Department of Environment
and Resource Management

# Baseline Assessment Guideline

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Department of Environment and Resource Management



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# Executive summary

Under the *Water Act 2000* (the Water Act) baseline assessments of water bores are required in areas where petroleum and gas production testing or production has commenced. Baseline assessments of private water bores are required to assist with any potential make good agreements in future.

This guideline provides both petroleum tenure holders and bore owners with information on: the purpose of baseline assessments; the legislative requirements that must be met by both petroleum tenure holders and bore owners; and, technical advice on the mechanisms for undertaking baseline assessments.

# Background

## What is a baseline assessment

A baseline assessment is an assessment of a water bore undertaken by a petroleum tenure holder to obtain information about the bore, including the following:

- the level and quality of water in the bore.
- how the bore is constructed.
- the type of infrastructure used to pump water from the bore.

## Why are baseline assessments required?

The requirement for undertaking baseline assessments of private water bores is a key step in the process of managing the underground water impacts of petroleum tenure holders by exercising underground water rights. The information that will be collected when conducting baseline assessments will include bore construction details; pumping details and supply information, such as historical water use information, as well as current water level and water quality analysis where possible.

The information collected in baseline assessments will establish benchmark data prior to any impact of the petroleum tenure holder exercising its underground water rights.

Baseline assessments are intended to:

- Provide a measure of security for both bore owners and petroleum tenure holders, through understanding what the current condition and pumping capacity is for each water supply bore located within petroleum tenures where production testing or production is occurring. The baseline assessment framework also comes into effect where bores are outside petroleum tenures but within aquifers that are predicted to have drawdown above trigger thresholds.
- Provide a reference point for comparison with subsequent bore assessments to assist in the negotiation of make good agreements.
- Assist in resolution of any future disputes that may arise between bore owners and petroleum tenure holders following a bore assessment or in the negotiation of a make good agreement. However, it should be noted that comparison with baseline assessments will not be the only consideration when determining impaired capacity from bore assessments.

## When do baseline assessments need to be undertaken?

Section 397 of the Water Act requires petroleum tenure holders to prepare a baseline assessment plan for each authorised water bore in the tenure area. This plan will set out a timetable for undertaking baseline assessments.

The baseline assessment plan must identify priority areas for undertaking baseline assessments. Petroleum tenure holders are required to undertake baseline assessments for all water bores in a priority area identified in the baseline assessment plan. The assessment must be undertaken in accordance with the approved timetable in the plan. Timetables must provide for baseline assessments being undertaken prior to commencing any petroleum production in a priority area; or prior to production testing in the same aquifer as the bore, and within two kilometres horizontally in the priority area; or by 30 days after production testing in the priority area.

The requirement to undertake a baseline assessment applies to petroleum tenure holders that were testing for, or producing petroleum when the Water Act amendments commenced and any time thereafter.

It should also be noted that under Section 402 of the Water Act, the chief executive may direct a petroleum tenure holder to undertake a baseline assessment at any time if it is reasonably considered that a bore is likely to be affected by the petroleum tenure holder's operations.

If it becomes apparent that the timetable requirements of the approved baseline assessment plan will not be met, the petroleum

tenure holder should apply to amend the plan.

Section 396(2) of the Water Act recognises baseline assessments for water supply bores may have already been undertaken by petroleum tenure holders. Provided that the baseline assessments previously undertaken substantially meet the minimum requirements for baseline assessments set out by these guidelines, they may be submitted as complying with the requirements in the Water Act.

A program for undertaking baseline assessments for all water bores within a long term affected area but outside a petroleum tenure is required as part of the water monitoring strategy within underground water impact reports. A long term affected area is an area where aquifer levels are predicted to decline by more than the relevant bore trigger threshold (5 m for consolidated aquifers and 2 m for unconsolidated aquifers), but not within three years.

## Baseline assessment plans

Section 397(1) of the Water Act obligates petroleum tenure holders to provide a baseline assessment plan for the area of the holder's tenure, which will then be assessed and approved (with or without conditions) by the chief executive. If these plans are deemed to be inadequate, the chief executive can also direct petroleum tenure holders to amend and resubmit them for approval. The baseline assessment plan must be provided to the chief executive before the start day for the petroleum tenure, or if this day has already passed, within 30 days of commencement of the legislation, unless a longer period is agreed to by the chief executive.

A baseline assessment plan for the area of the petroleum tenure must:

- state whether a baseline assessment has been undertaken for any bores in the area before the day the plan is given to the chief executive, and if so, identify the bores; and
- identify each area of the holder's petroleum tenure in which water bores, other than the bores that have already been subject to baseline assessment, are or may be located (each defined as a "priority area"); and
- state a timetable for undertaking baseline assessments of water bores in each priority area where assessment has not already been completed. This must include the day by which all baseline assessments in each priority area will be undertaken to ensure compliance with the baseline assessment timetable provision outlined below (Section 398 of the Water Act); and
- state the rationale for the baseline assessment timetable.

## Baseline assessment timetable

Section 398 of the Water Act states that a baseline assessment timetable for a holder's petroleum tenure must provide for baseline assessments to be undertaken for a water bore located in a priority area for the tenure by the earliest of the following:

1. before production testing starts if:
    a) a bore in the priority area is located within 2 km of the production testing; and
    b) during the production testing, water will be taken from the aquifer supplying the water bore;
2. before production of petroleum starts in the priority area
3. the day after a period of 30 days, whether continuous or not, of undertaking production testing in the priority area

However, if the tenure holder obtains the written agreement of the owner of the water bore, the baseline assessment for that particular water bore/s, may be undertaken on a later day than mentioned above.

The baseline assessment timetable must propose a day by which the baseline assessment will be undertaken for each water bore in the priority area if, on the commencement of the legislation:

- production testing in the priority area has been undertaken for a period of more than 30 days, whether continuous or not; or
- production of petroleum in the priority area has started.

A baseline assessment timetable must state the rationale for each proposed date by which baseline assessments will be undertaken.

## Compliance with an approved baseline assessment plan

A petroleum tenure holder must undertake a baseline assessment of a water bore by the day stated in the holder's approved baseline assessment plan, unless the holder has a reasonable excuse.

In the event that there is a need to substantiate a reasonable excuse, petroleum tenure holders must maintain written records outlining attempts to comply with:

- the timetable presented in the baseline assessment plan; and
- the processes outlined in this guideline for meeting the minimum requirements for the plan..

## Bore owner responsibilities

Bore owners will receive a notice from the petroleum tenure holder at least 10 business days before undertaking a baseline assessment. The Water Act also gives petroleum tenure holders the power to request information required for the baseline assessment from land owners. Land owners with water bores on their land are expected to comply with any reasonable request for information from the petroleum tenure holder, as the provision of this information will result in more accurate baseline assessments and consequently greater confidence around any future make good agreements.

## How is baseline assessment information to be reported?

Information collected from baseline assessments must be reported in the approved form under Section 405 of the Water Act, which is available for download from the Department of Environment and Resource Management's (DERM) website <www.derm.qld.gov.au>.

A copy of the information collected using the approved form must be provided to the bore owner and the Queensland Water Commission (the commission) within 30 business days after undertaking the assessment. It should be noted that the assessment includes analysing data obtained about water level, water quality, bore construction and infrastructure therefore, the 30 business day period commences once laboratory results are received and this information has been analysed. The information collected during baseline assessments should also be retained by both the bore owner and the petroleum tenure holder.

## What happens to the information gathered during a baseline assessment?

The information collected from baseline assessments will be collated and stored by the commission. This will assist in regional underground water flow modelling providing more accurate predictions of underground water impacts.

# 1.0 Minimum requirements of baseline assessments

Under Section 394 of the Water Act, a baseline assessment is an assessment undertaken by the petroleum tenure holder and must contain the following information about the water supply bore:

- the level and quality of water in the bore
- how the bore is constructed
- the type of infrastructure used to pump water from the bore.

This Baseline Assessment Guideline is produced under Section 395 of the Water Act and provides further detail about the minimum requirements for undertaking a baseline assessment including circumstances where obtaining baseline assessment information is not required (such as inability to access the bore or where significant modifications would be required to infrastructure). This guideline also outlines useful elements in addition to the minimum requirements.

# 2.0 Essential elements of baseline assessments

There are a number of essential elements that will ensure that baseline assessments are appropriate and meaningful for all parties involved.

## Requirement for best quality data

As the baseline assessment is a key component of future determination of impaired capacity and negotiation of make good agreements, it is essential that the best quality data be obtained from this assessment process. The data collection processes must be robust and provide for the collection of accurate, appropriate and defensible data. This provides protection for both the bore owner and the tenure holder.

Considerable literature already exists on the topic of underground water monitoring and sampling. Relevant industry standards that should be referenced include, but are not limited to the below or subsequent versions thereof:

- Monitoring and Sampling Manual 2009, Version 2 (DERM, 2010) <http://www.derm.qld.gov.au/environmental_management/water/water_quality_monitoring/monitoring_and_sampling_manual.html>

- EPA Guidelines: Regulatory Monitoring and Testing, Underground Water Sampling (South Australia Environment Protection Authority, 2007)
- Groundwater Sampling and Analysis—A Field Guide (Geoscience Australia, 2009) <https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=68901>
- DERM - Water Monitoring Data Collection Standards—March 2007
- AS/NZS 5667.11:1998 Water Quality—Sampling—Guidance on Sampling of Groundwaters.

## Minimum qualifications for persons conducting baseline assessments

The tasks associated with a baseline assessment require an appropriate level of skill, experience and expertise. While having a degree in science or engineering may be relevant to the task, this on its own does not guarantee appropriate skills, experience and expertise.

The minimum requirements for persons conducting the field measurements required for a baseline assessment are:

- a minimum of two years prior experience in the following fields:
  - underground water level monitoring programs, including monitoring of water level in bores equipped with pumping infrastructure
  - the conduct of underground water quality sampling programs
  - underground water hydrology and/or engineering
- a practical knowledge of water bore construction and infrastructure.

When allocating personnel to conduct a baseline assessment, the petroleum tenure holder should be mindful that they must be able to demonstrate that these persons satisfy the minimum qualification requirements. Failure to use appropriate field data collection personnel may impact the petroleum tenure holder's rights in any future bore assessment process.

Should the bore owner be concerned that the person(s) conducting the bore assessment do not have the appropriate skills and experience, the bore owner may request the tenure holder to provide evidence of the person(s) skills and expertise.

## Quality assurance and quality control

As the water level and water quality data collected from the baseline assessment will provide the foundation on which future bore assessments are based, it is imperative that the necessary level of confidence can be demonstrated in relation to data integrity and accuracy.

A formal quality assurance program must be developed by the tenure holder which is consistent with the principles of AS/NZ 9000 and QA/QC requirements of AS5667 and the DERM Monitoring and Sampling Manual. The primary purpose of this program is to document the procedures and protocols for all aspects of the baseline assessment and must include quality control procedures.

Quality control procedures may include requirements such as performance of work by two personnel, thus enabling field checks, and analysis of duplicate water quality samples. It is the responsibility of the petroleum tenure holder to develop relevant best practice quality control procedures.

## Independent third party certification

All baseline assessments must be completed by an independent third party or certified by an independent third party, through signoff on the approved form for submitting baseline assessment information. It should be noted that independent certification does not require an independent person being present in the field for all baseline assessments. However, the independent third party certification program must include at least the following:

- field verification of a minimum of 10% of the baseline assessments being certified including:
  - that quality assurance and quality control procedures are being implemented, inclusive of compliance with the relevant standards and manuals referenced above
  - that all aspects of the baseline assessments are undertaken in compliance with this guideline
- verification of the minimum qualifications, training and experience of all persons conducting baseline assessments.

Independent third parties conducting baseline assessments or providing certification must:

- not be an employee of, nor have a financial interest or any involvement which would lead to a conflict of interest with the

petroleum tenure holder whose baseline assessments are being certified

- have a degree in a relevant science or engineering discipline
- have a minimum of five years prior experience in the following fields:
  - underground water level monitoring programs, including monitoring of water level in bores equipped with pumping infrastructure
  - the conduct of underground water quality sampling programs
  - underground water hydrology and/or engineering
- have a practical knowledge of water bore construction and infrastructure.

# 3.0 Completing a baseline assessment

The groundwater impact management framework in the Water Act, including baseline assessments, applies to all authorised water bores potentially affected by the exercise of water rights by petroleum tenure holders.

Prior to the petroleum tenure holder visiting the bore site to undertake a baseline assessment it is recommended that the petroleum tenure holder undertake a search of relevant information about the bore.

The petroleum tenure holder should obtain all relevant information from DERM's groundwater database. This will enable the petroleum tenure holder to have a record of relevant details about the bore prior to visiting the bore site. This data can then be verified with the bore owner and through the baseline assessment.

The petroleum tenure holder may ask a bore owner for information about the bore owner's water bore if the tenure holder reasonably requires the information to undertake a baseline assessment. The bore owner has an obligation under Section 404 of the Water Act to comply with any reasonable request from the tenure holder, if the bore owner has the information.

## PART A: - Document identification and bore site information

It is essential that the information collected during a baseline assessment has a unique identifier.

In Queensland's groundwater database (GWDB), each water bore is given a registration number (the Bore RN). However, there are some difficulties in using the registration number as a unique identifier for survey purposes, because in some instances it may be difficult to correlate a bores' physical location in the field with the registration number.

In addition, there may be other authorised bores which may not be recorded in the groundwater database and may not have a registration number. Therefore, assigning a unique identifier (Bore ID) for each visited bore at the time of survey is required. This unique identifier should be a sequential number with a reference to the petroleum tenure holder XYZ [such as Origin 231]. Where a registration number is known for that bore, this should also be recorded separately (Bore RN) as additional information for cross referencing. In instances where there could be a possibility of more than one registration number correlating to a bore in the field, more than one registration number can be provided.

The purpose of this information is for cross-referencing and comparing with other nearby bores in the petroleum tenure that have been assessed during this baseline assessment by the petroleum tenure holder. This is important for evaluating the likely accuracy of the standing water level measurement in Part F.

The bore owner may have a bore registration number for their water bore. This information is to be recorded when available as it will assist in identifying the correct bore in any future bore assessments.

In many cases, it may be difficult to be confident that the bore registration number matches the bore site. For example; there may be two bore sites within close proximity to one another, and this may lead to confusion over which bore registration number is assigned to which bore. If there is some doubt over the registration number, then commentary around the confidence level or accuracy would be necessary to record for the purposes of identifying the bore in future.

If the bore owner has a local name for the bore, this would be useful information to record, as it will assist in identifying the correct bore in any future bore assessments.

The tenure holder should record the location of the bore site referenced to GDA94, to ensure that the bore site has been accurately captured. One possibility is to utilise a GPS-ready digital camera to capture the bore site. Utilising a GPS-ready digital camera would also allow the information to be transferred via GPS-Photo Link into ESRI Geographic Information Systems.

## PART B - Bore construction details

The name of the aquifer/geological formation that is the source of supply for the bore is to be recorded where available. This information should be available on any drilling logs that are available for the bore. In many cases, it may be difficult to be confident that the bore is accessing a certain geological formation. Therefore, any commentary on the confidence level of the source aquifer (e.g. how confident is the assessor that the bore is in fact accessing the Springbok formation) is to be recorded.

Petroleum tenure holders must collect and record information about the construction of the water bore as shown in Table 2 where this information is available.

**Table 2: Bore Construction Information**

| Information required | Purpose for which information is used. |
|---|---|
| Date of construction | Determination of the likely condition of the casing and perforated interval/s. |
| Type of casing | Assists in the interpretation of the chemical composition of the water from the bore and the condition of the casing. The most commonly used materials are steel or PVC. |
| Name of drilling contractor | Drilling contractor may be contacted for construction details if they are unknown to bore owner. |
| Casing strings and diameters | Calculation of the volume of water that is contained within casing storage prior to purging the water bore before sampling the water. This information is usually found only on the driller's log for the water bore. In some cases it is also contained in property records. |
| Perforated intervals and / or screens that have been installed in the bore | Important for assessing the aquifer/s that the water bore taps for its supply. |
| Details of any seals and cement grouting installed in the bore annulus | Important for assessing whether there is any possibility of corrosion of the casing and invasion of the bore's supply e.g. saline aquifer water. |
| Bore strata log | Generally contains most of the information listed above. Also assists in assessment of aquifer that the water bore intersects. |

Details of the water supply bore's capacity (yield) would normally have been established at the time of development of the bore. The Minimum Construction Requirements for Water Bores in Australia recommend that: 'On completion of any production bore, adequate testing should be carried out by the driller to provide the client with a reasonable indication of the capacity of the bore. This test will also demonstrate to the client that the bore has been constructed properly and is therefore capable of producing clean water'.

In addition, Section 24(g) of the *Water Regulation 2002* (Queensland) requires that records for water bores drilled contain 'an estimation of the rate at which water may be produced from the bore'.

Hence, rather than undertaking a capacity assessment at the time of baseline assessment, information should be obtained from driller's records on the capacity of the bore (yield) whenever this information is available.

## PART C - Bore equipment & condition details

Petroleum tenure holders must record information about the pumping equipment in the water bore including whether the bore is metered, the pump type and make and whether the bore is in operating condition or has been decommissioned. Additional information on the power source for the bore, and details on the riser and headworks should also be recorded. This information will assist both the petroleum tenure holder and the bore owner at the time of undertaking a future bore assessment and determining whether the bore has an impaired capacity.

The tenure holder must photograph the bore and the bore equipment, to accurately capture the condition of the bore and equipment at the time of conducting the baseline assessment. The pictures should be representative of the bore and detail each site individually, including a shot of the site and a shot of the headworks.

The pump setting depth at the time of baseline assessment is to be established as part of the baseline assessment. This information will be useful in future bore assessment. If the bore is determined to have an impaired capacity—one possible mitigation measure may be to lower the pump.

The tenure holder should record any details that the bore owner has about any repairs or maintenance that has previously been undertaken on the bore. For example, it is useful to record information about who has carried out maintenance on the bore and when. These records will be useful background information to support any future bore assessment and determination of whether the bore has an impaired capacity.

# PART D - Bore supply information

The tenure holder must establish the purpose of the bore with the bore owner. Understanding the purpose of the bore at the time of baseline assessment is a vitally important component of the assessment and any subsequent make-good agreements. Additional commentary as to how often the bore is utilised (hours pumped/day) is to be recorded where available. This information will support any future bore assessment and determination of whether the bore has an impaired capacity.

Where known, the operating capacity of the bore and any associated commentary on the operating capacity of the bore that the bore owner can supply, including any seasonal variation in use must be recorded.

The bore owner should supply any historical water use records that are available for the bore. These records will be valuable background information for the tenure holder and will assist both the tenure holder and the QWC in understanding regional groundwater trends.

Peak usage information for the bore (including maximum volumes extracted and period of peak extraction) is to be obtained wherever available. Should this information not be available, accurate information relating to the use of the water extracted from the bore that needs to be captured could include:

- stock watering (type, head)
- domestic use (number of households supplied, area of gardens watered)

Where no volumetric usage information is available, the figures supplied in Appendix 1 should be used to estimate volumes supplied by the bore.

# PART E - Standing water level measurement

It is a requirement of the baseline assessment that a standing water level (SWL) be obtained for water bores in the area of a holder's petroleum tenure wherever practicable. Before a standing water level can be obtained from a bore, consideration must be given to the condition of the bore and whether a meaningful water level can be obtained without causing significant modifications or damage to the bore. For example, significant modification would include pulling windmills or removing pumps and in these circumstances a standing water level is not required.

If a bore is not equipped with a pump, the bore may still be of use to the bore owner and therefore will require a water level measurement.

For those bores that are equipped with a pump, there is often limited space in the annulus of the bore to allow for unobstructed access for the water level probe. If access can be provided through minor works of a non-structural nature, these works should be negotiated with the bore owner, whose permission must be obtained prior to undertaking any works. As an example, minor works to obtain access may include removing a face plate or jacking up a well head.

## Bore pumping at time of inspection

At the time of the site visit to obtain a water level, it may be possible that the bore could be pumping or has recently ceased pumping. In these circumstances, the optimal course of action is to revisit the bore when the water level has fully recovered from the influence of pumping and the water level has stabilised.

The residual drawdown of the water level of a bore can take many hours or days to recover to a standing water level. It has been assumed that the time for the water level to recover is a function of the yield of the bore, the higher the yield, then the greater the time to recover.

As a guide, a bore that has a yield less than five litres per second should be given at least 48 hours recovery. A bore that has a yield greater than five litres per second should be given at least 96 hours recovery. However, the recovery period for each bore should be considered on its own merit. These time estimates are indicative only and should be discussed with the bore owner.

It is acknowledged that in some circumstances, such as where an extensive irrigation campaign is underway, it is not practicable for the landholder to cease pumping the bore for an extended period of time. In these cases, best endeavours should be made to take the most representative water level measurement possible. It is critically important that in these circumstances detailed information relating to the antecedent conditions of the bore are obtained and recorded. This information must include periods of pumping and rest periods and maximum pumping rates whenever this information is available.

Where an appropriate recovery period cannot be achieved, the use of automatic water level data loggers may be adopted to obtain detailed information regarding impacts of extraction from the bore and nearby bores. It should be noted that while data-loggers are considered a very useful tool to improve the accuracy of bore level measurements, they are not considered necessary to meet the minimum requirements of a baseline assessment.

Where automatic data loggers are not being used, the water level should be measured for as long as possible to record recovery and specify the bore recovery rate at the time the final water level was recorded.

Where the above measures are not feasible, a return visit at a later time, while not considered essential as part of a baseline assessment, may be scheduled. In these circumstances, the timetable requirements of the baseline assessment plan should be taken into account when rescheduling. If it becomes apparent that rescheduling may not be possible within the timetable requirements of the approved baseline assessment plan, the petroleum tenure holder should apply to amend the plan.

### Datum point

Before any water level measurement is taken in a water bore, a datum must be established on the water bore to ensure that any future measurements taken in the water bore will be referenced back to the same point.

All depth measurements are conventionally taken from the top of the bore casing or bore cover (at a marked point, such as the padlocking point). When selected, this point will need to be documented for each individual bore. This is to be achieved by photographing the bore head with the datum point clearly marked.

The photograph must include a legible written record of:

- the unique identification number of the bore and the government registered number if available
- the bore owner's name
- property name
- the date of the photograph.

The height of the datum above ground level is also to be measured and recorded.

Underground water levels are expressed as a level relative to the ground surface. The distance between the measuring point (e.g. datum at the top of casing) and the ground surface is subtracted from the measured distance between the measuring point (e.g. datum at the top of casing) and the level in the bore. If the water level in the bore is below ground, the result is recorded as negative (–), and positive (+) if it is above ground (i.e. water standing in the casing above ground).

### Accuracy and calibration

The instruments that are taking water level measurements need to be regularly checked that they are within calibration. This means that the device must be checked against an applied standard value to ensure that the device is indicating that value within a specified accuracy. Accuracy and calibration should be part of quality assurance and quality control procedures for baseline assessments, and error should not exceed ±50mm for water level measurements.

## PART F - Water quality assessment

Water quality data is to be collected consistent with the approved use of the bore. This may include activities such as stock watering, irrigation, industrial or potable uses. A comprehensive water quality assessment ensures that all of the necessary data will exist in the future, should a bore assessment be required and should a bore's approved use change.

It should be noted that only changes in water quality caused by a decline in water level which results from the exercise of underground water rights, form part of the make good framework. However, water quality information is also important as part of a baseline assessment as it can provide information about other issues with the bore leading to water quality problems, such as faults in casing or cementing integrity.

Potential water quality impacts that may have resulted from other activities such as the use of hydraulic fracturing products (fraccing products) are dealt with through the framework of the *Environmental Protection Act 1994* (EP Act). Water quality analytes which may be associated with such matters are therefore not a mandatory requirement of the baseline assessment or bore assessment water quality framework. However, petroleum tenure holders may consider assessing further water quality analytes on a voluntary basis.

Water quality samples must be collected from all bores equipped with pumping infrastructure. If a bore is not equipped with pumping infrastructure, best endeavours should be made to obtain water quality samples. However, it is recognised that in some circumstances difficulties in purging the bore will mean that obtaining a representative water quality sample is not practicable. Further guidance is provided in the "Sampling procedure" section below about what actions may be taken in order to obtain a water quality sample. Petroleum tenure holders should be aware that if no water quality sample is able to be taken as part of a baseline assessment and it becomes evident this baseline water quality information is required, DERM may issue a direction to undertake a baseline assessment including obtaining a water quality sample.

### Selection of sampling location

Sample collection must occur as close to the water bore as possible, and where possible, before any other pipework joins the bore discharge pipework. Manipulation of headworks for access is not required. This will minimise the effects of temperature and pressure changes on the sample and avoid contamination of the sample from other sources.

The tenure holder and the bore owner should reach agreement on the most appropriate place to obtain a sample that will be representative of the bore water. When taking samples, potential sources of contamination must be identified and avoided wherever practicable and disturbance to the existing infrastructure must be minimised. The location of the sampling point must be documented and where the sampling point is not within 15 m of the bore, it must be photographed. Its position must also be recorded using a handheld GPS. Samples of bore water should not be collected from storages such as water tanks, troughs or dams.

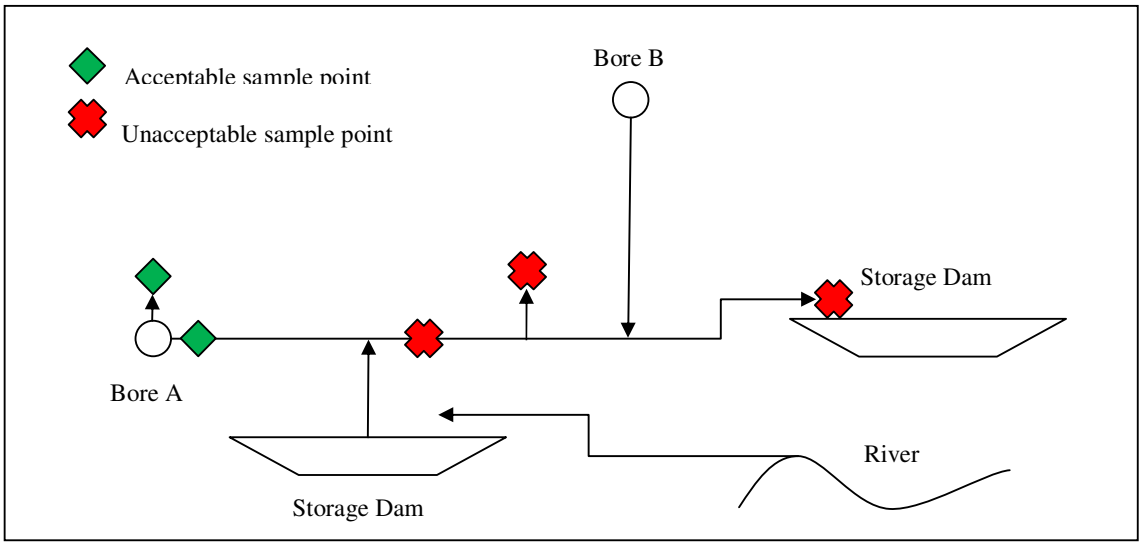


**Figure 2: Schematic of acceptable water sampling locations from Bore A**

## Sampling procedure

Prior to sampling a water bore, wherever practicable, the volume of stagnant water within the bore casing and discharge piping (upstream of the sampling point) must be calculated. Water quality samples should only be collected:

- after three times the volume of stagnant water in the bore casing and the discharge piping (including a sufficient additional volume to account for any error in volume calculations) have been discharged, and
- when the field water quality parameters have stabilised.

Stabilisation of the water quality parameters indicates the bore is producing formation water.

It is recognised that there may be circumstances where full purging of a bore in compliance with the above requirements prior to sampling is not practicable, such as when the bore is not equipped with pumping equipment or where there are restrictions on disposing of the purge water. In such cases, the petroleum tenure holder should develop an appropriate strategy for purging and sampling bores. This strategy should be representative and consistent with recognised standards and guidelines for purging and sampling bores. Methods such as low flow micro-purging techniques may be a viable sampling method under some circumstances with a flow controller and flow through cell.

In cases where full purging is not practicable but a meaningful sample can still be collected, the pumping history of the bore, particularly when the bore was last used must be recorded in detail if it is available. When water quality samples are taken where there is no pumping equipment in place in the bore, photographs showing the bore and sampling setup are to be taken by the tenure holder as this assists in demonstrating the integrity of the sampling process.

Possible options for obtaining a sample when pumping equipment is already in place may include:

- sampling from an existing valve and pipe
- temporarily replacing another piece of equipment (e.g. a pressure gauge) with a valve to enable a sample to be obtained from this point
- installing a temporary valve and piping setup to be removed after sampling with reinstatement of the original piping.

The preferred option is that which allows sample collection to occur in a controlled manner and avoids disturbance to the sample by contamination from physical, chemical or biological processes. Use of a diversion pipe and flow regulating valve is therefore recommended.

## Minimum requirements for field parameters and laboratory analytes

Table 3 specifies the minimum requirements for water quality data. All samples for baseline assessments are to be analysed at National Association of Testing Authorities (NATA) accredited laboratories. The limit of detection must be sufficient for assessment against current and relevant guidelines, including but not limited to:

- ANZECC & ARMCANZ, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy Paper No. 4, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- NHMRC & NRMMC 2004, Australian Drinking Water Guidelines, National Water Quality Management Strategy Paper No. 6, National Health and Medical Research Council and Natural Resource Management Ministerial Council.

**Table 3: Minimum water quality analytes for baseline assessments**

| Category | parameters | |
|---|---|---|
| Physical parameters | pH (field and laboratory)<br>temperature (field only)<br>electrical conductivity (field and laboratory)<br>total dissolved solids (laboratory only) | |
| Ions | calcium<br>chloride<br>fluoride<br>magnesium | potassium<br>sodium<br>sulphate |
| Metals (dissolved & total) | aluminium<br>arsenic<br>barium<br>beryllium<br>boron<br>cadmium<br>chromium<br>cobalt<br>copper<br>iron | lead<br>manganese<br>mercury<br>molybdenum<br>nickel<br>selenium<br>uranium<br>vanadium<br>zinc |
| Alkalinity and hardness | alkalinity - bicarbonate, carbonate, hydroxide and total as CaCO3 (field and laboratory)<br>total hardness as CaCO3 | |
| Dissolved gases | carbon dioxide (field)<br>methane<br>hydrogen sulphide | |

These requirements ensure that all potential underground water end-users are protected and provides information essential to investigating the cause(s) of any future impairment. For example, dissolved carbon dioxide can lead to deposition of calcium carbonate where calcium and bicarbonate ions are in solution and is also responsible for enhanced corrosion of steel when the carbon dioxide concentration typically exceeds 40-50 mg/L. Reduced water levels and aquifer depressurisation therefore have the potential to both increase fouling and corrosion, hence obtaining data on these parameters is imperative prior to petroleum and gas activities.

## Presence and analysis of gas

The bore owner must advise the tenure holder if gas is present and information should be sought on under what conditions it occurs. All bores must be measured for the presence of carbon dioxide, methane and hydrogen sulphide using a multi-parameter gas detector and in compliance with the Department of Employment, Economic Development and Innovation's guideline entitled "*Code of Practice for coal seam gas well head emissions detection and reporting*" dated April 2011, or subsequent versions thereof.

Samples for dissolved gas are required to be collected whenever water quality samples are being collected. The preferred method to obtain dissolved gas samples is through the use of a flow-through cell (or gas separator/stripper) installed on the bore discharge pipework where this can be achieved without modifications to the bore infrastructure. Where a flow-through cell can be utilised, the quantity of gas to water is to be determined and should gas be present, field measurements of concentration are to be obtained using a suitably calibrated gas analyser sampling directly from the flow-through cell (or gas separator/stripper), or via a field titration test kit. In such cases, the tenure holder must obtain a sample of gas for compositional analysis by a laboratory via the flow-through cell (or gas separator/stripper).

Where water quality samples are being collected but a flow-through cell cannot practicably be used, dissolved gas samples must be collected using the methods outlined in section 7.2 of Groundwater Sampling and Analysis—A Field Guide (Geoscience Australia, 2009).

It is recognised that the presence or absence of gas may be affected by factors including petroleum and gas activities, biogenic sources, seasonal factors or the bores use. Therefore, the pumping regime prior to assessing the presence or absence of gas, must be recorded as part of the baseline assessment.

## Additional water quality analytes

Potential water quality impacts that may have resulted from other petroleum and gas activities, such as hydraulic fracturing or injection of CSG water into aquifers are managed through the EP Act. The following additional constituents are not considered minimum requirements of a baseline assessment under the Water Act but may be analysed as deemed necessary by the petroleum tenure holder, or as required by the chief executive under the EP Act.

Water quality data that is collected should be collected consistent with the approved use of the bore, which may include activities such as stock watering, irrigation, industrial or potable uses.

**Table 4: Suggested additional water quality analytes for baseline assessment**

| Category | parameters |
|---|---|
| Physical parameters | benzene<br>toluene<br>ethyl-benzene<br>xylene (Total)<br>naphthalene<br>phenanthrene<br>benzo (a) pyrene<br>sodium hypochlorate<br>sodium hydroxide<br>formaldehyde<br>ethanol<br>gross alpha radiation |
| Nutrients | ammonia<br>nitrate as N<br>nitrite as N<br>nitrate + nitrite as N<br>total nitrogen as N<br>total phosphorus |
| Microbiological | total heterotrophic plate count<br>sulphate-reducing bacteria |
| Miscellaneous | ionic balance<br>sodium adsorption ratio (calculated) |

The total heterotrophic plate count provides a broad assessment on the biological condition of the bore, which in turn can indicate the level of fouling which exists prior to petroleum and gas development. Sulphate reducing bacteria are an indicator of the severity of anaerobic growth in the bore, and can be responsible for taste and odour issues as well as corrosion damage.

### Sample identification, preservation and transportation

Sample identification, preservation and transport must adhere to best practice industry standards with the minimum requirements to be considered including:

- Samples must have a unique identification number that can be cross-referenced to the monitoring location and time of sampling
- Sample preservation measures are to be documented and must comply with the laboratories requirements and relevant standards (e.g. AS/NZS 5667.1:1998)
- Sample integrity is to be maintained through the use of chain of custody procedures and documentation

### Rescheduling of water sampling

Should sampling of the water from the water bore not be feasible at the time of the initial field visit, the bore owner and tenure holder may choose to agree on another time for obtaining a sample. If sampling is rescheduled, then, both parties should formally record the agreed rescheduled timeframe. It should be noted that the rescheduled timeframe for obtaining a sample must be within the timetabled date in the approved baseline assessment plan for the area in which the bore is located, or if this is not possible the baseline assessment plan should be amended to account for the new agreed timeframe.

Should the bore owner choose not to reschedule a time for water quality sampling, the tenure holder must record this within the results of baseline assessment.

## PART G - Assessment officer details

Record the contact details of the assessment officer responsible for conducting the baseline assessment.

## PART H - Declaration

The contact details of the officer accountable for “sign off” on the data collected during the baseline assessment must be recorded.

The baseline assessment must be certified by an independent third party in accordance with the requirements of Section 2 of this guideline.

A witnessed declaration for and on behalf of the petroleum tenure holder by a person authorised to sign on behalf of the petroleum tenure holder must be included in each baseline assessment.

## PART I - Property owner/manager details

Record the contact details of the person responsible for providing information to the petroleum tenure holder about the baseline assessment.

# References

ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy Paper No. 4*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

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Department of Environment and Resource Management March 2006, *Fact sheet iron bacteria in water bores.*.

Department of Environment and Resource Management 2010, *Monitoring and Sampling Manual 2009, Version 2*.

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NHMRC & NRMMC 2004 *Australian Drinking Water Guidelines, National Water Quality Management Strategy Paper No. 6,* National Health and Medical Research Council and Natural Resource Management Ministerial Council.

Standards Australia 1988, *AS/NZS 5667.11:1998 Water quality - Sampling - Guidance on Sampling of Groundwaters.*

Standards Australia1990, *Australian Standard 2368 1990 - Test Pumping of Water Wells*.

# Definitions/Glossary

**Analyte**

A chemical parameter determined by either physical measurement at the bore head (e.g. electrical conductivity), or by laboratory analysis.

**Aquifer**

A saturated underground rock or sediment formation which is sufficiently permeable to transmit water to wells and springs.

**Artesian water bore**

A water bore in which underground water flows naturally to or above the land surface.

**Authorised water bore**

An authorised water bore includes water bores for which the taking of, or interfering with, water is authorised under the Water Act, and if required, a development approval has been granted under the *Sustainable Planning Act 2009* (or was granted under the repealed *Integrated Planning Act 1997*). This includes water bores from which the taking or interference with water is authorised without the requirement for a water entitlement under Section 20 of the Water Act.

**Baseline Assessment**

An assessment of a water bore undertaken by a petroleum tenure holder to obtain information about the bore, including the following:

(a) the level and quality of water in the bore

(b) how the bore is constructed

(c) the type of infrastructure used to pump water from the bore.

Note: undertaking a baseline assessment includes analysing data obtained during the assessment to establish the matters in paragraphs (a) to (c).

**Bore trigger threshold**

A decline in water level in an aquifer prescribed by regulation, or otherwise 5 m for consolidated aquifers, and 2 m for unconsolidated aquifers. These threshold values apply if no other threshold is prescribed by regulation. They are intended to reflect a water level decline in an aquifer that would have significant risk of causing a noticeable decline in the amount of water that can be pumped from a water bore tapping the aquifer.

**Coefficient of storage**

The volume of water an aquifer released from an aquifer per unit surface area of the aquifer and per unit change in head.

**Consolidated aquifer**

An aquifer consisting predominantly of consolidated sediment. The term includes geological formations such as sandstone, fractured mudstone and basalt.

**Datum point**

An agreed reference point at the bore head. This is usually the top of the casing.

**Impaired capacity**

A water bore is considered to have an impaired capacity if the water bore is unable to continue to provide a reasonable supply of water in terms of quality and quantity, for the bore's authorised purpose or use as a result of water extraction associated with petroleum and gas production.

**Petroleum tenure holder**

The holder of an authority to prospect or petroleum lease issued under either the *Petroleum Act 1923* or the *Petroleum and Gas (Production and Safety) Act 2004*.

**Residual drawdown**

The depth of the water level calculated by subtracting the static water level before pumping began from appropriate water levels taken during the recovery process.

**Spring**

Points in the landscape at which underground water naturally expresses at the surface (i.e. without the need for a water bore).

**Start day**

The earlier of the following:

- the day production testing starts in the area of the petroleum tenure;
- the day production of petroleum starts in the area of the petroleum tenure; or

If production testing or production of petroleum had already started in the area of the tenure on 10 December 2010—10 December 2010.

**Subartesian water bore**

A water bore in which underground water does not flow naturally to or above the land surface and must be pumped.

**Unconsolidated aquifer**

An aquifer that is not a consolidated aquifer. This includes geological formations such as alluvial aquifers.

**Underground water quality**

A term that encompasses the chemical and biological characteristics of the water from a bore. It is assessed by physical measurements at the bore head and follow-up laboratory analysis of sample/s of the water.

**Water level**

In an artesian bore, the level to which the water would, if it were tapped by a water bore and the water were contained vertically above the surface of the land, rise naturally above the surface of the land.

In a subartesian bore, the level to which the water would rise, if the aquifer were tapped by a water bore.

# Appendix 1—Water consumption estimates

| Type of livestock | Average daily consumption | Peak daily consumption | Average annual consumption |
|---|---|---|---|
| | **litres per head** | **litres per head** | **litres per head** |
| **Sheep** | | | |
| Nursing ewes on dry feed | 9 | 11.5 | 3 600 |
| Mature sheep on dry pastures | 7 | 8.5 | 2 700 |
| Mature sheep on irrigated pastures | 3.5 | 4.5 | 1 300 |
| Fattening lambs on dry pastures | 2.2 | 3.0 | 900 |
| Fattening lambs on irrigated pastures | 1.1 | 1.5 | 400 |
| **Cattle** | | | |
| Dairy cows in milk | 70 | 85 | 25 000 |
| Dairy cows, dry | 45 | 60 | 17 000 |
| Beef cattle | 45 | 60 | 17 000 |
| Calves | 22 | 30 | 8 000 |
| **Horses** | | | |
| Working | 55 | 70 | 20 000 |
| Grazing | 35 | 45 | 13 000 |
| **Pigs** | | | |
| Brood sows | 22 | 30 | 8 000 |
| Mature pigs | 11 | 15 | 4 000 |
| **Poultry** | **litres per 100 birds** | **litres per 100 birds** | **litres per 100 birds** |
| Laying hens | 32 | 40 | 11 500 |
| Non-laying hens | 18 | 23 | 6 500 |
| Turkeys | 55 | 70 | 20 000 |

| Use | Average Consumption | |
|---|---|---|
| | **litres/head/day** | **litres/head/year** |
| Household with septic system | 180 | 65 000 |
| Household without septic system | 135 | 50 000 |
| Homestead Gardens | As an approximate rule of thumb for small gardens an average daily consumption of 35 000 litres per hectare of watered garden, decreasing to 17 000 litres for the winter months, can be used. | |