Annual Report 2018

for the
Surat Underground Water Impact Report 2016

June 2018

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

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 assignment of 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 That initial report has now been superseded by the Surat UWIR 2016 which took effect from 19 September 2016.

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 second annual report in the current UWIR 2016 reporting cycle. The previous annual report was submitted to the then Department of Environment and Heritage Protection in June 2017 and is available on OGIA's website.

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 annual report has been updated based on the information available as of March 2018. In 2017, the net planned development area had increased by about 14 per cent since publication of the UWIR 2016, but remained well within the potential development area as identified in the UWIR 2016. The potential development area is the land area for which tenure holders hold the required approvals for development.

Since 2017 there has been little change in the planned development area, with less than one per cent reduction in overall footprint. However, there are some changes in the development schedule whereby planned commencement has generally shifted to later years. There is a slight reduction in Santos's planned production area while Arrow's, Origin's and Senex's planned production areas have remained relatively similar to previous years with some minor delays in planned commencement. There is no change to QGC's planned production area.

As reported in the last annual report, revised model predictions based on the industry development profile in 2017 suggested that 19 of the 91 Immediately Affected Area (IAA) bores listed in the UWIR 2016 were no longer expected to be impacted by more than five metres in the short term (i.e. prior to the end of 2018). Also, a further three bores that were previously predicted to be impacted by less than five metres in the short term were expected to be impacted by more than five metres.

Compared to 2017, there is little overall change in the long-term predicted impact area in response to the revised development profile in 2018. The total number of bores expected to be impacted remains less than that predicted in the UWIR – from 459, at the time of the UWIR 2016, to 456 – based on the current industry development profile. In terms of the short-term impacted bores, practically there is no change.

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. The UWIR requires 633 monitoring points to be established by the end of 2019. As of March 2018, there are 587 monitoring points in place.

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. Interim findings from the analysis of trends in the eastern and southern gas fields suggest that the primary cause for a declining pressure trend is non-CSG water use. Final outcomes of the analysis will be included in the UWIR 2019.

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. In 2017-18 a pilot project was implemented by OGIA to evaluate new monitoring methods. The project will provide a basis for recommending monitoring methods and techniques to be included in the UWIR 2019.

The UWIR 2016 identifies four spring complexes where pressure impacts in the source aquifers are 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, if and when appropriate. At the two other sites, the tenure holder is implementing endorsed research activities. Outcomes of the research are expected soon.

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, continued work on studying connectivity of the Condamine Alluvium with the Walloon Coal Measures, development of a sub-regional model, development of monitoring methods for springs, watercourse springs, assessment of terrestrial groundwater-dependent ecosystems and improvement in non-CSG water use estimates.

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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 to 'make good' 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 second annual report in the current UWIR 2016 reporting cycle. The previous annual report was submitted to the then Department of Environment and Heritage Protection in June 2017 and is available on OGIA's website.

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 (within 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 annual updates from tenure holders about their current development profiles. Based on a review of this information, OGIA compiled a revised whole-of-industry cumulative development profile and provided a comparison with the UWIR 2016 in the Annual Report 2017. A similar comparison between the 2017 and 2018 cumulative industry development profiles for the purpose of this annual report is provided in Figure 1. Significant changes are described below.

2.2.1 Overview of the cumulative changes

In 2017, the net planned development area had increased by about 14 per cent since the UWIR 2016, but remained well within the potential development area as identified in the UWIR 2016. The potential development area is the land area for which tenure holders hold the required approvals for development.

Since 2017 there has been little change in the planned development area, with less than one per cent reduction in the overall footprint. However, there are some changes in the development schedule, whereby planned commencement has generally shifted to later years.

There is a slight reduction in Santos's planned production area while Arrow's, Origin's and Senex's planned production areas have remained relatively similar to previous years with some minor delays in planned commencement. There is no change to QGC's planned production area.

As a result of the changes in the cumulative industry development profile, around 8000 CSG wells are still expected to be in place by the end of 2018, with a total of around 20,000 CSG wells projected during the life of the industry, as reported in the Annual Report 2017. However, due to delays in planned commencement, relatively fewer wells are proposed to be constructed in next three to four years (Figure 2).

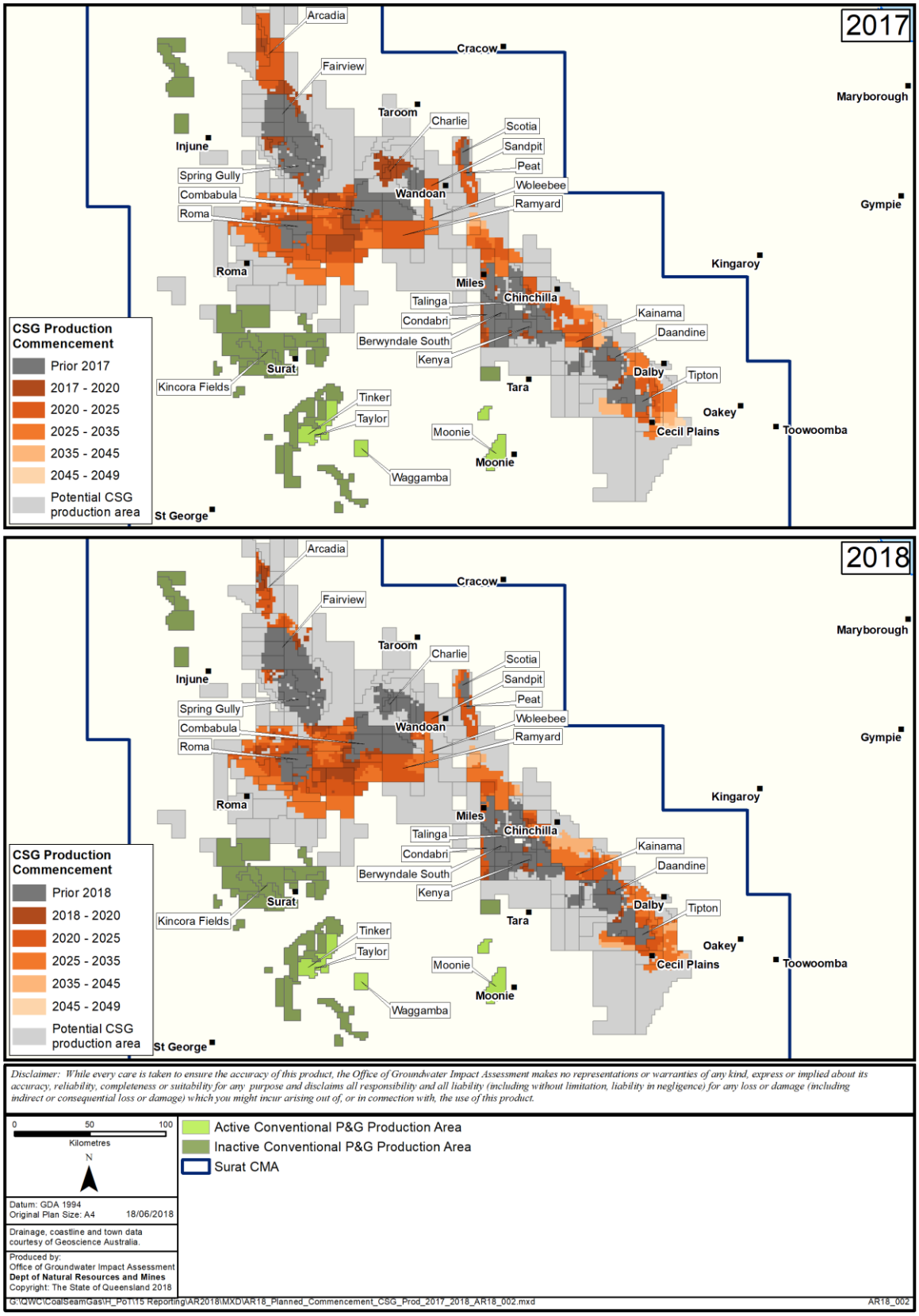

Figure 1 – A comparison of CSG development profiles from the current and previous annual reports

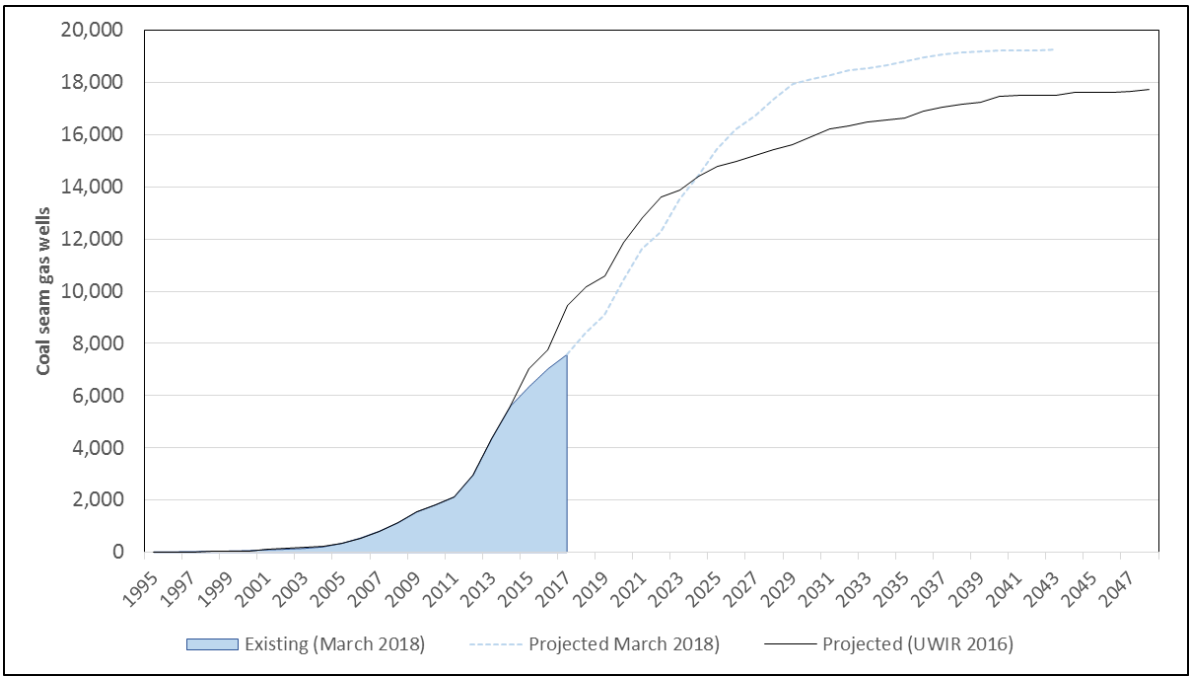

Figure 2 – Existing and projected CSG wells in the Surat CMA in current and planned production areas

Updated CSG water extraction volumes are presented in Figure 3 which shows a current stabilisation in the rate of extraction from around 65,000 ML/year in July 2015 to around 60,000 ML/year at the end of 2017.

2.2.2 Santos

There is a reduction in Santos's overall planned footprint by about 300 km^2 when compared to the 2017 development plan, most notably around its Arcadia gas field. Arcadia also has some minor timing changes with a delay of two years, while a small area in the north east of the field has been brought forward by five years, from 2023 to 2018.

Plans for the Fairview gas field remain largely unchanged with the only notable change being a delay of up to nine years in production commencement in the northern part of the gas field. The Roma and Scotia gas fields retain a similar footprint to 2017 plans. There has been some minor scheduling changes of less than three years.

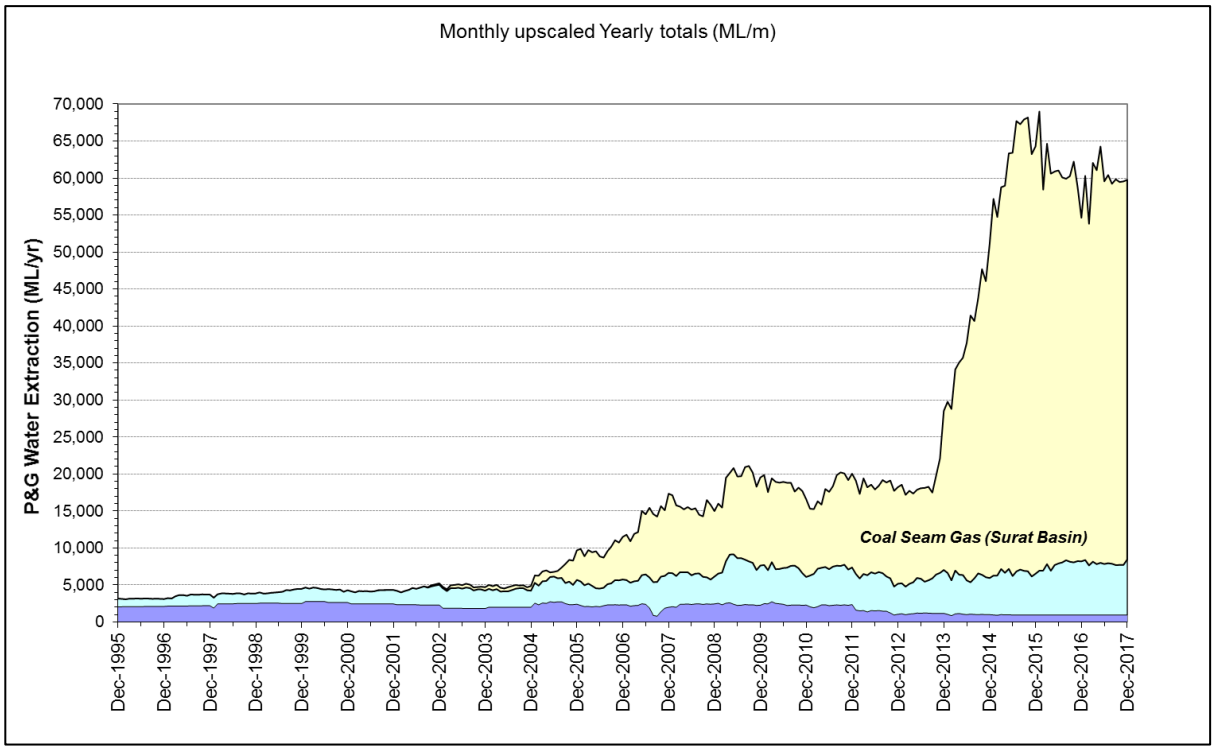

Figure 3 – P&G water extraction

2.2.3 Origin

There is practically no change in Origin's planned production footprint except a minor contraction in some parts of the Spring Gully field. There are minor changes in the development schedule, where planned commencement for new fields has been postponed by about five years across most of the gas fields, and brought forward in others. The only exception is the Ramyard gas field, where the delay is up to nine years.

2.2.4 QGC

Since 2017 there have been no significant changes to the QGC proposed development plan.

2.2.5 Arrow Energy

Arrow's production area has remained relatively similar to previous years, with one notable expansion in Development Area 5, located between Dalby and Chinchilla, where there is an expansion of approximately 100 km^2 to the east with development progression timing now being from south-east to north-west, toward Chinchilla.

Development Area 2, north of Miles, has also been delayed by two years with some areas being delayed up to 10 years. In Development Area 8, east of Cecil Plains, the planned commencement has been brought forward by up to 20 years with production scheduled to commence in 2027.

2.2.6 Senex

Senex's proposed Western Surat Gas Project planned production area is largely unchanged since the UWIR 2016. There are some minor scheduling changes in the south east of the project area. Early in 2018, Senex was also granted a Petroleum Lease (PL1037) south west of Wandoan for the 'Atlas Project' with a total footprint of about 60 km^2. PL1037 is a dedicated domestic gas supply tenure, with production to commence between 2019 and 2024.

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, termed 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 Area (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.

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 Annual Report 2017 are described in Chapter 2. The 2016 groundwater model is 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 used for the Annual Report 2017 and the predictions made using the current cumulative industry development profile.

3.4 Changes to short-term impacts

As reported in the Annual Report 2017, revised model predictions based on the industry development profile at the time suggested that 19 of the 91 IAA bores listed in the UWIR 2016 were no longer expected to be impacted by more than five metres in the short term (i.e. prior to the end of 2018). These bores were located in and around QGC's Charlie Project area and Origin's Talinga and Orana gas fields where planned production areas had contracted. Conversely, a further three bores that were previously predicted to be impacted by less than five metres in the short term were expected to be impacted by more than five metres.

However, as described in Chapter 2, there have been only minor changes to the proposed footprint or timing of development since 2017. As a result, only one additional bore is likely to be affected by more than five metres in the short term. However, this bore is in a coal mining area and is now recorded in the DNRME Groundwater Database (GWDB) as abandoned and destroyed.

3.5 Changes to long-term impacts

Changes to the cumulative industry development profile have resulted in some relatively minor changes to the LAA. In 2017, the long-term impact areas for the Springbok Sandstone, Walloon Coal Measures and Hutton Sandstone slightly contracted to the north west of Wandoan due to contraction of the Charlie Project area, and expanded slightly towards the south west 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 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 also expanded east of Wandoan due to planned extension of the existing Peat and Scotia fields.

Despite a slight overall expansion of the predicted LAA in 2017, there was 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.

Compared to 2017, there is little overall change in the long-term predicted impact area in response to the revised development profile in 2018. The Walloon Coal Measures LAA has expanded slightly towards the east, around Dalby, due to a slight increase in the CSG footprint in this area. This has led to a 6% increase in the number of bores expected to be impacted in the long term, since there is a relatively high density of water bores in this area. The total number of bores expected to be impacted, however, remains less than that predicted in the UWIR 2016 since the Annual Report 2017 predicted a similar 6% reduction in bores. The net effect of these two changes is a small decrease in the number of bores expected to impacted – from 459 at the time of the UWIR 2016, to 456 – based on the current industry development profile.

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 aquifers within the IAAs for the aquifers and enter into make good agreements with the bore owners about measures to make good the impairment of bore supply.

Together with the maps showing the IAAs, the UWIR 2016 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 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 GWDB on an ongoing basis.

4.2 Corrections to bore records

As reported in the Annual Report 2017, a correction was made to the record of a bore within an IAA, correcting the information about the aquifer from which the bore accesses water. This was based on a report by the bore owner and a follow-up investigation by DNRME. This investigation confirmed that the bore in question was slightly deeper than previously known and was likely to source water from the Walloon Coal Measures, rather than the overlying Springbok Sandstone.

Since the Annual Report 2017, a bore assessment submitted by QGC for another bore indicated that it was not accessing the Walloon Coal Measures, but rather the underlying Hutton Sandstone. Similar to the above, a subsequent DRNME investigation supported QGC's conclusion that the bore was screened in the Hutton Sandstone. Impacts on this bore are not predicted in the short term. However, impacts of more than five metres are predicted in the long term in the Hutton Sandstone at this location.

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.

The UWIR monitoring network has progressively expanded since the initial Surat UWIR in 2012. In addition to the network required under the UWIR monitoring network, OGIA also receives other data (non-UWIR) from tenure holders within the Surat CMA. As a result, OGIA collectively receives data for more than 1000 monitoring points.

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 requires the construction of 612 monitoring points by December 2017. Tenure holders are required to report on progress against this schedule every six months, in March and September each year.

The UWIR requires 633 monitoring points to be established by the end of 2019. As of March 2018, there are 587 monitoring points in place, comprising:

- 532 which are operational
- 10 which have been constructed but are dry
- 38 which are temporarily inactive due to equipment failure
- 7 which have permanently failed.

In preparation for the UWIR 2019, OGIA is reviewing the adequacy of the regional monitoring network. This will include consideration of key findings from OGIA's research and subsequent modelling in late 2018. During this review, monitoring points which have failed will be considered and OGIA will decide if a replacement is necessary or if an alternative location for monitoring is required.

Responsible tenure holders also provide monitoring data to OGIA every six months, in March and September each year. This includes monitoring data and construction information. OGIA reviews each data submission for completeness and technical accuracy, following which data is stored in the GWDB and made publicly available through Queensland Globe. The March 2018 data submission is currently under review. Data for all operational monitoring points is uploaded to the 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 final outcomes are likely to be available in late 2018 for inclusion in the next UWIR.

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 drawdown increasing 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 implementation of the UWIR 2016, due to CSG extraction from the underlying Walloon Coal Measures at this location. Possible CSG impacts have also now been observed at a small number of other locations in the Springbok Sandstone, although pressures at most locations have remained relatively stable or show no departure from background trends.

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-CSG water extraction from the Hutton Sandstone. There is no definite evidence of contribution from CSG extraction from the overlying Walloon Coal Measures. This is being 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 300m 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 is being investigated further as part of the detailed OGIA review (see Chapter 7).

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 are identified as potentially affected.

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

The UWIR 2016 includes a risk assessment for springs and specifies 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 is 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 aquifers. 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.

Consistent with the Annual Report 2017, the latest predictions indicate impacts will not occur 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.

At the majority of sites, eight quarterly monitoring rounds were completed during the last UWIR cycle. There have been difficulties in gaining access at some locations since the 2016 UWIR commenced. OGIA will seek to assist tenure holders in gaining land access for the 2018 monitoring rounds.

In 2017-18 a pilot project was 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. Further discussion of this project is provided in the following chapter (see Chapter 7). The project will provide a basis for recommending monitoring methods and techniques to be included in the UWIR 2019.

6.4 Prevention or mitigation of spring impacts

The UWIR 2016 identifies four spring complexes where pressure impacts in the source aquifers are 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 continue to be negotiated between the responsible tenure holders and the relevant bore owners to cooperate in the implementation of the measures, if and when appropriate.

At the two other mitigation sites (Springrock Creek and 311/Yebna), the UWIR 2016 requires Santos to develop a spring research plan. To date, key components of Santos's research include:

- a longitudinal survey of the Hutton Creek and Dawson River to confirm local geology and identify the primary gaining sections of these watercourses – completed 2017
- a local-scale hydrogeological conceptualisation of the area integrating the findings from the field investigations – due June 2018.

In parallel, OGIA has remapped the geological contact between the Precipice Sandstone and the Bandanna Formation in this area. This is the primary impact propagation pathway to these mitigation sites.

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.

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 and Yebna/311 is developed in advance of any potential future impact and appropriate mitigation actions may be developed as part of the UWIR 2019.

7 Update on research projects

7.1 Overview

OGIA is continuing to update and build knowledge about the regional groundwater flow system through its ongoing research programs, industry initiatives and research by other organisations.

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

Since the development of the current UWIR in 2016, a range of additional data sets have become available, particularly geological and formation properties data from additional CSG wells, and groundwater monitoring data from a network of almost 600 monitoring points, established through the UWIR obligations as well industry's own monitoring initiatives. OGIA is now in the process of building knowledge from these additional data sets. OGIA's research efforts are focused in three areas:

- sub-regional-scale hydrogeological assessments around CSG gas fields that have been in production for some time and where significant new monitoring data has now become available
- improving methods and tools for assessment such as estimation of non-CSG water use, modelling techniques, uncertainties due to bore connectivity and geological faults and spring monitoring
- improving regional-scale conceptualisation and modelling.

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 up-to-date.

A further revision of the geological model for the Surat and southern Bowen basins is now complete. This revised model incorporates data which has become available since 2015 when the previous geological model was prepared. This includes the geophysical data from a further 3000 CSG wells 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 into the model. Previous interpretations of major fault systems have been reviewed and revised.

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 analysis of trends in the eastern and southern gas fields, covering areas west of Dalby and south of Chinchilla and Miles, is complete, while similar analyses for the northern Surat Basin and the Bowen Basin are currently underway. Interim findings suggest that the primary cause for the

declining pressure trend is non-CSG water use. Preliminary findings from this work have been presented in various landholder forums and outcomes will be incorporated into the UWIR 2019.

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. Further detailed field investigations including a bore sampling program planned for Phase 2 of the project have also commenced.

The results from this study, scheduled for completion in late 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 commenced a project aimed at first mapping and then understanding the likely hydrogeological behaviour of minor faults. During the initial mapping stage, this study has drawn on the improved seismic data set provided by the School of Earth Sciences at the University of Queensland. This information is being integrated with other data sets such as the groundwater levels, groundwater chemistry and CSG water extraction 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 late 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. An analysis of ongoing monitoring data from existing investigation sites and additional monitoring data from other sites is continuing. Analysis so far is consistent with the findings previously reported.

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.

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. A project report is now available on OGIA's website.

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, termed '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, will be used to inform research, monitoring and mitigation actions to be outlined in the next UWIR.

7.10 Refinement of the non-CSG 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 has continued to refine this method to incorporate historical changes in land use, landholder water use practices and progressive bore abandonment over time. OGIA has now also developed a similar method for estimating water use by non-stock and domestic users, such as feedlots, town water supply and industrial use.

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 has also developed a sub-regional model to support detailed analysis of observed trends in groundwater pressure data (Section 7.3) and identify and test 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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