Annual Report 2017

for the

Surat Underground Water Impact Report 2016

June 2017

This publication has been compiled by the Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

Summary

The production of coal seam gas (CSG) involves the pumping of water from coal formations to reduce groundwater pressure and release the gas. This can affect groundwater pressures in overlying and underlying aquifers because of connectivity between the formations. In an area of concentrated CSG development, the impacts on groundwater pressures caused by individual CSG projects can overlap. In these situations, it is difficult for individual tenure holders to assess cumulative groundwater impacts and to determine individual tenure holder responsibilities for monitoring and make good obligations.

To ensure a comprehensive cumulative groundwater assessment is completed and to provide clarity on the management responsibilities of individual tenure holders, such an area can be declared a 'cumulative management area' (CMA) under Queensland legislation. Within a CMA, the Office of Groundwater Impact Assessment (OGIA) carries out a cumulative assessment. This includes specification of integrated monitoring and other management requirements and assigns responsibility for implementation to individual petroleum tenure holders. These arrangements are set out in an Underground Water Impact Report (UWIR).

The Surat CMA was established in April 2010 and the first UWIR for the Surat CMA was prepared in 2012. That initial report has now been superseded by the Surat UWIR 2016 which took effect from 19 September 2016. This 2017 Annual Report describes changes that have occurred since the UWIR 2016 was prepared.

To prepare the UWIR 2016 a regional groundwater flow model was constructed to predict the impact of current and planned CSG development on groundwater pressures in aquifers. The model is the best available tool to assess regional groundwater impacts and has been used in the preparation of this annual report.

Production on individual petroleum leases will commence and cease at different times over the life of the industry. The collective set of commencement and cessation times is termed the cumulative industry development profile and is used as input to the UWIR groundwater flow model. Industry planning for development will change over time for many reasons. The cumulative industry development profile is therefore updated every year and predicted impacts are reassessed.

The cumulative industry development profile presented in this report has been updated based on the information available as of March 2017. Compared to UWIR 2016, there has been a slight increase to the long-term footprint of planned development. Areas that have expanded include Roma and to the south and east of Wandoan. However, there is some contraction northwest of Wandoan. In general, the timing of commencement of production has shifted to later years.

The changes to the cumulative industry development profile have little impact on the extent of long-term predicted impacts. However, because of the changes to the scheduling of commencement, there have been some changes to the short-term predicted impacts. The UWIR 2016 reported that 91 existing bores would be impacted in the short-term by more than five metres of water level decline. Based on the current cumulative industry development profile, 19 of those bores are now likely to be impacted by slightly less than the five-metre threshold.

The UWIR 2016 specifies a regional monitoring network and assigns to individual tenure holders responsibility to implement separate parts of the network. A total of 603 monitoring points were to be installed by December 2016; this is on target, although there are some monitoring points that are not yet operational due to various logistical reasons.

Monitoring data that has become available since the publication of UWIR 2016 suggests that overall trends in groundwater pressure are similar to those reported. OGIA is currently undertaking a review of the available groundwater pressure and water quality data for all monitored aquifers, with a particular emphasis on investigating a range of potential causes for observed pressure declines in the Hutton Sandstone. Outcomes from this project are likely to be available in 2018.

The UWIR 2016 identifies where there are predicted long-term pressure impacts in aquifers underlying springs. It specifies monitoring requirements at 11 spring complexes and three watercourse springs. The monitoring program seeks to provide information about the background variability in the hydraulic function of the springs. Monitoring is in progress with results contributing to an improved understanding of spring functions.

The UWIR 2016 identifies four spring complexes where pressure impacts in the source aquifers were predicted to be greater than 0.2 metres at some time in the future. At two of those sites, predicted impacts are able to be balanced out by relocating stock water supply bores that are already impacting the springs. Agreements are being negotiated between the responsible tenure holders and the relevant bore owners to cooperate in the implementation of the measures when, and if, appropriate. At the two other sites, the tenure holder is implementing endorsed research activities. Outcomes of the research will then determine appropriate measures for managing predicted impacts.

Currently, a major focus for OGIA is to undertake a range of technical research projects to build new knowledge about the groundwater flow system. Outcomes from these projects will be incorporated into the construction of a revised groundwater flow model which will be used in updating the next UWIR in 2019. Key focus areas are the revision of the geological model based on up-to-date data, analysis of monitoring trends, investigations of bore connectivity, continuing work on studying Condamine connectivity, development of a sub-regional model, development of monitoring methods for springs, watercourse springs, assessment of terrestrial groundwater dependent ecosystems and improving non-P&G water use estimates.

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Abbreviations

CMA	Cumulative Management Area
CSG	Coal seam gas
DEHP	Department of Environment and Heritage Protection
DNRM	Department of Natural Resources and Mines
GWDB	Groundwater Database
IAA	Immediately Affected Area
LAA	Long-term Affected Area
OGIA	Office of Groundwater Impact Assessment
SIMS	Spring Impact Management Strategy
UWIR	Underground Water Impact Report
WMS	Water Monitoring Strategy

Chapter 1 Introduction

1.1 Regulatory framework

Under the Queensland regulatory framework, petroleum and gas (P&G) tenure holders have a limited right for the extraction of groundwater in the process of producing P&G. This right is subject to responsibilities for 'make good' of impairment of private groundwater supplies caused by the water extraction activities and to carry out monitoring and other management activities. Effective from December 2016, legislative changes have now extended these arrangements to the mining sector.

In an area of concentrated P&G development such as coal seam gas (CSG), the impacts on groundwater pressures caused by individual projects can overlap. In these situations, it is difficult for individual tenure holders to assess cumulative groundwater impacts and to determine individual tenure holder responsibilities for monitoring and make good obligations. To ensure a comprehensive cumulative groundwater assessment is completed and to provide clarity on the management responsibilities of individual tenure holders, such an area can be declared a 'cumulative management area' (CMA) under Queensland legislation.

Where a CMA is established, the Office of Groundwater Impact Assessment (OGIA) is responsible for undertaking assessments, establishing management arrangements and identifying responsible tenure holders to implement specific aspects of those management arrangements. Responsible tenure holders have a statutory obligation to implement management arrangements and OGIA oversees the implementation of those arrangements. These assessments and management arrangements are set out in an Underground Water Impact Report (UWIR) which is revised every three years. Once approved, the report becomes a statutory instrument and provides a basis for ongoing management of groundwater impacts in line with the strategies outlined in the report.

1.2 The Surat Underground Water Impact Report

The Surat CMA was established in April 2010 and the first UWIR for the Surat CMA was prepared in 2012. That initial report has now been superseded by the Surat UWIR 2016 which took effect from 19 September 2016.

The UWIR 2016 is currently being implemented. The report contains:

- predictions of short-term and long-term cumulative impacts on groundwater pressures in aquifers
- a regional water monitoring strategy
- a regional spring impact management strategy
- assignment of management responsibilities to individual tenure holders
- a research program to build knowledge and improve predictions of impacts.

The significance of each component of a UWIR is summarised below.

Prediction of impacts: Multiple aquifers can be affected by a single CSG operation because of interconnectivity between aquifers. Impacts are identified using a regional groundwater flow model. For each affected aquifer, an Immediately Affected Area (IAA) is identified. The IAA for an aquifer is the area where groundwater pressure reductions exceeding trigger thresholds—five metres for consolidated aquifers and two metres for unconsolidated aquifers (such as alluvium)—are predicted

within three years. For each bore sourcing water from an aquifer in its IAA, responsible tenure holders must, on approval of the UWIR, carry out a bore assessment and enter into a make good agreement with the bore owner. This proactive arrangement ensures make good actions are implemented prior to a bore becoming impaired. A Long-term Affected Area (LAA)—where modelling indicates that the statutory triggers may be exceeded at any time in the future—is also identified to show the predicted whole-of-life regional impacts.

Regional Water Monitoring Strategy (WMS): The WMS identifies a regional network of dedicated monitoring bores for the collection of groundwater pressure and water quality data. This data is required to improve the accuracy of future regional groundwater flow modelling. Monitoring data also helps in improving the knowledge of groundwater systems and in the prediction of impacts.

Regional Spring Impact Management Strategy (SIMS): The flow of water to springs can potentially be affected by groundwater extraction. The SIMS specifies spring monitoring and other spring management arrangements that are needed to understand and manage risks to springs.

Assignment of management responsibilities to individual tenure holders: Rules in the UWIR assign responsibilities for implementation of component parts of the WMS and SIMS to individual tenure holders. Rules also provide for the identification of a single petroleum tenure holder as being responsible for make good responsibilities in relation to any particular water bore.

Research: A UWIR is revised every three years to take into account new knowledge from research and monitoring data. The UWIR describes the forward research program for improvements in knowledge and groundwater flow modelling.

1.3 Purpose of the Annual Report

An annual report is prepared to provide an update on changes to circumstances that would impact on the predictions reported in the UWIR, and to provide updates on the implementation of management strategies specified in the UWIR. This is the first annual report in the current UWIR 2016 reporting cycle. Another annual report will be prepared in June 2018 prior to revision of the current UWIR in 2019.

Chapter 2 Update on industry development profile

2.1 Planned development

Many factors can change industry's plans for development over time. Changes can relate to the timing of development of individual petroleum lease areas, or to the long-term footprint of development.

Any change to the cumulative industry development profile directly affects the extent and timing of predicted impacts on groundwater pressure. In order to prepare the UWIR 2016, a whole-of-life cumulative industry development profile was prepared and used as the input scenario for the regional groundwater flow model for impact predictions. Output from the model provided short-term (three years) and long-term predicted cumulative impacts on groundwater pressures in aquifers for the given profile.

The cumulative industry development profile was prepared based on information available at the time about historic and planned development from individual tenure holders. A summary of the development profile was provided in Figures A-1 to A-6 of the UWIR 2016. Those figures illustrate the planned time of commencement and cessation of production on tenures across the CMA.

2.2 Description of changes to planned development

The cumulative industry development profile presented in the UWIR 2016 was based on the information available in late 2015. Since then, OGIA has received updates from tenure holders and has compiled a revised whole-of-industry cumulative development profile based on current information. For comparison, this current cumulative industry development profile and the UWIR 2016 version are provided in Figure 1. Significant changes are described below.

2.2.1 Overview of the cumulative changes

There have been changes to the cumulative industry development profile since the UWIR 2016 was prepared. In general, although there is some contraction, the planned development area has increased by about 14 per cent[1], but remains well within the potential development area as identified in the UWIR 2016. The potential development area is the land area for which tenure holders have necessary approvals for development.

The majority of the changes are in tenure areas held by Santos around the existing Roma, Arcadia, Fairview and Scotia fields where the planned production area has increased. Origin is also intending to expand operations around the existing Peat gas field and now plans to develop the Ramyard, Wooleebee, Kainama and Sandpit areas. QGC's Charlie Project area west of Wandoan has retracted eastward. There has been no change in Arrow's planned production area.

Relatively minor changes are made to the proposed timing of development since the UWIR 2016. The changes include some areas where development will be delayed until after 2018, which directly affects predicted short-term impacts (Section 3.4).

As a result of the changes in the cumulative industry development profile, around 8000 CSG wells are now forecast to be constructed by the end of 2018, compared to around 10,000 projected at the time of the UWIR 2016. This is expected to increase to about 20,000 CSG wells by 2050 (Figure 2).

[1] Nearly half of this overall increase is due to an administrative error by Santos when providing the data in 2015.

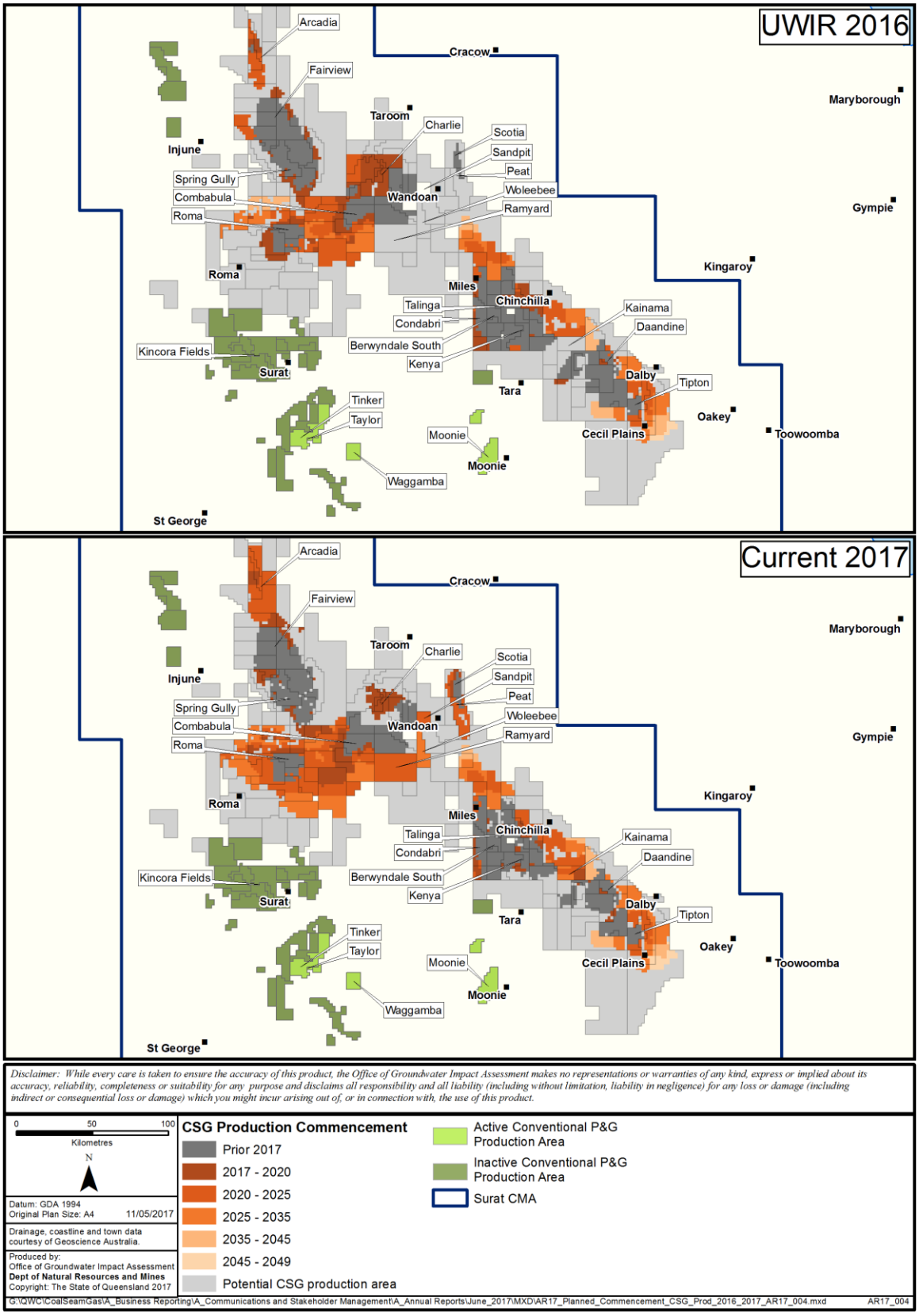

Figure 1 – A comparison of the current and UWIR 2016 planned CSG development profiles

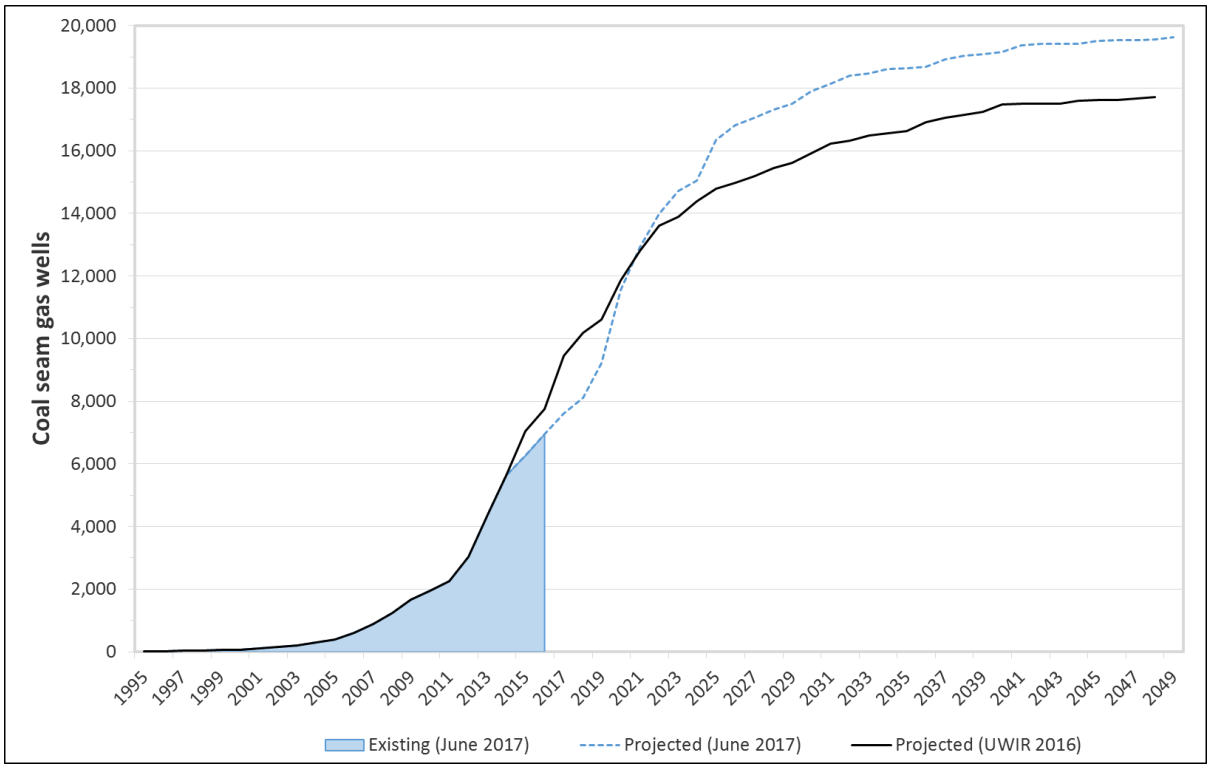

Figure 2 – Existing and projected CSG wells in the Surat CMA in current and planned production areas

Updated CSG water extraction volumes are presented in Figure 3. This shows a recent reduction in the rate of extraction from around 65,000 ML/year in July 2015 to around 55,000 ML/year in July 2016.

2.2.2 Santos

Santos's current planned development profile includes an increase of around 1100 km^2 in the planned production area northeast of Roma, into tenure areas which were identified as potential production areas in the UWIR 2016 (Figure 1). Nearly two-thirds of this area was excluded from the planned production area in the UWIR 2016 due to an administrative error by the tenure holder when providing the data at the time. This error has been taken into account in assessing changes in predictions as presented in the next chapter and does not materially affect the number of impacted bores.

The planned production area associated with the Arcadia and Fairview Bandanna Formation gas fields in the Bowen Basin has expanded slightly since the UWIR 2016. However, development of the Cattle Creek Formation west of Fairview is no longer anticipated.

There have also been some minor changes to the timing of development in some areas. In particular, production in parts of the Fairview gas field is now expected to commence around two years earlier than previously anticipated.

Since the release of the UWIR 2016, Santos has also completed the sale of the Moonie oil field. Ownership of this tenure has now passed to Bridgeport (Surat Basin) Pty Ltd which intends to continue to operate the existing field.

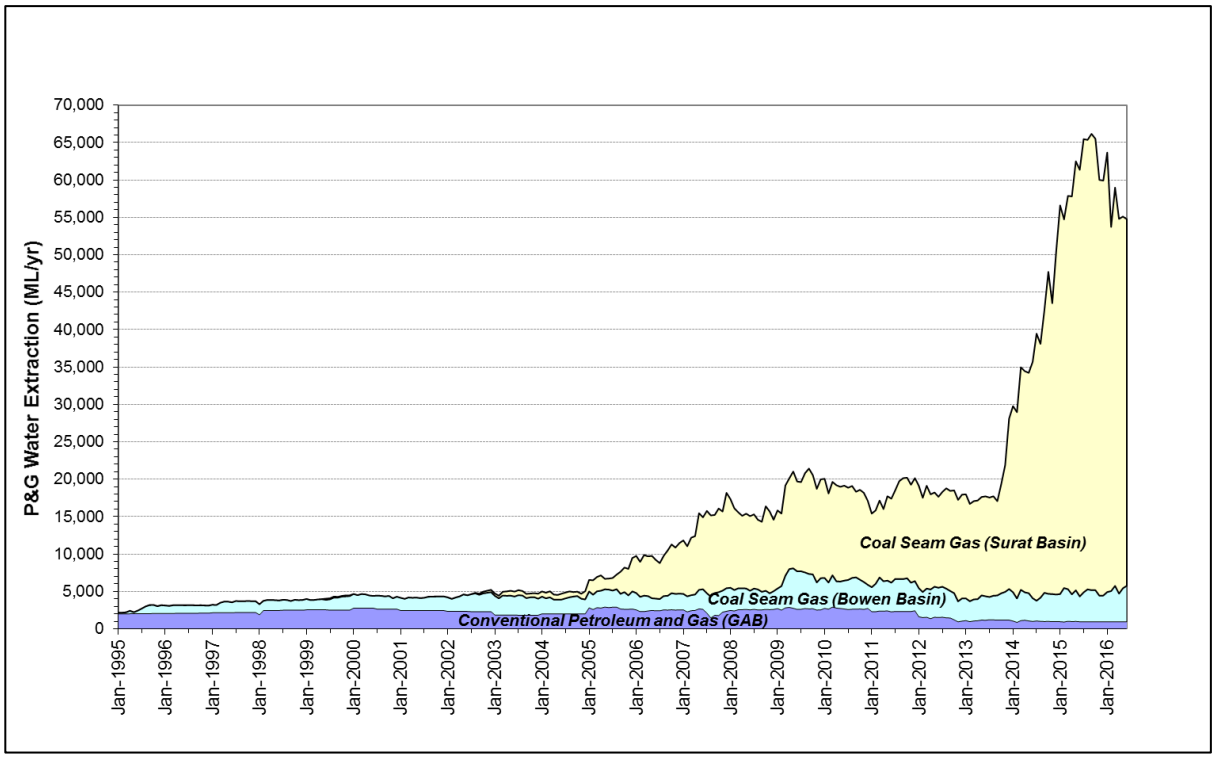

Figure 3 – P&G water extraction

2.2.3 Origin

Origin now plans to develop the Ramyard, Wooleebee, Kainama and Sandpit gas fields, commencing production between 2019 and 2026. An expansion of the existing Peat gas field, northeast of Wandoan, and the Spring Gully field, east of Injune, is also proposed with production commencing between 2017 and 2022 (Figure 1).

Elsewhere, there have been some minor changes in the timing of development in some areas, including a delay of up to five years in the development of parts of the Talinga and Orana gas fields southwest of Chinchilla.

Since 2016, Origin has also undertaken a number of tenure transactions, selling some conventional tenure holdings south of Roma.

2.2.4 QGC

QGC's proposed development plan areas have significantly contracted in each of its southern, northern and central development areas. In particular, the footprint of Charlie Project, which forms part of the northern development area west of Wandoan, has retracted eastward by approximately 10 km. Development of some parts of the southern and central development areas has also been delayed by up to three years. Elsewhere, the timing of development remains much the same as was reported in the UWIR 2016.

2.2.5 Arrow Energy

Arrow's current plan for development remains unchanged since the UWIR 2016. There have been no changes to the proposed development area but production is now expected to commence one year later than previously reported.

2.2.6 Senex

Senex's proposed development area is largely unchanged since the UWIR 2016. Production commencement in some sub-blocks towards the north of its tenure has been brought forward from 2036 to 2018, but drilling has not yet commenced.

Chapter 3 Update on predicted impacts on groundwater pressures

3.1 The UWIR groundwater model

A revised regional groundwater flow model was constructed to support the preparation of the UWIR 2016 (the 2016 groundwater model). It was used to predict the impact of the cumulative industry development profile on groundwater pressures in aquifers. OGIA is undertaking ongoing work to improve this model for the next UWIR in 2019. Currently, the 2016 groundwater model is the best available model for cumulative groundwater impact predictions for the Surat CMA and is used by OGIA for annual reporting purposes. It is also used by the tenure holders to meet various regulatory requirements.

3.2 Overview of predicted impacts in the UWIR 2016

The UWIR 2016 identified the Immediately Affected Areas (IAAs) for each aquifer. The IAA for a consolidated aquifer, such as sandstone, is the area where groundwater pressure is predicted to decline by more than five metres within three years as a result of water extraction for P&G development. Water supply bores accessing water in the affected area of an aquifer become IAA bores. For these bores, relevant tenure holders are then required to undertake bore assessments and, if necessary, enter into make good arrangements with bore owners.

In total, 91 existing bores in the Walloon Coal Measures were identified as IAA bores in the UWIR 2016. This comprised 57 newly identified bores and 34 bores which were previously identified in the UWIR 2012 and remained in existence at the time. Since UWIR 2016, 17 of those 34 previously identified bores have been decommissioned.

The UWIR 2016 also identified the Long-term Affected Area (LAA) for each aquifer. The LAA for a consolidated aquifer, such as sandstone, is the area where groundwater pressure is predicted to decline by more than five metres at any time in future. A total of 459 existing bores were predicted to be impacted in the long term.

3.3 Assessing changes to predicted impacts

Changes to the whole-of-life cumulative industry development profile since the preparation of UWIR 2016 are described in Chapter 2. The 2016 groundwater model has been used to predict the effect of those changes by re-running the model based on the current cumulative industry development profile.

This chapter describes the differences between the predictions in the UWIR 2016 and the predictions made using the current cumulative industry development profile.

3.4 Changes to short-term impacts

Based on the revised model predictions using the current development profile for the same short-term period (i.e. end of 2019), 19 of the 91 IAA bores listed in the UWIR 2016 are now predicted to be impacted by less than five metres. These bores are located in and around the QGC Charlie Project area and the Origin Talinga and Orana gas fields where planned production areas have contracted.

Although the overall planned production area has increased, most of the additional area will not be developed until after 2018 and so will not affect short-term impact predictions. On the other hand,

development of several areas which were to be developed in the near future, including parts of the Charlie Project and the Talinga and Orana gas fields, has been delayed or will no longer take place.

While the overall effect of the changes to the cumulative industry development profile is for fewer bores to be impacted in the short term, other minor changes to the development schedule have resulted in impacts occurring earlier than previously predicted in some areas. There are three bores that were previously predicted to be impacted by less than five metres in the short term that are now predicted to experience more than five metres of impact. OGIA has advised the responsible tenure holder that it would be appropriate to commence bore assessments and, if necessary, enter into make good agreements with the owners of these bores. If necessary, DEHP has the power to direct that bore assessments be carried out for those bores.

3.5 Changes to long-term impacts

Changes to the cumulative industry development profile have resulted in some relatively minor changes to the LAA. The long-term impacts for the Springbok Sandstone, Walloon Coal Measures and Hutton Sandstone have slightly contracted to the northwest of Wandoan, due to contraction of the Charlie Project area, and expanded slightly towards the southwest in the vicinity of Roma, due to a corresponding increase in the planned production area.

In the Bowen Basin, the impacts for the Cattle Creek Formation have contracted westward, since development of these coal seams west of Fairview no longer forms part of the Santos development plan. The impact area for the Bandanna Formation has expanded east of Wandoan due to planned extension of the existing Peat and Scotia fields.

Despite a slight overall expansion of the LAA, there is a marginal (6%) reduction in existing water bores affected in the long term compared to the predictions reported in the UWIR 2016. This is because the impact area has contracted in areas where there is a high density of water bores and expanded in areas where there are fewer bores.

Chapter 4 Corrections to bore records

4.1 Bores in Immediately Affected Areas

If the supply from a water bore is impaired as a result of CSG water extraction, the responsible tenure holder has an obligation under the *Water Act 2000* (the Act) to carry out a bore assessment and enter into an agreement with the bore owner about measures to make good the impairment.

The Act includes arrangements to trigger proactive action which seeks to ensure make good measures are in place before impairment occurs. It requires that, on approval of a UWIR, the responsible tenure holders carry out assessments of bores that tap an aquifer within the IAA for the aquifer and enter into make good agreements with the bore owners about measures to make good impairment of bore supply. This is based on the premise that a groundwater pressure decline of five metres in a bore in a consolidated aquifer may pose a significant risk of impairment to the water supply available from the bore.

Together with the maps showing the IAAs, the UWIR included a list of the water bores understood to tap aquifers within IAAs. The list was provided to assist tenure holders in carrying out their responsibilities and also for community information purposes. The bores were identified using bore construction records in the DNRM groundwater database (GWDB) and geological model surfaces developed by OGIA to identify the aquifers tapped by the bores. All the bores identified as IAA bores in the UWIR 2016 were found to be accessing the Walloon Coal Measures.

The data in the GWDB has been assembled from a variety of sources over many years. In some cases, the data held can be inaccurate or incomplete. Therefore, it was expected that information collected in the process of carrying out bore assessments, as well as from other sources, would result in corrections to the database on an ongoing basis.

4.2 Corrections to bore records

Since the UWIR 2016, only a single correction has been made to a bore record within an IAA, correcting the information about the aquifer from which the bore is accessing water. This was based on a report by the bore owner and a follow-up investigation by the DNRM CSG Compliance Unit. This investigation confirmed that the bore in question is slightly deeper than previously thought and is likely to source water from the Walloon Coal Measures, rather than the overlying Springbok Sandstone.

Although the correction of the aforementioned bore record has changed the source aquifer, impacts of more than five metres are still not predicted in the short term since the bore only penetrates a short distance into the upper part of the Walloon Coal Measures.

Chapter 5 Implementation of the UWIR Water Monitoring Strategy

5.1 The UWIR Water Monitoring Strategy

The UWIR 2016 includes a Water Monitoring Strategy which specifies a regional monitoring network comprising 675 groundwater pressure or water quality monitoring points. Of these, 491 monitoring points were established at the time the UWIR 2016 was approved. The majority of the remaining monitoring points are planned to be completed before 2019.

The regional monitoring network is designed for the collection of data to meet multiple objectives related to regional groundwater assessment. The primary objectives are to:

- improve understanding of system response within production areas
- identify pressure changes near specific areas of interest
- improve understanding of background trends in pressure
- provide sufficient data for model calibration.

The UWIR 2016 identifies each required monitoring point's location, target formation, responsible tenure holder and a date by which the monitoring point must be established. The UWIR 2016 recognises that the locations of the identified sites may need to be altered during implementation due to practical operational issues. It provides for tenure holders to propose to OGIA variations to implementation requirements that overcome operational constraints while not undermining the overall objectives of the monitoring network.

In addition to the UWIR monitoring network, there is additional monitoring carried out by tenure holders and DNRM to meet other objectives and legislative responsibilities. Where appropriate, OGIA utilises that additional data in carrying out technical assessments.

5.2 Installation of the Water Monitoring Network

Table G-1 of the UWIR 2016 specifies the implementation schedule for the regional monitoring network. The UWIR 2016 required the construction of 603 monitoring points by December 2016. Tenure holders are required to report on progress against this schedule every six months, in March and September. As of March 2017, the status of the UWIR monitoring network is as follows:

- 547 monitoring points are operational and OGIA is receiving data
- 56 monitoring points are drilled but not yet operational
- 55 monitoring points are scheduled to be drilled before 2019.

Responsible tenure holders also provide monitoring data to OGIA every six months, in March and September. This includes monitoring data and construction information. OGIA reviews each data submission for completeness and technical accuracy, following which the data is stored in the GWDB and made publicly available through Queensland Globe. The March 2017 data submission is currently under review. Data from approximately 77% of the operational monitoring points has been uploaded to GWDB.

5.3 Update on trends in groundwater pressure

The UWIR 2016 stated that there are long-term background trends in groundwater pressure relating to variations in rainfall recharge and groundwater extraction, and that there was limited evidence of a departure from background trends other than within the coal formations.

Since the UWIR 2016, more data has become available. Key observations about groundwater pressure trends from this additional data are summarised in the following sub-sections.

OGIA is also currently undertaking a review of the available groundwater pressure and water quality data for all monitored aquifers, with a particular emphasis on investigating potential causes for observed pressure declines in the Hutton Sandstone. As detailed in Chapter 7, this project is in progress and outcomes are likely to be available in 2018.

5.3.1 Walloon Coal Measures

Consistent with the gradual increase in the area of CSG development, there has been a steady increase in the number of monitoring points in the Walloon Coal Measures showing significant pressure reductions. However, as noted in the UWIR 2016, impacts tend to be limited to the immediate vicinity of CSG production areas. There is now also evidence of increasing drawdown with depth within the Walloon Coal Measures. This is consistent with predictions from the groundwater model simulations.

5.3.2 Springbok Sandstone

Groundwater pressures in the Springbok Sandstone at Kenya East (RN160525) have continued to decline since the UWIR 2016, due to CSG extraction from the underlying Walloon Coal Measures at this location. However, elsewhere within the Springbok Sandstone, groundwater pressures have remained relatively stable.

5.3.3 Hutton Sandstone

Groundwater pressure at a number of monitoring points in the Hutton Sandstone, including at Talinga (RN160634) and Ruby Jo (RN160439), has continued to decline since the UWIR 2016. At this stage, it is considered likely that the majority of the observed pressure decline is due to non-P&G water extraction from the Hutton Sandstone with a minor contribution due to CSG extraction from the overlying Walloon Coal Measures. This will be investigated further as part of the detailed OGIA review (see Chapter 7).

5.3.4 Bandanna Formation

There are relatively few monitoring points in the Bandanna Formation with long-term records. The data that is available suggests substantial pressure reductions of up to around 300 metres in parts of the Fairview, Spring Gully, Peat and Scotia fields. This is as expected, since CSG has been extracted in these areas since 1995.

5.3.5 Precipice Sandstone

Recent data for the Precipice Sandstone in the Spring Gully and Fairview areas suggests a continuation of relatively stable levels, with some minor recent increases in pressure due to the operation of the nearby Precipice Sandstone re-injection scheme. However, there is some evidence of declining pressures in the Precipice Sandstone in the Peat and Scotia gas field areas in the east. This will be investigated further as part of the detailed OGIA review (see Chapter 7).

Chapter 6 Implementation of the UWIR Spring Impact Management Strategy

6.1 The UWIR Spring Impact Management Strategy

The Spring Impact Management Strategy in the UWIR 2016 identified springs that may be at risk due to underlying aquifers being affected by P&G development. The criteria for identifying potentially affected springs are conservative, i.e. springs overlying aquifers with predicted long-term pressure impacts of 0.2 metres or more.

As noted in Chapter 2, there have been changes to the cumulative industry development profile. This has resulted in alterations to the magnitude and timing of predicted impacts as described in Chapter 3. These alterations do not significantly change the situation with regard to predicted impacts at the majority of spring locations.

The UWIR 2016 included a risk assessment for springs and specified a monitoring program for 11 spring complexes and three watercourse springs that are at higher risk of being affected. Responsibility for implementing the monitoring program was assigned to individual tenure holders.

Among the springs to be monitored is a group of four complexes which, on the basis of UWIR model predictions, are expected to experience some decrease in pressure in the springs' source aquifer(s). For those springs, the UWIR requires tenure holders to assess options for prevention or mitigation of those impacts.

6.2 Changes to predictions of impacts at spring sites

As detailed in Chapter 3, changes to the cumulative industry development profile have resulted in minor changes to the long-term impacts on groundwater pressure. In relation to springs, Table H-3 in the UWIR 2016 presented that the earliest impacts at Springrock Creek were predicted to occur in the next six years.

The revised predictions indicate that this may now not happen until much later and the long-term maximum predicted impact is also now less than 0.5 metres, compared to 5–6 metres reported in the UWIR 2016. This is because Santos does not currently plan to develop the CSG resources of the Cattle Creek Formation in this area. There is a high degree of connectivity between the source aquifer for this spring, the Precipice Sandstone, and the Cattle Creek Formation in this area.

6.3 Spring monitoring

The UWIR 2016 identifies 11 spring complexes (50 spring vents) and three watercourse springs for monitoring, and specifies the monitoring approach and parameters to be measured at each site.

The objectives of spring monitoring are to understand the natural variability in spring discharge and to better understand the source aquifers that feed the springs at some locations. This understanding will ensure that any future impacts from P&G water extraction are correctly identified.

There have been some delays by tenure holders in undertaking the spring monitoring as the monitoring requirement in 2012 transitioned to the requirements in UWIR 2016. At the majority of sites, eight quarterly monitoring rounds were completed during the last UWIR cycle. In the UWIR 2016, monitoring frequency has been reduced to twice a year; the consequence of this delay is therefore unlikely to significantly compromise the objectives of the monitoring.

A pilot project is currently being implemented by OGIA to evaluate new monitoring methods. At four spring complexes, the pilot project overlaps with tenure holder monitoring obligations under the UWIR. At these sites, OGIA's pilot project displaces the tenure holder's obligations under the UWIR. Further discussion of this project is provided in the following chapter. Outcomes from this project will be used in the next update of the UWIR.

Overall, tenure holder monitoring and early results from the spring monitoring pilot indicate spring form and discharge is significantly influenced by climate and land use activities within the immediate vicinity of the springs. However, relationships are emerging between climate, discharge (flow and chemistry) and vegetation through the monitoring. OGIA is leading a project to trial new monitoring techniques at springs (see Chapter 7). This project will further enhance our understanding of these relationships. This will be useful in predicting likely responses at springs in relation to changes in groundwater conditions.

6.4 Prevention or mitigation of spring impacts

The UWIR 2016 identifies four spring complexes where pressure impacts in the source aquifers were predicted to be greater than 0.2 metres at some time in the future. As detailed in the UWIR 2016, predicted impacts at two of these sites (Barton and Scotts Creek) are able to be balanced out by relocating stock water supply bores that are already impacting the springs. Agreements are being negotiated between the responsible tenure holders and the relevant bore owners to cooperate in the implementation of the measures when, and if, appropriate.

At the two other mitigation sites (Springrock Creek and 311/Yebna), the UWIR 2016 requires the responsible tenure holder (Santos) to develop a research plan to address key knowledge gaps with regard to the available pressure and ecological values of the discharge area. Santos prepared a research plan which has been endorsed by OGIA. Santos is currently implementing the plan. Outcomes of the research program will then determine appropriate measures for managing predicted impacts.

At both Springrock Creek and 311/Yebna, changes to the cumulative industry development profile described in Chapter 2 have resulted in a significant reduction in the magnitude, and a delay in the timing, of predicted impacts in the source aquifer for these springs. This primarily relates to Santos's decision to reduce previously planned development in the early Permian, Cattle Creek Formation, as detailed in previous chapters.

The cumulative industry development profile is likely to change over time and, as a result, impacts may increase or decrease accordingly. In addition, the hydrogeological conditions around Springrock Creek are complex and OGIA, industry and research organisations continue to work towards improving hydrogeological understanding and reducing uncertainty in this area.

For these reasons, OGIA will continue to require Santos to implement the spring research plan in accordance with the UWIR 2016. This will ensure knowledge about Springrock Creek is developed in advance of any potential future impact and appropriate mitigation actions may be developed.

Chapter 7 Update on research projects

7.1 Overview

Extensive knowledge continues to be built about the regional groundwater flow system through OGIA's ongoing research programs, industry initiatives and other research organisations. This contributed to the update of the UWIR in 2016 and knowledge about the system is continuing to improve.

In preparing the UWIR 2016, a number of areas where knowledge would be most beneficially improved were identified. OGIA has subsequently prioritised a research program and implemented the program to meet those needs.

This chapter provides a summary of some of the key research projects that are being implemented.

7.2 Update of the geological model

A three-dimensional representation of the geology underpins much of OGIA's work in the Surat CMA. In addition to providing a geological framework for the development of the groundwater flow model, the geological model is also used to attribute landholder bores and other bores to aquifers. It is important that this model is as up-to-date and accurate as possible.

A further revision of the geological model for the Surat and southern Bowen basins is nearing completion. This revised model incorporates geophysical data from a further 3000 CSG wells which was not available during development of the previous model and a database of improved seismic data provided by the School of Earth Sciences at the University of Queensland. Revised outcrop mapping resulting from a collaborative project between the Geological Survey of Queensland and a number of CSG companies has also been incorporated. Previous interpretations of major fault systems have been reviewed and revised where necessary.

7.3 Trends in groundwater pressure

As mentioned previously in Section 5.3, OGIA is currently undertaking a detailed review of the available groundwater pressure and water quality data for all monitored aquifers, with a particular emphasis on investigating a range of potential causes for observed pressure declines in the Hutton Sandstone. An initial collation and assessment of the available hydrogeological data for a number of focus areas centred around operational CSG fields is being undertaken. In some cases where there are observed pressure declines and multiple potential causes, further subregional-scale numerical models are also being developed in order to further assess the likely contribution of each potential cause.

This project is in progress and outcomes are likely to be available in 2018.

7.4 Bore connectivity

The potential for water bores and other wells to allow water movement between geological formations is being assessed by another OGIA research project. This study includes a significant field program aimed at collecting data for a range of different well types in the Surat CMA. Phase 1 of the project largely comprised initial field visits to representative bores, with further more detailed field investigations planned for Phase 2.

The results from this study, scheduled for completion in 2018, will provide a key input to revised impact predictions made using the OGIA regional groundwater flow model.

7.5 Fault characterisation

Building on the revised conceptualisation of major fault systems completed as part of the geological modelling work (Section 7.2), OGIA has also commenced a project aimed at first mapping and then understanding the likely hydrogeological behaviour of other minor faults. During the initial mapping stage, this study will draw on the improved seismic data set provided by the School of Earth Sciences at the University of Queensland. Later stages of the project will involve the use of information such as groundwater levels, groundwater chemistry and CSG water extraction data to infer the hydrogeological behaviour of individual faults or groups of faults.

Like the bore connectivity study discussed above (Section 7.4), the fault characterisation project is seen as a key input to revised impact predictions and is scheduled for completion in 2018.

7.6 Condamine connectivity

OGIA is continuing the study to improve understanding of the connectivity between the Condamine Alluvium and the Walloon Coal Measures. Initial stages of the study prior to the UWIR 2016 focused on multiple lines of evidence relating to field investigations, drilling and completion of monitoring bores, geological modelling, test-pumping and hydrochemistry analysis that collectively concluded that there is a low level of connectivity. OGIA's current work is now focused on numerically testing alternative conceptualisations and additional hydrochemistry analysis. This work is also supported by the industry carrying out some complementary analysis of geo-mechanical loading effects on groundwater level responses.

7.7 Spring monitoring pilot

The UWIR 2016 requires monitoring at 11 spring complexes (50 spring vents). Monitoring is required to improve understanding of the natural variability of groundwater discharge, wetland dynamics and linkages with aquatic assemblages. The improved understanding enables a clearer prediction of impacts from changes in the groundwater regime.

OGIA is currently implementing a pilot monitoring project at four spring sites to improve the efficiency and effectiveness of existing monitoring. These springs sites are selected because they represent the different types of springs that occur in the Surat CMA.

The purpose of the project is to test new methods for monitoring springs. Therefore, multiple monitoring techniques are being applied including remote sensing, ground geophysics, vegetation transects, spring vegetation and discharge extents, soil and water chemistry. The 12-month project will provide a basis for recommending monitoring methods and techniques to be included in the next UWIR.

7.8 Validation of connected watercourses

The UWIR 2016 identifies 40 gaining streams in the Surat CMA. These locations have been identified through available literature as areas where groundwater is interpreted to discharge through the streambed. Discharge occurs as either permanent to ephemeral waterholes or as flowing sections of watercourses supporting important environmental processes and values. The location of these streams is used in the UWIR for the development of the Spring Impact Management Strategy.

At a desktop level, OGIA has now mapped new and additional areas of potentially gaining streams using new data sets and information generated since previous mapping was undertaken in 2005. Field validation of gaining streams has already been undertaken at two sites, Juandah Creek and Bungaban Creek, to improve confidence and further refine the mapping methodology.

Given the large spatial extent of the study area, the magnitude of predicted impacts was used to prioritise areas for field validation. There are 10 additional reaches identified as priorities for field validation over the next 12 months. Outcomes from this project will be used to inform monitoring and mitigation actions in next UWIR in 2019.

7.9 Methods for the assessment of impacts on terrestrial ecosystems

Legislative changes in late 2016 expanded the scope of UWIRs in relation to the assessment of environmental values. In addition to springs and watercourse springs (gaining streams), environmental values also encompass terrestrial vegetation dependent on groundwater: terrestrial groundwater-dependent ecosystems (GDEs).

OGIA is currently running a project to lead the development of a consistent method for the assessment of impacts on terrestrial GDEs. The method is being developed in consultation with technical experts and, once finalised, it will be used to inform research, monitoring and mitigation actions to be outlined in the next UWIR.

7.10 Refinement of the non-P&G water use estimate

For the 2016 UWIR, OGIA refined the method used to estimate water extraction from unmetered stock and domestic bores. The UWIR method considers property size, livestock-carrying capacity and the availability of other water supplies to estimate the groundwater demand. The method also differentiates between rural and urban or peri-urban properties.

This information is an important component of the regional water balance and a key input into the regional groundwater model. OGIA is continuing to refine this method to incorporate historical changes in land use, landholder water use practices and progressive bore abandonment over time.

7.11 Improvements to groundwater flow modelling

OGIA will be using a revised and improved groundwater flow model for preparation of the next UWIR. The revised model will incorporate additional data and information generated since the UWIR 2016, including the use of a revised geological model (Section 7.2).

OGIA is currently developing a number of sub-regional models to support detailed analysis of observed trends in groundwater pressure data (Section 7.3) and identifying areas for improvement in the regional flow model. This more detailed sub-regional modelling work will improve the regional model in specific areas where CSG production has been occurring and detailed groundwater data is available for model calibration.

References

Office of Groundwater Impact Assessment, 2012, *Underground water impact report for the Surat Cumulative Management Area*, OGIA, Brisbane.

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