



# Groundwater Reinjection for Exploration Well Testing of Ramsay Project Wells

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PEL 687 – Yorke Peninsula

Environmental  
Impact Report

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## Summary

Gold Hydrogen Ltd (Gold Hydrogen) is exploring for natural hydrogen and helium generated from geological processes occurring in parts of the Earth's crust. As a replacement for carbon-based fuels, naturally occurring hydrogen (also known as 'gold' or 'white' hydrogen) offers significant cost and emissions advantages relative to other sources of hydrogen production, with the potential to be a clean, low-cost energy source into the future.

Gold Hydrogen holds Petroleum Exploration Licence (PEL) 687, which covers large sections of Yorke Peninsula and Kangaroo Island. This EIR has been prepared under the *Energy Resources Act 2000* to cover groundwater reinjection activities carried out as part of exploration well testing for the Ramsay Project within PEL 687 on Yorke Peninsula.

## Background

Gold Hydrogen drilled and tested two exploration wells in late 2023 and early 2024 (Ramsay-1 and Ramsay-2, located approximately 10 km east of Minlaton in PEL 687) and reported finds of natural hydrogen and helium in these wells. Additional exploration wells are planned to be drilled and tested from late 2025 to evaluate the hydrogen and helium resource potential of the Ramsay Project.

As some of the hydrogen and helium resources may be entrained or dissolved in water trapped in underground reservoirs, the exploration well testing program will require pumping groundwater from the geological formations being tested to the surface to recover the hydrogen and helium gases. Groundwater pumped to the surface during the testing is proposed to be transported through temporary pipelines to the Ramsay-1 site and reinjected in the Ramsay-1 well.

## Scope

The scope of this EIR and the accompanying Statement of Environmental Objectives (SEO) (Gold Hydrogen 2025) covers activities related to groundwater reinjection for exploration well testing that are outside the coverage of the existing drilling and well testing EIR and SEO (Gold Hydrogen 2023a and 2023b). These activities are:

- temporary pipelines to transport groundwater to the reinjection well
- downhole reinjection of groundwater (into Ramsay-1).

This EIR and the accompanying SEO are designed to operate in conjunction with the existing drilling and well testing EIR and SEO.

## Land use and environment

The existing and proposed Ramsay wells are located east of Minlaton on Yorke Peninsula. Ramsay-1 is approximately 10 km east of Minlaton, 7 km south of Curramulka and 13 km west of Port Vincent. Ramsay Conservation Park is approximately 7 km to the east of Ramsay-1.

The wells are located in the Yorke Peninsula Council local government area. The area of the wells is traversed by the sealed Port Vincent Road and the sealed Minlaton Road to the south, and several unsealed roads, including Old Port Vincent Road, which is adjacent to Ramsay-1.

The wells are located in an area of gently undulating topography, dominated by cleared agricultural land, with scattered native vegetation limited mainly to road reserves and fence lines. The wells are



located in cropped paddocks and are generally distant from houses, ranging from 600 m – 800 m to the nearest house.

Groundwater use in the vicinity of Ramsay-1 is limited, with only five wells registered within a 2 km radius of Ramsay-1. All wells drilled in this area are less than 100 m deep, with the deepest operational well approximately 69 m deep. Most wells in the area are used for stock watering purposes even though they generally have poor water quality. Salinity is often between 5,000 mg/L and 27,000 mg/L.

Groundwater is present in Ramsay-1 from a depth of approximately 67 m, down to the basement. Groundwater salinity increases with depth, with salinities of approximately 8,000 to 10,000 mg/L recorded at 200 to 300 m depth, increasing to approximately 95,000 mg/L at 750 m depth and 126,000 mg/L at 1,000 m.

The groundwater reinjected into Ramsay-1 is expected to be in the order of 40,000 to 60,000 mg/L, but could be lower or higher if shallower or deeper zones are tested in isolation. Reinjecting groundwater will be in contact with all formations below 218 m depth, as Ramsay-1 is cased and cemented to 218 m and has a slotted liner from 218 m to 1005 m. Reinjecting groundwater is expected to preferentially flow into a high hydraulic conductivity zone that is present at approximately 316 m depth. The poor water quality of groundwater in the formations that will be in contact with reinjected groundwater (including the zone at 316 m depth) means that it has limited potential for use.

There are no significant surface water features present at the Ramsay well locations.

The Yorke Peninsula component of PEL 687 is located on the traditional lands of the Narungga people and within the area of the determined Narungga Nation native title claim (which recognises the claimants as native title holders for native title land in the claim area).

Searches of the central archives for the Ramsay well locations have not identified any registered Aboriginal heritage sites in close proximity to the well locations. There are no registered non-Aboriginal heritage sites in the vicinity of the Ramsay wells.

### Environment impact assessment

This EIR assesses the potential impacts that may result from groundwater reinjection activities. The impact assessment indicates that the impacts are not significant, are generally short term and localised and can be adequately managed to prevent unacceptable environmental impacts. Key impacts are discussed below.

#### Groundwater

Existing groundwater users are not expected to be impacted by groundwater reinjection in Ramsay-1. The likelihood of the proposed reinjection impacting shallow aquifers (e.g. less than 100 m depth) is negligible and the consequences of such impacts would also be low, for the following reasons:

- There are very few existing groundwater wells in the vicinity of Ramsay-1, and all operational wells are significantly less than 100 m depth.
- The vertical distance and the low permeability of the intervening formations means that all groundwater users have significant vertical disconnection from the formations in contact with reinjected groundwater (and particularly from the high hydraulic conductivity zone at 316 m where reinjected groundwater is expected to preferentially flow).
- The low permeability throughout the profile also means that any potentiometric head increases from reinjection will not impact the shallow water table aquifers.



The value of receiving groundwater will not be significantly impacted by the proposed reinjection. While there will be a localised increase in salinity at 316 m depth, this would not result in a significant loss of value. The key reasons for this conclusion are:

- The receiving water in Ramsay-1 is not used as a groundwater resource and has limited value due to its significant depth and poor water quality.
- The radius of influence of injected water is small (e.g. maximum of 600-1000 m if all reinjected groundwater flows into the high hydraulic conductivity zone at 316 m). This radius would reduce if there is additional preferential flow to other fractured and/or karstic zones within Ramsay-1.
- Any biocide in the reinjected groundwater is expected to degrade naturally and be diluted through dispersion in the aquifer, thus presenting a very low risk to the groundwater resource and its intrinsic value (which is characterised by poor water quality).

Controls that will be in place, including well design and construction, and monitoring and control of reinjection pressures, will ensure that well integrity failure during reinjection is not a credible impact event.

### *Other elements of the environment*

Soil, shallow groundwater and surface water are unlikely to be impacted by spills of saline water. If a spill occurred, impacts would generally be localised and short term.

Flora, fauna and biodiversity are not likely to be impacted as it is expected there will be little or no native vegetation impact from pipeline installation or removal. If impacts to vegetation on any pipeline routes are unavoidable, they would be very localised and small scale.

Aboriginal heritage impacts from pipeline installation or removal are considered unlikely to occur, due to the location on agricultural land with a long history of cultivation. Control measures would be implemented, including consultation with the Narungga Nation Aboriginal Corporation, cultural heritage survey where required, avoidance of any identified sites or areas of cultural heritage significance and Aboriginal heritage discovery protocols where no authorisations are in place.

Public health and safety impacts resulting from reinjection activities and associated infrastructure (e.g. pressurised piping) are unlikely. Control measures would be implemented including control of public access to the sites during well testing and reinjection activities and design and engineering controls to prevent an unplanned incident such as pipeline rupture.

Social environment, land use and infrastructure impacts are not expected to be significant. Events such as disturbance to landowner infrastructure and introduction of weeds and pests are unlikely to occur. Potential impacts to landholders and land use from the proposed activities are localised and limited scale and readily manageable with appropriate consultation and standard control measures

### *Stakeholder consultation*

Gold Hydrogen is committed to early, genuine and transparent engagement with the community. Gold Hydrogen takes seriously its responsibility to provide the community with timely, accurate, accessible information and opportunities to learn more about natural hydrogen and the proposed exploration activities in PEL 687.

Gold Hydrogen has engaged stakeholders through a range of methods over the period from 2023-2025, preceding the development of this EIR and the SEO, including local media advertisements,



community information sessions, attendance at agricultural shows, presentations to council, distribution of EIRs and SEOs to key stakeholders and publication of EIRs and SEOs and other information on its web site. Gold Hydrogen has also worked closely with landowners at drilling and well testing locations to develop agreements for land access and land use, understand and address any concerns, provide compensation as required and to realise any opportunities or benefits that may arise from the proposed activities.

During planning for the well testing and reinjection activities and the development of this EIR and SEO, engagement by Gold Hydrogen has included meetings with regulatory agencies, use of existing planned engagement sessions such as scheduled landowner meetings to discuss the reinjection activities, contacted Narungga Nation Aboriginal Corporation to provide information about the proposed reinjection activity and developed communication materials including reinjection fact sheet and associated updates to website.

Consultation on this EIR and SEO by Gold Hydrogen has been carried out in accordance with a consultation plan approved by the Department for Energy and Mining (DEM). Consultation targeted relevant stakeholders with the purpose of receiving feedback on the draft EIR and SEO documents. It includes publication of the documents on the Gold Hydrogen website, meetings or telephone calls and provision of links to the documents with landowners within a 1.5 km radius of Ramsay-1 with whom Gold Hydrogen have existing relationships, contact with other relevant landowners by telephone, letter or email, and email contact with Yorke Peninsula Council, Narungga Nation Aboriginal Corporation, and relevant government agencies.

Following Gold Hydrogen's stakeholder consultation, this EIR and the SEO has been updated to address the issues raised during the consultation and submitted to DEM for consideration under the Energy Resources Act. Once satisfied the documents are compliant with the Act's requirements, DEM will undertake public consultation inviting written submissions for a minimum 30 business day period. Any submissions received during this consultation will be provided to Gold Hydrogen. All relevant comments received from the public consultation will be addressed and, where appropriate, incorporated into the EIR and / or SEO.



## 1. Introduction

Gold Hydrogen Ltd (Gold Hydrogen) is operator and 100% working interest owner of Petroleum Exploration Licence (PEL) 687, which covers large sections of Yorke Peninsula and Kangaroo Island (refer Figure 1-1).

Gold Hydrogen is exploring for natural hydrogen and helium generated from geological processes occurring in parts of the Earth's crust. As a replacement for carbon-based fuels, naturally occurring hydrogen (also known as 'gold' or 'white' hydrogen) offers significant cost and emissions advantages relative to other sources of hydrogen production, with the potential to be a clean, low-cost energy source into the future.

Gold Hydrogen drilled and tested two exploration wells in late 2023 and early 2024 (Ramsay-1 and Ramsay-2) and reported finds of natural hydrogen and helium in these wells. Additional exploration wells are planned to be drilled and tested from late 2025 to evaluate the hydrogen and helium resource potential of the Ramsay Project.

As some of the hydrogen and helium resources may be entrained or dissolved in water trapped in underground reservoirs, the exploration well testing program will require pumping groundwater from the geological formations being tested to the surface to recover the hydrogen and helium gases.

Groundwater pumped to the surface during the testing is proposed to be transported through temporary pipelines to the Ramsay-1 site and reinjected in the Ramsay-1 well.

Exploration for natural hydrogen is regulated under the *Energy Resources Act 2000* (ER Act) and must be undertaken under an approved Statement of Environmental Objectives (SEO). Gold Hydrogen's existing drilling and well testing Environmental Impact Report (EIR) and SEO (Gold Hydrogen 2023a and 2023b) covers exploration well testing activities, however these documents do not cover reinjection of groundwater.

This EIR has been prepared to cover groundwater reinjection activities carried out as part of exploration well testing. It and the accompanying SEO (Gold Hydrogen 2025) are designed to operate in conjunction with the existing drilling and well testing EIR and SEO (Gold Hydrogen 2023a and 2023b).

### 1.1. Background

Gold Hydrogen's PEL 687 covers known occurrences of natural hydrogen on Yorke Peninsula and Kangaroo Island which were discovered during the 1920s and 1930s during hydrocarbon exploration activities.

Gold Hydrogen's exploration program (the 'Ramsay Project') aims to:

- Initially validate the natural hydrogen occurrences of the 1920s and 1930s and prove that natural hydrogen is present within PEL 687 on Yorke Peninsula.
- Demonstrate that natural hydrogen is present in sufficient volumes to be extracted for commercial use.

Gold Hydrogen's exploration activities which have been previously approved and undertaken to date include:



- Airborne gravity-magnetic surveys of PEL 687 undertaken in March - April 2023 to measure and capture natural variations in the strength and other characteristics of the Earth's gravity and magnetic fields.
- Non-invasive soil gas surveys in the southern portion of Yorke Peninsula in April 2023.
- An initial two well exploration drilling and testing program in late 2023 (Ramsay-1 and Ramsay-2) which confirmed the presence of natural hydrogen and helium in the Ramsay Project area
- Acquisition of seismic survey data in 2024 to increase understanding of the subsurface geology identify locations for further exploration drilling and testing
- Commencement of a second drilling program of up to three new wells in the Ramsay Project area in late 2025.

## 1.2. Gold Hydrogen Company Profile

Gold Hydrogen is an Australian Stock Exchange Listed (ASX-listed) company focused on the exploration and development of natural hydrogen and helium gases in South Australia. Gold Hydrogen is headquartered in Brisbane, Queensland.

The combined natural hydrogen permit area of the Gold Hydrogen group is approximately 75,000 km<sup>2</sup>. Gold Hydrogen holds one granted petroleum exploration licence (PEL 687) and one application for a PEL (Petroleum Exploration Licence Application (PELA) 792) and its two 100% owned subsidiary companies (White Hydrogen Australia and Byrock Resources) hold an additional seven applications for natural hydrogen exploration licences within South Australia.

Gold Hydrogen is also the preferred applicant for four Gas Storage Exploration Licence Applications (GSELA) covering an additional 8,107 km<sup>2</sup> within the renewable energy zone of PEL 687 of the Yorke Peninsula region of South Australia.

Figure 1-1: Location of PEL 687 on Yorke Peninsula



- Legend**
- Towns
  - State Maintained Roads
  - Roads
  - PEL 687 Boundary
  - NPW Act 1972 Reserved Area
  - ▨ Wetlands
  - Indigenous Protected Areas



### 1.3. About this Document

This document has been prepared to satisfy the requirements of an EIR under the ER Act. It has been prepared in accordance with current legislative requirements, in particular Section 97 of the Act and Regulation 10 of the *Energy Resources Regulations 2013* (ER Regulations).

Table 1-1 gives a brief outline of the content and structure of each section of this EIR.

**Table 1-1: Environmental Impact report outline**

Section	Title	Content
1	Introduction	Introduces the purpose and format of this document, provides background and defines scope.
2	Legislative Framework	Provides a brief description of the relevant legislation and the assessment and approval process
3	Description of Activities	Describes operations for groundwater reinjection for exploration well testing
4	Overview of the Environment	Provides a broad overview of the environment of the project area and surrounds
5	Environmental Impact Assessment	Outlines the environmental impact assessment methodology and provides the environmental impact assessment for each element of the environment
6	Environmental Management Framework	Outlines Gold Hydrogen's management system and relevant management strategies
7	Stakeholder Consultation	Documents Gold Hydrogen's consultation approach and activities undertaken for development of the EIR and SEO
8	References	Lists reference material used in the preparation of this document
9	Abbreviations and Glossary	Lists definitions of abbreviations and terms used in this document
Appendix A	Hydrogeological Risk Assessment	Provides hydrogeological information and assesses the risk to groundwater of the reinjection activities
Appendix B	Summary of issues raised - Gold Hydrogen consultation	Provides details on stakeholder comments on the draft EIR and SEO and Gold Hydrogen responses
Appendix C	Summary of issues raised - formal ER Act consultation	<i>To be completed following formal DEM consultation. Provides details on public and government agency comments on the EIR and SEO and Gold Hydrogen responses</i>

#### 1.3.1. Scope of the EIR and SEO

This EIR (and the accompanying SEO) cover groundwater reinjection activities that are undertaken as part of exploration well testing for the Ramsay Project within PEL 687 on Yorke Peninsula. These activities are described in Section 3.

The scope of this EIR is limited to activities related to groundwater reinjection for exploration well testing that are outside the coverage of the existing drilling and well testing EIR and SEO (Gold Hydrogen 2023a and 2023b). These activities are:

- temporary pipelines to transport groundwater to the reinjection well
- downhole reinjection of groundwater (into Ramsay-1).



The following natural hydrogen exploration activities undertaken by Gold Hydrogen are outside the scope of this document, as they are addressed in Gold Hydrogen’s existing EIRs for drilling and well testing (Gold Hydrogen 2023a) and low impact on-road geophysical activities (Gold Hydrogen 2024):

- well site and access track construction
- drilling, well completions and workovers
- well testing, including equipment at well sites such as pumps, separator tanks, storage tanks and gas vents
- restoration of well sites and access tracks
- geophysical surveys and investigations
- supporting activities and infrastructure.

The coverage of this EIR and the accompanying SEO is limited to groundwater reinjection for exploration and appraisal well testing only. It does not cover groundwater reinjection for any possible future hydrogen or helium production operations.

### Geographical area and exclusions

This EIR covers downhole reinjection into Ramsay-1 and temporary pipelines within a short distance of the Ramsay-1 well.

Gold Hydrogen’s drilling and well testing EIR (Gold Hydrogen 2023a) identifies areas that would specifically be avoided by Gold Hydrogen’s exploration activities. These areas, which are listed below, are also excluded from the scope of this EIR and the accompanying SEO:

- the portion of PEL 687 located on Kangaroo Island
- activities in reserves established under the *National Parks and Wildlife Act 1972* or exploration activities immediately adjacent to a Marine Park established under the *Marine Parks Act 2007*
- activities in mining production tenement regulation areas identified in Schedule 14 of the *Planning, Development and Infrastructure (General) Regulations 2017*<sup>1</sup>
- Wardang Island Indigenous Protected Area
- Native Vegetation Heritage Agreement areas
- land where access has not been agreed with the landowner
- land in close proximity to towns or sensitive receptors
- areas of high-quality native vegetation
- significant wetland areas
- areas of identified cultural heritage significance.

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<sup>1</sup> Mining Production Tenement Regulation Areas (MPTRA) incorporate the coastline and several other areas on Yorke Peninsula. The *Planning Development and Infrastructure Act 2016* requires referral of new SEOs (and mining production tenement applications) for activities in MPTRAs to the Planning Minister for advice. These areas have not been identified by Gold Hydrogen for exploration drilling and testing and have been excluded from the scope to simplify the SEO approval process.



## 2. Legislative Framework

This chapter briefly describes the legislative framework that currently applies to activities regulated under the *Energy Resources Act 2000* and *Energy Resources Regulations 2013* in South Australia.

### 2.1. Energy Resources Act

The principal legislation governing onshore exploration for natural hydrogen in South Australia is the ER Act and ER Regulations. This legislation is administered by the Department for Energy and Mining (DEM).

Key objectives of the legislation include:

- establishing an effective, efficient and flexible regulatory scheme to enable the exploration for, and the recovery, production, transmission, storage and management of energy resources that encourages and maintains an appropriate level of competition
- ensuring that energy rights and resources are managed for the benefit of the State
- ensuring that the exploration for, and the recovery, production, transmission, storage and management of, energy resources is carried out safely and is ecologically sustainable
- ensuring that regulated activities that may have adverse effects on the environment
  - are properly managed to reduce environmental damage
  - are carried out in a way that eliminates or limits the risk of significant long term environmental damage; and to ensure as far as reasonably practicable, security of supply for users of natural gas
- ensuring that land adversely affected by regulated activities is properly rehabilitated
- establishing appropriate consultative processes with people directly affected by regulated activities including Aboriginal people and the public generally
- protecting the public from risks inherent in regulated activities.

The ER Act and ER Regulations are objective-based rather than prescriptive. An objective-based regulatory approach principally seeks to ensure that industry effectively manages its activities by complying with performance standards that are cooperatively developed by the licensee, the regulatory authority and the community. This contrasts with prescriptive regulation where detailed management strategies for particular risks are stipulated in legislation.

The regulated resources, substances and activities to which the Act applies are defined within the ER Act.

- Regulated resources as defined in Part 1 of the Act includes a naturally occurring underground accumulation of a regulated substance
- Regulated substances as defined in Part 1 of the Act includes hydrogen and hydrogen compounds or by-products of the production of hydrogen
- Regulated activities relevant for the purposes of this EIR are defined in section 10(1) as
  - exploring for a regulated resource



- operations to establish the nature and extent of a discovery of a regulated resource, and to establish the commercial feasibility of production and the appropriate production techniques.

### 2.1.1. Statement of Environmental Objectives

As a requirement of Part 12 of the Act, a regulated activity can only be conducted if an approved Statement of Environmental Objectives (SEO) is in force for the relevant activity. The SEO must set out environmental objectives to be achieved, assessment criteria, leading performance criteria and immediately reportable and reportable incidents, in accordance with section 100 of the ER Act.

A SEO is based on the information provided in the Environmental Impact Report (EIR).

### 2.1.2. Environmental Impact Report

Under section 97 of the ER Act, an EIR must be prepared for proposed regulated activities. This document addresses the potential impacts to the environment and outlines the extent to which these impacts can be managed. The EIR must:

- take into account cultural, amenity and other values of Aboriginal and other Australians insofar as those values are relevant to the assessment
- take into account risks to the health and safety of the public inherent in the regulated activities
- contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment
- include an assessment of the environmental impact of regulated activities to which the report applies against the environmental impact assessment criteria.

Section 4(1) of the ER Act defines the environment as including:

- land, air, water (including both surface and underground water and sea water), organisms, ecosystems, flora, fauna
- buildings, structures and other forms of infrastructure, and cultural artefacts
- existing and potential land use
- public health, safety or amenity
- the heritage, aesthetic, or cultural values of an area
- the economic or social impact on an area.

As per ER Regulation 10, for the purposes of an EIR, a licensee must provide:

- a description of the regulated activities to be carried out under the licence (including their location)
- a description of the specific features of the environment that can reasonably be expected to be affected by the activities, with particular reference to the environment and existing land uses
- an assessment of the cultural and heritage values of Aboriginal and other Australians which could reasonably be foreseen to be affected by the activities in the area of the licence, and the



public health and safety risks inherent in those activities (insofar as these matters are relevant in the particular circumstances)

- if required by the Minister – a prudential assessment of the security of natural gas supply
- information on any consultation that has occurred with the owner of the relevant land, any Aboriginal groups or representatives, any agency or instrumentality of the Crown, or any other relevant stakeholders, including specific details about relevant issues that have been raised and any response to those issues, but not including confidential information.

### Environmental impact assessment criteria

Under section 96A of the Act, the Minister is required to determine the criteria against which the environmental impact of an authorised operation is to be assessed. An impact assessment against these environmental impact assessment criteria must be prepared by the licensee and be included as part of the EIR submitted by the licensee.

The Environmental Impact Assessment Criteria<sup>2</sup>, to be addressed in the EIR are:

- Criteria 1 – elements of the environment
- Criteria 2 – potential impact events
- Criteria 3 – confirmation of impact events
- Criteria 4 – control and management strategies and uncertainty assessment
- Criteria 5 – Environmental significance assessment
- Criteria 6 – Statement of environmental objectives.

#### 2.1.3. Consultation on the EIR and SEO

Under sections 97 and 99 of the ER Act and Regulation 11, a licensee is required to undertake consultation on a proposed EIR and SEO in compliance with an approved consultation plan prepared and implemented in accordance with the ER Regulations. An EIR and SEO consultation plan must be submitted to DEM for approval prior to undertaking mandatory consultation on the EIR and SEO.

Following consultation by the licensee, the EIR and SEO are formally submitted to DEM and an assessment will be undertaken to ensure the documents meet the requirements of the Act, Regulations and the Environmental Impact Assessment Criteria as required under section 97(4). Once satisfied the documents are compliant, DEM undertakes public consultation inviting written submissions for a minimum 30 business day period in accordance with Regulation 14.

Any submissions received during this consultation are provided to the licensee. All relevant comments received from the public consultation will be required to be addressed by the licensee and, where appropriate, incorporated into the EIR and / or SEO.

#### 2.1.4. Activity Notification / Approval Process

Prior to commencing a regulated activity, Section 74(3) of the ER Act provides that:

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<sup>2</sup> The environmental impact assessment criteria can be accessed at <https://www.energymining.sa.gov.au/industry/energy-resources/regulation/environmental-register#eia>



- The Minister’s prior written approval is required for activities requiring high level official surveillance (as per Regulation 19), and
- Notice of activities requiring low level official surveillance is to be given at least 21 days in advance (as per Regulation 18).

The proposed activities would fall in the high-level official surveillance category (all new licensees are initially high-level official surveillance operators for all activities).

In order to obtain written approval for activities requiring high level official surveillance, an application and notification of activities (in accordance with Regulation 20) must be submitted to the Minister at least 35 days prior to the commencement of activities. The notification of activities must provide specific technical and environmental information on the proposed activity and include an assessment to demonstrate that it is covered by an existing SEO.

This activity notification and approval process is often referred to as Stage 3 of the approval process under the ER Act, as it follows licensing (Stage 1) and the EIR and SEO approval process (Stage 2). The Stage 3 activity notification and approval process provides an additional opportunity for DEM to ensure that the proposed activities and their impacts can be effectively managed and are consistent with the approvals obtained in the EIR and SEO approval process.

The site-specific detail provided would include an environmental assessment report (EAR), which provides details on site-specific issues and their management and detailing how the proposed activities will meet the requirements of the approved SEO. The EAR would address potential impacts and management for all relevant issues identified in the EIR / SEO and during site surveys such as land use, cultural heritage, surface water, native vegetation, threatened species, weeds and pests.

## 2.2. Other Legislation

A variety of legislation is potentially applicable to the proposed activities and is listed below. This is not a comprehensive list of all applicable legislation. Further detail on key legislation is provided following the list.

### **Commonwealth**

*Aboriginal and Torres Strait Islander Heritage Protection Act 1984*

*Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*

*Native Title Act 1993*

### **South Australia**

*Aboriginal Heritage Act 1988*

*Crown Land Management Act 2009*

*Dangerous Substances Act 1979*

*Environment Protection Act 1993*

*Fire and Emergency Services Act 2005*

*Heritage Places Act 1993*

*Landscape South Australia Act 2019*

*National Parks and Wildlife Act 1972*



*Native Title (South Australia) Act 1994*

*Native Vegetation Act 1991*

*South Australian Public Health Act 2011*

*Work Health and Safety Act 2012.*

### 2.2.1. Commonwealth Environment Protection and Biodiversity Conservation Act

Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for activities that are likely to impact matters of national environmental significance including World Heritage properties, National Heritage places, Ramsar wetlands of international importance, listed threatened species and ecological communities, migratory species, Commonwealth marine areas, the Great Barrier Reef Marine Park, nuclear actions and a water resource in relation to coal seam gas development and large coal mining development.

With regard to operations in the Ramsay Project area, issues that may trigger approval requirements under the EPBC Act are expected to be readily avoidable by appropriate site selection. Assessments of the Ramsay well sites have not detected any EPBC-listed threatened species (or other matters of national environmental significance) at or near the sites. Based on current expectations, Gold Hydrogen believes that a requirement for approval under the Act is not likely to be triggered.

### 2.2.2. Landscape South Australia Act

The *Landscape South Australia Act 2019* (Landscape SA Act) provides a framework for the sustainable and integrated management of the state's water resources including surface water and groundwater. It provides the mechanism to prescribe a watercourse or underground waters and establish a water allocation plan for the prescribed area. The project is not located within a prescribed water resources area or wells area.

The Landscape SA Act and the relevant Water Affecting Activities Control Policy (N&YLB 2020) also set out a number of water affecting activities that must not be undertaken without a permit. A permit to drain or discharge water into a well, pursuant to section 112 of the Act, will be required for the groundwater reinjection activities.

The Landscape SA Act also governs the control of declared pest plants and animals.

### 2.2.3. Native Vegetation Act

Exploration activities that are approved under the ER Act do not require approval under the *Native Vegetation Act 1991* for clearance of native vegetation, provided that they are undertaken in accordance with industry standards endorsed by the Native Vegetation Council (NVC) that are directed towards minimising impact and encouraging regrowth of any cleared native vegetation (see Regulation 15 of the *Native Vegetation Regulations 2017*).

If there are no applicable industry standards, or if it is not possible to undertake the operations in accordance with applicable industry standards, the clearance is permitted if undertaken in accordance with a management plan, approved by the NVC, that results in a significant environmental benefit, or if the person undertaking the operations makes a payment into the Native Vegetation Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit.

As discussed in the existing drilling and well testing EIR (Gold Hydrogen 2023a) and Section 5.5 of this document, Gold Hydrogen plans to avoid activities in areas of high quality or significant remnant vegetation.



#### 2.2.4. National Parks and Wildlife Act

The *National Parks and Wildlife Act 1972* provides for the establishment and management of reserves and the conservation of wildlife in a natural environment. There are a number of reserves established under this Act within and adjacent to PEL 687, the majority of which do not allow access for activities regulated under the ER Act.

Gold Hydrogen do not propose to conduct activities in any reserves established under the National Parks and Wildlife Act.

#### 2.2.5. Aboriginal Heritage Act

The South Australian *Aboriginal Heritage Act 1988* provides protection for all Aboriginal sites, objects and remains across the state. The Act applies to all land and bodies of water and vests the powers to protect and preserve Aboriginal heritage to the Minister for Aboriginal Affairs, who is required to take such measures as are practicable for protecting and preserving Aboriginal sites, objects and remains.

It is an offence to damage, disturb or interfere with Aboriginal sites, objects or remains unless prior written authorisation has been obtained from the Minister for Aboriginal Affairs under the relevant section of the Act. Penalties apply for failure to comply.

#### 2.2.6. Environment Protection Act

The *Environment Protection Act 1993* imposes a general duty of care not to undertake an activity that pollutes, or might pollute, the environment unless all reasonable and practicable measures have been taken to prevent or minimise any resulting environmental harm. The Act's framework includes Environment Protection Policies that cover aspects including air quality, water quality, noise and waste. Environmental authorisations are required to undertake activities prescribed under the Act.

The Environment Protection Act does not apply to exploration activity undertaken under the ER Act or to wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a lease or licence under the ER Act when produced and disposed of to land and contained within the area of the lease or licence (pursuant to Section 7(4) of the Environment Protection Act).

As the proposed groundwater reinjection activities are exploration activities under a Petroleum Exploration Licence, the Environment Protection Act would not apply, and as a consequence they would be regulated under the framework of the ER Act and the Landscape SA Act.



### 3. Description of Activities

The following section provides a description of activities that would be involved with groundwater reinjection for exploration well testing. In order to provide context, it also provides a broad overview of the exploration well testing operation.

As discussed in Section 1.3.1, the scope of this EIR is limited to the following activities related to groundwater reinjection for the exploration testing program that are outside the coverage of the existing drilling and well testing EIR and SEO (Gold Hydrogen 2023a and 2023b):

- temporary pipelines to transport groundwater to the reinjection well
- downhole reinjection of groundwater into Ramsay-1.

Detail on these activities is provided in Sections 3.2 and 3.3 below.

#### 3.1. Overview of Exploration Well Testing Activities

As noted above, exploration well testing is covered by the existing drilling and well testing EIR and SEO (Gold Hydrogen 2023a and 2023b). The information in this subsection is provided to give context for the groundwater reinjection activities, however the activities described are outside the scope of this EIR.

##### 3.1.1. Background

In order to appraise and assess the hydrogen and helium resource potential of the Ramsay Project, an exploration well test program is proposed following the 2025/26 drilling campaign. The goal of the well test program is to flow both gases vertically through the exploration wells to surface facilities in order to measure flow rates, concentrations and pressures.

Based on existing data derived to date on the Ramsay Project, including results from the Ramsay-1 and Ramsay-2 wells, it is expected that some of the hydrogen and helium resources may be entrained or dissolved in water trapped in underground reservoirs. The exploration well testing program is therefore likely to require pumping groundwater from the geological formations being tested through the exploration well to the surface, in order to recover the hydrogen and helium gases.

Groundwater pumped to the surface will then be transported through temporary pipelines to the Ramsay-1 site and reinjected in the Ramsay-1 well, as discussed further in Sections 3.2 and 3.3.

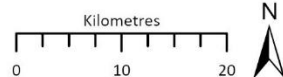
The general location of the Ramsay-1 well on Yorke Peninsula is shown in Figure 3-1.

Figure 3-1: Ramsay well locations



Legend

- Towns
- State maintained roads
- ▭ PEL 687
- Wells
- Ramsay 1
- Ramsay 2
- Ramsay well location



### 3.1.2. Well testing locations

Gold Hydrogen plans to drill up to three exploration wells during its upcoming 2025/26 drilling campaign and expects to drill additional exploration and appraisal wells in the future across the Ramsay Project area. The most likely wells to be drilled are the Ramsay-3, Ramsay-4 and Ramsay-5 locations<sup>3</sup> (see Figure 3-2) however locations may be subject to change due to initial drilling results, including the potential for the drilling of additional wells. The wells to be tested would be selected dependent on drilling results (including drill stem tests, wireline logging and other sampling analyses undertaken during drilling).

Exploration well testing is expected to be undertaken at some or all of the well locations in the 2025/26 campaign, with exploration well drilling and testing possible at other locations in the surrounding area (see Figure 3-2). It is expected that any future wells that undergo exploration well testing and reinjection into Ramsay-1 via pipelines would be within a short distance of Ramsay-1.



Figure 3-2: Project Area

### 3.1.3. Well testing facilities

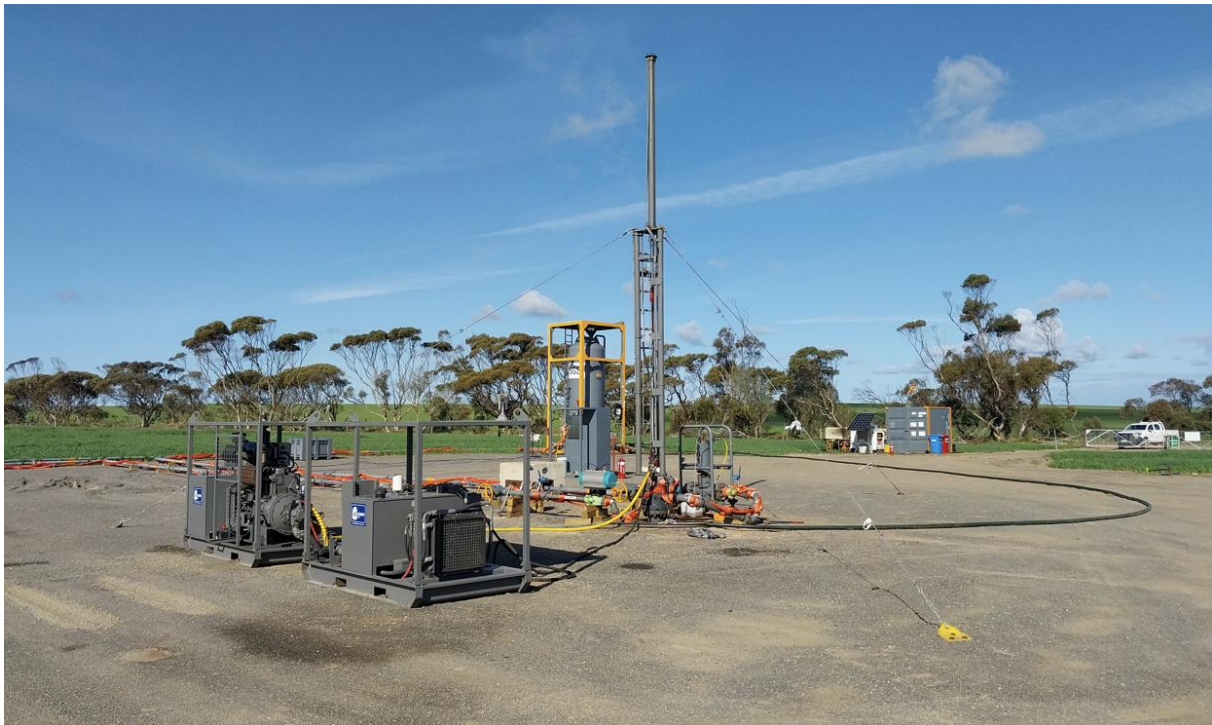
Equipment at the well testing sites and the Ramsay-1 site will be located on a gravel pad, as described in the drilling and well testing EIR (Gold Hydrogen 2023a). Pads constructed for drilling of the wells

<sup>3</sup> Depending on initial drilling results at Ramsay-3, the order of drilling may change and consequently the numbering of the Ramsay-4 and Ramsay-5 wells would change, in accordance with naming conventions under the ER Act. The preliminary numbering of these wells has been used throughout this document.

that will be tested will remain in place after drilling is completed. The Ramsay-1 pad, which was reduced in size after it was drilled, will be re-established for the well testing operations. Equipment on site at the well being tested and/or the Ramsay-1 site will include generators, pumps, separator tanks, valve work and piping, and a gas vent / flare stack to safely discharge hydrogen (noting that hydrogen will be vented rather than flared unless flow rates are above 1 MMscf/day). Steel-sided above-ground tanks for temporary storage of groundwater will be located at both the well testing location and the Ramsay-1 site, or alternatively at the laydown area adjacent to Ramsay-1, dependent on site space restrictions or landowner requirements.

Ancillary equipment at the well test site is expected to include a transportable office block, tools container/workshop, transportable amenities block and a tank for storage of fuel. A transportable container/workshop and transportable toilet facilities may also be located at the Ramsay-1 site or adjacent existing laydown area.

Plate 3-1 shows equipment that was on site for the 2024 Ramsay-1 well testing. Figure 3-3 provides an indicative well test site layout for the upcoming exploration well test campaign.



**Plate 3-1: Ramsay-1 well test operations during 2024 testing campaign**

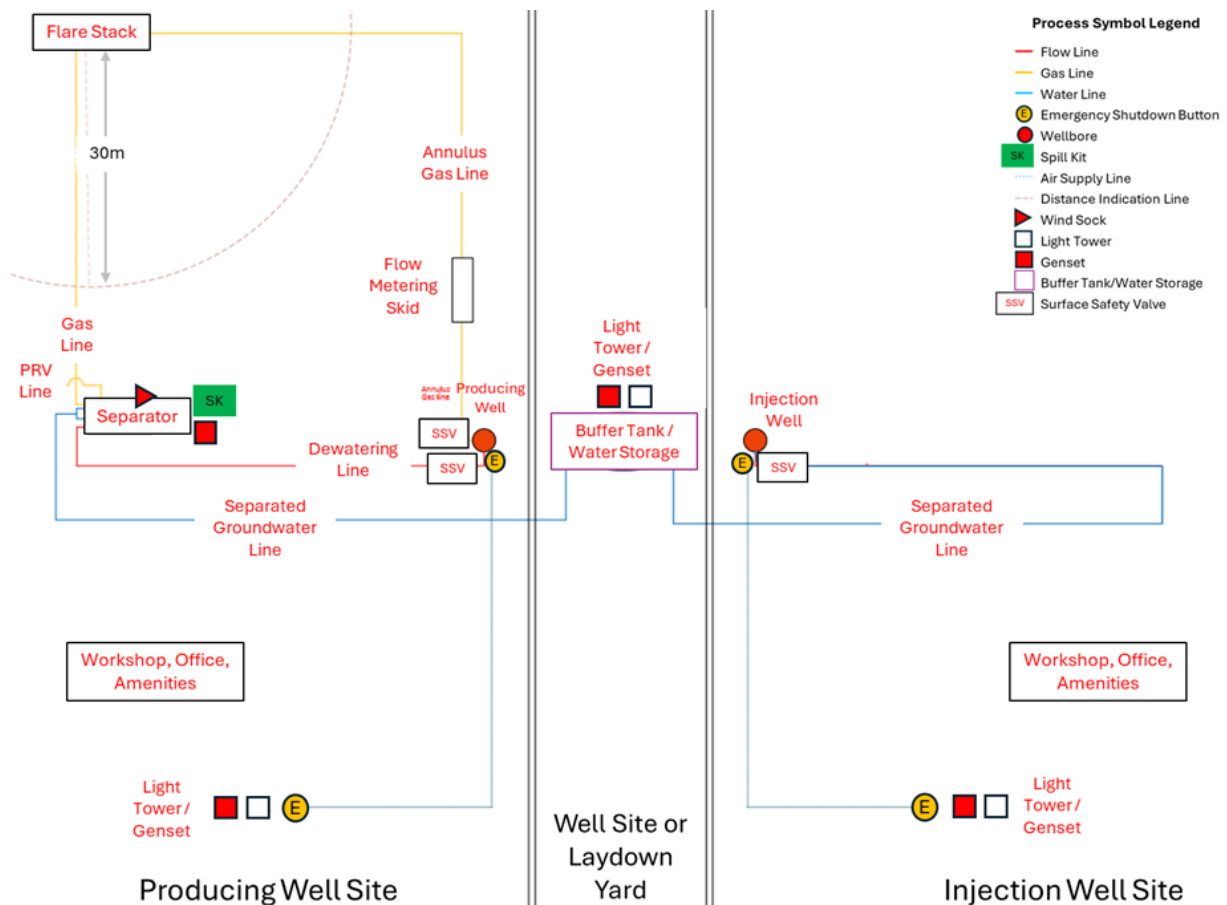


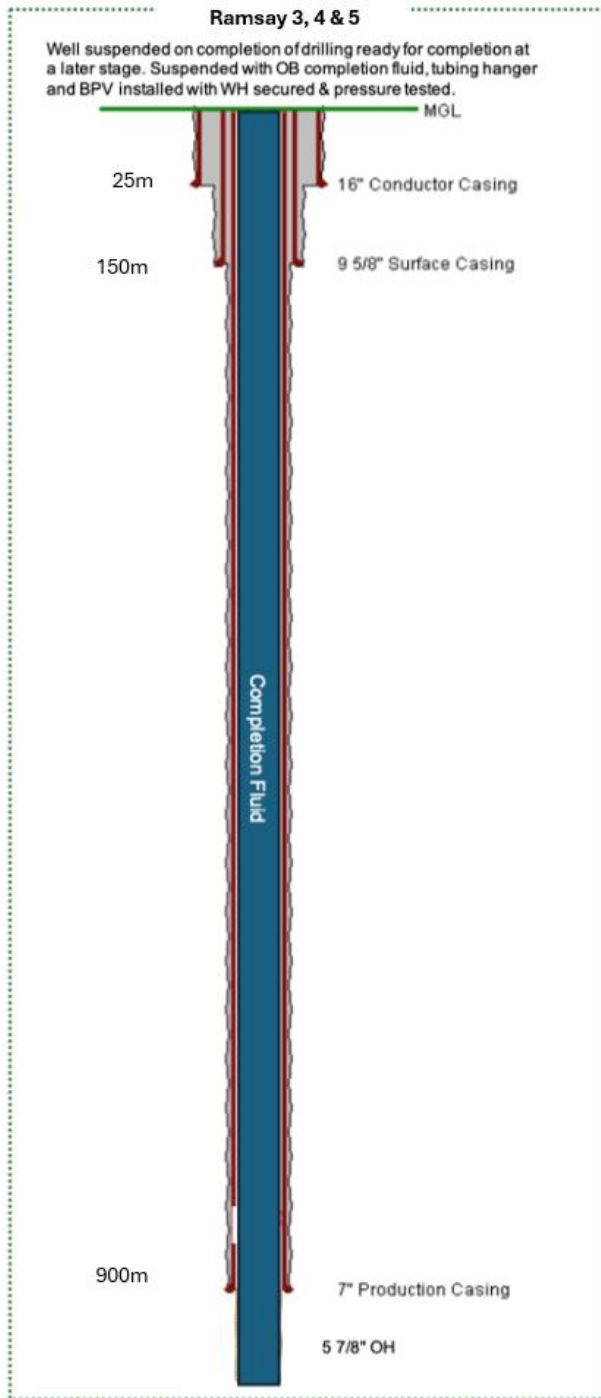
Figure 3-3: Indicative well test site layout

Site establishment will require minor on-lease earthworks for pump skid pads, pipeline tie-ins, and above ground temporary water storage tank installation. Works will generally be confined to previously cleared or disturbed areas. Ground disturbance in areas away from the well site is expected to be limited to shallow trenching or conduit installation for transfer pipeline crossings of roads or tracks where required (as discussed in Section 3.2).

### 3.1.4. Well completions and testing design (downhole)

Ramsay 3, 4 and 5 will be completed as a cased hole well with 7-inch casing as shown in Figure 3-4. An Electrical Submersible Pump (ESP) will be installed in the well with 4-inch tubing (installed inside the casing) for either a commingled test (where different zones/depths are tested at the same time) or a zonal test (where different zones/depths are tested separately). No packer<sup>4</sup> will be installed to allow access to the annulus (the space between the tubing and casing) during flow testing of shallow formation groundwater. The zones where the well will be perforated for testing will be selected based on hydrogen and helium shows detected by gas chromatograph analysis and open hole wireline logging completed during drilling operations. The well completion and testing of any future wells is expected to be similar to Ramsay 3, 4 and 5.

<sup>4</sup> A packer is a downhole tool used to seal the annular space between the tubing and the casing.



**Figure 3-4: Well completion schematic for Ramsay-3, 4 and 5**

### 3.1.5. Groundwater handling

Groundwater pumped from the well being tested will be temporarily stored in an above-ground tank at either the well test site or an adjacent laydown yard, before being pumped to the Ramsay-1 wellsite through the transfer pipeline, where it will be temporarily stored in an above-ground tank either at the well site or an adjacent laydown yard before being reinjected. (Note: Refer to sections 3.2 and 3.3 for discussion of transfer pipelines and reinjection).

The above-ground tanks would provide short-term surge and buffer capacity and ensure well testing can continue during pump maintenance or short shutdowns.

The above ground tanks are expected to be a modular steel system, with an impermeable liner system and approximately 3 ML capacity (e.g. 30 m diameter and 3.5 m high). An example of an above-ground tank is shown in Plate 3-2.



Plate 3-2: Example of above-ground storage tank. Source: Tango Hire<sup>5</sup>

In addition to the downhole ESP, pumps on the surface likely to be used for the testing include:

- a diesel or electric transfer pump located at the well being tested, rated to deliver up to 20,000 barrels (i.e. 3.18 ML) per day.
- a surface injection pump skid at the receiving well to manage pressure control and sustain reinjection into the target formation.

Groundwater pumped to the surface and reinjected will be treated to prevent corrosion and bacterial growth, as described in Section 3.3.

### 3.1.6. Timing and duration

The exploration well testing is planned to commence in the first quarter of 2026 (targeting early March), subject to obtaining necessary approvals.

Gold Hydrogen is planning for exploration well testing to be carried out for approximately 30 days for each well tested, however the parameters and design of the well test will be finalised based on drilling and formation evaluation results. Well testing would run continuously (i.e. 24 hours per day).

### 3.1.7. Personnel and accommodation

Gold Hydrogen expect to have a well test crew consisting of approximately 12 personnel. Operations will be run 24 hours per day, with day shift operating 06:00am to 06:00pm and night shift operating 06:00pm to 06:00am.

Personnel providing additional services and support will fluctuate depending on operational requirements. These may include personnel involved with well completion and servicing; workover and intervention; compliance, assurance and commissioning; electrical and mechanical specialists as required, water and gas sampling, civil services and fluid transport services.

Personnel will be accommodated at commercially available local accommodation.

<sup>5</sup> <http://tangohire.com.au/>

### 3.2. Temporary Pipelines

Two parallel high-density polyethylene (HDPE) flowlines will be used to transfer groundwater from the well being tested to the Ramsay-1 site. Use of two flowlines will provide redundancy, operational flexibility, and reduced flow velocity.

The two parallel flowlines are expected to be 150 mm to 180 mm diameter high-density polyethylene (HDPE) pipelines. The pipelines will be suitable for saline service and have electrofusion welded joints and stainless tie-in spools and fittings at pump and well interfaces.

Operating pressure of the pipelines is expected to be approximately 150 psi, and they would be rated to a maximum operating pressure of 250 psi, subject to pipeline modelling and flow analysis.

Ancillary components will include isolation valves, air/vacuum release valves at high points, low-point drains, and leak detection.

Pipelines will be laid predominantly on the surface within existing well lease and access corridors where possible. Where required for public road or access track crossings, lines will be sleeved or buried in a conduit with protective bollards and signage.

As noted above, ground disturbance is expected to be limited to shallow trenching or conduit installation for pipeline crossings of roads or tracks (where required).

Pipeline routes will be determined in consultation with landowners and will aim to avoid impacting landholder infrastructure and activities and native vegetation. Potential indicative pipeline routes from the Ramsay-3, Ramsay-4 and Ramsay-5 well sites are shown in Figure 3-5.

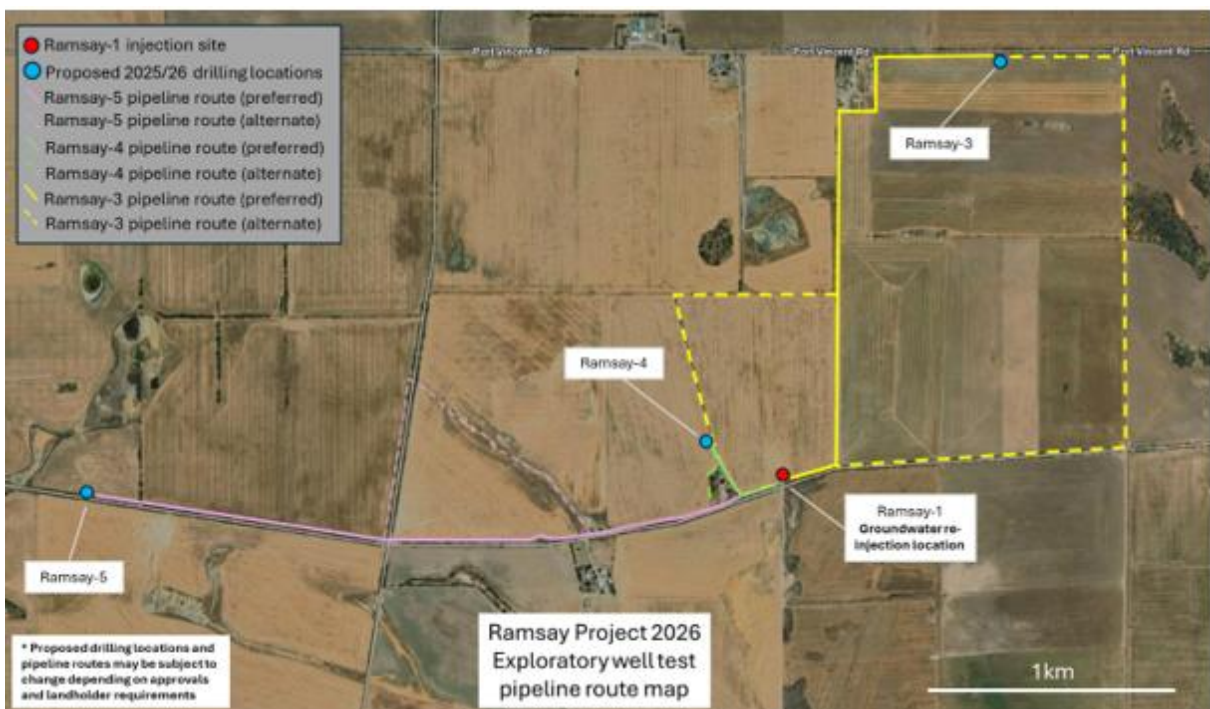


Figure 3-5: Potential locations of transfer pipelines (indicative)

### 3.3. Groundwater Reinjection

Groundwater will be reinjected into the Ramsay-1 through the existing wellhead (shown in Plate 3-3) using a pump at the surface. Injection pressures will be monitored at the surface and maintained below levels that could cause fracturing in the geological formations in the open section of the well.



Preliminary calculations have indicated that the maximum surface injection pressure at the wellhead is likely to be in the order of 850 psi (5,860 kPa), based on an assumed average fracture gradient of 0.8 psi/ft in the dolomite formation as bottom hole injection control. There will be pressure control instrumentation in place to ensure that allowable pressures in the well are not exceeded, including emergency shut down systems and a pressure safety valve at or near the wellhead.



**Plate 3-3: Ramsay-1 wellhead**

### 3.3.1. Reinjection rates and volumes

Reinjection rates at Ramsay-1 would match the groundwater pumping rates at the well being tested and are expected to be no greater than 20,000 barrels (i.e. 3.18 ML) per day. As this is an exploration well testing program, these rates are calculated based on the expected design and objectives of the planned testing program (including the capacity of the pumps that are expected to be used) and results from Ramsay-1 and Ramsay-2 drilling and testing. Rates may vary depending on specific downhole conditions that are measured in the well being tested (e.g. presence of groundwater, groundwater head, hydraulic conductivity<sup>6</sup> of the formation, response of the reservoir to pumping) and well test parameters (e.g. depth and size of zone(s) being tested, targeted flow and pressure). Reinjection rates will also be dependent on the response of the formations and reservoirs at Ramsay-1 to groundwater reinjection. Small-scale injectivity testing is planned for Q1 2026, which, along with the results of drilling of the wells, will allow some assumptions and modelling to be refined.

As the proposed testing is an exploration program (and one of the aims of the testing and reinjection activities will be to increase understanding of the groundwater system), the well test and reinjection parameters may vary as data are gathered and understanding of the system matures.

The total volume of groundwater reinjected into Ramsay-1 will be dependent on the well test pumping rates, test durations and the number of wells tested. It is expected that wells will be tested for a maximum of 30 days, which would equate to a total of approximately 95 ML per well tested if groundwater is pumped at 20,000 barrels per day. If three wells are tested for 30 days at this pumping rate, this would equate to a total of 285 ML. As there is currently a range in the likely total injection volume, a high-end estimate of 300 ML total injection has been assumed for the purposes of the assessment in this EIR.

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<sup>6</sup> Hydraulic conductivity is a measure of how easily a fluid (e.g. water) can flow through a porous material such as soil or rock



### 3.3.2. Formations receiving reinjected groundwater

The groundwater reinjected into Ramsay-1 will be in contact with all formations below 218 m depth, due to the type of completion of the Ramsay-1 well (which is cased and cemented to 218 m and has a slotted liner from 218 m to 1005 m as shown in Figure 5-2 in Section 5.2). It is expected that injected groundwater will preferentially flow into a high hydraulic conductivity zone that is present in the Parara Limestone at approximately 316 m depth, as this zone will have the least resistance to flow and higher capacity to accept groundwater. The majority of injected groundwater is expected to flow into this zone. Flow into the other formations is expected to be significantly lower as they have much lower hydraulic conductivity (see Section 5.2 for further discussion).

### 3.3.3. Salinity of reinjected groundwater

The salinity of reinjected water will be dependent on the groundwater salinity in the well being tested, which will vary according to the specific geological formations and depths that are being tested. The geological formations and groundwater salinity in the wells being tested are expected to be similar to Ramsay-1 and Ramsay-2, given they will be located nearby and in the same geological setting. Salinity in Ramsay-1 and Ramsay-2 increases with depth, with salinities of approximately 8,000 to 10,000 mg/L recorded at 200 to 300 m depth in the Parara Limestone, and increasing to approximately 95,000 mg/L at 750 m depth in the Kulpara Formation and 126,000 mg/L at 1,000 m in the granite basement, as described in Section 5.2. In well tests where multiple zones are being tested simultaneously, groundwater pumped to the surface would be mixed across all zones (e.g. limestone, dolomite and granite) and expected to be in the order of 40,000 to 60,000 mg/L. Salinities could be lower if shallower zones are tested in isolation, and higher if deeper zones are tested in isolation.

### 3.3.4. Monitoring

Monitoring of reinjection activities at Ramsay-1 will include surface monitoring of injection rates, volumes and pressures (as outlined above) and downhole monitoring. This will include a downhole pressure gauge to monitor bottom hole pressure and Distributed Temperature Sensing and Distributed Acoustic Sensing (DTS and DAS)<sup>7</sup> installed in the well to assess flow contribution, micro-seismic events and well integrity during reinjection. Ramsay-3 will also have DTS and DAS cable cemented in place, to enable monitoring of fluid flows, seismic events and well integrity changes across all formations.

Two groundwater monitoring bores have been installed to up to 250 m depth, one approximately 7 km west-southwest and the other 6.5 km north-east of Ramsay-1 with downhole pressure sensors and fluid sampling systems. Existing shallower water bores will also be sampled (subject to landholder permission) to monitor for any hydrogeological changes, including an existing groundwater bore near the Ramsay-3 well location which will be sampled intermittently during the drilling and exploration well test program. Gold Hydrogen also plan to confirm location of existing groundwater wells and groundwater use during ongoing consultation with landholders.

The monitoring program will include, as a minimum, baseline sampling in advance of the well testing program, sampling immediately prior to and on completion of the well testing program and sampling approximately 12 months after completion.

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<sup>7</sup> DTS is a fibre optic technology used for downhole monitoring that provides a continuous, real-time temperature profile along the entire length of a wellbore and allows monitoring of subsurface processes such as fluid flow. DAS is a fibre optic technology that can detect and locate mechanical vibrations along the length of a wellbore to allow for monitoring of aspects such as seismic events and well integrity.



Figure 3-6: Location of water monitoring bores

### 3.3.5. Water treatment

Groundwater will be treated with biocide and oxygen scavengers when pumped from the well being tested and prior to re-injection. This treatment is required to prevent corrosion and growth of microorganisms (e.g. algae or bacteria) that could impact testing or reinjection equipment or result in corrosion and/or downhole bacteria in Ramsay-1. The treatments will likely be added to the above-ground tank, although they can be injected straight into the pipeline if required. A specific chemical injection program will be developed based on previous well test data and water samples. Typically, a biocide and oxygen scavenger is sufficient treatment and common industry practice. Gold Hydrogen will consult with subsurface water experts to ensure appropriate chemical additives are used, and dosing procedures are established.

### 3.3.6. Reinjection rationale and alternatives

Gold Hydrogen considers that reinjection is the most appropriate method of managing groundwater for the short-term exploration well testing program. It avoids surface impacts that may result from other alternatives (e.g. use of evaporation ponds) and is considered to be low impact and low risk. The rationale for reinjection into Ramsay-1 and the alternatives considered are discussed further below.

Ramsay-1 is considered to be a good candidate for reinjection due to the presence of the high hydraulic conductivity zone of the Parara Limestone at approximately 316m depth. The high conductivity of this zone is expected to facilitate reinjection at rates that should enable meaningful testing and avoid other more complex fluid/water handling processes which would not be feasible for an exploration program. The depth of the zone, its elevated salinity and the vertical separation and hydraulic isolation from shallower aquifers (that contain a small number of groundwater wells) result in a very low level of risk to shallow aquifers, groundwater wells / existing users, or the value of groundwater resources, as discussed in Section 5.2.



A number of alternative options for water management and disposal have been considered including injection into the Ramsay-2 well, establishment of evaporation ponds on site or trucking of water to disposal sites, however these options are not feasible or appropriate, as discussed below.

Ramsay-2 is not considered a feasible option for reinjection as a high hydraulic conductivity zone was not intersected during drilling. Ramsay-2 is also a potential future producer of hydrogen and helium resources is therefore not considered an appropriate reinjection candidate from a potential future production perspective, which could include a potential pilot project to confirm proof of concept for hydrogen and/or helium production.

The trucking and evaporation pond options are not considered appropriate options for several reasons including impact to road infrastructure, large surface environmental footprint and community and visual impacts. Evaporation ponds to handle a volume of 95 ML for one exploration well test would be very large (in the order of 180 m x 180 m x 3m deep), which would result in significant surface impact, over a period of 6-12 months or more while water evaporated. Trucking of 20,000 barrels per day would require more than 100 trucks per day, which would result in significant impacts to roads and local amenity. Furthermore, off-site disposal would not be economically feasible.

A reduction in pumping rates or well testing duration has also been considered to reduce the total volume of groundwater pumped to the surface, however Gold Hydrogen considers that the proposed rate and duration are likely to be required to adequately characterise the hydrogen and helium resources and evaluate its commercial potential.

Reinjection of groundwater is also favourable to help maintain the regional in situ groundwater state. The reinjection program will also provide valuable information about the hydrogeology and reservoir behaviour of the region.

### 3.4. Decommissioning and Rehabilitation

Decommissioning and site rehabilitation are covered by the drilling and well testing SEO (Gold Hydrogen 2023b) and are summarised below.

Well testing and reinjection materials and equipment would be removed from the well sites following completion of well testing. If the well is to be retained, the wellhead would be fenced and the paved area reduced in size. Final decommissioning and rehabilitation would include:

- placing plugs in wells to isolate different aquifers and hydrogen producing zones and cutting off the wellhead below ground level
- removal of equipment and materials (including temporary pipelines), waste and imported paving material
- restoring original topography and slope of the well site, and redistributing topsoil across the disturbed area to restore original drainage and cropping / grazing potential
- sowing of crop / pasture for additional soil stabilisation.

Further details are provided in the drilling and well testing EIR (Gold Hydrogen 2023a).



## 4. Overview of the Environment

This section provides a broad overview of the environment of the project area and surrounds, to provide supporting context for the discussion in Section 5.1.1. Further detail on specific environmental elements is provided where relevant in Sections 5.2 to 5.8. The existing drilling and well testing EIR (Gold Hydrogen 2023a) also provides a description of the environment more broadly across PEL 687.

The Ramsay wells are located within PEL 687 on Yorke Peninsula. Ramsay-1 itself is located approximately 10 km east of Minlaton, 7 km south of Curramulka and approximately 13 km west of Port Vincent. Ramsay Conservation Park is approximately 7 km to the east of Ramsay-1.

The wells are located in the Yorke Peninsula Council local government area. The area of the wells is traversed by the sealed Port Vincent Road and the sealed Minlaton Road to the south, and several unsealed roads, including Old Port Vincent Road, which is adjacent to Ramsay-1.

The wells are located in an area of gently undulating topography, dominated by cropped paddocks, with scattered native vegetation limited mainly to road reserves and fence lines. The well sites are generally distant from houses, ranging from 600 m – 800 m to the nearest house.

Searches of the central archives<sup>8</sup> for the Ramsay well locations have not identified any registered Aboriginal heritage sites in close proximity to the well locations (refer Section 5.6.2). There are no registered non-Aboriginal heritage sites in the vicinity of the Ramsay wells (DEW 2025).

Yorke Peninsula has a warm summer and cold winter climate, and the region is considered temperate under the Köppen classification (BOM 2023). Mean daily maximum temperature at Minlaton<sup>9</sup> ranges from approximately 15°C in the coolest months (June to September) to 29°C in the hottest months (December to February). Mean daily minimum temperatures range from 7°C in the cooler months to 15°C in the hottest months. Average annual rainfall at Minlaton is 346 mm, with highest rainfall averages occurring during June and July.

Figure 4-1 provides an overview of environmental features of the project area. Indicative photographs of the Ramsay-1, Ramsay-3, Ramsay-4 and Ramsay-5 well locations are provided in Plate 4-1 to Plate 4-4.

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<sup>8</sup> It is noted that the central archives are not an exhaustive record of all Aboriginal sites, objects and remains in the State.

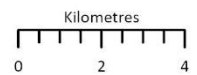
<sup>9</sup> Station # 022031 (Minlaton Aero). Records at Minlaton Aero commenced in 2001. Source: BOM (2025)

Figure 4 1: Environment of Ramsay well locations and surrounds



Legend

- |                          |                |                        |
|--------------------------|----------------|------------------------|
| ● Towns                  | Waterbodies    | Wells                  |
| — Watercourse            | National Parks | ● Ramsay 1             |
| — Minor roads            | PEL 687        | ● Ramsay 2             |
| — State maintained roads |                | ● Ramsay well location |





**Plate 4-1: Ramsay-1 looking north from Old Port Vincent Road**



**Plate 4-2: Ramsay-3 location looking west from adjacent to Port Vincent Road**



**Plate 4-3: Ramsay-4 location looking north towards site**



**Plate 4-4: Ramsay-5 location looking west towards site**



## 5. Environmental Impact Assessment

This section summarises the methodology and results of the environmental impact assessment for the groundwater reinjection activities.

### 5.1. Methodology

The impact assessment method has been developed in accordance with the Environmental Impact Assessment Criteria published under the ER Act (DEM 2024a), using guidance provided in the Environmental Impact Assessment Criteria Guideline (DEM 2024b).

The impact assessment was undertaken using the following steps:

1. **Identifying environmental elements** that could be impacted by the proposed regulated activities (Criteria 1)
2. **Identifying the potential impact events** that could impact elements of the environment during the construction, operation and decommissioning phases (Criteria 2).
3. **Confirming the potential of impact events to occur** (Criteria 3).
4. **Identifying relevant control and management strategies** for each potential impact event, needed to eliminate or otherwise reduce any potential environmental harm to as low as reasonably practicable (part Criteria 4)
5. **Identifying uncertainties and assumptions** associated with the effectiveness of control and management strategies (part Criteria 4)
6. **Assessing environmental significance** of each potential impact event, based on the sensitivity of the receiving environment and the magnitude of potential impacts, considering factors such as the frequency, duration, extent and severity of impacts as well as potential cumulative impacts (Criteria 5).
7. **Developing environmental objectives and assessment criteria** for all potential impacts determined for the elements of the environment. These objectives will be carried through to the SEO (Criteria 6).

The results of the impact assessment were then captured in the impact assessment summary tables provided in Sections 5.2 to 5.8.

The steps followed in the impact assessment are described below.

#### 5.1.1. Identifying environmental elements

Elements of the environment that have the potential to be impacted by the regulated activities were first identified. All phases of the regulated activities were considered including construction, operation, decommissioning and rehabilitation. Table 5-1 lists the elements of the environment that could potentially be affected by the proposed activities and identifies where the potential effects have been addressed in the EIR.



**Table 5-1: Elements of the environment potentially affected by proposed activities**

Environmental element <sup>1</sup>	Potentially affected	Relevant section
Public health and safety	Yes (pipelines)	Section 5.7 Public health and safety
Heritage (Aboriginal and non-Aboriginal)	Yes (pipelines)	Section 5.6 Aboriginal heritage (No non-Aboriginal heritage in or near the project area)
Weeds, pests and plant pathogens	Yes (pipelines)	Section 5.8 Social environment, land use and infrastructure
Soil	Yes (spills/leaks)	Section 5.3 Soil and Shallow Groundwater
Waste	N/A	Covered by drilling and well testing EIR/SEO
Groundwater, including quality and quantity	Yes (re injection)	Section 5.2 Groundwater
Surface water, including quality and quantity	Yes (spills/leaks)	Section 5.4 Surface water
Noise and vibration	N/A	Covered by drilling and well testing EIR/SEO
Air quality	N/A	Covered by drilling and well testing EIR/SEO
Existing land use and infrastructure	Yes (pipelines)	Section 5.8 Social environment, land use and infrastructure
Native fauna	Yes (pipelines)	Section 5.5 Flora, fauna and biodiversity
Native vegetation	Yes (pipelines)	Section 5.5 Flora, fauna and biodiversity
Biodiversity and sensitive ecosystems	Yes (pipelines)	Section 5.5 Flora, fauna and biodiversity
Visual amenity	N/A	Covered by drilling and well testing EIR/SEO

<sup>1</sup> Elements of the environment in this table reflect the listing in the Environmental Impact Assessment Criteria Guideline (DEM, 2024b)

### 5.1.2. Identifying potential impacts

Elements of the environment may be impacted in different ways by the regulated activities. All potential impacts from the regulated activities were identified and defined as potential impact events.

Each potential impact event was characterised by:

- the source of impact, defined as the activities associated with the proposed operation that could reasonably be expected to negatively impact a receptor for the environmental element (considering construction, operation or decommissioning and rehabilitation stages)
- the pathway of impact, defined as the mechanism by which a proposed activity may interfere with environmental elements
- the environmental receptor of impact, defined as the component of the environmental element that may be detrimentally affected by the proposed activity in the absence of control measures.

Any uncertainties in the identification and description of the sources, pathways and environmental receptors as a result of assumptions or knowledge gaps were identified for each potential impact event.



### 5.1.3. Confirming the potential of impact events to occur

For each potential impact event, the occurrence of the source, pathway and environmental receptor within the proposed regulated activities scope and at the proposed location was verified.

Potential impact events for which the full source, pathway and environmental receptor linkage was confirmed were considered as having the potential to occur and relevant control and management measures were then identified.

Potential impact events for which the source, pathway and environmental receptor linkage was incomplete were not considered as having the potential to occur and were not considered further in this environmental impact assessment.

### 5.1.4. Identifying relevant control and management measures

Measures to control and manage potential impact events were identified. The hierarchy of controls approach was adopted consistently with the Environmental Impact Assessment Criteria Guideline (DEM 2024b). Identification of control and management measures considered the following priority of order:

- **Elimination** - measures that eliminate the source of a potential impact event, preventing the impact from occurring.
- **Substitution** - measures that replace the material or process at the source of a potential impact event with a less hazardous one, significantly reducing the likelihood of a potential impact event to occur.
- **Design and engineering (physical) control** - measures that act to separate the source from the pathway and environmental receptor to either:
  - avoid or reduce the likelihood of a potential impact event to occur, or
  - avoid or reduce the consequences of an impact event occurring.
- **Management system control** - measures that implement a procedure to manage the activity at the source of a potential impact event to either:
  - avoid or reduce the likelihood of a potential impact event to occur, or
  - avoid or reduce the consequences of an impact event occurring.

### 5.1.5. Identifying uncertainties and assumptions

Uncertainties and assumptions related to the likely effectiveness of the proposed control and management strategies were identified. This included the assumptions underlying any analysis or modelling undertaken to assess potential impacts and effectiveness of proposed measures.

### 5.1.6. Assessing environmental significance

The level of significance of potential impact events was assessed, considering the following factors outlined in the Environmental Impact Assessment Criteria Guideline (DEM 2024b):

- the level to which a potential impact can be avoided through elimination (prevention)
- the estimated frequency of the potential impact occurring
- the anticipated duration of the potential impact



- the extent of the potential impact
- the severity of the potential impact
- the cumulative effects (if any) of the potential impact when considered in conjunction with other impacts on the same receptor
- the sensitivity of the receiving environment.

To assist in describing potential impacts for each factor listed above, the definitions in Table 5-2 and Table 5-3 were used.

**Table 5-2: Definitions used to describe potential impacts**

Factor		Description
Avoidance		<b>Yes:</b> Impacts can be avoided through the identified controls
		<b>No:</b> Impact cannot be avoided through the identified controls
Magnitude	Frequency	<b>High:</b> Impacts occur frequently or are present throughout the life of the project
		<b>Moderate:</b> Impacts occur several times during the lifespan of activities
		<b>Low:</b> Impacts occur infrequently
		<b>Rare:</b> Impacts not expected or only occur in exceptional circumstances
	Duration	<b>Permanent:</b> Impacts to the environment are permanent and non-reversible
		<b>Long lasting:</b> Impact to the environment persist for a period of years but are reversible
		<b>Short term:</b> impacts of less than a year duration and are reversible
	Extent	<b>Widespread:</b> Impacts occur on a regional scale
		<b>Moderate:</b> Impacts extend beyond the project site and immediate surrounds without occurring on a regional scale
		<b>Localised:</b> Impacts are limited to the project site and immediate surrounds
	Severity	<b>High:</b> Statutory reference values or environmental quality standards are exceeded
		<b>Moderate:</b> Statutory reference values or environmental quality standards are not exceeded but the impact results in an increase in the occurring content/level
		<b>Low:</b> imperceptible or indistinguishable from natural background levels
Cumulative effects		<b>Yes:</b> Receptors are already impacted by similar activities
		<b>Possible:</b> Receptors could be impacted by similar activities depending on the site
		<b>No:</b> Receptors are not already impacted by similar activities
Sensitivity		Refer Table 5-3

### Overall environmental significance

The overall environmental significance of each potential impact event was assessed using a matrix that considered the sensitivity of the receiving environment and the magnitude of the impact (Table 5-5).

Categories for sensitivity and magnitude used in this matrix are defined in Table 5-3 and Table 5-4. (Note: The categories of magnitude consider frequency, duration, extent, severity and cumulative effects, and align with the more detailed definitions provided in Table 5-2 above).

Impacts were considered acceptable if they were in the ‘Negligible’ or ‘Low’ category of environmental significance, while impacts in the ‘Moderate’ category were generally considered acceptable if they



were as low as reasonably practicable (ALARP) following the application of mitigation measures. High and Major impacts would be considered unacceptable necessitating redesign of the regulated activities (however there were no High or Major impacts identified).

Additional commentary providing justification why impacts are considered ALARP for ‘Moderate’ impacts is provided in the impact assessment summary tables in Sections 5.2 to 5.8.

The environmental significance assessment considers any proposed controls or management measures to determine the outcome of the significance assessment.

**Table 5-3: Criteria for sensitivity**

Sensitivity	Description
<b>High</b>	<ul style="list-style-type: none"> <li>The environmental value is protected as a result of Australia’s international commitments</li> <li>The environmental value holds a statutory protection (national parks, etc)</li> <li>The environmental value is intact</li> <li>The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area which is poorly represented in the region, territory, country or the world.</li> <li>It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value.</li> </ul>
<b>Moderate</b>	<ul style="list-style-type: none"> <li>The environmental value is recorded as being important at a regional or local level</li> <li>The environmental value is in a moderate to good condition despite it being exposed to threatening processes.</li> <li>It is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are limited by threatening processes.</li> <li>Threatening processes have reduced its resilience to change.</li> </ul>
<b>Low</b>	<ul style="list-style-type: none"> <li>The environmental value is not listed on any recognised or statutory register.</li> <li>It is in a poor to moderate condition as a result of threatening processes</li> <li>It is abundant and widely distributed or representative examples exists throughout the host systems/areas.</li> <li>There is no detectable response to change, or change does not result in further degradation of the environmental value.</li> </ul>

**Table 5-4: Criteria for magnitude**

Magnitude	Description
<b>High</b>	<p>An impact that is widespread and/or is permanent or long-lasting.</p> <p>An impact that occurs frequently.</p> <p>Statutory reference values or environmental quality standards are exceeded.</p>
<b>Moderate</b>	<p>An impact that has a relatively large scope or is long-lasting.</p> <p>An impact that occurs several times during the lifespan of activities.</p> <p>Statutory reference values or environmental quality standards are not exceeded but the impact results in an increase in the occurring content/level.</p>
<b>Low</b>	<p>An impact with no or little effects on the receptor.</p> <p>The effects have a limited scope and are short-term.</p> <p>An impact that is infrequent.</p> <p>The effect is deemed to be imperceptible or indistinguishable from natural background levels</p>

*\*Note: If one or more of these criteria are exceeded, the magnitude would generally be elevated to the next level.*



**Table 5-5: Significance assessment matrix**

Sensitivity of environmental values	Magnitude of impact		
	High	Moderate	Low
High	Major	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Negligible

### 5.1.7. Developing environmental objectives and assessment criteria

Environmental objectives and assessment criteria were developed for all potential impacts determined through the environmental impact assessment process. Objectives were developed to align with the elements of the environment. These objectives are defined in the impact assessment summary tables provided in Sections 5.2 to 5.8 and will be carried through to the SEO.

Leading performance criteria were also developed for impact events that rely significantly on a control strategy to reduce the potential environmental impact.

### 5.1.8. Summary of impact events and source-pathway-receptor linkage

Table 5-6 summarises the potential impact events that have been identified for the groundwater reinjection activities covered by this EIR and identifies whether they have been confirmed as having a complete source, pathway and environmental receptor linkage.

A detailed assessment of the source, pathway and environmental receptor (SPR) linkage for each of these impact events is provided in Sections 5.2 to 5.8. Where a complete source, pathway and receptor linkage has been identified, the impact event is carried through the full impact assessment process in Sections 5.2 to 5.8.

**Table 5-6: Confirmation of source-pathway-receptor linkage for groundwater reinjection activities**

Potential impact events	SPR Linkage	Comment
<b>Groundwater</b>		
Reinjection results in reduced groundwater quality (increased salinity) that impacts existing groundwater users	No	Very few groundwater bores, at significantly shallower depths than reinjection with vertical separation and hydraulic isolation.
Reinjection results in reduced groundwater quality (increased salinity) in receiving groundwater	Yes	Reinjection will result in localised increase in salinity at over 300m depth in the vicinity of Ramsay-1.
Injection well integrity failure results in increased salinity in shallower aquifers and impact to existing groundwater users	Yes	Unplanned event is extremely unlikely but could result in SPR linkage. Note this is not considered a credible impact event with the controls that will be in place.
<b>Soil and Shallow Groundwater</b>		
Spills of saline water result in deterioration of soil and/or shallow groundwater quality	Yes	Unplanned event could result in SPR linkage.
<b>Surface water</b>		
Spills of saline water result in deterioration of surface water quality	Yes	Unplanned event could result in SPR linkage.



Potential impact events	SPR Linkage	Comment
<b>Flora, fauna and biodiversity</b>		
Vegetation disturbance for pipeline installation or removal results in a loss of native vegetation and biodiversity	Yes	Vegetation clearance expected to be avoided but minor impacts may be unavoidable.
<b>Aboriginal heritage</b>		
Pipeline installation or removal results in damage or loss of Aboriginal heritage	Yes	Unplanned event could result in SPR linkage.
<b>Public health and safety</b>		
Reinjection activities and associated infrastructure (e.g. pressurised piping) increase public safety hazard	Yes	Unplanned event (e.g. pipeline rupture) could result in SPR linkage.
<b>Social environment, land use and infrastructure</b>		
Presence of pipeline disrupts landholder infrastructure or activities	Yes	Potential for minor impact.
Introduction and spread of weed(s), pest(s) and/or pathogen(s) impacts land use or native vegetation	Yes	Unplanned event could result in SPR linkage.



## 5.2. Groundwater

### 5.2.1. Setting the context

Table 5-7 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to groundwater.

**Table 5-7: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Landscape South Australia Act 2019</i> Northern and Yorke Landscape Board Water-Affecting Activities Control Policy	<i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)</i> <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)</i> EPA Guideline 3 - <i>Establishing baseline groundwater quality</i>		Groundwater users Groundwater value

### 5.2.2. Existing environment

This section provides a summary of the hydrogeologic setting of Ramsay-1. Further detail is provided in the hydrogeological risk assessment (Appendix A) which has been prepared by Water Technology to assess the risk of the reinjection activities.

#### Existing wells and groundwater use near Ramsay-1

There are a limited number of current and historical wells in close proximity to Ramsay-1, with most wells in the broader area concentrated around Minlaton or scattered to the north and east of Ramsay-1 (see Figure 5-1).

The vast majority of water wells in the region were drilled less than 100 m deep. Only seven of the wells shown in Figure 5-1 are greater than 100 m deep and the deepest of those is 160 m. Within a 2 km radius of Ramsay-1 there are only five water wells: two are operational and were originally drilled to 68.58 m and 96.01 m, although the deeper well has since collapsed to 4.88 m; one is recorded as rehabilitated to zero depth; one was abandoned in 1995; and one has unknown status but was only drilled to 7.62 m depth.

Consequently, all existing groundwater wells in the area, especially those within 2 km of Ramsay-1, have significant vertical disconnection from the Parara Limestone at 218 m depth (the start of the slotted casing in Ramsay-1), the high hydraulic conductivity zone at 316 m depth in Ramsay-1, and all deeper formations.

Most wells in the area are used for stock watering purposes even though they generally have poor water quality. Salinity (as Total Dissolved Solids, TDS) is often between 5,000 mg/L and 27,000 mg/L. The closest wells to Ramsay-1 report salinities (as TDS) of 8,069 mg/L (well 6428-396, 1 km east of Ramsay-1), 5,103 mg/L (well 6428-388, 1.2 km north-east of Ramsay-1) and 1,754 mg/L (well 6428-397, 1.4 km east of Ramsay-1, noting that this well also has a historical salinity record of 9,192 mg/L) (WaterConnect 2025). Gold Hydrogen sampled groundwater in April 2025 from the existing well located 780 m south-west of Ramsay-3 and approximately 1.2 km to the north-east of Ramsay-1

(understood to be well number 6428-388<sup>10</sup>) and recorded salinity (as TDS) of 5,460-5,680 mg/L. Gold Hydrogen also plans to undertake further groundwater sampling, as discussed in Section 5.2.4.

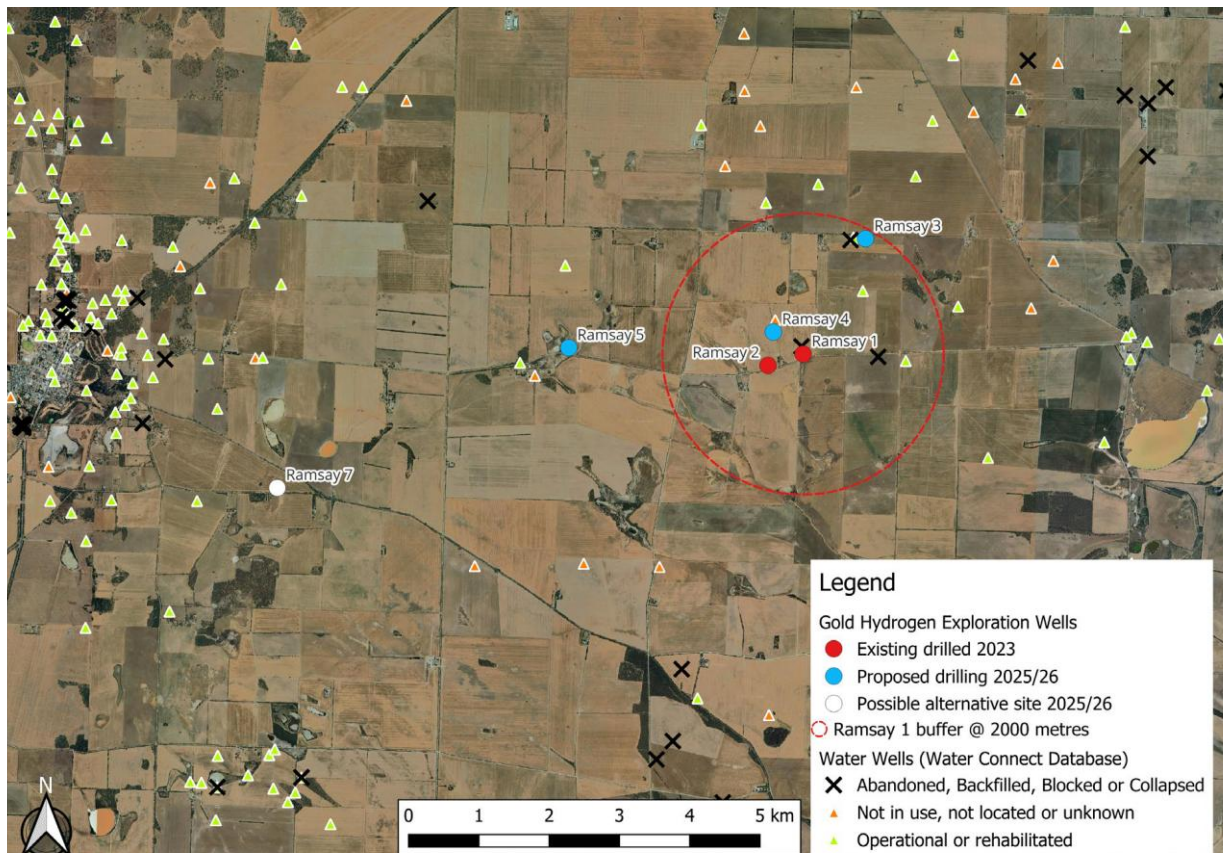


Figure 5-1: Location of exploration wells and existing water wells (Source: Water Technology 2026)

### Ramsay-1 hydrogeology and hydraulics

Downhole geology of Ramsay-1 is shown in Figure 5-2. This figure also shows the completion of the Ramsay-1 well, which is cased and cemented to 218 m and has a slotted liner from 218 m to 1005 m. The slotted liner means that the groundwater reinjected into Ramsay-1 will be in contact with all formations below 218 m depth (as noted in Section 3.3.2).

At the time of drilling Ramsay-1 there was complete loss of circulation (i.e. no return of drilling mud to the surface) at 316 m depth in the Parara Limestone, This was later identified to be a fracture/dissolution zone of very high transmissivity – to the extent that injection testing could not raise the standing water level in the well. This is referred to as the ‘high hydraulic conductivity zone’ throughout this document and as noted in Section 3.3.2, it is expected that reinjection will result in preferential flow into this zone.

Groundwater is present in all formations in Ramsay-1 from a depth of approximately 67 m and throughout the profile to the basement.

Routine core analysis on sidewall cores collected from Ramsay-1 (predominantly in non-reservoir and non-fractured sections) has revealed extremely low permeability throughout the profile and particularly in the uppermost 630 m. Two cores from just above the high hydraulic conductivity zone

<sup>10</sup> Coordinates of the well sampled are 748862m E, 6150473m N which is 200m west of the location recorded in the WaterConnect database

at 316 m depth returned permeabilities that are characteristic of very tight, low-permeability aquitards (see Appendix A Table 3-1 for details).

Whilst there are some faults mapped in the area their ability to provide hydraulic connection between deeper strata and shallow aquifers is currently unknown. The presence of a hydrostatic head gradient throughout most of the profile at Ramsay-2 suggests there may be some degree of connection, however the salinity profile is more characteristic of a diffusion dominated system (at least in the vertical direction). The latter is an observation of the natural (i.e. unperturbed) hydrochemical conditions and does not discount the possibility of vertical advective flow under stressed (e.g. reinjection) conditions.

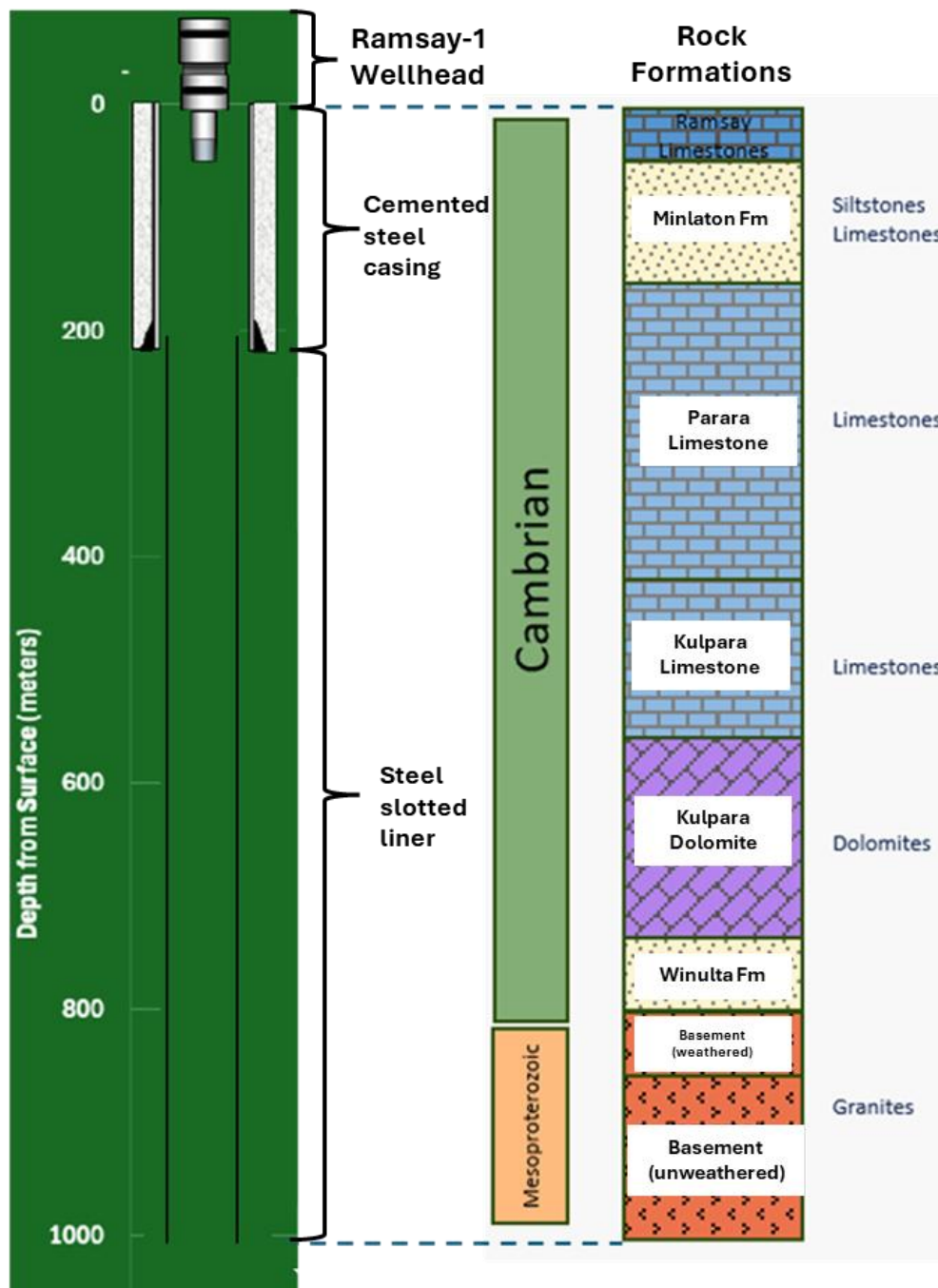


Figure 5-2: Ramsay-1 well completion and downhole geology



## Ramsay-1 water quality

### Salinity

Groundwater exhibits a strong gradient of increasing salinity with depth, as shown in Table 5-8 (for the Ramsay-2 well). Similar information is not available for Ramsay-1 as the well is open hole from 218 – 1005 m depth. However, it is expected that Ramsay-1 and the new wells to be drilled and tested will exhibit similar vertical trends in salinity given their close proximity and they will be drilled to similar depths in the same geological formations.

The salinity of groundwater in the formations that will be in contact with reinjected groundwater (including the zone at 316 m depth where reinjected water is expected to preferentially flow) means that it has limited potential for use. Sheep are the only livestock that could tolerate salinity of around 10,000 mg/L and water quality guidelines (ANZECC/ARMCANZ 2000) indicate that this salinity would result in a decline in condition (unless lush green feed was available).

**Table 5-8: Groundwater salinity in the Ramsay-2 well**

Zone	Perforation interval (m)	Salinity (mg/L)
Zone 8	194 - 200m	8,123
Zone 7	286 - 292m	9,386
Zone 6	343.5 – 349.5m	10,650
Zone 5	384 - 387m	12,455
Zone 4	529.5 – 532.5m	N/A
Zone 3	608 - 611m, 639.5 – 645.5m	97,470
Zone 2	710.5 – 713.5m, 748 - 754m	92,055
Zone 1	1002 - 1008m	126,350

### Groundwater chemistry and metal concentrations

Samples taken from Ramsay-2 in March-April 2024 (which are considered the most representative of formation waters across the site) indicate that the ambient groundwater at the depths tested (approximately 200 m to 1000 m) shows no clear trend of increasing concentration with depth for heavy metal concentrations.

Water quality exceeds trigger levels for livestock drinking water (defined in ANZECC/ARMCANZ 2000) for several analytes at various depths, including molybdenum at a similar depths to the high hydraulic conductivity zone at 316 m. The concentrations of many analytes are also at least one to two orders of magnitude higher than guideline values for aquaculture. Appendix A for provides further detailed analyses and discussion.

### Groundwater resource value

The available groundwater salinity and chemistry data indicate that the groundwater below the cemented steel casing in Ramsay-1 has limited value as a groundwater resource, due to its depth and poor water quality (which would require treatment before use).



### 5.2.3. Impact events

The impact events that have been identified as relevant to groundwater are<sup>11</sup>:

- Reinjection results in reduced groundwater quality (increased salinity) that impacts existing groundwater users
- Reinjection results in reduced groundwater quality (increased salinity) in receiving groundwater
- Injection well integrity failure in results in increased salinity in shallower aquifers and impact to existing groundwater users.

The potential for spills to impact very shallow groundwater is dealt with in Section 5.3.

### 5.2.4. Assessment of impacts

The impact assessment detailed in Table 5-9 to Table 5-11 indicates that the significance of the potential impacts is in the **low** category. Further discussion is provided below.

#### Impact to existing groundwater users

Groundwater reinjection in Ramsay-1 is not expected to impact existing groundwater users. The hydrogeological risk assessment (Appendix A) concludes that the likelihood of the proposed reinjection impacting shallow aquifers (e.g. less than 100 m depth) is negligible and the consequence of such impacts would also be low. The key reasons for this conclusion are:

- There are very few existing groundwater wells in the vicinity of Ramsay-1, and all operational wells are significantly less than 100 m depth.
- The vertical distance and the low permeability of the intervening formations means that all groundwater users have significant vertical disconnection from the formations in contact with reinjected groundwater (and particularly from the high hydraulic conductivity zone at 316 m where reinjected groundwater is expected to preferentially flow).
- The low permeability throughout the profile also means that any potentiometric head<sup>12</sup> increases from reinjection will not impact the shallow water table aquifers.

Table 5-9 presents the results of the impact assessment for this impact event. Although a source-pathway-receptor linkage is not confirmed, the impact assessment has been carried through the full process (i.e. identification of relevant control and management measures, objectives/criteria and impact significance) as the absence of an SPR linkage is based on limited data from historical exploration wells, Ramsay-1 and 2 wells, 2D seismic survey and the WaterConnect groundwater well database.

A groundwater monitoring program will also be implemented, as discussed in Section 3.3.4.

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<sup>11</sup> Impact to the marine environment is not a credible impact event and has not been considered here. Based on the assessment in Appendix A, reinjected water would not reach St Vincent Gulf for tens to hundreds of thousands of years (if ever) due to very low hydraulic gradients and significant depth and even then, any very slow seepage would be dwarfed by dilution in tidal currents.

<sup>12</sup> Potentiometric head is the total head/pressure of groundwater, defined by the height (or 'head') to which water will rise in a well. A potentiometric water table surface map is provided at Figure 5-1 in Appendix A.



### Impact to receiving groundwater

The proposed reinjection will not have a significant impact on the value of receiving groundwater. The hydrogeological risk assessment (Appendix A) concludes that while there will be a localised increase in salinity at 316 m depth, reinjection of higher salinity water during the exploration well testing would not result in a significant loss of value. The key reasons for this conclusion are:

- The receiving water in Ramsay-1 is not used as a groundwater resource and has limited value due to its significant depth and poor water quality, as discussed in Section 5.2.2.
- The radius of influence of injected water is small. If it is assumed all reinjected groundwater flows into the high hydraulic conductivity zone at 316 m, the maximum radius of water quality impact would be in the order of 600 m to 1,000 m for three well tests. This radius of influence would be further reduced if there is additional preferential flow to other fractured and/or karstic zones within Ramsay-1.
- Any biocide in the reinjected groundwater is expected to degrade naturally and be diluted through dispersion in the aquifer, thus presenting a very low risk to the groundwater resource and its intrinsic value (which is characterised by poor water quality). Use of biocide will also prevent impacts to the receiving formation from introduction of microbiota.

Surface and downhole monitoring of reinjection will be undertaken to monitor injection rates, volumes, pressures and assess flows into receiving formations, and a groundwater monitoring program will also be implemented, as discussed in Section 3.3.4.

### Injection well integrity failure

Controls that will be in place, including well design and construction, and monitoring and control of reinjection pressures, will ensure that well integrity failure during reinjection is not a credible impact event. The impact assessment summarised in Table 5-11 indicates that the significance of this potential impact to the environment is low.



**Table 5-9: Environmental impact and significance assessment – Impact ID GRO01**

Groundwater: Impact ID GRO01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Reinjection results in reduced groundwater quality (increased salinity) that impacts existing groundwater users	Reinjection	Reinjected groundwater	Groundwater flow through formations above reinjection zone	Value of groundwater in shallower aquifers Groundwater users	No SPR linkage, however minor uncertainty as hydrogeological understanding and vertical disconnection of shallower aquifers is based on limited data from historical exploration wells, Ramsay-1 and 2 wells, 2D seismic and groundwater well database	Low sensitivity if assumptions are incorrect. Groundwater use in the vicinity of Ramsay-1 is very limited and from much shallower depths. Very few groundwater wells within the potential radius of impact if assumptions regarding vertical disconnection of shallow aquifers were incorrect.	No. However, assessment carried through as absence of SPR linkage based on limited information
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>Ramsay-1 reinjection well cased and cemented to 218 m depth preventing groundwater reinjection to shallower aquifers</li> <li>Well logs and statutory well integrity requirements during operations demonstrate casing and cement integrity</li> <li>Low permeability formations above reinjection depths restrict upwards movement of reinjected water</li> <li>Injectivity test conducted prior to groundwater reinjection program to gather data on formation injectivity parameters including formation integrity, injectivity rates and pressures</li> <li>Maximum injection pressure controlled to prevent fracture stimulation and potentially compromising integrity of reservoirs and confining layers</li> <li>Emergency shut-down systems set to prevent reinjection exceeding maximum injection pressure</li> <li>Pressure safety valve installed near the wellhead</li> <li>Surface monitoring of injection rates, volumes and pressures</li> <li>Downhole monitoring (including a downhole pressure gauge and DTS and DAS in the well) to assess flow contribution, micro-seismic events and well integrity</li> </ul>					Moderate to high certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low	



Control Measures	Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions
<ul style="list-style-type: none"> <li>Groundwater monitoring program implemented including landholder bores (subject to landholder permission) and two new groundwater monitoring bores. Monitoring program design considers EPA Guideline 3 - <i>Establishing baseline groundwater quality</i> and adopts elements where appropriate.</li> <li>Reinjection undertaken in accordance with water affecting activity permit conditions</li> </ul>		

SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No impact to existing groundwater users and the value of groundwater resources	<p>Records of sampling undertaken in accordance with groundwater monitoring program demonstrate no adverse impact to water quality in aquifers accessed by groundwater users (e.g. less than 100 m depth) as a result of groundwater reinjection activities.</p> <p>Well integrity monitoring program (e.g. through well logs or pressure measurements / testing) demonstrate appropriate barriers exist to protect aquifer systems above the Ramsay-1 surface casing shoe at 218 m.</p> <p>Reinjection activities undertaken in accordance with water affecting activities permit under the <i>Landscape South Australia Act 2019</i></p>	<p>Monitoring of groundwater reinjection demonstrates maximum injection pressure not exceeded.</p> <p>Downhole monitoring of reinjection demonstrates flow to formations below depth of the Ramsay-1 surface casing shoe at 218 m.</p> <p>If well integrity monitoring identifies potential issues, risk assessment undertaken to identify hazards / scenarios, and mitigation controls implemented where appropriate to reduce or monitor risk.</p>

Environmental significance assessment		Environmental significance assessment outcome
Avoidance	Yes. Reinjection at depth is expected to avoid any impact to aquifers accessed by groundwater users	Low (refer to Table 5-5)
Frequency	Rare. Likelihood of impacting shallow aquifers is negligible.	
Duration	Long lasting (if assumptions were incorrect and reinjected groundwater reached shallow aquifers).	
Extent	Localised (if assumptions were incorrect and reinjected groundwater reached shallow aquifers).	
Severity	Moderate (if assumptions were incorrect and reinjected groundwater reached shallow aquifers).	
Cumulative effects	No	
Sensitivity	Low. Groundwater use near Ramsay-1 is very limited and quality is relatively low.	



**Table 5-10: Environmental impact and significance assessment – Impact ID GRO02**

Groundwater: Impact GRO02							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Reinjection results in reduced groundwater quality (increased salinity) in receiving groundwater	Reinjection	Reinjected groundwater	Lateral flow through permeable formations	Groundwater value of receiving aquifers	Minor uncertainty, as understanding of hydrogeology and value of receiving groundwater is based on limited data from Ramsay-1 and 2 wells and 2D seismic	Low sensitivity if assumptions are incorrect. If the preferential flow to the high hydraulic conductivity zone at 316 m does not occur (e.g. if there are losses to other fractured and/or karstic zones) impacts may reduce.	Yes. Groundwater with higher salinity than receiving groundwater will be reinjected
Control Measures					Uncertainties and assumptions (Control Measures)	Sensitivity to Change of assumptions	
<ul style="list-style-type: none"> <li>Injectivity test conducted prior to groundwater reinjection program to gather data on formation injectivity parameters including formation integrity, injectivity rates and pressures</li> <li>Maximum injection pressure controlled to prevent fracture stimulation and potentially compromising integrity of reservoirs and confining layers</li> <li>Exposure to the atmosphere minimised as far as practicable for groundwater to be re-injected. Water treated with biocide prior to reinjection.</li> <li>Biocide selection to minimise potential impact on receiving groundwater (e.g. readily degradable)</li> <li>Compatibility studies regarding water chemistry conducted prior to injection</li> <li>Filtering of water to promote efficient injection into formation</li> <li>Frequent quality testing of injection waters</li> <li>Downhole monitoring (including a downhole pressure gauge and DTS and DAS in the well) to assess flow contribution, micro-seismic events and well integrity</li> <li>Groundwater monitoring program implemented including landholder bores (subject to landholder permission) and two new groundwater monitoring bores</li> <li>Reinjection undertaken in accordance with water affecting activity permit conditions</li> </ul>					Moderate to high certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low.	



SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No impact to existing groundwater users and the value of groundwater resources	Records of well integrity monitoring program (e.g. through well logs or pressure measurements / testing) demonstrate appropriate barriers exist to protect aquifer systems above the Ramsay-1 surface casing shoe at 218 m.  Reinjection activities undertaken in accordance with water affecting activities permit under the <i>Landscape South Australia Act 2019</i>	Monitoring of groundwater reinjection demonstrates maximum injection pressure not exceeded.  Downhole monitoring of reinjection demonstrates flow to formations below depth of the Ramsay-1 surface casing shoe at 218 m.  If well integrity monitoring identifies potential issues, risk assessment undertaken to identify hazards / scenarios, and mitigation controls implemented where appropriate to reduce or monitor risk.
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	No. Groundwater with higher salinity than receiving groundwater will be reinjected.		Low (refer to Table 5-5)  Localised changes to groundwater quality will not result in a significant loss of value.
Frequency	High. Localised increase in salinity will occur	Overall magnitude is Moderate (refer Table 5-4).	
Duration	Long lasting		
Extent	Localised		
Severity	Moderate. Salinity in the receiving groundwater is likely to increase but this will not result in a significant loss of value.		
Cumulative effects	No		
Sensitivity	Low. Receiving groundwater has very limited value due to its significant depth and poor water quality.		



**Table 5-11: Environmental impact and significance assessment – Impact ID GRO03**

Groundwater: Impact ID GRO03							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Injection well integrity failure results in increased salinity in shallower aquifers and impact to existing groundwater users	Reinjection	Reinjected groundwater	Well integrity failure	Value of groundwater in shallower aquifers Groundwater users	SPR linkage assumes there is potential for a well integrity failure during reinjection (which is extremely unlikely)	If well integrity failure occurred, it could result in impact to shallower aquifers	Yes. Unplanned event is extremely unlikely but could result in SPR linkage. Note: This is not considered a credible impact event with the controls that will be in place
Control Measures					Uncertainties and assumptions (Control Measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>• Activities performed in accordance with applicable industry and regulatory standards.</li> <li>• Well logs and statutory well integrity requirements during operations demonstrate casing and cement integrity</li> <li>• Injectivity test conducted prior to groundwater reinjection program to gather data on formation injectivity parameters including formation integrity, injectivity rates and pressures</li> <li>• Maximum injection pressure controlled to avoid impact to casing and cement integrity</li> <li>• Emergency shut-down systems set to prevent reinjection exceeding maximum injection pressure</li> <li>• Pressure safety valve installed near the wellhead</li> <li>• Surface monitoring of injection rates, volumes and pressures</li> <li>• Downhole monitoring (including a downhole pressure gauge and DTS and DAS in the well) to assess flow contribution, micro-seismic events and well integrity</li> <li>• Well design and reinjection activities in accordance with Drilling and Testing EIR, including:               <ul style="list-style-type: none"> <li>○ Well designed to meet pressure, temperature, operational stresses and loads.</li> <li>○ Design of the well and well test considers the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the operations.</li> <li>○ Specialist metallurgical advice sought to ensure that equipment and materials are not at risk of failure due to exposure to a potential hydrogen environment during testing.</li> </ul> </li> </ul>					High certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low	



Control Measures		Uncertainties and assumptions (Control Measures)	Sensitivity to change of assumptions
<ul style="list-style-type: none"> <li>○ Monitoring programs implemented (e.g. through well logs or pressure measurements / testing) to aid in the assessment of wellbore barrier conditions during drilling, completion and well testing activities where appropriate.</li> <li>○ Where monitoring identifies potential issues during drilling activities, risk assessment undertaken to identify hazards / scenarios and propose recommendations and mitigation controls where appropriate to reduce or monitor risk.</li> <li>○ Emergency response plan in place and drills conducted.</li> <li>○ Emergency response procedures included in staff training</li> </ul>			
SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No impact to existing groundwater users and the value of groundwater resources	Records of well integrity monitoring program (e.g. through well logs or pressure measurements / testing) demonstrate appropriate barriers exist to protect aquifer systems above the Ramsay-1 surface casing shoe at 218 m.	Monitoring of groundwater reinjection demonstrates maximum injection pressure not exceeded. Downhole monitoring of reinjection demonstrates flow to formations below depth of the Ramsay-1 surface casing shoe at 218 m.
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	Yes. Design and engineering controls, and management system controls are put in place to avoid loss of well integrity.		Low (refer to Table 5-5)
Frequency	Rare		
Duration	Long lasting		
Extent	Localised		
Severity	Moderate		
Cumulative effects	No		
Sensitivity	Low. Groundwater use near Ramsay-1 is very limited and quality is relatively low.		



## 5.3. Soil and Shallow Groundwater

### 5.3.1. Setting the context

Table 5-12 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to soil and very shallow groundwater.

**Table 5-12: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Landscape South Australia Act 2019</i>	<i>AS/NZS 4130 Polyethylene (PE) pipes for pressure applications</i> <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)</i> <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)</i> <i>National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013 (Site Contamination NEPM))</i>		Soil quality Shallow groundwater quality Land use Native vegetation

### 5.3.2. Existing environment

The project area is within the Stansbury Scrub land system, which is characterised by landscapes consist of undulating to gently undulating rises and plains, and some drainage depressions, saline depressions, and small salt lakes (DEWNR, n.d.). Soils within this area (in the Yorketown IBRA Association) are described as reddish calcareous loams, grey calcareous loams, brownish sands, sandy pedal mottled-yellow duplex soils, whitish calcareous sands (DEW 2013, Laut et al. 1977).

The Ramsay well locations are in an area of gently undulating topography. Soils at the well sites are generally grey-brown sandy loam.

The depth to shallow groundwater is mapped as over 5-20 m (DEW 2016). Drilling at the Ramsay Oil Bore 1 and Ramsay-1 and Ramsay-2 wells encountered groundwater at over 40 m depth. Ramsay-5 is adjacent to a small swampy depression that appears to be surface water fed and is vegetated with salt-tolerant plants (including samphire, *Tecticornia* spp.) which suggests there is potential for the presence of localised very shallow, saline groundwater in the immediate vicinity.

### 5.3.3. Impact events

The impact events relevant to soil and shallow groundwater are:

- Spills of saline water result in deterioration of soil and/or shallow groundwater quality.

### 5.3.4. Assessment of impacts

The impact assessment detailed in Table 5-13 indicates that the significance of the potential impact from a spill of saline water is in the **low** category. If a spill occurred, impacts would generally be localised and short term and readily manageable using standard control measures.



**Table 5-13: Environmental impact and significance assessment – Impact ID SOI01**

Soil and shallow groundwater: Impact ID SOI01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Spills of saline water result in deterioration of soil and/or shallow groundwater quality	Reinjection	Spill or leak from tanks or pipelines	Spill or leak direct to ground Percolation through soil (to very shallow groundwater)	Soil quality Shallow groundwater quality Land use Native vegetation	Uncertainty in extent of impact, if a spill occurs, however there would be some impact to soil at the site. Groundwater depths suggest most spills would not reach shallow groundwater.	Larger spills or leaks could impact a greater area.	Yes. Unplanned event could result in SPR linkage.
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>Groundwater storage, transport and reinjection is designed and implemented in accordance with applicable industry and regulatory standards (e.g. AS/NZS 4130 Polyethylene (PE) pipes for pressure applications).</li> <li>Pipeline designed to meet operating pressure and conditions (e.g. suitable for saline service with electrofusion welded joints and stainless tie-in spools and fittings at pump and well interfaces)</li> <li>Use of reeled (rather than strung and welded) pipelines to reduce connections and limit exposure to leak areas</li> <li>Pipeline equipped with isolation valves, air/vacuum release valves at high points, low point drains and leak detection.</li> <li>Piping and tanks to be inspected and integrity verified prior to use</li> <li>Equipment regularly inspected for leaks and maintain in good working order.</li> <li>Reinjection activities monitored at all times with personnel on site where required, subject to testing requirements and risk assessment.</li> <li>Spills or leaks are immediately contained, reported (both internally and to State regulators as required) and clean up actions initiated.</li> <li>Spills that cannot be immediately contained, cleaned up and/or delineated will be assessed and remediated in consultation with DEM and in accordance with relevant standards and guidelines (e.g. Site Contamination NEPM and SA EPA guidelines).</li> </ul>					High certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low	



Control Measures		Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions
<ul style="list-style-type: none"> <li>Areas affected by a spill are fenced if threat is posed to livestock or native fauna. Consultation to be undertaken with landholders to ensure appropriate practices are developed and implemented to mitigate risks.</li> </ul>			
SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No significant changes in soil quality as a result of activities	<p>Records of audits/inspections demonstrate that any escape of saline groundwater is immediately contained, and clean-up actions initiated.</p> <p>Records of audits/inspections and/or incident management system demonstrate no adverse impact to land use or native vegetation and native fauna outside well sites due to an escape of saline water.</p>	<p>Inspections demonstrate no evidence of spills or leaks of as a result of activities.</p> <p>Personnel trained in spill response procedures.</p> <p>Appropriate spill response equipment is available on site.</p>
	No significant adverse impacts to surface water and shallow groundwater quality	Records of audits/inspections and/or incident management system demonstrate no unauthorised discharge or escape of saline groundwater to surface and/or groundwater.	<p>Inspections demonstrate no evidence of spills or leaks of as a result of activities.</p> <p>Personnel trained in spill response procedures.</p> <p>Appropriate spill response equipment is available on site.</p>
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	No. Design and engineering controls, and management system controls are put in place to avoid spills, however spills may occur during exceptional circumstances.		Low (refer to Table 5-5)
Frequency	Rare		
Duration	Short term. Soil salinity would be elevated following a spill but is expected to recover as salts are flushed through the soil profile.		
Extent	Localised		
Severity	Moderate		
Cumulative effects	No		
Sensitivity	Low to moderate. Ramsay sites are located in cropping land which would be sensitive to spills of saline water, however saline soils and small salt lakes are a common feature in the area.		



## 5.4. Surface water

### 5.4.1. Setting the context

Table 5-14 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to surface water.

**Table 5-14: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Landscape South Australia Act 2019</i>	<i>AS/NZS 4130 Polyethylene (PE) pipes for pressure applications</i> <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)</i> <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)</i> National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013 (Site Contamination NEPM))		Surface water quality

### 5.4.2. Existing environment

There are no significant surface water features present at the Ramsay well locations. As noted in Section 5.3.2 above, a low-lying area (vegetated with samphire shrubland) is present adjacent to Ramsay-5, which may be subject to shallow inundation during winter. There is also small salt lake located approximately 100 m west of the Ramsay-5 site.

### 5.4.3. Impact events

The impact events relevant to surface water are:

- Spills of saline water result in deterioration of surface water quality.

### 5.4.4. Assessment of impacts

The impact assessment detailed in Table 5-15 indicates that the significance of the potential impact from a spill of saline water is in the **low** category. There are limited surface water features in the vicinity of the wells, and these have reduced sensitivity due to their saline nature. If a spill occurred, impacts would generally be localised and short term.



**Table 5-15: Environmental impact and significance assessment – Impact ID SUR01**

Surface water: Impact ID SUR01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Spills of saline water result in deterioration of surface water quality	Reinjection	Spill or leak from tanks or pipelines	Spill or leak direct to surface water or overland flow from spill or leak	Surface water quality	Uncertainty in whether spill would reach surface water.	Most well locations and potential pipeline routes are not close to surface water features, which reduces the likelihood of spills reaching surface water	Yes. Unplanned event could result in SPR linkage.
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>Groundwater storage, transport and reinjection is designed and implemented in accordance with applicable industry and regulatory standards (e.g. AS/NZS 4130 Polyethylene (PE) pipes for pressure applications).</li> <li>Pipeline designed to meet operating pressure and conditions (e.g. suitable for saline service with electrofusion welded joints and stainless tie-in spools and fittings at pump and well interfaces)</li> <li>Use of reeled (rather than strung and welded) pipelines to reduce connections and limit exposure to leak areas</li> <li>Pipeline equipped with isolation valves, air/vacuum release valves at high points, low-point drains and leak detection.</li> <li>Piping and tanks to be inspected and integrity verified prior to use</li> <li>Equipment regularly inspected for leaks and maintain in good working order.</li> <li>Reinjection activities monitored at all times with personnel on site where required, subject to testing requirements and risk assessment.</li> <li>Spills or leaks are immediately contained, reported (both internally and to State regulators as required) and clean up actions initiated.</li> <li>Spills that cannot be immediately contained, cleaned up and/or delineated will be assessed and remediated in consultation with DEM and in accordance with relevant standards and guidelines (e.g. Site Contamination NEPM and SA EPA guidelines).</li> </ul>					High certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low	



Control Measures	Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions
Areas affected by a spill are fenced if threat is posed to livestock or native fauna. Consultation to be undertaken with landholders to ensure appropriate practices are developed and implemented to mitigate risks.		

SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No significant adverse impacts to surface water and shallow groundwater quality	Records of audits/inspections and/or incident management system demonstrate no unauthorised discharge or escape of saline groundwater to surface and/or groundwater.	<p>Inspections demonstrate no evidence of spills or leaks of as a result of activities.</p> <p>Personnel trained in spill response procedures.</p> <p>Appropriate spill response equipment is available on site.</p>

Environmental significance assessment		Environmental significance assessment outcome
Avoidance	No. Design and engineering controls, and management system controls are put in place to avoid spills, however spills may occur during exceptional circumstances. The limited number of surface water features and spill response procedures limit the possibility of saline water reaching surface water, however complete avoidance may not be possible.	Low (refer to Table 5-5)
Frequency	Rare	
Duration	Short-term	
Extent	Localised	
Severity	Moderate	
Cumulative effects	No	
Sensitivity	Low. Sensitivity to spill of saline water is reduced due to saline nature of surface water features and abundance and wide distribution of saline surface water features in the region.	

## 5.5. Flora, fauna and biodiversity

### 5.5.1. Setting the context

Table 5-16 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to flora, fauna and biodiversity.

**Table 5-16: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Native Vegetation Act 1991</i> <i>National Parks and Wildlife Act 1972</i> <i>Landscape South Australia Act 2019</i> <i>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</i>	South Australia’s Biosecurity Policy 2020-2023 Australian Weeds Strategy 2017-2027		Native vegetation Native flora and fauna species

### 5.5.2. Existing environment

The well sites are located in cropped paddocks which were planted with crops (wheat/barley or legumes) at the time of site inspections prior to well drilling in mid-2025. Native vegetation is generally limited to adjacent road reserves and fence lines, which predominantly support narrow strips of degraded mallee woodland dominated by mallee (*Eucalyptus* spp.) and Teatree (*Melaleuca* spp.) (see Plate 5-1).

There is no vegetation mapped within the ‘State Significant Vegetation Overlay’ or Heritage Agreements at or near the well locations.

There is no significant fauna habitat present at the well locations. The roadside vegetation adjacent to the well locations is generally narrow and degraded and presents limited fauna habitat.



**Plate 5-1: Vegetation on Cook Road, looking north from Old Port Vincent Road (Source: Google Earth)**



### 5.5.3. Impact events

The impact event relevant to flora, fauna and biodiversity is:

- Vegetation disturbance for pipeline installation or removal results in a loss of native vegetation and biodiversity.

The potential impact from introduction or spread of weeds is dealt with in Section 5.8.

### 5.5.4. Assessment of impacts

The impact assessment detailed in the Table 5-17 indicates that the significance of the potential impact to native vegetation and biodiversity is generally in the **low** category.

It is expected that there will be little or no native vegetation impact from pipeline installation or removal. Potential pipeline alignments are likely to be able to avoid impacting native vegetation. Cook Road, which would need to be crossed by a pipeline from Ramsay-5, has a narrow strip of degraded mallee in the roadside, however there are large gaps where it could be crossed with little or no impact to native vegetation (see Plate 5-1). If impacts to vegetation on any pipeline routes are unavoidable, they would be very localised and small scale and readily manageable using standard control measures.

As noted in the existing drilling and well testing EIR (Gold Hydrogen 2023a), activities in areas of high quality or significant remnant vegetation would be avoided.



**Table 5-17: Environmental impact and significance assessment – Impact ID FLO01**

Flora, fauna and biodiversity: Impact ID FLO01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Vegetation disturbance for pipeline installation or removal results in a loss of native vegetation and biodiversity	Reinjection	Clearance of native vegetation during pipeline installation or removal	Direct disturbance	Native vegetation Native flora and fauna species	Uncertainty in whether there will be an impact as native vegetation is likely to be avoided.	SPR linkage could be removed by route selection	Yes. Minor impacts to native vegetation may be unavoidable
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>Appropriately trained and experienced personnel have assessed or scouted proposed pipeline locations to identify native vegetation and flag significant (or rare, vulnerable or endangered) species and communities.</li> <li>Native vegetation clearance avoided or minimised by locating pipeline routes appropriately.</li> <li>Vegetation is trimmed rather than removed where possible.</li> <li>Areas of high quality or significant<sup>13</sup> remnant vegetation or Heritage Agreement Areas are avoided.</li> <li>Areas of low-quality native vegetation are avoided unless there are no viable alternatives (e.g. use of adjacent cleared areas).</li> <li>Activities are not carried out in parks or reserves established under the National Parks and Wildlife Act.</li> <li>Fauna mortality (if it occurs) to be captured by incident reporting system with advice from an ecologist if required.</li> <li>Sites with native vegetation are rehabilitated in consultation with DEM, DEW and other relevant stakeholders. If rehabilitation is not carried out within 12 months, 'significant environmental benefit' obligations satisfied, in accordance with the <i>Guide for a Significant Environmental Benefit for the Clearance of Native Vegetation Associated with the Minerals and Petroleum Industry</i> (NVC 2025)<sup>14</sup></li> </ul>					High certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low	

<sup>13</sup> Significant in this context includes listed plant species, listed communities or important fauna habitat

<sup>14</sup> NVC (2025) indicates that Regulation 14 (Clearance for mining and petroleum activities) would apply, and consequently a payment into the Native Vegetation Fund of an amount considered by the Council to be sufficient to achieve a 'significant environmental benefit' (SEB) or an on-ground SEB would be required



SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No clearance of native vegetation or disturbance to native fauna unless prior approval under the relevant legislation is obtained	<p>Ecological assessment by appropriately trained and experienced personnel undertaken to determine biodiversity values and to identify and avoid any areas of sensitivity or 'no-go' areas.</p> <p>If vegetation clearance is required, records demonstrate that necessary approvals under the Native Vegetation Act have been obtained and any 'significant environmental benefit' obligation has been satisfied in accordance with NVC (2025).</p> <p>Records (e.g. ecological assessments) demonstrate no listed threatened and/or migratory species will be significantly impacted (unless appropriate approval has been obtained) and that high quality or significant<sup>15</sup> remnant vegetation will not be cleared.</p> <p>Records of audits/inspections demonstrate there has been no unauthorised clearing of native vegetation.</p> <p>Records (e.g. ecological assessments) demonstrate that disturbance to fauna has been considered and measures implemented to minimise it where appropriate.</p>	Pipeline route selection and micro-siting avoids or minimises native vegetation impacts and avoids any threatened flora species.
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	Potentially, however there may be locations where minor impact to degraded vegetation is unavoidable.		Low (refer to Table 5-5)
Frequency	Rare. Clearance is expected to be avoided	Overall magnitude is Low (refer Table 5-4).	
Duration	Long lasting		
Extent	Localised		
Severity	Low		
Cumulative effects	Possible. Minor vegetation clearance for other activities (e.g. access to well sites could occur) but these would also be localised and small scale		
Sensitivity	Low to moderate. Vegetation in the vicinity of the Ramsay sites is generally degraded, however it retains some value as there is very limited native vegetation remaining in the region,		

<sup>15</sup> Significant in this context includes listed plant species, listed communities or important fauna habitat. Site specific assessment by an appropriately qualified specialist would be used to determine whether any native vegetation proposed to be cleared constitutes large trees, high quality vegetation or significant vegetation



## 5.6. Aboriginal heritage

### 5.6.1. Setting the context

Table 5-18 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to Aboriginal heritage.

**Table 5-18: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Aboriginal Heritage Act 1988</i> <i>Aboriginal and Torres Strait Islander Act 2005</i> <i>Native Title Act 1993</i> <i>Coroners Act 2003</i>	<i>A guide to Aboriginal heritage in South Australia (AGD 2025)</i>		Aboriginal sites, objects and remains Traditional Owners

### 5.6.2. Existing environment

The Yorke Peninsula component of PEL 687 is located on the traditional lands of the Narungga people. Archaeological evidence of their ties to the land and water is recorded in the central archives (including the Register of Sites and Objects) administered by Aboriginal Affairs and Reconciliation (AAR). Previous searches of the central archives for the PEL 687 area have indicated there are entries for Aboriginal heritage across Yorke Peninsula which include archaeological and cultural sites, stone quarries, arrangements, historic sites and culturally modified trees and burial sites (Gold Hydrogen 2023a).

Searches of the central archives for the Ramsay well locations undertaken in December 2024 and July 2025 did not identify any registered Aboriginal heritage sites in close proximity to the well locations. The well locations are situated in cropped paddocks in agricultural land, which has been subject to historic and ongoing ground disturbance for agricultural use.

Given the historical and current land uses in the region, it is anticipated that significant ground disturbance will have previously occurred on pipeline routes, which are expected to be located almost exclusively within cropped paddocks. However, it is possible that cultural heritage (tangible and/or intangible) may still exist.

### 5.6.3. Impact events

The impact events relevant to Aboriginal heritage are:

- Pipeline installation or removal results in damage or loss of Aboriginal heritage

### 5.6.4. Assessment of impacts

The impact assessment detailed in Table 5-19 indicates that significance of the potential impact from pipeline installation or removal is in the **moderate** category. Although the likelihood of damage to Aboriginal heritage on agricultural land with a long history of cultivation is limited, particularly with the control measures in place, the value and sensitivity of Aboriginal heritage sites, objects and remains are high. Control measures would be implemented to reduce the risk to ALARP, including consultation with the Narungga Nation Aboriginal Corporation, cultural heritage survey where required, avoidance of any identified sites or areas of cultural heritage significance and Aboriginal heritage discovery protocols where no authorisations are in place.



**Table 5-19: Environmental impact and significance assessment – Impact ID HER01**

Aboriginal Heritage: Impact ID HER01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Pipeline installation or removal results in damage or loss of Aboriginal heritage	Pipeline installation / removal	Earthworks (if required)	Direct disturbance	Aboriginal sites, objects and remains Traditional Owners	Understanding of potential for Aboriginal heritage based on searches of the central archive and agricultural disturbance history of the project area.	Consultation with Traditional Owners could identify sites of Aboriginal heritage. Aboriginal heritage not previously recorded / identified could be encountered in surveys or activities.	Yes. Although unlikely Aboriginal heritage could occur and be impacted (in unplanned event)
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>Any sites identified in searches of the Central Archive and the Register of Aboriginal Sites and Objects are avoided.</li> <li>Consultation carried out with the Narungga Nation Aboriginal Corporation regarding the risk of damage to Aboriginal heritage, and a cultural heritage survey carried out where required. Any identified sites are avoided.</li> <li>Known sites identified and protected from operations where required (e.g. using temporary flagging if present in the vicinity of operations).</li> <li>Cultural heritage issues covered in inductions. Key personnel (e.g. supervisors, machinery operators) receive appropriate cultural heritage training.</li> <li>Procedures consistent with the relevant obligations under the Aboriginal Heritage Act are in place to appropriately report and respond to any sites discovered during activities</li> <li>If Aboriginal sites, objects and remains are discovered during activities:               <ul style="list-style-type: none"> <li>works halt immediately in the vicinity of the discovery</li> <li>AAR and Narungga Nation Aboriginal Corporation notified of the discovery</li> <li>advice sought from the Narungga Nation Aboriginal Corporation and, depending on the extent of the discovery, a qualified heritage consultant</li> </ul> </li> </ul>					High certainty that proposed control measures will be effective.	Low.	



Control Measures	Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions
<ul style="list-style-type: none"> <li>- mitigation measures implemented to ensure the discovery is avoided. (If the works cannot be relocated to avoid the Aboriginal site, object or remains, authorisation would be obtained under the Aboriginal Heritage Act).</li> <li>• Aboriginal heritage discoveries reported to AAR on behalf of the Minister in accordance with section 20 of the <i>Aboriginal Heritage Act 1988</i><sup>16</sup>.</li> <li>• Records relating to management/avoidance of any identified sites of cultural heritage significance kept and available for audit.</li> <li>• Where damage, disturbance or interference to Aboriginal sites, objects or remains discovered during activities is unavoidable, then an application for authorisation pursuant to section 23 of the <i>Aboriginal Heritage Act 1988</i> (the Act) will be sought from the Minister for Aboriginal Affairs. Appropriate consultation with Aboriginal organisations, traditional owners or Aboriginal persons with interests in the matter, as well as the State Aboriginal Heritage Committee, will be conducted by AAR in relation to the application (as per section 13 of the Act).</li> </ul>		

SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	<p>No damage, disturbance or interference to Aboriginal heritage</p>	<p>Records of audits/inspections demonstrate that damage, disturbance or interference to any Aboriginal sites, objects and remains (all as defined under the <i>Aboriginal Heritage Act 1988</i>) is avoided unless authorisation has been obtained under the <i>Aboriginal Heritage Act 1988</i>.</p> <p>Any Aboriginal heritage sites, objects and remains discovered during operations have been appropriately reported and responded to, consistent with the <i>Aboriginal Heritage Act 1988</i> and the <i>Coroners Act 2003</i>.</p> <p>Records demonstrate that works have stopped in the vicinity of a discovery of Aboriginal heritage.</p>	<p>In the event the conditions<sup>17</sup> of a cultural heritage clearance are not complied with, the incident is appropriately reported<sup>18</sup>, investigated and remediated in consultation with the relevant Aboriginal heritage organisations, including Native Title groups, Recognised Aboriginal Representative Bodies (RARBs), Aboriginal heritage associations, Traditional Owners and AAR.</p>

<sup>16</sup> SA Police must be notified under the *Coroners Act 2003* if skeletal remains are discovered.

<sup>17</sup> Note that cultural heritage clearances are not defined under or referenced by the *Aboriginal Heritage Act 1988* and cannot ever authorise impacts to Aboriginal heritage.

<sup>18</sup> This may include compliance with reporting obligations pursuant to s.20 of the *Aboriginal Heritage Act 1988*.



Environmental significance assessment		Environmental significance assessment outcome
Avoidance	No – Design and engineering controls, and management system controls are put in place to avoid damage or loss of Aboriginal heritage sites, objects or remains, however unknown Aboriginal heritage may be encountered during exceptional circumstances, e.g. site discovery during construction.	
Frequency	Rare	Overall magnitude Moderate (refer Table 5-4).
Duration	Long lasting to permanent	
Extent	Localised	
Severity	High (worst case)	
Cumulative effects	Possible. Multiple incidents of damage or loss of Aboriginal heritage would result in cumulative impacts, however this is very unlikely to occur.	
Sensitivity	Moderate to high	



## 5.7. Public health and safety

### 5.7.1. Setting the context

Table 5-20 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to public health and safety.

**Table 5-20: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Work Health and Safety Act 2012</i>	<i>AS/NZS 4130 Polyethylene (PE) pipes for pressure applications</i> <i>AS 4041 Pressure piping</i>		Landholders Local and regional community General public

### 5.7.2. Existing environment

The Ramsay well sites and potential pipeline routes are accessible to landholders but have limited accessibility to the public. The well sites are located on private land, and potential pipeline routes are also located on private land, other than the crossing of an unsealed public road by the Ramsay-5 pipeline. Public roads adjacent to the well sites and parts of the pipeline routes carry varying amounts of vehicle traffic but little or no pedestrian traffic.

### 5.7.3. Impact events

The impact events relevant to public, health and safety are:

- Reinjection activities and associated infrastructure (e.g. pressurised piping) increase public safety hazard.

### 5.7.4. Assessment of impacts

The impact assessment detailed Table 5-21 indicates that significance of the potential impacts is in the **low** category. Although very unlikely to occur, the magnitude of impact events has the potential to be high but with proposed control measures it is assessed as ALARP. Control measures include control of public access to the sites during well testing and reinjection activities and design and engineering controls to prevent an unplanned incident such as pipeline rupture.



**Table 5-21: Environmental impact and significance assessment – Impact ID PUB01**

Public Health and Safety: Impact ID PUB01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Reinjection activities and associated infrastructure (e.g. pressurised piping) increase public safety hazard	Reinjection	Pressurised pipelines and injection equipment	Direct impact (if a failure occurs when in close proximity)	Landholders Local and regional community General public	SPR linkage requires an unplanned event (e.g. pipeline rupture) to occur when a third party is in very close proximity. This is extremely unlikely	If an unplanned event (e.g. pipeline rupture) occurred without a third party in very close proximity there would be no impact to public health and safety	Yes. Unplanned event (e.g. pipeline rupture) could result in SPR linkage
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>• Signage and fencing installed where relevant to indicate restricted access.</li> <li>• Exclusion zones implemented during pressure testing and subsequent reinjection operations.</li> <li>• Engineering design of reinjection program considers the interface with hydrogen gas, to ensure that appropriate equipment and materials are utilised to safely conduct the test.</li> <li>• Groundwater storage, transport and reinjection is designed and implemented in accordance with applicable industry and regulatory standards (e.g. AS/NZS 4130 Polyethylene (PE) pipes for pressure applications).</li> <li>• Pipeline designed to meet operating pressure and conditions (e.g. suitable for saline service with electrofusion welded joints and stainless tie-in spools and fittings at pump and well interfaces).</li> <li>• Use of reeled (rather than strung and welded) pipelines to reduce connections and limit exposure to leak areas.</li> <li>• Pipeline equipped with isolation valves, air/vacuum release valves at high points, low point drains and leak detection.</li> <li>• Emergency shut-down systems set to prevent pipeline exceeding maximum allowable operating pressure</li> <li>• Pipelines are sleeved or buried in a conduit where required for public road or access track crossings, with protective bollards and signage.</li> <li>• Reinjection activities monitored at all times with personnel on site.</li> <li>• Piping and tanks to be inspected and integrity verified prior to use.</li> <li>• Emergency response procedures in place.</li> </ul>					High certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low - Standard industry management strategies and short-term duration of program	



SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No injuries, deaths or health impacts to the public or third parties from regulated activities that could have been reasonably prevented by the operator	Any notifiable incidents (as per s35 of the <i>Work Health and Safety Act 2012</i> ) involving the public investigated by a suitably qualified independent third party and the results of the investigation show that the accident could not have been reasonably prevented by the operator.	Documentation indicates reinjection infrastructure and pipelines designed and operated in accordance with relevant standards. Safety audits are undertaken and any identified additional actions that could be reasonably implemented to reduce the risks to the public are implemented.
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	No. Design and engineering controls, and management system controls are put in place, however an impact may occur during exceptional circumstances		Moderate (refer to Table 5-5) ALARP assessment: Control measures in place require design and operation in accordance with standards and controls on members of the public accessing hazardous areas. Control measures are recognised as standard industry practice and are considered effective. As such, impacts are managed to ALARP.
Frequency	Rare		
Duration	Long lasting		
Extent	Localised		
Severity	High (if worst case impact occurred)		
Cumulative effects	No		
Sensitivity	Moderate		
			Overall magnitude is Moderate (refer Table 5-4).



## 5.8. Social environment, land use and infrastructure

### 5.8.1. Setting the context

Table 5-22 summarises legislation and non-legislated standards, views of affected parties and lists the key environmental receptors relevant to social environment, land use and infrastructure.

**Table 5-22: Legislation and non-legislated standards**

Applicable legislation	Applicable non-legislated standards	Views of affected parties	Environmental receptor
<i>Landscape South Australia Act 2019</i> <i>Biosecurity Act 2015 (Cth)</i> <i>Public Health (Wastewater) Regulations 2013</i>	South Australia's Biosecurity Policy 2020-2023  Australian Weeds Strategy 2017-2027 (Commonwealth of Australia, 2017)		Landholders Land use Native vegetation

### 5.8.2. Existing environment

The Ramsay well sites and potential pipeline routes are located on (and surrounded by) agricultural land. The dominant land use is broadacre cropping and sheep farming. The well sites are located in cropped paddocks which were planted with crops (wheat/barley or legumes) at the time of site inspections prior to well drilling in mid-2025.

The closest residences range from 600 m to 800 m from the sites, and there is also other agricultural infrastructure such as sheds and tanks in the vicinity of Ramsay-1. A quarry is present approximately 600 m to the north-east of Ramsay-4. The well sites are adjacent to either the unsealed Old Port Vincent Road or the sealed Port Vincent Road.

### 5.8.3. Impact events

The impact events relevant to social environment, land use and infrastructure are:

- Presence of pipeline disrupts landholder infrastructure or activities
- Introduction and spread of weed(s), pest(s) and/or pathogen(s) impacts land use or native vegetation.

### 5.8.4. Assessment of impacts

The impact assessment detailed in the following Table 5-23 and Table 5-24 indicates that the significance of the potential impacts is in the **low** category. Events such as disturbance to landowner infrastructure and introduction of weeds and pests are unlikely to occur. Potential impacts to landholders and land use from the proposed activities are localised and limited scale and readily manageable with appropriate consultation and standard control measures.



**Table 5-23: Environmental impact and significance assessment – Impact ID SOC01**

Social environment, land use and infrastructure: Impact ID SOC01							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
Presence of pipeline disrupts landholder infrastructure or activities	Pipeline installation, operation and removal.	Presence of pipeline	Direct disturbance	Landholders Land use	Pipelines would be located in consultation with landowners and impact is unlikely	Disruption to landholders could occur if there is a change in circumstances e.g. change in timing of Gold Hydrogen or landholder activities	Yes
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to change of assumptions	
<ul style="list-style-type: none"> <li>Landowner is consulted regarding the location, management and timing of proposed activities. Ongoing landowner liaison during and following operations.</li> <li>Activities are restricted to agreed / defined areas.</li> <li>Pipelines are sleeved or buried in a conduit where required for public road or access track crossings, with protective bollards and signage</li> <li>Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate.</li> <li>Compliance with Part 10 of the PGE Act (Notice of Entry requirements).</li> <li>Pipelines and other imported materials are removed from site during rehabilitation and contours restored unless otherwise agreed with the landowner.</li> <li>Compacted areas of soil (e.g., laydown areas) are rehabilitated in consultation with the landowner</li> <li>Rehabilitation of disturbed areas to be approved by the landowner or in accordance with landowner’s wishes.</li> </ul>					High certainty that proposed control measures will be effective.	Low - Standard industry management strategies and short-term duration of program	



SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	Minimise disturbance to landowners and land use	<p>Records of audits/inspections demonstrate no adverse impact (outside agreed disturbance / compensation areas) on land use as a result of activities.</p> <p>Records demonstrate timely consultation and notification of proposed activities with relevant landowners and directly affected stakeholders.</p> <p>Landowner / stakeholder complaints are documented and reasonable steps taken to resolve them can be demonstrated.</p>	Adverse impacts of accidental or unforeseen disturbance to infrastructure or land use resolved to the reasonable satisfaction of the landowner.
	Rehabilitate land adversely affected by regulated activities	<p>Records of audits / inspections demonstrate that land has been appropriately rehabilitated, including removal of surface structures and waste, re-contouring of the ground surface and revegetating (where required) consistent with pre-existing conditions (unless alternative agreement is reached with the regulator and landowner).</p> <p>Records demonstrate no reasonable landowner complaints regarding rehabilitation of land are left unresolved.</p>	Rehabilitation of disturbed areas to be approved by the landowner or in accordance with landowner's wishes.
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	No. Disturbance will generally be avoided or kept to agreed areas or timing, however impact could occur if circumstances change e.g. change in timing of Gold Hydrogen or landholder activities		Low (refer to Table 5-5)
Frequency	Rare	Overall magnitude is Low (refer Table 5-4).	
Duration	Short term		
Extent	Localised		
Severity	Low		
Cumulative effects	Possible. Other activities may also disrupt land use		
Sensitivity	Moderate		



**Table 5-24: Environmental impact and significance assessment – Impact ID SOC02**

Social environment, land use and infrastructure: Impact ID SOC02							
Potential Impact Event	Phase/ component of Project	Source	Pathway	Receptor	SPR uncertainties and assumptions	Sensitivity to change in assumptions	Confirmation of SPR
<b>Introduction and spread of weed(s), pest(s) and/or pathogen(s) impacts land use or native vegetation</b>	Pipeline installation / removal	Weed/pest/pathogen introduction and spread	Vehicle, equipment, materials and worker movements	Landholders Land use Native vegetation	SPR linkage generally requires vehicle and equipment movements off roads or tracks, which would generally be restricted to pipeline installation / removal	Weed abundance in the vicinity of the well locations (and the risk of spreading weeds) is generally low, however this could change seasonally or temporally	Yes. Unplanned event (introduction or spread) could impact agricultural activities
Control Measures					Uncertainties and assumptions (control measures)	Sensitivity to Change of assumptions	
<ul style="list-style-type: none"> <li>All reasonable and practical endeavours taken to minimise the risks of introducing weeds, exotic pest fauna and pathogens into the area of the activity.</li> <li>Appropriate consultation regarding weeds or pathogens carried out with landowners (and Landscape Board officers where appropriate).</li> <li>Vehicles and equipment arriving at the site must be clean and free of soil and plant material.</li> <li>Vehicles and equipment entering the region or moving between sites (especially from weed or pathogen infested areas into non-infested areas) will be assessed for the risk of transporting weeds and pathogens and cleaned down where appropriate.</li> <li>Local earthworks contractors used where possible rather than bringing in equipment from outside the region.</li> <li>All records of vehicle or equipment inspections and cleaning will be kept for auditing.</li> <li>Biosecurity procedures implemented as agreed with landowners.</li> <li>Paving materials will be sourced from licensed quarries that are free of weeds.</li> <li>Sites and access tracks will be monitored on a regular basis for new weed species / infestations and treated as necessary in accordance with requirements of the landowner, and if appropriate the Landscape Board.</li> <li>Records of detection, monitoring or eradication of weeds or pathogens introduced by activities are kept and available for review.</li> </ul>					High certainty that proposed control measures will be effective. Industry standard control measures that are well understood and that have been successfully implemented.	Low - Standard industry management strategies and short-term duration of program	



SEO	Proposed environmental objectives	Assessment Criteria	Leading performance criteria
	No introduction or spread of weeds, pest animals and pathogens as a consequence of regulated activities	Records of audits/inspections demonstrate that the presence of weeds, pest animals or pathogens is consistent with or better than pre-disturbance conditions and adjacent land or where this is not the case, a management plan is implemented promptly.  Declared plants occurring as a result of regulated activities are reported and managed in accordance with the <i>Landscape South Australia Act 2019</i> and applicable Landscape plans.	Records demonstrate that all equipment and vehicles are inspected, and cleaned where required, before arrival at the site.
Environmental significance assessment			Environmental significance assessment outcome
Avoidance	No. Introduction or spread of weeds could occur due to site activities.		Low (refer to Table 5-5)
Frequency	Low	Overall magnitude is Low (refer Table 5-4).	
Duration	Short term		
Extent	Localised		
Severity	Moderate		
Cumulative effects	Possible		
Sensitivity	Moderate		



## 6. Environmental Management Framework

Groundwater reinjection will be undertaken in accordance with Gold Hydrogen’s Health, Safety and Environment (HSE) Management Plan. It provides a framework for the coordinated and consistent management of environmental issues and addresses the:

- establishment of an environmental policy (<https://www.goldhydrogen.com.au>)
- identification of environmental risks and legal and other requirements relevant to the operations
- setting of appropriate environmental objectives and targets
- delineation of responsibilities
- establishment of a structure and program to implement environmental policy and achieve objectives and targets, including the development of procedures or guidelines for specific activities and education and induction programs
- facilitation of planning, control monitoring, corrective action, auditing and review of activities to ensure that the requirements and aspirations of the environmental policy are achieved.

Key aspects are discussed in the following sections.

### 6.1.1. Environmental objectives

Environmental objectives for groundwater reinjection have been developed in this EIR based on the information and issues identified in this EIR. These complement the objectives developed in the existing drilling and well testing EIR and SEO (Gold Hydrogen 2023a and 2023b).

### 6.1.2. Responsibilities

Environmental management and compliance are the responsibility of all personnel.

The overall responsibility for environmental compliance lies with Gold Hydrogen, who will maintain a high level of on-site supervision. The well testing and reinjection contractor and individuals will also be responsible and accountable through their conditions of contract. The training of all personnel will ensure that each individual is aware of their environmental responsibility.

Indicative organisation and responsibilities for environmental management are outlined in Table 6-1. It is noted that the exact nature and title of these roles may vary, and positions may be amalgamated or the responsibilities shared.

**Table 6-1: Indicative roles and responsibilities**

Role	Responsibility
Gold Hydrogen management	<p>Licence holders</p> <p>Hold overall responsibility for activities and environmental management</p> <p>Responsible for coordinating the management of the activities, including all environmental aspects</p> <p>Responsible for overall implementation of EHS</p> <p>Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO</p> <p>Overall responsibility for reporting on environmental performance and due diligence</p>



Role	Responsibility
	Coordinates environmental incident internal reporting, investigation and emergency response Incident notification to authorities
Gold Hydrogen on-site representative	Directly responsible for on-site management, including all environmental aspects and emergency response Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO Reports to Gold Hydrogen management on environmental performance and due diligence Coordinates the monitoring and audit program Environmental internal reporting and incident investigation
Well testing and reinjection contractor	Responsible for ensuring that works meet regulatory requirements and all environmental objectives contained in the SEO Directly responsible for the overseeing and fulfilling of commitments contained in relevant approvals, EIR and SEO Responsible for ensuring adequate resources are provided for constructing and maintaining environmental controls Inspection of work area to ensure appropriate environmental management Environmental internal reporting and incident investigation

### 6.1.3. Environmental management procedures

All employees and contractors are responsible for ensuring compliance with environmental procedures which are contained in the HSE Management Plan and associated documents. The HSE Management Plan and associated procedures are developed to identify environmental risks and set minimum operating standards to ensure that Gold Hydrogen and its contractors comply with the relevant environmental legislation.

### 6.1.4. Induction and training

Prior to the start of field operations all field personnel will be required to undertake an environmental induction to ensure they understand their role in protecting the environment. This induction will be part of a general induction process which also includes safety procedures. Site specific environmental requirements will be documented in the work program or work instruction.

A record of induction and attendees will be maintained.

### 6.1.5. Emergency response and contingency planning

In the course of normal operations, there is always the potential for environmental incidents and accidents to occur. To manage these incidents, emergency response plans are developed to guide actions to be taken to minimise the impacts of accidents and incidents. Emergency response plans will be reviewed and updated on a regular basis to incorporate new information arising from any incidents, near misses and hazards, and emergency response simulation training sessions. These plans will also include the facilitation of fire danger season restrictions and requirements.

Emergency response drills will also be undertaken at regular intervals to ensure that personnel are familiar with the plans and the types of emergencies to which they apply, and that there will be a rapid and effective response in the event of a real emergency occurring.



### 6.1.6. Environmental monitoring and audits

Monitoring and auditing of reinjection operations will be undertaken to determine whether significant environmental risks are being managed, minimised and where reasonably possible, eliminated.

Monitoring and auditing undertaken will assess aspects such as:

- compliance with regulatory requirements (particularly the Statement of Environmental Objectives)
- impact upon land use and local community
- impact on flora and fauna
- contractor performance.

### 6.1.7. Incident management, recording and corrective actions

Gold Hydrogen and its contractors have a system in place to record environmental incidents, near misses and hazards, track the implementation and close out of corrective actions, and allow analysis of such incidents to identify areas requiring improvement. The system also provides a mechanism for recording 'reportable' incidents, as defined under the ER Act and associated regulations.

### 6.1.8. Reporting

Internal and external reporting procedures will be implemented to ensure that environmental issues and / or incidents are appropriately responded to. A key component of the internal reporting will be contractors' progress and incident reports to Gold Hydrogen.

External reporting (e.g. incidents, annual reports) will be carried out in accordance with ER Act requirements and the SEO. Incident reporting requirements are detailed in the SEO.



## 7. Stakeholder Consultation

### 7.1. Stakeholder Engagement Context

The Yorke Peninsula is the traditional land of the Narungga people. It is characterised as a mix of small coastal towns, farming communities, and holiday destinations. Its permanent resident population is ~28,000 (ABS 2024), with high visitor numbers in the summer months. The economy is based on agriculture (largely grain and sheep production), fishing and aquaculture, and tourism. Many residents have multi-generational ties to the land or the sea.

Gold Hydrogen recognises the importance of stakeholder engagement and has been engaging with the Yorke Peninsula community since the Ramsay Project commenced in early 2023, guided by their stakeholder and community engagement strategy. This strategy sets out Gold Hydrogen's approach to identifying and engaging with community stakeholders.

The strategy is designed to ensure consistent, respectful, and effective engagement with stakeholders (landholders, communities, local government, Traditional Owners). It supports Gold Hydrogen's operational, regulatory and community obligations relating to the Project and more broadly its exploration portfolio in South Australia.

Gold Hydrogen's communication and engagement efforts align with four core objectives. These objectives are to:

- establish a clear, structured and aligned approach to stakeholder engagement and communication
- provide opportunities for stakeholders to engage with Gold Hydrogen about the Ramsay Project and its benefits, seek clarification as needed and participate in regulatory approvals process consultation requirements
- build relationships with stakeholders and foster trust through transparent, genuine two-way engagement
- establish community and stakeholder confidence in the Ramsay Project and Gold Hydrogen's ability to deliver it, recognising the importance of gaining and maintaining a social licence.

Over the 2023 - 2025 period Gold Hydrogen has engaged stakeholders in relation to the following exploration activities:

- **soil gas survey** to detect natural hydrogen generated from various geological processes that could be occurring in the survey area
- **aerial gravity-magnetic survey** to measure and capture natural variations in the strength and other characteristics of the earth's gravity and magnetic fields
- **2D seismic program** – a geophysical survey completed using public roads on the southern Yorke Peninsula
- **exploration drilling and initial testing** to prove and appraise the natural hydrogen and helium resource.

#### 7.1.1. General engagement activities 2023-2025

Gold Hydrogen has engaged stakeholders using various methods preceding the development of this EIR and the accompanying SEO. Gold Hydrogen has also worked closely with landowners at drilling and



well testing locations to develop agreements for land access and land use, understand and address any concerns they may have, provide compensation as agreed, and to realise any opportunities or benefits that may arise from the proposed activities. Gold Hydrogen engagement activities are summarised in Table 7-1.

**Table 7-1: Gold Hydrogen engagement activities 2023-2025**

Year	Activity
2023	<ul style="list-style-type: none"><li>• advertisements to inform community about aerial gravity-magnetic survey (March)</li><li>• advertisements to inform community about soil gas survey (April)</li><li>• Drilling and Well Testing EIR and SEO published to Gold Hydrogen website and sent to key stakeholders (May)</li><li>• community information sessions (x2) (June)</li><li>• Yorke Peninsula Field Days (September)</li><li>• attendance at Minlaton Show (October)</li></ul>
2024	<ul style="list-style-type: none"><li>• advertisement to inform community about seismic survey (January and June)</li><li>• on-road seismic survey EIR and SEO published to Gold Hydrogen website and emailed to key stakeholders (February)</li><li>• attendance at Maitland Show (March)</li><li>• presentation to Yorke Peninsula Council meeting on proposed seismic survey (May)</li></ul>
2025	<ul style="list-style-type: none"><li>• attendance at Gynburra Show (January)</li><li>• presentation to Yorke Peninsula Council meeting on proposed drilling campaign (September)</li><li>• Yorke Peninsula Field Days (September /October)</li><li>• advertisements to inform community about the drilling program (Oct-Nov).</li></ul>

### 7.1.2. Engagement on reinjection activity prior to Gold Hydrogen formal consultation

During planning for the well testing and reinjection activities and the development of this EIR and the SEO, engagement by Gold Hydrogen has included the following activities:

- meetings with regulatory agencies (DEM, DEW and Northern and Yorke Landscape Board) to discuss approval requirements for the program
- using existing planned engagement sessions such as scheduled landowner meetings to discuss the reinjection activity
- contacted Narungga Nation Aboriginal Corporation to provide information about the proposed reinjection activity
- developed communication materials including a reinjection fact sheet and published it and associated updates to the company's website.

### 7.1.3. Gold Hydrogen formal consultation on EIR and SEO

As discussed in Section 2.1.3, the ER Act requires licensees to undertake consultation on a proposed EIR and SEO in compliance with an approved consultation plan, prepared and implemented in accordance with the ER Regulations.

A groundwater reinjection EIR and SEO consultation plan was submitted to DEM for Ministerial approval in December 2025 which was granted on 8 December 2025. The consultation approach outlined in the plan was consistent with the overarching stakeholder engagement and communication strategy and met the consultation requirements under the ER Act.



Table 7-2 lists the key stakeholders for consultation on the EIR and SEO for groundwater reinjection. Table 7-3 summarises formal consultation activities undertaken for the EIR/SEO.

Key details of the consultation undertaken is summarised below.

- General consultation period: Monday 8 December to Friday 9 January 2026.
- Draft EIR and SEO documents uploaded to Gold Hydrogen website and provided as PDF directly to stakeholders if requested (Note: none requested).
- Gold Hydrogen identified landholders within a 1.5 km radius of the proposed reinjection well (Ramsay 1) and had meetings and or telephone calls (depending on availability) with those landowners with whom Gold Hydrogen have an existing relationship.
- Gold Hydrogen attempted to contact relevant landowners with whom there is not an existing relationship by telephone where possible. Follow up letters or emails were sent to provide a fact sheet as pdf and link to draft documents for comment.
- Gold Hydrogen sent letters or emails to relevant landowners as a reminder of the close of submissions on 9 January 2026.
- Targeted emails were sent to Yorke Peninsula Council, Narungga Nation Aboriginal Corporation, and relevant government agencies, including a fact sheet, a link to the draft EIR and SEO documents, and details of feedback process. If directly requested, hard copy documents were available (none were requested).
- Gold Hydrogen sent letters or emails to Yorke Peninsula Council, Narungga Nation Aboriginal Corporation, and relevant government agencies as a reminder of the close of submissions on 9 January 2026.

**Table 7-2: Key stakeholders for consultation on the EIR and SEO for groundwater reinjection**

Category	Stakeholder / stakeholder group
<b>Relevant landowners</b>	Landholders within a 1.5km radius of Ramsay-1, the well in which groundwater is proposed to be reinjected, and those in close proximity to potential pipeline routes, have been defined as being those potentially impacted by the reinjection activity and therefore relevant to this activity for the purpose of consultation. The radius has been determined as being the outer boundary to which reinjected water may extend in the aquifer at ~316 m depth plus a buffer of 500 m.
<b>Traditional Owners</b>	Narungga Nation Aboriginal Corporation
<b>Council</b>	Yorke Peninsula Council
<b>State Government Departments and Agencies</b>	Department for Energy and Mining Department for Environment and Water Department for Infrastructure and Transport Environment Protection Authority PIRSA Planning and Land Use Services (PLUS), Department for Housing and Urban Development Aboriginal Affairs and Reconciliation SafeWork Northern and Yorke Landscape Board
<b>Commonwealth Government Departments and Agencies</b>	Regional Development Australia Yorke and Mid North



Category	Stakeholder / stakeholder group
<b>Non-government Organisations</b>	Landowner Information Service Conservation Council SA Wilderness Society
<b>Mining companies with overlapping tenements</b>	Rex Minerals Paralana Pty Ltd

**Table 7-3: Consultation summary**

Stakeholder	Action 1	Action 2	Response (Y/N)
<b>Traditional Owners</b>			
<b>Narungga Nation Aboriginal Corporation (NNAC)</b>	Email sent 10/12/25	Follow up email sent 06/01/26	N
<b>Landowners</b>			
1*	Email sent 06/12/25 (failed 16/12/25) Letter sent 17/12/25	Follow up letter sent 06/01/26	Landholder responses are summarised in Table 7-4
2*	Email sent 16/12/25	Follow up email sent 06/01/26	
3*	Email sent 17/12/25	Follow up email sent 06/01/26	
4*	Email sent 16/12/25	Follow up email sent 06/01/26	
5	Letter sent 17/12/25	Follow up letter sent 05/01/26	
6	Letter sent 17/12/25	Follow up letter sent 05/01/26	
7	Letter sent 17/12/25	Follow up letter sent 05/01/26	
8*	Email sent 17/12/25	Follow up email sent 05/01/26	
11	Letter sent 17/12/25	Follow up letter sent 05/01/26	
12	Email sent 16/12/25	Follow up email sent 06/01/26	
13	Letter sent 17/12/25	Follow up letter sent 05/01/26	
14	Letter sent 17/12/25	Follow up letter sent 05/01/26	
15	Letter sent 13/01/26	Follow up letter sent 23/01/26	

\*Gold Hydrogen held existing relationships with these landowners prior to the consultation on the EIR and SEO addressed by this document.

<b>Local Council</b>			
<b>Yorke Peninsula Council - Also landowner 10*</b>	Email sent 16/12/25	Follow up email sent 06/01/26	N
<b>SA Government Departments and Agencies</b>			
<b>Department for Energy and Mining</b>	Email sent 12/12/2025	Follow up email sent 05/01/26	N
<b>Department for Environment and Water</b>	Email sent 12/12/2025	Not required	See Appendix B
<b>PIRSA</b>	Email sent 12/12/2025	Follow up email sent 05/01/26	See Appendix B



Stakeholder	Action 1	Action 2	Response (Y/N)
Department of Infrastructure and Transport	Email sent 12/12/2025	Follow up email sent 05/01/26	N
Department for Housing and Urban Development Planning and Land Use Services (PLUS)	Email sent 12/12/2025	Not required	See Appendix B
Aboriginal Affairs and Reconciliation	Email sent 12/12/2025	Follow up email sent 05/01/26	See Appendix B
SafeWork	Email sent 17/12/2025 (Email sent 12/12/25 failed)	Follow up email sent 05/01/26	N
Northern and Yorke Landscape Board	Email sent 12/12/2025	Not required	See Appendix B
Environmental Protection Agency	Email sent 12/12/2025	Follow up email sent 05/01/26	N
<b>Commonwealth Government Departments and Agencies</b>			
Regional Development Australia Yorke and Mid North	Email sent 12/12/2025	Follow up email sent 05/01/26	N
<b>Non-government Organisations</b>			
Landowner Information Service	Email sent 15/12/2025	Follow up email sent 05/01/26	N
Conservation Council SA	Email sent 15/12/2025	Follow up email sent 05/01/26	N
Wilderness Society	Email sent 15/12/2025	Follow up email sent 05/01/26	N
<b>Other (mining companies)</b>			
Rex Minerals	Email sent 15/12/2025	Follow up email sent 05/01/26	N
Paralana Pty Ltd	Email sent 17/12/2025	Follow up email sent 05/01/26	N

## 7.2. Outcomes of Stakeholder Consultation on the draft EIR and SEO

Issues raised by landowners and Gold Hydrogen’s responses during the consultation period have been summarised in Table 7-4 below. Comments and issues raised by non-landowner stakeholders and the corresponding responses are summarised in Table B-1 in Appendix B.

The EIR and draft SEO were updated accordingly for formal submission to DEM, for further review and consultation under the formal ER Act consultation process (summarised below in Section 7.3).



**Table 7-4: Summary of landowner comments and Gold Hydrogen’s response.**

Issue raised	Addressed in the EIR	Response
<p>Process for managing spills of hyper-saline water on cropped land.</p>	<p>EIR Section 5.3, Table 5-13</p>	<p>Gold Hydrogen understands the sensitivity of cropping land to potential spills of saline water and has addressed this in the EIR and SEO. The EIR and SEO set out the measures that Gold Hydrogen will put in place to minimise the risk of spills occurring, as well as the actions that will be taken to mitigate the impacts to soil and water in the unlikely event of a leak or spill of saline water. Assessment in the EIR concludes that if a spill occurred, impacts would generally be localised and short-term and readily manageable using standard control measures.</p> <p>Storage, transport and reinjection of the groundwater will be in accordance with industry and regulatory standards and the temporary pipeline will be designed to meet the prevailing operating pressure and conditions. Gold Hydrogen will also be required under the SEO to implement leak detection measures and undertake regular inspections of the pipeline and tanks and reinjection activities will be monitored at all times.</p> <p>Should there be a leak or spill despite the implementation of the control measures set out in the EIR, it will be immediately contained, reported (both internally and to State regulators as required) and clean up actions initiated. Depending on the extent of the spill, this may involve implementation of remediation measures in consultation with the landowner, which may include the removal and replacement of soil in the affected area.</p> <p>Spills that cannot be immediately contained, cleaned up and/or delineated will be assessed and remediated in consultation with the landowner, DEM and in accordance with relevant standards and guidelines which include the Site Contamination NEPM and SA EPA guidelines.</p>
<p>Landowner consultation regarding the location and timing of installation of pipes on cropping land.</p>	<p>EIR Section 5.8, Table 5-23</p>	<p>Gold Hydrogen takes seriously its responsibility to minimise impacts on affected landowners and their farming activities. Every effort will be made to ensure that the location, timing and duration of the installation of the temporary pipelines does not interfere with farm infrastructure and activities.</p> <p>As stated in the EIR, activities will be restricted to those areas that have been agreed or defined with affected landowners for disturbance / compensation (where relevant). Pipeline locations are intended to follow fencelines, roads and other access tracks, avoiding crossing of open paddocks or impacting other farming infrastructure. All activities will be conducted in accordance with the notification, timing and duration details agreed with landowners.</p>
<p>Potential for impacts to water quality of surrounding bores from reinjected hyper-saline water into Ramsay 1.</p>	<p>EIR Section 5.2, Table 5-9</p>	<p>Gold Hydrogen commissioned a hydrogeological risk assessment by groundwater specialists Water Technology as part of the preparation of the EIR and SEO, in order to determine the risk of impacts to shallow groundwater aquifers from reinjected groundwater. Important findings from the report include:</p> <ul style="list-style-type: none"> <li>• The Ramsay-1 well is cased and cemented to 218 m depth preventing reinjection of groundwater into the shallower aquifers. Groundwater will be reinjected into formations below 218 m and is expected to preferentially flow into a highly permeable (fractured and faulted) zone at 316 m. As</li> </ul>



Issue raised	Addressed in the EIR	Response
		<p>there is very little evidence of porous or permeable formations above this zone, propagation of reinjected groundwater into the shallow aquifers from which nearby bores source water is not expected.</p> <ul style="list-style-type: none"> <li>• There are only five water wells within a 2 km radius of Ramsay-1: two are operational and were originally drilled to 68.58 m and 96.01 m; one is recorded as rehabilitated to zero depth; one was abandoned in 1995; and one has unknown status but was only drilled to 7.62 m depth. All existing groundwater users in the area, especially those within 2 km of Ramsay 1 injection well, therefore have significant vertical disconnection from the Parara Limestone at 218 m depth and all deeper formations.</li> <li>• The reinjected groundwater is expected to be more saline than the groundwater present at 316 m. The more saline water is, the denser it becomes creating the potential for downwards convection of the reinjected groundwater into deeper more saline formations, which are not accessed by the surrounding bores.</li> </ul> <p>Gold Hydrogen therefore consider that the risk of impacts to shallow groundwater aquifers and the bores which draw water from these aquifers due to groundwater reinjection is very low. The hydrogeology assessment is attached to the EIR at Appendix A.</p>
Possible impact of hyper-saline water reinjected at level where water salinity is lower.		See response above
Effectiveness of recently drilled groundwater monitoring bores in measuring salinity effects on surrounding water bores.	EIR Section 3.3.4, Table 5-11	<p>The recently drilled groundwater monitoring bores approximately 7km from Ramsay 1 are designed to be sampled regularly and provide information for confirming baselines for pressure and groundwater quality over the greater Ramsay project area, and support the long-term monitoring program.</p> <p>Gold Hydrogen also plan to confirm the location of existing groundwater wells and groundwater use during ongoing consultation with landholders in the Ramsay project area. A sampling program of working waterbores in close vicinity of Ramsay 1 will be conducted (subject to landholder permission) to provide specific datapoints on the quality of the aquifers being used by landowners in the area. Baseline samples have already been collected for analysis and the ongoing sampling program will look at groundwater quality characteristics, mineralogy and geochemical analysis.</p> <p>The monitoring program will include sampling immediately prior to and on completion of the well testing program and sampling approximately 12 months after completion.</p>
Monitoring used and unused bores for possible impacts.		In discussions with landowners, Gold Hydrogen may consider installing monitoring equipment on existing bores to determine if there are any impacts.
Size and location of temporary groundwater storage tanks.		Steel-sided above-ground tanks for temporary storage of groundwater will be located at the well testing location and the Ramsay-1 site.



Issue raised	Addressed in the EIR	Response
		Gold Hydrogen is working through various proposals for tank sizes from contractors which includes options for taller tanks with smaller footprints. The final storage tank configuration (including location) would be agreed with affected landholders.
Removal of residual water in the holding tank.		As much residual water as possible would be pumped from the storage tanks to the pipelines for reinjection into Ramsay-1. Evaporation is the primary method used to empty water from large ponds, and this may also be considered for the storage tanks, which would likely require the tanks to remain in place for several months after operations cease. This approach would be considered when determining the location of the tanks and in consultation with the affected landowner.
Depth of water reinjection.		As noted above, groundwater will be re injected in the Ramsay 1 well into formations below 218 m depth and is expected to primarily flow into a highly permeable zone at 316 m.

### 7.3. Formal ER Act Consultation Process

Following Gold Hydrogen’s stakeholder consultation, this EIR and the accompanying SEO have been updated to address the issues raised during the consultation prior to submission to DEM.

DEM are inviting written submissions for a minimum 30 business day period in accordance with Regulation 14 of the Act. Any submissions received during the public consultation will be provided to Gold Hydrogen. All relevant comments received from the public consultation will be addressed and, where appropriate, incorporated into the EIR and / or SEO.

The comments received during this process and Gold Hydrogen’s responses will be summarised and addressed in Table C-1 in Appendix C in the final EIR. The EIR and SEO will be updated accordingly and submitted to DEM for approval.

### 7.4. Ongoing Consultation

Gold Hydrogen will continue to engage with and update relevant landowners, the community and other stakeholders should the proposed activities be approved. This could include (but not be limited to) consulting and advising affected stakeholders of proposed activities in a timely manner, responding to any issues raised, maintaining a database of interested stakeholders in order to provide regular updates, including information on the website on progress of the Ramsay Project, and provision of factsheets and other information.



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## 9. Abbreviations and Glossary

Abbreviation / Glossary	Definition
2D seismic survey	A geophysical method that records seismic waves along a single line to produce a two-dimensional cross-sectional image of the Earth's subsurface.
AAR	Aboriginal Affairs and Reconciliation, Attorney-General's Department (South Australia)
ALARP	as low as reasonably practicable
annulus	The space in a well between the tubing and casing
ANZECC	Australian and New Zealand Environment and Conservation Council
aquitard	A bed of low permeability adjacent to an aquifer
ASX	Australian Stock Exchange
basement	Crystalline rocks lying above the mantle and beneath all other rocks and sediments. Generally used to indicate igneous and metamorphic rocks, usually older than Cambrian (539 – 485 million years) in age, that lie below a cover of sedimentary rocks
casing	Steel pipes that are screwed together to form a casing string, which is run into a core hole or well and cemented in place
casing string	A series of casing rods screwed together
commingled test	A well test where different zones/depths are tested at the same time.
DEM	Department for Energy and Mining
DEW	Department for Environment and Water (SA)
DEWNR	Department for Environment, Water and Natural Resources (now DEW) (SA)
DAS	Distributed Acoustic Sensing. A fibre optic technology that can detect and locate mechanical vibrations along the length of a wellbore to allow for monitoring of aspects such as seismic events and well integrity.
DTS	Distributed Temperature Sensing. A fibre optic technology used for downhole monitoring that provides a continuous, real-time temperature profile along the entire length of a wellbore and allows monitoring of subsurface processes such as fluid flow.
drill stem test	A valved test tool is lowered down a well on the end of the drill string to a specific reservoir formation and the valve opened to admit formation fluids.
EAR	environment assessment report
EHS	Environment, Health and Safety
EIR	Environmental Impact Report prepared in accordance with Section 97 of the South Australian <i>Petroleum and Geothermal Energy Act 2000</i> and Regulation 10
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)
ER Act	<i>Energy Resources Act 2000</i> (SA)
ESP	Electrical submersible pump
flare	Burning of gas through a pipe (called a flare).
flow test	Tests in a well to determine its flow capacity at specific conditions of reservoir and flowing pressures
formation	The term for the primary unit in stratigraphy consisting of a succession of strata useful for mapping or description, which possesses certain distinctive lithologic and other features



Abbreviation / Glossary	Definition
GSELA	Gas Storage Exploration Licence Applications
Gold Hydrogen	Gold Hydrogen Ltd
HDPE	high-density polyethylene
hydraulic conductivity	A measure of how easily a fluid (e.g. water) can flow through a porous material such as soil or rock
IBRA	Interim Biogeographical Regionalisation for Australia
km	kilometre
kPa	kilopascal
Landscape SA Act	<i>Landscape South Australia Act 2019 (SA)</i>
m	metre
MPTRA	Mining Production Tenement Regulation Area
mg/L	milligrams per litre
ML	megalitre (1,000,000 litres)
MMscf/day	million standard cubic feet
Native Vegetation Council	A council established under the South Australian <i>Native Vegetation Act 1991</i> to assess vegetation clearance applications
NEPM	National Environmental Protection Measure
packer	A device that can be run into a wellbore with a smaller initial outside diameter that then expands externally to seal the wellbore.
perforate	The process of punching holes in the casing or liner of a well to connect it to the reservoir
PE	polyethylene
PEL	Petroleum Exploration Licence
PELA	Petroleum Exploration Licence Application
PIRSA	Department of Primary Industries and Regions, South Australia
potentiometric head	The total head or pressure of groundwater, defined by the height (or 'head') to which water will rise in a well.
psi	pounds per square inch
psi/ft	pounds per square inch per foot
SEO	Statement of Environmental Objectives
SPR	Source Pathway Receptor
stratigraphy	The study of rock layers and layering (stratification)
vent	The release of gases to the atmosphere, typically through a vertical pipe (called a vent or vent stack)
well completion	A generic term used to describe the assembly of downhole tubulars and equipment required to enable safe and efficient production from a well.
well head	The part of a well which terminates at the surface, where reservoir fluids can be withdrawn.
wireline logging	A measuring instrument is raised up the well on a wireline to log or record rock properties and fluids



Abbreviation / Glossary	Definition
workover	The process of performing maintenance or remedial treatments on an existing well, generally for the purpose of restoring, prolonging or enhancing production.
zone	An interval or unit of rock differentiated from surrounding rocks on the basis of its fossil content or other features, such as faults or fractures. Often used to describe a layer of reservoir rock that contains a target resource (e.g. hydrocarbons or natural hydrogen)
zonal test	A well test where different zones/depths are tested separately.



## Appendix A: Hydrogeological Risk Assessment

# MEMORANDUM

**To** Marshall Hood, Gold Hydrogen Limited  
**From** Dr. Glenn Harrington, National Lead – Groundwater | Senior Principal Hydrogeologist  
**Date** Updated 19 January 2026  
**Subject** Gold Hydrogen Reinjection Hydrogeological Risk Assessment  
**Our ref** WT Memo\_Gold Hydrogen\_\_M02v04

## 1 INTRODUCTION

Gold Hydrogen (GHY) has previously drilled, constructed and tested two wells for the purpose of hydrogen and helium exploration in PEL 687 to the east of Minlaton on Yorke Peninsula, SA. These wells are named Ramsay 1 and Ramsay 2 (Figure 1-1) and both yielded positive results for gas shows during drilling and samples collected during subsequent testing (Figure 1-2). As part of further exploration and field appraisal, GHY propose to drill up to three new exploration wells during a 2025/2026 field campaign. The new well locations are likely to be Ramsay 3, 4 and 5 (Figure 1-1), however other locations may become preferred options after initial results from drilling the first one or two wells of the campaign. In any case, it is expected that up to three wells will be flow tested by pumping groundwater from one (zonal test) or multiple (comingled test) discrete zones for sampling and analysis of coproduced hydrogen and helium.

Groundwater pumped from each new well for exploration testing is proposed to be temporarily stored in above ground tanks, treated with biocide and oxygen scavengers, and then transferred via temporary pipelines to the Ramsay 1 well for aquifer reinjection. This well has approximately 800 m of slotted casing (218 – 1005 mMD) and is open to Parara Limestone, Kulpara Limestone, Kulpara Dolomite, Winulta Sandstone and fractured granite basement. At the time of drilling Ramsay 1 there was complete loss of circulation at 316 m depth in the Parara Limestone, which was later identified to be a fracture/dissolution zone with very high hydraulic conductivity (K) – to the extent that injection testing could not raise the standing water level in the well. This high-K zone is referred to as the primary ‘thief zone’ of Ramsay 1 in the remainder of this document.

The orientation of the thief zone conforms to bedding in the Parara Limestone, which consistently dips towards the southeast at approximately 7 degrees in Ramsay 1 and Ramsay 2. Gamma Ray correlation between the two wells indicates the zone extends laterally with no evidence of pinching. Further afield it is possible that the zone is no longer cavernous, in which case the ultimate fate of any reinjected water in this zone would change from rapid fracture flow to that of a more low-permeability-porous media conceptualisation, with slow migration and radial flow away from the dissolution zone.

The rate of groundwater reinjection into Ramsay 1 will be commensurate with pumping rates at the well being tested, which will depend on downhole conditions encountered at the time of drilling and well construction. GHY has estimated an upper limit of 20,000 barrels (i.e., 3.18 ML) pumped per day and a maximum duration of 30 days per test. Thus the total volume likely to be pumped from each new well and reinjected into Ramsay 1 would be approximately 95.4 ML, yielding a combined total volume of approximately 286.2 ML for testing three wells. As there is currently a range in the likely total reinjection volume, a high-end estimate of 300 ML has been assumed for assessment.

This memorandum presents a Hydrogeological Risk Assessment to support approvals for the groundwater reinjection component of the exploration well testing, specifically a Water Affecting Activity (WAA) permit application and an Environmental Impact Report (EIR) being prepared by JBS&G Australia that also provides details on test design, equipment and operation, pipeline infrastructure, water treatment and monitoring.

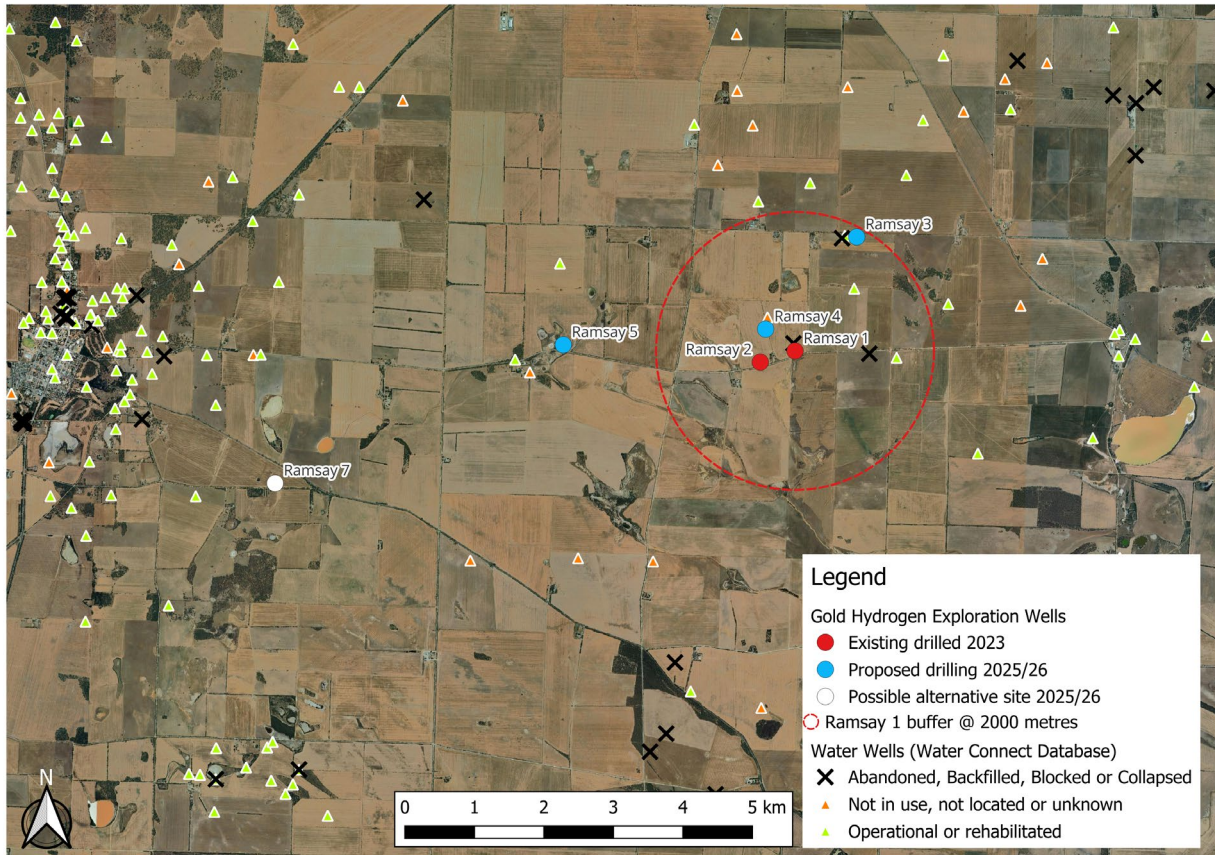


Figure 1-1 Location of existing and proposed gas exploration and water wells.

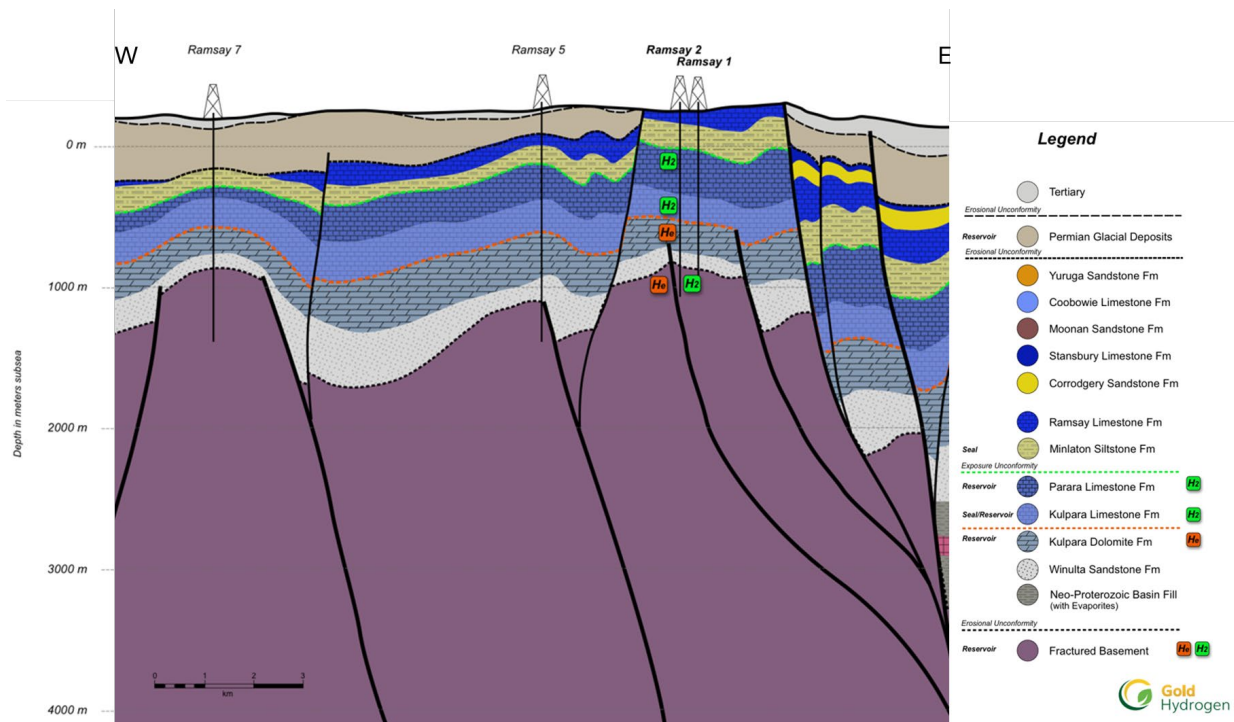


Figure 1-2 Schematic geological cross section through existing Ramsay 1 and Ramsay 2 wells and proposed Ramsay 5 and Ramsay 7 wells.



## 2 POLICY SETTING

The project site is located within the Northern and Yorke Landscape Board Water-Affecting Activity (WAA) Control Policy zone NY1, which requires a permit for the draining or discharging of water directly or indirectly into a well pursuant to Section 104(3)(c) of the Landscape SA Act 2019 (the Act).

Table 2-1 outlines the principles that will be considered by the Minister when determining whether to grant or refuse a permit for such a WAA, as well as commentary to guide the reader where each principle (as relevant) is addressed in this Hydrogeological Risk Assessment.



**Table 2-1 Principles for Drainage or discharging water into a well (NYLB, 2020)**

Principle	Relevance to this Memo
<p>1. A permit is required for the draining or discharging of water directly or indirectly into a well, pursuant to Section 104(3)(c) of the Act. Additional authorisations may be required under the Environmental Protection Act 1993.</p>	<p>Noted.</p>
<p>2. A permit to drain or discharge water into a well will not be issued unless a risk assessment is undertaken to the satisfaction of the Minister. This risk assessment must be consistent with the National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health &amp; Environmental Risks, Phase 1 2006 and other related documents current at the time, and include:</p> <p>a. An investigation into the suitability of the draining or discharging site, including but not limited to tests for transmissivity, maximum injection pressures and calculated likely impacts on the integrity of the well and confining layers, and impacts of potentiometric head changes to other underground water users.</p> <p>b. An appropriate operation or management plan demonstrating that operational procedures and monitoring regime are in place to protect the integrity of the aquifer, minimise the wastage of water and protect the discharge site on an ongoing basis.</p> <p>c. A water quality assessment which identifies hazards in the source water.</p> <p>d. A report on the consequences and impacts to the native underground water resource where the water quality characteristics (salinity and chemistry composition) of the water to be discharge differs to that of the native underground water.</p>	<p>This Memo presents the hydrogeological aspects of the risk assessment.</p> <p>Please refer to paragraph immediately following this table for commentary on NWQMS Guidelines.</p> <p>Addressed in Section 3: Ramsay-1 Reinjection (Discharge) Site – Hydraulics</p> <p>Prepared separately by Gold Hydrogen</p> <p>Addressed in Section 4: Native Underground Water Resource – Water Quality</p> <p>Addressed in Section 4: Native Underground Water Resource – Water Quality</p>
<p>3. The water quality assessment required in 2(c) above will include assessments of (but not limited to):</p> <p>a. pH, total dissolved solvents, turbidity, ammonia, nitrate, nitrite, total phosphorus, sodium, chloride, sulphate, calcium, magnesium, bicarbonate, iron, total arsenic, total boron, total cadmium, total chromium, total lead, total manganese, total zinc; and</p> <p>b. Pesticides, volatile organic compounds and petroleum hydrocarbons; and</p> <p>c. Trihalomethanes where the water to be drained or discharged has been treated by chlorination.</p>	<p>Addressed in Section 4: Native Underground Water Resource – Water Quality</p> <p>Not applicable – discharge water is sourced from native underground water at significant depth and beneath thick, low-permeability aquitards; hence free of pesticides, VOCs, PHCs and THMs.</p>



Principle	Relevance to this Memo
4. Water that is drained or discharged into a well only by means of gravity is exempt from meeting the requirements of principle 2(a).	Not applicable – water will be discharged via reinjection
5. Roof runoff (surface water) that is drained or discharged into a well via a closed system of capture and transport is exempt from meeting the requirements of principles 2(a), (c) and (d), provided that the system is equipped with a mechanism to divert first flush water.	Not applicable – discharge water is from native underground water not roof runoff.
6. Further to principle 2(b), continuation of draining and discharge is dependent on an annual report that addresses the impacts to the native underground water at the draining or discharge site. Roof run-off (surface water) captured in a closed system and then drained or discharged into a well is exempt from this principle.	Not applicable – discharge of water from exploration well testing via reinjection into Ramsay-1 will not be ongoing.
7. For the purposes of principles 1 and 2, the relevant concentrations, levels or amounts shall be measured in sufficient representative samples of: <ul style="list-style-type: none"> <li>a. the water to be drained or discharged; and</li> <li>b. native underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection; where “sufficient representative samples” means suitable samples, collected with equipment appropriate for the substance, material or characteristic to be measured and taken at suitable locations and times to accurately represent the quality of the relevant water.</li> </ul>	Addressed in Section 4: Native Underground Water Resource – Water Quality
8. For the purposes of this WAA Control Policy, the term “native underground water” means water occurring naturally below ground level that exists in the relevant aquifer absent of any such water drained or discharged to that aquifer by artificial means.	Noted.
9. The draining or discharging of water directly or indirectly into a well must not detrimentally affect the ability of other persons to lawfully take from that underground water, or degrade ecosystems dependent on the underground water.	Addressed in Section 3: Ramsay-1 Reinjection (Discharge) Site – Hydraulics

With regard to the National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health & Environmental Risks, Phase 1 2006, it must be noted that these guidelines have been developed specifically in the context of ‘recycled water’ defined therein as “*Water generated from sewage, greywater or stormwater systems and treated to a standard that is appropriate for its intended use.*” Accordingly, whilst the intent of the Guidelines is transferrable to the current Gold Hydrogen project, most of the specific requirements are not relevant.



### 3 RAMSAY-1 REINJECTION (DISCHARGE) SITE – HYDRAULICS

#### 3.1 Well construction and hydrogeological properties

Ramsay 1 is constructed with a slotted liner from 218 m to 1005 m below ground level (bgl) and is thus open to all formations across that interval. The well annulus from 218 m depth is fully grouted with bentonite cement back to surface. Injecting water into Ramsay 1 will initiate vertical flow below 218 m depth in both the slotted casing and the wellbore annulus. It is reasonable to expect this would result in preferential water loss to the high-K ‘thief zone’ of Parara Limestone at approximately 316 m depth (~200 mAHD).

#### 3.2 Impacts to well integrity and confining layers

A maximum injection pressure to prevent fracture stimulation and thereby avoid compromising the integrity of the reservoir and confining layers can be estimated as follows:

$$\text{WHP} = (\text{BHFP} - \text{HP}) \times \text{TVD}$$

where WHP is wellhead pressure (psi), BHFP is average bottom hole fracture pressure gradient (psi/ft), HP is hydrostatic pressure gradient (approximately 0.43 psi/ft for seawater) and TVD is true vertical depth (ft).

The thief zone at 316 m depth is a natural fracture and thus any fracture gradient control is meaningless because the natural fracture will absorb the excess pressure by taking some (if not most) of the injected water. The target zone for reinjection is the deeper, high salinity formations of the Dolomite and granite basement. Accordingly, GHY have proposed a TVD of 700m and an average fracture gradient of 0.8 psi/ft for dolomite as the bottom hole injection control.

Using this approach yields a maximum WHP during reinjection of 850 psi to avoid fracture initiation in the dolomite. This pressure is unlikely to present any risk of rupturing the steel casing, however possible compromise of the cement shoe and grouted annulus at the foot of the casing would require analysis using the Mohr-Coulomb criterion, or similar, which requires geomechanical expertise and is therefore outside the scope of this hydrogeological assessment.

#### 3.3 Impacts of potentiometric head changes to other underground water users

There is a widespread distribution of current and historical water wells in the area, particularly closer into and around Minlaton (Figure 1-1). The vast majority of these wells were drilled less than 100 m deep and most are used for stock watering purposes even though they generally have poor water quality (i.e., TDS between 5,000 – 27,000 mg/L). Only seven of the wells shown in the map are greater than 100m deep and the deepest of those is 160 m. Within a 2 km radius of Ramsay 1 there are only five water wells: two are operational and were originally drilled to 68.58 m and 96.01 m, although the deeper well has since collapsed to 4.88 m; one is recorded as rehabilitated to zero depth; one was abandoned in 1995; and one has unknown status but was only drilled to 7.62 m depth. Therefore, all existing groundwater users in the area, especially those within 2 km of Ramsay 1 injection well, have significant vertical disconnection from the Parara Limestone at 218 m depth (corresponding to the start of the slotted casing) and all deeper formations.

Routine Core Analysis (RCA) on sidewall cores collected from Ramsay 1 has revealed extremely low permeability (Table 3-1) throughout the profile and particularly in the uppermost 630 m (NB. most cores were collected from non-reservoir and non-fractured sections of the drillhole). Two cores from just above the primary thief zone, which is at 316 m depth, returned permeabilities of 0.00051 mD and 0.00070 mD. These equate to saturated hydraulic conductivities of approximately  $5 \times 10^{-12}$  m/s (or  $5 \times 10^{-7}$  m/d) which are characteristic of very tight, low-permeability aquitards. Therefore, any potentiometric head increases in the thief zone (and deeper strata) as a result of reinjection will not propagate to impact the shallow water table aquifers that are accessed by existing groundwater users.



Whilst there are some faults mapped in the area (Figure 1-2) their ability to provide hydraulic connection between deeper strata and the shallow aquifer is currently unknown. The presence of a hydrostatic head gradient throughout most of the profile at Ramsay 2 (Water Tech, 2025) suggests there may be some degree of vertical connection, however the salinity profile (see next section) is more characteristic of a diffusion dominated system (at least in the vertical direction). The latter is an observation of the natural (i.e. unperturbed) hydrochemical conditions and does not discount the possibility of vertical advective flow under stressed (e.g. reinjection) conditions.

**Table 3-1 Permeability (k) and saturated hydraulic conductivity (K) of sidewall cores from Ramsay 1.**

Sample No.	Sample Depth (m)	Klinkenberg Permeability k (mD)	Hydraulic Conductivity K (m/s)
5	931.00	0.002	1.97E-11
9	857.77	5.73	5.66E-08
12	828.50	0.098	9.67E-10
18	727.50	0.159	1.57E-09
20	704.00	-	-
23	632.62	0.00053	5.23E-12
32	525.45	0.003	2.96E-11
40	402.00	0.00045	4.44E-12
42	374.61	0.00051	5.03E-12
47	310.84	0.00051	5.03E-12
48	291.00	0.00070	6.91E-12

## 4 NATIVE GROUNDWATER RESOURCE – WATER QUALITY

### 4.1 Salinity of source and receiving aquifers

Groundwater salinity was measured for eight different zones whilst testing Ramsay 2, demonstrating a strong gradient of increasing salinity with depth as presented in Table 4-1. Similar information is not available for Ramsay 1 as the well is open hole from 218 – 1005 m depth. However, it is expected that Ramsay 1 and the new wells to be drilled and tested in 2025/2026 will exhibit similar vertical trends in salinity as they will be drilled to similar depths in the same geological formations.

The salinity of reinjected water will depend on the depths that are being tested, and whether the test is zonal or comingled. Accordingly, the reinjected water will vary in salinity from 10,000 – 120,000 mg/L, which will always be higher than the receiving aquifer in the main thief zone in Ramsay 1 where it is circa 10,000 mg/L.

### 4.2 Groundwater chemistry and metal concentrations

Principle 1 for the drainage or discharging of water into a well (Table 2-1) notes that “*Additional authorisations may be required under the Environmental Protection Act 1993*”. Neither the Environmental Protection Act 1993 (EP Act) nor Environment Protection (Water Quality) Policy 2015 apply to this project due to the exemption under Section 7(4)(a) of the EP Act, however the following points should be considered.



Table 4-1 Groundwater salinity in Ramsay 2 well (Gold Hydrogen, 2024).

Zone	Perforation interval (m)	Salinity (mg/L)
Zone 8	194 - 200m	8,123
Zone 7	286 - 292m	9,386
Zone 6	343.5 – 349.5m	10,650
Zone 5	384 - 387m	12,455
Zone 4	529.5 – 532.5m	N/A
Zone 3	608 - 611m, 639.5 – 645.5m	97,470
Zone 2	710.5 – 713.5m, 748 - 754m	92,055
Zone 1	1002 - 1008m	126,350

The receiving water in Ramsay 1 – assuming a worst case scenario in which all reinjected water is lost to the thief zone at 316 m depth – would be deemed under the EP (WQ) Policy to have environmental value for ‘primary industries - livestock drinking water’ and ‘primary industries – aquaculture and human consumption of aquatic foods’. However, the salinity of the groundwater is near the upper limit of the range (3,000 – 13,000 mg/L TDS) ascribed for environmental value in the Policy. Sheep are the only livestock that could tolerate salinity of around 10,000 mg/L as TDS and this salinity would result in a decline in condition unless on lush green feed (ANZECC/ARMCANZ, 2000) . Therefore, the receiving groundwater has very limited value due to its significant depth and poor quality.

Water samples have been collected from Ramsay 1 and Ramsay 2 for water quality analysis over three separate campaigns:

- i. At the time of drilling – two Modular Formation Dynamics Tester (MDT) samples from one depth in Ramsay 1, and six MDT samples from three depths in Ramsay 2.
- ii. March-April 2024 testing phase – 12 samples from Ramsay 1 and 25 samples from Ramsay 2.
- iii. July-August 2024 testing phase – four samples from each of Ramsay 1 and Ramsay 2.

Fifteen of the Ramsay 2 samples from March-April 2024 are considered the most representative of formation waters across the site. Table 4-2 and Table 4-3 provide a comparison of the measured range in concentrations (i.e., minimum and maximum concentrations) of key analytes in these 15 samples against guideline and trigger values for freshwater quality according to ANZECC/ARMCANZ (2000)<sup>1</sup>. Bold numbers shown in Table 4-2 indicate the ambient groundwater in Ramsay 2 – and by inference across the exploration area of PEL687 – is not suitable for livestock as it exceeds trigger levels for boron, cadmium, copper, lead and molybdenum. The full suite of heavy metal and metalloid analytical data for each sample is tabulated in Appendix 1. This data shows no clear trend of increasing concentration with depth for any analyte (cf. the salinity trend evident in Table 4-1) and also that ambient groundwater at similar depth to the 316 mMD thief zone in Ramsay 1 exceeds the trigger values for molybdenum (see sample nos. 121, 130 and 151).

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<sup>1</sup> Note the ANZECC/ARMCANZ (2000) guidelines have recently been revised for livestock drinking water (see [Livestock Drinking Water Guidelines 2023](#)), however these values are currently only draft for public comment and the changes have no consequence to the outcomes of the assessment for this reinjection project.



The concentrations of many analytes are also at least one to two orders of magnitude higher than guideline values for aquaculture<sup>2</sup> (Table 4-3 and Appendix 1) thereby further demonstrating this groundwater has no reasonable environmental value. Even ambient groundwater at similar depth to the 316 mMD thief zone in Ramsay 1 exceeds the guideline values for iron, lead, magnesium, manganese, nickel, nitrate and phosphate (see sample nos. 121, 130 and 151).

The only chemicals proposed to be added to the source water prior to reinjection are a biocide and oxygen scavenger to prevent microbial growth and algal mats, which have the potential to cause clogging of the slotted casing and impede injection, thereby requiring increased wellhead pressures. Any biocide is expected to degrade naturally and be diluted through dispersion in the aquifer, thus presenting a very low risk to the groundwater resource and its intrinsic value characterised by very poor water quality.

**Table 4-2 Comparison of Ramsay 2 water quality (15 samples) against recommended trigger values (low risk) for heavy metals and metalloids in livestock drinking water (ANZECC/ARMCANZ, 2000)**

Metal or metalloid	Minimum Conc. (mg/L)	Maximum Conc. (mg/L)	Trigger value (mg/L)
Aluminium	<0.1	1	5
Arsenic	Not measured		0.5
Boron	2	7	5
Cadmium	<0.1	0.2	0.01
Chromium	<0.1	<0.1	1
Cobalt	Not measured		1
Copper	<0.1	7	0.4 (sheep) – 5 (poultry)
Fluoride	Not measured		2
Lead	<0.1	7	0.1
Mercury	Not measured		0.002
Molybdenum	<0.1	3	0.15
Nickel	<0.1	0.9	1
Selenium	Not measured		0.02
Uranium	Not measured		0.2
Zinc	<0.1	2	20

<sup>2</sup> Guideline values for aquaculture and human consumption of aquatic foods have not been revised since ANZECC/ARMCANZ (2000).



**Table 4-3 Comparison of Ramsay 2 water quality (15 samples spanning all depths) against guideline values for the protection of aquaculture species (ANZECC/ARMCANZ, 2000)**

Inorganic Analyte	Minimum Conc. (mg/L)	Maximum Conc. (mg/L)	Guideline value (mg/L)
Aluminium	<0.1	<b>1</b>	<0.03 (pH>6.5) <0.01 (pH<6.5)
Ammonia	Not measured		<0.02-0.03
Arsenic	Not measured		<0.05
Cadmium	<0.1	<b>0.2</b>	<0.002-0.0018
Chlorine	Not measured		<0.003
Chromium	<0.1	<0.1	<0.02
Copper	<0.1	<b>7</b>	<0.005
Cyanide	Not measured		<0.005
Fluoride	Not measured		<0.02
Hydrogen sulfide	Not measured		<0.001
Iron	0.2	<b>140</b>	<0.01
Lead	<0.1	<b>7</b>	<0.001-0.007
Magnesium	41	<b>2100</b>	<15
Manganese	0.1	<b>17</b>	<0.01
Mercury	Not measured		<0.001
Nickel	<0.1	<b>0.9</b>	<0.1
Nitrate	<0.1	19	<50
Nitrite	Not measured		<0.1
Phosphate	<0.2 as P	<b>130 as P</b>	<0.1
Selenium	Not measured		<0.01
Silver	Not measured		<0.003
Vanadium	<0.1	<b>0.3</b>	<0.1
Zinc	<0.1	<b>2</b>	<0.005

### 4.3 Radius of injection influence

The volume of reinjected water will result in a “bubble” of water (not air) that is restricted to a small area around Ramsay 1. Under a worst case scenario in which all reinjected water is lost to the single thief zone at 316 m depth, the maximum radius of water quality impact can be estimated by assuming a thickness of one metre and an average porosity of 9% (GHY, pers. comm.). Table 4-4 shows the maximum radius is between 600 – 1000 metres for 1 – 3 tests. For a nominal maximum reinjection volume of 300 ML the radius is 1030 m. Note that losses to other fractured and/or karstic zones within Ramsay 1 would result in multiple injectant ‘bubbles’ with even smaller radii determined by their relative transmissivity.



Table 4-4 Maximum radius of reinjected water in thief zone

No. well tests to reinject	Total Volume (ML)	Maximum radius of Impact (km)
1	95.4	0.6
2	190.8	0.8
3	286.2	1.0

#### 4.4 Migration of reinjected water post testing

The salinity of reinjected water derived from the exploration flow tests (10,000 – 120,000 mg/L) will often be much higher than the ambient salinity in the thief zone in Ramsay 1 (approx. 10,000 mg/L), resulting in a strong density contrast that will create potential for vertical convection (and downwards diffusion) of injectant salt loads to deeper strata.

The long-term fate of the reinjected groundwater is likely to be very slow horizontal migration via advection down hydraulic gradient, which is anticipated to be towards Gulf St Vincent consistent with topographic gradient and the hydraulic gradient in the shallow water table aquifer (Figure 5-1). However, the significant depth below sea level of the thief zone in Ramsay 1 (circa -200 mAHD) and the potential for injectant to be lost to greater depths, means this unlikely to ever reach the marine environment. The role of extensive sub-vertical faulting in the area (e.g., Figure 1-2) on creating barriers to lateral groundwater flow is currently unknown.

## 5 OVERALL RISK EVALUATION

Whilst the Environment Protection (Water Quality) Policy 2015 would deem the receiving water in Ramsay 1 to have environmental value, detailed examination of the water chemistry at different depths in Ramsay 2 has shown that it is highly unsuitable for both livestock drinking water and aquaculture and human consumption of aquatic foods. Therefore, it can be concluded the ambient groundwater in the aquifers/depths being tested and reinjected within PEL687 has no reasonable value.

The likelihood of the proposed reinjection impacting shallow aquifers (e.g. less than 100 m depth) is negligible in terms of both water level/pressure and water quality impacts. The consequence of such impacts would also be low as there is a very limited number of existing groundwater wells / users within several kilometres due to the generally poor ambient water quality.

Gulf St Vincent is located 12.5 km to the east but due to the very low horizontal hydraulic gradients (0.004 in the surficial aquifers) and the significant depth at which the majority of reinjected water is likely to reside in hydraulic isolation (200 m below sea level), the reinjected water would not reach the Gulf for tens to hundreds of thousands of years, if ever. Furthermore, if any groundwater discharge to the marine environment occurred over these extended time periods, it would be slow and diffuse thereby enabling rapid dilution and mixing through tidal currents.

The overall risk to shallow aquifers, groundwater wells / existing users, the value of groundwater resources or the marine environment is very low.

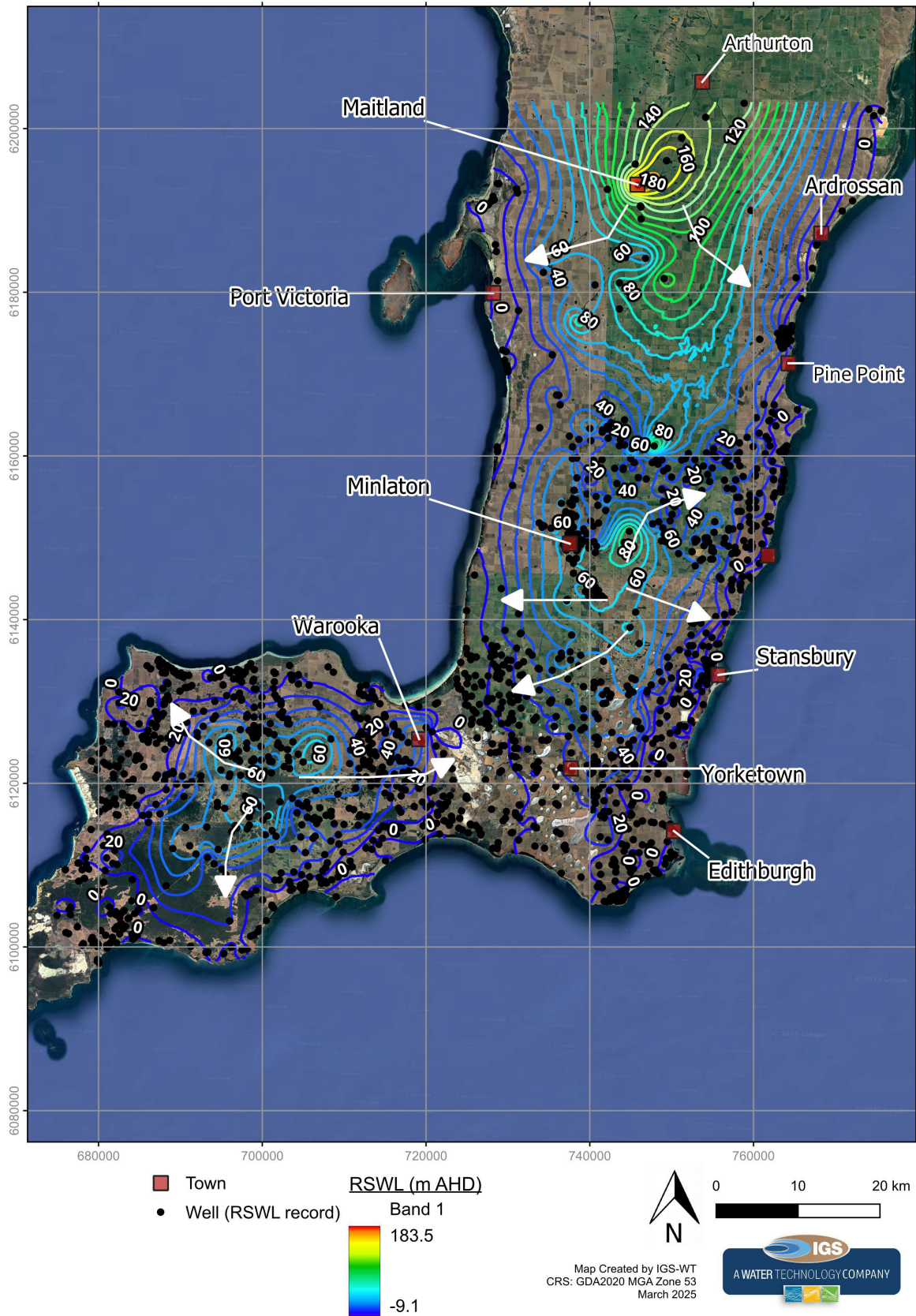


Figure 5-1 Potentiometric water table surface map (IGS, 2023)



## REFERENCES

- ANZECC/ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The Guidelines (Chapters 1-7). Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand. October 2000.
- Gold Hydrogen (2024). Ramsay 1 and 2 Well Testing and Fluid Sampling Analysis. RAM-SBS-REP-003.
- Innovative Groundwater Solutions Pty Ltd. (2023). Hydrogeology of Petroleum Exploration Licence 687 on Yorke Peninsula. A report prepared by IGS for JBS&G on behalf of Gold Hydrogen, 9 June 2023.
- Northern and Yorke Landscape Board (2020). Water-Affecting Activities Control Policy, Effective from 6<sup>th</sup> December 2020.
- Water Technology (2025). Hydrogeological knowledge at PEL 687, Yorke Peninsula SA. Technical memorandum prepared for Gold Hydrogen, 9 May 2025.

Appendix 1 (continued next page). Comparison of Ramsay 2 water quality (15 samples) against recommended trigger values (low risk) for heavy metals and metalloids in livestock drinking water (ANZECC/ARMCANZ, 2000).

Sample No.	6	21	22	23	25	32	42	49	54	71	98	121	130	151	170	Trigger Value (mg/L)
<b>Zone</b>	1	1	1	1	2,2a,3,3a	2,2a,3,3a	2,2a,3,3a	2,2a,3,3a	2,2a,3,3a	4	5	6	6	7	8	-
<b>Depth (m)</b>	1002 - 1008	1002 - 1008	1002 - 1008	1002 - 1008	754 712 642.50	754 712 642.50	754 712 642.50	754 712 642.50	754 712 642.50	529.5 - 532.5	384 - 387	343.5 - 349.5	343.5 - 349.5	286 - 292	194 - 200	
<b>Aluminium</b>	0.7	0.4	<0.1	0.8	0.8	0.1	<0.1	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5
<b>Boron</b>	5	4	5	5	4	3	7	4	6	3	4	2	2	4	3	5
<b>Cadmium</b>	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.01
<b>Chromium</b>	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1
<b>Copper</b>	6	<0.1	0.1	0.4	5	0.4	0.3	0.2	<0.1	7	0.5	<0.1	<0.1	<0.1	<0.1	0.4 (sheep) - 5 (poultry)
<b>Lead</b>	7	<0.1	<0.1	<0.1	5	0.3	2	<0.1	0.4	6	0.8	<0.1	<0.1	0.1	<0.1	0.1
<b>Molybdenum</b>	3	<0.1	<0.1	0.5	0.1	<0.1	0.1	<0.1	0.5	3	0.4	0.5	0.3	0.3	0.3	0.15
<b>Nickel</b>	0.9	0.6	0.4	<0.1	0.2	0.4	0.9	0.4	<0.1	0.1	0.5	<0.1	<0.1	0.4	0.1	1
<b>Zinc</b>	0.8	0.1	<0.1	0.6	2	0.6	0.7	<0.1	0.3	0.2	0.9	<0.1	<0.1	<0.1	<0.1	20



Appendix 1 (continued). Comparison of Ramsay 2 water quality (15 samples) against guideline values for the protection of aquaculture species (ANZECC/ARMCANZ, 2000).

Sample No.	6	21	22	23	25	32	42	49	54	71	98	121	130	151	170	Guideline value (mg/L)
Zone	1	1	1	1	2,2a,3,3a	2,2a,3,3a	2,2a,3,3a	2,2a,3,3a	2,2a,3,3a	4	5	6	6	7	8	-
Depth (m)	1002 - 1008	1002 - 1008	1002 - 1008	1002 - 1008	754 712 642.50	754 712 642.50	754 712 642.50	754 712 642.50	754 712 642.50	529.5 - 532.5	384 - 387	343.5 - 349.5	343.5 - 349.5	286 - 292	194 - 200	-
Aluminium	0.7	0.4	<0.1	0.8	0.8	0.1	<0.1	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.03 (pH>6.5) <0.01 (pH<6.5)
Cadmium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.002-0.0018
Chromium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.02
Copper	6	<0.1	0.1	0.4	5	0.4	0.3	0.2	<0.1	7	0.5	<0.1	<0.1	<0.1	<0.1	<0.005
Iron	11	0.2	0.2	<0.1	140	3	0.4	7	0.2	4	0.2	0.2	<0.1	2	1	<0.01
Lead	7	<0.1	<0.1	<0.1	5	0.3	2	<0.1	0.4	6	0.8	<0.1	<0.1	0.1	<0.1	<0.001-0.007
Magnesium	1300	1200	1200	1200	1500	1400	1900	1900	2100	41	430	130	190	350	260	<15
Manganese	17	4	4	4	4	0.9	1	0.9	1	0.9	0.4	0.1	0.2	0.7	0.3	<0.01
Nickel	0.9	0.6	0.4	<0.1	0.2	0.4	0.9	0.4	<0.1	0.1	0.5	<0.1	<0.1	0.4	0.1	<0.1
Nitrate	4	1	<0.1	0.5	19	16	5	8	<0.1	3	2	18	19	<0.1	<0.1	<50
Phosphate	78	40	15	46	<0.2	27	<0.2	130	5	0.7	<0.2	19	13	3	7	<0.1
Vanadium	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	0.8	0.1	<0.1	0.6	2	0.6	0.7	<0.1	0.3	0.2	0.9	<0.1	<0.1	<0.1	<0.1	<0.005



## Appendix B: Summary of issues raised - Gold Hydrogen consultation

Comments on the draft EIR and SEO were received from Aboriginal Affairs and Reconciliation, Department for Environment and Water, Department for Housing and Urban Development, Department of Primary Industries and Regions South Australia, Northern and Yorke Landscape Board and are addressed below.

Comments received from landowners have been addressed in Section 7 Stakeholder Engagement (Table 7-4).

**Table B-1: Summary of stakeholder comments and Gold Hydrogen Responses**

Submitter	EIR / SEO Reference	Comment / issue raised	Response
<b>EIR</b>			
<b>Aboriginal Affairs and Reconciliation</b>	EIR Summary –p.vii and Section 4 Overview of the Environment p. 24	<p><i>‘Searches of the central archives for the Ramsay well locations have not identified any registered Aboriginal heritage sites in close proximity to the well locations.’</i></p> <p>AAR suggests the EIR acknowledges that AAR’s central archives are not an exhaustive record of all Aboriginal sites, objects and remains (together, heritage) in the state.</p>	<p>Footnote text added at p.24: <i>“It is noted that the central archives are not an exhaustive record of all Aboriginal sites, objects and remains in the State”.</i></p> <p>Text on p.vii has not been updated as this level of detail is not required in the EIR Executive Summary.</p>
	Section 2.2.5. Aboriginal Heritage Act p. 11	<p><i>‘Authorisation is required for any damage, disturbance or interference to Aboriginal sites, objects or remains. Penalties apply for failure to comply.’</i></p> <p>Rather than authorisations being required for any damage etc., section 23 of the <i>Aboriginal Heritage Act 1988 (SA) (AH Act)</i> prohibits any damage, disturbance, or interference with Aboriginal heritage without authorisation from the Minister for Aboriginal Affairs. The awareness of notification of discoveries under section 20 of the AH Act described in the SEO and EIR is acknowledged.</p> <p>Please note changes to the AH Act came into effect 1 January 2025 including increased penalties under section 20 of the AH Act – see AAR’s website here for further details</p>	<p>Identified text in Section 2.2.5 on p.11 has been updated to read: <i>“It is an offence to damage, disturb or interfere with Aboriginal sites, objects or remains unless prior written authorisation has been obtained from the Minister for Aboriginal Affairs under the relevant section of the Act.”</i></p>
	EIR Summary – p.vii and Section 5.6.4. Assessment of impacts p. 56	<p><i>‘Control measures would be implemented, including consultation with the Narungga Nation Aboriginal Corporation, cultural heritage survey where required, avoidance of any identified sites or areas of cultural heritage significance and accidental discovery protocols.’</i></p>	<p>Text on pp. viii and 56 updated to read:</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
		<p>Please incorporate the Aboriginal Heritage Discovery Protocols attached, to be used when no authorisations are in place, in the proposed control measures.</p>	<p>“.....areas of cultural heritage significance <i>and Aboriginal heritage discovery protocols where no authorisations are in place.</i>”</p> <p>Control measures Table 5-19 (see response below) set out the steps to be taken if Aboriginal sites, objects and remains are discovered during activities. These steps are consistent with the Aboriginal Heritage Discovery Protocols, March 2025.</p>
	<p>Table 5-19: Environmental impact and significance assessment – Impact ID HER01 p.57</p>	<p><i>‘If Aboriginal sites, objects and remains are discovered during activities: - works halt in the vicinity of the discovery - advice sought from the Narungga Nation Aboriginal Corporation, a qualified heritage consultant or AAR - mitigation measures implemented to ensure the discovery is avoided. (If the works cannot be relocated to avoid the Aboriginal site, object or remains, authorisation would be obtained under the Aboriginal Heritage Act)’.</i></p> <p>Consider rewording the statement above to be in keeping with the attached Discovery Protocols, that is after stopping works in the vicinity notify AAR and seek advice from the Narungga Nation Aboriginal Corporation and depending on the extent of the discovery a qualified heritage consultant.</p>	<p>Text in Table 5-19 p.57 updated to read:</p> <p><i>‘If Aboriginal sites, objects and remains are discovered during activities:</i></p> <ul style="list-style-type: none"> <li>• <i>works halt immediately in the vicinity of the discovery</i></li> <li>• <i>AAR and Narungga Nation Aboriginal Corporation notified of the discovery</i></li> <li>• <i>advice sought from the Narungga Nation Aboriginal Corporation and, depending on the extent of the discovery, a qualified heritage consultant’’</i></li> </ul>
	<p>EIR Table 5-19: Environmental impact and significance assessment – Impact ID HER01 pg59</p>	<p><i>‘...however disturbance may occur during exceptional circumstances, e.g. site discovery during construction.’</i></p> <p>AAR is concerned that this item contemplates disturbance to Aboriginal heritage without Ministerial authorisation. AAR strongly recommends rewording this statement to ‘...however unknown Aboriginal heritage may still be encountered during construction works. Engaging heritage monitors or carrying out a heritage survey prior to construction may assist in mitigating the risk of project activities encountered unknown Aboriginal heritage. No damage, disturbance, or interference with Aboriginal heritage (that is, sites, objects or remains) is legally permitted without a valid Ministerial authorisation under sections 21 and 23 of the Aboriginal Heritage Act 1988 (SA). Significant penalties apply for unauthorised breaches of the Aboriginal Heritage Act 1988 (SA). Where Aboriginal heritage is discovered, it cannot be legally removed by either the proponent or by</p>	<p>This section of the impact assessment table addresses the level to which a potential impact can be avoided through prevention. As such detail of requirements of the Aboriginal Heritage Act are not required here.</p> <p>Text amended as follows:</p> <p><i>“.....however unknown Aboriginal heritage may be encountered during exceptional circumstances, e.g. site discovery during construction”.</i></p> <p>Gold Hydrogen will develop procedures consistent with the relevant obligations under the Aboriginal Heritage Act to appropriately report and respond to any sites discovered during activities.</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
		<p>Traditional Owners. It must be reported to the Minister for Aboriginal Affairs, via Aboriginal Affairs and Reconciliation, as soon as reasonably practicable. Following discovery, the discovery must be retained in place and protected”</p>	
<p><b>Department for Environment and Water</b> <b>(Water Science and Monitoring)</b></p>	<p>EIR Summary Section 3.3.2 p.21 Section 5.2.2 p.35 Section 5.2.2 p.36 App A p.7 Section 5.2.4 p.38</p>	<p><i>Reinjected groundwater is expected to preferentially flow into a high hydraulic conductivity zone that is present at approximately 316 m depth.</i></p> <p><i>...and particularly from the high hydraulic conductivity zone at 316 m where reinjected groundwater is expected to preferentially flow).</i></p> <p><i>The low permeability throughout the profile also means that any potentiometric head increases from reinjection will not impact the shallow water table aquifers.</i></p> <p><i>It is expected that injected groundwater will preferentially flow into a high hydraulic conductivity zone that is present in the Parara Limestone at approximately 316 m depth, as this zone will have the least resistance to flow and higher capacity to accept groundwater.</i></p> <p><i>This is referred to as the ‘high hydraulic conductivity zone’ throughout this document and as noted in Section 3.3.2, it is expected that reinjection will result in preferential flow into this zone.</i></p> <p><i>Whilst there are some faults mapped in the area their ability to provide hydraulic connection between deeper strata and shallow aquifers is currently unknown.</i></p> <p><i>The vertical distance and the low permeability of the intervening formations means that all groundwater users have significant vertical disconnection from the formations in contact with reinjected groundwater (and particularly from the high hydraulic conductivity zone at 316 m where reinjected groundwater is expected to preferentially flow).</i></p> <p>DEW implies from information provided that the groundwater bearing unit in question could be either described as dual porosity or dominated by secondary porosity and permeability and consequently the equivalent of a Fractured Rock Aquifer. Fractured Rock Aquifers may be characterised with high hydraulic conductivity associated with the fractures, low storage and asymmetric preferential flow.</p>	<p>The hydrological risk assessment report has been updated to address conceptual hydrogeology and strike and dip orientations (refer Appendix A p.1 Introduction).</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
		<p>The description of the fate of reinjected waters with respect to the hydrogeological conceptualisation could be clarified; whilst reinjected water is anticipated to flow into high K zones at 316m depth, is there any information concerning the strike and dip orientations of this “high hydraulic conductivity zone” beyond its occurrence at 316m depth in Ramsay 1? Does this zone conform with bedding or an understood fault orientation? Does this zone have the potential to become shallower at distance from Ramsay 1? Further, is migratory fate after migration into the high conductivity zone expected to conform to a more low-permeability-porous media conceptualisation, with slow migration and radial flow away from the fracture zone?</p> <p>DEW notes and agrees with the proponent’s acknowledgement that the potential for faulting to provide hydraulic connectivity between shallow and deeper parts of the strata remains a key unknown.</p>	
	<p>Section 5.2.3 p.39 App A p.9 Section 3.3.5 p.22 Table 5-10 p.42</p>	<p><i>Any biocide in the reinjected groundwater is expected to degrade naturally and be diluted through dispersion in the aquifer, thus presenting a very low risk to the groundwater resource and its intrinsic value (which is characterised by poor water quality).</i></p> <p><i>Groundwater will be treated with biocide and oxygen scavengers when pumped from the well being tested and prior to re-injection.</i></p> <p>Could the proponent please provide more specific information regarding additives once formalised, including MDMA sheets and degradations rates so the residual risk may be better understood?</p>	<p>A specific chemical injection program for groundwater treatment will be developed based on well test data and water samples. This will include details of the additives and dosing based on water analysis results. Gold Hydrogen will consult with subsurface water experts to ensure appropriate chemical additives are used, and dosing procedures are established in accordance with common industry practice.</p> <p>Gold Hydrogen will provide more specific information to DEM as part of the reinjection Activity Notification process and the application for the Water Affecting Activities permit.</p>
	<p>Section 3.3.3 p.21</p>	<p><i>In well tests where multiple zones are being tested simultaneously, groundwater pumped to the surface would be mixed across all zones (e.g. limestone, dolomite and granite) and expected to be in the order of 40,000 to 60,000 mg/L. Salinities could be lower if shallower zones are tested in isolation, and higher if deeper zones are tested in isolation.</i></p> <p>Is this potential to “shandy” re-injected groundwater from different strata depths so it more closely matches groundwater at the target depth a potential control measure that requires discussion in Section 5 and Table 5.10?</p>	<p>As a consequence of the proposed well test program, co-mingled groundwater from well testing may coincidentally provide reinjected groundwater salinity that more closely matches baseline groundwater at the high permeability zone at 316m in Ramsay 1. However as this is not a controlled process (i.e. mixing of groundwater from multiple zones), Gold Hydrogen considers that it could not be regarded as a control measure to meet groundwater quality objectives.</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
	Section 5.2.2 p.36	<p><i>The presence of a hydrostatic head gradient throughout most of the profile at Ramsay-2 suggests there may be some degree of connection, however the salinity profile is more characteristic of a diffusion dominated system (at least in the vertical direction).</i></p> <p>Hydrogeological systems may appear diffusion dominated even if advection is possible if groundwater flow velocities are sufficiently slow and if the system is not artificially stressed.</p> <p>Is this observation of diffusion dominance meant to discount the possibility of advective flow or is more a comment on the nature of the hydraulic system as encountered? Please clarify.</p>	<p>The hydrological risk assessment has been updated to clarify the possibility of advective flow (refer Appendix A p.7, para 1).</p> <p>The EIR has been updated at p.36 as follows:</p> <p><i>“The latter is an observation of the natural (i.e. unperturbed) hydrochemical conditions and does not discount the possibility of vertical advective flow under stressed (e.g. reinjection) conditions.”</i></p>
	Footnote 10 p.38 App A Section 4.4 p.11	<p><i>The long-term fate of the reinjected groundwater is likely to be very slow lateral migration via advection down hydraulic gradient, which is anticipated to be towards Gulf St Vincent consistent with topographic gradient and the hydraulic gradient in the shallow water table aquifer.</i></p> <p>There is no potentiometric surface map presented in the EIR that provides evidence for this potential fate. Please provide one.</p>	<p>A new map has been inserted in Appendix A as Figure 5-1 at p.12.</p> <p>The EIR has been updated at footnote 10 at p.38 referencing new map in App A.</p>
	Table 5-9 p. 41	<p><i>Groundwater monitoring program implemented including landholder bores (subject to landholder permission) and two new groundwater monitoring bores. Monitoring program design considers EPA Guideline 3 - Establishing baseline groundwater quality and adopts elements where appropriate.</i></p> <p>Are “make good” arrangements planned if groundwater quality impacts occur and are conclusively found to be a result of re-injection activities?</p>	<p>The hydrogeological risk assessment (Appendix A) concludes that the likelihood of the proposed reinjection impacting shallow aquifers (e.g. less than 100 m depth) is negligible and the consequence of such impacts would also be low. The key reasons are:</p> <ul style="list-style-type: none"> <li>• Very few existing groundwater wells in the vicinity of Ramsay-1, and all operational wells are significantly less than 100 m depth.</li> <li>• Vertical distance and low permeability of intervening formations means all groundwater users have significant vertical disconnection from formations in contact with reinjected groundwater</li> <li>• Low permeability throughout the profile means that any potentiometric head increases from reinjection will not impact the shallow water table aquifers.</li> </ul> <p>If significant groundwater quality impacts were conclusively established to have been caused by reinjection activities, Gold</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
			Hydrogen would engage with DEM, DEW, affected landowners and other relevant stakeholders to determine the nature of any response.
	Table 5-9	DEW recommend the proponent reference and implement recommendations from the <i>SA EPA Guideline 3 – Establishing baseline groundwater quality</i> to ensure proper water quality and hydrochemical baseline is established prior to the trial, as practicably as possible, to ensure material groundwater quality impacts, if they occur, can be conclusively identified from “false positives”.	As noted in the control measures in Table5-9, the monitoring program design will consider <i>EPA Guideline 3 - Establishing baseline groundwater quality</i> and adopt elements where appropriate.
	App A p.8	<p><i>Bold numbers shown in Table 4-2 indicate the ambient groundwater in Ramsay 2 – and by inference across the exploration area of PEL687 – is not suitable for livestock as it exceeds trigger levels for boron, cadmium, copper, lead and molybdenum.</i></p> <p>Can the proponent please detail any Quality Assurance or Quality Control (QA/QC) that has been undertaken on these results to ensure they are representative of formation waters prior to assessment?</p> <p>DEW notes that results for the analytes Cu, Pb, Zn, Fe, and Nitrate presented in Appendix 1 are all notably higher in the first result presented for Zones 1 and 2,2a,3, 3a than any of the proceeding results. For Al and Mo, this is observed for Zone 1 specifically. In some cases, this first result is an order of magnitude higher than any of the proceeding results. Assuming the order of results indicates unique sampling events undertaken sequentially, this interpretation would imply that the first sampling event for Zones 1, 2 and 3 may have been anomalous, either via an issue with well development, other sampling protocol or through laboratory analysis. This would consequently alter the water-utility interpretation if such results were found to be anomalous and / or in error.</p> <p>Finally, please build appropriate QA/QC protocols into sampling and groundwater monitoring procedure to ensure that subsequent results are adequately reliable for risk assessment purposes.</p>	<p>Gold Hydrogen understands that data integrity and adherence to standards is important for confidence in sampling results for both the company and regulators.</p> <p>Gold Hydrogen acknowledges the anomalies in the samples collected initially from the Ramsay-2 well bore, and is reviewing relevant procedures as part of the development of the ongoing program of sampling, monitoring and other collection of groundwater data proposed for the reinjection program. If any shortcomings in previous sampling are identified, these will be addressed and Gold Hydrogen will ensure that future sampling is undertaken in accordance with industry standard QA/QC protocols by suitability qualified professionals.</p>
		The subject site is located within the Rural Zone of the Planning & Design Code, which envisages a range of primary production, forestry, and renewable energy generation to support the economic prosperity	Noted.



Submitter	EIR / SEO Reference	Comment / issue raised	Response
<b>Department for Housing and Urban Development</b> <b>(Crown and Impact Assessment Team)</b>		of the South Australia. Development should support, protect and maintain the productive value of rural land.	<p>Gold Hydrogen acknowledges the importance of protecting the productive value of rural land.</p> <p>Landowners will be consulted regarding the location, management and timing of proposed activities and there will be ongoing landowner liaison during and following operations. Rehabilitation of disturbed areas will be as approved by the landowner or in accordance with landowner’s wishes. If requested by landowners and where practicable, Gold Hydrogen will design or undertake exploration activity in a manner that could be of benefit to be the agricultural use of the property.</p>
	Section 5.8	The EIR states that land use impacts are expected to be localised and temporary, with access arrangements and the final route of temporary pipelines to be determined in consultation with landowners. The EIR further states that decommissioning and rehabilitation will occur, including removal of temporary pipelines, to return the land to its original drainage and cropping / grazing potential. On this basis, the proposal is acceptable from a land use perspective	Noted.
<b>Department of Primary Industries and Regions South Australia</b>		No additional comments, but note as you have outlined, the Yorke Peninsula contains some of the state’s prime Agricultural land and is also a place with a strong tourism industry that would need to be considered in any exploration efforts.	Noted.
<b>Northern and Yorke Landscape Board</b>		<p><u>Groundwater reinjection considerations</u></p> <p>Please ensure alignment with the Water Affecting Activity Control Policy and related requirements of the <i>Landscape SA Act 2019</i>.</p> <p><i>Northern and Yorke Landscape Board Water-Affecting Activities Control Policy, 2020</i></p> <p><u>Water-affecting activity permit policies for zone NY1</u></p> <p>2.2.3 Drainage or discharging water into a well—section 104(3)(c)</p> <p>A permit is required for the draining or discharging of water directly or indirectly into a well pursuant to Section 104(3)(c) of the Act. Additional authorisations may be required under the <i>Environmental Protection Act 1993</i>.</p>	<p>Gold Hydrogen will not undertake ‘water affecting activities’ (as defined by the <i>Landscape SA Act 2019</i> and the Northern and Yorke Landscape Board Water Affecting Activities Control Policy 2020) unless relevant permits have been obtained.</p> <p>Reinjection will be undertaken in accordance with any water affecting activity permit conditions.</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
		<p>The following principles shall be considered by the Minister when determining whether to grant or refuse a permit for an activity under sections 104(3)(c) of the Act.</p> <p>1. A permit is required for the draining or discharging of water directly or indirectly into a well, pursuant to Section 104(3)(c) of the Act. Additional authorisations may be required under the <i>Environmental Protection Act 1993</i>.</p> <p>2. A permit to drain or discharge water into a well will not be issued unless a risk assessment is undertaken to the satisfaction of the Minister. This risk assessment must be consistent with the National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health &amp; Environmental Risks, Phase 1 2006 and other related documents current at the time, and include:</p> <p>a. An investigation into the suitability of the draining or discharging site, including but not limited to tests for transmissivity, maximum injection pressures and calculated likely impacts on the integrity of the well and confining layers, and impacts of potentiometric head changes to other underground water users.</p> <p>b. An appropriate operation or management plan demonstrating that operational procedures and monitoring regime are in place to protect the integrity of the aquifer, minimise the wastage of water and protect the discharge site on an ongoing basis.</p> <p>c. A water quality assessment which identifies hazards in the source water.</p> <p>d. A report on the consequences and impacts to the native underground water resource where the water quality characteristics (salinity and chemistry composition) of the water to be discharge differs to that of the native underground water</p> <p>3. The water quality assessment required in 2(c) above will include assessments of (but not limited to):</p> <p>a. pH, total dissolved solvents, turbidity, ammonia, nitrate, nitrite, total phosphorus, sodium, chloride, sulphate, calcium, magnesium,</p>	



Submitter	EIR / SEO Reference	Comment / issue raised	Response
		<p>bicarbonate, iron, total arsenic, total boron, total cadmium, total chromium, total lead, total manganese, total zinc; and</p> <p>b. Pesticides, volatile organic compounds and petroleum hydrocarbons; and</p> <p>c. Trihalomethanes where the water to be drained or discharged has been treated by chlorination.</p> <p>6. Further to principle 2(b), continuation of draining and discharge is dependent on an annual report that addresses the impacts to the native underground water at the draining or discharge site.</p> <p>7. For the purposes of principles 1 and 2, the relevant concentrations, levels or amounts shall be measured in sufficient representative samples of:</p> <p>a. the water to be drained or discharged; and</p> <p>b. native underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection; where “sufficient representative samples” means suitable samples, collected with equipment appropriate for the substance, material or characteristic to be measured and taken at suitable locations and times to accurately represent the quality of the relevant water.</p> <p>8. For the purposes of this WAA Control Policy, the term “native underground water” means water occurring naturally below ground level that exists in the relevant aquifer absent of any such water drained or discharged to that aquifer by artificial means.</p> <p>9. The draining or discharging of water directly or indirectly into a well must not detrimentally affect the ability of other persons to lawfully take from that underground water, or degrade ecosystems dependent on the underground water.</p>	
<b>SEO</b>			
<b>Department for Environment and Water</b>	Table 3-1 p.13	<i>Identification of cross flows between aquifers in natural hydraulic isolation, or uncontrolled flows to the surface.</i>	This table sets out immediately reportable and reportable incident definitions as required by the <i>Energy Resources Act 2000</i> .



Submitter	EIR / SEO Reference	Comment / issue raised	Response
<b>(Water Science and Monitoring)</b>		For the purposes of this SEO, can these aquifers be explicitly identified please?	The incidents identified are by necessity high-level and general to ensure that they can be applied in a range of locations and activities. Aquifer information relevant to a reported incident would be provided to DEM as part of the reporting requirements.
<b>Department for Housing and Urban Development (Crown and Impact Assessment Team)</b>		Noting that reinjection activities are proposed to occur continuously (24-hour basis) during the well testing period, noise impacts to sensitive receivers may require consideration as part of Objective 7 (minimise disturbance to landowners and land use).	<p>Noise from Gold Hydrogen well testing activities is addressed in the Natural Hydrogen Exploration Drilling and Well Testing EIR and SEO (Gold Hydrogen 2023a and 2023b).</p> <p>Measures identified in the Drilling and Well testing SEO (Objective 1 Minimise disturbance to land use and the local community) include:</p> <ul style="list-style-type: none"> <li>• Assessments of potential noise impacts undertaken as appropriate during design and planning stages.</li> <li>• Noise limitation (particularly at night) to be included as part of induction procedures.</li> <li>• Locations where energy sources are used (near the well) are not in close proximity to residences or other built infrastructure.</li> <li>• Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate.</li> </ul>
<b>Northern and Yorke Landscape Board</b>		<p><u>Declared Pest Plant Considerations</u></p> <p>The Board is supportive of Objective 8 of the Environmental Objectives, namely ‘No introduction or spread of weeds, pest animals and pathogens as a consequence of regulated activities’, but note that this objective does not cover an increase in the density of pest plants as a result of soil disturbance.</p> <p>We note that four high priority declared weed species have been mapped as occurring or likely to occur in the Ramsey area, these being African Boxthorn (<i>Lycium ferocium</i>), Boneseed (<i>Osteospermum moniliferum</i>), Bridal Creeper (<i>Asparagus asparagoides</i>) and Silver-leaf Nightshade (<i>Solanum elaeagnifolium</i>). Landholders and managers are obligated to control these pest plants where present on their property under section 192 (2) of the <i>Landscape South Australia Act (2019)</i>.</p>	<p>Noted.</p> <p>Gold Hydrogen understands its responsibilities under the <i>Landscape South Australia Act 2019</i> and to the landowners upon whose land activities are proposed and surrounding properties.</p> <p>While minor earthworks (shallow trenching) for installation of the pipeline may be required, movement of plant material or soil contaminated with plant material is not proposed as part of the well reinjection activities.</p> <p>Gold Hydrogen considers that the potential for an increase in density of pest plants as a result of soil disturbance is covered by the proposed control measures to address introduction and spread of weeds (EIR Table 5-24).</p>



Submitter	EIR / SEO Reference	Comment / issue raised	Response
		<p>Where earthworks or soil movement are conducted in the presence of declared pest plant species there is a risk that soil disturbance will promote the germination and growth of these species. A weed management plan is recommended to prevent pest plants spreading to surrounding properties, as well as meet your obligations under the Landscape Act (2019) section 192 (1, 2). Proper plant, soil and debris management will also need to be undertaken to ensure adequate hygiene practices to prevent the spread of seed or plant materials away from the site and compliance with Section 186 (2) of the Landscape Act (2019).</p> <p>Should any plant material or soil contaminated with plant material (including seed) require movement via public roads during the project, then a permit to transport is required under section 186 (2) of the Landscape Act (2019). If this activity is identified as necessary, then Northern and Yorke Landscape Board should be consulted for said permit as soon as practicable.</p>	<p>These measures include:</p> <ul style="list-style-type: none"><li>• Appropriate consultation regarding weeds or pathogens carried out with landowners (and Landscape Board officers where appropriate).</li><li>• Sites and access tracks will be monitored on a regular basis for new weed species / infestations and treated as necessary in accordance with requirements of the landowner, and if appropriate the Landscape Board.</li><li>• Records of detection, monitoring or eradication of weeds or pathogens introduced by activities are kept and available for review.</li></ul>



## Appendix C: Summary of issues raised - formal Energy Resources Act Consultation

*[To be completed following consultation under the Energy Resources Act by DEM. Table will address comments on the EIR and SEO provided to DEM and how they have been addressed by Gold Hydrogen.]*

**Table C-1: Summary of comments and Gold Hydrogen Responses**

Submitter	EIR / SEO Reference	Comment / issue raised	Response
EIR			
SEO			