Chapter 5 – SURVEYING AND MAPPING

LIST OF APPENDICES

LIST OF APPENDIX EXHIBITS

5A.1 CODE OF SAFE SURVEYING PRACTICE

Surveyors and field engineers face unique hazards, namely site conditions and logistics, which must be afforded proper consideration to ensure health and safety of employees, consultants, contractors and visitors. The following Code of Safe Surveying Practice was developed to summarize health and safety policies uniquely pertinent to surveying and field engineering work:

1. **Distribution**. All surveyors and field engineers, including employees, consultants and contractors, shall have ready access to this Code.
2. **Philosophy**. No project is so important or urgent enough to warrant compromising safe field practices.
3. **Responsibilities**. The following describes the responsibilities that apply to individuals and supervisors:
   a. *Individuals*. All field personnel shall have a practical working knowledge of this Code and the health and safety policies and practices of FLHO. Individuals are responsible for:
      - Doing everything reasonably necessary to protect life, safety and the health of themselves, other field personnel and the public.
      - Complying with all occupational safety and health policies, procedures, laws, rules and regulations.
      - Promptly reporting injuries, illness, accidents and unsafe conditions, tools and equipment, to their supervisor or the lead worker in charge.
      - Reporting to work mentally and physically able to perform all their assigned duties without jeopardizing the health and safety of themselves, other personnel, consultants, contractors or the public.

   b. *Supervisors*. Supervisors or lead workers in charge are responsible for:
      - Monitoring safety conditions and employee performance.
      - Instructing employees about safety policies and practices affecting them.
      - Prohibiting employees from working either when they appear to be unable to perform their duties or if there is concern about their or others' health and/or safety.
4. **Planning for Safety**. Safety shall be given top priority in planning all surveys and field engineering assignments. Factors considered when planning an assignment shall include:
   a. Scheduling work for the safest time of day.
   b. Assigning the optimum number of personnel to accomplish the assignment safely.
   c. Assigning specially trained and qualified personnel to the more hazardous jobs.
   d. Using methods that minimize exposure of personnel to hazardous conditions.

e. Ensuring access to, and sufficiency of, specialized tools and equipment necessary to conduct the assignment safely.

5. **Personal Protective Equipment**. Each employee must provide and wear clothing and footwear that will provide adequate protection for the assigned task, including as required or directed:

   a. Necessary clothing, hat, gloves and boots to adequately protect against the outdoor elements (e.g., heat, cold, rain, snow, rugged terrain, construction hazards).

   b. Orange or strong yellow-green vests, shirts or other highly visible garments when exposed to vehicular or equipment traffic.

   c. Hard hats and eye protection while exposed to vehicular and equipment traffic, falling or flying material and other similar hazards.

   d. Earplugs or muffs must be worn when working around noise levels that may cause injury or hearing loss.

   e. Other special safety equipment (e.g., chaps, climbing gear, boot covers).

6. **Personal Health**. Every employee must take precautions to avoid dehydration during strenuous outdoor activity by drinking sufficient fluids and electrolyte replacement drinks throughout the workday and by carrying water while working for long periods in remote locations.

   Additionally, each employee must have proper food, nutrition, lunch, etc.

   It is important that every employee be in fit physical condition before performing work, especially strenuous activity.

7. **Safety Meetings**. Special attention shall be given to matters of health and safety at the project initiation meeting conducted at the start of the project. A project safety briefing will be prepared including, as a minimum:

   - Points of contact for reporting purposes.
   - Phone numbers and locations of emergency medical support resources.
   - Any special considerations related to the particular project.

   Tailgate safety meetings shall be held at least once every ten working days. Hold safety meetings as applicable to prepare for imminent and especially potent hazards, such as:

   - Poisonous plants,
   - Snakes,
   - Insects,
   - Animal hazards,
   - Mountainous terrain,
   - High fire hazard areas,
   - Traffic,
   - Heavy equipment,
   - Water exposure, and
   - Temperature extremes.

8. **Vehicular Traffic**. Work, no matter how short the duration, must not be performed on or adjacent to traveled roadways without instituting proper protective measures to protect other drivers and pedestrians. These measures include using appropriate signs, flaggers, lookouts and/or lane closures, as required to work safely.

9. **Tools and Equipment**. Only the proper tool, in the proper condition, should be used for each job. Equipment should not be operated unless the employee is familiar with its use and convinced it is functioning properly.

10. **First-Aid Requirements**. At least one member of each field survey team shall have received first-aid training and possess a current certification. Each survey team vehicle shall be equipped with a standard first-aid kit, *Red Cross Manual* and a fire extinguisher.

11. **Vehicle Operation**. Every field survey team member shall have a current driver's license. Each driver must drive defensively and observe all applicable traffic laws. Every survey team vehicle shall have a current certificate of liability insurance.

12. **Operational Precautions**. Each field survey team member shall observe operational precautions by:

    - Not entering ditches, trenches or confined spaces until you are certain it is safe to do so.
    - Suspending operations when unsafe conditions or uncontrollable hazards develop; and resuming work only when safe conditions have been restored.
    - Check with others about safe procedures when working in an unfamiliar environment.
    - Using particular caution when working at night.
    - Wearing reflective clothing when working near equipment or traffic during hours of darkness.

5A.2 STANDARDS FOR CONTROL SURVEY ACCURACY CLASSIFICATION

Exhibit 5A.2–A STANDARDS FOR CONTROL SURVEY ACCURACY CLASSIFICATION

Accuracy Standards by Type of Survey

FLH Class	PT Series	Type of Survey	95% Probability Circle*
A	2000	GPS	0.06 ft [0.020 m]
B	3000 5000	Primary (Terrestrial or GPS)	0.10 ft [0.030 m]
C	4000	Secondary (A Lines) (Terrestrial or GPS)	0.25 ft [0.080 m]
D	6000	Cadastral (Terrestrial or GPS)	0.25 ft [0.080 m]
E	8000	Wing Points (Terrestrial or GPS)	0.30 ft [0.100 m]

Notes:

1. *The semi-major axis of the error ellipse may be substituted and noted.*
2. *Exceptions to these standards must be noted in the control report.*

GPS Only Standards

Local Accuracy (95% Probability Circle)	Network Accuracy (95% Probability)	GPS Orthometric Heights (95% Probability Circle)
0.06 ft [0.02 m]	0.10 ft [0.03 m]	0.30 ft [0.1 m]

Vertical Accuracy Standards

FLH Class	Type of Survey	Accuracy
A	Primary Control Network (Differential leveling)	0.05 ft/√Mi [0.008 m/√K]
B	Secondary Control (A Lines) (Differential leveling, trigonometric leveling)	0.06 ft [0.020 m]
C	Wing Points (Differential leveling, trigonometric leveling, GPS observations)	0.30 ft [0.1 m]

5A.3 SPECIFICATIONS FOR CONTROL SURVEYS

Exhibit 5A.3–A provides a sample Survey Monument Record.

5A.3.1 PHYSICAL STANDARDS FOR CONTROL MONUMENTS

1. Primary Control and Supplemental Control Monuments shall be set no more than 1,450 ft [450 m] apart and shall be inter-visible with at least two other control points. Monuments shall be set flush with natural ground or approximately 0.2 ft [5 cm] below the existing road surface. Monuments shall be placed outside of the proposed construction limits.
2. Monuments shall be constructed and set in the ground such that the monument can be reasonably anticipated to remain stable horizontally and vertically for a minimum of 10 years. The monuments shall have durable markings that identify the monument uniquely and unambiguously.
3. Type III Monument (Class D) shall meet the standards set forth by State statute in the state which the project is located.
4. A 2½ in x 4 ft [63 mm x 1.2 m] brown fiberglass marker post, Carsonite Pattern No. 7092-SM or equivalent, shall be placed at each control point and be marked with decals of the control point number.

5A.3.2 GPS CONTROL POINTS ESTABLISHED BY ANY METHOD (STATIC OR RTK)

A minimum of two occupations is required with a significantly different constellation required for the second observations (minimum of two hours).

5A.3.3 TERRESTRIAL TRAVERSE FOR PRIMARY CONTROL (3000 SERIES)

1. Multiple pointings: 3D 3R, rejection limit 6 sec from mean; positional tolerance = 0.01 ft [3 mm] (e.g., 0.01 ft/200 ft [3 mm/60 m] = 10 sec).
2. 10 to 12 stations between azimuth checks (GPS pairs or known azimuth).
3. Azimuth closure = 3 sec/N (N = number of stations).
4. Reciprocal zenith angles: 3D 3R, rejection limit = 10 from mean.
5. Positional tolerance = 0.2 ft /Mi (Mi = distance in miles) [0.04 m /K (K = distance in kilometers)]
6. Recommend maximum distance between primary control NTE 1450 ft [450 m].
7. Traverse must be closed on a point other than the beginning point.
8. Length standard errors not to exceed 30 ppm.

5A.3.4 TERRESTRIAL TRAVERSE FOR SECONDARY MAPPING CONTROL (4000 SERIES)

1. Multiple pointings – 2D 2R, rejection limit 8 sec from mean; positional tolerance = 0.015 ft [5 mm].
2. 20 stations maximum between primary control checks.
3. Distances measured forward and back; reciprocal zeniths.
4. Zenith Angles: 1D 1R.
5. Positional tolerance = 0.26 sft [0.080 m]
6. Traverse must be closed on a point other than the beginning point.

5A.3.5 TERRESTRIAL TRAVERSE FOR WING POINTS

1. Multiple pointings: 1D 1R, rejection limit 5 sec from the mean.
2. Distances measured forward and back; reciprocal zeniths.
3. Open traverse, no geometric redundancy.
4. The photogrammetrist checks the accuracy of the points.

5A.3.6 TERRESTRIAL LEVELS

1. Electronic levels.
2. Positional tolerance = 0.033 ft * the square root of the length of the circuit in miles [0.008 m *the square root of the length of the circuit in kilometers].
3. Always closed on know point (previously established elevation) of equal or higher standards and specifications. A terrestrial traverse is not closed under this definition unless an angular closure can be computed from the field data.

5A.3.7 CADASTRAL OR RIGHT-OF-WAY TIES

1. ALTA Standards (Rural surveys adopted 1997).
2. Cadastral ties can be made from A, B, or C class points.
3. RTK methods can be utilized for cadastral ties.
    - Two sessions at least ten minutes long, at least two hours apart.
    - The antenna shall be supported by either a bipod or tripod.

5A.3.8 NOTES ON SPECIFICATIONS

1. Instruments shall be calibrated before and after the project at a NGS/NOA5A-approved calibration course using the methods specified by NGS in a publication titled "Use of Calibration Base Lines." Also, see calibration baseline locations.
2. The Firm shall pay the cost of calibration.
3. Instruments shall be adjusted to compensate for atmospheric conditions (PPM). Many FLHD projects are at high elevations. Barometric pressures need to be verified and PPM corrections made without adjusting the pressure to sea level.
4. "Primary Control", refers to reasonably permanent monumentation that is coordinated to provide the basis for all surveying, mapping and construction operations for a particular project.
5. "Secondary Control", refers to monumentation that has been coordinated to serve a particular short term surveying application.
6. "Wing Points", refer to aerial targets that are coordinated to provide control for photogrammetric mapping.
7. "D", means direct reading with terrestrial instrument in the direct position.
8. "R", means reverse reading with the terrestrial instrument in the inverted position.
9. "Multiple pointings", means the number of times a reading is taken with the instrument cross hairs centered on a target centered on a remote point.
10. "Positional tolerance", with respect to angular observations means a trigonometric computation of the linear uncertainty based on the product of the sine (or the tangent) of the angular discrepancy and the length of the measured line.
11. "Azimuth check" means comparing a computed azimuth based on field observations to a reliable known azimuth derived independently from equal or higher standard and specifications than the current survey.
12. "Traverse must be closed", means that coordinate calculations can be made for each point and sufficient redundancy is provided for valid statistical analysis. A known point is one for which coordinates have been calculated by independent means from field observations of equal or higher standards and specifications. A terrestrial traverse is not closed under this definition unless an angular closure can be computed from the field data.
13. "Electronic Level" means an electronic digital level instrument capable of reading bar-coded level rod.
14. "ALTA" standards refer to the standards and specifications established by the American Land Title Association and the American Congress on Surveying and Mapping adopted in 1997.
15. "Rural surveys" refer to the positional tolerance chart and the maximum angle, distance and closure requirements for Survey Measurements Which Control Land Boundaries chart contained within the document. No other requirements contained with the ALTA standards document are applicable.

Exhibit 5A.3–A SURVEY MONUMENT RECORD

FEDERAL LANDS HIGHWAY
SURVEY MONUMENT RECORD

PARK: ____________________	MONUMENT	STAMPED

DEVELOPED AREA: ____________________

____

TYPE OF PROJECT: ____________________

____

SHEET____OF____DRAWING NO.____________________

ESTABLISHED
____
DATE:
RECOVERED
____

SET BY: □ FHWA □ OTHER AGENCY □ A / E FIRM ____________________

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _STATE SYSTEM OF PLANE COORDINATES_ _ _ _ _ _ _ _ZONE_ _ _ _ _ _ _ _ _

LATITUDE:	° ‘ “	NORTHING (y) =
LONGITUDE:	° ‘ “	EASTING (x) =
MAPPING ANGLE θ :	° ‘ “	ELEVATION =

GRID SCALE FACTOR:	HEIGHT FACTOR:	COMBINED FACTOR:
DATUM	ORDER OF SURVEY	ACCURACY
HORZ: □ NAD 1927 □ LOCAL	□ 1ST □ 2ND □ 3RD □ 4TH	1 PART IN
VERT: □ NAD 1929 □ LOCAL	□ 1ST □ 2ND □ 3RD □ 4TH	

OBJECT	GRID BEARING	GRID DISTANCE (FEET) (METERS)

DESCRIPTION: □ ALUM.CAP □ BRASS CAP □ COPPERWELD □ OTHER ____________________

SKETCH

5A.4 GUIDELINES FOR PLANNING AERIAL PHOTOGRAMMETRY

5A.4.1 RELATIONSHIPS

Exhibit 5A.4–A provides the typical relationships between plotting scale, contour interval, aerial photography scale and pixel resolution.

Design of the ground control scheme and placement of aerial premarks must provide accuracy and distribution sufficient to solve each photogrammetric model. Project constraints in the field often impose constraints that must be accommodated. Typical issues include steep terrain, limited visibility to the ground and environmental restrictions.

Exhibit 5A.4–B and Exhibit 5A.4–C depict examples of ground control schemes and provide information on the purpose of each.

5A.4.2 GUIDELINES FOR AERIAL PHOTOGRAPHIC PRODUCTS

Each flight line will have full stereoscopic coverage, for its entire length. Normal forward overlap is 60 percent at the mean terrain elevation of each flight strip and is never less than 55 percent. Ground control is established before the flight date.

Photography for a typical design project is planned at an average scale of 1:4800. The photography is obtained using a precision aerial mapping camera having a focal length of approximately 6 in [150 mm] with a 9 in by 9 in [228 mm by 228 mm] negative format. Photography for FLH projects is suitable for mapping and digitizing with a second order, optical train stereo plotter as well as a Photogrammetric Work Station (softcopy).

The suitability of the camera is determinable from the camera calibration report, which is based on adequate tests and measurements made by an approved aerial camera testing authority. Camera calibration reports are valid if completed within 36 months prior to the date of the photo mission.

Factors influencing acceptable photography products include:

- No breaks in the flight line;
- No crabbing or tilting in excess of 5 degrees;
- No flight strips deviating from the proposed flight path;
- No blurring of imagery when magnified up to 6 diameters;
- No deep shadows, smoke, haze, snow or clouds; or
- The sun is at least 30 degrees above the horizon.

Aerial photography deliverables typically include:

- Contact prints in color and black and white,
- Photo index in black and white and its negative,

- Digital photo index (in lieu of hard copy listed above),
- Film roll in canister, and
- Digital image file for each photograph.

Exhibit 5A.4–A AERIAL PHOTOGRAMMETRY COVERAGE
(US Customary)

Photo Scale 1"= ___'	Flying Height (ft)	Topo Plotting Scale 1"= ___'	Contour Interval (ft)	Forward Model Coverage (ft)	Forward Model Coverage (ft)	Pixal Resolution	Ortho Plotting Scale 1"= ___'
167	1002	20	1	601	1052	0.10	20
200	1200	20	1	720	1260	0.17	30
300	1800	30	1	1080	1890	0.25	40
400	2400	40	1	1440	2520	0.33	50
500	3000	50	2	1800	3150	0.42	70
600	3600	60	2	2160	3780	0.50	80
800	4800	80	3	2880	5040	0.67	110
1000	6000	100	3	3600	6300	0.83	140
1200	7200	120	4	4320	7560	1.00	170
1500	9000	150	5	5400	9450	1.25	230
2000	12000	200	7	7200	12600	1.67	330
3000	18000	300	10	10800	18900	2.50	550
5000	30000	500	17	18000	31500	4.17	1000

Exhibit 5A.4–A AERIAL PHOTOGRAMMETRY COVERAGE
(Metric)

Photo Scale 1: ___	Flying Height (m)	Topo Plotting Scale 1: ___	Contour Interval (m)	Forward Model Coverage (m)	Forward Model Coverage (m)	Pixal Resolution	Ortho Plotting Scale 1: ___
2000	300	250	0.2	183	320	0.05	250
2500	380	250	0.2	229	400	0.10	300
3000	450	300	0.25	274	480	0.10	400
5000	760	500	0.5	457	800	0.15	700
7500	1140	750	0.5	686	1200	0.15	1000
10000	1520	1000	1	914	1600	0.20	1500
15000	2300	1500	2	1372	2400	0.30	2000
20000	3000	2000	2	1829	3200	0.50	3000
50000	7600	5000	5	4572	8001	1.00	6000
100000	15000	10000	10	9144	16002	2.00	13000

Exhibit 5A.4–B TYPICAL CORRIDOR PHOTOGRAPHY MISSION

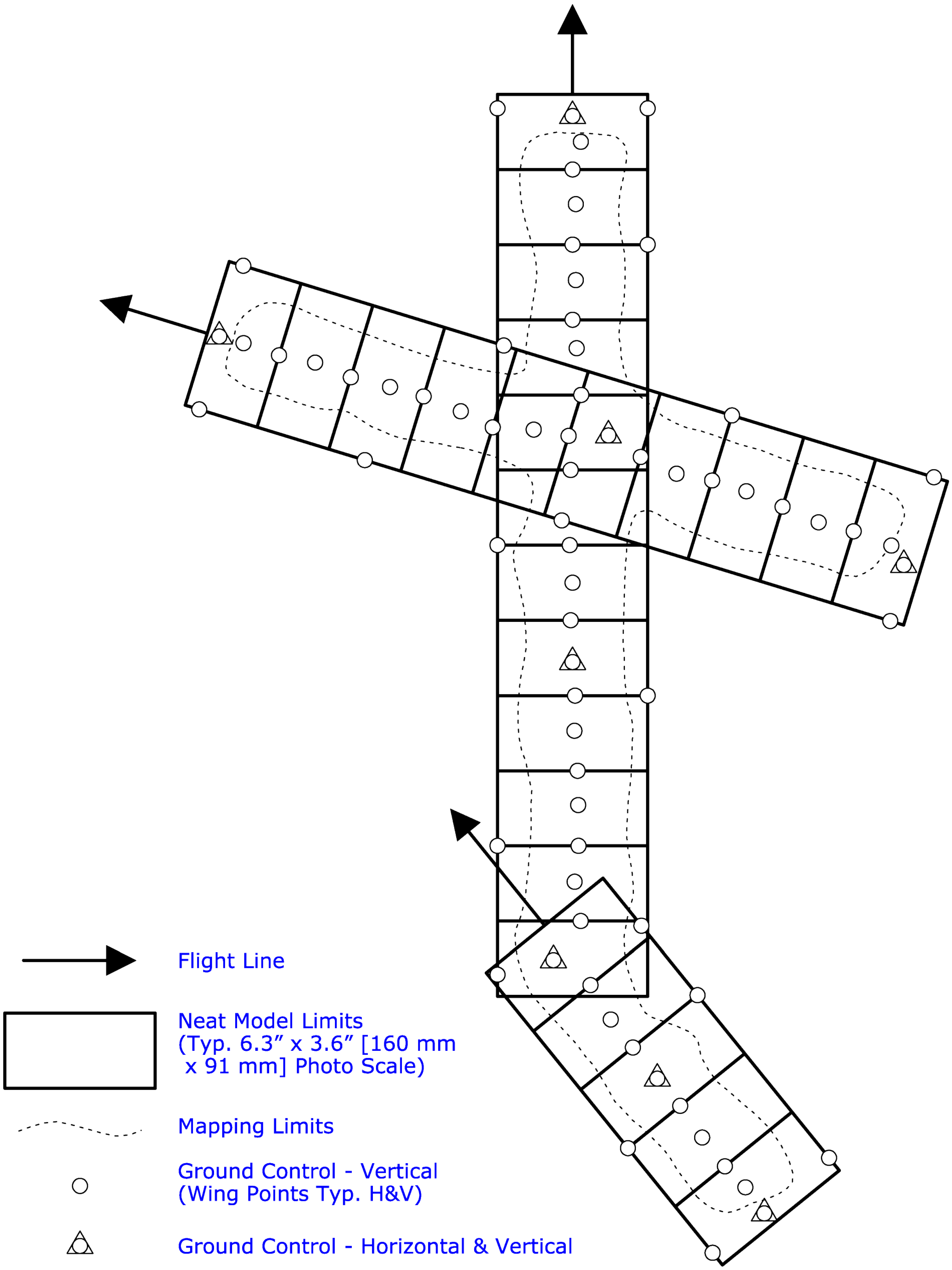
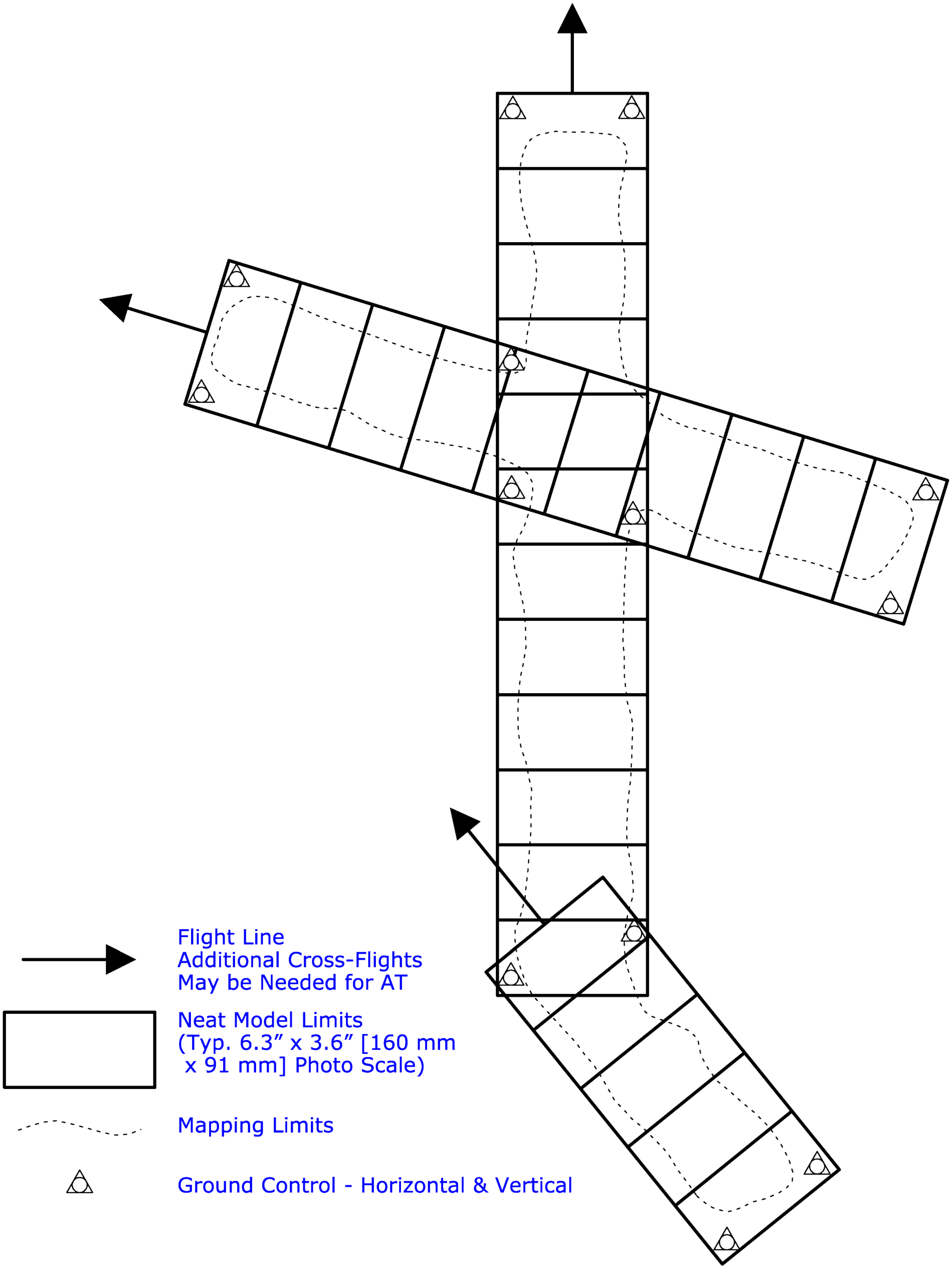


Exhibit 5A.4–C TYPICAL AIRBORNE GPS-ASSISTED CORRIDOR PHOTOGRAPHY MISSION



5A.5 GUIDELINES FOR ANALYTICAL AERIAL TRIANGULATION

5A.5.1 SECOND ORDER OPTICAL TRAIN STEREO PLOTTER

Each exposure in an aerial photography flight line needs at least three supplemental control points. These points (normally required by the analytical aerial triangulation process) are located approximately perpendicular to the flight line and through the photo center. They should not fall outside the area of triple overlap for each exposure. The distance between the two outermost points should be between 4.5 and 7.5 in [115 and 190 mm]. When practical, the centerpoint should be within a 0.5 in [13 mm] radius of the photo center. Additional analytical points in the area of overlapping flight lines can be created as necessary to ensure good results.

The accuracy of the analytically computed control, as determined by the Root Mean Square (RMS) method for X, Y, Z coordinates, should be in keeping with the National Map Accuracy Standards for Second Order aerial surveys. This accuracy is dependent on several factors including:

- Quality of the photography;
- Average photo scale;
- Type of aerial camera used and its calibrated focal length;
- Quantity, quality, placement and accuracy of the pre-marked (targeted) ground control; and
- Other controls used (e.g., photo identifiable features).

The method of measurement and computations for the aerial triangulation should be fully analytical; meaning no intermediate solutions derived by analog methods will be used (as in semi-analytical triangulation, where an analog stereo plotter is incorporated). The RMS residual error shall be computed for all input field control points in the three coordinate directions. Any field control point found to be in error by more than an acceptable amount may be omitted from the field control input list, provided it does not adversely affect the analytical transformation of points in that area.

The camera coordinated three-dimensional points position should be computed for each exposure, be furnished on all projects and include:

- X, Y & Z and roll [Ω] (omega);
- Pitch [Φ] (phi); and
- Yaw [K] (kappa).

The suggested point naming convention for the analytical control is 5 digits. For example, 01053 would represent flight line No. 1, exposure No. 5 and analytical point No. 3.

Flight Line Number	Exposure Number	Analytical Point Number
01	05	3

The naming convention for camera coordinates shall be the flight line number followed by a hyphen followed by the exposure number.

Flight Line Number	-	Exposure Number
01	-	05

5A.5.2 SOFTCOPY AEROTRIANGULATION CONSIDERATIONS

- The analytic points shall have a maximum diameter of 0.002” [50 µm].
- The combination of photo control and analytic points shall be a minimum of seven per neat model.
- There shall be an analytic point or photo control near each corner of all neat models.
- The combination of photo control and analytic points shall be a minimum of three between two adjacent neat models.
- Additional analytical control points shall be created as geometrically warranted between overlapping flight lines

5A.5.3 MENSURATION

Requirements for the mensuration of the photo control and the analytic points include the following:

- The maximum residual shall be 0.0008” [20 µm] on the mensuration of a photo control or analytic point.
- The standard error of the mean shall have a maximum value of 0.0002” [6 µm] for the mensuration of the photo control and analytic points.
- No mensuration shall take place outside of a neat model’s symmetric plane.

Verified values of the photo control are applied in order to perform a constrained adjustment.

Requirements for the analysis of the constrained aerotriangulation adjustment include the following:

- The standard mean error value of the adjusted image shall not exceed 0.0002” [5 µm].
- The maximum standard mean error value of the adjusted photo control and analytic point’s elevation shall not exceed 1/10,000 of the flying height.

The maximum standard mean error of the adjusted photo control and analytic point’s horizontal coordinates shall not exceed 1/15,000 of the flying height.

5A.6 GUIDELINES FOR GROUND TOPOGRAPHY AND PLANIMETRY

FLH field mapping consists of obtaining three dimensional data for all break lines, natural and cultural (man made) features, utilities and ground surface data. Measurements are taken longitudinally along all natural and man-made features and along break lines. All breaks and features that vary from the prevailing ground terrain by more than one half the contour interval are collected. A measurement along features is recorded at regular intervals and at all breaks such that the distance between recorded shots does not exceed 30 ft [10 m]. Features typically include:

- Edge-of-road,
- Roadway ditch,
- Top-of-roadway cut,
- Toe-of-roadway fill,
- Drainage flow line,
- Ridges,
- Edge-of-water, and
- Retaining walls.

Break lines have a unique point code that describes the break. FLH uses the following codes along features, as needed:

- Begin Line (BL*),
- End Line (EL*), and
- Close Figure (CL*).

Ground terrain is mapped by taking ground shots as needed, not to exceed 30 ft [10 m] transversely and longitudinally toward the direction of the roadway centerline. Additional shots are taken where spot elevations need to be shown on the final map. These areas include all high points, ridges, swales, saddles and depressions. Other locations pertinent to highway engineering needing spot elevations include:

- Road intersections,
- Road crests and sags,
- Road centerline at culvert crossings,
- Culvert inlets at the flow line, and
- Culvert outlets at the flow line.

Because digital terrain files will be generated from this field data and used for triangulation and cross section extraction, they require a high degree of accuracy. Measurements of well-defined features that are easily recovered on the ground have a vertical accuracy of 0.13 ft [40 mm] and a horizontal accuracy of 0.20 ft □[60 mm], based on measurements of higher accuracy for all planimetrics.

Vertical accuracy of at least 67 percent of all spot elevations at well-defined points, ground shots, break line shots, etc., will fall within one-third the contour interval of the map. Additionally, per National Map Accuracy Standards, 90 percent of the values should fall within one-half a contour interval.

5A.7 SAMPLE METADATA FOR HORIZONTAL AND VERTICAL CONTROL PROJECT

5A.7.1 SUMMARY OF METADATA

- Identification_Information
- Data_Quality_Information
- Spatial_Data_Organization_Information
- Spatial_Reference_Information
- Entity_and_Attribute_Information
- Distribution_Information
- Metadata_Reference_Information

5A.7.2 IDENTIFICATION_INFORMATION

Originator: [*responsible agency, department or consultant*]

Publication_Date: 20XX

Title: Sample Highway - Horizonal and Vertical Project Control Survey

Edition: Version [date]

Geospatial_Data_Presentation_Form: Control Listing and Report

Publication_Place: FHwA Central Federal Lands Highways Division, Lakewood, CO

Publisher: FHWA Central Federal Lands Highways Division

Online_Linkage: < http://www.cflhd.gov/project.html>

Description: Primary horizontal and vertical control for Sample Highway, Stations 00+00 to ___

Abstract: GPS geodetic control network using combined static and RTK methods. Project control tied to national CORS network through OPUS solutions at four (4) project points. Project elevation datum is based upon NAVD88 with GPS ties to two NGS benchmarks and GeoidXX model. Precise digital leveling completed between all project points.

Purpose: Provide a base base of reference for latitude, longitude and height throughout the United States.

Time_Period_of_Content: [*date range*]

Status: Complete

West_Bounding_Coordinate: [*signed longitude in d.dd*]

East_Bounding_Coordinate: [*signed longitude in d.dd*]

North_Bounding_Coordinate: [*signed latitude in d.dd*]

South_Bounding_Coordinate: [*signed latitude in d.dd*]

Point_of_Contact: [*Name*]

Contact_Organization: [*agency, department, consultant]*

Contact_Position: [*title*]

Contact_Address: [*number and street*]

City: [*city*]

State_or_Province: [*State*]

Postal_Code: [*zip*]

Country: USA

Contact_Voice_Telephone: [*phone*]

Contact_Facsimile_Telephone: [*fax*]

Contact_Electronic_Mail_Address: [*email*]

5A.7.3 DATA_QUALITY_INFORMATION

Attribute_Accuracy: Monument descriptions are included in the project report on file with FLH. Point numbering is in accordance with Appendix 5A.2 and Chapter 5. No digital feature coding was part of the data collection or processing.

Attribute_Accuracy_Explanation: [*additional notes as necessary for clarity, i.e., reference to feature code data dictionar*y].

Positional_Accuracy: Horizontal and vertical control was established in accordance with procedures and methods outlined in Chapter 5. The methods and procedures are designed to provide local project control, tied to the National Spatial Reference System, and evaluated for local accuracy classification in accordance with the Federal Geographic Data Committee's Geospatial Positioning Accuracy Standard, Part 2, Geodetic Control Networks, FGDC-STD-007.2-1998.

2000, 3000 and 4000 series point numbers are in accordance with Appendix 5A.2 and Chapter 5 for accuracy classification. All other points are for reference only and have not been classified for positional accuracy.

Horizontal_Positional_Accuracy: Primary survey control points (3000 series point numbers) meet a local accuracy of +/- 0.05 ft [15 mm] at the 95 percent confidence level.

Secondary survey control points (5000 series point numbers) meet a local accuracy of +/- 0.10 ft [30 mm] at the 95 percent confidence level.

Horizontal_Positional_Accuracy_Report: GPS observation data was post-processed for GPS vectors with Trimble TGO software suite, version x.x. Post-processed vectors and RTK vectors were combined in a least squares network adjustment using Star*Net Pro, version y.y. OPUS solutions at three (3) project stations were held fixed for latitude, longitude and two NGS benchmarks were held fixed for othometric height in the final over-constrained adjustment.

Horizontal_Positional_Accuracy_Explanation: [*additional notes of explanation as needed*].

Vertical_Positional_Accuracy: Primary survey control points (3000 series point numbers) meet a local accuracy of +/- 0.05 ft [15 mm] at the 95 percent confidence level.

Secondary survey control points (5000 series point numbers) meet a local accuracy of +/- 0.20 ft [60 mm] at the 95 percent confidence level.

Vertical_Positional_Accuracy_Report: Project elevations were computed from precise digital leveling holding fixed the derived orthometric height for station ___. Misclosure of the precise level loop was less than 0.02 ft [6 mm] and deemed small enough that no adjustment was applied.

Vertical_Positional_Accuracy_Explanation: [*additional notes of explanation as needed*].

Process_Description: [*descriptive notes of data processing procedures; more applicable to mapping data sets*].

5A.7.4 SPATIAL_DATA_ORGANIZATION_INFORMATION

SDTS_Point_and_Vector_Object_Type: point

Point_and_Vector_Object_Count: 1,500,000

5A.7.5 SPATIAL_REFERENCE_INFORMATION

Horizontal_Coordinate_System_Definition: [*State*] State Plane Coordinate System of 1983, Zone [zone].

Geographic:

Latitude_Resolution: 0.00001.

Longitude_Resolution: 0.00001.

Geographic_Coordinate_Units: degrees, minutes, and decimal seconds.

Geodetic_Model: Geoid xx.

Horizontal_Datum_Name: North American Datum of 1983 (NAD 83), Epoch 2002.00.

Ellipsoid_Name: Geodetic Reference System 80 (GRS80).

Semi-major_Axis: 6378137 m.

Denominator_of_Flattening_Ratio: 298.26.

Vertical_Coordinate_System_Definition:

Altitude_System_Definition: Local project control based upon NAVD88.

Altitude_Datum_Name:

North American Vertical Datum of 1988 (NAVD 88), including Ellipsoidal and Orthometric Heights.

Altitude_Resolution: .01.

Altitude_Distance_Units: US Survey Foot.

5A.7.6 ENTITY_AND_ATTRIBUTE_INFORMATION

Overview_Description: [*describe CADD or GIS software and general process*].

Entity_and_Attribute_Overview: [listing feature codes, abbreviations, levels and line styles as appropriate].

5A.7.7 DISTRIBUTION_INFORMATION

Distributor: Federal Highways Administration, __ Federal Lands Highway Division

Contact_Person: [*name*]

Contact_Organization: [*agency, department*]

Contact_Position: [*title*]

Contact_Address: [*number and street*]

City: [*city*]

State_or_Province: [*State*]

Postal_Code: [*zip*]

Country: USA

Contact_Voice_Telephone: [*phone*]

Contact_Facsimile_Telephone: [*fax*]

Contact_Electronic_Mail_Address: [*email*]

Resource_Description: Project control listing

Fees: free if downloaded via FTP

5A.7.8 METADATA_REFERENCE_INFORMATION

Metadata_Date: [*date*]

Contact_Person: [*name*]

Contact_Organization: [*agency, department, consultant*]

Contact_Position: [*title*]

Contact_Address: [*number and street*]

City: [*city*]

State_or_Province: [*State*]

Postal_Code: [*zip*]

Country: USA

Contact_Voice_Telephone: [*phone*]

Contact_Facsimile_Telephone: [*fax*]

Contact_Electronic_Mail_Address: [*email*]

Metadata_Standard_Name: Reduced data tag FGDC Content Standards for Digital Geospatial Metadata.

Metadata_Standard_Version: FGDC-STD-001-1998