Australia Pacific LNG Upstream Phase 1
Aquifer Injection Feasibility Studies

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1. Introduction

1.1 Project Overview

APLNG injection feasibility studies are a nominal two-year program designed to determine the technical and economic feasibility of injecting treated Coal Seam Gas water into Great Artesian Basin (GAB) aquifers. The program will focus on existing and proposed water treatment facilities (WTF) as these locations will be the future source of the water for injection (injectate). The investigation centres are:

- Spring Gully
- Talinga
- Condabri Central
- Reedy Creek

The Talinga, Condabri and Reedy Creek sites are collectively called the Walloons Sites.

The drilling and initial testing of trial injection and monitoring bores at Spring Gully was completed in early to mid 2011 and the treatment system fabrication is scheduled for completion in October 2011. The Spring Gully trials will be used to refine treatment system design and process for the Walloons Sites.

During the studies, the feasibility of injecting into several prospective aquifers will be assessed. The program has been designed to maximise information gathering from regional monitoring bore drilling program and existing infrastructure.

1.2 Project Objectives

The primary objective of the aquifer injection feasibility studies is to assess the technical and economic feasibility of aquifer injection as a water management option. Assessing injection feasibility in advance of water treatment plant design may reduce ultimate WTF capacity. If injection is feasible in areas of poorer receiving water quality, a reduction in the brine stream from the WTF's may be possible, with associated lower energy consumption and brine storage capacity/footprint.

At the time of writing, the State Government is actively developing policy relating to the definition of numerous aspects of technical and economic feasibility.

For the purposes of this assessment, technical feasibility will be defined as the ability to inject water into the target aquifer in compliance with regulatory conditions using commonly available treatment technologies and injection pressures common to the water industry.

Economic feasibility will be defined as acceptable when compared with alternative water disposal options taking into account CAPEX and OPEX costs, regulatory requirements, existing investment in water management alternatives, and potential cost offsets such as make good costs.

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1.3 Project Constraints

Project constraints, listed in perceived order of concern, include:

- Availability of CSG rigs to drill investigation and test bores;
- Land access and compensation agreements;
- Regulatory approval of injection under project Environmental Authorities, and the granting of Exclusion Decisions under the *Water Supply (Safety and Reliability) Act 2008;*
- Long lead item delivery within in program timeframe (treatment systems, inert casing etc); and,
- The availability of water to inject, and the disposal of brine and pumping test water from testing program, particularly at sites remote from existing treatment and disposal facilities.

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2. Project Scope

The project scope comprises several components:

- Hydrogeological and hydrogeochemical investigations and trial bore drilling and construction;
- Surface infrastructure design, fabrication and commissioning;
- Conducting injection trials;
- Feasibility level design of full-scale injection systems;
- Technical and economic feasibility assessment

Subject to positive findings from each phase of the investigation, up to nine separate injection trials will be undertaken into three different aquifer across the four locations.

3. Hydrogeological Investigations

The project can effectively be divided into the following components:

- Exploration activities
- Treatment system design, fabrication and commissioning
- Field trials
- Regulatory approvals
- Feasibility assessments

The figure below (Figure 1) provides the general flow of work to undertake the feasibility studies:

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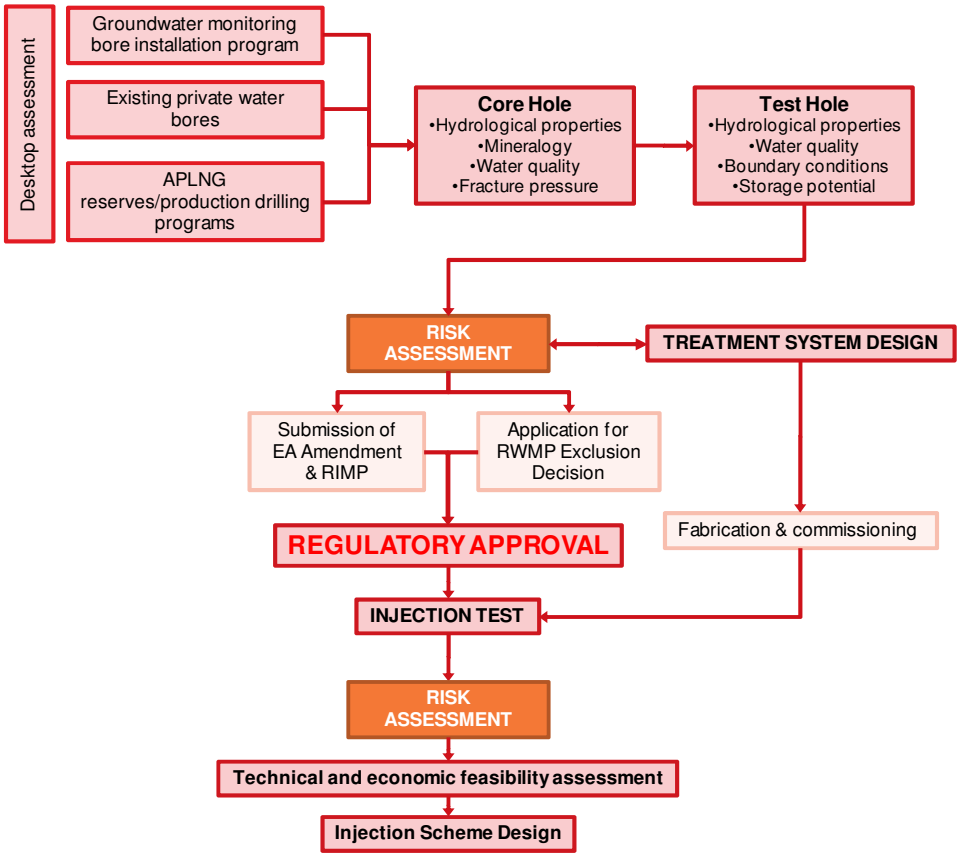
Figure 1 Aquifer Injection Feasibility Studies Workflow



Each risk assessment represents a hold point at which the decision to proceed to the next stage or cease further investigation will be made. This applies to each target aquifer in each location.

Although regulatory approvals are shown after exploration activities, the applications will be made at the time of the field investigations to ensure that approvals do not impact on the overall program schedule.

3.1 Desktop Assessment

The purpose of the desktop assessment is to assess existing information in order to undertake a pre-feasibility assessment of injection potential. The desktop assessment for the Australia Pacific LNG aquifer injection studies has been completed through a review of the following data sources:

- Literature search to establish relevant geology and hydrogeology of the gas fields;
- Mapping of groundwater database bore locations with yield and water quality information for each aquifer;
- Review of daily drilling records and testing from CSG well drilling to identify locations and zones of potential enhanced permeability; and,

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- Identification of existing infrastructure and injectate sources to utilise for injection trials.

The desktop assessment indicated that targets were generally formation based, with no specific sub-regional targets with the exception of the shallow aquifer in ATP606, where water quality appeared to be significantly poorer than surrounding areas, thus provided a potential target for high blend ratios. This site will be investigated through the drilling and testing of a monitoring bore in that location only. Should this indicate sufficient potential, further investigation may be undertaken at a later date.

3.2 Exploration Activities

The purpose of the exploration activities is to characterise subsurface conditions. Exploration will include the installation and testing of bores to determine the aquifers' injection characteristics, specifically likely injection rates, hydrogeochemical properties, and continuity and variability of the aquifer that may affect the design and installation of an operational injection scheme.

At each Walloons trial location (Talinga, Condabri, Reedy Creek) a primary site will be established for an injection trial. A secondary site will be drilled and tested for sub-regional characterisation of the aquifer at both Condabri and Reedy Creek. The locations of the primary and secondary sites are shown on Figure 2.Should an investigation stage (i.e. drilling of the coreholes, or test pumping of the trial hole) indicate poor injectivity potential, the next stage of testing may not proceed. For example, if the Hutton Sandstone at Condabri indicates poor prospectivity from the coring program, a trial injection bore hole may not be installed.

Requirements of the individual components of the exploration program are provided in the following sections, with a summary of site specific activities in Appendix A.

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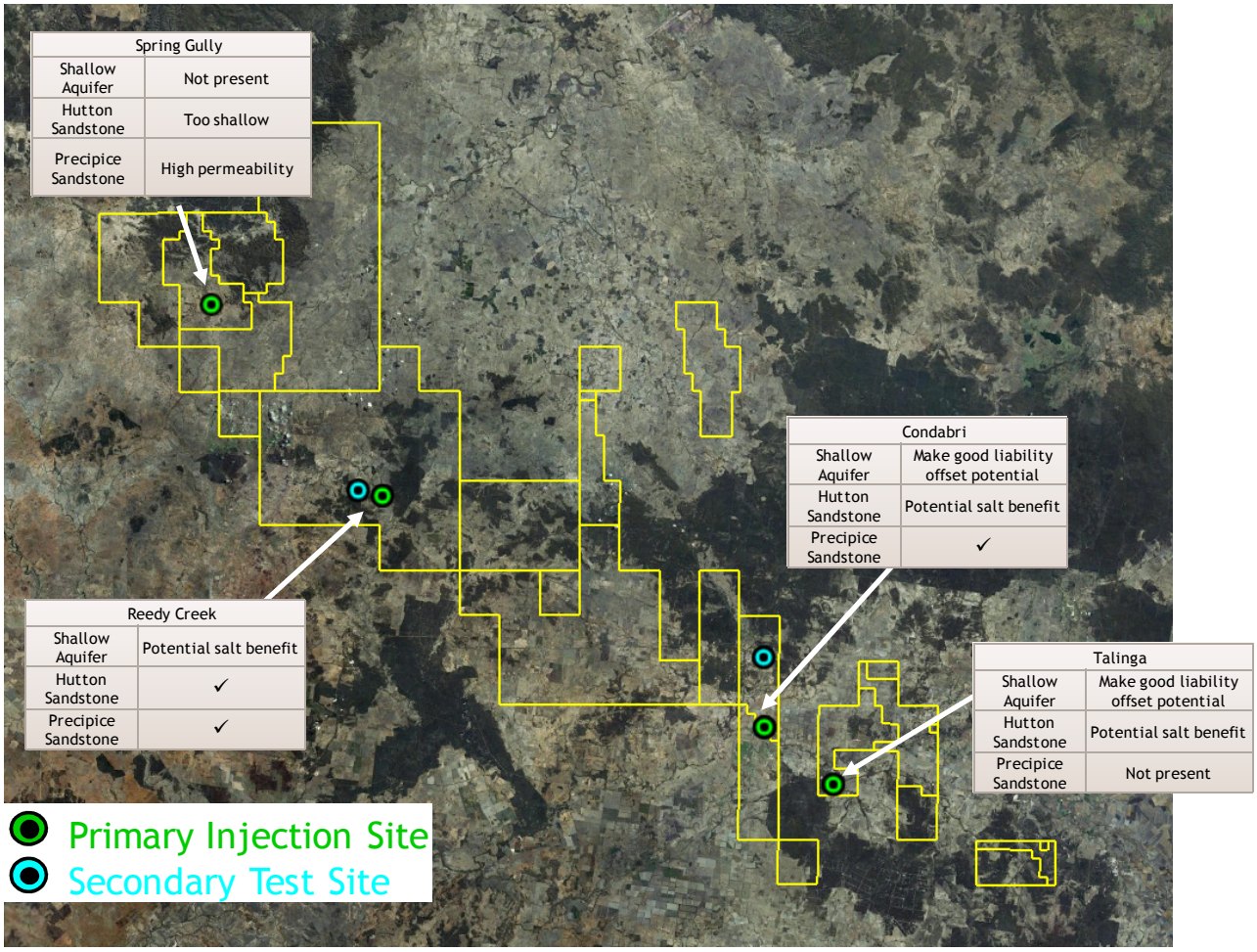
Figure 2 Locations of Aquifer Injection Investigation Sites



3.2.1 *Drilling and Construction*

Drilling and construction of bores targeting the aquifer underlying the Walloons Coal Measures will be undertaken using CSG rigs under existing contracts managed through the Origin Drilling and Completions department. Shallow bores, targeting formations above the coal measures will be drilled by a waterbore drilling contractor.

Trial injection bores will be located as close together as drilling rig layout allows. Where possible, all trial injection bores will be located on the same drillpad.

Trial bores targeting the Hutton and Precipice Sandstones will be constructed of 7" glass-reinforced epoxy (GRE) lined carbon steel casing with inline stainless steel wirewound screens. Gubberamunda Sandstone trial injection bores will be constructed of GRE casing, and are likely to be constructed using a telescope technique, utilising smaller diameter stainless steel wirewound screens. Casing will be pressure cemented from the top of the screen interval to surface. Pressure testing and cement bond logs (CBL) will be run to ensure casing and grout integrity. Trial injection bores will be developed by pumping.

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Observation bore construction will consist of pressure cemented casing to the top of the target formation and open hole in the target formation. The constructed diameter will be dependent on the drilling rig used. The openhole section will be cored, with samples submitted for physical, chemical and mineralogical analysis. Sufficient core will be selected to provide representative samples and to provide an understanding of variability within the aquifer. The selected core samples will be stored in an inert environment, i.e. under pressure in nitrogen and shipped to CSIRO laboratories. Remaining core will be stored at Weatherford Laboratories. Observation bores will be developed through a combination of airlifting and pumping, as appropriate.

Where required, drill cuttings and core will be logged by an on-site hydrogeologist in accordance with the Origin Hydrogeological Logging Guidelines.

Wireline geophysical logging will be undertaken on the Hutton or Precipice bores. This logging will comprise the following minimum suite (or equivalent):

- Natural gamma
- Calliper
- Neutron
- Density
- Array Induction
- Acoustic televiewer/formation image log (coreholes only)

Drilling and construction of all bores would be in accordance with the *P&G Act*, *Water Act*, *Minimum Standards for the Construction of Waterbores in Australia*, and Origin Energy directives, as relevant.

3.2.2 *Fracture Pressures*

For the Hutton and Precipice Sandstones, fracture pressures will be determined from extended leak-off tests. Testing pressures will be determined by the grade of casing used in the bore completion or the capacity of the rig pumps, but are not expected to exceed 5000PSI. The extended leak-off test will be undertaken at the final casing shoe, with fracture pressures extrapolated to overlying and underlying aquifers using geophysical and other inputs.

Where the target aquifer is less than 100m deep, fracture pressures for the shallow aquifer will be estimated from the dry overburden pressure at the top of the screened interval, calculated based on laboratory bulk density results of core samples from that bore.

3.2.3 *Test Pumping*

Test pumping will be undertaken on all observation and test holes. The purpose of the test pumping is to remove drilling fluids and fines, to determine aquifer hydraulic parameters and for the collection of representative in-situ groundwater samples. The duration of the test pumping will be primarily driven by the ability to dispose of extracted water but also the need to observe a response in the observation bore for the calculation of storage parameters.

During the testing of observation bores, water will be transported offsite using tankers, unless suitable, approved (by landholder or operations), on-site storage exists. Water from the

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testing of trial bores will be directed to existing CSG water storage ponds (either pilot ponds or feed/brine ponds).

Test pumping will comprise a minimum of a development phase and a constant rate test for observation bores, and for trial bores are to include a multi-rate test. Water will be transmitted to storage via temporary pipework.

Field water quality (pH, EC, temperature, redox, dissolved oxygen) will be logged throughout the test pumping. A sample for laboratory analysis will be collected at the completion of testing of the observation bores, and a minimum of one sample per 24hours will be collected during longer term testing, collected from the pumping bore.

Samples will be collected in new laboratory supplied containers (pre-dosed with preservatives) and will be submitted under chain-of-custody protocols.

3.2.4 *Laboratory Testing*

Water quality

Samples for water quality analysis will be collected from observation and trial bores.

Chemical water quality analyses will primarily be undertaken by Australia Laboratory Services (ALS). The minimum sampling suite comprises:

- Physical Parameters – pH, electrical conductivity (EC), total dissolved solids, total suspended solids
- Major Cations and Major Anions – calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate, carbonate and total alkalinity
- Minor Anions – bromide, fluoride, and iodide
- Dissolved Metals and Metalloids – aluminium, boron, barium, cobalt, iron, manganese, molybdenum, selenium, silver, strontium, tin, arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury, and silica
- Dissolved sulphide
- Dissolved organic carbon
- Total organic carbon
- Nutrients – nitrate, nitrate and total phosphorous
- Phenols and polycyclic aromatic hydrocarbons (PAHs)
- Total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylenes (BTEX)
- Dissolved methane
- Radionuclide's (Gross alpha and beta)

The laboratory will be National Association of Testing Authorities (NATA) accredited to undertake the analyses where appropriate.

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Core Physical Testing

Core samples will be collected during the drilling of the observation bores and will be submitted for one or more of the following physical tests:

- Unconfined compressive strength;
- Indirect tensile strength (Brazilian);
- Dry density;
- Vertical permeability;
- Horizontal permeability; and
- Porosity

The number of samples per interval will be dependent on geological variability assessed from detailed geological logging, geophysical logging and total thickness of the target interval.

Aquifer mineralogy (XRD) and chemistry (XRF)

Core samples collected from the drilling of the observation bores and will be submitted for X-ray Diffraction (XRD) analysis to assess mineralogical characteristics.

Chemical composition of the aquifer matrix will be analysed in the field or core shed using a handheld X-ray Fluorescence (XRF) unit. Selected core samples will be also submitted for laboratory XRF analysis for quality control purposes.

Microbiological analysis

Samples for microbiological analysis will be collected for analysis during the testing pumping activities.

Column testing

With the exception of the Spring Gully trial, column testing will be undertaken through the collaborative GISERA alliance with CSIRO. Due to the gross similarities in the aquifer hydrogeochemistry, the column testing will not be undertaken for every target, rather will be applied to ensure representative coverage of all of the aquifers. Results will then be applied to remaining sites based on comparisons of whole rock geochemistry, mineralogy and aquifer water quality.

3.2.5 *Aquifer Monitoring*

The monitoring program associated with the injection trials will comprise two components:

- Monitoring of injection and observation bores during testing; and,
- Baseline sampling of landholder bores in the vicinity of the test prior to the commencement of field activities.

Monitoring of the injection and monitoring bores during testing will comprise measurements of water level, extraction and injection rates, and water quality. Automated loggers may be utilised to assist in data collection.

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All landholder bores on Australia Pacific LNG tenure within the calculated maximum hydraulic impact zone of the proposed pumping or injection test will be considered when establishing the monitoring program.

3.2.6 *Hydrogeochemical Modelling*

Two components of hydrogeochemical modelling will be undertaken:

- Initial risk assessments to understand the potential risks associated with mixing the injectate with the native groundwater and the aquifer matrix. This will be undertaken using PHREEQC or similar hydrogeochemical modelling software and will be based on the laboratory results and anticipated water qualities of the injectate at each site.
- Reactive transport modelling will be undertaken on the basis of the column test and field trial water quality results. This will be undertaken by CSIRO through the GISERA alliance.

3.3 Treatment System

The treatment philosophy is for engineering design to minimise the maintenance requirements operational costs of the injection system. Water treatment will be dependent on the characteristics of the receiving aquifer, which will be assessed as part of the trials program, and anticipated the injectate quality for each of the trials.

The post-treatment facilities (additional to RO treatment for the feed water) have been designed for the Spring Gully injection trial, and will form the basis for future treatment systems. The trials will inform decisions on refinement of post-treatment process. The Spring Gully Permeate Reinjection Plant (SGPRP) is currently scheduled for commissioning in September 2011.

The control system for the SGPRP automatically incorporates recycling of the water at various stages throughout the treatment process (preventing injection) if any of the monitored parameters are not within an specified range (set relative to the approved limits and the operational requirements of the equipment).

A process flow diagram of the SGPRP is provided and further description of the process follows.

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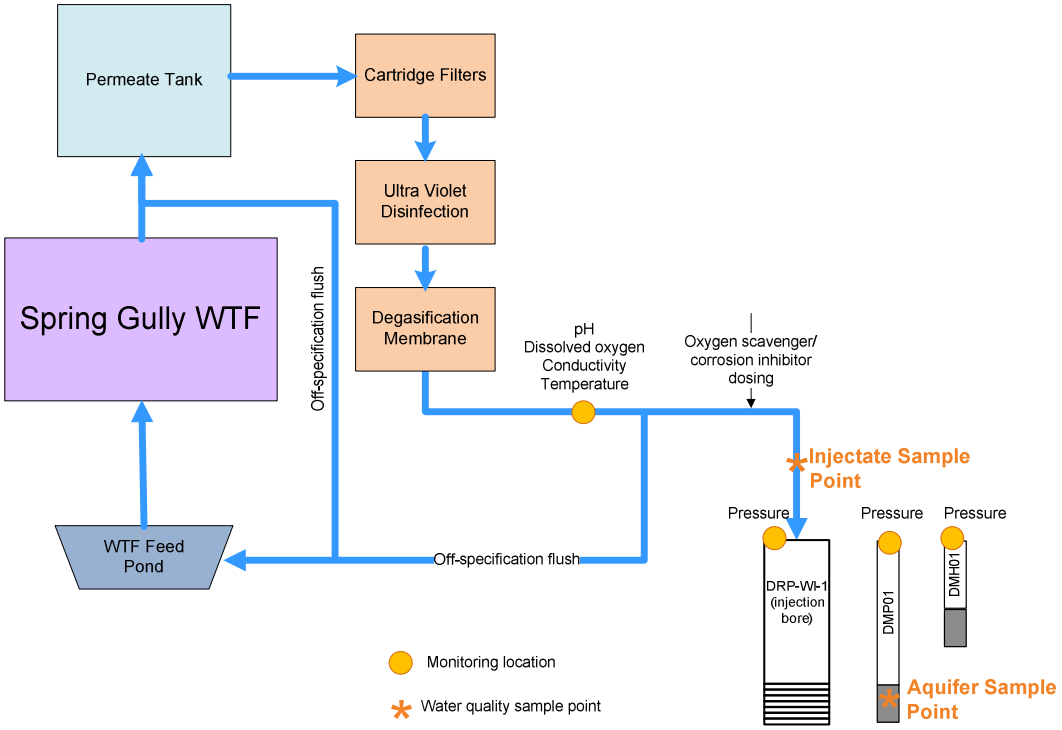
Figure 3 Post-Treatment Process Flow Diagram



Cartridge Filtration

Although the RO process removes all particulate matter, the potential exists for limited amounts of particulate matter to enter the permeate while it is stored in the permeate tank, which is vented to the atmosphere. The cartridge filter will remove any remaining particulate matter.

Disinfection

Disinfection of the permeate will be achieved through ultra-violet (UV) irradiation. The disinfection reduces biological risk associated with the RO permeate being temporarily stored in the permeate tank which is open to the atmosphere. Dual UV intensity monitoring ensures that the required dose rate is achieved. Failure of either UV unit will result in water being recyled to the feed pond.

Degasification

The degasification membrane system will utilise a vacuum pump and nitrogen gas sweep stream to lower the partial pressure of oxygen, drawing the oxygen out of solution across the membrane from the water. The degasification membranes are designed to reduce dissolved oxygen concentrations to less than 10 µg/L.

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A separation tower will condense and separate water from the sweep stream prior to discharge to atmosphere where the nitrogen will remix with ambient air. The water from the separation tower will be discharged to the recirculation tank, which has a level float operated pump, discharging back to the Permeate Reinjection Buffer Tank, and an overflow which will run back to the feed pond.

Oxygen Scavenger and Corrosion Inhibitor (Spring Gully only)

Sodium erythorbate (C6H7NaO6), an anti-oxidant used in various foods, will be added (food grade, ≥99% purity) to the degasified permeate at a concentration entering the injection bore of 0.5mg/L. The purpose of this additive is to further reduce dissolved oxygen concentrations but also to inhibit the corrosion of the carbon steel bore casing. The sodium erythorbate is expected to be consumed in this process.

Sodium erythorbate will not be used for the portable treatment plant used at the Walloons sites because of the use of GRE-lined casing in the injection bores. GRE is chemically inert to the constituents of the injectate and will therefore not be subject to corrosion.

Injectate Monitoring

Permeate will be continuously analysed for pH, dissolved oxygen (dual redundant), conductivity and temperature at the outlet of the degasification system, prior to injection. Should the parameters measured be outside of specification, automated isolation valves will redirect the water back to either the Permeate Buffer Tank via the recirculation line, or to the RO Plant feed pond, depending on the operational mode of the water treatment plant at that time.

Generally, the same basis of design will be used for the trials at the Walloons sites, with key differences being:

- The plant will be portable to facilitate trials at multiple locations;
- The plant will have capacity to blend permeate and untreated water to a target water quality. The blend water will undergo pre-filtration and will join the treatment process upstream of the cartridge filter;
- A portable reverse osmosis plant will be used where appropriate for the treatment of pilot water into permeate for blending to an acceptable water quailty;
- A portable power supply for both the reinjection plant and the portable RO (where required) will be procured and commissioned;
- Pilot ponds may require temporary divisions installed for management of brine from the portable RO. This will need to be constructed in accordance with the DERM (2011) *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams constructed as part of environmentally relevant activities pursuant to the Environmental Protection Act 1994 Version 1.1 Draft for Consultation*

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3.4 Regulatory Approvals

Two levels of regulatory approvals are required for aquifer injection (both trials and ongoing). These are:

- Environmental Authority (EA) conditions, administered through DERM;
- Recycled water management plan approval or granting of an exclusion decision, administered through the Office of the Water Supply Regulator.

3.4.1 *Environmental Authorities*

EA ammendments have been submitted for Talinga, Combabula (including Reedy Creek), Condabri (granted) and Spring Gully (granted) incorporating conditions for the aquifer injection trials.

3.4.2 *RWMP/Exclusion Decisions*

The requirement for a recycled water management plan is triggered if there is a reasonable expectation that injection will materially impact a potable town water supply within in proximity to injection activities. If there is negligible risk of material impact, , an exclusion decision (with or without conditions) may negate the requirement for a RWMP.

Initial modelling indicates that several potable water supplies may be within hydraulic impact zones of the injection trials, however injection rates and durations will be designed and managed to ensure that there is negligible risk of material impact. Numerical modelling has been undertaken to assess potential risks associated with water quality impacts to the town water supplies, and indicates that injection trial water quality impact zones will be confined to within several hundred meters of the trial bores only.

Exclusion decision applications are made through the Office of the Water Supply Regulator (OWSR). They are currently not linked to the EA Application process. Information to be included in an application are (OWSR, 2010 *Draft Guidelines for Recycled Water Management Plans and Exclusion Decisions*):

- Characterisation of the injection source water (raw and treated) – completed January 2011;
- Description of the treatment system and design objectives – completed January 2011;
- Modelling to assess hydraulic and water quality impact zones.

The statutory review period for an exclusion decision is 60 days, but may be processed in a shorter period. However should additional information be required, the review period resets to 60 days from the provision of the additional information. Currently, exclusion decision applications will be submitted for injection trials as follows:

- Spring Gully – February 2011, draft provided early July 2011;
- Talinga – September 2011.
- Reedy Creek – October 2011; and,
- Condabri – November 2011.

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3.5 Field Trials

3.5.1 *Treatment Equipment Commissioning and Operation*

The treatment infrastructure at Spring Gully will be a permanent installation. The details below pertain to the Walloons trial sites.

Trial bores will be located to minimise the need for movement of the treatment equipment between individual trial injection bores at the same site.

Commissioning of infrastructure will be detailed in an Aquifer Injection Trials Commissioning Plan, which will include:

- Pre-commissioning construction activities;
- Mobilisation and commissioning of treatment and associated equipment;
- Transfer of treatment equipment between sites; and,
- Modification and installation of temporary brine storage facilities (where required).

3.5.2 *Trial Process*

Hydraulic and hydrogeochemical analysis of data collected at Spring Gully indicates that the capacity of the aquifer to take the water is greater than the flow capacity of the degasification plant, and that the risk of adverse geochemical reactions is low. Thus, it is anticipated that injection will continue for the duration of the trial (1 year).

The Walloons trials will be dependent on the outcomes of the field investigations, however it is currently anticipated that injection will occur into each aquifer at a site sequentially, with the exception of an aquifer having a lower injection potential than that of the treatment system, in which case injection may be into two formations simultaneously. Should this occur, water quality will be matched to that of the better quality aquifer. It is assumed that trials on each bore at Condabri and Reedy Creek (where there are no existin water treatment plants to provide injectate) will continue for 30 to 60 days, but will be dependent on water availability. At Talinga, where there is an existing water treatment facility, the trial may continue for the duration of the EA condition (1 year).

Injection will be carried out at a number of different rates, culminating with a maximum rate that does not exceed the allowable maximum pressure based on fracture pressures or the design capacity of the treatment plant.

3.5.3 *Data Collection*

The following data will be collected during the trials:

- Injection rates and pressures;
- Dissolved oxygen, electrical conductivity and pH of the injectate;
- Waterlevels in observation bores; and,
- Water quality of the injectate and in the aquifer as sampled in observation bores.

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3.5.4 *Data Analysis*

Data will be analysed to assess:

- Change in performance of the injection bore;
- Change in transmissivity of the aquifer due to potential clogging or dissolution of the aquifer matrix;
- Changes in water quality in the aquifer;
- Hydraulic parameters of the aquifer, including boundary conditions;
- Extent of hydraulic impact; and,
- Extent of water quality impact.

The data analysis will be applied to assess potential treatment system and operational design considerations that may affect the feasibility of long term, full-scale injection.

4. Community Engagement

Community engagement will be undertaken in accordance with the Draft Groundwater Stakeholder Engagement Plan. The main components of the plan in terms of community engagement are:

- The Groundwater Team will have a scheduled presence of at least 2 personnel between 3 and 5 days at the gasfields every three months, alternating between Roma/Spring Gully and Chinchilla/Talinga;
- At least 4 weeks prior to these events, appropriate Brisbane based and regional internal stakeholders and representatives from local/state/federal government, NGO's, contractors and local landholders will be contacted advising them of the scheduled visit and presentations, and calling for other engagement requests and requirements; and,
- Co-ordination of invitations and engagement sessions will be jointly organised between the Groundwater Team, the Stakeholder Engagement Team, and the relevant Origin relationship managers.

At a minimum, presentations regarding the aquifer inject trials program will be given at the scheduled visits. Site visits of injection facilities will be considered depending on access and safety requirements.

Scheduled visits commenced in May 2011.

5. Risk Management

Prior to the commencement of any trial, a risk assessment will be conducted in accordance with the *Australian Guidelines for Water Recycling: Managed Aquifer Recharge (July 2009).* Public health / environmental risks under guideline include:

- Pathogens;
- Inorganic Chemicals;
- Salinity and Sodicity;

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- Nutrients;
- Organic Chemicals;
- Turbidity and Particulates;
- Radionuclides;
- Pressure, flow rates, volumes and levels;
- Contaminant migration in fractured rock and karstic aquifers;
- Aquifer dissolution and aquitard and well stability;
- Impacts on groundwater –dependant ecosystems; and
- Greenhouse gases.

Non-assessable risks that will also be considered are:

- Operational issues – clogging; and
- Impacts on existing entitlement holders.

Appropriate preventative measures will also be proposed and residual risk levels estimated. This risk assessment process will initially be undertaken at a desktop information for the re-injection management plans and will revised following further investigation and detailed treatment system design, as outlined in Figure 1.

Australia Pacific LNG has recently entered into the Gas Industry Social and Environmental Research Alliance (GISERA) with CSIRO. GISERA is intended to provide the CSG industry, government and the community with quality assured scientific research to better understand the social and environmental challenges and opportunities of the CSG industry. Long term risks to aquifer water quality and associated potential human health impacts, as well as operation risks associated with clogging, will be assessed as part of the following GISERA research projects:

- Project 1: Understanding and quantifying the geochemical response to re-injection of CSG water permeates, brines and blends
- Project 2: Understanding and quantifying clogging and its management during re-injection of CSG water permeates, brines and blends
- Project 3: High performance groundwater modelling for risk assessment and management option analysis of large scale injection schemes

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6. Schedule

The current project implementation schedule and progress is as follows

- Spring Gully
  - Injection commenced 21 April 2012;,
  - Feasibility assessment currently underway
- Condabri
  - All trial bores completed;
  - Testing underway,
  - Trials to scheduled to commence Q2 2013, following completion of trials at Reedy Creek (common treatment equipment).
- Talinga
  - All drilling and testing completed
  - All approvals in place, however EA amendment required as some conditions not technically feasible
  - Trials currently scheduled to commence Q1 2013.
- Reedy Ck
  - All drilling and testing completed
  - All approvals in place
  - Treatment system on site and currently undergoing commissioning
  - Trials scheduled to commence December 2012

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7. Plan Preparation

This plan has been prepared by the following team:

Role	Name	Position	Qualifications	Relevant Experience
Author	Ryan Morris	Senior Hydrogeologist	BScHons (Geology) RPGeo (Hydrogeology)	11 years
Technical Review	Andrew Moser	Groundwater Manager Senior Hydrogeologist	BSc (Applied Geology) RPGeo (Hydrogeology)	21 years

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Appendix A - Site Specific Exploration Activities

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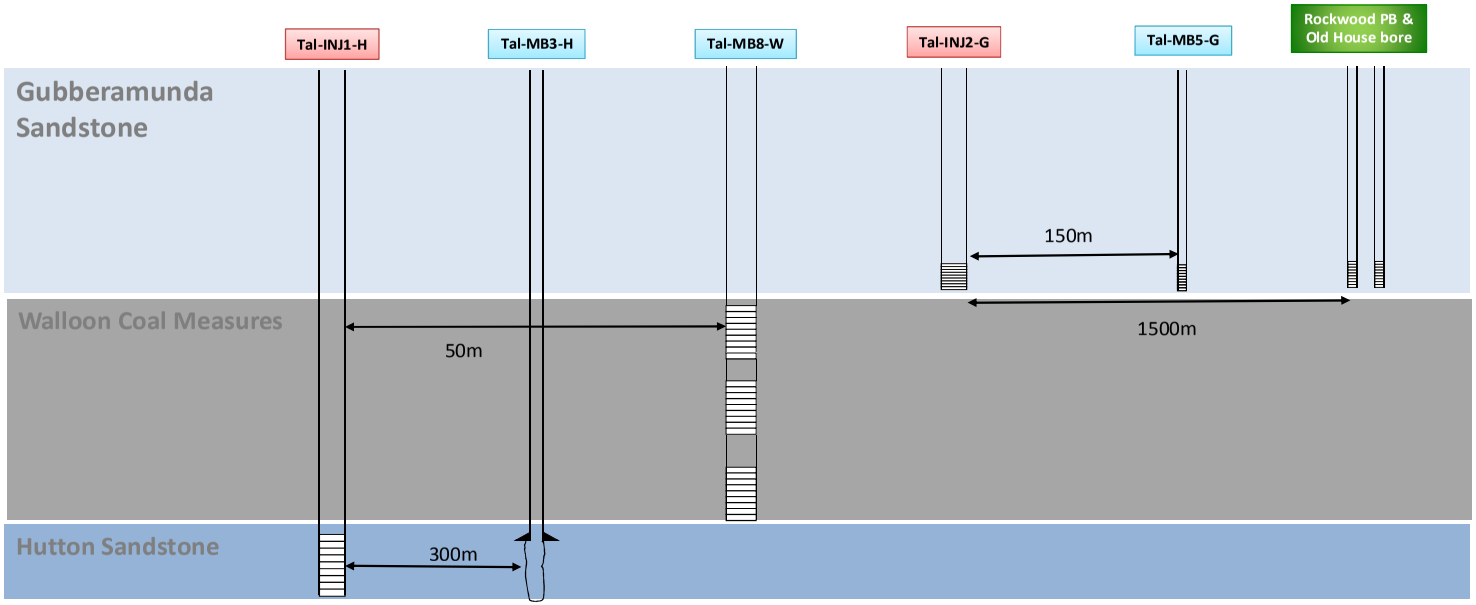
Talinga



Rig Type	CSG	Core	CSG	Waterwell	Waterwell	Existing
Min Pumping Test Duration	48 hrs	4 hrs	NA	24 hrs	4 hrs	8 hrs
Water disposal	RO feed pond	Truck	NA	RO feed pond	Truck	Permanent
Injectate Source	Tal RO Plant	NA	NA	Tal RO Plant	NA	NA
Brine Disposal	Brine Pond	NA	NA	Brine Pond	NA	NA
Waterlevel	✓	✓	✓	✓	✓	✓
Hydraulic Conductivity	✓	✓	**NA**	✓	✓	✓
Storage Co-efficient	Tal-MB3-H	Tal-INJ1-H	**NA**	✓	✓	✖
Water Quality	✓	✓	**NA**	✓	✓	✓
Mineralogy	✖	✓	**NA**	✖	✖	✖
Frac Gradient	✖	✓	✓	✖	✖	✖

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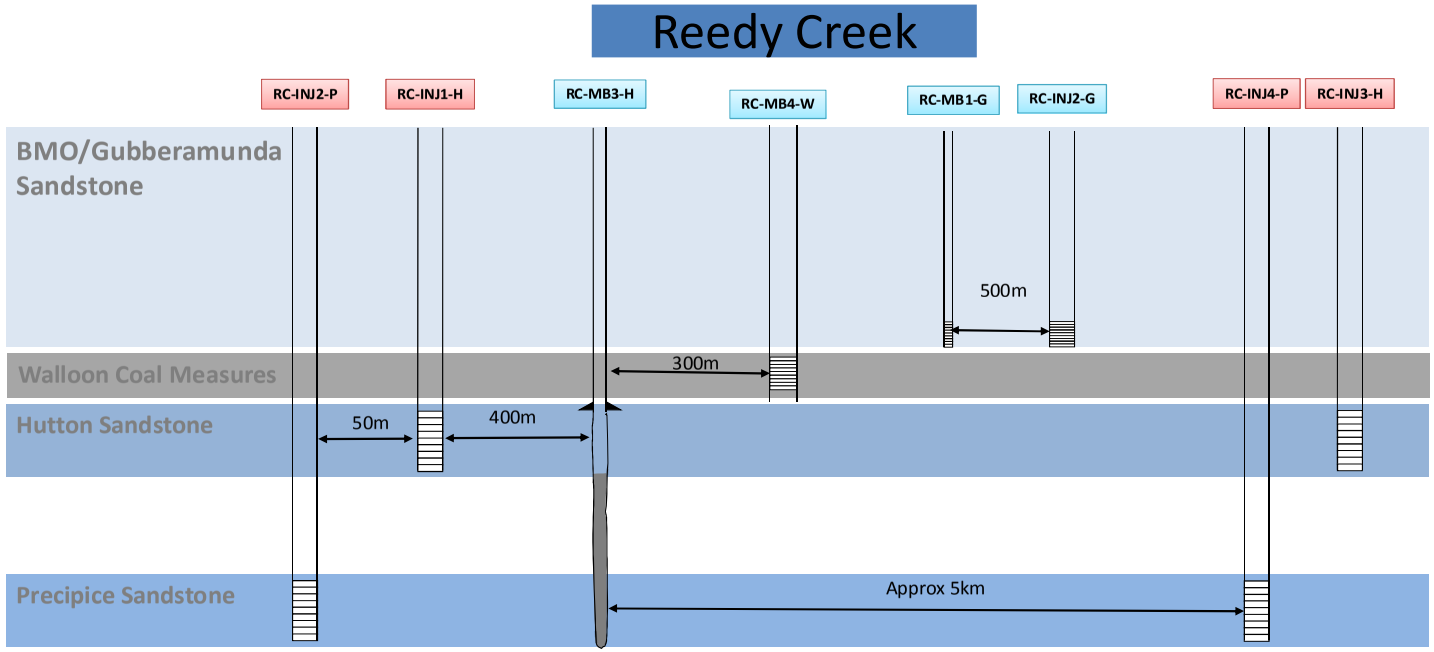

Rig Type	CSG	CSG	Core	CSG	NA	Water	CSG	CSG
Min Pumping Test Duration	2 days	2 days	4 hrs	NA	4 hrs	24 hrs	8 hrs	8 hrs
Water disposal	Pilot pond	Pilot pond	Pilot pond	NA	**Pilot Pond**	**Pilot Pond**	**Landholder***	**Landholder***
Injectate Source	Portable RO	Portable RO	NA	NA	NA	Portable RO	NA	NA
Brine Disposal	Pilot Pond	Pilot Pond	NA	NA	NA	Pilot Pond	NA	NA
Waterlevel	✓	✓	✓	✓	✓	✓	✓	✓
Hydraulic Conductivity	✓	✓	✓	**NA**	✓	✓	✓	✓
Storage Co-efficient	**RC-INJ4-P**	**RC-MB3-H**	**RC-INJ2-H**	**NA**	**RC-INJ1-G**	**RC-MB1-G**	**RC-INJ2-P**	**RC-INJ2-H**
Water Quality	✓	✓	✓	**NA**	✓	✓	✓	✓
Mineralogy	✖	✖	✓	**NA**	✓	✖	✖	✖
Frac Gradient	✓	✓	✓	✓	✖	✖	✓	✓

* Use of landholder dam to be determined. Alternative may be required

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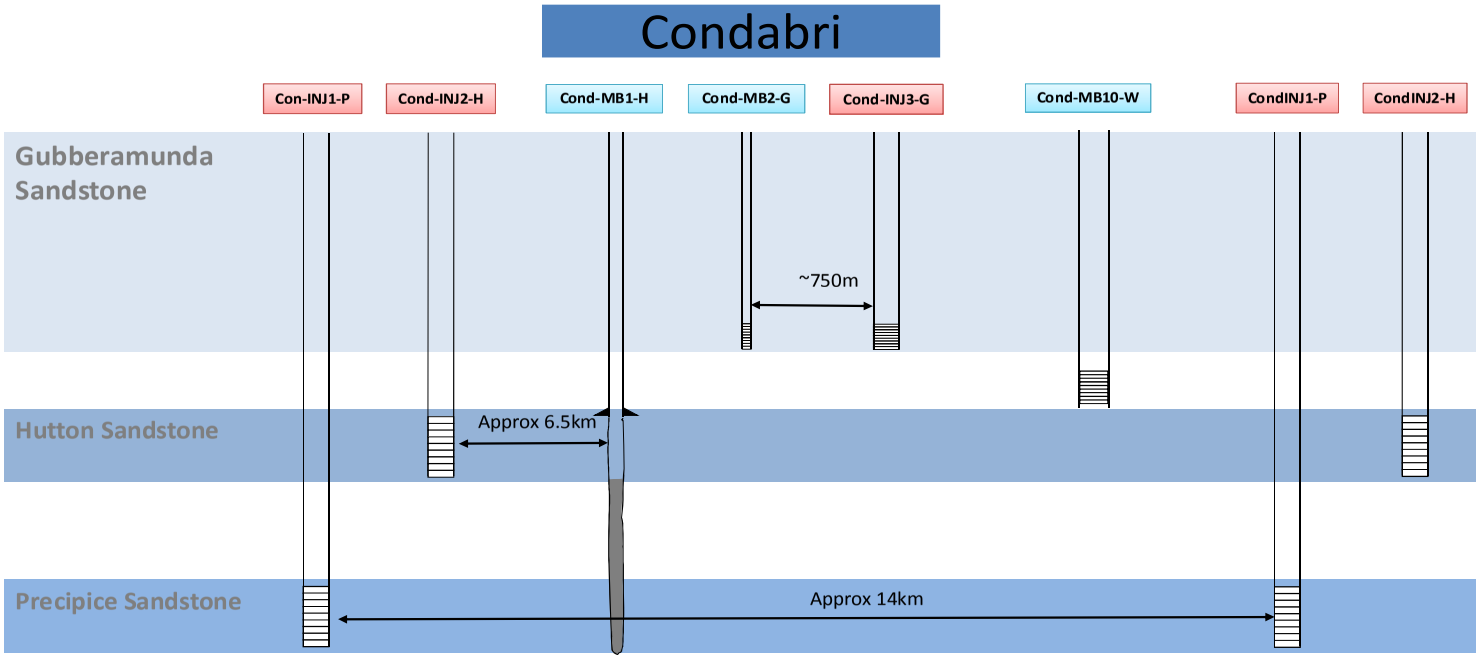

Rig Type	CSG	CSG	Core	Waterwell	Waterwell	CSG	CSG	CSG
Min Pumping Test Duration	2 days	2 days	4 hrs	4 hrs	24 hrs	NA	8hrs	8hrs
Water disposal	Pilot pond	Pilot pond	Landholder	Landholder	Pilot Pond	NA	Pilot ponds	Pilot ponds
Injectate Source	Portable RO	Portable RO	NA	NA	Portable RO	NA	NA	NA
Brine Disposal	Temp mod to pilot pond	Temp mod to pilot pond	NA	NA	Temp mod to pilot pond	NA	NA	NA
Waterlevel	✓	✓	✓	✓	✓	✓	✓	✓
Hydraulic Conductivity	✓	✓	✓	✓	✓	**NA**	✓	✓
Storage Co-efficient	**Feedlot**	**Cond-MB1-H**	**Cond-INJ2-H**	**Cond-INJ3-G**	**Cond-MB2-G**	**NA**	✖	✖
Water Quality	✓	✓	✓	✓	✓	**NA**	✓	✓
Mineralogy	✖	✖	✓	✓	✖	**NA**	✖	✖
Frac Gradient	✓	✓	✓	✖	✖	✓	✖	✖

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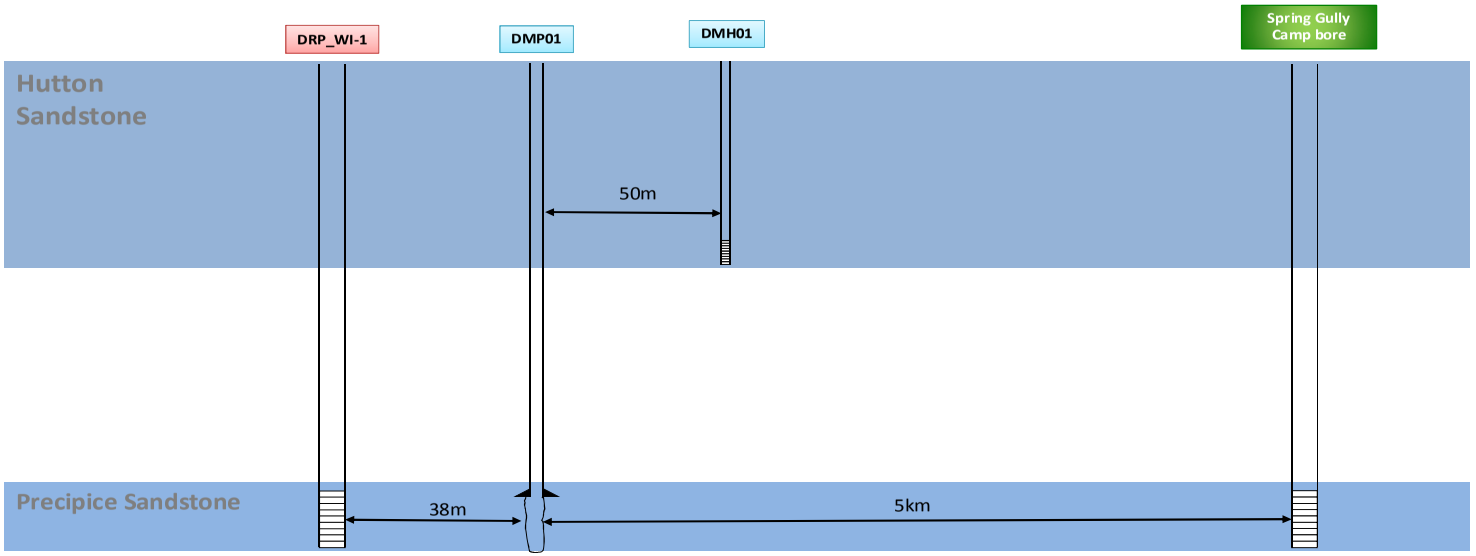
Spring Gully



Rig Type	CSG	Core	Waterwell	Existing
Min Pumping Test Duration	48 hrs	4 hrs	NA	NA
Water disposal	RO feed pond	Brine Pond	NA	Permanent
Injectate Source	SG RO Plant	NA	NA	NA
Brine Disposal	Brine Pond	NA	NA	NA
Waterlevel	✓	✓	✓	✓
Hydraulic Conductivity	✓	✓	✖	**NA**
Storage Co-efficient	DMP01	✖	✖	✖
Water Quality	✓	✓	✓	✓
Mineralogy	✖	✓	✖	✖
Frac Gradient	✖	✓	✖	✖

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