Environmental Defenders Office

How to collect groundwater evidence on your property

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Groundwater level monitoring

Why monitor?

Monitoring at the property level not only documents the conditions on your own property but can also contribute to a broader understanding of groundwater conditions in the area. Groundwater modelling can be useful to understand changes that may be occurring due to natural or climatic variability (by establishing baseline conditions), and to show evidence that conditions are changing in response to outside forces such as a nearby land development.

Establishing baselines is important where landholders are entitled to compensation for any impacts to groundwater caused by other users – such as coal seam gas developments or mines. Baselines should ideally be gathered before the new user begins operations.

Several tools can be used for monitoring groundwater conditions at the property level. The goal is to find the right tool that fits your budget and available time and gives accurate measurements.

What is groundwater monitoring?

Groundwater is an important water resource to both humans and the natural environment across most of Australia. In general, groundwater moves through an aquifer very slowly. However, some disturbances to an aquifer (for example, large water extractions) may become apparent in the surrounding landscape soon after the disturbance has occurred.

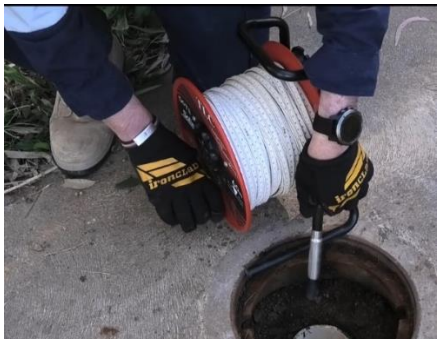
At a property level, we may notice these changes through shifts in the level of the water table. Information on the level of the water table is the most fundamental information we have about groundwater. This level is not only an indicator of what is happening in the aquifer, but also has practical implications for the bore owner. In particular, if the water

level drops, the bore may go dry. Therefore, it is important to monitor the water level to understand any changes in the aquifer. Using simple tools, anyone can collect water level measurements relatively quickly.

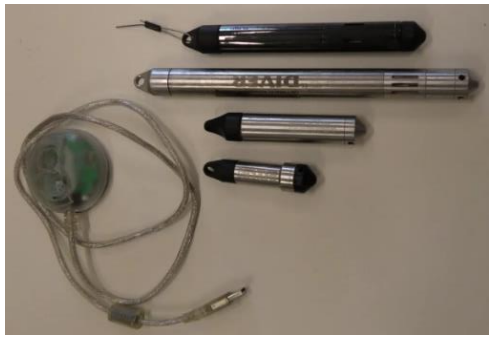
N.B. An aquifer is defined as an underground layer that stores and yields water at a rate that is useful for human use.

Monitoring equipment

Scientists and water managers typically use two tools to monitor water levels in boreholes. The first device is an electric "dip meter". This device is essentially a long measuring tape that beeps when it touches the water surface. When the beep is heard, the depth to the water table is read from the tape measure at the surface. It provides a standard and accurate way of manually measuring the elevation of the water table.



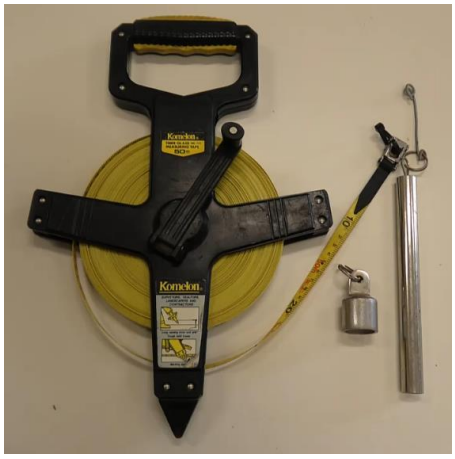
First device: dip meter



Second device: sensor and datalogger

The second device is a combination of sensor and datalogger, which can be placed inside the borehole to automatically measure water levels over time. These sensors are great for measuring changes in water levels over regular time intervals with little effort, but manual measurements are still needed to adjust the measured pressure to a known water level and to check that the sensor measurements haven't drifted over time.

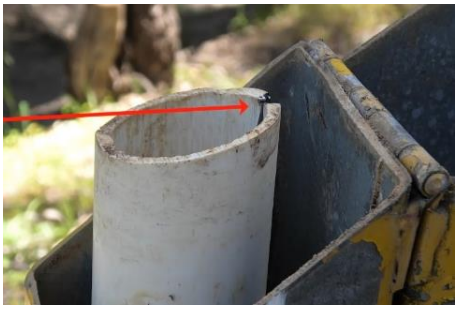
Bore water levels can be measured even if an electric dip meter is not available. Typically, a weight (or even large whistle) is placed on the end of a flexible tape measure and lowered until a “plop” is heard as the weight touches the water table. As with the electric version, the depth to the water table is then read from the tape measure at the surface. To aid in finding the exact level, the weighted end of the tape measure can be chalked and the weight lowered into the water. The water will displace the chalk, showing how much of the tape was submerged, and the exact distance between the water table and the surface can be calculated simply.



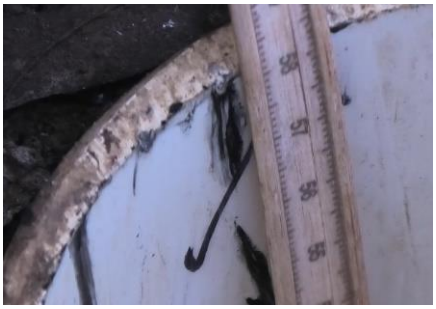
Flexible tape measure with weight

Measurement tips

- Measure from the same point at the surface each time. Usually, measurements are taken at the top of the well casing, and the distance from the top of the casing to the ground surface is subtracted from the measurement afterward. A line or arrow is drawn on the casing to indicate which side of the casing to measure from.



Always measure water levels from the same point on the casing.



Use the measuring tape to read depth from top of the casing to the water level.

- Measure water level before pumping.
- Electric dip meters often give false detections of the water level in areas where the salinity is high. They can still be used but must be lowered slowly to avoid touching salt or water drips on the sides of the casing.
- Keep a dedicated notebook to record the measurements. Include the date, time, who made the measurement, device used, whether the measurement was to the ground level or top of casing, and any other observations.
- Clean the measuring tape between use in different wells. This is especially important if a bore is suspected of containing bacteria or other contaminants.
- If using an automatic sensor, water levels can be recorded every hour to understand recovery from pumping, every 6 hours, or every day. Most loggers can collect data for

many months between downloading if data is collected 1-4 times per day. Always perform manual measurements with a tape when checking or downloading the automatic logger, as the timing device on most automatic loggers' drifts slightly (e.g. by some minutes) over time.

- Manual measurements should be collected as often as feasible; how often measurements are collected will depend on ease of access and the variability of groundwater levels. For example, shallow groundwater levels fluctuate seasonally and may also change in response to large rainfall events; therefore, weekly to monthly measurements are useful. In contrast, deeper (>25 m) groundwater levels may remain relatively stable, and seasonal to annual measurements may be sufficient for discerning long-term trends.
- In the special case of artesian bores, measurement must be conducted differently.

Visit:	Bureau of Meteorology website to view the Australian Standard for water level measurement: http://www.bom.gov.au/water/standards/documents/NI_GL_100_02-2019.pdf
Visit:	Western Australia Department of Primary Industries and Regional Development for information regarding measuring groundwater levels: https://www.agric.wa.gov.au/soil-salinity/monitoring-groundwater
Watch:	U.S. Geological Survey YouTube video showing how to use tape and chalk to measure a water level: https://www.youtube.com/watch?v=b23FvXkD6VM

Groundwater quality monitoring

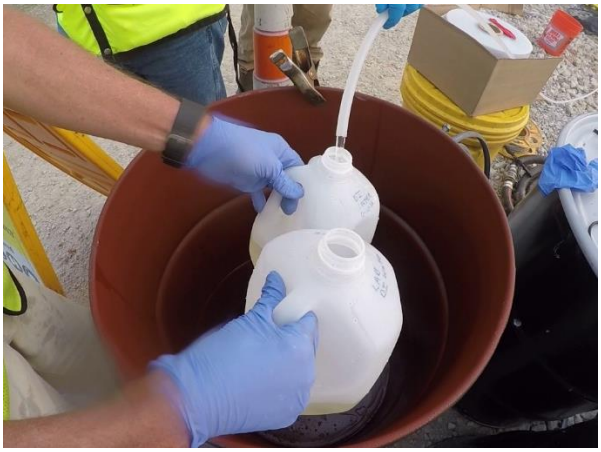
In addition to water levels, the *quality* of an aquifer determines whether it can be used for domestic, stock, and agricultural purposes. Even small changes in the water quality can have impacts on the feasibility of its use. For example, increases in salinity can corrode the casing or pipes or require the water to be mixed with fresher water before use. Changes in pH may also cause corrosion or may enable bacterial growth. On a regional level, changes in these water quality indicators can signal impacts to the aquifer, which are typically long-lasting. Regular monitoring of borehole water quality not only documents the existing water quality and any local changes but may also provide an early warning of impacts on overall aquifer health.

There is a wide range of parameters that define water quality. Water used for domestic consumption is typically tested for major ions (that is, the salts that make up the salinity), metals and trace elements, and bacterial contaminants. Water may also be tested for other contaminants if there is suspicion of impacts on the aquifer due to mining or agricultural uses. While a full suite of testing can only be done in the laboratory, several basic tests can be done at the borehole, providing useful information about salinity, temperature, and pH, which are fundamental to groundwater quality.

Monitoring equipment

Scientists and water managers generally measure water quality in a borehole by pumping water to the surface and collecting samples in various types of containers, depending on what parameters should be analysed. Alternatively, water can be collected using a bailer. This is simply a tube with a ball at one end. The ball initially gets displaced by the water, allowing the tube to fill; when the bailer is pulled upward, the ball falls back to the bottom of the tube, preventing the water from escaping.

First method: bailer



Second method: collection with plastic bottles

Water samples can be collected and analysed at the property level. If the bore is already being pumped, collect a sample in a clean plastic water bottle or cup. One litre is plenty of water. Physical properties such as salinity, temperature, and pH (acidity or alkalinity) are typically measured right at the borehole.

These measurements do not need to be expensive; pocket-sized salinity meters are available online or even at hardware stores or pool supply shops for under $200. Salinity meters almost always include a temperature sensor. Often, these meters also include pH. Alternatively, a separate pH meter can be purchased, or pH can be measured using test strips, just as you would use in a pool.

Nutrient and bacterial concentrations are typically measured in a laboratory, requiring a water sample to be shipped for analysis (and sometimes filtered first). It may cost as little as $20 to have a water sample tested for these basic parameters.

Measurement tips

- Measure borehole water quality after (or at the end of) pumping. If the borehole is not pumped regularly, the water in the casing may be stagnant and not give an indication of aquifer water quality.
- If nutrient, bacterial, or other contaminant analysis is desired, store the water samples in the fridge or freezer. Mark the sample with the date, time, and location of collection.

- Electronic salinity loggers typically measure electrical conductivity (EC) as an indicator of salinity. As EC is dependent on temperature, it is important to also record the water temperature.
- Electronic salinity and pH sensors vary widely in price. Although this price difference is somewhat related to durability and accuracy, even an inexpensive sensor will usually give a sufficient understanding of the approximate values.
- As with water levels, keep a dedicated notebook or spreadsheet to record water quality information, recording the location, date and time of day, who collected and analysed the sample, water quality information with units of measurement, and any comments.

Electronic salinity logger

Visit: UNSW Connected Water Initiative for further information about DIY groundwater monitoring: http://www.connectedwaters.unsw.edu.au/schools-resources/fact-sheets/diy-groundwater-monitoring

Visit: Victoria Government Environment Protection Agency for water sampling guidelines: www.epa.vic.gov.au/-/media/epa/files/publications/669.pdf

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