

**SECTION 11 83 00
GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)
REFERENCE SYSTEM**

PART 1 - GENERAL

[SPEC WRITER NOTE]: NCA subject matter expert for GNSS is part of Cemetery Development and Improvement Service (CDIS). Contact CDIS for any questions or concerns with the content in the specification.

1.1 SUMMARY

A. The Contractor shall furnish all labor, materials, manpower, tools and equipment required to install, and make fully operational, a Global Navigation Satellite System (GNSS) reference station. The installed system shall provide complete Real-Time Kinematic (RTK) coverage for the rover equipment, operating at centimeter-level (i.e., survey-grade) accuracy, at all developed areas of the cemetery (including developed non-burial sections), and consist of the following equipment and facilities:

1. GNSS reference station (to be referred to as "Base Station").

2. Professional survey-grade GNSS handheld receiver systems (to be referred to as "Rover Units").

a. **[SPEC WRITER NOTE]: The quantity of rover units provided will be calculated using current/expected interment rate of the cemetery as follows: one rover unit for each six (6) interments per day (rounded up to a whole number), plus one additional rover unit as a backup. Should the quantity determined/calculated be less than three (3) rover units, then three (3) will be the quantity provided.**

EXAMPLE: Expected/current interment rate is 19 interments/day:

$19/6 = 3.16 \rightarrow$ rounds up to 4 + 1 backup = 5 total rover units

3. Radio Antenna Facilities (RAF) for transmitting satellite corrections from the base station to the rover units. A radio survey will determine the number and locations of RAFs to ensure complete coverage of the developed portions of the cemetery.

B. The base station is to be a Continuously Operating Reference System (CORS) comprised of the following hardware and software components: a GNSS reference antenna, a GNSS receiver, UHF radio transmitter, transmitting antenna, voltage converter, cables and conduits necessary to link the system equipment. The base station will not be registered with the National Geodetic Survey (NGS) as a fully approved CORS facility; however, the base station is required to follow NGS published *Guidelines for New and Existing Continuously Operating Reference*

Stations (CORS) (latest edition). Any configuration not meeting NGS CORS guidelines shall be pre-approved by NCA's CDIS GIS group.

- C. The base station shall be installed at a location recommended by the GPS Sales and Service Contractor within the cemetery meeting both the requirements specified in the *NGS Guidelines for New and Existing Continuously Operating Reference Stations (latest edition)* and suitable areas identified in the radio survey, with the following exceptions to the NGS guidelines:

1. The base station does not need to meet 70 km distance requirement from other CORS stations.

Why: Most of NCA's cemeteries are already within the 70 km buffer. The NGS requirement is to prevent inclusion of areas already covered in the NGS CORS network and, since the cemetery base station will not be part of the CORS network, it is not applicable.

2. Building age requirement of 5 years is not required for roof-based monuments.

Why: Building mounted GNSS antenna are preferred over pillar-based because of the ascetics, additional height buildings provide, proximity to a power source and climate-controlled storage of all non-antenna base station components. Newly established cemeteries and those with new buildings being installed as part of the project would not be permissible without omitting this requirement. As long as all other guidelines are met, the amount of impact by building settling would be negligible.

If no such areas exist to suffice both NGS guidelines and radio survey, locations meeting NGS guidelines will take precedence and adjustments to the RAF strategy will need to be made. The Contractor shall provide all required labor, materials, manpower, tools and equipment necessary to furnish, install, test and certify a fully operational GNSS reference station as specified herein.

- D. The base station and rover units shall be an operating RTK system, capable of broadcasting and receiving corrections through UHF radio signals from 2-watt to 35-watt power at the approved radio frequency assigned to NCA for GNSS reference stations, currently 414.55 MHz. The lowest power output setting for the base station radio, to support coverage of all developed areas of the cemetery, will be used.

- E. The GNSS receivers, base station and rover units, shall be capable of utilizing Global Positioning System (GPS), Modernized GPS, Galileo, and GLONASS satellite signals. The system shall be capable of code and phase measurements, internal raw data logging, raw data streaming, and have internal data storage capabilities.
- F. All field data collected by the rover units shall meet or exceed 1 centimeter accuracy standards as defined by the Federal Geographic Data Committee (FGDC), Draft Geospatial Positioning Accuracy Standards, Part 2, Standards for Geodetic Networks.
- G. There will be at least one (1) RAF but more may be required depending on the result of a radio survey. The selected antenna location(s) shall be established in areas where respective signals combined produce full coverage for all developed areas of the cemetery, including developed non-burial sections. The antenna location(s) shall be confirmed and adjusted, as required, following the Contractor provided radio survey (if the survey hasn't been completed before bidding). The radio survey will be conducted with "leaves on" and used to determine suitable locations and elevations for each RAF. One RAF location shall be within a 200-foot cable run from the radio transmitter (signal booster is required for longer cable runs when necessary, as recommended by the equipment provider). Additional antenna locations, as needed to provide complete coverage, shall function as radio repeater stations. If the radio survey determines that the location for one or more of the antennas needs to be on top of an existing building, then the mounting options, as recommended by the manufacturer, will be evaluated by the RE/COR and A/E. All final antenna locations shall be approved by the RE/COR and A/E, acceptable to the GPS equipment supplier/installer, and selected from within the areas determined suitable during the radio survey; taking into consideration the mounting of each antenna and the aesthetics of the mounted location.
- H. Any appurtenant work required to make the system fully functional shall be provided, including but not limited to furnishing and installing all required labor, materials, tools and equipment. The completed work shall be performed as much as possible to hide the equipment, conduit, wiring, mounting hardware, etc. and shall include restoration and/or repair of any disturbed materials and facilities to pre-work conditions. This appurtenant work shall also include calibrating and testing all other required facilities and equipment to make the GNSS

reference system fully functional as described herein, including work that is covered in other specifications sections or indicated on the contract drawings.

- I. **[SPEC WRITER OPTION] - Consult with CDIS to determine applicability and extent of training required for the cemetery.** The Contractor shall provide training for the cemetery staff on the operation and maintenance of all GNSS equipment and components. The Contractor shall provide Operations and Maintenance (O&M) Manuals for all equipment in hardcopy and digital PDF format. The O&M Manuals shall include specific procedures for operation of equipment provided under this contract and shall include photographs of equipment provided for this project. Coordination with NCA CDIS shall be done to schedule data collection training in conjunction with equipment training by the contractor. Data collection training must be completed prior to acceptance of the equipment.

1.2 RELATED WORK

- A. See Section: 32 12 16 Asphalt Paving
- B. See Section: 03 30 00 Cast-in-Place Concrete
- C. See Section: 32 05 23 Cement and Concrete Work for Exterior Improvements
- D. See Section: 26 05 33 Raceway and Electrical Boxes
- E. See Section: 31 20 00 Earth Moving
- F. See Section: 11 83 02 GNSS & GIS Mapping and GeoData

1.3 REFERENCES

- A. The entire installation shall comply with all local and state laws and ordinances, and with all established codes applicable thereto.
- B. In all cases where the specifications require that the work be performed under the direction and/or inspection of the Resident Engineer, notify the Resident Engineer at least 24 hours in advance of the time when such inspection and/or direction is required. Any alterations to the system needed because of the Contractor's failure to have the required inspections shall be performed at the Contractor's expense.
- C. National Geodetic Survey, Guidelines for New and Existing Continually Operating Reference Stations (CORS), August 2018.

SPEC WRITER NOTES:

- 1. Spec writer should check with the PM and Cemetery Operations during the design process regarding preference as to the type of tower for mounting the

antenna on the GPS base station.
There are multiple types of tower configurations as well as building mounts for the GPS base stations

2. Select the appropriate type of tower for mounting the antenna on the GPS Base Station and complete the specifications according to the selection, or incorporate a different type, as long as the tower can be approvable as an official CORS location in the future, if desired.

- D. Federal Geographic Data Committee, Draft Geospatial Positioning Accuracy Standards, Part 2, Standards for Geodetic Networks - FGDC-STD-007.2-1998.
- E. US Army Corp of Engineers EM 1110-1-1002 Survey Markers and Monumentation.

1.4 SUBMITTALS

- A. Provide manufacturer's literature and specifications of system components for review by RE/COR and A/E.
- B. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. Complete shop and installation drawings of all GNSS system components, inclusive of GNSS base station monument and RAF antenna installations, poles and foundations, showing dimensions and details of construction, installation and relation to adjoining work, reinforcements, anchorages, attachments, location of all conduit and other items to be installed in the work of other trades, joint treatment, and other work required for a complete installation.
- C. Provide product information, O&M manuals and any additional paperwork associated with each system component, individually tabbed for ease in location, and the entire system in duplicate in separate three-ring binders for Government records. Included in the documentation will be a photographed record of the installation, with each piece of equipment identified and referenced to the applicable tabbed location in the three-ring binders. Include in the Appendix a list of all devices with their make, model, and serial number.
- D. Include in the O&M manual a troubleshooting list of items to check in the event of problems with the normal operation of the equipment, or system failure. The equipment in the troubleshooting list shall also be photo documented with the actual equipment installed for this project. Provide the owner with a step-by-step guide of operational checks to fix problems, prior to calling technical support.

- E. Produce a PDF version of all documentation, organized as in the binders.
- F. **[SPEC WRITER OPTION] - Should any burial sections be scheduled for early turnover, prior to the full completion of the project, all requirements described herein shall also be scheduled as part of early turnover.**

1.5 QUALITY CONTROL

- A. Have a competent superintendent satisfactory to the Resident Engineer, with authority to act in all matters pertaining to the installation of the project work, present on the project site during all installation activities.
- B. Coordinate all work with other site contractors and the RE.
- C. The base station installation, including the calibration, startup, testing, and all activities needed to make the station fully functional and operational with the rover units, as well as confirming location and accuracy information is correctly being reported to the GPS collection software, shall be coordinated with the GPS equipment supplier and the GIS contractor for this project. The Contractor shall implement a quality control program throughout the construction process, up to the turn-over of the fully functional GNSS reference system for this project, that delivers a GNSS reference system which conforms to the performance specifications documented herein.

1.6 SITE CONDITIONS

- A. Submission of an executed proposal shall be considered evidence that the site, plans and specifications as issued, and/or legally modified, have been examined and accepted.
- B. Report to the Resident Engineer any deviations between contract documents and actual conditions. Failure to do so prior to the installation of equipment and which results in the replacement and/or relocation of equipment shall be at the Contractor's expense.
- C. The exact location of all new and existing utilities and structures may not be indicated on the drawings; their locations shall be field verified by the Contractor prior to starting work, and installation of work shall proceed to prevent interruption of service or damage to them. Protect existing structures and utility services and replace, at no cost to the Government, if damaged. Where conflicts occur, notify the Resident Engineer of any relocation required to complete the work of this contract.

1.7 GUARANTEE

- A. The furnished and installed operational GNSS reference system shall be capable of providing Real Time Kinematic (RTK) corrections for the roving GNSS handheld receivers as described herein.

SPEC WRITER NOTES:

1. Modify the following paragraph as needed to create an extended warranty scenario acceptable to the project.
 2. Modify the following to clearly describe the conditions and/or circumstances wherein the Guarantee for service to repair and/or replace non-functional facilities for the extended 5 year period are not included.
- B. Contractor shall demonstrate complete radio coverage of the RTK system, to include existing and current project non-burial areas, prior to VA acceptance of installation. The system components shall be guaranteed as operational in every detail, except for power interruption, for a period of five (5) years from the date of its acceptance. Provide any required labor, manpower, tools, materials and equipment required to repair and/or replace any contractor provided elements of the functional GNSS reference system within the five-year period with no cost to the owner.

1.8 ACCEPTANCE

- A. Acceptance of the CORS base station facilities and the rover units will result only when the installed system has been demonstrated to function as specified herein. The acceptance of the above systems shall require use of the approved radio broadcast frequency by the VA Radio Frequency Spectrum Management Office, demonstration data collection using the rover units as described in the contract documents can be achieved, and the data is accurately reported to NCA's collection software. Prior to requesting final inspection of equipment, contact the Resident Engineer to review installation of hardware, software, cable and conduit runs, demonstrate the functionality of the equipment, and coordinate any staff training required.
- B. **[SPEC WRITER OPTION] - Consult with CDIS to determine applicability and extent of training required for the cemetery.** The training on use of the equipment shall be performed after final acceptance of the training materials by the RE/COR and when the equipment can be utilized with the GIS data, as specified in Section 11 83 02. The training program shall

not be considered complete until after the O&M Manual has been submitted and approved in its final form.

PART 2 - MATERIALS

2.1 GNSS REFERENCE SYSTEM EQUIPMENT

All equipment and accessories will be new, unused, and not reconditioned, remanufactured, nor recertified.

A. GNSS Receiver for Base Station

Hardware and software shall be from a single manufacturer. Basis of design is the Trimble Alloy GNSS System with a Zephyr 3 Base Station Antenna or approved equal.

1. GNSS receiver shall have a built-in Wi-Fi access point and graphical user interface (GUI). The GUI must allow for configuration of all settings and firmware updates to be installed.
2. The GNSS receiver shall, after the loss of satellite signals, provide re-acquisition of both L1 and L2 signals typically within 10 seconds.
3. Electronics shall be 100% fully sealed from sand, dust, and moisture.
4. Shall be able to operate to measurement specification in temperatures between -40 degrees F to +149 degrees F.
5. Shall not be less than 100% condensing humidity proof.
6. Connectors shall fully seal the receiver when a like-connector is attached.
7. Power requirements shall be in the range of 9.5 V DC to 28V DC external power input with over-voltage protection.
8. Dual hot swappable batteries (7.4 V, 7800mA-hr, Li-Ion batteries) capable supporting at least fifteen (15) hours of operation. Automatic battery use upon loss of external power with no interruption in operation upon switching power source. Battery to be included.
9. The GNSS receiver shall support simultaneous signal tracking of all:
 - a. GPS: L1C/A, L2C, L2E, L5
 - b. GLONASS: L1C/A, L2C/A, L3CDMA
 - c. SBAS: L1C/A, L5
 - d. Galileo L1CBOC, E5A, E5B, E5AltBOC, E6
10. The GNSS receiver shall contain a high-precision multiple correlator for L1, L2 and L5 pseudo-range measurements.

11. Performance of the receiver shall not be lower during times when anti-spoofing is activated, compared to during times when anti-spoofing is not activated.
 12. The GNSS receiver shall employ multipath mitigation techniques.
 13. Provide network connectivity employing Cat5 cable with RJ45 connection.
 14. All damaged or rejected materials due to defect or non-conformance shall be removed from the site.
- B. Radio Transmitter for Base Station
- Basis of design is the Trimble TDL 450H Radio or approved equal.
1. Radio to transmit the satellite corrections from the base station shall be of the same manufacturer as the base station GNSS receiver.
 2. All radio equipment must be able to broadcast in the UHF 390 MHz to 430 MHz and 430 MHz to 473 MHz frequency ranges. The assigned NCA frequency for GNSS base station is 414.55 MHz.
 3. All radio equipment shall be rated IP67.
 4. Radio must be capable of broadcasting between 2-watts to 35-watts output power. The lowest setting yielding complete site coverage will be used.
 5. Radio must be able to withstand operating temperatures of -22 degrees F to +149 degrees F.

SPEC WRITER NOTES:

1. Spec writer shall choose the style for the tower to be constructed as the CORS type Base Station for the project.
2. Alternative Styles for the GPS base station are acceptable as long as they meet the standards to be acceptable as an official CORS facility, and that the installation is acceptable by the NCA as being suitable for the location within the Cemetery.
3. Modify the specifications and drawings to include a suitable plant bed, or other suitable methods acceptable for the specific project location, for screening that will not interfere with the operation of the GPS base station. The main purposes for the plant bed is to provide visual screening, while maintaining access to the facility for maintenance and adjustment, and to provide a buffer around the base station tower from the mowing operations.

4. Modify the specifications and drawings as needed if the location for the GPS (CORS type) base station is deemed to be in a location where additional security needs to be provide. If needed, the GPS base station can be located inside of the fenced area that can be screened or not, depending upon the site specific conditions.

C. Antenna Mount and Support Hardware

1. Roof-based mounting is the preferred mounting choice and should be used when mounting options conforming to NGS roof-based monument guidelines are available. Should the roof-based mounting option not be available then reinforced concrete pier foundation shall be installed per drawings at the location specified on contract drawings.

SPEC WRITER NOTES:

1. Modify the following subparagraphs according to the configuration for the GPS Base Station (similar to CORS), for the specific project. Include sufficient information either in the specifications on the drawings to clearly indicate what materials and sizes are for the equipment to be installed. Include details for the buried conduit, junction box(es), ground rod(s), lightning protection and grounding, weatherproof splice kits, cable, and antenna signal amplifier (if required).
2. All necessary hardware, conduits, junction boxes and fittings required for a complete and functional system in accordance with manufacturer's recommendations and NGS CORS guidelines shall be provided.
 1. Modify the following to clearly indicate which of the methods for construction of the tower onto which the GPS antenna will be mounted as part of the CORS like base station to be constructed for the project.
 2. The specifications shall be modified to coordinate with the drawing details that are provided regarding the materials, dimensions, and method of construction for the foundation and tower for the GPS antenna.
 3. The second Paragraph 3 should be selected and modified based upon the project conditions.
3. Roof-based mounts shall be made of stainless steel and mounted per NGS CORS guidelines to the building. Ground-based mounting will use

eight (8) foot stainless steel mast, with a four place reinforced gusset system along the lower four (4) feet of the mast. All stainless steel hardware for fastening the mast to the foundation shall be included and be specified according to manufacturer.

4. A NGS approved leveling & orientating device (e.g., tribrach) is to be used to attach the GNSS antenna to the monument.

D. GNSS Antenna

Basis of design is the Trimble Zephyr Geodetic 3 GNSS Base Antenna or approved equal.

1. GNSS antenna shall be of the same manufacturer as the base station receiver and capable of receiving all satellite signals the base station receiver is required to track.
2. Quality signal tracking, even below 5 degrees elevation.
3. Four point antenna feed for phase center stability and enhanced polarization.
- 4.
4. 13 dB amplifier margin supports cable runs of over 60 m without special coaxial cable on in-line amplifiers.
5. North orientation marking on exterior.
6. 50 dB signal gain for reliable tracking in difficult environments.
7. Low voltage, low power consumption.
8. Integral low noise amplifier.
9. 5/8" x 11 female threaded stainless steel mount point.
10. Powered by GNSS receiver via coaxial cable.
11. Advanced LNA (low noise amplifier) to reduce jamming by high power out-of-band transmitters.
12. Stealth Ground Plane - integrated lightweight stealth technology with enhanced right hand
13. 100% humidity proof and fully sealed.
14. Operating temperature (-40 to +185 degrees F)

E. GNSS Rover Units (GNSS rover receiver)

Basis of design is the Trimble R2 GNSS Receiver (RTK Rover, GPS/GLO/GLA/BEI, UHF Rx, NMEA).

1. Each rover unit shall receive correction signals from the on-site base station, via a built-in 450 MHz radio receiver, and provide real time positional accuracies within the manufacturer's published horizontal and vertical positioning accuracy in all developed areas of the cemetery.

2. The GNSS antenna for the rover shall be able to track GPS, GLONASS, Galileo, BeiDou, QZSS satellites.
3. The GNSS antenna for the rover shall be of the same manufacturer as the base station receiver.
4. The GNSS receiver shall be capable of utilizing Trimble's CenterPoint® RTX correction service.
5. The horizontal accuracy classification shall be a one (1) centimeter horizontal accuracy at the 95-percent confidence interval.
6. The GNSS receiver shall use a rechargeable and removable battery. Extra batteries to provide full day of use shall be provided for each component. Dual battery charger, capable of simultaneous charging of batteries, will be provided.
7. GNSS receiver shall be capable of Bluetooth connection to GFE handheld devices, typically iPad/iPhone provided by VA, to provide location data to the collection application running on the handheld device.
7. All rover components shall meet or exceed IP65 rating.
8. Rover GNSS receivers shall be able to withstand a 2-meter drop onto concrete.
10. All rover components shall have an operating temperature range of at least -4 degrees F to +131 degrees F.
11. The system shall include a ruggedized carry case for each rover, both protecting the rover and providing storage while in the field.
12. An accessory kit with a 2-meter carbon fiber telescopic, with snap-lock, rover pole, with thumb-release bipod, and pole storage bags shall be included for each rover.
13. **[SPEC WRITER NOTE]: If the cemetery is already existing, they will have non-RTK GPS equipment and a subscription to the collection application for each existing rover unit. If the determined quantity of rover units to be delivered as part of this project is greater than the existing quantity of non-RTK rovers, additional subscription licenses for the difference will be required with the rover units to be added to NCA's account. The collection application license/subscription shall be for 1 year starting on the day of equipment turnover. At the time of this writing the collection application being used requires an ESRI Mobile Worker subscription for each rover unit. Confirmation of the required software subscription should be made with NCA's CDIS before purchase.**

2.2 SYSTEM CONTROL BOX

A. General

SPEC WRITER NOTES:

1. Clarify and or modify the following based upon the specific location where the GPS Base Station receiver is to be located within the Cemetery facility. Whenever possible, the GPS receiver and antenna signal amplifier, if necessary, should be located in a building within the Cemetery. The receiver requires a dedicated circuit, and the equipment plugs into a standard 110VAC outlet. If the GPS base station at the Cemetery is to be converted to a full CORS station, made part of the NGS system, then there will need to be additional electrical system elements, including the potential for connection to a generator system to power the facility long term, when there is a power outage in the electrical grid serving the Cemetery.

1. The base station receiver and radio shall be installed in an enclosed storage cabinet, similar to the Tripplite SRW6u Wall Mount Rack Enclosure. The control box shall be mounted in a location identified by the COR/RE. The size of the control box shall be no larger than 3 feet wide by 3 feet high, by 2 feet deep. It shall include a locking door.

SPEC WRITER NOTES:

1. Modify the following paragraphs to indicate the specific location for the control box for the project. Coordinate the location with the electrical plans, provide code applicable conduit for the cable between the receiver and the GPS antenna on the base station.
2. Coordinate the specifications with the drawings for the project to ensure that there are no inconsistencies as to where the equipment is to be installed.
2. The control box shall provide a secure location for equipment placement and ventilation for continuous system operation.
- 3.
3. All connections to hardware shall be made in accordance to component manufacturer specifications, including length of cable, type of cable and connection types. No modifications to cables, connections or installation shall be made that would void component manufacturer warranties.

4. Technical instructions on troubleshooting the system and restarting after power failure, shall be created and installed by the Contractor on the inside door of system control box.

SPEC WRITER NOTES:

1. Modify this paragraph as applicable to the specific installation location for the new GPS base station at the facility. If the installation is to follow the installation in Appendix "A" then use the first Paragraph A.
2. For other types of installations use and/or modify the second Paragraph A and subsequent paragraphs in this section as applicable for the intended installation.

2.3 CABLE AND CONDUIT CONNECTIONS

- A. Design basis for cable shall be the Times Microwave LMR 600 Flooded DB (direct bury) coaxial cable, or approved equivalent.
- B. Furnish and install antenna signal amplifier as indicated on drawings. Basis of design is Model LA20RPDC by GPS Networking Inc. (Denver CO).
- C. See Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS, for conduit specifications.
- D. All exposed cables and wiring outside of buildings should be ran through conduits to the max extent possible. All openings in conduits shall be sealed.
- E. A lightning surge arrestor shall be installed between the antenna and receiver, located in a utility box near the base of the GNSS antenna monument, with enough cable slack to allow easy replacement of the arrestor. Another lightning surge arrestor shall be installed between the radio antenna and radio, in a utility box near the base of the radio antenna, with enough cable slack to allow easy replacement of the arrestor. All lightning arrestors must be grounded.

2.4 REFERENCE MONUMENTS

- A. General
 1. Five (5) survey monuments shall be installed being a minimum 3.5 inches in diameter, with a 1/2 inch minimum metallic rod centered within the concrete, running the length of the monument. The monuments shall be a minimum depth of 3 feet in length where no frost occurs and a depth below the frost depth for areas where frost occurs.

SPEC WRITER NOTES:

1. Modify the following for the specific project conditions. If possible, provide specific areas within the project (for a new Cemetery) or within the developed or to be developed portion of the Cemetery, say 20 foot diameter circles, where the monuments are to be located.
2. Monument locations shall be installed in a stable surface that is not subject to effects of geologic and soil activity in the region, in accordance with contract drawings and reference provided in paragraph 1.3. Monuments must be highly visible away from vegetation, floodplain, burial sections, or man-made structures that are subject to movements, etc.
3. The Contractor shall submit a map and listing, with northing/easting/elevation in local SPCS, of permanent survey markers installed with the applicable coordinates along with temporary benchmarks (i.e., PK nails, etc.) required by this contract.

PART 3 - EXECUTION

SPEC WRITER NOTES:

1. Modify the following to match the specifics for the project location.
2. The specific location for the GPS base station, the receiver for the base station, the control box, junction box location and/or requirements, cable, junction box for ground and lightning equipment, grounding for the electrical equipment providing power for the receiver, location and configuration of the reference monuments, site calibration for the GPS base station, and installation and configuration of the "Rover Units" shall be included in this specification section.
3. The field code installation, the technical training of the staff and the preparation and acceptance of the O&M Manuals shall be included in the Spec section on the GIS equipment
4. The first "A" sub-paragraph in each of the following numbered paragraphs is indicated with the // marks and represents the requirements for the IGNC project only. For other projects remove these paragraphs and adjust the remainder to reflect the conditions at the project site.

3.1 SITE CALIBRATION AND QUALITY CONTROL

- A. Static satellite observations shall be made on all five (5) reference monuments, with a minimum of two (2) hours of static data being collected on each monument, with a geodetic grade GNSS receiver.
- B. Static observations shall be collected by the base station simultaneous to all reference monuments being observed, to ensure simultaneous data is collected on both the reference station and all reference monuments for final evaluation and approval of adjusted coordinates.
- C. All static observations shall be submitted to the NGS Online Positioning User Service (OPUS) for adjusted calculation of all monument locations.
- D. Adjusted ITRF2014 coordinate values, as obtained from the NGS OPUS adjustment, shall be used as record coordinates for the base station and on any future data collection stakeout of site facilities. All OPUS solutions will be provided in the provided documentation.
- E. The Contractor shall install the record ITRF2014 coordinates in the base station firmware, and initiate broadcast signals. All reference monuments shall be navigated to using the record coordinates obtained from OPUS. The residual error shall be noted by the Contractor and certified to be within tolerances set forth in specification documents.
- F. A/E shall provide CAD files to the Contractor at NTP for use in building the GIS maps. The Contractor shall populate the maps with geodata per geospatial standards as work progresses. Any early turnover areas and features must be provided in GIS format, per Spec 11 83 02 Geodata, prior to transferring the area to the cemetery so the cemetery may start tracking interments and populating the GIS database.

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