Quantum Spatial, Inc.
517 SW 2nd St., Suite 400
Corvallis, OR 97333
TIN: 39-1133181

Nebraska Community Foundation
PO Box 83107
Lincoln, NE 68501-3107
FEIN: 47-0769903

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

FIRST AMENDMENT

To Agreement between Nebraska Community Foundation, Platte River Recovery Implementation Program, and Quantum Spatial, Inc.

1. Parties.
This is the First Amendment to the Agreement entered into by and between Nebraska Community Foundation ("Foundation") of Lincoln, Nebraska, representing all signatories to the Platte River Recovery Implementation Program ("Program"), and Quantum Spatial, Inc. ("Contractor") executed June 1, 2020. The following persons are authorized to represent the parties through this Agreement: Diane Wilson of the Foundation, Jason Farnsworth of the Program; and Andrew Brenner of the Contractor.

2. Purpose and Authority.
This First Amendment to the Agreement between Foundation and Contractor is being made in order to:

(1) Expand the Scope of Work to accommodate a one-time acquisition of lower Platte River topobathymetric LiDAR as described in Attachment A to this First Amendment.

(2) Increase maximum billable Contract amount by $310,000 to accomplish the Scope of Work in Attachment A to this First Amendment.

(3) Specify that the activities set forth in the Scope of Work shall only be performed following written Notice to Proceed by the Program. Notice will only be granted if lower Platte River conditions are conducive to successful data acquisition. That determination shall be made solely by the Program. Contractor acknowledges that it is not entitled to any of the compensation set forth in this First Amendment if the Program makes a determination not to proceed.

All other terms of the original agreement remain in effect as originally written.

IN WITNESS WHEREOF, the Parties have executed this Agreement.

Nebraska Community Foundation	Quantum Spatial, Inc.
By_____	By_____
Diane M. Wilson, Manager Public/Private Partnerships	Andrew Brenner, Senior Program Director
Date: _____	Date: _____

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM ACKNOWLEDGEMENT

I hereby certify that the Governance Committee of the Platte Program has authorized the Nebraska Community Foundation, acting as contracting agent of the Governance Committee of the Platte Program, to enter into this agreement.

_____	_____
Jason Farnsworth	Date
Executive Director	

ATTACHMENT A:

Lower Platte River, NE Topobathymetric LiDAR Cost Proposal

Justin Brei
Headwaters Corporation
(720) 524-6115
breij@headwaterscorp.com

Lower Platte River, NE
Topobathymetric Lidar Cost Proposal

NV5 Geospatial (NV5G) appreciates the opportunity to present to the **Headwaters Corporation (Headwaters)** a price quote and brief statement of work for acquiring and processing topobathymetric lidar over the **Lower Platte River** in eastern Nebraska. Data will be utilized to support various long-term research, change detection, and monitoring goals and to aid in the management, restoration, and protection of this valuable river floodplain. The following provides a brief synopsis of our services, specifications, and associated costs for this area of interest.

Project Area of Interest

The area of interest (AOI) for this cost proposal includes a portion of the **Lower Platte River (117 sq. miles)** from its confluence with the Missouri River to just west of its fork with the Loup River in eastern Nebraska (Figure 1). The AOI will be buffered by 50-100 meters to ensure complete coverage and adequate point densities around study area boundaries.

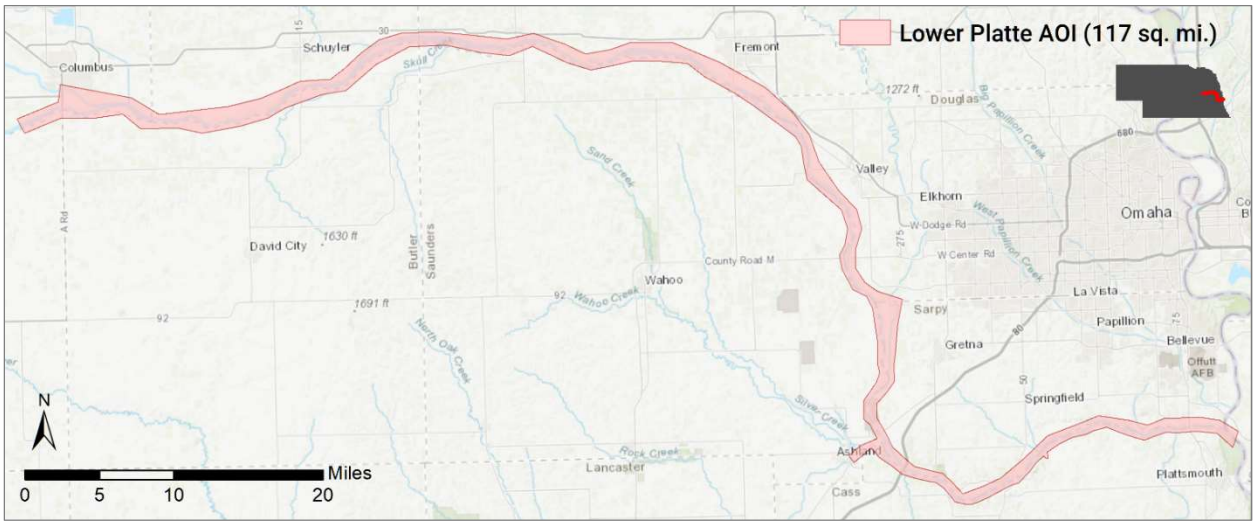


Figure 1. Area of interest for topobathymetric lidar collection in eastern Nebraska.

Services

Acquisition

Topobathymetric lidar data will be acquired using a state-of-the-art Riegl VQ-880 GII or equivalent hydrographic airborne laser system. The systems contain a green wavelength (λ=532 nm) laser capable of penetrating water, and a high repetition pulse rate, high scanning speed, small laser footprint, and wide field of view together facilitate high resolution coverage of topographic and bathymetric surfaces. Additionally, the short laser pulse length of our bathy system is ideal and critical for shallow-water systems allowing for effective discrimination between water and bathymetric surfaces when mapping near-shore, shallow, and dynamic aquatic environments.

Lidar Specifications Summary	
Sensor	Riegl VQ-880 GII (or equivalent)
Pulse Density	≥ 6 pulses/m^2 (0.70 m post spacing)
Scan Angle	40° (± 20° off nadir)
Swath Overlap	≥ 60% side-lap (110% overlap)
Field of View	40°, 20° forward fixed angle
Intensity	16-bit
Data Recording	Discrete (On-Line) Full Wave Form
Secchi Depth	1.5 (up to ~20 ft in clear water)
Flightlines	Opposing
Vertical Accuracy$_z$ / RMSE	18 cm / 9.2 cm
Horizontal Accuracy$_z$ / RMSE	1.04 m / 60 cm

Lidar data will be collected to produce a high resolution topobathymetric data set (combined average ≥ 6 pulses/m^2) with a maximum scan angle of ± 20° (off nadir). Water clarity affects the degree to which the laser can penetrate to the bathymetric bottom, wherein high turbidity scatters the energy throughout the water column, diminishing laser returns to the sensor. Additionally, the bottom surface must be reflective enough to return remaining laser energy back to the sensor at a detectable level. Our systems demonstrate hydrographic depth ranging capability of at least 1.5 Secchi depth (reliably up to ~20 ft in clear water) on bright reflective surfaces, but the actual depth performance will depend on bottom reflectivity and water clarity at time of acquisition. Finally, the laser will not penetrate dense aquatic vegetation. Data will be collected during the best possible conditions for success which include no fog/rain and any other conditions affecting water clarity.

Survey Control

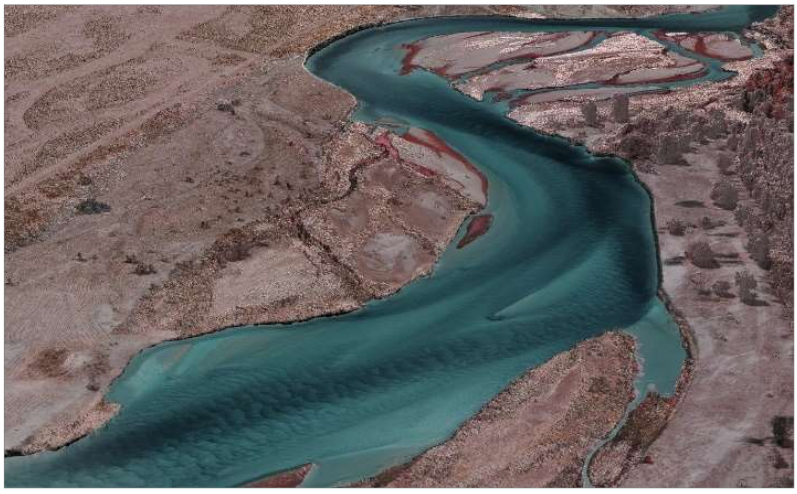
To enable geospatial correction of aircraft positional coordinate data, NV5G will use Trimble® CenterPoint™ Post-Processed Real-Time Extended ('PP-RTX') and/or TerraPos® Precise Point Positioning ('PPP'). To calibrate the data and enable accuracy assessments, our field crew will collect ground check points (GCPs) using GPS-based real-time kinematic (RTK) survey techniques. For an RTK survey, the ground crew uses a roving unit to receive radio-relayed corrected positional coordinates for all GCPs from a GPS base unit set up over a survey control monument. Our team will distribute a suitable number of hard, bare earth GCPs on level slope throughout project areas, as feasible given road access and GPS conditions. Check points will

also be collected in shallow water, as feasible, to assess accuracy of the bathymetric surface model. The feasibility and number of check points/cross sections will depend on access, bottom stability, and radio range on the RTK rover. The techniques for establishing all ground check points will be outlined in the Report of Survey, including the identity, locations, and position residuals of all GCPs used to evaluate survey accuracy. In addition, we will work with Headwaters to gain access to river survey areas for bathymetric lidar ground survey verification.

Bathymetric checkpoint collection on the Platte

Processing

Lidar processing tasks involve echo extraction; calculations of laser point position, relative accuracy, and flight line calibration; refraction correction; water surface extraction; point classification; and accuracy assessments. Derived topobathymetric DEMs will be developed once the seamless topographic/bathymetric lidar point cloud is finalized for positional and classification accuracy. NV5G will identify and evaluate clarity and reflectivity as they impact the dataset. Depths ranging beyond the sensor's detection capability will produce voids in the data set, and these will be identified in the dataset as well as evaluated in reporting. NV5G will correct raw intensity values from the bathymetric lidar returns to account for attenuation due to depth and angle of incidence. The return intensity values will be further normalized to account for swath-to-swath variability and the corrected values stored in the standard LAS 1.4 deliverable. Our team will assess the accuracy of the topobathymetric lidar system using bare earth and any shallow water check points collected during the survey. Prior experience has shown bathymetric surface accuracies (RMSE) of ≤ 10.0 cm.



Topobathymetric lidar bare earth model with point cloud overlay colored by NIR imagery, Platte River, NE.

Deliverables

All data and imagery will be delivered on USB hard drives.

Data & Products

Point Cloud

- All Returns, *Las 1.4 format*

  Point files will include the following fields: X, Y, Z, Return Intensity, Return Number, Point Classification (topographic ground, default, water), Scan Angle, Adjusted GPS Time
  Class 1 – Unclassified ('Default' = non ground; buildings, vegetation, etc.)
  Class 2 – Ground
  Class 7 – Low point and noise
  Class 9 – Water
  Class 12 - Overlap

Surface Models

- Hydro-flattened Bare Earth DEM, *3-ft resolution, Esri Grid format*
- Combined (topobathymetric) Surface Model (DEM), *Tiles, 3-ft resolution, Esri Grid format*
- Combined (topobathymetric) Surface Model (DEM), *Mosaic, 3-ft resolution, Esri Grid format*
- Highest Hit DEM (with water surface), *3-ft resolution, Esri Grid format*
- Intensity Images, *1.5-ft resolution, GeoTiff format*

Vectors

- Survey Boundary, *shapefile format*
- Tile delineation, *shapefile format*
- Flightlines, attributed by date/time, *shapefile format*
- Hydro Breaklines, *shapefile format (polyline)*
- Submerged Topography Density*, *shapefile format (polygon)*

** Because point density decreases with depth, we will include a shapefile that summarizes areas with lower return densities and hence lower confidence in the resulting bathymetric model*

Reporting

- Daily Acquisition Reporting: displaying flight lines and completed areas
- Ground Check Points, *shapefile format*
- Project Summary: Methods(including time/date of all flightlines), Results, Accuracy Assessments, **.pdf format*
- FGDC-compliant Metadata

Coordinate System

Nebraska State Plane, NAD 1983 (2011), NAVD88 (Geoid 03), Units: US Survey Feet.

Timeline & Delivery

Data acquisition is anticipated for June 2022, during leaf-on conditions. NV5G will work with Headwaters to coordinate data collection during optimal conditions for success. Data and products will be delivered within 90 days of acquisition.

Pricing

The cost for topobathymetric lidar is provided below for the study area portrayed in Figure 1, assuming the deliverables and timeline outlined above.

Lower Platte River, NE (117 sq. miles)	Total Cost
Topobathymetric Lidar Acquisition and Processing	$309,753

Point of Contact

I will represent NV5 Geospatial during the performance of services provided under this agreement. If you have any questions or concerns, please do not hesitate to contact me directly. Thank you for the opportunity to provide this quote and information.

Andrew Brenner, Program Manager
andrew.brenner@nv5.com

Mobile: 734.680.6424

NV5 Geospatial Difference

Our geospatial services have strategic value in countless applications – from habitat assessment and land use planning to regulatory compliance, engineering design, and disaster preparedness.

We've successfully delivered millions of acres of geospatial data to support projects for federal, state, tribal, private and non-governmental organizations.