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5.0
Establishing a comprehensive monitoring network – Stage 2

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Conditions
49, 52 and 65 to 67

5.1 INTRODUCTION

As planned, QGC has progressed the establishment of an extensive monitoring program to being able to monitor changes in aquifer status (both water level and quality) across its production tenements for the life of the project. The monitoring points were selected across and around production tenements to capture the potential regional extent and effect of CSG extraction activities.

QGC's monitoring program includes the construction of standpipe groundwater monitoring bores and multi-level Vibrating Wire Piezometer (VWP).

A high priority during the Stage 1 WMMP was the phased establishment of the monitoring well network encompassing the QCLNG gas field areas. This included construction of 13 bores by the end of 2011 in the Gubberamunda Sandstone and Springbok Formations in the existing central and future southern development areas. The Stage 2 drilling program is currently underway, with eight out of 32 bores completed into a number of Surat Basin aquifers and aquitards as of August 2012.

Once installed, these bores will provide ongoing aquifer monitoring of:

- Free-standing water levels for specific aquifers of interest
- Aquifer-specific pressures
- Water quality through collection of aquifer water samples (standpipe bores only).

5.2 MONITORING NETWORK OBJECTIVES

The object of the monitoring wells network is to generate ongoing data streams for analysis of any groundwater level changes due to natural occurring processes (e.g. rainfall recharge, barometric and earth tide fluctuations), CSG activities and/or other groundwater usage.

In support of this objective, specific secondary monitoring network program objectives are:

- To enable baseline and ongoing groundwater monitoring in order to predict any impacts from CSG activities on aquifers and EPBC listed springs
- To acquire additional geological and hydrogeological data from the new bores to assist in the characterisation of Surat Basin geological formations
- To monitor planned appraisal pilot trials in support of connectivity studies prior, during and after testing in order to identify possible leakage from adjacent formations
- To monitor aquifer injection trials (near-field and far-field monitoring of potential response)
- To comply with Australian and Queensland regulatory requirements (in particular, QWC and State environmental authorities)
- To support reservoir development activities
- To inform other QGC programs and research as required.

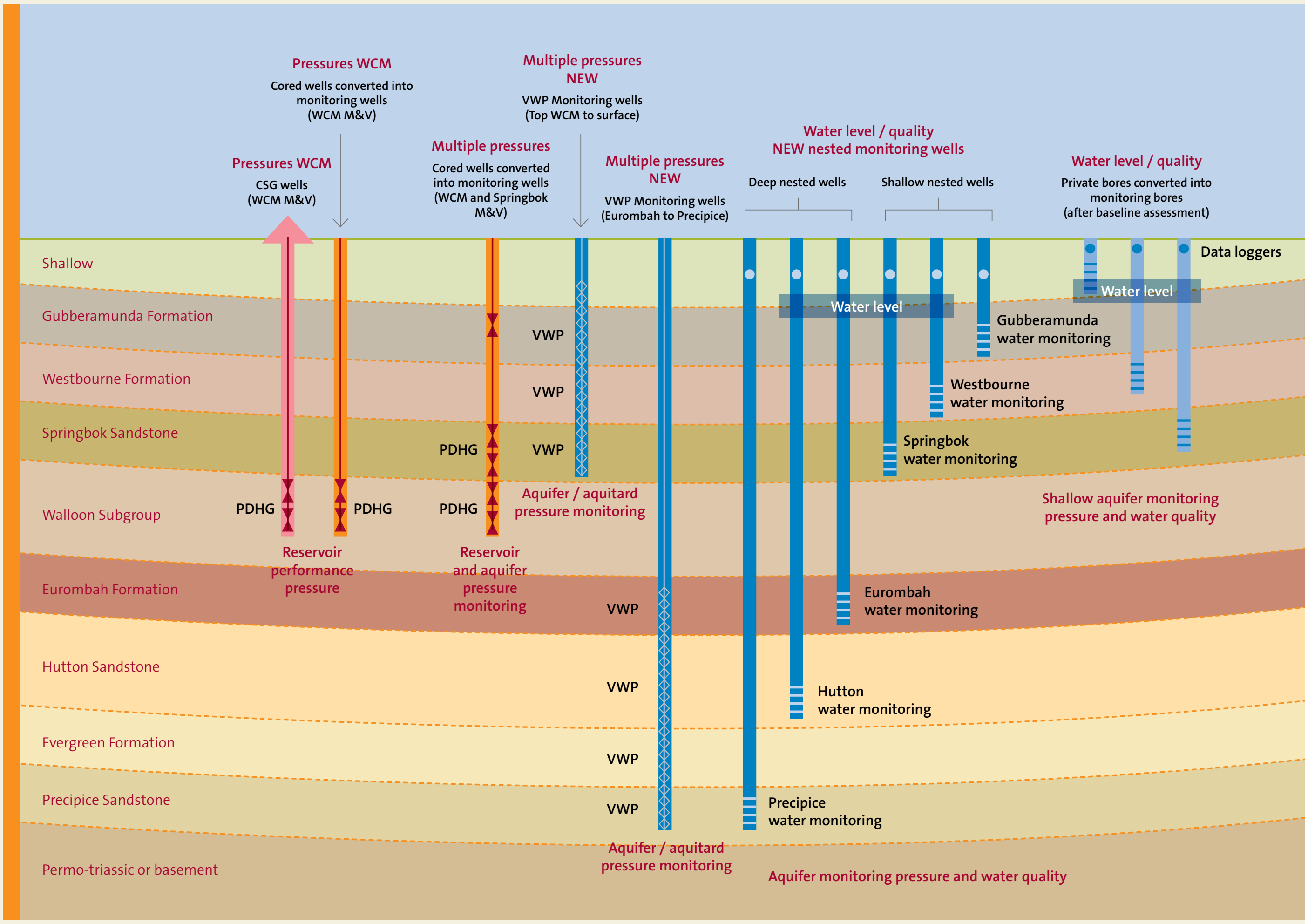


Figure 22 – Schematic of nested monitoring bores and VWPs

5.3 MONITORING BORE RATIONALE

In the development of QGC's monitoring bore network, these objectives (above) were considered and a rationale has subsequently been developed regarding the selection of each bore location and formation to be monitored.

The rationale for each bore location and design/construction and depth, comprises a series of elements. A bore may be located to satisfy only one element or, alternatively, a bore location will satisfy a number of elements. The more elements a bore satisfies, the stronger its design rationale.

Detailed below are the elements QGC considered when defining its rationale for each bore. Table 7 present the determined monitoring bore locations, their target aquifer and the elements satisfied.

Stage 2 Monitoring Bore program is scheduled to be finalised with QWC during the Draft UWIR Consultation period.

The seven elements identified determine the 3D spatial distribution of the monitoring network while the requirements of QWC's UWIR will also influence network design. In broad terms, the two highest risk aquifers, namely the Springbok and Hutton, have received highest priority.

5.3.1 STATISTICAL METHODS FOR GROUNDWATER MONITORING NETWORK DESIGN

QGC is of the view that statistically-based methods for the design of groundwater monitoring networks (for example, as discussed in Merrick, 1998, and Theodossiou and Latinopoulos, 2006) are of limited use because there are many different factors (as discussed below in detail) which determine the location of monitoring bores. Nonetheless, QGC proposes to undertake a review of the adequacy of the groundwater monitoring network once the UWIR requirements are finalised and the results of the GEN3 modelling are providing 'history matched' groundwater drawdown results. When QGC is confident that good quality groundwater drawdown projections are available, then QGC will evaluate the use of statistical methods to assist the design of the network. This will be reported in April 2013.

5.3.2 HYDROGEOLOGICAL APPROACH TO GROUNDWATER MONITORING NETWORK DESIGN IN THE DAWSON RIVER CATCHMENT

Seven elements have been considered for siting and designing bore types for QGC's regional groundwater monitoring network. These are discussed in detail below. Table 7 provides details of all completed and planned monitoring bores and summarises the rationale basis for each monitoring bore including its primary purpose.

Rationale Element 1 – Aquifer Connection to MNES/Sensitive Receptors/Current Use
The protection of identified EPBC listed springs is a key requirement of both SEWPAC and QWC. To this end, a monitoring bore's location and depth is partly defined by its ability to provide an early warning in the source aquifers for these springs.

For example, part of the rationale for bores QGC drills in the northern tenements is to monitor aquifers feeding EPBC listed springs, so bore depths intersecting Hutton and Precipice aquifers are selected in these areas. Bores drilled in the south do not have the requirement to monitor springs but Hutton and Precipice bores will be completed from a regional water use perspective.

Rationale Element 2 – Development of Baseline Datasets, Establishing Trends
Baseline aquifer monitoring is crucial in the establishment of aquifer conditions prior to commencing CSG activities. A valid aquifer baseline dataset enables assessment of natural fluctuations such as earth tides, seasonal variations and drought or anthropogenic inputs like local farm bore or commercial, agricultural or industrial use extraction.

Consequently, one siting element rationale is to ensure bores are sited in areas and aquifers where groundwater may already be subject to natural or anthropogenic influences so as to allow characterisation. An example is in the southern area where the Springbok Formation outcrops at surface and may be sensitive to direct rainfall recharge events – influencing the rationale for the Springbok bores drilled in the Poppy field.

The positioning of these bores in appropriate locations to assess response is an important component in defining baseline conditions prior to CSG activities. Bore-by-bore baseline monitoring of aquifers will allow QGC to produce a base water level and water quality trend for each aquifer of interest, allowing natural or anthropogenic influences to be clearly defined.

Rationale Element 3 – Ongoing Monitoring, Assessing Impacts

Following on from the establishment of individual aquifer conditions, QGC will undertake an extensive, ongoing monitoring program for the life of the operation and beyond. This ongoing monitoring program will continue the program developed during the baseline works, utilising the same bores but with flexibility to expand as needed into specific areas. This will enable rapid assessment of:

- Changes in aquifer conditions towards and around EPBC listed springs or other sensitive receptors
- Changes in aquifer conditions and inter-formation leakage in and around areas of CSG operation
- Aquifer response to future re-injection activities.

For example, a well may be sited in relation to the long-term field development plan so that when a CSG field is commissioned the bore has a valid baseline dataset and is positioned to monitor accurately any aquifer responses. The bores drilled at Woleebee Creek in 2012 illustrate this element as part of the rationale for their location, design and depth (including all assessment points).

Rationale Element 4 – Supporting Connectivity Studies

A fundamental QGC focus is on assessing and quantifying the potential connectivity of the Walloon Coal Measures to aquifers above and below the formation – prior to and during CSG activity. Monitoring hydraulic heads (via pressure or standing water level) of specific aquifers during pilot tests and then over the life of the operation helps develop connectivity profiles for aquifers of interest.

In relation to pilot trials planned for various CSG fields, QGC has identified three specific areas within its tenements where extensive monitoring and assessment of aquifer connectivity will occur. These areas are Woleebee Creek in the Northern Gas Fields and Kenya East and Ruby-Jo in the Central and Southern Gas Fields.

At each of these locations, multiple wells are proposed with each targeting a specific aquifer or aquitard. In this way, during production trials and later during general operations, hydraulic heads can be monitored, pressure differentials between formations recorded and changes noted. Changes in pressure regimes may then be quantified to determine potential leakage between aquifers.

Rationale Element 5 – Field Development and Tenement Coverage

This element, referenced against QGC field development plans, relates to the location and scheduling of monitoring bores to be drilled and installed. Considerations include:

- Field development plans – aligning drilling and installation with a CSG field's scheduled pilot or full-scale production
- Planning installation timing to allow for the establishment of baseline conditions
- Planned water extraction rates
- Achievement of good spatial coverage of QGC tenements
- Access to selected locations, in relation to landholder negotiation, compensation and ongoing access needs
- Coverage of QGC tenure
- Availability of existing QGC infrastructure, such as existing pads, to minimise the drilling footprint.

Each of these factors is considered when developing a monitoring bore drilling schedule, as summarised in Table 7.

Rationale Element 6 – Conceptual Siting Numerical Modelling

A key component in defining bore rationale relates to conceptual and numerical regional hydrogeological models. Monitoring programs are designed to inform refinement and continual development so that these models can accurately reconcile measured groundwater level and pressure data against tested model assumptions.

Based on inputs, hydrogeological numerical models can identify areas within each aquifer where depressurisation and drawdowns may be expected. Model outputs and associated pressure zones are considered when examining bore locations to determine if this will assist in confirming modelled depressurisation. This is a key mechanism for undertaking future numerical model reconciliation.

Rationale Element 7 – Geological and Hydrogeological Data Acquisition
A number of geological and hydrogeological models are utilised by QGC across a number of disciplines. Drilling these monitoring bores generates new data to complement and expand existing datasets. Bore location and depth address any known data gaps in existing models and supports ongoing model refinement.

5.3.3 BOXVALE AND MOOGA UNITS

The elements defined above have been utilised in the aquifer assessment process for all but two of the geologic units within QGC's tenements in the Surat Basin. Detailed below is a discussion on the units that were not considered as part of the monitoring program and some detail on their geologic occurrence within the basin.

Based on these assessments QGC have considered the installation of monitoring infrastructure into these units unnecessary at this time. Should future assessment works demonstrate that there is a clear need to monitor these units then under QGC's adaptive management approach additions to the monitoring network may be considered.

Boxvale Sandstone member
The Boxvale Sandstone Member is located between the upper and lower Evergreen formation. The Boxvale Sandstone Member is laterally present across most of the Northern Surat Basin. It is locally thin, comprising 10-40 m thickness, average of 29 m, and does not exceed 35 m thickness in any of the deep wells within QGC's northern tenements. The unit is not typically one discrete interval; rather it is often split into several arenaceous sections divided by clay rich shales. QGC has considered the need for monitoring of the Boxvale Sandstone member and believes that this is not necessary because there is extensive monitoring of the overlying (Hutton Sandstone) and underlying (Precipice Sandstone) units which are the main source aquifers for EPBC listed springs in the region. Also the trigger response criteria of the adjacent units are identical, hence it is believed that any effects felt in the adjacent units would be felt in the Boxvale Sandstone. The very preliminary assessments at the EPBC listed springs identified the Boxvale as a possible secondary source aquifer at Cockatoo Creek. Should further assessments at the EPBC listed springs identify the Boxvale as a credible source aquifer, QGC would then consider the usefulness of any monitoring bores. Note: The QWC UWIR Spring Management Strategy does not require monitoring of the Cockatoo Creek Springs.

Mooga Sandstone
The Mooga Sandstone conformably overlies the Orallo Formation across most of the eastern edge of the Surat Basin. Towards the western Nebine Ridge where the Orallo Formation thins, the Mooga Sandstone rests directly on the Gubberamunda Sandstone. The unit thickens into the centre of the basement however overall it ranges between 0 m and 50 m within the QCLNG project area. QCLNG project tenements are largely situated on or beyond the outcrop extents of the Mooga Sandstone. The lack of Mooga Sandstone presence across much of QCLNG project development areas and the well developed presence of the Orallo Formation hydraulically separating the Gubberamunda and Mooga Sandstones, infers that the likelihood of impact from QGC CSG operations in this region is effectively negligible. QGC is committed to long-term groundwater monitoring of the Gubberamunda Sandstone as well as the Springbok Sandstone. If this monitoring shows impacts caused by CSG operations in excess of current modelling, then under QGC's adaptive approach, monitoring can be considered. Hence QGC is of the view that there is little benefit of monitoring the Mooga sandstone. Nonetheless in some tenements, VWPs will be constructed into the Mooga sandstone, as shown in Table 8.

5.4 MONITORING BORE TYPES

Once the locations are selected based on the rationale defined above then the bore type is defined.
The type of bore drilled at each location considers the elements of the rationale, regulator requirements and internal QGC data needs. Based on the outcomes of this assessment a bore type is selected. In broad terms:

- Where only water level data is required an open standpipe bore could be utilised, or a VWP pressure bore installed
- Where water levels and water quality are required an open standpipe bore will be installed.

The different styles of monitoring bore available are presented in Figure 22. Table 7 provides details of QGC's proposed standpipe monitoring and VWP construction program. Table 8 outlines the planned VWP borehole conversion program.

5.5 CURRENT PROGRAM STATUS

Due to technical and legislative requirements, the nested bore drilling program was planned as two sub-programs:

- A 'shallow' nested bore program (above the WCM and typically up to 350 m in depth) to monitor the Gubberamunda, Westbourne and Springbok Formations (Stage 1 was completed in 2011)
- A 'deep' nested bore program (below the WCM and typically more than 350 m in depth) to monitor the Eurombah, Hutton and Precipice Formations (Stage 2 commenced in 2012 and is currently in progress). In some cases VWP installations may used.

The Stage 1 Program was completed in Q4, 2011, with 13 bores drilled, as detailed in Table 7. The Stage 1 Bore Completion Report documents this work and findings and is attached as Appendix H.

Complete								
Area	**Tenure**	**Location**	**Well Name**	**Primary Function**	**Rationale Element**	**Target**	**Monitoring**	**Year**
Stage 1 – Complete (Shallows)								
Central	PL201	Berwyndale South #50	Berwyndale South GW1	Monitoring	3, 5, 6	Gubberamunda	P&W	2011
Central	PL201	Berwyndale South #50	Berwyndale South GW2	Monitoring	3, 5, 6	Springbok	P&W	2011
Central	PL180	Lauren #14	Lauren GW1	Monitoring	3, 5, 6	Gubberamunda	P&W	2011
Central	PL180	Lauren #14	Lauren GW2	Monitoring	3, 5, 6	Springbok	P&W	2011
South	ATP648	Camp Pad	Kenya East GW1	Connectivity	2, 3, 4, 5, 6	Gubberamunda	P&W	2011
South	ATP648	Camp Pad	Kenya East GW2	Connectivity	2, 3, 4, 5, 6	Springbok	P&W	2011
South	ATP648	Poppy #2	Poppy GW1	Connectivity	2, 3, 5, 6	Springbok (upper)	P&W	2011
South	ATP648	Poppy #2	Poppy GW2	Connectivity	2, 3, 5, 6	Springbok (lower)	P&W	2011
North	ATP651	Woleebee Creek #7	Woleebee Creek GW1	Connectivity	2, 3, 4, 5, 6	Gubberamunda	P&W	2011
North	ATP651	Woleebee Creek #7	Woleebee Creek GW2	Connectivity	2, 3, 4, 5, 6	Springbok	P&W	2011
Central	ATP648	Kenya East #28	Kenya East GW3	Connectivity	2, 3, 4, 5, 6	Gubberamunda	P&W	2011
Central	ATP648	Kenya East #28	Kenya East GW4	Connectivity	2, 3, 4, 5, 6	Springbok	P&W	2011
Central	PL247	Bellevue #1M	Bellevue GW2	Monitoring	3, 5, 6	Springbok	P&W	2011
Stage 2 – Complete (Deep)								
North	ATP651	Woleebee Creek #7	Woleebee Creek GW3	Connectivity	1, 2, 3, 4, 5, 6, 7	Hutton	P&W	2012
North	ATP651	Woleebee Creek #7	Woleebee Creek GW8	Connectivity	1, 2, 3, 4, 5, 6, 7	Eurombah	P&W	2012
North	ATP651	Woleebee Creek #7	Woleebee Creek GW9	Connectivity	1, 2, 3, 4, 5, 6, 7	Springbok	P&W	2012
North	ATP651	Woleebee Creek #7	Woleebee Creek GW7	Connectivity	1, 2, 3, 4, 5, 6, 7	Westbourne	P&W	2012
North	ATP651	Woleebee Creek #7	Woleebee Creek GW4	Connectivity / Injection Trial	1, 2, 3, 4, 5, 6, 7	Precipice	P&W	2012
Central	ATP648	Kenya East #28	Kenya East GW7	Connectivity	2, 3, 4, 5, 6, 7	Precipice	P&W	2012
Central	ATP648	Kenya East #28	Kenya East GW6	Connectivity	2, 3, 4, 5, 6, 7	Hutton	P&W	2012

In Progress								
Area	**Tenure**	**Location**	**Well Name**	**Primary Function**	**Rationale Element**	**Target**	**Monitoring**	**Year**
				Stage 2 – Ongoing				
Central	ATP648	Kenya East #28	Kenya East GW5	Connectivity	2, 3, 4, 5, 6, 7	Precipice	P&W	2012
North	ATP651	MAR 1H Monitoring	Woleebee Creek GW10	Injection Trial Monitoring	1, 2, 3, 4, 5, 6	Precipice	VWP deep	2012
South	ATP648	Ruby-Jo #12	Ruby-Jo GW4	Connectivity	2, 3, 4, 5, 6, 7	Precipice	VWP deep	2012
South	ATP648	Ruby-Jo #12	Ruby-Jo GW3	Connectivity	2, 3, 4, 5, 6, 7	Hutton	P&W	2012
South	ATP648	Ruby-Jo #12	Ruby-Jo GW2	Connectivity	2, 3, 4, 5, 6, 7	Springbok	P&W	2012
South	ATP648	Ruby-Jo #12	Ruby-Jo GW5	Connectivity	2, 3, 4, 5, 6, 7	Springbok	VWP shallow	2012
Central	PL180	Lauren #66	Lauren GW4	Monitoring	2, 3, 4, 5, 6, 7	Precipice	P&W	2013
Central	PL180	Lauren #66	Lauren GW3	Monitoring	2, 3, 4, 5, 6, 7	Hutton	P&W	2013
Central	ATP620	Kenya #148	Kenya GW2	Monitoring	2, 3, 4, 5, 6, 7	Springbok	P&W	2013
North	PLA464	Charlie	Charlie GW2	Springs Early Warning	1, 2, 3, 4, 5, 6	Precipice	P&W	2013
North	PLA464	Charlie	Charlie GW1	Springs Early Warning	1, 2, 3, 4, 5, 6	Hutton	P&W	2013
North	PLA399	Cassio	Cassio GW2	Springs Early Warning	1, 2, 3, 4, 5, 6	Precipice	P&W	2013
North	PLA399	Cassio	Cassio GW1	Springs Early Warning	1, 2, 3, 4, 5, 6	Hutton	P&W	2013
North	PLA402	Charlotte #1	Charlotte GW2	Springs Trigger Monitoring	1, 2, 3, 4, 5, 6	Precipice	P&W	2013
North	PLA402	Charlotte #1	Charlotte GW1	Springs Trigger Monitoring	1, 2, 3, 4, 5, 6	Hutton	P&W	2013
North	ATP768	CHAR1584	CHAR1584 GW2	Springs Trigger Monitoring	1, 2, 3, 4, 5, 6	Precipice	P&W	2013
North	ATP768	CHAR1584	CHAR1584 GW1	Springs Trigger Monitoring	1, 2, 3, 4, 5, 6	Hutton	P&W	2013
North	ATP574	Peebs #14	Peebs GW6	Monitoring	1, 2, 3, 4, 5, 6	Precipice	VWP deep	2013
South	ATP648	Broadwater #134	Broadwater GW11	Monitoring	2, 3, 4, 5, 6, 7	Precipice	VWP deep	2013
South	ATP648	Broadwater #134	Broadwater GW4	Monitoring	2, 3, 4, 5, 6, 7	Springbok	P&W	2013
South	ATP648	Broadwater #134	Broadwater GW1	Monitoring	2, 3, 4, 5, 6, 7	Alluvium	P&W	2013
South	ATP648	Broadwater #134	Broadwater GW2	Monitoring	2, 3, 4, 5, 6, 7	Gubberamunda	P&W	2013
South	ATP648	Broadwater #133	Broadwater GW7	Monitoring	2, 3, 4, 5, 6, 7	Alluvium	P&W	2013
South	PLA262	Teviot #2	Teviot GW1	Monitoring	2, 3, 5, 6, 7	Precipice	VWP deep	2013
South	PLA261	Will #1	Will GW1	Monitoring	2, 3, 5, 6, 7	Precipice	VWP deep	2013

P&W: Pressure and water quality.

Table 7 – Monitoring bore development plan (existing and future)

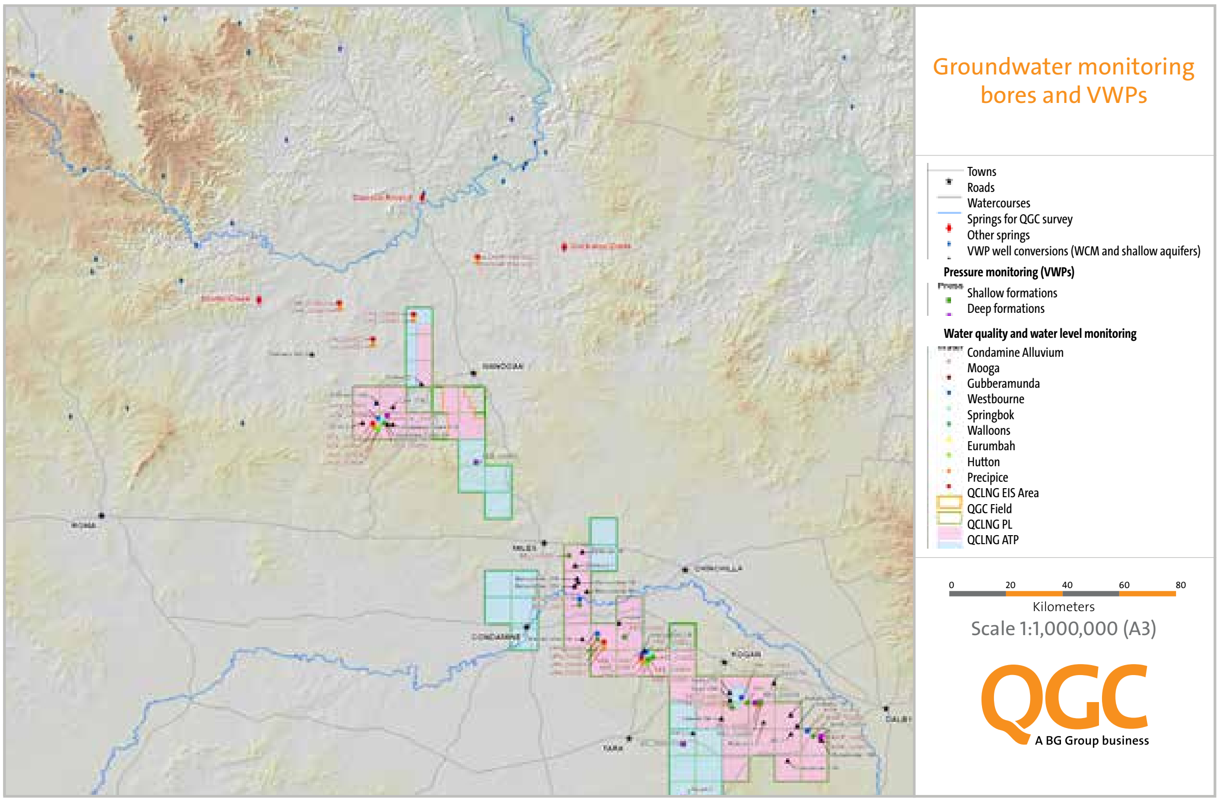
Stage 2 is focused primarily on the deeper Eurombah, Hutton, Evergreen and Precipice Sandstones. At some locations, there are also bores targeting the shallower Gubberamunda, Westbourne and Springbok Formations. Regional MNES early warning threshold and Trigger Monitoring Bores (Hutton and/or Precipice Sandstones) at four locations are planned for construction in 2012 and 2013 in the Northern Gas Fields.

The Stage 2 Program is currently underway, with eight wells completed into a number of Surat aquifers and aquitards at Woleebee Creek (northern leases) and Kenya East (southern leases) as of August 2012. Both programs are intended to monitor production pilots and complement QGC's existing monitoring network of bores and VWPs in current operational areas.

Moving forward, a tentative monitoring bore drilling program is outlined in Table 7. QGC's program reflects bore locations and proposed arrangements with other CSG proponents for spring early warning and trigger monitoring bores in the region of the northern leases. QGC's monitoring bore program may be expanded following finalisation of the joint industry spring monitoring approach and the Monitoring Bore Implementation submission to QWC in February 2013.

QGC commits to evaluate and incorporate where necessary any additional monitoring bore requirements into its program by the end of February 2013.

Locations of Stage 1 and proposed Stage 2 monitoring bores and VWPs are shown in Figure 23.



Refer to the A3 sized version in the Figures compendium appendix

Figure 23 – Groundwater monitoring bores and VWPs

Additional groundwater monitoring activities proposed for 2012/2013 include:

- Retrofitting existing exploration core holes or CSG wells with VWPs in the Gubberamunda (where present) Springbok Sandstone and WCM formations. Installation of VWPs in up to 23 existing core holes.
- Investigation of existing bores on QGC land for monitoring purposes
- Identification of suitable private landholder bores for ongoing monitoring.

Bore	Aquifer	Monitoring purpose
Polaris #22, Thackery #6, David #7, Woleebee Creek #17M, Broadwater #14, Glendower #13, Kathleen #18, Cam #17	S, WCM	Future production area
Sean #17M, Sean #19M	S, WCM	Future production area
Matilda-John VWP1	G, S, WCM	Future production area

Table 8 – VWP borehole conversion plan

5.6 MONITORING DATA NEEDS, MONITORING TIMING

Once installed, bores will be monitored for water levels and pressure and also for water quality in order to meet regulatory requirements and support and inform a number of QGC programs.

Water levels required as part of this monitoring program will be collected via:

- Dedicated nested monitoring bores
- Private bores
- VWPs.

Levels in these wells will be collected using a blend of manual measurements supported by automated pressure and water level data logger instruments with telemetry connections to QGC's Brisbane office. Automated water level monitoring systems will be established to record data at a minimum of twice per day. In new development areas, water level data is planned to be collected initially to support aquifer baseline trend development and later to assess potential CSG impacts.

5.7 BASELINE MONITORING PERIODS

Considering the program plan (see Tables 7 and 8) and the current field development plan, QGC has determined the following planned well locations to provide expected baseline periods:

Northern Gas Fields

- Groundwater monitoring bores have been installed on the Woleebee Creek block in multiple aquifers (Gubberamunda, Westbourne, Springbok, Hutton, Durabilla and Precipice) for monitoring a four-well production pilot scheduled to commence in December 2012. Between one and 11 months of baseline monitoring is available for the various bores to assess pilot program performance. In addition, two VWPs with multiple gauges in the Springbok and WCM will record groundwater pressure changes. Typically, each well is individually tested for 30 days and all wells are tested together for at least 180 days.
- Early warning and Trigger Monitoring Bores are scheduled for construction at four locations between QCLNG tenements and Scott's Creek and Dawson River 8 springs in the Hutton and/or Precipice Sandstone aquifers between March and July 2013.
- Deep VWPs for monitoring the Precipice Sandstone are also proposed at Woleebee Creek (injection test monitoring) and on Peebs block (monitoring regional groundwater level in the vicinity of the inferred groundwater divide between the Dawson River Valley and Surat Basin groundwater systems).
- Production area depressurisation from the northern leases is expected to commence in October 2014. Consequently, more than two years' pre-production groundwater level monitoring data will have been collected from the Woleebee Creek bores and at least 12 months of data from the early warning and Trigger Monitoring Bores.

Central Gas Fields

- Gas production from QGC's Berwyndale South, Kenya, Argyle, Bellevue and Codie/Lauren fields have been brought on line progressively between 2005 and 2012. Groundwater monitoring of the shallow Gubberamunda Sandstone aquifer commenced at the Kenya field in 2008. Several monitoring bores were installed in the Mooga and Gubberamunda Sandstones. The Walloon Coal Measures VWPs have been monitored across the Central area gas fields since 2006. Continuous automatic groundwater level recorders were installed in the Gubberamunda and/or Springbok Formation bores at the Berwyndale South, Lauren and Bellevue fields in 2011. QCLNG water production in the Central area is expected to start in October 2013.
- Additional monitoring bores scheduled for construction in the Central Area include:
  - Kenya block, existing production area, Springbok Formation
  - Lauren block, existing production area, Hutton and Precipice Formations.

Southern Gas Fields

- Groundwater monitoring bores have been installed on the Kenya East block in multiple aquifers and aquitards (in the Gubberamunda, Westbourne, Springbok, Eurombah and Hutton Formations) for monitoring a four-to-five well production pilot scheduled to commence in October 2012. Up to six months of baseline monitoring data is available for various wells to assess pilot program performance. In addition, numerous VWPs with multiple gauges in the Springbok and Walloon Coal Measures will record groundwater pressure changes.
- Additional monitoring bores and VWPs proposed for the southern blocks in 2012 include:
  - Ruby-Jo pilot monitoring and connectivity studies with bores in the Springbok, Hutton and Precipice Formations in 2012
  - Ruby-Jo 1M VWP monitoring the Springbok in 2012
- Production area depressurisation from the southern leases is expected to commence in November 2013, so at least 12 months of monitoring data will be available from bores at Kenya East, Poppy (continuous water level records) and VWPs at Isabella and Jen with six to 12 months' baseline data from the Ruby-Jo bores and VWPs.
- Additional monitoring bores and VWPs proposed for the southern blocks in 2013 include:
  - Broadwater regional monitoring bores (Alluvium (x2), Gubberamunda, Springbok) 2013
  - Broadwater GW11 VWP, Precipice 2013
  - Teviot GW1 VWP, Precipice 2013
  - Baseline data periods prior to QCLNG production are indicated on Figure 24.

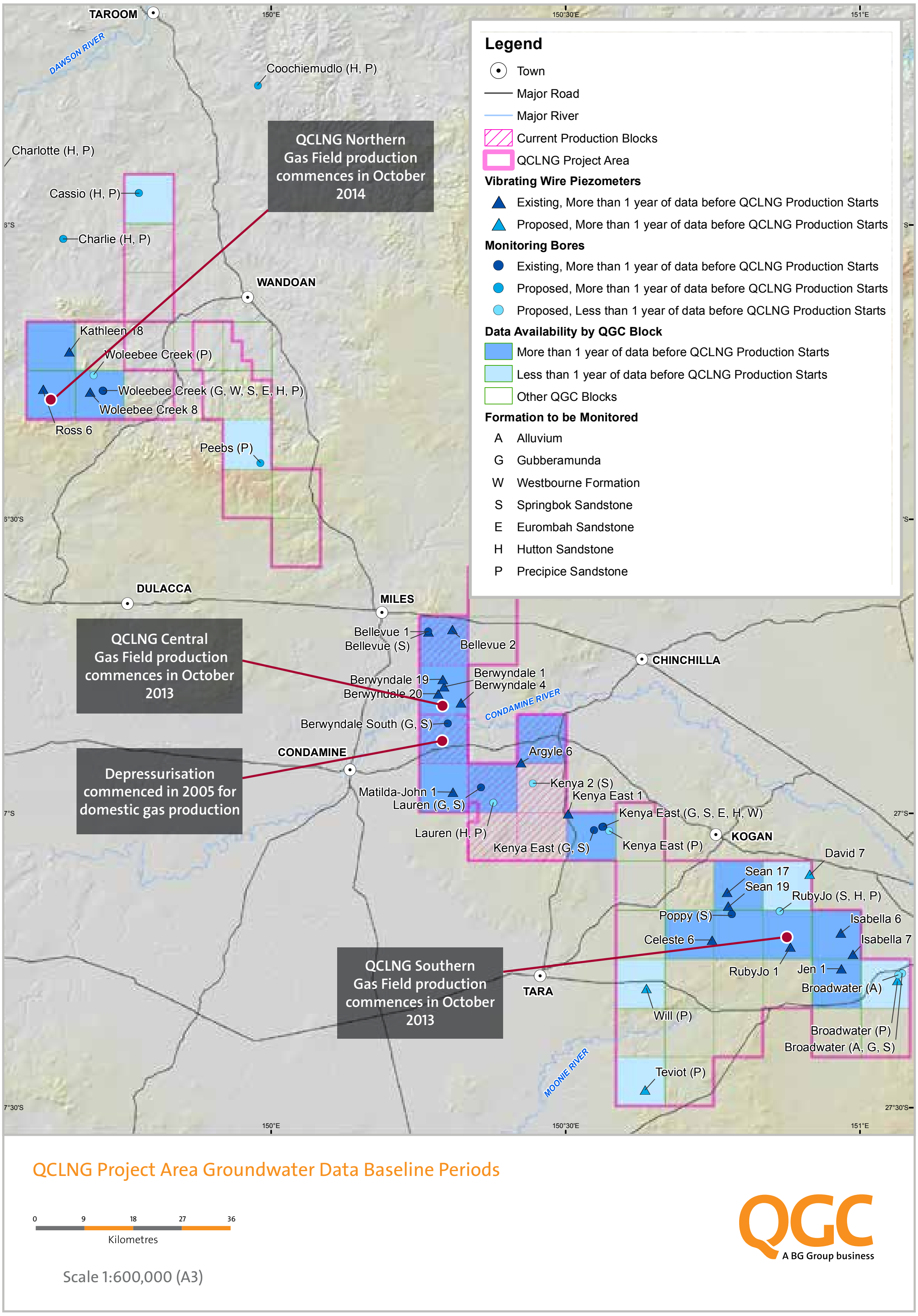


Figure 24 – QCLNG Project Area Groundwater Data Baseline Periods

Water chemistry will be defined through water quality sampling and analysis utilising the deep and shallow nested bores and any private bores considered suitable for monitoring. It is proposed that water quality sampling and analysis be completed on a six-monthly basis.

5.8 DATA REPORTING

QGC intends that both water level and water chemistry data from these bores be made available via technical reports (such as bore completion reports), and that this same data will form an integral part of annual aquifer reporting requirements to Australian and Queensland government agencies.

QGC commits to providing an interpretation of groundwater monitoring data on an annual basis and an upgraded regional groundwater model on a triennial basis. The annual reports will include a trend analysis of both groundwater level and quality. Raw data will be provided in the annual reports. The timing of these reports will be such as to inform QWC's UWIR modelling and reporting cycle.

5.9 INSTALLING BORES FOR MONITORING

Groundwater monitoring bore construction varies according to purpose and installation depth. For example, standpipe bores are used for water level and quality monitoring while VWPs focus on groundwater pressure. Shallow bores are installed above the WCM according to 'Minimum Construction Guidelines for Water Bores in Australia'. Below the WCM bores are constructed in accordance with the Petroleum and Gas (Production and Safety) Act 2004. Consequently, all bores penetrating the WCM are fitted with surface blow-out preventers.

Open standpipe bores use one of two designs, namely 'shallow 'and 'deep'. Shallow well designs less than 300 m deep and above the WCM. They are constructed of 5" DN uPVC casing with 5 m or 10 m of wire-wound screen.

Using 5" or 6" DN uPVC casing allows for the future installation of an electro-submersible pump for aquifer pumping tests and well purging when sampling. VWP bores run up to six individual vibrating wire gauges set at target depths into an open borehole with cement grouting up to the surface.

After drilling and before bore construction, boreholes are geophysically logging using various tools including neutron gamma, neutron/density, caliper, spontaneous potential, resistivity and deviation. Final well screen intervals or VWP gauge installation depths are selected using geophysical logs which identify geology, stratigraphic formations and permeable zones. VWP gauges are cemented in place inside the bore, thereby isolating the various formations and the gauges from each other. These longlife and accurate instruments will give pressure data for various formations.

Groundwater monitoring wells which penetrate the WCM are constructed in accordance with the stricter Petroleum and Gas Act 2004, and these wells also ensure that shallow aquifers and the WCM are isolated from each other. These deeper monitoring bores require more engineering than shallower bores since the bores are targeting the lower part of the GAB and hence isolation of overlying aquifers and other formations is required. Long term monitoring of the deeper GAB aquifers require these wells to be constructed with steel casing in accordance with industry best practice. These wells also have a deeper well head to shallower bores, which provides long-term safe and efficient access for sampling and water level monitoring. The deeper wells can also be converted for installation of VWP gauges for measuring groundwater pressures in various layers.

5.10 VWP INSTALLATION

The design purpose of a multi-level vibrating wire piezometer (VWP) is to measure fluid or pore-water pressures. VWPs will be installed to record responses to nearby depressurisation activities. VWPs do not allow for the collection of groundwater samples as instruments are grouted into the drilled hole using a cement slurry.

VWPs will be installed in boreholes, or adapted to redundant CSG exploration coreholes, in each of the main QGC production areas. VWPs allow monitoring of aquifer pressures in a number of vertical units cost-effectively at a single location.

The sensor of the VWP consists of a pressure transducer with an internal thin resonating wire connected to a sensitive perpendicular diaphragm. Water pressure exerted against the diaphragm wall causes it to deflect and alter the tension of the wire and this in turn causes the wire to resonate at different frequencies. An electromagnetic field induced from coils adjacent to the vibrating wire causes it to be plucked and resonate at a frequency signal which is sent through the signal cable to a readout unit or logger at the ground surface.

5.11 CORING SEQUENCES

Various bores are being earmarked for core runs from yet-to-be-selected horizons in zones of interest. A total of 3,000 m of coring is planned. A core of the complete Surat Basin sequence (excluding the WCM) was collected at the Woleebee Creek location, totalling some 1,100 m. Additional core collection is planned for Kenya East and the program will be reviewed and updated once this core has been recovered and inspected.

Cores will be stored and selectively sampled for various permeability and porosity testing – with results feeding into future groundwater model development.

Commitments	Target completion date
Incorporation of potential additional UWIR groundwater monitoring requirements into Stage 2 Bore Construction Program	February 2013
Completion of Stage 2 Monitoring Bore and VWP conversion programs (as outlined in this Plan)	December 2013
Submission of Annual Report including (from October 2013) reporting results of ongoing GEN3 model recalibration	October 2013 and annually thereafter
Construction of additional UWIR monitoring bores (if deemed necessary)	In accordance with UWIR timing requirements. Either December 2013 or December 2016
Collation and reporting of groundwater monitoring results	April 2013 and annually thereafter
Collection of six-monthly groundwater quality samples and analysis	Bi-annually

The above commitments are aimed at satisfying Conditions 49b and 52c (i) - (iv).