APPENDIX D

Guide Specification for Photogrammetric Mapping and Aerial Photography Services Instructions

D-1. General. This guide specification is intended for use in preparing Architect-Engineer (A-E) contracts for professional photogrammetric mapping services using digital metric cameras. These specifications are applicable to all A-E contracts used to support US Army Corps of Engineers (USACE) civil works and military construction design, construction, operations, maintenance, regulatory, and real estate activities. This guide shall be used primarily for contracts obtained using Public Law (PL) 92-582 (Brooks Act) qualification-based selection procedures and for which unit prices in the contract schedule are negotiated. Limited exceptions to this contracting method are identified herein. When digital metric cameras are used, this guide supersedes the similar guide in Appendix D, EM 1110-1-1000 PHOTOGRAMMETRIC MAPPING, dated May 5, 2000 which was designed primarily for photogrammetric mapping from aerial film photography. Two sentences in Chapter 8, Cameras and Sensing Systems, of the 6th edition of the *Manual of Photogrammetry*, published by the American Society for Photogrammetry and Remote Sensing (ASPRS, 2013), summarize the reason for USACE's current focus on digital metric cameras: (1) "… the replacement of analog cameras by digital sensors has been practically completed in the US in the past seven years," and (2) "The current generation of large-format digital camera systems is so advanced that there is no comparison to film-based technology anymore." Furthermore, many of the popular aerial film types used in the past have been discontinued by manufacturers because of declining sales. For the limited number of USACE projects where film photography is determined to be the preferred alternative, the prior Appendix D in the older version of EM 1110-1-1000 may still be used.

D-2. Coverage. This guide specification contains the technical standards and/or references necessary to specify all phases of a photogrammetric mapping project. These include aircraft operations; aerial cameras; digital image processing; photogrammetric rectification and stereocompilation; planimetric and topographic map compilation; generation of Computer-Aided Drafting and Design (CADD) system, Geographic Information System (GIS), Land Information System (LIS), Automated Mapping/Facility Management (AM/FM), and other spatial databases; ground survey control support; supplemental ground topographic survey densification; and contractor quality control functions.

D-3. Applicability. The following types of A-E contract actions are supported by these instructions:

a. Fixed-price photogrammetric mapping and aerial photography service contracts.

b. Indefinite delivery type (IDT) photogrammetric mapping contracts.

c. A multidiscipline surveying and mapping IDT contract in which photogrammetric services are a line item supporting other surveying, mapping, hydrography, and/or other surveying services.

d. A work order or task order placed against an IDT contract.

e. Design and design-construct contracts that include incidental surveying and mapping services (including Title II services). Both fixed-price and IDT design contracts are supported by these instructions.

D-4. Contract Format. The contract format outlined in this guide follows the uniform contract format (UCF) as prescribed in Federal Acquisition Regulation (FAR) 14.201-1. The UCF supports Public Law (PL) 92-582 ("The Brooks Act")/ Standard Form (SF) 252 qualification-based A-E procurement actions.

D-5. Photogrammetric Line Mapping Applications. This guide is intended primarily to support complete, field-to-finish type contracts written for large- scale (1 in. = 400 ft or greater) site plan mapping work, as would be used for design and subsequent contracted construction plans and specifications. Typical applications include building or structure design or relocation; river, harbor, floodplain, or reservoir project mapping; and installation master planning activities. Both planimetric feature detail and topographic data are generated or encoded using softcopy photogrammetric workstations. Specifying field-to-finish implies that all phases of the photogrammetric process, from aerial image acquisition through final map compilation, are performed by the professional contractor. In addition, the contractor is responsible for exercising complete quality control over all phases of the work.

D-6. Supplemental Aerial Imagery Products. This guide may also be used to specify other associated photographic products commonly used in USACE design, planning, construction, and regulatory enforcement work. Requirements for these products would be included as supplemental line items in a professional A-E services contract intended for design mapping.

a. Image-Based Plan Drawings. Large-scale digital orthophotos, e.g., 3-inch pixel size, are suitable and commonly used for plan drawings, including detailed design, in lieu of annotated film

transparencies used in the past for construction location reference drawings or navigation project condition reports.

b. Aerial Imagery. Although standard 9- by 9-in. aerial photographs (black and white, color, or color infrared) from precision aerial mapping film cameras are still acceptable for USACE for limited applications, multi-band digital metric cameras are now preferred for most projects because of advantages listed in Chapter 4 of EM 1110-1-1000 and the 6th edition of the *Manual of Photogrammetry* (ASPRS, 2013). Such imagery may be intended for subsequent line mapping compilation by either USACE hired-labor forces or another A-E contractor. Alternatively, it may be intended only for regulatory enforcement or environmental interpretative purposes, or for general reconnaissance photography of a large region.

c. Digital Orthophotos. Digital orthophotos are now widely used for display and general planning purposes because they are easily produced from digital imagery acquired with direct georeferencing of position and orientation data for efficient production of orthorectified imagery, accompanied by limited ground control.

D-7. Aerial Imagery Procurement Using Other than A-E Firms. This guide is also designed to support procurement of basic aerial photography or imagery by methods other than A-E service contracts. Basic aerial photography may be obtained by price competition, where award is based primarily on price (i.e., low-bid), and not using professional/ technical qualification-based selection criteria but only when contracting for aerial photography and delivery of raw photographic images to the Government.

a. Strictly price-competitive (i.e., low-bid) procurement shall not be used if the photography or imagery is an integral part of a broader scoped contract that results in a map product, or if photogrammetric mensurations, mapping, orthorectifications, or any like realignment or rescaling is to be performed on the photography. Price-competitive procurement shall also not be used if photographic spatial data are input to any type of GIS, CADD system, LIS, or any other similar database that develops vector or raster/coordinate relationships or attributes. In all such instances, PL 92-582 qualification-based selection procedures must be used.

b. Some USACE photographic (not photogrammetric) needs may be procured using price competition methods. However, the following factors must be fully considered by USACE Commands in determining whether to use price competition or PL 92-582 methods:

(1) Price-competitive (low-bid) procurement methods may be applicable to aerial photography or digital imagery used for image or photo interpretative work, such as regulatory enforcement, where the 9-in by 9-in. photographic prints or unrectified digital imagery can be used as is. No subsequent mapping is intended from such photography or imagery.

(2) When aerial photography or imagery is to be compiled into line maps by a party other than the firm that flew it, a certain amount of quality control is lost over the process. Inadequacies in the photography may not be detected until stereocompilation commences, which may occur long after the aerial photography contract has been closed out. Likewise, photo control field surveys are best performed under the direct supervision and control of the firm responsible for compilation. Unless there are other compelling reasons (e.g., in-house stereocompilation), full field-to-finish mapping should be performed by the same contractor using PL 92-582 procurement. Use of low-bid procurement methods to obtain the aerial photography, and then passing such photography to another photogrammetric mapping firm for compilation, is a practice (or procurement strategy) that should be avoided if at all possible.

(3) Price-competitive procurement methods require exacting specifications and more rigorous Government quality control. Experienced in-house personnel must be capable of assessing photographic quality, coverage, and suitability for subsequent aerotriangulation and stereocompilation. Unless such activities are routinely performed within the USACE Command, evaluating contract performance is marginal, at best.

(4) When only small-scale, reconnaissance-type photography is required over a large area (e.g., an installation, watershed basin, or state), a price-competitive low-bid procurement action would be recommended.

(5) Air photo paper enlargements or unrectified digital imagery of a small, specific site may often be obtained by simple purchase order.

(6) Use of strictly price-competitive IDT contracts is not recommended.

c. USACE Commands must ultimately assess the project requirements, along with their in-house quality control capabilities, in deciding between the two forms of contracting. As a general rule of thumb, if the photographic products are to be used for construction contract plans and specifications, reproducible project condition drawings, boundary delineation or demarcation, or environmental/regulatory assessment or litigation, or will be encoded into some type of GIS,

LIS, AM/FM, or CADD spatial database, the recommended method is to follow PL 92-582 qualification-based procurement methods for reasons explained in Chapter 9 of this manual.

D-8. General Guide Use. In adapting this guide specification to any project, specific requirements will be changed as necessary for the work contemplated. Changes will be made by deletions or insertions within this format. With appropriate adaptation, this guide form may also be tailored for direct input in the Standard Procurement System/ Procurement Desktop Defense (SPS/PD2). Clauses and/or provisions shown in this guide will be renumbered during SPS/PD2 input.

D-9. Guide Arrangement. The work items listed in Section B price schedule are in the general order of performance on a typical photogrammetric mapping project. Scheduled line items in Section B follow the same general sequence.

D-10. Insertion of Technical Specifications. Engineer Manual (EM) 1110-1-1000, Photogrammetric and LiDAR Mapping, should be attached to and made part of any contract for aerial photography or imagery, photogrammetric or LiDAR mapping services. This EM contains specifications and quality control criteria for the total (field-to-finish) execution of a photogrammetric or LiDAR mapping project.

a. The latest edition of the American Society for Photogrammetry and Remote Sensing's (ASPRS) *Manual of Photogrammetry* (currently 6th edition) should also be attached by reference to any contract. This manual represents a comprehensive treatment of aerial imaging and photogrammetric mapping, and should be deferred to in cases of disputes over quality of services delivered.

b. Technical specifications for photogrammetric mapping that are specific to the project (including items such as the scope of work, procedural requirements, and accuracy requirements) will be placed under the SOW. The prescribed format for placing these technical specifications is contained in this guide. Project-specific technical specifications shall not contain contract administrative functions—these should be placed in more appropriate sections of the contract.

c. Appendix F of this manual provides the USGS Lidar Base Specification Version 1.2 relevant to many USACE aerial LiDAR mapping projects. For topographic LiDAR projects, the USGS Lidar Base Specification Version 1.2 (or newer) should be used as the starting point from which more-demanding USACE requirements can be specified, if required.

d. Technical specifications for other survey functions required in a photogrammetric or LiDAR mapping services contract may be developed from other Civil Works Construction Guide Specifications that are applicable to the surveying and mapping discipline(s) required.

e. Standards and other specifications should be checked for obsolescence and for dates and applicability of amendments and revisions issued subsequent to the publication of this specification. Use Engineer Pamphlet (EP) 25-1-1, Index of USACE/OCE Publications. Maximum use should be made of existing EM's, Technical Manuals, and other recognized or current industry standards and specifications.

f. Many technical provisions in this guide have incorporated both traditional analytical and softcopy stereoplotting and compilation methods. The on-going developments and refinements in planimetric and topographic mapping, orthophotography, digital photography, GIS, CADD, etc., require the guide user to ensure that redundant, obsolete, or inefficient procedures in this guide are continuously updated.

D-11. Cost Estimates for Photogrammetric Mapping Services. General guidance on preparing independent Government cost estimates is contained in Chapter 9 of EM 1110-1-1000. The unit of measure (lump sum/job or labor interval) shown in Section B, below, will be highly project dependent. Given the nonlinearity of many of these services, fixed unit prices in an IDT contract may be difficult to establish. In some instances, a work order placed against an IDT contract may require adjustments for services not contemplated in the initial base contract.

D-12. Alternate Clauses/Provisions or Options. In order to distinguish between required clauses and optional clauses, required clauses are generally shown in capital letters. Optional or selective clauses are generally in lower case. In other instances, alternate clauses/provisions may be indicated by brackets "[ ]" and/or clauses preceded by a single asterisk "*". A single asterisk signifies that a clause or provision that is inapplicable to the particular section may be omitted, or that a choice of clauses may be made depending upon the technical surveying and mapping requirement. Clauses requiring insertion of descriptive material or additional project-specific specifications are indicated by underlining inside brackets (e.g., "[_____]"). In many instances, explanatory notes are included regarding the selection of alternate clauses or provisions.

D-13. Notes and Comments. General comments and instructions used in this guide are contained in blocked asterisks. These comments and instructions should be removed from the final contract.

D-14. Indefinite Delivery Type (IDT) Contracts and Individual Work Order Assignments. Contract clauses pertaining to IDT contracts, or task orders thereto, are generally indicated by notes adjacent to the provision. These clauses should be deleted for fixed-price contracts. In general, sections dealing with IDT contracts are supplemented with appropriate comments pertaining to their use. Work orders against a basic IDT contract should be constructed using the general format of sample scopes of work outlined in this EM. Clauses contained in the basic contract should not be repeated in work orders.

SECTION A SOLICITATION/TASK ORDER FORM

SECTION B SERVICES AND PRICES/COSTS

TASK ORDER SCHEDULE

SECTION A

SOLICITATION/TASK ORDER FORM

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NOTE: Include here SF 252 in accordance with the instructions in Appendix B of PARC IL 92-4.
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SF 252 -- (Block 5): PROJECT TITLE AND LOCATION

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NOTE: Sample title for fixed-price contract:
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PHOTOGRAMMETRIC SITE PLAN MAPPING SURVEYS IN SUPPORT OF PRELIMINARY CONCEPT DESIGN OF FAMILY HOUSING COMPLEX ALPHA, AND RELATED INSTALLATION MASTER PLANNING GEOGRAPHIC INFORMATION SYSTEM DATA BASE UPDATES, AT FORT _____, ALABAMA.

PHOTOGRAMMETRIC SITE PLAN MAPPING, HIGH-RESOLUTION DIGITAL ORTHOPHOTOS FOR DREDGE DISPOSAL DESIGN, CONSTRUCTION, AND BOUNDARY DEMARCATION, OF _____ [PROJECT], _____, CALIFORNIA.

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NOTE: Sample title for indefinite delivery type contract:
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INDEFINITE DELIVERY CONTRACT FOR PROFESSIONAL PHOTOGRAMMETRIC MAPPING, AND RELATED SURVEYING SERVICES, IN SUPPORT OF VARIOUS *[CIVIL WORKS] [MILITARY CONSTRUCTION] PROJECTS *[IN] [ASSIGNED TO] THE _____ DISTRICT.

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NOTE: When other surveying services are also required as part of a broader surveying contract, the clause shown in EAL 90-1 shall be used.

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SECTION B

SERVICES AND PRICES/COSTS

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NOTE: The fee schedule for photogrammetric mapping and related survey services should be developed in conjunction with the preparation of the independent Government estimate (IGE) along with the technical specifications. Two general unit of measure (U/M) methods may be used in a fee schedule for photogrammetric mapping services: (1) an Hourly or Daily Rate basis or (2) a Cost per Unit Area basis (unit pricing).

The following tables contain sample fee schedules that may be tailored for use on most photogrammetric mapping service contracts. The guide writer should select those line items applicable to the project, or for those projects envisioned over the course of an IDT contract. Other line items may be added that are unique to the project(s). If applicable, a separate fee schedule for contract option periods should be developed and negotiated during contract negotiations and included with the contract during initial award. Unit prices (U/P) shall include direct and indirect overheads. Profit is not included on IDT contract unit prices. Profit is calculated per project or task order and is based on length of time for the work, risk, and minority participation.

For reasons explained in Chapter 9, detailed procedures for estimating line item unit prices are no longer described in EM 1110-1-1000. Determination of these estimated unit prices must conform to the detailed analysis method, or "seven-item breakdown." The scope of each scheduled line item used in Section B must be thoroughly defined. Many of the line item units of measure comprise costs from a variety of sources. These sources are combined in the IGE to arrive at the scheduled rate. For example, aircraft operation, maintenance, and labor costs are reduced to a cost per flight hour. Survey crew day rates include labor, travel, transportation, expendable materials, and numerous other items that are developed as part of the IGE.

Chapter 9 of EM 1110-1-1000 is designed to equip government personnel to better estimate “relative” (not absolute) costs associated with procuring professional mapping services. Chapter 9 will help Contracting Officers and technical personnel associated with contracting to better estimate how the scope, schedule, and technical merits of a project can affect the relative cost of professional services. Chapter 9 will not help determine the actual costs associated with procuring professional mapping services. Instead, it will help readers understand which factors should be

considered when drafting a solicitation and how those factors affect the associated cost, schedule, and complexity of the procurement.

On IDT contracts, the specification writer should strive to avoid scheduling items with little probability of being required during the contract period. Since each line item must be separately estimated and negotiated, considerable Government (and contractor) resources may be consumed in developing negotiated unit costs for unused items. For example, line items such as color infrared (CIR) digital orthophotos would not be included on an IDT contract, even though a digital camera may collect CIR imagery as part of a typical 4-band image acquisition, unless there is a fair degree of assurance that these items would be required on a subsequent work order.

In addition, the specification writer should attempt to include only those line items that represent a major cost activity/phase in performing photogrammetric mapping. Cost estimating emphasis and resources should be committed to major cost items such as aerial image acquisition, stereocompilation, and control surveys, with emphasis given to those contracting factors in Table 9-1 with the highest impact on cost, schedule and complexity. Avoid cluttering the schedule with small and relatively insignificant (to the overall project cost) supply and material items, again minimizing the administrative costs of estimating and negotiating these items. These should be included as part of a major line item or be contained in the firm's overhead. Examples of normal supply items that the guide user should avoid scheduling are field survey books or bundles of 2-in by 2-in. survey stakes. These items would, however, be compensated for in the IGE. Care must be taken in developing these schedules with the IGE to preclude duplication of costs between line items or overheads. This is particularly important when breaking out softcopy workstation stereocompilation costs with associated computer and CADD actions.

The guide user and cost estimator must have a good working knowledge of photogrammetric mapping production processes to properly allocate time and costs. The following schedules may be tailored for either A-E fixed-price or A-E IDT contracts. For fixed-price contracts, the estimated quantities are available from the government estimate. For IDT contracts, a unit quantity for each line item would be negotiated and included in the basic contract. Daily units of measure may be modified to hourly or other nominal units if needed. Lump sum or areal units of measure are also included or may be developed for some of the services. For non-A-E type contracts for photography, the schedule would have to be modified for bid submittal. The item numbers shown are for reference in this guide only--they would be renumbered in the final contract.
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In the Table below, AMT = Dollar Amount for numbered item, from multiplying QUAN (Quantity) by either the U/M (Unit of Measure) or U/P (Unit Pricing). C/Day = Crew Day; M/Day = Man Day; M/Hour = Man Hour; L/S = Lump Sum.

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
	AERIAL IMAGE ACQUISITION				
0500	Aircraft Flight Operations: Aircraft ownership, operation and maintenance costs; camera; GPS; IMU; pilot, cameraman; fuel; landing fees, etc. based on accumulated flight time between contractor's home base/airfield to project site, between project sites, and/or temporary landing fields near project sites (if applicable), over project sites and return to home base/airfield. {Note: Negotiated hourly rate is determined primarily from field pricing support audit of firm's aircraft operating costs.}		Flight Hours		
0501	Additional Aircraft Flight Crew Costs: Flight crew and cameraman labor and per diem on temporary duty at project site. {Note: This line item is included only when a unique project scope, size or location requires the aircraft and crew to temporarily locate at the project site. Normal standby time at the home base is not included in this item; it is more properly included in the firm's overhead.}		Crew Days		
0502	Emergency Aircraft and Flight Crew Standby: Surcharge cost of aircraft and crew for dedicating operations exclusively to government-directed work during emergency operation periods. {Note: Include on IDT contracts as applicable. U/P is essentially firm's overhead rate for aircraft and crew while on non-flight status.}		Crew Days		
0503	Aircraft and Flight Crew Surcharge for *[OCONUS] [_____] Transit, Travel, and Related Nonstandard Fees and Expenses Associated Therewith. {Note: Use, as applicable, for either non-conventional or OCONUS (outside the continental United States) sites and/or projects. Fee is in addition to those routinely covered above, and could include items such as aircraft long-distance transit modifications, customs fees, fuel surcharges, OCONUS per diem, etc.}		Job	L/S	

0504	Aerial Photography/Imaging: Perform flight planning; obtain stereoscopic coverage *[Black & White Panchromatic] [Color] [Color Infrared] [_____] photography using high-precision aerial mapping camera in accordance with scale, ground sample distance (GSD), coverage, and/or other applicable technical specifications contained in *[and/or Task Order Scope], and maps or attachments thereto; and perform quality review of ground control, raw imagery, airborne GPS and inertial measurement unit (IMU) post-processing for Direct Georeferencing, and digital image processing steps to ensure suitability for aerial triangulation (AT). {Note: Aerial imaging shall be performed with a calibrated metric camera flown at an altitude to obtain the GSD suitable for planimetric map scales indicated in Table 3-2 and/or orthophoto pixel sizes in Table 3-1, Chapter 3 of EM 1110-1-1000. Furthermore, Appendix D of 1110-1-1000 should be consulted to ensure other accuracy and quality parameters are achieved.}		Man Hour		
1000	Photo Index: Professional labor and materials required to prepare photo indices in accordance with the technical specifications described in the SOW for the task order.		Job	L/S	
	AERIAL TRIANGULATION				
1100	Aerial Triangulation (AT): Furnish professional labor, hardware, software and data required to perform aerial triangulation for digital orthophotography, planimetric or topographic mapping. {Note: AT includes image scanning, model setup and orientation if film imagery is used.}		Man Hour		
	DIGITAL ORTHOPHOTOGRAPHY				
1200	Digital Orthophotographs, black and white, color, or color infrared (CIR). Furnish professional labor, hardware, software and data required to produce digital orthophotos. {Note: Topo or feature overlay requirements, as well as ground survey control, are covered separately.}		Man Hour		
	LAND SURVEYING				
1300	Registered/Professional Land Surveyor		Man Days		

1301	Survey Computor (Office)		Man Days		
1302	[Two][Three][Four][____]-Person Photo Control Survey Party, consisting of all labor, travel, transportation, survey equipment, and materials necessary to perform photo control surveys, including paneling, quality control, topographic detailing, and other functions. {Note: Unit rates for individual Survey Party members are below.}		Crew Days		
1303	Survey Party Chief		Man Days		
1304	Surveying Technician-Instrumentman/Recorder		Man Days		
1305	Surveying Aid-Rodman		Man Days		
1306	Station Monuments {Note: Specify disc type and monument construction.}		Each		
1307	Field Classification and Edit Surveys: [Two][____] -Person Survey Party (Party Chief + Instrumentman/Recorder)		Crew Days		
1308	Quality Assurance/Quality Control (QA/QC) Testing Surveys: [Two][____]-Person Survey Party (Party Chief + Instrumentman/Recorder)		Crew Days		
	STEREO COMPILATION: Furnish professional labor, hardware, software, materials and data required to stereo-compile planimetric and/or topographic features or data.				
1400	Automated or Semi-Automated Stereocompilation of Digital Elevation Models (DEMs) or Digital Surface Models (DSMs)		Man Hours		
1401	Planimetric Feature Manual Stereocompilation		Man Hours		
1402	Topographic Feature Manual Stereocompilation {Note: The above items may be combined}		Man Hours		
	DELIVERABLES: Furnish professional labor, hardware, software, materials, data and media required for submission of hardcopy and/or digital deliverables				
1500	Magnetic Media (DVDs, CDs, USB hard drives, tapes)		Job	L/S	

1501	CADD/GIS-Generated Paper Prints (Color or B/W)		Each		
1502	Film Transparencies *[F-Size]		Each		
1503	Stable-Based Mylar *[F-Size]		Sheet		
1504	Bond Paper *[F-Size]		Sheet		
1505	Planimetric Feature Plotting		Man Hours		
1506	Topographic Feature Plotting		Man Hours		
1507	CADD Operator (Editor)		Man Hours		
1508	GIS Technician		Man Hours		
1509	Photogrammetrist		Man Hours		
1510	Chief Photogrammetrist (Production Manager)		Man Hours		
	Project Manager		Man Hours		
1511	Computer Usage: CADD/GIS computer charges not included in overhead		Hour		