TECHNICAL MEMORANDUM

To: Lower Columbia Estuary Partnership

From: Inter-Fluve

Date: September 25, 2018

Subject: East Fork Lewis River, Ridgefield Pits – Survey Methods and Results

Introduction

The Ridgefield Pits project area is located between River Mile 7.2 & 9.5 on the East Fork Lewis River near La Center, WA. The Lower Columbia Estuary Partnership (LCEP) is developing designs for habitat restoration along the mainstem East Fork Lewis River, including an area of former gravel ponds captured by the river during the 1996 flood and two adjoining side channels. The project will seek to improve salmonid habitat throughout the project site. Habitat quality was adversely impacted during the 1996 flood event resulting in channel erosion and instability, habitat simplification, impaired floodplain function, increased water temperatures, impaired flow, and an increase of habitat types that favor invasive predatory fish.

Inter-Fluve and LCEP staff collected bathymetric and topographic data in the spring of 2018 to be used by LCEP, and in combination with LiDAR data, to develop a topographic surface representing existing conditions throughout the project site. This surface will be used to perform hydraulic modeling and to support designs for habitat restoration actions. This technical memo summarizes the field survey data collection and data processing effort.

Figure 1. Boat-based survey data collection in the mainstem East Fork Lewis River.

Survey Methods

Topographic and bathymetric data were collected throughout the project site using boat-based and land-based data collection methods. Boat-based survey was utilized along the mainstem of the East Fork Lewis River from river mile 10.0 (Daybreak Bridge) to river mile 6.3. Land-based survey was used to capture data in areas of the channel which were inaccessible by boat; channel tops and toes, gravel bars, select floodplain areas, and select side channels where restoration treatments are likely to be located. A map of topographic and bathymetric survey points is depicted in Figure 2.

BOAT-BASED DATA COLLECTION

Bathymetric survey was performed by Inter-Fluve staff on April 12 & 13, 2018. Bathymetric data were collected using a single-beam echosounder (Seafloor SonarMite MILSpec) mounted on a boat with an outboard jet drive engine. The echosounder was coupled with an RTK GPS rover. An RTK GPS base station was established within the project site and static GPS data were collected throughout the day. Radio signal between the base station and GPS rover was maintained throughout the survey. Using this system, horizontal and vertical position are collected by the RTK GPS rover and paired with water depth measurements collected by the echosounder. The resulting data forms a point cloud representing the bathymetric surface of the waterbody surveyed. Water depth measurements were filtered using sonar quality information and points were only stored when established data quality targets were met for both the GPS rover and the echosounder. Surveyed depths were assumed to be collected in a direct vertical orientation and no correction was made for vessel movement (i.e. pitch and roll), which was assumed to be minor and to have a negligible effect on the data.

In addition to the bathymetric survey, a minimum of three ground control points were occupied by the RTK rover during each day of the boat-based survey.

LAND-BASED DATA COLLECTION

Topographic and bathymetric data were collected on May 21 & 22, 2018 by Inter-Fluve and LCEP staff. Data were collected using RTK GPS and total station. RTK GPS was used to define the tops and toes of the existing mainstem channel and ponds, to collect additional topographic and bathymetric data in shallow areas of the main channel where boat-based survey was impractical, and to define existing bar features. A total station was used to collect topographic data of wetted side channels on river-right (north side) where tree canopy cover precluded the use of RTK GPS, where canopy cover likely limits the accuracy of LiDAR, and where habitat enhancement is likely to occur.

An RTK GPS base station was established within the project site each day and static GPS data were collected. A minimum of two previously established control points were occupied by each surveyor, each day.

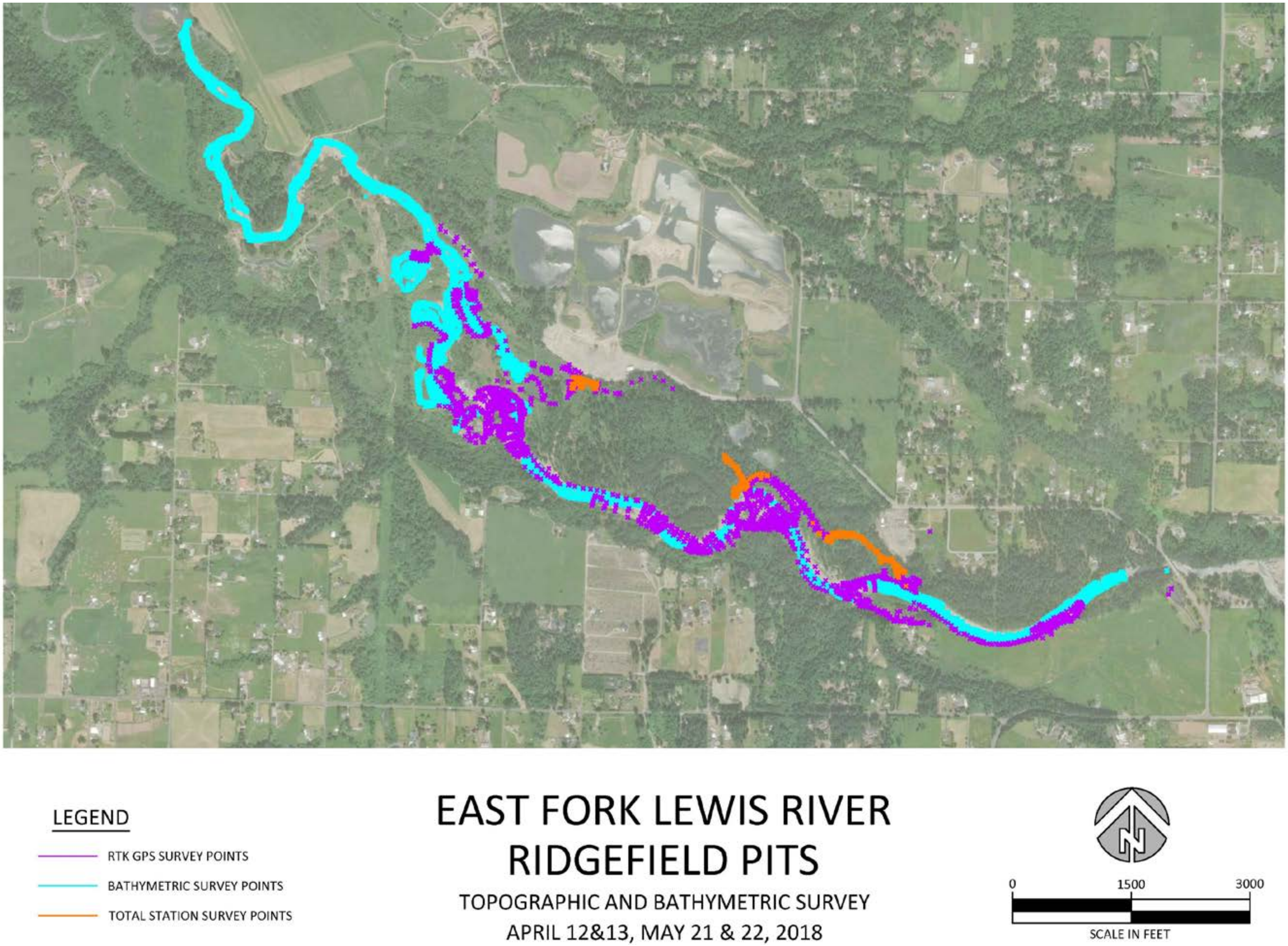

Figure 2. Map of survey data collected at the site.

SURVEY CONTROL

Control points were established during the survey (Table 1). Permanent control, including rebar with plastic caps and PK nails imbedded in paved areas, were established throughout the project site and marked with flagging. Additional temporary control points (wooden stakes) were set to aid in completion of the survey but are not expected to be recoverable in the future. The locations of survey control points are depicted in Figure 3. Photos of selected points are included in Table 2

Multiple control points were occupied each day by each surveyor. GPS static data were collected each day and processed using the National Geodetic Survey Online Positioning User Service (OPUS). Ground-based survey data were corrected to the OPUS solutions for control points 500 & 600. Boat-based survey data were corrected to the OPUS solutions for control points 100 and 105. Repeat occupations of control points which were corrected to different OPUS solutions were compared and found to match closely. Coordinates of control points with multiple occupations were averaged to establish the final northing, easting and elevation values. These coordinates are provided in Table 1.

A Washington State Department of Transportation benchmark (monument ID: 4880) was surveyed on September 13, 2018 to compare to the site survey data. The elevation difference was within 0.06 ft. and the horizontal difference was within 0.01 ft.

Table 1. Survey control established by Inter-Fluve, Inc. Coordinate system is NAD83 WA State Plane South zone, US Feet, NAVD88.

Point #	Northing (ft)	Easting (ft)	Elevation (ft)	Description	Notes
100	181622.13	1105673.59	76.50	CP	Permanent – Rebar (OPUS solution)
101	181776.01	1105925.50	76.16	TBM	Temporary – Wooden stake
102	181570.38	1105564.03	77.04	Rebar	Permanent – Rebar
103	182120.67	1107148.41	77.26	Nail	Permanent – PK nail
104	183711.27	1099320.03	41.38	TBM	Temporary – Wooden stake
105	185130.21	1097802.86	31.97	Rebar	Permanent – Rebar (OPUS solution)
106	186104.11	1097183.41	36.27	Rebar	Permanent – Rebar
107	186148.61	1097335.74	33.11	Nail	Temporary – PK nail
108	187149.97	1097001.57	33.85	TBM	Temporary – Wooden stake
401	183506.32	1101837.42	50.07	CP	Temporary – Wooden stake
402	183582.88	1101998.23	50.01	CP	Temporary – Wooden stake
403	184800.12	1099755.42	35.56	CP	Temporary – Wooden stake
404	184811.48	1099881.42	36.55	CP	Temporary – Wooden stake
500	182917.67	1104135.92	63.84	Rebar	Permanent – Rebar (OPUS solution)
502	182336.38	1103744.82	58.95	CP	Temporary – Wooden stake
503	182228.90	1103832.33	60.20	CP	Temporary – Wooden stake
504	182411.10	1103710.65	58.76	CP	Temporary – Wooden stake

Point #	Northing (ft)	Easting (ft)	Elevation (ft)	Description	Notes
505	182473.26	1103727.51	56.21	CP	Temporary – Wooden stake
506	182559.34	1103640.55	56.17	CP	Temporary – Wooden stake
507	182583.00	1103536.49	55.22	CP	Temporary – Wooden stake
508	182719.70	1103394.25	52.59	CP	Temporary – Wooden stake
509	182837.66	1103283.41	54.45	CP	Temporary – Wooden stake
510	182897.62	1103076.87	54.31	CP	Temporary – Wooden stake
511	182819.47	1102822.32	52.59	CP	Temporary – Wooden stake
600	185026.98	1099576.57	43.30	Rebar	Permanent – Rebar (OPUS solution)
601	183573.11	1101763.93	48.24	CP	Temporary – Wooden stake
602	183696.45	1101712.06	48.63	CP	Temporary – Wooden stake

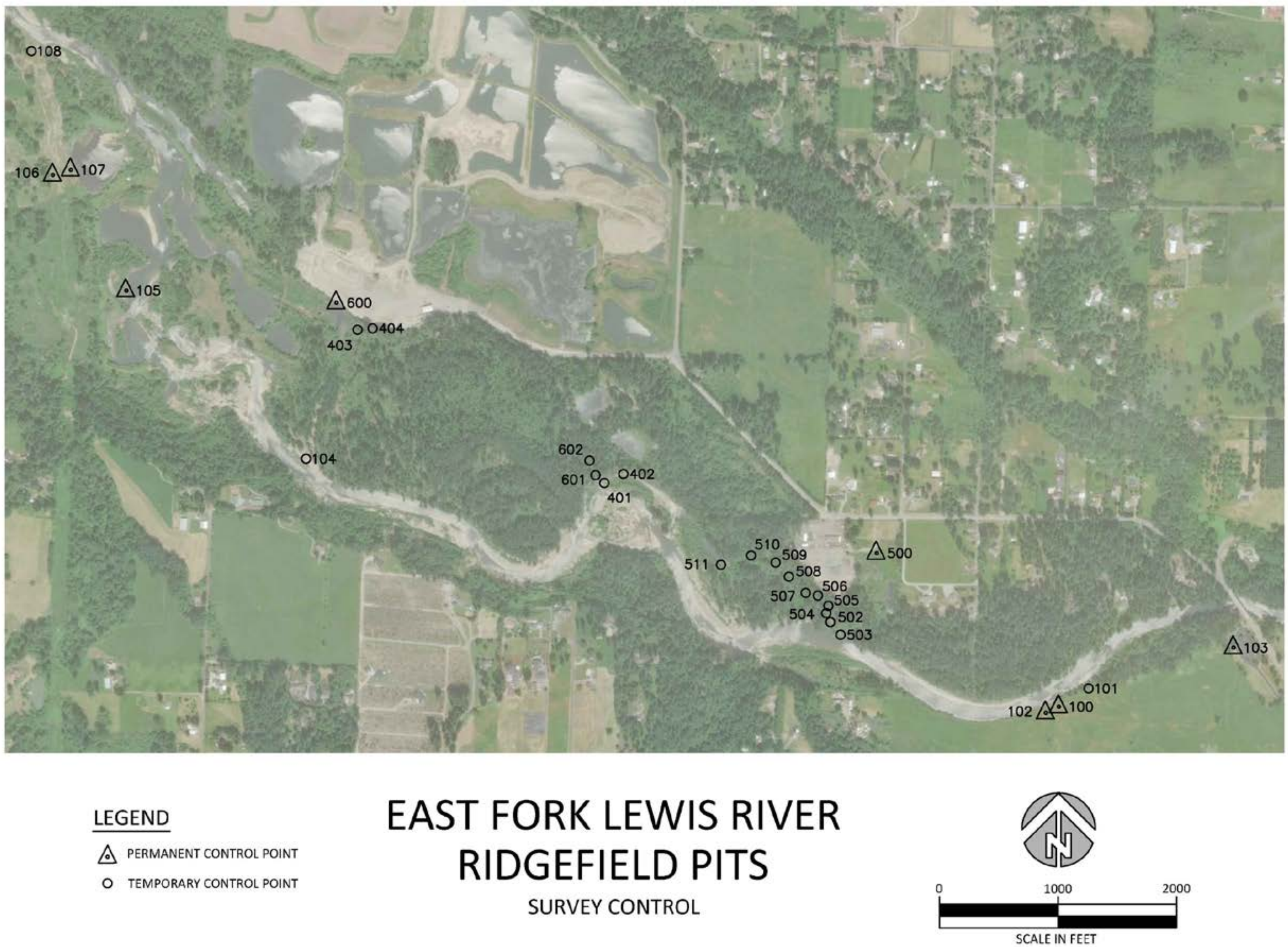

Figure 3. Survey control locations.

Table 2. Photos of selected control points.

CP 100 – Rebar with orange plastic cap

CP 101 – Wooden stake

CP 103 - PK nail in pavement

CP 106 - Rebar with orange plastic cap

CP 107 – PK nail in log

CP 500 – Rebar with orange plastic cap

Data Processing

BOAT-BASED SURVEY DATA PROCESSING

Boat-based survey data were corrected using the OPUS solution obtained for the RTK GPS base station used that day. A triangular irregular network (TIN) was created using the boat-based survey data. Contours were generated from the TIN and were used to identify survey points containing elevational outliers. These points were excluded from the dataset.

LAND-BASED SURVEY DATA PROCESSING

Survey control was established and corrected using the OPUS solution obtained for the RTK GPS base station used that day. Land-based RTK and total station data were corrected to the established control points, and the solution was verified by comparing the coordinates for multiple control points occupied during the survey.

Survey Quality Evaluations

REPEAT SURVEYS OF CONTROL POINTS

Many control points were occupied multiple times throughout the survey. Coordinates from repeat occupations were compared against established criteria for maximum vertical variability of less than 0.1 meter (0.33 ft). The elevations surveyed during repeat occupations for the majority of control points matched within 0.05 ft. Elevations for all repeat control occupations matched within the established criteria of 0.1 m (0.33 ft). These data are summarized in Figure 4.

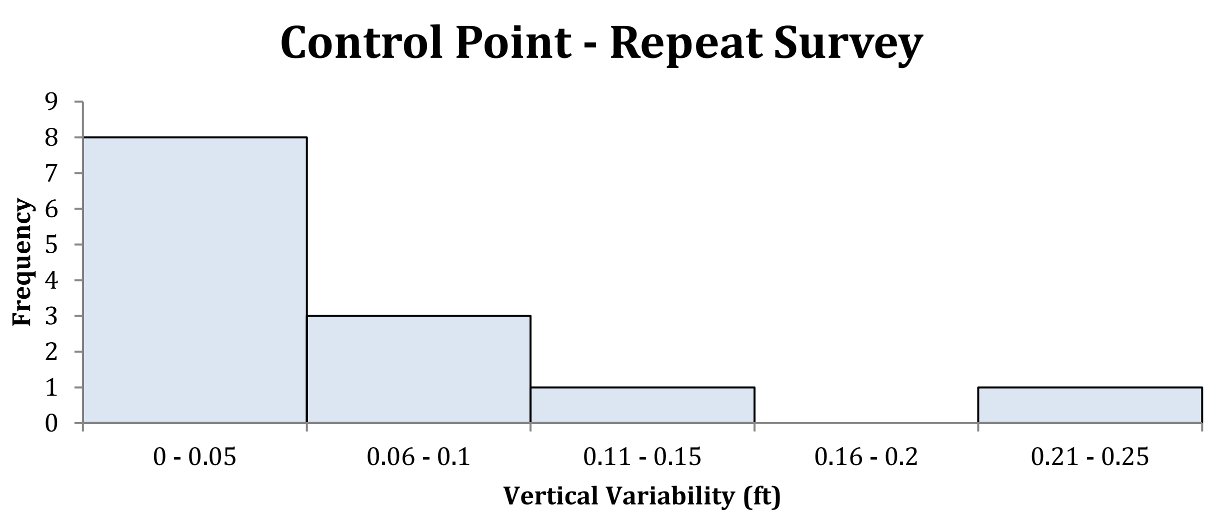

Figure 4. Vertical variability in repeat control point occupations.

ACCURACY OF SONAR READINGS

Sonar depth readings were compared to measurements of water depth by stadia rod in two locations. The locations selected exhibited little variation in bed surface and included the concrete boat ramp at Daybreak Park and a section of cobble-bedded river near river mile 8.8. These comparisons were used to verify that the accuracy of the sonar readings met the established tolerance for maximum vertical variability of less than 0.1 meter (0.33 ft). At the boat ramp, the measured depth was 0.02 ft deeper than the sonar reading. In the cobble-bottom location the measured depth was 0.05 ft deeper than the sonar reading.

Accuracy of the boat-based survey methods were also compared to the ground-based RTK survey by selecting nearby point pairs where points had been collected via each method. This occurred at several locations throughout the project area. These points were not collected with the original intent of comparison, and are located on a variety of bed surfaces including gravel and cobble – so some variation is to be expected. The elevations of the majority of the survey points compared matched within 0.2 ft. These data are summarized in Figure 5.

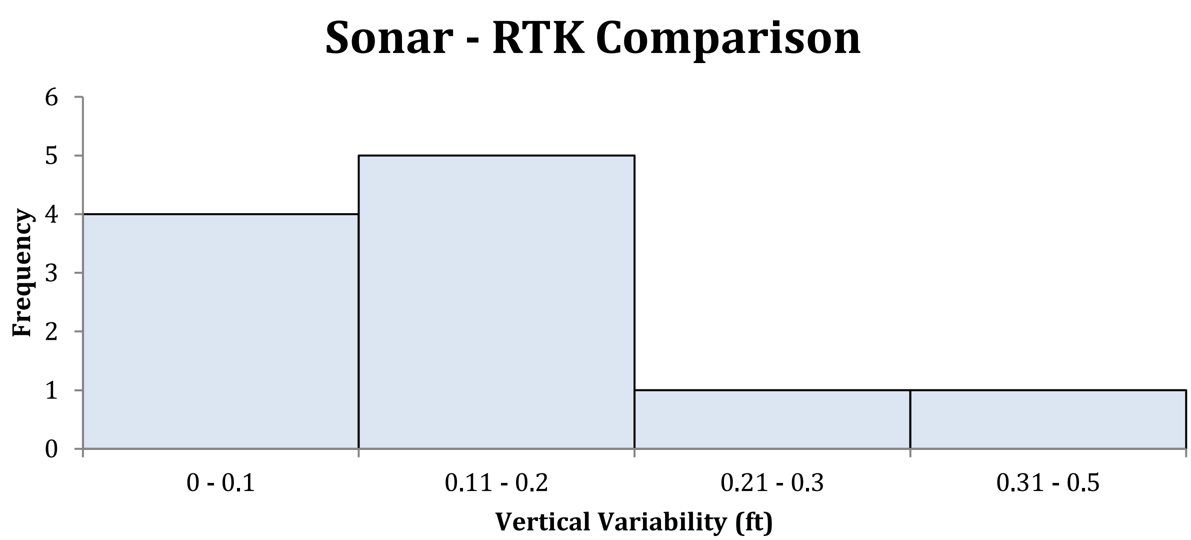

Figure 5. Vertical variability in land-based RTK survey data and boat-based sonar survey data.

COMPARISION WITH LIDAR

Light detection and ranging (LiDAR) data flown in 2010 by the US Army Corps of Engineers (USACE) was obtained for the project area. These data were compared to land-based survey data collected on site. Comparison points were chosen in areas where the LiDAR was expected to correspond closely with the survey data. These points included areas which were not inundated during the LiDAR flight and which were unlikely to have experienced erosion and/or deposition since the LiDAR flight. A total of 30 survey points were compared to the LiDAR surface. Elevations for all of the comparison points were within 1.0 ft of LiDAR surface and the majority of the points matched the elevation of the LiDAR surface within 0.4 ft. Results are summarized in Figure 6.

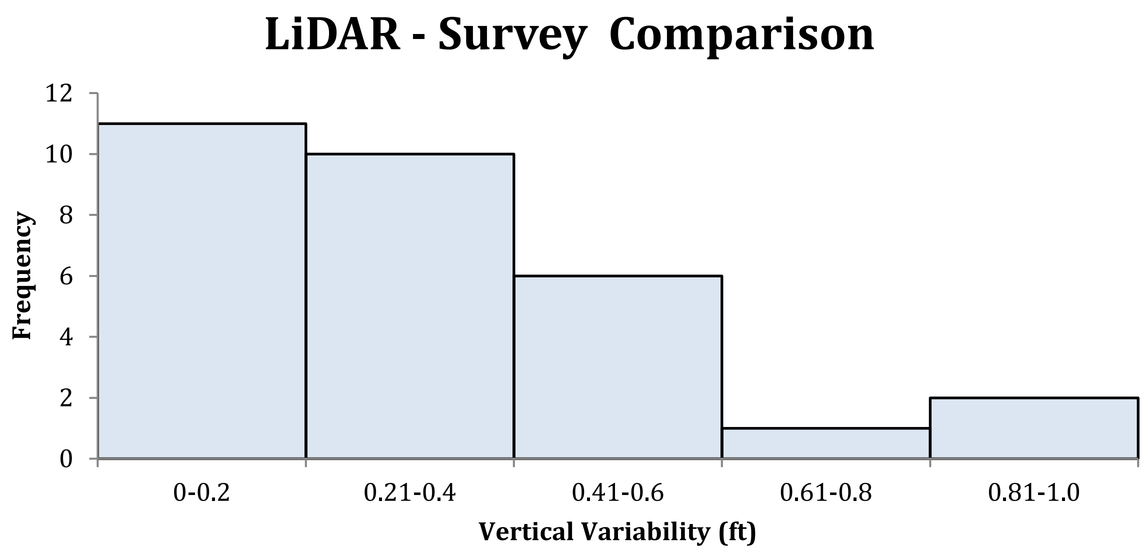

Figure 6. Vertical variability in land-based survey data and 2010 USACE LiDAR.