Surveyor's Report for Willwood Dam Bathymetric Survey

Completed for:

Wyoming Game & Fish Department

Headquarters

5400 Bishop Boulevard

Cheyenne, WY 82006

307-777-4600

Wyoming Department of Environmental Quality

Water Quality Division

200 W. 17th St.,

4th Floor

Cheyenne, WY 82002

Surveyor's Statement

I, Darby A. Schock, a duly registered Professional Land Surveyor in the State of Wyoming, acting as an agent for the Wyoming Game & Fish Department, do hereby certify the Surveyor's Report represented hereon, truly and correctly represents the results of a survey made under my direct supervision and was completed in accordance with applicable standards of practice. The results shown hereon are true and accurate to the best of my knowledge, information and belief. This certification does not constitute a guaranty of warranty, either expressed or implied.

Darby A. Schock

Wyoming Registered P.L.S. # 15432

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Introduction

This survey was undertaken due to a joint request of the Water Quality Division of the Wyoming Department of Environmental Quality (DEQ) and the Cody Regional Office of the Wyoming Game and Fish Department (WGFD). The purpose of the survey was to complete a bathymetric survey of the upstream area above the Willwood Dam on the Shoshone River.

The dam has undergone maintenance in the recent past (2015 through 2017) which highlighted issues with sediment at the dam. The bathymetric survey was completed as the initial effort in a multi-year project. The goal of the project is to monitor sediment levels over time, directly above the dam.

This initial survey effort consisted of a bathymetric survey of the Shoshone River upstream of Willwood Dam, topographic survey of the overbank in the same river reach and establishing a survey grade GNSS (global navigation satellite system) control network.

The Shoshone River is located northwest Wyoming with the Willwood Dam being located approximately 18 miles northeast of Cody, WY off of Highway 14A. The dam is used for irrigation purposes and is approximately 50’ tall.

Sediment monitoring, as previously mentioned, is the ultimate goal of the project. Both the WGFD and the DEQ are interested in monitoring the sediment in the Shoshone River. Future survey efforts are planned to be conducted to monitor sediment levels above the dam.

Methodology

The fieldwork for this survey was conducted on November 28th-30th, 2017 by WGFD and DEQ personnel. Darby A. Schock, PLS was party chief with assistance from Sol Brich and Jeremy Zumberge.

Land Based Equipment Procedures

GPS RTK equipment was used in this survey. This equipment included two Trimble R8s GPS antennas, a Trimble TDL 450H radio transmitter, and a Trimble TSC3 data collector. The bathymetric portion of the survey included the above Trimble equipment along with a Sonarmite depth sounder.

Standard GPS RTK methods were used in determining the locations. Procedures for the standard method include:

- A local site for a survey control point was selected and a monument was set.
- One of the Trimble R8s GPS antennas was configured as a "base station" unit and was placed over the initial survey control point using a set of tripod legs and a tribrach. The GPS antenna was positioned so as to be plumb and level, in a stable position over the survey control point.
- The second Trimble R8s GPS antenna was configured in "rover" unit and placed on a 2 meter collapsible rod with the TSC3 data collector attached.
- Additional survey control points were selected based on proximity to the river reach in question.
- The additional survey control points were monumented and observed over a continuous 3 minute (180 epochs) time period.
- A check shot was taken at the nearest secondary control point location during subsequent field days.
- Spatial point location data was collected with the rover unit by positioning the fully extended two meter rod over the point in question and collecting GPS positional. The rover unit was held steady in a plumb and level position while collecting data. At the completion of the data collection, the point data is stored in the TSC3 data collector along with the appropriate survey code.

Additionally the "base station" GPS antenna was set to collect satellite positional data at five second intervals. This data was submitted to the NGS OPUS service as a means of an additional check on the base station's positional accuracy.

Bathymetric Equipment Procedures

In addition to the procedures outlined above, the following methods were used when collecting bathymetric data:

- The "base station" and initial "rover" setup are the same and include a check shot at the nearest secondary control point location.
- The "rover" is then moved to an integrated rod that includes the depth sounder. The length of the rover rod can vary and the rod height is recorded as needed.
- The integrated rod can be positioned as needed via a specialized bracket on the water craft.

- The integrated rod is positioned as near to vertical as possible and held in place by the specialized bracket.
- The TSC3 data collector is placed into a “continuous topo” mode and can be set to positional measurements at specified distance and, or time intervals.
- Bar checks are performed as needed throughout the bathymetric survey to verify the depth sounding equipment is working properly.

Post Processing Procedures

Post processing procedures consisted of adjusting the base station position to conform to the NGS OPUS solution report, which also confirmed GPS precision. Checks of the GNSS point data and depth sounder data were performed with the following software packages: Trimble Business Center v3.70; AutoCAD Civil3D 2017; and ArcMap 10.3.1. See the Results and Conclusions sections for further information.

Results

Datum Parameters:

Horizontal: NAD83(2011 - CONUS)

Vertical: NAVD88(GEIOD12B - CONUS)

Projection: State Plane based on SP-Wyoming West Central Zone

GNSS Survey Control Network

The initial GNSS survey control network was established at on-site locations convenient to the project reach. All locations are based on the NGS OPUS solution report derived from the initial day's data at CP 1.

Table 1 – GNSS Survey Control Network Coordinates

Point	Northing	Easting	Ortho Ht	Code	Lat	Long	Ellip Ht
1	1520540.970	1926667.872	4535.983	CP	44.67229	-108.91081	4493.616
2	1520444.649	1925566.060	4474.895	CP	44.67202	-108.91504	4432.574
3	1520023.988	1926914.645	4526.523	CP	44.67088	-108.90986	4484.156
4	1516622.742	1922238.468	4588.308	CP	44.66152	-108.92780	4546.204
5	1516523.369	1922261.263	4519.311	CP	44.66125	-108.92771	4477.208

Table 2 – GNSS Survey Control Network Vectors

From Point ID	To Point ID	PDOP	HDOP	VDOP	RMS (usft)	H. Precision (95%)	V. Precision (95%)
1	2	1.42	0.78	1.19	0.009	0.048	0.059
1	3	1.28	0.72	1.05	0.010	0.049	0.056
1	4	1.52	0.81	1.28	0.020	0.065	0.082
1	5	2.08	1.13	1.75	0.015	0.080	0.099

Table 3 - Daily Check Shot

The daily check-in was taken at CP 3. The table below shows the difference between the initial recorded position of CP 3 and the daily check shot location.

Date	Δ Horizontal	Δ Vertical
2017 November 29	0.021'	0.024'
2017 November 30	0.031'	-0.014'

Table 4 - Average Daily Positional Precision

The table below shows the daily positional precision level for all GPS vectors (averaged) at the 95% confidence level as well as the averaged daily RMS.

Date	Horizontal Precision (95%)	Vertical Precision (95%)	RMS (usft)
11/28/2017	0.094	0.111	0.013
11/29/2017	0.064	0.080	0.010
11/30/2017	0.101	0.121	0.012

Conclusions

All systems (GNSS and depth sounder) were operating well within acceptable parameters of positional tolerance necessary to establish a reliable data set. The Sonarmite depth sounder does not give accurate readings when the measured depth is less than 1' +/-. In those cases where the water depth was shallower than could be measured, no elevation information is listed in the data files for the relevant point location.

Point data for the bathymetric and overbank topographic surveys is included with this report as .csv files. Also included is a .csv file showing the GNSS vector quality information and the OPUS Solution Report for CP 1.

Table 5 – Data Files

File	Description
Nov_2017_Land_Data.csv	Control & overbank data collected November 2017
Nov_2017_Bathy_Data.csv	Bathymetric data collected November 2017
Nov_2017_GNSS_Vector_Data.csv	Vector QC information for data collected November 2017
OPUS solution _ 1 TR8659497066470.pdf	OPUS Solution Report for CP 1