Standard Operating Procedures for RDI Workhorse Rio Grande ADCP

General practices when handling equipment (taken directly from the Riogrande setup safety guide):

- <u>*Never set the transducer on a hard or rough surface*</u>
- Avoid prolonged sunlight exposure to transducers (cover if necessary)
- *Do not lift or support* a Rio Grande *by the external I/O cable*
- *Do not connect* or disconnect the I/O cable *with power applied*
- Avoid using ferro-magnetic materials in the mounting fixtures or near the Rio Grande
- For more information see Riogrande setup card pg. 3

Table of Contents:

1. **Plan**
    A. Determine GPS accuracy/options (see Trimble DSM 232 GPS users guide pgs 10-19)
    B. Plan route (if applicable)
        1. We started by going along the edge of the reservoir to get an outline and then filling in the middle by going back and forth, trying to keep the spacing even between our transects. We used strava to look at our route.
        2. Consider how large your reservoir is and how much bathymetric detail you need.
        3. We found that transects spaced ~25 feet apart collected enough data for accurate interpolation in ArcGIS for a reservoir ~0.1 km^2.
    C. Pick a day in which the lake/reservoir is close to full pond and very little stratification has occurred - you want the lake to be mixed!
        1. Stratification interferes with the speed of sound making depth measurements less accurate
    D. Packing list:
        1. Riverboat
        2. ADCP case with ADCP, GPS, GPS box, cords, etc
        3. ADCP toolbox with additional cords, rope, field notebook, etc
        4. Walkie Talkies
        5. Two 12V batteries for running the trolling motor (if needed)
        6. Two 12V batteries (for ADCP/GPS/computer)
        7. Computer inverter cord for backup charging
        8. First Aid kit
        9. Skiff powered by trolling motor + Life jackets
        10. Buoys for marking (optional)
        11. Smartphone or similar device with Strava app (optional)

    Note: It can be helpful to use Strava, or some other GPS tracking app, to visualize the route of the boat in real time

2. **Mounting the ADCP & GPS to Riverboat**
    A. **Attach ADCP** to Riverboat
        1. Find **mounting hardware** bag (includes six ¼ -20 wing nuts, two bolts) in the white hatch on the Riverboat
        2. **Flip Riverboat upside down** and prop it up on two surfaces for easier access
            a) We place the Riverboat on top of the case and toolbox in order to elevate it a bit from the ground
            b) Alternatively, the ADCP can be placed face down onto a life jacket (or similar soft surface to avoid scratching the lenses), and the river boat can be placed over top of the ADCP for securing following steps 5 and 6 below.
        3. Remove yellow cap from ADCP

4. **Place the ADCP** red side down (transducer side-up) into the hole located in the center of the Riverboat
    a) Note: do not set the transducer outside in prolonged sunlight exposure
5. <u>*Making sure that the ADCP is oriented such that the "3" is facing the bow*</u> of the Riverboat, align the bolts of the ADCP with the holes on the black framework of the Riverboat. *See Fig. below*
6. **Secure ADCP** to Riverboat with four ¼-20 wing nuts from the hardware bag (this is where propping the boat up may come in handy). *See Fig. below*

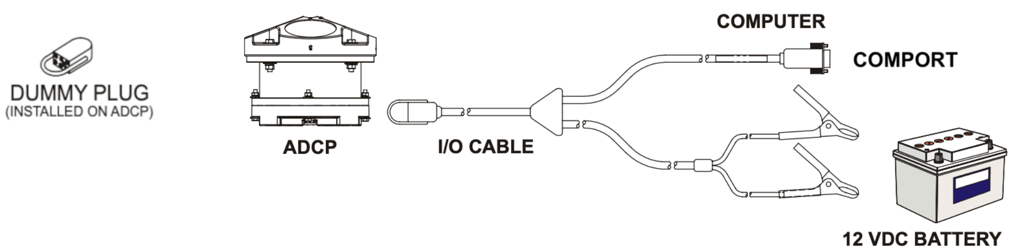
Left: Upside-down Riverboat propped up on two carts. Blue arrows indicate ADCP bolt placement while yellow arrow indicates orientation of ADCP.

Right: View of top of Riverboat from below. Shows bolt alignment and wingnut application.

B. **Attach GPS** to Riverboat
   1. <u>Carefully</u> flip the boat over, <u>keeping it propped up so that it is not resting on the transducer faces</u>
   2. You will be securing the GPS to the port side of the Riverboat, maneuvering the silver metal bar to align with the holes on the GPS as shown below
      a) Necessary bolts (x2) and wing nuts (x2) are located in the mounting hardware bag
      b) You will need to connect the hole on the metal bar to the GPS first (see purple circle on image below) before connecting to the hole on the black frame (see green circle on image below)

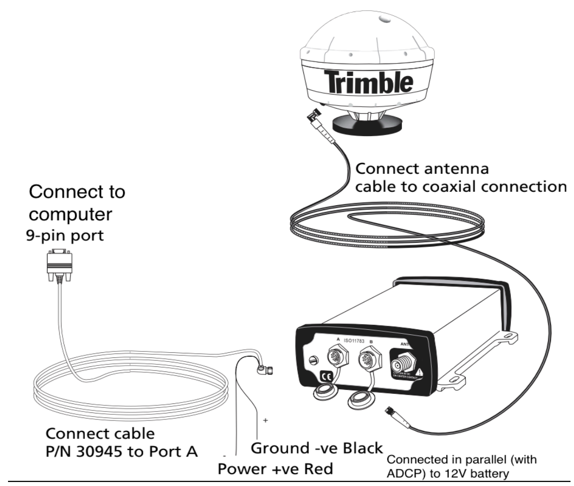
Note: Ideally, the GPS would be mounted directly above the ADCP but this may not be possible for all Riverboat models, such as ours.

C. Connecting **ADCP cords**
   1. Remove the dummy plug on the ADCP.
   2. Plug I/O cable into ADCP end-cap connector.
      a. Be sure to line it up correctly with the ADCP and take your time wiggling it into place; you want a good seal since the connection will be close to the water.
   3. Attach I/O cable to the 12V battery and then the COMport station on either the USB adaptor or directly into the computer.
   4. <u>Note: some field laptops have 9pin RS232 ports, allowing users to connect the GPS and ADCP directly to the computer.</u>
      a. We directly connected the GPS and ADCP to the computer through two RS232 ports, thus bypassing the adapter due to issues with connection.



Note: attaching the ADCP and GPS to the battery will automatically turn them on.

D. Connecting **GPS cords**
   1. Follow the setup illustration below.

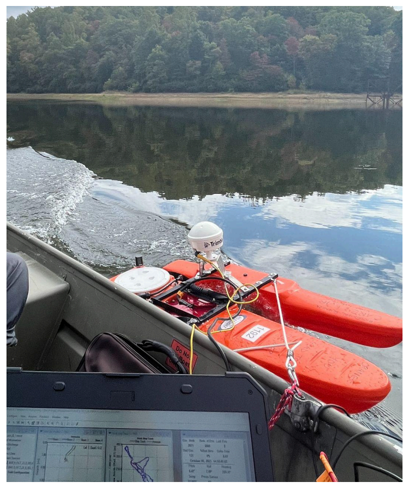


Original image sourced from DSM; modified by Ryan Keverline.

Note: GPS and ADCP can be connected in parallel to the same power source, this power source can be a 12V DC converter or a 12V battery.

2. If the GPS and ADCP are disconnected from the battery during data collection, make sure to reconnect them to the battery, save your current file, and follow the setup procedure below in WinRiver II.
    a) Open WinRiver II > Acquire > Configuration Wizard
    b) GPS and ADCP should reconnect automatically after opening the configuration wizard, but if not follow steps D-I. in section III.
3. Re-callibrate the ADCP (section IV.) before resuming data collection (section V.)

E. **Connecting to the boat**
1. Place Riverboat in the water
2. Connect carabiner to side of towboat using rope so that the riverboat is snugly tethered to the side *(see figure below)*



3. Optional: attach third tether cord as shown below to carabiner and screw onto ADCP bolt for additional security (*see figure below*)

III. Connecting the ADCP & GPS to WinRiver II

A. See WinRiver II Quick Start Guide pgs 5-13 for more information
B. Turn on the computer, close all non-related tabs/programs.
C. File > New Measurement

      1. Save site and rating information for later; skip to configuration dialogue.

   D. Configuration dialogue will automatically try to find ADCP; if this does not work find ADCP manually with *baud rate 38400* by clicking NO and selecting comport.
      1. May have to try several different comports.
      2. If unable to connect see section below on additional ways to connect to WinRiver II.
      3. BBtalk can be opened to confirm the baud rate as well.
         Note: ADCP is successfully connected if light turns green
   E. In Configuration Dialogue select GPS to connect
      1. Note: you may have to try several different comports
      2. Be sure to select *baud rate 19200*
         Note: Instructions on navigating the screen on the GPS box are located in DSM users guide pgs 30-40, 118, although this is not necessary for regular deployment.
   F. Set the transducer depth as 0.1m.
      1. Note: if this step is skipped it can be redone during post processing.
   G. Set the magnetic variation.
      1. This website can be used to calculate magnetic variation: https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml
      2. Note: if this step is skipped it can be redone during post processing.
   H. Skip over commands preview page; check over summary page to ensure all information is correct.
   I. Click finish.

IV. ADCP Calibration (WinRiver II Quick Start Guide pgs 23-24)

   A. Set ADCP clock
      1. Acquire > Set ADCP Clock; set to PC time.
   B. Test ADCP
      1. Acquire > Execute ADCP Test
      2. Run until sensor data is displayed at the bottom of the screen; hit the spacebar to finish the test.
   C. Calibrate Compass
      1. Acquire > Execute Compass Calibration
      2. Slowly rotate ADCP, or spin boat, at about a rate of 5 degrees per second; be careful to *keep the ADCP level throughout*
         a) This can be done either from the side of the boat, on the dock, or when boating; if while boating be sure to use trolling motor and go very slowly in a circle.
      3. After the test, scroll up to check that the overall error is less than 2 degrees.
         a) If it is more than 2 degrees, you should redo the calibration.
         b) Repeat steps 1-2 from above to redo the calibration.
   D. Measure water temperature & salinity (if applicable), record, and compare to ADCP reported measurements.

1. **We recommend taking a CTD cast in case it is needed for temperature corrections.**

V. Data Collection

A. View > Acquire Data
    1. Small box will pop up in the bottom right corner that says “Not Recording,” “Not Pinging” and “GPS Status No Data.”
B. Acquire > Start Pinging (**F4**)
    1. “Programming instrument” will briefly pop up.
    2. ADCP status will change to “Pinging” and noise will sound from ADCP.
C. Acquire > Start transect (**F5**)
    1. Input the distance from shore and click left or right bank.
    2. ADCP will start recording data and will display “Raw Data Recording.”

    Note: For bathymetric purposes it is advised to collect all of the data in one continuous transect since this does not impact processing and allows for more data to be collected. If desired, separate transects may also be conducted and the data combined.
D. Sampling Over Multiple Days:
    1. Be sure to choose days with similar weather conditions and ideally close together.
    2. Note the water level each day and make corresponding adjustments to collected data if needed. This can be done in R by adding the difference to the new set of data.
    3. Be sure to collect CTD for each sampling day if the water column is stratified while sampling so that corrections can be applied.
E. Collecting Manual Points in Shallow, Macrophyte-dense, or Inaccessible Regions:
    1. Additional Equipment:
        a) Meter stick
        b) Weighted rope, Secchi disk, or depth finder
        c) Waders (optional)
        d) Field notebook
        e) Handheld GPS device
    2. Collecting Data
        a) After initial passes with ADCP, identify missing regions of data to cover
        b) Take manual depth measurements using a handheld depth finder, a weighted rope, or a meter stick. Alternatively, we used a Secchi disc attached to a measuring rope. These regions may be reached using waders or by canoe/kayak if there are concerns of sediment disturbance.
        c) Record depths and GPS coordinates.
        d) Cross-reference coordinates with ADCP measurements for those locations.

VI. **Stop Data Collection and Save Data from WinRiver II**

A. Acquire - End Transect (**F5**)
   1. ADCP will stop recording data.
B. Acquire - Stop Pinging (**F4**)
   1. ADCP will stop making noise.
C. File - Save Measurement
   1. Name the file with the format STATIONNAME_DAYMONTHYEAR (Ex: FCR_6JUL23)
D. **Before closing anything** check that the data files are saved to the laptop; they should be saved as a measurement file (mmt.), and as text files (GPS.TXT) and .PD0 files for each transect.
   1. Rename the folder that contains the files with the format STATIONNAME_DAYMONTHYEAR (Ex: FCR_6JUL23)
E. File - Close Measurement
F. Close out of Winriver II

VII. **Clean Up the ADCP**

A. Follow sections II and III in reverse to disconnect and store the ADCP.
B. Once back in the lab, take the ADCP out to let it dry overnight. Remove the yellow cap, leave the case open, and lightly cover the transducers overnight before replacing the cap and putting the sensor away.

VIII. **Troubleshooting: Additional Ways to Connect the ADCP & GPS to WinRiver II**

A. Configure > Peripherals
B. Read Raw ADCP Data
   1. Can click on Port: ADCP Serial Port and select different comports with the ADCP at baud rate 38400. Click on Test Port to see if correct comport was selected; will receive a break message if correct
   2. Can right click on Instrument: ADCP Instrument and select Auto Detect to automatically find ADCP
C. Add > GPS
   1. Read NMEA GPS Data 1
      a) Select (double click) Port: GPS Serial Port 1 and select a comport with *baud rate 19200*
      b) Select Test Port to test if correct comport was selected.
      c) Repeat until the correct COMport is selected

IX. **How to Export Data from WinRiver II into a R compatible format**

A. Have **WinRiver II** open with your desired measurement (.mmt) file
   1. Find files in the measurement folder.
   2. Open measurement

B. Before reprocessing data check that the transducer depth and magnetic variation are correctly set.
    1. Acquire - Configuration Wizard
        a. Hit cancel on windows that pop up asking about ADCP and GPS connection
    2. Set the transducer depth as 0.1m.
        a. Set the magnetic variation. This website can be used to calculate magnetic variation: https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml
    3. Reprocess the data following step D.
C. To create a new ASCII output template file:
    1. Select **Configure>ASCII Output>Classic ASCII Output**
    2. Select **Output Backscatter Data**, then click **Finish**
D. To load all of the data into an ASCII text file, it must be reprocessed first
    1. Make sure all transects are selected in the leftmost box
    2. Select **Playback>Reprocess Checked Transects** and wait until all transects have been processed
    3. Can also right click on each transect and click **Reprocess Transect**

   Note: for more information on ASCII files see the following section on "Exporting Data as a ASCII File"
E. Open **Velocity Mapping Toolbox**, see "How to install Velocity Mapping Toolbox"
    1. Import the Classic ASCII Output files into VMT by selecting **File>Open>TDRI ASCII Files**
    2. Select all the transect data ending in ###_ASC.TXT that you would like processed into split-beam bathymetry
    3. After all of the data has loaded into VMT, select **File>Export>Export Multibeam Bathymetry**. You can name the file whatever you like and place it in whatever working directory you would like to use.
    4. Now you have a .csv file that you can use in R very easily.

How to install Velocity Mapping Toolbox:

A. Install Matlab Runtime:
    a. Here are instructions to install Matlab Runtime: https://www.mathworks.com/help/compiler/install-the-matlab-runtime.html
    b. Visit https://www.mathworks.com/products/compiler/matlab-runtime.html to find version 9.0 (R2015b) of Matlab Runtime. You'll probably want to install the 64-bit version
B. Install Velocity Mapping Toolbox (4.09):
    a. Go to https://hydroacoustics.usgs.gov/movingboat/VMT/VMT.shtml and click on "4.09" under "Downloading the Software".
    b. Extract the compressed folder when it's finished downloading, and then run VMT.exe.

X. Applying Temperature Corrections

If the water column was stratified when collecting bathymetry data, you may need to apply temperature corrections. See the steps below for how to do that.

A. Use QRev (see below for how to install) to check if temperature corrections are needed.
    1. Add in the data you are checking. Click the folder ( ) then add the .mmt files you want.
    2. Click Temp/Sal tab > Data > on the “Temperature Source” column click on “Internal (ADCP) > click on “User (C)” and input the bottom depth temperature of the reservoir OR the average of the stratified water column in degrees celcius. *Note: the speed of sound source will change once the temperature is changed.*
    3. To determine if the bathymetry data changed significantly from changing the average temperature, go to Adv. Graph tab > click “Beam Depths” > click plot. Select the transect with the deepest depth to view before and after differences from changing the average temperature.

B. If temperature corrections are needed:
    1. Find CTD data from around when sampling was done
        a. CTD data was taken from this repository: https://portal.edirepository.org/nis/mapbrowse?packageid=edi.200.14
    2. Filter data to extract only that date. Only temperature and depth data is needed.
    3. Use **Equation 4 of the ADCP Coordinate Transformation** handbook to calculate the speed of sound from the depth and temperature.

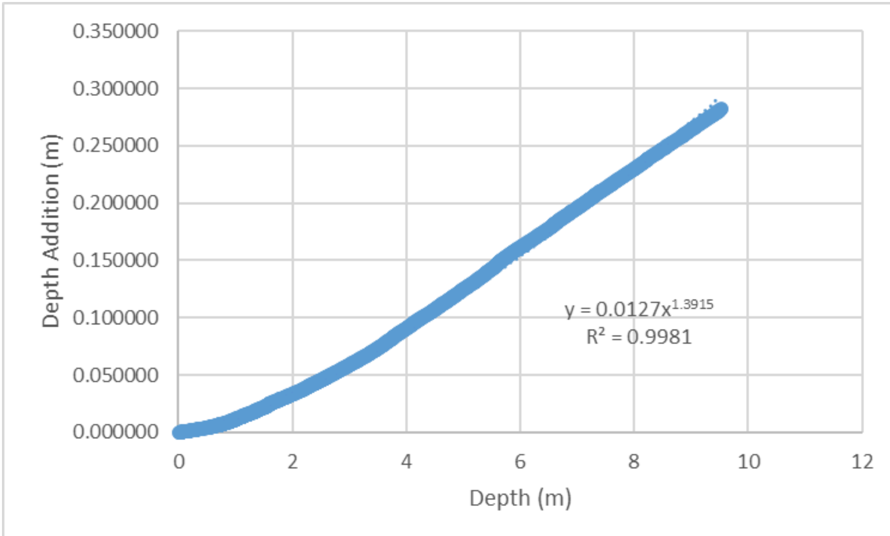
Where C is the real sound speed at the transducer, and C_A is the speed of sound used by the ADCP. You can calculate the speed of sound in m/s, c, using the equation (Urick, 1983):

$$c = 1449.2 + 4.6\boldsymbol{T} - 0.055\boldsymbol{T}^2 + 0.00029\boldsymbol{T}^3 + (1.34 - 0.01\boldsymbol{T})(\boldsymbol{S} - 35) + 0.016\boldsymbol{D}$$

Equation 4

Where: D = Depth, in meters
S = Salinity, in parts per thousand
T = Temperature, in °C

    4. Calculate the rolling average for the speed of sound since the ADCP sends pings through the water column.
    5. Calculate the difference between the average speed of sound used by the ADCP and the rolling average.
        a. Speed of sound used by the ADCP can be found in QRev by uploading the data - Temp/Sal - Data
        b. Speed of sound used by each transect should be displayed in a table; to change the speed of sound:
            i. Click on Temperature Source
            ii. Change to “User:”
            iii. Input the average temperature from the CTD data or the minimum temperature to see the biggest difference in speed of sound.
    6. Multiply the difference by the depth to find the depth correction.
    7. Graph the depth vs. depth correction and plot a power law curve.



C. Use the power law equation to apply corrections in Excel
    1. Calculate correction depth using bathy depths.
    2. Subtract the correction depth from the bathy depths to find the final depth.

Note: the ADCP over-estimates the depth since it uses the temperature at the surface for the speed of sound of the water column which is a larger value than the actual speed of sound at the bottom of the lake/reservoir.

QRev was developed by the USGS to compute discharge measurements from ADCP data. It is another useful software to use to visualize transects and provides interesting calculations. Below is how to install QRev:

A. Follow the link to the USGS homepage on QRev: https://hydroacoustics.usgs.gov/movingboat/QRev.shtml
B. Scroll down to find all versions of the software. QRev can be installed by clicking on the version number in the table.
C. Unzip the file and click on the application to begin running QRev.
D. Note: QRev works best when clicking on the application within the download folder, rather than trying to search within your computer and opening it that way.

XI. Finding Outline of Waterbody using Google Earth Pro

You'll need:

- Google Earth Pro
- Dates of when waterbody is at full-pond

A. This is written for Google Earth Pro v7.3.6.9345 as of October 10, 2023 In Google Earth Pro:
B. Zoom to your reservoir using the search bar on the left

C. Open the timeline tool () and select a date where the waterbody imagery most closely matches its full-pond depth. Use winter imagery, if available, to avoid any errors caused by foliage.
D. Orient the reservoir so that it maximizes the area on your screen:
    - **Rotate View:** Use the CTRL+Left or Right Arrow Keys
    - **Zoom View:** Mouse Wheel
    - **Reset Tilt:** U on keyboard
    - **Drag View:** Click and drag or Arrow Keys
E. Select the polygon tool ()in the toolbar and under the “Style, Color” tab, change the Area opacity to 0%; this will make it easier to see the boundaries you are tracing.
F. Do not select any other options in the polygon dialog box and drag it out of the way as much as possible, but not off the screen so you can revisit it later.
G. Using the polygon cursor in the map viewer, click individual points around the waterbody to trace its shape. It may take a few attempts to get the hang of it.
    1. To trace at a finer resolution, zoom in and reset the tilt, then move while tracing
    2. Avoid holding and dragging the mouse. This will cause many points to be created at once and will make it hard to go back and edit the outline.
    3. The point colored blue represents the current point. If you click back on a point to edit its position, make sure to click the last point in your tracing before you continue or it will connect your edited point to your newest point.
    4. If there is a foliage shadow obstructing the satellite view of the reservoir, try to compensate for the foliage (i.e. treetops) by tracing slightly inside of their obstruction.
H. After you’ve completed tracing the polygon, click OK on the New Polygon dialog box to complete the action.
I. To export the polygon as a .kmz file, in the Places tab on the left-hand side of the menu, right click the polygon. Select “Save Place As”. Save the file to your desired location.

XII. Creating a Bathymetric TIN in ArcGIS

For this section, you should have the following:

- Access to ArcGIS
- Full-pond elevation of reservoir
- Actual depth on day of ADCP usage (i.e. the full-pond elevation of FCR is 511.45m and the average depth of the three days of data collection was -0.08m)

1. Open ArcGIS. Select the “Map” icon to create a new map. Name and select a location for the map on your computer.
2. Use Add Data to import the reservoir outline
3. Import the XYZ point data from the reservoir. If the file is a .csv, you can directly drag it into the Contents pane. If the file is a “.xlsx”, then use the “Excel to Table” tool.
4. Create a copy of the table by right clicking it in the Contents pane and selecting Data > Export Table. You can remove the original table from the Contents pane now.
5. Right click the new table and create a new field named “elevation”. Save the new field and close the Fields pane. In the Table view, right click the new field and select “Calculate Field”. If the depth is represented by negative numbers, use the following equation:
   $$elevation = full\,pond\,elevation \; - \; actual\,depth \; + \; [depth]$$
   where the full pond elevation and the actual depth are constants and the $[depth]$ is the depth column in the XYZ table.
6. Open the geoprocessing pane and search for the “XY Table to Point” tool. Use the following settings:
   - **X points:** Easting (Longitude)
   - **Y points:** Northing (Latitude)
   - **Z points:** leave blank
   - **Coordinate System:** Use whatever coordinate system you collected the points in. The ADCP collects points in WGS 1984. Most smartphone mapping applications use WGS 1984, but it’s always good to double check.
7. Reproject the new Table into your map’s coordinate system if needed.
8. Open the Attribute Table and create a new field called “elevation”. Select “Calculate Field” and set it to the full-pond elevation. Make sure to save the new field.
9. Use the Create TIN tool with the following settings:
   - **Coordinate System:** WGS84 UTM Zone [your UTM zone]
   - **Input Features:**
     - Reservoir outline
       - **Height:** elevation
       - **Type:** Hard Clip
     - XY points
       - **Height:** elevation
       - **Type:** Mass Points
10. Use the Delineate TIN Data Area tool with the following settings to correct any perimeter errors:
    - **Edge Length:** 20

- **Method:** Perimeter Edges

11. Use the Smooth Bathymetric TIN to correct any internal area errors:
    - **Depth Direction:** Positive Up
    - 15 **Smoothing Iterations** (may be more or less depending on the size of the reservoir)
    - Additionally smoothing can be applied on this TIN to remove bumps from the Epilimnetic Mixer (50 smoothing iterations was used for the published TIN)

XIII. Creating Raster from TIN

Use the TIN to Raster tool in the Geoprocessing pane:

- **Input TIN:** TIN file
- **Output Data Type:** Floating Point
- **Method:** Linear
- **Sampling Distance:** Observations

XIV. Creating Outline Polygon from TIN

Use the TIN Domain Tool in the Geoprocessing pane.

XV. Creating Contour Lines in ArcGIS Pro

Use the Surface Contour tool in the Geoprocessing pane:

- **Input Surface:** TIN file
- **Contour Interval:** the distance between each contour starting at the topmost contour
- **Base Contour:** the elevation of the reservoir, also the highest number of the TIN

XVI. Calculating Surface Area and Volume

Use the Surface Volume tool in the Geoprocessing pane:

- Use **Below the Plane**
- **Plane Height:** the elevation of the reservoir, also the highest number of the TIN
- After calculating the surface and volume at the highest elevation in the TIN, go in 0.5m intervals rerunning the calculation until you reach the max depth and a volume of 0
    - NOTE that the surface area is in m^2 and volume is in m^3. There are also two different surface area calculations in the output, for EDI publication you want the 2D surface area
    - Additionally for EDI you should convert the volume from m^3 to liters
    - In EDI you will publish the surface area and volume at each layer, and additionally the volume between layers

Resources

Carey, C.C., A.S. Lewis, and A. Breef-Pilz. 2024. Time series of high-frequency profiles of depth, temperature, dissolved oxygen, conductivity, specific conductance, chlorophyll a, turbidity, pH, oxidation-reduction potential, photosynthetically active radiation, colored dissolved organic matter, phycocyanin, phycoerythrin, and descent rate for Beaverdam Reservoir, Carvins Cove Reservoir, Falling Creek Reservoir, Gatewood Reservoir, and Spring Hollow Reservoir in southwestern Virginia, USA 2013-2023 ver 14. Environmental Data Initiative. https://doi.org/10.6073/pasta/b406e9a104dafb1b91e1ad85a19384db.

Environmental Data Initiative (EDI). CTD data from Freshwater Research. *https://portal.edirepository.org/nis/mapbrowse?packageid=edi.200.14*

Mueller, D.S. 2013. *QRev Technical Memorandum*. U.S. Geological Survey. *https://hydroacoustics.usgs.gov/software/QRev_Tech.pdf*

Mueller, D.S. 2013. *QRev User's Guide*. U.S. Geological Survey. *https://hydroacoustics.usgs.gov/software/QRev_Users.pdf*

National Centers for Environmental Information (NCEI), NOAA. Magnetic Declination Calculator. *https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml*

Teledyne RD Instruments. *Coordinate Transformation: A discussion of the transformation of velocity data between the beam, instrument, ship, and earth coordinate systems*. *https://www.teledynemarine.com/en-us/support/SiteAssets/RDI/Manuals%20and%20Guides/General%20Interest/Coordinate_Transformation.pdf*

Teledyne RD Instruments. *WinRiver User Guide: International Version*. *https://www.comm-tec.com/Prods/mfgs/RDI/Software/Manuals/WinRiver-Manual/WinRiver%20User%20Guide%20International%20Version.pdf*

Teledyne RD Instruments. 2007. *Rio Grande ADCP User's Guide*. P/N 957-6167-00. Teledyne RD Instruments, Poway, California, USA. *https://www.teledynemarine.com*

Trimble Navigation Limited. 2006. *DSM 232 GPS Receiver User Guide*, Version 2.00, Revision A. Trimble Navigation Limited, Dayton, Ohio, USA. *https://www.trimble.com*

U.S. Geological Survey (USGS). QRev: Discharge computation software. *https://hydroacoustics.usgs.gov/movingboat/QRev.shtml*

U.S. Geological Survey (USGS). VMT: Velocity Mapping Toolbox. *https://hydroacoustics.usgs.gov/movingboat/VMT/VMT.shtml*

Appendix A: Exporting Data as an ASCII file

We no longer follow these steps to export data since VMT extracts this information from a classic ASCII output file as shown in section IX. However, if you are unable to get VMT to work, this procedure will extract the necessary bathymetry data from the raw ADCP files.

A. Have WinRiver II open with your desired measurement (.mmt) file(s).
    1. Find files in the measurement folder
B. To create a new ASCII output template file:
    1. Select **Configure>ASCII Output>Generic ASCII Output**
    2. Select **Create New ASCII Output Template** and select **Next**
    3. Click the **[+]** dropdown next to **Processed Ensemble Data** and highlight what data you would like outputted. Press the right arrow between the left and right columns to select it as an output. Click **Next** when you're done.
        a. For creating a bathymetry map select Beams Average Depth (m), Ensemble Number, GGA Latitude, and GGA Longitude
    4. The **Output Format Selection** page can be left unmodified unless you know exactly how you want the data formatted. Click **Next.**
    5. On the next page, check the box next to **To File (Output to Project Directory)** and click **Next.**
    6. On the next screen, click **Browse** to select where you want to save the template file (.ttf)
        a. Name the file with the format STATIONNAME_DAYMONTHYEAR (Ex: FCR_6JUL23)
C. To load all of the data into an ASCII text file, it must be reprocessed first.
    1. Make sure all transects are selected in the leftmost box
    2. Select **Playback>Reprocess Checked Transects** and wait until all transects have been processed
        a. Can also right click on each transect and click **Reprocess Transect**
    3. To quickly gather all of the outputted text files, you can go to File Explorer and select them all under the format file.

Note: to better use the data in R, be sure to add a header to the columns by opening the ASCII text files and adding a header

sample_template_3.ttf	6/20/2023 11:02 AM	TrueType font file	1 KB
sample_template_3_000_ASC.TXT	6/20/2023 11:02 AM	Text Document	6 KB
sample_template_3_001_ASC.TXT	6/20/2023 11:02 AM	Text Document	4 KB
sample_template_3_002_ASC.TXT	6/20/2023 11:02 AM	Text Document	6 KB
sample_template_3_003_ASC.TXT	6/20/2023 11:02 AM	Text Document	5 KB
sample_template_3_004_ASC.TXT	6/20/2023 11:02 AM	Text Document	8 KB
sample_template_3_005_ASC.TXT	6/20/2023 11:03 AM	Text Document	7 KB
sample_template_3_006_ASC.TXT	6/20/2023 11:03 AM	Text Document	13 KB
sample_template_3_007_ASC.TXT	6/20/2023 11:03 AM	Text Document	25 KB
sample_template_3_008_ASC.TXT	6/20/2023 11:03 AM	Text Document	12 KB
sample_template_3_009_ASC.TXT	6/20/2023 11:03 AM	Text Document	41 KB

Above is an example of the file outputs from Winriver II; be sure to check that there is one file for each transect completed.