Guidance on the sampling of groundwaters

1 Purpose and scope

This document provides some general information on groundwater and its importance for assessment of impacts. Detailed instructions on how to sample groundwaters are provided in Geosciences Australia *Groundwater sampling and analysis – a field guide* (Sundaram et al. 2009), and AS/NZS 5667.11:1998 (R2016), *Water Quality – Sampling – Guidance on sampling of groundwaters.* Both of these documents should be referred to when undertaking groundwater sampling, and the Geosciences Australia field guide (Sundaram et al. 2009) can be used as a default standard operating procedure (SOP) for groundwater sampling.

2 Introduction

Groundwater is a valuable natural resource that has a range of environmental values including the provision of drinking water for humans and livestock, cultural and spiritual values, ecosystem values and provision of water flows to groundwater dependent ecosystems. Groundwater is also used for agriculture and industrial applications. In dryland areas, groundwater can be the only reliable source of water and can sustain water levels in river and wetland ecosystems during extended dry periods. In Queensland, the *Environmental Protection Act 1994* and the Environmental Protection (Water) Policy 2009 provide a framework for protecting groundwater quality.

Groundwater quality can be highly variable, both spatially and temporally (Australian Government 2013), more so than surface water quality. Groundwater quality can be influenced by local geology, residence time in the aquifer, groundwater chemistry and groundwater-rock interactions. Groundwater can have naturally elevated salinity concentrations, dissolved nutrients and metals.

3 Understanding the system

The assessment of impacts to groundwater requires an understanding of the aquifer system that hosts the groundwater, including its depth, physical and chemical properties, and hydrologic interaction with surface water systems. The term ‘groundwater’ refers to water that seeps into the ground and accumulates in the pores and cracks of the saturated zone of the earth’s crust. The term “aquifer” refers to the body of rock or sediment that can store and transmit groundwater. Groundwater can occur in the *saturated zone* where all available spaces are filled with water, and in the *unsaturated zone*, the space between the land surface and the water table (upper surface of the zone of saturation of an unconfined aquifer), where there are pockets of air that contain some water (Centre for Groundwater Studies 2001).

If an aquifer becomes polluted, the polluted water can be transported to the surface at one or more discharge sites. This can occur naturally via normal discharge (e.g. to springs, creeks, wetlands) or artificially via extraction/abstraction from a bore or pumping well. This is important when the discharge site is a surface water body that is used for drinking water, agriculture (i.e. livestock watering), industrial applications, or has aquatic ecosystem values.

Poor groundwater quality has the potential to impact extractive users of the groundwater, surface water quality and groundwater dependent ecosystems (GDE). A GDE is an ecosystem that requires access to groundwater to maintain communities of plants and animals, ecological processes and ecosystem services. GDEs can depend on sub-surface and surface expression of groundwater and can be categorised into three broad types (Australian Government 2013):

- Surface ecosystems that rely on groundwater discharge to rivers, wetlands and springs
- Surface ecosystems that access groundwater from below the water table, e.g. terrestrial vegetation

- Subterranean aquatic ecosystems, which include stygofauna, in aquifers and caves.

4 Groundwater sampling

Groundwater sampling requires special equipment for sampling from a bore or, with a procedure to ensure sampling of fresh and undisturbed groundwater or water representative of the aquifer, as opposed to potentially stagnant water held in the bore column. Sometimes special precautions are needed to prevent changes in quality of the groundwater due to effects such as:

- reduced pressure when brought to the surface. This can cause gases in solution at the higher pressures found underground to move into a gas phase at the surface. In some cases, these can be toxic gases, such as hydrogen cyanide if the groundwater has been contaminated by cyanide solution.
- exposure to components of the atmosphere such as oxygen. This can oxidise compounds naturally present in the reduced form (for example, ferrous ions).
- temperature changes can influence the kinetic energy (chemical) of the system. This can influence the redox reaction regime and the rate of bio-degradation. Temperature changes could also increase the volatilisation of dissolved constituents.

Detailed information on collecting groundwater samples is provided in Geosciences Australia *Groundwater sampling and analysis – a field guide* (Sundaram et al. 2009) and AS/NZS 5667.11:1998 (R2016) *Water Quality – Sampling – Guidance on sampling of groundwaters*. More detailed information on low flow sampling can be found in USEPA (1996). Sampling should be undertaken in line with these documents.

Purging or low flow sampling methods are preferred for accurate groundwater sampling. Low flow methods minimise the impact of the sampling method on the aquifer and are more likely to obtain a representative sample, while some high flow pumps can sometimes induce water chemistry changes. Bailers: should only be used where no other pump can be used; b) should only be used for shallow wells where a small volume of water needs to be purged prior to sampling; and c) water samples taken using a bailer may have lower accuracy for some analytes and therefore it is important to record that a bailer was used to collect water samples.

5 Groundwater quality assessment

Groundwater quality is generally assessed based on a comparison of measured groundwater quality indicators against guideline values. Groundwater investigation levels (GILs) are provided in Schedule B6 of the National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013). A framework for risk-based assessment of groundwater that has been affected, or may have been affected by site contamination is also provided in this document. Basin specific water quality objectives (WQO) may be prescribed under the Environmental Protection (Water) Policy 2009 (see https://www.ehp.qld.gov.au/water/policy/).

It is essential that the groundwater system and groundwater quality characteristics are adequately described and understood in order to assess current groundwater quality and the potential future risks to the groundwater. Shallow groundwater quality in particular can be variable temporarily and spatially due to a range of factors including changes in the lithology of the aquifer, seasonal conditions, recharge events, and pumping regimes.

The information required would typically include:

- descriptions of groundwater hydrogeology and hydraulics within the potentially impacted aquifer/s
- water quality characteristics, of the groundwater within the potentially impacted aquifer/s (including the major cation and anion composition).

6 References and additional reading

AS/NZS 5667.11:1998 (R2016), *Water Quality – Sampling – Guidance on sampling of groundwaters*, Standards Australia.

ANZECC & ARMCANZ 1998, *National Water Quality Management Strategy*. *Implementation Guidelines*. Australian and New Zealand Conservation Council, Agriculture Resource Management Council of Australia and New Zealand, Commonwealth of Australia, Canberra.

Australian Government 2013, *Guidelines for Groundwater Quality Protection in Australia - 2013*. National Water Quality Management Strategy, Australian Government, Canberra.

Centre for Groundwater Studies 2001, *Australian Groundwater School Fundamentals of Groundwater Science, Technology and Management*, 3rd ed.

Department of Environment and Heritage Protection (DEHP) 2010, *Queensland Water Quality Guidelines, Version 3,* ISBN 978-0-9806986-0-2, Department of Environment and Heritage Protection (DEHP), Queensland Government, Brisbane.

Department of Science Information Technology and Innovation (DSITI) 2017, *Using monitoring data to assess groundwater quality and potential environmental impacts*, *Version 1*, Department of Science, Information Technology and Innovation (DSITI), Queensland Government, Brisbane.

National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013), NEPC 2013, Canberra.

Sundaram, B, Feitz, A, Caritat, P de, Plazinska, A, Brodie, R, Coram, J and Ransley, T 2009, *Groundwater Sampling and Analysis – A Field Guide,* Geosciences Australia, Record 2009/27. Available from: http://www.cffet.net/env/uploads/gsa/BOOK-Groundwater-sampling-%26-analysis-A-field-guide.pdf

United States Environmental Protection Agency (USEPA) 1996, *Low stress (low flow) purging and sampling procedure for the collection of ground water samples from monitoring wells*. Available from: https://www.orau.org/ptp/PTP%20Library/library/Subject/Environmental/r1_lowflow.pdf