ADCP –Sontek Gauging

Overview:

Site selection is probably the most important element for ADCP gaugings. It is easy to make a good measurement, unless an irregular, high velocity, turbulent or shallow section is picked and in that case the measurements will vary dramatically.

Similar to conventional gaugings pick a site that has the most even velocities across the section that also has velocities right up to the bank edges i.e. no effective waters edges. Avoid trees and back-eddies or any site where pulsing water is greatly exaggerated. Your flow results will usually vary considerably at these sites.

Slow and smooth boat operation is critical for the collection of top quality data. This is especially true when you are measuring off a bridge and you have a very long tether, the boat becomes hard to control when there is no drogue and at higher velocities trimaran type boats tend to shoot out into the flow instead of edging out bow first. Aim for 5 minutes passes as this means there is more data to be processed and will generally give you more reliable results.

Sontek M9

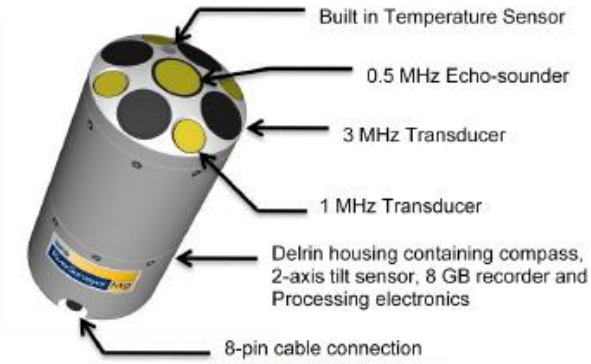


Figure 2. M9 ADP Features


Figure 7. SonTek Hydroboard with Optional GPS

Before a gauging begins there are several steps that must be taken first to ensure quality assurance.

- A beam alignment test should be completed periodically, especially after a factory repair or firmware upgrade.

- Instrument comparision should also be completed annually. Pick a stable site with a solid rating and gauge with similar ADCP's, flowtrackers, or conventional methods. If the site has no moving bed then the references (bottom track/vertical beam/GPS) need to be kept the same to avoid potential discrepancies

Field Procedures:

This section provides a brief explanation of the correct field procedures for the Sontek M9. For more detailed notes please refer to the system manuals:

Sontek M9 System Manual –
\\Hera\CouncilData\Hydrology\Hydrology Sites\General Site Information\Gaugings\ADCP Sontek\River Surveyor Software\2.5\RiverSurveyorLive\ RiverSurveyorLiveManual.pdf

1. ADCP Setup

a) Insert the battery into the PCM Bluetooth module and plug in the power/GPS cables.

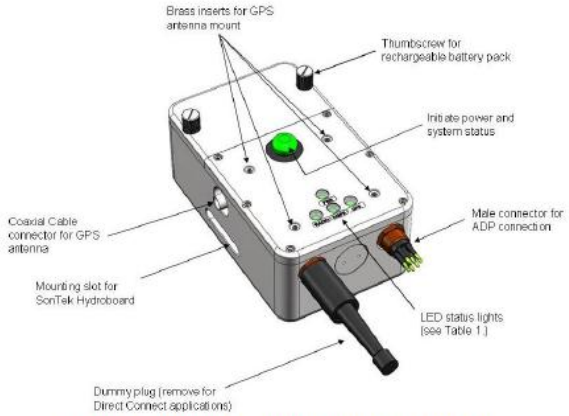


Figure 4. Power and Communications Module (PCM)

b) Mount the Sontek unit and bluetooth module into the raft and make sure everything is secure, including all carabiners.

c) There are a few communications options for the Sontek:

Direct Connect: a cabled connection between the ADCP and a PC (using a USB to Serial adapter), such as Jetboat gaugings.

Bluetooth: wireless communication between the ADCP and a PC (using supplied Parani Bluetooth dongle, 200m range) or the Motorola Q Mobile device (60m range)

d) Press the green button to turn the Sontek on. It will now try to secure comms to the phone or laptop and connect to any available satellites.

2.Software Setup

Start 'RiverSurveyor Live' from either your PC or Mobile device. If the software only finds one Sontek serial number, it will automatically connect. Otherwise you may have to select the correct serial number and com port. Please note if using the parani Bluetooth dongle from your PC, you will have to tick the 'Parani Bluetooth Connection' option box.

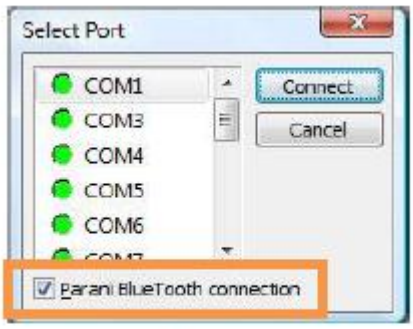


Figure 26. COM Port Selection Window

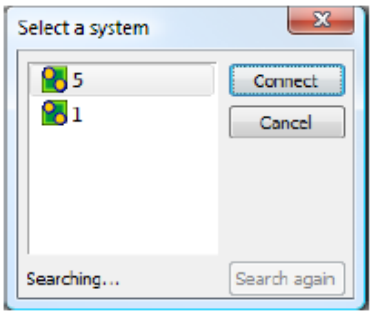


Figure 27. System Select Window

Once connected to the software, site specific information can be entered.

Option 1: Site Information

The main fields that must be entered are Site name (site code as a minimum), Party, Boat type. Please try and get spelling correct as it can be difficult to change later. Once completed, press Ok ('Done' on Mobile device).

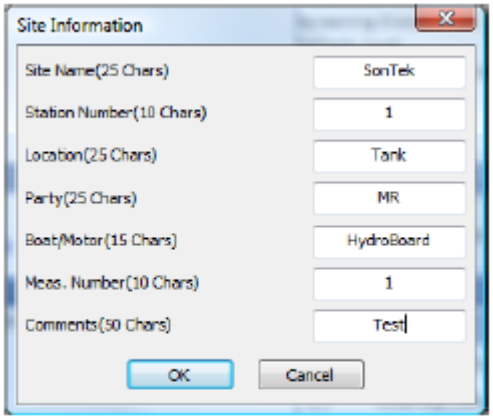


Figure 29. Site Information Menu

Option 2: System Settings

Transducer depth (m) – this is the distance that the vertical beam transducer is submerged under water. This needs to be accurately measured using a tape measure. If the unit needs to be lowered due to water turbulence and cavitation, the transducer depth will need to be re-measured.

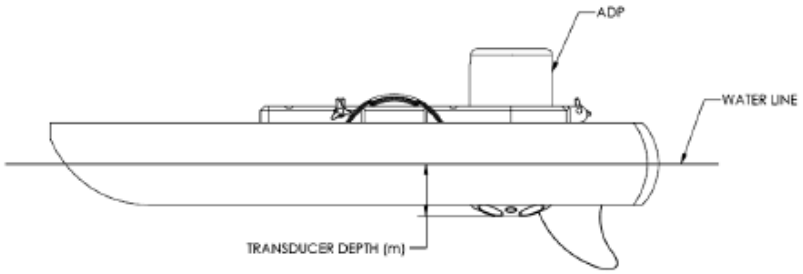


Figure 31. Explanation of Transducer Depth Measurement

When using the flutterboard, insert the M9 unit so that the bottom of the Sontek sticker is level with the top of the board. This transducer depth is 0.05m.

Screening distance (m) – this is the distance below the vertical beam transducer that you want to start collecting data from; start collecting data below a certain depth. The only time you would need to change this value is to avoid flow disturbance from the wake of a boat-mounted gauging.

Salinity (ppt) – for freshwater gaugings this doesn't need to be changed, the default value is 0 ppt. However, when working near estuaries or tidal environments, salinity and temperature reading should be recorded where possible; this would help represent the local water conditions.

Magnetic Declination (deg) – magnetic declination varies geographically and spatially. Therefore, site specific declinations must be entered for each gauging location. A generic value of 21.5 may be entered while in the field, but the correct value must be entered in post-processing. There is a list in 'General Site Info' with magnetic declinations for each site, or try www.magnetic-declination.com, or 'Declination' app for the iPhone.

Once completed, press Ok ('Done' on Mobile device).

Option 3: Track and Depth Reference

i. Track Reference

- Bottom Track – this option is highly accurate, providing there is no moving bed. If a moving bed is present, using bottom track as a track reference will bias discharge calculations.
- GGA-GPS – New Zealand doesn't have coverage from any ground based augmentation satellite systems. So unless you lock onto a local 'Real-Time Kinematic' (RTK) please use VTG.
- VTG-GPS – this option has sub meter accuracy and is the default GPS option.

ii. Depth Reference

- Vertical Beam (primary) – highly accurate echo sounder used to determine water depth. The vertical beam will give a more precise depth reference as it is directly underneath the unit, has a wider lower frequency beam and may also compare more favourably with historic data.
- Bottom-Track (secondary) – uses data from the four angled beams to determine the depth; an average depth from each beam. Bottom track can be used when compiling a measurement when vertical beam misses data or a relevant explanation is provided.

The selection of the two above references is purely site specific, although it is intended to use the vertical beam as the primary.

Bottom track will give a smoother depth than the vertical beam. To best represent the historic gaugings it was thought that we should use the vertical beam to represent the depth. This may be useful if gaugings are done at different cross sections; they may be difficult to over plot. It would make it easier if more sites had slacklines or marked areas where gaugings are consistently carried out.

The Sontek M9 has a 25cm depth limit. However, rather than push the ADCP to its limits and collect no or limited edge data, try and collect good accurate data and estimate a larger edge distance.

iii. Coordinate System

- ENU (primary) – the traditional East, North, and Up coordinate system.
  XYZ is also available as an option, but should only be used for specialised applications.

- SmartPulseHD – enabled, never disable this feature.

Once completed, press Ok ('Done' on Mobile device).

Option 4: Compass Calibration

A Compass Calibration must be completed for every gauging and recalibrated at each new site. It is used to compensate for magnetic interference in the vicinity of the ADCP. The magnetic north readings are used to reference 'True North'. Improved magnetic north readings reduce the need to make minor heading corrections in order to properly align the compass to true north.

To perform a calibration, click start, and rotate the unit through two complete circles while varying the pitch and roll. It needs to be at least 1min, but not more than 2 minutes in duration. Click stop once completed and the calibration results will be displayed in the window.

If the calibration fails, perform another calibration.

Try to perform the compass calibration as close to the cross section as possible, this will take into effect any local variations such as bridges, metal structures and geology.

If the ADCP is mounted from a boat, then the entire boat must perform the calibration with the ADCP in place.

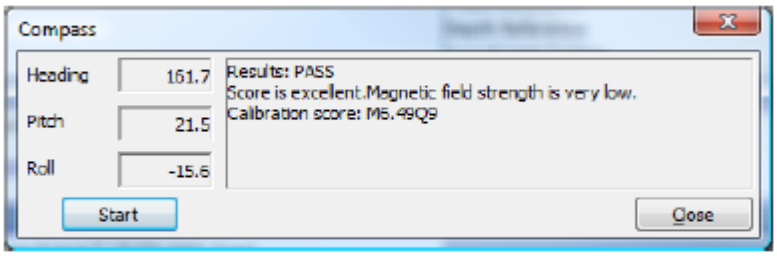


Figure 35. Calibration Score Window

Once completed, press Close ('Done' on Mobile device).

Option 5: Recorder

This is where gaugings can be downloaded or formatted from the Sontek internal storage. Once back in the office, the user should download all the gauging files and then format the internal storage.

Option 6: Loop Method

Select 'LC & MB' (Loop Correction & Moving Boat), so that you can perform a loop test.

Before every gauging, a loop test must be completed. This is to determine if a moving bed is present and helps in post-processing and quality assurance; selecting the correct bottom and track referencing. A compass calibration must be completed before you perform this test. Bottom tracking requires that the riverbed be stationary in order to properly compute boat speed. If moving bed is present, it will produce a bias in the bottom tracking and discharge results.

The 'Loop Method' is used for correcting discharges biased by moving bed. It provides a valid alternative to the use of GPS when measuring discharge in water with moving bed conditions. It should be noted that the loop method provides an average moving bed (m/s) and applies a correction across the entire section. If there is moving bed in only one part of the river, it will apply the correction to the entire transect.

Further information can be found in Appendix H (page 134) of the Sontek System Manual or referring to the USGS Scientific Investigations Report 2006-5079 (http://pubs.usgs.gov/sir/2006/5079/).

- Make sure the compass has been calibrated before you begin the loop method.
- Establish a good starting point in the river, where you can easily control the raft.
- Keep in mind that you will need to start and end in the same location in order to compute the moving bed speed correctly.
- You don't need to get as close to the bank as you would for a regular discharge measurement. Try and maintain a uniform and steady boat speed during the entire measurement.
- Click on Loop Method from your mobile device (located in the Utilities Menu for the PC), and click start.
- Move the raft across the river, once near the far bank, gently turn the boat and return to the starting point. Assuming accurate user control, any difference in the bottom tracking indicates a moving bed. The results will be displayed in the PC window, it will tell you if there is enough moving bed
- Your Loop Method measurement will be available in post-processing to correct the discharge results.

Another technique is to perform a stationary moving bed test. Insert the raft into main part of flow and leave stationary for 10 minutes. If the ship track starts to move upstream, then you have moving bed. Even though you can perform both a stationary and loop test. The loop test is the preferred method as it is now incorporated into RiverSurveyor.

Loop test
Compass must be calibrated
Duration > 180 seconds
Boat speed less than 1.5 * water speed
V_{mb}= Dist Upstream / Duration

Moving bed if:
V_{mb} > 0.012 m/s and V_{mb}/V_w> 0.01
V_w is the mean water velocity

Stationary moving bed test
Compass must be calibrated
Duration of test > 600 seconds
V_{mb}= Dist Upstream / Duration

Moving bed if:
Anchored or tethered V_{mb}/V_w> 0.01
Not Anchored Boat V_{mb}/V_w> 0.02
GPS Referenced V_{mb}/V_w> 0.01
V_w is the mean water velocity

Vmb = Mean velocity of moving bed. Vw = Mean velocity of water.

"To ensure the quality of the data collected, every moving-boat measurement made with an ADCP **must** have a recorded moving-bed test. If a site routinely has a moving bed and GPS is always used with the ADCP, a moving-bed test is still required but need only be 5 minutes in length" (Overview of ADCP 'Best Practices' Report, USGS).

If the loop test indicates no moving bed, the preferred track reference is:
1: Bottom track/GPS-RTK
2: GPS-VTG (only sub-meter accuracy)

If loop test indicates a moving bed, the preferred track reference is:
1: GPS-RTK/Stationary software
2: GPS-VTG
3: Bottom track – loop corrected
4: Bottom track – no loop correction (because no loop test was performed)

Option 7: Other Settings

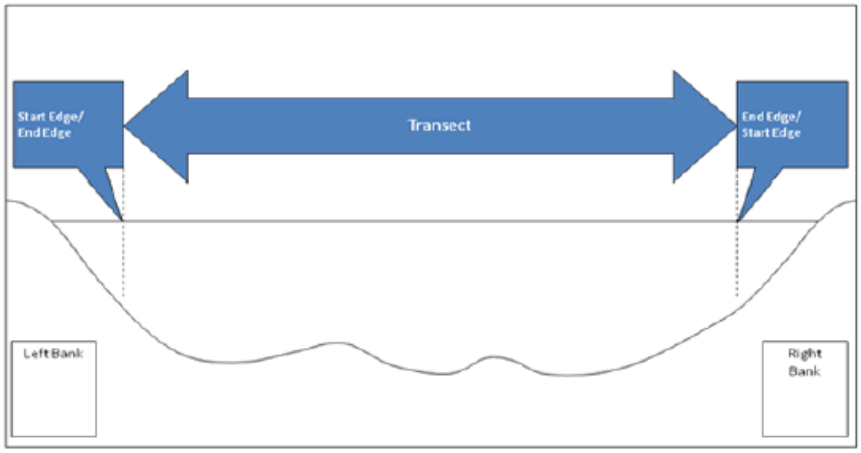
A System Test must be completed with every gauging. This performs a verification that the components of the hardware are functional. It tests the system battery, compass, SD card, and that the temperature sensor is working.

System Time must also be checked before every gauging, it must be in New Zealand Standard Time (NZST). Do not adjust for Daylight Savings; care needs to be taken around this time of year.

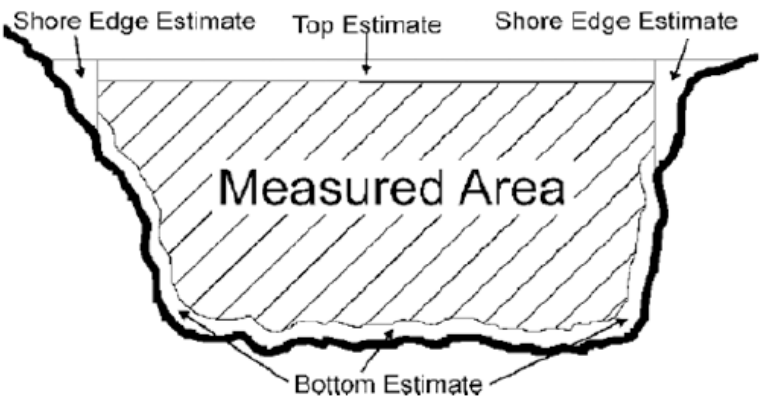
3.Gauging

You are now ready to perform a gauging. Click the Start button or 'Start a Measurement (F5)' from your PC. For a description of the RiverSurveyor Live Icons, please refer to the Appendix A (pg82) RiverSurveyor System Manual.

Start Edge – enter the distance to the bank edge (from the centre of the unit) and whether sloped or vertical. You must collect 15 edge samples, while keeping the raft as stationary as possible. This ensures the edge estimates, widths and areas are similar. A minimum of **2 cells** is required to record accurate edge data.



Start Moving – try to keep the raft speed and direction constant as it progresses across the river to the end edge. It is considered best practice to have a minimum of four transects, two transects in each direction to remove any bias in the results. The measured discharge will be the average of the 4 transects if the Coefficient of Variance is less than 5%.



End Edge – once the raft reaches near the opposite bank press the End Edge button; enter the distance and bank slope. A further 15 samples must be measured here, with a minimum of 2 cells.

End Transect – after the 15 samples, press the End Transect button. The discharge summary will be displayed, where you can review your transects. To complete another transect, press the Start Edge button again.

The most important piece of information to look at while gauging, is the Signal to Noise ratio (SNR Ratio). This is located in the bottom left corner of your screen and will indicate any cavitation of the transducers. Cavitation is basically air bubbles causing turbulence under the sensor. This needs to be looked at closely, because if cavitation is present, then you have the ability in the field to lower the sensor and collect better measurements.

Once you are back in the office it's too late. You can't post-process or correct for cavitation.

4.Summary

Before each gauging, you must perform the following:

- Compass calibration
- System test
- System Time check (NZST)
- Loop test

You must complete a minimum of four transects, preferably within 5%, and with a total exposure time of at least 720s (12min); unless flood conditions prevent this, when one or two transects can be used.

If four within 5 % is not achievable, then another four transects should be completed if time permits; you should aim for eight measurements that lie within 10% of each other. These must be reliable transects that have no obvious errors for exclusion. Reasons for excluding these may be cavitation, loss of bottom track, unreliable GPS signal, spikes in the data and missing data in the section. There is more detail on post-processing and quality assurance in Section 6.35 Sontek Data Entry.

The eight measurements within 10% has been introduced in an effort standardise across authorities what is a reliable transect and what is not. The inherent issues that arise with an ADCP measurement lies in the interpretation of a good measurement and one that is not. Artistic licence is not intended to be part of this standard, so as an extension to the “4 within 5%” that has been commonly accepted worldwide this standard attempts to clarify the next 4 measurements that are needed for ADCP measurement more often than not.

Full Quality Coding will be applied once you have post-processed the gauging, and will target the following:

- Cross Section Quality
- Total Exposure Time
- Compass Calibration
- Moving Bed Test
- Max GPS HDOP’s
- Cavitation
- Percent Measured
- Edge Data (number of cells)
- Pitch & Roll
- Moving Bed Track reference