MoDOT

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P.O. Box 270
Jefferson City, Missouri 65102

Missouri Department of Transportation
Kevin Keith, Director

573.751.2551
Fax: 573.751.6555
1.888.ASK MODOT (275.6636)

May 24, 2012

Dear Consultant:

The Missouri Highway and Transportation Commission requests the services of consulting firms to perform professional services as described on the following pages. This solicitation is the first step in developing and executing a Master Agreement with a period of service ending June 2014, for on-call Light Detection and Ranging (LiDAR) services. The Master Agreement allows MoDOT to enter into Memorandums of Understanding (MOU) with consultants on an "as need" basis. These Hourly Rate MOU agreements have a limited scope of services and contract cost below $100,000 per project. Execution of a Master Agreement does not guarantee work.

Limit your Letter of Interest to no more than two pages and should include any other information, which might help in the selection process, such as the persons or team you will assign, their backgrounds, office locations and projects your company has recently completed or are now active. We will utilize the consultant information already on file so a lengthy submittal of other general company information is not necessary.

Disadvantaged Business Enterprises (DBE) are strongly encouraged to submit Letters of Interest for categories in which they are qualified. DBE firms must be certified by the Missouri Department of Transportation.

MoDOT will evaluate firms based on a) experience and competence b) the capacity of the firm to perform the work in the timeframe needed, c) past performance, and d) proximity to and familiarity with the project area.

All letters must be received by 3:00 p.m., June 30, 2012 at the appropriate office.

Sincerely,

Kathy Harvey
State Design Engineer

cc: Don Hillis-do
Dennis Heckman-br
George Kopp-de

DISTRICT OFFICES

Central Office
Brad McCloud
Missouri Department of Transportation
830 MoDOT Drive
Jefferson City, MO. 65109

Contact
Brad McCloud
573-526-2955
Bradley.McCloud@modot.mo.gov
Email responses are encouraged

EXHIBIT I

SCOPE OF SERVICES

The work covered by this Agreement shall include furnishing equipment, materials, professional, technical, and personnel resources necessary for the performance of Light Detection and Ranging (LiDAR) services for design and development of the specified highway project.

The following information will explain and define the items of importance relating to this project. All the elements of work that are necessary to satisfactorily complete the LiDAR and mapping of this project may not be listed. The lack of a specific listing of an element or item of work does not; in itself constitute a basis for additional services or work supplement, and/or adjustment in compensation.

I. PROJECT

LiDAR services for the specified project area. These services shall include analytics, compilation and terrain modeling in addition to ground targeting, LiDAR acquisition and control surveying. The services shall provide data necessary for application in preliminary highway design.

II. PROJECT LOCATION AND LIMITS

The project sites are located in Missouri. The limits of each site are located in files furnished by the Commission.

III. SERVICES AND DATA PROVIDED BY THE Commission

The Commission will provide available information of record to the Consultant as well as:

1) The project locations and limits for mapping (.dgn format). The map will specify limits of the all types of LiDAR classification to be collected.

2) Access to the MoDOT Global Positioning System (GPS) Reference Station Network and 1 second data for post process flight data.

IV. SCOPE OF WORK

Work covered in this document shall include furnishing the professional, technical, and other personnel necessary for LiDAR acquisition for the project. The services shall address the following:

1) **Planning**. The Consultant is responsible for project planning as it relates to coordinating the control targeting prior to the LiDAR mission.

2) **Mission Planning.** The Consultant shall be responsible for the final flight/route plans and shall make the necessary adjustments to meet ALL required specifications herein.

3) **Standards**. The Consultant shall comply with the most recent and applicable State and Federal Laws. Aerial and Mobile LiDAR procedures shall be performed in a manner that supports procedures in accordance with the United States National Map Accuracy Standards and any applicable portion of the Missouri Department of Transportation Engineering Policy Guide section 238.1 Photogrammetric Surveying

V. SPECIFICATIONS FOR SURVEYING

1) **Control Survey**. The Consultant shall perform a control survey for the project. This survey will ensure precise positions of traverse stations and/or GPS network stations throughout the project.

   The survey shall comply with the following specifications. If any portion of the survey does not comply with these specifications, a written report substantiating the material variances for the specification with the responsible surveyor's signature is required. The Commission reserves the right to disallow variation.

   a. Horizontal and Vertical Control. The control points will be tied to the MoDOT GPS Reference Station Network. A 180 epoch double occupancy Real Time Kinematic (RTK) surveys, within the MoDOT GPS Reference Station Network, with a fixed ambiguity within said network and a minimum of 4 hours between occupations of control points. The positional accuracy of a control point shall not exceed thirty millimeters (30mm). If the MoDOT network is unavailable then the control points will be tied the National Spatial Reference System (NSRS) through direct GPS ties to first or second order stations as defined in the Missouri Code of State Regulations (CSR) 30-4.050. NSRS horizontal and vertical monuments using post-processing software or by National Geodetic Survey (NGS) Online Positioning User Service (OPUS) solutions. All OPUS solutions shall be based on a minimum of two hours of dual

frequency data. The control station is to be described in such a manner as to facilitate navigation and recovery of its location.

b. Control. The control points will be referenced to NGS Vertical control. Benchmarks near the project should be used for the vertical reference for a project. If the NGS vertical control marks are not found nearby or a considerable distance away, then the GPS derived, elevations should be used for the project.

2) Types of Control Points:

a. Primary Control. A Primary Control Survey Network (PCSN) consisting of semi-permanent, intervisible, control point pair(s) (5/8 x 18 - 24 inch iron pin with center punch set below the ground surface or chiseled X-cut) will be set and referenced at each site. One intervisible control point pair will be established for approximately each mile of alignment. A constrained least squares adjustment shall be made for all the points that comprise the PCSN. If a single project exceeds twenty (20) miles in length, a supplemental control tie to the NSRS shall be made at the approximate midpoint.

The survey report shall include a summary of closures and accuracies for the PCSN. A minimum of three (3) reference ties to recoverable accessories will be made for each control station. The control station is to be described in such manner as to facilitate navigation and recovery of its location.

b. LiDAR Control Points (target/photo-identifiables). The Consultant will plan and establish horizontal and vertical control points required for the topographic mapping. Pins will be recessed for targets that are not located on a paved surface. The elevation of both the target and the pin will be reported. Both the ground and pin elevations shall be recorded and stored in the following MoDOT designated ASCII files respectively: .CTL file and .REC file. The accuracies shall be sufficient to support the topographic mapping requirements. Identifiable control points can be used to supplement the ground control. These points include, but are not limited to; utility poles, corners of concrete structures, painted stripes, manhole covers, etc. LiDAR control points will not be referenced. RTK GPS survey procedures are permitted for this survey type.

3) **Linear measurements**. Linear measurements shall be made in the English System. The base unit shall be the United States Survey Foot (and decimal parts thereof).

4) **Coordinate System**. All coordinates shall be based on the State Plane Coordinate System, North American Datum (NAD) of 1983 (1997) in the appropriate zone.

5) **Vertical Datum**. The elevations shall be based on the North American Vertical Datum (NAVD) of 1988.

6) **GPS**. Consultant will use GPS survey technology to establish the ground control. The elevations shall be based upon ellipsoidal heights that have been modified by the NGS Geoid 09 model.

7) **Projection Factor**. The Consultant is responsible for developing a project projection factor based on the Missouri Coordinate System of 1983 Manual for Land Surveyors.

   a. Scale Factor. Using the most easterly and westerly control points within the project to develop a centroid point for a project. Use the converted English easting of the centroid point in the correct zone formula below.

   East Zone = (easting – 820,208.3333) *0.00000000045 * (easting – 820,208.3333) + 0.9999333 = 393,700

   Central Zone = (easting – 1,640,416.6665) *0.00000000045 * (easting – 1,640,416.6665) + 0.9999333 = 393,700

   West Zone = (easting – 2,788,708.3331) *0.00000000045 * (easting – 2,788,708.3331) + 0.9999412 = 393,700

   b. Elevation Factor is determined by dividing the ellipsoid radius by the ellipsoid radius plus the mean elevation for the project.

   $$\text{Elevation Factor} = \frac{20909689}{[20909689 + (\text{elevation in feet} - 100.065)]}.$$

   c. Grid Factor is the result of multiplying the Elevation Factor by the Scale Factor of the centroid point of the project.

   Grid Factor = Elevation factor * Scale factor

d. Projection Factor is the reciprocal of the grid factor.

Projection Factor = 1 / Grid factor

VI. SPECIFICATIONS FOR LIGHT DETECTION AND RANGING (LiDAR)

The following specifications set forth the minimum requirements that must be met by the Consultant when providing LiDAR to the MoDOT.

1) **Technical Specifications**. The Consultant shall provide the necessary LiDAR coverage for the project. Specifications and instructions for delivery for LiDAR are contained in the MoDOT *Specifications for LiDAR*.

2) **Beginning the work.**

a. No work shall be done without MoDOT notification that work may begin.

b. No scanning shall be performed while there is ground snow within the area to be scanned.

c. No scanning shall be performed when the ground is obscured by haze, smoke or dust, or when clouds are present below the flight path.

d. The procedures indicated in the specifications shall be followed.

3) **LiDAR Sensor Calibration Reports.**

a. LiDAR sensor, the Consultant shall provide the calibration report and/or the manufacture's recommended equivalent procedure. If a manufacturer recommended procedure is provided, a Statement of Compliance on company letterhead will be submitted. The statement of compliance will:

i. Certify that the manufacture's recommended procedure; was completed at the recommended intervals as required.

ii. Identify the date the procedure was last accomplished before the project was flown.

iii. Be signed by an authorized representative of the company submitting the Statement of Compliance.

b. If requested, the Consultant shall submit a statement certifying that the LiDAR sensor has not been disturbed, repaired or modified in any fashion since the submitted calibration report or statement of compliance as made.

c. If at any time after award of the contract, the LiDAR sensor is disturbed, repaired or modified in any fashion, the Consultant shall submit to MoDOT a new calibration report or statement of compliance.

d. MoDOT reserves the right to restrict the use of any LiDAR sensor based upon the data contained in the calibration report, or based upon operational results.

4) LiDAR Requirements.

a. Horizontal and Vertical Datum. Horizontal Datum shall be referenced to the Missouri State Plane Coordinate System, Units US Survey Feet, North American Datum of 1983 adjustment. Vertical Datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88).

b. Aircraft shall be equipped with an Aerial Sensor Management System (ASMS) for guidance, positioning and flight management, Airborne Global Positioning System (ABGPS) survey and Inertial Measurement Unit (IMU) measurement technology shall be employed, estimating the imagery capture control stations.

c. Mobile units shall be equipped with a Global Positioning System (GPS), Inertial Measurement Unit (IMU) and Distance Measurement Instrument (DMI) technology shall be employed, estimating the imagery capture control stations.

d. Consultant shall use static logging information from base stations within MoDOT's GPS Reference Station Network for all post processing of ABGPS data. A user ID will be provided by MoDOT to access MoDOT's GPS Reference Station Network web site for the purpose of downloading the necessary GPS data accentual to post processing. GPS static data must be downloaded from GPS Reference Station Network web site within 30 days of flight.

5) **Post-Processing of LiDAR data**. The Consultant shall be responsible for all post-processing of the LiDAR to meet the following specifications.

   a. Type A – Roadway and Pavement Scans.

      i. Internal Horizontal / Vertical Accuracy of 0.3 feet at 95% confidence.

      ii. Maximum point spacing of 0.3 feet on the full classified LAS file.

   b. Type B – Corridor and earthwork Scans Urban.

      i. Internal Horizontal / Vertical Accuracy of 0.5 feet at 95% confidence.

      ii. Maximum point spacing of 1 foot on the full classified LAS file.

   c. Type C – Corridor and earthwork Scans Rural.

      i. Internal Horizontal / Vertical Accuracy of 0.5 feet at 95% confidence.

      ii. Maximum point spacing of 2 foot on the full classified LAS file.

   d. Each LAS file shall be less than 1 GB in size.

   e. Each LAS file shall be named to include the MoDOT required information. The text shall be placed from left to right in the following order.

      i. Project number (i.e. J8P2202).

      ii. The unique tile number (tiles are numbered in sequence). The first tile shall be labeled as number one (1), with each succeeding tile having a number one greater than the tile before it.

VIII. MAPPING.

Work covered in this document shall include furnishing the professional, technical, and other personnel necessary to perform mapping services for the project. The services shall address the following:

1) **Project Limits.** The mapping shall be performed within the limits that are graphically marked and indicated on the Commission provided Microstation design files (dgn's) and photographs.

2) **Accuracy**

   a. Type A - Internal Horizontal / Vertical Accuracy of 0.3 feet at 95% confidence.

   b. Type B/C –Internal Horizontal / Vertical Accuracy of 0.5 feet at 95% confidence.

3) **Topography.** The mapping data shall include natural positions on the earth's surface within the project limits that determine the configuration of the terrain. The positions shall be in the form of points and strings that locate vertical and horizontal transitions. This shall include a Geopak Digital Terrain Model (.tin) for the entire project.

4) **Planimetrics.** The mapping data shall include the positions of all man-made features within the project limits. The positions shall be in the form of points and strings that define the shape, size and position of the features. This shall include a Geopak Coordinate Geometry Database (.gpk) containing the data imported for the project.

5) **Position Definition.** All positions mapped will be defined by their unique identifier, coordinate value and feature code. These values are referenced to the aforementioned systems and datum. These are expressed in the format of:
   - Identifier = Point number
   - Coordinate value = X (easting), Y (northing), Z (elev.)
   - Feature code = Number

6) **Feature Codes.** Position description will be derived from the *MoDOT Standard Photogrammetric Feature Codes*. These codes will be used on all mapped positions. Features to be plotted at 1" = 100' scale. Standards are available in the GEOPAK Survey Manager Database (.smd) which is made available through the department's internet web site at:

7) **Map Files**. All map files shall conform to the department's standards as specified in the MoDOT Engineering Policy Guide and the CADD Standards Manual, which is available from the department's internet site. For ease in implementation of these standards, all standard items shown in the above documents are selectable from department created Microstation Settings managers that are also available on the department's internet site.

   http://www.modot.mo.gov/business/standards_and_specs/caddstandards.htm

8) **Return of Source Data.** The Consultant shall return to the Commission all of the provided source data, including all aerial photographs and maps.

9) **Standards.** The Consultant shall comply with the most recent and applicable State and Federal Laws. Procedures and criteria shall be determined in accordance with any applicable portions of the Missouri Department of Transportation Engineering Policy Guide, Section 238.1, Photogrammetric Surveys.

10) **Deliverables.** The Consultant shall provide mapping data in the digital formats set forth in this document's Specifications for Deliverables and its associated appendix.

11) **Data Quality**. The Consultant shall be responsible for the professional quality, technical precision and the coordination of data, documents and other services furnished for this project. The Consultant shall, without additional compensation, correct or revise any errors or deficiencies in the delivered services and information.

12) **Additional Services.** The Commission reserves the right to request additional work beyond the scope of services addressed in this document. In this event, a supplemental agreement shall be executed and approved prior to the performance of additional services. Changes in compensation will be addressed in the supplemental agreement.

13) **Documentation.** The Consultant shall provide any documentation necessary to explain, support and clarify the procedures used for data development. After map compilation has been completed, the Consultant shall be available to the Commission to discuss and interpret provided data.

14) **Data Ownership.** All data and documents prepared in performance of this Scope of Services shall be delivered to and become the property of the Commission upon suspension, abandonment, cancellation, termination, or completion of the Consultant's services.

15) Payment to the Consultant for the LiDAR, surveying and engineering deliverables will not be made until all of the map files for the project have met the satisfaction of the department.

IX. SPECIFICATIONS FOR SURVEY DELIVERABLES

The Consultant shall provide to the Commission the following items:

1) Three ASCII coordinate files all containing the primary control, photo control and check points for the project survey. These files are:

   a. Pin Elevations. The survey control file. A file listing control positions by point number, X, Y, and Z values in project units referenced to the Missouri Coordinate System of 1983, Zone name Zone, with X and Y values modified by the projection factor. This ASCII formatted file will be named J#######.rec with specifications for file setup in Appendix A, Item 2.

   b. The Geodetic Control File. A file containing latitude and longitude information for all control points named J#######.txt with file format listed in appendix A, Item, 3. All OPUS solution sheets and/or data sheets from post processed static GPS sessions, calculations for grid and projection factor including the centroid point, mean elevation and the final grid and projection factor will also be listed in this file.

2) **MoDOT Survey Report**. A MoDOT survey project report for each project.

3) Copies of all intervisible control survey pair station descriptions along with all benchmark descriptions and field ties. A sketch of each point shall be provided showing the relative location of field ties to the point being referenced.

4) The Consultant shall provide a letter certifying that the below mentioned surveying specifications have been achieved for this project. The letter shall document the relative positional accuracies in parts per million, the confidence level in percent, and the post

adjustment residual values in centimeters that were achieved on this project. If any portion of the survey does not comply with these specifications, a written report substantiating the material variances from the specifications with the responsible surveyor's signature is required. The Commission reserves the right to disallow variations.

The survey report documents proof of these specifications:

a. Fixed preprocess baseline solutions.

b. Control station relative positional accuracies of 10 ppm in relation to adjacent stations at the 95% confidence level.

c. Post adjustment residual values < 3 cm in any dimension for control stations.

d. A Microstation design file (*dgn) with all survey control points plotted and labeled.

5) The Consultant shall furnish the files on CD ROM format. All submittals shall consist of two CD ROMs; one shall be labeled "working set" and one set labeled "archive set". In addition, the CD ROMs shall contain a text file describing the contents including project name, file names, Consultant's name and the date of submittal. This file shall be named contents.txt and be located in the root directory of the disk.

X. SPECIFICATIONS FOR LiDAR DELIVERABLES

The following materials shall be delivered to and shall become the property of Commission:

1) For any LiDAR project, the following shall be delivered:

a. Data will be delivered in LAS version 1.2 format or newer with the following information.

i. Record return

ii. Intensity

iii. GPS time

iv. Swath line number designation

v. Classification values after trimming (without data voids between swath lines)

0 = raw, never classified
1 = unclassified
2 = ground (i.e. bare earth)
3 = low vegetation
4 = medium vegetation
5 = high vegetation
6 = building
7 = low point
9 = water
10 = bridge
12 = overlap

b. LiDAR Processing Report.

c. Vertical Accuracy Report.

d. A shape file containing numbered LAS tiles.

XI. ACCEPTANCE OF COMPLETED WORK

1) The Consultant shall submit all completed work promptly to allow time for proper review. Work reviewed and found in accordance with the specifications shall be considered to constitute "satisfactorily completed and accepted work".

2) The Commission will determine which LiDAR work is in accordance with these specifications and represents acceptable work. Failure to produce acceptable work as specified, and after the Consultant has exercised the right to verify the quality of the work will cause the following:

3) The Commission may reject that portion of the work and the Consultant will accept a hundred (100) percent reduction in payment, at the agreement price, for the affected portions of work.

4) In the event that some work is found to be unacceptable in accordance with the specifications, and reworking is deemed necessary, the Consultant agrees that it shall re-fly such work without expense to the Commission, even though final payment may have been received. The Consultant must give immediate attention to these changes so there will be a minimum delay. The above and foregoing is not to be construed as a limitation of the Commission's right to seek recovery of damages for negligence on the part of the Consultant.

5) **Return of Source Data**: The Consultant shall return to the Commission all of the provided source data, including, all LiDAR data and maps.

6) **Data Quality**. The Consultant shall be responsible for the professional quality, technical accuracy and the coordination of data, documents and other services furnished for this project.

7) **Additional Services**. The Commission reserves the right to request additional work beyond the scope of services addressed in this document. In this event, a supplemental agreement shall be executed and approved prior to the performance of additional services. Changes in compensation will be addressed in the supplemental agreement.

8) **Documentation**. The Consultant shall provide any documentation necessary to explain, support and clarify the procedures used for data development. The Consultant shall be available to the Commission to discuss and interpret provided data.

9) **Data Ownership**. All data and documents prepared in performance of this Scope of Services shall be delivered to and become the property of the Commission upon suspension, abandonment, cancellation, termination, or completion of the Consultant's services.

XII. SCHEDULE AND DELIVERY

1) All deliverables shall be received no later than **90 days after the notice to proceed date**.

2) **Extensions.** The Commission will grant time extensions for unavoidable delays beyond the control of the Consultant. Requests for extensions of time shall be in writing by the Consultant, before plans are due stating fully the reasons for the request.

3) All material shall be delivered to:

Missouri Department of Transportation
830 MoDOT Drive
Jefferson City MO 65109
Attention: Photogrammetry