

WATER MONITORING

Bathymetric surveys of waterholes

WMO015A

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Aquatic Ecosystems

Field method

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1 Purpose and scope

This method is used to profile waterholes for accurate calculation of storage volume and identification of shallow and deep-water areas, which are important habitats for aquatic species. Bathymetric mapping of these areas provides information that can be used in the management of waterholes and other aquatic habitats.

2 Associated Methods

[AEML013 Post-processing of waterhole survey data](#)¹

3 Permits and approvals

Under the *Nature Conservation Act 1992* (NCA), approval from Queensland Parks and Wildlife Service (QPWS) is required to conduct activities involving protected wildlife and places. Failure to obtain approval prior to the commencement of activities is a breach under the NCA.

To ensure you have all the correct permits and approvals in place before using this method, refer to the [Permits work practice](#)² and the [Permits and approvals checklist](#)³.

4 Workplace health and safety

Risk assessment is an important part of identifying and reducing risks from potential hazards in the workplace. In section 27A of the *Workplace Health and Safety Act 1995*, five basic steps are outlined that must be followed to manage exposure to risks. The Workplace Health and Safety Queensland Risk Management Code of Practice 2007 outlines the obligations of both the employer and employee when carrying out risk assessment in the workplace. More information can be found at:

- [Workplace Health and Safety Act 1995](#)
- The Department of Employment and Industrial Relations [Workplace Health and Safety Queensland Risk Management Code of Practice 2007](#)
- DERM's [Risk Management Standard](#).

4.1 Field based work

For all fieldwork there must be a minimum of two persons per sampling party. Ensure that all risk assessment and trip approval paperwork is complete and that a ring-in schedule has been arranged. When working in areas potentially inhabited by estuarine crocodiles - additional protective measures must be taken. Refer to HRS/2007/3011 [Field Operations](#)⁴ and [Crocodiles – Be croc wise](#)⁵ for more information.

NOTE: Before following the methods contained in this document, a detailed risk assessment must be completed as outlined in Table 1.

¹ AEML013 Post-processing of waterhole survey data (version 2.1, 57/01/2011)

² WM26 *Department of Environment and Resource Management approvals for activities involving protected species or places*. (version 2.0, 14/03/2011)

³ WM28 *Permits and Approvals Checklist* (version 2.0, 13/04/2011)

⁴ HRS/2007/3011 *Field Operations* (version 1.0, 12/05/2007)

⁵ Crocodiles – Be croc wise, DERM (last viewed 20/12/2011, http://www.derm.qld.gov.au/wildlife-ecosystems/wildlife/living_with_wildlife/crocodiles/crocodiles__be_croc_wise.html)

Table 1: Workplace Health & Safety Risk Assessment for Sampling Benthic Diatoms (See [Appendix A](#) for Risk Analysis Matrix and Risk Scores).

CONTEXT	HAZARDS	RISK	RISK RATING			CONTROL MEASURES	MONITORING	REVIEW DATE
			CONSEQUENCE	LIKELIHOOD	RATING			
FIELD OPERATIONS - undertaking sampling on-site	Unpredictable water depths & velocities	Drowning Personal Injury	Major	Unlikely	Medium (14)	Life-jackets to be worn at all times Ensure staff are capable swimmers First Aid Qualifications	Life-jackets to be tested Updating of First Aid qualifications Appropriate call-in procedure in place	Annually
	Sun & heat exposure	Sunburn & heat exhaustion	Minor	Unlikely	Low (5)	Appropriate Personal Protective Equipment (PPE) to be utilised	Monitor condition of PPE	Annually
	Navigation of unstable terrain	Personal Injury	Minor	Possible	Medium (8)	Appropriate PPE to be utilised First Aid Qualifications Two staff members to travel together at all times	Monitor condition of PPE Updating of First Aid qualifications	Annually
	Manual Handling Awkward postures	Personal Injury	Minor	Possible	Medium (8)	Two people to perform lifting of heavy objects Safe handling techniques covered in DOTS	Ensure staff are aware of new correct manual handling procedures	Annually
FIELD OPERATIONS - driving to / from site	Collision Car Rollover Breakdown	Personal Injury	Catastrophic	Rare	Medium (15)	Recovery equipment to be carried at all times Drive with due care 4WD training qualifications	Condition of car & recovery equipment to be inspected prior to leaving office Updating of driving licences	Annually

5 Skills, competency and experience

Skills specific to this method include:

- Boat operators require a Qld Recreational Boat Operators Licence.
- It is desirable to have at least one person with experience in waterhole profiling, as well as experience in the use of GPS and depth sounders.

Staff skills, training and experience records should be kept up to date in the [Water Monitoring Sharepoint training database](#).

6 Chemicals

No chemicals specific to this method identified.

7 Equipment

Equipment specific to this method includes:

- 1 x boat or canoe
- GPS (with NMEA output capability), plus spare batteries
- External antenna for GPS (if required)
- Depth sounder (capable of outputting NMEA data strings - the depth sounder must be wired with a suitable DB9 serial plug)
- Transducer for depth sounder (plus cables, mount and screws, or clamps)
- Rugged Brookhouse NMEA 0183 Data Logger
- 12V DC battery, plus spare
- Battery charger
- Laptop
- Brookhouse download cable and serial to USB converter (if required)
- Fieldsheet
- Digital camera
- Satellite phone
- EPIRB
- Jerry can with spare fuel
- Toolkit
- First Aid kit
- Vehicle recovery gear

8 Method

8.1 Equipment Setup

8.1.1 Depth sounder and transducer

The depth sounder for use in this method must be able to output NMEA data strings via a DB9 serial communications cable (see associated manual). The transducer for the depth sounder must be fixed to a suitable mount on the boat. This can either be fixed to the transom or mounted on a suitable fixture and clamped to the boat, however, it is recommended to mount the transducer at the bow of the boat. This is useful for getting close to edges and shallow areas. The depth of the transducer under the surface of the water must be measured and recorded on the fieldsheet.

This distance will need to be added onto the recorded depth in order to get the actual depth from surface to bottom.

Once the depth sounder has been mounted in a suitable position in the boat, the transducer cable can be connected to the back of the sounder and the power connected to a 12V battery. After switching the depth sounder on, ensure that the NMEA function is switched on. To ensure the accuracy of the depth sounder data, manual depth measurements directly under the transducer need to be made in a relatively flat bottomed area. Any difference to the recorded depth and measured depth needs to be noted. The DB9 serial cable from the depth sounder needs to be connected to **serial port 2** of a Rugged Brookhouse NMEA 0183 Data Logger.

8.1.2 GPS

A GPS capable of outputting NMEA data must be used. It is recommended to power the GPS from a 12V battery. For this reason a combined power/data cable suitable for the model GPS being used is needed. It is recommended that the GPS is used with an external antenna. This antenna needs to be mounted as close as possible to a location directly above the depth sounders' transducer. Mounting the antenna well above the confines of the boat is also essential, and should be mounted at least 0.5 m above the sides of the boat. This will enable improved satellite reception.

Depending on the model of the GPS, a number of settings need to be configured to allow it to output NMEA data to the data logger. Refer to the GPS user manual on how to configure the GPS to the following settings.

Serial data format (Output) – set to NMEA (NB. If using DPGS this setting needs to be RTCM in/NMEA out.

Baud Rate – 4800

Datum – GDA 94

The DB9 serial port is connected to **serial port 1** on the Rugged Brookhouse NMEA 0183 Data Logger.

8.1.3 Differential GPS

If intensive and/or specific habitat surveys are required a differential GPS could be used. Please refer to the differential GPS manual for setup. The NMEA output from the corrected GPS position needs to be connected to serial port 1 of the Brookhouse NMEA data logger and the same configuration settings used.

8.1.4 Rugged Brookhouse NMEA 0183 Data Logger

The Brookhouse NMEA data logger is a compact device for recording NMEA data such as water-depth, coupled to GPS co-ordinates. The standard logger comes with a 16 megabyte (MB) module. This provides sufficient storage for approx. 70 hours of recording.

Connections

1. Power

Connect the fixed power cable with cigarette lighter plug to a 12V power source.

2. GPS and Depth Sounder

There are two DB9 RS232 male plugs on two short separate cable ends. Port 1 is used for connecting a GPS and also for uploading information. Port 2 is used for connecting the depth sounder or a combined GPS/depth sounder combo. Both of these ports are set to 4800bps during recording (standard NMEA data rate).

3. Computer connection for uploading data and service mode.

Plug the supplied serial cable with one end in the data logger connector of port #1 and the other end in a serial DB9 computer Com port. A serial-to-USB converter will be required if using a computer with no serial ports and only USB ports. During uploading the data-rate of port #1 is set to 9600bps.

Operation

Function Select

After the data logger is switched on, it performs a self-test. During start-up and self-test, which takes about 10 seconds, the LCD stays blank. After start-up, the user is asked which function is required. If the * key on the keypad is pressed, the response is 'Yes', if the # key is pressed, the response is 'No'.

The available functions are:

- Bathymetry
- NMEA Logger
- Seataalk
- Maintenance

Select the bathymetry function for waterhole profiling. The following functions are available:

- Record
- Upload
- Ozieload
- Fast Upload
- Erase

Record

Select this function to start profiling. Data is written to flash memory and if the data-logger has been switched off, recording resumes at the end of the already recorded data. Each time a data record is created, a beep-sound is generated. This audible signal is a useful confirmation for the operator that the instruments are working and data is recorded. If no valid GPS fixes have been received for 30 seconds, recording stops, no more beep-sounds are produced and the operator knows that something is wrong. This will prompt him to check the GPS and connections of GPS and sounder to the recorder.

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During recording, the keypad has the following function:

1. By pressing the * key, data received from the GPS and Depth sounder can be displayed. Initially the latest GPS fix is displayed. By pressing once, the depth in metres is displayed; pressing again displays the depth in feet, etc.
2. By pressing any of the other keys, a stamp is generated on the next record that is created. This can be useful to mark special areas or observations at a given point (i.e habitat features such as logs, boulders etc). Holding down a particular key will allow access to other letters on that key. A description of the codes used should be recorded on the fieldsheet for future reference.

Recording can only be stopped by switching the unit off.

Upload

Select this function to upload the data once profiling is complete. The upload function reads back the recorded data, re-formats it and outputs the records via port #1 at 9600bps in ASCII code. With the simple ASCII data-format, uploading to any computer with any operating system is possible. No special software is required. On a Windows-PC, data can be captured to a file with the standard Windows program, HyperTerminal (Start/ Programs/Accessories/ Communications). HyperTerminal must be configured as follows:

Direct communication via a COM port.
Data speed – 9600bps, no parity, no flow control.

Connect the supplied serial cable between the logger and the computer (note, a serial-to-USB converter will be required if using a computer with no serial ports and only USB ports). Connect with HyperTerminal (All Programs / Accessories / Communications / HyperTerminal) and proceed as follows:

1. Select the upload function on the data logger.
2. Press any of the keypad-keys to commence uploading
3. A message should now appear on the HyperTerminal screen, explaining how to proceed.
4. In HyperTerminal, click on “Transfer” and select “Capture Text”. Specify the file name where the data has to be written to.
5. Press<C> to start the data transfer.
6. After all data has been transferred from the data logger to the computer, a continuous beep-sound is produced to indicate the end of the data. Switch the data logger off.
7. Terminate HyperTerminal text-capture.
8. Check the contents of the file contents with the Windows program Notepad or Wordpad.

Erase

Select this function to erase data that has been uploaded. Erase recorded data only after it has been established that the recorded data has been successfully uploaded.

8.2 Waterhole profiling

8.2.1 The Waterhole

Prior to undertaking the profile, the length of the waterhole should be determined. This can be achieved through the use of detailed maps, aerial photography and/or satellite imagery. It should be noted that ground-truthing the ends of the waterhole is the only real way of accurately determining the length and size of the waterhole. Mark waypoints, or use the codes on the datalogger for points of interest (eg. Habitat areas or areas of significant profile change, eg. Shallow bend). If desired, waypoints on the GPS at both ends of the waterhole can be marked if an initial survey is undertaken. Note the name of these marks. In addition, at the start and finish of the survey, the position shown on the GPS should be checked against the known position determined from maps or GIS. The error of the GPS at the start and finish should also be noted on the datasheet as a reference to accuracy on the day of survey. If available, the use of GIS such as MapInfo with geotracking could also be used to assist in determining cross section locations and boat movements.

8.2.2 Cross-sections

Using the GPS waypoints for the ends of the waterhole as a reference, calculate the total length of the waterhole (NB: for the lengths of waterholes that aren't straight (with major bends) will need to be calculated with the track feature of the GPS or multiple waypoints). If an initial survey has not been undertaken then use the total length as estimated from mapping. Two and a half percent (2.5%) of this total length is the interval distance at which the cross sections should be undertaken (a total of 40 cross sections for the length of the waterhole). In areas of importance (ie. Those areas way-pointed in the initial waterhole survey) greater numbers of cross sections could be undertaken.

Using a range finder, or the GPS, find the distance between cross sections will help in the initial survey of these sections. Once a person can estimate the distance reasonably well, the range finder might not be needed. Use of the range finder occasionally, would provide the person with an error check.

Switch the GPS on and wait for it to obtain a position before proceeding. Then switch the sounder and data logger on, start the boat and ensure that the GPS and depth sounder are effectively logging to the data logger (an audible beep will be heard if the data logging is successfully occurring). Starting as close as possible to the starting edge, begin the cross section (ensuring that the logger is making an audible beep). Steer the boat perpendicular to the edge towards the other bank. Turn the boat as close as practical to the bank and commence a track heading for the opposite bank at a distance where the next cross section will commence. At the turns, the distance from the bank can be recorded using Brookhouse codes, which will allow for a more accurate boundary layer to be created during post-processing of the data (Refer to method [AEML013 Post processing of waterhole bathymetric survey data](#),¹ for further information on creation of the boundary layer). Continue this process until the end of the waterhole is reached.

N.B. For more intensive surveys a perimeter and longitudinal section can be undertaken.

¹ AEML013 Post-processing of waterhole survey data (version 2.1, 57/01/2011)

8.2.3 Longitudinal section

A longitudinal section can be undertaken to determine the depth through the middle of the waterhole along its entire length. This is undertaken by simply starting at one end and navigating up the centre of the waterhole until the opposite end is reached. A variation to this method is to make long sweeping arcs as one navigates from one to the other.

8.2.4 Perimeter section

This is undertaken by mounting the transducer and GPS antenna to the side of the boat (or on a pole if the depth is not required) and driving as close as practical to the edge of the bank. Continue to follow the bank until the entire circumference has been completed. Note on the fieldsheet the presence of any sandbars, snags or shallow sections that prevent close access to the edge. A mudmap of the site is recommended, to assist with the creation of the boundary layer during post-processing of the data (Refer to method [AEML013 Post processing of waterhole bathymetric survey data](#),¹ for further information on creation of the boundary layer).

8.3 Data Management

When the waterhole profiling is complete, the data logger cable can be connected to the serial port of your laptop and all files uploaded (as described in the uploading section). While the uploaded data is in an ASCII format that can be read in many software programs (e.g. Notepad, Excel), mapping software (e.g. Surfer, ArcGIS) is required to actually view the data. Refer to method [AEML013 Post processing of waterhole bathymetric survey data](#),¹ for further information.

8.4 Variation to the method

8.4.1 Data logger and computer

Instead of using a data logger, the GPS and depth sounder can be linked to a laptop computer that is running OziExplorer (or a similar moving map) software. This not only enables the logging of data to computer but also allows you to view the current boat tracks on screen.

8.4.2 Acoustic Doppler

An Acoustic Doppler current profiler (RD Instruments, San Diego) can be used instead of the depth sounder. Use of a Doppler enables velocity measurements to be taken at the same time as depth profiling.

¹ AEML013 Post-processing of waterhole survey data (version 2.1, 57/01/2011)

8.4.3 Intensive Habitat Mapping

In areas of importance where more detail is required and the depth is not critical, habitat mapping can be undertaken with a DGPS. For example mapping log jams or the edge of the water. This can be undertaken by mounting the GPS aerial onto a long pole. The pole can then be moved in and around the areas to be defined (mapped). Noting a GPS mark (waypoint) to each area of interest will enable referencing when processing data.

8.5 Limitations to use

Profiling is limited to sections of waterhole that are not too shallow to allow passage by boat (approx. 0.4m or less). These areas can be defined by marking their start and end points and if possible their perimeter. A shallow value of <0.5m for example, can then be given to this total area. This needs to be done in post processing.

Dense sections of logs within the channel, and low overhanging bank vegetation will limit access to some areas of the waterhole. Dense stands of macrophytes could result in the depth sounder recording depth incorrectly or not at all. If the macrophyte is attached to the bottom, an increase in gain on the sounder could provide a better track of the substrate. If the macrophyte is floating or has extensive leaves near/at the water level, this might severely limit the application of the method.

Dense overhanging canopy and/or geographic location might result in poor satellite coverage. In such cases, an external antenna (mounted high) is recommended for use.

9 Quality Assurance

A GPS check should be performed before commencing profiling. The latitude, longitude and error should be recorded in the section provided on the fieldsheet. This will give indication to accuracy of plotted data points.

The data should be uploaded to a laptop computer before leaving the site, and visually inspected. The start and end time of the data should represent the start and end time of profiling. Also, if Brookhouse codes were used check to see that they have been captured in the data.

It is recommended to plot the point data over satellite imagery before leaving the site. Refer to method [AEML013 Post processing of waterhole bathymetric survey data](#),¹ for instructions on how to do this.

10 References

N/A

¹ AEML013 Post-processing of waterhole survey data (version 2.1, 57/01/2011)

11 Appendices

Appendix A.

Photographs



Figure 1 Rugged Brookhouse NMEA 0183 Data Logger

