

Guideline

Environmental Protection Act 1994

Requirements for site-specific and amendment applications— underground water rights

The purpose of this guideline is to provide assistance to resource tenure holders regarding the information requirements under sections 126A and 227AA of the Environmental Protection Act 1994, and when the information required under these sections must be provided in site-specific and amendment applications.

Table of contents

1	Introduction	3
1.1	Legislative framework	3
1.1.1	What are underground water rights?	3
1.1.2	EA and application requirements	4
1.1.3	When must the information required under section 126A be provided with a site-specific application?	5
1.1.4	When must the information required under section 227AA be provided with an amendment application?	5
1.1.5	Mandatory requirements	6
1.1.6	Information about conditioning an EA where the applicant is intending to exercise underground water rights	6
1.1.7	Adaptive management of impacts to groundwater: relationship with Chapter 3 of the Water Act	7
1.1.8	Requirements under the <i>Environmental Offsets Act 2014</i>	8
2	Requirements for site-specific applications exercising underground water rights— particular resource projects and activities	9
2.1	Part A—A statement that the applicant proposes to exercise underground water rights	10
2.2	Part B—A description of the area/s in which underground water rights are proposed to be exercised	10
2.3	Part C—A description of the aquifer/s affected or likely to be affected	10
2.4	Part D—An analysis of the movement of underground water to and from the affected or potentially affected aquifer/s	11
2.4.1	Inputs	11
2.4.2	Underground water elevations	12
2.4.3	Connectivity	12
2.4.4	Preferential flow paths	12
2.4.5	Springs	12

Guideline
**Requirements for site-specific and amendment applications—
underground water rights**

2.5 Part E—A description of the area of the aquifer or aquifers where the water level is predicted to decline because of the exercise of underground water rights13

2.6 Part F—The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights.....14

2.7 Part G—Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights.....15

2.8 Part H—Information on the environmental values that will, or may, be affected by the exercise of underground water rights.....16

2.8.1 Identifying and describing environmental values 17

2.8.2 Nature and extent of the impacts on the environmental values 19

2.8.3 Impacts to formation integrity and surface subsidence..... 20

2.9 Part I—Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater21

3 References24

4 Glossary25

5 Acronyms27

Version history

Version	Effective date	Description of changes
1.00	06 December 2016	First published version of the guideline.
1.01	06 December 2016	The document template, header and footer have been updated to reflect current Queensland Government corporate identity requirements and comply with the Policy Register.

1 Introduction

This guideline provides information to those preparing a site-specific application for a new environmental authority (EA) (site-specific application) or an application to amend an EA (amendment application) for resource projects or activities that:

- are carried out on one or more resource tenures for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and
- involve the exercise of underground water rights or a change to the exercise of underground water rights.

The primary purpose of this guideline is to assist applicants in understanding the information requirements of sections 126A and 227AA of the *Environmental Protection Act 1994* (EP Act) for site-specific and amendment applications. This guideline will assist applicants in lodging a legislatively compliant, well supported application. If the application does not include all the mandatory requirements, it will be determined to be not properly made and the applicant will need to re-apply.

This guideline also includes recommendations about the level of information that an applicant should provide with an application to assist in streamlining the assessment process and meeting the legislative requirements of sections 126A and 227AA of the EP Act. The information requirements of sections 126A and 227AA of the EP Act are similar to the content requirements for an underground water impact report (UWIR), which is required to be prepared under Chapter 3 of the *Water Act 2000* (Water Act).

Information previously provided to meet Water Act requirements or equally, requirements of an environmental impact statement (EIS), may be used, where applicable, to meet the requirements of sections 126A and 227AA of the EP Act.

The level of detail required for each section will depend on the specific characteristics of the project activities and the potential impact to environmental values and groundwater quality. The amount of information provided must be commensurate with the risk of environmental harm and be based on an assessment of the potential impacts of the proposed activities on the environmental values of the project site.

Section 2 of the guideline details specific methods and information that the Department of Environment and Science (the department) believes to be appropriate to provide the administering authority with the necessary information to meet the requirements of section 126A of the EP Act. The technical terms contained in this guideline are defined in section 4.

1.1 Legislative framework

1.1.1 What are underground water rights?

For the purposes of the EP Act, underground water rights mean any of the following:

- (a) Underground water rights provided to mineral development licence and mining lease holders in the *Mineral Resources Act 1989*;
- (b) Underground water rights provided to petroleum lease holders in the *Petroleum and Gas (Production and Safety) Act 2004*; and
- (c) Underground water rights provided to petroleum lease holders in the *Petroleum Act 1923*.

Underground water rights provide the tenure holder with a statutory right to take or interfere with underground water in the area of the tenure if the taking or interference with that water is necessarily and unavoidably obtained in the process of extracting the resource. For example, mine dewatering to the extent necessary to achieve safe operating conditions. This is also known as associated water.

With these underground water rights comes an obligation that tenure holders comply with underground water obligations provided for in Chapter 3 of the Water Act. Sections 126A and 227AA of the EP Act complement Chapter 3 of the Water Act, by ensuring that an upfront assessment of the impacts to environmental values from the exercise of these underground water rights has been undertaken, and that potential impacts are appropriately managed.

Water that is taken for consumptive uses such as camp water or hydraulic fracturing is known as nonassociated water. Resource tenure holders are required (mining lease and mineral development licence holders) or will be required (petroleum lease holders) to obtain a water authorisation under the Water Act before extracting non-associated water in a regulated groundwater area.

1.1.2 EA and application requirements

The *Petroleum and Gas (Production and Safety) Act 2004* and the *Mineral Resources Act 1989* provide that tenure cannot be granted unless an EA has been issued for the tenure under the EP Act. Sections 125 and 226 of the EP Act outline a list of requirements that must be provided by the applicant when submitting an application for an EA or an application to amend an EA.

For resource projects which involve coal seam gas activities, section 126 of the EP Act requires additional information regarding the management of coal seam gas (CSG) water. Section 227 of the EP Act requires that this additional information must also be provided if the amendment would result in changes to the management of CSG water. More information on this particular requirement is outlined in the guideline application requirements for petroleum activities (ESR/2016/2357¹).

The amendments introduced by the *Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016* have introduced new information requirements into the EP Act. Section 126A outlines a list of information requirements which must accompany a site-specific application where the resource activity or project involves the exercise of underground water rights. Section 227AA requires that this

¹ This is the publication number, which can be used as a search term to find the latest version of the publication at www.qld.gov.au.

information also be included with an amendment application where the proposed amendment involves a change in the exercise of underground water rights.

1.1.3 When must the information required under section 126A be provided with a site-specific application?

Any resource activity or project that involves the exercise of underground water rights has the potential, from that take of underground water, to impact environmental values. Section 126A of the EP Act therefore requires that a site-specific application include mandatory content to allow the administering authority to assess and regulate those impacts. The information requirements in section 126A must be provided for all site-specific applications that relate to—

- (a) a resource project that includes a resource tenure that is a mineral development licence, mining lease or petroleum lease; or
- (b) a resource activity for which the relevant tenure is a mineral development licence, mining lease or petroleum lease.

1.1.4 When must the information required under section 227AA be provided with an amendment application?

Section 227AA requires that an applicant must provide the information required by section 126A of the EP Act where the application is for a resource activity or project and the amendment involves changes to the exercise of underground water rights.

Amendment applications will only need to include information relating to the changes to the proposed exercise of underground water rights which will occur, or are predicted to occur, as a result of the proposed amendment to the EA.

Examples of proposed amendments which may indicate a change to the exercise of underground water rights include where—

- there is a change in tenure, for example converting an ATP to a PL;
- adding a new tenure to the EA;
- there is a significant change to the nature or scale of activities;
- there is a significant change to the volumes of water proposed to be taken; or
- there are likely to be different impacts on environmental values.

Like section 126A of the EP Act, only site-specific EAs (that is, an EA that includes any environmental relevant activities that are ineligible ERAs) relating to mining leases, mineral development licences or petroleum leases are captured by section 227AA.

1.1.5 Mandatory requirements

Where the applicant is proposing to exercise underground water rights, a site-specific or amendment application must include the mandatory information outlined in section 126A of the EP Act. Section 126A requires that the applicant must include the following:

- state any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure;
- describe the areas in which underground water rights are proposed to be exercised;
- for each aquifer affected, or likely to be affected by the exercise of underground water rights, include—
 - a description of the aquifer;
 - an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water;
 - a description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights; and
 - the predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out;
- detail the environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values;
- detail any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out; and
- detail strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater.

Section 227AA requires that an applicant must also provide the information required by section 126A of the EP Act where the application is for a resource activity or project and the amendment involves a change to the exercise of underground water rights.

1.1.6 Information about conditioning an EA where the applicant is intending to exercise underground water rights

Section 203 of the EP Act provides that the administering authority may impose a condition on an EA which it considers is necessary or desirable. In accordance with section 207(1)(g) of the EP Act, a condition imposed on an EA may relate to the exercise of underground water rights.

A condition imposed on an EA may state that the condition continues to apply after the EA has ended or ceased to have effect. While the administering authority endeavours to develop conditions that both the administering authority and the applicant are satisfied with, an applicant's agreement is not required for conditions to be included on an EA.

1.1.7 Adaptive management of impacts to groundwater: relationship with Chapter 3 of the Water Act

Potential impacts on groundwater will be managed through an adaptive management regime through both the EP Act and the UWIR process in Chapter 3 of the Water Act.

The requirements of section 126A of the EP Act are complementary with the information requirements for an UWIR under section 376 of the Water Act. It is anticipated that the information supplied with the EA application will be utilised and built upon for the applicant’s submission of the UWIR. Equally, any relevant information contained in an approved UWIR may be utilised as part of the EA application. However, new information, data or understandings gained between the time of an approved UWIR and submission of the EA application should be reflected in the application material.

Table 1 below provides guidance on where the application requirements under section 126A of the EP Act are similar to the content requirements for an UWIR under section 376 of the Water Act.

Table 1: Requirements under section 126A of the *Environmental Protection Act 1994* and section 376 of the *Water Act 2000*

Application Requirement	<i>Environmental Protection Act 1994</i>	<i>Water Act 2000</i>
A statement that the applicant proposes to exercise underground water rights	Section 126A(2)(a)	Not required
A description of the area/s in which underground water rights are proposed to be exercised	Section 126A(2)(b)	Not required
A description of the aquifer/s affected or likely to be affected	Section 126A(2)(c)(i)	Section 376(b)(i)
An analysis of the movement of underground water to and from the affected or potentially affected aquifer/s	Section 126A(2)(c)(ii)	Section 376(b)(ii)

Guideline

**Requirements for site-specific and amendment applications—
underground water rights**

A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights	Section 126A(2)(c)(iii)	Similar to section 376(b)(iv)-(v)
The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights	Section 126A(2)(c)(iv), noting that EP Act requires take for life of the project is required.	Similar to section 376(a)(ii), noting that Water Act only requires 3-year period starting on the consultation day for the report.
Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights	Section 126A(2)(e)	Not explicitly required, but will form part of the reporting on impacts to environmental values under section 376(da)-(db)
Information on the environmental values that will, or may, be affected by the exercise of underground water rights	Section 126A(2)(d)	Sections 376(da)-(db)
Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater	Section 126A(2)(f)	Not explicitly required, however note that requirements submitted under section 376(f)-(g), and make good obligations may be utilised as some of the proposed strategies to meet the requirements of section 126A(2)(f) of the EP Act.

An EA may be amended in response to the contents of an UWIR. UWIRs are reviewed annually and are updated on a three-yearly basis. This framework ensures that there is sufficient monitoring, collection and review of information for ongoing adaptive management of groundwater impacts due to the resource sector's statutory right to take underground water.

1.1.8 Requirements under the *Environmental Offsets Act 2014*

Applicants should note that, in addition to the above requirements under the EP Act, the *Environmental Offsets Act 2014* may also apply where despite all reasonable measures to avoid or minimise impacts to prescribed

environmental matters as a result of a prescribed activity, there is still likely to be significant residual impact on those matters. This may include significant impacts resulting from the exercise of underground water rights undertaken as part of a resource activity or project.

Applicants should refer to the Queensland Environmental Offsets Policy—Significant Residual Impact Guideline (Department of Environment and Science, 2014) for more information.

2 Requirements for site-specific applications exercising underground water rights—particular resource projects and activities

This guideline suggests specific methods and information that the department believes to be appropriate to provide the administering authority with the necessary information to meet the requirements of section 126A of the EP Act. The guideline recommends specific methods for making predictions about the impacts to environmental values and groundwater quality due to the exercise of underground water rights. The guideline also provides information on the types of environmental values that the department believe may potentially be affected due to the exercise of underground water rights, and outlines what level of information may be required on strategies to manage these impacts.

The department acknowledges that these methods may not need to be adopted in all cases and that it may be appropriate to use alternative methods. In cases where the applicant chooses to use methods other than those specified in this guideline, the applicant will need to consider the potential impacts of underground water extractions and justify the method chosen as being appropriate to the circumstances.

When site-specific applications are submitted for resource projects and activities that involve the exercise of underground water rights, the application must contain the information that has been outlined in each of the following parts of this guideline:

- Part A—A statement that the applicant proposes to exercise underground water rights
- Part B—A description of the area/s in which underground water rights are proposed to be exercised
- Part C—A description of the aquifer/s affected or likely to be affected
- Part D—An analysis of the movement of underground water to and from the aquifer
- Part E—A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights
- Part F—The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights
- Part G—Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights
- Part H—Information on the environmental values that will, or may, be affected by the exercise of underground water rights

- Part I—Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater.

2.1 Part A—A statement that the applicant proposes to exercise underground water rights

Section 126A(2)(a) of the EP Act provides that the applicant must include a statement outlining that they are proposing to exercise underground water rights during the period in which resource activities will be carried out under the relevant tenure. A description of the exact timing of when underground water rights may be exercised is not required for this section.

Applicants should be aware that under Chapter 3 of the Water Act, an UWIR must be submitted prior to the exercise of underground water rights for mining activities and 14 months after exercising underground water rights for petroleum leases. For more information on the requirements of an UWIR, applicants should also familiarise themselves with the Underground water impact report and final reports guideline (ESR/2016/2000²).

2.2 Part B—A description of the area/s in which underground water rights are proposed to be exercised

Section 126A(2)(b) of the EP Act requires that the applicant must provide a description of the areas in which underground water rights are proposed to be exercised.

Maps and tables showing the area where underground water rights are proposed to be exercised should be provided including, where possible, details of project staging. The exact locations (i.e. spatial coordinates) of where resource activities will be undertaken within the relevant tenure is not required, where this information is not known at the time of application. However, a general description of the area should be provided in the absence of exact locations. For example, an EA application for a petroleum lease may not know the exact longitude and latitude of where each production well will be drilled at the time of making an application, but a general description of the area where wells will be drilled should be provided.

2.3 Part C—A description of the aquifer/s affected or likely to be affected

Section 126A(2)(c)(i) of the EP Act requires that the applicant must identify and describe the aquifer or aquifers that are going to be affected or likely to be affected by the exercise of underground water rights. Section 376(b)(i) of the Water Act also requires this information to be provided by an applicant when preparing an UWIR. The department anticipates that applicants will use this information for both purposes.

All aquifers that occur within or outside of the tenure, and are going to be affected or likely to be affected, must be described. These descriptions should be based on accepted aquifer nomenclature. For example, aquifer descriptions within the Great Artesian Basin (GAB) should be based on the stratigraphic sequence described in the hydrogeological framework report for the GAB water resource plan area (Department of Natural Resources, Mines and Energy, 2005).

² This is the publication number, which can be used as a search term to find the latest version of the publication at www.qld.gov.au.

Descriptions of aquifers should include:

- aquifer type (confined, unconfined, fractured etc.)
- geology/stratigraphy (such as alluvium, volcanic, metamorphic) for each aquifer
- depth to and thickness of the aquifers
- a description of the physical integrity of the aquifer, fluvial processes and morphology of groundwater resources
- depth to water level and seasonal changes in levels

To assist in describing the aquifers, hydrogeological cross sections should also be included to show:

- affected or potentially affected aquifers;
- the elevations and relative positions of each of these aquifers;
- the location of water bores screened within these aquifers (if known);
- the location of any significant faults that intersect each potentially affected aquifer; and
- available data on current underground water levels.

Multiple cross sections should be included if the above points above are unable to be included in a single cross section due to scale or complexity. Maps should also be provided to show the physical extent of each of the affected or potentially affected aquifers.

This should be accompanied by a description of the methodology used to determine aquifer extent, for example, the data used and the interpolation methods used. Ultimately, the assessment of whether aquifers are likely to be affected should be based on predicted drawdown (that is, from underground water modelling) which is discussed in Part E.

2.4 Part D—An analysis of the movement of underground water to and from the affected or potentially affected aquifer/s

Section 126A(2)(c)(ii) of the EP Act requires that the applicant must include for each aquifer predicted to be affected or likely to be affected, an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water. This requirement is largely similar to section 376(b)(ii) of the Water Act. The department anticipates that applicants will use this information for both purposes. The scope of this information should include at least the following:

2.4.1 Inputs

Inputs (e.g. recharge from rainfall or other aquifers) to and outputs (e.g. discharge to springs, baseflow to watercourses and extraction from water bores) from potentially affected aquifers should then be described and estimated based on available data. Information on the location of water bores can be acquired by requesting a search of the Department of Natural Resources, Mines and Energy' (DNRME's) Groundwater Database.

2.4.2 Underground water elevations

To analyse the movement of underground water in aquifers, contours of underground water elevations should first be produced to determine general underground water flow directions.

2.4.3 Connectivity

To assess the connectivity between aquifers, information is needed about the aquifer/s (and aquitard) hydraulic properties. In addition to any available pumping test data and drill stem test data, stratigraphic information can be combined with a literature review to estimate hydraulic properties for the aquifers of interest (Hackbarth, 1978). Where no pumping test data or drill stem test data is available, pumping tests should be conducted to determine aquifer hydraulic properties.

In addition to hydraulic property information, other approaches are available for assessing interactions between aquifers. By comparing pressure heads, underground water hydrographs and/or underground water chemical composition (e.g. electrical conductivity, major ion chemistry and environmental tracers) between the aquifers of interest, assessments can be made about the connectivity between these aquifers. These approaches should be considered before conclusions are drawn about connectivity between aquifers.

2.4.4 Preferential flow paths

Consideration should also be given to natural and anthropogenic preferential flow paths such as faults and abandoned water bores, petroleum wells and coal exploration bores. An assessment of the connectivity between the aquifers affected or potentially affected with surface water is also required. To analyse aquifer interaction with surface water systems, an important consideration is any potential connectivity between the aquifer(s) and any overlying spring or surface water system. Several methods are available to make assessments about “source aquifers” i.e. determinations of the aquifers that are hydraulically connected to springs (EHA, 2009). These methods include assessments of hydrogeology, hydrology and hydrochemistry. Multiple methods should be employed as the application of a single method is unlikely to result in an unequivocal attribution of spring discharge to a source aquifer (EHA, 2009).

2.4.5 Springs

Hydrogeological assessments aim to gather information about possible source aquifers. Spring locations should be compared with geological and hydrogeological maps (noting the occurrence of springs within outcrop areas of specific formations). Information about subsurface geometry of aquifers should also be provided to identify physical pathways by which water can travel through aquifer(s) to a spring.

Hydrological assessments involve investigations of spring discharge. The temporal pattern of underground water discharge from springs should be examined in relation to temporal changes in underground water levels (and extraction) in underlying aquifers. Comparisons should also be made between spring discharge surface elevations and potentiometric surface values for underlying aquifers. A spring can only discharge at a site where the potentiometric surface of its source aquifer is at or above the ground surface (EHA, 2009).

Hydrochemical methods involve comparisons of the chemical composition of the water in the spring with the chemical composition of the water in the underlying aquifers. Similarities in the concentrations of major ions, minor elements and environmental tracers would suggest connectivity between the spring and the aquifer(s).

Spring inventory

The spring inventory should include the details of each spring i.e. spring name, spring type (e.g. recharge, discharge or watercourse) and spring location. As a first step, the tenure holder should refer to the Queensland Government's Wetland Info-GDE website at <http://wetlandinfo.des.qld.gov.au/wetlands/facts> —this provides an overview of spring mapping in Queensland and includes instructions to access all relevant data sets.

In addition, tenure holders should refer to the GAB water plan available on the Business Queensland website at <https://www.business.qld.gov.au/industries/mining-energy-water/water/catchments-planning/water-plan-areas/great-artesian-basin> - to find information about the GAB spring register for recharge, discharge and watercourse springs.

The spring inventory should include a field survey to confirm or update the data from these sources. The inventory should be revisited when the UWIR is revised. The location of springs should be presented using maps, with a list of coordinates for each spring. Aerial photographs would assist in showing the extent of vegetation surrounding each spring.

2.5 Part E—A description of the area of the aquifer or aquifers where the water level is predicted to decline because of the exercise of underground water rights

Section 126A(2)(c)(iii) of the EP Act requires that the applicant must provide a description of the aquifer or aquifers where the water level in that aquifer is predicted to decline because of the exercise of underground water rights. This information will then be utilised in later parts of the application requirements to determine impacts and potential impacts to environmental values and water quality. Predictions should

- be made for the life of the resource project and for post resource tenure closure
- be made about the timing, spatial extent and magnitude of maximum water level declines in affected aquifers; and
- be made about the timing and magnitude of groundwater level equilibrium in affected aquifers.

Potentiometric contour maps should be produced to show the maximum predicted water level declines for each affected aquifer. These maps should also state the year in which the maximum water level decline are predicted to occur. Where possible, estimates of predictive uncertainty (Doherty, 2003) should be provided to accompany the maps in this section.

It is recommended that descriptions of the methods and techniques used to predict water level declines are also detailed in the application material. In order to make predictions of underground water drawdown, it is expected that underground water modelling will be required. An underground water model is any computer-based representation of the essential features of the hydrogeological system that uses the laws of science and mathematics. The complexity of the underground water model required will depend on the size of the tenure,

the characteristics of the aquifer(s) (i.e. degree of confinement and heterogeneities in hydraulic properties), the magnitude of underground water extractions and the data available for model construction. Where possible, the development of a transient model is recommended as this is the most appropriate model type for simulating changes in drawdown over time. For guidance on modelling approaches, refer to the Australian groundwater modelling guidelines (Barnett et al, 2012).

Models developed under an environmental impact statement (EIS) process or for UWIRs under the Water Act can be utilised. The department anticipates that this will then be built upon for future UWIR requirements under the Water Act.

It is recommended that detailed information be supplied about the underground water model, including:

- model type (e.g. numerical or analytical);
- modelling platform;
- model inputs (e.g. aquifer hydraulic properties, the extraction regime and locations of the bores/wells);
 - model boundary conditions;
- model assumptions and limitations (including those related to connectivity between aquifers and water balance components); and
- details of any sensitivity analysis and/or calibration that was performed.

2.6 Part F—The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights

Section 126A(2)(c)(iv) of the EP Act states that the applicant must provide a prediction of the quantities of water that will be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out on the relevant tenure/s.

An estimate of the underground water that will be extracted during the period in which the resource activities are carried out must be provided. This should correspond to any description of project staging discussed under Part B.

This prediction should be based on the projected production or extraction schedule, and the methods used to determine these should be reported along with the estimated total. It is recommended that data obtained through exploration activities would be used to inform the methodology of the prediction.

The methodology that will be used for measuring extraction volumes should also be detailed.

2.7 Part G—Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights

Section 126A(2)(e) of the EP Act requires that the applicant must provide information on any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights at any time.

To be able to determine impacts on the quality of groundwater that will, or may happen, because of the exercise of underground water rights, the applicant should identify the quality of the groundwater prior to the resource activity commencing. This information should be utilised as a baseline to compare predicted impacts to groundwater quality.

Depending on the site-specific nature of the affected aquifer/s, the following parameters should be included:

- pH
- electrical conductivity [$\mu\text{S/m}$]
- turbidity [NTU]
- total dissolved solids [mg/L]
- temperature [$^{\circ}\text{C}$]
- dissolved oxygen [mg/L]
- alkalinity (bicarbonate, carbonate, hydroxide and total as CaCO_3) [mg/L]
- anions (bicarbonate, carbonate, hydroxide, chloride, sulphate) [mg/L]
- cations (aluminium, calcium, magnesium, potassium, sodium) [mg/L]
- silica [mg/L]
- dissolved and total metals and metalloids (including but not necessarily being limited to:
 - aluminium, arsenic, barium, borate (boron), cadmium, chromium III, cobalt, copper, iron, fluoride, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, tin, uranium, vanadium and zinc) [$\mu\text{g/L}$]
 - total phosphorus [mg/L]
- ammonia, nitrate, nitrite as nitrogen [mg/L]
- gross alpha + gross beta or radionuclides by gamma spectroscopy [Bq/L].

These parameters listed are recommended to determine the general water quality characteristics of the environment. However, site-specific testing of additional parameters based on the identified risks to environmental values may be required. It is also noted that there may be literature or a substantial body of research which indicates that the above parameters will not be present in the affected aquifer/s. If an applicant

can demonstrate that testing of the above parameters is not required, then the reasons for this should be documented.

Further guidance is provided in the Australian Government's Groundwater Sampling and Analysis – A Field Guide (Sundaram, et al., 2009).

The application should also provide an explanation of the variation of chemical concentrations as a result of chemical reactions over the life of the project due to the exercise of underground water rights. Negative impacts on water quality that may be associated with water-level declines, due to the exercise of underground water rights, may include:

1. Increases in salinity and/or changes in major ion composition due to induced flow of water from underlying or overlying formations; and/or
2. Increase in the concentrations of dissolved gas associated with the depressurisation of coal seams.

To estimate the extent of impacts to groundwater quality and analyse the likelihood of these impact/s occurring, the following contributing factors should be evaluated:

- Magnitude of the water level decline;
- Differences in water quality in aquifers overlying and /or underlying this aquifer; and
- The connectivity between the target aquifer for resource activities and the underlying and overlying aquifer.

When identifying potential impacts to water quality, a thorough review of the planned operations should be undertaken. There are many factors that could potentially impact groundwater quality, which may require discussion in the application. Examples include:

- Any areas of groundwater contamination in close proximity could be mobilised by the extraction of underground water. This may be relevant in areas of overlapping industry and/or resource activity; and
- Indirect impacts to groundwater due to inadequate storage of brines or waste water, potentially seeping to shallow aquifers, etc.

2.8 Part H—Information on the environmental values that will, or may, be affected by the exercise of underground water rights

Section 126A(2)(d) of the EP Act requires that the applicant must provide information on the environmental values that will, or may, be affected by the exercise of underground water rights as well as including detail of the nature and extent of those predicted impacts to environmental values. When identifying and describing environmental values, any gaps in knowledge should be clearly stated.

Applicants should also note that the department expects that this information will be built upon and reported against through the UWIR prepared under the Water Act. Section 376(1A)(da)-(db) will require that a tenure holder preparing an UWIR, include a description of the impacts on environmental values that have occurred, or

are likely to occur, because of any previous exercise of underground water rights as well as to predict impacts into the future both in the short-term and life of the project.

2.8.1 Identifying and describing environmental values

An environmental value is defined in section 9 of the EP Act to be:

- a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

Under the Environmental Protection (Water) Policy 2009 (Water EPP), all Queensland waters including groundwater have prescribed environmental values and water quality objectives. For some waterway basins and areas, environmental values and water quality objectives are listed in Schedule 1 of the Water EPP.

Where this is not the case, default environmental values are prescribed under section 6 (2) of the policy. These include:

- aquatic ecosystem health for:
 - high ecological value waters;
 - slightly disturbed waters;
 - moderately disturbed waters;
 - highly disturbed waters;
- uses which include:
 - aquaculture and human consumption of aquatic foods;
 - agricultural uses (e.g. stock watering and irrigation)
 - recreational uses (e.g. swimming, wading, boating, fishing and aesthetic)
 - drinking water (raw water supply)
 - industrial uses (e.g. power generation and manufacturing, mining and minerals refining/processing)
 - cultural and spiritual values (aesthetic, historical, scientific, social or other significance of the waters to the present, past, or future generations).

The Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013) can also provide further guidance on deriving environmental values for groundwater.

When identifying environmental values, the application must also consider potential for underground water to interact with surface water (e.g. baseflow to watercourses) and support groundwater dependent ecosystems. This is particularly relevant if under section 126A(2)(c)(ii), surface water interconnectivity has been identified.

Groundwater dependent ecosystems (GDEs) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. Ecosystem dependency on groundwater may vary temporally (over time) and spatially (depending on its location in the landscape). GDEs include aquifers, caves, lakes, palustrine wetlands, lacustrine wetlands, rivers and vegetation.

Additional information on GDEs including details of the Queensland GDE mapping method, conceptual models and mapping products are available on the *WetlandInfo* website at <http://wetlandinfo.des.qld.gov.au/wetlands/>.

The Environmental Protection Regulation 2008 section 81A sets the environmental values of wetlands as:

- the health and biodiversity of the wetland's ecosystems
- the wetland's natural state and biological integrity
- the presence of distinct or unique features, plants or animals and their habitats, including threatened wildlife, near threatened wildlife and rare wildlife under the *Nature Conservation Act 1992*
- the wetland's natural hydrological cycle
- the natural interaction of the wetland with other ecosystems, including other wetlands.

For further guidance on the identification and description of GDEs, it is recommended that the applicant refer to the EIS information guideline—Groundwater dependent ecosystems (Department of Environment and Science, 2016). Further guidance for aquatic ecological values is also provided in the EIS information guideline—Aquatic ecology (Department of Environment and Science, 2016).

To describe each environmental value further, it is recommended that, where impacts are predicted, the following is described in the context of potential impacts from groundwater level changes:

- source aquifer (noting that this will link to the description of affected aquifers in Parts C and D);
- likely relationship between the value and source aquifer (including hydrogeological and ecological conceptualisations);
- an estimation of the water requirements (e.g. supply for users or ecological water requirements for GDEs);
- availability of the water, including both quality and quantity to meet water requirements of the environmental value;
- sensitivity of the environmental value to a change in water quality and quantity resulting from decline in groundwater levels; and;

- any knowledge gaps or uncertainties and any assumptions used to address these.

Many of the human use values listed above are sourced from bores, therefore it is important to identify operating bores within the areas predicted to be affected by the exercise of underground water rights. This data should be presented in tables or maps, and it is recommended that the following information should be included:

- a unique bore identifier for each bore
- the tenure in which the bore is located
- the lot and plan in which the bore is located or some other means of identifying the location of the bore
- the aquifer in which the bore is screened if known (preferably in tabular format).

Initially, this information can be acquired by responsible tenure holders requesting a search of the DNRME's Groundwater Database.

To support the identification of environmental values, the resource tenure holder may, for the examples of environmental values discussed above, identify those environmental values that are not, or are unlikely to be impacted as a result of underground water rights. For instance, the resource tenure holder may demonstrate that the affected aquifers are geologically isolated from surface water systems and therefore not connected to surface water or any known surface GDEs in the area.

2.8.2 Nature and extent of the impacts on the environmental values

Once the values have been identified and described, the application must also include a description of the nature and extent of the impacts on the environmental values due to the exercise of underground water rights. The applicant is only required to undertake this analysis for environmental values that have been identified as being, or potentially being, impacted due to the exercise of underground water rights. The modelling used to predict water level decline, should be utilised to inform the analysis of impacts to the identified environmental values. It is also recommended that the information on changes to groundwater quality (Part G above) would also be included in assessing impacts to environmental values.

Correct and comprehensive identification of the potential impacts on environmental values is crucial for an efficient assessment of the application. Information requests are most frequently issued on applications where this has not been done correctly and may result in delays in the assessment of the application. The potential impact on environmental values may extend beyond the project area to surrounding areas and include potential regional and cumulative impacts.

Assessment of the adverse impacts on environmental values, should for each value, include an assessment of the following aspects:

- the magnitude, relative size or actual extent of any impact in relation to the environmental value being affected by groundwater level changes, particularly a decline in water level (i.e. the information described in Part E and F);
- the vulnerability or resilience of the environmental value to the predicted impacts considering:
 - the severity of any adverse effect ; and
 - the duration of the effect, for example the impact may be seasonal, or it may end with the activity or extend beyond the cessation of the activity;
- an indication of the level of uncertainty of impacts and any assumptions used to address the uncertainty in any of the data or proposed commitments to protect the environmental values.

It is anticipated that to assess the nature and extent of predicted impacts on environmental values a risk assessment will be required. This will incorporate predictions of impact from the groundwater model, the estimated water requirements of all relevant environmental values, and the sensitivity of these environmental values to a change in water level. This will provide a focus for the monitoring strategy and areas of future research.

In determining the potential impact of the activities, research, investigations, surveys, modelling and monitoring may be required. The raw data associated with this work is commonly required as part of the assessment process and should be submitted as part of the EA application. For GDEs, the impact of changes in groundwater quantity and quality is determined by the degree and nature of their groundwater dependency. Applicants should refer to the EIS guideline—Groundwater dependent ecosystems (Department of Environment and Science, 2016) for more information. The definition of waters includes the bed and banks of waters, so assessments also need to consider the nature and extent of impacts on aquatic flora and fauna, including benthos and riparian vegetation.

2.8.3 Impacts to formation integrity and surface subsidence

The exercise of underground water rights may result in damage to the physical integrity of confining geological formations and may also result in surface subsidence. The applicant should consider factors such as topographic variations and geological complexities when determining if these impacts are likely.

A risk based approach is required for the assessment of impacts from subsidence. Where impacts are predicted, the following should be provided:

- a description of the potential impacts to the physical integrity of confining geological formations;
- surface subsidence predictions presented on maps with appropriate contour increments and a scale appropriate for assessment of surface subsidence impacts;
- a description of the methodology used to make the predictions, including an assessment of the accuracy and precision of the predictions;
- a description of the environmental values of subsided land;

- an analysis of potential subsidence impacts on environmental values; and
- a description of the potential changes in the composition of vegetation communities due to areas of permanent ponding or changed drainage caused by subsidence; and
- a subsidence monitoring program including monitoring locations, rationale, methods and frequency.

2.9 Part I—Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater

Section 126A(2)(f) of the EP Act requires that the applicant must provide information on strategies for avoiding, mitigating and managing the predicted impacts on both environmental values and predicted changes in groundwater quality.

The applicant will be required to develop and implement a water monitoring strategy and a spring impact management strategy, as part of an UWIR prepared under the Water Act. The department recommends that the applicant consult the Underground water impact report and final reports guideline (ESR/2016/2000³) to ensure that the strategies included in the application (i.e. to meet the requirement of section 126A(2)(f) of the EP Act) complement these requirements of the UWIR.

The administering authority must be satisfied that all reasonable steps and strategies are in place to minimise the predicted impact to environmental values and groundwater quality. In determining whether the strategies are reasonable, the administering authority will consider the following factors:

- the nature of the harm or potential environmental harm to environmental values
- the sensitivity of the receiving environment
- the current state of technical knowledge for the activity
- the current state of technical knowledge of the environmental values
- the likelihood of successful application of strategies to minimise the adverse effects.

The strategies should be based on practical options and be derived from site specific environmental assessments, environmental best practice and proven research and/or justification in science, legislation, guidelines, etc. Where knowledge gaps are identified or there is a level of uncertainty in any of the data, the knowledge gaps, uncertainty and any assumptions used to address these should be clearly stated to allow the administering authority to consider the adequacy of the assessment in the context of existing knowledge. Considerable assessment effort is often required to assess applications that include unsubstantiated environmental protection commitments, which can result in significant delays in finalising the assessment of applications.

³ This is the publication number, which can be used as a search term to find the latest version of the publication at www.qld.gov.au.

Guideline

Requirements for site-specific and amendment applications— underground water rights

In proposing measures to protect groundwater, the Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013) should be referenced.

Indigenous heritage values should be managed according to the requirements of the *Queensland Heritage Act 1992*, *Aboriginal Cultural Heritage Act 2003* or *Torres Strait Islander Cultural Heritage Act 2003* and do not need to be detailed in the application documents.

Strategies for avoiding, mitigating and managing the predicted impacts on both environmental values and predicted changes in groundwater quality should include:

- objectives which define the outcomes that are intended to be achieved (i.e. avoiding, mitigating and managing the predicted impacts) and a description of unavoidable impacts to environmental values
- measures (specific methods/procedures/tools) to be implemented to demonstrate how the objectives will be achieved
- indicators relevant to protection of the environmental values (i.e. indicators are the values that are to be measured to gauge whether the objectives are being achieved and are used to be used in auditing the performance of measures)
- a program for monitoring the indicators
- a reporting program which includes triggers for the review of the strategies, and identifies additional data, assessment, analysis and reporting requirements.

Appropriate indicators, standards and control strategies can be determined from existing legislation, regulations, federal, state and local government policy, EPPs, model conditions, results of environmental impact assessment, results from research, investigations, surveys, monitoring, modelling, community consultation, technical guidelines and any other guidelines including those from international agencies.

Harm to environmental values generally implies some adverse change in environmental condition. In relation to underground water, the degree of change accepted before harm is considered to have occurred is generally governed by changes to the water quality objectives. These may include physical, chemical, radiological and biological objectives as well as narrative statements on environmental condition.

The degree of change acceptable in environmental condition for human use environmental values such as drinking, stock water, aquaculture and irrigation is limited to that which does not affect suitability for those uses. It is noted that the applicant will likely be able to use the obligations under Chapter 3 of the Water Act, including the statutory requirement to 'make good' impacts to water bores, as a management strategy for the predicted impacts on human use values.

For ecological environmental values, a specified acceptable degree of departure from a reference condition is generally used for ecological stressors and biological indicators, and in respect of toxic substances, guidance based on relevant aquatic toxicity studies. The degree of departure from natural condition and level of

ecosystem protection afforded from toxic substances is based on the level of ecosystem protection prescribed for the relevant waters.

Under the Water EPP, there are four levels of ecosystem protection, namely high ecological value, slightly disturbed, moderately disturbed and highly disturbed. Guidance on how water quality objectives are applied in each case is described in the Queensland Water Quality Guidelines 2009 (Department of Environment and Science, 2013). These guidelines provide water quality objectives for various water types for Queensland regions/sub regions. Where waters are listed under Schedule 1 of the Water EPP, the Water EPP scheduling documents provide environmental values and water quality objectives.

The Australian Water Quality Guidelines (ANZECC and ARMCANZ, 2000), the Australian Drinking Water Guidelines (National Health and Medical Research Council, 2011) and the Guidelines for Managing Risks in Recreational Water (National Health and Medical Research Council, 2008) are also relevant and should be consulted.

The monitoring program should:

- track changes against pre-development conditions by collecting sufficient data to assess background/baseline conditions, seasonal variations and recharge/discharge behaviours;
- to an appropriate extent, extend monitoring beyond the predicted impact areas to confirm that impacts are not occurring beyond these areas;
- supplement existing monitoring programs to fill any critical gaps in data;
 - include a rationale that includes (but is not restricted to):
 - a methodology for the number, location and placement of monitoring sites for each indicator and standard to be monitored;
 - an explanation about how it will improve the understanding about the impacts of underground water extraction on identified environmental values and water quality; and
 - maps to demonstrate the purpose and location of monitoring points including co_ordinates details;
- include monitoring bores constructed in accordance with the minimum construction requirements;
- include drilling logs and construction details of all monitoring bores and where vibrating wire piezometers are installed, depths and construction details of each piezometer should be provided;
- Methods of groundwater sampling should comply with the latest edition of the Queensland Monitoring and Sampling Manual (Department of Environment and Science, 2010), AS/NZS 5667:11 1998 Water Sampling Guidelines—Part 11: Guidance on sampling groundwater (Technical Committee EV/8, 1998), and the Australian Government’s Groundwater Sampling and Analysis—A Field Guide (Sundaram, et al., 2009) as relevant and as may change from time to time;

- manage water quality monitoring in accordance with the relevant National Water Quality Management Strategy (NWQMS) guideline: Australian Guidelines for Water Quality Monitoring and Reporting (AWQG) (ANZECC and ARMCANZ, 2000);
- manage stygofauna sampling in accordance with the Department of Science, Information Technology and Innovation's guideline for the Environmental Assessment of Subterranean Aquatic Fauna (Department of Science, Information Technology and Innovation, 2015); and
- provide a description and supporting rationale of any alternative or additional monitoring methodologies.

3 References

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4 Glossary

Aquitard	A low-permeability unit that can store underground water and also transmit it slowly from one aquifer to another.
Baseflow	The water in a stream that comes from underground water.
Drawdown	A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by extraction of underground water from wells.
Hydraulic properties	Quantitative measures of an aquifer's ability to store and transmit water.
Potentiometric surface	A surface that represents the level to which water will rise in tightly cased wells.
Prescribed activity	See Schedule 1 of the Environmental Offsets Regulation 2014.
Prescribed environmental matters	See Schedule 2 of the Environmental Offsets Regulation 2014.

Guideline
**Requirements for site-specific and amendment applications—
 underground water rights**

Recharge	Water that percolates through the unsaturated zone and reaches the saturated zone.
Resource tenure holder	Resource tenure holder has the meaning in section 364 of the Water Act and means the holder of an authority to prospect or petroleum lease issued under either the <i>Petroleum Act 1923</i> or the <i>Petroleum and Gas (Production and Safety) Act 2004</i> or the holder of a mineral development licence or mining lease issued under the <i>Mineral Resources Act 1989</i> .
Source aquifer	An aquifer providing water requirements to environmental values.
Spring	A spring has the meaning in schedule 4 of the Water Act and means— if a feature is identified on the watercourse identification map as a spring— the feature identified on the map; or otherwise—the land to which water rises naturally from below the ground and the land over which the water then flows.
Stratigraphic	The arrangement and succession of geological strata.
Underground water rights	Underground water rights has the meaning in section 112 of the EP Act and means any of the following: Underground water rights provided to mineral development licence and mining lease holders in the Mineral Resources Act 1989; Underground water rights provided to petroleum lease holders in the Petroleum and Gas (Production and Safety) Act 2004; and Underground water rights provided to petroleum lease holders in the Petroleum Act 1923.
Water level	Water level of an aquifer has the meaning in section 362 of the Water Act and means— if the aquifer was tapped by an artesian bore—the level to which the water would rise naturally above the surface of the land at the location of the bore if the water was contained vertically above the surface of the land; or if the aquifer were tapped by a subartesian bore—the level of the water in the bore.

5 Acronyms

CSG	Coal seam gas
DNRME	Department of Natural Resources, Mines and Energy
EA	Environmental authority
EIS	Environmental impact statement
EP Act	<i>Environmental Protection Act 1994</i>
GAB	Great Artesian Basin
GDEs	Groundwater dependent ecosystems
NWQMS	National Water Quality Management Strategy
UWIR	Underground water impact report [under the <i>Water Act 2000</i>]
Water EPP	Environmental Protection (Water) Policy 2009

Disclaimer

This document has been prepared with all due diligence and care, based on the best available information at the time of publication. The department holds no responsibility for any errors or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties. Information contained in this document is from a number of sources and, as such, does not necessarily represent government or departmental policy.

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