



# Groundwater Management and Monitoring Plan

## Project Stage 1

### EPBC (2012/6615)

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Appendix 1 - Joint Industry Plan for an Early Warning System for the Monitoring and Protection of EPBC Springs, 30 September 2013.

Appendix 2 - Underground Water Impact Report for the Surat Cumulative Management Area, 2016



## 1. Background

### 1.1. Introduction

The Santos Gas Field Development (GFD) Project extends the Santos GLNG development area from 6,887 km<sup>2</sup> to 10,676 km<sup>2</sup>. It will see the development of up to 6,100 production wells (and associated infrastructure) beyond the currently authorised 2,650 production wells. The area of the project comprises 35 petroleum tenures, which includes the existing GLNG project area and some surrounding tenures in Arcadia, Fairview, Roma and Scotia. These areas combined are called the Santos GLNG Upstream Project Area.

### 1.2. Purpose and scope

The Ground Water Management and Monitoring Plan (GMMP) has been prepared to satisfy the conditions of approval 2012/6615 issued under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This plan specifically satisfies requirements of Condition 22A. This condition relates to the potential impact of coal seam water extraction on Matters of National Environmental Significance (MNES) for Project Stage 1.

Project Stage 1 comprises the installation and operation of up to 110 CSG wells on PL176 (Scotia). The GMMP for the GLNG GFD Project will be updated pending revision and approval of a whole-of-industry approach (currently the Joint Industry Plan) for the monitoring and management of impacts to groundwater. Until such time as a whole-of-industry approach is approved by the Minister or his delegate, or the Minister or delegate advises an alternative approach, Santos will apply the commitments made within the currently approved Joint Industry Plan to the Scotia Development of the GLNG GFD as if it has been approved for this Project.

## 2. Overview

The Project Stage 1 development comprises the installation and operation of up to 110 CSG wells on PL176. This document explains how the currently approved Joint Industry Plan (JIP) for the monitoring and management of cumulative CSG impacts adequately manages the potential risk of impact to MNES (Matters of National Environmental Significance) due to the planned Project Stage 1 development.

The Underground Water Impact Report (UWIR) for the Surat Cumulative Management Area (Surat CMA) predicts negligible impacts to groundwater pressures due to the development of coal seam gas wells within the Scotia tenure PL176, inclusive of the Stage 1 Development. The CSG development scenario that was contemplated by the Surat CMA UWIR published in 2016 included the development of up to 182 CSG wells on the Scotia tenement PL176 in addition to those which are already in operation (i.e. 182 additional CSG wells comprises new wells installed over three construction phases, of which Stage 1 (comprising up to 110 CSG wells) is the first phase). Outputs of the 2016 UWIR can be used to show that there is minimal



risk of adverse impact to groundwater environmental values due to the proposed Scotia development.

Until such time that the Joint Industry Plan (JIP) is revised and the GMMP for the GFD Project can be approved, the risk to groundwater due to the development of 110 CSG wells as part of the Project Stage 1 Development is deemed very low. In the meantime, the incumbent and approved monitoring and management approach adequately provides ongoing assurance.

### **3. Approved Joint Industry Plan**

#### **3.1. History**

The Santos GLNG project was approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 22 October 2010. The approval conditions relating to gas field development (EPBC 2008/4059) required Santos to submit detailed water monitoring and management plans.

On 9 October 2013 Santos submitted its Stage 2 Water Monitoring and Management Plan to satisfy condition 53 attached to the approval (EPBC 2008/4059). The Stage 2 Water Monitoring and Management plan was reviewed and endorsed by the then Commonwealth Government's "Expert Panel for Major Coal Seam Gas Projects". During the review, the panel considered technical advice from Geoscience Australia and the University of New South Wales Water Research Laboratory. The Santos Stage 2 Water Monitoring and Management Plan was approved as meeting the requirements of EPBC Approval 2008/4059 on 29<sup>th</sup> November 2013.

The approved Santos Stage 2 Water monitoring and Management Plan included a Joint Industry Plan (JIP) to satisfy several of the project approval conditions. The JIP specifies the monitoring and management of the cumulative impact to groundwater from CSG in the Surat Cumulative Management Area. It is a strategy for monitoring and detecting for potential impacts to all EPBC springs that are at risk of impact due to the development of CSG.

#### **3.2. Scotia Development and the JIP**

The JIP monitors and manages potential risk to EPBC springs from all proposed CSG development inclusive of the Scotia tenure PL176 even though CSG development on Scotia PL176 was not within the remit of the GLNG project EPBC approval. This is because the JIP assess the cumulative impact of the CSG industry, not any one particular sub-project.

The JIP specifies the monitoring and management activities for the potential risks to EPBC springs from all proposed CSG development inclusive of the Scotia tenure PL176 even though CSG development on Scotia PL176 was not within the remit of the GLNG project EPBC approval (EPBC 2008/4059). This is because the JIP assesses the cumulative impact of the CSG industry, not any one particular sub-project.



In accordance with the currently approved JIP, Santos will continue to monitor groundwater at these locations (refer Table 1 and Figure 1). The data will continue to be assessed in accordance with the methodology which is prescribed within the approved JIP. The data is used to provide an early warning of potential impacts to springs protected under the EPBC Act.

Section 8 of the JIP (Appendix I to the Stage 2 CWMMP), specifically Table 8-1, Table 8-2 and Table 8-3, define the early warning, trigger threshold, and limits for individual groundwater pressure monitoring points. The proposed exceedance response plan is specified in Section 9 of the JIP.

**Table 1: EPBC Spring Early Warning System Monitoring Locations (as proposed in the Joint Industry Plan)**

Bore ID	Latitude (WGS84)	Longitude (WGS84)	Aquifer	Date monitoring commenced	Status
AVLOP01	-25.9419	150.0742	Precipice Sandstone	Dec 2015	Active
AVLGWH	-25.9141	150.0736	Hutton Sandstone	Dec 2013	Active
AVLVWH1 AVLVWH2	-25.9379	150.0739	Hutton Sandstone	Dec 2012	Active
AVLVWP1 AVLVWP2	-25.9379	150.0739	Precipice Sandstone	Dec 2012	Active

#### 4. Impact Assessment for Scotia Development Area

Whilst the JIP proposes monitoring and management of potential impact to EPBC listed springs, it does not describe monitoring and management for other potential risks to non-EPBC listed springs, watercourse springs, non-spring based groundwater dependent ecosystems (also referred to as terrestrial GDEs), or the availability of water to other users (i.e. groundwater extractions from bores). However, given the location and scale of this Scotia development, such potential risk of impacts have been assessed and considered negligible. The following sections provide a qualitative impact assessment to these values with these potential risks to be addressed within the next update of the GMMP.

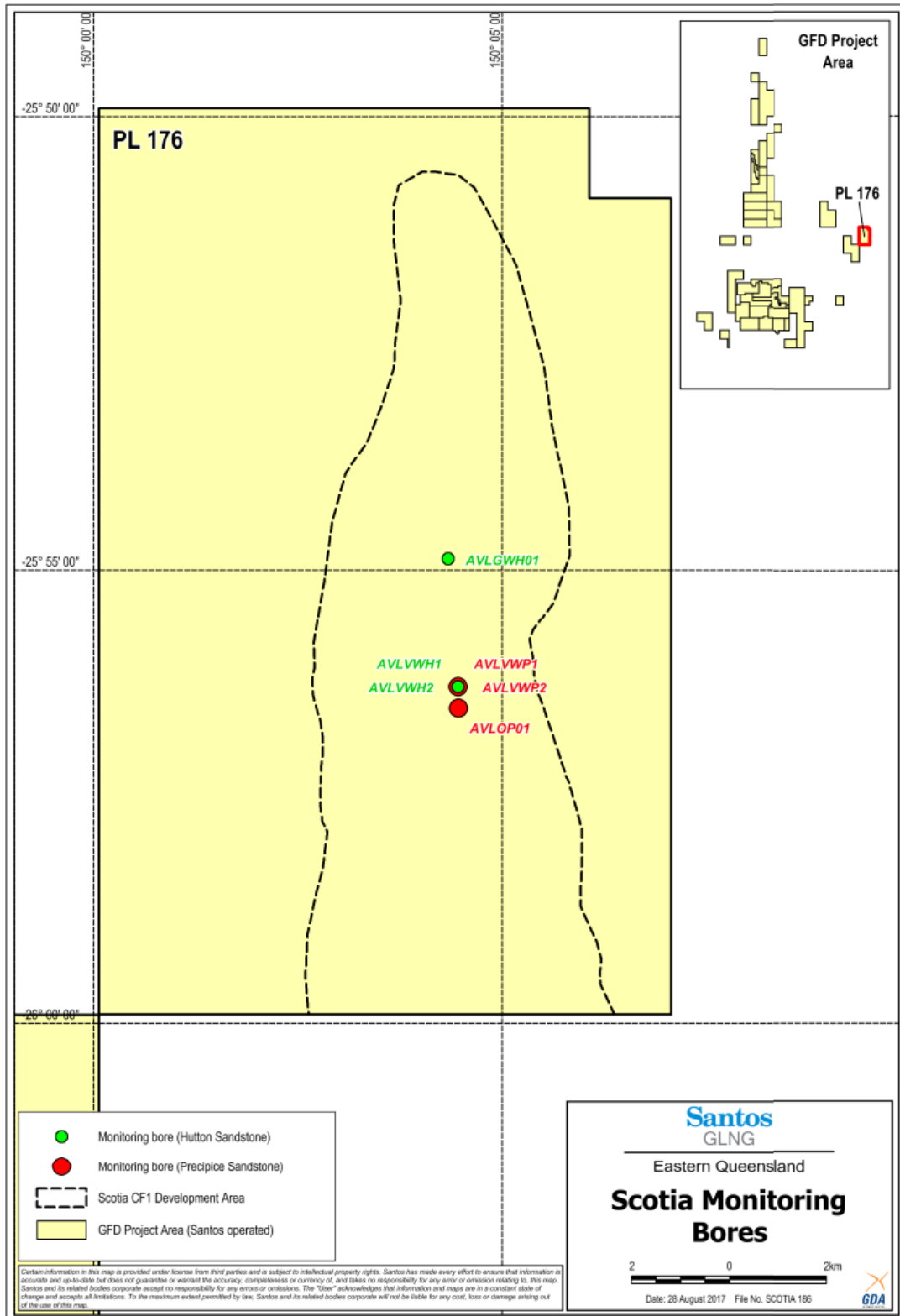


Figure 1: Groundwater Monitoring Locations on Scotia PL176 specified in the Joint Industry Plan

### **4.1. Low Coal Seam Permeability and Water Production**

CSG development on Scotia PL176 will target the Upper Permian Baralaba coal measures of the Bowen Basin. These are equivalent but hydraulically distinct from the Bandanna Coal to the west of the Mimosoa Syncline in the Bowen Basin. Approximate forecasts of water production from all proposed development of Scotia PL176 is expected to peak at less than 0.5 ML/d across more than 100 CSG wells. This equates to a peak flow rate of less than 0.05 L/second per well, on average.

Low water production rates demonstrate that the coal is not particularly permeable relative to other coal seam gas targets in the Bowen and Surat Basins.

### **4.2. Connectivity of the Bandanna Formation**

The deeper Permian formations underlying the Bandanna Formation have extremely low permeability. Therefore it is unlikely that depressurisation of the Bandanna Formation will affect the underlying formations.

The geology across the Scotia PL176 is shown on Figure 2. The shallower Triassic aquifers of the Bowen Basin that overly the equivalent Bandanna Coals in the west of the Bowen Basin are not present on PL176. The Baralaba coal measures are isolated from the overlying major aquifers of the Surat Basin by the thick and low permeability mudstones of the Rewan Group. Therefore depressurisation of the Baralaba coal measures will not affect overlying aquifers.

The closest overlying aquifer to the Baralaba coal measures is the Precipice Sandstone. The Hutton Sandstone is present on Scotia PL176, but it is shallower than the Precipice Sandstone (see Figure 2). The Hutton Sandstone could not be affected by drawdown of the Baralaba Coal Measures without any significant drawdown first being observed in the Precipice Sandstone which lies between them.

### **4.3. Non-EPBC listed springs and watercourse springs**

The 2016 UWIR assesses the risk to springs within the Surat CMA. A risk assessment is presented and a monitoring and impact management plan is proposed.

There are no springs identified in the UWIR (2016) which are at risk of impact due to the development of CSG within Scotia PL 176, inclusive of the proposed 110 CSG wells comprising the Project Stage 1 Development.

There is a watercourse spring (Bungaban Creek) mapped adjacent to development on Scotia PL176 (see Figure 3). This watercourse spring is fed directly by discharge from the Hutton Sandstone. The 2016 UWIR assesses that this spring is at no risk of impact due to development on Scotia PL176. This will be due to the lack of connectivity between the Baralaba coal measures and the shallow Hutton Sandstone.

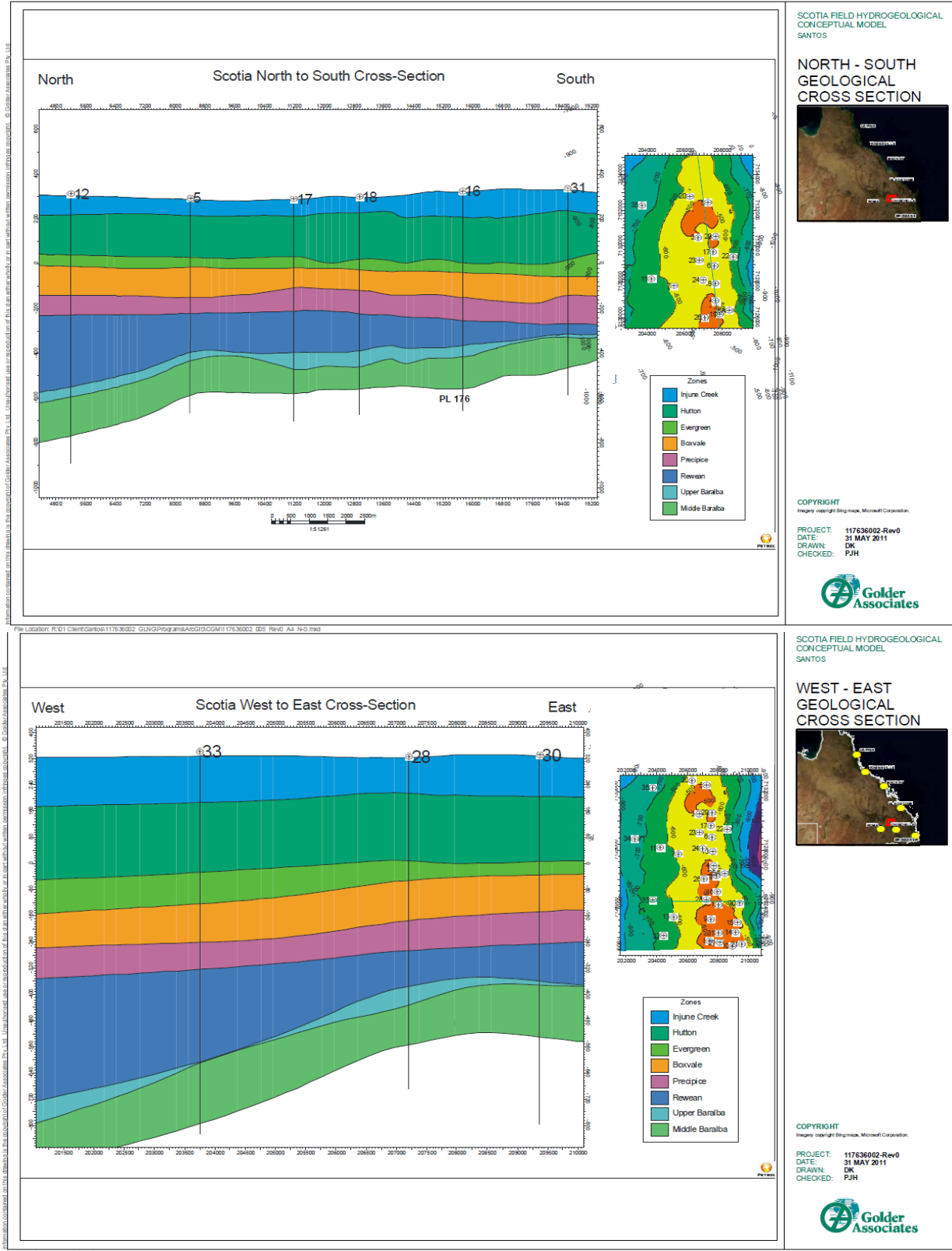


Figure 2: Geological Cross Sections across Scotia PL176



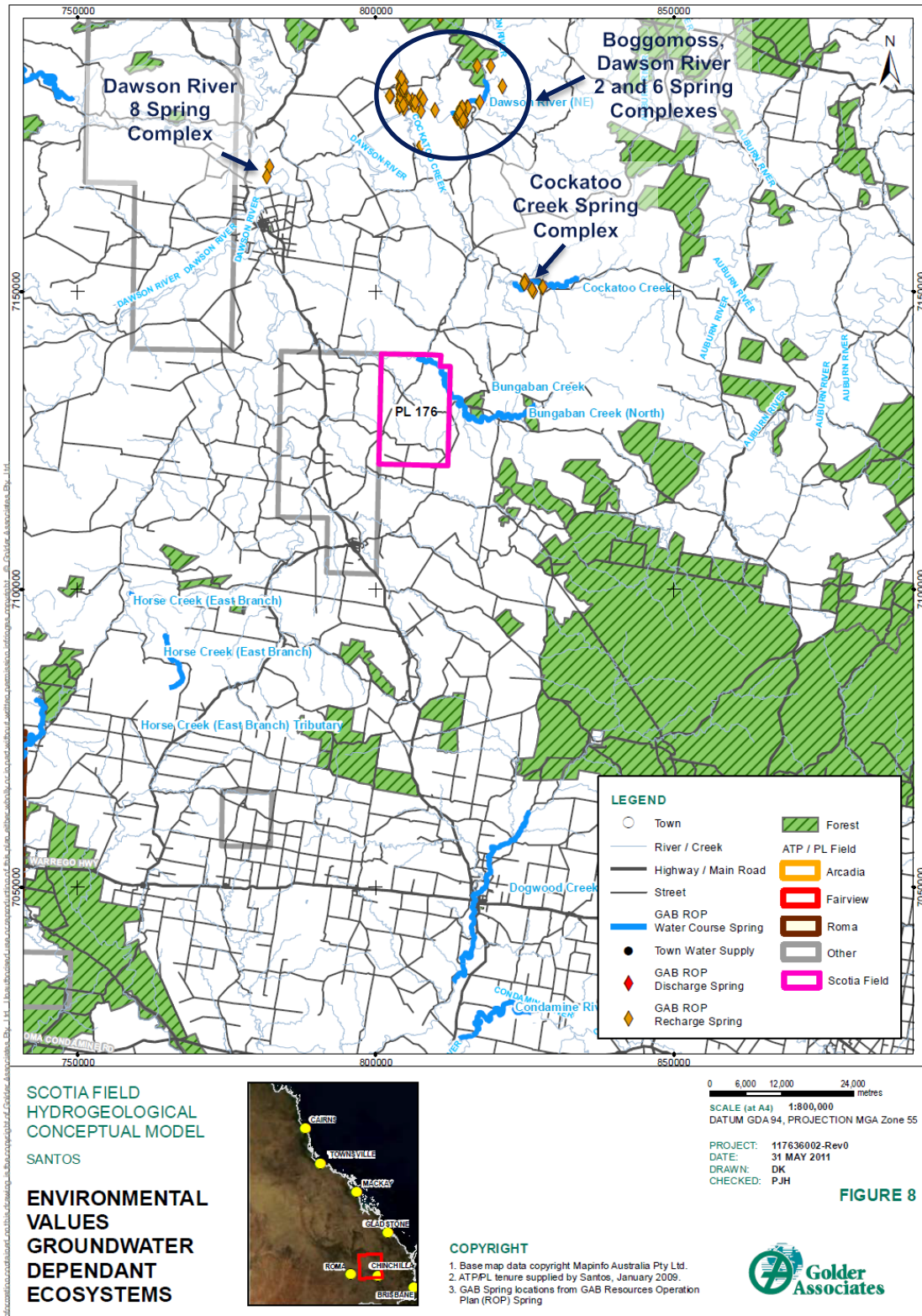


Figure 3: Environmental Values in Proximity to Scotia PL176 – Groundwater Dependent Ecosystems



The nearest spring complex is the EPBC listed Cockatoo Creek Spring Complex. It is also associated with a watercourse spring (Cockatoo Creek) (see Figure 3). These springs are connected to the Precipice Sandstone aquifer. The 2016 UWIR spring impact risk assessment has stated that these springs are not at risk due to CSG development (including that on PL176). This is because there is insignificant degree of connectivity between the Baralaba Coal and the Precipice Sandstone. Furthermore the springs are located a sufficient distance away from the development (~30km). The location of the springs is shown in Figure 1.

Other spring complexes which are also present within the region are the Dawson River and Boggomoss complexes (see Figure 3). These springs have been assessed to not be at risk by CSG development as stated in the UWIR 2016. These springs are not at risk as they are fed by groundwater from the Hutton Sandstone (which is shallower than the Precipice Sandstone) and are located even further away from the development (>50km).

#### **4.4. Terrestrial GDEs**

The UWIR does not directly assess impacts to terrestrial GDEs however the outputs of the model which are presented in that report can be used to assess the risk to terrestrial GDEs. Assessment of those model outputs show that there is no risk to terrestrial GDEs.

In absence of any published guidance in this regard, this determination assumes that a drawdown of less than 1m in an outcropping and water bearing formation is not likely to impact on potential terrestrial GDEs.

#### **4.5. Availability of groundwater to other users**

The 2016 UWIR assesses impact to availability of water for other groundwater users. Maps of the long term affected areas (see Figure 4) show that no aquifers are predicted to be impacted by more than 5 m of drawdown due to the Project Stage 1 Development. A drawdown in excess of 5 m is required to trigger Make Good obligations in accordance with the Queensland *Water Act (2000)*.

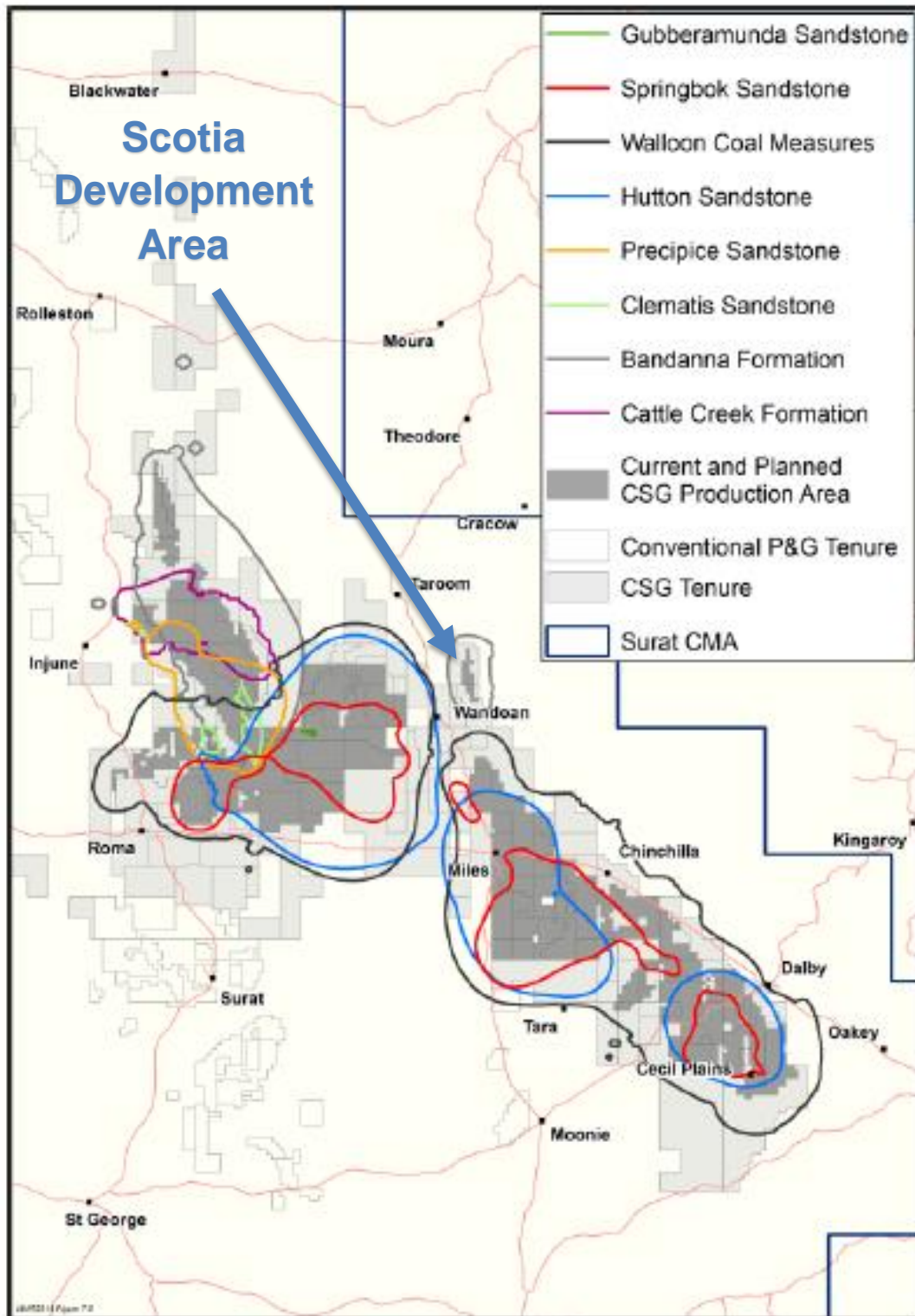


Figure 4: Extent of the Long Term Affected Areas as Predicted by the 2016 UWIR (location of Scotia Development Area shown)



## **5. Revision of the GMMP**

Santos will not commence extraction of water or coal seam gas from wells other than the 110 referred to in this version of the plan until a revised version of the GMMP, either specific to the next planned element of the GFD project, or applicable to the entire GFD project, is approved in writing by the Minister. The revised GMMP will contain detailed information regarding how water resources will be monitored and protected.

## **6. Conclusion**

The risk to groundwater due to the development of 110 CSG wells as part of the Project Stage 1 development is deemed very low. More cumulative monitoring and management actions will be addressed in the next version of the GMMP.