APPENDIX I
SCOPE OF WORK
Sample JALBTCX Project
Contractor
Contract #
Name of Project

1 General

1.1 Purpose: This survey is to collect lidar elevation and imagery data [describe the area, e.g. for a portion of the Puget Sound shoreline] in support of [describe the application of the data if desired, e.g. coastal shoreline erosion studies]. The data collected will include Bathymetric Lidar, Topographic Lidar, RGB Imagery, and Hyperspectral Imagery as specified below. The polygon delineated in Figure 1 indicates the area where JALBTCX shall collect data. The goal of this survey is to provide topographic elevations and bathymetric soundings that tie seamlessly, within the accuracy tolerances specified in this Scope of Work. Quality of the imagery [is/is not] a key focus of this survey.

1.2 Compliance: Surveying and Mapping shall be in strict compliance with USACE EM-1110-1-1000 for Photogrammetric and LiDAR Mapping, USACE EM -1110-1-1002 Survey Markers and Monumentation, USACE EM -1110-1-1003 NAVSTAR Global Positioning System Surveying, USACE EM -1110-1-1004 Deformation Monitoring and Control Surveying, USACE EM -1110-1-1005 Topographic Surveying, USACE EM -1110-2-1003 Hydrographic Surveying, USACE EM -1110-1-2909 Geospatial Data and System, Tri-Services A/E/C CADD Standards, Tri-Services Spatial Data Standards, and Related Spatial Data Products. Engineering Manuals (EM) can be obtained on the internet at: http://www.usace.army.mil/inet/usace-docs/eng-manuals/em.htm.

1.3 Safety: Operations shall be in full compliance with appropriate federal, state, county, and city safety rules and regulations.

Figure 1: Locality map showing extents of required data collection. The polygon delineates the requested area.

2 Bathymetric Survey Requirements

2.1 Bathymetric lidar data are required within the polygon shown in Figure 1, or to laser extinction, which is determined by water clarity.

2.2 Nominal lidar density shall be <=2 meters.

2.3 Vertical positions shall be accurate to 15 cm (one standard deviation).

2.4 Horizontal positions shall be accurate to 1.5m (RMSE).

2.5 For QA/QC purposes, one cross line is required every 25 miles alongshore.

2.6 If airspace restrictions are anticipated or known, JALBTCX will work to obtain the necessary clearance(s). If clearance cannot be obtained, survey requirements within these areas shall be eliminated and the scope shall be reduced or modified accordingly.

3 Topographic Survey Requirements

3.1 Data is required for the polygon delineated in Figure 1.

3.2 Spot spacing will be nominal 1 meter or less.

3.3 Vertical elevations will be accurate to 9.25 cm RMSE.

3.4 Horizontal positions will be accurate to 0.5 m (RMSE). For QA/QC purposes, one cross line is required every 25 miles alongshore.

4 RGB Imagery Requirements

4.1 RGB images will be collected concurrently with the lidar data. The resolution will be 30 cm Ground Sample Distance (GSD) or less. During the collection the minimum solar elevation shall be 20°.

5 Hyperspectral Requirements

5.1 Hyperspectral imagery will be collected concurrent with the lidar data. Resolution will be 1 m GSD or less. Spectral data will be obtained in 48 evenly spaced spectral bands providing continuous spectral coverage from 375-1050 nm.

5.2 Preferred data collection times are with the sun angle no lower than 20°.

5.3 Collection of the lidar data should not be precluded by meeting the hyperspectral collection parameters above. The hyperspectral data may be collected at a different time than the topographic lidar and at a higher altitude that still allows 1 m resolution.

6 Horizontal Control Datum

6.1 Control monuments used will be NGS published monuments that are horizontal Order B or better. The monuments chosen for use should be included in the NGS 2011 re-adjustment. Monuments not included in NGS 2011 re-adjustment effort must be tied to NGS 2011 re-adjustment network through a control survey and all notes provided in a control report or as a portion of the Report of Survey. If Order B or better is not available in the area needed then a monument will be established and coordinates generated by Precise Point Processing or with NGS Opus Projects.

6.2 All data will be referenced to NAD83 (NSRS2011) geographic coordinate system.

7 Vertical Control Datum

7.1 Control monuments used will be either NGS published monuments with vertical position quality of First Order Class 1 or better or tied through control surveys to the latest NGS network. If new monuments are established, they shall be tied to the NGS network through control surveys. Full documentation of all control used, existing or established, shall be provided in the Report of Survey

7.2 All data will be referenced to NAVD88, in meters, using the latest geoid model.

8 Quality Control

8.1 The following quality control measure items will be calculated, documented and provided within the Report of Survey.

8.1.1 Lidar Data

8.1.1.1 Bathymetric lidar calibration against ground truth will be performed in the current aircraft configuration.

8.1.1.2 Bathymetric lidar data viewed in profile will exhibit thickness < 30 cm. Alternately, a grid of standard deviation generated from bathymetric lidar data will not exceed 15 cm in flat areas for > 5% of the grid cells.

8.1.1.3 Topographic lidar calibration against ground truth will be performed in the current aircraft installation.

8.1.1.4 Topographic lidar data viewed in profile will exhibit thickness < 18.5 cm. Alternately, a grid of standard deviation generated from topographic lidar data will not exceed 9.25 cm in flat areas for > 5% of the grid cells.

8.1.2 RGB Imagery Data

8.1.2.1 A comparison of known positions of at least 4 well distributed check points per ground truth area shall be performed. The 4 positions may be points surveyed on the ground or derived from the lidar data. The center of the RGB imagery pixels compared must be located within 3m (RMSE) relative to the location of the comparison point.

8.1.3 Hyperspectral Imagery Data

8.1.3.1 A comparison of known positions of at least 4 well distributed check points per ground truth area shall be performed. The 4 positions may be points surveyed on the ground or derived from the lidar data. The center of the hyperspectral imagery pixels compared must be located within 3m (RMSE) relative to the location of the comparison point.

8.2 Ground Truth

8.2.1 Spot elevations will be collected along the survey area such that no lidar survey point is more than 50 miles from a spot elevation check point.

8.2.2 Spot elevations to determine the accuracy of the overall dataset should be selected on flat terrain, or on uniformly sloping terrain for 5 meters in all directions from each checkpoint. Whereas flat terrain is preferable, this is not always possible. Whenever possible, terrain slope should not be steeper than a 20 percent grade because horizontal errors will unduly influence the vertical RMSE calculations.

8.2.3 The RMSE shall be computed in accordance with the ASPRS Positional Accuracy Standards for Digital Geospatial Data, 2014. A copy of this specification may be found at Appendix D of this manual.

9 Deliverables

9.1 Final products shall include point cloud, ortho-mosaicked RGB imagery (TIFF), hyperspectral imagery, and a Report of Survey. Complete FGDC-endorsed metadata shall be provided for each of the preceding products except the Report of Survey.

9.2 All valid data collected during the production flight lines shall be processed and used to generate the products including data collected outside of the survey boundary.

9.3 Additional information for each of the following products is found in Attachment A, below, except for the ground truth.

- Data Coverage
- Point Data
- RGB Ortho-mosaic imagery
- Hyperspectral Imagery
- Report of Survey
- Ground truth data
- Complete metadata will be provided for each of these products. The metadata will be provided in xml format and will adhere to an FDGC-endorsed metadata standard (ie. ISO 19115-2). As a minimum, the core elements of the FGDC-endorsed metadata standard will be completed. In addition to the core metadata elements, process steps, including software packages and version numbers, will be provided with sufficient detail to allow reproduction of the product file.

10 Schedule

10.1 Data acquisition is scheduled during the months of April-June 2014.

10.2 A pdf map showing survey coverage will be delivered at the completion of the survey.

10.3 The lidar-based data deliverables, excluding the coverage files, will be delivered to POC no later than 60 days from the end of the survey. Imagery based products shall be provided no later than 90 days from the end of the survey.

10.4 The POC will review the final versions of the delivered data for accuracy and completeness and provide comments to JALBTCX. Corrections to these issues shall be made and revised files resubmitted within 30 days.

11 Government Pricing Analysis

Attachment B shows the format for the Government's pricing analysis for this example SOW. The contractor will submit a cost proposal in this format which the Government will compare with its independent cost estimate. Government independent cost estimates, when completed, are confidential, for Government use only.

Points of Contact

For USGS: For JALBTCX:

Attachment A

Point Data

The lidar data for each flight line will be provided in LAS 1.2 format. These files shall contain all data that has been collected. The positions in this file shall be provided in the horizontal reference frames and vertical datums specified in sections 6.2 and 7.2, respectively. The GPS times are to be recorded in adjusted GPS time (instead of the GPS week time) and to contain sufficient precision to allow for unique timestamps for each return. If the resulting LAS files contain classification values, it shall be reported in the metadata and survey report Classification values for topographic lidar adhere to the ASPRS classification standard. For bathymetric lidar, a custom classification scheme is utilized, and is outlined below.

1 – unclassified, valid topographic data
2 – ground-classified, valid topographic data
7 – low point-classified, invalid topographic data
21 – land-classified, valid bathymetric data
27 – land- and water-classified, invalid bathymetric data
29 – water-classified, valid bathymetric data

The metadata will be provided in xml format and will adhere to an FDGC-endorsed metadata standard (ie. ISO 19115-2). One metadata file is required for documenting the series of flight line LAS files delivered.

RGB Ortho-mosaic Imagery
One ortho-mosaic is required for each tile and will contain all images collected within the tile that show land mass or fixed features in the water, such as jetties, breakwaters, etc. Areas containing no imagery will have a background RGB values of 0, 0, and 0, respectively. These files shall be provided in GeoTIFF format and referenced to the horizontal reference frame specified in section 6.2..

The metadata will be provided in xml format and will adhere to an FDGC-endorsed metadata standard (ie. ISO 19115-2). One FGDC-endorsed metadata file is required per image tile.

Hyperspectral Imagery
The processed images will be radiometrically, geometrically and atmospherically corrected. The flight line images will be mosaicked into tiles and referenced to the NAD83 (NSRS2011) reference frame in UTM coordinates. If the concurrent lidar data is not available for orthorectification then another elevation source (USGS National Elevation Datasets (NED), Shuttle Radar Topo Mission (SRTM) data, etc.) may be used.

The metadata will be provided in xml format and will adhere to an FDGC-endorsed metadata standard (ie. ISO 19115-2). One FGDC-endorsed metadata file, in xml format, is required per data tile.

Report of Survey
Report will include, as a minimum, airborne collection logs, calibration reports, accuracy check reports, daily reports, gps logs, ngs control sheets, photos of control points, processing logs, list of delivered files, description of survey, dates of collection, and a list of problems encountered.

The report will be delivered in pdf format.

Tiling Scheme
The tiling scheme utilized for the delivery of imagery products will be provided by Jalbtcx as an ESRI feature class. In general, the tiles, which Jalbtcx refers to as ‘NCMP boxes’, are 5 km in width and extend alongshore. The center of each tile is coincident with the shoreline. Where acquired data exists outside these tile boundaries, the USGS quarter-quad tiles will be utilized for delivery of data products.

Attachment B – Form used for Contractor and Government Cost Estimates
Totals ___ Square Miles, Project Name, LiDAR, Orthos and Hyperspectral Imagery
Contractor Contract #
Task Order #

DIRECT LABOR	HOURS	HOURLY RATE	LABOR COST
Project Manager	____	$____.__	$_____.__
Quality Manager	____	$____.__	$_____.__
Supervisory Photogrammetrist	____	$____.__	$_____.__
Photogrammetric Technician	____	$____.__	$_____.__
Aerial Photography Pilot	____	$____.__	$_____.__
Aerial / Sensor Operator	____	$____.__	$_____.__
GPS Engineer	____	$____.__	$_____.__
Orthophoto Technician	____	$____.__	$_____.__
GIS Technician	____	$____.__	$_____.__
LiDAR Technician	____	$____.__	$_____.__
Survey Office Engineer (PLS)	____	$____.__	$_____.__
Survey Supervisor (Party Chief)	____	$____.__	$_____.__
Survey Instrument Technician	____	$____.__	$_____.__
Subtotal--Direct Labor	**Use hourly contract rates**		**$_____A_.__**
Overhead on Direct Labor and General and Admin. (G&A) Overhead Combined	___% **Use contract OH, G&A**		**$_____B_.__**
OTHER DIRECT COSTS	UNIT	UNIT RATE	ODC COST
Aircraft (twin engine piston) w/ABGPS/hour	___	$_____.__	$_____.__
LIDAR sensor/hour	___	$_____.__	$_____.__
Large format digital sensor/hour	___	$_____.__	$_____.__
USB External hard drives/each	___	$_____.__	$_____.__
Travel/Lodging/Per Diem/day	___	$_____.__	$_____.__
Rental / Survey Vehicle/day	___	$_____.__	$_____.__
Subtotal—Other Direct Costs	**Use unit contract rates**		**$_____C_.__**
Subtotal--DL, OH & Other Direct Costs			**$A + $B + $C**
Profit (negotiated for individual task orders)		___%	**$_____D_.__**
(SUBCONTRACT) Flight (if not performed by prime contractor)			$_____E_.__
(SUBCONTRACT) Ground Control (if not performed by prime contractor)			$_____F_.__
PROJECT GRAND TOTAL			**$A + $B + $C + $D + $E + $F**

Prepared By: _____ Date: _____

Reviewed By: _____ Date: _____

Approved By: _____ Date: _____