# Appendix C
# Contract Schedules for GPS Surveying Services

## C-1. General

This Appendix contains a guide specification for use in preparing Architect-Engineer (A-E) contracts for professional surveying and mapping services where use of GPS methods is an integral part of the effort. 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. Since GPS is only a tool for supporting topographic, photogrammetric, or hydrographic surveys, an exclusive GPS survey contract would not normally be developed--i.e. these specifications would normally be incorporated into a traditional site plan mapping, photogrammetric mapping, or hydrographic surveying contract. This guide specification is intended for contracts, which are obtained using PL 92-582 (Brooks Act) qualification-based selection procedures.

## C-2. Coverage

This guide specification contains the technical standards and/or references necessary to specify the more common static and kinematic differential (carrier phase tracking) GPS surveying methods that are currently (2002) in use. It is intended to support precise GPS control surveys performed for engineering and construction purposes. This guide supports the following types of differential GPS carrier phase surveying:

- Static Differential GPS Positioning
- Rapid Static Differential GPS Positioning
- Stop-and-Go Differential GPS Positioning
- Pseudo-kinematic Differential GPS Positioning
- Real-time On-the-Fly Differential GPS Positioning

Continuing developments of the above applications, along with the evolution of newer GPS survey techniques, mandates that these guide specifications be continuously evaluated by USACE Commands to insure they are technologically current.

## C-3. Applicability

The following types of negotiated A-E contract actions are supported by these instructions:

*a*. Fixed-price surveying service contracts requiring GPS control.

*b*. Indefinite delivery contracts (IDC) for surveying services.

*c*. A multi-discipline surveying and mapping IDC contract in which GPS surveying services is a line item supporting other surveying, mapping, hydrography, and/or photogrammetry services.

*d*. A task order placed against an IDC contract.

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

## C-4. Insertion of Technical Specifications

This Engineer Manual (EM 1110-1-1003, NAVSTAR GPS Surveying) shall be attached to and made part of any service contract for GPS surveying. References to this EM are made throughout this guide. These references will normally suffice for most USACE GPS survey specifications; however the guide also identifies areas where deviations from this manual must be considered.

*a*. Technical specifications for GPS surveying that are specific to the project, (including items such as the scope of work, procedural requirements, and accuracy requirements), will be placed under Section C of the SF 252 (Block 10). The prescribed format for developing the technical specifications is contained in this guide specification. Project-specific technical specifications shall not contain contract administrative functions -- these should be placed in more appropriate sections of the contract.

*b*. Standards and other specifications referenced in this guide specification should be checked for obsolescence and for dates and applicability of amendments and revisions issued subsequent to the publication of this specification. Maximum use should be made of existing EM's, Technical Manuals, and other recognized industry standards and specifications.

*c*. Throughout Section C of this guide, the specification writer must elect a contract performance method: (1) the government designs the GPS occupation/observing schedule, or (2) the contractor designs his performance method based on the criteria given in EM 1110-1-1003. Selection of the first method depends on the GPS survey expertise of the specification writer. This method also transfers much of the contract risk to the government. The second method is the preferred contract procedure.

## C-5. Alternate Clauses/Provisions or Options

In order to distinguish between required clauses and optional clauses, required clauses are generally shown in capitol letters. Optional or selective clauses, such as would be used in a work order, 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 either ellipsis or underlining in brackets (e.g., "[...]" "[_____]"). In many instances, explanatory notes are included regarding the selection of alternate clauses or provisions.

## C-6. Notes and Comments

General comments and instructions used in this guide are contained within asterisk blocks. These comments and instructions should be removed from the final contract.

## C-7. Indefinite Delivery Contracts and Individual Task Order Assignments

Contract clauses that pertain to IDC 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 IDC contracts are supplemented with appropriate comments pertaining to their use. Task orders against a basic IDC contract may be constructed using the format contained in Section C of this guide. This contract section is therefore applicable to any type of GPS service contracting action.

## THE CONTRACT SCHEDULE

**SECTION A**

**SOLICITATION/CONTRACT FORM**

**********
NOTE: Include here Standard Form 252
**********

SF 252 -- (Block 5): PROJECT TITLE AND LOCATION

**********
NOTE: The following sample titles represent projects under which static or kinematic GPS surveys are expected to play a significant role in developing basic project control, photo control, or local site plan mapping control. GPS surveys are used to support subsequent photogrammetric, plane table/total station site plan mapping, and construction layout operations.
**********

{Fixed-price contract -- sample title}:

PROJECT CONTROL AND PHOTOGRAMMETRIC MAPPING CONTROL SURVEYS USING KINEMATIC DIFFERENTIAL NAVSTAR GPS IN SUPPORT OF SITE PLAN MAPPING FOR PRELIMINARY CONCEPT DESIGN OF FAMILY HOUSING COMPLEX ALPHA, FORT _____, ALABAMA.

PROJECT CONTROL REFERENCE SURVEYS USING STATIC DIFFERENTIAL NAVSTAR GPS POSITIONING FOR BOUNDARY DEMARCATION SURVEYS OF _____ [PROJECT], _____, CALIFORNIA.

{Indefinite Delivery Contract -- sample title}:

INDEFINITE DELIVERY CONTRACT FOR GEODETIC CONTROL, TOPOGRAPHIC MAPPING, AND RELATED SURVEYING SERVICES IN SUPPORT OF VARIOUS *[CIVIL WORKS] [MILITARY CONSTRUCTION] PROJECTS *[IN] [ASSIGNED TO] THE _____ DISTRICT.

**********

**SECTION B**

**SERVICES AND PRICES/COSTS**

**********
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. The unit of measure (U/M) used in a fee schedule for GPS mapping services is generally established on a daily rate basis (i.e. crew-day). U/Ms based on "per occupied point" or "per

baseline observation" are no longer recommended given the high variability in GPS equipment production.

The table below contains sample fee schedules that may be tailored for use on most GPS control surveying or 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 IDC contract. Other line items may be added which 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 shall include direct and indirect overheads. Profit may or may not be included on IDC contract unit prices.

Procedures for estimating line item unit prices (U/P) are described in Chapter 12 of this EM. Determination of these estimated unit prices should conform to the detailed analysis method. The scope of each scheduled line item used in Section B must be thoroughly defined--either with the line item in Section B or at its corresponding reference in Section C of the contract. Many of the line item units of measure are comprised of costs from a variety of sources. These sources are combined in the IGE to arrive at the scheduled rate. Survey crew day rates normally include labor, travel, transportation, expendable materials, and numerous other items which are developed as part of the IGE. However, large items, such as travel, may be separately scheduled.

On IDC contracts, the specification writer should strive to avoid scheduling items, which have 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. Individual line items should not be included on an IDC contract unless there is a fair degree of assurance that these items will 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 GPS surveying. Cost estimating emphasis and resources should be placed on major cost items, such as field crew labor. 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"x2" 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 against duplication of costs between line items or overheads. Specific personnel and equipment requirements should be identified and itemized in applicable contract sections. This is particularly important when breaking out GPS receiver costs. The guide user (and cost estimator) must have a good working knowledge of GPS field surveying, baseline reduction, and data adjustment processes to properly allocate time and costs.

The following Section B outline may be tailored for either A-E fixed-price or A-E IDC contracts. For fixed-price contracts, the estimated quantities are available from the government estimate. For IDC contracts, a unit quantity for each line item would be negotiated and included in the basic contract. Daily units of measure (U/M) may be modified to hourly or other nominal units if needed. Lump sum or areal U/M (e.g., per baseline observation) may be developed for some of the services, although this is not recommended. The item numbers shown are for reference in this guide only -- they would be renumbered in the final contract. A sample of a completed "Schedule B" is shown in Chapter 12.

## SERVICES AND PRICES/COSTS

**********

| ITEM | DESCRIPTION | QUAN | U/M | U/P | AMOUNT |
|---|---|---|---|---|---|
| 0001 | Registered/Licensed Land Surveyor-Office | [1] | Day | | |
| 0002 | Registered/Licensed Land Surveyor-Field | [1] | Day | | |
| 0003 | Civil Engineering Technician -- Field Party Supervisor (Multiple Crews) | [1] | Day | | |
| 0004 | Engineering Technician (Draftsman)-Office | [1] | Day | | |
| 0005 | Supervisory Survey Technician (Field) | [1] | Day | | |
| 0006 | Surveying Technician -- GPS Instrumentman/Recorder | [1] | Day | | |
| 0007 | Surveying Aid -- Rodman/Chainman {Conventional surveys} | [1] | Day | | |
| 0008 | [Two][Three][Four][___]- Man [Static] [Kinematic] GPS Survey Party [___] GPS Receiver(s) [___] Vehicle(s) [___] Computer(s) {Detail specific personnel/equipment requirements in applicable contract sections | [1] | CrewDay | | |
| 0009 | Additional GPS Receiver {Add Item 0006 observers as necessary} | [1] | Day | | |
| 0010 | {Travel/Per Diem -- add line item if not included in above items} | [1] | Day | | |
| 0011 | Survey Technical (Office Computer) | [1] | Day | | |
| 0012 | | | | | |
| 0013 | | | | | |

## SECTION C

## STATEMENT OF WORK

C.1 GENERAL. THE CONTRACTOR, OPERATING AS AN INDEPENDENT CONTRACTOR AND NOT AN AGENT OF THE GOVERNMENT, SHALL PROVIDE ALL LABOR, MATERIAL, AND EQUIPMENT NECESSARY TO PERFORM THE PROFESSIONAL SURVEYING *[AND MAPPING WORK] *[FROM TIME TO TIME] DURING THE PERIOD OF SERVICE AS STATED IN SECTION D, IN CONNECTION WITH PERFORMANCE OF *[_____] SURVEYS *[AND THE PREPARATION OF SUCH MAPS] AS MAY BE REQUIRED FOR *[ADVANCE PLANNING,] [DESIGN,] [AND CONSTRUCTION] [or other function] [ON VARIOUS PROJECTS] *[specify project(s)] . THE CONTRACTOR SHALL FURNISH THE REQUIRED PERSONNEL, EQUIPMENT, INSTRUMENTS, AND TRANSPORTATION, AS NECESSARY TO ACCOMPLISH THE REQUIRED SERVICES AND FURNISH TO THE GOVERNMENT REPORTS AND OTHER DATA TOGETHER WITH SUPPORTING MATERIAL DEVELOPED DURING THE FIELD DATA ACQUISITION PROCESS. DURING THE PROSECUTION OF THE WORK, THE CONTRACTOR SHALL PROVIDE ADEQUATE PROFESSIONAL SUPERVISION AND QUALITY CONTROL TO ASSURE THE ACCURACY, QUALITY, COMPLETENESS, AND PROGRESS OF THE WORK.

**********
NOTE: The above clause is intended for use on an IDC contract for survey services. It is not exclusive to GPS-performed surveys. It may be used for Fixed-price service contract by deleting appropriate IDC language and adding the specific project survey required. This clause is not repeated on individual task orders.
**********

C.2 LOCATION OF WORK.

**********
NOTE: Use the following clause for a fixed-scope contract or individual work order.
**********

C.2.1. *[STATIC] [KINEMATIC] SURVEYS USING NAVSTAR GPS EQUIPMENT WILL BE PERFORMED AT [...] *[list project area or areas required]. *[A MAP DETAILING THE WORK SITE IS ATTACHED AT SECTION G OF THIS CONTRACT.]

**********
NOTE: Use the following when specifying an indefinite delivery contract for surveying and mapping services.
**********

C.2.2. SURVEYING SERVICES WILL BE PERFORMED IN CONNECTION WITH PROJECTS *[LOCATED IN] [ASSIGNED TO] THE [_____] DISTRICT. *[THE _____ DISTRICT INCLUDES THE GEOGRAPHICAL REGIONS WITHIN *[AND COASTAL WATERS] [AND RIVER SYSTEMS] ADJACENT TO:]

*_____
{list states, regions, etc.}

**********
NOTE: Note also any local points-of-contact, right-of-entry requirements, clearing restrictions, installation security requirements, etc.
**********

C.3 TECHNICAL CRITERIA AND STANDARDS.

REFERENCE STANDARDS:

C.3.1. US ARMY CORPS OF ENGINEERS EM 1110-1-1003, NAVSTAR GPS SURVEYING. THIS REFERENCE IS ATTACHED TO AND MADE PART OF THIS CONTRACT. (SEE CONTRACT SECTION G).

C.3.2. US ARMY CORPS OF ENGINEERS ENGINEER MANUAL EM 1110-1-1002, SURVEY MARKERS AND MONUMENTATION. *[THIS REFERENCE IS ATTACHED TO AND MADE PART OF THIS CONTRACT. (SEE CONTRACT SECTION G).]

C.3.4. *[List other applicable USACE reference manuals and standards].

**********
NOTE: Reference may also be made to other applicable Engineering Manuals or standard criteria documents. Such documents need not be attached to the Contract; if attached, however, reference should be made to their placement in contract Section G.
**********

C.4 WORK TO BE PERFORMED. PROFESSIONAL NAVSTAR GPS SURVEYING AND MAPPING SERVICES TO BE PERFORMED UNDER THIS CONTRACT ARE LISTED BELOW. UNLESS OTHERWISE INDICATED IN THIS CONTRACT *[OR IN TASK ORDERS THERETO], EACH REQUIRED SERVICE SHALL INCLUDE FIELD-TO-FINISH EFFORT.

**********
NOTE: The following clauses under this paragraph may be used for either Fixed-price service contracts, IDC work orders under an IDC contract, or IDC contracts where GPS control services are part of a schedule of various survey disciplines. Clearly identify the functional requirements of any GPS surveys, including recommended static or kinematic procedures.

Fixed-scope contracts: Detail specific GPS surveying and mapping technical work requirements and performance criteria, which are necessary to accomplish the work.

IDC contracts and work orders: Since specific project scopes are indefinite at the time a basic contract is prepared, only general technical criteria and standards can be outlined. Project or site-specific criteria will be contained in each task order, along with any deviations from technical standards identified in the basic IDC contract. The clauses contained herein are used to develop the general requirements for a basic IDC contract. Subsequent task orders will reference these clauses; adding project-specific work requirements as required. Task order formats should follow the outline established for the basic IDC contract.
**********

C.4.1. GENERAL REQUIREMENTS (GPS SURVEYS). BASIC PROJECT CONTROL SURVEYS WILL BE PERFORMED USING PRECISE DIFFERENTIAL CARRIER-PHASE TRACKING NAVSTAR GPS MEASUREMENT PROCEDURES. DIFFERENTIAL GPS BASELINE VECTOR OBSERVATIONS WILL BE MADE IN STRICT ACCORDANCE WITH THE CRITERIA CONTAINED IN EM 1110-1-1003, EXCEPT AS MODIFIED OR AMPLIFIED HEREIN. THE GPS MEASUREMENT TECHNIQUE TO BE EMPLOYED IN MEASURING RELATIVE BASELINE VECTORS FOR *[PROJECT CONTROL] [PHOTO CONTROL] [TOPOGRAPHIC SITE PLAN MAPPING] IS *[STATIC] [STOP-AND-GO] [RAPID STATIC] [RTK] [PSEUDO-KINEMATIC], *[OR COMBINATIONS THEREOF]. *[CONVENTIONAL SURVEY METHODS WILL BE USED TO DENSIFY SUPPLEMENTAL POINTS RELATIVE TO ESTABLISHED GPS STATIONS.] *[SPECIFIC GPS BASELINES TO BE OCCUPIED AND OBSERVED IN THE DIFFERENTIAL MODE ARE INDICATED IN THESE SPECIFICATIONS.]

C.4.2. HORIZONTAL ACCURACY REQUIREMENTS. NEW *[PRIMARY] STATIONS SHALL BE ESTABLISHED TO A *[_____]-ORDER, *[CLASS *[___]] RELATIVE ACCURACY CLASSIFICATION, OR *[___ PART IN _____]. *[SUPPLEMENTAL TOPOGRAPHIC/PHOTOGRAMMETRIC MAPPING POINTS SHALL BE ESTABLISHED TO A *[_____]-ORDER, *[CLASS *[___]] RELATIVE ACCURACY CLASSIFICATION, OR *[___ PART IN _____].] *[GPS HORIZONTAL ACCURACY REQUIREMENTS SPECIFIED FOR NEWLY POSITIONED STATIONS SHALL BE BASED ON A FREE (UNCONSTRAINED) ADJUSTMENT OF OBSERVATIONS AND SHALL MEET THE RELATIVE ACCURACY AND/OR LOOP MISCLOSURE CRITERIA INDICATED IN EM 1110-1-1003.]

**********
NOTE: Note that accuracy classifications, and related contract quality control and acceptance, are based on a free adjustment of the work -- not a constrained adjustment to fixed/existing control that often is of less accuracy than the new GPS work. GPS derived topographic mapping control need only meet general positional mapping requirements based on the site plan scale -- refer to ASPRS horizontal and vertical accuracy standards.
**********

C.4.3. * VERTICAL ACCURACY REQUIREMENTS. GPS-DERIVED ELEVATIONS SHALL HAVE STANDARD ERRORS NOT EXCEEDING *[____] OR SHALL BE COMMENSURATE WITH THE CONTOUR INTERVAL OF THE FINAL TOPOGRAPHIC MAP BEING PRODUCED. ALL ELEVATION MEASUREMENTS DERIVED FROM GPS OBSERVATIONS SHALL BE PERFORMED IN ACCORDANCE WITH THE STANDARDS AND SPECIFICATIONS IN EM 1110-1-1003, AND SUPPLEMENTAL REFERENCES THEREOF.

**********
NOTE: When GPS techniques are used to establish vertical elevations for photo or topo mapping projects, the required vertical accuracy must be specified. Extreme caution must be employed in specifying the use of GPS in densifying vertical control -- its application for engineering and construction work requires extensive redundancy.
**********

C.4.4. PROCEDURAL OBSERVATION REQUIREMENTS. NETWORK DESIGN, STATION AND BASELINE OCCUPATION REQUIREMENTS FOR STATIC AND KINEMATIC SURVEYS, SATELLITE OBSERVING TIME PER BASELINE, BASELINE REDUNDANCIES, AND CONNECTION REQUIREMENTS TO EXISTING NETWORKS, SHALL FOLLOW THE CRITERIA GIVEN IN EM 1110-1-1003, EXCEPT AS MODIFIED IN THESE SPECIFICATIONS.

**********
NOTE: At this point, indicate any exceptions, modifications, and/or deviations from EM 1110-1-1003. The specification writer may optionally elect to have the contractor design his observing procedures in accordance with general EM 1110-1-1003 criteria. Alternatively, specific baselines or stations requiring occupation may be specified. Use of either option depends on the GPS and geodetic survey experience/expertise of the specification writer. The preferred method is to allow the maximum flexibility be given to the contractor to determine the most optimum network design (interconnections, traverses, loops, spurs, etc.). In specifying baselines/points that have been monumented, contingencies should be allowed for resetting marks and/or eccentric observations due to obscured satellite visibility. Maximum use of more efficient kinematic control densification methods (as opposed to static methods) should be specified.
**********

C.4.5. * SPECIFIC BASELINES TO BE MEASURED.

**********
NOTE: Use the above clause only if the government specification writer is designing the network.
**********

*(1) THE FOLLOWING BASELINES SHALL BE OBSERVED ON THIS PROJECT: [...]
*[list specific station-station baselines and any requirements for redundant observations]

*(2) THESE BASELINES ARE INDICATED BY [...] *[specify line symbol] ON THE ATTACHED MAP IN SECTION G.

C.4.6. NEW STATIONS TO BE *[MONUMENTED AND] OCCUPIED.

(1) THE FOLLOWING *[...] *[indicate number of] STATIONS ARE TO BE OCCUPIED AND POSITIONED USING GPS SURVEY TECHNIQUES: *[list/tabulate new stations name and/or area designation, accuracy requirements (order/class), redundant occupations, etc.]

(2) THE NEW STATIONS *[GENERAL LOCATIONS] ARE INDICATED WITH A *[...] *[indicate map symbol used] ON THE ATTACHED MAP. *[ACTUAL STATION LOCATION WITHIN THE GENERALLY DEFINED AREA SHALL BE SELECTED BY THE CONTRACTOR AND SHALL BE LOCATED SUCH THAT ADEQUATE SATELLITE VISIBILITY IS AFFORDED.]

C.4.7. EXISTING NETWORK CONTROL STATIONS TO BE OCCUPIED AND CONNECTED.

(1) A TOTAL OF *[...] *[specify number of] EXISTING HORIZONTAL CONTROL STATIONS WILL BE USED TO REFERENCE HORIZONTAL GPS OBSERVATIONS ON THIS SURVEY. A LISTING OF THESE FIXED POINTS *[IS SHOWN BELOW] [IS SHOWN IN ATTACHMENT G.*]. FIXED COORDINATES ARE *[NAD 27] [NAD 83] [WGS 84 GEOCENTRIC] [...].

**********
NOTE: List each existing control station(s) or, alternately, refer to a map or tabulation attachment in contract Section G.
**********

(2) A TOTAL OF *[...] [specify number] VERTICAL CONTROL STATIONS (BENCHMARKS) WILL BE OCCUPIED AND USED TO CONTROL AND/OR PROVIDE VERTICAL ORIENTATION REFERENCE TO GPS VERTICAL COMPONENTS. A LISTING OF THESE FIXED BENCHMARKS *[IS SHOWN BELOW] [IS SHOWN IN ATTACHMENT G.*]. ELEVATIONS FOR ALL FIXED BENCHMARKS ARE BASED ON *[NGVD 29] [NAVD 88] [IGLD-55] [...] DATUM. GEOID SEPARATION IS *[...] [ASSUMED TO BE ZERO].

**********
NOTE: list or reference attachment for existing benchmarks.
**********

(3) REQUIRED GPS BASELINE CONNECTIONS TO EXISTING CONTROL IS SHOWN ON ATTACHMENT G.* IN SECTION G. THESE FIXED POINTS WILL BE USED IN PERFORMING A FINAL CONSTRAINED ADJUSTMENT OF ALL NEW WORK. HORIZONTAL POINTS ARE INDICATED BY A [...], VERTICAL POINTS BY A [...], COMBINED POINTS BY A [...], AND GPS BASELINES BY A [...].

**********
NOTE: Use the above clause when existing control points to be connected are specified in the contract.
**********

(4) ALL HORIZONTAL AND VERTICAL MONUMENTS ARE KNOWN TO BE IN-PLACE AS OF *[date]. DESCRIPTIONS FOR EACH POINT *[WILL BE PROVIDED PRIOR TO

CONTRACT AWARD] *[ARE ATTACHED AT CONTRACT SECTION G]. THE SOURCE AGENCY, AND ESTIMATED ACCURACY, OF EACH POINT IS INDICATED ON THE DESCRIPTION. *[A GPS OBSTRUCTION SKETCH IS SHOWN ON (HAS BEEN ADDED TO) THE DESCRIPTIONS.] *[IF SATELLITE VISIBILITY IS OBSCURED AT AN EXISTING STATION, THEN A NEW MARK SHALL BE SET AT THE RATE FOR ITEM [____] IN SECTION B.] *[THE CONTRACTOR'S FIELD REPRESENTATIVE SHALL IMMEDIATELY NOTIFY THE GOVERNMENT'S CONTRACTING OFFICER REPRESENTATIVE IF EXISTING CONTROL POINTS HAVE BEEN DISTURBED AND/OR SATELLITE VISIBILITIES ARE NOT AS INDICATED IN THE FURNISHED DESCRIPTIONS.]

**********
NOTE: Use the following clause(s) only when network design and observation schedule/sequence will be determined by the contractor.
**********

(5) * UNLESS OTHERWISE SPECIFIED IN THESE INSTRUCTIONS, AT LEAST *[ONE] [TWO] [THREE] [____] EXISTING (PUBLISHED) CONTROL STATIONS MUST BE OCCUPIED IN THE NETWORK. CONNECTION METHODS AND REDUNDANCY ARE AT THE CONTRACTOR'S OPTION. PRIOR TO USING ANY CONTROL POINTS, THE MONUMENTS SHALL BE CHECKED TO ENSURE THAT THEY HAVE NOT BEEN MOVED OR DISTURBED.

C.4.8. NEW STATION MONUMENTATION, MARKING, AND OTHER CONTROL REQUIREMENTS.

(1) ALL STATIONS SHALL BE MONUMENTED IN ACCORDANCE WITH EM 1110-1-1002, SURVEY MARKERS AND MONUMENTATION. MONUMENTATION FOR THIS PROJECT SHALL BE TYPE *[...] FOR HORIZONTAL AND TYPE *[...] FOR VERTICAL; PER EM 1110-1-1002 CRITERIA. *[MONUMENTATION SHALL BE DEFINED TO INCLUDE THE REQUIRED REFERENCE MARKS AND AZIMUTH MARKS REQUIRED BY EM 1110-1-1002.]. *[ALL MONUMENTS FOR NEW STATIONS ARE CURRENTLY IN PLACE AND DESCRIPTIONS ARE ATTACHED AT SECTION G.] *[IF SATELLITE VISIBILITY SHOWN ON THE DESCRIPTIONS IS OBSCURED AT AN EXISTING STATION, THEN A NEW MARK SHALL BE SET AT THE RATE FOR ITEM *[____] IN SECTION B.]

**********
NOTE: Deviations from EM 1110-1-1002 should be indicated as required. USACE project control rarely requires supplemental reference/azimuth marks -- the optional specification clauses below should be tailored accordingly.
**********

*(2) At each station, angle and distance measurements shall be made between a network station and reference marks and azimuth marks set that were established in accordance with the requirements set forth in EM 1110-1-1002. All observations shall be recorded in a standard field book.

*(a) For reference marks, two (2) directional positions are required (reject limit ±10 " arc) and with steel taping performed to the nearest ±0.01 foot.

*(b) Four directional positions are required to azimuth marks. The reject limit for a one-second theodolite is +5 seconds. Azimuth mark landmarks shall be easily defined/described natural features or structures that are of sufficient distance to maintain a *[± ___]-second angular accuracy. *[_____-order astronomic azimuths shall be observed to azimuth marks.]

*(c) A compass reading shall be taken at each station to reference monuments and azimuth marks.

C.4.9. STATION DESCRIPTION AND RECOVERY REQUIREMENTS.

(1) STATION DESCRIPTIONS AND/OR RECOVERY NOTES SHALL BE WRITTEN IN ACCORDANCE WITH THE INSTRUCTIONS CONTAINED IN EM 1110-1-1002. [FORM *[_____] SHALL BE USED FOR THESE DESCRIPTIONS.] DESCRIPTIONS SHALL BE *[WRITTEN] [TYPED].

(2) DESCRIPTIONS *[ARE] [ARE NOT] REQUIRED FOR *[EXISTING] [AND/OR NEWLY ESTABLISHED] STATIONS.

(3) RECOVERY NOTES *[ARE] [ARE NOT] REQUIRED FOR EXISTING STATIONS.

C.4.10. MINIMUM OCCUPATION TIMES FOR OCCUPIED BASELINES. BASELINES SHALL BE OCCUPIED FOR A PERIOD OF TIME THAT IS CONSISTENT WITH THE SPECIFIED ACCURACY REQUIREMENT FOR THE PROJECT AND/OR PARTICULAR NEW STATION/LINE. RECOMMENDED MINIMUM OCCUPATION TIMES ARE CONTAINED IN EM 1110-1-1003. UNLESS OTHERWISE STATED IN THESE SPECIFICATIONS, THE CRITERIA SHOWN IN THIS MANUAL SHALL BE FOLLOWED FOR EACH PROJECT AND/OR OBSERVED BASELINE. MINIMUM OCCUPATION TIMES FOR KINEMATIC GPS SURVEY OBSERVATIONS SHALL BE CONSISTENT WITH MANUFACTURER RECOMMENDATIONS AND REQUIRED ACCURACIES OF TOPOGRAPHIC FEATURES.

C.4.11. TYPE AND NUMBER OF GPS RECEIVER UNITS TO BE DEPLOYED.

(1) THE CONTRACTING OFFICER RESERVES THE RIGHT TO REQUEST PUBLISHED DOCUMENTATION ON THE ACCURACY/QUALITY OF THE HARDWARE/SOFTWARE USED FOR THIS PROJECT. ALL GPS RECEIVERS AND POST-PROCESSING SOFTWARE USED UNDER THIS *[CONTRACT] [ASSIGNMENT] SHALL BE SUBJECT TO REVIEW BY THE CONTRACTING OFFICER. SYSTEM COMPONENTS SUBJECT TO REVIEW SHALL INCLUDE:

(A) RECEIVERS
(B) ANTENNAS
(C) POWER SOURCE
(D) DATA RECORDING UNITS AND STORAGE MEDIA
(E) REAL-TIME OR POST-PROCESSING HARDWARE AND SOFTWARE

(2) A MINIMUM OF [...] GPS FIELD RECEIVER UNITS SHALL BE CONTINUOUSLY AND SIMULTANEOUSLY DEPLOYED DURING THIS *[TASK ORDER] [PROJECT].

**********
NOTE: Add any applicable variations due to project specific requirements.
**********

C.4.12. FIELD GPS OBSERVATION RECORDING PROCEDURES.

(1) FIELD LOG *[SHEETS] [FORMS] [NOTES] SHALL BE COMPLETED FOR EACH STATION OF EACH SESSION AND SUBMITTED TO THE GOVERNMENT. MINIMUM DATA

FOR STATIC AND KINEMATIC OBSERVATIONS TO BE INCLUDED ON THESE FIELD LOG RECORDS ARE DESCRIBED IN EM 1110-1-1003.

(2) RAW SATELLITE TRACKING DATA, BASELINE REDUCTION DATA, AND ADJUSTMENT SOLUTIONS SHALL BE RECORDED AND SUBMITTED TO THE GOVERNMENT ON *[___-INCH FLOPPY DISKS] [A PRE-APPROVED MEDIUM].

(3) IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO ASSURE THAT AMPLE OBSERVATIONS ARE CONDUCTED SO THAT ALL POINTS ARE INTERCONNECTED IN A COMPLETE INTERCONNECTING NETWORK OR GPS TRAVERSE SURVEY; AND/OR IN ACCORDANCE WITH THE REQUIRED BASELINE MEASUREMENTS SPECIFIED HEREIN. *[ADEQUATE FIELD COMPUTATIONAL CAPABILITY SHALL EXIST IN ORDER TO VERIFY MISCLOSURES PRIOR TO SITE DEPARTURE.]

C.4.13. BASELINE DATA REDUCTION REQUIREMENTS (CONTROL SURVEYS).

(1) SOFTWARE FOR POST-PROCESSING OF SATELLITE TRACKING DATA SHALL BE SUBJECT TO APPROVAL BY THE CONTRACTING OFFICER. ALL SOFTWARE MUST BE ABLE TO PRODUCE FROM THE RAW DATA RELATIVE POSITION COORDINATES *[AND CORRESPONDING VARIANCE-COVARIANCE STATISTICS WHICH IN TURN CAN BE USED AS INPUT TO THREE-DIMENSIONAL NETWORK ADJUSTMENT PROGRAMS.]

**********
NOTE: Baseline output statistics are generally only specified when rigorous least-squares adjustments are required; and then only if the specified adjustment software utilizes such statistics. This is not applicable to topographic surveying uses of GPS.
**********

(2) BASELINE PROCESSING SHALL BE COMPLETED FOR ALL BASELINES AND SELECTED FOR USE IN THE FINAL NETWORK ADJUSTMENT BASED ON AN ANALYSIS OF THE STATISTICAL DATA AND RELATIVE SPATIAL RELATIONSHIPS BETWEEN POINTS. TEST CONSTANTS GIVEN FOR A PARTICULAR SOFTWARE SYSTEM SHALL BE COMPARED TO THE PROCESSED RESULTS AND ANY SUSPECT BASELINE THAT DOES NOT MEET THE CRITERIA SHALL BE REOBSERVED OR NOT INCLUDED IN THE FINAL ADJUSTMENT. BASELINE ACCEPTANCE AND REJECTION CRITERIA ARE CONTAINED IN EM 1110-1-1003.

C.4.14. FINAL ADJUSTMENT REQUIREMENTS (CONTROL SURVEYS). GPS SURVEY TRAVERSE LOOPS AND NETWORKS SHALL BE ADJUSTED AND EVALUATED IN ACCORDANCE WITH THE PROCEDURES AND CRITERIA OUTLINED IN EM 1110-1-1003. FINAL VECTOR MISCLOSURES MAY BE PROPORTIONATELY DISTRIBUTED AMONGST THE OBSERVED VECTORS USING EITHER APPROXIMATE OR LEAST-SQUARES ADJUSTMENT TECHNIQUES DESCRIBED IN EM 1110-1-1003.

(1) ADJUSTMENTS ARE NORMALLY PERFORMED USING X-Y-Z GEOCENTRIC COORDINATES RELATIVE TO THE WGS 84 SPHEROID. TRANSFORMED FINAL ADJUSTED HORIZONTAL DATA SHALL BE EXPRESSED IN *[SPCS] [UTM] [GEOGRAPHIC] [GEOCENTRIC] [OTHER] COORDINATES, AND SHALL BE REFERENCED TO *[NAD 27] [NAD 83] [PROJECT] DATUM. FINAL COORDINATES SHALL BE TABULATED IN *[METERS] [FEET] [other] TO ONLY *[___] DECIMAL POINTS OF PRECISION. *[FINAL ADJUSTED VERTICAL DATA FOR TOPOGRAPHIC MAPPING APPLICATIONS SHALL BE SHOWN AS

ORTHOMETRIC HEIGHTS ON *[NGVD 29] [NAVD 88] [other] VERTICAL DATUM. GPS-DERIVED ELEVATIONS SHALL BE ROUNDED TO THE NEAREST *[METER] [FOOT].]

* (2) FOR PROJECT CONTROL SURVEYS AN ADJUSTMENT ANALYSIS SHALL INCLUDE THE FOLLOWING:

* (a) GPS TRAVERSE LOOPS SHALL BE ANALYZED RELATIVE TO THE INTERNAL CLOSURE CRITERIA GIVEN IN EM 1110-1-1003. INTERNAL ACCEPTABILITY OF THE WORK WILL BE BASED ON THE MAGNITUDE OF THE THREE-DIMENSIONAL VECTOR MISCLOSURES RELATIVE TO THE LOOP LENGTH. SUCH LOOP CLOSURE ANALYSIS WILL BE CONSIDERED THE INTERNAL, MINIMALLY-CONSTRAINED, FREE ADJUSTMENT. LOOPS/LINES WITH INTERNAL MISCLOSURE RATIOS IN EXCESS OF THOSE SPECIFIED IN THIS CONTRACT SHALL BE REOBSERVED. MISCLOSURES BETWEEN EXTERNAL FIXED CONTROL MAY BE DISTRIBUTED USING THE APPROXIMATE DISTRIBUTION METHODS GIVEN IN EM 1110-1-1003. FINAL CONSTRAINED ACCURACY ESTIMATES WILL BE BASED ON RELATIVE MISCLOSURES AT FIXED POINTS.

(b) * WHEN A FREE (OR MINIMALLY CONSTRAINED) LEAST-SQUARES ADJUSTMENT IS PERFORMED ON THE BASELINE VECTORS, A CLASSIFICATION BASED ON THIS INTERNAL ADJUSTMENT SHALL BE DERIVED AND EVALUATED AGAINST THE MINIMUM ALLOWABLE STANDARDS SHOWN IN EM 1110-1-1003 FOR THE GIVEN REQUIRED ACCURACY. THIS FREE ADJUSTMENT, ALONG WITH AN ANALYSIS OF THE BASELINE REDUCTION DATA, WILL BE USED IN EVALUATING THE CONTRACTUAL ACCEPTABILITY OF THE OBSERVED NETWORK. STATION *[_____] SHALL BE HELD FIXED FOR THIS UNCONSTRAINED ADJUSTMENT. THE NORMALIZED RESIDUALS SHALL BE COMPUTED AND ANALYZED RELATIVE TO THE CRITERIA CONTAINED IN EM 1110-1-1003. THE VARIANCE OF UNIT WEIGHT FOR THE MINIMALLY CONSTRAINED NETWORK ADJUSTMENT SHALL CONFORM TO THE CRITERIA GIVEN IN EM 1110-1-1003. RELATIVE LINE ACCURACIES SHALL BE COMPUTED FOR PAIR OF POINTS ON THE NETWORK USING STATISTICAL DATA CONTAINED IN THE FREE ADJUSTMENT. THESE RELATIVE LINE ACCURACIES SHALL NOT EXCEED THE REQUIRED ACCURACY CLASSIFICATIONS PRESCRIBED FOR THE WORK. STATIONS/BASELINES/NETWORK AREAS WITH FREE ADJUSTMENT RELATIVE ACCURACIES NOT MEETING THE REQUIRED CRITERIA MUST BE REOBSERVED; IT IS THEREFORE CONTINGENT ON THE CONTRACTOR TO INSURE THAT MISCLOSURE TOLERANCES ARE CHECKED IN THE FIELD.

(c) * A CONSTRAINED LEAST-SQUARES ADJUSTMENT WILL BE PERFORMED HOLDING *[FIXED] [PARTIALLY CONSTRAINED] THE COORDINATES OF THE STATIONS LISTED UNDER THE EXISTING CONTROL CLAUSE IN THIS CONTRACT SECTION. FOR THE PURPOSE OF THESE SPECIFICATIONS, BOTH FULLY CONSTRAINED AND PARTIALLY CONSTRAINED POINTS ARE REFERRED TO AS "FIXED" POINTS. THE CONSTRAINED LEAST-SQUARES ADJUSTMENT SHALL USE MODELS WHICH ACCOUNT FOR: THE REFERENCE ELLIPSOID FOR THE REFERENCE CONTROL, THE ORIENTATION AND SCALE DIFFERENCES BETWEEN THE SATELLITE AND NETWORK CONTROL DATUMS, GEOID-ELLIPSOID RELATIONSHIPS, AND DISTORTIONS AND/OR RELIABILITY IN THE NETWORK CONTROL.

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NOTE: A variety of free and/or constrained adjustment combinations may be specified. Specific stations to be held fixed may have been indicated in a prior contract section or the contractor may be instructed to determine the optimum adjustment, including appropriate weighting for constrained points. When fixed

stations are to be partially constrained, then appropriate statistical information must be provided -- either variance-covariance matrices or relative positional accuracy estimates which may be converted into approximate variance-covariance matrices in the constrained adjustment.
**********

[1] *WHEN DIFFERENT COMBINATIONS OF CONSTRAINED ADJUSTMENTS ARE PERFORMED DUE TO INDICATIONS OF ONE OR MORE FIXED STATIONS CAUSING UNDUE BIASING OF THE DATA, AN ANALYSIS SHALL BE MADE AS TO A RECOMMENDED SOLUTION WHICH PROVIDES THE BEST FIT FOR THE NETWORK. ANY FIXED CONTROL POINTS WHICH SHOULD BE READJUSTED (TO ANOMALIES FROM THE ADJUSTMENT(S)) SHOULD BE CLEARLY INDICATED IN A FINAL ANALYSIS RECOMMENDATION.

[2] *THE FINAL ADJUSTED HORIZONTAL AND/OR VERTICAL COORDINATE VALUES SHALL BE ASSIGNED AN ACCURACY CLASSIFICATION BASED ON THE LEAST-SQUARES ADJUSTMENT STATISTICAL RESULTS AND IN ACCORDANCE WITH THE CRITERIA INDICATED IN EM 1110-1-1003. THIS CLASSIFICATION SHALL INCLUDE BOTH THE RESULTANT GEODETIC/CARTESIAN COORDINATES AND THE BASELINE DIFFERENTIAL RESULTS. THE FINAL ADJUSTED COORDINATES SHALL STATE THE 95% CONFIDENCE REGION OF EACH POINT AND THE 95% RELATIVE LINE ACCURACY IN PARTS PER MILLION (PPM) BETWEEN ALL POINTS IN THE NETWORK.

(3) *FINAL ADJUSTED COORDINATE LISTINGS SHALL BE PROVIDED ON HARD COPY *[AND ON *[___] [specify] COMPUTER MEDIA].

(4) * A SCALED PLOT SHALL BE SUBMITTED WITH THE ADJUSTMENT REPORT SHOWING THE PROPER LOCATIONS AND DESIGNATIONS OF ALL STATIONS ESTABLISHED.

C.5 SUBMITTAL REQUIREMENTS:

C.5.1. SUBMITTAL SCHEDULE: THE COMPLETED SURVEY REPORT SHALL BE DELIVERED WITHIN *[___ DAYS AFTER NOTICE TO PROCEED IS ISSUED] *[BY calendar date]

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NOTE: Include a more detailed submittal schedule breakdown if applicable to project.
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C.5.2. SUBMITTED ITEMS: SUBMITTALS SHALL CONFORM THOSE SPECIFIED IN EM 1110-1-1003 *[EXCEPT AS MODIFIED HEREIN].

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NOTE: Reference should be made to EM 1110-1-1003 for typical GPS survey submittal requirements. Modify and/or add items as required.
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C.5.3. PACKAGING AND MARKING: PACKAGING OF COMPLETED WORK SHALL BE ACCOMPLISHED SUCH THAT THE MATERIALS WILL BE PROTECTED FROM HANDLING DAMAGE. EACH PACKAGE SHALL CONTAIN A TRANSMITTAL LETTER OR SHIPPING FORM, IN DUPLICATE, LISTING THE MATERIALS BEING TRANSMITTED, BEING PROPERLY NUMBERED, DATED AND SIGNED. SHIPPING LABELS SHALL BE MARKED AS FOLLOWS:

US ARMY ENGINEER DISTRICT, _____
ATTN: _____
*[include office symbol and name]
CONTRACT NO. _____
*[TASK ORDER NO. _____]
[STREET/PO BOX] _____
*[complete local mailing address]

*HAND CARRIED SUBMISSIONS SHALL BE PACKAGED AND MARKED AS ABOVE, AND DELIVERED TO THE FOLLOWING OFFICE ADDRESS:

_____
*[insert office/room number as required]

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NOTE: In this section, also reference any automated data submittal requirements for GPS observations, if applicable.
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C.6 PROGRESS SCHEDULES AND WRITTEN REPORTS.

C.6.1. *PRE-WORK CONFERENCE:

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NOTE: Detail any requirements for a Prework conference after contract award, including requirements for preparing written reports for such conferences. Most of the following sections are completed by the District's Contracting Office.
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**SECTION D**

**CONTRACT ADMINISTRATION DATA**

**SECTION E**

**SPECIAL CONTRACT REQUIREMENTS**

**SECTION F**

**CONTRACT CLAUSES**

**SECTION G**

## LIST OF ATTACHMENTS

G.1. US ARMY CORPS OF ENGINEERS EM 1110-1-1003, NAVSTAR GPS SURVEYING. THIS REFERENCE IS ATTACHED TO AND MADE PART OF THIS CONTRACT.

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NOTE: List any other attachments called for in contract section C or in other contract sections. This includes items such as:

- Marked-up project sketches/drawings.

- Station/Monument descriptions or Recovery Notes.

- Lists of baseline connections to existing network.

- Lists of fixed (existing) stations to be connected with and adjusted to.

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**SECTION H**

## REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERERS

**SECTION I**

## INSTRUCTIONS, CONDITIONS, AND NOTICES TO OFFERERS