/logo
  9. Border data - title of map
  10. Border data - legend
  11. Border data - north arrow
  12. Border data - bar graph (scale)
  13. Border data - Contractor's name and address
  14. Border data - border lines
  15. Border data - map number
  16. Border data - date of aerial photography
  17. Border data - horizontal and vertical datum
  18. Map index